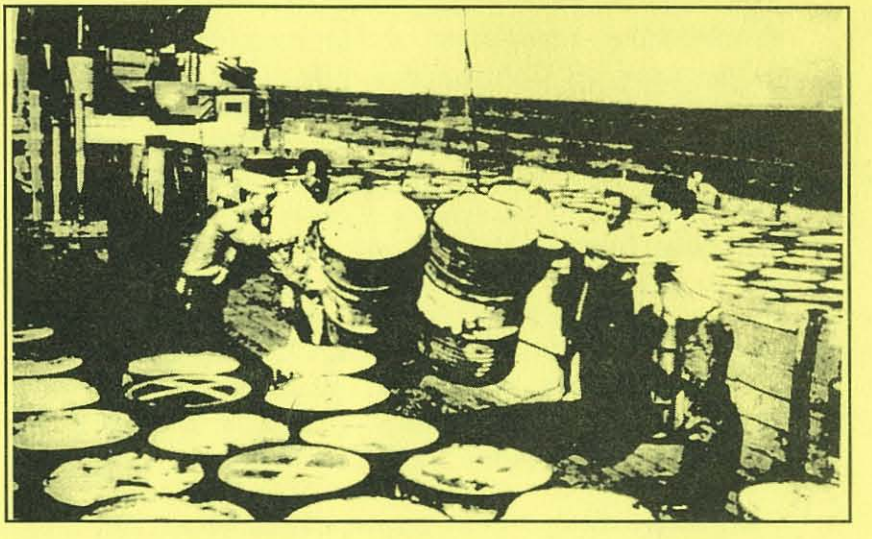
NOAA Technical Memorandum NOS ORCA 99

The Massachusetts Bay Industrial Waste Site: A Preliminary Survey of Hazardous Waste Containers And an Assessment of Seafood Safety

(May and June 1992)



Seattle, Washington
June 1996

noaa NATIONAL OCEANIC AND ATMOSPHERIC ADMINISTRATION

National Ocean Service

Office of Ocean Resources Conservation and Assessment
National Ocean Service
National Oceanic and Atmospheric Administration
U.S. Department of Commerce

The Office of Ocean Resources Conservation and Assessment (ORCA) provides decisionmakers comprehensive, scientific information on characteristics of the oceans, coastal areas, and estuaries of the United States of America. The information ranges from strategic, national assessments of coastal and estuarine environmental quality to real-time information for navigation or hazardous materials spill response. Through its National Status and Trends (NS&T) Program, ORCA uses uniform techniques to monitor toxic chemical contamination of bottom-feeding fish, mussels and oysters, and sediments at about 300 locations throughout the United States. A related NS&T Program of directed research examines the relationships between contaminant exposure and indicators of biological responses in fish and shellfish.

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ORCA implements NOAA responsibilities under Title II of the Marine Protection, Research, and Sanctuaries Act of 1972; Section 6 of the National Ocean Pollution Planning Act of 1978; the Oil Pollution Act of 1990; the National Coastal Monitoring Act of 1992; and other Federal laws. It has four major line organizations: Coastal Monitoring and Bioeffects Assessment Division, Hazardous Materials Response and Assessment Division, Strategic Environmental Assessment Division, and the Damage Assessment Center.

Cover picture: Radioactive wastes of uncertain composition are enclosed in barrels or blocks of cement. The containers were loaded onto oceanic vessels, as shown in the picture, and dumped at sea. Courtesy of Brookhaven National Laboratory.

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(May and June 1992)

Participating Agencies

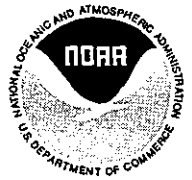
Massachusetts Office of Coastal Zone Management
Massachusetts Division of Marine Fisheries
Massachusetts Department of Public Health
U.S. Department of the Army Corps of Engineers
U.S. Coast Guard
U.S. Department of Commerce, National Oceanic and Atmospheric Administration
U.S. Department of Energy
U.S. Department of the Interior
U.S. Environmental Protection Agency
U.S. Department of Health and Human Services, Food and Drug Administration
U.S. Department of the Navy

with assistance from

The International Wildlife Coalition

Edited By:

John Lindsay, Chief Scientist/Principal Investigator
NOAA Hazardous Materials Response and Assessment Division
7600 Sand Point Way Northeast
Seattle, Washington 98115



Seattle, Washington

United States Department of Commerce Mickey Kantor Secretary	National Oceanic and Atmospheric Administration D. James Baker Under Secretary for Oceans and Atmosphere	National Ocean Service W. Stanley Wilson Assistant Administrator for Ocean Services and Coastal Zone Management

Hazardous Materials Response and Assessment Division
Office of Ocean Resources Conservation and Assessment
National Ocean Service
National Oceanic and Atmospheric Administration
U.S. Department of Commerce
Silver Spring, Maryland

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Acknowledgments

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Contributing Authors

(listed in alphabetical order)

Tim Askew, Harbor Branch Oceanographic Institution, Fort Pierce, Florida 34946

William Adams, Winchester Engineering and Analytical Center, U.S. Food and Drug Administration, Winchester, Massachusetts 01890

Ivar Babb, NOAA National Undersea Research Center, University of Connecticut, Avery Point, Groton, Connecticut 06340

William Bell, Office of Radiation Control, Massachusetts Department of Public Health, Executive Office of Environmental Affairs, Northhampton, Massachusetts 01060

Dr. Warren Boothman, Atlantic Ecology Division, National Health and Environmental Effects Research Laboratory, EPA, Narragansett, Rhode Island 02882.

Dr. Elizabeth Borque, Principal Investigator, Division of Food and Drugs, Massachusetts Department of Public Health, Executive Office of Environmental Affairs, Jamaica Plain, Massachusetts 02130

Leigh Bridges, Massachusetts Division of Marine Fisheries, Executive Office of Environmental Affairs, Boston, Massachusetts 02202

Barbara Brown, Atlantic Ecology Division, EPA National Health and Environmental Effects Research Laboratory, Narragansett, Rhode Island 02882

James Cherniak, Radiation Safety Officer, EPA, Region I, Boston, Massachusetts 02203

Dave P. Colton, Remote Sensing Laboratory, U.S. Department of Energy, Las Vegas, Nevada

Dr. Gregory Cramer, Principal Investigator, Office of Seafood, Department of Health and Human Services, FDA, Washington, DC. 20204

Darryl Keith, Chief Scientist/Principal Investigator, Atlantic Ecology Division, EPA National Health and Environmental Effects Research Laboratory, Narragansett, Rhode Island 02882

John A. Lindsay, Chief Scientist/Principal Investigator, Hazardous Materials Response and Assessment Division, NOAA, Seattle, Washington 98115

H. "Chip" L. Louft, Remote Sensing Laboratory, US Department of Energy, Las Vegas, Nevada

Mary B. Matta, Hazardous Materials Response and Assessment Division, NOAA, Seattle, Washington 98115

John M. McCann, Jr. Winchester Engineering and Analytical Center, US Food and Drug Administration, Winchester, Massachusetts 01890

Dr. Judith Pederson, Office of Sea Grant, Massachusetts Institute of Technology, Cambridge, Massachusetts.

William Phillips, USEPA Environmental Monitoring and Support Laboratory, Las Vegas, Nevada 89114

Dr. Richard Pruell, Atlantic Ecology Division, EPA National Health and Environmental Effects Research Laboratory, Narragansett, Rhode Island 02882

Alyson Saben, Principal Investigator, Department of Health and Human Services, District Office, FDA, Stoneham, Massachusetts 02180

Dr. Lance Stewart, Chief Scientist/Principal Investigator, Cooperative Extension System, College of Agriculture and Natural Sciences, University of Connecticut, Norwich, Connecticut 06360

Dave Tomey, EPA, Region I, Boston, Massachusetts 02203

Thomas Waddel, EPA, Triangle Park, North Carolina

Executive Summary

Based upon a request from Congressman Gerry Studds of Massachusetts, Chairman, House Subcommittee on Fisheries and Wildlife Conservation and the Environment; the U.S. Environmental Protection Agency (EPA); the U.S. Food and Drug Administration (FDA); the National Oceanic and Atmospheric Administration (NOAA); the Massachusetts Department of Public Health (MDPH); and other federal and state authorities formed an interagency coalition in November 1991 to initiate an assessment of the Massachusetts Bay Industrial Waste Site (IWS). The assessment was intended to examine fish and sediments in that area for potential toxic and radioactive contamination. The IWS was the focus of attention because recent surveys revealed the potential presence of thousands of barrels of hazardous and radioactive wastes on the seafloor deposited as a result of historical hazardous substance disposal practices. The interagency coalition determined that a screening survey would provide the greatest amount of information with the limited resources available to determine the need for future investigations and monitoring efforts. Also, the data could be used to verify or reject the hypothesis of an imminent and substantial endangerment to human health or the environment caused by the waste disposal.

The study had several specific objectives including:

- the analysis of edible seafood samples for industrial and radiological contaminants and evaluation for human health risk,
- the analysis of sediment samples taken immediately adjacent to the waste containers and evaluated for environmental risk and,
- the evaluations of both remotely operated vehicles and manned submersibles as location, photographic, sampling, and in situ marine contamination and radioactivity detection tools.

Six target areas near the IWS were delineated based on information from a previous survey by the EPA Region I/International Wildlife Coalition (IWC). To allow comparison of the sediment contaminant burdens within and outside the IWS, two reference areas outside the operations area were also selected.

The target areas were investigated using a variety of surface platforms and methods. The NOAA research vessel (R/V) *Ferrel*, was used to deploy lobster and fish trap trawl lines, and collect sediment samples. The R/V *Seward Johnson* (Harbor Branch Oceanographic Institution) provided the surface platform for the manned submersible, *Johnson Sea Link-II (JSL-II)*, which was equipped with still and video cameras, a hydraulic manipulator for deployment of an Underwater Radiation Spectral Identification System (URSIS), and a sodium iodide-based gamma spectrometer. The R/V *Gloria Michelle* served as a surface platform for a remotely operated vehicle (ROV) "Phantom" equipped with a video camera and a sodium iodide radiation detector.

The *Gloria Michelle, Ferrel* and *Seaward Johnson* maintained locational position using differential global positioning systems (DGPS) and LORAN-C. An integrated navigational system (INS) was installed, coupled with a Trac Point™ acoustic plotter, on the R/V *Gloria Michelle* and the R/V *Seward Johnson,* to provide precision navigation and plotting of undersea vehicle search patterns and determine the exact position of all waste barrels and concurrent sampling points.

The collection of fish and shellfish samples using the R/V *Gloria Michelle* enabled FDA to evaluate risks to human health posed by consuming seafood harvested near the IWS. The MDPH also collected a small number of fish and lobsters for radiological analysis. Because of the presence of numerous bottom hazards, the R/V *Ferrel* attempted to collect fish and shellfish from four of the target areas within the IWS using lobster and fish traps instead of otter trawls. Significantly fewer bottom hazards outside the IWS permitted the use of the more efficient otter trawl method to collect fish. Sampling inside and outside the IWS was to enable comparisons of contaminant concentrations in fish and shellfish between the area of supposed maximum contamination and the area immediately outside the marked bounds of the IWS. However, the trap collection method within the IWS was of limited usefulness.

The ROV was used to reconnoiter targets for investigation by the manned submersible, and visually determine whether a target was ordnance or some other type of container, gauge the relative distance between target barrels, estimate general water clarity, and identify other objects found. The ROV was also used for in situ gross gamma counting to verify that the target was safe for examination by a manned submersible. The ROV examined 26 individual barrels during six dives.

The manned submersible was used to approach targets identified as barrels to visually examine the condition and contents of each barrel, scan the barrel for radioactivity, and to take sediment samples immediately adjacent to each barrel using box or punch cores. This approach was considered the most direct manner for collecting sediment samples to obtain the highest probable contaminant load. This approach also provided the most direct manner in which to describe in situ ecological conditions. The *JSL-II* examined 17 waste barrels during three dives.

Sediment samples at two reference sites were collected using a Smith-McIntyre grab sampler deployed from the R/V *Ferrel*. Samples from these sites, one near-field to the IWS and the other representative of Massachusetts Bay background, allowed comparisons of contaminant levels in the samples obtained by manned submersible in the IWS.

Responsibilities for performing laboratory analyses on the various sample components were divided among participating agencies based upon fiscal capacity and expertise. Sediment samples were analyzed for particle size, total organic carbon (TOC), a standard suite of inorganic and organic contaminants, and radionuclides. Fish and shellfish tissues were analyzed to screen the relative potential toxicological threat posed by the IWS to marine resources and seafood. Screening surveys typically followed agency specific protocols. Four agencies, (FDA, EPA, NOAA, and MDPH) assumed analytical responsibility for various media and various perspectives (e.g., seafood safety, ecological risk, and sediment physical/chemical conditions, including the presence of radionuclides).

FDA collected more than 890 kilograms (kg) of fish and shellfish of which 758 kg came from ten edible, commercially important species; 369 kg were subjected to chemical and radiological analyses. A total of 571 individual fish and shellfish were composited such that 56 samples were analyzed by FDA for: organohalogen pesticides, organophosphate pesticides, polychlorinated biphenyls (PCBs), lead, cadmium, methylmercury, arsenic, radionuclides, and polynuclear aromatic hydrocarbons (PAHs). Samples were composited by individual species and area of harvest to provide a total of 56 samples. EPA collected 10 seafood samples and 84 sediment samples and selectively analyzed for: radionuclides, TOC, grain size, metals, cyanide, organophosphorus pesticides, PCBs, and semi-volatile compounds. NOAA collected 41 biological samples and analyzed them for metals, PCBs, and organochlorine pesticides. MDPH collected

nine biological samples and seven sediment samples for radiological analysis, and nine biological samples for biotoxin analyses.

The results of these investigations were similar to other studies in the area. The FDA survey of the edible portions of seafood samples demonstrated only trace amounts of pesticides. One PCB composite sample (lobster tomalley) outside the bounds of the IWS exceeded the FDA tolerance level of 2.0 parts per million (ppm) wet weight (ww), while one tomalley composite sample within the IWS exceeded the tolerance level by an order of magnitude.

Residues of PAHs in finfish samples were quite low, with higher levels in shellfish tissues, especially lobster tomalley, which is known to concentrate xenobiotics. No seafood samples showed more than trace amounts of radionuclides and none of these could be attributed to past radioactive waste disposal. The degree of contribution by previous dumping of chemical wastes to chemical residues in seafood near the IWS and Massachusetts Bay is uncertain. However, no chemical residues in the fish tissues exceeded federal limits of safety for human consumption except for two lobster tomalley samples.

The concentrations of most organic contaminants in the sediments were similar to those found at the reference sites. However, concentrations approximated the detection levels that were, in some cases, raised or estimated. The inorganic chemistry analysis showed elevated levels of antimony, beryllium, calcium, cobalt, and cyanide in comparison to the reference sites. These findings are consistent with previous investigations in the area. No anthropogenic gamma radiation emitting radionuclides were present at the investigated anchorage sites, and radionuclide levels found in the sediment samples were comparable to natural background levels. Results do not indicate radionuclide contamination from waste disposal operations, and levels observed do not indicate a measurable threat to the environment. As with biological tissue contamination, the degree of contribution by previous dumping of chemical wastes to sediment chemical residues near the IWS and Massachusetts Bay is uncertain.

Based upon the results of this screening survey, further investigations of wastes previously disposed in the IWS should be considered only as one of several potential contaminant-related issues meriting continued investigation in Massachusetts Bay. These include:

- dredge material disposal
- combined sewer overflows
- non-point atmospheric deposition
- input from the Merrimack River

However, due to the amount and hazardous nature of the debris within the IWS as verified by in-situ observations, the existing fishing advisory and the closure for surf clam and quahog harvesting should continue. Expanded limits of the bottom hazards and potential unexploded ordnance should be better defined on charts, at least within the IWS. In addition, the elevated concentrations of PCBs in lobster tomalley collected within the IWS suggests the need for future investigations relative to ecological risk.

CHAPTER 1
Introduction

On August 15, 1991, Congressman Gerry E. Studds of Massachusetts, Chairman of the Subcommittee on Fisheries and Wildlife Conservation and the Environment, requested that the U.S. Environmental Protection Agency (EPA) evaluate the Massachusetts Bay Industrial Waste Site (IWS) as a possible National Priorities List (NPL) site under the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA), as amended (Appendix A). A similar appeal (letter of November 5, 1991) was echoed by the Commonwealth of Massachusetts' Secretary, Executive Office of Environmental Affairs (EOEA) (Appendix A). On October 24, 1991, Congressman Studds requested the U.S. Food and Drug Administration (FDA) evaluate the potential human health risks associated with eating fish caught near the IWS (Appendix A). Congressman Studds requested the agency to immediately initiate a testing program that would examine possible toxic and radioactive contamination of fish, particularly bottom-feeding fish.

The EPA and FDA (letters of September 23, 1991, and November 1, 1991, respectively) responded to Congressman Studds' request by agreeing to address his concerns (Appendix A). Congressman Studds reiterated his concern to EPA in a letter dated October 10, 1991, (Appendix A). In November 1991, Ms. Julia Belaga, EPA Region I Administrator, spoke before a Congressional Subcommittee regarding this matter. To expeditiously address these concerns, EPA and the FDA solicited the assistance of the National Oceanic and Atmospheric Administration (NOAA) for a joint survey and expedition. At the time of the request, NOAA was evaluating the Stellwagen Bank as a National Marine Sanctuary (sanctuary status was legislated in 1993). One proposed boundary of the sanctuary ran through a portion of the IWS. Therefore, NOAA had immediate interest in any potential threats posed by contamination at this site. The enormity of the request without accompanying funds led to the collaboration of numerous federal and state agencies with common jurisdictional interests and accompanying expertise. Such multi-agency collaboration was necessary for a successful survey and assessment of such complex environmental and human health issues.

EPA, in consultation with NOAA, determined that a preliminary assessment/ preliminary survey (PA/PS), or screening survey, focusing on the area with the greatest known concentration of waste containers, the IWS, was the logical next step for

developing an information base necessary before and if EPA decided to score the area through the CERCLA Hazard Ranking System (HRS) for possible inclusion on the NPL. Recent changes in the HRS assigned greater weight to environmental threats than did the earlier versions against which the site was assessed in 1987.

Relying on the best available information, the agencies focused on a potentially worst-case condition. In addition, the agencies hoped that the information obtained for this PA/PS would be sufficiently useful to determine the need for future investigations and/or monitoring efforts. If future investigations were determined appropriate, then the PA/PS should provide future direction regarding the technological applications most appropriate for investigating hazardous substances in this unique environment.

The various agencies determined that an intense technological expedition was necessary to gather sufficient data to provide a preliminary assessment of the nature and extent of any potential threats posed by chemical and radioactive contaminants at the IWS. Further, EPA intended that the resulting survey data could be used to verify or reject the hypothesis of an imminent and substantial danger to human health or the environment and the need to initiate an immediate CERCLA response or removal action to protect those considerations.

Historical Record of Concern

Numerous disposal activities have been conducted in Massachusetts Bay including derelict vessels, dredged materials, construction debris, chemicals, radioactive materials, and ordnance.

Disposal of Low-level Radioactive Wastes in the IWS

In 1957, the U.S. Army Corps of Engineers (ACOE) designated four sites in Massachusetts Bay for the disposal of radioactive wastes (EPA 1984). The radioactive waste disposal activity in Massachusetts Bay was conducted under licenses issued to Crossroads Marine Disposal & Salvage Co. (CMD) by the U.S. Atomic Energy Commission (USAEC) in 1953 and 1957. Early communication from CMD to the USAEC mentions pre-license experience in disposal of low-level radioactive wastes (LLW), as far back as 1946. The USAEC licensed CMD to receive, transport, and store by-product material with atomic numbers 3 through 83 for ultimate disposal at sea.

This LLW includes such items as contaminated clothing, laboratory glassware, and tools. By definition, LLW specifically excludes spent reactor fuel or weapons-grade material. The generators of this waste were engaged in commercial manufacturing, medical and non-medical research, and medical treatment. Over the years the principals of CMD have maintained that radioactive waste accounted for only about 5 percent of their business, the majority of which was hazardous chemical disposal.

Records from CMD report that 4,008 LLW containers were disposed of in Massachusetts Bay. The containers included 1,438 five-gallon pails, 1,860 thirty-gallon drums and 710 fifty-five-gallon drums. In addition, CMD received 940 cubic feet of LLW that would not fit into the standard containers (EPA 1984).

Based on a review of available records at the time and interviews with the principals of CMD, EPA believed that most of the LLW disposal activity took place at the IWS (EPA 1984).

It is interesting to note that the IWS was not designated as a disposal site for radioactive materials until March 1957 (the permit also authorized chemical and toxic wastes). Nevertheless, a letter from the Boston Harbor Master, in December 1952, directs Captain Perry to the Foul Area (Boston Police Department 1952). In November 1957, CMD filed a report on disposal since October 1955. The report references the Foul Area as the location of disposal. No other location is specified.

Hazardous Waste Disposal

The IWS was designated as a munitions disposal area in 1945 (NOAA 1992). Munitions or ordnance, explosives, industrial and chemical wastes, construction debris and derelict vessels were disposed of in the IWS from the 1940s through 1977 (EPA 1992a).

As indicated above, industrial waste disposal occurred as far back as 1947. However, these wastes were permitted for disposal in 1953 and 1957 by the ACOE under authority granted by the Rivers and Harbors Act of 1899. In 1959, the ACOE issued permits to CMD for the disposal of industrial wastes and explosives only at the IWS. In the mid 1960s the ACOE issued disposal permits to Safety Products & Engineering (SP&E) for industrial

waste disposal at the IWS. From 1973-77, EPA continued to issue permits for disposal of industrial wastes at the IWS to SP&E. In 1977, dumping was discontinued at the IWS.

Only very limited records exist quantifying the amounts or types of hazardous waste materials disposed of in Massachusetts Bay or the IWS. In 1976 and 1977, EPA authorized SP&E to dispose of 43 barrels of explosives embedded in concrete and 129 fifty-five-gallon drums of metallic sodium, lithium, and magnesium from industrial chemical processes. EPA also authorized the disposal of neutralized acids and bases and small quantities of miscellaneous laboratory chemicals encased in concrete. One manifest of SP&E's activities in February 1976 listed many substances known to illicit carcinogenic, neoplastic, mutagenic, or teratogenic effects (Kamlet 1985). Many containers were punctured by rifle shots or other devices to ensure sinking of the containers and or dilution of the wastes.

Despite these findings, in 1987, EPA's Superfund Support Section determined that, based upon past assessments of site information, emergency removal or NPL eligibility was unjustifiable following a PA.

Retrieval of Contaminated Materials by Fishermen

Over the years several commercial fishermen have retrieved hazardous chemical and radioactive waste containers.

Chemical Wastes

On September 5, 1989, Captain Salvador Lo Grasso of the fishing vessel (F/V) *Italia* snagged several barrels of industrial waste in his fishing nets. Four 55-gallon drums and one 30-gallon drum were brought to the surface. Phosphorus pentoxide, methylene chloride, chloroform, chloroethene, and chromic acid were among the chemicals identified. The coordinates given by Mr. Lo Grasso appeared to traverse through the IWS.

Radioactive Wastes

Since the 1960s, unintentional recovery of radioactive waste containers has been documented three times:

- In September 1960, a fishing vessel reportedly recovered a 30-gallon drum in 89 meters (m) of water, 12 miles east of Marblehead, Massachusetts. Radiation levels were measured at less than 0.7 millirem/hour (USNRC 1978).

- During May 1967, a concrete container was recovered by a fishing vessel 5 miles off Scituate, Massachusetts. It was believed that this container held radium dials and thorium oxide. The container was dumped overboard (USNRC 1978) before the vessel reached port.

- In May 1978, a fishing vessel recovered a broken concrete container, described as being about 18 inches square by about 5 feet long, at a position 9.5 miles north-northeast of Scituate. The container, which held plastic, wood and metal, was discarded overboard. Later that day, the vessel's gear, deck, hold and catch, and the crew and their clothing were surveyed by a representative of the Massachusetts Department of Public Health. No indication of radioactive contamination was found (Bell 1978).

In addition to the above documented cases, there are several anecdotal reports of recoveries of possible radioactive or chemical waste containers by fishermen working in Massachusetts Bay.

CHAPTER 2

LEGISLATIVE AND REGULATORY BACKGROUND

Environmental Protection Agency

The EPA has the lead responsibility for regulating the disposal of all wastes at sea allowable by the London Dumping Convention under the Marine Protection, Research and Sanctuaries Act (MPRSA) of 1972. Under this authority, EPA issues permits for transport and disposal of all wastes except dredged material; dredge spoils are administered by the ACOE. Under the current regulations promulgated under the Ocean Dumping Ban Act of 1988, EPA has banned the ocean disposal of all industrial wastes and sewage sludge. However, the regulations do not preclude the disposal of LLW, although a moratorium on such waste disposal has been recently signed by most members of the London Convention.

EPA, under MPRSA, also has the authority to designate, de-designate, and monitor disposal sites. The Massachusetts Bay IWS was designated as "interim" in 1977 under the MPRSA regulations. However, the IWS was officially terminated by notice in the Federal Register in 1980. EPA then de-designated the IWS on February 2, 1990, resulting in a de-listing of the disposal site in the regulations (40 CFR 228.12). Various on-going monitoring activities continue at the site under the ACOE Disposal Area Monitoring System (DAMOS) Program (for dredged material) and by the EPA. Both monitoring efforts are funded under MPRSA.

The EPA is also the lead agency for investigating releases of hazardous substances posing threats to human health or the environment pursuant to: CERCLA, as amended in 1986; Executive Order 12580; the National Oil and Hazardous Substances Pollution Contingency Plan 40 CFR Part 300, March 8, 1990 (NCP); and the Memorandum of Understanding between EPA and the U.S. Coast Guard (USCG).

Before proposing or listing a site for inclusion on the NPL, a PA is conducted by EPA in anticipation of scoring a site using the HRS in accordance with NCP §300.420. The PA can also be used as a basis to warrant a removal action (NCP §300.420 (b)(3)).

National Oceanic and Atmospheric Administration

NOAA is a natural resource trustee agency designated under CERCLA, Executive Order 12580, and the NCP, Subpart G, §300.600. Pursuant to CERCLA, the lead agency is required to notify any potentially affected natural resource trustee of possible injuries to its trust resources when a removal or response action is underway, and to coordinate all investigations leading to possible abatement of the injuries. NOAA, in collaboration with EPA, determined that a PS (also known as a screening survey) as authorized in the NCP, Subpart G, §300.615, was necessary at the IWS. The U.S. Fish and Wildlife Service (USFWS), acting on behalf of the U.S. Department of the Interior as a natural resource trustee, provided technical assistance to NOAA as a co-trustee agency, as did agencies of the Commonwealth of Massachusetts' EOEA, also a co-trustee.

This screening survey will be used by EPA and the natural resource trustee agencies to evaluate the potential hazardous substance threat to human health, environment, and marine resources.

NOAA's National Marine Fisheries Service (NMFS) is authorized under the Magnuson Fishery Conservation and Management Act to manage fishery resources. Further, the Magnuson Act creates Regional Fisheries Management Councils to develop Fishery Management Plans (FMP) to manage species under their jurisdiction. Authorities granted within FMPs can allow closing areas to fishing because of environmental degradation; however, only one such plan has been drafted in this manner. This FMP is for the Atlantic surf clam and ocean quahog fisheries, and encompasses Massachusetts Bay and allows for the closure of surf clam and ocean quahog beds because of environmental degradation. Paragraph 50 CFR 652.23 (a)(1) of the FMP describes "The Boston Foul ground as closed because of environmental degradation." This closure does not extend to any species other then surf clams and ocean quahogs. On an emergency basis, the Secretary of Commerce or delegate (NMFS) may promulgate emergency regulations to close a fishery, however, a fishery closure due to an emergency can last for a maximum of 180 days. At any time the Regional Director may issue an advisory or warning against fishing in an area, but such advisories have no force or effect of law.

Food and Drug Administration

The FDA falls under the confines of the U.S. Public Health Service, which lies within the U.S. Department of Health and Human Services.

As a regulatory agency charged with consumer protection, FDA's responsibility is to assure consumers that the food supply, including seafood, is safe and wholesome for human consumption and free from adulteration. This authority is mandated by the Federal Food, Drug, and Cosmetic Act, as amended, which appears in the United States Code under Title 21.

Fishing Advisories and Closures at the IWS

In 1971, FDA issued a notice to fishermen, warning them against fishing at the IWS.

In 1980, FDA's Northeast Region in cooperation with the Northeast Region of NMFS issued a joint advisory to all fishermen requesting that they avoid harvesting bottom-dwelling species in the portion of Massachusetts Bay known as the "Foul Area - An Industrial Waste Dump Site" (Appendix A).

In 1980, the NMFS banned the harvesting of surf clams and ocean quahogs in the portion of Massachusetts Bay known as the Foul Area. This notice of closure was published in Federal Register Volume 45, Number 2, Thursday, January 3, 1980 (Appendix A).

In March 1992, the Northeast Regional Offices of FDA and NMFS re-issued an advisory to fishermen warning them against harvesting bottom-dwelling fauna from the "Foul Area - An Industrial Waste Dump Site" (Appendix A).

Despite these warnings to fishermen, information gathered during this survey revealed that the area in and around the IWS is actively being fished. This statement is based upon the following observations:

- On at least two occasions, commercial lobster boats approached the research vessel (R/V) *Gloria Michelle* to express concern that the survey operations being conducted in the area would interfere with commercial traps that had been set in the same area.
- The trawl area in Site 8, which most closely corresponds to Target Area IV, within the confines of the IWS, had to be adjusted due to the presence of commercial lobster gear in the area.

- On May 30, 1992, when the anchor of the R/V *Gloria Michelle* was raised after conducting remotely operated vehicle (ROV) operations in Target Area IV, a commercial lobster trap containing one lobster was observed entangled on the fluke of the anchor; also entangled were fragments of a barrel.

Interagency Collaboration

Numerous federal and state agencies having jurisdictional interests in the IWS afforded expertise particularly valuable for the successful conduct of this survey. The following is an alphabetical listing with a brief description of the roles played by all those agencies who participated in this survey. Individuals participating in the survey are given in Appendix B "Survey Plan."

- The Commonwealth of Massachusetts, Division of Marine Fisheries (MDMF) provided expert knowledge and field assistance regarding the capture of biological specimens for body burden analysis.

- The Commonwealth of Massachusetts, Department of Public Health's (MDPH) Division of Food and Drugs, and the Radiation Control Program helped harvest the fish, performed laboratory analyses on radionuclides in sediments and biota, and biotoxins in biota. MDPH also conducted a radiological monitoring and safety program for the survey's field personnel.

- The Commonwealth of Massachusetts, Environmental Police provided lobster traps at no cost for use in the survey collection of biota.

- The Commonwealth of Massachusetts, Office of Coastal Zone Management assisted in the sampling design and interpretations of Massachusetts Bay contaminants relative to the IWS.

- The ACOE provided valuable data relative to the types and abundance of species indigenous to the sampling area during the time of the survey. The ACOE assisted in the coordination of on-going dredged materials disposal and other activities in the survey area. The ACOE also helped interpret the historical contaminant database in the survey area. In the spring of 1993, they sponsored a test survey of a portion in the IWS with a laser-line scanner system.

- The USCG was responsible for marine safety issues. The USCG Gloucester Station made its facilities available to the participating vessels and the attendant scientific crews involved in the survey.

- The U.S. Department of Commerce (DOC), NOAA, NMFS Northeast Regional Office, Gloucester, Massachusetts provided fisheries related expertise from the regional office including its Seafood Testing facility, as well as Northeast Fisheries Center Offices in Woods Hole, Massachusetts; the Fisheries Engineering Group in Narragansett, Rhode Island; and the Sandy Hook Laboratory in Highlands, New Jersey. NMFS provided the R/V *Gloria Michelle* making the collection of biological samples and deploying an ROV possible.

- The DOC, NOAA, National Ocean Service (NOS), Office of Ocean Resource Conservation and Assessment (ORCA) provided the R/V *Ferrel* as a surface platform for the collection of sediment and biological samples. In addition, ORCAs Hazardous Materials Response and Assessment Division (HAZMAT) coordinated the interagency participation in the field survey and compiled the information resulting from the survey into this final report. The National Undersea Research Program through the National Undersea Research Center (NURC) at the University of Connecticut provided the ROV and facilitated the involvement of the Harbor Branch Oceanographic Institution's R/V *Seward Johnson* with its' manned submersible the *Johnson Sea Link II (JSL-II)*. The *JSL-II* gathered sediment samples and afforded direct and photographic observations of the seafloor. NURC also prepared visual displays of electronically logged navigational data. The University of New Hampshire's Sea Grant Program in cooperation with HAZMAT sponsored the participation of three junior high/high school classes (Dover, North Stratford, and Newmarket, New Hampshire) onboard the R/V *Ferrel* and R/V *Seward Johnson* as part of an educational outreach experience.

- The U.S. Department of Energy (DOE) Remote Sensing Laboratory in collaboration with EPA's Environmental Monitoring Systems Laboratory—Las Vegas (EMSL-LV), provided the survey with radiological monitoring equipment and advanced positioning system technology.

- The U.S. Department of the Interior (DOI), USFWS provided field personnel to prepare biological materials and analytical protocols for the analysis of biological materials.

- The EPA Region I Environmental Research Laboratory at Narragansett (ERL-N), Rhode Island and EMSL-LV staffs played a key role in scoping and coordinating the survey. The Agency's Superfund Contract Laboratory Program (CLP) analyzed sediment samples for a suite of chemicals. EPA regional staff provided a radiological monitoring and safety program for field survey personnel and equipment, including monitoring during the manned submersible operations. Regional staff, including the Environmental Services Division-Lexington, played significant roles in the collection of sediment and biological samples. Several Office of Research and Development laboratories provided expertise for both the field effort and subsequent laboratory analytical chemistry and radiochemistry. The (ERL-N) worked closely with NOAA and NURC by providing expertise in design, deployment, and interpretation of sonar mapping technologies and readings; as well as developing sampling strategies, processing sediment samples, and summarizing the results from the sediment chemistry. The EMSL-LV worked closely with the DOE to develop necessary radiation monitoring and health physics and conducted radiochemistry of sediment samples.

- The U.S. Department of Health & Human Services, FDA played an instrumental role in the coordination of the survey and was the lead agency responsible for the collection of all biological specimens. To undertake this sampling effort, in part, FDA secured the use of the R/V *Gloria Michelle* and acquired all necessary sampling gear. Personnel from FDA's Boston District Office and Northeast Technical Services Unit provided onboard support and were responsible for sorting, measuring, preparing, and delivering biological samples to the appropriate FDA laboratory. Samples of commercially important species were analyzed for a host of contaminants by several FDA laboratories including New York Regional Laboratory, Buffalo District Laboratory, and Winchester and Engineering Analytical Center. Personnel from FDA's Office of Seafood helped develop a sound sampling rationale, provided onboard support, and evaluated the data to assess the potential human health risks associated with the consumption of seafood harvested in the area. FDA's Boston District Office compiled FDA's data resulting from the survey for this final report.

- The U.S. Department of the Navy provided onboard expertise in munitions identification and hazards, as well as onboard ready assistance identifying and

handling unexploded ordnance that may have been found by the ROV or *JSL-II*, or brought aboard during trawl retrieval.

- The IWC, while not a governmental agency, provided invaluable assistance by making available location information and video footage of target fields previously identified in its 1991 survey funded by EPA (Wiley et al. 1992).

CHAPTER 3

SCREENING SURVEY OBJECTIVES

Representatives of the participating agencies met on March 30, 1992, and agreed upon several primary and secondary screening survey objectives that shaped the design of the overall study (see Survey Plan in Appendix B). These objectives were meant to allow EPA, FDA, and NOAA to address their concerns.

Primary Objectives

The seven primary objectives were:

1. Evaluate samples of seafood harvested near the IWS for pesticide residues, polychlorinated biphenyls (PCBs,) heavy metals, polycyclic aromatic hydrocarbons (PAHs), and radionuclides.

2. Evaluate the seafood data to assess potential human health risks associated with toxic and radioactive materials.

3. Analyze sediment samples taken within proximity to the containers for selected organic chemicals, inorganic chemicals, trace elements, and radionuclides.

4. Evaluate the effectiveness of a ROV to locate and position bottom objects for specific target area deployment of a manned submersible.

5. Evaluate a manned submersible as a platform for visual and photographic (35 mm still camera and 8 mm video) observation of bottom objects, including hazardous waste containers, on the seafloor with respect to density, overall condition, and identifying marks for comparison with observations taken during previous ROV and side-scan sonar surveys.

6. Evaluate a manned submersible as a platform from which to collect sediment samples close to hazardous waste containers.

7. Evaluate the ability to sample potential target species in proximity to potential hazardous substance targets on the seafloor.

Secondary Objectives

The four secondary objectives were:

1. Evaluate the utility of the ROV as a platform for in-situ radioactivity detection.

2. Evaluate the utility of the manned submersible as a platform for in-situ radioactivity detection.

3. Evaluate biological samples for contaminant body burden analysis for preliminary estimates of ecological risk.

4. Quantify the amount of paralytic shellfish toxins and domoic acid found in lobster tomalley in animals harvested from the Massachusetts Bay IWS.

CHAPTER 4
Industrial Waste Site

The Massachusetts Bay IWS functioned as a permitted disposal site from 1957 through 1977. However, anecdotal information indicates that the site had been used by the U.S. Navy since 1946 for munitions disposal. It was not until 1990 that the site was officially de-designated for disposal. Concern over the human health and environmental threats posed by these historical disposal practices began to surface in the late 1970s as evidenced by federally sponsored surveys beginning in the early 1980s. A description of the permitted disposal site is summarized below.

IWS Description

Physiography

Massachusetts Bay is bounded to the north by Cape Ann, Massachusetts and to the south by the Cape Cod Peninsula (Figure 4.1). At the eastern opening of the bay are the Stellwagen Bank and the Stellwagen Bank National Marine Sanctuary, an elevated sand and gravel feature of the seafloor that rises to within 20 m of the surface. Massachusetts Bay encompasses approximately 1,400 square miles of surface area (excluding Cape Cod Bay). The IWS is located in an area also known as the "Boston Foul Area" or simply the "Foul Area" within the Stellwagen Basin and west-northwest of Stellwagen Bank.

The IWS bears 158°T from Eastern Point Light, at the entrance to Gloucester Harbor, some 9.8 nautical miles (nm) distant, approximately 22 nm east from Boston, and 074°T from Northeast Graves some 13.3 nm. The IWS lies outside the territorial sea, but within the contiguous zone.

The IWS is defined as a circle of two nautical miles in diameter centered at 42°25.7′ N, 70°34.9′ W (Figure 4.2). Contiguous with and overlapping the IWS is the Massachusetts Bay Dredged Material Disposal Site (MBDS) Figure 4.2, which has subsequently been repositioned through regulatory processes to overlap more of the IWS. The IWS has nominal depths varying from 75 to 91 m (240 to 300 feet [ft]). The only significant topographic features include rises in the north and northeast quadrant where the bottom shoals toward the Stellwagen Bank, a circular mound rises in its north-central section, and a small depression is near its center (EPA 1984).

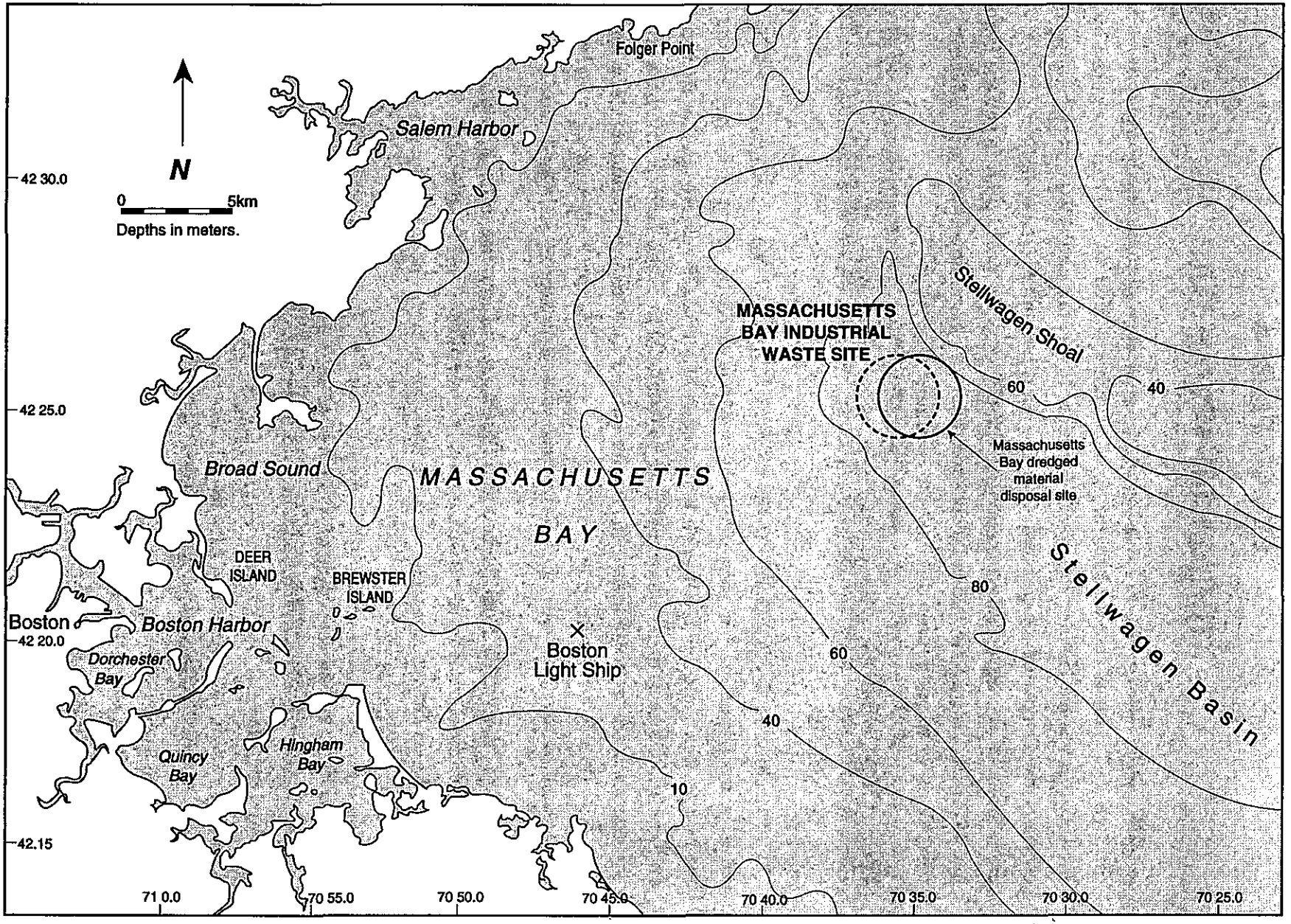


Figure 4.1. Location of Massachusetts Bay Industrial Waste Site.

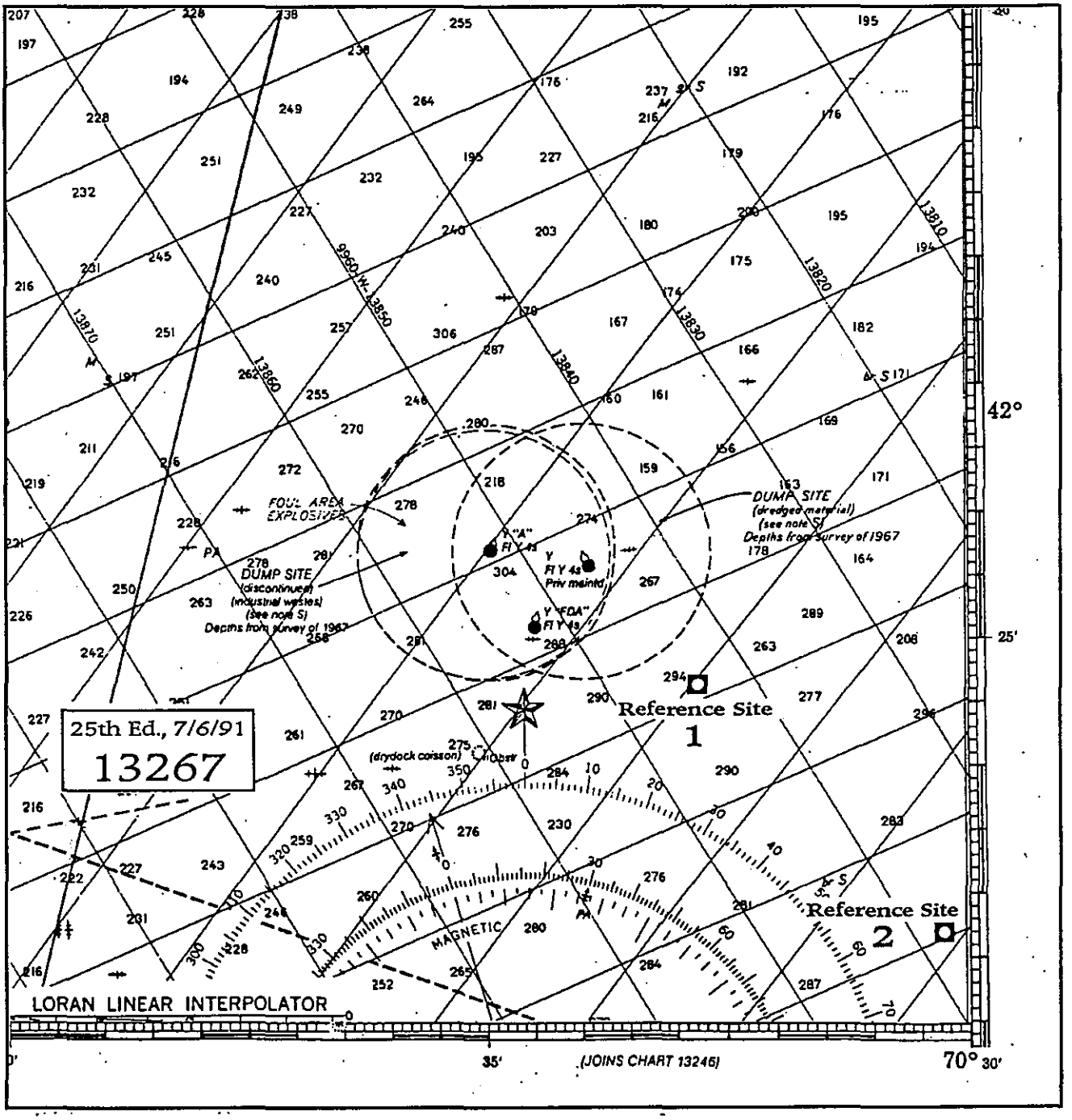


Figure 4.2. The Massachusetts Bay IWS and overlapping disposal site. Also shown are the sediment Reference Sites 1 and 2.

