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WORK PLAN

REMEDIAL INVESTIGATION AND FEASIBILITY STUDY

NEW BEDFORD SITE
BRISTOL COUNTY, MASSACHUSETTS

EPA WORK ASSIGNMENT NUMBER 28-1L43
CONTRACT NUMBER 68-01-6699

NUS PROJECT 0725.01

NOVEMBER 1983

NUS CORPORATION

Park West Two
Cliff Mine Road
Pittsburgh, PA 15275
412-788-1080

R-31-7-3-29
NB- 1 -F-I

Site: New Bedford
Break: 3.4
Other: 54560

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SUBMITTED FOR NUS BY:

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CONTENTS

CONTENTS (CONTINUED)

CONTENTS (CONTINUED)

TABLES

FIGURES

1

1.0 WORK PLAN SUMMARY

1.1 Objectives of the Study

The purpose of this Work Plan is to provide a detailed scope of work for the Remedial Investigation and Feasibility Study (RI/FS) portions of a remedial action program in New Bedford and surrounding areas of Bristol County, Massachusetts. The overall objective of the remedial action program is to attenuate the release of contaminants from various sources and sites to a level that is consistent with the protection of public health, safety, welfare, and the environment. This encompasses the protection of the surface water, groundwater, air, and terrestrial resources of the regional area. Other objectives more specific to New Bedford Harbor and environs include the return of commercial fishing to areas presently affected by closure, the removal of restrictions to dredging projects essential to progressive development of the harbor, and the restoration of the recreational potential of the harbor environment. The RI/FS is directed toward the development and recommendation of remedial actions that best satisfy these objectives within the framework of pre-established evaluation criteria. Principal technical components of the RI/FS include:

- Determination of the impacts of the various sources and sites of contamination on the environment;

- Determination of whether remedial action is necessary, and if it is, development of a series of viable remedial action alternatives;

- Investigation of the feasibility and cost of each remedial action alternative;

- Selection of the most appropriate remedial action alternatives;

- Development of a conceptual design and implementation plan for the selected remedial actions.

In the case of New Bedford, the Remedial Investigation portion of the RI/FS is actually comprised of a number of regional and site-specific investigations. Their purpose is to document and characterize each source/site of environmental contamination, to assess the degree of hazard associated with each, and to prioritize the sources and sites for remedial action. Technical information on the distribution, transport, and fate of PCBs and heavy metals in the critical environmental systems will be provided, and predictive models to assess the response of the contaminant-environment interactions to alternative remedial actions (including the "no action" alternative) will be developed. Specific levels of residual contamination investigated will include 50, 10, and 1 ppm.

The Feasibility Study will also be addressed on a site-specific basis within the regional setting. For each prioritized source/site of contamination, the findings of the corresponding remedial investigations will be utilized to develop, evaluate, and select final remedial actions. Conceptual designs of the selected remedial actions will also be developed.

1.2 Overall Scope of Work

The scope of work to be implemented for the Remedial Investigation and Feasibility Study (RI/FS) for the New Bedford sites is outlined in EPA Work Assignment No. 28-1L43, issued August 24, 1983. (The Work Assignment is presented in Appendix A.) All specific tasks requested in the Work Assignment have been included in the scope of work and are presented in detail in Sections 3.0-5.0 of this Work Plan. Other items of the Work Plan include an assessment of the current problem, which summarizes available information from previous studies on the individual sources/sites of contamination (Section 2.0); a description of the managment plan, including a statement of reporting requirements and anticipated meetings (Section 6.0); and a presentation of estimated costs and the project schedule (Section 7.0).

Section 3.0 provides information on what can be termed support tasks for the RI/FS. Although these tasks are considered to be activities within the Remedial Investigation for costing purposes, in practice they are generally applicable to the overall RI/FS. These include the health and safety, quality assurance, and community relations programs. The identification of permit requirements and data management and evaluation are also presented in Section 3.0 since they function as mechanisms for informational transfer to both the Remedial Investigation and Feasibility Study. Two tasks not specfically included in the Work Assignment, the development of the Work Plan and subcontractor procurement, involve significant efforts and costs that are not directly identifiable with site-specific technical requirements. Therefore, these tasks are also included in Section 3.0.

The technically oriented tasks of the Remedial Investigation are described in considerable detail in Section 4.0. The level of detail provided for each task varies with the level of information currently available on the corresponding source/site, and with the degree to which technical requirements can be developed prior to subcontractor selection and completion of related subtasks. Several subtasks presented in Section 4.0 were not explicitly included in the Work Assignment. These have been added to the Work Plan either to better delineate the work elements within the tasks of the Work Assignment or to provide supplementary information necessary for achieving the RI/FS objectives.

Section 5.0 presents details of the Feasibility Study, including site-specific feasibility studies and their respective implementation plans. The technical efforts proposed for the Feasibility Study are only approximate and could change considerably based on the progressive findings of the Remedial Investigation.

Figure 1-1 identifies the individual tasks itemized in the Work Assignment and provides an overview of their interrelationships with respect to the RI/FS. The arabic numerals shown for each task are NUS assigned, while the roman numerals correspond to those designated in the Work Assignment. Five tasks that represent relatively independent remedial investigations are identified along the left-hand margin of Figure 1-1. The results of these investigative efforts will be fed directly into the feasibility studies. Any sampling data generated in these studies will enter the data management system, which will serve as the process point for all sampling and analytical data in the RI/FS. Upon receipt, evaluation, and systematization, the data will be channeled to other investigative tasks and to the feasibility

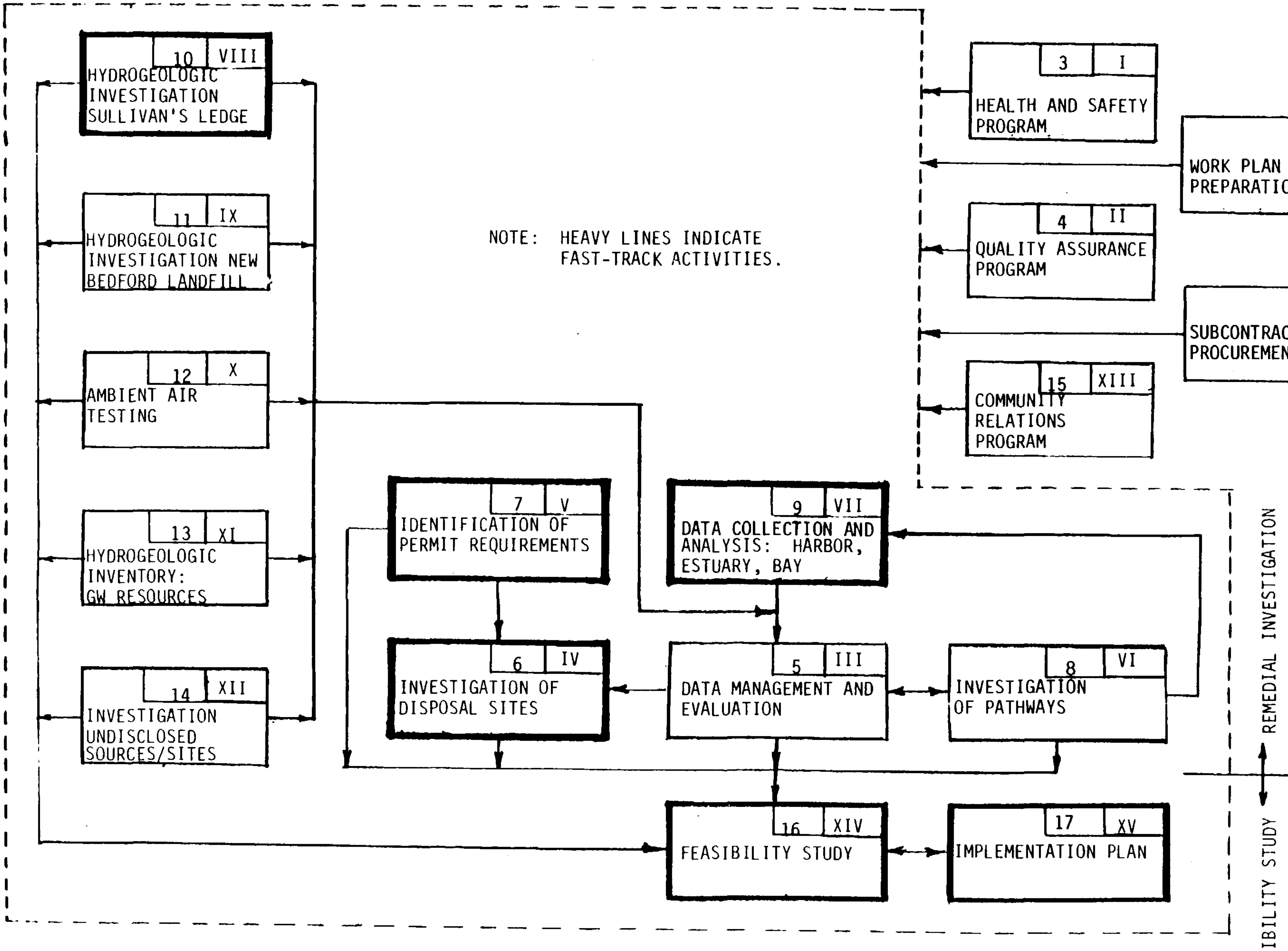

FIGURE 1-1
FLOW DIAGRAM OF RI/FS TASKS

studies. The sampling program for the harbor, estuary, and bay will be developed around the needs of other tasks, particularly hot-spot remediation and the modeling investigation of contaminant pathways. These sampling results will also be made available to the respective tasks via the data management system. The identification of permit requirements is of particular importance to the investigation of potential waste disposal sites, but will also feed information directly to the feasibility studies for the assessment of other alternatives. Both the investigation of disposal sites and the model study of contaminant pathways will focus on the needs of the feasibility studies and will provide direct input to the latter. Although not explicitly shown on Figure 1-1, the progressive findings of the feasibility studies could provide direction to the concurrent investigative tasks.

Five fast-track tasks have been noted on Figure 1-1. The hydrogeologic investigation of Sullivan's Ledge represents one fast-track effort due to recent concern as to the potential extent and impacts of site contamination. The remaining four tasks are all directed toward the fast-track remedial investigation and feasibility study for the remediation of hot spot areas. Other tasks, as for example the health and safety program and the data management system, will also have to progress concurrently to properly support the fast-track activities.

1.3 Labor and Cost Estimates

The estimated level of effort (man-hours) for the RI/FS for the New Bedford Sites is as follows:

	Manhours		
	REMPO (NUS)	Subcontractor	Total
Remedial Investigation	17,242	32,270	49,512
Feasibility Study	15,304	0	15,304
Total	32,546	32,270	64,816

These estimates are based on the scope of work defined in Section 3.0 (Remedial Investigation/Feasibility Study Support Tasks), Section 4.0 (Technical Approach: Remedial Investigation), and Section 5.0 (Technical Approach: Feasibility Study). The man-hour estimates were developed from a very detailed breakdown of the 17 principal tasks of the RI/FS into a total of over 150 subtasks. A summary of the distribution of man-hours using an intermediate number of subtasks (85) is provided in Section 7.1, while a summary-by-labor category is provided for the 17 principal tasks in the exhibits accompanying Optional Form 60 (submitted under separate cover). Even at this level of estimating detail, the man-hour allotments for several tasks must be considered preliminary since the technical requirements cannot be completely defined until other tasks are underway or completed.

The subcontractor man-hours account for the anticipated use of subcontractors to support the REMPO (NUS) Remedial Investigation Team. These man-hours reflect only those activities that represent an extension of the REMPO (NUS) team due to particular capabilities or previous efforts involving the New Bedford Sites, and do not include more generic subcontracting items such as drilling, surveying, etc. The man-hours allotted to subcontractors are primarily for the purpose of accounting for appropriate direct labor mark-up in the preparation of the project budget and should be considered as preliminary approximations of anticipated needs.

The total estimated cost for the performance of the RI/FS is $3,397,521. The exhibits supporting Optional Form 60 (submitted under separate cover) provide a detailed breakdown of project costs. In order to generate this estimated cost, hourly labor rates and overhead, G&A, and fee factors had to be assumed for subcontracted tasks. The rates and factors used in the estimate represent average values for six subcontractors currently performing RI/FS activities for NUS, and may require adjustment once particular firms are selected.

Of particular note is Task 10: Hydrogeologic Investigation of Sullivan's Ledge. The scope of work proposed for this task in the RAMP was prepared prior to the completion of a first-phase investigation study by GCA Corporation, under a separate EPA contract. As a result of the recently reported findings of the GCA study, it was judged that the proposed effort for Sullivan's Ledge had to be expanded. Necessary project funds were made available by a concomitant decision to reduce the proposed level of effort for Task 7 (Hydrogeologic Investigation of the New Bedford Landfill) based on the results of a concurrent GCA investigation of the landfill. The resultant scope of work for Sullivan's Ledge, as presented in

Work Assignment. If this occurs and additional funds become available, a more comprehensive remedial investigation than that proposed herein should be considered.

1.4 Schedule

It is estimated that the RI/FS for the New Bedford Sites will take two years (24 months) to complete following approval of the Work Plan and authorization to begin work. A diagram of the schedule is provided in Section 7.2. Several fast-track activities related to the remediation of hot-spot areas have been identified and will be conducted so as to achieve a 9-month schedule for the completion of the fast-track feasibility study. The fast-track hydrogeologic investigation of Sullivan's Ledge and the corresponding feasibility study have been assigned a 15-month performance schedule, but this could be delayed as a result of the recent designation of Sullivan's Ledge as a separate entry of the NPL.

The following three factors could adversely impact the RI/FS schedule:

- Subcontractor procurement;
- Proximity of project start-up to the winter season;
- Turnaround of analytical results from EPA's Contract Laboratory Program (CLP).

Subcontractor procurement is important not only for the actual start-up of subcontracted work items, but also because the final scoping of related tasks (e.g., harbor sampling in Task 10), must await input from the collective REMPO (NUS)-subcontractor team. The time required for subcontractor procurement is highly dependent on the type of procurement mechanisms to be utilized, and these cannot be determined at this time (refer to Section 6.6). The potential size (i.e., dollar amount) of the subcontracts is a factor working against a timely resolution of this issue.

The proximity of project start-up to the winter season is critical since the necessary sampling efforts may have to be postponed until the spring if delays in subcontractor procurement or other activities occur. Every effort will be made to satisfy the most critical sampling requirements before the onset of unsuitable weather conditions. On the other hand, such a delay may not have a significant effect on the overall completion of the project due to the large data base already available. For example, the waste disposal siting study, the hot-spot feasibility study, and the development of the physical-chemical and food-web models can be initiated without new data. The loss will be in overall project efficiency, since the tasks will be proceeding based on assumed conditions from previous studies and could require eventual modification as the updated data base develops.

The third factor, delays in CLP turnaround, has caused scheduling difficulties in ongoing RI/FS work at other sites. The same could occur in this study as the need for new data develops in the various RI/FS tasks.

2

2.0 PROBLEM ASSESSMENT

2.1 Overview

The Remedial Action Master Plan (RAMP) identified eight sources and sites of PCB and heavy metal contamination in the New Bedford area (Figure 2-1). These include:

- The sediments and water column of the estuary/harbor/bay environment;
- Sullivan's Ledge;
- The New Bedford municipal landfill;
- The New Bedford municipal wastewater system;
- Commercial properties, including Aerovox and Cornell Dubilier;
- Ambient air;
- Biota;
- Undisclosed sources and sites.

In the following subsections, individual problem assessments are developed for the estuary/harbor/bay environment, Sullivan's Ledge, the municipal landfill, and the undisclosed sources and sites. The ambient air and biota are not treated as separately identifiable contaminant problem areas, but rather are incorporated into the other four site-oriented problem assessments. Contamination associated with the municipal wastewater system and the two commercial properties is not within the scope of this Remedial Investigation and Feasibility Study (RI/FS), and corresponding problem assessments are not included in this section. In the case of the wastewater system, previous studies and recent sampling have provided sufficient documentation of the nature and extent of the contamination. The need for a remedial investigation as part of the current New Bedford RI/FS is therefore eliminated. A feasibiity study is likewise not warranted since some remedial efforts (i.e., sewer cleaning) have already been completed by Cornell-Dubilier, and the direction of any future actions is relatively well-defined at this time. Clean-up activities related to PCB contamination at the Aerovox and Cornell-Dubilier

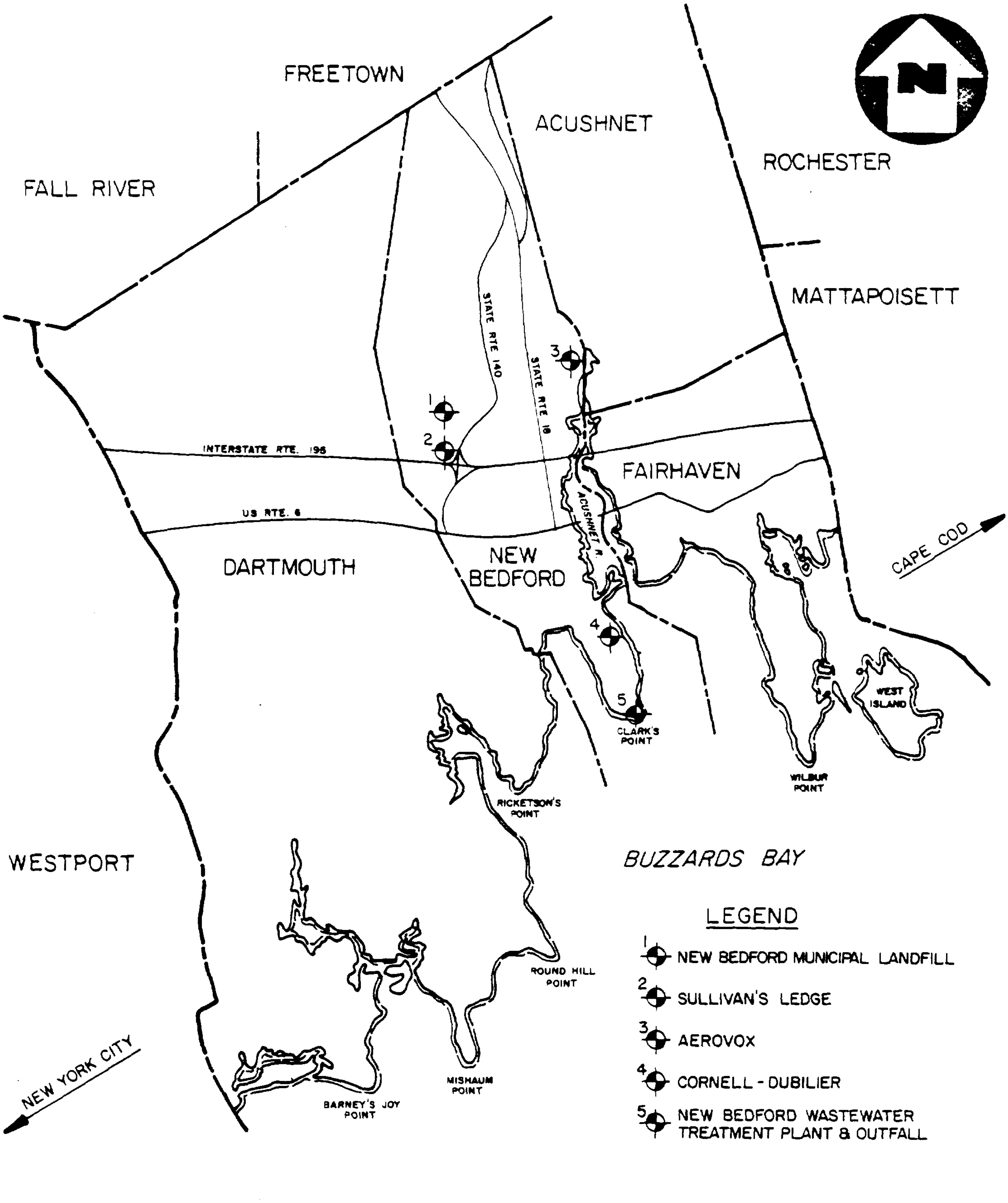

FIGURE 2-1

PROJECT AREA
NEW BEDFORD SITE, NEW BEDFORD, MA
SCALE: 1" = 2.2 MILES

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properties have also been initiated by the respective property owners under consent orders. Consequently, a remedial investigation and feasibility study for these two sites is not warranted and is not within the scope of the current study.

The widespread and high priority nature of PCB and heavy metal contamination within the New Bedford area has led to the implementation of numerous investigations between 1974 and the present. Even a summary presentation of the findings and conclusions of these investigations within the framework of the following problem assessments would be cumbersome and, in fact, repetitive relative to the investigative briefs prepared by Roy F. Weston, Inc., as part of the RAMP effort. Consequently, these briefs have simply been reproduced as Appendix B to this Work Plan. The appendix has been supplemented to account for reports either released subsequent to the RAMP or overlooked in the preparation of the RAMP. Because many of the previous investigations have an overview or regional theme, a one-to-one correspondence with the individual sources or sites of contamination is prohibited. A cross-referencing is therefore provided in Table 2-1, with the cited reference numbers corresponding to the respective entries in Appendix B.

2.2 Estuary/Harbor/Bay Environment

2.2.1 Site History and Description

New Bedford, Massachusetts is a port city located on Buzzards Bay approximately 55 miles south of Boston. With a 1980 population of 98,500, New Bedford is the fourth largest municipality in Massachusetts. Major water bodies in the area include the Acushnet River, New Bedford-Fairhaven Harbor, and Buzzards Bay. The Acushnet River has a drainage area of approximately 3.6 square miles. The mouth of the river, a tidal estuary forming New Bedford-Fairhaven Harbor, discharges into the northwestern side of Buzzards Bay. Buzzards Bay is a semi-enclosed sea with no major tributaries; however, a number of small streams provide local fresh water structure, particularly in the upper bay. Portions of the bay freeze during winter. Flows within the bay, through the Cape Cod Canal, and

Table 2-1

Previous Investigations Related to Sources and Sites of Contamination

Reference Number	Activity	Estuary Harbor Bay	Sulli-van's Ledge	Muni, Land-fill	Waste-water System	Aerovox, Cornell Dub.	Ambient Air	Biota	Unais. Sources, Sites
1	Review of New Bedford PCB Problem	X	X	X	X	X	X	X	
2	Appraisal of New Bedford Harbor Situation	X	X	X	X	X	X	X	
3	Background Data on Current Rate, Wind Velocity, and Tidal Movement in the New Bedford Area	X							
4	To Determine PCB Content of Edible Portions of Marine Finfish, Shell-fish, and Crustaceans in the New Bedford Area Waters							X	
5	Review of Solid Waste Land Disposal Practices in the New Bedford Area		X	X					X
6	Assessment of New Bedford Municipal Landfill			X			X	X	
7	Report on Disposal of PCB's By Aerovox and Cornell-Dubilier			X		X			
8	Study of the Fine-Grained Sediment and Metals Distribution	X							
9	Hot Spot Sediment Sampling near Aerovox	X				X			
10	Evaluation of PCB Contamination and Remedial Dredging Alternatives in New Bedford Harbor	X							
11	Review of Data Needs and Dredging Techniques	X							
12	Investigation of Dredging Tech-niques	X							
13	Investigation of PCB Removal in Biological Wastewater Treatment				X				
14	PCB Survey of New Bedford Sewer System				X				
15	Evaluation of PCB Removal at the New Bedford Incinerator				X				
16	Quality Assurance Plan for Incin-erator Study				X				
17	Data Management	X	X	X	X	X	X	X	
18	Comprehensive Sampling and Analysis Program				X				
19	Continuous Monitoring of the Water Mass Passing the Coggeshall Bridge for 3 Complete Tidal Cycles	X							
20	Evaluation of Remedial Action Alternatives					X			
21	Preparation of the Remedial Action Master Plan	X	X	X	X	X	X	X	X
22	Sampling and Analysis Program for the New Bedford Municipal Landfill and Sullivan's Ledge		X	X					

through straits formed by the Elizabeth Islands at the edge of Vineyard Sound, are strongly tidal. However, local wind-driven and far-field barotrophic effects can be significant.

New Bedford is nationally known for its role in the development of the whaling industry and as the largest revenue-producing fishing port on the East Coast. Before the closure of portions of the harbor to fishing, New Bedford ranked eleventh among the nation's major ports in volume of fish landed (99 million pounds in 1980) and fifth in value of catch ($71 million in 1980). Over half of the value of the catch is represented by scallop sales, making New Bedford "The Scallop Capital of the World." A small local lobster fishery is also based in the port. The fishing industry is the principal user of the harbor's 9-mile waterfront.

The discovery of oil in Pennsylvania in 1860 signaled the beginning of the end for the whaling industry. Ironically, it was on New Bedford's own Fish Island that the process of refining petroleum was perfected. The decline of the whaling industry, already hurt by newly found oil reserves, accelerated during the Civil War, when Confederate raiders sank approximately 50 New Bedford whaling ships on the high seas.

As the whaling industry continued to decline, New Bedford's economy turned to cotton milling. During the half century following the Civil War, 26 cotton textile mills were constructed along the New Bedford shore of the Acushnet River. The industry developed to such a degree that by the early 1900's, the city was the country's premier cotton textile center. This industry flourished in New Bedford until the 1930's, when the Great Depression led to the progressive decline of the industry.

Since the end of World War II, the city has attempted to broaden its economic base through the creation of an industrial park and other incentives designed to encourage the movement of new industry into the area. In 1929, the first of two major electrical component manufacturers, Cornell-Dubilier Electronics Corporation, began operation in New Bedford. The second, Aerovox Industries, Inc., began operation in the 1930's. Both remain in business today. They are housed in old textile mill houses located near the waterfront of the Acushnet River Estuary. Major metals and alloy manufacturing activities are also located on the banks.

The Acushnet River Estuary and New Bedford Harbor have received large volumes of industrial wastes by direct discharge and by runoff and leachate from land repositories since the late 1800's. Toxic metals such as copper, chromium, zinc, and lead were contributed by metals manufacturing and textile dyeing operations over the past 80 years. PCBs were used in the manufacture of capacitors in New Bedford from at least the 1940's to 1976. The disposal of excess and waste PCBs by industry has led to severe environmental contamination in the estuary/harbor/bay system and upland disposal sites.

2.2.2 Nature and Extent of Problem

PCB contamination in the New Bedford was first documented by both academic researchers and the Federal Government between the years 1974-1976. The Environmental Protection Agency (EPA) conducted a New England-wide PCB survey and found high levels of the chemical in various harbor locations. Testing revealed that Aerovox and Cornell-Dubilier were discharging wastewaters containing PCBs to New Bedford Harbor both by direct discharge and indirectly via the New Bedford municipal wastewater treatment facility.

Since this initial survey of the New Bedford area, a much better understanding of the extent of PCB contamination has been gained. The entire 985-acre New Bedford Harbor is underlain by sediments containing elevated levels of PCBs and heavy metals. PCB concentrations range from a few parts per million (ppm) to over 100,000 ppm. Portions of western Buzzards Bay sediments are also contaminated, with concentrations occasionally exceeding 50 ppm. The water column in New Bedford Harbor has been measured to contain PCBs in the parts per billion range, well in excess of EPA's "1 part per trillion" guideline. Much of the PCB sampling done before 1980 was analyzed for only one PCB isomer, Aroclor 1254. Woods Hole Oceanographic Institution scientists have presented evidence suggesting that, as a result, the PCB contamination is often understated by factors of three to five. If so, the extent of PCB contamination in New Bedford Harbor and Buzzards Bay could be much greater than what the historical data indicates. Sediment copper concentrations were reported in 1977 to range from more than 6,000 ppm near the head of the harbor, to less than 100 ppm at the edge of Buzzards Bay. Other metals are also present at elevated concentrations, but at lower concentrations.

The direct discharge of PCB-contaminated wastewater from Cornell-Dubilier has been significantly reduced, while the Aerovox discharge has been nearly eliminated. However, the discharge of PCBs from New Bedford's municipal wastewater treatment plant remains significant. Studies have shown that 200 to 700 pounds of PCBs are being discharged per year to Buzzards Bay via the Clarks Point outfall.

The problems facing New Bedford with respect to PCB and heavy metal contamination can be put into three main categories;

- Human health effects
- Effects on fishing in the area
- Effects on harbor maintenance and development

The most probable link of PCB to human intake is the consumption of contaminated fish and shellfish. Widespread contamination of the Acushnet River Estuary environs has resulted in the accumulation of PCBs in many marine species. Although thousands of acres have been closed to the harvesting of shellfish, finfish, and lobsters, residents are known to still harvest both finfish and shellfish, thus exposing themselves to contaminants through the food-chain mechanism. In addition, many individuals regularly consumed contaminated fish long before the extent of environmental contamination and the adverse effects of PCB were known. The chronic toxicity effects on these people have not been evaluated.

With regard to fishing resources, the closure of the harbor and sections of Buzzards Bay to fishermen has resulted in an estimated capital loss of $250,000 per year to the lobster industry alone. Shellfish and finfish industries as well as recreational fishing have also suffered. Figure 2-2 shows the three closure areas established by the Masachusetts Department of Public Health on September 25, 1979. Area I (New Bedford Harbor) is closed to the taking of all finfish, shellfish, and lobsters. Area II is closed to the taking of lobster and bottom-feeding fish (eels, scup, flounder, and tautog). Area III is closed to the taking of lobsters. Responsibility for enforcement of these closures is entrusted to the Massachusetts Division of Law Enforcement.

Contaminated sediments have had a devastating effect on proposed harbor development projects, most of which require dredging. Dredging in New Bedford Harbor is restricted by the difficulties encountered in fulfilling State and Federal regulatory requirements for the disposal of contaminated dredge spoils.

2.2.3 Objectives

The objectives relating to the estuary/harbor/bay environment are as follows:

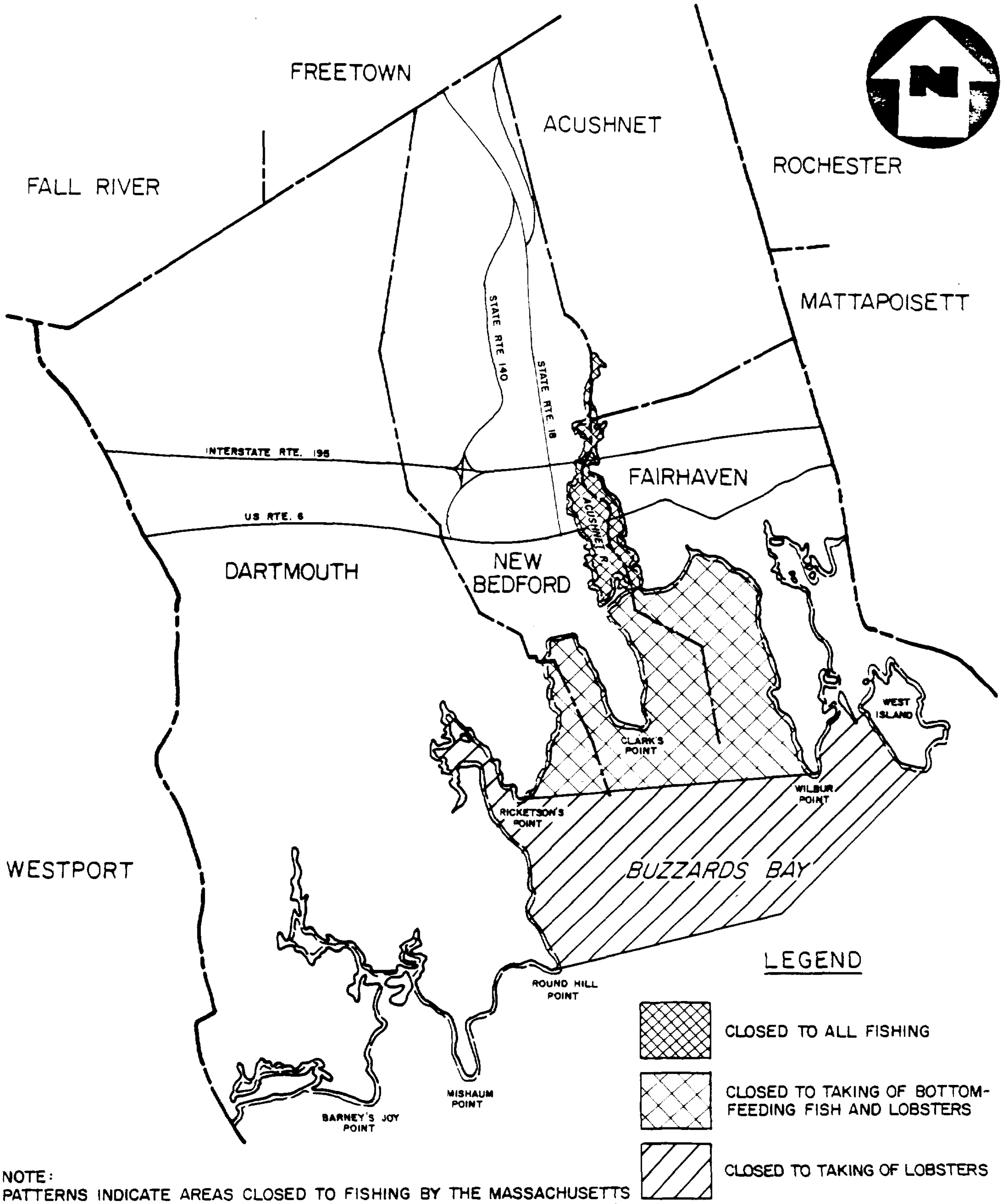
- To reduce the PCB levels in aquatic life generally, and specifically in organisms of commercial and sport fishing importance.

- To lift constraints on harbor development projects.

- To protect human health and welfare, and the environment.

2.2.4 Proposed Response

The proposed response for the estuary/harbor/bay system is a Remedial Investigation and Feasibility Study (RI/FS). The system will be examined in detail as to its nature, hazard potential, and priority for remedial action. Recommendations for corrective action will be presented based on the identification, development, and evaluation of alternatives for remedial measures. The Feasibility Study will be phased as necessary to permit fast-track evaluation



NOTE:
PATTERNS INDICATE AREAS CLOSED TO FISHING BY THE MASSACHUSETTS DEPARTMENT OF PUBLIC HEALTH IN 1979 BECAUSE OF PCB CONTAMINATION.

FIGURE 2-2

RESTRICTED FISHING AREAS
NEW BEDFORD SITE, NEW BEDFORD, MA
SCALE: 1" = 2.2 MILES

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and remediation of situations deemed by EPA to have the highest priority. Presently, the PCB hot spots in the Acushnet River Estuary near the Aerovox plant have been defined as a priority site.

2.3 Sullivan's Ledge

2.3.1 Site History and Description

The Sullivan's Ledge Site is approximately 10 acres in size and is located between the Route 140/195 interchange, Hathaway Road, and the New Bedford Whaler Inn property. A stream forms the southern and eastern borders of the Sullivan's Ledge site and flows northwest under Hathaway Road, across the municipal golf course and into Apponagansett Swamp. The site was originally operated as a granite quarry that supplied building stone to the New Bedford area. Depressed economic conditions and problems with excessive groundwater forced its closing. After a period as a local swimming hole, the property was taken and managed by the City of New Bedford as a waste disposal site.

Previous studies, records, and conversations with local residents indicate that a variety of construction/demolition materials including brush, trees, timbers, cobblestones, brick, glass, and metal, as well as large amounts of rubber tires, junk cars, oils, sludges, reject capacitors, and reject transformers were disposed of here. There is a lack of evidence as to whether the site received significant amounts of domestic wastes.

Today, the Sullivan's Ledge Site is no longer used as a waste landfill. The site has been completely filled and graded, although large piles of cobblestone, mooring debris, timbers, and boulders cover areas about the site.

2.3.2 Nature and Extent of Problem

Sullivan's Ledge has served as a disposal site for materials containing polychlorinated biphenyls (PCBs) as well as other industrial and commercial wastes. A recent publication prepared by the Massachusetts Coastal Zone Management substantiated that large volumes of PCBs may be buried at the Sullivan's Ledge Site. Until recently, however, few studies have been conducted that addressed the extent of contamination at the site. As part of recent EPA efforts to evaluate the overall New Bedford problem, GCA/Technology Division was contracted to determine the extent of groundwater contamination surrounding the Sullivan's Ledge Site and the adjacent New Bedford municipal landfill. Both locations are situated adjacent to Apponagansett Swamp which serves as a source of recharge to drinking water wells in Dartmouth, Massachusettts.

