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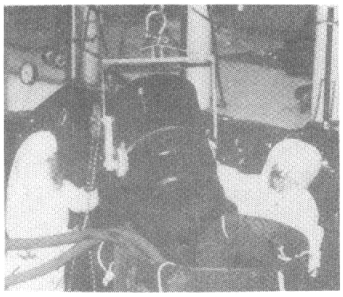

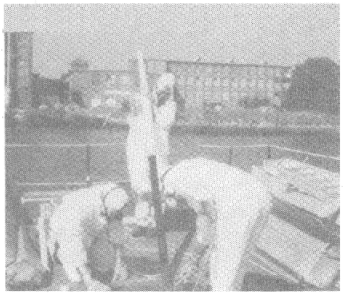

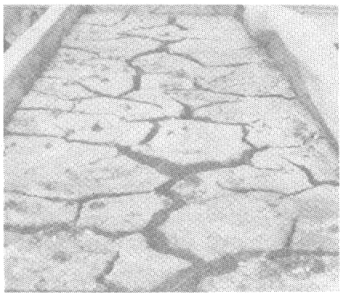

TECHNICAL REPORT EL-88-15

NEW BEDFORD HARBOR SUPERFUND PROJECT, ACUSHNET RIVER ESTUARY ENGINEERING FEASIBILITY STUDY OF DREDGING AND DREDGED MATERIAL DISPOSAL ALTERNATIVES

Report 1

STUDY OVERVIEW

by

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Sediments in the New Bedford Harbor and Acushnet River Estuary have been contaminated with polychlorinated biphenyl compounds and heavy metals. The high levels of contamination have resulted in the New Bedford Harbor being placed on the National Priorities List of the Nation's worst hazardous waste sites. Efforts are under way to develop and implement remedial actions for protection of the environment under the Federal Superfund Program.

Since most remedial alternatives involve dredging the contaminated sediments, the US Environmental Protection Agency (USEPA) employed the US Army Corps of Engineers (USACE), the Nation's dredging expert, to perform an "Engineering Feasibility Study (EFS) of Dredging and Dredged Material Disposal Alternatives." Offices of the USACE

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participating in the EFS were the Waterways Experiment Station, the New England Division, the Omaha District, and the Dredging Division.

This report is an introduction to and an overview of a series of reports describing the results of the EFS. It presents the overall study objectives and scope of work, describes the objectives and scope of the 10 EFS tasks, and presents a brief synopsis of the other 11 reports in the series. The appendix to the report discusses technical issues related to dredging and dredged material disposal and how they are addressed by the EFS versus the additional information that can be obtained by conducting a Pilot Study at the Superfund site.

The EFS technical approach used field data collection activities, literature reviews, laboratory (bench-scale) studies, and analytical and numerical modeling techniques to assess engineering feasibility and develop conceptual alternatives for dredging and dredged material disposal. Technical and engineering issues addressed by the EFS included baseline mapping, geotechnical investigations, hydrodynamics, sediment resuspension and transport, contaminant releases to surface and ground water, dredged material settling properties, dredging equipment and controls, effluent treatment, solidification/stabilization of dredged material, confined disposal facility design, contained aquatic disposal facility design, and cost estimates for the alternatives evaluated. Dredged material treatment or detoxification, other than solidification/stabilization, is not considered by this EFS but is being addressed by USEPA contractors.

PREFACE

This study was conducted as a part of the Acushnet River Estuary Engineering Feasibility Study (EFS) of Dredging and Dredged Material Disposal Alternatives. The US Army Corps of Engineers (USACE) performed the EFS for the US Environmental Protection Agency (USEPA), Region 1, as a component of the comprehensive USEPA Feasibility Study for the New Bedford Harbor Superfund Site, New Bedford, MA. This report, Report 1 of a series, was prepared by the US Army Engineer Waterways Experiment Station (WES) in cooperation with the New England Division (NED), USACE. Coordination and management support was provided by the Omaha District, USACE, and dredging program coordination was provided by the Dredging Division, USACE. The study was conducted between August 1985 and March 1988.

Project manager for the USEPA was Mr. Frank Ciavattieri. The NED project managers were Messrs. Mark J. Otis and Alan Randall. Omaha District project managers were Messrs. Kevin Mayberry and William Bonneau. Project managers for the WES were Messrs. Norman R. Francingues, Jr., and Daniel E. Averett.

This report was prepared by Messrs. Francingues and Averett, Water Supply and Waste Treatment Group, Environmental Engineering Division (EED), Environmental Laboratory (EL), WES, and Mr. Otis, New Bedford Harbor Superfund Project Office, Operations Division, NED. The report was edited by Ms. Jessica S. Ruff of the WES Information Technology Laboratory.

The study was conducted under the general supervision of Dr. Raymond L. Montgomery, Chief, EED, and Dr. John Harrison, Chief, EL; Mr. Vyto Andreliunas, NED; and Mr. David Mathis, Dredging Division, USACE.

Colonel Dwayne G. Lee, FN, was the Commander and Director of WES. Dr. Robert W. Whalin was Technical Director.

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NEW BEDFORD HARBOR SUPERFUND PROJECT, ACUSHNET RIVER ESTUARY ENGINEERING FEASIBILITY STUDY OF DREDGING AND DREDGED MATERIAL DISPOSAL ALTERNATIVES

STUDY OVERVIEW

PART I: INTRODUCTION

1. Industrial and municipal waste releases into the Acushnet River Estuary and harbor areas adjacent to New Bedford, MA (Figure 1), contaminated the bottom sediments with organic chemicals, principally chlorinated hydrocarbons, and with heavy metals. Polychlorinated biphenyl (PCB) concentrations in the percent levels have been detected in sediments in the upper estuary region of New Bedford Harbor (US Environmental Protection Agency (USEPA) 1983, Weaver 1982). Studies conducted by the State of Massachusetts and the USEPA during the 1970s and early 1980s led to the Harbor being proposed in 1982 to the National Priorities List of the Nation's worst hazardous waste sites. Thus, the New Bedford Harbor site was designated a Federal Superfund site and became eligible for Federal cleanup funds.

2. The USEPA began work on a Superfund Feasibility Study (FS) to develop remedial action alternatives for the highly contaminated sediments in the upper estuary above the Coggeshall Street Bridge. The FS was completed in 1984 (NUS Corporation 1984); however, comments received by the USEPA on the proposed alternatives raised a number of concerns about their engineering complexity and potential for increased environmental impact. The USEPA responded to these concerns in 1985 by enlisting the assistance of the US Army Corps of Engineers (USACE) to evaluate the engineering feasibility of alternatives involving the dredging and disposal of the highly contaminated sediments in the upper estuary. The series of reports described herein documents the results of the USACE Engineering Feasibility Study (EFS) for the New Bedford Harbor Superfund Project.