Because the IWS lies within a depression, turbidity can be quite high compared to shallower areas. This turbidity has frequently been blamed for hindering visual inspections of the bottom.

CHAPTER 5

FIELD SURVEY PLAN

Target Areas and Reference Sites

Target Areas

On March 30, 1992, representatives from several federal and state agencies, and a representative from the IWC met to:

- identify agency interests and areas of collaboration;
- determine a scope for a May-June survey;
- identify principal contacts and responsibilities, and
- agree upon a well-defined set of objectives laid out in the Field Survey Plan (Appendix B).

On April 30, 1992, members of the survey team met with scientists from the EPA ERL-N to decide upon a study design appropriate for the objectives. The scientists agreed that considering the fiscal constraints and preliminary nature of the scope a statistically designed study was inappropriate. Therefore, a strategy was developed to focus data collection at several high-concentration, container target areas (also referred to as target fields).

The science team relied on side-scan sonar records that followed a survey design initiated by EPA in 1991 (Figure 5.1) and subsequent ROV observations (Figure 5.2) from the 1991 IWC (Wiley et al. 1992) and EPA surveys (EPA 1992b). The Wiley et al. survey established anchorage points and assigned them alphabetical descriptors (e.g., A, L, Q). Their ROV operations focused around these anchorage points. Descriptions of targets observed at each anchorage point were provided in their report. Because the distances between targets at some clustered anchorage points were relatively small (e.g., 100 m), the survey team subjectively delineated anchorage points into target areas for this expedition.

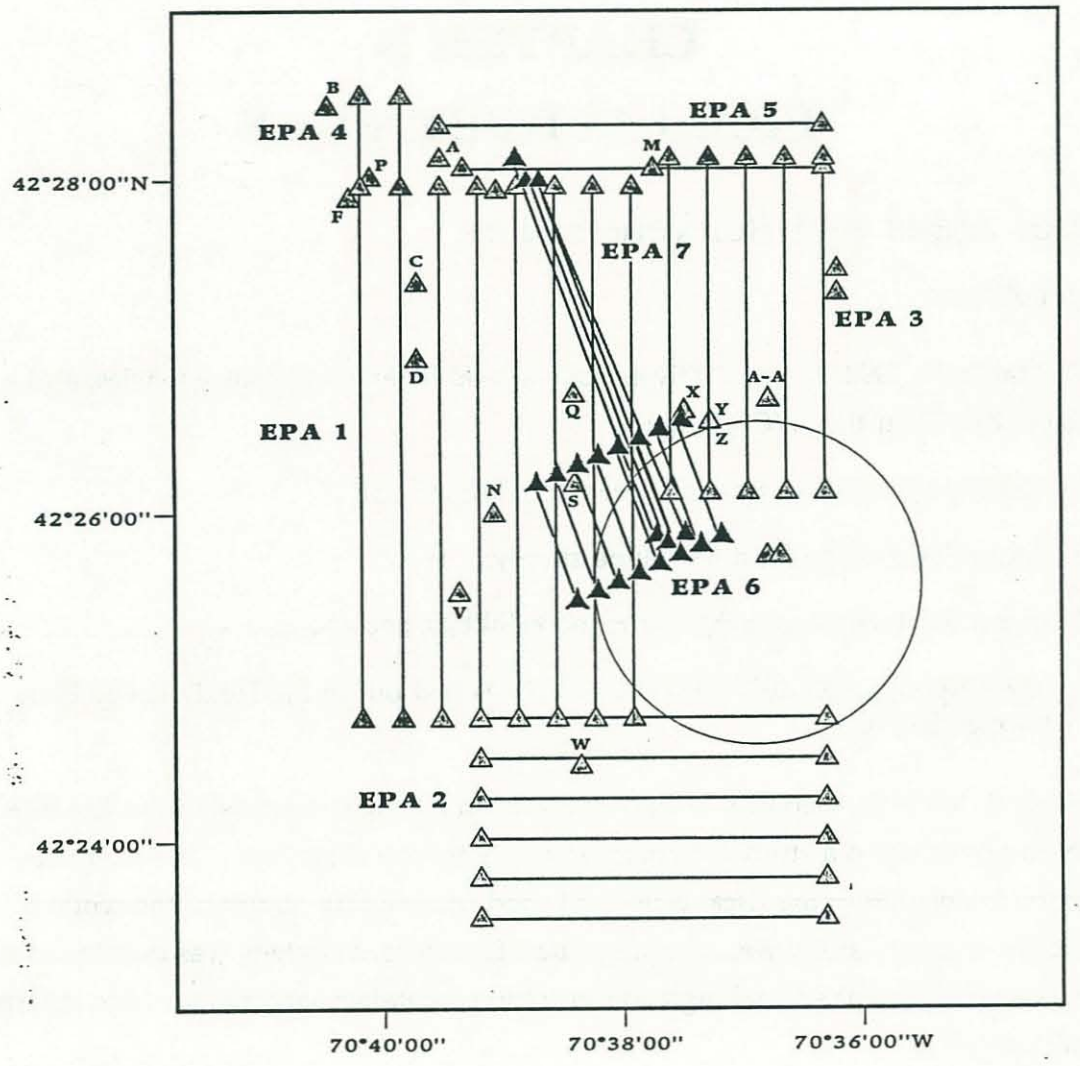


Figure 5.1. Side-scan sonar survey design for survey conducted in July 1991 (EPA 1992b). Circle depicts the perimeter of the Massachusetts Bay IWS. (Symbol shading is for clarity only.)

Six target areas were delineated (I, II, III, IV, V, and VI; Figure 5.2) by the survey team. These target areas were numbered from highest expected encounters (Target Area I) to lowest expected encounters (Target Area VI), again based upon the earlier side-scan sonar and ROV observations. The survey team estimated that only four target areas could be explored by the manned submersible within the operations window. Target Areas V and VI were contingent target areas in the event that areas I through IV did not reveal the anticipated high concentrations of containers. All target areas were in the northwest quadrant of the IWS, with Target Areas I and II extending beyond the defined perimeter of the IWS.

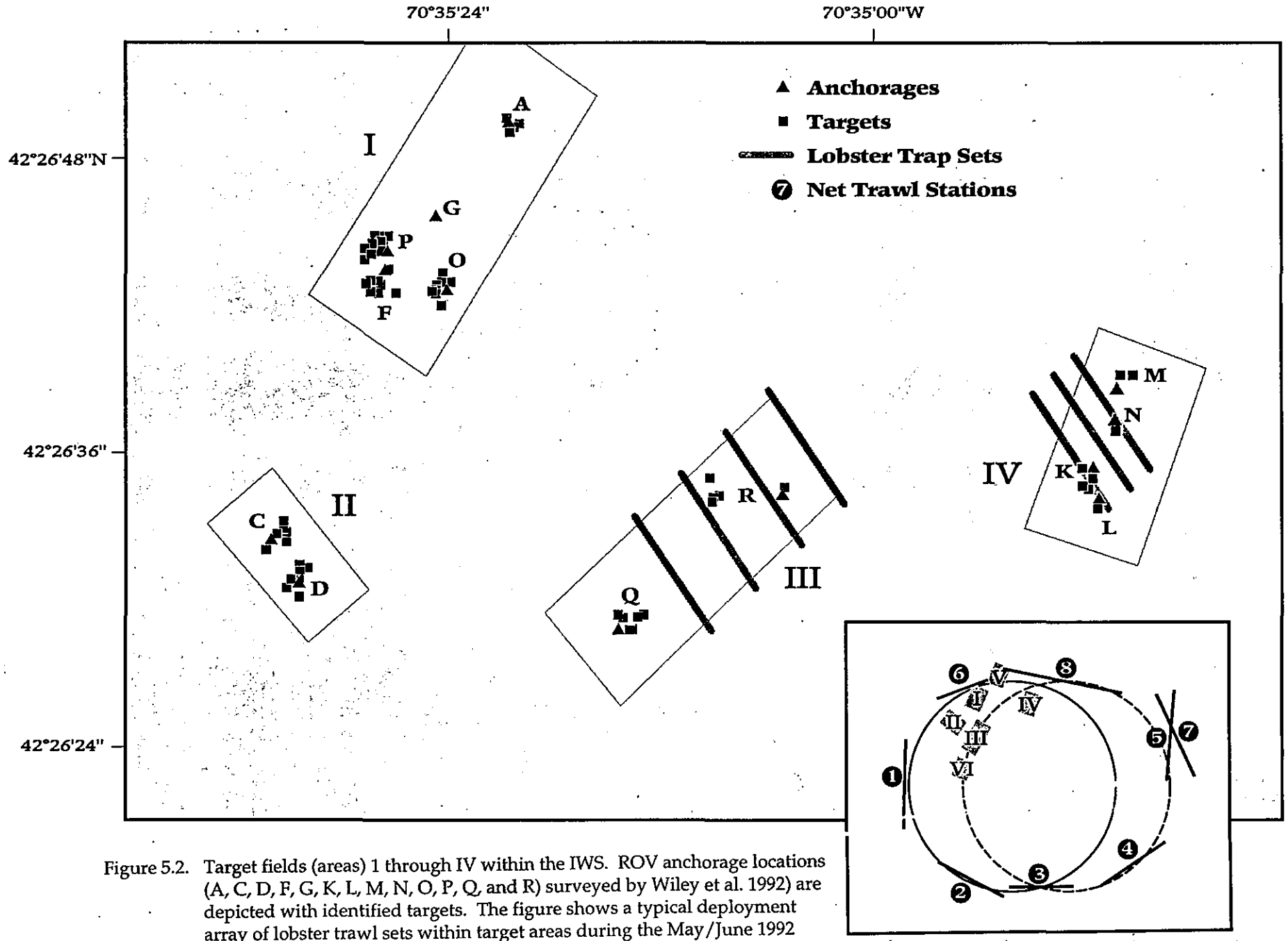


Figure 5.2. Target fields (areas) 1 through IV within the IWS. ROV anchorage locations (A, C, D, F, G, K, L, M, N, O, P, Q, and R) surveyed by Wiley et al. 1992) are depicted with identified targets. The figure shows a typical deployment array of lobster trawl sets within target areas during the May/June 1992 survey. The inset depicts the otter trawl stations (1 through 8) and the relative location of the six target fields.

The target areas with anchorage points were defined by the scientific team as follows:

Target Area I:	Anchorages A, O, F, P, and G (note that anchorages G and F did not reveal targets of potential interest; nonetheless they are located within the field).
Target Area II:	Anchorages C and D
Target Area III:	Anchorages Q and R
Target Area IV:	Anchorages K, L, M, and N
Target Area V:	Side-Scan Record @ 42°26.5′ N x 70°35.2′ W
Target Area VI:	Side-Scan Record @ 42°25.9′ N x 70° 35.2′ W

Reference Sites

Two historical Reference Sites (1 and 2) were selected to compare sediment contaminant burdens within the bounds of the IWS with sediments outside the IWS (Figure 5.2). Depths at the reference sites are similar to those within the IWS. Although some contamination from hazardous container releases is possible considering the nature of the known disposal practices, these reference sites are considered a near-field reference site (Reference Site 1) and a reference site (Reference Site 2) of Massachusetts Bay background concentrations (Keckler 1991, USEPA 1992a). Previous investigations of these reference sites did not analyze sediments for the full suite of contaminants being considered in this survey, but their historical record serves as a basis by which to compare sediments collected from within the IWS to areas within relative proximity.

Only one of the two reference sites (Reference Site 2) was used for the collection of biological specimens in this survey. Reference Site 2 is the most distant from the IWS and the scientific team felt that considering the mobility of the primary species of concern, the American lobster, that the relative proximity of Reference Site 1 to the IWS may confuse data interpretation.

Reference Site 1 served as the reference site in historical (Station REF) dredged material disposal site investigations (EPA 1989). The site coordinates are 42°24.6′ N by 70°32.8′ W with a depth of approximately 91 m. The sediments at this site are predominantly fine silt with a mean grain size of 0.013 millimeters (mm). Reference Site 2 is identified as Reference Site A in recent dredged material disposal site investigations

(EPA 1992a). Reference Site 2 is located at coordinates 42°22.7′ N by 70°30.3′ W; depth is approximately 85 m.

Survey Vessels

The survey vessels used for the expedition were uniquely qualified to provide solutions to the different questions formulated by the survey objectives presented in Chapter 3.

R/V *Gloria Michelle*

The NOAA R/V *Gloria Michelle* is a converted 20-m (65-ft) southern shrimper confiscated by U.S. Customs in 1979 and subsequently granted to the NMFS. The R/V *Gloria Michelle* is based in Sandy Hook, New Jersey, has a 7.9 m^2 dry laboratory, and is equipped for stern trawling. The R/V *Gloria Michelle* was used as the ROV platform and for collecting fish using the otter trawl.

R/V *Ferrel*

The NOAA R/V *Ferrel*, a 39-m (127-ft) vessel based in Norfolk, Virginia is a modified off-shore oil rig supply boat design outfitted for oceanographic sampling. The vessel is equipped with twin screws and a bowthruster to improve maneuverability. More than 46 m^2 of laboratory space including a -62°C freezer is available for onboard scientific tasks. The vessel is used as part of NOAA's National Status and Trends (NS&T) Program. As such, this vessel was ideally suited for the task of biological specimen collection in well-defined areas of deep, open water. The R/V *Ferrel* was used for deploying lobster/fish trap trawl lines and collecting sediment samples in the reference areas requiring a surface deployed grab sampler.

R/V *Seward Johnson and Johnson Sea Link-II*

The 53-m (176-ft) R/V *Seward Johnson* operated by the Harbor Branch Oceanographic Institution, Ft. Pierce, Florida under contract to NURC-University of Connecticut Avery Point (UCAP), and supported by funds from NOAA, NURC, and EPA, provided the manned submersible *JSL-II* The vessel was equipped with wet and dry laboratory space for sample processing and state-of-the-art navigation and tracking control.

The *JSL-II* accommodates a pilot and observer within the forward 12.7-centimeter (cm) thick acrylic sphere. A second crew member and another observer occupy the after observation chamber where a video monitor and side-view ports provide forward and side observation. In this survey, the after-observation chamber held radiation detection instruments operated by a field scientist. The *JSL*-II is certified to a maximum operating depth of 914 m (3,000 ft). The submersible is outfitted with a manipulator arm, sector-scan sonar, laser-aimed still and broadcast-quality video cameras. Figure 5.3 shows *JSL-II* onboard the R/V *Seward Johnson*.

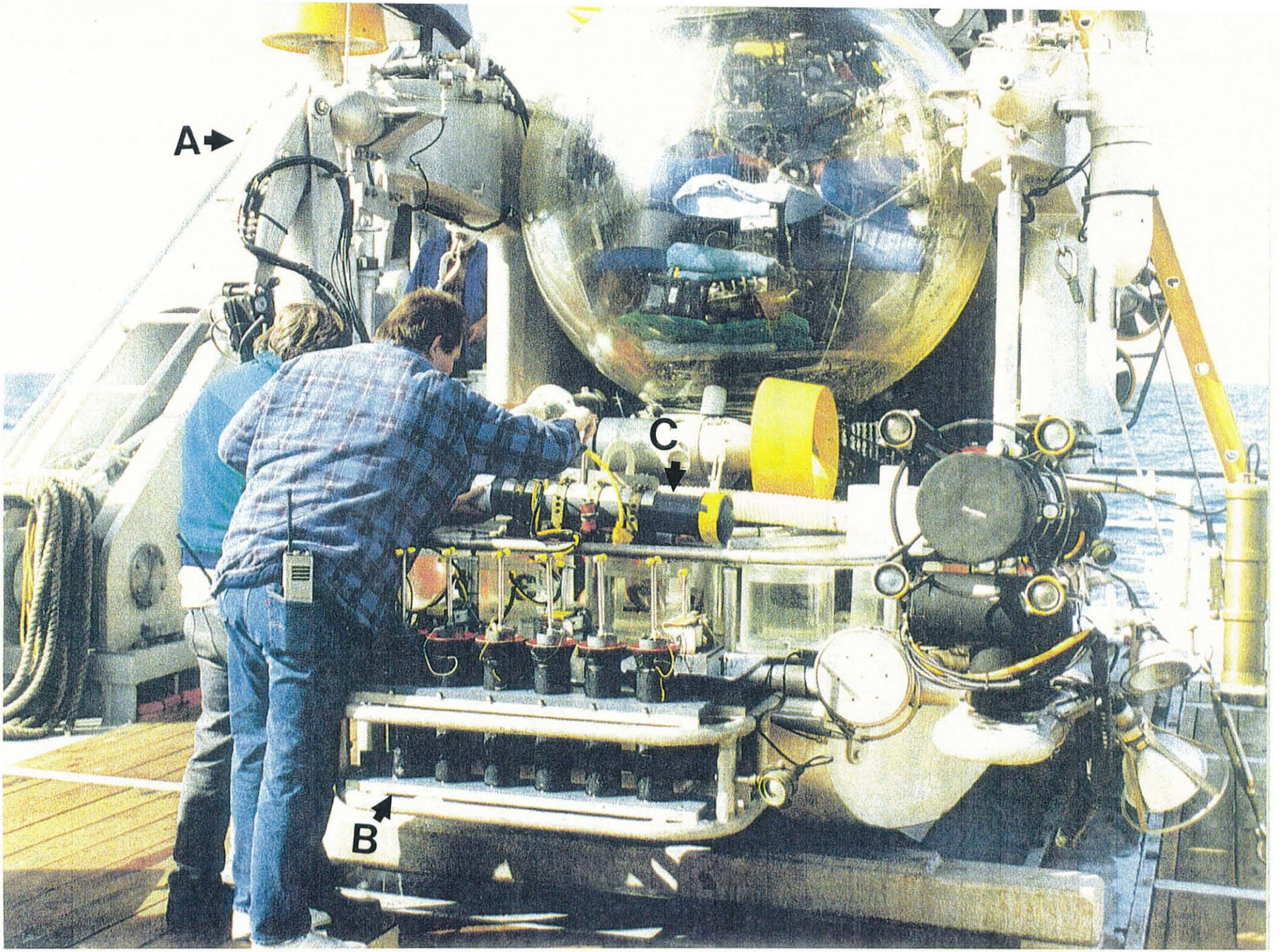
Survey Navigation

R/V Gloria Michelle

The R/V *Gloria Michelle* served as the ROV platform. This vessel's normal navigation is provided by Loran C; but ROV operations relied upon a DGPS linked with an integrated navigational system (INS). The differential global positioning system (DGPS) (Magnavox MX200) provided positional fixes with a 2- to 5-m error. The Sea Trac™ INS provided interface between the DGPS, Loran C, and ship's heading and the ROV tracking system, Track Point II™. This system provided a video display of real-time ship and ROV position, thereby, allowing a systematic search of the area. ROV movement was plotted on a real-time monitor or Hewlett-Packard printer paper copy. Various scale plots (10- to 100-m) were used to record ROV track lines and exact locations of barrel targets and other bottom topographical features. The coordinates were recorded on floppy disk at defined intervals and marks for later upload into the Geographic Information System (GIS). A printout of the ROV, submersible, and ship tracks and any target (e.g., fishing gear, barrels) was available through a Hewlett-Packard color printer.

The location information from the INS was coupled with detailed sample information (i.e., number and type of sediment cores, voucher specimens, videotape number, photograph numbers, etc.) for integration into the GIS.

Facing Page: Figure 5.3. The *JSL-II* onboard the R/V *Seward Johnson* at the Massachusetts Bay IWS, June 1992. The figure depicts the (A) manipulator arm (partially hidden, (B) punch corers in the quiver array, and the (C) radiation detector.


A
C
B

R/V Ferrel

The R/V *Ferrel* served as a platform for the collection of sediment grab samples and the deployment and retrieval of lobster traps. Station locations were determined with Loran C and a GPS.

R/V Seward Johnson and JSL-II

The same system used to track the ROV was installed on the R/V *Seward Johnson* and used to track the *JSL-II* search path, targets located by the submersible, sample locations, and all photographic records.

The INS was installed in the dry laboratory for simultaneous tracking of the *JSL-II.*

The R/V *Seward Johnson* also used an integrated mission profiler (IMP) system on the bridge. The IMP used GPS as a general navigational aid for mother-ship tending of the submersible.

Underwater Radiation Spectral Identification

A gamma spectrum collection live-time interval of 300 seconds was employed for this survey. This interval was deemed sufficient to achieve the minimum detectable activities (MDA) and sediment concentrations cited in Table 5.1 and Table 6.1, respecitively. These MDA and concentration levels were derived from a radiation transport model
(page 5-15) that used:

1. An optimum detector-to-target distance in seawater of approximately 10 cm.
2. No shielding except for seawater between the detector and the target (e.g., concrete, steel barrel).
3. A sediment moisture content of 25 percent and soil density of 1.5 g/cm^3.
4. A reciprocal relaxation depth of 0.1 cm^{-1}.
5. A maximum source distribution depth of 10 cm.

Table 5.1. Minimum detectable activities (MDA) and sediment concentrations.

Isotope	Peak Energy (keV)	Relative Abundance	Point Source Activity (nCi)	Sediment Concentration	
				uCi/m^2	pCi/g
Am-241	60	0.359	85.9	21.4	90.1
Cs-137	662	0.846	1.10	0.07	0.23
Co-60	1332	1.000	0.61	0.03	0.11
K-40	1461	0.110	9.4	0.35	1.49
Tl-208	2615	1.000	0.57	0.01	0.05

Source distribution model assumptions:

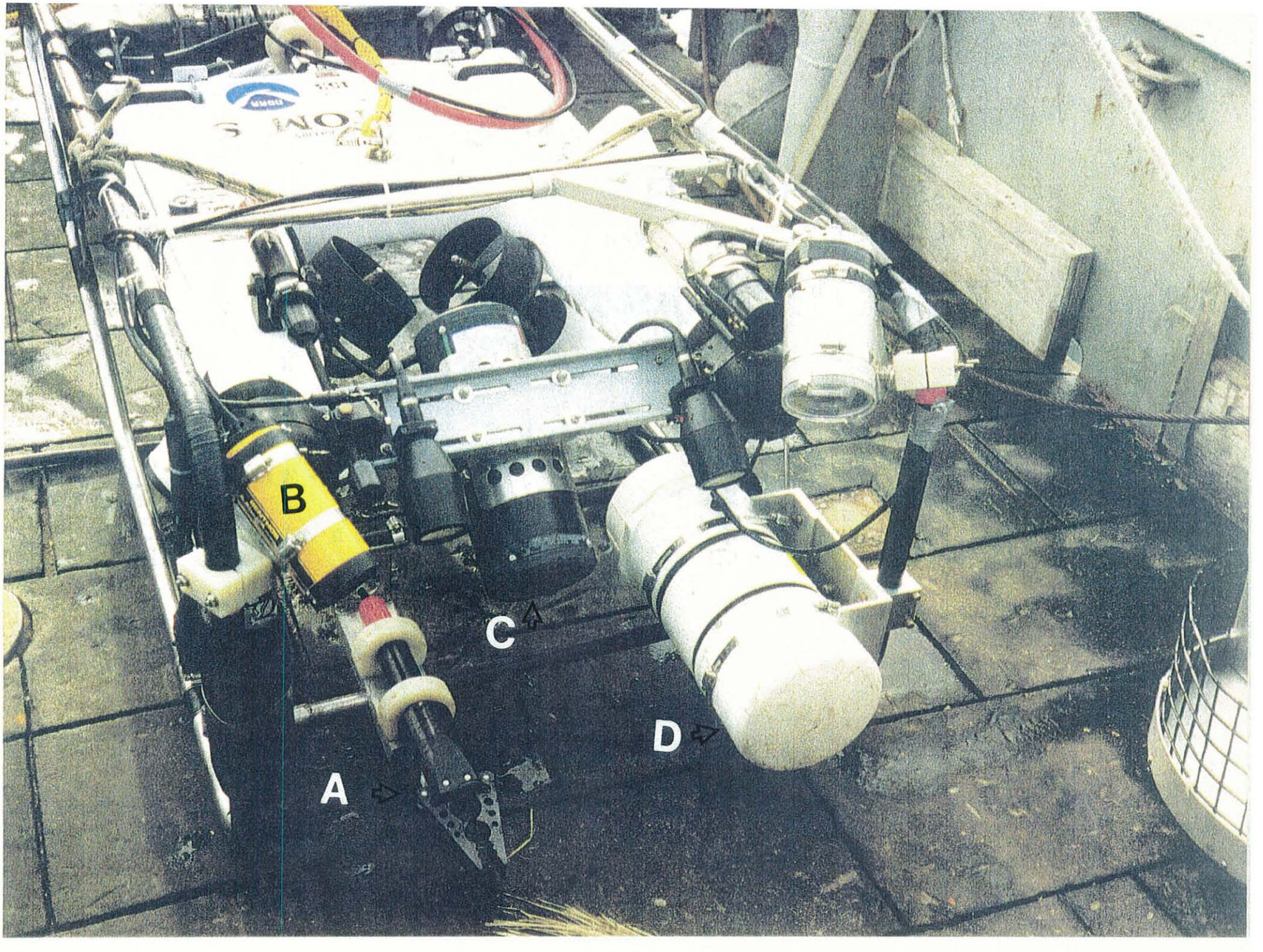
Sediment moisture content: 25 percent
Reciprocal relaxation depth = 0.1 cm^{-1}
Distributed source depth in the sediment = 10.0 cm
Detector to target distance in seawater = 10.0 cm

The Underwater Radiation Spectral Identification System

The Underwater Radiation Spectral Identification System (URSIS) was designed and constructed by DOE's Remote Sensing Laboratory. The basic components of the URSIS are a waterproof, sodium iodide-based spectrometer; a battery operated multichannel pulsed height analyzer; and a portable laptop computer system for data processing. A second sodium iodide detector located onboard the ROV was used for in-situ gross gamma counting (Figure 5.4).

A background gamma radiation spectrum was collected from each of the sampling locations. The background spectrum was to be acquired at the same distance above the seabed as was the suspect object, but at a remote distance of one to two meters. A typical background gamma ray spectrum acquired at the IWS is shown in Figure 5.5.

Facing Page: Figure 5.4. The NOAA NURC Phantom S 2 ROV showing: (A) the manipulator arm, (B) 35-mm and (C) video cameras, and (D) radiation detector.


B
C
D
A

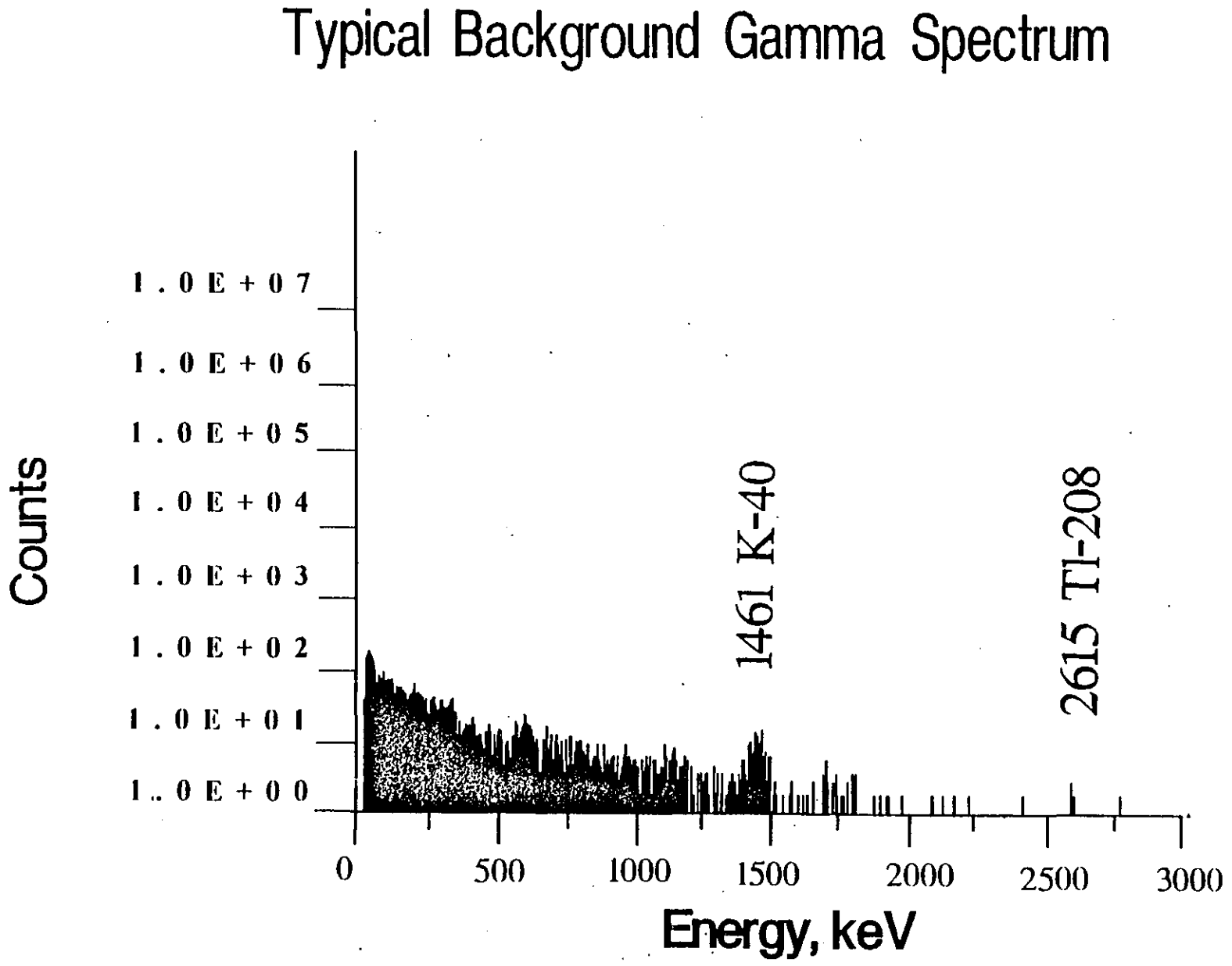


Figure 5.5. A typical background gamma spectrum from the Massachusetts Bay IWS, May/June 1992.

The spectrometer was manually positioned by use of the *JSL-II* extendible manipulator. The operator positioned the spectrometer at the location where the observed gamma gross-count rate was at its maximum. The operator was instructed to hold the spectrometer close to the suspect object at a distance ranging from 5 to 15 cm and at the same distance above the seabed.

Sodium Iodide [NaI (Tl)] Spectrometer

A schematic illustration of the portable sodium iodide-based spectrometer is shown in Figure 5.6. The portable spectrometer is designed to be operated in a horizontal configuration, where the operator can maneuver the spectrometer into position by grasping the stainless steel T-bar handle attached around the body of the spectrometer housing. The waterproof housing is constructed from 1.6-cm thick PVC plastic tubing that has an outside diameter of 13 cm and a length of 87 cm. The dimensions of the spectrometer were sufficient to provide space for the NaI (Tl) detector crystal, the preamplifier electronics package, and an eight 1.5-volt (V) D-cell battery pack. To maintain the system's watertight integrity, O-ring seals were used to seal the front and rear sections of the waterproof housing. The NaI (Tl) detector crystal was 7.6 cm (3 inches [in]) in diameter and 15.24-cm (6-in) long and had a 7.6 percent energy resolution for the 662 keV gamma photopeak of cesium-137 (^{137}Cs).

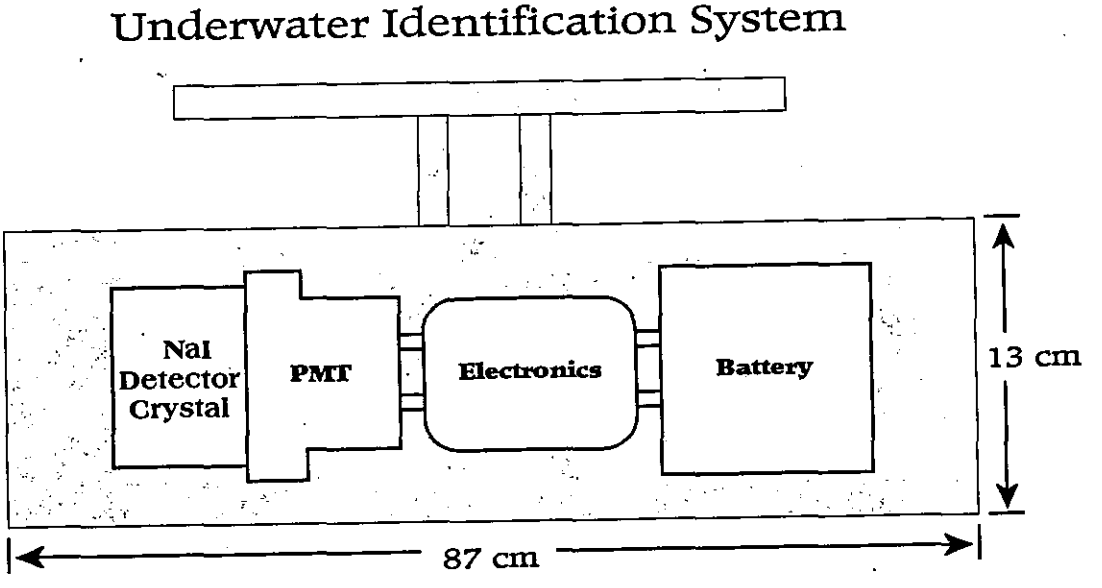


Figure 5.6. Underwater radiation spectral identification system (URSIS) schematic.

Davidson Multichannel Analyzer

The output signal from the spectrometer is fed via coaxial cable to a 512-channel Davidson portable multichannel analyzer (MCA), which was located within the aft observation chamber of the *JSL-II*. The MCA is able to acquire, display, and perform preliminary spectra analysis on the acquired gamma spectral data. The acquired spectral data is then stored onto mini data cassettes for later retrieval. The spectra can also be transmitted digitally through a EIA RS-232C serial port for real-time data processing.

Preamplifier Electronic Package

The preamplifier signal from the spectrometer was calibrated using a ^{137}Cs and cobalt-60 (^{60}Co) radioactive check source. The preamplifier electronics were adjusted until the photopeak energies of the check sources appeared in pre-selected channels on the MCA.

Grid Laptop Computer

Post-processing of the gamma spectral data was conducted on a portable computer system. This computer system included a dot matrix Epson printer and a Grid Laptop Model 1550SX portable computer equipped with a 386SX processor, 2 megabyte (Mbyte) RAM, 60 Mbyte hard disk, 3.5 inch, high-density floppy disk drive, and a SX/LCD VGA display.

Operational Limitations

The NaI (Tl) detector crystal is extremely fragile and sensitive to rapid changes in its environmental operating temperature. Rapid immersion of the spectrometer from ambient air temperatures to the 1° to 4° C water temperatures observed at the approximate 90-m search depth, would damage the detector crystal. Therefore, to avoid damaging the spectrometer, it was refrigerated every night and placed inside an ice chest when being moved or operated topside.

The spectrometer was operable up to 24 hours on its internal eight 1.5V D-cell battery pack. The portable Davidson MCA was operable up to 6 to 8 hours before its internal 12-V rechargeable Gel-cell battery pack required recharging.

Radiation Spectral Analysis

Gamma ray spectral data acquired by the URSIS were analyzed with the EG&G ORTEC's "MAESTRO FOR WINDOWS" computer program. The results produced by MAESTRO were in the form of photopeak net area count rates. By applying a predetermined set of conversion factors to the net area count rates, the sediment concentration levels or activity for the most prominent radionuclides present could be derived.

Point Source Activity (nCi)

In general terms, the relationship between the point-source strength (activity) and the observed photopeak net counting rate can be written:

$$S_o = [\ (<CR> * 4\pi R^2\ ) / (eA * f * 37\ )\ ] * \exp\ (\mu_w * \rho_w * r_w) \qquad (1)$$

where

S_o = Radioactive material strength or activity (nanocurie)[nCi]

<CR> = Photopeak net area count rate (counts/sec)

R = Detector-to-Target distance (cm)

eA = Detector effective area (cm^2), energy dependent

f^* = Radionuclide photopeak relative abundance (fraction of total number of decayed events)

37 dps = 1.0 nCi.

μ_w, ρ_w = seawater mass attenuation (cm^2/g) and density (g/cm^3)

r_w = Distance in sea water between spectrometer and target (cm)

[*Note: the original DOE report used the term "beta" for relative intensity; to avoid confusion, in this report "beta" was changed to *f* and relative intensity to relative abundance.]

The manmade radionuclides that were anticipated were americium-241 (^{241}Am), ^{137}Cs, and ^{60}Co. The photopeak energies (keV) investigated and their relative abundances (*f*) are listed in Table 5.1.

The distance (R) between the detector and the target can be written as:

$$R = r_{barrel} + r_w \quad (2)$$

where

r_{barrel} = Distance between the radioactive material and the outer rim of the barrel situated along the direction that the spectrometer is pointing (cm).

r_w = Distance in seawater between the spectrometer and the outer rim of the barrel (cm).

The distance r_{barrel} is an unknown. Unless the barrel has sufficiently deteriorated allowing access to the interior, this distance can be as small as the thickness of the barrel's outer shell or the full length of the barrel. For this report and the reported MDA values cited in Table 5.1, r_{barrel} is assumed to be zero.

Also, depending upon the type of interior packing material used (e.g., wood, concrete), the true count-rate signal would be significantly greater than the observed count rate thereby causing an underestimated value for the source's activity or sediment concentration being reported.

The distance r_w was assumed to be 10 cm. If the container's outer shell had deteriorated, the amount of seawater between the spectrometer and the source may have been greater than that assumed for this analysis.

The detector effective area (eA) represents the experimentally determined detector efficiency and response characteristics. Figure 5.7 shows the eA for the NaI (Tl) spectrometer versus energy that was acquired in air at a distance of 100 cm. For the 60, 662, and 1332 keV energy photopeaks, the eA are 2.72, 22.16 and 11.80 cm^2, respectively.

The attenuation of the gamma ray passing through 10 cm of seawater and 10 cm of concrete is significant and cannot be ignored. Table 5.2 shows the type of materials, operational parameters, and percentage of attenuation anticipated during the survey. However, since no concrete encased barrels were discovered the attenuation effects due to concrete were not included in the analysis. Figure 5.8 shows the NaI (Tl) spectrometer's efficiency (gamma count rate/source strength) in seawater for several detector-to-target distances ranging from 5 to 25 cm.

Table 5.2. Mass attenuation and density coefficients.

	Peak Energy (keV)	Mass Attenuation (cm^2/g)	Material Density (g/cm^3)	Material Thickness (cm)	Percent Attenuated
Seawater	60	0.2060	1.02813	10.0	88.0
	662	0.0862	1.02813	10.0	58.8
	1332	0.0619	1.02813	10.0	47.1
Concrete	60	0.2950	2.40	10.0	99.9
	662	0.0779	2.40	10.0	84.6
	1332	0.0530	2.40	10.0	72.0

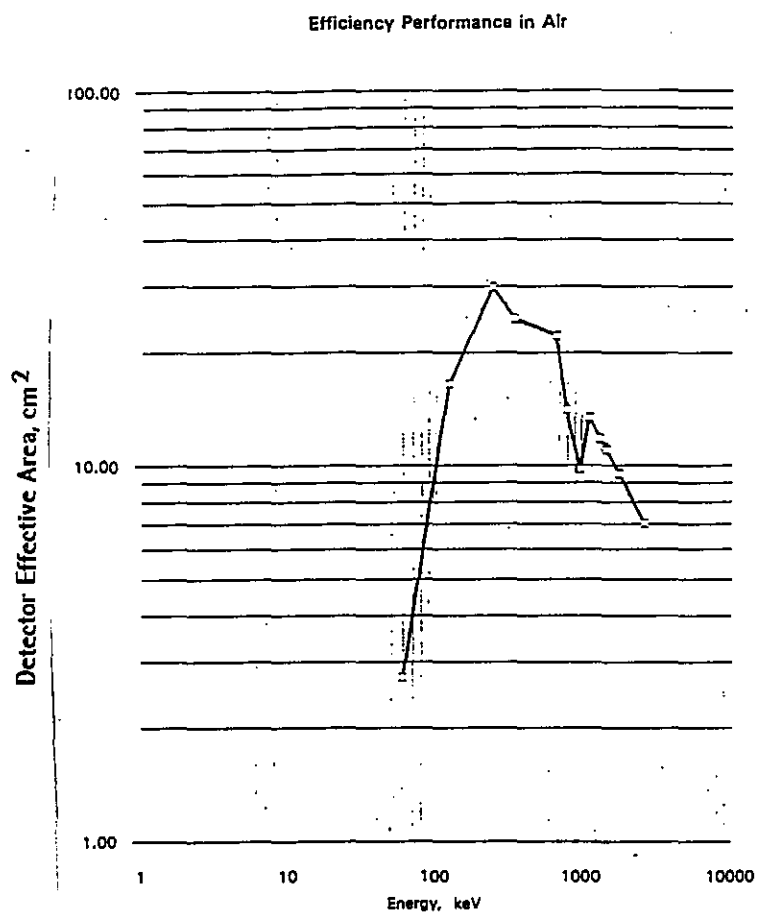


Figure 5.7. NaI(Tl) spectrometer effective area versus energy response in air.

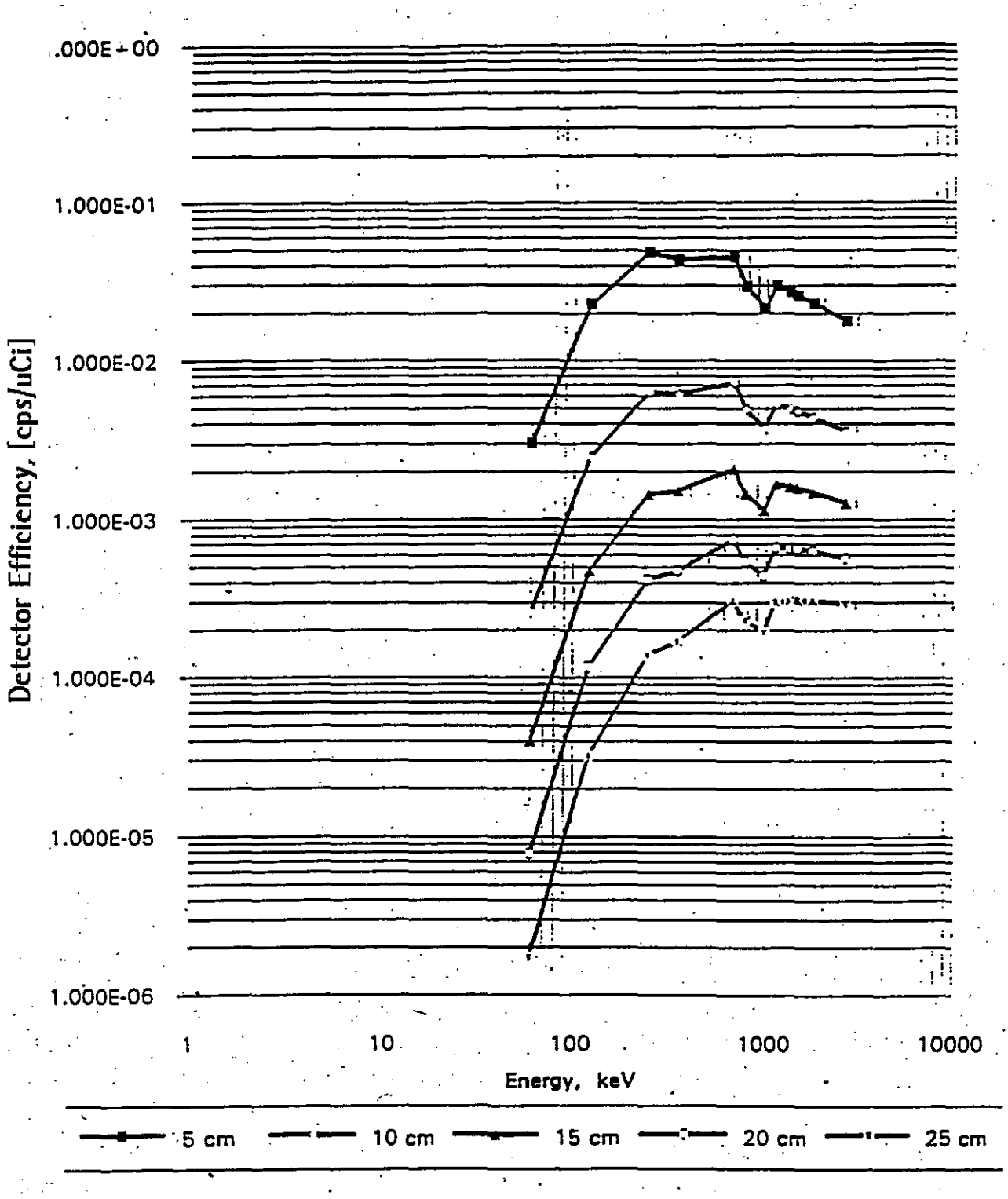


Figure 5.8. NaI(Tl) spectrometer efficiency performance in seawater for several "detector-to-target" distances.

Due to the attenuation of the gamma signal by the seawater, the nominal system dead-time rates were very low and their effects on the observed photopeak count rates were significantly less than one percent and can be ignored. The system dead time is the amount or percentage of time that the system is "occupied" and cannot process any new counts. The fraction of time during which the spectrometer system was insensitive to receiving new counts in this study was essentially zero percent.

Distributed Sediment Concentration ($\mu Ci/m^2$ or pCi/g)

Similarly, concentration levels for the prominent gamma emitting radionuclides in the sediment can be derived by applying a predetermined conversion factor to the observed photopeak count rates. The predetermined conversion factors were derived from a radiation transport model using the assumptions cited on page 5-8 pertaining to the sediment depth distribution.

It is further assumed that the leakage near the deteriorating containers would probably be uniformly distributed over the seabed surface. Hence, the sediment concentrations for those radionuclides are reported in units of $\mu Ci/m^2$. Conversely, the naturally occurring radionuclides, such as potassium-40 (^{40}K) and thallium-208 (^{208}Tl), were assumed to be exponentially distributed within the sediment. Hence, their sediment concentrations are reported in units of picocuries per gram (pCi/g).

> [Note: The in-situ radiation detectors are prototype instruments developed specifically for this survey and applied for the first time in a marine environment. To comply with NOAA NURC safety provisions, all pressure housings for ROV and *JSL-II* mounted radiometer units were hydrostatically tested to 15 times the IWS operating depth. No pressure or wiring interface problems were encountered in the ROV or *JSL-II* dives conducted at the 70- to 90-m water depths. Chilled ice baths were used to assure temperature stability for the URSIS unit before all *JSL-II* deployments.]