GCA concluded from its study results that the Sullivan's Ledge Site is a significant source of groundwater contamination. Industrial refuse in the quarry is supplying PCBs and organic contaminants directly to groundwater that has a high potential to flow through fractured bedrock to wells or other points of surface discharge. The contaminated surface soils at the Sullivan's Ledge Site are subject to erosion into nearby streams during storm events. This mechanism is the most likely source of any contaminated sediments that may be in these streams. Based on the array of contaminants detected, industrial sources of the refuse material are suspected to be in the categories of plastics, rubber, metal pressing, cleaning, and capacitor and transformer manufacturing. It was recommended that further investigations be conducted to quantify the hazard that the Sullivan's Ledge Site represents to human health and the environment and to identify appropriate remedial options.

2.3.3 Objectives

Present information indicates very high levels of contamination at the Sullivan's Ledge quarry. The potential for risk to human health and the environment, as well as the continuing contamination of the resources in the area, creates a need for action at this site. A major objective in the case of the Sullivan's Ledge Site is protection of groundwater and surface water resources, particularly those which serve as actual or potential drinking water supplies. The extent of PCB and selected pollutant contamination within and around the site needs to be defined and documented.

2.3.4 Proposed Response

The proposed response to the need for action at Sullivan's Ledge is a Remedial Investigation and Feasibility Study (RI/FS), examining in detail the site conditions and correlating the existing and newly acquired data. Recommendations and alternatives for cleanup and/or control of contamination from the quarry will be developed.

2.4 New Bedford Municipal Landfill

2.4.1 Site History and Description

The New Bedford municipal landfill, in operation since the early 1920's, occupies 40 acres of marsh northwest of the city. The landfill is located one-half mile southeast of the Paskamanset River near the southern end of a large glacial lake deposit that extends from the Apponagansett Swamp to the northern limit of the Acushnet Cedar Swamp, with Hathaway Road to the south and Shawmut Avenue to the east.

The geology of the area consists of a layer of freshwater peat varying from 7 to 10 feet thick, underlain by a thin layer of silty fine sand, and then layers of stratified silts and clayey silts with thin layers of silty clay. The sand and silt layers vary from 8 to 36 feet deep.

The landfill has been used as a repository for domestic, commercial, and industrial wastes. Originally operated as an open dump, the site is now maintained as a landfill in accordance with State and Federal regulations. Prior to 1971, incinerator ash containing unknown quantities of PCB residue was buried there. The incinerator, located on the landfill, was the primary method of solid waste disposal (including residential, commercial and industrial wastes) utilized in New Bedford from the 1920's until 1970. In February 1971, the city began landfilling all refuse except paper and commercial waste which continued to go to the incinerator. The incinerator was completely closed down in January 1974. Liquid PCB wastes and other hazardous substances also may have entered the landfill since its inception. Historically, over one-half million pounds of solid PCB wastes may have been disposed in the municipal landfill.

The New Bedford landfill remains an active facility, but is likely to be filled to capacity before 1985. In 1981, the city of New Bedford contracted Camp, Dresser & McKee (CDM) to design and develop a closure and cover plan for the municipal landfill. As part of the plan, a transfer station was proposed which was to be situated near the access road to the incinerator. The north side and top of the landfill was graded and covered to its present configuration. Four observation wells were constructed at the proposed transfer station site as part of CDM's geotechnical investigation.

2.4.2 Nature and Extent of Problem

Monitoring for PCBs has revealed no significant offsite contamination problems in the area of the landfill. EPA sponsored a study in 1978 which documented contamination of less than 1 ppb in shallow groundwaters to the immediate north of the landfill. No contamination within detectable limits was found to the west, northwest, and east of the site. Low levels of PCBs were found in the sediment and benthic organisms of the adjacent Apponagansett Swamp and Paskamanset River. PCBs were also detected in fish and field mice taken from the surroundings. Historically, air-borne PCBs at the landfill registered only 0.02 $\mu g/m^3$ in winter, but exceeded 1 $\mu g/m^3$ in summer. Recent EPA data indicates that summer levels have dropped to typical ambient levels (0.008 $\mu g/m^3$). This is probably due to the fact that historic PCB deposits have been covered by several feet of refuse.

The New Bedford landfill is situated over an aquifer which is the source for the municipal wells of the town of Dartmouth. The 1978 study showed no PCB contamination of this drinking water supply, a finding which was also reached by Gidley Laboratories Inc. in 1980.

A study of the landfill done by GCA/Technology Division during the period of February to March, 1983, substantiated these results. Aqueous samples were analyzed for volatile organics, pesticides/PCBs, and extractable organics. All soil samples collected were analyzed for volatile organics, and representative samples were selected for PCB analyses and comprehensive organic analysis by GC/MS. Analysis of the soil samples taken at the landfill and near Shawmut Brook revealed low ppb (1 to 13 ug/kg) levels of aromatic and chlorinated aliphatic solvents at the landfill and no detectable levels of organic contaminants near Shawmut Brook. Groundwater analyses at these locations showed trace levels (up to 10 µg/l) of several chlorinated solvents and of PCBs at the landfill. At the Shawmut Brook location, analyses showed only trace levels of two organic pesticides. Surface water samples taken near the landfill and in the swamp were analyzed for PCB; no detectable levels were found.

GCA concluded that the New Bedford municipal landfill is not currently a significant source of hazardous contaminants to the Paskamansett River system. The locations of the surface and groundwater samples were specifically selected to detect contaminant migration. The contaminants analyzed for in this investigation were not detected in significant amounts in any soil or water samples taken near the landfill or in the Apponagansett Swamp.

2.4.3 Proposed Response

Due to the apparent lack of contaminant migration off site, a Remedial Investigation and Feasibility Study for the municipal landfill is not warranted. However, monitoring of existing wells should continue. If subsequent investigations and monitoring reveal that offsite migration is occurring, the need for a site-specific RI/FS will be re-evaluated.

2.5 Undisclosed Sources And Sites

2.5.1 Description of Potential Problems

It is suspected that other sources and sites of contamination within the New Bedford area may exist that have not been identified through previous investigations and monitoring. The RAMP has grouped these other sources and sites, which number greater than 30, as follows:

- Public and private landfills and chemical disposal areas
- Dredge disposal sites (upland, shoreline, and ocean)
- Miscellaneous public and private properties, including fill areas
- Scrap metal dealerships
- Properties adjacent to areas of known high PCB concentrations
- Other sources/sites

2.5.2 Objectives

The objective of these investigations will be to identify, evaluate, and document these sources and sites of potential or suspected contamination. The hazard potential of each site will be assessed.

2.5.3 Proposed Response

The proposed response included as part of this Work Plan is to conduct an initial identification and assessment of these sites. Principal work items will include searches of pertinent available literature and records, interviews, and site reconnaisance. Based on the results of this initial investigation, those sources/sites determined to possess significant hazard potential will be recommended for detailed remedial investigations to quantify the distribution and magnitude of contamination by PCBs and other hazardous substances. Knowledge gained would be used to develop and evaluate recommendations and alternatives for cleanup and/or control of contamination in related feasibility studies for the most critical sources/sites.

3

3.0 REMEDIAL INVESTIGATION/FEASIBILITY STUDY SUPPORT TASKS

3.1 Task 1: Work Plan Preparation

The work conducted to prepare this Work Plan for the New Bedford Sites is designated as the first of the support activities. This Work Plan details, to the extent practical at this time, the activities of the Remedial Investigation and Feasibility Study necessary to characterize the onsite and offsite contamination and to evaluate remedial measures at the sites.

3.2 Task 2: Subcontractor Procurement

The need for subcontractors is anticipated for several tasks of the New Bedford project, including primarily tasks within the Remedial Investigation and support field activities. REMPO's involvement in the development of procurement options, the preparation of requests for competitive proposals or bids, technical and financial reviews of the responses, and subcontractor selection and procurement will be accounted for in the subcontractor procurement task.

A more detailed presentation of anticipated subcontracting needs and of procedures to be followed in the selection process is provided in Section 6.6.

3.3 Task 3: Health and Safety Program

A Health and Safety Program will be prepared based on guidelines in the current version of the NUS Superfund Division Health and Safety Manual. The purpose of the program will be to:

- Provide minimum safety protection requirements and procedures for site field crews and subcontractors.

- Ensure adequate training and equipment to perform expected tasks.

- Provide ongoing site monitoring to verify preliminary safety requirements and to revise specific protection levels as required.

- Protect the general public and the environment.

Based on the current understanding of the contamination problems within the New Bedford study area, the need for site-specific health and safety plans is anticipated only for the remedial investigation at Sullivan's Ledge and for the sampling and other onsite activities in the estuary/harbor/bay system, particularly the hot-spot areas. The health and safety requirements for other site investigations of a regional nature will be developed as needed.

Elements important to the site-specific health and safety plans include a risk assessment of the site hazards, knowledge of the tasks expected to be performed at the site, protective and monitoring equipment to be used, training appropriate to the work to be done, health monitoring to identify adverse effects, and emergency planning for quick response to accidents or contaminant releases. Available information on the New Bedford Sites is sufficient to initiate the development of site-specific health and safety plans prior to the completion of other activities. A conservative approach will be used in the initial determination of levels of protection and other health and safety requirements, with potential relaxation as new data are acquired in the course of the remedial investigation.

The site-specific health and safety plans will be incorporated into an overall site-specific operations plan, the purpose of which is to consolidate all site-specific operational requirements into a single document. Other types of information to be included in the operations plan will be quality assurance requirements, sampling protocol, equipment needs, subcontracting specifications, etc.

3.4 Task 4: Quality Assurance Program

A Quality Assurance program will be developed for the New Bedford Sites based on the general NUS Quality Assurance Project Plan. Consideration will be given to requirements of sampling; field testing; surveying; chain-of-custody; sample handling, packaging, preservation and shipping; and recordkeeping and documentation. Analysis requirements, in addition to those listed in the Contract Laboratory Program (CLP), will be given along with any other procedures needed for remedial investigation/feasibility studies on or related to the site. The quality assurance requirements (QAR's) applicable to the New Bedford Sites include:

QAR 3.0	Design Control
QAR 4.0	Data Acquisition
QAR 5.0	Procurement Document Control
QAR 6.0	Instructions and Procedures
QAR 7.0	Document Control
QAR 8.0	Control of Purchased Items and Services
QAR 9.0	Identification and Control of Laboratory Samples (Includes Chain-of-Custody)
QAR 11.0	Inspection
QAR 12.0	Control of Measuring and Test Equipment
QAR 13.0	Handling, Storage, and Shipping of Hazardous Substances
QAR 14.0	Control of Nonconformances
QAR 15.0	Corrective Action
QAR 16.0	Quality Assurance Records
QAR 17.0	Audits

The implementing procedures associated with the above QAR's are also applicable, as are standard instructional procedures (Quality Control Procedures) for sampling, chain-of-custody, shipping, and the like.

As with the Health and Safety Program, site-specific quality assurance plans will be prepared for Sullivan's Ledge and the estuary/harbor/bay system. These will be incorporated into the site-specific operations plans. The quality assurance requirements of other tasks will likely be satisfied by the general Project Plan.

3.5 Task 5: Data Management and Evaluation

The data management and evaluation system, as defined for purposes of the RI/FS, will function to satisfy three principal study needs. These include:

1. A computer-based clearinghouse for the storage and retrieval of all existing and new data, thereby assuring that the data are centrally available to all study participants in a relatively consistent format. The system must allow for the routine addition of new records, the deletion of old records, and the modification of existing records, and must be formatted such that flexible data retrieval (e.g., by sample number, type, date, source, etc.) is provided to the user.

2. An analytical tool to help satisfy resource management needs. Such tools would include report writing capabilities, statistical analysis routines, and graphics/plotting packages. The system must be well documented and user-interactive, with the overall capability to satisfy additional data management needs as they develop.

3. A mechanism to screen data against a set of pre-established criteria, thereby allowing the selection of only those data points that are reliable or useable for the purposes of a particuiar study component.

A data management and evaluation system that satisfies these functional needs has already been developed for the New Bedford study by Metcalf and Eddy, Inc., under a separate EPA contract. Metcalf and Eddy remains the custodian of the system under the previous contract, and until recently continued to enter and validate new data records as they became available. A complete description of this system has been prepared by Metcalf and Eddy (1983), and is not repeated in detail here. Figure 3-1 presents a schematic of the current system, which has its basis in Digital Equipment Corporation's DATATRIEVE-II computer software package. A critical element in the data management system is the initial screening of data against defined criteria to determine its adequacy for decision making. This involves a multi-phased review of the sample collection and analytical techniques

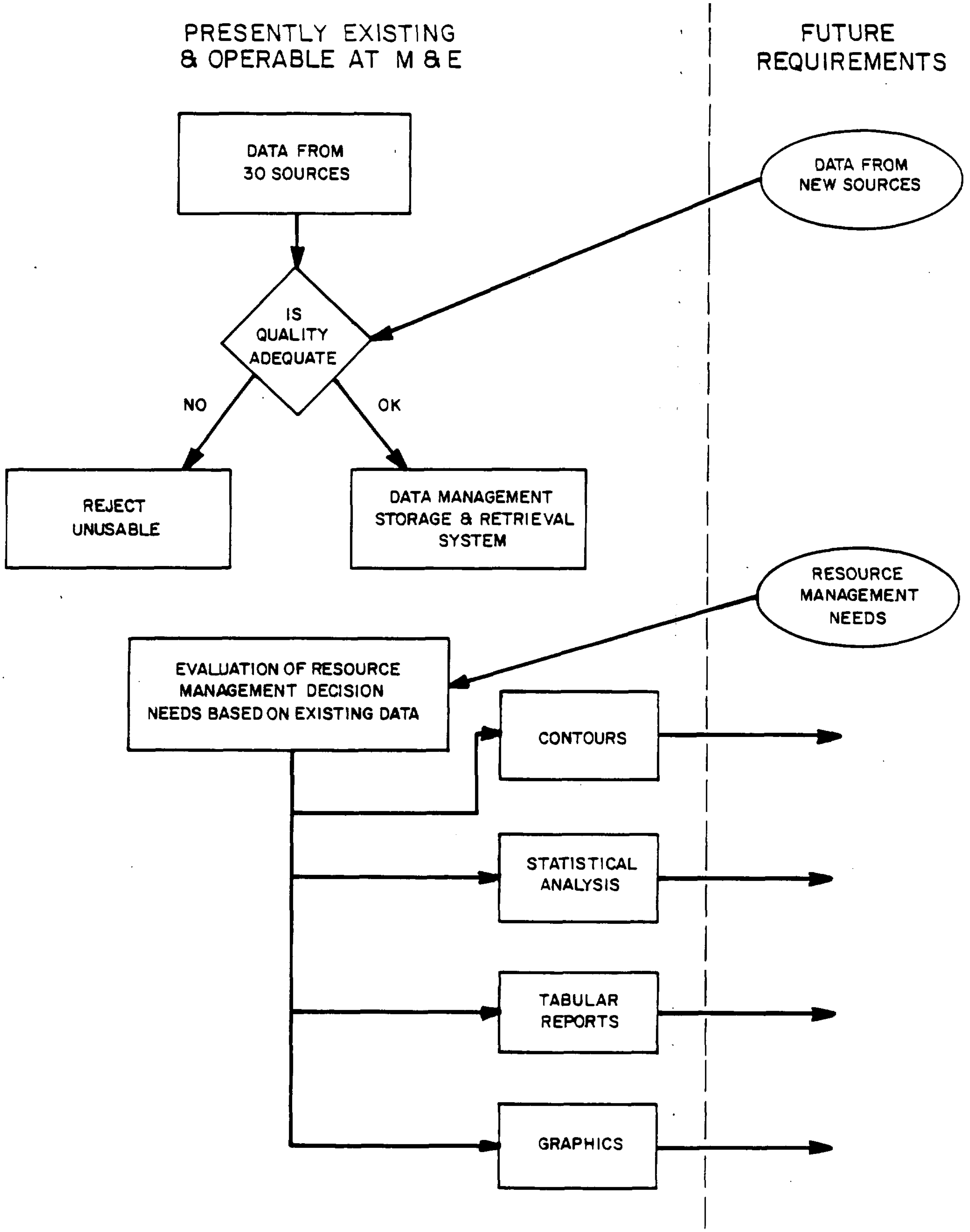

FIGURE 3-1

EXISTING DATA MANAGEMENT AND EVALUATION SYSTEM
NEW BEDFORD SITE, NEW BEDFORD, MA

NUS CORPORATION
A Halliburton Company

employed, and involves a team of individuals trained and experienced in the appropriate disciplines. Each data record is eventually classified into one of three categories:

- "Reliable": Data that is trustworthy or possesses a reliability worthy of fullest confidence;

- "Incomplete": Data for which the sampling and/or analytical methodology is not defined or reported in sufficient detail to judge its adequacy; or data that cannot be assessed due to suspect or incomplete reporting;

- "Unusable": Data possessing collection and/or analytical deficiencies which preclude its use in decision making.

Of the 5,062 records currently in the system, 91 percent were determined to be reliable, 5 percent incomplete, and 4 percent unusable.

Much of the previous effort of Metcalf and Eddy has involved the development and "debugging" of the basic system and supplementary capabilities, and the tracking down of all background information on the collection and analysis techniques used in each of numerous previous investigations. The anticipated work should be more conducive to further system development and use since the quality assurance controls should minimize any sample collection, analysis, and reporting deficiencies. In addition, because Metcalf and Eddy has been able to anticipate future data management needs via periodic reviews with EPA and the Interagency Task Force, the implementation of any new system requirements should be straightforward for the data management subcontractor.

The work to be performed as part of the RI/FS will, in effect, be a continuation of the services recently provided by Metcalf and Eddy. It will be response-oriented, since the data and resources management needs of the various users may evolve in a sporadic manner with a requirement for short response times. In addition, data to be validated and entered into the system will likely be batch-oriented to further inhibit an uninterrupted scheduling of personnel. A representative of the data management subcontractor will also be expected to attend project planning or review meetings to maintain a pulse on user needs and to address any pertinent questions or problems. For purposes of estimating the required level of effort, the equivalent of one person with approximately full-time involvement over the duration of the project has been assumed. This is consistent with the personnel requirements experienced under the recent EPA contract with Metcalf and Eddy.

Logistically, relatively small and well-defined data retrieval needs will be satisfied by the data management subcontractor. Remote access to the data files is another possibility if appropriate access security is maintained. More long-term needs with a high degree of data interaction, as for example in the development and calibration of the models, would more likely involve a direct transfer of the appropriate data files to the user (e.g., via magnetic tapes), with periodic updating by the data management subcontractor as new data is received. Any statistical analyses or graphics/plotting requirements involving the new data or simple manipulations thereof will be the responsibility of the data management subcontractor. All requests for data and informational transfer must go through REMPO (NUS) project personnel.

An initial work item of this task will be the preparation of a guidance document that will summarize the existing capabilities of the system, the methodologies of user access, and other information that will promote the full potential of the user-interactive capabilities. The current data evaluation criteria developed by Metcalf and Eddy will be reviewed by REMPO (NUS) project personnel, the RSPO, and an independent peer review team possibly consisting of experts from other task subcontractors. Suggested modifications will then be implemented. In addition, written system updates will be prepared on a monthly basis by the data management subcontractor for controlled distribution to all system users. These will include a summary of all new data entered into the system, a description of any newly developed support routines (e.g., analysis or plotting routines), and information on user access and potential applications of the new routines to satisfy RI/FS needs.

3.6 Task 7: Identification of Permit Requirements

The responsibility of identifying permit requirements for implementation of various remedial actions has been assumed by EPA Region I. Use will be made of the Interagency Task Force in this regard. The role of REMPO (NUS) personnel in this task will be attendance at planning meetings regarding the permits, and any other interactions necessary to ensure that requirements for the RI/FS are being met.

Timing is a significant factor in this task. The investigation of these requirements should be performed in conjunction with the waste disposal siting study and the evaluation of alternatives during the feasibility study. It should occur early enough to identify possible regulatory obstacles, and to avoid delays in implementing remedial actions.

To expedite the removal and disposal of PCB hot spots in the estuary/harbor/bay environment, the investigation of permit requirements will be pursued as a priority activity.

The following are to be identified during this task:

- Areas of jurisdiction and legal responsibility among Federal, State, and local authorities;
- Applicable statutes and regulations;
- Agency review procedures;
- Permit requirements;
- Potential conflicts or obstacles (as between different agency requirements or between new technologies and standing regulations;
- Approximate required time allotment for project review and issuance of permits by responsible agencies.

A preliminary list of Federal and State agencies and legislation has been compiled in the RAMP. The Federal and State legislation which may pertain to the various remedial measures considered includes, but is not limited to, the following:

- Federal
  - National Environmental Policy Act of 1969 (NEPA)
  - Water Pollution Control Act of 1972 (WPCA) as amended by the Clean Water Act of 1977 (CWA)
  - Marine Protection, Research, and Sanctuaries Act of 1972 (MPRSA)
  - Safe Drinking Water Act of 1974 (SDWA)
  - Toxic Substances Control Act of 1976 (TSCA)
  - Resource Conservation and Recovery Act of 1976 (RCRA)
  - Clean Air Act as amended, 1977 (CAA)
  - Comprehensive Environmental Response, Compensation, and Liability Act of 1980 (CERCLA)
- State
  - Massachusetts Environmental Policy Act of 1972 (MEPA)
  - Hazardous Waste Management Act of 1979 (HWMA), MGL Ch.21C
  - Hazardous Waste Facility Siting Act of 1980 (HWFSA), MGL Ch.21D

Agencies having responsibility for project oversight, review, and permit assurance include:

- U.S. Environmental Protection Agency (EPA) - Primary interpreter and enforcer of Federal regulations, and general administrator of the Superfund Program under CERCLA;

- U.S. Army Corps of Engineers (COE) - Responsible for overseeing and permitting projects involving dredging, filling, or ocean disposal issues permits under CWA Section 404 for dredging and filling, Section 10 for structures in waterways, and MPRSA Section 103 for ocean transport and disposal of dredged materials;

- Massachusetts Executive Office of Environmental Affairs (EOEA) - Umbrella agency for State environmental departments; processes notifications of proposed projects and ensures compliance with MEPA;

- Massachusetts Office of Coastal Zone Management (CZM) - Establishes management policies for coastal areas and reviews projects for consistency with same;

- Massachusetts Department of Environmental Quality Engineering (DEQE) - Principal regulatory and enforcement agency in environmental matters; responsible for technical review of project plans; issues licenses and permits; administers State and Federal programs including Superfund;

  - Division of Water Pollution Control - Administers CWA, issues discharge permits, regulates special wastes;

  - Division of Hazardous Wastes - Administers RCRA and HWMA, reviews all landfill projects for both hazardous and non-hazardous materials;

  - Division of Air Quality Control - Administers CAA, regulates hazardous waste incinerators, monitors fugutive emissions;

- Division of Waterways - Issues permits for dredging and licenses for construction in waterways;

- Massachusetts Department of Environmental Management (DEM) - Responsible for implementing HWFSA through its Bureau of Solid Waste Disposal, in cooperation with the Hazardous Waste Facility Site Safety Council.

Local agencies having review authority may include conservation commissions, boards of health, and others. Site assignment for hazardous waste disposal facilities is the responsibility of local boards of health.

3.7 Task 15: Community Relations Program

A Community Relations Program will be developed by EPA Region I. The primary role of NUS in the program will be one of support for the activities planned and conducted by EPA. NUS personnel will not represent EPA or take the lead in Community Relations.

The community relations plan is designed to reach all of the varied sectors of the community interested in, and affected by the problem. It is intended to provide a means of communication between the communities and the regulatory agencies.

Both the Work Assignment and RAMP have identified the following specific activities to be undertaken by the EPA to achieve these goals:

- Public meetings to be held at key points of the remedial process to provide the opportunity for public questioning and comments on proposed activities.

- Local document repositories established at the New Bedford and Fairhaven town halls and libraries.

- An informational brochure on the nature of PCBs and their environmental impact.

- News releases

- Fact sheets to explain site activities and study findings.

- Briefings with local government officials.

- Small group meetings.

- Formal public hearings on recommended remedial activities.

- Slide shows and scripts for public meetings.

The support provided by NUS will fall into two main categories: logistical support for the planning and execution of the activities, and technical support to ensure that all information furnished to the public is accurate and current.

4

4.0 TECHNICAL APPROACH: REMEDIAL INVESTIGATION

4.1 Task 6: Investigation of Potential Disposal Sites

4.1.1 Objectives

Many of the alternatives preliminarily identified for remedial action of the environmental contamination within New Bedford and environs involve the removal of contaminated sediment or soil. Of particular note are large quantities of sediments within New Bedford Harbor that contain high levels of PCBs and heavy metals. The successful implementation of any such alternatives requires permitted sites for the disposal of the removed materials, including any areas necessary for ancillary operations such as material dewatering or leachate treatment. The objective of this task is to conduct several phases of the engineering effort required for the permitting of a hazardous waste disposal site. In particular, the identification, evaluation, and selection of appropriate sites for the disposal of sediments or soil contaminated with PCBs, heavy metals, or other toxic substances will be completed. A multi-phased technical approach that progressively reduces the number of candidate sites as the level of investigative detail increases will be utilized to achieve the task objective in a cost-effective manner without loss of detail.

4.1.2 Overview of Methodology

The methodology proposed for use in the identification, evaluation, and selection of disposal sites is schematized in Figure 4-1. Based on a review of available information from involved agencies, previous studies, and other available documents and maps, an initial identification of potential sites will be conducted. The objective of this initial screening is to eliminate the obviously unacceptable sites rather than to identify the best sites. A preliminary ranking of all remaining sites will then be conducted. This ranking will have a quantitative basis, but will deal with general engineering, environmental, and cost factors that are identifiable from the background information. Those sites with the highest rankings, and all

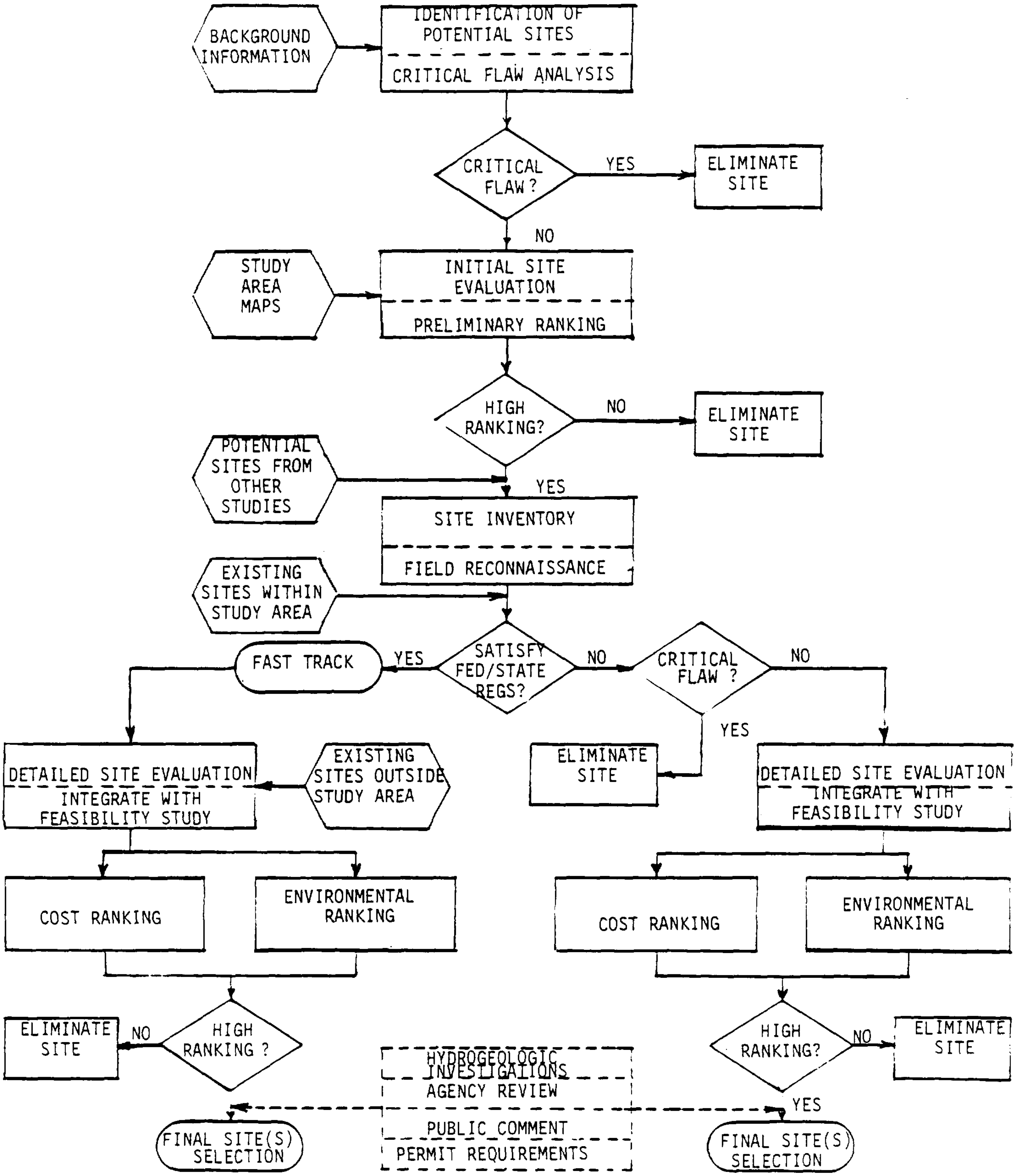

FIGURE 4-1
METHODOLOGY FOR DISPOSAL SITE SELECTION

sites identified as potential solid waste disposal sites in previous studies, will then enter a third phase of evaluation. This phase will involve an onsite evaluation to "ground truth" the background information and to identify any additional positive or negative site features. Emphasis will be placed on those site characteristics important to regulatory and permitting requirements. A differentiation of all remaining sites will be conducted in relation to whether a given site satisfies the basic criteria of the Federal and State regulations for chemical waste landfills. Any existing waste disposal areas or landfills within the study area will also be evaluated relative to these criteria for chemical waste disposal.

Those sites found to satisfy the more stringent landfill disposal criteria will be further evaluated in conjunction with the fast-track feasibility study for hot-spot remediation. The use of any other sites for the disposal of hot-spot sediments would require special exemption from Federal and State regulations. However, this possibility cannot be ruled out in the case of New Bedford, and additional sites may be considered in the fast-track evaluation. Separate rankings based on costs and environmental impacts will be developed, with a subsequent determination of the most favorable sites. Secure chemical landfills outside the study area will also be assessed at this point. After public comment and agency review, a final site selection will be made by the lead agency.

Within the framework of the overall feasibility study, any sites that did not satisfy the chemical landfill criteria will be evaluated and selected for the disposal of less contaminated wastes. A methodology similar to that used for the potential chemical landfill sites will be implemented.

4.1.3 Identification of Potential Sites

The initial task in site selection is best-termed a "critical flaw" analysis, in which available information for the entire area under consideration is reviewed for the purpose of eliminating any areas that involve features prohibitive to waste disposal site development. Four work items comprise this task, as follows:

- Contact agencies and organizations that have regulatory control or background information pertinent to the siting study;

- Compile and review all background information;

- Meet with appropriate permitting agencies;

- Eliminate all areas that involve any of a pre-defined list of negative site features.

A partial list of agencies and organizations that will be contacted is given in Table 4-1. In addition to seeking any regional or local site information that could support the siting study, these contacts will serve to identify or clarify any policies that will affect site evaluation criteria or eventual site selection. Particular emphasis will be placed on any previous studies by these agencies and organizations that deal with local or regional waste management.

In addition to the information compiled via the agency/organization contacts, regional and local data pertinent to the siting study from other sources will be assembled and reviewed. These sources could include technical reports of a regional nature, previous studies on the New Bedford PCB problem, and land use, soils, geologic, and topographic maps. Individuals involved with existing solid waste disposal sites will also be contacted. A review will also be made of existing aerial photographs to provide an overview of the regional and principal siting features.

The information gained in the initial work items will be compared to a list of negative site factors in order to eliminate any sites that are obviously unsuitable for hazardous waste disposal. The following is a preliminary list of such site exclusion criteria:

TABLE 4-1

LIST OF AGENCIES AND ORGANIZATIONS TO BE CONTACTED

Federal

- U.S. Environmental Protection Agency
- U.S. Army Corps of Engineers
- U.S. Coast Guard
- U.S. Soil Conservation Service
- U.S. Geological Survey
- U.S. Fish and Wildlife Service

State

- Department of Environmental Quality Engineering
  - Division of Water Pollution Control
  - Division of Air Quality and Hazardous Waste
  - Division of Waterways

- Department of Environmental Management
  - Division of Water Resources
  - Division of Forests and Parks
  - Bureau of Solid Waste Disposal

- Executive Office of Environmental Affairs
- Department of Public Health
- Office of Coastal Zone Management
- Department of Fisheries, Wildlife, and Recreational Vehicles
- Massachusetts Environmental Policy Act Unit
- Department of Public Works
- Department of Public Utilities
- Historical Commission

Local

- New Bedford, Acushnet, and Fairhaven Planning Departments
- Southeastern Regional Planning and Economic Development District

Committees

- Acushnet River Estuary PCB Commission
- Interagency Task Force
- Ad Hoc Committee on the Acushnet River Estuary Disaster

- Inadequate size or capacity;

- Beyond reasonable distance for waste transport, preliminary set at 10 miles;

- Conflicting land use such as residential zones; state parks; forest, game, or conservation lands; airports; military facilities; and areas where previous land use practices could introduce additional environmental liabilities;

- Social and environmental constraints such as watersheds of public water supply sources (surface water or groundwater); environmentally sensitive watersheds; and historic sites;

- Engineering constraints such as steep slopes or unsuitable geology that are readily identified using available information.

This preliminary list will be updated and finalized in coordination with the RSPO as background information becomes available. Upon completion of this critical flaw screening, particular sites within those areas not eliminated will be identified for the next phase of evaluation.

At some point early in the siting study, a meeting with the RSPO and various regulatory agencies will be held to discuss policies, procedures, and anticipated actions relative to site selection and permitting. This meeting will help to focus any future investigative and selection actions.

The products of the initial screening effort will be a series of study area maps that depict areas subject to each of the exclusion criteria, and those sites selected for further evaluation.

4.1.4 Initial Site Evaluation

The next phase of site screening will involve a first-level quantitative ranking, as described below. In preparation for the ranking, a limited field reconnaissance of all sites will be conducted. This will involve a brief viewing of each potential site, with supporting photographs, and a field-based evaluation with respect to the ranking categories. A series of study area maps showing surface slope, soil, bedrock, surface water, and groundwater conditions will also be prepared to facilitate the second-level screening.

The quantitative ranking system to be used in this task will have a categorical basis consistent with the overview nature of available information. The categories will reflect site features important to engineering feasibility, developmental costs, and environmental acceptability. An example of such categories, along with tentative point scores and weighting factors, is given in Table 4-2. This information will be finalized in conjunction with the RSPO, based on input received from the agencies and organizations previously contacted. For each site, a point score will be subjectively assigned to each category. These values will then be multiplied by the respective weighting factors and will be summed over all categories to yield the site ranking values. The distribution of resulting values will determine how many and which sites will be retained for further analysis. Unless an obvious limitation is discovered, any potential site identified by others in previous studies will be retained. It is expected that no more than ten sites will remain under consideration at this level of screening.