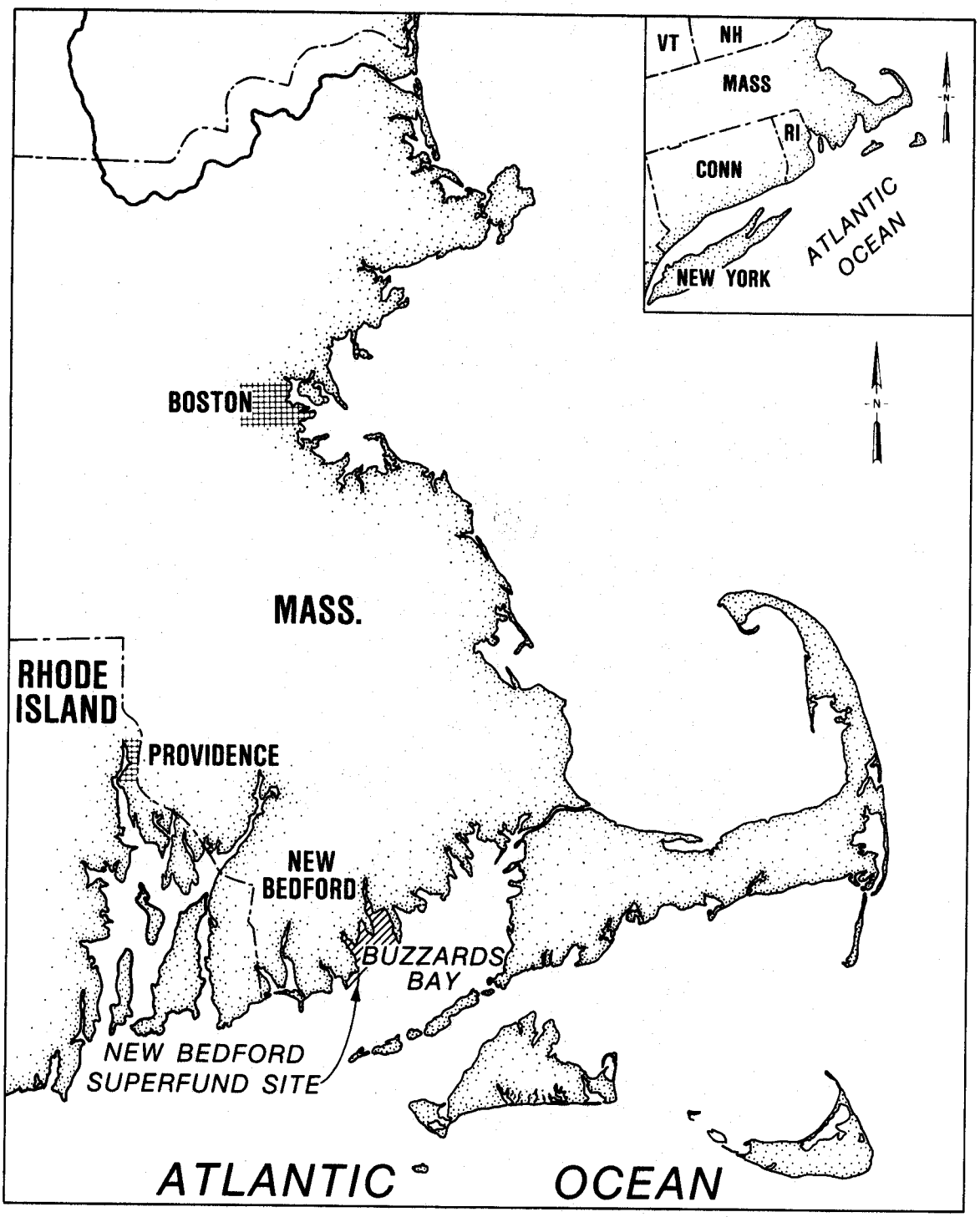

Figure 1. Location of New Bedford, MA

Background

Site description

3. New Bedford Harbor is located between the city of New Bedford on the west and the towns of Fairhaven and Acushnet on the east at the head of Buzzards Bay, Massachusetts (Figure 2). The most northern portion of the Superfund site, referred to as the Acushnet River Estuary, extends from the Coggeshall Street Bridge north to Wood Street in Acushnet (Figure 2). The remainder of the site, called the lower New Bedford Harbor and upper Buzzards Bay area, extends south from the Coggeshall Street Bridge through the New Bedford Hurricane Barrier and into Buzzards Bay. The estuary hot spot is a small area (3 acres, or 1.2 ha) within the estuary where sediment PCB concentrations are the greatest (>10,000 ppm PCB). Geographic boundaries include the shoreline, wetlands, and surrounding upland areas.

4. The PCB contamination in New Bedford was reported initially by academic researchers and the Federal Government between the years 1974 and 1976. Subsequent surveying of the New Bedford area has provided a better understanding of the extent of contamination in the estuary (Figure 3). The entire area north of the Hurricane Barrier, an area of 985 acres (399 ha), is underlain by sediments containing elevated levels of PCBs and heavy metals, including cadmium, copper, chromium, zinc, and lead. The PCB concentrations range from a few parts per million to more than 100,000 ppm. Portions of western Buzzards Bay sediments are also contaminated, with concentrations occasionally exceeding 50 ppm (Weaver 1982). The water column in New Bedford Harbor has been measured to contain PCBs in the parts per billion range (USEPA 1983), exceeding the marine water quality chronic criteria. Figure 4 shows areas that have been closed to fishing and lobstering because of bioaccumulation of contaminants in these species.

Feasibility Study

5. In August 1984, the USEPA reported on the Feasibility Study of Remedial Action Alternatives for the upper Acushnet River Estuary above the Coggeshall Street Bridge (NUS Corporation 1984). The USEPA Feasibility Study proposed five remedial alternatives for the contaminated sediments.

a. Channelizing the Acushnet River north of the Coggeshall Street Bridge and capping contaminated sediments in the remaining open-water areas.