The derivations of the conversion factors for the minimum detectable activities and the sediment concentrations were derived from models using point-source measurements. The radioactive point sources used to derive these conversion factors are traceable to the National Institute of Standards and Technology (NIST).

The expression to represent the flux of rays above a smooth water-ground interface caused by an emitter distributed in the sediment can be written as:

$$\langle CR \rangle = \int_0^\infty \int_0^\infty S_V * eA/4\pi R^2 \, e^{-\alpha z} \, e^{-\mu w \rho w r w} \, e^{-\mu s \rho s r s} \, 2\pi d * dz \qquad (3)$$

where

<CR>=		Photopeak net area count rate (counts/second)
S_v	=	Activity per unit volume at the surface $\left[(\text{gamma}/\text{sec})/\text{cm}^3\right]$
eA	=	Detector eA (cm^2), energy dependent
R	=	$r_w + r_s$; Detector to source distance in seawater and the sediment combined (cm)
α	=	Reciprocal of the relaxation depth (cm^{-1}), energy dependent
z	=	Source distribution depth (cm)
μ_w, μ_s	=	Seawater and sediment mass attenuation coefficients (cm^2/g)
ρ_w, ρ_s	=	Seawater and sediment density (g/cm^3)

A more detailed explanation concerning the theory of deriving the sediment concentration conversion factors from point sources is found in Reiman (1991) and Beck et al. (1972).

Using the point-source measurement results obtained by the URSIS in air at a distance of 100 cm, a set of conversion factors was generated from Equation 3 for several radionuclide photopeaks (Table 5.3).

Table 5.3. NaI (Tl) spectrometer sediment concentration and point-source activity conversion factors.

Isotope	Peak Energy (keV)	Point Source Activity (nCi/cps)	Sediment Concentration	
			$uCi/m^2/cps$	pCi/g/cps
Am-241	60	288.67	71.9	302.9
Cs-137	662	4.39	0.218	0.919
Co-60	1332	2.72	0.113	0.477
K-40	1461	51.27	1.931	8.136
Tl-208	2615	7.56	1.141	4.807

Source distribution model assumptions:

Sediment moisture content: 25 percent
Reciprocal relaxation depth = 0.1 cm^{-1}
Distributed source depth in the sediment = 10.0 cm
Detector-to-source distance in seawater = 10.0 cm

Remotely Operated Vehicle Survey

A ROV survey was conducted to gauge the relative distance between target barrels, estimate general water clarity, identify other objects found (e.g., ordnance), and conduct radiation scans of encountered barrels in preparation for manned-submersible operations.

The ROV survey was conducted from the R/V *Gloria Michelle*. The NURC-UCAP Phantom S2 ROV investigated Target Areas I through VI for visual inspection and sampling. The vessel/ROV location was determined using a DGPS receiver, INS, and "Track Point"™ providing 2- to 5-m accuracy. Using the Wiley et al. (1992) report as a guide for targeting areas with high concentrations of containers, but using a different positioning system than Wiley's, the ROV was expected to successfully explore and verify these areas. The coordinates of each container within a target area were plotted with the INS, coded, and printed for later identification.

ROV deployment and search within a target field required placement on a two-point moor as close to the designated search area as possible. Once secured, a downweight was lowered on a 7.6 mm diameter wire from an oceanographic winch, and the ROV tether and radiometer cable were secured at intervals on lowering to 10 m above bottom. This method prevented caternary action on the ROV tether and provided a firm anchor point for ROV search directly beneath the support vessel. The ROV used 50 m of free tether to search and navigate in all compass directions around the downweight.

The Phantom S2 ROV was modified for wide-angle and close (macro) video recording with parallel mounted 35-mm still photographic capability (Figure 5.4) to provide photographic documentation of barrel condition, contents such as laboratory glassware, degree of barrel disintegration, barrel orientation, and associated fauna. Also, a simultaneous record of environmental parameters (i.e., depth, salinity, temperature, pH, dissolved oxygen) was recorded on video tape.

The ROV was fitted with a DOE-supplied radiation detector as part of a field test of this device for measuring in-situ radiation levels (page 5-8). On approach to each drum and contents, the ROV was maneuvered so the detector was positioned 5- to 15-cm from the object and held in place to measure ambient radiation. A 37-kilohertz (kHz) sonic pinger was carried in the ROV manipulator jaw for immediate deployment if there were

elevated radiation levels. Onboard vessel radiation scanning surveys were routinely performed on the ROV, anchors, and sediments upon retrieval.

After an anchorage had been satisfactorily explored, the R/V *Gloria Michelle* was either repositioned on its two-point moor or a new anchorage was set. The coordinates for each search area are given in Table 5.4.

An explosive ordnance expert from the U.S. Navy observed all dive video records to identify potentially explosive targets. During the entire survey, only one target was tentatively identified by the naval expert as being potentially explosive; a depth charge. The suspected depth charge appeared to have been partially corroded, likely making it inoperable.

After completing the search of a target area, the R/V *Gloria Michelle* deployed a marker buoy by which the R/V *Ferrel* was guided to deploy lobster/fish trap trawls (see page 5-26). This method was employed to best ensure the placement of traps within a verified area of high container concentrations.

ROV Logs of Inspection

The ROV survey data are presented in Table 5.4 for the three-day inspection survey May 27 to 29, 1993. The table includes:

- ROV dive numbers;
- target field as determined from the anchorages logged by the IWC 1991 survey (Field/IWC anchorages);
- cross-referenced fixes between the IWC survey and the Fix/INS (the term fix refers to a target position indexed to an INS code that references an exact latitude and longitude);
- latitude and longitude (lat/long) coordinates for each target within the specific target area or target field;
- video index number (video count) for each target;
- description of each target;
- relative condition of each target (Intact/Puncture) indicating whether it appeared without corrosion holes or it appeared punctured as has been described as one method for disposal;
- visual description of the contents, if possible;

- radiation counts per second;
- 35-mm photos taken; and
- notes on associated fauna (i.e. observations).

Appendix C includes Sea Trac™ plots of each ROV dive (Plot No. 2, 3, 4, 5, and 6). The plots include examples of ROV search paths (dotted location fixes logged every 15 seconds) and all target locations at each site on a 10-m expanded scale. Targets are identified numerically (i.e., 1 through 26) and can be referenced against ROV logs of inspection (Table 5.4). Plot No. 1 depicts the overall survey, including:

- Target Fields I, II, III, IV and VI and corresponding IWC 1991 Anchorages P, O, C, Q, and L.
- The cluster of ROV and *JSL-II* tracks at each dive site.
- The fixed gear trap locations within the high-density target fields.
- Spatial proximity of all dive site locations (within 0.5 nm diameter).

Table 5.4. Massachusetts Bay IWS ROV Log, NURC-UCAP, May 1992.

Date	Dive Number	Field/ IWC	Fix Number IWC	Latitude	Longitude	Video Count	Description	Condition
5/27/92	2	I/P	1-194	42.26 43.99	70.35 27.71	2-0914 or 1-3199	drum	half buried
			2-192	42.26 44.25	70.35 27.68	2-1212 or 2-4085	drum	open, with glassware
5/28/92	3	II/C	3-190	42.26 32.31	70.35 33.31	914 or 1367	drum	encrusted, intact, with corrosion holes
			4-188	42.26 32.54	70.35 34.44	1773 or 2280	drum	broken open
			5-186	42.26 33.45	70.35 34.59	2860 or 3530	drum rim	completely disintegrated
	4	III/0	6-182	42.26 28.50	70.35 16.90	3-0571	drum	disintegrated
			180	42.26 28.48	70.35 16.72		dropped pinger	
			7-178	42.26 28.83	70.35 15.37	3-1580	2 drums	hole in one
			8-176	42.26 28.68	70.35 16.53	3-2917	drum	punctured end
			9-174	42.26 28.78	70.35 16.25	3-31141	drum	disintegrated
			10-172	42.26 29.19	70.35 16.21	3-3530	piling or beam	
			11-170	42.26 29.28	70.35 16.56	3-3715	drum	disintegrated, half exposed
			12-168	42.25 29.37	70.35 16.82	3-3840	drum	intact/atop sediment
			13-166	42.26 28.21	70.35 18.48	3-4386	drum	collapsed fragments
5/29/92	5	IV/L	14-149	42.26 35.08	70.34 45.15	4-0930	drum	solid/hole in top, half buried
			15-147 & 145	42.26 34.31	70.34 45.15	4-1745	drum	disintegrated, half gone
			16-143	42.26 35.26	70.34 45.78	4-2660	drum	disintegrated fragment
			17-141	42.25 36.31	70.34 45.41	4-2921	drum contents	disintegrated
			18-139	42.26 37.74	70.34 44.93	4-3168	drum	disintegrated, white plastic
			19-137	42.26 35.62	70.34 46.39	4-3717	drum	disintegrated, top with hole
			19-135	42.26 39.90	70.34 47.43		hot anchor	
	6	VI	20-132	42.26 54.28	70.35 15.12	5-1280	metal, rusted rim	only fragment
	7	I/O	21-122	42.26 42.03	70.35 24.85	6-1748 or 0305	drum	collapsed on contact
			22-120	42.26 42.11	70.35 25.21	6-1028	drum	disintegrated, top half gone
			23-118	42.26 42.28	70.35 25.81	6-1186	drum	intact, puncture
			24-116	42.26 42.39	70.35 25.85	6-1246	drum	3/4 disintegrated fragment
			25-114	42.26 42.97	70.35 25.54	6-1366	drum	intact, punctured
			26-112	42.26 43.90	70.35 25.40	Jun-56	drum	intact, possible ordnance, smaller

Table 5.4 (continued)

Intact/ Punctured	Contents	Radiometer counts/second	Photos role(frames)	Observations
N/corroded		25	2 (6-9)	animals, mud/silt bottom, sponges, brachiopods, *Myxicola*
N/Y		25	2 (12-17)	anemones, seastars
Y/N	not visible	25	2(6-9)	
	glassware, lobster	23-81 (24)	2 (13-19)	2 redfish, excavation at base, 2 lobsters, hydroids, white sulfur bacteria
	not determined	25	2 (22	
	not determined	25	3 (4-5)	seastar, hydroid
Y/Y		27	3 (7-11)	2 redfish
Y/Y	not determined	22 (25)	3 (12-15)	lobster
N/-	not determined	25	3 (16-18)	shrimp, brachiopod, hydroids
		25	3 (19-29)	redfish, hydroids
N/-	not determined	25	3 (21)	hydroids
Y/-				little fouling
N/-	not determined	25	3 (24)	seastar
Y/-	not determined	25	4 (6-7)	hydroids, tunicate, brachiopod
N/-	not determined	25 (23)	4 (12)	plastic debris nearby, lobster burrow, *Myxicola*
N/-	not determined	25 (06)	4(17)	lobster
N/-	not determined	25	4(18)	
N/-	not determined	25 (22)	4 (19)	
YH/Y	not determined	25	4(21,22,23,28)	2 redfish, hydroid, brachiopod
N/-				shrimp
N/-		25		"harry's dream"—no fouling
N/-	not determined	25		brachiopods
Y/Y				brachiopods
N/-	not determined			
N/Y	not determined	25		*bolocera* and *corianthu* attached, mud anemone
Y/N	not determined	25		redfish, seastar

Biota Sampling

Biological specimens were collected primarily to enable the FDA to evaluate the risk to human health posed by the consumption of seafood harvested near the IWS. Secondarily, specimen analysis (by NOAA) would help ecologists and toxicologists make preliminary estimates of the relative degree of the ecological risk from any chemical and radioactive substances identified at the IWS. MDPH also collected a small number of fin fish and lobster samples for radiological analysis. In addition, the MDPH collected lobsters to assess biotoxin levels in the vicinity at the time of the overall survey.

Reference Site 2

The R/V *Ferrel* deployed lobster and fish traps to collect biological samples at Reference Site 2. Station location was determined with Loran C. Two trawls were deployed for approximately 45 hours each, beginning on May 26, and a single trawl fished for approximately 49 hours, beginning on May 31 (Table 5.5). As a result of a navigational error, the placement of the trawls on May 31 deviated several miles from Reference Site 2; coordinates are presented in Table 5.5. The water depth of the May 31 sampling was approximately one half that at Reference Site 2.

The IWS

Following verification with the ROV that there were high concentrations of containers within the target areas, a field decision was made to focus all further survey work on Target Areas I, II, III, and IV as originally intended by the survey team; thereby deleting Target Areas V and VI from further survey considerations. The decision to delete Target Areas V and VI was based on survey time constraints.

The R/V *Ferrel* deployed lobster and fish traps to collect biological samples in each of the four target areas. Target area positions were ascertained visually using previously deployed "high flyer" buoys with radar reflectors following target area verification with the ROV (page 5-21). Headings for deployment were determined by compass bearing; start and end positions were determined with DGPS. Trawls were laid in parallel. Figure 5.2 shows an example of a deployment pattern. Generally, two trawls, consisting of five lobster traps (wooden and metal) and an experimental fish trap were deployed in each target field for approximately 48-hour sets. Actual times and number of trawls differed for various reasons including weather and an interest in gathering specimens from

select areas. Alewives were used as bait. Two eel traps were placed randomly on various trawls during selected sampling periods. The eel and fish traps were attached for experimental reasons to test their potential efficiency to capture biological specimens at that location. Eel and fish traps were new and not presoaked; lobster traps were previously used, but were not presoaked before the start of the survey.

A total of 19 trawl sets were deployed in the IWS between May 26 and June 2 for from 24 to 48 hours each. A summary of the information regarding trawl deployment is provided in Table 5.5. The schedule for trap deployment is given in Table 5.6. Trawl locations within the IWS in comparison to the overall survey are depicted in Appendix C on Plot No. 1. The trawls within the target fields are identified, for example as Ia-b, IIa-b, etc., to denote the position of the "high flyer" buoys (i.e., A and B) marking either end of the trawl line.

The IWS Perimeter

Otter trawl samples were collected with the R/V *Gloria Michelle* at eight sites around the perimeter of the combined IWS and the MBDS (Figure 5.2) on May 31 and June 2, 1992. Commercial species targeted for sampling included American plaice (*Hippoglossoides plattesoides*), other bottom fish, American lobster (*Homarus americanus*), and other edible shellfish (e.g., sea scallop, *Placopecten magellanicus*).

Each site was sonar surveyed before trawling for bottom hardness and hazards (e.g., rocks). When acceptable, the net trawl was deployed and dragged for approximately 20 minutes. Position coordinates and water depth were recorded for each tow (Table 5.7). Despite precautions, numerous net hauls contained fragments of corroded barrels and other debris.

Table 5.5. Massachusetts Bay Survey 1992 with NOAA R/V *Ferrel*, May 26, 1992, through June 2, 1992.

Target Area	Trap Array	Deployment Date	1st Trap Latitude Longitude	Last Trap Latitude Longitude	Depth [1] (meters)	Recovery Date	1st Trap Latitude Longitude	Last Trap Latitude Longitude	Depth [1] (meters)
Ref Site 2	1	26 May	42°22.77'N 070°30.29'W		88		Information	not	logged
	2		42°22.69'N 070°29.81'W	42°22.79'N 070°29.47'W	78		Information	not	logged
Ref Site 1	A	27 May	42°26.68'N 070°35.61'W	42°26.68'N 07035.47'W	78*	29 May	42°26.65'N 070°35.61'W	42°26.62'N 070°35.60'W	85
	B		42°26.71'N 070°35.44'W	42°26.72'N 07°35.38'W	91*		42°26.68'N 070°35.49'W	42°26.68'N 070°35.93'W	72
II	A	28 May	42°26.55'N 070°35.28'W	42°26.47'N 070°35.52'W	90*	30 May	42°26.55'N 070°35.52'W	42°26.56'N 070°35.53'W	85
	B		42°26.71'N 070°35.71'W	42°26.45'N 070°35.66'W	82*		42°26.49'N 070°35.69W	42°26.53'N 170°35.68'W	84*
III	A	28 May	42°26.45'N 070°35.28'W	42°26.39'NM 070°35.27'W	86	30 May	42°26.47'N 070°35.24'W	42°26.38'N 070°35.22'W	87
	B		42°26.47'N 070°35.23'W	42°26.42'N 070°35.20'W	87		42°26.49'N 070°35.18'W	42°26.50'N 070°35.16'W	88
Ref Site 2	A	28 May	42°26,55'N 072°35.58'W	42°26.47'N 070°35.52'W	90*		Smith, McIntyre	grab samples	
	B		42°26.51'N 070°35.71'W	42°26.45'N 070°35.66'W	82*		Smith, McIntyre	grab samples	
I	A	29 May	42°26.68'N 070°35.40'W	42°26.62'N 070°35.30'W	90	30 May	42°26.67'N 070°35.36'W	42°26.70'N 070°35.36'W	86*
	B		42°26.75'N 070°35.40'W	42°26.64'N 070°35.36'W	85		42°26.69'N 070°35.43'W	42°26.68'N 070°35.38'W	80*
IV	4A	29 May	42°26.69'N' 070°34.77'W	42°26.61'N 070°34.79'W	85	2 June	42°26.71'N 070°34.71'W	42°26.72'N 070°34.63'W	86*
	4B		42°26.68'N 070°35.40'W	42°26.62'N 070°34.67'W	84		42°26.69'N 070°34.57'W	42°26.66'N 070°34.53'W	85

Table 5.5 (continued)

Target Area	Trap Array	Deployment Date	1st Trap Latitude Longitude	Last Trap Latitude Longitude	Depth [1] (meters)	Recovery Date	1st Trap Latitude Longitude	Last Trap Latitude Longitude	Depth [1] (meters)
III	1A	30 May	42°26.49'N 070°35.15'W	42°25.43'N 070°35.11'W	87	31 May	42°26.57'N 070°35.11'W	42°26.57'N 070°35.09'W	87
	1B		42°26.53'N 070°35.05'W	42°26.43'N 070°35.01'W	86*		42°26.56'N 070°34.96'W	42°26.60'N 070°34.95'W	86*
	3A	30 May	42°26.52'N 070°35.21'W	42°26.45'N 070°35.20'W	87*	31 May	42°26.57'N 070°35.16'W	42°26.60'N 070°35.15'W	87
	3B		42°26.53'N 070°35.23'W	42°26.45'N 070°35.19'W	87*		42°26.62'N 070°35.10'W	42°26.67'N 070°35.02W	89
IV	2A	30 May	42°26.72N 070°34.80'W	442°26.68'N 070°34.85'W	84*	2 June	42°26.70'N 070°35.13'W	42°26.60'N 070°35.08'W	88*
Ref Site 2		31 May	42°22.71'N 070°29.24'W	42°22.67'N 070°29.19'W	87*	2 June	42°22.63'N 070°29.25'W	42°22.61'N 070°29.31'W	46*

[1] An asterik (*) denotes the average depth of the first and last traps. In all other cases, the number reported is actual recorded depth.

Table 5.6. The schedule of 1992 lobster operations conducted by NOAA R/V *Ferrel* in Target Areas 1 through IV within the IWS from May 27 through June 2, 1992.

Target Area	Strings Deployed	Deployment Date	Recovery Date	Lobsters Caught	String/Trap Number
I	2	27 May	29 May	2	1A -4
II	2	28 May	30 May	1	1B - 5
III	2	28 May	30 May	2	3A - 3 3A - 4
	4	30 May	31 May	3	1A - 3 1B - 3 1B - 1
IV	2	29 May	2 June	0	------
	1	30 May	2 June	3	2A - 2 2A - 5 4A - 3

During net retrieval, the trawl gear was monitored for radioactive contamination. Immediately after the net's contents were released on deck, a radiation specialist surveyed the catch using a thin-window Geiger-Mueller (GM) instrument. The catch was then sorted by species. After the catch was sorted, it was weighed using a spring scale, and the total weight in pounds (subsequently converted into kilograms [kg]) of each species was recorded. All commercial species in the catch were then sampled. The total length of each fish, and carapace length to the nearest mm for lobster were recorded by onboard personnel.

Selected specimens in excess of those necessary to satisfy the analytical needs of the FDA and MDPH were retained by EPA and NOAA for body-burden residue analysis to estimate potential ecological risk. Any fish left after agency selection were discarded overboard.

Table 5.7. Trawl sites 1 through 5 sampled on May 31, 1992 and trawl sites 6 through 8 sampled on June 2, 1992 by R/V *Gloria Michelle* .

Trawl site	Date	Course	Time	Time Diff	Time Diff	Latitude	Longitude	Depth (meters)	Wire (fathoms)	Conditions
1 Start	31 May	005°T	0903	13863.1	44271.5	42°25.29'N	70°36.34"W	86	150	sunny 1-ft waves
End			0923	13858.1	44276.2	42°26.15'N	70°36.25'W	85		
2 Start		320°T	1020	13859.1	44265.2	42°24.57'N	70°35.13'W	88	150	sunny 1-ft waves
End			1040	13861.9	44269.4	42°25.06'W	70°35.97'W	88		
3 Start		275°T	1142	13850.9	44263.8	42°24.71'N	70°33.94W	93	150	overcast/ moderate 1-2 ft waves Sea-S
End			1202	13857.2	44265.9	42°24.75'N	70°35.97'W	90		
4 Start		230°T	1258	13839.7	44463.8	42°25.18'N	70°32.53'W	90	150	overcast/ moderate 2-ft waves Sea-SSW
End			1318	13847.0	44262.7	42°24.71N	70°33.32'W	93		
5 Start		180°T	1432	13832.4	44271.1	42°26.51'N	70°32.46'W	49	75-90	overcast/ moderate
End			1452	13837.0	44266.9	40°25.74'N	70°32.56'N	57		
6 Start		050°T	0742	13856.9	44275.5	42°26.12'N	70°36.03'W	86	140	sunny 1-2-ft waves
End			0802	13849.8	44227.1	42°26.63'N	70°35.33'W	90		
6a Start	2 June		0844	13837.4	44273.9	42°26.71'N	70°33.41'W	50	net hung	sunny
7 Start		320°T	0931	13833.6	44266.5	42°25.71'N	70°32.19'W	50	75	sunny/1-2-ft waves/hard flat bottom
End			0951	*25711.1	44271.2	42°26.36'N	70°32.80'W	51		
8 Start		270°T	1124	13837.8	44274.5	42°26.77'N	70°33.53'N	51	75	sunny 1-2-ft waves hard bottom Sea NE
End			1150	13847.1	44277.1	42°26.76'N	70°34.99'N	91	25, 25 15, 140	

Trawling speed for all trawls was 2.5 knots.
* This cycle failed, therefore went to different Loran Chain.
^ More wire let out because there was a change in water depth.

All species sampled by FDA and MDPH were isolated in styrofoam coolers lined with aluminum foil and layered with ice. Individuals of each species sampled by EPA and NOAA were wrapped in aluminum foil and placed in plastic coolers and layered with ice. Upon arrival at port on the evening of May 31, 1992, the sample coolers were transported to the NMFS's Gloucester Laboratory and stored in a walk-in freezer. On the morning of June 1, two Boston District Investigators retrieved the FDA coolers and delivered them to Winchester Engineering and Analytical Center (WEAC) where FDA personnel prepared and composited samples for shipment to respective analytical laboratories. Samples collected on June 2, 1992, during tows six through eight were delivered directly to WEAC for compositing and shipment. EPA/NOAA samples remained at the NMFS facility. On June 11, NOAA personnel selected specimens for chemical analysis. In July, all remaining specimens were retrieved from the Gloucester facility and transported for storage to the EPA ERL-N. MDPH biotoxin samples collected on May 31 and June 2 were delivered directly to the MDPH laboratory on the day of collection.

Submersible Survey

The *JSL-II* four-person dive system provided a platform for in-situ inspection and sampling close to suspected hazardous waste barrels. This approach was considered the most direct manner for collecting sediment sample cores immediately adjacent to waste barrels to obtain the highest probable contaminant load. This approach also provided the most direct manner in which to describe in-situ ecological conditions. Three dives per day were planned (May 31 through June 2).

Dive objectives included sector-scan sonar location of barrels, video/still documentation of condition/contents/associated marine life, manipulator deployment of an URSIS specifically designed for this survey, and sediment sampling using manipulator controlled coring devices.

The following dive procedures were employed as precautionary measures:

1. The position of the first dive was in an area of low-target density to reduce potential hazard encounters while checks by the crew were made for visibility, general bottom and ocean-current conditions, and operating procedures for the sonar/camera search.

2. When the sector-scan sonar detected a target, the *JSL-II* approached it using sonar continuously. Visual and video assessments were made during approach. When maneuvering next to a barrel and the sampling protocol was appropriate for the target, the radiation detector was placed by manipulator arm in proximity to the target for a specified time. In the event that radiation counts exceeded levels of concern, the *JSL-II* crew was to mark the position with a 37 kilohertz (kHz) sonic pinger for possible future observations. No identified radioactive media were to be sampled during this phase of the operation. If no anomalous radioactive signal was encountered, two punch-core and one box-core samples were taken less than 1 m from the target. Simultaneous video recording would document sample collection and overt target characteristics. The *JSL-II* pilot verified that an accurate fix position was logged aboard the R/V *Seward Johnson* before leaving the target.

   Special precautions were employed when handling the potentially toxic/ radioactive sediments brought aboard the R/V *Seaward Johnson* by the *JSL-II*.

3. Attempts were to be made to visit up to four targets per dive and undertake the above sampling.

4. If a positive radiation signal was taken during the dive, after surfacing, the *JSL-II* would be dragged for one minute behind the R/V *Seward Johnson* to attempt to wash off any contaminated material.

5. While suspended from the A-frame, the *JSL-II* was screened for any radioactive signals. If radiation was detected, the *JSL-II* was to be re-immersed and dragged for another minute and re-screened. A comprehensive screening of the *JSL-II* was routinely done after it was on deck.

6. The radiation detector was immediately removed from the *JSL-II* and placed on ice. Punch- and box-core samplers were removed and placed in containers to wait onboard processing or shipment to appropriate laboratories.

7. All personnel on deck or participating in *JSL-II* or ROV dives wore radiation dosimeter badges.

JSL-II Logs of Inspections and Samples

The *JSL-II* dive log is summarized in Table 5.8 and includes:

- The date of the dive.
- The sequential dive number (*JSL =II* Dive #).
- The target field and corresponding IWS anchorage point.
- The position fix number on the Fix/INS.
- The time of the fix.
- The latitude and longitude coordinates at the time of the position fix.
- The onboard forward scientist and pilot.
- The onboard aft radiation specialist (Observer) and emergency pilot (Crew).
- The total bottom time (TBT).
- The sampling depth.
- The type, number and number of samples collected.
- The EPA box- and punch-core index (referencing organic/inorganic sediment chemistry, i.e., Appendix Tables D-1 through D-5).
- The video index number for each target.
- The bottom type near each target.
- A sequential target number and a description of the target encountered.
- A brief description of observed associated fauna.

While three dives per day were planned, only two dives were possible, for a total of six dives. Weather, mechanical problems, and general "shakedown" problems accounted for the difficulties in attaining the three-dives-per-day objective. Consensus was reached among the participating scientists to conduct the sixth dive near the former Boston Lightship disposal site because earlier side-scan records indicated possible targets of interest and this site had been considered a high-interest area to the public. Also, up to that point, no verifiable radioactive waste containers had been observed by the *JSL-II* or ROV in the IWS.

Table 5.8. Industrial waste site, JSL-II Log, NURC-UCAP, May 1992.

Date	JSL-II Dive Number	Field/IWC	Fix Number/ INS	Time	Latitude	Longitude	Scientist/Pilot Observer/Crew	TBT (hours/minutes)	Depth (meters)	Samples
5/31/92	2343 (1)	II/C	1-193	113140	42.26 32.59	70.35 38.72	L. Stewart/T. Askew	2:34	88	punch core #1, box core #1, punch core #2
			2-189	122100	42.26 34.51	70.35 36.98	J. Cherniak/D. Norquist		88	box core #2, punch cores # 3 and 4
			3-187	130000	42.26 35.56	70.35 57.95			88	box core #3, punch cores #5 and 6
			4-185	132700					88	no samples taken
	2344 (2)	III/Q	5-178	174142	42.25 31.10	70.25 18.53	I. Babb/T. Askew		88	samples taken @ drum - 1 punch
			6-187	185402	42.26 31.93	70.35 16.34	N. Worobey/D. Norquist	2:34	84	punch core - 2
			7-174	185402	42.26 29.46	70.35 18.78			88	lost box core - punch core 3
			8-172	191000	42.26 30.40	70.35 19.76			88	punch cores 4, 5, 6, 7,
6/1/92	2345 (3)	I/P	9-198	092000	42.26 40.36	70.35 32.31	L. Stewart/M. Adams J. Cherniak/D. Norquist	3:39	79	no samples taken
			10-195	094504	42.26 41.43	70.35 32.67			75	box core #1, punch cores 1 and 2
			11-189	104804	42.26 46.02	70.35 27.30			85	box core #2, punch core and reagent bottle
			12-185	111924	42.26 46.41	70.35 25.44			88	box core #2, punch cores 5 and 6
6/2/92	2346 (4)	IV/L	13-176	091242	42.26 36.69	70.34 46.14	J. Lindsay/M. Adams	2:16	73	box core #1, punch core
			14-160	094922	42.26 35.85	70.34 46.68	J. Cherniak/D. Norquist		78	box core #2, punch cores 3 and 4
				101302	42.26 35.99	70.34 47.66			78	radiometer only
			15-154	102522	42.26 35.99	70.34 47.66			78	box core #3, punch cores 5 and 6
			16-152	104442	42.26 35.85	70.34 47.62			78	radiometer only
6/2/92	2347 (5)	IV/L	17-147	133828	42.26 40.19	70.34 50.40	L. Stewart/M. Adams	1:34		box core #1, punch cores 1 and 2
			18-143	142208	42.26 41.51	70.34 49.79	J. Cherniak/D. Norquist			lobster trap
		anchor	19-141		42.26 41.60	70.34 49.04			78	fragment
	2348 (6)	L. Ship	20-134	175100	42.22 .427	70.41.801	D. Keith/M. Adams J. Cherniak/D. Norquist	1:11	55	1 target metal fragment, 1 punch core
										Total: 10 box cores: 28 punch cores

Table 5.8 (continued)

EPA Core Index	Tape Number	Bottom Type	Target #/Barrel Description	Observations
BC1, PC1, PC2	JSL-92-01001	soft, mud	#1—intact, lids off, solid filler "white plastic," 1/4 buried	sponge
BC2, PC3, PC4	JSL-92-01001	silt, turbid	#2—half disintegrated, red plastic liner	flounder
BC3, PC5, PC6	JSL-92-01001		#3—1/8 corroded, net fragments, punch core inside metal fillings	red fish, caprellids on net, slight biofouling
	JSL-92-01002		#4—drum top with solid concrete, adjacent "paint can"	
PC7	92-JSL-01003		#5—barrel fragments (rim)	redfish
PC8	92-JSL-01003		#6—intact cracked drum, top punched, disintegrated on contact	
PC9	92-JSL-01003		#7—intact drum, collapsed, holes, contained debris	anemone
PC10, PC11, PC12, PC13	92-JSL-01003			
	92-JSL-01004	rocky knoll, sediment	#8—fragments	boulder, much greater fauna, anemone, sponge
	92-JSL-01004		#9—intact barrel	
BC4, PC14, PC15	92-JSL-01004		#10—whole barrel, top collapsed "reagent jar" collected	anemone, brachiopod, codfish,ocean pout, cunner on boulder
	92-JSL-01005		#11—intact	
BC5, PC16, PC17	92-JSL-01006	soft mud silt, clear	#12—fragments, empty rims	2 redfish
BC6, PC18, PC19	92-JSL-01006		#13—intact	seastars, lobster
BC7, PC20, PC21	92-JSL-01006		#14—top only exposed, heavy "different"	
BC8, PC22, PC23			#15—partial exposed, heavy buried	redfish, *Myxicola*
	92-JSL-01007	soft mud, lobster trap	#16—drum split in half	
BC9, PC24, PC25	92-JSL-01007	sonar "false" targets	#17—lobster trap?	sponge
	92-JSL-01007		#18—fragment, 1.5'below surface eroded	redfish, brachiopods
BC10, PC26, PC27	92-JSL-01008	hard sand, gravel	#19—metal frame, not probable drum	sponge
				flounder, ocean pout
				lobster
PC28				

Appendix C includes Sea Trac™ plots of each *JSL-II* dive (Plot No. 1, 7, 8, 9, 10, 11, and 12). Plot No. 1 depicts the overall survey, including: Target Fields I, II, III, IV and VI, and corresponding IWC 1991 anchorage points P, O, C, Q, and L; the cluster of ROV and *JSL-II* tracks at each dive site; the fixed-gear trap locations within the high-density target fields; and spatial proximity of all dive site locations (within 0.5 nm diameter). Various scales (100- to 20-m) were used in Plot Nos. 7 through 12 to illustrate precision DGPS navigation fixes on the targets and sample locations within Target Fields I, II, II, and IV and the former Boston Lightship disposal site approximately 7 nm west-southwest of the IWS.

Sediment Sampling Methods - Reference Sites and the IWS

Reference Sites

Sediment samples were collected from the R/V *Ferrel* at Reference Sites 1 and 2 using a Smith-McIntyre grab sampler. The grab sampler has a 0.1 m^2 sample area. Three grabs were taken at each site. Coordinates for the grab stations and approximate station depth are given in Table 5.5.

Upon retrieval, samples were extracted for grain size analysis, total organic carbon (TOC), sediment chemistry and radiation. A 6.35-cm outer diameter acrylic push-tube core was inserted into each grab sample. In this manner, four cores were removed; one each for grain-size and TOC analysis by ERL-N, and two for radiological analysis, one each by MPDH and EMSL-LV.

Following core extraction, additional sediments were removed from the Smith-McIntyre for chemical analysis by ERL-N. Using a stainless-steel spoon, the top ten centimeters of sediment were removed and homogenized in a stainless-steel bowl. Then, with the stainless-steel spoon, enough sediment was scooped out of the bowl to fill four 8-ounce glass jars. Two of the jars were labeled for organic analysis (organophosphorus pesticides, PCB/pesticide sludge) and two for inorganics (metals). The jars were put into plastic bags and placed on ice.

Industrial Waste Site

The *JSL-II* was used to collect sediment samples close to barrels. Pre-selected target areas served to guide the *JSL-II* crew in their search for barrels around which punch-core and box-core samples would be taken and analyzed for grain size, TOC,

organophosphorus pesticides, inorganics (metals), PCB/pesticides analyses by ERL-N, and radionuclide analyses by EMSL-LV. Once a barrel was observed by the *JSL-II* crew, the operator maneuvered the submersible close enough for visual inspection. Video and still imageries were taken.

The chief scientist, in consultation with the operator, then determined whether the barrel appeared appropriate for further examination or should be passed by either because of its physical condition (i.e., grossly corroded) or potential danger (e.g., munitions). The final decision to pass a barrel was always left to the discretion of the *JSL-II* pilot. If the decision was to undertake further inspection, a radiation detector was placed close to the barrel using the submersible's manipulator. A radiation expert in the aft section of the submersible acquired radiation data for 300 seconds. If no radiation was detected, the chief scientist decided whether to take sediment samples. If the decision was to take sediment samples, the chief scientist directed the submersible to specific sampling points about the barrel.

Video documentation of the core sampling process at all sites provided a record for the exact location of each sediment core obtained relative to barrel condition, orientation, and proximity. Accurate *JSL-II* position fixes were reported at each target sample site by underwater communications system between the *JSL-II* and the R/V *Seward Johnson* bridge. These communications resulted in precision navigation (Sea Trac™ INS) plots (Appendix C).

Box-core samples were dedicated to sediment chemistry only by ERL-N. Four samples were extracted from each box corer: two for organic and two for metals analysis. The procedures used for sediment removal and preparation with the Smith-McIntyre grab samples described above were applied to the submersible box-core samples.

Punch cores made of acrylic plastic (6-cm outer diameter and 45 cm long) were used to collect sediment samples for grain size and TOC by ERL-N, and radiological analysis by EMSL-LV. Every effort was made to take two punch-core samples by each barrel selected for sampling. Once onboard the research vessel, the punch cores were removed from their containers, capped, and refrigerated. Once in the laboratory at ERL-N the six punch cores taken at Target Field IV Anchorage L were split vertically, one half was analyzed for TOC and grain size, the other half was shipped to EMSL-LV and the 0-5 cm horizon analyzed for radionuclides.

In one instance, a box corer was lost during sampling maneuvers (i.e., target 7-174). Only one sample was collected at Target Field III Target No. 6-187 and it was sampled for chemical constituents only; therefore, no grain size or radiological analyses were performed at this target. At Target Nos. 7-174 and 8-172 in Target Field III, no box-core samples were collected for grain size, chemistry, or radiology.

At what is called "the anchor site" (Target Area IV, Target 19-141) where radioactive sediment was discovered (Chapter 6), two punch cores were taken, one (PC27) for radiological analysis by EMSL-LV and one (PC26) for grain size analysis by ERL-N.

CHAPTER 6
IN-SITU OBSERVATIONS

The ROV and the *JSL-II* afforded the opportunity to obtain real-time measurements of seabed radionuclide activity. Visual observations of natural resources on the bottom, and the general conditions of waste containers on the seafloor were recorded by video and 35-mm photography over all courses of ROV and submersible reconnaissance. An edited video summary tape (available at NURC UCAP) depicts all underwater drums seen by the ROV and *JSL-II* search, as well as, natural seabed terrain, benthic fauna, and sample collection.

In-Situ Spectral Radiation

The results of the URSIS are presented as levels of sediment concentration in pCi/g. The reported sediment concentration levels represent the computed value obtained by multiplying the observed photopeak net count rate by the predetermined conversion factor shown in Table 5.3.

The concentration results are given in units of pCi/g and based on a homogeneous, three-dimensional distribution of the species within the sediment matrix, and averaged over the top 10 cm of sediment.

Underwater Background Measurements

The data presented in Table 6.1 represent the background sediment concentrations that were measured near the targets. The reported sediment concentrations for the background measurements are representative of the naturally occurring radionuclides present in the study area.

Underwater Target Measurements

All the spectra indicated that the radionuclides present were consistent with natural background and their results are reported in Table 6.2. An example of a typical net gamma spectrum of one of the targets is shown in Figure 6.1. The net gamma spectrum shown was acquired at Target Area II on May 31, 1992, on *JSL-II* Dive No. 2343 for Target No. 2-189. The principal emanating photopeaks are for ^{40}K and ^{208}Tl, both naturally occurring radionuclides.

Table 6.1. Sediment concentration (pCi/g) and standard error results for the anchorage sites' background gamma spectral measurements taken during *JSL-II* operations within the IWS, 31 May, 1 June, and 2 June 1992.

Date	*JSL Dive No.	Anchor Site	Description	^{214}Am	^{137}Cs	^{60}Co	^{40}K	$^{208}T1$
31 May	2343	C	Acquired less than 1.2 m from Target #1 (barrel)	N/D	N/D	N/D	1.55 (0.46)	N/D
	2344	Q	Acquired more than 1 m from Target #7 (intact barrel)	N/D	N/D	N/D	2.33 (0.49)	N/D
1 June	2345	P	Acquired less than 1 m from Target #9 (barrel): sea anemone in area. Rocky terrain.	U/D	U/D	U/D	U/D	U/D
2 June	2346	L	Acquired less than 1 m from Target #14 (barrel)	N/D	N/D	N/D	2.92 (0.40)	0.01 (0.01)
	2347	L	Acquired less than 1.2 m from Target #17 (barrel) and 10 cm above sediment	N/D	N/D	N/D	23.49 (1.49)	0.25 (.05)
	2348	X	Acquired less than 1 m from Target #20 (piece of metal) and 20 cm above sea bed.	N/D	N/D	N/D	4.92 (0.50)	0.07 (0.02)

N/D = Not Detectable
U/D = Unrecoverable Data
* Cross reference with Table 5.8

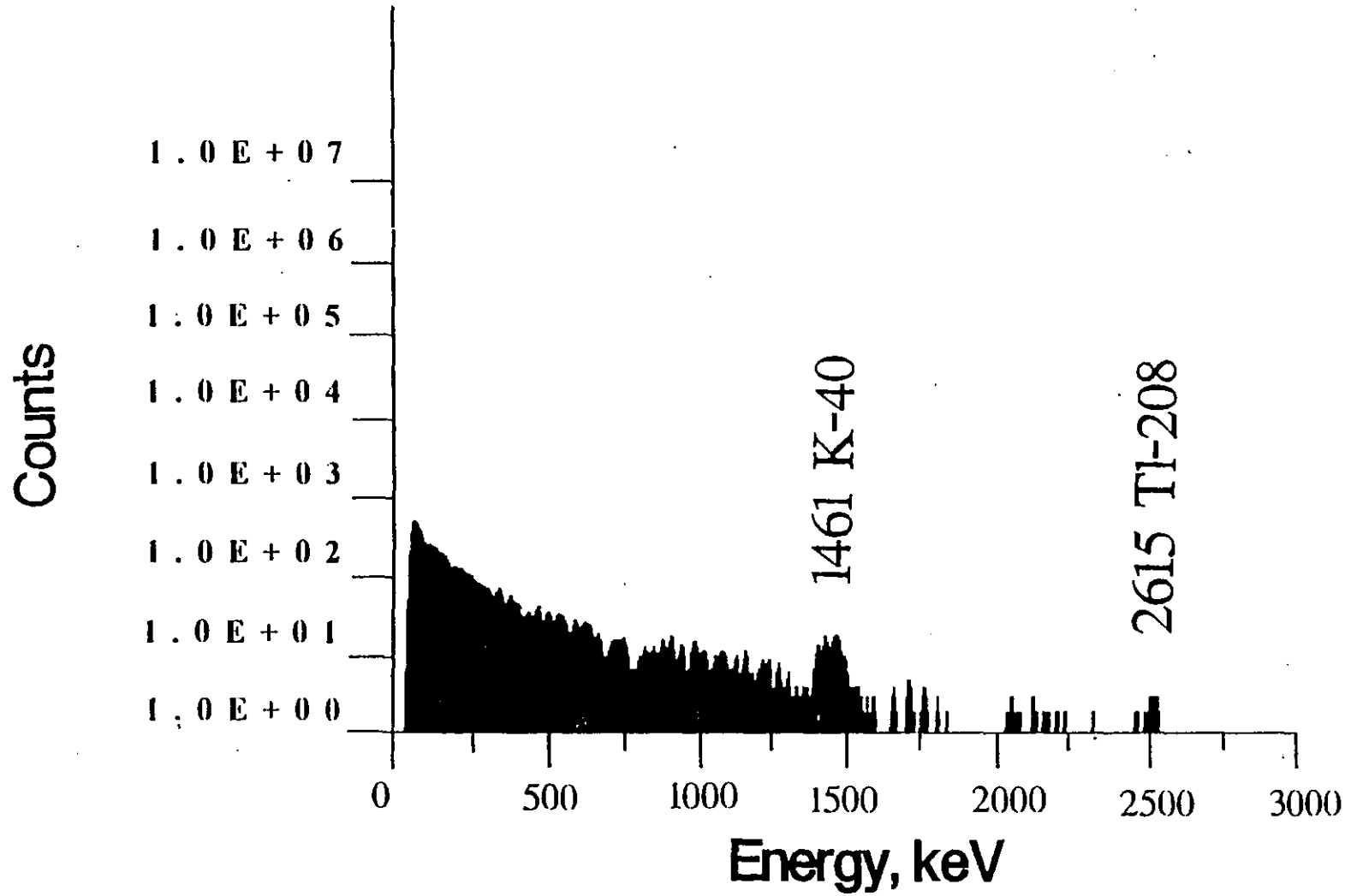


Figure 6.1. Net gamma spectrum for Target No. 2-189 in Target Area II, acquired on May 31, 1992. *JSL-II* Dive No. 2343.

Table 6.2. Net sediment concentration (pCi/g) and standard error results for gamma spectral measurements taken at respective targets encountered during *JSL-II* operations within the IWS and the Boston Lightship Area 31 May - 2 June 1992.

Date	JSL Dive No.	*Target Fix No./ INS	Description	^{214}Am	^{137}Cs	^{60}Co	^{40}K	$^{208}T1$
31 May	2343	1-193	Barrel	N/D	N/D	N/D	5.61 (1.56)	0.02 (0.02)
		2-189	Barrel broken at bottom near sediment	N/D	N/D	N/D	25.63 (2.12)	0.46 (0.07)
		3-187	Barrel and otter trawl with wire meshing	U/D	U/D	U/D	4.28 (1.75)	0.09 (0.02)
		4-185	Paint can sized container	N/D	N/D	N/D	26.60 (2.16)	0.29 (0.06)
31 May	2344	5-178	Badly deterioated barrel. Redfish nearby	N/D	N/D	N/D	21.89 (3.26)	0.31 (.09)
		6-187	Barrel is brittle and cracked. Punch hole in top	N/D	N/D	N/D	18.17 (2.30)	0.25 (0.05)
		7-174	Barrel intact				9.07 (2.43)	0.06 (0.04)
1 June	2345	9-198	Barrel side deteriorated. Sea anemone in area.	N/A	N/A	N/A	N/A	N/A
		10-195	Barrel intact. Large sea anemone on barrel.	U/D	U/D	U/D	U/D	U/D
		11-189	Barrel with sponges. Hole in center. Glassware laying outside barrel.	U/D	U/D	U/D	U/D	U/D
		12-185	Barrel mostly intact.	U/D	U/D	U/D	U/D	U/D

N/D = Not detectable

U/D = Unrecoverable data

N/A = No spectrum acquired

* Cross-reference Table 5.8

Table 6.2. Continued

Date	JSL Dive No.	Target Fix No./ INS	Description	^{214}Am	^{137}Cs	^{60}Co	^{40}K	$^{208}T1$
2 June	2646	13-176	Corroded barrel, silty, muddy flat seabed	N/D	N/D	N/D	1.51 (1.85)	0.05 (0.11)
		14-160	Barrel with hole in bottom	N/D	N/D	N/D	6.95 (1.92)	0.15 (0.11)
		15-154	Barrel shaped like beer key with bar less than 1 m in diameter. May be concrete inside	U/D	U/D	U/D	11.01 (1.96)	0.20 (0.11)
		16-152	Round ball-like object	N/D	N/D	N/D	2.93 (1.85)	0.01 (0.11)
2 June	2347	17-147	Barrel lying sideways on sea bed. Top of barrel deteriorated.	N/D	N/D	N/D	10.9 (1.08)	0.19 (0.03)
		18-143	Lobster trap (not measured)	N/A	N/A	N/A	N/A	N/A
2 June	2348	20-134	Piece of metal. Detector placed 5 cm above sediment	N/D	N/D	N/D	4.61 (2.39)	0.02 (0.27)

N/D = Not detectable
U/D = Unrecoverable data
N/A = No spectrum acquired

No manmade radionuclides were detected at any of the target or background measurement locations. However, some of the suspect targets did exhibit count rates that were 2 to 30 times higher than the measured background in the same locale. Upon examination of their net gamma spectra, the presence of only naturally occurring radionuclides was detected. In a few cases, the measured background count rates were higher than those of the suspect target, which is not an unusual occurrence and has been noted during prior in-situ (surface) measurement surveys.