4.1.5 Site Inventory

A more formal inventory of site features will be developed for each of the remaining sites. The primary purpose of this inventory is to document which sites qualify as potential candidates for a secure chemical landfill under current Federal and State regulatory criteria. A completed site inventory evaluation form similar to that shown in Figure 4-2 represents the principal product of this task and provides the mechanism for qualifying sites. A refined inventory form will be developed during the course of the study subject to the approval of the RSPO. In

TABLE 4-2

EXAMPLE OF SITE RANKING FACTORS

CONDITION	EXAMPLE POINT SCORES: CONDITION	EXAMPLE POINT SCORES: SCORE	WEIGHTING FACTOR
TRANSPORT DISTANCE	Point Score = 10 - No. Miles from site		9
ROUTE CONDITIONS (weight limits, grades, bridge restrictions, population along route, need for pumping if piped, etc.)	Minor Restrictions	10	5
	Few Restrictions	5	
	Many Significant Restrictions	0	
ENVIRONMENTAL ACCEPTABILITY (visual impacts, air quality, water quality, noise, cultural resources, ecology, etc.)	Minor Problems	10	10
	Surmountable Problems	5	
	Significant Restrictions	0	
CURRENT LAND USE (zoning restrictions, prime agricultural lands, adjacent development, buffer zones, ownership, etc.)	Inactive/Minor Problems	10	7
	Passive/Few Problems	5	
	Intensive/Significant Problems	0	
SURFACE CONDITIONS (ground slope, cover, site drainage, receiving stream, storage available, etc)	Minor Problems	10	4
	Few Problems	5	
	Significant Restrictions	0	
SUBSURFACE CONDITIONS (soil characteristics bedrock, depth to groundwater, adjacent sources of contamination, etc.)	Minor Problems	10	8
	Few Problems	5	
	Significant Restrictions	0	

FIGURE 4-2

PRELIMINARY SITE INVENTORY FORM

Site Location: ____________________

& Reference No: ____________________

Present Land Use:

		%Site
____	Residential	
	____ Rural	____
	____ Subdivision	____
____	Commercial, Services and Institutional	____
____	Mining Activities	____
	____ Active	____
	____ Inactive	____
____	Oil and Gas	____
____	Open Areas (Parks, Golf Courses, Cemetaries)	____
____	Cropland and Pasture (Orchards)	____
____	Forest and Wetlands	____

Comments: ____________________

____

Population Factors:

- Number of Buildings Within Site Limits ____
- Number of Buildings Near Site Periphery ____
- Number of Buildings Along Access Routes ____

Comments: ____________________

____

Route Factors:

- General Roadway Conditions ____________________

  ____
- Load Limitations ____________________
- Road Grades ____________________
- Traffic Density ____________________
- Accessibility Into Site ____________________
- Haul Distance ____________________
- Visibility From Peripheral Roads ____________________

  ____

Comments: ____________________

____

Physical Features:

- Watershed Slope Area ____________________
- Recently Active Landslides, Soil Slump, Etc. ____________________

  ____
- Bedrock Exposures ____________________
- Localized Seeps and Springs ____________________

  ____
- Hazards/Pollution ____________________
- Topographic Features Affecting Site Construction ____________________

  ____

Comments: ____________________

____

Utilities:

- Pipe and Transmission Lines ____________________
- Oil and Gas Wells ____________________
- Local Water Supplies ____________________

Comments: ____________________

____

Soil Properties:

	Armagh Silt Loam	Cavade Silt Loam	Ernest Silt Loam	Gilpin Channery Silt Loam
• Soil Types				
• % Slope	____	____	____	____
• Permeability	____	____	____	____
Depth to Bedrock	____	____	____	____
Depth to Watertable	____	____	____	____
• Eng. Applications				
Topsoils	____	____	____	____
Embankments	____	____	____	____

General Comments: ____________________

____

____

order to effectively complete these forms, all available information will be reexamined for site-specific information. A threefold field reconnaissance of each site will also be conducted. The sites will be covered by foot (to the extent possible) by an engineer, geologist, and/or biologist in order to provide more detailed inventory data on the site and surrounding areas. A windshield survey of potential transport routes will also be completed. The third element of the field investigation will be an aerial reconnaissance to provide a useful overview of the specific site features, adjacent areas, and the transport routes.

Upon completion of the inventory forms, each site will be assessed relative to its potential candidacy as a chemical waste landfill. Existing solid waste disposal sites within the study area will also be assessed according to the same criteria. Consideration will be given to the fact that the comprehensive development of a chemical waste landfill could include the following components: containment area, containment site liner, storage pond, dewatering areas, water treatment plant, chemical feed system, storm water drainage system, leachate collection system, containment site cover, air and water monitoring systems, security fencing, onsite access roads, and miscellaneous appurtenances. The most favorable sites will be routed into the fast-track fourth level of screening, whereas all other sites will be channelled into a similar evaluation scenario but on a delayed schedule. The only sites that would be eliminated after the detailed site inventory are those involving a previously undisclosed critical flaw.

An exception would be any sites that do not satisfy the criteria for a chemical waste landfill, but are particularly favorable from a cost-effectiveness standpoint. These sites will also enter the fast-track study under the premise that exemptions to the Federal and State criteria could be justified.

4.1.6 Fast-Track Detailed Site Evaluation

Previous studies conducted at a lower level of detail were not successful in identifying upland sites suitable for the disposal of moderate to highly contaminated chemical wastes in the vicinity of New Bedford. For this reason, the number of potential sites entering this fourth level of screening on a fast-track basis is expected to be small (i.e., less than five). In this task, the high priority sites will be evaluated in detail on the basis of estimated costs and environmental impacts of site development and operation. These factors are expected to be the ultimate site selection criteria, since engineering considerations will inherently be incorporated into the cost and environmental impact analyses. This detailed investigation on a site-by-site basis cannot be totally differentiated from the comparative evaluation of alternatives in the Feasibility Study, and the tasks must be integrated. For example, the costing of alternatives is more in accordance with the work performed in the Feasibility Study, but comparative site costs are also a principal determinant in the prioritization of sites to be accomplished in this task.

The economic analysis of each site will be based on standard procedures for engineering cost estimating, with the results expressed in dollars per unit weight (or unit volume) of material dredged or otherwise removed. Components of a chemical waste landfill that would have to be considered in the development of capital costs were listed in Section 4.1.5. The significance of operation and maintenance costs will vary with each component. Costs for disposal at secure chemical landfills outside the study area will also be estimated for comparison purposes.

A quantitative measure of the environmental impact of each site will be derived using an evaluation matrix approach. A technique similar to that developed by the Electric Power Research Institute (EPRI) for utility waste disposal sites will be used. This technique, which yields an Environmental Evaluation Factor (EEF) for each site that quantitatively measures the severity of impact on various environmental and social parameters, is described in Appendix C.

Site ranking in terms of environmental impact versus cost will then be illustrated by plotting the EEF values against the corresponding costs for each site. Sites with particularly high EEF values and costs will be eliminated at this point.

A report documenting the methodology, findings, and conclusions of the waste disposal area siting study will be prepared. This report will then be submitted to appropriate agencies (as determined by the RSPO) and the public for review and comments. Based on the comprehensive study results and feedback from the review, the lead agency will make a final decision regarding the location of site(s) for the disposal of highly contaminated wastes.

4.1.7 Detailed Evaluation of Other Sites

Sites not satisfying the criteria for chemical waste landfills will also undergo a fourth level of screening similar to that described in Section 4.1.6. The primary difference is the schedule, which in this case will coincide with the overall Feasibility Study rather than the fast-track study for hot-spot remediation. The report will be a takeoff from the fast-track report, since no significant differentiation in methodology or results occurs until this detailed evaluation of sites. The sites ultimately selected by the lead agency under this task will qualify only for the disposal of low-level chemical wastes not regulated under the Toxic Substances Control Act.

4.1.8 Other Potential Work Items

Based on the progressive findings of the siting study described in the previous sections, a need for additional items of work not included in this work plan could develop. Two possibilities of note are the identification and evaluation of ocean disposal sites and the performance of onsite hydrogeologic investigations to confirm study findings. The viability of ocean disposal of chemical wastes will depend in large part on the future status of national and international policies and should be better defined upon completion of the initial agency contacts. As for the hydrogeologic investigations, adequate scoping cannot be performed since both the need and technical approach are dependent on specific site conditions that are not known at this time.

4.2 Task 8: Investigation of Biological, Chemical, and Hydrodyanamic Pathways in the Acushnet Estuary/New Bedford Harbor/Buzzards Bay System

4.2.1 Introduction and Work Plan Scoping

The objective of this task is to develop, calibrate/validate, and apply a series of models for the evaluation of the distribution, transport, and fate of PCBs and selected heavy metals in the Acushnet River Estuary, New Bedford Harbor, and Buzzards Bay. The primary purpose of the models is to evaluate the significance of various waste sources on observed contaminant levels and patterns, and to predict the effects of various proposed remedial actions on these levels and patterns. All work must be performed in a technically credible manner since it may serve as the basis for potential litigation.

Three work items will provide the basic analytical tools for achieving the study objectives. These include a planned data acquisition program to provide a complete source inventory and determination of present contamination distributions, a mathematical model of the physical-chemical processes affecting PCB and heavy metal transport in the estuary/harbor/bay system, and a mathematical model of the food web to relate contaminant concentrations in the water column and sediments to that in the biota. Each modeling effort will include several support studies.

The distribution, transport, and fate of PCBs and heavy metals in a natural water system are controlled by complex interactions of physical, chemical, and biological systems. The incorporation of the interactive processes into a mathematical model is complicated by the wide variety of characteristic spatial and time scales of the processes and by differences in the level of current understanding of each. This latter problem is particularly significant because the overall reliability of a model is usually a function of its weakest link. Therefore, to provide a detailed submodel of one process that has been extensively researched would be a futile effort if one of the key forcing functions is the output from a submodel for which little knowledge and data are available. For these reasons, the scoping of this task must be achieved by recognized experts in the major disciplines involved. This will allow not only for an a priori determination of the processes important to contaminant distribution and transport, but also for an initial identification of informational/data needs and recommended modeling approaches. In turn, this will serve to integrate each of the respective technical efforts into a meaningful predictive tool and to achieve a unanimity of purpose among those involved.

The work plan for this task, as presented herein, is consequently not directed toward a detailed statement of the technical approach. Rather, allowance has been made for appropriate scoping by those actually performing the work once the task is initiated. The following sections provide an overview of the issues, problems, and tasks to be addressed within the scope of this investigation.

4.2.2 Data Collection

Numerous studies have been completed on contaminant levels in the water column, sediments, and biota of New Bedford Harbor. These have ranged from simple sediment sampling programs and laboratory analyses for various PCB isomers, to a four-phased research program by Woods Hole Oceanographic Institution that was designed to establish and explain the patterns of movement and accumulation of fine-grained sediment, human waste, and industrial waste in the harbor, However, because these investigations were performed independently without a common objective, the extensive set of resultant data lacks continuity and is of reduced value to the current investigation. The purpose of this work item is to critically review the existing data base in relation to the modeling needs, and to satisfy any additional needs for data and information on contaminant sources and distributions within the estuary/harbor/bay environment. Examples of possible needs are the measurement of contaminant levels in representative, coincident samples of the water column, sediment, and biota; the evaluation of particle size, density and composition of suspended and bottom sediments; and the analysis of PCBs and heavy metals associated with specific fractions. Coincident sampling at 25 locations has been assumed for cost estimating purposes. These data collection efforts will supplement the data collection and analysis program being conducted in Task 9.

It is expected that this work item will involve a cooperative effort of the modeling team, even though the actual execution of all sampling, analysis, and/or laboratory testing efforts will be assigned to a single subcontractor. (This subcontractor will likely be the same as that selected for Task 9.) A cooperative effort comes into play because each of the modeling team members involved in the various aspects of the modeling effort will be responsible for defining the data/information needs of their respective model segments.

Each team member will first review the available data/information related to their particular effort. Where appropriate, observable correlations among physical and chemical parameters will be determined in order to identify indicator species. Once the individual data needs are defined, REMPO (NUS) personnel and the RSPO will meet with the sampling subcontractor, the data management subcontractor, and those responsible for the models to design a detailed data collection program within the budgetary and scheduling constraints. This meeting could be held in conjunction with the scoping meeting for the modeling effort for cost effectiveness (see below). The design of the program may be amended at any point during the investigations in response to new findings or data requirements. All data generated in this work plan will be entered into the data management system.

4.2.3 Model of Contaminant Transport and Fate (Physical-Chemical Model)

The modeling for the distribution, transport, and fate of PCBs and heavy metals in the estuary/harbor/bay system is a complex undertaking due to the large number of potentially important physical, chemical, and biological processes involved. Not only must the dominant processes be conducive to a meaningful mathematical representation within the current state of knowledge, but interactions and feedback mechanisms among the various processes must also be mathematically represented. For example, PCB initially immobilized in the sediments via chemical interactions could be resuspended into the water column by hydrodynamic shear forces. The PCB could then enter the food chain and eventually be returned to the sediments in association with fecal pellets that have settling and resuspension characteristics quite different from the sediment particle to which the PCB was originally attached. Before commenting on these individual processes, two basic elements of any modeling effort--the dimensionality and the time and space scales--will be addressed.

The decision as to the dimensionality of a model represents a conflict between an increased level of resolution of the results and the increased level of effort and cost required to achieve it. For example, to proceed from a one-dimensional (longitudinal direction) effort to a two-dimensional (vertical direction) model would allow for a more refined differentiation of average streamflow velocities and the local bottom velocity that is critical to sediment resuspension. A three-dimensional (lateral direction) model would be even more attractive since additional insight could be gained to explain observed contaminant deposition patterns and to assess the impacts of proposed remediation of hot spot areas. Opposing the positive aspects of higher dimensionality is the fact that the level of effort increases significantly as additional dimensions are accounted for. Not only is the complexity of the mathematical representation increased, which leads to a more burdensome task if any modifications to the model are required or if additional processes are to be incorporated, but the data requirements for model calibration and verification also increase accordingly. The final decision must be whether the additional efforts and costs of higher dimension models are justified within the framework of current knowledge, available data, and the objectives and eventual use of the model. (Note that such a choice is not always possible within the constraints of the physical setting. For example, a two-dimensional model may be the minimum required if thermal and salinity stratification are dominant factors controlling circulation patterns. The circulation in Buzzards Bay may even require a three-dimensional model due to the combined influences of stratification, wind-induced waves, tidal currents, and local hydrographic features.) This and other decisions will be made by the modeling team during the early phases of the work.

The time and space scales are important for two reasons. First, they are integrally tied into study objectives, model use, and the selection of controlling processes. For example, whether one is interested only in the net movement of PCB out of the harbor during an average year, or whether the extent of PCB movement from point A to point B during a single storm event is of primary interest, could significantly influence the modeling approach. If both are of interest, as is the case for the proposed study, it still remains to be determined whether two separate models should be developed (possibly an empirical model based on field data for long-term movements), or whether the results of a model of short-term events should simply be extrapolated to account for net annual movements.

The second factor related to time and space scales is that the interfacing of various submodels is often limited by the different scales of the processes being modeled. A good example is work currently being performed at Woods Hole Oceanographic Institution. In one study, a detailed bottom boundary layer/sediment transport model is being refined that will account for temperature and salinity induced stratification; combined effects of waves and currents; suspended sediment induced stratification; moveable bed effects; a depth-limited boundary layer; and bed armoring in Buzzards Bay. In another study, a hydrographic survey is being conducted to characterize the large-scale mixing in Buzzards Bay and to develop a simple tidal model. Although both studies are important to the transport and fate of contaminants within Buzzards Bay, the different time and space scales of interest prohibit a direct interfacing of the resultant models. Rather, an estimate of the total amount of sediments put into suspension (from the first study) will be analyzed with respect to the ambient flow field (from the second study) to provide useful information on the general magnitude and direction of contaminant transport in Buzzards Bay. The direct coupling of detailed models of individual processes known to play a critical role in contaminant transport with generally applicable hydrodynamic and water quality models, or at least an effective integration of the results of such models, respresents a principal technical challenge of the modeling study. In fact, the degree to which research-oriented models of individual processes are even consistent with the needs of the study and available data remains a viable question to be addressed by the modeling team.

Many of the physical, chemical, and biological factors potentially important to PCB and heavy metal transport within the estuary/harbor/bay system are presented in Table 4-3. This list may not be complete, but it substantiates why a prudent screening of these factors and related models by recognized experts will be necessary at the outset of the modeling study.

Although the technical details of the modeling study cannot be defined at this time, general tasks that will provide for the development and integration of a meaningful modeling program are described in the following sections.

Selection of Modeling Team

In this task, REMPO (NUS) personnel and the RSPO will select individuals and/or organizations to form the modeling team. Emphasis will be placed on the overall capabilities of each to provide expertise in a number of the factors identified in Table 4-3, while trying to minimize both the redundancy in expertise and the number of individuals or groups involved. The available mechanisms for subcontractor selection include competitive solicitations, sole source contracts if unique capabilities or the elimination of cost duplication can be justified, and the Basic Order Agreement (BOA) contracts for RI/FS work recently awarded by NUS. This item must be initiated immediately since the modeling and sampling efforts await its completion.

Development of Model Criteria and Review of Data

Each of the selected team members will review and analyze the state-of-the-art of their particular phase of the modeling effort in preparation for the aforementioned meeting of the modeling team. The following subtasks are of importance:

- Determination of dominant physical, chemical, and biological processes to be available in existing models or to be added as modifications to such models. This will involve an analysis and determination of those factors that are necessary to adequately describe the temporal and spatial resolution of contaminant transport and distribution of concern.

- Screening of existing models. This subtask will consist of a literature review of both individual models and completed assessments of existing models. The purpose is to identify and screen the hydrodynamic, sediment transport, water quality, and food web models in the public domain that are pertinent to contamination of the estuary/harbor/bay system.

TABLE 4-3

PHYSICAL, CHEMICAL, AND BIOLOGICAL FACTORS FOR POTENTIAL INCLUSION IN MODELING STUDY

NO.	FACTOR	REASON FOR POTENTIAL INCLUSION
1	Acushnet River Freshwater Discharge	Although relatively small, provides for net flushing of the estuary and harbor. Particularly important under high flow conditions.
2	Tidal Currents	Significant influence on the hydrodynamics of the estuary and harbor, and on the progressive transport of salt, heat, and contaminants across the harbor boundary (e.g. across the hurricane barrier). Also dominates the inflows and outflows, and thus the ambient circulation patterns, of Buzzards Bay.
3	Wind-Generated Waves	Cause large boundary-layer shear stress values that result in resuspension of sediment from the seabed; cause mixing that destroys the thermal/salinity stratification, thereby modifying the flow field; affect bedform and thus mean friction and drag on boundary layer flow; in Buzzards Bay can shift mean transport from tidal dominated to wave dominated.
4	Secondary Flows/Eddy Currents	Can be significant near channel constrictions, as evidenced by current reversals during flow monitoring at the I-195 and Coggeshall Street bridges.
5	Thermal Stratification	Inhibits the vertical transfer of heat, momentum, and mass; can significantly modify the near-bottom velocity profile and stress; consequently affects sediment resuspension and vertical migration.
6	Salinity Stratification	Similar to "Thermal Stratification." Salinity can also influence the equilibrium conditions and reaction kinetics of the chemical and biological systems.

TABLE 4-3
POTENTIAL MODEL FACTORS
PAGE TWO

NO.	FACTOR	REASON FOR POTENTIAL INCLUSION
7	Suspended Sediment Stratification	Under certain flow conditions, can be severe enough near sediment-water interface to modify near-bottom velocity profile and subsequent transport. Vertical distribution of suspended sediment important to overall contaminant transport since flow field also varies with depth.
8	Bedload Sediment Transport	Can be significant under certain hydrodynamic conditions, and must be treated independently of suspended sediment transport due to differing forcing mechanisms; could involve a different partitioning of the contaminants.
9	Storm Events	Inherently associated with other factors (e.g., wind-generated waves), but included separately due to a particular interest in contaminant resuspension and transport, and biotic response, during a severe storm event. Could require special submodel for harbor/estuary.
10	Meteorological Conditions	Primary need would be if a thermal stratification model is to be implemented and would include ambient temperature, relative humidity, incident solar radiation, cloud cover, and other parameters. Also needed to recreate a single storm event.
11	Mechanical Mixing/Disturbances	Could be important in local areas but cannot be integrated into a physical transport model. A secondary study of potential impacts (e.g., from prop wash) may be valuable for regulatory purposes.

TABLE 4-3
POTENTIAL MODEL FACTORS
PAGE THREE

NO.	FACTOR	REASON FOR POTENTIAL INCLUSION
12	Size Distribution of Bed Sediments	Important for several reasons: 1) boundary shear stress necessary to resuspend sediment dependent on grain size; 2) influence bedform, and thus friction and drag on boundary layer flow; 3) PCB partitioning dependent on grain size; 4) effects degree of bed armoring; 5) influences ratio of suspended to bedload sediment transport
13	Size Distribution of Suspended Sediment	Important to PCB particle-solution partitioning; principal factor in the redeposition process; could influence biological uptake rates.
14	Cohesive/Colloidal Organic Matter	Considered to be an important factor to PCB partitioning; particularly difficult to model as per resuspension and transport characteristics; current research work being conducted at Woods Hole Oceanographic Institution.
15	Coagulation	Current research at MIT indicates that this can be a controlling factor in the redeposition (and thus transport) of cohesive/colloidal matter and associated contaminants that are resuspended into the water column.
16	Bed Armoring	Prevents sediments that would be conducive to resuspension under a given flow field condition from reaching sediment surface and being subject to the shearing forces. Thereby reduces potential resuspension.
17	Settling Characteristics of Suspended Sediments	Critical parameter in redeposition of suspended sediments; could be complicated by coagulation/flocculation.
18	Bioturbation	Influences sediment resuspension directly by sediment re-working action, and indirectly by a modification of bedform; current research at Woods Hole addressing this issue; also influences interstitial water movement to the bed surface.

TABLE 4-3
POTENTIAL MODEL FACTORS
PAGE FOUR

NO.	FACTOR	REASON FOR POTENTIAL INCLUSION
19	Interstitial Water	Possibly contains elevated PCB/heavy metal concentrations; could be a source of PCBs to the overlying water due to tidal and/or wave-induced water movements; current research at Woods Hole addressing this issue.
20	Volatilization	Secondary sink for PCBs that may be important to mass balance studies; more important for the less chlorinated PCBs.
21	Chemical Adsorption/Desorption	Controlling mechanisms in PCB particle-solution partitioning; partition coefficients dependent on both particle type and PCB isomer; heavy metal adsorption onto sediments also important.
22	Chemical Precipitation/Solubilization	Could be important both to heavy metal chemistry and PCB isomer partitioning; ionic strength effects of seawater would play a role in equilibrium reactions.
23	Various PCB Isomers	The following are dependent on the individual PCB isomers: 1) particle-solution partitioning; 2) solubility; 3) volatilization 4) bioavailability/uptake rates; 5) biodegradation
24	Fecal Pellets	Associated with food-web model, but also influences sediment resuspension by inducing the adhesion of fine-grained material to mucus of fecal pellets.
25	Food-Web Factors	(Addressed in the next section)

- Review of available data and needs. This subtask is threefold and will include a review of the available data base; a screening of the identified models in relation to their compatibility with the temporal and spatial coverage of the available data; and an identification of additional data needs to resolve any deficiencies in the model/data compatibility.

In effect, these preliminary efforts represent the initial steps in the formulation of a modeling approach as proposed by Ambrose et al. (1981). This process is schematized in Figure 4-3 and will serve as a guide throughout the planning stages of the modeling task. Even though this may be a superfluous task to experts in the respective disciplines, explicit consideration must be given to the particular conditions and needs in the New Bedford estuary/harbor/bay system and to the need for integrating the individual efforts into a unified predictive tool.

Meeting of Team Members

Following the preliminary review of the processes, data, and models, a meeting will be held so that REMPO (NUS) personnel, the RSPO, and the individual members of the modeling team can share and come to agreement on the respective modeling philosophies and proposed efforts. In essence, this meeting will establish the overall framework for the two-year modeling study and related sampling program so that the individual technical efforts are compatible. The meeting will also serve as a forum for technology transfer, as for example to update research activities on individual processes that would be useful to those performing the overall hydrodynamic, sediment transport, water quality, and food-web modeling tasks. It is anticipated that a Technical Advisory Board composed of recognized experts will be formed to support the modeling effort in a review capacity, and these individuals will attend the start-up meeting to provide additional guidance.

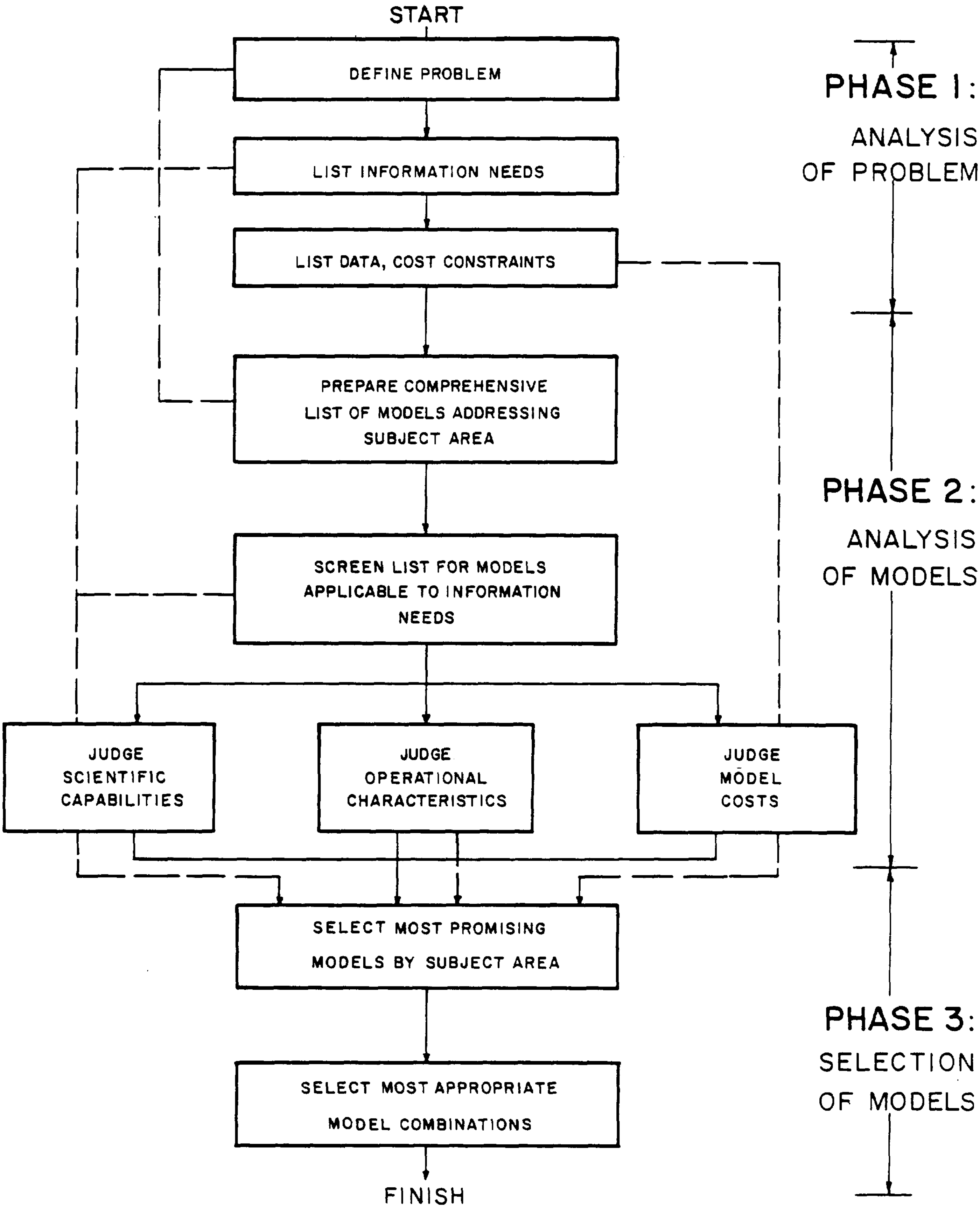

FIGURE 4-3

OVERVIEW OF MODEL SELECTION PROCESS
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Finalization of Work Plan for Modeling the Estuary/Harbor/Bay System

Based on the conclusions and recommendations of the meeting, the modeling team will prepare a formal work plan, including a refined cost estimate. A critical element of this subtask will be a final selection of the models to be adapted to the respective components of the estuary/harbor/bay system. To achieve this, the structure of each of the candidate models will be reviewed with respect to any performance criteria established at the meeting. The most viable modeling alternative to achieve the stated objective of the project will then be selected.

Each of the principal hydrodynamic, sediment transport, and water quality submodels developed for use in this study will have its basis in an existing, "off the shelf" numerical model that most satisfactorily accounts for the respective physical, chemical, and biological factors of concern. It is anticipated that the hydrodynamic model will utilize a finite element code to solve the equations of mass and momentum conservation. A finite element code will also be used to solve the convection-dispersion equations in the sediment transport model. Both water column and bedload sediment transport will be considered, with a differentiation of the sand, silt, and clay fractions of the sediment. Even though the dimensionality and time and space scales of the models cannot be established at this time (as previously discussed), it is expected that the numerical computation grid will vary in the respective modeling tasks. For example, a finer resolution will be used within the hurricane barrier than in Buzzards Bay. A conversion of the numerical grid to a coarser scale will be appropriate for coupling to the food web model.

Development and Application of the Model

Modifications and additions to the existing models will be necessary to account for both site-specific conditions and state-of-the-art knowledge of critical processes of particular importance to this study. For this reason, an initial effort in this subtask will be the formulation of any modifications and additions, with subsequent incorporation into the existing models.

Concurrent with this model formulation, all pertinent data for model use will be acquired and reduced into an appropriate format. Examples of such data include nautical charts and bathymetric charts for use in schematizing the channel geometry, freshwater inflows from the Acushnet River, meteorological parameters, tidal records, salinity concentrations, etc.

Model calibration will be a stepwise process, in which the various submodels will be progressively calibrated as additional dependent processes come into play. The hydrodynamic submodel will be first calibrated (e.g., tidal amplitude/phases and salinity profiles, and possibly temperature profiles), followed by the sediment transport submodel, and finally the contaminant transport submodel. In each case, the model results will be compared to field data, and the model will be adjusted until a satisfactory "fit" is achieved. The adjustments most often entail a "tuning" of model parameters, although it is possible that the incorporation of additional processes may be found to be necessary in order to effectively reproduce the field data. The fitting parameters will depend on the models eventually selected, but could include the shear stress factor, diffusivity constants, partition coefficients, uptake rates, etc. For individual submodels, data available prior to the RI/FS sampling program may be adequate for calibration. When this occurs, the new data will be used to validate the corresponding submodels.

The development and calibration of the individual submodels can proceed independently to some extent since field data can be used to establish initial and boundary conditions. Even in the event that a critical submodel component is delayed, the computational behavior of a completed submodel can be tested by developing hypothetical, though practical scenarios. However, before an integrated modeling approach can be "debugged" and used for the prediction of system response to proposed remedial actions, all submodels must be available. For example, the sediment and contaminant transport routine will require results from the physical transport submodel; the food-web submodel will require both flow and contaminant concentration values from other submodels; and the model of the outer harbor/bay will require the results of the estuary/inner harbor model to define the appropriate boundary conditions. A tight coordination of the schedules is therefore important to the timely prediction of environmental responses, and thus to the overall feasibility study.

The use of the model for predicting the spatial and temporal responses of contaminant residues to various remedial actions will be achieved by modifying the input data to simulate the consequences of the actions. For example, modifications could be made to channel geometry to reflect dredging and/or nearshore disposal; to initial contaminant concentrations to simulate contaminated sediment removal or in-situ treatment; or to critical boundary shear stresses to account for contaminant immobilization via physical or chemical means. The results of these modified runs will be compared to both the "no action" results and applicable regulatory limits to judge the overall effectiveness of the various remedial alternatives on PCB and heavy metal residues. An effort will be made during model application to analyze the degree of uncertainty or likely error contained in numerical model predictions.

The models will also be used to perform sensitivity analyses to gain insight into the processes controlling the distribution, transport, and fate of PCBs and heavy metals in the estuary/harbor/bay system. This could then provide feedback to the development of remedial action alternatives in the Feasibility Study.

Miscellaneous Support Subtasks

Two miscellaneous subtasks, the mapping of scourable sediments and the mapping and profiling of tidal currents, have been identified in the RAMP under the modeling task. For purposes of this study, the scourable sediment mapping will be based solely on previous sampling data, the results of the sediment transport model and other studies, and any data collected in support of other tasks of the RI/FS. If any flume experiments are required to establish the scour potential of various in-situ materials, these will be incorporated into the laboratory studies subsection of the Feasibility Study for which a separate work plan is to be developed once the needs are identified.

The mapping and profiling of tidal currents will be based on the results of the hydrodynamic model. These results will have been calibrated with field data collected in an earlier subtask, and should thus provide a reliable representation of the current field.

Miscellaneous laboratory studies could be required to satisfy critical informational needs in the model development and calibration tasks. Examples are studies of sediment consolidation, settling velocity, and the adsorption-desorption relationships between sediment types and the contaminants of interest. The proposed budget should allow for some laboratory efforts within the respective model development and calibration tasks, but a final determination of study needs must await the results of the initial model selection and informational review.

4.2.4 Food Web Model

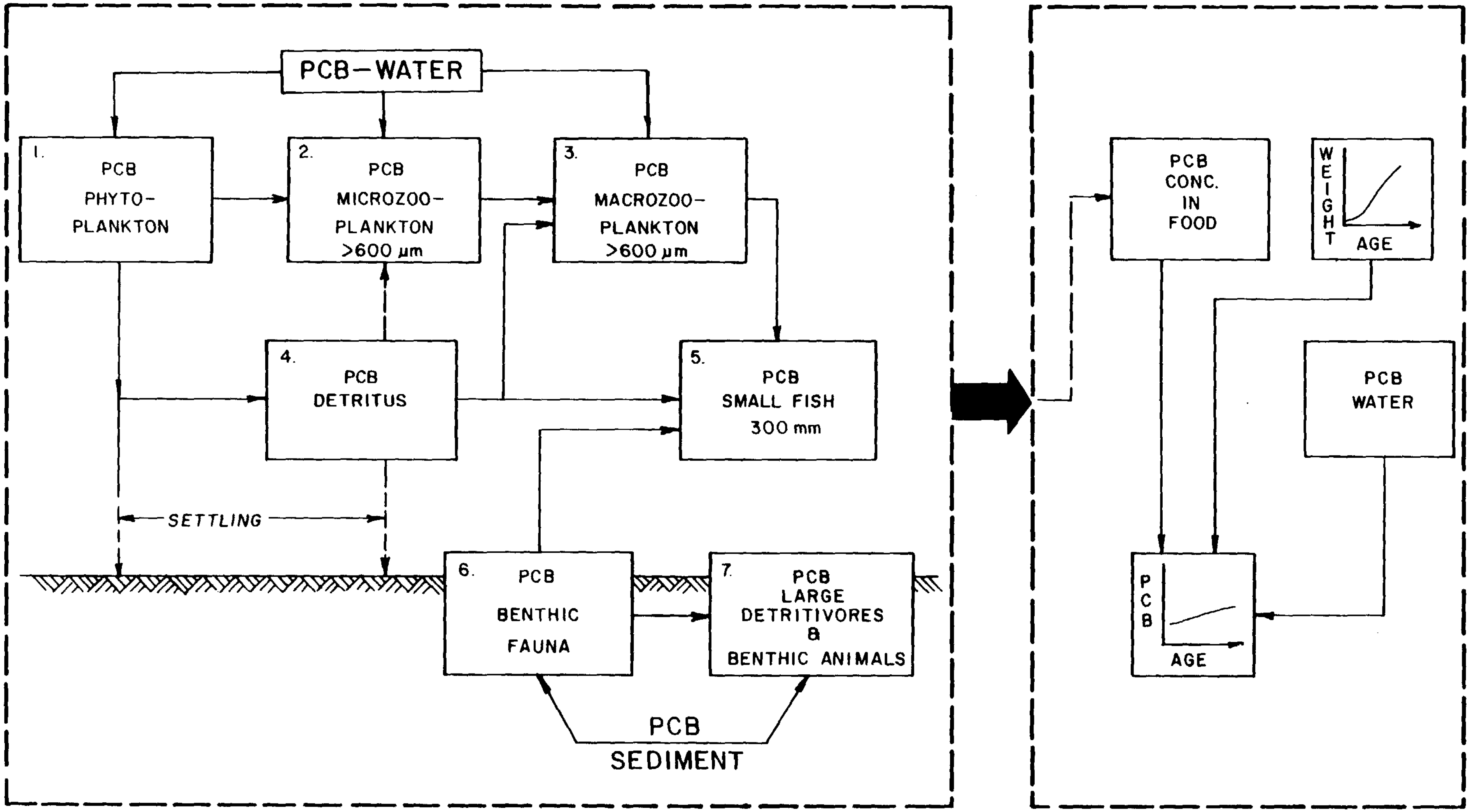
The food-web model will provide the final results of the comprehensive modeling effort in terms of PCB/heavy metal residues in important biological species as a consequence of various remedial measures. The technical approach for the development, calibration, and validation of the food-web model is generally consistent with that just described for the physical-chemical model. As such, only issues and decisions peculiar to the food-web model will be addressed in this section.