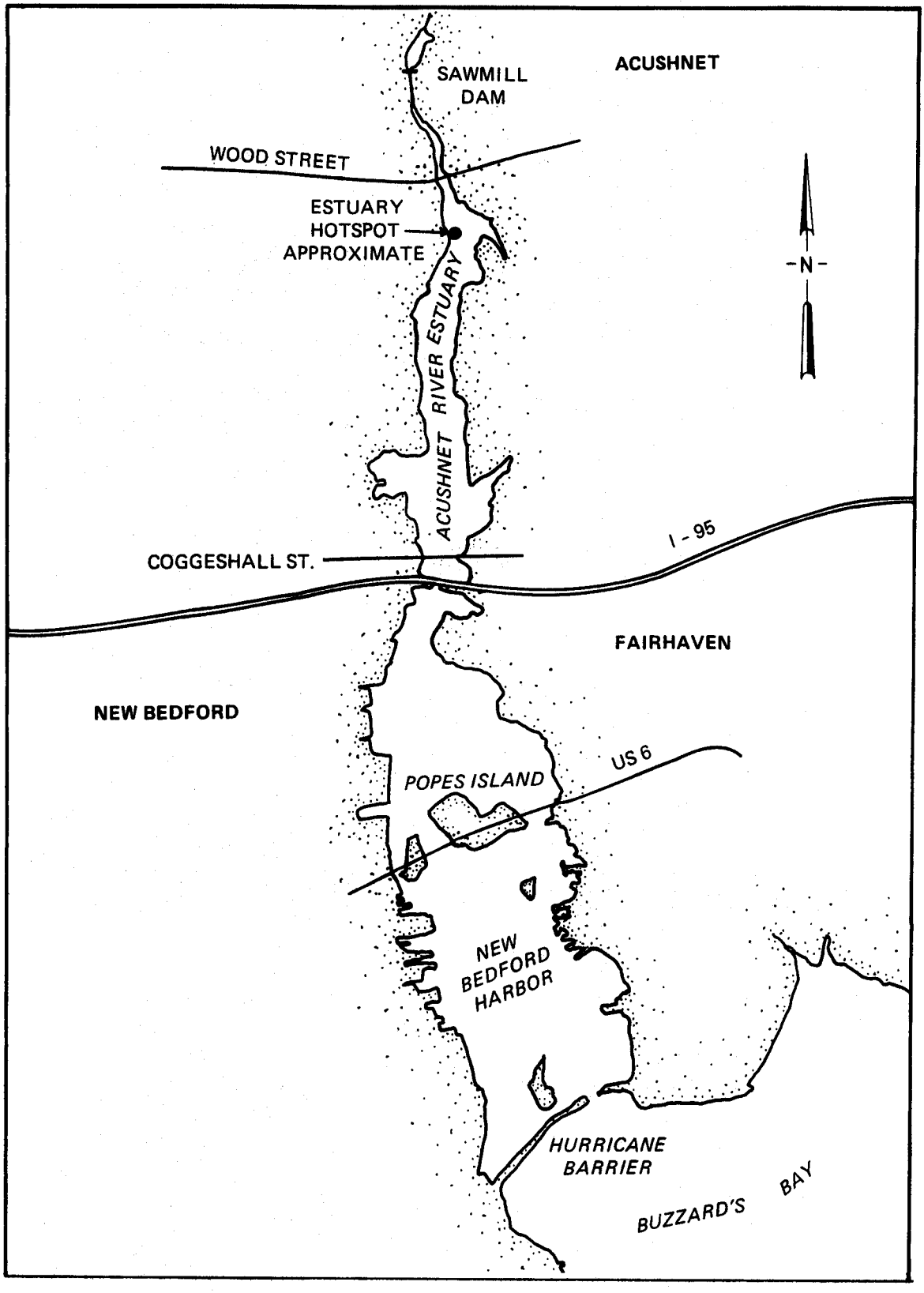

Figure 2. New Bedford Harbor and Acushnet River Estuary

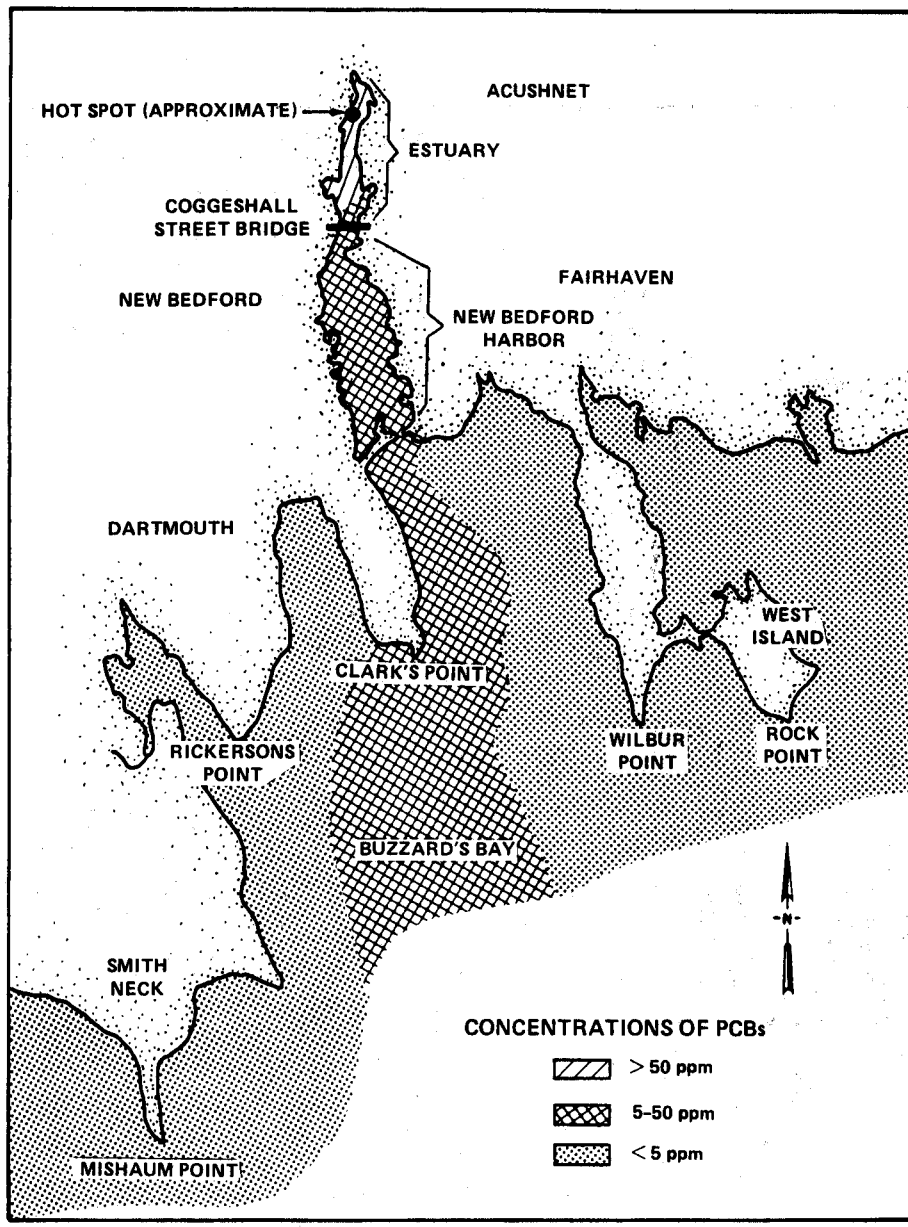

Figure 3. New Bedford Harbor PCB contamination (USEPA 1987)

b. Dredging contaminated sediments and disposing of them in a partially lined containment site in the northern part of the estuary along the eastern shore.

c. Same as option as b except that the containment site would be lined on the bottom, as well as on the sides.

d. Dredging contaminated sediments and disposing of them in an upland containment site.

e. Dredging contaminated sediments (which lay over clean sediments) and dredging clean sediments, temporarily storing both before returning the contaminated sediments to a specially constructed

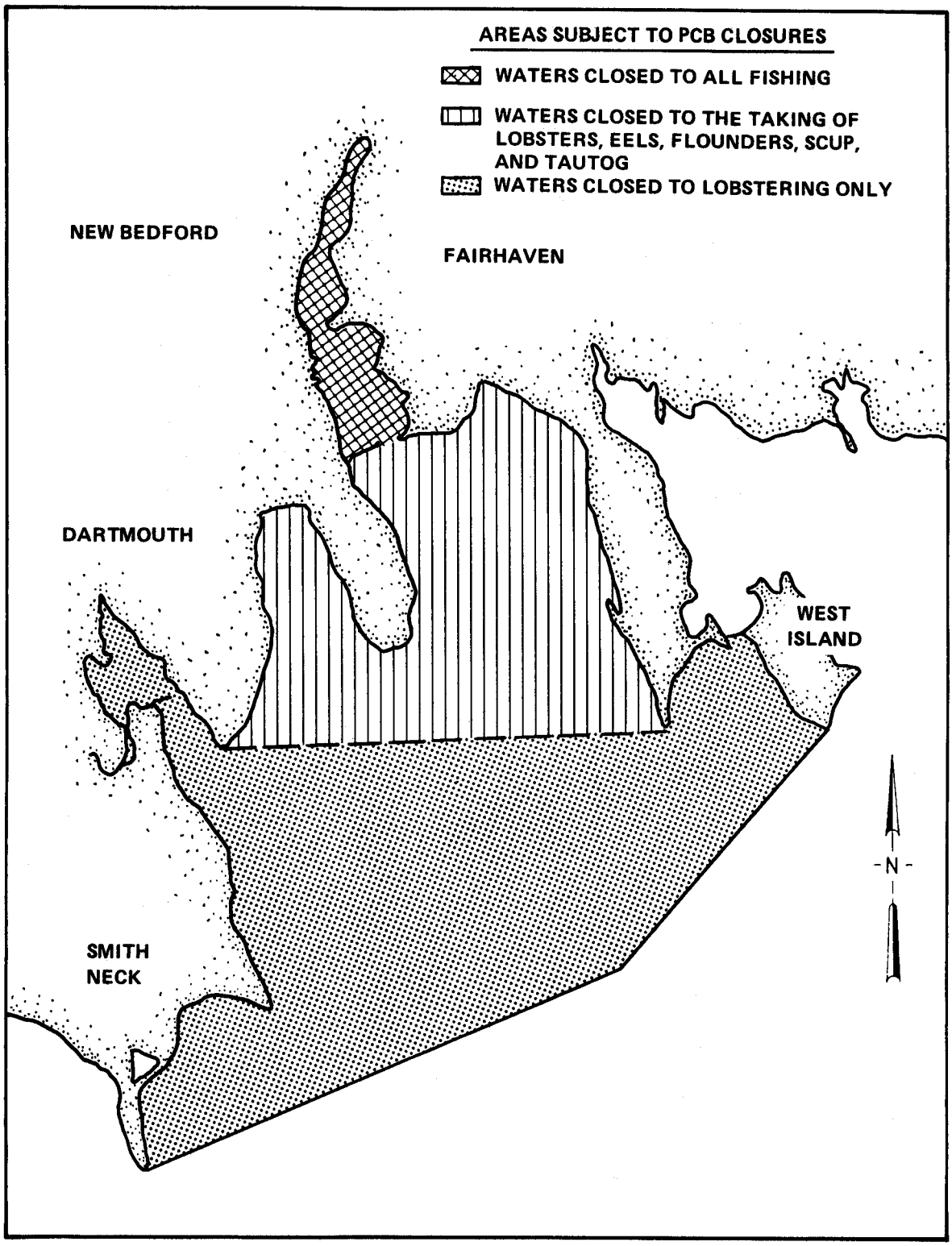

Figure 4. New Bedford Harbor areas closed to fishing (Weaver 1982)

cell in the channel bottom and covering with clean capping material. This alternative is termed contained aquatic disposal (CAD).