It should be noted that on June 1, 1992, *JSL-II* Dive No. 2345 at Anchorage Site "P," the gamma spectral data for Target Nos. 10-195, 11-189, and 12-185 were unrecoverable due to an unanticipated event that was not discovered until after the completion of the dive. (However, sediment samples later analyzed indicated no radioactivity above background at those targets.) Procedures were implemented to prevent a re-occurrence of the problem. Also, the operator recorded in the Underwater ID Log that spectral data for the following targets were not or could not be acquired:

1. June 1, 1992; *JSL-II* Dive No. 2345; Site "P;" Target No. 9-198: Deteriorated barrel with sea anemone.[1]

2. June 2, 1992; *JSL-II* Dive No. 2347; Site "L;" Target No. 18-143: Lobster traps.

Radionuclide Contamination on Stern Anchor

On May 29, 1992, the R/V *Gloria Michelle*'s anchor became fouled with a lobster trawl, portions of a metal drum, and sediment during retrieval of the ROV in Target Area IV Anchorage Site "L." A wire lobster trap holding a single lobster on the trawl was entangled with the anchor. Following standard survey protocols against potential radioactive contamination, the trap and metal drum were scanned for radioactivity using a Ludlum thin window, GM beta/gamma radiation counter. The GM counter performance was verified using two gas-lantern mantles in a plastic bag. The mantles yielded about 6,000 counts per minute (cpm) on contact, while background on the R/V *Gloria Michelle* was 50- to 60-cpm. When no radioactivity was detected on the lobster trap or trawl, they were returned to the water.

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[1] This spectrum would have been unrecoverable even if it had been acquired due to the operator error previously mentioned

Sediment on the anchor was surveyed after the entanglements were removed. Sediment that was found to be above background was removed from the anchor and sealed in plastic bags for later analysis. The radioactive source appeared to be located in mud deposits caught in the lower part of the anchor (Figure 6.2).

Figure 6.2. Radiation survey on the R/V *Gloria Michelle* anchor found contaminated with ^{90}Sr on May 29, 1992, at the Massachusetts Bay IWS.

Once the anchor was free of visible sediment, elevated count rates were still present on various anchor surfaces. The maximum GM readings approximated 2,000 cpm. A smear sample was taken in the area of maximum count rate. Contamination was fixed to the anchor surface. All personnel involved, their gloves, all tools used, the deck, trawl doors, and the outside hull surfaces near the anchor were surveyed for radioactive contamination. No contamination was detected.

Gamma spectral measurements acquired from the stern anchor, the barrel fragments, and the sediment samples were reported in units of pCi/g (Table 6.3). Nothing unusual was identified on the gamma spectra, except all measurements of the stern anchor and sediment samples exhibited an increase in the low energy Compton scattering count rate. This rise in

the Compton scatter may be attributed to the presence of a beta radiation emitting radionuclide that cannot be identified or detected by the URSIS. The mud samples were sent to EPA EMSL-LV for analysis. The analysis determined that the mud samples were contaminated with ^{90}Sr, a beta emitter.

On the following day, the anchor was cleaned, then completely surveyed. All surfaces were at background. Smear samples were also at background.

Ecological Profile

Observations of the seafloor within the various target fields showed a difference between elevated-knoll and soft-basin environments. ROV dives conducted in Target Areas I and IV (Anchorages P and L) revealed areas of topographic rises (73- to 76-m depth) within the uniform flat mud basin depth of 91 m. These knolls were generally composed of coarser sand and cobble substrate in patches with occasional 0.5- to 1-m diameter exposed boulders. At the transition depths (approximately 82 m), high densities of anemone (*Cerianthus* spp.) forests were found. Higher concentrations of fish were noted on these rises (i.e., cod, redfish, American plaice, witch flounder, ocean pout), and decapod crustacean excavations (American lobster) were apparent beneath boulders and 55-gallon barrels. The attached hard-rock faunal assemblage (*Telia* anemones, tunicates, brachiopods, hydroids, bryozoans, and sponges) was dramatically more luxuriant on these glacial knolls. Water turbidity was less at these slightly shallower depths, presumably due to a lesser effect of flocculent settlement characteristic of the deeper nepheloid layer found at 82 to 91 m.

Most of the seafloor surveyed was characterized as soft sediment with a uniform horizon typical of a depositional basin. A sediment surface marked with features of biogenic origin was characterized by small-scale bioturbation associated with polychaete worms and amphipods and larger disruptions via the burrowing activity of lobsters throughout the cohesive mud habitat (Figure 6.3). The conical mound seen in front of one barrel may be that of the deep burrowing shrimp, *Axius sp.* (Figure 6.4). Barrels resting on this flat terrain harbored clusters of species, such as the frequently found redfish (Figure 6.5), as well as the occasional lobster, demonstrating a strong thigmotactic attraction to the relief and refuge offered by these waste containers.

Table 6.3. Net concentration (pCi/g) and standard error results for the R/V *Gloria Michelle* stern anchor gamma spectral measurements, May 29, 1992.

Sample	Description	^{214}Am	^{137}Cs	^{60}Co	^{40}K	$^{208}T1$
1	Background measured on vessel's upper deck while docked at USCG facility in Gloucester, Massachusetts	N/D	N/D	N/D	2.27 (0.34)	N/D
2*	Stern anchor made in Korea, hottest GM reading (2000 cpm) located in blade joint. Measured spectrum at a distance of 10 cm (net spectrum)	N/D	N/D	N/D	-0.17 (1.58)	N/D
3*	Mud scraped from stern anchor. Plastic bag #7 front side. GM reading: 1000 cpm. Distance: 10 cm (net spectrum)	N/D	N/D	N/D	-0.15 (1.58)	N/D
4*	Stern anchor mud—plastic bag #7. Measured back side. GM reading: 1000 cpm. Distance: 5 cm (net spectrum)	N/D	N/D	N/D	0.15 (1.69)	N/D
5	Pieces of the metal barrel picked up by the stern anchor. No GM reading detected. Distance: 15 cm (net spectrum)	N/D	N/D	N/D	0.43 (1.58)	N/D

*Note: All the measurements made on the stern anchor and mud samples exhibited an increase in the low energy Compton scattering count rate but no identifiable photopeaks were present. This rise in the Compton may be attributed to the presence of a beta radiation emitting radionuclide that can not be identified or reasonably detected by the URSIS.

N/D: Not Detectable

Figure 6.3. A biologically active area within the IWS. Lobster burrows surrounded by polychaete worm and amphipod tubes. Photo taken with the ROV, May 1992. (NURC UCAP)

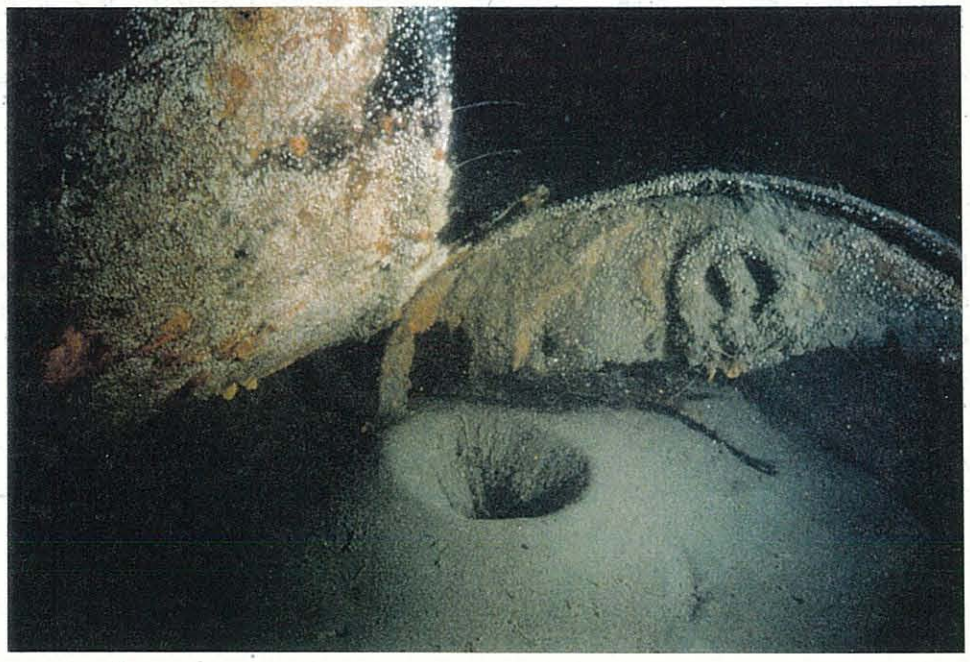

Figure 6.4. The burrow of a shrimp, possibly *Axius* sp. near a waste container located in the IWS. Photo taken with the ROV, May 1992. (NURC UCAP)

Figure 6.5. A corroded waste container with contents exposed, possibly reagent bottles. Redfish commonly frequent the area around the containers. Photo taken in the IWS with an ROV, May 1992. (NURC UCAP)

Waste Containers

A total of six ROV dives found 26 barrels and one other object, a dock structure. Summary Table 6.4 provides notes on the number and relative condition of the target barrels encountered during ROV and *JSL-II* operations. Data presentation is consistent with that provided by Wiley et al. (1992).

The present survey data show similar trends in barrel type and condition with the IWC survey. All barrels are suspected hazardous waste containers with the exception of one barrel object identified by the U.S. Navy ordnance specialist as a probable depth charge (see Table 5.4, Fix No. 26-112). The only barrels appearing intact without holes or punctures were *JSL-II* Target Nos. 7-174 (two barrels together at this position; one intact and one with a hole) and 12-185, and ROV Fix No. 12-168. All other barrels had visible holes or punctures or exhibited severe corrosion.

Table 6.4. IWS Survey (May and June 1992)—ROV and submersible inspection /target descriptions.

	Dives	Targets (total)	Container/drum (N) = No . of targets	Intact Drum Empty	Drum with contents	disintegrated fragments	Other
ROV	6	26	(14) 53%	(10) 39%	(4) 15%	(11) 42%	(1) 4% dock piling
JSL-II	5 IWS 1 lightship	18 1	(13) 72%	(7) 39%	(6) 33%	(4) 22%	(1) 5% lobster trap
In-situ totals	11 sites	44	(27) 61%	(17) 39%	(10) 22%	(15)	(1) 2%
Wiley et al. 1992	18	93	(64) 69%	(19) 30% undetermined	(18) 28% (26) 41%	Broken (48) 75%	

Target No. 19-135 (Table 5.4) refers to the fix taken for the ship's position at the time the presence of the radioactive material was confirmed on the anchor of the R/V *Gloria Michelle.* (page 6-6). This information, coupled with the anchoring mooring site fix, was used to estimate the area where the radioactive material may have been intercepted by anchor retrieval.

The *JSL-II* encountered 17 barrels on five dives; 13 of which were either observed as intact or containing contents. Solid contents were observed in six of the barrels; i.e., Target Nos. 1-193, 2-189, 3-187, 4-185, 7-174, and 10-195 (Table 5.8). These contents included plastic filler, red disposal plastic bags, concrete (paint can beside the barrel), reagent jars, metal filings with solvent aroma (determined following collection with punch core from within the barrel and observed onboard the R/V *Seward Johnson).* Targets 5-178, 8-172, 12-185, and 18-143 were disintegrated fragments, likely due to corrosion. Targets 6-187, 9-198, 11-189, 13-176, and 16-152 were either whole barrels that disintegrated upon contact or had what appeared to be punctured tops. Barrels with punctured tops allegedly contained fluid wastes and were punctured to allow the fluids to escape and the barrel to sink to the bottom. Targets 14-160 and 15-154 were atypical in that they were sunk nearly wholly into the soft sediment, with a more vertical than horizontal orientation suggesting heavy contents. No ordnance was observed by the *JSL-II* crew.

Photo plates illustrate barrel condition, substrate type, and species observed in the IWS barrel field during the May/June 1992 survey. Figure 6.6 illustrates the open end of a barrel with "solid contents." Biofouling on this barrel is dominated by the brachiopod, *Terebratulina* and tube clusters of the polychaete worm, *Myxicola*. Some sponge and hydroid colonies are also visible. Another possibly "solid content" barrel, although appearing "intact" is shown in Figure 6.7. This barrel is half buried in sediment. The two-thirds buried barrel in Figure 6.8 illustrates a waste barrel partially corroded and with a puncture typically practiced during disposal operations. Similar faunal assemblages, as depicted in Figure 6.6, are seen along the upper-right rim of the barrel. Figure 6.9 illustrates a "disintegrated" barrel.

Figure 6.6. Open-ended waste barrel showing solid contents, tunicate, brachiopod, and bryozoan fouling. Photo taken with an ROV in the IWS, May 1992. (NURC UCAP)

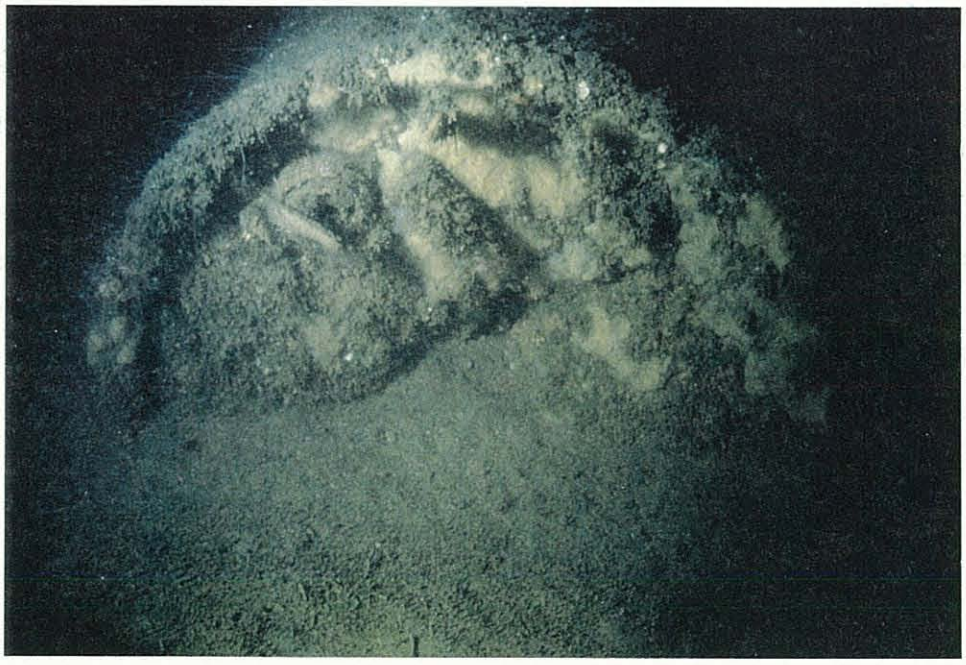

Figure 6.7. A waste barrel, half buried in the sediment at the IWS, appears to contain solid contents. Photo taken with an ROV in the IWS, May 1992. (NURC UCAP)

Figure 6.8. A waste barrel approximately two-thirds buried and showing a puncture (side) (a typical practice during disposal) and corrosion (top). Photo taken with an ROV in the IWS, May 1992.

Figure 6.9. The rim of a disintegrated waste barrel nearly half buried in the sediment. Photo taken with an ROV in the IWS, May 1992.

Two purposes were served by categorizing barrel condition (e.g., intact, with solid contents, punctured, disintegrated) Table 6.4. First, categorization allowed a comparison, on a percentage basis, with the findings of the IWC survey (Wiley et al. 1992). Second, categorization enabled an estimate of the potential threat posed by the barrels. It was generally assumed that top-punctured barrels (a common practice by the disposal company) would have allowed dissipation of fluid wastes soon after disposal. Therefore, such barrels would not likely pose an imminent contaminant threat. Conversely, intact barrels and those with solid contents (25 percent of the barrels observed) conservatively represent an imminent potential threat.

Evidence of Fishing Activity

A notable observation relative to the condition of the barrels suggests minimal mobile fishing gear activity in this survey area. Although the survey covered only a small area within a 0.5-nm circle, several fragile barrel frames were observed protruding from the mud or lay only partially buried in the sediment. The condition of these barrels suggests that they would be easily collapsed on contact by otter trawl passage. Observation of intact barrels and barrel frames upright in the sediment argues that most lie as they were originally deposited following disposal.

However, one drum was seen with a large fragment of a trawl net's cod end along side (*JSL-II* Dive No. 2343, Target No. 3-187) Table 5.8. The fragment was not a tear out due to barrel/bottom resistance, but possibly it represents a net cut out after a barrel was inadvertently collected and subsequently re-deposited. Throughout the ROV and *JSL-II* survey, barrel distribution and spacing appeared to represent undisturbed original placement. No observations were made of trawl-door furrows or foot-rope sweep-marks. However, many lobster traps were found in the area, and sonar targets were often subsequently visually confirmed as wire lobster traps, rather than barrels.

Laser Line Scanner

In April 1993, a relatively new technology, the laser line scanner, made available in the public sector was examined at the IWS. This technology is briefly discussed in Appendix G.

CHAPTER 7

LABORATORY METHODS

Responsibilities for conducting analyses on the various sample components were divided among participating agencies based upon fiscal capacity and expertise. Table 7.1 depicts the distribution of sediment and biological samples to the various agencies.

Table 7.1 Agency disbursement of samples collected at the Massachusetts Bay IWS, May/June 1992. Analyses in wet weight (ww) unless otherwise indicated.

Agency	Sample Type	Medium	Number of Samples	Type of analysis
FDA	lobster traps	lobster meat	4 (composites)	pesticides organohalogens PCB lead and cadmium meHg radionuclides PAH
	lobster traps	lobster tomalley	4 (composites)	pesticides PCB lead and cadmium PAH
	otter trawls	lobster meat	8 (composites)	pesticides organohalogens PCB lead and cadmium meHg radionuclides PAH
	otter trawls	lobster tomalley	8 (composites)	pesticides PCB lead and cadmium PAH
	otter trawls	sea scallop	4 (composites)	pesticides PCB arsenic lead and cadmium meHg

* Each FDA sample is a composite of several individuals; refer to Appendix Table D-7 a-h for the number of individuals of each species in each sample.

** meHg = methylmercury

Table 7.1 (continued)

Agency	Sample Type	Medium	Number of Samples	Type of analysis
FDA	otter trawls	fish	44 composites	pesticides organohalogens PCBs lead and cadmium arsenic meHg radionuclides PAH
NOAA	lobster traps	whelk	2	metals
		spider crab	3	metals PCB organochlorine pesticides
		fish	9	metals PCB organochlorine pesticides
	otter trawls	fish	27	metals PCB
EPA EMSL-LV	otter trawls	lobster	4	radionuclides
		rock crab	1	radionuclides
		fish	5	radionuclides
	R/V *Gloria Michelle* Anchor	sediments	3	radionuclides
	JSL-II	sediments	6	*radionuclides
EPA ERL-N	punch corer (2 depth horizons x:19 cores)	sediments	38	TOC and grain size
	Smith-McIntyre Grab sampler (R/V *Ferrel*) (2 depth horizons x 6 cores)	sediments	12	TOC and grain size

* analyzed at EMSL-LV

Table 7.1 (continued)

Agency	Sample Type	Medium	Number of Samples	Type of analysis
EPA ERL-N	Smith-McIntyre Grab (R/V *Ferrel*)	sediments (dry weight)	12	metals/cyanide
			12	organophosphorus pesticides PCB organochlorine pesticides semivolatiles tentatively identified compounds
	punch corer (*JSL-II*)	sediments (dry weight)	5 (1 composite of 2 PCs)	metals/cyanide organophosphorus pesticides PCB organochlorine pesticides semivolatiles tentatively identified compounds
	box corer (*JSL-II*)	sediments (dry weight)	10	metals/cyanide organophosphorus pesticides PCB organochlorine pesticides semivolatiles tentatively identified compounds
MDPH	otter trawl	lobster tomalley	19	biotoxins
		lobster meat	2	radionuclides
		fish	8	radionuclides
		sea anemone	1	radionuclides
	anchor	sediments	1	radionuclides
	Smith-McIntyre Grab (R/V *Ferrel*)	sediments	6	radionuclides

Sediments

Sediment samples were collected at two reference sites and close to barrels. These samples were subjected to various analyses including particle analysis, inorganic and organic chemistry, and radionuclides. On receipt at ERL-N, the punch core (PC) samples were split vertically in the acrylic tube. One half was retained for the various physical and chemical analyses and the other half was sent to EMSL-LV for radiological analysis.

Particle Analysis - EPA ERL-N

Grain size analysis was conducted in accordance with a standard operating procedure (SOP) developed at EPA ERL-N. Analyses were conducted using a Galai Instruments CIS-1000 scanning laser/particle size analyzer system.

The percentages, by volume, of sand, silt, and clay in the sediment cores were determined with the CIS-1000. This instrument uses a focused scanning He-Ne laser system to perform accurate and rapid measurements over a range of particle sizes from 2 to 3,600 microns (μ). For this study, sediments were measured using the 2 to 300μ size range (clay to fine sand). This range was chosen because initial analyses of a wide variety of samples indicated no particles more than 300 μ in size.

The analytical process was automated using an IBM-compatible 386 computer, simplifying it to a turnkey operation and assuring exact replication of all measured parameters. During the analytical process, a focused laser beam using time-of-transition analysis, is scanned in a circular motion at a constant frequency. The focused beam interacts with sediment particles in a scanning zone, producing interaction pulses detected by PIN photodiode. The rotational frequency of the laser beam is such that particle motion relative to the beam is negligible and particles appear to be stationary in the scanning zone. The width of the interaction pulse represents the time of interaction as the laser beam scans across the surface of the particle. The height of the pulse represents the reduction in light intensity reaching the detector as the result of the interaction. The time of the interaction provides a parameter with which to directly measure the size of the particle (Karasikov et al. 1991; Aharonson and Karasikov 1985). Therefore, the larger the particle the longer the interaction time.

A peristaltic pump was also used to slowly pump (30 ml/min) a slurry of sediment plus deionized water through the scanning zone. To ensure that the total amount of sediment, prepared for analysis had been scanned by the laser and that the results were not biased by

the rapid gravitational settling of coarse particles, the time of analysis was increased. Further, visual observations of water clarity and sediment concentrations in clear tubing connected from the base of the laser unit to the peristaltic pump confirmed that the total sample had flowed passed the scanning zone. At this time, the system was thoroughly flushed with deionized water and reset for additional analyses. The total time for each analysis was approximately 10 minutes.

The number of particle interactions during analysis of each sample were actually greater than 100,000. Algorithms then determined the validity of each interaction (i.e., measurement), statistical moments were calculated, and the total accumulated data presented as cumulative curves and histograms. For this study, the total accumulated data base for each sample was 30,000 data points before these data were presented graphically. These data were then archived on computer diskettes and presented graphically with particle mean, median, standard deviation, and confidence limits.

Total Organic Carbon

TOC was determined using a Perkin Elmer 2400 Series II CHNS/O Analyzer configured in the CHN operating mode. This mode uses combustion in a pure-oxygen environment to convert the sample elements to simple gases. Scrubbing reagents are also used to remove halogens and sulfur. The resulting gases from combustion include CO_2, H_20, and N_2. These gases are homogenized and controlled to exact conditions of temperature, pressure, and volume. The gases are then allowed to de-pressurize through a column where they are separated in a step-wise, steady-state manner and detected as a function of their thermal conductivity. For further details concerning this method, refer to the CHN User Manual (Perkin Elmer, 1991).

Sediment preparation followed the method developed at the Marine Ecosystem Research Laboratory (MERL), University of Rhode Island (Beach et al. undated). Sediment was dried at 110°C for 24 hours. Large shell fragments (> 0.5 cm) were removed first. The 30 mg of sediment required was removed and placed into a 20-ml glass beaker. The beaker was then placed in a sealed desiccator in an atmosphere of concentrated hydrochloric acid (HCl). The sample was allowed to fume for at least 15 hours to remove any inorganic carbon. The beaker was then transferred to an oven and dried for an additional 2 hours at 110° C. After that, between 5 and 10 mg of sediment were weighed and placed into a tin capsule. The capsule was then crimped into a small ball and re-weighed. The weight was recorded along with the corresponding sample number.

The sample was then analyzed following the SOP for the instrument. Instrument calibration was checked and readjusted if necessary after every ten sample runs. A quality assurance (QA) run was also performed after ten runs. A known standard, acetanilide, was used and the resulting carbon percentage was required to be with ± 0.30 of its theoretical percentage.

Inorganic and Organic Chemistry - EPA ERL-N

Sediment samples collected for inorganic and organic chemical analysis were delivered to the following EPA CLP contractors for the appropriate constituent analyses as follows:

Metals and cyanide analyses -	ChemTech Consulting Group Englewood, New Jersey 07631
Base Neutral Analyses (BNA) -	RECRA Environmental Inc. Amherst, New York 14228-2298
Organochlorine pesticides/PCBs -	RECRA Environmental Inc. Columbia, Maryland 21046
Organophosphate pesticides -	Spectrolytix Consulting Group Gaithersburg, Maryland 20877

Prior to shipment ERL-N composited PC 10 and 11 for analyses. Sediments were analyzed according to various EPA methods.

Metals and cyanide were analyzed using EPA-CLP Method ILMO2.0 modified under SAS No. 7338A-05 (Appendix D)

Base neutral analyses (BNA) (volatile and semivolatile compounds) followed protocols EPA CLP Method OLM01.0 modified under SAS 7338A-03 (Appendix D)

Organochlorine pesticides and PCBs were analyzed using EPA CLP Method OLM01.0 modified under SAS 7388A-02; SDG No. SA3101.

Organophosphorus pesticides were analyzed following EPA CLP Method 8140 modified under SAS 7388A-01 (Appendix D)

Tentatively identified compounds were analyzed using EPA CLP Method OLM01.0.

Radionuclides - EPA EMSL-LV

EPA's EMSL-LV conducted radionuclide analyses on sediment samples using gamma and beta emitting methodologies (Table 7.2). All samples were analyzed for ^{90}Sr and ^{239}Pu following methods provided in EMSL-LV-0539-17, 1979. After being dried and weighed, six

samples were placed in liquid scintillation vials, placed directly on the high-purity germanium detector, and counted for 1,000 minutes. Dry sediment weights ranged from 11.58 to 23.4 gm.

Table 7.2, The number of sediment samples collected near the Massachusetts Bay IWS (May/June 1992) and analyzed for radionuclides at EMSL-LV.

Sample Type	Number	Gamma-scan	Sr^{90}	$Pu^{238,239}$
sediment	12	12	12	10
sediment (HP)*	3	0	3	1
Total	15	12	15	11

*HP = health physics. These samples were from the contaminated anchor.

Radionuclides - MDPH

The MDPH Massachusetts Environmental Radiation Laboratory also conducted radionuclide analyses. Each of six frozen push-tube core samples (three each from Reference Sites 1 and 2) were sectioned into top, middle, and bottom horizons. Each section was weighed and then counted for 7,200 to 60,000 seconds on a Canberra MCA gamma spectrometer with a high purity, germanium detector. Also, MDPH similarly analyzed one whole sample of sediment collected from the bow anchor of the R/V *Gloria Michelle* on May 27.

Biota

Human Health Risk vs. Ecological Risk

Again, this survey was designed for screening the relative potential toxicological threat to marine resources and seafood posed by the IWS. Screening surveys typically follow agency-specific protocols. Four agencies (FDA, EPA, NOAA, and MDPH) assumed analytical responsibility for various media and perspectives (e.g., seafood safety, ecological risk, sediment physical/chemical conditions; Table 7.1).

EPA regulates the cleanup of hazardous waste sites. During its investigations of potential waste sites, EPA follows CLP methodologies. The CLP limits analysis to specific

hazardous substances and contaminants commonly found during waste site investigations. The majority of these substances elicit either a toxic or carcinogenic response in humans. Many of these substances have the potential to bioaccumulate and transfer through the food chain. These substances are found on two lists: the target analyte list (TAL) includes 23 inorganics (metals and cyanide) and the target compound list (TCL) includes 126 organic compounds (volatiles, semivolatiles, PCBs, and pesticides). Some of these substances have Federal criteria and standards associated with them depending upon the medium in which they may be found (e.g., ambient surface water, drinking water). Exceeding criteria in a medium of concern may lead to some form of abatement or remedial action.

However, at the time of this investigation, EPA had not promulgated specific regulatory criteria or standards for hazardous substances found in sediments, or biota in general. This lack of criteria or standards in these media can create difficulties for those assessing risks to human health, the environment, or ecological receptors.

EPA and FDA have established tolerance levels and action levels for a small number of hazardous substances and contaminants in certain edible biota. Although these tolerance and actionlevels are enforced by FDA with respect to human consumption, these levels may be used by EPA to determine the appropriateness for abatement or remedial action.

In this screening survey the FDA was concerned with seafood safety. FDA uses analytical protocols that focus on determining the potential risk posed to humans from the consumption of edible portions of fish and shellfish. The potential risks posed to humans are evaluated in a different manner from that used for marine biota. Using mercury (Hg) as an example, FDA has calculated a risk potential from consuming seafood contaminated by methylmercury (meHg). FDA has established a 1.0 ppm wet weight (ww) meHg action level to limit the concentration of meHg in edible portions of seafood. FDA's analytical detection limit therefore focuses on this criterion.

For ecological receptors, as noted above, no similarly promulgated Federal action levels, or regulatory criteria or standards exist for meHg or any other hazardous substance. Consequently, determining the potential toxicological risk to marine biota posed by contaminated sediments or trophic transfer generally becomes a case-by-case assessment. Nonetheless, some generalities can be applied using information gathered from studies performed in laboratories or from site-specific field investigations.

NOAA's Coastal Resource Coordinator (CRC) Program represents the agencies CERCLA authority for the protection of estuarine and marine species (i.e. trust species) from hazardous substance releases. For screening purposes, the CRC Program relies on a wide variety of information from which to formulate decisions regarding the need to seek abatement or remedial action for the protection of NOAA's trust species. One source of information used for screening purposes only is a report prepared by Long and Morgan (1992). Long and Morgan regard total Hg in sediments at concentrations of 1.3 mg/kg as the moderate probable effects concentration (effects range moderate, ER-M). However, site conditions, which include TOC content, redox potential, etc., also affect the potential toxicological and bioaccumulation risk posed by Hg and most other hazardous substances. Therefore, site-specific assessments may be justified, especially when concentrations greatly exceed the screening levels.

While the Long and Morgan document is routinely used by the NOAA CRC Program for screening purposes, the document was written as part of the NS&T Program, which limits analyses to a small group of selected hazardous substances. While hundreds of PAHs exist, for example, the NS&T Program routinely analyzes for only 23 of the most commonly found constituents. On the other hand, FDA routinely analyzes for only 10 PAH constituents.

Consequently, the perspective by which agencies routinely view the toxicological risks posed by hazardous substances and contaminants is affected, not only by the number of substances analyzed for in the investigation, but also by the analytical protocols to which the various media were subjected.

A compilation of the various fish and shellfish species collected and analyzed during this investigation by the various federal and state agencies involved is given in Table 7.3.

Table 7.3. Species collected by the various agencies for chemical analysis.

Common Name	Scientific Name
American plaice	*Hippoglossoides plattesoides*
winter flounder	*Pseudopleuronectes americanus*
yellowtail flounder	*Limanda ferruginea*
witch flounder	*Glyptocephalus cynoglossus*
silver hake	*Merluccius bilinearis*
blueback herring	*Alosa aestivalis*
Atlantic herring	*Clupea harengus harengus*
goosefish	*Lophius americanus*
longhorn sculpin	*Myoxocephalus octodecemspinousus*
sea raven	*Hemitripterus americanus*
spiny dogfish	*Squalus acanthias*
skate	*Raja* spp.
redfish	*Sebastes marinus*
wrymouth	*Cryptocanthodes maculatus*
ocean pout	*Macrozoarces americanus*
cod	*Gadus morhua*
whelk	*Colus stimpsoni*
sea scallop	*Placopecten magellanicus*
squid	*Loligo sp.*
spider crab	*Lithodes maja*
rock crab	*Cancer borealis*
Pandalid shrimp	*Pandalus spp.*
American lobster	*Homarus americanus*

Fish and Shellfish Tissue Inorganic and Organic Chemistry - FDA

Edible portions of the fish and shellfish samples were analyzed for: PCB, pesticides, lead, cadmium, arsenic, meHg, PAHs, and radionuclides. Samples were apportioned to different FDA laboratories according to the specialty of each:

organohalogen/organophosphorus pesticides, PCB residues, lead, and cadmium	Buffalo District Laboratory
meHg and arsenic	New York Regional Laboratory
PAHs, radionuclides	WEAC

The *Standard Reference Material 1974* (from NIST) was used for PAH analyses to detect: fluoranthene, pyrene, benzo(a)anthracene, chrysene, benzo(b)fluoranthene,

benzo(k)fluoranthene, benzo(a)pyrene, dibenz(a,h)anthracene, benzo(g,h,i)perylene, and indeno(1,2,3-cd)pyrene. Analytical limits of detection and quantitation are given in Table 7.4.

Table 7.4. Fish and shellfish limits of detection and quantitation in FDA chemical analyses.

Limits of Detection/Quantitation		
Contaminant	**Limit of Detection**	**Limit of Quantitation**
PCB	0.02	0.10
Pesticides	0.005	0.02
lead	0.005	0.01
cadmium	0.02	0.05
meHg	0.01	0.06
Arsenic	0.01	0.05

Fish and Shellfish Tissue Inorganic and Organic Chemistry - NOAA

On September 21, 1992, NOAA and EPA personnel packaged the selected fish and shellfish specimens collected from the IWS and its perimeter, and shipped them by overnight express mail to NOAA's contract laboratory, Columbia Analytical Services in Kelso, Washington for analysis.

Potential bioaccumulation of contaminants was measured by examining the tissue concentrations or residues of contaminants in various fish and shellfish. Partitioning of chemicals into biotic tissues is a highly variable phenomenon. An organism's size, age, metabolism, reproductive status, and lipid content, as well as sample size and analytical limitations contribute to data variability. Great variability is also associated with uptake, depuration, and excretion rates among species. For these reasons, statistical analyses of the biotic residue results were not attempted.

Chemical analyses were conducted on whole fish. Shells of crab and whelk were removed and tissues homogenized before analysis. Columbia Analytical Services, Inc. conducted the chemical analyses according to:

- EPA methods 200.8, 7471, and 7950 for metals.
- EPA methods 3550 and 8080 for organochlorine pesticides and PCBs.

- EPA Method 413.1, for oil and grease in water was modified to determine lipid concentrations in tissue. Modification called for analyzing a smaller amount of sample than the method protocol requires, which may have raised the detection limits.

Fish and Shellfish Tissue Radionuclides - FDA

Fish and lobster samples prepared for radionuclide analysis were subjected to a gamma-screen for iodine-131 (^{131}I), ruthenium-106 (^{106}Ru), ^{134}Cs, ^{137}Cs, and barium-140 (^{140}Ba). Plutonium-239 (^{239}Pu) and ^{90}Sr analyses were also conducted on selected samples. Radionuclide analytical limits of detection are given in Table 7.5. Radionuclide analysis was conducted at WEAC.

Table 7.5. Fish and shellfish limits of detection in FDA radionuclide analyses.

Analysis of fish and shellfish for radioactivity Limits of Detection	
^{131}I	10 pCi/kg
^{10}Ru	10 pCi/kg
^{134}Cs	10 pCi/kg
^{137}Cs	10 pCi/kg
^{140}Ba	10 pCi/kg
^{90}Sr	2.0 pCi/kg
^{239}Pu*	0.1 pCi/kg

* ^{239}Pu results were high by a factor of 100 fCi/kg because the results are expressed as picocuries/kg (1×10^{-12} curies) rather than as femtocuries/kg ($1X10^{-15}$ curies).

Fish and Shellfish Tissue Radionuclides - EPA EMSL-LV

Fish and shellfish were ashed and the ash subjected to a gamma screen (i.e., counted for 1,000 minutes in 1-liter Marinelli beakers brought to volume with distilled water). Ash was analyzed for ^{90}Sr and ^{239}Pu using EPA's EMSL-LV methods referenced on page 7-6.

Fish and Shellfish Tissues Radionuclides - MDPH

Fish and shellfish samples for radionuclide analysis by gamma-spectroscopy were frozen onboard and transferred to the MDPH-Massachusetts Environmental Radiation Laboratory.

In the laboratory, uncooked edible portions of finfish and lobsters were dissected from individuals in each sample. Each aliquot was then pureed, weighed, and preserved by adding formaldehyde. Samples were counted for 10,000 to 60,000 seconds on a Canberra MCA gamma spectrometer with a high-purity germanium detector.

A sample of opportunity, a sea anemone attached to a small metal drum fragment, was collected from trawl 6. This entire individual and the attached metal fragment were pureed and processed as described above for edible species.

Biotoxins - MDPH

Nineteen live lobsters from the otter trawl Sites 3, 4 and 6 were delivered to the laboratory for paralytic shellfish poisoning (PSP) and amnesic shellfish poisoning (ASP) analyses. The lobsters were weighed, measured, and assigned laboratory accession numbers upon receipt in the laboratory (see Table 8.17). The lobsters were steamed over freshwater for 15 to 20 minutes, then the muscle tissue and tomalley were removed from the shell. The muscle tissue was frozen for potential future analyses. Since lobsters from net trawl sites 3 and 6 were small, animals from the same site were combined to provide sufficient tomalley for analysis.

An acid aqueous extract of each of the nine samples was prepared in accordance with the algorithm shown in Figure 7.1. Each extract was analyzed for PSP by mouse bioassay (intraperitoneal injection) and by gradient elution, reversed-phase, high-pressure liquid chromatography (HPLC) with post-column derivatization and fluorescence detection. In addition, each extract was tested for domoic acid by isocratic, reversed-phase HPLC with ultraviolet detection.

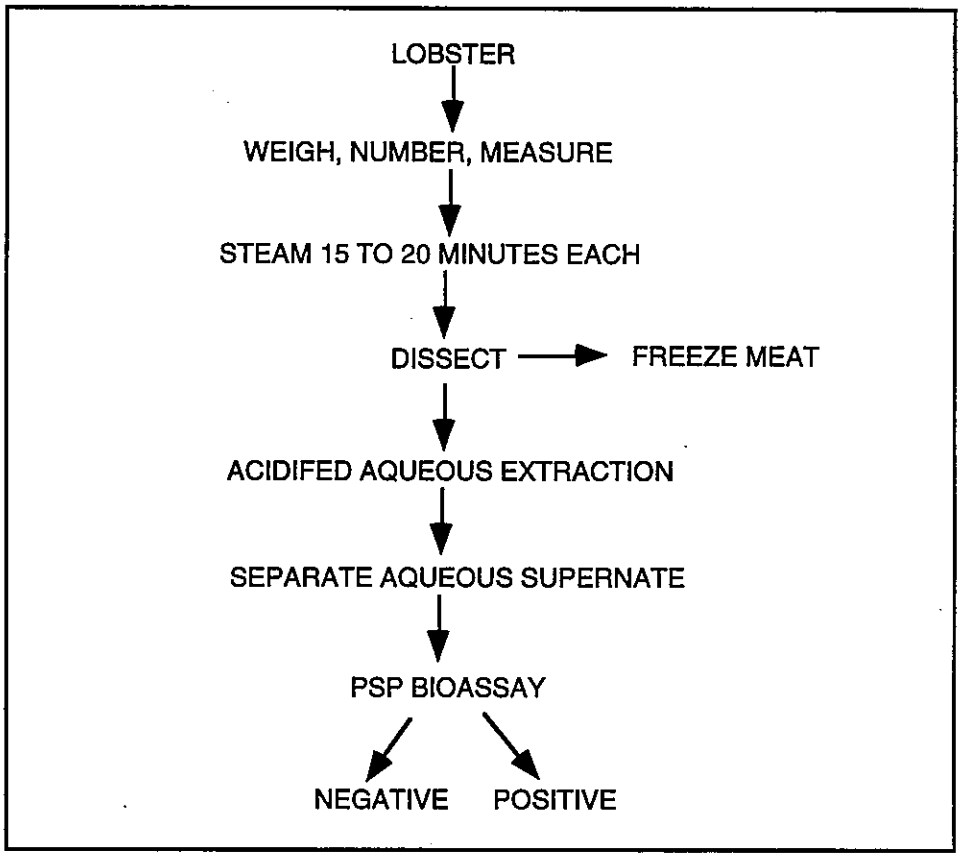

Figure 7.1 Lobster sample processing and testing protocol.

CHAPTER 8

FIELD AND LABORATORY ANALYTICAL RESULTS AND DISCUSSION

SEDIMENTS

Sediment samples were collected at two reference sites and in proximity (i.e., <1 m) to 14 barrels (see Table 5.8). These samples were subjected to various analyses including particle analysis, inorganic and organic chemistry, and radionuclides, although not all samples were subjected to all analyses, and some samples were subjected to similar analyses but by different agencies.

Particle Analysis - EPA ERL-N

Grain Size

The ratio of percent silt (4-63 μ) and clay (<4 μ), as determined by particle size for each sediment sample, was plotted against its percent sand content (>63 μ) on the ternary diagram to determine the sediment name (Folk et al. 1970, Figure 8.1). A total of 19 punch-core samples were collected and analyzed for grain size; 17 of these samples were taken next to barrels (i.e., targets). In addition, one punch core sample (PC26)was taken in the vicinity (Target Field IV, Anchorage L) where the ^{90}Sr was detected on the anchor of the R/V *Gloria Michelle*, and another punch core sample (PC27) was taken during a *JSL-II* dive near the former Boston Lightship disposal area. These 19 samples resulted in a total of 38 analyses that were partitioned among the 0 to 3 cm and 10 to 32 cm horizons, and five QA analyses (Table 8.1).

Three sediment samples were taken from each of the two reference stations resulting in six analyses each (total of 12) from two depth horizons (Table 8.1). In addition, one QA sample was run on this set from the reference stations.

Based on the grain size distribution, IWS and reference-site sediments are classified as sandy silts (sZ on Figure 8.1). Mean grain size, based on the Udden-Wentworth scale, at the dive locations ranged from approximately 76 μ (very fine sand) to approximately 22 μ (medium silt). Mean grain size at the reference stations ranged from approximately 53 μ (coarse silt) to approximately 17 μ (medium silt).

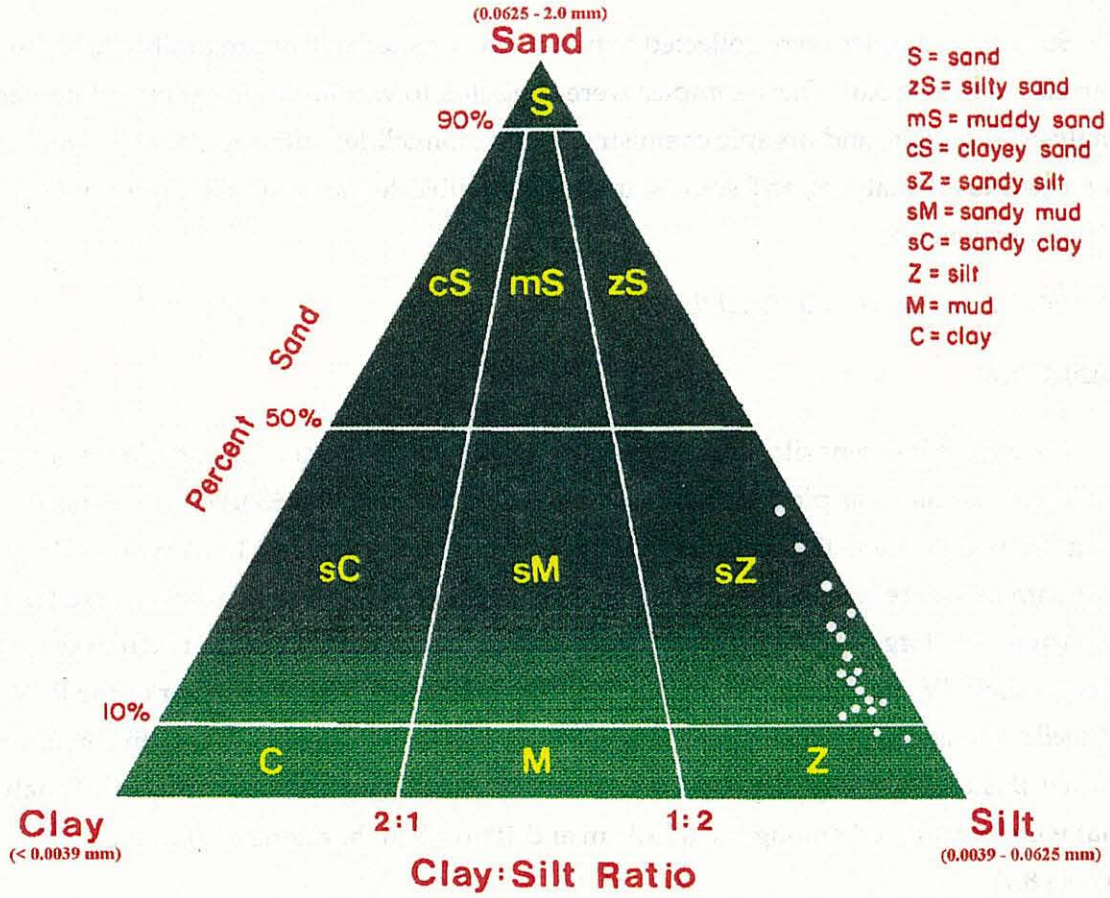

Figure 8.1. A ternary diagram depicting the sample grain size distribution within the Massachusetts Bay IWS, May/June 1992.

Table 8.1. Sediment particle analysis Massachusetts Bay IWS. IWS Survey May/June 1992. (ERL-N).