Laboratory investigations related to PCB uptake by various organisms have routinely measured the PCB concentration factor (ratio of organism concentration to water concentration) due to direct transfer from the water column to the organism. However, field studies have found concentration factors up to an order of magnitude greater than the laboratory values as a result of food-web transfer via ingestion of contaminated prey. A technically realistic food-web model must, therefore, account for both direct biological uptake from the water column and food-web transfers.

Such models have been developed and applied in similar investigations, as for example the work of Hydroscience, Inc., that assessed the impacts of remedial actions on PCB levels in the Hudson River food web (Hydroscience 1978, 1979). A schematic of the compartments in the Hydroscience food-web model has been reproduced as Figure 4-4. In this particular model, which is representative of the types of models available, the biotic sector is actualy divided into two submodels. PCB concentrations in the water and sediment are input to the general food-web model, and the PCB concentration in the seven ecosystem compartments are calculated via a solution of the respective biomass equations. This establishes the concentration of PCB in the food for input to the large fish model, which yields PCB levels in the fish as a function of age. Details of the mathematatial formulation are provided in Hydroscience, 1979. Considerable research has been completed on the mechanisms and rates of exchange between the various compartments in recent years, and will be incorporated into the food web model for the New Bedford study.

In order to effectively satisfy the modeling objectives, at least three commercially and/or recreationally important marine species must be considered (in addition to representative species in the lower levels of the food chain). These include a pelagic fish such as the striped bass or blue fish, a bottom feeder such as the flounder or American eel, and a crustacean such as the lobster. A final determination will be made at the time of the study.

Because the bioavailability and biodegradation properties of PCBs are dependent on both the organism and the individual PCB isomers, a decision must also be made as to which isomers will be accounted for in the model. At least Aroclors 1254 and 1016/1242 will be necessary. A related issue is the number of individual heavy metal species to be included in the food-web model. Copper, chromium, and zinc have been proposed in the RAMP for the overall modeling study, and should be sufficient unless a better indicator species is identified during the aforementioned data correlation subtask.



FOOD WEB MODEL

STRIPED BASS MODEL

FIGURE 4-4

SCHEMATIC OF FOOD WEB MODEL

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As with the physical-chemical model, the RAMP identifies several subtasks to support the food-web modeling effort. Of these subtasks, the following will be inherently satisfied during the literature review and model development tasks, and should be straightforward to the recognized experts that are expected to be part of the modeling team:

- Identification of target species;
- Literature review and evaluation of PCBs in target species and cogenus species;
- Evaluation of the relative importance of direct PCB uptake from food organisms;
- Literature review and evaluation of PCB depuration rates in harvestable species;
- Seasonal migration patterns.

Other subtasks, as for example the testing of locally favored edible species at specific sites and the field validation of the relationship between target species body burden and site-specific PCB concentrations in the water column and sediments, will be completed via previous and ongoing studies and the sampling programs in Tasks 8 and 9 of this remedial investigation. The only subtask that will require an independent effort is an inventory of the flora and fauna of the area, and this should be minimal due to available information.

4.3 Task 9: Data Collection and Analysis - Estuary/Harbor/Bay

The data collection and analysis program for the estuary/harbor/bay system has two principal objectives. First, to establish a data base on PCBs, selected heavy metals, and physical processes that is consistent with the needs for model development and calibration in Task 8. Second, to satisfy any spatial gaps in available data such that a statistically defendable isopleth mapping of the vertical and horizontal distribution of PCBs and selected metals in the sediments can be achieved. This will allow the development of meaningful estimates of sediment volumes associated with various ranges of contaminant concentration. In order to better focus on these individual objectives, a two-phase data collection and analysis program will be performed. It is recognized, however, that any sampling conducted for the modeling effort will inherently contribute to the overall data base for purposes of isopleth mapping.

4.3.1. Phase I: Data to Support Model

The data management system formulated and currently operated by Metcalf and Eddy will provide the modeling team with a comprehensive compilation, screening, and analysis of the existing data base on PCBs and heavy metals in the estuary/harbor/bay system. Together with completed and ongoing work at Woods Hole Oceanographic Institution, EPA's Narragansett Laboratory (ERLN), and elsewhere on PCB-sediment partitioning and food-chain relationships, it is expected that the informational requirements for the modeling effort will be satisfied to a large extent prior to the execution of this task. Nevertheless, several deficiencies can be identified, as follows:

- Gaps in the spatial coverage necessary to establish initial conditions as per the horizontal and vertical distribution of PCBs in the sediments and water column;

- General lack of data on heavy metals in both the sediments and water column;

- General lack of knowledge on the relationship between sediment particle size and PCB/heavy metal partitioning, and the suspended sediment - water column partitioning of PCBs and heavy metals;

- Deficiencies in the data base on particle size distribution and composition of bottom and suspended sediments;

- Lack of concurrently collected sediment and water samples from specifically selected locations;

- Lack of data on biota, particularly fish species;

- Lack of data on tides, salinities, etc., necessary for the hydrodynamic model.

The data collection and analysis program proposed for the Phase I investigation will, to varying degrees, satisfy each of these informational deficiencies. Emphasis will be on an enhanced understanding of the relationships among variables rather than on simply filling in spatial data gaps, as the latter is the objective of the Phase II investigation. The proposed effort is to collect a sediment and water column sample at each of a number of locations within the estuary/harbor/bay system. The water column samples will be filtered, and both the residue and the filtrate will be analyzed for PCBs and selected heavy metals. (PCB analysis for all samples in this task will include Aroclors 1016/1242 and 1254. The selected heavy metals include copper, chromium, and zinc.) In addition, the clay fraction of the residue and the salinity of the filtrate will be measured. The particle size distribution of the bed sediment sample will be determined via settling tests, and a representative sample of the sand, silt, and clay fractions will each be analyzed for PCBs and heavy metals. The interstitial water will also be analyzed for the same parameters and salinity. For cost estimating purposes, it is assumed that a total of 25 locations will be sampled. This should provide sufficient information to develop relationships between the variables of interest.

In addition, 25 samples each of a pelagic finfish (e.g., striped bass), bottom feeder (e.g., flounder), and crustacean (e.g., lobster) will be collected and analyzed for PCB body burden and selected metals. If possible, a sample of the water column near the point of capture will also be collected and analyzed for the same parameters and salinity.

Another type of informational need is the field measurement of tides, salinities, and current velocities to calibrate and verify the physical transport model. Tide gages will be required at various locations for a several month period, while the deployment of recording current-temperature-conductivity meters at numerous locations will be necessary over a shorter time period (on the order of a month). A boat-based, comprehensive sampling program over a full tidal cycle will also be valuable, particularly if suspended sediment and contaminant concentrations are obtained concurrently with the aforementioned physical parameters. A dye-release study could be incorporated into this latter program if the available budget permits.

It must be recognized that the data collection and analysis program just described is preliminary. The intent is to provide both general insight into the type of program to be performed and sufficient information for cost estimating purposes. The ultimate needs of this task will be strongly influenced by the structure and related data needs of the selected models, and a final decision as to the extent of the sampling and analysis program must await a joint decision by REMPO (NUS) personnel, the RSPO, and the modeling team performing Task 8.

4.3.2 Phase II: Data to Satisfy Informational Gaps

Several types of data are expected to be collected in the Phase II investigation in order to comprehensively define the lateral and vertical distribution of PCBs and other selected contaminants in the estuary/harbor/bay system. As with the Phase I investigation, the proposed effort described in the following paragraphs is preliminary and will be subject to modification as the existing data base and study needs are progressively analyzed in the execution of this and other tasks. A final determination of the additional data needs will be a coordinated effort involving the data management subcontractor, REMPO (NUS) personnel, and the RSPO.

Additional samples of the water column and bed sediments will be collected at pre-determined locations. At each location, grab samples of the water column will be collected near the surface and within 12 inches of the sediment-water interface. The sediment sample will be a 24-inch core sample, and will be sectioned for analysis as follows: 0-1 inch (top); 5.5-6.5 inches; 10-13 inches; and 20-24 inches (bottom). Six samples will therefore be analyzed at each location. For cost estimating purposes, it is assumed that samples from 25 locations will be analyzed for Aroclors 1016/1242 and 1254, and Zn, Cu, and Cr. The salinity and total suspended solids in the water column samples will also be measured. At an additional 25 locations, samples will be collected and analyzed only for the three metals due to the current deficiency in the heavy metals data base.

Ten sediment samples corresponding to the location and depth of highest PCB concentrations will also be analyzed for dioxins and polychlorinated dibenzofurans (PCDFs). This will further document whether other types of contaminants not previously measured are present in the system. At least two of these samples will be located opposite Cornell-Dubilier (i.e., near the hurricane barrier), and at least two near the outfall of the New Bedford municipal treatment plant.

A final component of the Phase II investigation will be the collection and analysis of five deep sediment cores (at least 4 feet deep) within the hot-spot areas. These cores will be segmented for PCB and heavy metal analysis as follows: 15-18 inches; 20-24 inches; 30-34 inches; and 44-48 inches. The purpose of this effort is to confirm that sediment contamination does not extend below the currently perceived 24-inch limiting depth.

4.3.3 Sampling and Analysis Protocol

As discussed in Section 3.2 and 3.3, a site-specific operations plan will be developed for the sampling and analysis program prior to initiating related work. This plan will address operational techniques, health and safety features, and quality assurance requirements. Consideration will be given to sample collection and preservation; analytical protocols, including sample bank receipt and chain of custody, core sectioning, and sample analysis; and quality control requirements such as replicate analyses and blind samples. The basis for the site operations plan will be NUS health and safety and quality assurance manuals, and a similar plan established by GCA Corporation for a recent EPA-sponsored investigation involving the sampling and analysis of Acushnet River sediment cores for PCBs.

4.4 Task 10: Hydrogeologic Investigation of Sullivan's Ledge

A two-phase hydrogeologic investigation of Sullivan's Ledge was proposed in the Roy F. Weston RAMP of May 1983. The purpose of the proposed investigation was to define the extent of contamination, with special emphasis on PCB contamination. The investigation was, in part, contingent on the findings of an EPA-sponsored field investigation by GCA Corporation that was in progress at the time of the RAMP preparation. At that time, very little information concerning Sullivan's Ledge was available, particularly relative to contamination in surface water, groundwater, and stream sediments. Little documentation was available on waste types historically disposed of at the site.

The GCA investigation addressed conditions at both the nearby municipal landfill and Sullivan's Ledge. Specific investigative tasks relative to the Sullivan's Ledge program included:

- A review of previous studies and published reports on the area.
- The development of a Test Plan for Sampling and Analysis Protocols.
- The construction of 4 monitoring wells.
- The collection and analysis of soil and water samples from each monitoring well and selected surface water locations.
- The development of a groundwater map.

The completed GCA field investigation indicates that upgradient (southwest of the site) bedrock wells at Sullivan's Ledge are relatively free of contamination, while downgradient wells (northeast of site) exhibit significant concentrations of a number of organic contaminants. The GCA report further concludes that since the filled quarry is located between the two well sets, the refuse in and on top of the abandoned quarry is a significant source of groundwater contamination.

In accordance with the RAMP contingencies and the findings and recommendations of the GCA field investigation, a detailed hydrogeologic investigation of Sullivan's Ledge and vicinity is warranted at this time. The program to be implemented combines and enhances the work plans recommended in both the RAMP and GCA studies. Work items to be completed during this investigation follow.

4.4.1 Review of Existing Data and Literature

An initial task of the Sullivan's Ledge investigation is the compilation and review of available information on the geologic and environmental setting of the study area. Appropriate sources of geologic information include regional and local geologic maps and reports, air photos, and boring and well data. Much of this effort will likely be accomplished in conjunction with the waste disposal siting study (Task 6) and the regional groundwater investigation (Task 13). The GCA report provides a site-specific reference for geologic information.

The GCA investigation, the RAMP, and the Metcalf and Eddy computerized data base, including cited references therein, will be the primary informational sources of environmental data for Sullivan's Ledge. Other sources will include local, State and Federal agencies, local well-drilling companies and waste haulers, and aerial photographic contractors.

Information will also be collected (if available) on all wells in a one-mile radius. This information includes:

- Location and address
- Ownership
- Usage
- Well depth and water table level

All wells will be located and labelled on a USGS Quadrangle map. Remaining information will be presented in a tabular form.

Another type of information that would be of value to the overall study is a chronology of quarry development and use as a disposal site. It is probable that this will be made available via studies outside of this contract, as for example related enforcement contract activities.

4.4.2 Site-Specific Operations Plan

A site-specific operations plan necessary for project mobilization and performance will be developed prior to any field activity. Key elements will be the site-specific health and safety and quality assurance plans, as discussed in Sections 3.2 and 3.3. Health and safety considerations will include, for example, the identification of the required levels of protection, the designation of onsite monitoring equipment, and the determination of the location and needs of the command post, including a plan for site communications, sample and equipment storage, and document filing. Quality assurance requirements will include sampling and analytical protocols, chain-of-custody procedures, and a plan for replicate analyses and blind samples.

Other components of the site operations plan to be developed in this subtask include the identification and procurement of required equipment and the development of procedures to handle any wastes generated during the field activities. Two work items being performed under separate tasks will also be incorporated into the operations plan. These include the acquisition of permits, rights of entry, etc., and the procurement of subcontractors. Items expected to require subcontracting include aerial photography, the ground survey, test pit excavation, drilling and well installation, and possibly the geophysical survey. Any specifications necessary for site-specific operations will be prepared in this subtask.

4.4.3 Site Mapping

A topographic map of the site and appropriate proximal areas (15 acres) will be prepared at a scale of 1 inch = 50 feet with a two-foot contour interval. Mapping will be accomplished using an aerial mapping survey. Mapping will be initiated as soon as possible to provide a site base map required for other tasks.

4.4.4 Geotechnical Field Reconnaissance

A geotechnical reconnaissance of Sullivan's Ledge and adjacent areas will be conducted to provide general information on the geotechnical framework of the site. A critical element in the reconnaissance will be the study of local rock outcrops and high walls (e.g., other quarries) to assess the attitude (strike and dip) and approximate spacing of fractures in the granitic bedrock. Historical photographs of Sullivan's Ledge will also be studied in support of this analysis of fracture patterns, as these could provide evidence of site-specific patterns and their degree of consistency with regional patterns.

4.4.5 Definition of Quarry Pit

The purpose of this task is to determine the extent (surface boundary) and approximate depth of the original quarry pit(s). A preliminary map delineating the assumed pit boundary will first be developed using the information presented in Technical Report TS-PIC-2007, which includes historic aerial photographs. If possible, a representative aerial photograph will be selected and enlarged to a scale of 1 inch = 50 feet. The pit boundary will then be transferred to the site topographic map prepared in a previous subtask. A critical review of the resultant map will be conducted, and the need for additional field verification of the pit boundary will be assessed. A seismic survey will then be run both to determine pit depth and, where necessary, to verify the pit boundary.

4.4.6 Surface Water Flow Investigation

The objective of this task is to investigate the characteristics of the manmade channel (stream) that flows through the site, and surface runoff generated on site during precipitation events. The RAMP called for the development of a site water balance, the purpose apparently being to quantify the percent of precipitation that enters the stream versus that which infiltrates directly into the pit. This would typically require the deployment of continuously recording rainfall and stream gages. However, each of three options available for monitoring site runoff has technical problems, as follows:

- Install continuous flow measuring devices in the channel upstream and downstream of the site. The technical shortcoming is that the channel drains a relatively large urban watershed, and the runoff contribution from the site may be indistinguishable within the scatter of the recorded data. Also, it may be infeasible to restrict other offsite runoff from entering the stream between the two gages.

- Measure the runoff from the site prior to its discharge into the stream. Site topography is variable, and runoff from the site is not channelized but enters the stream as a distributed source at numerous points along the bank.

- Channelize the runoff from the site, so that monitoring can be achieved prior to reaching the stream. The principal technical problem is the potential need to excavate contaminated soil in order to construct a channel. In addition, the cost cannot be justified for reasons cited below.

The proposed effort is to utilize available analytical techniques for runoff estimation on small watersheds rather than continuous monitoring. Since considerable information on soil characteristics and a detailed topographic map are being produced in this study, reliable estimates of runoff from specific precipitation events can be analytically generated. In a similar manner, the hydrology and hydraulics of the channel will be analytically studied to determine its flooding potential. This would be important since inundation of the pits (or portions thereof) may be important to the conceptual design of potential remedial actions.

This modification of the technical approach, in addition to being more practical and cost-effective, appears to be consistent with a conclusion of GCA that the clayey nature of the cover material and the lack of site vegetation inhibit the infiltration process. Consequently, groundwater flow from upgradient areas would be expected to dominate onsite infiltration as the principal source of contaminant leaching and migration. A preliminary review of available information and a site visit by NUS personnel did not fully support these conclusions, however, and thus they will be reassessed based on the results of the proposed site investigations and analyses. If the new findings indicate otherwise, a more detailed field monitoring program may be required.

4.4.7 Surface Water and Sediment Sampling

The purpose of this task is to determine if contaminants move off site via surface water and/or soil erosion. The chemical quality of surface runoff, stream flow, and stream sediments will be evaluated.

Two surface water sampling stations will be established along the stream. The stations will be located where the stream enters and exits the site. These stations will be sampled twice, once during dry meteorological conditions and once during a precipitation event of sufficient magnitude to generate site runoff. During the precipitation event, two additional runoff samples will be taken. These samples will be taken at different locations on the site where precipitation-related drainage (i.e., runoff) is occurring and obviously entering the stream.

Four sediment samples will also be collected from the stream channel. One sample each will be collected where the stream enters and exits the site. Remaining samples will be collected from deep "straight" stretches (riffles) in the stream, or the inside loop of channel meanders. All samples will be of predominantly fine-grained materials.

All collected samples will be analyzed for priority pollutants, PCBs (Aroclors 1016/1242 and 1254), selected heavy metals (Cu, Zn, Cr), and non-priority pollutants detected in the GCA investigation (Table 4-4).

4.4.8 Investigation of Overburden Conditions

In this task, numerous test pits will be excavated using a backhoe in order to investigate the overburden material and related contamination. The types of information to be gained in this investigation include a characterization of the fill material and natural overburden, visible indicators of contamination, verification of quarry limits, groundwater levels, and conditions of the upper surface of the granite bedrock. The collection of representative soil and groundwater samples will also be permitted.

Approximately 15 test pits will be excavated to a depth of about 14 feet. The locations of the test pits will be selected to coincide with: 1) onsite location of historical dumping activities, as determined by earlier record searches; 2) the boundary of the quarry, as defined by the photographic analysis and seismic survey; and 3) upgradient and downgradient offsite locations based on observed groundwater levels. The location of each test pit and sample will be noted on the site topographic map, and elevations recorded. All soil and groundwater samples will be properly recorded and stored for possible future analysis, with care to prevent sample freezing. A log of each test pit will be prepared in the field by a trained geologist or soil scientist.

All samples will be analyzed for Aroclors 1016/1242 and 1254. In addition, the samples closest to the pit boundary will be tested for priority pollutants as an indicator of offsite contaminant migration. The results of this initial testing program will determine if analysis of the remaining samples from farther beyond the pit boundary is required. In addition, any remaining samples that exhibit visual evidence of contamination will be analyzed for priority pollutants. All samples will be retained for possible future testing needs. Compositing of the samples, either vertically at a single sampling location or spatially using samples from a number of locations, will be considered if the number of analyses cannot be accommodated.

TABLE 4-4

NON-PRIORITY POLLUTANTS DETECTED AT SULLIVAN'S LEDGE

Volatile Organics	Semivolatile Organics
benzene, chlorofluoroisomer	benzene, 1-ethenyl-4-methyl
benzene, dimethylisomer	ethanone, 1-phenyl
benzene, ethenyl	2-hydroxy benzothiazole
2-butanone	1-H-inden-1-one, 2,3-dihydronaphathalene, dichloro isomers
cyclohexane	naphthalene, methyl isomers
cyclohexane, dimethyl isomer	quinoline, 1, 2-dihydro-2,2,4-trimethyl
cyclohexane, methyl	
cyclopentane, methyl	
hexane	
pentane, 3-methyl	
2-pentanone, 4-methyl	

4.4.9 Subsurface Investigation/Monitoring Well Installation

The purpose of this task is to drill, log, and complete specified boreholes as monitoring wells. Ten boreholes are proposed for this subtask, as shown on Figure 4-5. These locations are preliminary, and could be modified based on the progressive findings of the Sullivan's Ledge investigation. The proposed locations include:

Well No. 1: This well is an onsite, deep bedrock well downgradient of the pit. It will be drilled adjacent to, but deeper than, the pit. It will reflect the water quality below the pit, and the lower extent of the plume will be investigated. It will directly address the possibility of offsite contaminant migration via vertical groundwater movement.

Well No. 2: This well will define the lateral flow to the southeast of the site.

Well No. 3: This well will define the lateral flow to the north/northwest of the site.

Well Nos. 4, 5, and 6: These wells will define the downgradient offsite extent of the contaminant plume.

Well No. 7: This well is not located on Figure 4-5. It will be located in a major fracture zone, downgradient of the site, in order to investigate the potential flow path of contaminated water in such a zone. Should no major fracture zones be located in previous subtasks, this hole will be deleted.

Well No. 8: This well is not located on Figure 4-5. It will be located 2500 feet downgradient of the site. It will serve as verification of the extent of the leachate plume. This hole will be drilled last and care will be utilized in selecting its location to maximize the probability of intercepting the path of any plume migrating from the site.

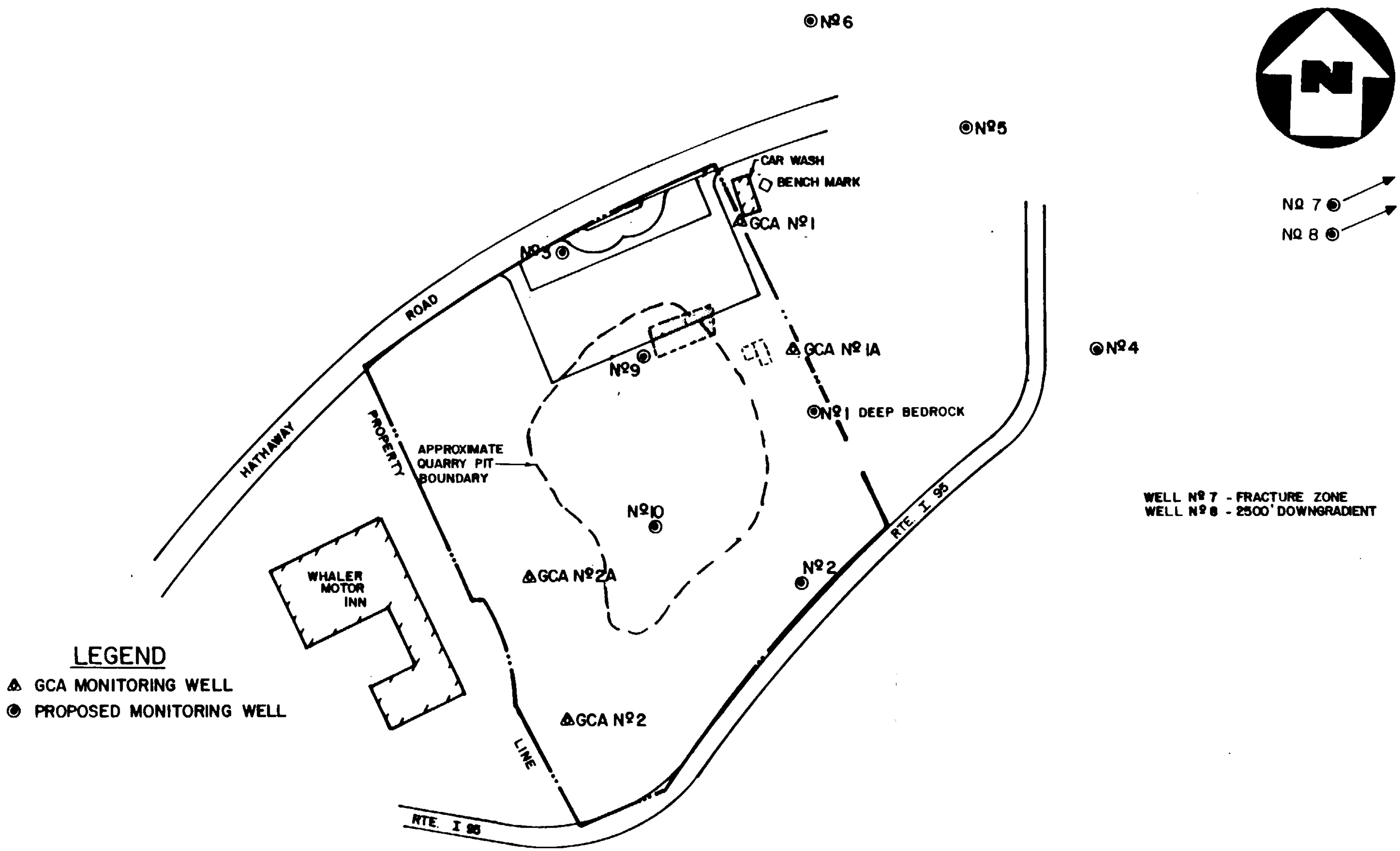

FIGURE 4-5

MONITORING WELL LOCATIONS: SULLIVAN'S LEDGE
NEW BEDFORD SITE, NEW BEDFORD, MA

SCALE 1" = 300'

NUS CORPORATION
A Halliburton Company

Well Nos. 9, 10: These wells will be drilled into each of two assumed pits based on aerial photographs. These wells will be used to verify pit depth and to investigate leachate quality within the pits themselves.

Based on available information, the approximate depth of the quarry is 100 feet. For cost estimating purposes, it is assumed that Borehole Nos. 2-8 will be drilled to 100 feet. If the actual depth of the quarry is found to be greater than 100 feet, adjustments to the proposed scope of work will be necessary. Exceptions to the 100-foot depth are the following:

- Borehole Nos. 9 and 10 will be quarry-pit exploration boreholes. These holes will be drilled to bedrock plus cored at least 10 feet into rock to verify the bedrock condition.

- Borehole No. 1 will be a deep bedrock well and will be drilled 50 feet deeper than the quarry pit bottom, or approximately 150 feet deep.

Boreholes will be advanced through overburden using steel casing and a roller bit, while borings in bedrock will be advanced with an NX or NQ wire line core barrel with a diamond impregnated bit. Soil borings will be obtained with a split-spoon sampler at changes of strata or at intervals not exceeding 5 feet from the last sample. All rock cores will be visually assessed in the field, logged, photographed, and placed in wooden core boxes. Care will be taken to prevent sample freezing and exposure to rain. Particular consideration will be given to rock quality and the degree and patterns of fractures.

Each borehole will be cased to bedrock with the exception of borehole Nos. 9 and 10, which will be cased with perforated pipe. Additionally, Borehole No. 1 will be cased to the elevation of the quarry pit base. Static water levels in all wells, including existing GCA wells, will be taken within a 24-hour period in order to develop a detailed piezometric map of the site and vicinity. This will be done on two occasions, once during dry meteorological conditions and once after a significant precipitation event.

One significant modification to the hydrogeologic investigation proposed in the RAMP and Work Assignment (Appendix A) is the deletion of the piezometer couplets. This decision was based on two findings of the GCA investigation. First, the horizontal flow through bedrock fractures appears to dominate the vertical component of flow in the formation. Second, the fractures are significant enough that the groundwater zones are hydraulically connected and essentially act as a single aquifer. Thus, the basic need for the couplets to investigate vertical flow patterns is essentially negated.

4.4.10 Monitoring Well Sampling

The monitoring well field will consist of the 10 new wells, 4 existing GCA wells, and all additional wells in a one-mile radius of the site. GCA wells 1 and 1A are located downgradient of the pit, while GCA wells 2 and 2A are upgradient of the pit (see Figure 4-5).

Two sets of samples will be obtained. The first set will include only the GCA wells and wells 1-10. The second set, to be collected after analysis and review of the first set of results, will include the same 14 wells and all wells in a one-mile radius of the site. The second round of sampling will be conducted within 3 months of the first set.

The first round of samples will be analyzed for priority pollutants, PCBs, selected metals, and non-priority pollutants detected in the GCA investigation. The second round of analysis will consist only of those contaminants detected in the first round of sampling. PCBs will be tested for in all samples, regardless of first round results. Potential PCB contamination is important not only within the scope of the Sullivan's Ledge site, but within the overall New Bedford study.

4.4.11 Final Report

A final report will be prepared summarizing the hydrogeology of Sullivan's Ledge, including both quantitative and qualitative characteristics. Offsite migration paths of contaminated surface water, sediments, and groundwater will be discussed. A risk assessment of the site hazard to public health, welfare, and the environment will be included.

The following maps/figures will be included within the text of the report:

- Topographic map (1" = 50')
- Geologic cross sections of site showing pit location and depth, groundwater table, top of rock, etc. (3 cross-sections assumed)
- Map showing fracture traces
- Site map indicating pit boundary
- Map showing sampling locations
- Map showing wells in one-mile radius
- Isometric map of PCBs and 3 additional significant hazardous substances
- Cross section and plan map of contamination plume
- Map of onsite flow paths

The report will include all collected data, e.g. borehole logs, flow records, chemical analysis, etc., in appendix form. The appendix may be submitted under separate cover but will accompany the report. Any further study requirements for purposes of the feasibility study will be identified.

4.5 Task 11: Hydrogeologic Investigation of the New Bedford Landfill

The RAMP proposed a relatively extensive hydrogeologic investigation of the New Bedford municipal landfill for the purpose of fully assessing actual and potential environmental impacts arising from historical waste disposal practices. However, the need for this investigation was contingent on the findings of an EPA-sponsored field investigation that was in progress at the time of RAMP preparation. The reason for this conditional proposal was that, even though previous studies had not found any significant offsite contamination, an a priori decision not to investigate the landfill as part of the RI/FS would have been premature, given the incomplete nature of the earlier studies. The potentially severe consequences of any public health and environmental impacts associated with past disposal practices at the landfill further warranted additional evidence prior to rejecting the need for a detailed investigation.

The recently completed field investigation by GCA Corporation has generally confirmed the findings of previous studies--that the municipal landfill is not currently a signficant source of hazardous contaminants to the local surface and groundwater systems. In this study, samples were collected at sites near the landfill and in Apponagansett Swamp that would be particularly susceptible to contaminant migration. Of those contaminants analyzed for in the study, none were detected in significant amounts in any of the soil or water samples taken. These results are particularly significant in light of earlier studies that documented PCB migration from the landfill through the surface water and biological systems, and to the ambient air via volatilization. The lack of recent evidence of such migration suggests that the progressive coverage of historic PCB deposits by refuse has lessened the potential for offsite movement.

In accordance with the RAMP contingencies and the findings and recommendations of the GCA field investigation, the EPA has decided that a detailed hydrogeologic investigation of the New Bedford municipal landfill is not warranted at this time. Rather, several lesser work items will be completed to review and update the data base and related decisions concerning further investigative efforts. The following work items recommended by GCA and the EPA will be completed:

- All previous investigations of the municipal landfill will be critically reviewed as per the objectives, field and analytical techniques, and interpretation of results. Emphasis will be placed on the reliability of the findings in relation to the pivotal conclusion that no significant offsite contamination is occurring.

- The four wells installed at the municipal landfill by GCA will be sampled initially and semi-annually (i.e., five samples per well) in order to detect any changes in groundwater quality over time. GCA Well 6 near the New Bedford Airport runway approach will be similarly monitored to detect water quality changes in the Apponagansett Swamp. All samples will be analyzed for PCBs and volatile organics.

- The initial sample from each well will also include a trace metal analysis to determine if the low pH conditions of the swamp are mobilizing metals from the landfill waste materials.

All analytical data will be entered into the data management system, and a report will be prepared to present the data and any significant findings.

4.6 Task 12: Ambient Air Testing

An extensive air sampling program conducted in September, 1982, and other lesser efforts have produced considerable data on PCBs in the ambient air at the principal sources/sites of contamination in the New Bedford area. PCB concentrations differing significantly from background values were detected only near Sullivan's Ledge, at the mudflats near the Aerovox plant, and in the emissions from the municipal sludge incinerator, the latter of which is outside the scope of this RI/FS. The proposed ambient air sampling effort will, therefore, focus on Sullivan's Ledge and the mudflats. The objective is to provide new data for a comparative evaluation either to confirm earlier results or to identify meaningful temporal changes. Additional analyses will be conducted on select samples in response to the recent detection of other toxic substances in groundwater samples near Sullivan's Ledge. The investigative monitoring of ambient air quality at sites of particular concern for public health reasons will also be pursued.

The proposed ambient air sampling program will be conducted over an eight-hour period (i.e., a single eight-hour composite sample) at each of an assumed ten monitoring stations. The following nine stations have been prioritized by EPA, leaving one site open for selection at the time of the study:

- Sullivan's Ledge:
  - 1 upwind
  - 1 on site
  - 3 downwind (1 downwind*)
- Mudflats in Northern Estuary:
  - 1 on site
  - 1 downwind*
- Rogers School in Fairhaven:
  - 1 near site*
- Background:
  - 1 upwind of New Bedford*

When possible, the actual locations of these monitoring stations will be selected to correspond to the stations of the 1982 and previous samplings. Based on a screening of ambient air data made possible by the earlier monitoring programs, neither high-volume sampling nor a mobile unit capable of real-time monitoring should be necessary to achieve the task objectives. All samples will be analyzed for the PCB isomers of interest, and screened for priority pollutants. A comprehensive analysis for volatile organics will also be completed at the four sites noted by an asterisk (*).

The results of the monitoring program will be comparatively evaluated in relation to previous data and existing air quality criteria and standards. All findings will be documented in a written report. A discussion of any identified discrepancies or trends in the data, or any violations of the criteria and standards, will be included in the report, as will any recommendations for future monitoring.

4.7 Task 13: Hydrogeologic Inventory of Ground Water Resources

The hydrogeologic inventory of ground water resources being proposed in this Work Plan involves both the development of a regional hydrogeologic scenario, and the evaluation and assessment of potential contaminant impacts on critical groundwater resources. The study area for this regional investigation will include New Bedford, Dartmouth, Fairhaven, and Acushnet, as well as any contiguous areas in Bristol County that have received PCB wastes in the past. As schematized in Figure 4-6, three types of informational searches will initially be conducted to establish a regional data base. The first is directed toward a definition of the regional geologic and groundwater resources and will include an identification of regional features such as the type, integrity, and depth of the key rock strata, overburden conditions, principal tapped and untapped aquifers, major faults or fractures, and large-scale groundwater dewatering operations such as quarries. Most of the information will be compiled from existing information, as for example previously completed engineering studies, published and unpublished documents of Federal and State geologic agencies, drilling logs, and soils information such as U.S.D.A. Soil Conservation Service reports and maps for Bristol County. Other informational sources will include any available low-altitude aerial photography, and a small-craft aerial reconnaissance conducted as part of the current study.

The identification of principal ground water users within the study area will be the focus of the second informational search. The key source of information will be direct contacts with local well drillers and appropriate State and local authorities (e.g., engineers/geologists with State agencies; municipal engineers, water authorities, and officials, etc.). Initial contacts will be made via the telephone, with follow-up interviews as necessary. Any records to document water usage will be sought. Additional information could be forthcoming from the aforementioned regional setting phase of the informational search. Emphasis will be on the identification of principal ground water users, as for example public water systems, large industrial users, and locally concentrated areas of private wells.