6. The USEPA received extensive comments on the options from other Federal, state, and local officials, potentially responsible parties, and individuals. Many of these comments expressed concern regarding the adequacy of available dredging techniques and the potential impacts of dredging on the harbor due to resuspension of contaminated sediments. The potential release of contaminated water (leachate) from an unlined disposal site was another area of concern.

7. In responding to these comments, the USEPA decided to conduct additional studies before selecting a cleanup method. Because dredging was associated with four of the five alternatives, the USEPA sought assistance from the Nation's dredging expert, the USACE, to carry out the majority of additional studies. The USACE began work on the Engineering Feasibility Study of dredging and disposal alternatives in August 1985 and completed it in March 1988. A major emphasis of the EFS was on evaluating the potential for contaminant releases from the dredging and disposal alternatives considered feasible for the upper Acushnet River Estuary site.

Objectives and Scope

8. The primary objective of the USACE's EFS was to evaluate further the engineering feasibility of a number of dredging and disposal alternatives for contaminated sediments in the upper estuary of the Acushnet River, north of the Coggeshall Street bridge. The intent of the EFS was to provide additional detailed information and assessment pertinent to New Bedford Harbor and specifically needed for the dredging assessment, and not to repeat work performed by others. The objectives addressed in the EFS were to:

a. Develop a baseline characterization of the upper Acushnet River Estuary with the degree of detail needed to assess the engineering feasibility of the proposed dredging and disposal alternatives.

b. Assess the magnitude and migration potential of contaminant releases due to resuspension of sediments during proposed dredging operations.

c. Perform laboratory and bench-scale testing developed specifically for dredged material to develop technical data needed for

predicting the behavior of the New Bedford Harbor sediments if placed in the various disposal environments under consideration.

d. Combine the technically feasible dredging and disposal technologies into implementable alternatives and provide concept design cost estimates for each implementable alternative.

9. The EFS was an evaluation of both the engineering and the cost associated with the available dredging and disposal alternatives. A number of dredging and disposal options were evaluated, and the technically feasible conceptual alternatives were developed. Only onsite CAD and confined disposal in the adjacent upland and intertidal environments, as identified in the NUS Corporation (1984) feasibility study, were investigated. The EFS included the following activities:

a. Gather data to establish permanent control points in the study area and to develop a base map for use in referencing existing and future work efforts, to include subsequent predesign and design studies.

b. Perform sediment sampling and analysis to determine appropriate compositing of samples for testing and the approximate limit of the dredging project (area and depth). Integrated physical and chemical data were needed to develop the compositing strategy for subsequent testing.

c. Conduct limited geotechnical investigations to provide preliminary physical data on dredging and disposal site conditions, suitability of disposal areas, and evaluations of alternatives.

d. Define the conditions for contaminant migration to include hydraulic characteristics of the upper harbor area, sediment/bed interaction characteristics (deposition and resuspension tests), long-term fate of material transported within the study area, and control of the dredging operation required to minimize its impact on spreading of contaminated sediments to other areas of the harbor.

e. Perform a suite of tests on a composited sediment(s) deemed to be representative of the material that will be dredged and ultimately disposed. The sediment testing was designed to provide technical data needed for subsequent analyses of the engineering feasibility of the dredging and disposal alternatives and for USEPA's assessment of any environmental impacts.

f. Formulate a number of technically feasible dredging and disposal alternatives, including a description of each alternative, a determination of engineering implementability, and costs for implementation and construction.

g. Prepare a final report detailing all work efforts performed, including all of the data acquired, testing performed, reference materials relied upon, and all analyses and information used to develop the alternatives available.

Analysis of the environmental (biological, etc.) impact of the options was outside the scope of the EFS; those evaluations were made separately by the USEPA and its contractors. Detoxification/destruction technologies for dredged material and nonremoval technologies are being evaluated by other contractors.

Project Management

10. The USACE, under a national interagency agreement, provides technical assistance and construction management support to the USEPA. This interagency agreement is coordinated by the Missouri River Division of the USACE. The Omaha District, USACE, has been designated as design center for USEPA Region 1 Federal Superfund projects. As part of USEPA's request, the Omaha District was assigned responsibility for coordinating and providing management support for the USACE studies. The New England Division (NED) and the US Army Engineer Waterways Experiment Station (WES) were tasked to cooperatively perform the EFS. The Dredging Division of USACE provided technical review of NED and WES tasks related to the dredging evaluation.

11. The EFS was accomplished in a series of 10 study tasks (Table 1). Overall management of the technical program was assigned to the WES Environmental Laboratory (EL). In addition, the EL performed a variety of laboratory (bench-scale) evaluations, such as contaminant mobility testing, treatment studies, and sediment stabilization/solidification testing. The WES Hydraulics Laboratory (HL) evaluated hydrodynamic and sediment transport in the upper estuary to assess sediment resuspension and transport during dredging and disposal operations. The NED performed the fieldwork, collecting basic engineering, geotechnical, and water/sediment quality data for the site. Evaluations of dredging and dredging control technologies, and the engineering feasibility and cost of alternatives, were cooperatively performed by the WES and the NED.

Table 1

Engineering Feasibility Study Tasks

Task	Description	Performing Organization
1	Baseline maps and controls	New England Division, USACE
2	Sediment characterization	New England Division, USACE
3	Geotechnical investigations	New England Division, USACE
4	Contaminant migration studies	Waterways Experiment Station (Hydraulics and Environmental Laboratories)
5	Composite sample collection	New England Division, USACE
6	Composite sample testing	Waterways Experiment Station (Environmental Laboratory)
7	Conceptual dredging and disposal alternatives and costs	Waterways Experiment Station; New England Division, USACE
8	Draft and final reports	Waterways Experiment Station; New England Division, USACE
9	Coordination	Waterways Experiment Station; New England Division, USACE; Omaha District, USACE; Dredging Division, USACE
10	Litigation support	Waterways Experiment Station; New England Division, USACE

PART II: TECHNICAL APPROACH

Management Strategy for Contaminated Dredged Material Disposal

12. The technical approach used for the EFS testing and evaluation of dredging and disposal of highly contaminated sediments in the upper estuary is consistent with the USACE management strategy for the disposal of dredged material (Francingues et al. 1985). The "Management Strategy" is based on findings of research conducted by the USACE, the USEPA, and others over the past decade and on worldwide experience in managing dredged material disposal. The USACE developed the Management Strategy (Figure 5) to provide a technically feasible and environmentally sound approach to the disposal of dredged material from Federal navigation projects. However, it is applicable to a wide variety of sediment types, including the most highly contaminated Superfund materials. The Management Strategy consists of a suite of tests developed specifically for the unique nature of dredged material that, when applied to New Bedford Harbor sediment, will allow for site-specific evaluation and conceptual design of available disposal alternatives. Some of the tests have been modified to address site-specific technical issues associated with the New Bedford Superfund site.

Description of EFS Tasks

13. The EFS technical approach used field data collection activities, literature reviews, laboratory and bench-scale studies, and analytical and numerical modeling techniques to assess engineering feasibility and develop conceptual alternatives. The technical portion of the EFS was accomplished in seven tasks: (a) baseline maps and controls, (b) sediment migration studies, (c) geotechnical investigations, (d) contaminant migration studies, (e) composite sample collection, (f) composite sample testing, and (g) conceptual dredging and disposal alternatives and costs. Descriptions of these tasks, along with the responsible organization, are given in Table 2. A summary description of each task is given in the following paragraphs.