Core (Field, Target #)	Dive	Depth (cm)	Percent TOC	Mean Grain Size (microns)	Percent Sand	Percent Silt	Percent Clay
*PC1 (II,1)	1	1	2.17	41.4	22.2	71.5	6.3
PC1 (II,1)	1	11	1.72	40.1	22.5	71.6	6.0
PC2 (II,1)	1	1	1.74	58.9	34.6	61.7	3.8
PC2 (II,1)	1	32	1.86	67.1	39.5	54.9	5.6
PC4 (II.2)	1	1	1.99	32.5	15.4	76.2	8.5
PC4 (II,2)	1	7	1.83	69.3	40.4	55.5	4.2
PC5 (II,3)	1	26	2.20	22.5	9.5	81.0	9.5
PC5 (II,3)	1	1	1.33	48.7	27.7	66.6	5.7
PC6 (II,3)	1	1	2.03	52.6	30.0	65.4	4.6
PC6 (II,3)	1	32	1.34	46.5	26.0	68.3	5.7
PC6 (II,3)	1	QA=>32	1.32	44.5	22.9	71.0	6.1
PC8(III,6)	2	1	1.99	47.5	26.0	69.8	4.2
PC8(III,6)	2	22	1.85	29.4	13.1	78.8	8.1
PC14 (I,10)	3	1	1.57	23.6	11.3	76.8	11.9
PC14 (I,10)	3	13	0.29	38.8	20.6	68.2	11.2
PC16 (I,11)	3	1	2.34	32.1	15.6	77.7	6.7
PC16 (I,11)	3	19	0.92	58.1	31.7	62.5	5.9
PC16 (I,11)	3	QA=>19	0.83	68.1	38.9	56.6	4.5
PC17 (I,11)	3	1	1.55	46.5	24.7	69.1	6.3
PC17 (I,11)	3	15	1.68	50.7	24.7	69.4	5.9
PC18 (I,12)	3	1	1.48	36.1	17.6	73.8	8.6
PC18 (I,12)	3	14	0.53	72.3	43.4	51.5	5.1
PC19 (I,12)	3	2	2.15	34.0	16.9	75.6	7.5
PC19 (I,12)	3	14	1.89	61.2	35.2	61.1	3.7
PC20 (IV,13)	4	1	2.27	66.7	38.8	57.7	3.6
PC20 (IV,13)	4	19	1.62	37.6	18.6	74.0	7.4
PC21 (IV,13)	4	1	2.41	24.2	9.4	81.6	9.0
PC21 (IV,13)	4	22	1.66	32.7	14.5	77.7	7.8
PC22 (IV,14)	4	1	0.99	31.8	15.3	76.2	8.5
PC22 (IV,14)	4	22	1.85	48.4	25.7	69.9	4.5
PC22 (IV,14)	4	QA=>22	1.82	44.0	23.9	71.7	4.4
PC23 (IV14)	4	1	2.17	26.5	12.5	78.7	8.8
PC23 (IV,14)	4	22	1.82	39.0	13.4	74.1	7.6
PC24 (IV,15)	4	1	2.36	28.4	13.2	78.2	8.6
PC24 (IV,15)	4	23	1.72	76.1	46.0	50.1	4.0
PC25 (IV,15)	4	1	1.85	42.5	22.5	72.2	5.3
PC25 (IV,15)	4	22	1.84	57.7	33.3	62.9	3.8
PC26 (Anch 1)	5	1	2.32	28.9	13.4	78.1	8.5
PC26 (Anch 1)	5	QA->1	2.48	31.1	14.2	78.9	7.0
PC26 (Anch 1)	5	26	1.15	38.5	19.0	75.6	5.6
PC28 (Light. 1)	6	1	0.48	110.8	66.2	31.3	2.5
PC28 (Light. 1)	6	QA=>1	0.39	104.6	65.1	32.5	2.4
PC28 (Light. 1)	6	14	0.19	124.6	76.5	21.1	2.4

Table 8.1 continued

Core (Field, Target #)	Dive	Depth (cm)	Percent TOC	Mean Grain Size (microns)	Percent Sand	Percent Silt	Percent Clay
**SM1-1 (REF 1)		1	2.59	17.0	3.7	86.2	10.1
SM1-1 (REF 1)		10	2.58	53.5	30.7	66.0	3.4
SM1-2 (REF 1)		1	2.54	34.1	16.3	78.4	5.3
SM1-2 (REF 1)		15	2.54	29.1	12.1	80.6	7.4
SM1-3 (REF 1)		1	2.59	20.3	5.7	85.0	9.2
SM1-3 (REF 1)		14	2.32	25.7	8.9	83.0	8.1
SM1-1 (REF 2)		1	2.09	44.1	22.5	71.8	5.8
SM1-1 (REF 2)		12	1.80	29.1	14.3	77.6	8.1
SM1-2 (REF 2)		1	2.00	38.1	20.6	72.5	7.0
SM1-2 (REF 2)		QA=>1	2.08	34.6	18.7	74.7	6.6
SM1-2 (REF 2)		13	1.73	36.5	21.5	71.2	7.3
SM1-3 (REF 2)		1	1.77	37.2	22.9	69.5	7.6
SM1-3 (REF 2)		11	1.57	28.5	13.4	78.9	7.7

*PC = punch core
**SM = Smith-McIntyre sample
QA = quality assurance

At the *JSL-II* sampling locations within the IWS, the percent sand content ranged from a high of approximately 46 percent at Target Field IV, Target No. 15-154 (cross reference with Table 5.8), to a low of approximately 9.4 percent at Target Field IV, Target No. 13-176. Silt content varied from a high of approximately 81 percent at Target Field IV, Target No. 13-176, to a low of approximately 50 percent at Target Field IV, Target No. 15-154. Clay content varied from a high of approximately 12 percent at Target Field I, Target No. 10-195, to a low of 3.6 percent at Target Field IV, Target No. 13-176.

At the reference sites, surficial sand content (1-cm depth) varied from approximately 23 percent at Reference Site 2 (SM1-3 [REF 2]) to approximately 4 percent at Reference Site 1 (SM1-1 [REF 1]). Sand content at a depth of 10 to 15 cm ranged from approximately 9 percent (SM1-3 [REF 1]) to 31 percent (SM1-1 (REF 1). Surficial silt content ranged from approximately 86 percent (SM1-1 [REF 1]) to approximately 69 percent (SM1-3 [REF 2]). Silt content at a depth of 10 to 15 cm ranged from approximately 83 percent (SM1-3 (REF 1)) to approximately 66 percent (SM1-1 (REF 1)). Clay content at 10 to 15 cm ranged from approximately 8 percent (SM1-3 (REF 1) and SM1-1 [REF 2]) to 3.4 percent (SM1-1 [REF 1).

Total Organic Carbon

TOC data are presented in Table 8.1 for 18 punch cores (PC) taken within the IWS survey area and one PC taken in the former Boston Lightship disposal area. In addition, six cores from Smith-McIntyre grabs were taken at the two reference sites. Maximum TOC recorded for the IWS was 2.41 percent (Target Field IV-Target 13), and minimum was 0.29 percent (Target Field I-Target 10). The maximum TOC at Reference Sites 1 and 2 were 2.59 percent and 2.09 percent, respectively.

Inorganic and Organic Chemistry - EPA ERL-N

Three replicate Smith-McIntyre grabs were taken at each of Reference Sites 1 and 2 for inorganic and organic sediment chemistry. From each replicate, 4 cores were collected for sediment chemistry resulting in 12 cores from each site. Therefore, 24 cores were extracted for organic and inorganic sediment chemistry at the two sites.

Within the IWS, the *JSL-II* collected five punch cores (PC7, PC8, PC9, PC10, PC11; PC10 and PC11 were composited in the lab leaving four punch cores for analysis) in Target Field III and ten box cores among Target Fields I, II, and IV for inorganic and organic sediment chemistry from 14 barrels (see Table 5.8). Samples were collected less than one meter from the containers. The box core was lost during operations at Target Field III and punch-core samples were used in its place.

CLP methods were selected for this investigation (see Chapter 7) as part of a PA under Superfund. CLP analytical methods have been developed primarily for terrestrial hazardous waste site investigations. More of the CLP compounds (TAL/TCL substances) may have been detected in this survey if more sensitive methodologies were employed. Results of sediment chemical analyses are provided in Appendix Tables D.1 through D.5.

Concentrations of inorganic and organic contaminants were compared to those found in other sediment surveys from offshore or uncontaminated coastal areas, and to levels thought to be associated with adverse biological effects (Table 8.2). Trace element concentrations were compared to aluminum concentrations as an indication of anthropogenic enrichment (Figures 8.2a-g).

Laboratory Quantitation Limits

Some of the analytical results were identified by the laboratory as estimated values (Appendix D Tables D.1 through D.4). Within the inorganic analyses for example, such

values include all the arsenic (As), cyanide, antimony (Sb), selenium (Se), and mercury (Hg) results, many of the silver (Ag) and copper (Cu) results, and some of the cadmium (Cd) results. The results for inorganics, organophosphorus pesticides, PCBs and pesticides, semivolatile organics, and tentatively identified compounds (TIC) are presented in Appendix Tables D.1 through D.5.

Analytical results were flagged with the following alpha designations J, U, and UJ, if the data were estimated. The J qualifier value indicates that the contaminant was detected but its quantitation was estimated due to uncertainties identified during quality control (QC) (data) review. Values assigned with the U indicate that the contaminant was not detected, and the detection limit was raised above the contract detection limit given in the respective table. A UJ value represents values not detected, and the detection limit is estimated to the value listed in the respective table. The As data were flagged (J) due to poor matrix spike recoveries suggesting that the reported As concentrations would underestimate the amount of As present (Appendix Table D.1).

Inorganic Compounds

To determine whether sediments near the barrels contained elevated concentrations of inorganics two types of comparisons were made. First, the concentrations of the reference site samples were compared with the concentrations of all samples taken near barrels (i.e., the four target fields combined). Then, the concentrations of contaminants at the reference sites were compared to concentrations in sediment from each of the four target fields. Where concentrations were below detection limits, the detection limit was used to calculate the mean.

As a first step in these analyses, concentrations of inorganic contaminants were evaluated to determine whether they were normally distributed. This step was completed by comparing frequency distributions and histograms for the sediment concentrations from the site to an expected normal distribution. Since most of the contaminants did not appear to be normally distributed, the nonparametric Mann-Whitney U test was applied and significance was determined at $p<0.05$. This test utilizes the ranks of the measurements to determine differences between two groups of samples (Zar 1984). For the most part, the concentrations of inorganic compounds were not normally distributed.

Redundant sentence

The comparison of contaminant concentrations at the reference sites to concentrations at the combined target fields revealed no significant differences, with the exception of a significantly higher concentration of zinc (Zn) in the target field samples.

Comparisons of concentrations between the reference stations and individual target fields revealed additional differences. At Target Field II, Cd, cobalt (Co), Sb, calcium (Ca), titanium (Ti), and cyanide concentrations were significantly higher than at the reference sites. At Target Field III, concentrations of Co were significantly higher than concentrations at the reference sites. At Target Field IV, only concentrations of beryllium (Be) were significantly higher than concentrations at the reference sites. The concentrations of inorganics at Target Field I did not significantly differ from the concentrations at the reference sites.

Comparisons to other Investigations

Metal concentrations measured in this study were also compared to past studies of uncontaminated and offshore areas of the northeast Atlantic (Table 8.2). Sediment concentrations were compared to the results of the NS&T Program (coastal Maine sites only, NOAA 1991), results of the Georges Bank Monitoring Program (Bothner et al. 1985), and a compilation of data from past continental shelf studies (Champ 1974). Analytical methods vary and have altered somewhat since 1974, so the older data may not be directly comparable.

Concentrations of a few metals appear to be higher at the target fields than those reported in past studies of other areas. These include As, Cd, iron (Fe), and nickel (Ni). For the most part, concentrations of the other metals appear to be within the range of concentrations detected in other studies.

Normalization to Aluminum

Ratios of trace element concentrations to the concentration of aluminum (Al) in sediment can be a useful tool to indicate the likelihood that trace elements are enriched anthropogenically. Concentrations of seven trace elements from the target fields and reference sites were plotted with their corresponding Al concentrations. These were overlain with the relationship between concentrations of trace elements and Al from uncontaminated areas of the Southeast United States obtained from Schropp (1990) Figures 8.2 a-g.

Results of these comparisons suggest that As (Figure 8.2a) concentrations at all stations fall within the range of uncontaminated sediments. However, the data are qualified (J value, see Appendix Table D.1) due to poor matrix spike recoveries in the analysis. The low recoveries suggest that these concentrations may underestimate the amount of arsenic present. Concentrations of Ni (Figure 8.2b), Pb (Figure 8.2c), Cd (Figure 8.2d), and Zn (Figure 8.2e) at all stations, including the reference sites, lie above the range of uncontaminated sediments, indicating the possibility that these contaminants are anthropogenically enriched in this area. Some of the stations appeared to be enriched with Cu (Figure 8.2f) and chromium (Cr) (Figure 8.2g). Stations with enriched Cu include Target Field I (Targets 11-189 and 12-185), Target Field II (Target 1-193), Target Field III (Targets 5-178, 7-174, and 8-172), and Target Field IV (Targets 13-176, 15-154, and 17-147) (Appendix Table D.1). None of the reference site samples were enriched with Cu. The silver concentrations reported as detectable (4.7-5.1 mg/kg) are high for marine sediments, but the other samples in the set have reported detection limits equal to or exceeding these values, thus making the "detected" concentrations suspect. Four of the samples appear to be enriched with Cr. These include Target Field I (Target 11-189), Target Field III (Target 3-187), and Target Field IV (Targets 15-154 and 17-147). None of the reference site sample Cr concentrations fell outside the range of uncontaminated sediments.

Potential Ecological Significance

The potential ecological significance of the inorganic compound concentrations in sediments was evaluated by comparing them to past studies of biological effects associated with contaminated sediments (Table 8.2). The comparison was made between mean and maximum concentrations at the target fields, and the ER-M. The ER-M is the sediment concentration above which biological effects were usually observed (Long and Morgan 1992).

None of the mean concentrations exceeded ER-M values, with the exception of Ni, which exceeded the ER-M value of 50 mg/kg at Target Fields II and IV. The maximum concentration for Cd was greater than the ER-M value of 9 mg/kg at Target Field II. Maximum concentrations for Cr were greater than the ER-M value of 145 mg/kg at Target Field IV.

Overall, the potential for adverse effects as a result of these metal concentrations is judged to be low to moderate, with concentrations of Ni, Cd, and Cr presenting the greatest potential concern at Target Fields II and IV.

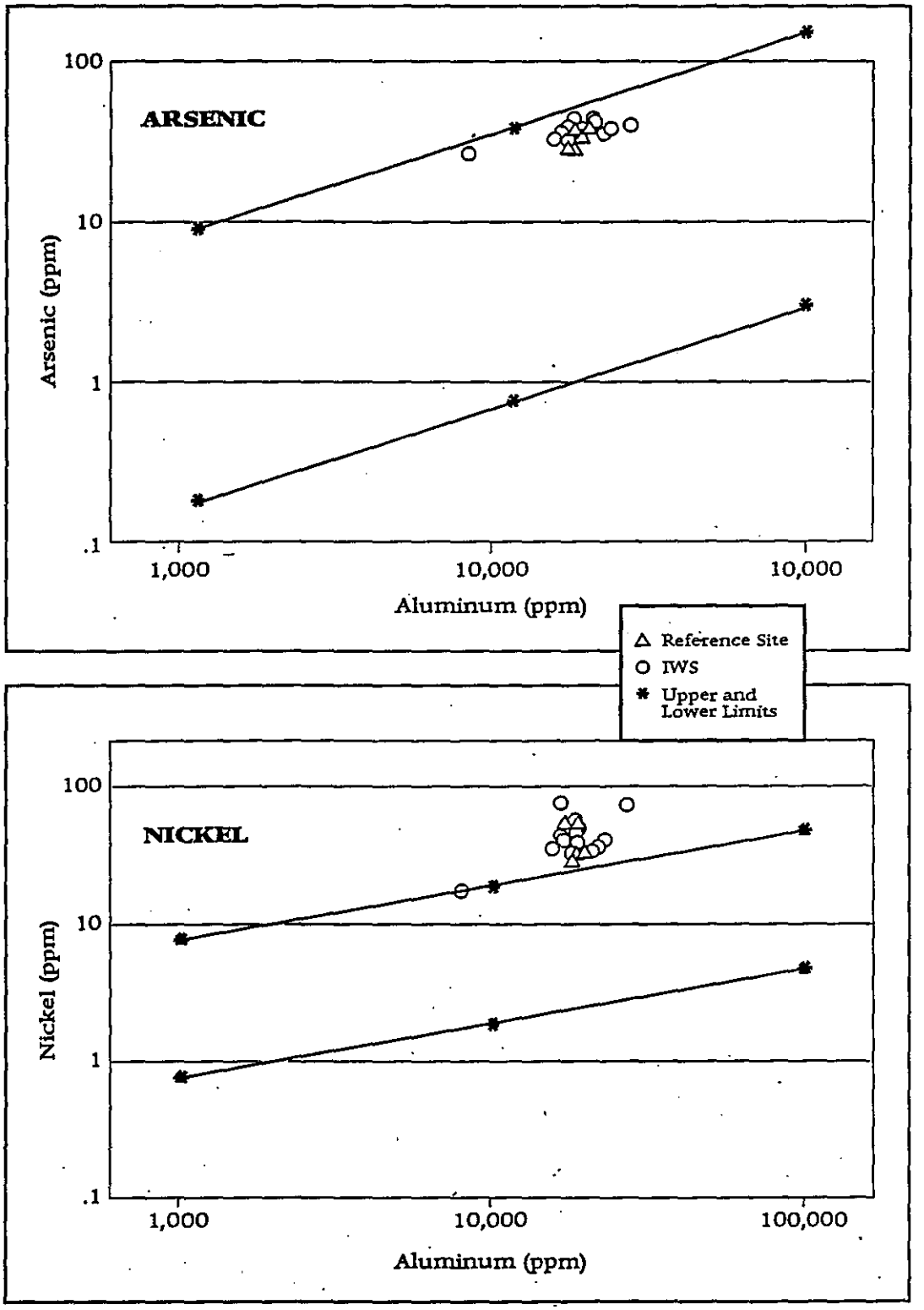

Figure 8.2a and 8.2b. Relationship between Al, and As, and Ni concentrations in sediment near the IWS as compared to those from uncontaminated areas (Schropp 1990). The upper and lower 95 percent confidence intervals are around the mean for uncontaminated areas.

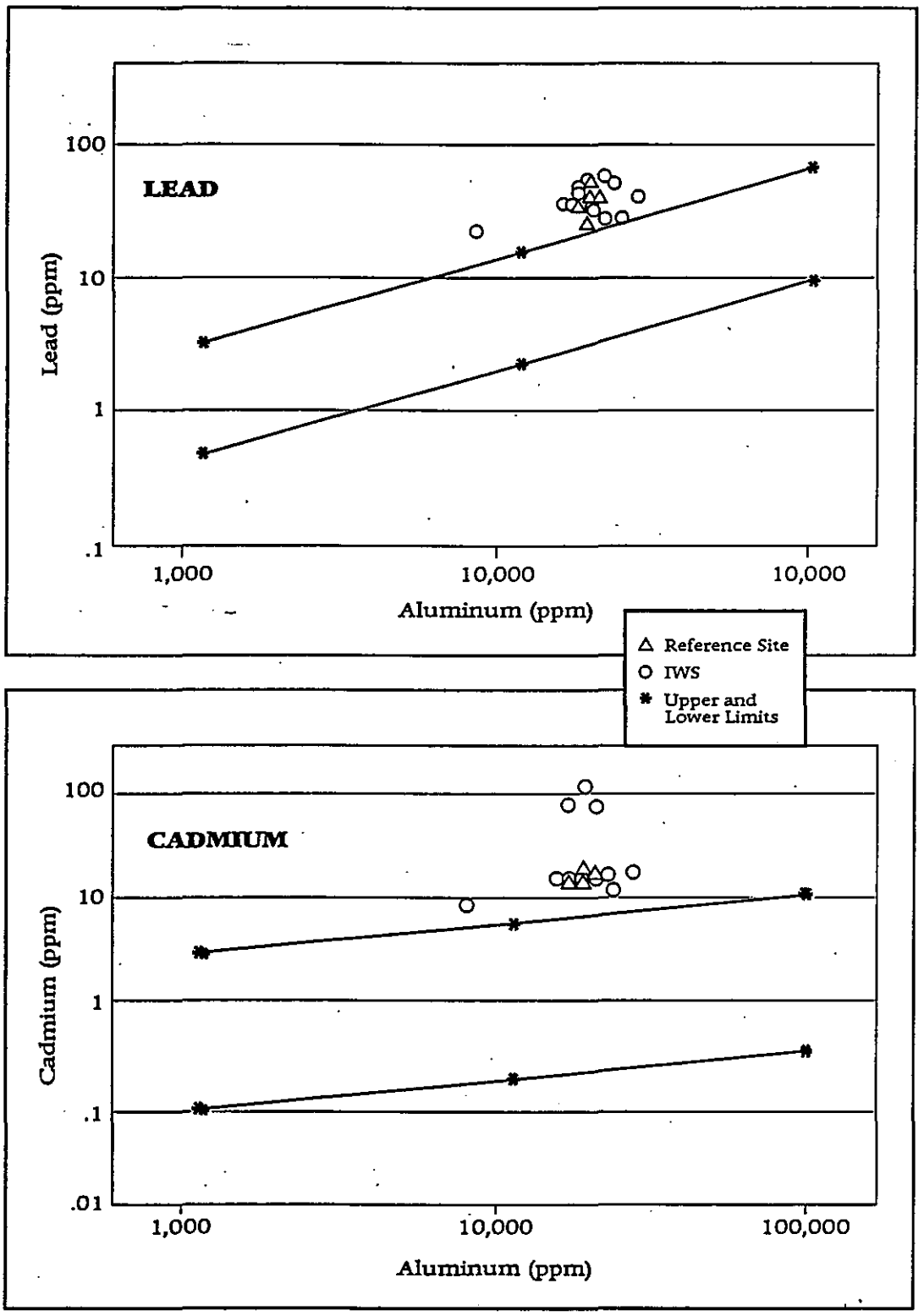

Figure 8.2c and 8.2d. Relationship between Al, and Pb, and Cd concentrations in sediment near the IWS as compared to those from uncontaminated areas (Schropp 1990). The upper and lower 95 percent confidence intervals are around the mean for uncontaminated areas.

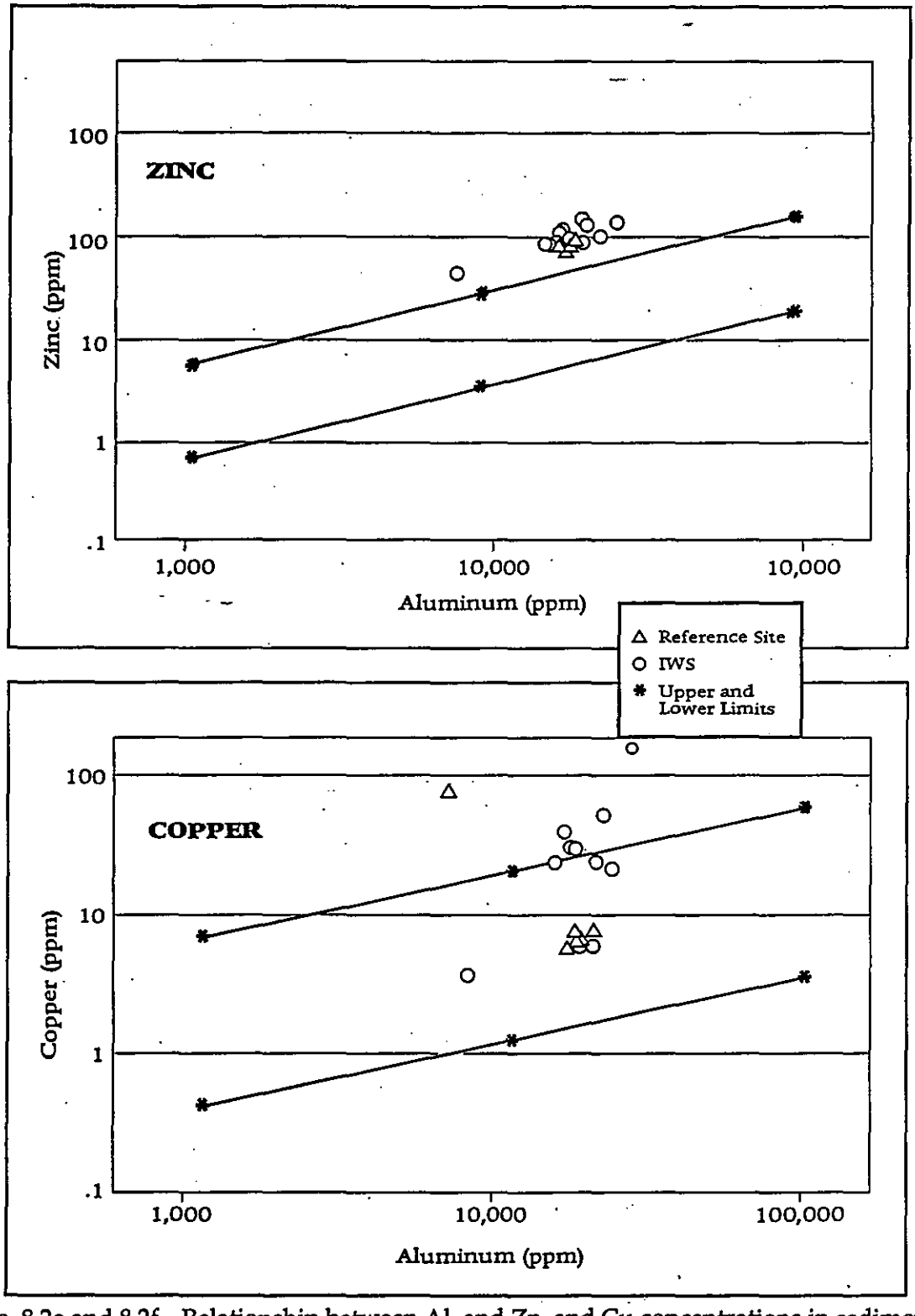

Figure 8.2e and 8.2f. Relationship between Al, and Zn, and Cu concentrations in sediment near the IWS as compared to those from uncontaminated areas (Schropp 1990). The upper and lower 95 percent confidence intervals are around the mean for uncontaminated areas.

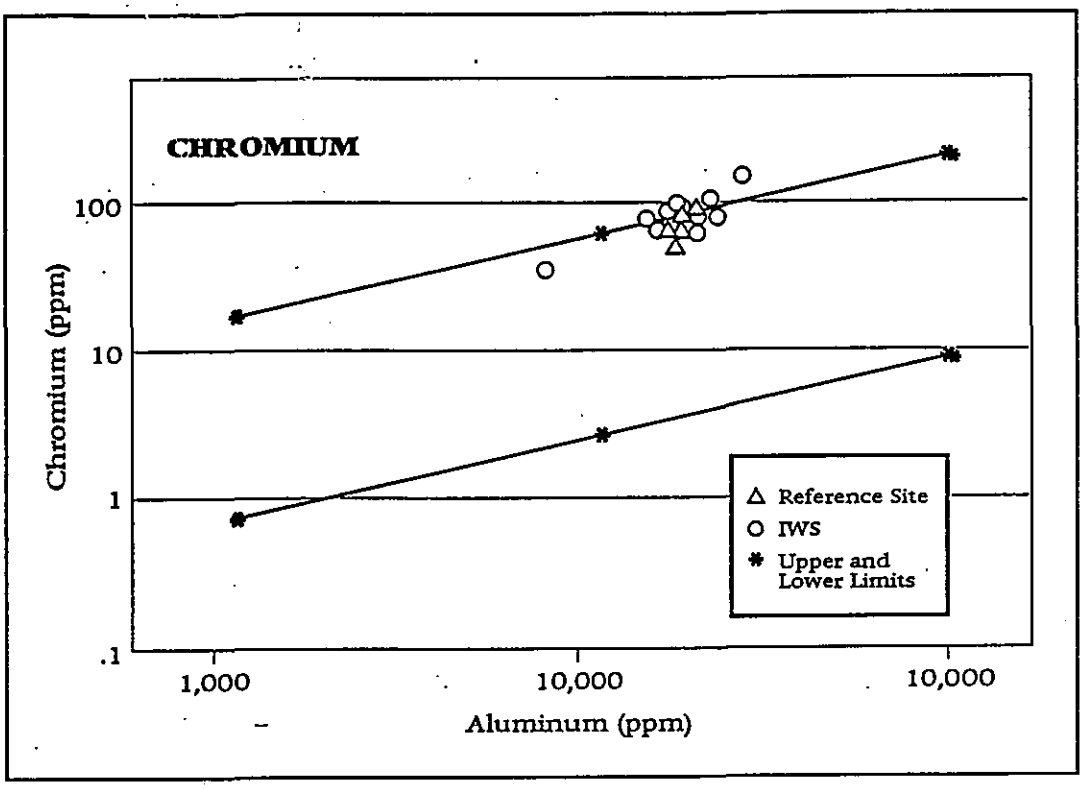

Figure 8.2g. Relationship between Al, and Cr concentrations in sediment near the IWS as compared to those from uncontaminated areas (Schropp 1990). The upper and lower 95 percent confidence intervals are around the mean for uncontaminated areas.

Summary

Cd shows significantly elevated levels above the reference sites in some IWS samples. When normalized for Al, Cd levels appear to be relatively enriched in comparison to other samples analyzed in the region. Cd levels are also higher than literature values recorded for the region, and Cd concentrations sometimes exceeded values that have been associated with biological affects (e.g., ER-M). Some other elements were elevated in selected samples, but not to the same extent as Cd.

Organic Compounds

Concentrations of organic contaminants were uniformly low (Appendix Tables D.2 through D.4); however, it should be noted that these were based upon estimated values. Most of the compounds were below detection limits. All organophosphorus pesticides, all PCB mixtures, and most of the organochlorine pesticides were below raised or estimated detection limits. Several organochlorine pesticides were detected at low concentrations, but

these concentrations were at raised or estimated detection limits. These include DDE, DDD, DDT, gamma-benzohexachloride (BHC), beta-BHC, aldrin, heptaclor epoxide, endosulfan I and II, dieldrin, and gamma-chlordane. Concentrations of these compounds were below three parts per billion (ppb) dry weight. Many of these compounds were detected at the reference sites as well as at the target field sites. These concentrations have been associated with adverse effects in past studies (Long and Morgan 1992), but confidence in these associations is low. These concentrations are found in many coastal areas (NOAA 1991).

A series of PAHs was also detected in most of the samples (Appendix Table D.4.). PAHs are usually present in surface-sediment samples. The PAH distributions seen are common and indicate a combustion source. Total PAH levels would be considered to pose a moderate toxic threat at concentrations of 35.0 parts per million (ppm), or at concentrations approximating 3,600 ppb for the most toxic of individual compounds, such as fluoranthene (Long and Morgan 1992).

2,6-dinitrotoluene (DNT) was detected (<15 ppb) in two samples (Target Nos. 2-189 = TFII,T2 and 17-147 = TFIV,T17, Appendix Table D.4.) None of the amine compounds were detected, but the QA results indicate problems with these analyses. DNT is a common ingredient of military and commercial explosives, but it is also an intermediate in the commercial production of polyurethanes and in dye processes. The QA results suggest that the methods employed for the amine compounds did not work properly, therefore, the absence of these compounds is inconclusive.

Table 8.2. Summary of mean inorganic concentrations (mg/kg dw) collected from sediments within the IWS and reference sites in May and June 1992 with a comparison to ER-M values and observations from other investigations (ERL-N).

SITE:	Aluminum ppm dw	Antimony ppm dw	Arsenic ppm dw	Barium ppm dw	Beryllium ppm dw	Cadmium ppm dw	Calcium ppm dw	Chromium ppm dw	Cobalt ppm dw
All Reference									
mean	18783		33.4	83.6	2.2	BD	5955	76.1	9.4
SD	1114		4.5	4.5	0.1		2734	16.6	2
range	17300-20700	<15.9-20	28.8-38.6	76-87	2.1-2.4	<1.4-<1.8	4400-11500	51.9-95.7	6.4-11.8
Target Field 1									
mean	15917	BD	32.5	65.6	2.2	BD	5483	75.7	8.3
sd	7211		5.9	26.8	0.9		2769	36.8	3.6
range	8150-22400	<9.8-<19.4	25.7-36.6	38.9-92.5	1.2-3	<0.84-<1.7	2590-8110	36.8-110	4.4-11.4
Target Field 2									
mean	18933	BD	38.3	84.7	2.2	8.8	10473	69.3	14.4
sd	2154		3.6	7	0.3	2.4	4041	2.6	2
range	16700-21000	<14.5-<15.8	35.2-42.2	77.3-91.3	1.9-2.5	7.2-11.5	5820-13100	66.4-71.4	12.4-16.4
Target Field 3									
mean	20150	BD	36.6	79.8	2.6	BD	5635	82.7	13.15
sd	2750		3.1	20	0.3		1014	10.5	2.5
range	17400-23700	<13.7-<17.5	32.2-39.4	60-98.9	2.3-2.9	<1.2-<1.5	4620-6920	68.7-91.2	11.7-16.9
Target Field 4									
mean	19900	BD	37	93.9	2.9	BD	5700	106.5	14
sd	5122		4.6	20.6	0.5		1732	33.1	8.2
range	15500-27300	<17-<18.6	31.6-41.7	88.4-123	2.5-3.6	<1.5-<1.6	4180-8120	77.8-153	8.3-25.8
All Target Fields Combined									
mean	18910	16.3	36.2	81.8	2.5	1.6		85.1	12.6
sd	4400	2.4	4.3	20.4	0.6	0.2		26.6	5
range	8150-27300	<9.8-20	25.7-42.4	38.9-123	2.1-3.6	<0.84-11.5	2590-13100	36.8-153	4.4-25.8
ER-M			85			9		145	
Past Studies Range									
1-Offshore Delaware						0.02-0.21		1-5.01	
2-Coastal Maine		0.71-3.9	11.0-20.0			0.09-0.56		90-170	
3-Georges Bank	1500-52000					<0.02-0.098		<2-68	

ER-M values from Long and Morgan (1992)

1: Champ, 1974

2: NOAA, 1991 (values reported are means of concentrations measured between 1984 and 1989)

3: Bothner et al., 1985

Table 8.2. (continued)

SITE:	Copper ppm dw	Iron ppm dw	Lead ppm dw	Magnesium ppm dw	Manganese ppm dw	Mercury ppm dw	Nickel ppm dw	Potassium ppm dw	Selenium ppm dw
All Reference									
mean	BD	29983	45.9	11275	301.7	0.36	41.9	5783	BD
SD		2536	11.8	987	19.9	0.13	10.3	313	
range	<6.4-<8.3	26000-33500	28-60.8	9850-12600	272-332	<0.23-0.54	29.9-53.8	5500-6100	<1.4-<1.8
Target Field 1									
mean	31	28900	42	8787	336.3	0.3	32.4	5023	2.2
sd	26.4	9924	17	3465	157.4	0.08	12.7	2253	1.7
range	<3.9-56.6	17600-36200	23.1-56.2	5000-11800	173-487	0.23-0.39	17.9-37.8	2560-6980	<0.84-4.1
Target Field 2									
mean	17.9	34233	35.1	12733	310	0.37	56.6	5480	BD
sd	20.1	10097	2.8	1904	22	0.17	24.2	646	
range	<6.2-41.1	26000-45500	32.1-37.6	14700-12600	296-335	<0.21-0.54	34.8-82.6	4920-6140	<1.3-<12.4
Target Field 3									
mean	22.6	33450	46.5	11425	326	0.27	39.5	6277	BD
sd	11.3	5496	14.4	1459	52	0.1	3.2	1256	
range	<7-33.9	28400-40700	31.6-63.1	10500-13600	285-401	<0.2-0.38	35.6-42.5	5210-8090	1.2-1.5
Target Field 4									
mean	60.1	44250	47.7	12025	347.5	0.29	50.9	5798	BD
sd	77.4	23699	8.1	2668	100.6	0.06	21.1	832	
range	<7.1-175	28700-79300	38.9-58.5	9800-15900	273-496	<0.25-0.38	32-77.3	5030-6980	<1.5-<1.8
All Target Fields Combined									
mean	34.1	35728	43.4		330.9	0.3	44.9	5783	1.6
sd	43.5	14235	11.6		84	0.1	17.5	313	0.17
range	<3.9-175	17600-79300	23.1-63.1	5000-15900	173-496	<0.2-0.54	17.9-82.6	7560-8090	<0.84-4.1
ER-M	390		110			1.3	50		
Past Studies Range									
1-Offshore D	<0.06-2.79	866-5124	0.7-8.8		3-188	0.008-0.1	0.17-3.4		
2-Coastal Mai	17-37		29-88			0.02-0.24	6.0-37.0		0.03-1.5
3-Georges Ba	<1-16	800-28000	1.5-29		54-410	0.01-0.04	<2-40		

Table 8.2. (continued)

SITE:	Silver ppm dw	Sodium ppm dw	Thallium ppm dw	Vanadium ppm dw	Zinc ppm dw	Titanium ppm dw	Zirconium ppm dw	Cyanide ppm dw
All Reference								
mean	BD	21700	BD	70.4	99.8	1083.3	14.5	BD
SD		3560		9.1	10	57.5	4.6	
range	<4.1-<5.3	17600-25500	<1.8-<2.4	59.3-85.5	84.4-112	1050-1150	11.0-23.6	<2.3-<2.9
Target Field 1								
mean	BD	15607	BD	63.2	105.5	911.7	11.03	BD
sd		7066		23.7	53.2	407.9	3.7	
range	<2.5-<5	8020-22000	<1.1-<2.2	36.7-82.3	48.6-155	455-1240	6.8-12.9	<1.4-<2.8
Target Field 2								
mean	4.4	15466	BD	62.9	130.7	988.3	21.4	BD
sd	0.6	2230		6	31.4	72.2	2.8	
range	<4-5.1	13800-18000	<1.7-<1.8	56.3-67.9	106-166	905-1030	18.7-24.2	<2.1-<2.3
Target Field 3								
mean	4.3	19800	BD	73.2	116.3	1135.8	16.8	BD
sd	0.5	1878		9.2	10.4	138.9	1.4	
range	<3.5-4.7	18300-22500	<1.6-<2	62.6-84.7	105-123	963-1290	15.3-18.6	<2-<2.5
Target Field 4								
mean	BD	20900	BD	83	126.5	1187.3	13.3	BD
sd		3881		19	27.5	295	2.7	
range	<4.4-<4.8	18600-26700	<1.9-<2	68.5-111	101-164	969-1620	11.8-17.3	<2.4-<2.7
All Target Fields Combined								
mean	4.8	21700	BD	71.6	120	1070.9	15.6	BD
sd	0.5	3560		16.4	29.8	252.6	4.5	
range	<2.5-5.3	8020-26700	<1.1-<2.3	36.7-111	48.6-164	455-1620	6.8-24.2	<1.4-<2.9
ER-M	2.2				270			
Past Studies Range								
1-Offshore Delaware					1.03-12.54			
2-Coastal Mai	0.06-0.31				85-190			
3-Georges Bank				<2-97	0.2-71			

Sediment Radionuclides - EPA EMSL-LV

Radionuclide analyses were performed on 15 sediment samples: 3 samples each from Reference Sites 1 and 2; 6 punch core samples by the *JSL-II* in Target Field IV, Anchorage L; and, 3 health physics samples taken from sediments removed from the R/V *Gloria Michelle's* anchor during the ROV survey. Three of the punch core samples (PC20, 21, and 22) from Target Field IV, collected on *JSL-II* Dive Number 2346, were taken near barrel Targets 13-176 and 14-160 (see Table 5.8). Additional punch cores (PC23, 24, and 25) were taken on the same dive near Target 15-154[1]. Target 15-154 was considered near the area dragged by the R/V *Gloria Michelle* anchor that picked up mud contaminated with ^{90}Sr.

Only the 0-5 cm depth horizon was examined from each core or grab sample analyzed, except PC20 in which the 0-10 cm horizon was analyzed. A summary of the laboratory sediment results is presented in Table 8.3; a full listing of the results is located in Appendix Table D.6. The results indicate the two-sigma error, representing the 95 percent confidence level, and the MDA for most samples. The MDA is the lowest concentration of radioactive material sampled that has a 95 percent probability of detection.

Cesium-137 and Iodine-131

The 15 samples from the IWS and the reference sites were also analyzed for ^{137}Cs and ^{131}I. After a field examination determined that three samples did not contain gamma emitting nuclides, they were not analyzed using gamma spectroscopy (see Chapter 6).

None of the 15 samples indicated the presence of ^{131}I. This result was expected considering the half-life of this gamma emitting radionuclide is only 8.05 days. Any ^{131}I from historical dumping at the IWS would have decayed away within months.

Positive readings for ^{137}Cs, a gamma emitting radionuclide with a half-life of approximately 30 years, were found in 4 of the 15 sediment samples (Appendix Table D.6.) The levels detected in the sediment samples were in the pCi/g range (1 pCi = 10^{-12} Curie). These levels are most probably due to fallout from the atmospheric testing of nuclear

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1 Target 15 corresponds to Target 4 on the EMSL-LV laboratory data sheet in Appendix D.

PC27 taken at Target Field III, Target 19-141 was not analyzed by ESML-LV as originally intended.

Federal Radiation Council Report estimates that the deposition of fallout in the New England area was 30-60 μCi (1 microcurie = $10e^{-6}$ Ci) per square mile. This concentration would equate to a deposition of between 124 μCi and 249 μCi in the 3.14 nm^2 IWS.

Table 8.3. Radionuclide sediment concentrations measured in pCi/g (EMSL-LV)

Sample Location	Sample Type	Analyte	Result	Two-Sigma	MDA
Reference Site 2 Replicate 1	Smith-McIntyre	Cs-137	2.52	1.54	—
		I-131	0	0	75.4
		Pu-238	0.001	0.002	0.00225
		Pu-239	0.052	0.01	0.00225
		Sr-90	0.065	0.102	0.182
Replicate 2		Cs-137	1.99	1.51	—
		I-131	0	0	69.3
		Sr-90	-0.01	0.09	0.169
Replicate 3		Cs-137	0	0	2.24
		I-131	0	0	70.5
		Pu-238	0.001	0.001	0.0015
		Pu-239	0.04	0.007	0.0015
		Sr-90	-0.004	0.06	0.122
Reference Site 1 Replicate 1		Cs-137	0	0	2.67
		I-131	0	0	63.9
		Pu-238	0.002	0.003	0.00355
		Pu-239	0.056	0.009	0.00159
		Sr-90	0.023	0.085	0.172
Replicate 2		Cs-137	0	0	4.05
		I-131	0	0	112
		Sr-90	-0.2	0.19	0.445
Replicate 3		Cs-137	4.65	2.68	
		I-131	0	0	80.6
		Pu-238	0.005	0.003	0.00131
		Pu-239	0.064	0.01	0.00131
		Sr-90	0.047	0.09	0.177
Anchor Sediment 1	Health Physics	Pu-238	0.001	.00007	0.00079
		Pu-239	0.011	0.002	0.00079
		Sr-90	85.3	1.48	2.44
Anchor Sediment 2		Sr-90	133	1.33	2.19
Anchor Sediment 3		Sr-90	671	4.04	6.65
Target Area IV Target 13-176	Punch Core 20 (0-10 cm)	Cs-137	0	0	2.47
		I-131	0	0	31.8
		Pu-238	0.000	0.001	0.00203
		Pu-239	0.03	0.004	0.00106
		Sr-90	0.002	0.058	0.139

Table 8.3 continued

Sample Location	Sample Type	Analyte	Result	Two-Sigma	MDA
Target Area IV					
Target 13-176	Punch Core 21	Cs-137	0	0	3.14
	(0-5 cm)	I-131	0	0	46.6
		Pu-238	0	0.0008	0.00116
		Pu-239	.0007	0.004	0.00094
		Sr-90	0.030	0.053	0.129
Target Area IV					
Target 14-160	Punch Core 22	Cs-137	0	0	2.21
	(0-5 cm)	I-131	0	0	36.2
		Pu-238	3E-04	8E-04	0.00116
		Pu-239	0.03	0.004	0.00051
		Sr-90	-0.01	0.055	0.134
Target Area IV					
Target 14-160	Punch Core 23	Cs-137	2.48	1.83	
	(0-5 cm)	I-131	0	0	42
		Pu-238	0.001	0.001	0.0012
		Pu-239	0.007	0.041	0.0012
		Sr-90	0.053	-0.01	0.127
Target Area IV					
Target 15-154	Punch Core 24	Cs-137	0	0	3.04
	(0-5 cm)	I-131	0	0	52.8
		Pu-238	0.0006	0.003	0.0045
		Pu-239	0.062	0.01	0.0023
		Sr-90	0.005	0.056	0.137
Target Area IV					
Target 15-154	Punch Core 25	Cs-137	0	0	2.54
	(0-5 cm)	I-131	0	0	41.4
		Pu-238	0.001	0.0009	0.001
		Pu-239	0.043	0.005	0.009
		Sr-90	-0.02	0.055	0.128

Strontium-90

As described above 15 sediment samples were also analyzed for ^{90}Sr, including the 3 health-physics samples taken from sediments removed from the R/V *Gloria Michelle's* anchor during the ROV survey. These three samples indicated positive results. The vessel's anchor apparently had been dragged through a barrel (see Chapter 6). Using survey instruments that indicate only beta emitting nuclides, health physicists isolated contaminated sediments, and packaged the samples for shipment to EMSL-LV for intensive analysis. The maximum ^{90}Sr (a beta-emitting isotope with a half life of 29 years) levels in aliquots of three samples ranged from 85.3 to 671 pCi/g. These levels are greater than might

be expected if atmospheric fallout had been the source. The health-physics samples are not comparable to punch-core samples as they do not accurately reflect conditions at the site.

Plutonium

Of the 12 sediment samples collected by the R/V *Ferrel* and the *JSL-II*, 11 were analyzed for ^{238}Pu and ^{239}Pu. Four sediment samples from the reference areas showed low levels of ^{238}Pu between 1 and 5 femtocurie per gram (fCi/g). This nuclide is a transuranic element with a half-life of 87 years and its presence is most probably due to atmospheric fallout from weapons testing in the early 1960s. All 11 samples contained low levels of ^{239}Pu, a transuranic radionuclide with a half-life of 24 to 390 years. The levels detected ranged from 11 to 64 fCi/g, which agrees with results reported by the Massachusetts Water Resources Authority in its January 8, 1990, technical memorandum the *Marine Resources Extended Monitoring Program*. The most probable source of ^{239}Pu is also atmospheric fallout.