The third phase of the informational search involves regional groundwater quality, and can probably be achieved in large part during the review of existing information in the first phase and durings contacts with State and local authorities in the second phase. Only readily available data on groundwater quality will be compiled at this point, since an explicit effort to acquire data on individual groundwater sources will be conducted in a subsequent work item.

The various categories of baseline information on regional groundwater resources will be consolidated and assessed in order to define areas where existing or potential impacts on groundwater by PCBs or other contaminants would be of particular concern. Interim findings of other ongoing tasks of the remedial investigation will also provide important input to this screening process, particularly the investigation of undisclosed sources and sites and the waste disposal siting study. One area of known importance is the nearshore mudflats north of the Coggeshall Street bridge, since the local groundwater regime will be a critical factor in the assessment of onsite disposal/treatment options. High usage areas would also be prioritized if existing or potential impacts are demonstrated.

The next step in the investigation will be to compile additional site-specific information on the designated critical areas. This investigation will rely primarily on previous contacts and new contacts with individual owners or operators. Any identified sources of information will be researched. No site-specific field effort, as for example geotechnical or geophysical testing, will be conducted unless it has been included under other tasks of the Remedial Investigation.

Groundwater samples will be collected from available wells within the critical areas. The samples will be analyzed for total PCBs and selected priority pollutants. The purpose of the sampling program is to appraise the level of contamination in wells already impacted by the areawide problems and to provide baseline information for assessing the future effects of remedial actions. For purposes of estimating the required effort, a total of 20 samples and analyses has been assumed.

An evaluation will be made of the significance of current and potential contamination in relation to the area's groundwater resources, with emphasis on groundwater usage and associated public health concerns. A report of findings will be prepared, including recommendations for further investigations or additional monitoring.

4.8 Task 14: Investigation of Undisclosed Sources and Sites

This task will entail the identification, evaluation, and documentation of both suspected and unknown sources and sites contaminated with PCBs. Identification will be made in accordance with the following general plan. A search of pertinent available records and literature, along with interviews, will be conducted. Resources might include:

- Past investigators
- Local, regional and State government waste management personnel
- Private waste handlers
- Private landfill owners and operators
- Personnel in industry
- Dredge operators
- Industrial records from PCB manufacturers, suppliers, and buyers
- Shipping manifests and billing records from waste handlers and landfill operators
- Tax or property maps or other sources which may indicate past industrial or dumping activities

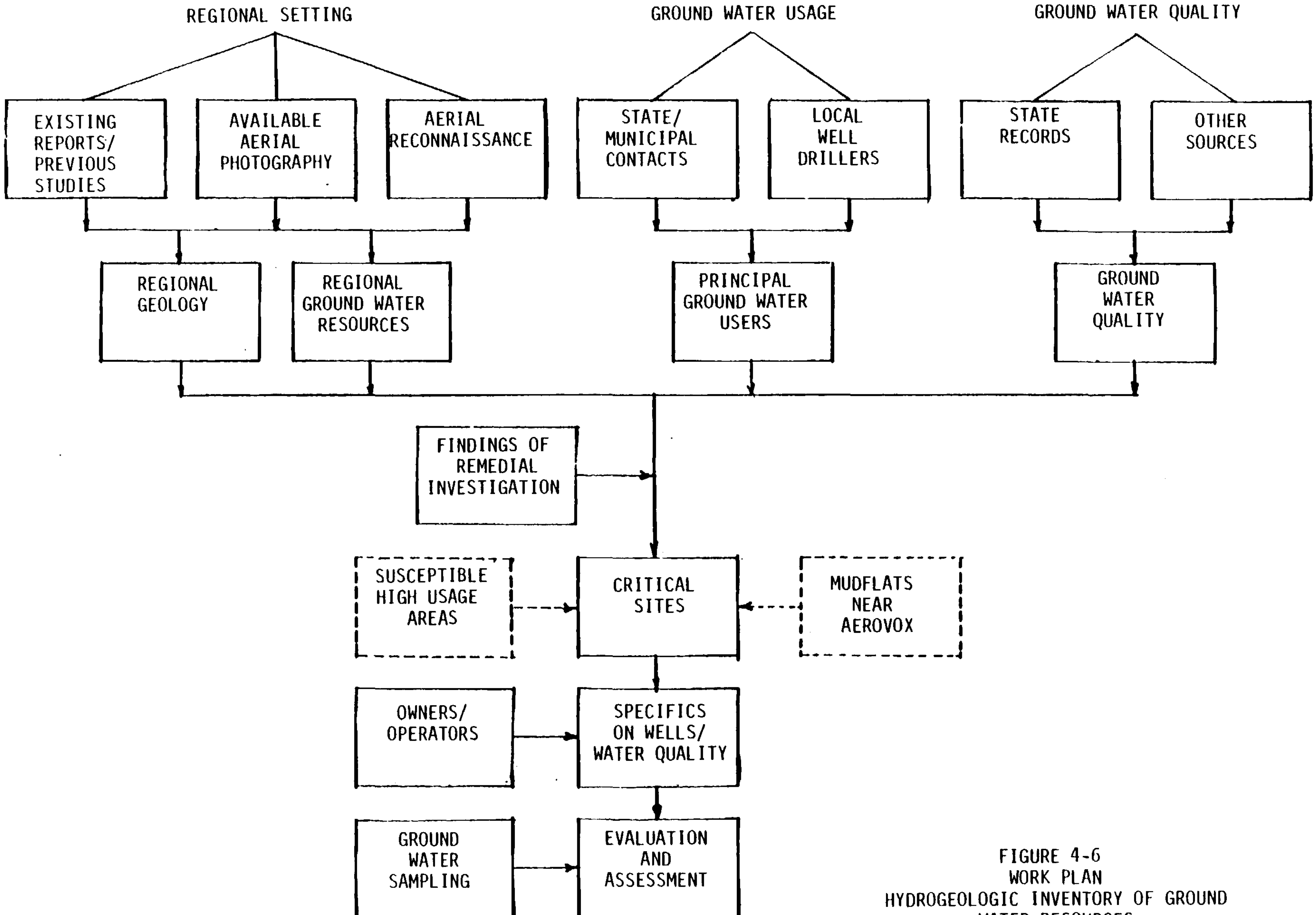

FIGURE 4-6
WORK PLAN
HYDROGEOLOGIC INVENTORY OF GROUND WATER RESOURCES

Principal industry investigations will focus on PCBs but will also include surveillance for metals and other selected pollutants. The data will be gathered from sources that include information on types and quantities of waste generated by individual industries; past and present practices in waste treatment, storage and disposal; and locations both on site and off site of waste treatment, storage, and disposal.

The RAMP has listed the following sources/sites, in addition to Sullivan's Ledge and the New Bedford municipal landfill, as possible repositories of PCB waste to be investigated.

- Landfill Sites
    - Acushnet Municipal Landfill
    - Dartmouth Municipal Landfill
    - Fairhaven Municipal Landfill
    - Private Landfills
- Dredge Disposal Sites
    - Route 195 crossing of Acushnet River
    - Popes Island
    - Marsh Island, Fairhaven
    - Area behind New Bedford Airport off Mt. Pleasant St.
    - North Fort Phoenix Beach, Fairhaven
    - Playground near South Terminal, New Bedford
    - Merrill's Wharf
    - West Island disposal area
    - North side of Coggeshall St., Fairhaven
- Other Suspected Sites
    - Railroad siding (chemical transfer area), New Bedford
    - Francis Playground

- New Bedford High School property
- Cushman Park, Fairhaven
- Miscellaneous private properties
- Roadways (waste oils)

- Scrap Metal Dealerships

Investigations will not necessarily be limited to the listing above, since other unknown sources/sites may exist in the greater New Bedford area. Individual sources and sites will be characterized through site inspections, study of available maps and aerial photographs, and application of available scientific and engineering data. Individual characterizations will include:

- Description of physical site, including size (area and depth), general appearance, current use, vegetative cover, presence of surface water, presence of manmade structures, visible signs of contamination, etc.

- Location of each source/site on a base map of appropriate scale.

- Sketch of each site to approximate scale showing pertinent features.

- Description of general surroundings, including type of environment (e.g., urban, suburban, etc.), topography, vegetation, surface waters, roadways, utilities, human habitation, commercial development, etc.

- Background data on area geology and hydrogeology.

- Estimation, to the extent possible, of the types and quantities of PCBs and other identified or suspected hazardous substances present at the site; and if it can be determined, an approximate distribution of these substances.

- Apparent violations of environmental, health, or safety statutes and regulations.

- Sampling and analysis for PCBs. A total of 40 soil samples (possibly composite samples from a single site) and 20 surface water samples has been assumed.

After the sources and sites have been identified and characterized, EPA will prioritize them for subsequent action according to the estimated severity of contamination and public health hazards. Additional work requested of REMPO in response to prioritized actions is not included in this Work Plan, but will be appropriately scoped upon notification from EPA.

5

5.0 TECHNICAL APPROACH: FEASIBILITY STUDY

5.1 Task 16: Feasibility Studies

5.1.1 General Objectives

The principal objective of the New Bedford remedial action program is to attenuate the release of contaminants to a level that is consistent with the protection of public health, safety, and welfare. Not only does this encompass the protection of the surface water, groundwater, air, and terrestrial resources of the regional area, but more specifically includes the return of commercial fishing to areas presently affected by closure, the removal of restrictions to dredging projects essential to the progressive commercial development of the harbor, and the restoration of the recreational potential of the harbor environment. The Remedial Investigation described in Section 4.0 had as its general purpose the documentation and characterization of the sources and sites of contamination that inhibit the realization of these objectives. In the Feasibility Study, an in-depth evaluation of alternatives for remedial action will be conducted in relation to cost, environmental impact, and engineering feasibility criteria. Recommended actions that best satisfy the aforementioned objectives within the framework of the evaluation criteria will then be developed for each source/site of contamination.

5.1.2 Site-Specific Objectives

In previous sections of this Work Plan, seven sources/sites of PCB or heavy metal contamination within the New Bedford area were identified. An eighth category (termed the undisclosed sources and sites) was also included so as not to limit future investigations. Two of these sources/sites, the municipal wastewater system and the commercial properties, are not within the scope of the RI/FS and will not be considered in the feasibility study. On the other hand, the ambient air and biota categories will be considered, but not as separate phases of the feasibiity study. The reason is that any remedial activities that impact on the air and biotic environments are likely to be developed and evaluated in relation to the other sources/sites under consideration. A fifth category, the New Bedford municipal landfill, has been determined a priori not to require a feasibility study of remedial alternatives due to the apparent lack of contaminant migration off site. If subsequent investigations and monitoring reveal otherwise, however, the need for a site-specific feasibility study of the landfill will be reevaluated. Of the undisclosed sources/sites, only those determined to possess significant hazard potential will require detailed remedial investigations and possibly feasibility studies. These cannot be scoped at the present time and are not included in the Work Plan.

Therefore, based on currently available information and for the reasons stated above, the scope of this Work Plan will provide only for site-specific feasibility studies of the estuary/harbor/bay system and Sullivan's Ledge. The objectives of the feasibility study for the estuary/harbor/bay system correspond totally with the overall objectives of the remedial action program identified in Section 5.1.1. In the case of Sullivan's Ledge, the primary objective is protection of groundwater and surface water resources, particularly those which serve as actual or potential drinking water supplies. Whether contaminant migration from Sullivan's Ledge is a causal factor in harbor contamination is uncertain at this time, and thus to extend the harbor-based objectives to the feasibility study for Sullivan's Ledge would be premature.

The documented high levels of contamination at Sullivan's Ledge and within the Acushnet River Estuary near the Aerovox plant have led EPA to designate these sites as high priority. The feasibility studies will therefore be phased to permit a fast-track evaluation and remediation of these sites. In essence, three phases will be conducted. The first two phases, the fast-track efforts for Sullivan's Ledge and the estuary hot spots, will be concurrent yet relatively independent, although support activities such as the waste disposal siting study and permit requirements will be common to both. The third phase, which is the feasibility study for the overall estuary/harbor/bay system, will utilize the findings of the corresponding fast-track study and remedial investigations over an extended time-frame.

The scope of work for the feasibility studies presented in the following sections is preliminary and necessarily general. The scope will be continually evaluated and revised based on the progressive findings of the remedial investigations, and in turn, feedback will be provided to the remedial investigations so that any ongoing efforts will address the needs of the feasibility studies.

According to the RAMP, the initial work product of the feasibility study is to be a written description of each source/site. It should contain a summary of all pertinent technical data, with conclusions regarding the nature, hazard potential, and priority for remedial action of the associated contamination. The objective of these reports is to provide a basis for a prioritization of sites by the lead agency. For managerial purposes, particularly as related to potential subcontracting of site-specific remedial investigations, these reports will be prepared as part of the individual remedial investigations rather than as a task within the feasibility study.

5.1.3 Identification of Alternatives for Remedial Action

Two previous engineering feasibility studies dealing with PCBs in the estuary and harbor have focused on the removal of contaminated sediments by dredging, with subsequent disposal (refer to entries 10 and 12 in Appendix B). This alternative for remedial action has received widespread attention and is considered by some to be the only currently feasible alternative. The feasibility study will not presume this, however, and all available technologies will be identified as a basis for the development of remedial alternatives. This could be important not only for the possible development of in-situ treatment or confinement strategies as alternatives to sediment dredging, but also for the potential identification of treatment options in lieu of disposal if dredging is performed.

To date, no advances in technology have been found in the literature regarding the in-situ chemical or biological immobilization of PCBs in contaminated soils or sediments. In-situ treatment or confinement would therefore be limited to physically-based options such as soil sealants, cement forming materials, or polymer films. These would be most pertinent to the Sullivan's Ledge situation, since the extent and dynamic nature of the estuary and harbor problems would likely eliminate these alternatives from consideration.

The PCB treatment technologies have recently been reviewed by NUS as part of ongoing work for the Hudson River and are summarized in Table 5-1. The technologies involve either the detoxification, degradation, or destruction of the contaminant, and can be conveniently categorized as biological systems, dechlorination processes, or destruction processes. Of those listed in Table 5-1, only rotary kiln facilities for the high temperature destruction of PCBs have been permitted by EPA for the treatment of PCBs in sediments. Wet oxidation can also be considered a demonstrated technology. Several other technologies have shown potential in laboratory or pilot plant studies, but have not been demonstrated commercially. In the course of this work item, PCB treatment technologies will be updated and evaluated in relation to the particular problems at New Bedford.

A similar review will also be conducted to identify treatment options for both the heavy metals under study and the most significant toxic chemicals found at Sullivan's Ledge. Any additional options for in-situ containment or dredge spoil disposal will also be identified.

5.1.4 Initial Screening of Alternatives

The treatment technologies and other remedial options identified in the previous work item do not, in themselves, always provide a workable alternative for remedial action. In many cases, several such components must be integrated in order to develop a feasible remedial plan. Figure 5-1 illustrates several pathways for the remediation of contaminated soil or sediments that are actually comprised of a series of individual technical options. Consequently, the initial screening of alternatives must evaluate the individual components in the context of the total alternative strategies. For example, even though the removal of contaminated sediments via dredging with subsequent disposal has gained widespread recognition, the findings of the waste disposal siting study (in Task 6) could shift priority from disposal to treatment if appropriate sites cannot be found or will not be permitted.

TABLE 5-1

PCB TREATMENT TECHNOLOGIES

Process	Status	Effectiveness
Biological	Laboratory scale on wastewater treatment systems. Some studies of residual PCBs in soils.	Limited to lesser chlorinated bi-phenyls.
LARC	Patented but not optimized for liquid treatment.	Not effective on viscous ultra-violet light ab-sorping materials.
NaPEG	Two limited scale field tests on in-situ soils are in progress.	EPA is optimistic regarding its potential.
KOHPEG	Laboratory-scale tests.	Appears to be more reactive and more tolerant of contaminants than NaPEG.
Acurex	Available but not permitted.	Tests indicate it is effective on liquids.
Acurex with solvent wash of sediment.	Pilot-scale in laboratory.	Expected to work.
PCBX	Commercially available and EPA permitted. Mobile.	Effective on transformer oils.
Wet Air Oxidation	In the process developmental stage.	Achieves very good (99 + %) obstruction of even highly chlorinated biphenyls. Should prove to be very useful on contaminated sediments.
PCBX with solvent wash of sediment.	Preliminary laboratory-scale.	No data, but expected to work.

TABLE 5-1
PCB TREATMENT TECHNOLOGIES
PAGE TWO

Process	Status	Effectiveness
Goodyear	Patented. Not portable.	Used for transformer oil. No work in progress to sediments.
Hydrothermal	Laboratory developmental.	Seems effective on liquids.
Photo-decomposition	Laboratory scale.	Not effective on contaminated sediments.
Rotary Kiln	Commercial facilities available.	EPA permitted for sediments.
Cement Kiln	Cement plants have been shut down and kilns may be available. Conversion to incineration of sediments has not been demonstrated.	Test burns of liquids have been successful. Cement kilns normally handle solids and and operate at temperatures and residence times similar to EPA-permitted rotary kilns.
Controlled Air Incinerator	Production scale to burn solids.	No test burn results or EPA permit.
Molten Salt Incinerator	Mobile pilot plant under construction.	Effective during laboratory-scale tests on liquids. Not applicable to sediments.
Fluidized Bed	Pilot-scale with no plans for scale up.	Successful on one-gallon PCB test burn.
Thagard HTFW	Pilot-scale with larger units in planning stages.	Successful in destruction of PCB. May be applicable to sediments.

TABLE 5-1
PCB TREATMENT TECHNOLOGIES
PAGE THREE

Process	Status	Effectiveness
Plasma Arc	Laboratory scale, with one gallon per minute unit under construction.	Successful in liquid tests. Expected to work on sediments.
Pyromagnetics	A unit with a capacity of one ton per hour of solid material has been sold, for $1.5 million.	Trial burn of PCBs has not been conducted.
Ozonation	Preliminary laboratory-scale.	Studies indicate 95% destruction of PCBs in wastewater.
Ultraviolet/Ozone	Wastewater treatment Pilot Plant.	Not effective on sediments.

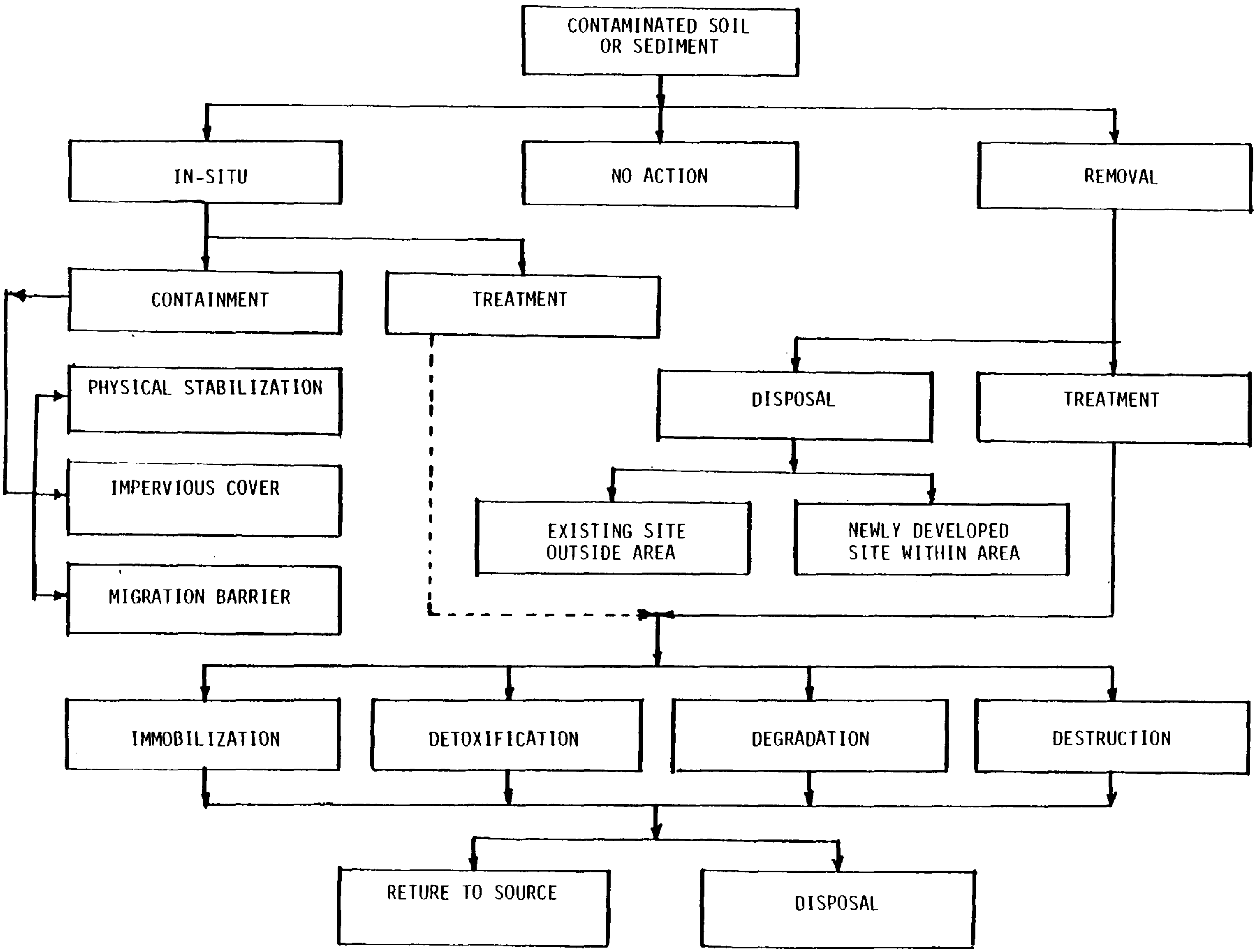

FIGURE 5-1
POSSIBLE ALTERNATIVES FOR REMEDIAL ACTION

This same example also serves to illustrate that, in the case of hazardous wastes, institutional or environmental constraints can often match or override engineering feasibility as selection criteria.

The initial screening of alternatives will therefore, at a minimum, include the following:

- Reliability:

  The extent to which an alternative is applicable to the particular site conditions in order to provide a reliable solution to the problem. Selected technologies must have a demonstrated ability to consistently meet the required technical criteria.

- Implementability:

  The probability of satisfying all permit requirements and other institutional constraints, or of securing a waiver of the same. Also includes a consideration of the potential for phasing the alternative either spatially or temporally in order to expedite the overall remedy.

- Environmental Concerns:

  From a negative standpoint, the degree to which adverse environmental impacts could result. From a positive standpoint, the degree to which adequate control of the source material will be achieved and the health of the public and environment will be protected.

- Cost Effectiveness:

  Alternatives which demonstrate the highest degree of cost-effectiveness (considering both capital and operation/maintenance costs) will be favored as long as the overall response plan achieves the objectives of the remedial action program.

- Operation and Maintenance Requirements

  With other factors being equal, remedial actions with lower operation and maintenance requirements will be preferred.

- Health and Safety Requirements:

  Alternatives for remedial action with lower health and safety impacts and related costs will be favored.

- National Contingency Plan:

  Various alternatives considered must be consistent with the requirements of Section 300.68 of the National Oil and Hazardous Substances Contingency Plan.

This initial screening will not be a comparative evaluation of alternatives. Rather, utilizing a common set of criteria, each remedial action candidate will be qualitatively assessed within the framework of the overall remedial alternatives (Figure 5-1) and the known conditions at each site. The purpose is to identify those candidates that do not warrant further investigation. Technical limitations or the lack of demonstrated capabilities (i.e., the "reliability" and "implementability" criteria) are expected to dominate the elimination process. Other criteria will become important if a given action has a critical flaw (e.g., an unresolvable environmental impact), or if the comparative advantages of one alternative over another are obvious and do not require further documentation in the subsequent detailed evaluation.

In addition to the technical information compiled for each option in this work item, other input for the initial screening will come from other tasks (e.g, disposal site selection or permitting requirements) and the ongoing contacts with the various agencies and institutions involved. The results of the initial screening will be presented to EPA at a regularly scheduled review meeting. No formal report is expected, although the initial screening effort will be included in the final feasibility report.

5.1.5 Laboratory Studies

Prior to initiating a detailed evaluation of the screened alternatives, laboratory and/or bench-scale studies may be necessary to fully satisfy the informational needs of the evaluation. This same information could also serve to establish engineering criteria for the subsequent conceptual design. Examples of the type of studies that could be required are:

- Settleability studies of dredged harbor sediments;
- Waste characterization studies for dredged harbor sediments, including leachate and decant water from dewatering operations;
- Treatability studies for the leachate and/or decant water;
- Compatibility tests of the waste/leachate with impermeable cover and liner materials.

The presence of saltwater within the dredged slurry could influence the behavior of the chemical system with respect to leachate production, treatability, and liner compatibility. This could invalidate the results of previous studies by process developers and others, which would further warrant the laboratory studies.

The scope of the laboratory studies will depend on the results of the remedial investigations and the initial evaluation of alternatives in the feasibility studies. Therefore, these studies are not included within the scope of this Work Plan. A separate work plan for proposed laboratory studies will be prepared and submitted to EPA during the course of the RI/FS. This submittal will be made in a timely manner so as to maintain steady progress of the feasibility studies.

5.1.6 Detailed Evaluation of Alternatives

The purpose of this work item is to refine the evaluation of alternative remedial actions to allow for the meaningful development of a recommended plan that best satisfies a comprehensive list of evaluation criteria. In this work item, each alternative that survived the initial screening will undergo a refined cost effectiveness evaluation based on a methodology developed for the EPA by Radian Corporation. The evaluation criteria will include cost, environmental effects, and the effectiveness of the remedial action in achieving the remedial program objectives.

Cost Evaluation

A cost estimate will be prepared for all feasible remedial action alternatives. The cost will be developed as a present worth, and will include the total cost of implementing the alternative (capital cost) and the annual operation and maintenance costs. Phasing of alternatives will be considered to allow for an estimate of the distribution of costs over time.

Environmental Assessment

Each alternative will be assessed in relation to primary and secondary impacts on a number of environmental systems. These include groundwater, surface water, ambient air, and terrestrial systems. Marine systems will be emphasized due to the commercial fisheries involved. Other environmental factors include public health and welfare, aesthetics, recreation, and socioeconomic impacts. The assessment will also consider the availability of methods to mitigate/minimize any identified adverse impacts, and the need to fulfill all requirements of the National Policy Act (NEPA) and the Massachusetts Environmental Policy Act (MEPA).

Effectiveness Measures

- Engineering Feasibility:

  A twofold evaluation of the technical feasibility of each alternative will be conducted. The first factor is the extent to which an alternative is applicable to the particular site location and conditions. In other words, whether or not the alternative can be physically implemented. The second factor is the probability of achieving a reliable and permanent solution to the problem. This is directed solely to the physical components of the alternative, and the degree of risk associated with potential failures of the engineered components.

- Level of Clean-Up/Isolation Achievable

  This factor attempts to evaluate how "clean" the site will be after the remedial action is implemented. The levels of clean-up achievable range from "no action" to complete excavation and removal or complete encapsulation of the wastes. For purposes of this study, clean-up implies that pollutants are removed from the site, whereas isolation means that no pollutants are removed but their transport from the site to the environment has been slowed or stopped.

- Time Required to Achieve Clean-Up/Isolation

  The time required for a remedial action alternative to achieve its designed degree of clean-up or isolation may range from weeks to many years. Evaluation of alternatives relative to this factor will be based solely on this time element.

- Ability to Minimize Community Impacts

- Ability to Minimize Adverse Health and Environmental Impacts During Implementation

This factor will account for the degree of any changes in the normal way of community life which will be directly or indirectly attributable to the remedial action. These changes include those that are permanent and clearly negative, such as a decline in property values or a permanent move from a condemned property, and those that are temporary irritants such as increased noise and traffic congestion during project implementation.

This measure assesses the type and the amount of emissions of effluents that occur during the construction of a remedial action alternative, and the potential impact of these emissions or effluents on both the health of the exposed human population and on the surrounding environment. The ability to minimize these impacts will also be considered.

- Technology Status

Technologies involved in a remedial alternative are either proven, widely used, or experimental when applied to uncontrolled hazardous waste sites. Generally, a proven and widely used technology is to be rated highest and experimental technologies lower. But for some specific pollution problems, the only technology available for use at uncontrolled sites may be in the experimental stage. In such cases, if the technologies involved receive high enough ratings relative to other generic and site-specific measures, an experimental technology may be chosen.

- Acceptability of Land, Surface Water, and Groundwater Resources After the Remedial Action

This factor assesses the remedial action in terms of achieving the best use of the land, surface water, and groundwater resources of the site after the remedial action has been completed. The highest value use of the resources is not limited to economic value, but must also consider the value with respect to the needs of the community as a whole (e.g., parks, greenbelts, etc.).

- Risk and Effects of Failure

  The risk factor is used to assess the probability of failure of the remedial action to achieve its stated objectives, and the overall consequences of such a failure. The public's perception of the risk and effects of failure must also be considered, since this could play a vital role in the eventual acceptance or rejection of the action.

- Site-Specific Effectiveness Measures

  Any factors dictated by conditions or objectives unique to the specific site will be addressed as distinct effectiveness measures. For example, the effects of harbor clean-up on plans for further development of the New Bedford waterfront could be identified as a site-specific measure.

A preferred evaluation/selection technique is to establish a quantitative ranking system that accounts for each of the evaluation criteria. However, this is made difficult for the following reasons:

- Most criteria are not directly quantifiable, and considerable judgment must be exercised to quantitatively assess the degree to which an alternative satisfies the criteria;

- Because no individual alternative can be expected to best satisfy each criteria, the individual criteria themselves must be subjectively evaluated as to their comparative importance (i.e., assigned weighting factors).

- The available alternatives for a given remedial action objective may not be directly comparable due to significant differences in the basic technical philosophies and methods.

The quantitative technique to be used is a trade-off matrix that rates the cost-effectiveness of the various remedial action alternatives via the assignment of normalized numerical ratings (between 1 and 5) for project cost and each of the aforementioned effectiveness measures. Capital and operation/maintenance costs are treated separately with each assigned to one of five predetermined cost ranges that are rated 1 (highest cost range) to 5 (lowest cost range). A weighting factor of 1.0 is arbitrarily assigned to the capital cost rating, with a weighting factor less than, equal to, or greater than 1.0 assigned to the operation/maintenance cost rating depending on its perceived importance relative to the capital cost. An overall cost rating is computed as the sum of the products of the capital and operation/maintenance cost ratings and their respective weighting factors.

Each of the effectiveness measures are likewise assigned a rating between 1 and 5, with 1 representing the "worst" condition (low effectiveness) and 5 the "best" (high effectiveness). A weighting factor of 1.0 is arbitrarily assigned to one effectiveness measure, with relative weighing factors assigned to all others to account for their importance to project feasibility and acceptability. An overall effectiveness rating is computed by multiplying the rating values and the respective weighting factors for each of the effectiveness measures, and summing the results.

A composite cost-effectiveness rating is computed for each alternative as the product of the overall cost rating and effectiveness rating values. This final value provides a common comparative basis for determining the most cost-effective of a series of possibly widely varying remedial action alternatives. In conjunction with the results of the environmental assessment, the most cost-effective and environmentally sound alternatives can be identified and recommended.

Primary input to this evaluation will come from the Remedial Investigation, any laboratory or bench-scale studies, technical information compiled on each technology during the initial screening, and feedback from the various agencies and institutions. Additional data needs could be identified at this point in the study, and these will be satisfied via ongoing Remedial Investigation tasks.

Because of the degree of engineering judgment required in the assignment of numerical ranking and weighting values, and the potential compounding of uncertainties as one progresses from the individual criteria to weighted composite rankings, an independent review by other involved parties such as EPA becomes a critical item in the evaluation process. On the other hand, the priorities and judgments of each individual reviewer are likely to vary. The decisions of REMPO (NUS) project personnel and the RSPO must therefore be advanced (unless critical deficiencies and problems are identified) if the development of a final recommended plan is not to be unnecessarily delayed. One must also recognize that the final ranking value is merely a quantitative representation of engineering judgments to put the various remedial alternatives on a common comparative basis for selection purposes. To go beyond this interpretation, as for example to state that Alternative A is twice as favorable as Alternative B, would be inconsistent with the intent of the methodology.

5.1.7 Fast-Track Feasibility Studies

The overall feasibility study will be very much guided by the results of the Remedial Investigation, in particular the sampling efforts and the model-based evaluation of contaminant pathways. On the other hand, the prioritization of the harbor hot-spot areas and Sullivan's Ledge requires an immediate start-up of the feasibility studies. Each feasibility study will follow the general work plan described in the preceding sections, with site-specific conditions introduced into both the identification/screening of alternatives and the assignment of ranking values for the detailed analysis.

In the case of PCB hot spots in the upper estuary, the quantity and nature of the contaminated sediments will be established via existing data and the results of confirmatory sampling to be conducted under Task 9. The alternative for remedial action most widely promoted is dredging of these highly contaminated sediments with disposal in a secure upland site. An alternative would be dredging with subsequent treatment of the contaminated sediments. Other options, for example in-situ immobilization, will also be included in the initial screening. Several of these options will require a bi-level ranking of alternatives. For example, separate evaluations will be completed for dredging activities, disposal options, and treatment technologies. A composite ranking value will then be computed for the comprehensive alternative (dredging/disposal vs. dredging/treatment) using the most favorable sub-options.

The evaluation of dredging options will include activities up through the transfer of sediments to the conveyance facility (i.e., truck or pipeline). Emphasis will be on the costs and environmental impacts on the marine environment, including primarily the release and dispersal of sediments during the dredging activity. Additional cost items (e.g., silt curtains) for the mitigation of environmental impacts will be included. Technical information will come primarily from manufacturers, the previous studies by Geotechnical Engineers, Inc., and Malcolm Pirnie Inc. that deal with New Bedford Harbor (See Appendix B), and extensive previous work completed for the Hudson River and Waukegan Harbor PCB remediation projects. Allowance has also been made for a trip to the U. S. Army Corps of Engineers' Waterways Experiment Station to discuss the available options with personnel involved in the Corps dredging research program. An evaluation of the disposal options will be integrated with the waste disposal siting study in Task 6. Treatment technologies will be similarly ranked, with emphasis on costs, demonstrated technical performance, and contaminant removal efficiency.

Potential remedial actions at Sullivan's Ledge are less defined and must await at least the intermediate findings of the Remedial Investigation. The areal extent and depth of the quarry would appear to rule out contaminant removal. The only possibility would be if isolated sources of contamination can be located, but this is unlikely given the large number of contaminants from differing sources at the site. The options would then shift to in-situ techniques, particularly onsite containment. The feasibility of each in-situ alternative will depend on the results of the geohydrologic study (Task 10) and the regional groundwater resources inventory (Task 13).

5.1.8 Recommendations and Conceptual Design

Based on the determinations of the detailed evaluation of alternatives, preliminary recommendations for remedial action will be prepared. After EPA review and the satisfactory completion of appropriate revisions, the recommended actions will be subjected to a review by the Massachusetts regulatory agencies, local governments, and by the public at large. Final recommendations will then be prepared which will form the basis of the engineered remedial actions.

The recommendations will consist of site-specific remedies presented at a level of detail consistent with a conceptual engineering design. This will provide sufficient detail for the subsequent development of a final engineering design, including plans and specifications, which is outside the scope of this RI/FS. Each recommended action will be accompanied by:

- A set of design criteria and a preliminary design for the engineered solution to be implemented;
- An environmental statement citing the predicted effects of the proposed action, its reliability, and the degree of risk;
- A determination of mitigative measures for minimizing the effects of any adverse impacts anticipated to result from the proposed action;
- Estimates of all capital, operating, and maintenance costs to be incurred, and their time distribution, for all phases of the proposed action from initial engineering through post-closure monitoring;
- A schedule for completion of the proposed action, with delineation of phases and priority activities.

5.1.9 Final Report

All findings and recommendations of the Feasibility Study will be presented in detail in a final engineering report. Intermediate technical reports will be issued in conjunction with the fast-track remedial efforts. Since these fast-track efforts are relatively independent of the overall feasibility study and will be proceeding toward implementation when the final report is issued, the intermediate reports will stand alone and will not be incorporated directly into the final report. Rather, appropriate technical material will be borrowed for the final report, and a summary of the fast-track activities will be presented as part of the overall findings and recommendations.