Task 1: Baseline maps and controls

14. In Task 1, the NED prepared maps of the estuary and shoreline areas that show more accurately the water depths and ground elevations. Detailed

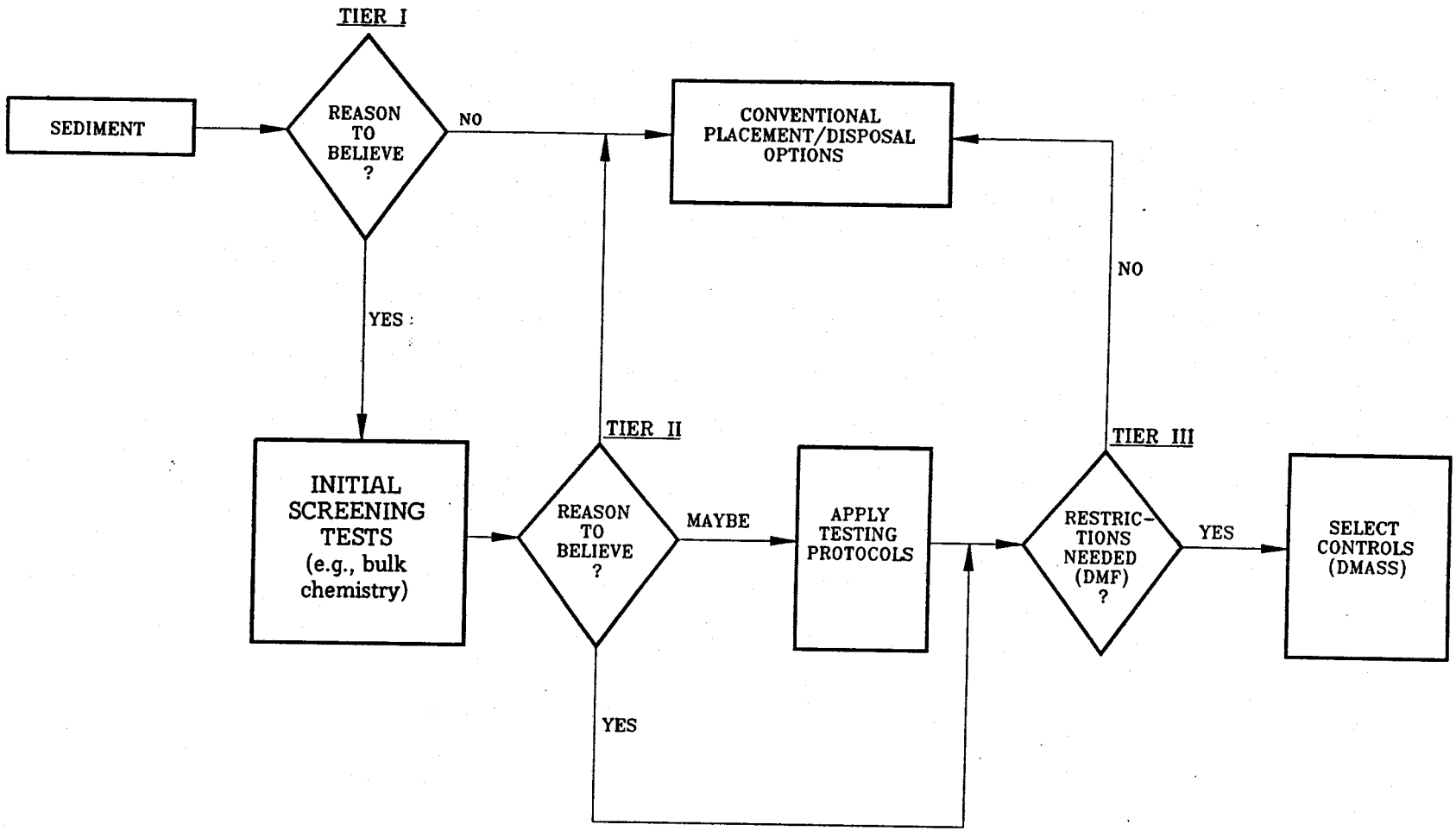

Figure 5. Management strategy executive flowchart

Table 2

Engineering Feasibility Study Technical Task Elements

Task	Element Description	Performing Organization
1	1. Establish controls	New England Division, USACE
	2. Hydrographic survey	New England Division, USACE
	3. Topographic survey	New England Division, USACE
	4. Sample positioning	New England Division, USACE
2	1. Sediment sampling (push cores)	New England Division, USACE
	2. Quality assurance/quality control plan	New England Division, USACE
	3. Site-specific safety plan	New England Division, USACE
	4. Physical tests	New England Division, USACE
	5. Chemical analysis	New England Division, USACE
	6. Reporting of test results	New England Division, USACE
3	1. Geophysical survey	New England Division, USACE
	2. Probes, borings, observation wells	New England Division, USACE
	3. Geotechnical report	New England Division, USACE
4	1. Testing for contaminant release during dredging	Waterways Experiment Station (Environmental Laboratory and Hydraulics Laboratory)
	2. Controls for dredging	Waterways Experiment Station (Hydraulics Laboratory and Environmental Laboratory)
	3. Hydraulic characteristics	Waterways Experiment Station (Hydraulics Laboratory)
	4. Deposition and resuspension tests	Waterways Experiment Station (Hydraulics Laboratory)
	5. Sediment migration analysis	Waterways Experiment Station (Hydraulics Laboratory)
5	1. Composite sample collection	New England Division, USACE
	2. Composite sample mixing and transport to WES	New England Division, USACE
6	1. Bulk sediment and water chemistry	Waterways Experiment Station (Environmental Laboratory)
	2. Modified elutriate tests	Waterways Experiment Station (Environmental Laboratory)
	3. Surface runoff tests	Waterways Experiment Station (Environmental Laboratory)
	4. Leachate quality prediction tests	Waterways Experiment Station (Environmental Laboratory)

(Continued)

Table 2 (Concluded)

Task	Element Description	Performing Organization
6 (Cont.)	5. Contained aquatic disposal effectiveness tests	Waterways Experiment Station (Environmental Laboratory)
	6. Engineering materials classification	Waterways Experiment Station (Environmental Laboratory)
	7. Settling tests	Waterways Experiment Station (Environmental Laboratory)
	8. Chemical clarification tests	Waterways Experiment Station (Environmental Laboratory)
	9. Consolidation tests	Waterways Experiment Station (Environmental Laboratory)
	10. Liner evaluation	Waterways Experiment Station (Environmental Laboratory)
	11. Sediment stabilization/ solidification tests	Waterways Experiment Station (Environmental Laboratory)
	12. Treatment evaluations	Waterways Experiment Station (Environmental Laboratory)
7	1. Dredging equipment evaluations	Waterways Experiment Station; New England Division, USACE
	2. Evaluation of confined upland/intertidal disposal	Waterways Experiment Station; New England Division, USACE
	3. Evaluation of confined aquatic disposal	Waterways Experiment Station; New England Division, USACE

maps were needed to define the volume of material that would have to be dredged to remove contaminated sediments. These maps not only supported the development and evaluation of the dredging and disposal options, but were also used to control the locations of the sampling points in the field sampling program (Task 2).

Task 2: Sediment characterization

15. After reviewing the existing data, the NED and WES decided that additional sampling should be conducted to support Tasks 4, 5, and 6. This sampling was designed to fill existing data gaps, particularly on the depth of contamination and the physical properties of the sediments.

Task 3: Geotechnical investigations

16. The NED was responsible for conducting the geotechnical investigations. These investigations provided additional information on the physical characteristics of the soil underlying the estuary. Information on groundwater elevations was also obtained. These data were used to more accurately evaluate the technical feasibility and costs of constructing various types of disposal sites.