Radionuclides - Sediments - MDPH

Eighteen analyses for gamma emitting radionuclides were conducted on sediment from the two reference areas. The only radionuclide found in the samples was naturally occurring potassium-40 (^{40}K). The results of these analyses are found in Table 8.4. No radionuclides were detected in the sediment sample taken from the bow anchor.

Table 8.4. Results of reference station sediment analyses for gamma emitting radionuclides - MDPH

Station	MERL ID#	Sample Weight Kg	Count Time Seconds	^{40}K pCi/Kg	Error ± 1 Sigma
REF Area 1 Rep 1	92D0562 top	6.41 E-2	60,000	1.73 E+5	3.36 E+3
	92D0562 middle	6.29 E-2	10,000	3.65 E+4	8.81 E+3
	92D0562 bottom	4.91 E-2	8,000	4.90 E+4	1.07 E+4
REF Area 1 Rep 2	92D0560 top	3.60 E-2	60,000	2.69 E+5	6.00 E+3
	92D0560 middle	5.06 E-2	7,200	3.17 E+4	6.19 E+3
	92D0560 bottom	8.49 E-2	10,000	4.35 E+4	6.65 E+3
REF Area 1 Rep 3	92D0559 top	8.71 E-2	60,000	3.96 E+4	3.07 E+3
	92D0559 middle	7.34 E-2	7,200	2.47 E+4	7.93 E+3
	92D0559 bottom	6.27 E-2	7,200	5.83 E+4	1.00 E+4
REF Area 2 Rep 1	92D0563 top	6.44 E-2	60,000	1.73 E+5	3.20 E+3
	92D0563 middle	8.56 E-2	10,000	1.22 E+5	5.32 E+3
	92D0563 bottom	7.04 E-2	58,751	4.84 E+4	3.99 E+3
REF Area 2 Rep 2	92D0561 top	8.01 E-2	10,000	4.77 E+4	6.61 E+3
	92D0561 middle	6.03 E-2	60,000	1.71 E+5	3.39 E+3
	92D0561 bottom	9.47 E-2	58,655	4.39 E+4	3.02 E+3
REF Area 2 Rep 3	92D0564 top	1.02 E-1	10,000	4.43 E+4	5.24 E+3
	92D0564 middle	5.94 E-2	10,000	1.81 E+5	8.20 E+3
	92D0564 bottom	6.40 E-2	10,000	1.76 E+5	7.91 E+3

Biota

Lobster Trap Survey - NOAA/FDA

A summary of the catch effort used to collect fish and shellfish within the IWS and at Reference Site 2 is provided in Table 8.5. More than 360 hours of fishing with a variety of traps, including lobster, fish, and eel traps yielded relatively few specimens as shown in Table 8.6. A total of four wrymouth (*Cryptocanthodes maculatus*) represents the only organisms captured in the lobster traps at Reference Site 2. The wrymouth, a single ocean pout (*Macrozoarces americanus*), and a single cod (*Gadus morhua*) represent the only fish captured in lobster traps at the reference site or the IWS.

Several spider crabs (*Lithodes maja*) and two specimens of the whelk, *Colus stimpsoni*, were the only shellfish invertebrates, other than American lobsters, recovered from the trap fishing within the IWS. No organisms were collected from any of the experimental fish traps or eel traps. [Note: no biota sampling was attempted at Reference Site 1.]

Table 8.5 Summary of the level of effort for the lobster, fish, and eel trap survey at the Massachusetts Bay IWS and vicinity, May 26 to June 2, 1992, (NOAA).

Date Deployed	Station	Approximate hours fished	Number of Trap Lines	Number. of Lobster Traps	Number of Fish Traps	Number of Eel Traps
5/26/92	REF 2	45	2	10	2	0
5/27/92	*TA I	40	2	12	1	1
5/28/92	TAII	45	2	10	2	1
5/28/93	TAIII	45	2	10 (1 lost)	2	1
5/29/93	TA I	22	2	10	2	1
5/29/93	TA IV	23	2	10	2	1
5/30/93	TA IV	69	3	18 (2 lost)	0	0
5/30/93	TA III	24	4	20	4	1 (lost)
5/31/93	REF 2	49	1	5	1	0

*TA = Target Area (Field): see map Figures 4.2 and 5.2.

Only 11 lobsters were collected with the lobster traps placed within the IWS. No lobsters were collected at Reference Site 2. Carapace lengths of all individuals taken within the IWS varied between 59 mm and 90 mm (Table 8.6). Males were predominate.

Within the IWS, Target Area III yielded the greatest number of American lobsters (five). No apparent difference was obvious on the localized distribution of American lobsters among the target areas.

Species collected in the lobster traps and analyzed for chemical body burdens are presented in Table 8.6.

Table 8.6. Inventory of species collected in lobster traps set by the R/V *Ferrel* from May 26 through June 2, 1992, at the Massachusetts Bay IWS (Target Areas I-IV) and reference site 2 (see Figure 5.2).

Date	Station	Species	Length	Weight (grams)	Trawl and Trap Numbers
5/28/92	REF2	wrymouth	76 cm	1260	Trawl 1A trap #3
		wrymouth	75 cm	840	" " " "
		wrymouth	76 cm	1220	" " " "
5/29/92	Target Area I	lobster (m)	78 mm	370	Trawl 1A trap #4
		lobster (m)	71 mm	266	Trawl 1B trap #5
		whelk	117 mm	105	Trawl 1B trap #5
		spider crab (f)	92 mm	433	Trawl 1B trap #3
		spider crab (f)	99 mm	533	Trawl 1B trap #2
5/30/92	Target Area I	wrymouth	69 cm	862	Trawl 1A trap #5
		whelk	108 mm	89	Trawl 1B trap #5
5/30/92	Target Area II	lobster (m)	77 mm	360	Trawl 2B trap #4
5/30/92	Target Area III	lobster (m)	78 mm	280	Trawl 3A trap #3
		lobster (m)	59 mm	160	Trawl 3A trap #4
5/31/92	Target Area III	lobster (m)	88 mm	390	Trawl 1B trap #3
		lobster (m)	75 mm	288	Trawl 1B trap #1
		cod	58 cm	2000	Trawl 1B trap #2
		spider crab (f)	80 mm	320	Trawl 1A trap #4
		lobster (m)	78 mm	305	Trawl 1A trap #3
		ocean pout	57 cm	1000	Trawl 1A trap #2
6/2/93	REF 2	wrymouth	81 cm	1587	Trawl 1A trap # 5
6/2/92	Target Area IV	wrymouth	86 cm	1887	Trawl 2A trap #4
		lobster (f)	78 mm	397	Trawl 2A trap #2
		lobster (m)	90 mm	765	Trawl 2A trap #5
		lobster (f)	81 mm	425	Trawl 4A trap #3

(m) = male
(f) = female
spider crab length = carapace width
fish length = total
lobster length = carapace length

Otter Trawl Survey - FDA

The otter trawls taken at eight locations around the perimeter of the IWS provided 17 species of fish, 4 species of shellfish, and a squid. Individuals from species considered edible commercial species were pooled into composite samples to evaluate the potential human-health risks. Select individuals in excess of those required for human-health risk assessment or individuals of select species not considered commercial species, were retained for either radionuclide analysis or chemical analyses from which to infer the potential ecological risk by NOAA. A species inventory by catch weight (kg) of all fish and shellfish collected at the eight trawl sites is presented in Table 8.7 An inventory of the fish and shellfish collected at Sites 1 through 8 is presented in Appendix Tables D.7 a-h, respectively.

A total of 117 American lobsters were collected from the eight trawl sites. Male lobsters predominated the catch. Lobster carapace lengths at the perimeter trawl sites were measured to the nearest centimeter. Average carapace lengths varied from 7 to 9 cm (Appendix Table D.7a-h).

At the perimeter sites, the fewest lobsters per trawl, 2, 0, and 2, came from Sites 5, 7, and 8, respectively. These sites are located on the north and northeast perimeter of the IWS and MBDS. The total number of lobsters in trawls from the other sites varied from 19 to 33.

Fish and Shellfish Tissue Organic and Inorganic Chemistry -FDA

Human Health Perspective

Two of the primary survey objectives focused on evaluations of contaminant body burdens in edible seafood and the potential risk, if any, associated with consumption of seafood harvested near the IWS.

Pesticides and PCBs

Nearly all (41 of 43) the fish and shellfish (sea scallop) samples showed non-detectable levels of pesticides (Table 8.8). Neither of the two remaining samples had levels exceeding trace amounts. Most (6 of 11) samples of lobster meat had non-detectable levels of pesticides, and of the remaining five samples, only one sample from within the IWS (note: no lobster meat sample was available for analysis at Target Field IV), had no more than trace amounts (Tables 8.9 and 8.10). In contrast, 11 of the 12 samples of lobster tomalley (three from within the IWS) had measurable levels of DDE (0.03-1 to 12 ppm). The action level for DDT/DDE/DDD is 5 ppm in the edible portion of seafood. Octachlor epoxide (aka

oxychlordane) was found in 4 of 12 samples of tomalley (0.03-0.09 ppm). The FDA action level for chlordane, including oxychlordane, is 0.3 ppm.

Table 8.7 Cumulative weight, in kilograms (kg), of seafood harvested and subsamples for chemical analysis at the conclusion of eight otter trawls taken on May 31 and June 2, 1992, by the NOAA R/V *Gloria Michelle*, around the perimeter of the Massachusetts Bay IWS and MBDS. (FDA).

Species	Total Catch Weight (kg)	Total Sub-Sample Weight (kg)	Number of Samples
No winter flounder collected			
* redfish	57	31	7
*American lobster	72	53	8
*goosefish	11	11	1
*American plaice	320	69	7
*witch flounder	32	23	6
*cod	103	89	9
*yellowtail flounder	20	19	4
*ocean pout	103	42	4
*winter flounder	35	23	2
*sea scallops	4	4	4
Atlantic herring	0.9		
longhorn sculpin	42		
skate	65		
sea raven	3		
Pandalid shrimp	0.5		
rock crab	1		
dogfish	7		
silver hake	1		
wolffish	13		
squid	———		
blueback herring	———		

* Analyzed for body burdens.

Alpha-benzohexachloride (α-BHC), a relatively non-toxic isomer of lindane, was found in 2 of 12 samples of tomalley (0.03 and 0.07 ppm, Tables 8.9 and 8.10). No FDA action-level criterion exists for α-BHC in seafood. For reference, the action level of BHC in frog legs is 0.3 ppm.

Table 8.8 Fish and shellfish samples analyzed for pesticides, PCBs and trace elements (ppm ww) collected at otter trawl Stations 1 through 8 (May/June 1992) around the perimeter of the IWS (FDA).

FDA Sample No.	Site	Species	Pesticide	PCB[1]	meHg	As	Pb	Cd
92-660-628	1	American plaice	none	none	0.02	0.61	0.06	none
92-660-630	1	sea scallop	none	.39*	0.04	1.24	0.051	0.157
92-660-661	1	winter flounder	none	none	0.02	2.86	0.027	none
92-660-662	1	yellowtail flounder	none	none	0.04	7.37	0.051	0.092
92-660-663	1	cod	none	none	0.12	8.9	none	none
92-660-664	1	goosefish	-[2]	-[2]	-[2]	-[2]	-[2]	-[2]
92-660-665	1	redfish	none	trace	0.12	1.42	none	none
92-660-631	2	American plaice	none	none	0.02	0.45	0.03	none
92-660=633	2	sea scallop	none	none	0.07	2.76	0.027	0.547
92-660-666	2	redfish	none	trace	0.03	1.84	+[3]	+[3]
92-660-667	2	witch flounder	none	trace	0.03	0.48	0.018	none
92-660-668	2	cod	none	none	0.08	4.48	none	none
92-660-634	3	American plaice	none	trace	0.04	1.80	none	none
92-660-636	3	sea scallop	none	trace	0.04	NA[4]	0.026	none
92-660-669	3	cod	none	trace	0.10	3.67	0.03	none
92-660-670	3	redfish	none	trace	0.08	1.1	0.043	none
92-660-671	3	witch flounder	none	trace	none	0.09	0.109	none
92-660-637	4	American plaice	none	none	0.01	0.83	0.036	none
92-660-672	4	redfish	none	trace	0.09	0.61	none	none
92-660-673	4	witch flounder	none	none	0.01	0.08	0.029	none
92-660-674	4	cod	none	trace	0.11	0.49	none	none
92-660-675	5	ocean pout	none	trace	0.07	0.24	0.029	none
92-660-676	5	cod	none	none	0.05	0.95	0.049	none
92-660-641	6	American plaice	none	trace	0.05	4.25	0.045	none
92-660-643	6	sea scallop	none	0.62*	0.08	1.82	0.014	0.221
92-660-677	6	cod	none	trace	0.04	1.08	0.096	none
92-660-678	6	witch flounder	none	trace	0.02	0.47	0.058	none
92-660-649	6	cod	none	none	0.17	0.49	none	none
92-660-650	6	redfish	none	trace	0.2	1.29	none	none
92-660-679	6	ocean pout	none	trace	0.08	5.44	0.006	none
92-660-680	6	yellowtail	none	trace	0.08	1.77	none	none
92-660-644	7	American plaice	none	none	0.06	1.10	0.111	none
92-660-651	7	redfish	trace[5]	trace	0.05	0.99	0.109	none
92-660-652	7	yellowtail	trace[5]	trace	0.04	0.26	0.045	none
92-660-653	7	ocean pout	none	trace	0.06	0.98	0.020	none

Table 8.8 continued

FDA Sample No.	Site	Species	Pesticide	PCB[1]	meHg	As	Pb	Cd
92-660-654	7	cod	none	none	0.05	4.23	none	none
92-660-655	7	winter flounder	none	none	0.06	0.47	none	none
92-660-646	8	American plaice	none	trace	0.03	2.62	0.049	none
92-660-659	8	yellowtail flounder	none	none	0.06	3.49	none	none
92-660-660	8	ocean pout	none	trace	0.12	3.76	0.026	none
92-660-481	8	witch flounder	none	0.22	0.02	NA[4]	0.080	none
92-660-656	8	winter flounder	none	none	0.07	6.89	none	none
92-660-657	8	cod	none	none	0.05	5.42	none	none
92-660-658	8	redfish	none	none	0.06	1.37	none	none

1 *denotes Aroclor 1242, in all other instances the number reported denotes Aroclor 1254. The FDA tolerance for both Aroclor 1242 and Aroclor 1254 is 2 ppm wet weight, total edible portion.

2 - denotes that the sample was not analyzed for this contaminant.

3 + denotes lost during analysis.

4 NA denotes that there was an insufficient amount of composite to analyze for this contaminant.

5 The pesticide detected was DDE. The FDA administrative guideline/action level for DDE is 5 ppm ww total edible portion.

PCB (Aroclor) levels were also quite low in all but the American lobster hepatopancreas samples (Tables 8.9 and 8.10). Of the 55 samples of finfish, lobster meat, and shellfish analyzed, 25 had non-detectable levels, 25 had trace amounts, and 5 had PCB levels exceeding trace amounts (Tables 8.9 and 8.10). These five samples included:

- two of the eleven American lobster meat samples (0.13 ppm as Aroclor 1254 and 0.76 ppm as Aroclor 1242),
- one of six witch flounder samples (0.22 ppm as Aroclor 1254), and
- two of four samples of sea scallops (0.39 and 0.62 ppm, both as Aroclor 1242).

In contrast, all 12 samples of American lobster tomalley had measurable levels of PCBs. Ten contained Aroclor 1254 at an average of 1.1 ppm, with one of these exceeding the FDA tolerance level of 2 ppm ww total PCBs at 2.12 ppm. One contained Aroclor 1260 at 0.22 ppm, and the remaining sample, a composite of two individuals, contained Aroclor 1242 at 21.3 ppm.

The results for PCBs are comparable to those observed in other recent studies in Massachusetts Bay. In 1988, FDA's Boston District conducted a study of PCBs in American lobsters and some finfish from Boston, Salem, and Gloucester, Massachusetts harbors (USFDA 1988). Meat samples from 11 lobsters were analyzed for total PCBs; 6 had trace levels and the other 5 had levels ranging from 0.18 to 0.30 ppm. Tomalley from 11 lobster samples had measurable levels of PCBs that ranged from 1.3 to 9.7 ppm. Sixteen composite samples (meat and tomalley) had levels ranging from 0.3 to 1.5 ppm. For the six flounder samples in the study, two had non-detectable levels, two had trace amounts, and two had levels averaging 0.1 ppm. In contrast, these samples were lower than values measured in Quincy Bay, Massachusetts in 1988. The total PCB (Aroclors 1242 and 1254) measured in lobster tomalley samples in Quincy Bay ranged from 22 to 61 ppm (Gardner and Pruell 1988).

A 1991 report issued by the Massachusetts Division of Marine Fisheries (Schwartz et al. 1991) provides the results of a study of PCBs in winter flounder, lobsters, and bivalve mollusks that was conducted from 1984-89 in coastal Massachusetts. Tissue samples were analyzed for total PCBs using method 212 of the FDA Pesticide Analytical Manual. For the 292 lobster samples, the range was 0.04 to 5.55 ppm (mean 0.65 ppm). Total PCB levels in 304 samples of winter flounder ranged from non-detectable levels to 1.3 ppm. The levels of PCBs in a variety of bivalve mollusks ranged from non-detectable to 0.16 ppm.

Table 8.9 American lobsters analyzed from Trawl Sites 1-8 for PCBs, pesticides, and metals. Tissue concentrations are reported in ppm (ww) (FDA).

Sample Number	Site	Tissue	BHC[1]	DDE,pp'-[2]	Aroclor[3]	Octachlor Epoxide[4]	lead	cadmium	methyl[5] mercury	arsenic
92-660-629	1	Tomalley	0.03	0.13	0.22**	0.02	1.030	6.187	NA	NA
		meat	none	none	none	none	0.088	0.174	0.1	1.18
92-660-632	2	Tomalley	none	0.09	0.61	none	none	3.550	NA	NA
		meat	none	none	none	none	0.042	0.052	0.25	2.32
92-660-635	3	Tomalley	none	0.06	0.97	none	none	5.528	NA	NA
		meat	none	trace	trace	none	0.112	0.171	0.16	1.88
92-660-638	4	Tomalley	none	0.04	0.29	none	0.108	6.201	NA	NA
		meat	none	trace	trace	none	none	0.114	0.19	8.66
92-660-639	5	Tomalley	none	0.35	2.12	none	0.027	3.332	NA	NA
		meat	none	none	trace	none	0.068	0.074	NA	NA
92-660-642	6	Tomalley	none	0.03	0.39	none	0.160	5.127	NA	NA
		meat	none	none	0.13	none	0.064	0.093	0.15	1.63
92-660-645	7	Tomalley	none	0.07	1.98	none	0.017	8.511	NA	NA
		meat	none	trace	trace	none	0.115	0.076	NA	NA
92-660-647	8	Tomalley	none	0.07	0.79	none	0.083	5.413	NA	NA
		meat	none	trace	trace	none	0.049	none	0.27	8.48

NA = not analyzed for this contaminant

1 Administrative guideline/action level is 0.3 ppm ww, total edible portion.

2. Administrative guideline/action level is 5 ppm ww, total edible portion..

3. A double asterisk (**) denotes Aroclor 1260. In all other instances, the number reported denotes Aroclor 1254. The tolerance for both Aroclor 1260 and Aroclor 1254 is 2 ppm ww, total edible portion.

4. Administrative guideline/action level is 0.3 ppm ww, total edible portion.

NOTE: Tomalley is equivalent to 17 percent of the total edible weight of a lobster.

Table 8.10 American lobsters analyzed from Target Areas I through IV for PCBs, pesticides, heavy metals. Tissue concentrations are reported in ppm (ww) (FDA).

Sample Number	Site	Tissue	BHC[1]	DDE,pp'-[2]	Aroclor[3]	Octachlor Epoxide[4]	lead	cadmium	methyl[5] mercury	arsenic
92-660-621	I	Tomalley	none	none	21.3**	none	0.630	5.156	NA	NA
		meat	none	none	0.76**	none	0.113	0.107	NA	NA
92-660-622	II	Tomalley	0.07	0.33	1.11	0.08	0.759	9.28	NA	NA
		meat	none	trace	trace**	none	0.031	0.201	NA	NA
92-660-623	III	Tomalley	none	0.42	1.60**	0.09	0.509	4.82	NA	NA
		meat	none	none	none**	none	0.666	0.093	0.22	3.73
92-660-624	IV	Tomalley	none	1.12	1.20**	0.09	0.462	7.91	NA	NA
		meat	no data	available						

NA - not analyzed for this contaminant

1 Administrative guideline/action level is 0.3 ppm ww, total edible portion.

2. Administrative guideline/action level is 5 ppm ww, total edible portion..

3. A double asterisk (**) denotes Aroclor 1260. In all other instances, the number reported denotes Aroclor 1254. The tolerance for both Aroclor 1260 and Aroclor 1254 is 2 ppm ww, total edible portion.

4. Administrative guideline/action level is 0.3 ppm ww, total edible portion.

NOTE: Tomalley is equivalent to 17 percent of the total edible weight of a lobster.

PAHs - FDA

Results of the sea scallop and American lobster samples analyzed for 10 different PAH compounds (fluoranthene, pyrene, benzo(a)anthracene, chrysene, benzo(b)fluoranthene, benzo(k)fluoranthene, benzo(a)pyrene, dibenz(a,h)anthracene, benzo(g,h,i)perylene, and indeno(1,2,3-cd)pyrene) are summarized in Table 8.11. Individual sample analyses are given in Appendix Table D.8.

Sea scallops, lobster meat, and lobster tomalleys had measurable levels of all 10 PAHs in nearly every sample. The levels in lobster tomalley were approximately 10 to 20 times greater than the concentrations observed in lobster meat. The levels in lobster meat were approximately two to three times greater than levels in sea scallops.

Finfish samples contained low and frequently non-detectable levels of PAHs. Approximately 5 of 10 PAHs were non-detectable in samples of redfish, yellowtail flounder, ocean pout, and winter flounder. No more than trace amounts of PAHs were detectable in the American plaice samples. All PAH data for finfish is provided in Appendix Table D.8.

Table 8.11 Mean concentrations of PAHs (ppb ww) in shellfish (range) collected near the Massachusetts Bay IWS, May/June 1992 (FDA).

PAH compound	Sea Scallop	Lobster Meat	Lobster Tomalley
Fluoranthene	5 (t-10)	18 (6-43)	290 (140-790)
Pyrene	6 (3-12)	17 (5-43)	260 (110-700)
Benzo(a)anthracene	2 (0.9-1.7)	3 (0.7-5.5)	29 (12-75)
Chrysene	2 (0.8-2.9)	3 (0.8-7.2)	36 (18-85)
Benzo(b)fluoranthene	3 (2.0-4.7)	5 (2-14)	48 (26-110)
Benzo(k)fluoranthene	2 (1.1-2.3)	2 (0.9-8)	31 (18-71)
Benzo(a)pyrene	2 (nd-2.7)	4 (1.6-10)	40 (22-95)
Dibenz(a,h)anthracene	t (nd-1.4)	5 (2.6-21)	68 (36-160)
Benzo(g,h,i)perylene	t (t-0.8)	4 (1.8-12)	40 (26-83)
Indeno(1,2,3-cd)pyrene	t (nd-t)	5 (1.9-12)	53 (36-100)

nd = non-detected; t = trace

Comparative data for PAH levels in sea scallops from other investigations appear to be wanting, although other bivalves have been investigated. In 1988, FDA's Buffalo District analyzed 24 samples of hard-shell clams (*Mercenaria mercenaria*) for fluoranthene, pyrene, and benzo(a)anthracene. These samples collected by the State of New York for assessing the environmental quality of growing areas used in the production of commercial hard-shell clams revealed the following:

- fluoranthene, 0.5 to 16 ppb,
- pyrene, 0.3 to 19 ppb, and
- benzo(a)anthracene, 0.3 to 4.8 ppb (USFDA 1993a, b).

Pruell et al. (1984) studied PAHs in hard-shell clams purchased from Rhode Island stores and found levels as follows:

- fluoranthene, 0.7 to 7.2 ppb,
- pyrene, 0.3 to 6.6 ppb, and
- benzo(a)anthracene, 0.1 to 0.8 ppb.

For a more general discussion of these contaminants in fish and shellfish see below.

Pancirov and Brown (1977) found clams and oysters collected along the northeastern United States with pyrene levels in the 1 to 60 ppb range; benzo(a)anthracene levels in the 0.3 to 8 ppb range, and benzo(a)pyrene levels in the 0.2 to 2 ppb range. The levels in these studies are within the same orders of magnitude as observed in sea scallops in this investigation.

In the lobster tomalley samples, most of the PAH residues were considerably lower than those found in Quincy Bay, Massachusetts. For example, the mean values in ppb were: fluoranthene 623 ;pyrene 434; benzo(a)anthracene 45; chrysene 173; and, the sum of benzo fluoranthenes 106. Four longer-chain PAHs were lower than those observed in the IWS samples, i.e., benzo(a)pyrene 27 ppb, dibenz(a,h)anthracene was non-detect, benzo(g,h,i)perylene 19 ppb, and indeno(1,2,3-cd)pyrene 25 ppb.

The lobster meat findings from this investigation are comparable to the results of a study of American lobsters from Quincy Bay, Massachusetts conducted by EPA (USEPA, 1988). The following results were provided by 16 lobster meat samples:

- fluoranthene, mean 9.7 ppb;
- pyrene, mean 6.7 ppb;
- benzo(a)anthracene, mean 0.8 ppb;

- chrysene, mean 3.4 ppb; and
- benzo(a)pyrene, mean 0.8 ppb.

It is unlikely that the PAH levels observed in American lobster meats taken from the IWS/MBDS vicinity and Quincy Bay are representative of levels occurring in American lobsters from less contaminated regions. Findings from the Mussel Watch Project (NOAA 1989) indicate that the Massachusetts Bay area contains some of the highest levels of PAHs in the U.S. marine environment. Since the PAH contamination in Massachusetts Bay is a regional issue not tied to the IWS or the MBDS, any conclusions from this investigation are more relevant to the concerns about regional pollution than to concerns about the impact of the IWS and MBDS on the safety of seafood from PAH contaminants.

From a seafood safety perspective, it is worth noting that PAHs are ubiquitous in the environment. Many sources exist for dietary exposures to PAHs. Broiled and smoked foods frequently contain PAHs at levels that exceed those observed in the American lobster samples (Fazio and Howard 1983).

Trace Elements (Inorganics)

Nearly all finfish, shellfish, American lobster meat, and lobster tomalley samples showed measurable levels of As, Pb, and meHg (Tables 8.8 through 8.10). Only one sample of finfish (yellowtail flounder) had measurable levels of Cd (0.09 ppm). The only FDA limit for any of these trace elements is the 1.0 ppm (ww) action level for meHg in fish and shellfish. All the samples were well below this limit. The highest concentration found was 0.27 ppm (ww) in one lobster sample.

Fish and Shellfish Tissue Organic and Inorganic Chemistry - NOAA

Ecological Perspective

One of the secondary objectives of this survey focused on an evaluation of contaminant body burdens within fish and shellfish to provide a preliminary estimate of ecological risk at the IWS. Because ecological risk was only a secondary objective of the survey, the level of effort placed into sample analysis was relatively minor.

Tissues were analyzed from six fish species (American plaice, winter flounder, redfish, wrymouth, ocean pout, and cod), and two invertebrates (whelk and spider crab) from eight

stations in the vicinity of the IWS, including one of the reference sites. All species were collected by otter trawl or lobster trap from depths of 50 to 91 m.

Matrix spike results were all within the CLP guidelines. Method blanks did not contain detectable levels of contaminants. Surrogate compound recoveries for organic compounds were lower than commonly established guidelines (e.g., PTI 1991) due to the high lipid content of the tissues. Using a strict interpretation of the guidelines would require that the values for pesticides and PCBs be qualified as estimates.

Inorganics

Fish and shellfish tissues collected from within the IWS, Reference Site 2, and around the perimeter of the IWS by otter trawl, were analyzed for potential ecological risks and are summarized in Table 8.12. For this analysis, whole fish were tested rather than just the edible portions as was used for the human-risk assessment. Whole fish are used in ecological risk analysis because the whole organism is generally consumed by higher trophic level species, whereas humans generally only eat specific portions of a fish. A full data listing is presented in Appendix Table D. 9.

In general, metal concentrations are highly variable in whole fish and vary considerably by species. Levels of As in fish varied from 4 ppm in a redfish to 68.7 ppm in an American plaice. Cd concentrations varied between 0.03 ppm in cod and American plaice to 0.13 ppm in an ocean pout. Cr concentrations varied from 1.1 ppm in a wrymouth to 10.7 ppm in an ocean pout. Cu concentrations varied from 1.36 ppm in wrymouth to 15.2 ppm in an American plaice. Pb concentrations varied from 0.09 ppm in a redfish to 3.11 ppm in a winter flounder. Total Hg concentrations varied from 0.08 in winter flounder to 0.8 ppm in a wrymouth. Zn concentrations varied from 16 ppm in a winter flounder to 77 ppm in an ocean pout.

Whelk (*Colus stimponsi)*and spider crabs also contained high concentrations of metals. Whelk contained higher levels of As (up to 775 ppm), Cd (up to 34 ppm), Cu (up to 549 ppm), Hg (up to 5.51 ppm), and Zn (up to 5,710 ppm) than any other species sampled in this survey. One spider crab contained the highest concentration of Pb detected in this survey (31.9 ppm). However, the other two spider crabs contained less than 1 ppm.

Table 8.12. Data summary of selected whole fish and shellfish metal- and PCB-contaminant residues (ppm, ww) for specimens collected in the vicinity of the IWS, May/June 1992.-NOAA.

Species	Site	N	~~Silver~~	Cadmium	Cr	Copper	Lead	Mercury	Zinc	Tot.. PCBs
American plaice	#8	5	8.9-19.7	0.04-0.06	3.2-4.6	2.5-3.5	1.35-2.46	0.09-0.23	35-49	0.06-0.12
		mean	12.44	0.05	3.74	2.952	1.828	0.134	43.2	0.088
		SD	4.29	0.007	0.56	0.41	0.45	0.057	5.67	0.022
	#6	5	7.9-68.7	0.03-0.09	1.6-4.8	1.9-15.2	0.78-2.89	0.09-0.26	33-61	
		mean	24.12	0.054	3	5.216	1.734	0.188	42.4	bd
		SD	25.12	0.023	1.32	5.62	0.79	0.065	11.44	
winter flounder	#8	5	10.8-25.2	0.04-0.12	2.0-4.1	2.02-3.13	0.61-3.11	0.08-0.22	16-68	<0.05-0.14
		mean	17.42	0.086	2.76	2.478	1.542	0.142	47.2	
		SD	6.44	0.036	0.91	0.43	0.98	0.056	19.89	
redfish	#6	5	4.8-12.0	0.05-0.1	1.7-2.1	2.13-3.47	0.15-0.41	0.1-0.47	41-52	0.06-0.12
		mean	6.84	0.074	1.84	2.64	0.268	0.314	45.4	0.088
		SD	2.94	0.018	0.17	0.59	0.1	0.16	4.28	0.026
	#3	7	4-6.5	0.06-0.09	1.5-7	1.7-3.4	0.09-0.13	0.09-0.13	41-51	bd-0.1
		mean	5.16	0.07	3.44	2.11	0.11	0.10	45.29	
		SD	0.91	0.01	2.1	0.63	0.01	0.01	3.73	
wrymouth	RS-2	3	8.4-38.8	.04-.08	1.1-2.8	1.36-2.98	0.46-1.03	0.22-0.59	46-60	0.2-0.4
		mean	25.23	0.057	2.0	2.23	0.60	0.44	54.7	0.27
		SD	15.46	0.021	0.85	0.82	0.38	0.2	7.57	0.12
	RS-2A	1	25.2	0.05	1.2	1.75	0.33	0.80	56	0.11
	TF-1	1	22.4	0.11	4.2	3.77	1.57	0.76	65	0.1
	TF-4	1	10.6	0.05	1.6	1.36	0.42	0.44	51	0.35
ocean pout	#8	1	13.0	0.13	10.7	2.80	0.55	0.16	60	0.08
	TF-3	1	18.4	0.10	2.3	2.67	0.64	0.26	77	0.2

Table 8.12. continued

Species	Site	N	Silver (ppm ww)	Cadmium	Chromium	Copper	Lead	Mercury	Zinc	Total PCBs
cod	TF-3	1	8.4	0.03	1.3	2.87	0.17	0.58	52	
FISH MEAN			**14.28**	**0.07**	**3.00**	**2.86**	**0.92**	**0.25**	**48.14**	**0.12***
FSH SD			**12.30**	**0.03**	**1.87**	**2.21**	**0.86**	**0.20**	**11.16**	**0.09***
FISH RANGE			**4.0-68.7**	**0.03-0.13**	**1.1-10.7**	**1.36-15.2**	**0.09-3.11**	**0.08-0.8**	**16-77**	**bd-0.4**
FISH MEDIAN			**10.80**	**0.60**	**2.30**	**2.52**	**0.58**	**0.17**	**46.50**	**0.08**
										***above bd values only**
whelk	TF-1	2	230-775	13.9-34	1.9-2.4	236-546	148-1.93	1.83-5.51	1120-5710	
(*Colus stimpsoni*)		mean	502.5	23.95	2.15	392.5	1.71	3.67	3415	
		SD	385.4	14.2	0.35	221..3	0.32	2.6	3245.6	
spider crab	TF-1	3	34.7-77.6	2.25-4.05	1.6-3.0	78.9-116	0.79-31.9	0.27-0.3	172-203	bd-0.1
(*Lithodes maja*)		mean	61.07	3.26	2.30	101.63	11.22	0.28	192.00	
		SD	23.08	0.92	0.70	19.91	17.91	0.02	17.35	

Concentrations of several metals in whole bodies exceeded concentrations found in livers of the same species in past studies of offshore areas of the North Atlantic (Hall et al. 1978). Almost every sample of fish, spider crab, and whelk contained higher levels of Zn and Cr than were detected in the same or similar species in historical surveys. Some samples contained higher levels of As, Cu, Pb, and total Hg than found in past surveys. No sample exceeded historical concentrations of Cd.

Reports by Eisler (1985, 1986) contain recommendations for body burden concentrations of Cd (2 ppm ww) and Cr (4 ppm dry weight) in fish and wildlife species that may indicate anthropogenic contamination. Tissue residues thought to cause problems for organisms are also provided (Cd, 5 ppm; Cr, 0.2 ppm ww). All samples in this study exceeded the level of concern for Cr, but only the whelk exceeded the level of concern for Cd. Similar concentrations representing tissue residues of concern for other contaminants are not available.

Gardner et al., in a report by USEPA (1992a), measured the concentration of metals in the tissues of several fish species and invertebrates, including winter flounder, American plaice, and American lobster, collected from within the IWS and MBDS. Essentially they reported low concentrations of these contaminants in edible tissues, and concluded that "...these data do not indicate that the Mass Bay site has a major impact on the concentrations of the measured contaminants in biota".

Concentrations of most contaminants in fish and invertebrate tissues from the study area are within the range of concentrations from conspecifics and confamilial species sampled by Gardner et al., as reported by USEPA (1992a), and Schwartz et al. (1993) investigations, as well as, others studying Massachusetts Bay and the outer Gulf of Maine in the past. However, no site-specific historical data were discovered on whole-body residues of these contaminants for the study organisms. Concentrations of contaminants in whole bodies usually fell between values for muscle and values for liver collected in those other areas. A significant amount of data were found for these species from offshore areas of the North Atlantic. Representative historical concentration data are presented in Table 8.13 More comprehensive reviews are presented in USEPA 1989 and 1992a.

The highest concentration of Hg in fish (0.8 ppm) was detected in the largest wrymouth (81 cm) collected during this survey. Larger fish generally accumulate more Hg in their tissues; however, a smaller wrymouth (69 cm) contained 0.76 ppm Hg.

Table 8.13. Contaminants in fish and invertebrates - historical studies.

Species	Reference	Area	Number	Tissue	Arsenic (ppm ww)	Cadmium (ppm ww)	Chromium (ppm ww)	Copper (ppm ww)	Lead (ppm ww)	Mercury (ppm ww)	Zinc (ppm ww)
winter flounder	Hall et al. 1978	North Atlantic Offshore	n=49	muscle	0.51-11.2	0.02-0.19	0.06-0.94	0.04-0.69	0.1-1.13	bd-0.54	0.69-12.5
			n=2	liver	3.15-8.75	0.23-0.3	0.06-0.11	2.06-13.12	0.12-1.12	bd-0.28	17.5-31.25
	Schwartz et al. 1993	Coastal MA	n=165	muscle		bd-2.04	bd-0.19	0.1-2.1	bd-0.90	0.014-0.163	3.63-9.03
	Gardner et al. (USEPA 1992a)	Mass Bay IWS	n=3	muscle		0.008-0.04 (dw)	0.09-0.21 (dw)	0.9-1.3 (dw)	0.08-.013 (dw)		25.5-27.5 (dw)
				liver		.31-0.85 (dw)	0.10-0.12 (dw)	21.4-40.1 (dw)	1.63-2.34 (dw)		110-132 (dw)
American plaice	Hall et al, 1978	North Atlantic Offshore	n=30	muscle	2.2-31.2	0.03-0.2	bd-0.38	bd-0.81	0.18-0.61	bd-0.3	2.5-6.5
		North Atlantic Nearshore	n=1	whole	5.062	0.115	0.56	0.47	1.35	bd	10.94
redfish	Hall et al. 1978	North Atlantic Offshore	n=2	liver	bd-5.5	0.06	0.15-0.31	3.25-3.7	0.15-0.69	0.06-0.36	17.3-23.1
			n=27	muscle	1.0-11.2	0.01-0.17	bd-1.6	0.04-2.2	0.19-1.5	0.02-0.46	2.21-5.63
ocean pout	Hall et al. 1978	North Atlantic Offshore	n=2	liver	4.675-5.05	0.71-1.63	0.12-0.38	0.87-4.5	0.38-0.56	bd	13.8-20.6
			n=16	muscle	0.71-6.75	0.03-0.12	0.04-0.65	0.04-0.63	0.13-0.56	bd-0.2	4.5-20
Atlantic cod	Hall et al. 1978	North Atlantic Offshore	n=71	Muscle	0.75-17.2	0.02-0.21	0.06-0.756	0.03-1.11	0.08-1.05	bd-0.34	0.87-7.88
			n=27	Liver	1.93-10.55	0.04-1.44	0.05-0.31	0.86-14.21	0.15-1.12	bd-0.26	4.4-35.36
wolf fish[a]	Hall et al. 1978	North Atlantic Offshore	n=19	muscle	1.22-23.11	0.04-0.19	0.06-0.69	0.09-0.38	0.04-0.62	0.02-0.63	3.87-12.72
			n=5	liver	2.57-50.83	1.41-6.8	0.13-0.19	bd-22.88	0.25-1.1	0.05-0.26	27.5-47
whelk[b] (*Thais lapillus*)	Butterworth et al. 1972 in Eisler (1985)			w/o shell		425 dw					
quahog	Gardner et al. (USEPA 1992a)	Mass Bay IWS	n-1	whole		3.46 (dw)	1.26 (dw)	48.6 (dw)	5.8 (dw)		2360 (dw)
rock crab (*Cancer iroratus*)	Hall et al. 1978	North Atlantic Offshore	n=6	w/o shell	8.3-17.53	0.33-0.55	0.21-0.38	5.38-13.13	0.79-1.06	0.055-0.25	42.5-68.75

a = related to wrymouth b = related to *Colus* dw = dry weight divide by 5 to approximate wet weight (ww) value

Pesticides and PCBs

Pesticide concentrations were uniformly low in whole fish (Appendix Table D.10), with the exception of one wrymouth that reportedly contained 1 ppm of methoxychlor. Three fish (a wrymouth, a cod, and an ocean pout) and one spider crab contained detectable levels of pp'DDE. These concentrations were 0.01 ppm in the wrymouth, spider crab, and ocean pout, and 0.04 ppm in the cod. The cod also contained 0.02 ppm of endosulfan and 0.02 ppm of pp'DDT. All other pesticide concentrations were below detection limits.

Methoxychlor, a pesticide chemically similar to DDT, was used extensively between 1945 and 1982. However, the reported elevated concentration of methoxychlor in a single wrymouth is inexplicable; possibilities include laboratory error to site contamination. In a previous review of pesticide contamination in U.S. fish and shellfish, the highest concentration of methoxychlor was 0.06 ppm found in tissues of freshwater mussels near Moss Landing, California and in oysters from Chesapeake Bay (Mearns et al. 1988).

The cod sample also contained 0.06 ppm total DDT. This value represents the highest DDT concentration detected in this survey. This concentration of DDT is similar to concentrations found in other coastal fish (Mearns et al. 1988). This cod contained 1.1 percent lipids, which was similar to the lipid concentration in most other samples.

Total PCB concentrations varied from less than 0.05 ppm to 0.4 ppm in fish, whelk, and spider crabs (Table 8.12 and Appendix Table D.11). Highest concentrations were detected in wrymouth. Most samples with detectable PCBs reportedly contained Aroclor 1260, while a few samples appeared to contain Aroclor 1254.

Wrymouth also contained the greatest concentration of lipids in their tissues (0.7 to 4.7%, Appendix Table D.9) of any fish species tested, which may explain why this species also contained the highest concentrations of PCBs, which are known to be lipophilic. When PCB concentrations are normalized to lipid content, the highest concentrations were still detected in wrymouth, but the overall variability decreased considerably. Detectable concentrations of PCBs on a lipid-normalized basis ranged from 3.1×10^{-6} g PCB/g lipid to 1.74×10^{-5} g PCB/g lipid. In a previous review of historical PCB contamination in U.S. fish, PCB concentrations in flatfish muscle from offshore areas of the North Atlantic were generally 0.01 to 0.1 ppm (Mearns et al. 1988).

Gardner et al. as reported by USEPA (1992a) measured the concentrations of PCBs, PAHs, and pesticides in the tissues of several fish and invertebrate species including winter

flounder, American plaice, and American lobster collected from within the IWS and MBDS. Essentially they reported low concentrations of these contaminants in edible tissues, and concluded that "...these data do not indicate that the Mass Bay site has a major impact on the concentrations of the measured contaminants in biota".

Fish and Shellfish Tissue Radionuclides - FDA

Edible portions of the fish and shellfish samples collected at the eight otter trawl sites were analyzed for radionuclides. Of the 56 samples collected, 40 contained sufficient tissue to be subjected to radionuclide analysis. A listing of results is provided in Appendix Table D.12. None of the 38 samples analyzed using a gamma-screen for ^{131}I, ^{106}Ru, ^{134}Cs, ^{137}Cs, and ^{140}Ba showed detectable levels. Of the 38 samples, 4, plus 2 that were not analyzed using the gamma-screen, were analyzed for ^{90}Sr. None showed detectable levels of ^{90}Sr. Of these 38 samples, 16 were analyzed using a gamma-screen and analyzed for ^{239}Pu. Five samples showed levels that barely exceeded the EPA detection limit of 0.1 pCi/kg of ^{239}Pu. Three of the American lobster samples showed levels of 0.12, 0.15 and 0.21 pCi/kg, while one witch flounder and one winter flounder each had levels of 0.20 pCi/kg ^{239}Pu.

FDA has conducted surveys of fishery products in Massachusetts Bay and other areas for radionuclide analysis. In one survey conducted in 1981-82 (USFDA 1984), fish examined from dump sites in Massachusetts Bay, the New Jersey coast, and the Farallon Islands found no detectable levels of ^{131}I, ^{140}Ba, or ^{239}Pu. ^{137}Cs was detected in nearly half of the 36 samples analyzed, but the levels were comparable to concentrations routinely seen at that time in total diet samples and imported food samples. Additionally, the levels were far below levels considered a human-health concern. The ^{137}Cs was attributed to fallout from atmospheric testing of nuclear weapons in the 1960s. The summary report for the 1981-82 survey also included results from a study conducted in 1978 and 1980 near the Farallon Islands. None of the samples collected during that study contained detectable levels of the gamma emitters, ^{90}Sr or ^{239}Pu.

A later study of fish from the Farallon Islands did not find detectable levels of ^{131}I, ^{137}Cs, or ^{136}Ru (USFDA 1990). However, four samples did contain detectable amounts of ^{239}Pu. Two of the samples were from one fish (0.76 pCi/kg and 0.22 pCi/kg), another from a composite of two fish (0.45 pCi/kg), and the fourth from a single fish (0.17 pCi/kg). The levels of ^{239}Pu found in that study are comparable to, but slightly higher than, levels found in seafood samples taken in this 1992 survey of the IWS and MBDS. The summary report for the 1990 Farallon Islands survey concluded that ingestion of one kilogram of fish per

day, containing the highest level of ^{239}Pu, represented 0.52 percent of the recommended daily human-health intake limit (148 pCi/day). The summary report concluded that no hazard was present in fish from the Farallon Islands.

If one assumes a more modest or realistic fish consumption practice than the 1990 Farallon Islands study, e.g., 100 grams per person per day, which is about four times the national per capita consumption figure, then ^{239}Pu exposures from fish from the Farallon Islands would be equivalent to about 0.05 percent of the recommended limit for ^{239}Pu. Using similar assumptions about fish consumption practices for products harvested from the vicinity of the IWS and MDBS it is estimated that daily intake of fish containing the highest level of ^{239}Pu found in this survey would result in exposures equivalent to only 0.014 percent of the recommended general population limit per day for ^{239}Pu.

Fish and Shellfish Tissue Radionuclides - EPA EMSL-LV

A total of 10 biological samples collected in otter trawl samples on the perimeter of the IWS were submitted to EMSL-LV for radionuclide analysis (Table 8.14). The results of each analysis are presented in Table 8.15; the laboratory transmittal letter is presented in Appendix Table D.6. The results also indicate the two-sigma error, representing the 95 percent confidence level, and the MDA for most samples. The MDA is the lowest concentration of radioactive material sampled that has a 95 percent probability of detection.

Table 8.14. The number of biological samples collected near the Massachusetts Bay IWS (May/June 1992) for radionuclide analyses (EMSL-LV).

Sample Type	Number	Gamma-scan	^{90}Sr
American lobster	4	4	4
Rock crab	1	1	1
American plaice	5	5	5
Total	10	10	10

All ten samples were analyzed for ^{137}Cs and ^{131}I; none indicated the presence of ^{131}I. This result was expected considering the half-life of this gamma-emitting fission product is only 8.05 days. Any historical dumping of ^{131}I at the IWS would have decayed away within months.

Table 8.15. Radionuclide tissue concentrations measured in pCi/g (EMSL-LV).