5.2 Task 17: Implementation Plan

A schematic of the basic approach to remedial measures for the New Bedford area problem has been reproduced from the RAMP as Figure 5-2. The RAMP (Remedial Action Master Plan) is to serve as the basic planning tool for conducting all remedial activities from remedial investigations through post-closure monitoring. However, because remedial action planning is inherently a dynamic process as new information becomes available and critical decisions are made, the RAMP prepared by Roy F. Weston, Inc. (1983) incorporated only the remedial investigations and feasibility study, leading up to the selection of remedial action alternatives. The objective of the so-called "implementation plan" is to extend the RAMP process once courses of remedial action have been decided. The implementation plan will address each of the remaining remedial action activities, including remedial design, implementation, and post-closure monitoring (Figure 5-2).

Work statements that summarize the administrative and technical activities necessary for the satisfactory execution of the selected remedial actions will be the key products of the implementation plan. As in the RAMP prepared by Roy F. Weston, Inc., each work statement will be organized as follows:

- Purpose: A statement of the broad or specific objectives of the activity being addressed in the work statement;

- Description: A summary of the work items to be performed to satisfy the activity objectives;

- Products: An identification of any verbal or written reporting requirements to adequately document and distribute the data, findings, recommendations, etc.;

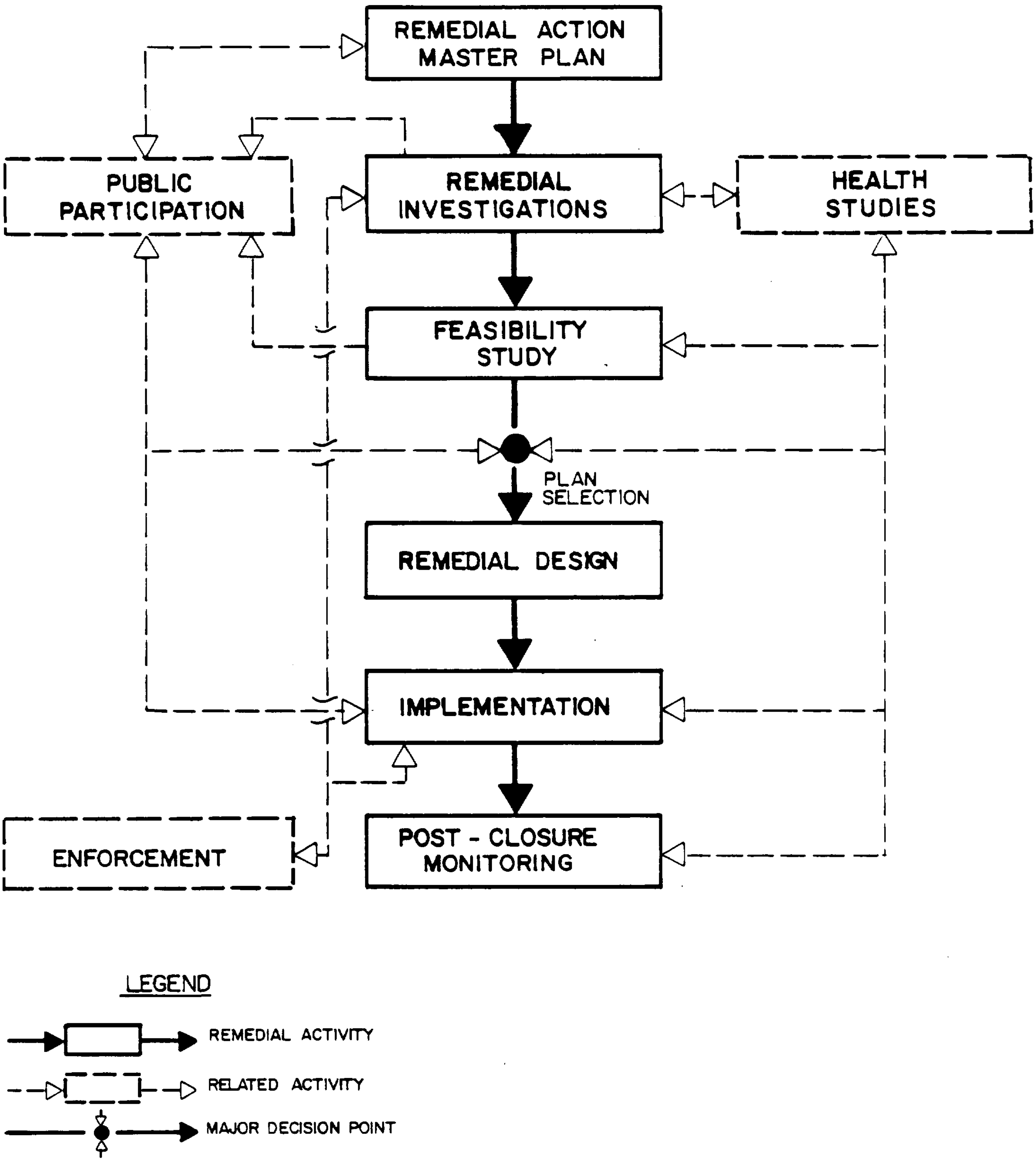

FIGURE 5-2

SCHEMATIC OF REMEDIAL ACTION PROGRAM
NEW BEDFORD SITE, NEW BEDFORD, MA

NUS CORPORATION
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- Decisions/Results: A statement of any decisions or results that are to be produced as a result of the activity, or that must be furnished by others or from other tasks for the successful and timely completion of the activity;

- Schedule: A realistic timetable for the completion of the activity, with anticipated starting dates and reporting deadlines, also would include any project/activity sequencing;

- Costs: An estimate of the labor and expenses to complete the activity.

A line diagram that illustrates the sequence and duration of the key activities will be prepared. This diagram will indicate the timing of major decision points and will identify interrelationships among the activities. A schedule/cost summary for the completion of all activities will also be prepared. In effect, the implementation plan will provide a framework for guiding the lead agency in the proper conduct of the remedial action work.

The following is a partial list of activities that could be required for a given remedial action alternative, and for which individual work statements would be prepared:

- Project Oversight: Development of a management structure and scheduling, cost control, and reporting responsibilities for the lead agency to direct and monitor remedial activities;

- Project Phasing and Prioritization: Identification of any fast-track activities, and overall coordination of activities to satisfy scheduling needs within budget availability;

- Quality Assurance: Development of a plan to assure that any data produced are reliable and useful;

- Health and Safety: Development of a plan to protect the health and safety of workers assigned to remedial activities;

- Site Security: Development of operational policies to protect against potential liability (e.g., due to injury) and to properly execute the Quality Assurance Plan;

- Community Relations: Development of a means of communication to provide timely and accurate information to the public, and to provide for public input;

- Permit Requirements: Permit requirements will be identified in the RI/FS; the development of a system to complete and track all required permits through the various agencies will now be required;

- Technical Requirements (Surveys, Design Drawings, Specifications, Pilot Studies): Development of a work plan to staff and conduct the engineering related activities;

- Competitive Bidding Process: Identification of subcontracting needs, and policies/procedures associated with subcontractor procurement;

- Execution of Remedial Activities: Development of a work plan to implement/construct the selected remedial action alternative (related to Project Oversight);

- Coordination with Harbor Improvements: Development of a procedure to consider the integration of harbor development needs with appropriate remedial activities;

- Maintenance of Waterway: Development of an activities control plan to minimize interference to commercial and recreational waterway traffic;

- Environmental Monitoring: Development of a monitoring plan for the timely detection of any adverse environmental impacts during the implementation work;

- Site Selection for Dredge Material: Site to be recommended in Feasibility Study, but still will require a strategy to uphold the selected site through agency reviews, public hearings, etc.;

- Site Closure: Development of a site closure plan that is consistent with site conditions, environmental concerns, regulatory requirements, and the sequencing of activities;

- Post-Closure Surveillance: Development of a plan to monitor the performance of the remedial action alternative in reducing environmental contamination; to detect resultant adverse environmental impacts; and to monitor the structural and mechanistic integrity of the system;

- Enforcement and Cost Recovery: Identification of additional data needs, and development of a recommended plan of action to institute enforcement proceedings to recover remedial action costs.

The implementation plan to be prepared under this RI/FS Work Plan will include only fast-track remedial activities, since particular courses of remedial action will have been selected only for the fast-track sites within the time frame of the RI/FS.

6

6.0 MANAGEMENT PLAN

6.1 Project Organization and Personnel

The New Bedford RI/FS will be performed by personnel from the Remedial Planning Office (REMPO) located in Pittsburgh, Pennsylvania. Subcontracting for individual tasks within the RI/FS will be required and is discussed in Section 6.6.

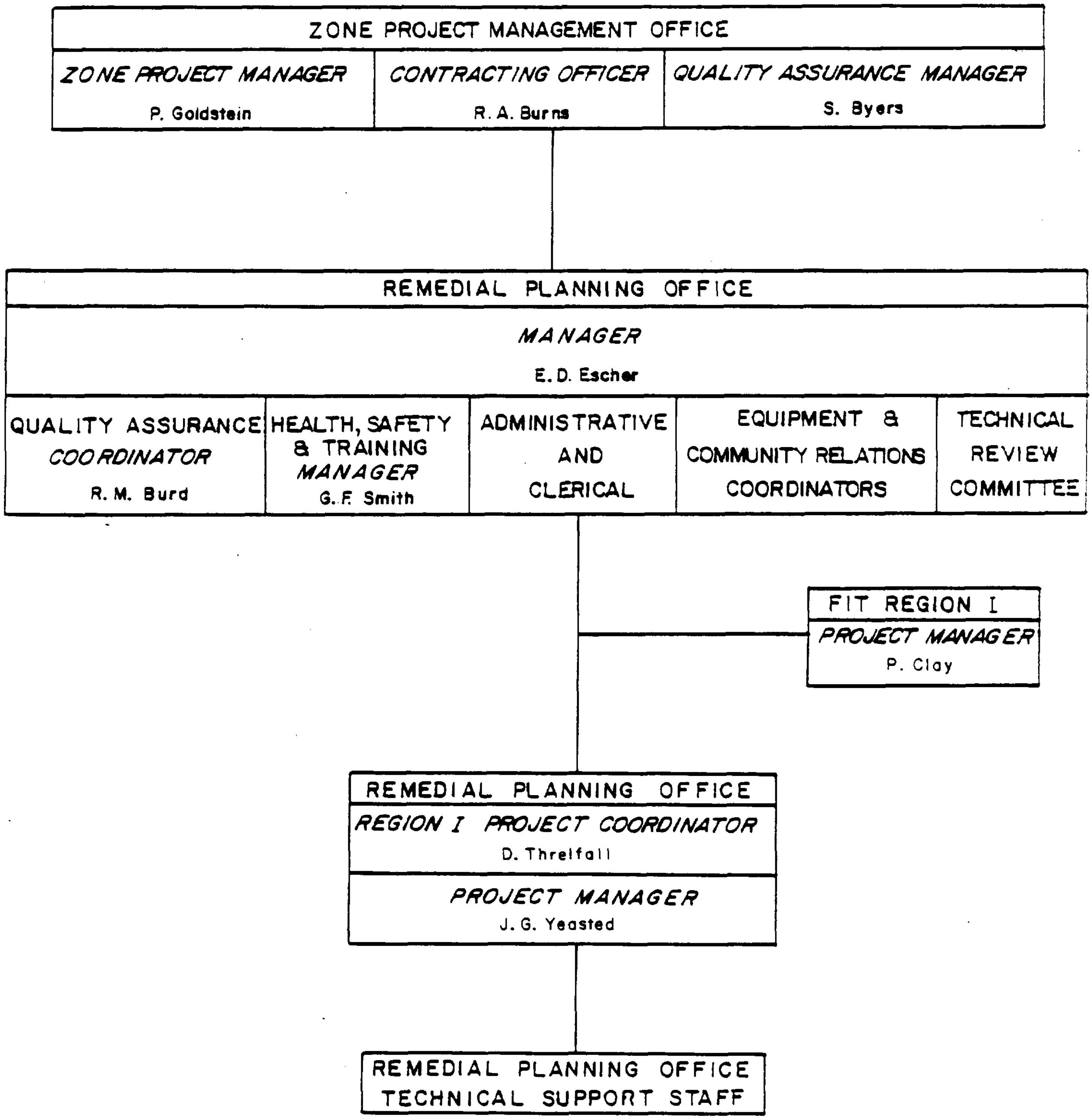
The New Bedford Study will be under the direction of REMPO Project Manager Joseph G. Yeasted. Dr. Yeasted will be responsible for all managerial and technical aspects of the project, except those specific duties of the Region I Project Coordinator.

Mr. E. Dennis Escher, Remedial Planning Office Manager (RPOM), has authority over regional remedial project teams and remedial planning staffs. Mr. Escher will provide managerial and engineering guidance to the project. Mr. Escher will also be responsible for committing Remedial Planning Office resources to the project.

Mr. Escher will be assisted by Mr. Daniel Threlfall, Region I Project Coordinator of REMPO. Mr. Threlfall will review the managerial and technical aspects of the project and monthly progress and financial reports. The project organization is shown in Figure 6-1.

Task assignments will be completed by project work teams. Certain tasks will have overlapping personnel. Three teams have been identified:

- Project Management Team
- Remedial Investigation Team
- Remedial Planning Team



RI/FS PROJECT ORGINIZATION
NEW BEDFORD SITE, NEW BEDFORD, MA

FIGURE 6-1

NUS CORPORATION
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The project management team will consist of the following:

- Region I Project Coordinator,
- Project Manager,
- Public Information Specialist,
- Quality Assurance Specialist,
- Secretarial and Administrative Support

The remedial investigation team will perform onsite work, modeling studies, investigative/informational research, data management and evaluation, and report preparation. The remedial investigation team will be led by the Project Manager, and will consist of numerous individuals with backgrounds ranging from entry-level engineers and scientists to internationally prominent researchers. At a minimum, the following categories of technical personnel will be used in one or more tasks:

- Environmental Engineers
- Civil Engineers
- Hydrogeologists
- Geologists
- Geophysicists
- Chemists
- Public Health Specialists
- Field Technicians

The remedial planning team is designed for remedial alternatives evaluation, conceptual designs, and cost estimating. Required technical disciplines will be similar to those just enumerated.

6.2 Interface Requirements

The Remedial Planning Office, with aid from approved subcontractors, will perform all phases of the RI/FS Study under the direction of Project Manager Joseph G. Yeasted. Assistance could also be provided by the Field Investigation Team (FIT) Region I Office under the direction of Mr. Paul Clay, FIT Office Manager.

Mr. E. Dennis Escher, RPOM, will oversee all work performed. He will also serve as the liaison between the office and contract administrators at the EPA Headquarters in Washington D.C. The Zone Project Management Office (ZPMO) will oversee the distribution of New Bedford project reports to EPA Headquarters, EPA Region I in Boston, and any other agencies or institutions designated by EPA. In addition, REMPO and EPA Region I personnel shall establish communications to provide for the exchange of New Bedford site information to be used during the study.

Mr. Daniel Threlfall, Region I Coordinator for REMPO, will maintain liason with the EPA Region I Project Officer (RPO). The REMPO Project Manager, Joseph G. Yeasted, will maintain project liaison with the EPA Region I Regional Site Project Officer (RSPO). All contact between REMPO and non-EPA individuals, businesses or organizations will be referred to the EPA. The project interface requirements are shown on Figure 6-2.

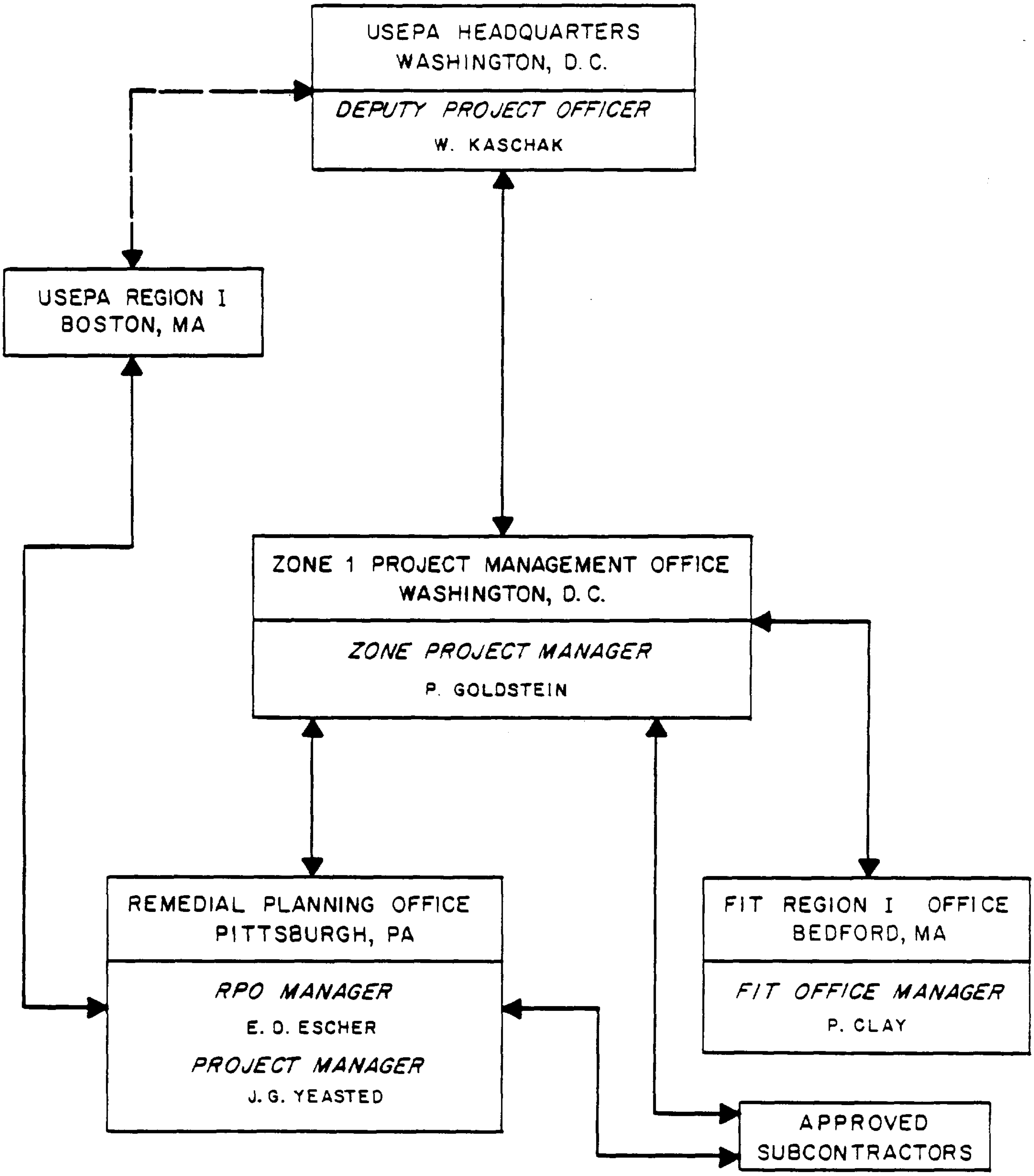
6.3 Field Office Operations

A mobile field trailer will be maintained on site during any non-routine sampling, monitoring, and field testing tasks (including drilling). A telephone will be installed in this trailer for safety and for project communications. Storage of field equipment will and sample-shipping supplies be part of the trailer's function. The designated team leader and senior field technician will plan and maintain the office.

6.4 Project Reports

6.4.1 Project Status Reports

A technical progress report and a financial management report will be submitted monthly. The contents of each report are as follows:



RI/FS PROJECT INTERFACE REQUIREMENTS
NEW BEDFORD SITE, NEW BEDFORD, MA

FIGURE 6-2

NUS CORPORATION
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- Technical Progress Reports
  - Identification of project tasks and milestones
  - Status of work at the sites and progress to date
  - Percent of completion (e.g., percent of task completed and work hours expended)
  - Difficulties encountered during the reporting period
  - Actions being taken to rectify problems
  - Activities planned for the next month
  - Personnel changes

The technical progress report will list target and actual completion dates for each project task, including project completion, and will provide an explanation of any deviation from the work plan schedule.

- Financial Management Report
  - Identification of project task
  - Actual expenditures, including fee and direct labor hours expended for this period*
  - Cumulative expenditures (including fee) and cumulative direct labor hours
  - Projection and expenditures for completing the project, including an explanation of any significant variation from the forecasted target*
  - A graphic representation of proposed versus actual expenditures (plus fee) and comparison of actual versus target direct labor hours. A projection to completion will be made for both.

(*) Indicates data required for input to EPA's Site Response Management System (SRMS). Standardized input forms will be provided for monthly dating of project shares.

Project status reports will be distributed monthly as follows:

Technical Progress Reports	Financial Management Reports	Addressee
2	2	Contracting Officer
2	2	Zone Manager (EPA Headquarters)
2	2	EPA Project Officer (Region I)
2	2	State Project Officer

6.4.2 Interim, Draft, and Final Reports

Due to the wide variety of activities being performed in the New Bedford RI/FS, the technical reporting requirements are unique to each task and have been identified in the individual task descriptions in Sections 3.0 - 5.0 of the Work Plan.

6.5 Meetings

Four principal types of meetings are anticipated for the RI/FS, including:

- Technical meetings that will focus on individual tasks, and are identified in the respective task descriptions in Section 3.0 - 5.0. These meetings could range from work scoping sessions to final technical review meetings;

- Regularly scheduled Interagency Task Force meetings, as requested;

- Regularly scheduled or special public meetings, when attendance by REMPO personnel is necessary for technical support;

- General project review meetings involving at least the REMPO Project Manager and the RSPO. These will be held monthly, unless other meetings attended by the same individuals satisfy the intent and purpose.

Although the full range of possible meetings is difficult to identify at this time, it has been assumed that one meeting per month over and above the technical meetings will require attendance by REMPO personnel.

6.6 Procurement Planning/Subcontractors

It is anticipated that several of the tasks in the Remedial Investigation will be conducted by subcontractors to REMPO (NUS). The reason for the subcontracts is either the need for particular expertise and/or equipment that cannot be comparably satisfied by REMPO, or the possible cost savings as a result of previous efforts and experience of others at the particular site under investigation. The following tasks are preliminarily identified as candidates for full or partial subcontracting:

- Task 5: Data Management and Evaluation
- Task 8: Investigation of Biological, Chemical, and Geophysical Pathways
- Task 9: Sampling and Analysis: Harbor, Estuary, Bay System
- Task 10: Hydrogeologic Investigation of Sullivan's Ledge
- Task 12: Ambient Air Testing

Procurement planning will be under the direction of the Zone Project Management Office (ZPMO), and in particular Mr. Robert A. Burns, Zone Deputy Project Officer and Contracting Officer. Mr. Burns will be made aware of subcontracting needs through the REMPO Project Manager.

Four mechanisms appear to be available for subcontractor procurement, depending on the particular requirements of the respective tasks. Sole source contracts provide for a rapid selection process but can only be justified if unique technical capabilities are required, or if cost duplication will be avoided due to previous work/experience of a particular individual or organization at a particular site. All requests and statements of justification for sole source contracts must be initiated by the EPA. Another mechanism to avoid scheduling delays is the use of an RI/FS subcontractor under the NUS Basic Order Agreement (BOA) Contract. The other mechanisms are either competitive bids from a pre-selected list of qualified firms or competitive proposals.

If competitive bids or proposals are to be utilized for subcontractor selection, the ZPMO and REMPO will assemble a source list of particularly qualified candidates. A selection process will be pre-defined, and the ZPMO and REMPO will select the subcontractor according to how well the competitive response satisfies the selection criteria. The EPA Contracting Officer will review and approve the subcontractor selection prior to award of the subcontract. Subcontractor quality assurance and health and safety will be the responsibility of REMPO.

REMPO personnel will establish a procedure for evaluating the performance of the consultant or subcontractor. REMPO will coordinate such reviews with the EPA, and advise the EPA when a consultant or subcontractor will be dropped from the source list.

6.7 Change Orders

The monthly progress report will identify any unusual problems forecasted for the project. If forecasts indicate that the work assignment budget or scope will change, written approval of the Contract Officer must be obtained. A written request for change will initiate this process.

7

7.0 COSTS AND SCHEDULE

7.1 Costs and Budget

The total estimated cost of the Remedial Investigation and Feasibility Study for the New Bedford Sites is $3,397,521. The Remedial Investigation accounts for $2,857,103 of this total, while the total estimated cost for the Feasibility Study is $540,418. A breakdown of these costs by task is provided in Table 7-1. An estimated $260,600 will be required in CLP analytical costs, with $108,700 of this total associated with the hydrogeologic investigation of Sullivan's Ledge in Task 10.

Table 7-2 provides a summary of the estimated direct labor requirements for completion of the 17 principal tasks (and subtasks thereof) of the New Bedford RI/FS. These manhours convert to a total labor cost of $2,168,371 for the Remedial Investigation, and $511,571 for the Feasibility Study. The total labor cost is therefore $2,679,942, or 79 percent of the total estimated project cost.

In order to generate this estimated cost, hourly labor rates and overhead, G&A, and fee factors had to be assumed for subcontracted tasks. The rates and factors used in the estimate represent average values for six subcontractors currently performing RI/FS activities for NUS, and may require adjustment once particular firms are selected.

7.2 Project Schedule

The schedule for the New Bedford RI/FS is shown in Figure 7-1. The schedule indicates that approximately two years (24 months) will be required to complete the RI/FS following approval of the Work Plan and authorization to begin work. Activities associated with the fast-track feasibility study for hot spot remediation will be completed within 9 months. The fast-track schedule for the investigation of Sullivan's Ledge is 15 months, but the start-up of this task is expected to be delayed due to its being independently named to the NPL.

TABLE 7-1

ESTIMATED COSTS BY TASK

TASK	DESCRIPTION	ESTIMATED COST
1	Work Plan	$ 46,389
2	Subcontractor Procurement	57,667
3	Health and Safety Program	13,811
4	Quality Assurance Program	12,028
5	Data Management And Evaluation	328,694
6	Investigation of Potential Disposal Sites	121,410
7	Identification of Permit Requirements	10,573
8 (A)	Physical-Chemical Model	957,436
8 (B)	Food Web Model	531,512
9	Data Collection/Analysis of Estuary/Harbor/Bay	298,976
10	Hydrogeologic Investigation: Sullivans Ledge	214,450
11	Hydrogeologic Investigation: New Bedford Landfill	29,718
12	Ambient Air Testing	30,604
13	Hydrogeologic Inventory of Groundwater Resources	74,154
14	Investigation of Undisclosed Sources/Sites	94,432
15	Community Relations Program	35,249
16	Feasibility Study	499,218*
17	Implementation Plan	41,200*
TOTAL COST: REMEDIAL INVESTIGATION		$2,857,103
TOTAL COST: FEASIBILITY STUDY (*)		$ 540,418
TOTAL PROJECT COST		$3,397,521

TABLE 7-2

ESTIMATED LABOR HOURS BY TASK

TASK NO.	TASK DESCRIPTION	SUB TASK DESCRIPTION	MAN-HOURS
1.	Work Plan	Prepare Work Plan	1,048
2.	Subcontractor Procurement	Select/Procure Subcontractors	1,244
3.	Health and Safety Program	Prepare General Health and Safety Plan	388
4.	Quality Assurance Program	Prepare General Quality Assurance Plan	336
5.	Data Management and Evaluation	Screen/Evaluate All Data	128 (1,160)
		Enter Data into System	100 (864)
		Develop New Routines/Capabilities	100 (816)
		Attend Planning/Management Meetings	168 (208)
		Prepare Manuals, Reports, Graphics	336 (1,816)
		Subtotal	832 (4,864)
6.	Investigation of Potential Disposal Sites	Compile/Review Available Information	268
		Conduct Initial Site Evaluation	480
		Conduct Second-Level Site Evaluation	492
		Complete Final Evaluation (Fast-track)	594
		Prepare Final Report (Fast-track)	448
		Complete Final Evaluation (Other Sites)	594
		Prepare Final Report (Fast-track)	448
		Subtotal	3,324
7.	Identification of Permit Requirements	Attend meetings with Agencies	128
8.	Investigation of Contaminant Pathways (Models)	Select Model Team	120 (80)
		Develop Model Criteria/Review Data	80 (448)
		Attend Start-up Meeting	48 (128)
		Finalize Work Plan	112 (400)

TABLE 7-2
ESTIMATED LABOR HOURS BY TASK
PAGE TWO

TASK NO.	TASK DESCRIPTION	SUB TASK DESCRIPTION	MAN-HOURS
		Collect Chemical Data	120 (636)
		Collect Food Web/Biota Data	40 (536)
		Develop Model: Physical-Chemical	310 (4,430)
		Food Wood	240 (1,840)
		Calibrate Model: Physical-Chemical	250 (3,830)
		Food Web	200 (1,740)
		Apply Model: Physical-Chemical	250 (3,830)
		Food Web	200 (1,740)
		Complete Miscellaneous Tasks	40 (280)
		Prepare Final Report: Physical-Chemical	116 (680)
		Food Web	116 (580)
		Subtotal	2,242 (21,178)
9.	Data Collection/Analysis: Estuary/Harbor/Bay System	Attend Planning/Management Meetings	32 (88)
		Develop Site Operations Plan	196 (264)
		Conduct Phase I Sampling	
		Water/Sediment	160 (440)
		Biota/Fish	164 (364)
		Physical Data Collection	96 (1296)
		Conduct Phase II Sampling	
		Water/Sediment	140 (440)
		Deep Cores	104 (244)
		Analyze/Transfer Data	228 (200)
		Subtotal	1,120 (3,336)

TABLE 7-2
ESTIMATED LABOR HOURS BY TASK
PAGE THREE

TASK NO.	TASK DESCRIPTION	SUB TASK DESCRIPTION	MAN-HOURS
10.	Hydrogeologic Investigation: Sullivan's Ledge	Compile Miscellaneous Support Tasks	168 (576)
		Develop Site-Specific Operations Plan	116 (140)
		Conduct Surface Water/Sediment Sampling and Overburden Study	16 (436)
		Install Monitoring Wells	84 (456)
		Sample Monitoring Wells	4 (96)
		Analyze Results	88 (392)
		Prepare Report	96 (340)
		Subtotal	572 (2,436)
11.	Hydrogeologic Investigation: New Bedford Landfill	Review Existing Information/Reports	200
		Sample Monitoring Wells	264
		Prepare Report	216
		Subtotal	680
12.	Ambient Air Testing	Develop Detailed Scope of Work	44 (76)
		Develop Site-Specific Operations Plan	40 (88)
		Collect Air Samples	44 (92)
		Prepare Report	52 (200)
		Subtotal	180 (456)
13.	Hydrogeologic Inventory of Groundwater Resources	Establish regional Geology/GW Setting	408
		Identify users, Including Visits	288
		Determine Critical Sites	244
		Establish Site-Specific Geo/GW Settings	196
		Sample Select Wells	112
		Assess Potential Impacts	276
		Prepare Report	464
		Subtotal	1,988

TABLE 7-2
ESTIMATED LABOR HOURS BY TASK
PAGE FOUR

TASK NO.	TASK DESCRIPTION	SUB TASK DESCRIPTION	MAN-HOURS
14.	Investigation of Undisclosed Sources/Sites	Compile/Review Available Information	272
		Conduct Interviews/Investigate Records	444
		Perform Reconnaissance of Sites	356
		Collect Soil/Water Samples	144
		Analyze Data	216
		Prepare Report/Describe Sites	888
		Subtotal	2,320
15.	Community Relations Program	Prepare for Meetings/PR Support	648
		Attend Meetings	192
		Subtotal	840
16.	Feasibility Study	Establish State-of-the-Art	440
		Identify/Screen Alternatives	1,184
		Perform Fast-track Detailed Evaluation	
		Engineering	1,704
		Cost	1,120
		Environmental	1,258
		Perform Overall Detailed Evaluation	
		Engineering	1,704
		Cost	1,120
		Environmental	1,258
		Prepare Fast-track Conceptual Design	1,424
		Prepare Overall Conceptual Design	1,424
		Prepare Fast-track Report	780
		Prepare Overall Report	780
		Subtotal	14,196

TABLE 7-2
ESTIMATED LABOR HOURS BY TASK
PAGE FIVE

TASK NO.	TASK DESCRIPTION	SUB TASK DESCRIPTION	MAN-HOURS
17.	Implementation Plan	Develop Implementation Activities	444
		Prepare Cost Estimates	236
		Prepare Schedule	72
		Prepare Plan Document	356
		Subtotal	1,108
Total Estimated Man-Hours		Remedial Investigation	17,242 (32,270)
		Feasibility Study	15,304 (0)
		Total	32,546 (32,270)

*Man-hours in parentheses refer to anticipated subcontracting efforts in support of the REMPO (NUS) Remedial Investigation Team. They do not include subcontracted items such as drilling, mapping, etc. and represent the estimate of NUS as to the level of effort necessary to complete the respective tasks. These estimates will be finalized upon selection of the subcontractors.