Task 4: Contaminant migration studies

17. Task 4 was a primary responsibility of the WES HL and involved a variety of studies designed to evaluate the amount of contaminants that would be expected to move out of the estuary during dredging and disposal operations. Means of controlling contaminant releases during dredging were also studied, including a determination of the most effective type and operation of dredging equipment. Foreign and innovative types of equipment were investigated. Two types of experiments were performed: (a) a series of laboratory and field tests to study the types of sediment material that may be released if disturbed by dredging, and the associated contaminant levels that could be released to the environment, and (b) a series of experiments in a specially constructed laboratory water tunnel to determine the relationship between the flows (currents) in the estuary and the amount of sediment that would be eroded from the bottom or that would settle to the bottom of the estuary. Also included in Task 4 was the collection of field data on tides and currents used in calibrating the estuarine hydrodynamic and transport model to predict sediment movement.

Task 5: Composite sample collection

18. Based on the results of the chemical and physical testing of sediment samples in Task 2, a decision was made on the type and location of sediments that would be most representative of the conditions in the estuary. This decision required the collection and mixing of sediment samples from a number of locations. A large quantity of this representative material was collected, properly mixed, and transported by the NED to the WES for subsequent testing.

Task 6: Composite sample testing

19. Task 6 consisted of a series of laboratory tests that were performed by the WES EL. The tests that were performed on the representative (composited) sample collected in Task 5 included the following:

a. Complete chemical analysis to fully characterize the composite sample prior to the initiation of other tests.

b. Tests to determine the physical properties and settling behavior of dredged sediments when placed in a confined disposal facility (CDF) and the quality of the water that would be ponded above the settled material and that would require treatment prior to its release back into the estuary.

c. Tests to determine if rainwater would cause a release of contaminants from dredged sediments in a CDF and the associated effects on treatment requirements. These tests utilized a special rainfall simulator developed by the WES.

d. Two types of tests to predict the quality of water (leachate) that potentially would be released from the bottom and sides of an unlined CDF. These tests were run under different conditions since the exact environment of the disposal site may change with time. A principal reason for these tests was to determine if a lined disposal site will be necessary to adequately protect surface and ground water. Initial batch leaching data produced additional questions related to contaminant sediment-water portioning. This led to a supplemental, more in-depth evaluation of batch leaching phenomena.

e. Laboratory tests to determine the thickness of clean material that would have to be placed over contaminated sediments in the CAD alternative evaluation.

f. Laboratory tests to assess the feasibility of using various chemical additives to promote settling and clarification of CDF effluent.

g. Tests to evaluate the consolidation properties of the sediments to be dredged. This was important to determination of the long-term storage capacity of the disposal site and to assessment of the feasibility of disposal in subsurface CAD.

h. Tests to determine if commercially available materials can be effectively used to solidify or stabilize the sediments prior to disposal. Compatibility of liner materials with contaminated dredged material was also assessed.

i. Laboratory studies to determine both the need for treatment of the water to be released from the disposal site and the types of treatment processes that would be most appropriate and effective.

Task 7: Conceptual dredging and disposal alternatives and costs

20. This final task involved the development and evaluation of the most feasible dredging and disposal alternatives based on the findings in Tasks 1-6. These conceptual alternatives were developed at a sufficient level of detail to determine technical feasibility and to develop meaningful cost estimates. The NED and WES collaborated on this effort.

Hot Spot Sediment Testing

21. During the course of the EFS, the USEPA and its contractors decided to separately evaluate removal and disposal of sediment from the estuary hot spot. Recognizing that contamination levels and physical characteristics in the hot spot sediment may differ from the EFS composite sample, the USEPA directed WES to extend selected EFS testing protocols to hot spot sediment. These protocols included bulk sediment chemistry, sediment physical characteristics, column settling tests, elutriate tests, and solidification/stabilization tests. Results of these tests are integrated into the scope of work and reports for the EFS tasks.

Pilot Study

22. Much of the information needed to evaluate the conceptual design of proposed dredging and disposal alternatives for the New Bedford Harbor Superfund Site (above the Coggeshall Street Bridge) can and will be provided by the EFS. This information will be critical to the record of decision (ROD) for selection of the remedial action alternative. However, the EFS approach uses laboratory (bench-scale) studies, literature reviews, and desktop analyses to assess engineering feasibility and develop conceptual designs. The sound engineering approach for the verification of design parameters is to perform

pilot-scale evaluations after laboratory studies and before final selection and design of a prototype system. This is particularly true for the New Bedford Project where dredging and disposal of highly contaminated sediment must be considered innovative application of alternatives, where dredging equipment must be evaluated without benefit of field-verified laboratory testing protocols, and where a data base for the impact of site-specific factors on design is currently not available.

23. Therefore, as an extension of the EFS, the USEPA and the USACE are planning a pilot project during the summer of 1988 (Otis and Andreliunas 1987). This pilot project will evaluate three types of hydraulic dredges and two disposal alternatives at the upper Acushnet River Estuary site. Field-scale experience and site-specific data for the dredging and disposal operations gained from the pilot project will provide important information for the evaluation of remedial action alternatives and for the Superfund ROD. If the alternatives evaluated by the pilot project are selected, then transition from pilot-scale to full-scale design and operation can be efficiently accomplished.

24. The pilot study provides the opportunity to evaluate different dredges, dredge operating procedures, disposal methods, and control techniques under the site-specific conditions of New Bedford Harbor. The information gathered during the pilot study will improve the ability to address the critical issues being evaluated by the EFS. Appendix A to this report contains a detailed comparison of the information that will be provided by the EFS and the additional or improved information that can be provided by the pilot study. Listed below are the specific technical objectives of the pilot study.

- a. Determine the efficiency of dredging for removal of PCB-contaminated sediment from New Bedford Harbor.
- b. Evaluate actual sediment resuspension and contaminant release during field conditions for selected dredging equipment, operational controls, and turbidity containment techniques.
- c. Refine and scale-up laboratory data for design of disposal/treatment processes for contaminated dredged material from the site.
- d. Develop and field test procedures for construction of CAD cells for contaminated dredged material under site-specific conditions.
- e. Evaluate containment of PCBs in a CDF and a CAD cell filled with contaminated dredged material.

f. Assess solidification/stabilization techniques for contaminated dredged material with respect to implementability.

g. Establish actual cost data for dredging and disposal of New Bedford Harbor sediment.

25. The reader is referred to the USACE report on the proposed pilot study (Otis and Andreliunas 1987) for a comprehensive assessment and detailed description of the study design and planned operation. A separate report on the pilot study will be prepared by the NED and WES. Thus, it will not be included in this EFS report series.

PART III: REPORTING OF RESULTS

26. During the course of the EFS, the WES and NED provided the USEPA and its contractors with interim results of various study tasks and elements. These interim results were made available in the form of interpretive summaries, verbal briefings, and draft interim reports. As part of Task 8 of the EFS, the results of the study are being compiled in this EFS report series. This part is used to present an overview of the WES EFS report series organization and to briefly describe each report.

Organization of WES EFS Report Series

27. The reporting of study results will be essentially in the order in which the study was organized and conducted. Twelve documents will be prepared to present the results of the tasks performed primarily by the WES EL and HL, with assistance from the NED. A listing of each report title is as follows:

a. Report 1, "Study Overview."

b. Report 2, "Sediment and Contaminant Hydraulic Transport Investigations."

c. Report 3, "Characterization and Elutriate Testing of Acushnet River Estuary Sediment."

d. Report 4, "Surface Runoff Quality Evaluation for Confined Disposal."

e. Report 5, "Evaluation of Leachate Quality."

f. Report 6, "Laboratory Testing for Subaqueous Capping."

g. Report 7, "Settling and Chemical Clarification Tests."

h. Report 8, "Compatibility of Liner Systems with New Bedford Harbor Dredged Material Contaminants."

i. Report 9, "Laboratory-Scale Application of Solidification/Stabilization Technology."

j. Report 10, "Evaluation of Dredging and Dredging Control Technologies."

k. Report 11, "Evaluation of Conceptual Dredging and Disposal Alternatives."

l. Report 12, "Executive Summary."