Sample Station	Tissue Type	Analyte	Results pCi/kg	Two-Sigma	MDA
Trawl 3	Lobster (carapace length 71 mm)	Cs-137	0.0978	0.0961	
		I-131	0	0	0.992
		Sr-90	0.014	0.042	0.068
	Lobster (carapace length 71 mm)	Cs-137	0	0	0.116
		I-131	0	0	0.785
		Sr-90	0.026	0.071	0.117
Trawl 4	Lobster (carapace length 71 mm)	Cs-137	0.151	0.0875	—
		I-131	0	0	0.766
		Sr-90	0.009	0.026	0.043
	Lobster (carapace length 79 mm	Cs-137	0.0593	0.0521	—
		I-131	0	0	0.893
		Sr-90	0.016	0.024	0.039
	Rock Crab (89 mm, width)	Cs-137	0.13	0.114	—
		I-131	0	0	1.84
		Sr-90	0.007	0.021	0.034
Trawl 6	American plaice (47 cm total length)	Cs-137		0.115	—
		I-131		0	0.096
		Sr-90		0.041	0.067
	American plaice (35 cm total length)	Cs-137	0.203	0.225	—
		I-131	0	0	2.38
		Sr-90	-0.031	0.059	0.097
Trawl 8	American plaice (33 cm total length)	Cs-137	0		0.377
		I-131	0		4.05
		Sr-90	0.019	0	0.128
				0.076	
	American plaice (33 cm total length)	Cs-137	0.158	0.188	—
		I-131	0	0	3.33
		Sr-90	0.02	0.049	0.08
	American plaice (35 cm total length)	Cs-137	0.27	0.201	—
		I-131	0	0	3.86
		Sr-90	0.043	0.049	0.081

Only one American lobster and one American plaice sample of the ten biological samples indicated positive readings for ^{137}Cs, a gamma emitting fission product with a half-life of approximately 30 years. The levels in the biota samples were measured in the fCi/g range (1 (fCi) = 10^{-15} Ci). These levels are most probably due to fallout from the atmospheric testing of nuclear weapons in the early 1960s (*cf.* Report No. 6, Federal

Radiation Council, October 1964). The Federal Radiation Council Report estimates that the deposition of fallout in the New England area was 30-60 μCi (1 μCi = 10^{-6} Ci) per square mile. This concentration would equate to a deposition of between 124 and 249 microcuries in the 3.14 nm^2 IWS.

None of the ten biological samples analyzed for ^{90}Sr indicated any positive readings. The biological samples were not analyzed for plutonium.

Fish and Shellfish Tissues Radionuclide Analysis - MDPH

American plaice, the most abundant fish species collected, and American lobster were selected for radionuclide analysis from the IWS perimeter trawl stations 1, 2, 3, 4, 6, and 8. Gamma emitting radionuclides were conducted on six samples of American plaice, two American lobsters, and one sea anemone (species unknown). The only radionuclide found in the samples was naturally occurring potassium-40 (^{40}K). The results of these analyses are provided in Table 8.16.

Table 8.16. Results of tissue analyses for radionuclides on fish and invertebrate samples collected at the IWS (May/June 1992) (MDPH).

Station	MERL ID#	Sample Weight (kg)	Count Time Seconds	^{40}K pCi/kg	Error ± 1 Sigma
Trawl #1 American Plaice	92F0550	3.25 E-1	55,000	4.36 E+3	8.52 E+2
Trawl #2 American Plaice	92F0551	3.89 E-1	10,800	2.08 E+3	1.13 E+3
Trawl #3 American Plaice	92F0552	4.52 E-1	14,400	2.25 E+3	9.86 E+2
Trawl #4 American Plaice	92F0553	4.48 E-1	21,600	3.57 E+3	7.98 E+2
Trawl #6 American Plaice	92F0554	4.40 E-1	60,000	4.10 E+2	1.60 E+2
Trawl #8 American Plaice	92F0555	4.39 E-1	60,000	2.25 E+3	5.62 E+2
Trawl #6 Lobster	92F0557	3.07 E-1	55,000	1.05 E+3	8.31 E+2
Trawl #8 Lobster	92F0558	2.68 E-1	60,000	4.39 E+3	9.41 E+2
Trawl #6 sea anemone	92F0556	3.98 3 E-1	55,000	9.79 E+2	6.45 E+2

Biotoxins - MDPH

The results of the biotoxin analyses of American lobster are displayed in Table 8.17 None of the samples had detectable PSP toxins when tested by mouse bioassay. A single sample (No. 055) had a measurable, but not toxicologically significant, level of saxitoxin when analyzed by the more sensitive HPLC method. For the purposes of this discussion, toxicologically significant is defined as the FDA action level of 80 µg/100g tissue.

Table 8.17. Biotoxin data for lobster tomalley harvested from the Massachusetts Bay IWS and vicinity, May/June 1992 (MDPH).

Sample Number	Number of lobsters in composite	Date collected	Trawl Site	Saxitoxin concentration* (µg (STX/100 g)	Saxitoxin concentration ** (µg STX equivalents/100 g	Domoic acid concentration ** (µg DA/g)
048	1	05/31/92	4	<40	< 5	<0.3
049	1	05/31/92	4	<40	< 5	<0.3
050	1	05/31/92	4	<40	< 5	<0.3
051	1	05/31/92	4	<40	< 5	<0.3
052	1	05/31/92	4	<40	< 5	<0.3
053	2	05/31/92	3	<40	< 5	<0.3
054	2	05/31/92	3	<40	< 5	<0.3
055	5	06/02/92	6	<40	5	<0.3
056	5	06/02/92	6	<40	< 5	<0.3

*Determined by mouse bioassay
**Determined by HPLC

Data generated by the MDPH laboratory and the Maine Department of Marine Resources indicate the potential for short-term accumulation of PSP contaminated mollusks. Since American lobster contamination is coincident with shellfish contamination, it is not surprising that these samples did not have appreciable PSP residues. Although the typical occurrence of a PSP bloom is May or June, in 1992 there had been no PSP bloom as late as October.

The American lobster samples were also negative for domoic acid the toxin associated with ASP. Few data exist regarding domoic acid contamination and related outbreaks; however, the toxin appears to be more prevalent in the fall and winter months.

The data presented should be viewed as a snapshot of the biotoxin status of these animals in late May and early June of 1992. Additional analyses during periods of PSP and ASP activity are necessary to determine the likelihood of biotoxin contamination of American lobster tomalley harvested from Massachusetts Bay.

A more thorough overview of marine biotoxins is presented in Appendix F.

CHAPTER 9
CONCLUSIONS AND RECOMMENDATIONS

CONCLUSIONS

This survey at the Massachusetts Bay IWS served as a screening investigation to determine the potential human health and ecological risk posed by historical disposal of hazardous substances, including LLW. Further, advanced technological approaches were employed for making comparisons to standard techniques for gathering information. The survey focused on seven primary objectives and four secondary objectives. The conclusions are presented in a manner consistent with the objectives.

Primary Objectives

Objective 1: Evaluate samples of seafood harvested near the IWS for pesticide residues, PCBs, heavy metals, PAHs, and radionuclides.

The multiagency, multisurface platform, and the application of a variety of sampling techniques as an approach to obtaining representative seafood samples inhabiting the bottom habitats in and about the IWS was successful. The survey was a demonstration that cooperation among federal and state agencies is possible and that despite significant differences in mandates a pooling of resources and expertise can be brought together in an expeditious manner to address the concerns of the public. An area needing improvement is in the ability to catch fish and shellfish inhabiting specific niches in and about bottom hazards, such as barrels or other debris located in moderately deep water.

Objective 2: Evaluate the seafood data to assess potential human-health risks associated with toxic and radioactive materials.

The FDA and MDPH survey of edible portions of seafood samples collected near the IWS and the MBDS did not reveal any remarkable findings. Samples of finfish, shellfish, and lobster meat were found to contain no more than trace amounts of pesticides and PCBs. The levels of trace elements (Cd, Pb, As, and meHg) in each of the species sampled were comparable to, or slightly less than corresponding levels reported in other studies (Hall et al. 1978, MADMF 1990). Residues of PAHs in finfish samples

were quite low, as expected, and frequently nondetectable. Measurable levels of PAHs in sea scallops, American lobster, and lobster tomalleys were found in nearly every sample. These results for sea scallops are similar to findings from other studies of shellfish. The levels of PAHs observed in the lobster tomalley are quite high, approximately 10 to 20 times higher than levels observed in lobster meat. The lobster tomalley is known to concentrate environmental contaminants, so this observation is not surprising. However, the levels of PAHs in the tomalley appear to be among the highest ever reported for food samples.

Samples of finfish, shellfish, and lobster meat were found to contain no more than trace amounts of radionuclides. None of the samples contained radionuclides that could be attributed to past radioactive waste disposal.

Based on the results of this limited survey, it would be inappropriate to conclude that previous dumping of chemicals near the IWS and the MBDS does not influence the levels of chemical residues in seafood from this area. However, even if the size of the study had been increased it would be quite difficult to link any chemical residues in seafood to previous dumping in the area. The aquatic environment near the IWS and MBDS is not unique, and there are many other sources of chemical contamination in Massachusetts Bay. Further, seafood harvested from the vicinity of the IWS and the MBDS will be influenced by the environmental quality of many aquatic environments, some within and some outside the Massachusetts Bay region.

The results from this limited study appear to demonstrate that seafood harvested from this region of Massachusetts Bay does not contain chemical or radioactive residues that exceed Federal limits or levels that substantially exceed levels found in other studies of seafood. Based on the results of this study and conclusions from other FDA studies of seafood from the area, it seems reasonable to conclude that seafood from the targeted area is safe for human consumption. Nevertheless, due to the amount and hazardous nature of the debris within the IWS, the existing fishing advisory and closure for surf clam and ocean quahog harvesting should continue.

Objective 3: Analyze sediment samples taken close to the containers for selected organic chemicals, inorganic chemicals, trace elements, and radionuclides.

The concentrations of most organic contaminants, including all organophosphorus pesticides, most organochlorine pesticides, and all PCBs were below detection limits. While several organochlorine pesticides were detected near many of the barrels, many were also detected in similar concentrations at the reference sites. Although a series of PAH compounds was detected in sediments, they indicate a combustion source. PAH contamination at these levels is common throughout Massachusetts Bay. DNT (2,6-dinitrotoluene) was the only unusual organic compound detected near two targets, although concentrations were extremely low (<15 ppb).

The inorganic contaminant data indicate that the variability is sufficiently great among all the waste barrels sampled that no significant differences are evident in comparison with the two reference sites. However, the concentrations of certain inorganic contaminants sampled, including Sb, Be, Ca, Cd, Co, and cyanide within individual target fields is significantly higher than those observed at the reference sites. Normalization of the inorganic data to aluminum suggests that Cd, Pb, Ni and Zn anthropogenically enriched in sediments at the IWS and the reference sites. Cr is the only trace metal that appears more significantly enriched at the IWS than at the reference sites.

The sediment concentration and gamma spectral data results taken during ROV and *JSL-II* operations indicate that no anthropogenic gamma radiation emitting radionuclides were present at the investigated anchorage sites.

The most prominent naturally occurring, gamma-emitting, radionuclides present in the study area were ^{40}K and ^{208}Tl.

Other than the ^{90}Sr detected in sediment after the retrieval of an anchor following an ROV survey, the radionuclide levels found in the biota and sediment samples were comparable to natural background levels. Results generally did not indicate radionuclide contamination from waste disposal operations and do not indicate a measurable threat to the environment.

Objective 4: Evaluate the effectiveness of a remotely operated vehicle to locate and position bottom objects for specific target area deployment of a manned submersible.

The ROV, owned and operated by NOAA's NURC at the University of Connecticut, made seven dives in three days within five previously identified high-density target

fields. The ROV camera systems enabled video and still-frame photo documentation of benthic ecological conditions, including identification of the predominant macrofaunal components. The ROV camera systems also provided real-time recognition of the targets' physical condition and real-time identification of a probable explosive ordnance (depth charge). The ROV is an appropriate technological apparatus for information gathering that is focused on large objects such as waste containers.

Objective 5: Evaluate a manned submersible as a platform for visual and photographic (35-mm still camera and 8-mm video) observation of bottom objects, including hazardous waste containers, on the seafloor with respect to density, overall condition, and identifying marks for comparison with observations taken during previous ROV and side-scan sonar surveys.

The *JSL-II* manned submersible, contracted from Harbor Branch Oceanographic Institution, provided the opportunity for five scientists to observe real-time conditions on the seafloor at a moderately deep (ca. 90 m/300 ft) hazardous waste disposal site. The *JSL-II* video and still-photographic documentation provided detailed in-situ records of ecological conditions, including associated fauna, species behavior, bottom topography, relative density, and waste container condition and disposition on the seafloor within the IWS. This documentation enabled other scientists and interested parties to appreciate the conditions that written description failed to convey.

Although no positive radiation readings were encountered, any positive readings that might have been encountered would likely have been more readily explained by the presence of human observers.

Precision navigation and integrated plotting technology provided exact positioning records of vehicle path and target and sample locations. The *JSL-II* was able to revisit specific targets of interest encountered by the ROV.

Full accomplishment of the dive plan was complicated by poor sea conditions that inhibited normal deployment and retrieval of the manned submersible.

Objective 6: Evaluate a manned submersible as a platform from which to collect sediment samples close to hazardous waste containers.

In addition to providing visual, video, and still-frame photo documentation of the waste container disposition and physical condition, the submersible operator, at the direction of a principal investigator, was able to collect sediment samples in the immediate proximity of targets, specifically waste barrels. The versatility of the vehicle permits the collection of sediments at any distance from the container or from within the container. Although a manned submersible is more costly than standard sampling techniques such as grab sampling, it affords an opportunity to gather one or more samples very close to targets of specific interest to the investigator. The investigator's presence enabled consideration of a greater level of site-specific conditions necessary for quick decision making than does limited viewing through the eye of a remote camera. Further, this approach enables the collection of multiple samples at varying, yet fairly precise, distances from the target. Samples or articles, such as reagent bottles, can also be taken from within the container. Although no biological samples were taken with the *JSL-II* during this expedition, it was capable of taking samples of relatively non-mobile species. The on-board scientist could have directed specific organisms for collection in contrast to hoping for the best using other means. Depending upon the manned submersible used, bottom currents can decrease the effectiveness of search operations for specific targets.

Objective 7: Evaluate the ability to sample potential target species in proximity to potential hazardous substance targets on the seafloor.

The experimental fish and eel traps did not prove to be useful collection devices, as no specimens were collected by them. This failure may in part be explained by the fact that the traps were not pre-soaked in seawater before they were used.

The use of lobster traps appears to be an inefficient technique for collecting large numbers of specimens quickly at the IWS. No specimens were taken at the Reference Site despite repeated attempts. However, lobster traps are an appropriate technique for gathering specimens in areas like the IWS that have bottom hazards that would likely interfere with trawling. Also, lobster traps can be deployed in specific-target areas when precision navigation techniques are combined with visual markers such as "high flyer" buoys. The lobster traps also proved useful in capturing certain species of fish, especially wrymouths.

Observers in the *JSL-II* saw numerous American lobsters, flatfish, and other species near the targets. Redfish were especially common about the targets. Potential benefits

could be derived from consideration for methods to collect mobile species among bottom hazards.

The fish-trawling technique potentially offers a greater number of specimens in a shorter time. The fish trawling procedures used during this investigation were appropriate for a widespread and quick collection of representative organisms from an edible seafood and ecological perspective. Trawls however have the potential to bring up unwanted hazards such as waste containers and explosives. In this survey, several trawl samples had obviously been dragged through waste barrels as the net contained unidentifiable barrel fragments and the fish were coated with iron oxide.

Secondary Objectives

Secondary Objective 1: Evaluate the utility of the ROV as a platform for in-situ radioactivity detection.

The ROV made seven dives in three days, surveying 26 objects and conducting in-situ radiation measurements at each object. Although no unusual readings were observed, the ROV was able to maintain position against targets long enough (300 seconds) to detect radioactive materials if present. The ROV also carried a sonic pinger that could have been placed at a high-count target for later relocation and sampling by the submersible.

Secondary Objective 2: Evaluate the utility of the manned submersible as a platform for in-situ radioactivity detection.

The manned submersible made five dives within the IWS and took radiation readings at most targets. An in-situ radiation detection prototype attached to the submersible was successfully deployed, although no unusual readings were observed.

Secondary Objective 3: Evaluate biological samples for contaminant body burden analysis for preliminary estimates of ecological risk.

Overall, the potential for adverse ecological effects as a result of inorganic or trace elements (metal) concentrations in sediment in proximity to waste barrels are judged

low to moderate. Concentrations of Ni, Cd, and/or Cr present the greatest concern near waste barrels in Target Fields II and IV.

Tissue residues of these contaminants generally are within the range of concentrations found in organisms from offshore areas of the North Atlantic. Concentrations of a few contaminants in a few species may be of concern. Concentrations of Hg in whelk, *Colus stimpsoni*, were very high, although the significance of this value is unknown for this species. Concentrations of Zn and Cr were elevated above concentrations found in the same or similar species in past surveys of offshore areas of the North Atlantic (Hall et al. 1978). Cr concentrations exceeded values thought to cause health problems for organisms (Eisler 1986), although many concentrations found in past surveys also exceeded this value. Although As, Cu, and Pb in a few species exceeded concentrations found in past surveys (Hall et al. 1978), it is not known if these concentrations indicate anthropogenic contamination. The implications of these concentrations on organism health are also unknown. Concentrations of pesticides, PCBs, and Cd most likely are not of concern.

Secondary Objective 4: Quantify the amount of paralytic shellfish toxins and domoic acid found in lobster tomalley in animals harvested from the Massachusetts Bay Industrial Waste Site.

While a single sample revealed detectable levels of saxitoxin, no toxicologically significant levels of biotoxins were observed in tested species. However, these samples should be regarded as opportunistic and they were not taken during a phytoplankton bloom period.

GENERAL CONCLUSIONS

The results of the survey of sediments and, fish and shellfish tissues generally agree with findings of previous investigations in the area.

No evidence was gathered that would support a conclusion that LLW or the hazardous substances investigated posed an imminent and widespread human-health or ecological threat. However, the documented presence and large concentration of waste containers along with known ordnance disposal in some areas of the IWS, pose potentially significant occupational risks to users of bottom-tending mobile gear.

Therefore, according to the conclusions of this screening survey, wastes previously disposed of in the area should be considered only as one of several sources of contamination to Massachusetts Bay.

RECOMMENDATIONS

Due to the amount and hazardous nature of the debris within the IWS as verified by in-situ observations, the existing fishing advisory and the closure for surf clam and ocean quahog harvesting should continue. In addition, considering that lobster tomalley concentrate marine toxins and various contaminants, consumption of lobster tomalley should be discouraged.

Further documentation of the locations of likely waste container fields within and contiguous to the IWS should be undertaken. Positions of concentrations of likely waste containers should be noted on nautical charts.

If further investigations reveal clusters of waste containers, it is recommended that the USCG, NMFS, and New England Fishery Management Council be apprised so that these regulatory authorities, or other appropriate regulatory authorities, can consider closing these areas to users of mobile bottom-tending gear on the basis of potential occupational risks and fisheries conservation and management concerns.

CHAPTER 10

REFERENCES/ACRONYMS

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ACRONYMS

ACOE	Army Corps of Engineers (United States)
Ag	silver
Al	aluminum
Am	americum
As	arsenic
ASP	amnesic shellfish poisoning
Ba	barium
Be	berryllium
BHC	benzohexachloride
BNA	base neutral analyses
Ca	calcium
Cd	cadmium
CERCLA	Comprehensive Environmental Response, Compensation, and Liability Act
CLP	Contract Laboratory Program (EPA)
cm	centimeter
CMD	Crossroads Marine Disposal and Salvage Company
Co	cobalt
CO_2	carbon dioxide
cpm	counts per minute
Cr	chromium
CRC	Coastal Resource Coordinator (NOAA)
Cs	cesium
Cu	copper
DAMOS	Disposal Area Monitoring System
DGPS	differential global positioning system
DNT	dinitrotoluene
DOC	Department of Commerce (United States)
DOE	Department of Energy (United States)
DOI	Department of the Interior (United States)
dw	dry weight
eA	effective area
EMSL-LV	Environmental Monitoring Systems Laboratory- Las Vegas
EOEA	Executive Office of Environmental Affairs (Massachusetts)
EPA	Environmental Protection Agency (United States)
ER-M	effects range-medium
ERL-N	Environmental Research Laboratory-Narragansett
fCi/g	femtocurie per gram
FDA	Food and Drug Administration (United States)
Fe	iron
FMP	Fisheries Management Plans
fCi	femtocurie
ft	foot
F/V	fishing vessel
g	gram

GIS	Geographic Information System
GM	Geiger-Mueller
GPS	Global Positioning System
H_2O	water
HAZMAT	Hazardous Materials Response and Assessment Division (NOAA)
HCl	hydrochloric acid
Hg	mercury
HP	Hewlitt-Packard
HPLC	high-pressure liquid chromatography
HRS	Hazard Ranking System
I	iodine
ID	identification
in	inch
IMP	integrated mission profiles system
INS	integrated navigational system
IWC	International Wildlife Coalition
IWS	Industrial Waste Site
JSL	Johnson Sea Link
K	potassium
kg	kilogram
kHz	kilohertz
KeV	kilovolt
lat/long	latitude/longitude
LLS	Laser-Line Scanner
LLW	low-level (radioactive) waste
m	meter
MBDS	Massachusetts Bay Dredged Material Disposal Site
Mbyte	megabyte
MCA	multichannel analyzer
MDA	minimum detectable activities
meHg	methylmercury
MDMF	Massachusetts Department of Marine Fisheries
MDPH	Massachusetts Department of Public Health
MERL	Marine Ecosystem Research Laboratory (University of Rhode Island)
mg	milligram
ml	milliliter
ml/min	millimeter per minute
mm	millimeter
MSL-LV	Monitoring Systems Laboratory-Las Vegas
MPRSA	Marine Protection, Research, and Sanctuaries Act
NCP	National Oil and Hazardous Substances Pollution Contingency Plan
Ni	nickel
NIST	National Institute of Standards and Technology
nm	nautical mile
NMFS	National Marine Fisheries Service (NOAA)

NOAA	National Oceanic and Atmospheric Administration
NOS	National Ocean Service (NOAA)
NPL	National Priority List
NRC	National
NS&T	National Status and Trends Program (NOAA)
NURC	National Undersea Research Center
NURC-UCAP	National Undersea Research Center-University of Connecticut Avery Point
ORCA	Office of Ocean Resources Conservation and Assessment (NOAA)
PA/PS	preliminary assessment/preliminary survey
PAH	polycyclic aromatic hydrocarbons
PC	punch core
PCB	polychlorinated biphenyls
pCi	picocuries
pCi/g	picocuries per gram
PIN	
ppb	parts per billion
ppm	parts per million
PSP	paralytic shellfish poisoning
Pu	plutonium
QA	quality assurance
QC	quality control
ROV	remotely operated vehicle
R/V	research vessel
Ru	ruthenium
SB	antimony
Se	selenium
SOP	standard operating procedure
SP&E	Safety Products and Engineering
Sr	strontium
TAL	target analyte list
TBT	total bottom time
TCL	target compound list
Ti	terilium
TIC	tentatively identified compounds
Tl	thallium
TOC	total organic carbon
URSIS	Underwater Radiation Spectral Identification System
USACOE	United States Army Corps of Engineers
USAEC	United States Atomic Energy Commission
USCG	United States Coast Guard
USEPA	United States Environmental Protection Agency
USFWS	United States Fish and Wildlife Service
V	volt
WEAC	Winchester Engineering and Analytical Center
ww	wet weight

Zn	zinc
μ	micron

APPENDIX A

Miscellaneous Letters, Memos, and Closure Notices Relating to the IWS

CHIEF COUNSEL
EDMUND B. WELCH

CHIEF CLERK
BARBARA L. CAVAS

MINORITY STAFF
DIRECTOR/CHIEF COUNSEL
GEORGE D. PENCE

U.S. House of Representatives
Committee on
Merchant Marine and Fisheries
Room 1334, Longworth House Office Building
Washington, DC 20515-6230

ACTION: [illegible]

August 15, 1991 RGR#: [illegible]

DUE DATE: 9-4-91

CC: [illegible]

Dear Ms. Belaga:

The recent disclosures of large quantities of potentially toxic waste drums haphazardly scattered about Massachusetts Bay since the 1940's has badly shaken public confidence and raised the specter of a Superfund time bomb of unknown proportions in our back yard. These disclosures reveal how little is actually known about the situation and how shallow were past assurances that all was well with the Massachusetts Bay Disposal Site.

In 1984 and after my request, the Environmental Protection Agency (EPA) reported that over 4000 containers of low-level radioactive wastes had been dumped in Massachusetts Bay, but the containers weren't causing any harm. This conclusion is hardly reassuring, as it turns out, because the report did not consider the type, quantity or potential environmental effects of other toxic wastes known to have been dumped at the site. Several years ago EPA also conducted a preliminary assessment of the site under CERCLA, but based its conclusions only on existing information -- primarily the 1984 report.

The recent work of the International Wildlife Center (IWC) represents a renewed effort to characterize the scope of the problem -- but it is only a first step. I am therefore writing to request that the Environmental Protection Agency undertake a full scale assessment under the Comprehensive Environmental Response, Liability and Compensation Act (CERCLA or Superfund) of the areas in which the drums are located to identify the scope and severity of the risks and to evaluate if the area should be listed as a Superfund site for cleanup purposes.

In particular, the assessment should determine:

- What kinds of wastes have been dumped, and where?
- To what extent are these materials posing risks to the marine environment and public health?
- Who is responsible for the dumping, and are they still available if cleanup actions -- capping or removal -- prove warranted?

Furthermore, I would strongly recommend that the assessment be undertaken rapidly so that the information it yields could be used in making decisions on where to dispose of the huge volume of clean dredged materials associated with the Third Harbor Tunnel Project and the channel dredging for Boston Harbor. If burying the barrels proves to be the best approach, the disposal program for these other projects ought if possible to be designed to get the job done.

I understand that you will be receiving a complete report from IWC this fall. I ask that you keep me informed of its findings, and of your schedule for conducting additional assessment activities. Thank you for your attention to this request and I look forward to working with you on this matter.

With kind regards.

Sincerely,

Gerry E. Studds
Chairman
Subcommittee on Fisheries and
Wildlife Conservation and the
Environment

Ms. Julie Belaga
Regional Administrator
U.S. EPA Region I
JFK Federal Building
Boston, MA 02203

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION I
J.F. KENNEDY FEDERAL BUILDING, BOSTON, MASSACHUSETTS 02203-2211

September 23, 1991

Honorable Gerry E. Studds
Member, U.S. House of Representatives
Committee on Merchant Marine and Fisheries
Room 1334, Longworth House Office Building
Washington, D.C. 20515-6230

Dear Congressman Studds:

Thank you for your letter concerning the Industrial Waste Site disposal area in Massachusetts Bay (IWS). I continue to share your concerns over the potential health hazards this site may cause, and the need for further information. This letter also addresses issues related to the IWS that have recently received additional public attention.

Background

The IWS was used as a dumping ground for hazardous waste and low level radioactive waste long before the EPA came into existence in 1970. After EPA was given jurisdiction over the disposal of waste at sea, the EPA issued one permit for one disposal operation in 1976. Since that time, EPA has issued no further permits for disposal at the IWS, and the IWS was formally de-designated for use as a disposal site in 1990.

However, concerns at EPA and among the public have continued with respect to this site, and I know it has been an ongoing issue for you for many years. Incidents in which fishermen have been exposed to hazardous substances brought up in nets anywhere in this area have heightened our concerns. Unconfirmed reports have circulated that wastes may have been dumped outside the specified dump site, that low level radioactive waste from the "Manhattan Project" may have been dumped outside the permitted location, that unauthorized dumping may have continued after the time it had become illegal, and that barrels dumped in the past could be leaking. The problem is compounded by reports that fishermen have been pulling up barrels in their nets and returning them to the ocean, resulting in the possible movement of the barrels.

The location, content, and the unknown factors associated with this site pose serious challenges for further study and possible remediation by EPA. In spite of the technical challenges this type of site presents, Region I has been a leader in applying the Comprehensive Environmental Response, Compensation and Liability Act (CERCLA) (commonly referred to as "Superfund") to hazardous waste problems in the marine environment, as, for example, in our efforts to clean-up New Bedford Harbor. We have also applied

CERCLA to the IWS, but it was determined in 1987 that the site was not eligible for continued investigation under the Superfund program. The site did not receive a score under the Hazard Ranking System (HRS) sufficient to qualify for such further investigation. The low HRS score was largely a result of the then current HRS model's focus on certain kinds of human health impacts. Specifically, because the surface water near the IWS is not used for drinking water, no "targets" under the HRS model were potentially impacted by a release of waste from the site. Therefore, we did not gain access to Superfund dollars to investigate the IWS.

Nevertheless, our concern over the IWS has continued. In our recent Draft Environmental Impact Statement evaluating the Massachusetts Bay Disposal Site (MBDS) used for the discharge of non-hazardous dredged materials, we identified the potential problems at the IWS and stated that further work was needed to determine if remedial action was warranted and what any such action might entail. We believe that it is imperative to base any possible remedial actions on sound technical information. This is not only because of the great expense that could be involved in a remedial action, but because, as is discussed below, certain kinds of remedial activities could cause more harm to the environment or risk to public health than the IWS currently presents. It is critical that we take intelligent, rather than precipitous, action.

Current Activities

But as your letter urges, the time has come to get moving on this matter. We must assess the seriousness of the problem posed by the IWS and, if remedial action is required, we must determine the best approach. Thus, last spring, EPA began funding a joint research project with the International Wildlife Center (IWC) to locate the barrels on the sea-floor in the IWS area. This project may yield information on the condition of some of the barrels. EPA is also conducting research on potential contamination of marine sediments at the IWS and fish histopathology in the IWS area. In 1992, EPA will be conducting research on sediment and benthic organism contamination in the IWS area. This research as well as recent information regarding location of "Manhattan Project" low level radioactive waste will begin to enable us to determine the nature and extent of the problem at the IWS.

Furthermore, we are planning to evaluate the IWS again under the Superfund program. The HRS model has very recently been revised to more fully assess threats posed by potential hazardous waste disposal sites. Among the many changes to the HRS model are the inclusion of new factors which assess potential threats posed by releases of hazardous substances to the human food chain and an expanded list of environmental "targets." Sites which were scored using the original HRS model may be re-scored using the revised HRS if those sites possess characteristics which were not assessed using the original HRS model. EPA believes that the IWS is such a

site, and intends to reassess it using the revised HRS model.

The first steps in the Superfund reassessment will be to collect and review all the currently available site information, and to determine whether any additional data is needed to support a revised HRS score. We expect that the information being generated via the joint EPA/IWC project and the other research described above will provide essential information for this reassessment effort. To the extent that the new information needed to re-score the site can be obtained from existing sources (including ongoing research projects such as the EPA/IWC project), a time savings in the site reevaluation process will be realized.

If the revised HRS score for the IWS meets or exceeds the 28.5 ranking cutoff for National Priorities List (NPL) eligibility, the site will be considered for possible inclusion on the NPL. If listed on the NPL, the IWS would become eligible for Superfund program remediation funds.

Possible Remedial Actions

If it is determined that remedial action is needed, a full analysis of possible remedial alternatives will be performed. It is important to emphasize that no remedial action has yet been recommended and the feasibility of possible alternatives will need to be carefully assessed before any action is taken. If remedial alternatives are to be investigated, three general remedial alternatives would likely be considered: 1) the "no action" alternative; 2) removal of waste products; and 3) capping the waste products with an appropriate material (such as, potentially, clean marine clays). We must emphasize that difficult questions will have to be addressed in determining what remedial action, if any, is appropriate for the industrial and radioactive wastes at the IWS. These questions concern such matters as defining the potential risk to the marine environment or public health posed by present conditions at the IWS, the dangers that would be posed by either attempting to remove or cover wastes on the sea floor, the availability of upland or aquatic disposal sites for any wastes that are removed, the availability of suitable cover materials if covering the waste is to be considered, and the cost of the various options. Possible alternatives are further discussed below.

The "no action alternative" would be preferred only if remedial action is determined to be unnecessary or more dangerous for the environment and public health than no action. The no action alternative could potentially include management methods to prevent fishermen or others from pulling up or removing waste barrels from the IWS.

The alternative of removing the waste products would also require careful evaluation. Removing the waste could be hazardous to the marine environment and to those asked to handle the waste. Waste barrels may be so fragile that any attempts to retrieve them would

cause them to break apart. If the barrels broke upon attempted retrieval, the contents could be dispersed into the marine environment, causing environmental harm rather than remedying it. Removal might also be extremely expensive. Additionally, it could be difficult and costly to test the contents of each barrel in order to consider a potentially proper strategy for disposal of the individual barrels. In addition, if wastes are removed, a method of disposal must be identified. This might also prove to be extremely difficult and costly, since there is a scarcity of land-based disposal capacity for hazardous and radioactive waste.

Finally, the alternative of capping the wastes would need to be assessed. Although precise cost estimates have not been conducted, capping appears to be the cheapest alternative, aside from no action. It may also be the most protective. Only materials that would meet the requirements of the regional dredged material testing protocol would be considered to cap the barrels. Such materials would most likely include native marine clays that are relatively far removed from known sources of pollution. However, there are also many questions related to the capping alternative, including whether barrels might be broken during capping efforts, thus dispersing waste products.

EPA cannot proceed with a remedial action until at least some of the above-described unknowns are resolved and a determination regarding the need for corrective action is made. Apart from legal requirements, it would be imprudent environmentally and fiscally to act otherwise. We are, however, already committing resources to answering these questions. Our studies are underway, future activities are planned, and we will work cooperatively with any assessment conducted by the General Accounting Office (GAO). We will gladly share our findings with you and the public as they are developed.

I share your concerns about this complex issue. Also, if you require any further information, please feel free to contact me, or have your staff contact Pat O'Leary of the Office of Government Relations at (617) 565-9125.

Sincerely,

Julie

Julie Belaga
Regional Administrator

U.S. House of Representatives
Committee on
Merchant Marine and Fisheries
Room 1334, Longworth House Office Building
Washington, DC 20515-6230

ACTION: Dave Fierro
RGR#: 518
DUE DATE: 10-28-91
CC: Mel Hohman
Dick Kotelly
Carl Delo
Kym Keckler
Dave Terdoff

October 10, 1991

Dear Ms. Belaga:

I am writing to thank you for your decision to reevaluate the Industrial Waste Site (IWS) under the Superfund program in response to my earlier request. I think the additional assessments will help put to rest lingering questions about the scope and severity of past disposal practices, and I commend you for pursuing it.

As you know, I earlier asked the General Accounting Office (GAO) to undertake an investigation of past dumping practices in Massachusetts Bay -- an effort that is now underway. I have asked the GAO to work closely with you and your staff, and to make available to your office all their findings as they proceed.

If you are not already planning to do so, I would strongly recommend that you consider certain areas outside of the IWS in your reassessment. Information from the joint EPA/International Wildlife Coalition study, from fishermen, and from other sources indicate that other disposal areas -- whether previously permitted or not -- may require investigation.

In addition, I fully understand that remedial actions, if required, are likely to be expensive and difficult. I very much hope that when all the facts are in, they will lead to the conclusion that past disposal actions pose no current risks to health or the marine environment.

RECEIVED
OCT 17 1991

I look forward to getting this process under way, and would appreciate being kept informed of your efforts. If I can be of any assistance, please contact me directly or have your staff contact Mr. William Stelle or Ms. Karen Steuer of my Subcommittee staff at (202) 226-3533.

With kind regards.

Sincerely,

Gerry E. Studds

Ms. Julie Belaga
Regional Administrator
U.S. Environmental Protection Agency
Region 1
JFK Federal Building
Boston, MA 02203

U.S. House of Representatives
Committee on
Merchant Marine and Fisheries
Room 1334, Longworth House Office Building
Washington, DC 20515-6230

October 24, 1991

Dear Mr. Billy:

I am writing to seek the assistance of your office in assuring that fish harvested from Massachusetts Bay is safe for public consumption.

The Subcommittee on Fisheries and Wildlife Conservation and the Environment has been conducting an investigation into the dumping of toxic and radioactive waste in Massachusetts Bay. As you may be aware, up until the early 1970's a variety of waste (including explosives, toxics and radioactive material) were legally dumped at two areas in the Bay. It was believed that the dumping of these materials was confined to the two designated dump sites northeast of Boston. This past summer, however, the EPA funded a study by the International Wildlife Coalition in which side-scan sonar and remote cameras were used to survey the waste sites. The study revealed that thousands of barrels--possibly as many as 80,000--lay on the ocean bottom far outside the designated dumping areas.

The discovery of these barrels has raised new concerns about possible contamination of the fish harvested by our fishermen in Massachusetts Bay. At this time I believe it is essential to assure both our fishermen and the consumers that fish harvested from the Bay is safe. Given the expertise of your agency and that of the National Oceanic and Atmospheric Administration (NOAA), I am requesting that you immediately initiate a testing program that examines possible toxic and radioactive contamination of fish, particularly bottom dwelling fish like flounder. I am advised that the Food and Drug Administration worked successfully with NOAA in the Farallon Islands in a similar situation.

October 24, 1991
Page Two

My office stands ready to provide you with any assistance you may need. The Subcommittee has scheduled a hearing on the dumping in Massachusetts Bay in Boston on November 4. Because I believe the issues of public health will be raised at that time I would appreciate a thorough response from you before the hearing.

I want to thank you in advance for your assistance.

With kind regards.

Sincerely,

Gerry E. Studds
Chairman
Subcommittee on Fisheries and Wildlife Conservation and the Environment

Mr. Thomas Billy, Director
Office of Seafood
Food and Drug Administration
1110 Vermont Ave., Suite 1110
Washington, D.C. 20005

cc: Dr. John Knauss

DEPARTMENT OF HEALTH & HUMAN SERVICES

Food and Drug Administration
Northeast Region

Office Of
The Regional Director
One Montvale Avenue
4th Floor
Stoneham, MA 02180-3500
Telephone:
617/279-1720

February 14, 1992

Mr. Richard B. Roe, Regional Director
Northeast Regional Office
National Marine Fisheries Service
One Blackburn Drive
Gloucester, Massachusetts 01930-2298

Dear Mr. Roe:

The Northeast Region of the U.S. Food and Drug Administration in cooperation with the Northeast Region of the National Marine Fisheries Service would like to reissue an advisory to all fishermen requesting that they avoid harvesting bottom dwelling species in the portion of Massachusetts Bay known as the "Foul Area - An Industrial Waste Dump Site." In an effort to focus this joint advisory to the fishing community I suggest that it be issued through a series of announcements by the National Weather Service (NWS) during their marine weather forecasts, and through the Notice to Mariners system of the National Ocean Service (NOS). Since the National Marine Fisheries Service currently has the "Foul Area" closed to the harvesting of surf clams and ocean quahogs (Federal Register Vol.45, No.2, Thursday, January 3, 1980) I also suggest that this information be included in the advisory. The NWS announcement would read as follows:

> "The Northeast Regional Offices of the U.S. Food and Drug Administration and the National Marine Fisheries Service advise all commercial and recreational fishermen to avoid harvesting bottom dwelling species in the portion of Massachusetts Bay known as the "Foul Area." Since 1980, this area has also been closed to the harvesting of surf clams and ocean quahogs by the National Marine Fisheries Service. The "Foul Area" is a former industrial waste dump site which is described by a circular area two nautical miles in diameter centered at $42^{\circ}25.7'$ North and $70^{\circ}35.0'$ West, approximately 20 miles east northeast of Boston. It is identified on coastal nautical charts as the "Foul Area - a Dump Site for Industrial Wastes." FDA and NMFS officials recommend that all fishermen avoid this area."

The NOS would be requested to add a note to the appropriate Massachusetts Bay coastal nautical charts which reads as follows:

> " The U.S. Food and Drug Administration and the National Marine Fisheries Service advise all commercial and recreational fishermen to avoid harvesting bottom dwelling species from the "Foul Area" - a former dump site for industrial wastes. Since 1980 this area has also been closed to surf clam and ocean quahog harvesting by the National Marine Fisheries Service. Inquiries may be directed to FDA/Northeast Region, One Montvale Avenue, Stoneham, MA 02180."

Our goal is to initiate this activity during March, 1992 and we would appreciate hearing any comments or suggestions you may have at your earliest convenience.

Thank you for your assistance in this matter..

Arthur J. Beebe, Jr.
Regional Food & Drug Director
FDA/Northeast Region

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Northeast Region
One Blackburn Drive
Gloucester, MA 01930

March 4, 1992

Mr. Arthur J. Beebe, Jr.
Regional Director
Food and Drug Administration
Northeast Region
One Montvale Avenue
Stoneham, MA 02180-3500

Dear Mr. Beebe:

With reference to the Massachusetts Bay Foul Area, I agree that it is timely for us to reissue a joint advisory on harvesting bottom dwelling fauna to the fishing community. I have asked my staff to work through our industry contacts and with local marine advisory program agents to disseminate the advisory as drafted. I have also tasked my staff to broadcast the advisory directly to the industry on our regional marine radio service. I have chosen this method versus the NOAA Weather Radio, as this message is a local advisory to be continued over an extended period of time and is not appropriate for the immediacy, criticality, and broadscale coverage of NOAA Weather Radio.

I have also requested the National Ocean Service to issue the drafted text as a Notice to Mariners, to include this material in the Coast Pilot, and provide an appropriate note on future editions to charts showing the Boston Foul Area.

Together, I believe these steps will help to keep fishermen advised of the potential contamination at the Boston Foul area, without confusing the general public of the safe quality of our New England seafoods.

Sincerely,

Richard B. Roe
Regional Director

NOV 01 1991

The Honorable Gerry E. Studds
Chairman, Subcommittee on
Fisheries and Wildlife
Conservation and the Environment
Committee on Merchant Marine and
Fisheries
U.S. House of Representatives
Washington, D.C. 20515

Dear Mr. Studds:

This letter responds to your letter of October 24 to the Food and Drug Administration (FDA) concerning the safety of fish harvested from Massachusetts Bay.

FDA shares your concerns regarding the possible hazards associated with the dumping of hazardous materials outside of the designated disposal areas in the Bay. Consequently, we have underway several actions directed at determining what, if any, hazards may exist, as well as reissuing an advisory against harvesting of shellfish and groundfish near these dump sites.

As you may know, FDA in 1973 advised fishermen to avoid fishing in at least one of the two sites mentioned in your letter. That site, at 42°25.5'N, 70°35'W, used by the Crosswards Marine Disposal Company, was and still is marked "Foul Area, Explosives." Although the Environmental Protection Agency (EPA) contract study clearly shows that material lies outside the designated dump areas, we believe it is still prudent to reissue the advisory warning against harvesting of shellfish and groundfish in the designated areas, where concentrations are believed to be greatest and contamination of organisms would also be greatest. FDA's Northeast Regional Office is taking steps to reissue this advisory.

In light of the EPA study showing material outside of the dump areas, FDA's Boston District has developed a special sampling plan for bivalves, flounder and lobsters to be collected from around the "Foul Area" described above. These samples will be analyzed by FDA for polynuclear aromatic hydrocarbons, volatile organic chemicals, radionuclides, dioxins, and toxic metals. At this time, we are working with both EPA and the National Oceanic and Atmospheric Administration (NOAA) to collect these samples.

FDA typically collects samples of seafood on shore at distribution centers, and, therefore, does not maintain records of exact harvest location. We cannot state whether any of the samples we have analyzed in the past originated in Massachusetts Bay, per se, only that the samples were generally representative of commercial landings in the New England area. Results of analyses conducted by FDA indicate that, in general, commercial seafood harvested in the New England area has not contained excessive levels of toxic chemicals and, therefore, has not presented health risks to consumers.

Nevertheless, FDA recognizes the importance of investigating potential seafood contamination associated with chemical dumping and is working aggressively with both NOAA and EPA to develop a comprehensive plan to investigate the extent of possible contamination of fish and shellfish as a result of dumping hazardous wastes in Massachusetts Bay, both within and without the designated dump sites. We have been advised recently that EPA is planning a December survey of the area with the research vessel, R/V Anderson, to better define the location and extent of this dumping. We also understand that based on that data, EPA will conduct a follow-up survey in the spring of 1992 to collect sediment and biological samples. FDA is working with EPA's Boston Regional Office to participate in that survey and in the analyses of edible species samples.

We will keep you advised of our joint activities with NOAA and EPA to assure that seafood harvested in Massachusetts Bay are safe.

Sincerely yours,

/s/

Kay Holcombe
Acting Associate Commissioner
for Legislative Affairs

cc: HFW-14 (2)
Hommel
HFF-6 (Schwartz)
Wetherell
HFF-500
HFF-400
HFF-300
Spiller
BOS-DO (McDonnell, Gesing, Cartwright)
HFW-10 (2)

R/D:HFH-410:RCWetherell:sw:10/30/91:8-838-5279
Revised:JJones:rdc:10/31/91:245-1466
Comments via phone:TSchwartz:flr:10/31/91
Comments:Spiller,Marzilli:11/1/91
Revised:CHommel:11/1/91
F/T:aor:11/01/91

B:\BOSSTUDD.LTR

The Commonwealth of Massachusetts
Executive Office of Environmental Affairs
100 Cambridge Street, Boston, 02202

WILLIAM F. WELD
GOVERNOR

ARGEO PAUL CELLUCCI
LIEUTENANT GOVERNOR

SUSAN F. TIERNEY
SECRETARY

(617) 727-9800

5 November, 1991

ACTION: Sierra
RGR#: 543
DUE DATE: 11-25-91
CC: Tony Stern Tordoff DeLoi Jenkins Smith

Julie Belaga, Regional Administrator
Region 1
U.S. Environmental Protection Agency
J.F. Kennedy Federal Building
Boston, Massachusetts 02203-2211

Dear Julie:

I was very pleased to learn a few weeks ago that EPA plans to use a research ship available to Region I in December to begin to explore the possible locations off Massachusetts' shores where containers holding low level radioactive wastes were once permitted to be disposed.

I am aware that the EPA has, in the past, attempted to identify the locations of these canisters. However, the recent information which has come to light regarding areas within Massachusetts Bay, not surveyed or studied in previous EPA investigations, where significant quantities of this material may have been disposed demands the kind of work you plan to initiate in December. In order to finally resolve the matter, EPA should locate, to the maximum extent possible, all sites in Massachusetts Bay where this material was disposed. Once these areas are located, we must determine whether the continued presence of this material in Massachusetts Bay poses an unacceptable risk to public health and safety, and if some risk is identified, what remediation action would be most effective.