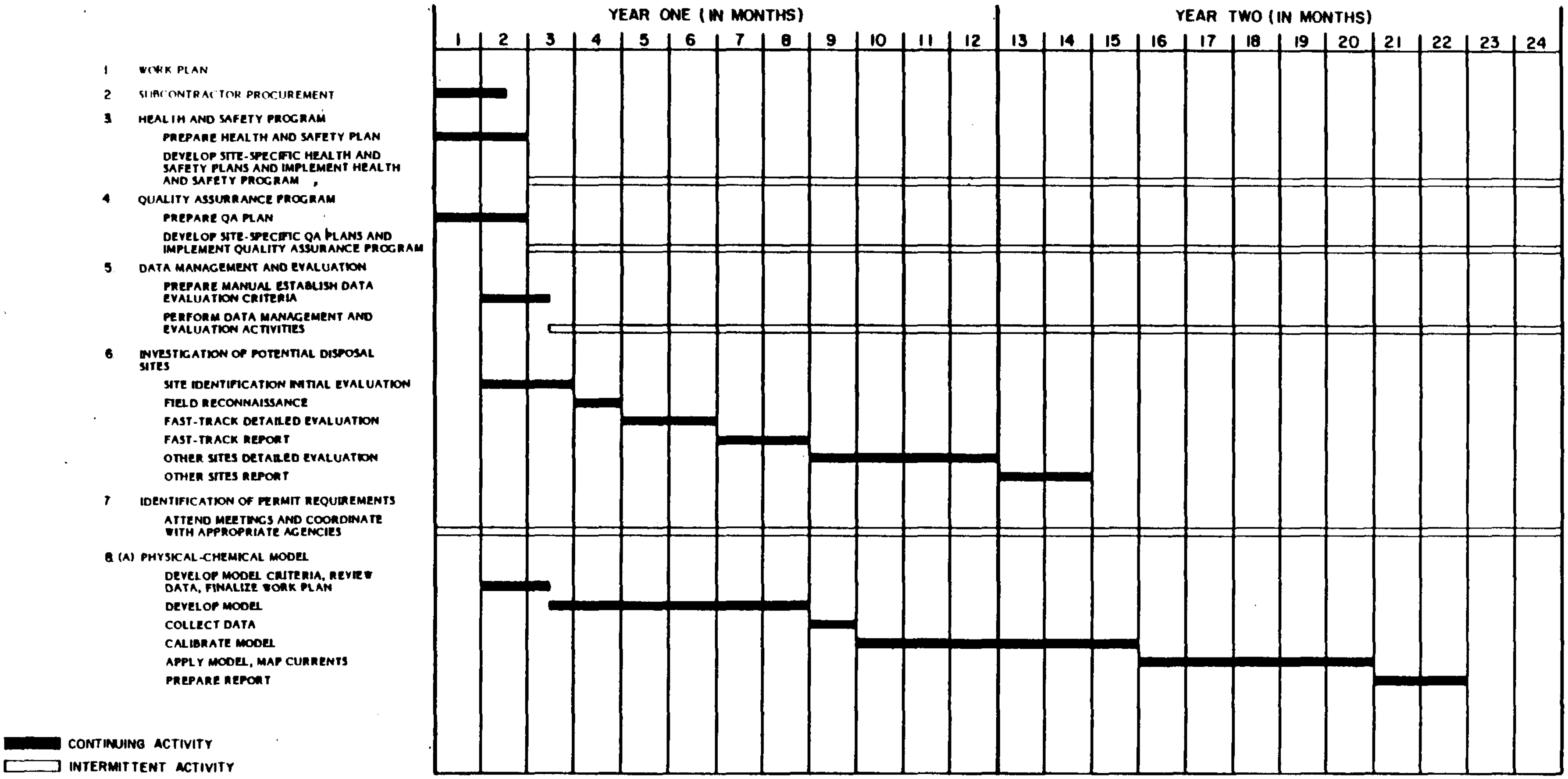

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FIGURE 7-1

PROJECT SCHEDULE
NEW BEDFORD SITE, NEW BEDFORD, MA

NUS CORPORATION
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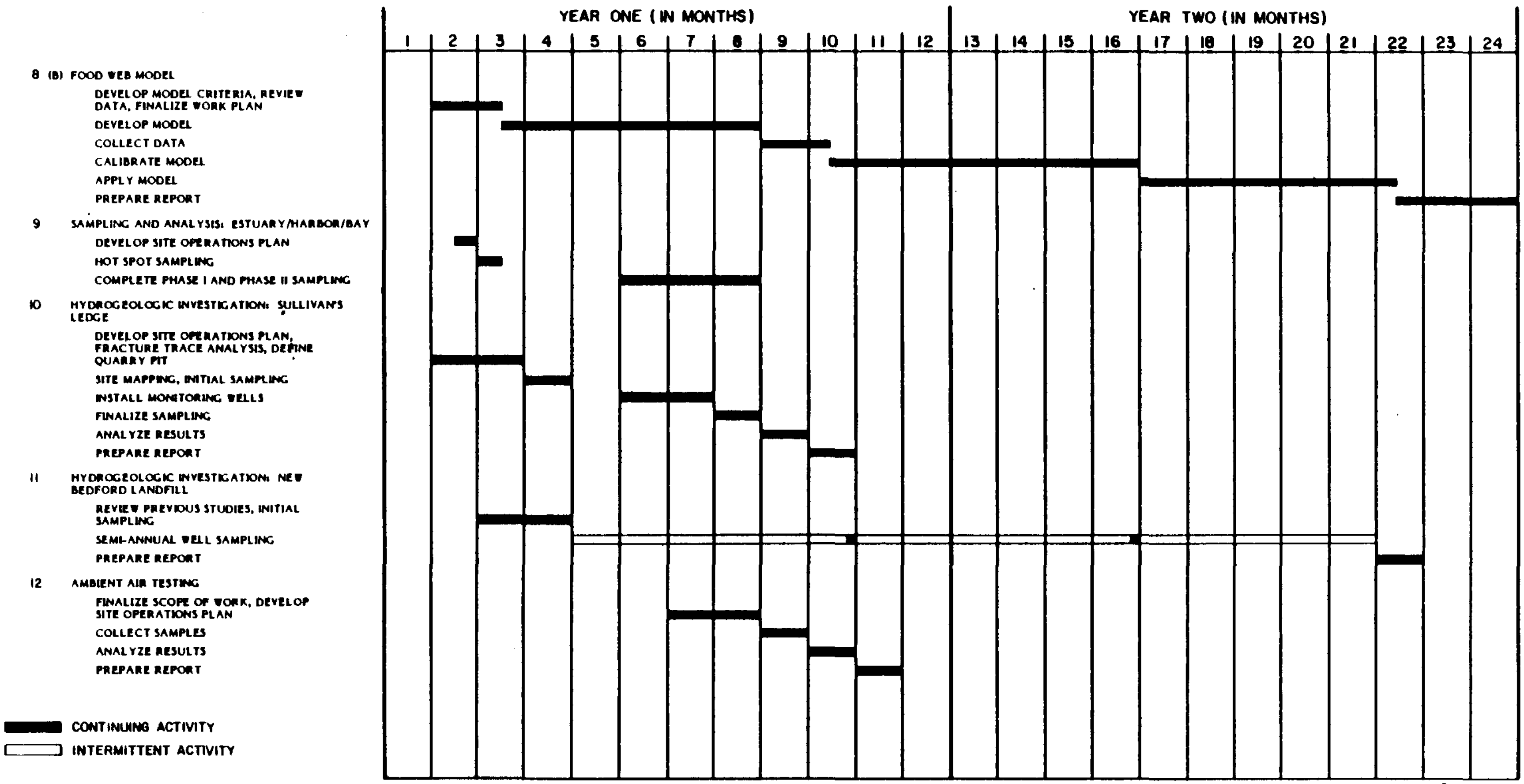

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FIGURE 7-1 cont.

PROJECT SCHEDULE
NEW BEDFORD SITE, NEW BEDFORD, MA

NUS CORPORATION
A Halliburton Company

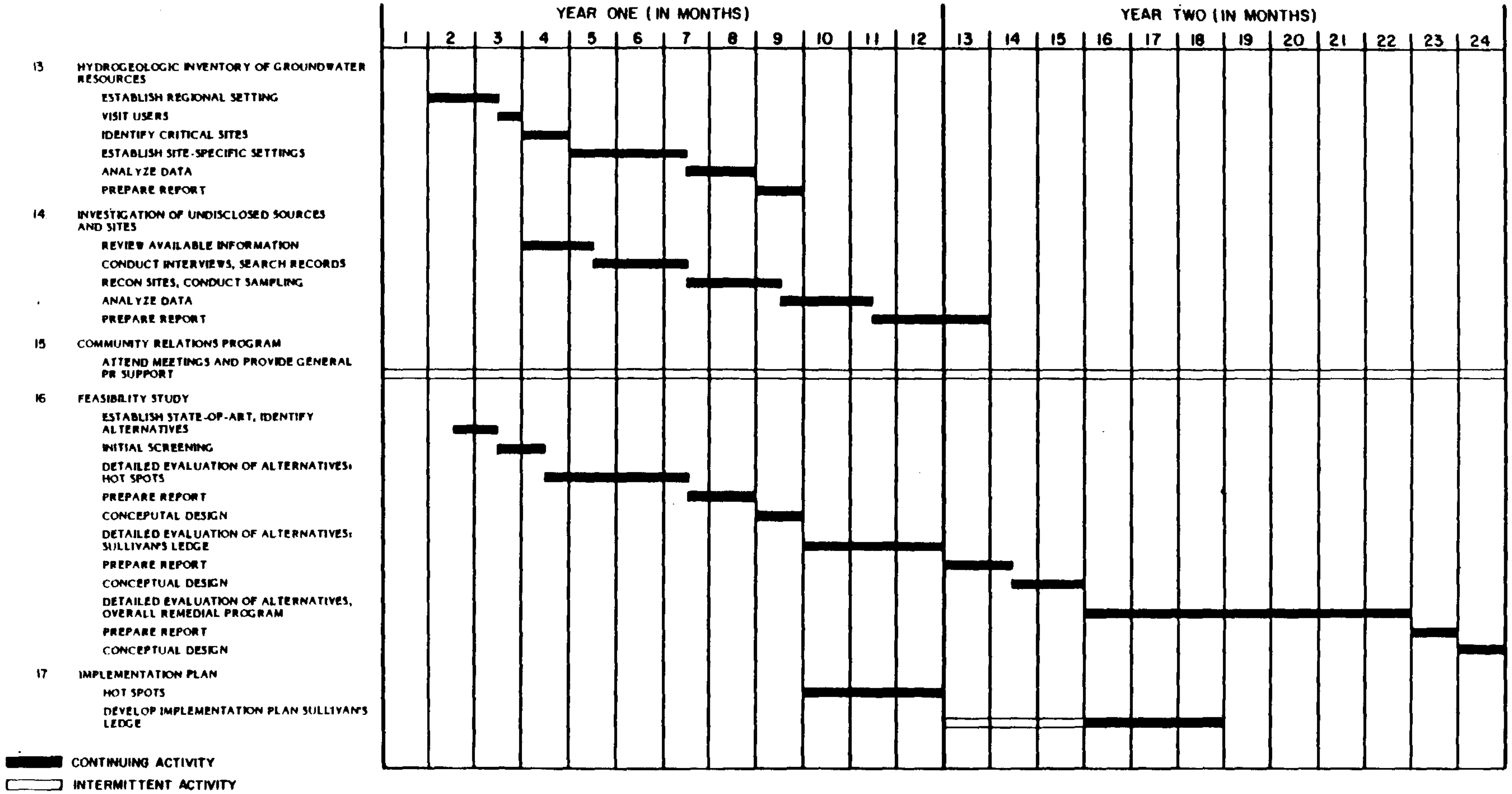

FIGURE 7.1 cont.

PROJECT SCHEDULE
NEW BEDFORD SITE, NEW BEDFORD, MA

NUS CORPORATION
A Halliburton Company

As discussed in Section 1.4, several factors could lead to undesirable delays in the proposed schedule. The primary factors are subcontractor procurement, the proximity of the start-up of the project to the onset of unfavorable winter conditions, and potential delays in the turnaround of analytical results from the Contract Laboratory Program. Efforts will be made to minimize these delays.

APPENDICES

A

APPENDIX A

SCOPE OF WORK
EPA WORK ASSIGNMENT NO. 28-1L43

REMEDIAL INVESTIGATION/FEASIBILITY STUDY

NEW BEDFORD SITES
NEW BEDFORD, BRISTOL COUNTY, MASSACHUSETTS

ATTACHMENT A
Scope of Work
Remedial Investigation/Feasibility Study

New Bedford Site
New Bedford, Bristol County, Massachusetts

The New Bedford Sites, located in New Bedford, Massachusetts include the Municipal Landfill, Sullivan's Ledge, New Bedford Harbor/Acushnet River and the Municipal Sewer System. Two companies, Cornell-Dubilier Electric, Inc., and the Aerovox Company used polychlorinated biphenyls (PCBs) over a period of time spanning several decades until the late 1970's. As a result of poor disposal practices, PCB contamination in the New Bedford area is widespread.

The municipal landfill contains an estimated 500,000 pounds of PCB waste. Nearby Sullivan's Ledge contains an unknown amount of PCBs, however, the groundwater and soil is contaminated with high levels of PCBs.

PCBs were discharged by the companies to surface waters, resulting in high concentrations in sediments, fish and shellfish. The companies also discharged PCB contaminated wastewater to the municipal sewer system. Currently, an estimated 200 to 700 pounds per year of PCBs are being discharged from the Clark's point outfall because of residual contamination in the sewer lines.

Responses to the New Bedford PCB problem, to date, include: Consent Orders with Aerovox Incorporated and Cornell-Dubilier to take remedial actions at their facilities; a comprehensive field investigation to more clearly delineate problem areas; and, a sewer system survey to identify contaminated areas.

A Remedial Action Master Plan (RAMP) has been completed for this site. The RAMP addresses the data needs for the sites and provides a list of items to consider in a work plan to alleviate these deficiencies.

Phase I

Remedial Investigation

The purpose of the remedial investigation is to alleviate the deficiencies of the existing site data to determine the nature and extent of the environmental, and public health and welfare problems presented by the New Bedford site.

The work plan for the detailed site remedial investigation is organized to minimize duplication of efforts and maximize use of existing reliable data. It consists of the following tasks:

- Health and Safety Program
- Quality Assurance Program
- Data Management and Evaluation
- Investigation of Potential Disposal Sites
- Identification of Permit Requirements
- Investigation of Pathways
- Sampling Estuary/Harbor/Bay
- Hydrogeologic Investigation of Sullivan's Ledge
- Hydrogeologic Investigation of New Bedford Landfill
- Ambient Air Testing
- Hydrogeologic Inventory of Ground Water Resources
- Investigation of Undisclosed Sources/Sites
- Community Relations Program

Task I Health and Safety Program

Prior to a detailed site investigation which involves field personnel in daily or direct contact with the sites, an assessment will be made as to associated health and safety hazards. Such an assessment will outline what precautions must be taken by the field workers.

The following outline of such a program is recommended:

A. Identify personnel responsible for safety
B. Medical surveillance program
C. Training program
D. Reporting and information handling
E. Specific site safety plan

Within 15 days after completion of this task a preliminary site safety plan will be prepared and submitted to the EPA and DEQE for review and comment. The final site safety plan will incorporate any comments generated above and will be completed prior to the performance of any other onsite field work.

Task II Quality Assurance Program

Prior to initiating any sampling, a quality assurance program will be prepared. The program will result in reliable and useful data through the application of consistent and accepted techniques in sample collection, handling, and analysis.

Quality assurance plans will, at a minimum, include:

A. Designation of responsible personnel;
B. Objectives for precision, accuracy, and validity of data and methods used;
C. Sampling procedures including preservation, storage, and shipping;
D. Sample custody and labeling;
E. Sample preparation;
F. Analytical procedures, including specific method used to quantitate PCBs;
G. Calibration procedures;
H. Internal quality controls;
I. Performance audits;
J. Procedures for corrective action.

Within 15 days after completion of this task a preliminary quality assurance plan will be prepared and submitted to the EPA and DEQE for review and comment. The final plan will incorporate any comments generated above and will be completed prior to the performance of any other onsite field work.

Task III Data Management and Evaluation

In order to minimize duplication of effort and to evaluate existing and new data, a data management system is necessary. The computerized system will provide ready access and flexible output capabilities.

The data management system should have the following features and capabilities:

- Individual data fields for parameter values;
- Ability to handle descriptive information (i.e. sample number, date, source, etc.);
- Ability to handle data in various forms including numeric, alphanumeric, textual, or coded;
- Allow addition of new data, deletion of old data, and modification of existing data;
- Readily accessible format;
- User-interactive system;
- Report writing output;
- Statistical capabilities;
- Graphics package;
- Able to sort, select and plot data;
- Evaluated data based upon pre-established criteria.

Within thirty (30) days after initiation of this task, a preliminary report describing the prepared data system, including user access information, will be proposed and submitted to EPA and DEQE for review and comment. This report shall be considered a draft report and will be amended to include EPA and DEQE comments.

Task IV Investigation of Potential Disposal Sites

Removal of contaminated sediment or soil, as in the dredging of harbor sediments, will necessitate the development of suitable locations and facilities for disposal of excavated materials. This task will identify and select sites for consideration for the disposal of sediment or soil contaminated with PCBs, heavy metals or other toxic substances.

The investigation will consist of three stages; list of potential sites, site evaluation, and site selection. The recommended methodology for siting includes:

Stage I - Identification of Potential Sites

- Inventory of existing disposal sites in the New Bedford area, and identify secure chemical landfills in the region.
- A review of existing technical reports on solid waste disposal in the general area, especially those which address the siting of land disposal facilities.
- Interview persons involved in local and regional solid waste management.

Stage II - Site Evaluation

- First-level screening: negative indicators (critical flaw analysis)
- Second-level screening: matrix analysis

Stage III - Site Selection

- Hydrogeolgic investigations
- Public comment
- Permit requirements

Within thirty (30) days after completion of this task, a preliminary report presenting the results will be prepared and submitted to EPA and DEQE for review and comment. This report will be considered a draft and shall be amended to include EPA and DEQE comments.

Task V Identification of Permit Requirements

Consideration of any remedial action must take into account federal, state, and local regulations and permit requirements. This task will identify permit requirements and regulations impacting implementation of various remedial actions.

This task will be conducted by EPA, DEQE, and other state and federal agencies. The report will include:

- Areas of jurisdiction and legal responsibility among Federal, State, and local authorities;
- Applicable statutes and regulations;
- Permit requirements;
- Potential conflicts or obstacles (as between different agency requirements or between new technologies and standing regulations);
- Approximate required time allotment for project review and issuance of permits by responsible agencies.

This task will be included in the State/EPA Agreement (SEA) for New Bedford, and will, likely, be coordinated thru the Interagency Task Force for New Bedford.

Task VI Investigation of Pathways

Conduct a study to evaluate the distribution, transport, and fate of PCBs and other contaminants - including trophic relationships - in New Bedford Harbor and Buzzards Bay, and to predict the effects of various remedial actions.

The study will be approached in four phases:

(1) Contaminant Sources and Distributions

Data acquisition on the water column, sediment, and biota will provide a complete source inventory and determination of present contaminant distributions. Investigations will include:

- Measurement of contaminant levels in representative samples of the water column, sediment, and biota (it may not be necessary to evaluate all parameters in all samples);
- Evaluation of particle size, density, and composition of suspended and bottom sediments, and PCBs associated with specific fractions;
- Determination of observable correlations among physical and chemical parameters; identification of indicators.

(2) Transport and Fate of PCBs and Metals in the System

A mathematical model of physical transport for the New Bedford Harbor - Buzzards Bay system will be developed and validated by field and laboratory measurements. This model will describe the movement of PCBs and metals in the system, with emphasis on exchanges between the harbor and the bay. The model will describe the processes of resuspension, transport, and redeposition, and will be used to estimate redistribution of PCBs by tides, currents, winds, and storm events. Related efforts will include:

- Evaluation of PCB absorption/desorption rates between water column and sediment;
- Evaluation of bioturbation and mechanical disturbances (prop wash) on sediment and PCB transport;

- Mapping of scourable sediments;
- Evaluation of micro- and macrocirculation patterns; evaluation of the effects of the hurricane barrier on circulation and transport;
- Mapping and profiling of tidal currents to determine suitable zones (less than 1 knot) for use of silt curtains during dredging;
- Mass balance calculations on PCB distribution and migration.

(3) Food Web Model

A mathematical model which incorporates the structure of the food web, and which describes biotic residues in terms of bioconcentration from environmental exposures and bioaccumulation from trophic transfers, will be developed and field-validated. The relationship between sediment PCB concentration and that in the biota will be established.

Investigations will include:

- Inventory of flora and fauna of the area;
- Identification of target species;
- Literature search on PCBs in target species and cogenus species;
- Evaluation of the relative importance of direct PCB uptake from food organisms, including analyses of the various food groups (benthos, plankton, fish, etc.);
- Evaluation of the relationship between target species body burden and site-specific levels of water column and sediment PCBs;
- Testing of locally favored edible species at specific sites;
- Seasonal migration patterns.

(4) Environmental Responses to Remedial Actions

Results from (2) and (3) will be synthesized to provide predictions of the spatial and temporal responses of PCB residues corresponding to various remedial alternatives. Estimates will be made of the required level of action to ensure that PCB residues are forced below the FDA (or other applicable) action limit in specified areas.

Trimester progress reports will be submitted to EPA and DEQE within thirty (30) days after the end of each trimester. The reports will describe progress to date, work remaining, anticipated problem areas (if any), proposed plan to resolve problems, and other pertinent information.

In lieu of the third trimester report, a comprehensive summary of the first year's activities will be prepared and submitted as scheduled, above. This report will include appropriate preliminary results, conclusions and recommendations. This report shall be considered a first draft and shall be updated to include EPA and DEQE comments.

Within thirty (30) days after completion of this Task, a preliminary report presenting the results will be prepared and submitted to EPA and DEQE for review and comment. This report shall be considered a first draft and shall be updated to include EPA and DEQE comments.

<u>Task VII</u> <u>Sampling and Analysis - Estuary/Harbor/Bay</u>

To provide the requisite data for Task VI (Investigation of Pathways) and to comprehensively define the lateral and vertical distribution of PCBs and other contaminants, a phased sampling and analysis program will be conducted in the estuary/harbor/bay system.

A phased program will commence according to the following plan:

Phase I

- ° Provide data for Task VI;
- ° Concurrently collected sediment, water and biota samples;

- ° Analyze for Arochlors 1016/1242, 1254 and selected heavy metals;
- ° Selected samples analyzed for specific PCB congeners;
- ° Specific sampling protocol to be determined jointly by EPA and the contractor responsible for Task VI.

Phase II

- ° Review existing data;
- ° Prepare isopleth sediment maps for PCBs;
- ° Determine additional data requirements to fill data gaps;
- ° Conduct sampling and analysis program for PCBs, selected heavy metals, and other contaminants(grab and core samples).

Within thirty (30) days after completion of this task, a preliminary report presenting the results (including raw data, isopleth maps, and an estimate of the mass of PCBs in sediments) will be prepared and submitted to EPA and DEQE for review and comment. This report shall be considered a first draft and shall be updated to include EPA and DEQE comments.

Task VIII Hydrogeologic Investigation of Sullivan's Ledge

This investigation will document and define the extent of PCB and selected pollutant contamination within and around the former quarry known as Sullivan's Ledge. A phased program will be implemented to address site conditions at Sullivan's Ledge.

The investigation will be conducted as follows:

Phase I - Site Identification - Preliminary Definition

In conjunction with the historic data collected during the investigation of undisclosed sites, the precise locations of backfilled pits and quarries at Sullivan's Ledge will be accurately determined. Tasks will include:

- ° Fracture Trace Analysis;
- ° Geophysical confirmation (GPR or seismic);

- Test pit investigations within and around suspected PCB disposal sites on the property;
- Sampling of the stream (and streams sediments) which flows northerly on the northeast side of the property;
- Preparation of a topographic base map of Sullivan's Ledge;
- Analysis of soil, water, and sediment samples for total PCBs and selected pollutants. Additional soil samples from test pits will be preserved for future analysis if necessary.

Phase II - Full Hydrogeologic Investigation

Results of the Phase I Study will be used to finalize a Phase II hydrogeologic investigation of the site. The Phase II investigation may consist of the following elements dependent upon the findings in the Phase I preliminary study:

- One exploratory boring drilled within each backfilled quarry or pit. Standard split spoon sampling at five-foot intervals to define stratigraphy and relationship of fill to saturation. Construction of a two-inch diameter piezometer in each boring beneath the fill deposits. Piezometers to be isolated in first zone of saturation beneath fill deposits by tremie grouting above screened zone. Three borings estimated.
- Piezometer couplets around perimeter of quarries and at remote positions on property to define flow in rock and unconsolidated deposits and relationship to a stream flow. Deep peizometers immediately adjacent to fill deposits to be continuously sampled.

  Cohesive soils to be representatively sampled with Shelby tube or Denison. Eight couplets estimated - two piezometers per couplet.
- Field studies consisting of in situ hydraulic conductivity tests, water level measurements, level run on top of casings, and water quality sampling for total PCBs. Estimated 24 samples of ground and surface water.

- Collection of hydrologic data for preparation of mass water balance. Flow measurements of stream.

- Analysis of total PCBs and selected pollutants on ground water samples. Phase II analysis of surface stream. Total PCB extract of soils. Soils to be analyzed sequentially from borings using following protocol:

Sampling Interval	Results	Action
Surface	All concentrations	Sample mid-depth
Mid-Depth	if <10 ug/g	Stop
Mid-Depth	if 10-50 ug/g	Sample bottom 1/4
Mid-Depth	if >50 ug/g	Sample top 1/4 & bottom 1/4

Splitting profile to be continued until full range >50 ug/g defined.

Within thirty (30) days after completion of this Task, a preliminary report presenting results will be prepared and submitted to EPA and DEQE for review and comment. The report will review the factual historical findings of previous site use for waste disposal. The report will characterize contaminated areas and probable modes of dispersion in the soil and water (surface and ground water) at the site through a comprehensive hydrogeologic analysis. This report will be considered a preliminary draft and shall be updated to include EPA and DEQE comments.

Task IX Hydrogeologic Investigation of the New Bedford Landfill

This study will document and define the extent of PCB and other contamination within the landfill. Based upon the results of a preliminary assessment (in progress) a hydrogeologic characterization of the site will be conducted. The final selection of tasks to be performed will be based upon the results of the preliminary assessment report.

Tasks may include:

- Review existing reports evaluating the full extent of fill deposits within the swamp and quantifying the magnitude of contamination within and directly beneath the landfill;

- Determining the local stratigraphy through the uppermost water-bearing zones in the underlying bedrock;

- Conducting a flow net analysis of the site in both horizontal and vertical directions;

- Identifying permeabilities, seepage velocities, and multi-aquifer analysis as necessary;

- Preparing a water balance of the site;

- Identifying ground and surface water resources and users in the area and testing those users nearest the landfill;

- Evaluating the capacity of the site for acceptance of additional PCB and other wastes.

Work to be implemented initially will consist of:

- Review of existing topographic map and grid layout of the landfill and areas 600 feet beyond the present site perimeter. The survey will be based on recent air photos with base control covering a minimum one square mile around the center of the landfill;

- Detailed analysis of site disposal records including interviews with landfill operators to isolate known hot spots or suspected zones of concentration; review of existing well data; air photo analysis;

- Layout of an exploratory boring program and monitor well cluster installation;

- Preliminary surface water and sediment sampling beyond the site perimeter. Test pits or power auger to be excavated on a radiating pattern from the fill perimeter. Sampling of soils at two-foot intervals to uppermost zones of saturation or to six feet. Retention of soil samples for possible future analysis for selected contaminants. Lithologic description of soil profile. Sediment sampling in perimeter streams and swamps following a radiating pattern from site perimeter. Surface water sampling on a grab sample basis in conjunction with soil and sediment sampling. Stake location of all sampling points. The total number of test pits/power auger holes is estimated at 30; each hole will average four soil samples. A total of 20 sediment samples are estimated from the swamp and tributary streams to the Paskamanset River. Twelve surface water samples are estimated from the Paskamanset River and tributary waters emanating from the landfill area.

Surface water, groundwater, sediment, and soil samples will be analyzed for total PCBs and selected pollutants. The analytical protocol for PCB analyses of soil samples from test pit and power auger probes will require that all surface samples (mixed top six inches) be analyzed for total PCBs. If greater than 10 ug/g the next lower sample will be analyzed until results less than 10 ug/g are obtained. A minimum of six samples will be run from mid-depth ranges of two to four feet independent of the surface results. A total of forty test pit soil samples are estimated.

Following the initial survey work and sampling, an exploratory boring and piezometer installation program will be undertaken. This work may consist of the following elements:

- Drilling through the fill deposits with split spoon sampling at standard five-foot intervals; all soil samples to be retained and preserved for possible later chemical analysis. Construction of a two-inch diameter piezometer in each exploratory boring in the uppermost zone of saturation beneath the fill deposits. The screened zone of each piezometer is to be isolated by tremie grouting above the sand-packed annulus. A minimum of three exploratory borings contemplated in fill.

- Performing deep exploratory borings with split spoon samples to refusal on bedrock. Confirmation of bedrock by nominal coring (independent on geologic conditions). Constructing shallow and deep piezometer couplets to monitor hydraulic heads of multi-aquifer conditions utilizing two-inch diameter PVC with non-glued fittings. All grout seals to be tremie placed. A minimum of four perimeter couplets and three remote couplets (within 200 feet of site). Continuous split spoon samples from three of the seven deep borings. Cohesive soils sampled with Shelby tube or Denison sampler.

- Construction of three bedrock monitoring wells at the three remote piezometer couplets. Wells to be drilled a nominal distance into bedrock (fifty feet); wells to be sealed annulus a minimum of five feet into rock (as dictated by geologic conditions).

- Performing hydrogeologic and engineering analysis of all data.

- Performing field studies consisting of in situ hydraulic conductivity tests, water level measurements, level run on top of casings, and water quality sampling for total PCBs. Estimated 20 samples of ground water from wells and piezometers. Collecting of ground water samples from nearby private, public, industrial well supplies.

- Collecting hydrologic data for preparation of mass water balance. Staff gages set in swamp.
- Performing total PCB analyses on 20 ground water samples. Re-sampling any hot spots identified in surface water and sediment grab samples. Estimated 6 soil, 3 water. Performing total PCB extract of soils. Soils to be analyzed sequentially from borings using following protocol:

Sampling Interval	Results	Action
Surface	All concentrations	Sample mid-depth
Mid-Depth	if <10 ug/g	Stop
Mid-Depth	if 10-50 ug/g	Sample ~~bottom~~ top 1/4 & bottom 1/4

Splitting profile to be continued until full range >50 ug/g defined.

Within thirty (30) days after completion of this Task, a preliminary report presenting the results will be prepared and submitted to EPA and DEQE for review and comment. This report shall be considered a first draft and shall be updated to include EPA and DEQE comments.

Task X Ambient Air Testing

Monitor ambient air levels of PCBs and other contaminants to permit judgement of the effects of known contaminant sources on ambient air quality in the study area.

A comprehensive air monitoring program for PCBs and other selected contaminants will be conducted in July or August 1983. Eight-hour samples are to be collected on one day from approximately 10-12 monitoring stations (some previously established), including 3-5 new stations to be installed in the vicinity of Sullivan's Ledge. The selected sampling period is to coincide with typical hot summer weather, when volatilization of PCBs from contaminated soil and water would be at or near maximum. Consideration will also be given to using the Sciex mass chromatography system, consisting of a mobile unit capable of measuring organic contaminant levels on site in real time, as potentially more cost-effective than fixed-station monitoring. Meteorological data from three existing monitors will be collected concurrently.

Within thirty (30) days after completion of this Task, a preliminary report presenting the results (including raw data) will be prepared and submitted to EPA and DEQE for review and comment. This report shall be considered a first draft and shall be updated to include EPA and DEQE comments.

Task XI Hydrogelogic Inventory of Ground Water Resources

This investigation will identify, evaluate, and document ground water resources and uses, including potable water supplies, in the New Bedford, Dartmouth, Fairhaven and Acushnet areas of Bristol County, Massachusetts, as well as contiguous areas known to have received PCB wastes in the past.

A water resource inventory will be prepared which will focus on available ground water resources in the region (including untapped aquifers) and consumptive sources of ground water. Large scale ground water dewatering operations such as quarries will also be identified.

The inventory will be initiated from a literature survey. Federal and State agency documents, both published and unpublished, will be researched. Interviews with appropriate municipal officials will be conducted to document existing area ground water users. Local well drillers will be contacted for a drilling records from the areas of interest.

The available data will be inventoried and mapped to fully characterize the hydrogeologic setting and nature of ground water withdrawals. This will include type of source, construction and service details, and water quality summary.

Depending on the number of public, private, and industrial sources, contacts will be made with owners and operators to verify and update the inventory data.

The inventory will be evaluated. Selected ground water sources will be sampled and analyzed for total PCBs and selected priority pollutants. A total of 20 PCB and volatile organic analyses is estimated.

Within thirty (30) days after completion of this Task, a preliminary report presenting the results will be prepared and submitted to EPA and DEQE for review and comment. This report shall be considered a first draft and shall be updated to include EPA and DEQE comments.

<u>Task XII</u> <u>Investigation of Undisclosed Sources/Sites</u>

This investigation will identify, evaluate, and document sources and sites of PCB contamination which are presently suspected or unknown.

Undisclosed sources and sites will be identified and characterized in accordance with the following general plan:

(1) <u>Source/Site Identification</u>

Sources and sites will be identified by means of interview and a search of pertinent available literature and records. Resources would include: past investigators; waste management personnel in local, regional, and state government; private waste handlers, private landfill owners and operators; personnel in industry; dredge operators; industrial records from PCB manufacturers, suppliers, and buyers; shipping manifests and billing records from waste handlers and landfill operators.

The investigation of principal industries will focus on PCBs but will also include surveillance for metals and selected other pollutants. Data gathering will include: types and quantitites of waste generated by individual industries; past and present practices in waste treatment, storage, and disposal; locations both on-site and off-site, of waste treatment, storage, and disposal.

(2) <u>Source/Site Characterization (Preliminary)</u>

Individual sources and sites will be characterized as fully as possible on the basis of the findings of (1) above and through site inspections, study of available maps and aerial photographs, and application of available scientific and engineering data. Pertinent information to be recorded will include:

- Description of physical site, including size (area and depth), general appearance, current use, vegetative cover, presence of surface water, presence of manmade structures, visible signs of contamination, etc.;

- ° Location of each source/site on a base map of appropriate scale;
- ° Sketch of each site to approximate scale showing pertinent features;
- ° Description of general surroundings, including type of environment (e.g., urban, suburban, etc.), topography, vegetation, surface waters, roadways, utilities, human habitation, commercial development, etc.);
- ° Background data on area geology and hydrogeology;
- ° Estimation, to the extent possible, of the types and quantities of PCBs and other identified or suspected hazardous substances present at the site; and approximate distribution of these substances if such can be determined;
- ° Apparent violations of environmental, health, or safety statutes and regulations;
- ° Sampling and analysis for PCBs.

Within thirty (30) days after completion of this Task, a preliminary report presenting the results will be prepared and submitted to EPA and DEQE for review and comment. This report shall be considered a first draft and shall be updated to include EPA and DEQE comments.

Task XIII Community Relations Program

The Community Relations Program will provide timely and accurate information to the public about the nature of the contamination problems and actions being taken to alleviate them. Also, provide the opportunity for public comment and input to decisions made by EPA and the state regarding response actions.

The community relations plan is designed to reach all of the varied sectors of the community interested in, and affected by, the problem. It is intended to provide a means of communication between the communities and the regulatory agencies.

Specific activities to be undertaken to achieve these goals include:

- ° Public meetings to be held at key points of the remedial process to provide the opportunity for public questioning and comments on proposed activities.

- Local document repositories established at the New Bedford and Fairhaven town halls and libraries.
- An informational brochure on the nature of PCBs and their environmental impact.
- News releases.
- Fact sheets to explain site activities and study findings.
- Briefings with local government officials.
- Small group meetings.
- Formal public hearings on recommended remedial actions.
- Slide show and script for public meetings.

This task will be conducted by EPA as an ongoing activity. The state will have input to this process primarily via the Interagency Task Force.

B

APPENDIX B

SUMMARIES OF PREVIOUS PROJECTS

REFERENCE NUMBER 1

PROJECT SUMMARY

ACTIVITY:	Review of New Bedford PCB problem
SPONSORS:	Executive Office of Environmental Affairs and Office of Coastal Zone Management
PURPOSE:	To provide the New Bedford PCB Task Force an overview of the problem and report of work to date
DESCRIPTION:	Introduction to PCB chemistry, measurement of PCBs, health and environmental effects, limits and standards, history and sources of PCB contamination in the New Bedford area, chronology, case histories of PCB pollution, glossary, references.
STATUS:	Completed, June 1982
REPORT:	Weaver, Grant. "PCB Pollution in the New Bedford, Massachusetts Area: A Status Report," Massachusetts Office of Coastal Zone Management, Boston, June 1982.
ANALYSIS:	Concise but inclusive review of the problem; touches all facets, points to on-going studies and information gaps. (Other opinions indicate less-than-acute effects on biological populations; see Drill, Friess, et al., 1982.)

REFERENCE NUMBER 2
PROJECT SUMMARY

ACTIVITY: Appraisal of New Bedford Harbor situation

SPONSOR: Office of Marine Pollution Assessment, NOAA

PURPOSE: To review the New Bedord Harbor situation and determine its relevance to NOAA vis-a-vis future management, research, or environmental surveys.

DESCRIPTION: Brief history; geologic, physical, and biological background; problem appraisal; study needs; possible courses of action; NOAA's involvement.

STATUS: Completed, April 1982

REPORT: Mayer, G.F. et al. "Appraisal of the New Bedford Harbor (Massachusetts) PCB Situation and Its Relevance to NOAA." Office of Marine Pollution Assessment, SUNY, Stoney Brook, NY, 26 April 1982.

ANALYSIS: Good synopsis of harbor-based problems and issues. Points out information gaps and study needs. Identifies area of study in which NOAA can assist other agencies and institutions in resolving the situation.

Needed study areas cited include refinement of data base on vertical and horizontal distribution of contaminants; evaluation of transport mechanisms, review of effects on commercial fisheries; evaluation of effects on fish, the ecosystem, and public health; development of a food web model; evaluation of impacts to economic development.

REFERENCE NUMBER 3
PROJECT SUMMARY

ACTIVITY: Background data on current rate, wind velocity, and tidal movement in the New Bedford area

SPONSOR: Woods Hole Oceanographic Institute

PURPOSE: To assist in defining the physical setting

DESCRIPTION: Cataloging of data by location, type of measurement, frequency of measurement, period of record, and study source.

STATUS: Completed

REPORT: Acushnet River Estuary PCB Commission. Appendix V of Status Report. Commonwealth of Massachusetts, Office of the Governor, Boston, September 1982.

ANALYSIS: Serves as basis for further study. Additional data are needed on the inner and outer harbors for comprehensive evaluation of water circulation and sediment transport.

REFERENCE NUMBER 4

PROJECT SUMMARY

ACTIVITY: PCB analyses of fish in the New Bedford area

SPONSOR: Mass. Division of Marine Fisheries

PURPOSE: To determine PCB content of edible portions of marine finfish, shellfish, and crustaceans in the New Bedford area waters.