Description of WES Reports

28. The following items describe each of the WES technical reports that will be published as part of the EFS report series. Each report is intended to provide a comprehensive document of the particular technical task or task element(s) performed as part of the EFS.

a. Report 1 is an overview of the USACE EFS. It provides a general introduction with emphasis on the tasks and elements by WES researchers in cooperation with the NED.

b. The second report, Report 2, summarizes the detailed studies performed by the WES HL under Task 4 and incorporates elements 1, 3, 4, and 5. It provides information on the field data collection activities, prototype sediment and contaminant results, laboratory sediment/water tunnel tests, near-field plume and CAD modeling, estuarine hydrodynamics and transport modeling, and potential for contaminant migration during various conceptual dredging and disposal operations.

c. Results of Task 5 conducted by NED and Task 6, elements 1, 2, and 6, by WES EL are presented in Report 3. The report provides a basic characterization of the sediments in the estuary along with physical and chemical characterizations of the composite sample used for the dredging and disposal evaluations. Descriptions of the contaminant mobility testing, standard and modified elutriate testing, and other contaminant release investigations are given.

d. Report 4 of the EFS series is on the surface runoff quality evaluations performed on a potential capping material for the confined upland or intertidal disposal alternative. The testing was accomplished under Task 6, element 3, by the WES EL. Results are presented for both the wet, unoxidized and dry, oxidized surface runoff conditions.

e. Evaluation of leachate quality from a confined upland or intertidal disposal operation is addressed in Report 5. The application of laboratory batch and permeameter tests is described. Results are presented and discussed in terms of theoretical leaching behavior. Leaching determinations are made based on the New Bedford Harbor sediment testing. This work was conducted by the WES EL under Task 6, element 4.

f. Report 6 summarizes the small-scale laboratory test results for prediction of subaqueous capping effectiveness. The work was completed under Task 6, element 5, by the WES EL.

g. Testing of dredged material settling characteristics and for chemically assisted suspended solids removal is reported in Report 7. This work was conducted by the WES EL as part of Task 6, elements 7 and 8. Data are presented on compression, zone, and flocculent settling rates and on various chemical polymers that were screened for additional suspended solids

removal. Results of this effort were also used to develop a conceptual design for a CDF.

h. Report 8 presents the results of a desktop evaluation of the potential for compatibility of various conceptual liner systems with New Bedford Harbor dredged material. Flexible membranes and soil liner systems are described and assessed for their potential use in both upland and intertidal sites. Potential problems that could lead to liner system failure are conceptually described. This work was accomplished by the WES EL as part of Task 6, element 10.

i. Report 9 documents results of the laboratory solidification/stabilization (S/S) technology assessment conducted by the WES EL under Task 6, element 11. The innovative laboratory evaluation procedures for assessing the effectiveness of the S/S technology are described. Results of the laboratory testing are presented on unconfined compressive strength, single-step and sequential batch leaching, and desorption isotherms. The potential for incorporating S/S technology in various implementation concepts is also presented.

j. The evaluation of dredging and dredging control technologies, Report 10, incorporates the results of Tasks 1, 2, and 3; Task 4, element 2; and Task 7, element 1. This report was prepared by the WES EL and HL and incorporates previous dredging evaluations made by the NED and WES for the pilot study. Information is presented on the required dredging volumes, equipment, and operations to effectively remove the highly contaminated sediments and properly dispose of the dredged material without significantly increasing contaminant migration from the site. Operational procedures are recommended to control sediment resuspension during dredging and disposal operations.

k. The results of the EFS technical program (Tasks 1-7) are incorporated in Report 11, prepared by the WES and NED. This report is used to document a number of technically feasible dredging and dredged material disposal alternatives to be considered in the overall USEPA Feasibility Study (FS). The process for development, screening, and detailed analysis of the available technologies and options is presented. The nearshore confined disposal facilities and confined aquatic disposal facilities are conceptualized for the available sites and alternatives considered during the study. The alternatives are developed to sufficient level of detail for assessment of engineering feasibility and cost.

l. Report 12 is the Executive Summary for the EFS report series. It provides a comprehensive review of the study results and pertinent conclusions and recommendations made as a result of the EFS. It is intended to provide the reader with a synopsis of the more important study findings and insight into the relation with other studies (e.g., the pilot study) being conducted for the New Bedford Harbor Superfund Project.

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APPENDIX A: TECHNICAL ISSUES
(ENGINEERING FEASIBILITY STUDY VERSUS PILOT STUDY)

1. Listed below are specific questions that must be answered in evaluating proposed dredging and disposal alternatives. For each question, the information to be provided by the EFS and the additional or improved information that can be provided by the pilot study are discussed.

a. What is the rate of sediment resuspension caused by the dredging operation?

EFS: Rate of sediment resuspension will be extracted from available literature. Most of this data is for maintenance dredging projects where water depths are usually considerably deeper than those that exist in the upper estuary. The studies that are available generally include measured concentrations of suspended sediment rather than rates of generation. Because the data depend on the type of material, the type of dredge, how the dredge is operated, water depth, and hydraulic conditions, there is high variance in the available data. Without site-specific data, a very conservative value, i.e., a high rate of sediment resuspension, will be used.

Pilot study: Field data will be collected to measure the rate of sediment resuspension caused by the dredging operation for the material characteristics specific to this site, for the site conditions, and for the types of equipment likely to be used for a full-scale dredging operation. Resuspension rates can then be related to dredge production rates and other operating parameters for the dredge. The pilot study also affords the opportunity to compare results for the different types of dredging equipment and to evaluate resuspension caused by other components of the dredging and disposal operation, such as movement of equipment and construction of in-water dikes.

b. What is the rate of contaminant release, in particular PCB release, associated with the dredging operation?

EFS: A series of laboratory tests are being performed to determine the concentrations of contaminants potentially released due to sediment resuspension during dredging. Elutriate testing has been performed on a composite sediment sample from the upper estuary to estimate PCB concentrations associated with the particulate and dissolved fractions. These laboratory procedures are straightforward. Limited field data were collected to support correlation between the laboratory and the field release associated with sediment resuspended by a sampling operation and with contaminant transport during existing conditions. However, because of the limited data available, conclusions made using these field data should be considered unverified.

Pilot study: The pilot study will allow direct measurement of contaminant release for soluble and particle-associated

fractions during dredging and will allow comparison of field data with predictions based on laboratory data. Data relating contaminant concentration to particle sizes resuspended by the dredge will be particularly helpful in assessing the rate of contaminant release during dredging and the transport of these particles away from the dredge and out of the upper Acushnet River estuary.

c. What dredging controls are needed to minimize the rate of sediment resuspension at the dredge, and what measures should be employed to contain the suspended sediment plume near its point of generation?

EFS: Information from the literature will address the effectiveness of various operational controls and suspended sediment containment techniques. Dredging conditions at this site are unique and may be outside the range of conditions covered in the literature.

Pilot study: The pilot study will allow testing of operational controls and techniques available for the type of equipment suited to this site and with the type of material and site conditions unique to this site. The need for and effectiveness of containment techniques can also be evaluated during the pilot study. If the pilot shows that dredging can be conducted without major physical controls, the prototype operation need not incur this expense. The pilot study will further define the costs and constraints, such as minimum water depth, operational controls, and major physical barriers.

d. What is the contaminant flux in and out of the upper estuary during dredging for various tidal conditions?

EFS: A two-dimensional sediment-associated contaminant transport model has been developed. The hydrodynamic model was developed for the upper estuary based on field hydraulic data collected during three tidal conditions. An analytical plume model is applied, and results for various currents and settling velocities are superimposed. Dispersal of resuspended sediment is predicted by a multiple-component numerical transport model. Results from the hydrodynamic model, data from laboratory flume studies to evaluate sediment resuspension and deposition, and estimates of contaminants in the various fractions (soluble and particle-associated) furnish input to the sediment transport model for several dredging scenarios. The transport model assumes that no adsorption or desorption occurs and tracks the contaminants as it tracks suspended sediment movement.