DESCRIPTION: Review of fishing closure; sampling and analysis in Areas 1 thru 4; results, discussions, and recommendations.

STATUS: Completed initial four year testing, January 1981.

REPORT: Kolek, A. and R. Ceurvels. "Polychlorinated Biphenyl (PCB) Analyses of Marine Organisms in the New Bedford Area 1976-1980. "Mass. Division of Marine Fisheries, Boston, January 1981.

ANALYSIS: PCB levels in bottom feeders correlate generally with degree of sediment contamination. Species differences correspond to body fat content, degree of exposure, and size (age) of organism. Not all bottom-feeding finfish in Area 2 had levels exceeding the 5 ppm FAL. The data suggest that depuration in some species occurred over the four-year study period. Seasonal migration of lobsters is a problem in the interpretation of data on this species.

Additional data are needed on PCB levels in biota and sediments and on depuration rates. DPH harvesting regulations should be reevaluated as soon as possible.

Some monitoring of the biota for PCBs has occurred since this report was issued.

REFERENCE NUMBER 5

PROJECT SUMMARY

ACTIVITY: Review of solid waste land disposal practices in the New Bedford area

SPONSOR: Mass. Southeastern Regional Planning and Economic Development District (SRPEDD)

PURPOSE: To evaluate existing land disposal sites and make recommendations for improvements to comply with Mass. DPH regulations (as part of comprehensive areawide solid waste study).

DESCRIPTION: Cataloging of sites as to location, service area, ownership and operation, wastes accepted, facilities and personnel, terrain, remaining life, recommended improvements, estimated costs of improvements and closure.

STATUS: Completed, March 1973

REPORT: Camp Dresser & McKee, Inc. "Greater New Bedford Solid Waste Study." Massachusetts Southeastern Regional Planning and Economic Development District, Marion, MA, March 1977.

ANALYSIS: Only the New Bedford municipal landfill and Sullivan's Ledge are specifically mentioned as having received liquid and/or sludge wastes, but the municipal landfills in Achushnet, Fairhaven, Dartmouth, and New Bedford are all listed as repositories of industrial wastes. No reference is made to PCB disposal. Seven other special disposal sites are described, both public and private. Any of the eleven sites could have received PCBs. Disposal of dredged harbor sediments is not mentioned.

More detailed study of the above sites and other possible disposal sites, including dredge spoil area, is needed. Significant changes could be expected since the 1973 study.

REFERENCE NUMBER 6
PROJECT SUMMARY

ACTIVITY: Assessment of New Bedford municipal landfill

SPONSOR: Office of Toxic Substance, USEPA (Contract No. 68-01-3248)

PURPOSE: To establish the degree and extent of PCB contamination and migration from the New Bedford municipal landfill

DESCRIPTION: Evaluation of ground waters, surface waters, drinking waters, soils, stream sediments, vegetation, aquatic and terrestrial biota, and air for a Aroclors 1016, 1242, and 1254.

STATUS: Completed, May 1978

REPORT: Environmental Science and Engineering, Inc. "Environmental Assessment of Polychlorinated Biphenyls (PCBs) near New Bedford, MA, Municipal Landfill." USEPA Office of Toxic Substances, Washington, DC, 26 May 1978.

ANALYSIS: Less than 1 ppb contamination in shallow groundwaters to the immediate north of the landfill, ND to the west, northwest and east, and in artesian aquifer (drinking water). Surface soils within Apponagansett Swamp had max. of 0.44 ppm PCB. Some contamination of Paskamanset River sediments north of I-195. Benthic organisms of river and swamp 1.4-2.5 ppm. Fish average 0.34 ppm. Herring gull eggs 4.6 ppm. Field mice 0.016 ppm. Extract of stream bottom sediment near Sullivan's Ledge 288 ppb.

Summer airborne PCB at landfill exceeded 1 $\mu g/m^3$; in winter, 0.02 $\mu g/m^3$. Negligible emissions from sludge incinerator and Cornell-Dubilier. Significant increase in PCB downwind from Aerovox.

No effort made to investigate PCDFs, PCQs, heavy metals, or other toxics. Additional migration is possible since study was completed.

REFERENCE NUMBER 7
PROJECT SUMMARY

ACTIVITY: Report on disposal of PCBs by Aerovox and Cornell-Dubilier.

SPONSOR: USEPA.

PURPOSE: To review PCB liquid and solid waste disposal practices by both industries since the 1930's.

DESCRIPTION: Review of PCB waste sources, disposal sites, and early monitoring efforts undertaken in 1976.

STATUS: Completed, June 1976.

REPORT: Moon, D. "Draft #2: Aerovox Industries and Cornell Dubilier, PCB Waste Processing." Internal report. U. S. Environmental Protection Agency, Region I, Boston, MA., June 1976.

ANALYIS: Virtually all commercial/industrial waste was incinerated at the New Bedford municipal incinerator until 1971-74, when the incinerator was phased out. Such incinerators typically do not reach temperatures high enough to destroy PCBs but only volatalize them. The ash was disposed at the municipal landfill prior to 1971 as were all solid PCB wastes from 1971 through the first half of 1975 (an estimated 500,000 lb). There is no information on liquid PCBs disposed by Aerovox and Cornell-Dubilier in the municipal landfill sewer system, or elsewhere. Ash from the treatment plant sludge incinerator is disposed in the New Bedford landfill.

PCBs were detected in one of four monitoring wells at the toe of the landfill's west face, in a surface leachate seep sample, and in the first 7.5 feet of a core sample. These data may not represent the present status.

REFERENCE NUMBER 8
PROJECT SUMMARY

ACTIVITY: Study of fine-grained sediment and metals distribution.

SPONSOR: NOAA, Office of Seal Grant (Contracts 04-6-158-44016 and 04-6-15-44106).

PURPOSE: To evaluate movement and accumulation of fine-grained sediment, human waste, and industrial waste in the waters of New Bedford Harbor and Buzzards Bay.

DESCRIPTION: Water properties; sediment properties; dispersal of sediment; sedimentation rates; origin, distribution, and dispersal of metals; accompanying maps and diagrams.

STATUS: Completed, April 1977.

REPORT: Summerhayes, C. et al. "Fine-Grained Sediment and Industrial Waste Distribution and Dispersal in New Bedford Harbor and Western Buzzards Bay, Massachusetts," WHOI Technical Report 76-115. Unpublished manuscript. National Oceanic and Atmospheric Administration, Woods Hole, MA, April 1977.

ANALYSIS: There is a net landward movement of fine-grained sediment into New Bedford Harbor. More silt than clay is deposited as a result of partial fractionation. The clay is preferentially concentrated in the deeps rather than the shallows. The clayey suspensions appear to be organically enriched, resulting in a thin mobile layer of "fluffy" sediments (easily disturbed) and a poorly developed sediment-water interface. Construction of the hurricane barrier caused sedimentation rates to increase from a few mm/year to about 4 cm/year in the deeper portions of the harbor.

The solids in waste water discharges are agglomerates of clay-silt size. They tend to settle to the bottom but are readily resuspended. Fine-grained surface sediment is richer in organic matter than the underlying silt.

Large quantities of Cu, Cr, Pb, and Zn, with lesser amounts of As, Ag, Cd, and Hg have been discharged into the harbor (a total of approximately 10^6 kg of Cu, alone, in the past 80 years; EPA estimates 90 kg/day recently). The metals are mainly confined to the harbor and are found at or near the surface only, in close association with the clay fraction. Concentrations decrease exponentially with distance from the harbor. Copper was found to be a good indicator of metals contamination.

REFERENCE NUMBER 9
PROJECT SUMMARY

ACTIVITY: Hot spot sediment sampling near Aerovox.

SPONSOR: USCG.

PURPOSE: To reveal the degree and depth of PCB contamination in the Acushnet River Estuary in the vicinity of the Aerovox plant.

DESCRIPTION: Core sampling and analysis of bottom sediments; isometric mapping of concentration.

STATUS: Completed, March-August 1982.

REPORT: U.S. Coast Guard. Internal memoranda and accompanying analytical reports. USCG, Groton, CT, 11 June and 1 July 1982.

ANALYSIS: Core samples at approximately 50 sites (the exact total is difficult to discern from the reports) were taken; replicate samples were collected. Samples were prepared from slices taken from the top inch, from 5-1/2 to 6-1/2 inches in depth, and from the bottom 2 inches of the core. Analysis was done by three methods (LC, TLC, and GC) for total PCB as Aroclor 1254 (no isomer study). Hot spots to >10,000 ppm were delineated. Most values were in the range of 100-1000 ppm at the surface, somewhat greater at mid-depths, and 10-100 ppm at the bottom of cores. Hot spots occurred in two locations along the west shore adjacent to Aerovox property. The main channel appeared to have concentrations below 1000 ppm at all depths studied.

REFERENCE NUMBER 10
PROJECT SUMMARY

ACTIVITY: Evaluation of PCB contamination and remedial dredging alternatives in New Bedford Harbor.

SPONSOR: Mass. DEQE

PURPOSE: To characterize PCB contamination in the Acushnet River Estuary/New Bedford Harbor area and to evaluate remedial dredging programs.

DESCRIPTION: Definition of problem and objectives, distribution of PCBs, engineering and environmental considerations, alternative dredging programs and potential impacts, recommendations.

STATUS: Draft report completed, September 1982.

REPORT: Malcolm Pirnie, Inc. "Acushnet River Estuary Study." Draft report. Mass. Dept. Environmental Quality Engineering, Div. Water Pollution Control, Westboro, MA, 15 September 1982.

ANALYSIS: In the upper estuary, elevated PCB levels are found at depths up to two feet. Average concentrations at the surface and six inches below the surface generally exceed 500 ppm (dry weight) in the vicinity of Aerovox and generally exceed 50 ppm in all other parts north of Pope's Island. Peripheral areas of the inner harbor between Pope's Island and the hurricane barrier are in the range of 10-50 ppm. PCBs in excess of 50 ppm occur in the northwest corner of the outer harbor (just below the hurricane barrier) and also in the vicinity of the Clark's Point wastewater outfall. Along the west shore of the outer harbor near Cornell-Dubilier, 10-50 ppm PCBs are found. All other areas are generally below 10 ppm. However, these conclusions are based largely on surface samples (except in the upper estuary) and on analytical procedures which failed to identify all Aroclors present. Future study should include an appropriate number and placement of core samples and complete PCB quantification.

Remedial alternatives considered were limited to dredging of contaminated sediments. Estimated volumes and order-of-magnitude costs are as follows:

Action Level	Cumulative Volume	Cost
500 ppm	70,000 cu. yd.	$5-10 mil.
50	2,200,000	60-70
10	4,400,000	110

Four additional alternatives for harbor development would involve dredging 80,000-900,000 cu. yd., depending on the scale of development, and would be considered apart from, or in conjunction with, remedial dredging for removal of contaminated sediment.

Dredge sediments containing >50 ppm PCBs would require upland disposal. Sediments <50 ppm PCBs were assumed suitable for shoreline disposal. No consideration of metal contaminants was made.

The report recommended the following further study:

(1) Evaluation of conceptual dredging costs vs. anticipated benefits to determine economic feasibility.

(2) Detailed monitoring program following initial dredging.

(3) Continued sampling of sediment, water, and biota; modeling studies to clarify PCB transport and uptake and the effects/benefits of remedial dredging on aquatic organisms.

(4) Technical studies to support remedial dredging program(s), including additional sediment sampling and site investigations, and pilot studies to evaluate dredge sediment settleability and treatability.

(5) Detailed sampling to fully characterize sediments which would be removed in harbor development programs.

The report concluded remedial dredging to be technically feasible but summarily dismissed other alternatives (e.g., in situ treatment or confinement) which could prove feasible on closer examination for certain portions of the harbor. An in-depth feasibility study should consider all possible options, given the scope and potential costs of remedial action. The presence of heavy metals should be evaluated.

The indicated order-of-magnitude dredge volumes and costs are conceptual. Real costs will be sensitive to methods and locations of dredge sediment treatment/disposal. The reported cost estimates were based largely on mechanical dredging technology. Careful consideration of pneumatic dredging (e.g., Oozer and Amtec) is warranted.

REFERENCE NUMBER 11

PROJECT SUMMARY

ACTIVITY: Review of data needs and dredging techniques.

SPONSOR: Mass. DWPC.

PURPOSE: To catalog PCB data on the Acushnet River/New Bedford Harbor area, identify data needs, and review applicable dredging techniques.

DESCRIPTION: Listing PCB concentrations by source, date and location; general statement of data deficiencies and needs; review of dredging techniques, their advantages and disadvantages.

STATUS: Completed, August 1981.

REPORT: Tomczyk, R. "A report on the PCB Data Needs and Dredge Techniques for the Acushnet River-New Bedford Harbor Area." Mass. DWPC, Boston, 17 August 1981.

ANALYSIS: Available PCB data are not comparable because of various expertise and techniques among the many laboratories which have performed sampling and analysis. Analysis for different isomers of PCB has been lacking. Other flaws: sampling locations not accurately known, collection of samples not uniform or precise. "There is a need for a well planned sampling program conducted by one laboratory experienced in PCB analysis..."

Hydraulic dredges: 80% water, 20% sediment. Pneumatic dredges: 20% water, 80% slurry, but need min. 30-40 feet of water. Most areas of the estuary and harbor are less than 20 feet deep. Mechanical dredges increase costs because sediments must be handled twice.

Open-ocean dumping may be prevented by the Clean Water Act and the Marine Protection, Research, and Sanctuaries Act - also, the London Ocean Dumping Convention Limits. PCBs greater than 50 ppm may have to be incinerated, disposed in a secure landfill, or disposed by other EPA-approved method.

The Japanese have developed a technique for immobilizing PCBs by solidification of disposed dredge materials.

REFERENCE NUMBER 12

PROJECT SUMMARY

ACTIVITY Investigation of dredging techniques.

SPONSOR New England Governors' Conference, Inc.

PURPOSE: To identify feasible dredging techniques for the removal of PCB-contaminated sediments from New Bedford Harbor and the Acushnet River Estuary.

DESCRIPTION: Introduction to the problem; characterization of sediments; discussion of dredging techniques, transportation of dredged material, and disposal options; relevant case histories.

STATUS: Draft report completed, August 1982.

REPORT: Geotechnical Engineers, Inc. "Dredging of PCB-Contaminated Sediments, New Bedford Harbor/Acushnet River Estuary, MA." Draft report. New England Governors' Conference, Inc., Boston, 13 August 1982.

ANALYSIS: PCBs are only slightly water-soluble but are readily adsorbed and held by fine-grained and organic sediments. Mobilization of PCBs during dredging would be minimized with hydraulic and pneumatic dredging; mechanical dredging may be acceptable in conjunction with silt curtains. Hydraulic and pneumatic dredging result in large volumes of entrained water requiring separation and treatment, hydraulic being worse in this regard, but less costly. Mechanical dredging has practical limitations. Lack of disposal site(s) may be the greatest impediment to dredging. Dredging and transportation techniques are tied to disposal; therefore, recommendations cannot be made at this time. The report dismisses incineration and biodegradation as feasible disposal options.

High concentrations of copper, lead, zinc, cadmium, and chromium were measured in sediment samples taken from tidal flats in the Acushnet River Estuary.

REFERENCE NUMBER 13
PROJECT SUMMARY

ACTIVITY: Investigation of PCB removal in biological wastewater treatment.

SPONSOR:
a. USEPA (Contract No. 68-01-3273, Task 13).
b. Monsanto Company.

PURPOSE: To evaluate the biodegradability and efficiency of removal of PCBs in wastewater treatment facilities.

DESCRIPTION: Bench-scale evaluation of biodegradation rates of commercial PCBs; evaluation of unit process PCB removal efficiencies at two publicly owned secondary wastewater treatment plants.

STATUS: Completed: a. July 1977; b. March 1975.

REPORTS:

a. U.S. Environmental Protection Agency. "PCBs Removal in Publicly-Owned Treatment Works." Report No. 440/5-77-017, USEPA, Criteria and Standards Divison, Washington, D.C., 19 July 1977.

b. Tucker, E.S. et al. "Activated Sludge Primary Biodegradation of Polychlorinated Biphenyls." Bull. Environ. Contam. Toxicol., 14,6,705. 1975.

ANALYSIS: Bench studies showed mono- and dichlorobiphenyls are readily biodegradable. Resistance to biodegradation increases with increasing chlorine substitution. This explains the presence of highly chlorinated biphenyls as residues in weathered samples.

Overall PCB removal efficiencies were 80-90% at the two municipal plants - slightly less than BOD and SS removal efficiencies. Primary treatment removed about 50% of total

PCB. Correlation with SS removal was observed in four of six unit processes.

Both studies indicated volatilization was not a significant mechanism in PCB removal.

Only primary degradation was evaluated. Neither study considered the fate or identity of associated compounds or degradation products.

The results of these studies should be directly applicable to the New Bedford situation.

REFERENCE NUMBER 14
PROJECT SUMMARY

ACTIVITY: PCB survey of New Bedford sewer system.

SPONSORS: Mass. DEQE and USEPA.

PURPOSE: To identify sources and measure concentrations of PCBs in the municipal wastewater collection system.

DESCRIPTION: Sampling and analysis for Aroclors at key locations in the system.

STATUS: Completed, October 1982.

REPORT: Dunn, D. Internal memorandum. Mass. DEQE Division of Water Pollution Control, Technical Services Branch, Westboro, MA, 5 October 1982.

ANALYSIS: Analyses provided full isomer scan (total PCBs). No flow measurements were taken. Sample composites were collected 16-25 June 1982 at 18 stations. Eight stations had 0-1 ppb total PCBs. Five stations receiving wastewater from the New Bedford Industrial Park and 0-5 ppb Aroclor 1248 (source unknown). One station near Cornell-Dubilier had 2-3 ppb Aroclor 1254 (source unknown). Three stations near Cornell-Dubilier had 23-120 ppb Aroclor 1242+1254. The New Bedford WWTP and Cove Road pump station receiving these flows had 5-10 ppb Aroclor 1242+1254 influent and effluent, <1 ppb WWTP sludge. The Fairhaven WWTP had <1 ppb PCBs.

Additional information was supplied by D. Dunn in phone conversation 4 November 1982. Work is part of Master's thesis. Other parameters analyzed: oil and grease, metals, solids, nutrients, BOD, chlorides, etc. WWTP flows during June study were 25-30 MGD, total PCBs 1.5-2 lb/day. An earlier study (March 1982) when flows were smaller showed 0.5-1 lb/day. Sewer lines just cleaned by C-D yielded about 50 barrels of sediments, 10,000-25,000 ppm PCBs. Barrels are in storage. Cornell-Dubilier has retained EG&G to clean up their property (consent decree). Source of PCBs from C-D may already have been eliminated -should be determined in future testing. Minor PCB source at Industrial Park (Polaroid Corp?) may warrant further investigation. All other areas do not appear to have significant wastewater PCB problem.

Mass input of PCBs into bay from WWTP should be reevaluated following present clean-up operations. Results should be reviewed with respect to water quality criteria to determine need for further action.

REFERENCE NUMBER 15
PROJECT SUMMARY

ACTIVITY: Evaluation of PCB removal at the New Bedford incinerator.

SPONSOR: USEPA (Contract No. 68-01-3154, Task 24).

PURPOSE: To evaluate the efficiency of PCB removal at the New Bedford wastewater sludge incinerator from mass balance determinations.

DESCRIPTION: Brief description of wastewater treatment plant, incinerator, and waste streams; description of sample collection, handling, and analytical procedures; determination of PCB input/output concentrations, mass rates, and removal efficiencies.

STATUS: Completed, September 1977.

REPORT: GCA Corporation. "PCB Compounds Emanating from the New Bedford Municipal Wastewater Incinerator." U.S. Environmental Protection Agency, Region I, Boston, MA, September 1977.

ANALYSIS:

Input	mg/hr	100% of Total
Sludge	220-590	(30-69%)
Scrubber water	260-710	(31-70)
Output	**mg/hr**	**23-54% of Total**
Ash	50-120	(4-15)
Scrubber Effluent	220-310	(16-37)
Flue Gas	8-25	(2-3)

The derivation of Aroclors in the scrubber effluent is unknown since primary effluent was the feedwater. Additional testing is needed.

REFERENCE NUMBER 16
PROJECT SUMMARY

ACTIVITY: Quality assurance plan for incinerator study.

SPONSOR: USEPA (Contract No. 68-02-3168).

PURPOSE: To provide QA/QC in the sampling and analysis of PCBs and other chlorinated hydrocarbons for completing a mass balance on PCBs at the New Bedford WWTP sludge incinerator.

DESCRIPTION: Objectives (precision, accuracy, completeness), sampling procedures, sample custody, calibration procedures, analytical methods, data management and reporting, quality control and performance audits, corrective action, QA reports.

STATUS: Completed, August 1982.

REPORT: GCA Corporation. "Quality Assurance Project Plan for Sampling and Analysis Activities for the Multiple Health Sewage Sludge Incinerator at the New Bedford Municipal Wastewater Treatment Plant." USEPA, August 1982.

ANALYSIS: Comprehensive. Should be applicable or adaptable to other sampling and analysis projects.

REFERENCE NUMBER 17

PROJECT SUMMARY

ACTIVITY: Data Management.

SPONSOR: USEPA (Contract No. 68-04-1009).

PURPOSE: To establish a data management system to consolidate all PCB-related data from all agencies and institutions involved.

DESCRIPTION: Cataloging all PCB data on water, sediments, air, land, sewer system, and biota; development of preliminary criteria for evaluating the usability of individual data sets (Phase I).

STATUS: Phase I completed, 1 September 1982.

REPORT: Metcalf & Eddy, Inc. "New Bedford PCB Data Management System." USEPA, 23 August 1982.

ANALYSIS: Comprehensive; includes all PCB data from all areas, plus metals and toxics data obtained in conjunction with PCB studies. System is user-interactive, has limited statistical capabilities, may input data into other computer programs.

Limited information available on sampling and analytical methods employed in any studies to date; no tide or time data. Needs include refinement and application of data evaluation criteria; determination of data needs; recommended program for filling data needs (Phase II).

REFERENCE NUMBER 18

PROJECT SUMMARY

ACTIVITY: Comprehensive sampling and analysis program.

SPONSOR: USEPA.

PURPOSE: To further define the extent of PCB contamination within the New Bedford sewerage transfer lines and to evaluate what impact contaminated sewage sludge and/or wastewater may have on bottom sediments in the vicinity of combined sewerage overflow points, also to provide data suitable for the conduct of future EPA enforcement actions.

DESCRIPTIONS: Report of sampling and analysis of solid residues within the municipal sewer system and bottom sediments from points near sewage outfalls.

STATUS: Draft Final Report Completed, May 1983.

REPORT: GCA Corporation, GCA/Technology Division. "New Bedford Environmental Investigation--Sampling and Analysis of Municipal Sewerage Lines and Bottom Sediments in the Vicinity of Sewerage Outfalls for Polychlorinated Biphenyls (PCBs)." Draft Final Report. U.S. Environmental Protection Agency, Research Triangle Park, N.C., May 1983.

ANALYSIS: Sampling was conducted in two phases. Outfall sediments were sampled on October 20 and 21, 1982 in a cooperative effort by GCA/Technology Division and the U.S. Coast Guard. Twenty stations were sampled. Sampling sites were selected from a summary listing of sewerage overflows provided to GCA by EPA Region I personnel. Sampling of sediments within the municipal sewer system was conducted by GCA personnel on December 10 and on December 14, 1982. Nineteen duplicate samples were taken.

Sampling protocols consisted primarily of the use of a Van Veen type grab sampler, which generally provided an 8 cm vertical grab sample of the bottom surface. Outfall samples were subdivided to represent upper (0-4 cm) and lower (4-8 cm) surfaces; sewer system solid residues were collected as duplicates from the top 0-4 cm of the grab sample. Aroclors present were 1242, 1254 and 1260. Concentrations detected ranged from values of 3 ppm to 78,000 ppm.

REFERENCE NUMBER 19

PROJECT SUMMARY

ACTIVITY: Continuous monitoring of the water mass passing through the Coggeshall Bridge for three complete tidal cycles (39 hours).

SPONSOR: USEPA.

PURPOSE: To provide a more detailed investigation of the mixing patterns and characteristics of the water mass passing beneath the Coggeshall Bridge.

DESCRIPTION: Study background, parameters measured; sampling and laboratory procedures; partitioning and mass transport of PCBs.

STATUS: Completed, March 4, 1983.

REPORT: Environmental Response Team and the Technical Assistance Team. "Tidal Cycle and PCB Mass Transport Study, January 10-12, 1983." USEPA, ERT. March 4, 1983.

ANALYSIS: Over 133 measurements of physical parameters, including transmissivity, conductivity, salinity, temperature, dissolved oxygen and current velocity were made at designated locations throughout the three-day study period. Also included in the data base are over 190 analyses of PCBs from the filterable and non-filterable fraction of water samples collected, as well as PCBs from sediments, and plankton net samples. In addition to the chemical and physical data from discrete locations, the continuous meter on the south-side of the Coggeshall Bridge compiled readings of conductivity, salinity, temperature, current direction and velocity at two-minute intervals throughout the three-day study period. Given the magnitude of this data base, a variety of statistical and graphing techniques were used to evaluate the data. It was concluded that large quantities of PCBs will continue to move from the Acushnet River estuary to contaminate the lower harbor and potentially Buzzards Bay.

REFERENCE NUMBER 20

PROJECT SUMMARY

ACTIVITY: Evaluation of remedial action alternatives.

SPONSOR: Aerovox.

PURPOSE: To determine the most appropriate remedial response for the Aerovox site.

DESCRIPTION: The evaluation was prepared in accordance with the Consent Orders entered into by Aerovox in May 1982 with the USEPA and the Massachusetts DEQE. The report consists of a summary of previous field investigations, description of current field investigations, site hydrogeology, water quality testing results, evaluation of remedial measures and a recommended remedial plan.

STATUS: Completed, February 11, 1983.

REPORT: GHR Engineering Corporation. "Evaluation of Remedial Alternatives for the Aerovox Property, New Bedford, Massachusetts." Aerovox Incorporated, New Bedord, MA, 11 February 1983.

ANALYSIS: On the basis of technical, economic, and environmental considerations GHR recommended that the final remedial action plan for the Aerovox property include:

1. Capping of the five contaminated soil areas by paving with hydraulic asphalt concrete and,

2. Installation of a silt washings trench to serve as a vertical barrier to groundwater and tidal flow into and out of the contaminated soils.

REFERENCE NUMBER 21
PROJECT SUMMARY

ACTIVITY: Preparation of the Remedial Action Master Plan (RAMP).

SPONSOR: USEPA.

PURPOSE: To review available data, to assess data needs and to the identify the type, scope, sequence, schedule, and costs of remedial projects which are appropriate to the situation.

DESCRIPTION: Document to be used by the EPA as a general planning tool for overseeing remedial actions in the New Bedford, Massachusetts area. Major issues addressed include: site investigations, feasibility assessment, permit requirements, data management, quality assurance, and public participation.

STATUS: Completed, May 1, 1983.

REPORT: Roy F. Weston, Inc. "New Bedford Remedial Action Master Plan." USEPA, 1 May 1983.

ANALYSIS: The RAMP has three essential components:

1. Project Work Statements - A series of work descriptions comprising the scope of activities leading to remediation.

2. Schedule/Cost Summary - A capsule report of estimated time and cost requirements for completion of the principal work elements outlined in the Project Work Statements.

3. RAMP Model - A line diagram representing key activities; showing interrelationships among activities, the sequence and duration of activities, and the timing of major decision points.

REFERENCE NUMBER 22

PROJECT SUMMARY

ACTIVITY: Sampling and analysis program for the New Bedford Municipal Landfill & Sullivan's Ledge.

SPONSOR: USEPA.

PURPOSE: To determine the extent of groundwater contamination surrounding the landfill and the quarry.

DESCRIPTION: Summary of the present program and recommendations of additional studies.

STATUS: Draft Final Report Completed, June 1983.

REPORT: GCA Corporation, GCA/Technology Division. "New Bedford Environmental Investigation Assessment of Groundwater Quality in the Vicinity of the Municipal Landfill and Sullivan's Ledge, New Bedford, Massachusetts." U.S. Environmental Protection Agency, Research Triangle Park, NC.

ANALYSIS: The field program consisted of well construction and ground water, surface water and soil sampling and analysis. Aqueous samples were analyzed for volatile organics, pesticides/PCBs and extractable organics. Soil samples were analyzed for volatile organics with half of the number of soil samples selected for PCB analyses and comprehensive organic analysis by GC/MS. Conclusions are that the municipal landfill is not currently a significant source of hazardous contaminants to the Paskamansett River system. Specifically, contaminants analyzed for in this investigation were not detected in significant amounts in any soil or water samples taken near the landfill or in Apponagonsett Swamp. However, results reveal that the Sullivan's Ledge site is a significant source of groundwater contamination. Industrial refuse in the quarry is supplying organic contaminants directly to groundwater which has a high potential to flow unimpeded through fractured bedrock to wells or other point of discharge for this groundwter system. Based on the array of contaminants detected, industrial sources of the refuse material are suspected to be in the categories of plastics, rubber, metal pressing, cleaning and capacitor and transformer manufacturing.

C

APPENDIX C

DESCRIPTION OF ENVIRONMENTAL EVALUATION FACTOR DETERMINATION

EXCERPTED FROM THE

COAL ASH DISPOSAL MANUAL
FP-1257
RESEARCH PROJECT 1404-1

PREPARED FOR

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As expected, the material presented in Appendix C focuses on the assessment of utility waste disposal sites. The intent of its inclusion is to provide a basic methodologial approach that will be adjusted as necessary for hazardous waste disposal.

Fly ash disposal necessitates the handling and placement of great quantities of material over an extended period of time. During the course of the disposal process, areas around the disposal site and along transportation routes are altered. These alterations reflect the disposal method practiced and the efficiency of the disposal operation. While impact on the environment is inherent in fly ash disposal, it can be minimized through proper planning, site selection and design. Concern about environmental effects should be based on a broad view of the disposal system as a whole.

In order to rank the final prospective site alternatives, it is necessary to evaluate the impact of site development, operation and closure activities on man and his environment. Organization of the pertinent environmental factors and impacts into matrix form greatly aids this process. The matrix presented in this section is based upon a technique developed by Leopold, et. al. (2), and is intended to provide a basis of environmental comparison between sites.

Methodology. The environmental evaluation matrix provides a means of gauging relative impacts through the generation of a numerical value (known as the environmental evaluation factor - EEF) for each site. Large EEF values correspond to high adverse impact.

The first step in the determination of an EEF for each site alternative is the development of environmental parameters to be evaluated. The selection of environmental parameters is, to a great extent, site specific. However, parameters such as the following should generally be considered:

- Aesthetics
- Air Quality
- Aquatic Ecology/Water Quality
- Cultural Resources
- Land Use
- Noise
- Public Health and Safety

- Terrestrial Ecology
- Socio-Economics

The list of environmental parameters given above can be reduced or expanded depending on the specific situation under study. For example, terrestrial ecology could be divided into plant and animal categories, or even selected species, if a more detailed analysis is warranted.

It is well known that construction and operation activities can produce environmental impacts at each site. However, significant environmental impacts can also occur following closure of the site. Thus, the overall environmental evaluation factor, EEF, for each site alternative is computed as the sum of a construction/operation $EEF_{c/o}$ and a post-closure EEF_{pc} as follows:

$$EEF = EEF_{c/o} + EEF_{pc}$$

$$EEF = WF_{c/o} \sum_{i=1}^{m} WF_{ic/o} \times IM_{ic/o} + WF_{pc} \sum_{i=1}^{m} WF_{ipc} \times IM_{ipc}$$

where:

EEF	=	overall environmental evaluation factor
$WF_{c/o}$	=	secondary weighting factor to reflect the importance of impacts during construction and operation relative to post closure; $0 \leq WF_{c/o} \leq 1$
$WF_{ic/o}$	=	primary weighting factor for environmental parameter i during construction and operation
$IM_{ic/o}$	=	magnitude of impact of the project on environmental parameter i during construction and operation
WF_{pc}	=	secondary weighting factor to reflect the importance of impacts post closure relative to pre-closure; $WF_{pc} = 1-WF_{c/o}$
WF_{ipc}	=	primary weighting factor for environmental parameter i after closure
IM_{ipc}	=	magnitude of impact of the project on environmental parameter i after closure
m	=	number of environmental parameters being considered

The selection of weighting factors (WF's) and impact magnitudes (IM's) is an important step in the development of the matrix. The selection of values for the secondary weighting factor $WF_{c/o}$ depends on whether the most significant impacts are going to occur during construction and operation or after closure. For example, if impacts during construction and operation are thought to be four times more significant than those which will occur after closure, then $WF_{c/o} = \frac{4}{5} = 0.8$. Accordingly, $WF_{pc} = 1 - WF_{c/o} = 1 - 0.8 = 0.2$

To assess values for the primary weighting factors associated with each environmental parameter, an arbitrary range from 1 to 10 has been assigned to the WF's with increasing values indicating increasing importance. Water quality, for example, is extremely important at most sites and might have a primary weighting factor value of 9. Land use may be somewhat less important, and as such could be weighted 3 or 4.

Environmental concerns and their primary weighting factors will generally vary from power plant to power plant throughout the United States; however, the primary weighting factor for a particular environmental parameter during construction and operation and after closure can generally be assumed to be identical for a particular power plant; that is $WF_{ic/o} = WF_{ipc}$ for a particular environmental parameter i at a given power plant.

To assess values for impact magnitudes for each environmental parameter, an arbitrary range from 0 to 10 has been assigned to the IM's. Negative values indicate beneficial impacts, such as strip mine reclamation.

Care should be taken to insure uniform application of the matrix to all prospective sites. It should be recognized that matrix evaluation entails a numerical evaluation of qualitative elements, and as such reflects the biases of individuals participating in the procedure. Group consensus techniques can help to minimize biased environmental evaluation, especially if individuals in the group have diverse backgrounds such as engineering, hydrology, geology, agronomy, ecology, construction, and planning.

Suggested Procedure. The procedure for matrix utilization can be separated into several steps.

1. Review areas of environmental concern and develop a list of environmental parameters.

2. Select a primary weighting factor (WF) for each environmental parameter and secondary weighting factors for the construction and operation and post-closure time periods.

3. Determine the magnitude of the impact (IM_i) which ash disposal would have on each environmental parameter during the construction and operation phase of disposal, and during the post-closure phase.

4. Calculate the environmental evaluation factor (EEF) for each parameter ($EEF_i = WF_i \times IM_i$) for both the construction/operation and post-closure phases.

5. Sum the EEF_i's for both the construction/operation and post-closure phase.

6. Apply secondary weighting factors.

7. Calculate the overall site EEF by adding the weighted construction/operation and post-closure EEF's.

EXAMPLE ENVIRONMENTAL EVALUATION FACTOR DETERMINATION

Environmental Parameter	Primary Weighting Factor		Site 1 C/O (1) IM		C/O (1) EEF	PC (2) EEF		PC (2) IM		Primary Weighting Factor
Aesthetics	8	x	5	=	40	16	=	2	x	8
Air Quality	5	x	7	=	35	0	=	0	x	5
Aquatic Ecology/ Water Quality	10	x	6	=	60	30	=	3	x	10
Cultural Resources	8	x	0	=	0	0	=	0	x	8
Land Use	5	x	9	=	45	40	=	8	x	5
Noise	8	x	9	=	72	0	=	0	x	8
Public Health and Safety	10	x	5	=	50	20	=	2	x	10
Socioeconomics	4	x	5	=	20	20	=	5	x	4
Terrestrial Ecology	9	x	5	=	45	18	=	2	x	9
Summary EEF (3)					367	144				
Weighted EEF (4)					312	22				
Overall EEF (5)					334					

(1) Construction/Operation Phase
(2) Post Construction Phase
(3) Sum of EEF's for all environmental parameters
(4) Weighted EEF = Summary EEF x weighting factor: 367 x 0.85 = 312, 144 x 0.15 = 22
(5) Overall EEF = Sum of c/o weighted EEF and PC weighted EEF= 312 + 22 = 334