Pilot study: Monitoring of sediment and contaminant fluxes near the dredge and at the Coggeshall Street Bridge will reverify the models and develop additional confidence in the results of the contaminant transport model for the case of increased suspended sediment concentrations during dredging. Migration of contaminants released from the confined disposal facility (CDF) and from placing material in the contained aquatic disposal (CAD) cell can also be addressed by collecting data on the rate of

contaminants released during these operations and feeding those data into the contaminant transport model.

e. What is the efficiency of contaminant removal by dredging?

EFS: Operational characteristics for various dredges will be reviewed. The cutting precision and amount of residual sediment after one or more passes and between adjacent cutting paths will be addressed, primarily based on manufacturer's literature.

Pilot study: The level of control for the dredge cut can be evaluated for the site-specific conditions and the types of equipment evaluated. Sediment sampling at various phases of the dredging project will measure the quantity of contaminants remaining. Minimizing the depth of cut or the number of dredging passes offers considerable cost savings not only by reducing dredging time, but also by reducing the volume of dredged material that must be disposed.

f. What is the effluent quality of the overflow from the CDF?

EFS: Effluent from the CDF is characterized by the modified elutriate test, which is one of the testing protocols included in the Management Strategy. This test defines the dissolved and particle-associated concentration of contaminants in the effluent and accounts for the settling behavior of the dredged material, retention time in the CDF, and chemical environment in ponded water during active disposal. This test has been field verified for at least three dredging projects, but these were not Superfund projects and the contaminant concentrations were not as high as at this site.

Pilot study: Verification of the modified elutriate test in the field study is not a primary objective of the pilot study. Its predictions are likely in the same order of magnitude as what will be encountered in the field, and adjustments in treatment measures for the prototype operation could be designed for without too much redundancy. However, for the proposed pilot study concept, a CDF will be necessary to store at least the initial excavation of contaminated sediment. Field data on CDF effluent quality will be required to address substantive requirements of Section 401 water quality certification and to ensure environmental protection. Data to verify predictions of the modified elutriate test for this site will be obtained during the effluent monitoring.

g. What will be the surface runoff quality from a CDF filled with contaminated sediment from this site?

EFS: A laboratory surface runoff test is being conducted using a rainfall simulator-lysimeter system. Sediment from the lower end of the upper estuary (near the Coggeshall Street Bridge) with a PCB concentration on the order of 80 ppm is being tested by applying rainfall to the wet sediment and later to a dewatered sediment. Contaminant concentrations in the rainfall runoff are then analyzed.

Pilot study: The CDF site will be capped by a cleaner sediment than that used in the laboratory surface runoff test. Surface runoff from the CDF will have the same control requirements (water quality and environmental protection) as CDF effluent produced by the dredging operation and will require monitoring and possible containment or treatment prior to release.

h. What is the leachate quality from the CDF?

EFS: Batch leaching tests and divided flow permeameter tests are being conducted on anaerobic and aerobic sediment from New Bedford. Data from these tests will be synthesized to provide an assessment of contaminant mobility in dredged material. A one-dimensional, convective-dispersive mass transfer equation with a source term for contaminant leaching will be used to model leachate quality in the disposal site and to estimate contaminant flux at the dredged material/site bottom interface.

Pilot study: An array of monitoring wells will be installed to detect contaminant movement through the dikes and bottom of the CDF. However, the time period required to detect this movement will exceed the target for getting results of the pilot study. Leachate monitoring is included as an environmental protection measure for long-term observation of the CDF. Undisturbed cores of dredged material will be collected after the CDF undergoes initial drying (1 to 6 months). These cores will be collected for the entire depth of dredged material in the CDF. They will be divided into strata if the sediment is dry and cohesive enough for this purpose. The dredged material samples will be centrifuged to separate pore water from the solids, and the water and solid fractions will be analyzed for contaminants. These analyses will directly indicate leachate quality in the CDF and may be compared to batch and permeameter leaching test data to support application of the laboratory tests to field conditions. Coupled with monitoring well data, this approach may also indicate attenuation of contaminants by the dike and foundation of the CDF.

i. What is the feasibility of the CAD alternative?

EFS: Laboratory studies are being conducted to determine the appropriate cap thickness required to isolate the contaminated dredged material. An engineering evaluation of the design requirements for a series of CAD cells for the entire project will be conducted. This evaluation is based on experience with capping contaminated sediment in the United States and on limited Dutch experience in excavating underwater cells for disposal of contaminated sediment.

Pilot study: Chemical migration through the cap can be evaluated under field conditions after the CAD cells are completed. However, the real benefit of the pilot study for CAD evaluation is derived from the field experience gained in implementing the construction sequence for removing contaminated material, deepening the cell by removing additional clean material, filling the bottom of the cell with contaminated material, and capping

the contaminated dredged material with clean material. Questions regarding the contaminant release during placement of contaminated material, consolidation/bulking of material in the CAD cell, feasibility of using a submerged diffuser to fill the cell, and stability of the cell after closure can be answered only by a field study.

j. What are the design parameters for the CDF?

EFS: Laboratory settling column tests provide design information for sizing CDFs and predicting the suspended solids concentration in the effluent. Scale-up factors from laboratory to field are available in the literature, but are based on a limited number of sites and may be very conservative.

Pilot study: Again, the pilot study provides the opportunity to obtain site-specific information for the extension from the laboratory to prototype design. Pilot-scale data will promote confidence in the final design and reduce costly contingencies for the prototype.

k. How will effluent from the CDF be treated to meet effluent suspended solids limitations for discharge to the estuary?

EFS: Bench-scale jar tests are being performed to determine the effectiveness of chemical polymers in reducing the suspended solids concentration for effluent from the CDF. A number of polymers from different manufacturers have been screened, and the most effective ones and optimum dosages for suspended solids removal have been determined.

Pilot study: Chemical clarification should be tested under field conditions to test its reliability and flexibility in treating the widely varying effluent characteristics from the CDF. Also to be tested is the settling efficiency in a settling pond where ideal settling conditions do not occur. The pilot study will also provide additional experience with equipment for adding polymers and mixing them with CDF effluent at the weir from the primary basin.

l. What is the feasibility of solidifying or stabilizing the contaminated dredged material?

EFS: Laboratory mixes of contaminated sediment and two types of stabilization reagents were prepared and subjected to unconfined compression strength tests and graded, serial batch leach tests.

Pilot study: Equipment and procedures for stabilization of contaminated materials are available. However, stabilization of dredged material under field conditions has not been demonstrated. An excellent opportunity exists in the pilot study to test reagents, equipment, and operations necessary to stabilize a portion of the contaminated sediment within the CDF.

m. What additional treatment beyond suspended solids removal is feasible for CDF effluent?

EFS: The treatment sequence considered is primary settling, chemical clarification, filtration, and carbon adsorption.

Bench-scale tests will be conducted for each of these processes to define basic design parameters and evaluate the efficiency of contaminant removal.

Pilot study: The pilot study will provide data for field-scale systems and for field operating conditions. Bench-scale testing for filtration and carbon adsorption creates some problems because of the large quantity of simulated CDF effluent required for adequate replications of data, particularly for removal of trace organics. Activated carbon studies could logically move from bench-scale adsorption isotherm testing to column breakthrough testing in the pilot scale. It is not proposed to treat the entire CDF effluent because effects for untreated effluent on contaminant migration should be evaluated. Pilot-scale treatability testing will involve treating a side stream of the CDF effluent.

n. What are the costs for the dredging and disposal alternatives?

EFS: Cost estimates for the conceptually designed dredging and disposal alternatives will be developed.

Pilot study: Site-specific production data to be generated by the pilot study will improve cost estimating for the prototype cleanup. The cost of cleanup at this site will be affected by the innovative disposal concepts for contaminated dredged material, the unique types of dredging equipment, safety requirements and decontamination procedures required for dealing with hazardous materials, shallow water, and the desire to effectively remove PCB contamination with a minimum volume of sediment. The pilot study will reduce the uncertainty in estimating cost for cleanup, which could affect selection of the final full-scale cleanup alternative.