I strongly support EPA's efforts to do what is necessary and appropriate to resolve this issue. I will certainly do what I can to support you in this important undertaking. To this end, I have asked Jeff Benoit to contact you directly to offer whatever technical assistance the Massachusetts Coastal Zone Management Office can provide to the EPA. If there are other ways in which EOEA might support your efforts in this regard, please let me know.

Sincerely,

Susan F. Tierney
Secretary

RECEIVED
NOV 14 1991
OFFICE OF REGIONAL ADMINISTRATOR
ENVIRONMENTAL REVIEW

cc: Jeff Benoit, MCZM

DEPARTMENT OF HEALTH, EDUCATION AND WELFARE

PUBLIC HEALTH SERVICE

FOOD AND DRUG ADMINISTRATION

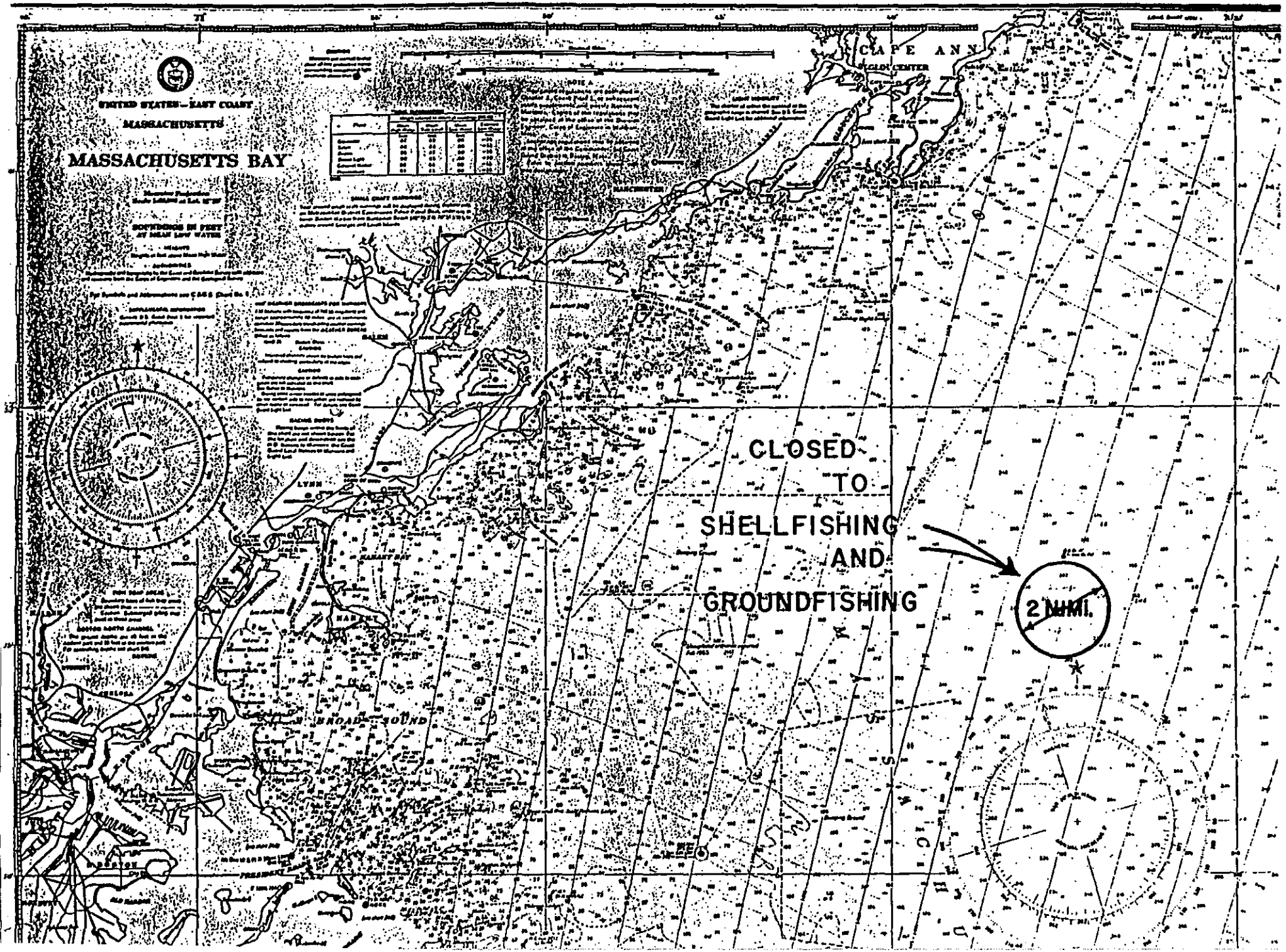
NOTICE TO HARVESTERS

WARNING

The Food and Drug Administration has found that the area shown on the reverse side is polluted and shellfish and other bottom harvested marine animals may be contaminated. You are requested to exercise care and avoid harvesting in this area. This warning is issued under the responsibilities of the National Shellfish Sanitation Program and the Region I office of the Food and Drug Administration. Persons desiring further information write:

Food and Drug Administration
Bureau of Foods
Division of Shellfish Sanitation (BF-230)
200 C Street, S.W.
Washington, D.C. 20204

Food and Drug Administration
Region I
585 Commercial Street
Boston, Massachusetts 02109


UNITED STATES—EAST COAST
MASSACHUSETTS
MASSACHUSETTS BAY
CAPE ANN
CLOSED
TO
SHELLFISHING
AND
GROUNDFISHING
2 NMI.

(C) Before using this make-up day provision, each vessel owner must notify the Regional Director, in writing, of the port from which the vessel fishes. If that port changes, the vessel owner shall promptly notify the Regional Director of the change, in writing.

(D) Any vessel which uses a make-up period without claiming it under this procedure, or which fishes during a scheduled authorized fishing period for which it has claimed a make-up period, shall be liable to forefeit its use of the make-up provision in the future; the vessel and its owner or operator also may be subject to other penalties as prescribed in section 652.9 of these regulations.

(8) *Presumption.* The presence of surf clams aboard any fishing vessel engaged in the surf clam fishery, or the presence of any part of a vessel's gear in the water more than 12 hours after a weekly closure occurs under this paragraph (a), shall be prima facie evidence that such surf clams were taken in violation of these regulations.

(b) *Surf clams, New England Area.* (1) Fishing for surf clams shall be permitted seven days per week.

(2) When 50 percent of the quota of surf clams indicated in section 652.21(b) has been caught, the Regional Director shall, on review of the available information and public comment, determine whether the total catch of surf clams during the remainder of the year will exceed the annual quota. If the Regional Director determines that the quota probably will be exceeded, the Regional Director may reduce the number of days per week, or establish authorized periods, during which fishing for surf clams is permitted.

(3) The Assistant Administrator shall publish a notice in the Federal Register of any reduction in days per week during which fishing for surf clams is permitted. The reduction may be effective immediately upon publication in the Federal Register. The Regional Director shall also send notice of any reduction to each surf clam or ocean quahog processor in the fishery and to each surf clam or ocean quahog vessel owner or operator.

(c) *Ocean Quahogs.* (1) Fishing for ocean quahogs shall be permitted seven days per week.

(2) When 50 percent of the quota of ocean quahogs for any time period indicated in section 652.21(c) has been caught, the Regional Director shall, on review of the available information and public comment, determine whether the total catch of ocean quahogs during the applicable time period will exceed the quota for that time period. If the Regional Director determines that the quota will be exceeded, the Regional Director may reduce the number of days per week during which fishing for ocean quahogs is permitted.

(3) The Assistant Administrator shall publish a notice in the Federal Register of any reduction in the days per week during which fishing for ocean quahogs is permitted. The reduction may be effective immediately upon publication in the Federal Register. The Regional Director shall also send notice of any reduction to each surf clam or ocean quahog processor in the fishery and to each surf clam or ocean quahog vessel owner or operator.

§ 652.23 Closed Areas.

(a) *Areas closed because of environmental degradation.* Certain areas are closed to all surf clam and ocean quahog fishing because of adverse environmental conditions. These areas will remain closed until the Assistant Administrator determines that the adverse environmental conditions have been corrected. If additional areas, due to the presence or introduction of hazardous materials or pollutants, are identified as being contaminated by the Food and Drug Administration, they may be closed by the Assistant Administrator after public hearing is held to discuss and assess the effects of such a closure. The areas currently closed are described as follows:

(1) A waste disposal site known as the "Boston Foul Ground" and located at 45°25'36" N latitude and 70°35'00" W longitude with a radius of one nautical mile in every direction from that point. *(See Appendix A)*

(2) A polluted area and waste disposal site known as the "New York Bight Closure" and located at 40°25'04" N latitude and 73°43'36" W longitude and with a radius of six nautical miles in every direction from that point, extending northwestward from a point on the arc at 40°31'00" N latitude and 73°43'36" W longitude directly toward Atlantic Beach Light in New York to the limit of state territorial waters of New York; and extending southwestward from a point on the arc at 40°19'48" N latitude and 73°45'42" W longitude to a point at the limit of the state territorial waters of New Jersey at 40°14'00" N latitude and 73°55'42" W longitude. *(See Appendix B)*

(3) A pair of areas used for the disposal of chemicals and sewage sludge known as the "Philadelphia and Dupont Closure" and located at 38°23'15" N latitude and 74°14'45" W longitude; and 38°32'30" N latitude and 74°20'00" W longitude with a radius of four and three-quarters nautical miles in every direction from those two points. *(See Appendix C)*

(4) A toxic industrial dump site known as the "106 Dumpsite" and located between 38°40'00" N latitude and 39°00'00" N latitude and between 72°00'00" W longitude and 72°30'00" W longitude.

(b) *Areas closed because of small surf clams.* Areas may be closed to surf clam and ocean quahog fishing upon a determination by the Regional Director (based on logbook entries, processors' reports, survey cruises, or other information) that the area contains surf clams of which:

(1) 60 percent or more are smaller than 4½ inches in size, and:

(2) not more than 15 percent are larger than 5½ inches in size. (Sizes shall be measured at the longest dimension of the surf clam.)

(c) *Notice.* The Assistant Administrator shall publish notice of any area closed under paragraphs (a) or (b) of this section in the Federal Register. The Regional Director shall send notice of the closed area to each surf clam or ocean quahog processor and to each surf clam or ocean quahog vessel owner or operator.

(d) *Presumption.* The presence of surf clams or ocean quahogs aboard any fishing vessel engaged in those fisheries, or the presence of any part of the vessel's gear in the water, in closed areas shall be prima facie evidence that such clams or quahogs were taken in violation of these regulations.

§ 652.24 Vessel moratorium.

The moratorium that became effective on November 17, 1977, prohibiting the entry of additional vessels into the surf clam fishery, shall remain in effect in the Mid-Atlantic Area until December 31, 1981, unless the Secretary determines, after public hearings and consultation with the Mid-Atlantic, New England and South Atlantic Fishery Management Councils, to terminate the moratorium at an earlier date. The moratorium no longer applies to vessels fishing in the New England Area.

BILLING CODE 3510-22-M

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Northeast Region
One Blackburn Drive
Gloucester, MA 01930

4/6/92

March 30, 1992

For your file
4/7/92

MEMORANDUM FOR: Captain John C. Albright, NOAA
Chief, Nautical Charting Division

FROM: Richard B. Roe
Northeast Regional Director, NMFS

SUBJECT: Notice to Fishermen on Massachusetts Bay Charts

The National Marine Fisheries Service Northeast Region and US Food and Drug Administration Northeast Region jointly request the placement of a "Note" on coastal nautical charts for Massachusetts Bay to inform fishermen of contamination of the bottom dwelling fauna from the Boston "Foul Area". The "Foul Area" is a former industrial waste dumpsite which is described by a circular area two nautical miles in diameter centered at 42 25.7′ North - 70 35.0′ West. The area is presently identified on nautical charts as "Foul Area - a Dumpsite for Industrial Wastes." Similarly, the note should be included in the appropriate sections of the Atlantic Coast Pilot.

We propose a note be added to Massachusetts Bay coastal nautical charts as follows:

> "The U.S. Food and Drug Administration and the National Marine Fisheries Service advise all commercial and recreational fishermen to avoid harvesting bottom dwelling species from the "Foul Area" - a former dumpsite for industrial wastes. Since 1980 this area has been closed to surf clam and ocean quahog harvesting by the National Marine Fisheries Service. Inquiries may be directed to FDA/Northeast Region, One Montvale Avenue, Stoneham, MA 02180."

Thank you for taking appropriate action on this request. If you need further information, please contact Commander Robert Pawlowski at FTS 837-9221.

cc FDA/NER - Beebe

APPENDIX B

Survey Plan: Massachusetts Bay
Industrial Waste Site
May 26 - June 3, 1992 (May 22, 1992)

Survey Plan
Massachusetts Bay/Industrial Waste Site
NOAA Remotely Operated Vehicle/Manned Submersible Program
NOAA R/V *Ferrel*
NOAA RV *Gloria Michelle*
May 26 - June 3, 1992

1. 0 Background

The Massachusetts Bay Industrial Waste Disposal Site (IWS) operated between 1952 and 1970. The IWS is located in the Stellwagen Basin defined as a two-nautical mile circle centered at 42°25.7'N, 70°34.9'W (Annex A, Figure 1). The site has a nominal depth of 85 to 90 meters (ca. 300 ft.) with the only significant topographic features occurring in the north and northeast quadrant where the bottom shoals toward the Stellwagen Bank.

This survey, plan includes those tasks being conducted between May 26 and June 3, 1992 aboard the 127-foot R/V *Ferrel*, the 72-foot R/V *Gloria Michelle*,, and the 187-foot R/V *Seward Johnson* as the support vessel of the *Johnson Sea Link-II* submersible.

2.0 Survey Objectives

2.1.1 Recent Investigation Background

In August 1991, the International Wildlife Coalition, sponsored in part by EPA, using a remotely operated vehicle (ROV) system with video recording, surveyed areas inside and outside the IWS. The ROV surveyed 18 sites and observed 93 objects: 64 were identified as containers, 28 percent of which had contents, 30 percent were empty, and 41 percent were indiscernible. The 1991 survey indicates that of the thousands of allegedly disposed waste containers in and about the IWS, many likely remain. In December 1991, U.S. Environmental Protection Agency (EPA) conducted side-scan and ROV surveys in areas outside the IWS to determine the potential threat from historical disposal activities in those areas. EPA determined that a survey focusing on the area of greatest known concentration of hazardous waste containers, the IWS, is a necessary step in developing a decision regarding the degree of intensity of future investigations and/or monitoring efforts. Therefore, the intent of the May/June 1992 survey is to gather sufficient data to preliminary assess the potential chemical contaminant threat posed to public and the environment at the IWS. One aspect of the survey will focus on the potential threat to human health through seafood. A second aspect will focus on pre-selected target areas within the IWS known to harbor high densities of waste containers. The gathered data will be used to verify or reject the contention that an imminent threat exists to the environment and public health in this sector.

2.1.2 Legislative Background

The National Oceanic and Atmospheric Administration (NOAA), as a natural resource trustee agency designated in the Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA) and the National Oil and Hazardous

Substances Pollution Contingency Plan (NCP) in collaboration with the EPA have determined that a preliminary survey (PS), as authorized in the NCP, Subpart G, §300.615, is necessary at the IWS. The U.S. Fish & Wildlife Service, acting on behalf of the U.S. Department of the Interior (DOI) as a natural resource trustee will provide technical assistance to NOAA as a co-trust sister agency.

The PS will be used to evaluate the potential hazardous substance threat to marine resources, and to provide information for inclusion in the Hazard Ranking System (HRS) that is used to score sites for possible listing on the National Priorities List (NPL). A field survey using surface and submersible vessels will acquire physical and biological samples necessary for contaminant analysis.

2.1.3 Agency Participation

Numerous federal and state agencies have interests in the IWS, or offer expertise particularly valuable to the success of this survey. The following is a brief description of the roles played by those agencies providing assistance to NOAA and EPA.

The U.S. Department of Health & Human Services, Food and Drug Administration is responsible for evaluating the quality of seafood consumed by the public. FDA has determined that a survey of fish and shellfish is necessary to assure the public of the quality of seafood caught near the IWS.

The U.S. Department of Energy, in fulfilling its obligations for ascertaining radioactive threats and in collaboration with EPA's Office of Radiation, will provide the survey with a radiological monitoring and safety program.

The U.S Department of the Navy with expertise in munitions will assist the survey team in identifying unexploded ordnance that may be encountered by the ROV or *JSL-II*.

The USCG is responsible for marine safety issues.

The Commonwealth of Massachusetts, Division of Marine Fisheries is providing expert knowledge and field assistance regarding the capture of biological specimens for body burden analysis. The Department of Public Health's Division of Food and Drugs and the Radiation Control Program will provide expert knowledge and field assistance regarding radiological safety and food safety issues, and will perform laboratory analyses for contaminants in biota. The Office of Coastal Zone Management is assisting in sampling design and interpretations of Massachusetts Bay contaminants relative to the IWS. It will provide assistance with future monitoring efforts.

The U.S. Army Corps of Engineers (ACOE) is responsible for the disposal of dredged materials and has historically permitted the disposal of wastes in the area. The ACOE will help coordinate the on-going dredged materials disposal operations and other activities in the survey area. The Corps will also help interpret the historical contaminant data base in the survey area and future monitoring efforts.

2.2 Primary Objectives

The six primary objectives have been identified as:

1. Analyze bottom sediment samples taken close to the containers for hazardous substances, including low level radionuclide characterizatio.

2. Evaluate biological samples for contaminant body burden analysis to assess potential public health risks.

3. Evaluate the effectiveness of a ROV to locate and position bottom objects for specific target area deployment of a manned submersible.

4. Evaluate a manned submersible as a platform for visual and photographic (35-mm still camera and 8-mm video) observation of bottom objects, including hazardous waste containers, on the seafloor with respect to density, overall condition, and identifying marks for comparison with observations taken during previous ROV and side scan sonar surveys.

5. Evaluate a manned submersible as a platform from which to collect sediment samples close to hazardous waste containers.

6. Evaluate the ability to sample potential target species close to potential hazardous substance targets on the seafloor.

2.3 Secondary Objectives

Four secondary objectives have been identified as:

1. Test the utility of the ROV as a platform for in situ radioactivity detection.

2. Test the utility of the manned submersible as a platform for in situ radioactivity detection.

3. Evaluate biological samples for contaminant body burden analysis for preliminary estimates of ecological risk.

4. Quantify the amount of paralytic shellfish toxins and domoic acid found in lobster tomalley in animals harvested from the Massachusetts Bay IWS area.

3.0 Survey Schedule

3.1 Vessels: R/V *Ferrel*
R/V *Gloria Michelle*
R/V *Seward Johnson*
Johnson Sea Link-II (JSL-II)

3.2 Schedule: (Detailed Daily Schedules are appended and will be posted onboard)

3.2.1 R/V *Ferrel*: depart Gloucester at 0800 hours daily return to dock at 1600 hours.

Date	Activity	Overnight Berthing	Sea Day
19 May	Transit to Gloucester	Gloucester	1
20 May	Day Off	Gloucester	
21 May	Day Off	Gloucester	
22 May	Day Off	Gloucester	
23 May	Day Off	Gloucester	
24 May	Day Off	Gloucester	
25 May	Day Off	Gloucester	
26 May	Collect sediment samples at the reference sites Deploy lobster traps in reference area	Gloucester	2
27 May	Deploy lobster and fish traps in Target Areas I and II	Gloucester	3
28 May	Deploy lobster traps in Target Areas III and IV Recover traps from reference area	Gloucester	4
29 May	Recover traps from Target Areas I and II Deploy traps in Target Areas V and VI Tentatively re-deploy traps In Target Areas I and II	Gloucester	5
30 May	Recover traps from Target Areas III and IV Tentatively re-deploy traps in Target Areas III and IV	Gloucester	6
31 May	Recover traps from Target Areas V and VI Tentatively recover traps from Target Areas I and II Demobilization (tentative)	Gloucester	7
1 June	Transit VIPs to dive site Tentatively recover traps from Areas III and IV	Gloucester	8
2 June	Weather day/transit VIPs to dive site	Gloucester	9
3 June	Weather day/transit to AMC, Norfolk, Virginia	Underway	
4 June	Arrive AMC, Norfolk, Virginia	AMC	

3.2.2 R/V *Gloria Michelle*: Depart Gloucester 0600 daily; return at dock at 2000*

Date	Activity	Overnight Berthing	Sea Day
26 May	Transit from Woods Hole to Gloucester Mobilization in Gloucester	Gloucester Gloucester	1
27 May	Deploy ROV Phantom S2 in the IWS	Gloucester	2
28 May	Deploy ROV Phantom S2 in the IWS	Gloucester	3
29 May	Deploy ROV Phantom S2 in the IWS	Gloucester	4
30 May	Demobilization	Gloucester	
31 May	Begin FDA fFish trawls	Gloucester	5
**1 June	FDA fish trawls	Gloucester	6
** 2 June	FDA fish trawls	Gloucester	7
**3 June	FDA fish trawls	Gloucester	8

* Actual docking schedule subject to meeting daily operational objectives
** FDA survey participants and daily schedule is in a separate document

3.2.3 R/V *Seward Johnson/JSL-II:*

Date	Activity	Overnight Berthing	Sea Day
23 May	Depart Fort Pierce, Florida		
30 May	Mobilization	Gloucester	
31 May	Commence survey (3 dives)	Gloucester	1
1 June	Continue survey (3 dives)	Gloucester	2
2 June	Continue survey (3 dives)	Gloucester	3
3-June	Demobilization/depart Massachusetts Bay	Gloucester	

4.0 Personnel

4.1 Chief Scientists

4.1.1 R/V *Ferrel* 5/26

Chief Scientist:
John A. Lindsay, NOAA/NOS/ORCA/HMRAD, Boston, Ma.
Work Phone: 617 573-9699
Home Phone: 603 868-3917
FAX: 617 573-9662

4.1.2 R/V *Ferrel* 5/27-5/31 or 6/1

Chief Scientist:

Patti Tyler, EPA Region I/ESD/BSB, Lexington, Ma.
Phone: 617 860-4342
FAX: 617

4.1.3 R/V *Gloria Michelle* 5/26-5/30

Co-Chief Scientists:

Lance L. Stewart, NURC-UCAP, Groton, Ct.
Phone: 203 445-4714
FAX: 203 445-2969

John A. Lindsay, NOAA/NOS/ORCA/HMRAD, Boston, Ma.
Phone: 617 573-9699
FAX: 617 573-9662

4.1.4 R/V *Seward Johnson* 5/31-6/03

Co-Chief Scientists:

John A. Lindsay, NOAA/NOS/ORCA/HMRAD, Boston, Massachusetts
Phone: 617 573-9699
FAX: 617 573-9662

Lance Stewart, NURC-UCAP, Groton, Connecticut
Phone: 203 445-4714
FAX: 203 445-2969

Darryl Keith, USEPA/ORD/NRL, Naragannsett, Rhode Island
Phone: 401 782-3135
FAX: 401 782-3030

4.1.2 The Chief Scientist is authorized to alter the scientific portion of this cruise plan with the concurrence of the Commanding Officer, provided that the proposed changes will not:

1. jeopardize the safety of the shop or ship's personnel,
2. exceed the time allotted for the cruise,
3. result in undue additional expense, or
4. change the general intent of the project.

Because of the number of vessels involved in this exercise, several individuals are designated as Co-Chief Scientists aboard the R/V *Seward Johnson* and *Gloria Michelle*. This designation is necessary to cover all potential contingencies.

4.1.3 The Chief Scientist shall be responsible for the proper upkeep and cleaning of all spaces assigned to the scientific party, both laboratory and living spaces.

4.1.4 The Chief Scientist is responsible for compiling completed participating scientist or visitor Medical History forms (SF 93) to the Commanding Officer of the R/V *Ferrel* and R/V *Gloria Michelle* at least two weeks prior to Project start (see 4.4).

4.2 Participating Scientists (All inclusive roster: daily roster will vary)

4.2.1 R/V *Ferrel* 5/22-6/3/92

	Name	Title	Sex	Nat.	Affil.
1.	John Lindsay	Coast. Res. Coord.	M	USA	NOAA
2.	Patti Tyler	Ecologist	F	USA	EPA
3.	Cyndi Perry	Contaminant Spec	F	USA	FWS
4.	Andrew Major	Biologist	M	USA	FWS
5.	Darryl Keith	Geol. Oceanog.	M	USA	EPA
6.	Paul Caruso	Fisheries Scientist	M	USA	DMF
8.	Bill Adler	Lobsterman	M	USA	Lob.A-
9.	Judy Pederson	Sr. Ecologist	F	USA	CZM
10.	Jim Cherniak	Health Phys.	M	USA	EPA
11.	Alyson Saben	Safety Off./Investigator	F	USA	FDA
12.	Bernie Gottham	Scientist	M	USA	NOAA

	Name	Title	Sex	Nat.	Affil.
13.	Tom Waddell	Scientist	M	USA	EPA
14.	John Noonan	Organoleptic Spec.	M	USA	FDA
15.	John Biello	Inestigator	M	USA	FDA
16.	William Phillips	Health Physicist	M	USA	EPA
17.	William Bell	Radiation Sci.	M	USA	DPH
18.	Leigh Bridges	Assist. Dir. M.Fisheries	M	USA	DMF
19.	Vern Nulk	Fisheries Scientist	M	USA	NMFS
20.	Pete Calaruso	Fisheries Scientist	M	U S	NMFS
21.	Amy Fox	QA/QC Spec.	F	USA	Lock.
22.	Kerry Diskin	QA/QC Spec.	F	USA	Lock.
23.	Gregory Cramer	Chemist	M	USA	FDA

Visiting Observers:

1. Dover, NH Public School System (May 29) one teacher; five students
2. Newmarket, NH Public School System (May 30) one teacher; four students
3. North Stratford, NH Public School System (May 31) two teachers; three students

4.2.2 R/V *Gloria Michelle*: 5/26-5/30/92

	Name	Title	Sex	Nat.	Affil.
1.	Lance Stewart	Science Director	M	USA	NURP
2.	Ivar Babb	Scientist	M	USA	NURP
3.	John Lindsay	Coast. Res. Coord.	M	USA	NOAA
4.	Dave Wiley	Scientist	M	USA	IWC
5.	William Bell	Rad. Spec.	M	USA	DPH
6.	Sue Larosa	ROV Operator	F	USA	NURP
7.	Nick Worobey	Tech.Spec	M	USA	NURP
8.	William Phillips	Rad. Spec.	M	USA	EPA
9.	Darryl Keith	Scientist	M	USA	EPA
10.	Harry Bostick	Ops. Coord.	M	USA	EG&G
11.	Chip Louft	Mission Mgr.	M	USA	EG&G
12.	Dave Smith	INS Spec.	M	USA	EG&G
13.	Lt. Dennis O'Connor	Ord. Spec.	M	USA	Navy
14	Dr. Tay	Scientist	M	Canada	E.Can
15.	Dave Smith	INS Spec.	M	USA	EG&G
16.	Bill Abrams	INS Spec.	M	USA	S.A.
17.	Donn Henry	INS Spec.	M	USA	EG&G

4.2.3. R/V *Seward Johnson*: 5/31-6/3/92
(Report at Dock 0530; Depart 0600)

	Name	Title	Sex	Nat.	Affil.
1.	John Lindsay	Coastal Res. Coord.	M	USA	NOAA
2.	Lance Stewart	Science Director	M	USA	NURP
3.	Darryl Keith	Scientist	M	USA	EPA
4.	Richard Cooper		M	USA	NURP
5.	Ivar Babb		M	USA	NURP
6.	Nick Worobey		M	USA	NURP
7.	William Bell		M	USA	
8.	Tom Waddell	Regional Scientist	M	USA	EPA
9.	Dave Tomey	Scientist	M	USA	EPA
10.	Dr. Tay	Scientist	M	Canada	En.Can.
11.	William Phillips		M	USA	EPA
12	Harry "Chip" Louft	Mission Mgr.	M	USA	EG&G
13.	Dave Smith	INS Spec.	M	USA	EG&G
14.		Ord. Spec.		USA	Navy
15.		Ord. Spec		USA	Navy
16.	Dave Wiley	Scientist	M	USA	IWC
17.	John Moakley	Attonrney	M	USA	NOAA
18.	Tom Bigford	Fisheries Scientist	M	USA	NOAA
19.	Leigh Bridges	Ast. Dir.	M	USA	Ma.DMF
20.	Norb Jaworski	ERL-N Dir.	M	USA	EPA
21.	Norman Rubenstein	ERL-N Br. Chier	M	USA	EPA
22.	Harry Bostick	Ops. Coord.	M	USA	EG&G
23.	Bill Abrams	NS Spec.	M	USA	S. A.
24	Donn Henry	INS Spec.	M	USA	EG&G

4.2.4. R/V *JSL II*: 5/31-6/3/92

	Name	Title	Sex	Nat.	Affil.
1.	John Lindsay	Coastal Res. Coord.	M	USA	NOAA
2.	Lance Stewart	Science Director	M	USA	NURP
3.	Darryl Keith	Geol. Oceanog.	M	USA	EPA
4.	Ivar Babb	Scientist	M	USA	NURP
5.	Nick Worobey	Ops. Spec.	M	USA	NURP

4.3 Foreign Nationals

The only foreign nationals onboard either vessel will be one or more representatives from Canada.

4.4 Medical History Form: R/V *Ferrel* and R/V *Gloria Michelle*

The Chief Scientist will forward a completed Report of Medical History (SF 93) for each cruise participant, at least two weeks prior to the start of the Project (if not already on

file), to the Commanding Officer, who will in turn forward all reports to the Atlantic marine Center Medical Officer (AMCx4) for approval. Cruise participation is dependent upon the Medical Officer's approval.

5.0 Equipment and Source

5.1 Equipment and Capabilities to be Provided by Vessel

The following items will be required to be onboard and operational prior to sailing in order to fulfill the survey objectives.

5.1.1 R/V *Ferrel*

1. Fish Checker box	
2. Winch(es) with 200 m of 1/4" stainless wire	1
3. 20 cu. ft. freezer	1
4. Charts	3
5. 23' Sea Ox (launch)	1
6. Smith McIntyre Grab Sampler	1

5.1.2 R/V *Gloria Michelle*

5.1.3 R/V *Seward Johnson:*

5.1.4 R/V *JSL-II*

1. Sediment Grab	3
2. Punch tubes	9
3. Punch tube core liners (acrylic Plexiglas)	?
4. 8 mm video film	
5. 35 mm film (800 ft Prof. Ecktachrome 200)	1
6. Bracket for radiometer	1

5.2 Equipment, Materials and Capabilities to be Provided by Scientists

The following items will be required to be onboard and operational prior to sailing in order to fulfill the survey objectives.

5.2.1 R/V *Ferrel*

1.	NOS Chart No. 13267	3
2.	Lobster Traps	75
3.	Spar buoys with radar reflectors	20
4.	Trailing buoys	20
5.	Trap Line (1/2 inch nylon)	12,000ft.
6.	Bait	1 barrel
7.	Dry ice	4 coolers
8.	Labels for biological samples	
9.	Bags for biological samples	
10.	Vinyl Gloves	10 pairs
11.	Surgical Gloves	3 doz.
12.	Aluminum foil	30 boxes
13.	Tissue Preparation Materials	
14.	Ice chests for holding specimens between catch and dissection, and for transfer of biological samples to laboratory	10
15.	Winch for biota trap recovery(?)	
16.	Snatch blocks(?)	
17.	Dissecting tools; scissors, knives, forceps, latex gloves, vials,	
18.	Fish measuring board	2
19.	Scale (gm/kg)	1
20.	Tool box	
21.	Fish Boxes	10.

5.2.2 R/V *Gloria Michelle*

1.	NOS Chart No. 13267	3
2.	Marker Buoys w/line and weight	10
3.	ROV System (Phantom S2)	1

5.2.3 R/V *Seward Johnson*

1.	NOS Chart No. 13267	3
2.	Labels for sediment samples	
3.	Containers for sediment samples	
4.	Geiger counter	
5.	Data sheets	
6.	Log books	
7.	Chain of custody forms	
8.	Punch Core Liners	75

5.3 Hazardous Materials

Hazardous materials brought aboard all vessels by visiting scientific parties shall be accompanied by an inventory list and a "Material Safety Data Sheet" for each hazardous

material. This information will be given to the Chief Scientist who shall will give it to the Commanding Officer. On departure from the ship, visiting scientific parties shall provide an inventory of hazardous materials brought aboard indicating that they have been properly used or removed in suitable waste containers.

6.0 Data Responsibilities

6.1.1 The Chief Scientist is responsible for the data quality feedback, disposition, and archiving of data and specimens collected aboard the ship for the primary project.

6.1.2 The Principal Investigator is responsible for removing sediment and biological samples from the collection gear and on-board processing, storage, and completion of chain-of-custody forms (see Annex B).

6.1.3 Station Plot: All stations will be plotted on NOS Chart No. 13267

7.0 Survey Procedures

7.1 Lobster Survey

7.1.1 Reference Samples

The R/V *Ferrel* will deploy 16 lobster traps in Reference Site 2 (which is Reference Site A in the dredged material disposal site surveys) with coordinates 42°22.7'N by 70°30.3'W (depth approximately 85 m) on May 26 to gather lobster and rock crabs for potential tissue analyses. The traps deployed in two lines of eight traps each will be retrieved after approximately 48 hours. Samples will be retained following protocols detailed in Annex B and analyzed only if the results of the IWS survey indicate contaminant concentrations are high enough to be of concern.

7.1.2 Target Field Samples

Lobster traps will be deployed following target field verification by the ROV off the R/V *Gloria Michelle* (see Section 7.2). Following verification, the R/V *Gloria Michelle* will drop a marker buoy and relay by radio to the Chief Scientist on the R/V *Ferrel*, the position of the marker buoy, target field, and any other pertinent description of the target field that will help the Chief Scientist make a decision for the deployment of lobster traps. Sixteen lobster traps in two trawls of eight traps will be deployed in the target field at the direction of the Chief Scientist. The traps will be retrieved after approximately 48 hours. Two target areas will be covered on each of the first, second, and third days of the operation, so that a total of 72 traps will have been deployed at six target areas over a three-day deployment period. Samples of lobster and rock crabs (*Cancer* spp.)will be processed following protocols detailed in Annex B.

7.2 ROV Survey

7.2.1 ROV Primary Objectives

The R/V *Gloria Michelle* upon arriving at the IWS on May 27, will deploy the ROV Phantom S2 while maintaining station on a two-point anchor mooring. The primary target areas are in the immediate proximity of the IWS, which is an approximately 4 mi^2 area between 42.24° and 42.28'N by 070.33° and 070.37'W (Annex A, Figure 2). The R/V *Gloria Michelle's* deposition will be determined with an Integrated Navigational System (INS) unit providing one- to two-m accuracy. The ROV survey will continue as necessary through May 30.

Six target fields have been pre-selected using descriptions provided in a report entitled, Location Survey and Condition Inspection of Waste Containers at the Massachusetts Bay Industrial Waste Site and Surrounding Areas (Wiley et al. 1992). The Chief Scientist will have a copy of this report onboard for reference. The approximate locations of the six target fields, identified as I, II, III, IV, V and VI are depicted on Annex A, Figure 2.

Target Fields I through IV are based on anchorage points located close to one another. Target Fields V and VI are contingent target fields, and their selection is based on a review of side-scan sonar records provided by the International Wildlife Coalition. These records suggest a potential for high target encounters in these "fields". Target fields are numbered in order from highest expected encounters (Target Field I) to lowest expected encounters (Target Field VI). The target fields will be explored with the ROV in numerical sequence beginning with Target Field I. The target fields with inclusive anchorages and their approximate positions (taken from Wiley et al. 1992) are as follows:

Target Field I: Anchorages A, O, F, P, and G (note that anchorages G and F did not reveal targets of potential interest, nonetheless they are located within the field.)

42 26.49°N x 70 35.20'W (Anchorage A)

Target Field II: Anchorages C and D
42 26.32°N x 70 35.34'W (Anchorage C)
42 26.30°N x 70 35.32'W (Anchorage D)

Target Field III: Anchorages Q and R
42 26.48°N x 70 35.14'W (Anchorage Q)
42 26.34°N x 70 35.05'W (Anchorage R)

Target Field IV: Anchorages K, L, M, and N
42 26.35°N x 70 34.48'W (Anchorage K)
42 26.34°N x 70 34.47'W (Anchorage L)
42 26.34°N x 70 34.47'W (Anchorage M)
42 26.37°N x 70 34.46'W (Anchorage N)

Target Field V: Side Scan Record @ **42 26.58°N x 70 35.22'W**

Target Field VI: Side Scan Record @ **42 25.93°N x 70 35.22'W**

The ROV operates off a downweight, deployed directly below the vessel. The ROV flies from the downweight with an additional 50- m free tether that is marked in meter increments to allow back calculation of distance to the downweight within a few meters. The ROV will search previously searched "anchorages" to verify fields with 'high' concentrations of containers and coordinates. The coordinates of verified container areas within a target field will be plotted with the INS.

An explosive ordnance expert from the U.S. Navy will monitor the video display to provide the Chief Scientist with opinions regarding the hazardous explosive nature of the targets.

The ROV will provide video documentation and simultaneous record of environmental parameters, including depth, salinity, temperature, pH, and dissolved oxygen.

After the Chief Scientist determines that an anchorage has been satisfactorily explored, either the R/V *Gloria Michelle* will be allowed to drop back on its anchor, or a new anchorage will be set. For planning purposes, two target fields will be explored each day for a total of six target fields. The expediency of the effort, or unforeseen delays may cause alteration of the proposed plan.

After completing the search of a target field, the R/V *Gloria Michelle* will deploy a marker buoy that the R/V *Ferrel* will use to guide its deployment of lobster traps. The Chief Scientist has the responsibility to notify the R/V *Ferrel* of the marker buoy deployment and provide coordinates and other information to help the Chief Scientist aboard the R/V *Ferrel* determine the best disposition of the lobster trawls.

The results of the ROV search will be used by the Chief Scientists to develop a search and sampling plan with the *JSL-II*.

7.2.2 ROV Secondary Objectives

7.2.2.1 Radiation Monitoring

The ROV will be fitted with a DOE supplied radiometer (a go/no go device). The radiometer will be used for field testing the suitability of the ROV platform, to sense near-field in situ radiation levels. The radiometer offers real-time, surface readout of the radiation levels measured in the vicinity of any suspicious canisters. Canisters yielding noteworthy radiation levels will be marked with an acoustic pinger.

The location of suspect radioactive targets will be plotted with the INS.

7.2.2.1 Sediment Sampling

Time permitting, the Chief Scientists may elect to collect sediment samples in the vicinity of selected target containers. The ROV will obtain a punch corer from the downweight basket, return to the target and recover a sediment sample. The position of the target will be plotted with the INS. No Attempts will be made to collect samples from targets indicating high levels of **radioactivity.**

7.3 Manned Submersible Survey

Bottom current velocities near the IWS based on measurements near 85 m seasonally have averaged 4-5 cm/sec, although they have been observed to approach 20 cm/sec (EPA Draft EIS 1989, pp 24-25). The dominant, yet weak, bottom flow pattern has been described as moving from west-northwest to east-southeast, with a secondary flow to the east-northeast. Surface water velocities vary under non-storm conditions around 15 to 20 cm/sec. The ACOE is conducting a dredged material plume dispersal monitoring study between approximately May 25 and May 30. Bottom-current information and turbidity information should be available from the contractor (EA Engineering) conducting the study. Two contractor vessels will be in the vicinity of the IWS during this period. The vessels are the R/V *Onrust* and the M/V *Marlin.* Onboard Principal Investigators from EA Engineering are Mr. Cliff Firstenberg and Mr. Steve Rives.

7.3.1 Positioning

The R/V *Seward Johnson* is the support vessel for the *JSL-II.* The R/V *Seward Johnson* is equipped with redundant Magnavox MX 200 GPS receivers and will also have the USCG "black box" to allow differential global positioning system (GPS) operation. In addition, the ship will be equipped with an INS, developed by Florida Atlantic University, that will provide a color VGA monitor real-time readout of the ships location and *JSL-II*'s location relative to the ship. The location coordinates will be recorded on floppy disks at user-defined intervals for later upload into a Geographic Information System (GIS). A color printout of the ship and submersible tracks, latitude and longitude, and any targets should also be available through a HP color printer.

7.3.2 *JSL-II* Survey Plan - Primary Objectives

7.3.2.1 Target Field Exploration

Target fields verified with the ROV will be the focus of each *JSL-II* dive (see 7.2.1). Target Fields will be explored in the following sequence.

Target Field III
Target Field II

Target Field I
Target Field IV

Target Field V
Target Field VI

The Primary Objective is to explore Target Fields I-IV. Target Fields V and VI are contingent fields and will be explored only as time permits or if the ROV survey indicates that they should be given higher priority. Tentatively two target fields will be explored each day. The decision on which target field to explore and the amount of time expended at each field will be determined in the field by the Chief Scientists.

Each dive will be of two to three hours in duration. Each dive will accommodate two scientists/observers; one fore and one aft. Once on-station, the *JSL-II* crew will make visual observations as to the areal extent of the target field. All visual observations will be voice recorded. Visual observations should include:

- container condition (intact or open)
- notes on the surrounding habitat, including noteworthy fauna.

Additionally, the *JSL-II* will acquire adequate photographic records with both 35 mm and 8 mm video film. After verifying the areal extent of the target field, the Chief Scientist will consult with the Principal Investigator(s) to initiate sampling. The JSL-II will take up to three box core (20x20 cm2) samples at representative stations along with five punch-core samples. Each sample will be photo documented with 8-mm video and 35-mm film and the sample location will be plotted in accordance with 7.1.2.1.

Upon surface retrieval of the box core, the sediment sample will be cored and frozen for later vertical sectioning and analysis.

The acrylic liners of each punch core sample will be removed from the core. The liner will be capped and frozen for future contaminant analysis.

7.4 Reference Sediment Survey

Two reference sites (1 and 2) have been selected as a near-field test of variance of contaminant distribution. Reference Site 1 (station REF in dredged material disposal site surveys) with coordinates 42 24.686°N by 70 32.814'W (depth 92 m) is composed predominantly of fine silt (mean grain size averaged 0.013 mm (EPA Draft EIS 1989, p 29)). This site has been previously used as a reference site for dredged material disposal studies, and it is not considered likely to have been affected by the releases from hazardous containers. Reference Site 2 (Reference Site A in the dredged material disposal site surveys) coordinates are 42 22.7°N by 70 30.3'W (depth approximately 85 m).

Although some contamination from hazardous container releases is possible, these sites are considered a near-field test and not a test of Massachusetts Bay background concentrations. Previous investigations of these reference sites did not analyze sediments for the full suite of contaminants being considered in this survey. On May 26 the R/V *Ferrel* will steam to the reference sites. A Smith-McIntyre grab sampler will be deployed to collect sediments. Upon retrieval, sediment core samples will be extracted and preserved for future analysis. Enough grabs samples will be taken to provide a sufficient number of replicate samples.

7.5 Seafood Safety Survey

Protocols for the seafood safety aspect of the overall survey, which was conducted by FDA, are attached as Annex C.

8.0 Communications

8.1 R/V *Ferrel*

8.1.1 The R/V *Ferrel* is equipped with INMARSAT and a cellular telephone. The Chief Scientist or his designee may have access to these with permission from the Commanding Officer. The use of either system by the Chief Scientist will be charged to a calling card provided by John Lindsay, NOAA program coordinator.

The R/V *Ferrel* is equipped with a cellular telephone that may be connected by first dialing ROMER ACCESS number **617-571-7626;** then dialing **804 434-3640.**

While berthed at the USCG Station in Boston, the *Ferrel* may be reached by calling **617 223-3354or 3355.**

8.1.2 A daily radio schedule will be maintained between the vessel and the NOAA Gloucester facility. All communications require prior approval by the Commanding Officer or his designee.

8.1.3 Since it may sometimes be necessary for the scientific staff to communicate with other research vessels, including the R/V *Seward Johnson,* the Chief Scientist, or his designee, may request from the Commanding Officer, the use of radio transceivers aboard the vessel.

8.2 R/V *Gloria Michelle*

Communications between the R/V *Gloria Michelle* and other survey vessels will be conducted over Channel 13 or some channel to be determined later as deemed appropriate.

8.3 R/V *Seward Johnson*

Communications between the R/V *Seward Johnson* and other survey vessels will be conducted either over Channel 13 or some channel to be determined later as deemed appropriate. Communications may also be conducted between vessels using vessel supplied VHF hand-held radios.

9.0 Health and Safety

Health and safety procedures will be followed according to the plan prepared by each vessel operator. The Commanding Officer or his/her designee of each vessel will review health and safety procedures before or during transit to the site of operations. It is

expected that this review will not be necessary for each successive field day except for newly boarding participants or visitors.

A radiological health and safety plan is attached as Annex D.

10.0 Meetings

10.1 Precruise

A precruise meeting between the Chief Scientists and their staffs, and the Commanding Officer and his staff, will be held prior to the start of the cruise to identify operational requirements. The meeting will be used to identify the day-to-day requirements of the project in order to best utilize the shipboard personnel resources and to identify overtime requirements and logistic support (meals, etc.) required by the scientific party.

10.2 Underway

A daily meeting, when applicable, will be held between the Chief Scientist and Commanding Officer/Field Operations Officer to discuss the day's operations and the next day's schedule. The Chief Scientist will then make up a plan for the day that he will submit to the Commanding Officer for approval and distribution.

10.3 Postcruise

A postcruise meeting between the Commanding Officer and the Chief Scientist will be held for debriefing and inspection of the rooms and facilities.

10.4 Meals

Meals aboard the R/V *Ferrel* will be provided to the scientific party. Meals aboard the R/V *Gloria Michelle* must be provided by each scientific member. Meals aboard the R/V *Seward Johnson* will be provided to the scientific party.

11.0 Addition Area Surface Vessel Traffic and Potential Hazards

11.1 Observation Vessels

Potentially the R/V *Navaho* (53-ft) belonging to the International Wildlife Coalition will be in the vicinity of the IWS area to observe survey activities.

11.2 Dredge Material Disposal

11.2.1 Disposal Traffic

On-going dredging associated with the construction of Boston's Third Harbor Tunnel Project has a need to dispose of dredged materials at the Massachusetts Bay Dredged Material Disposal Site (see Annex A, Figure 3), which overlaps the IWS (see Annex A, Figure 2). According to representatives associated with this activity, dredged material will likely be sticky clay and possibly some rock. The tug *Astoria* will have a barge in tow on a 500-1000 ft hauser line. Maximum disposal operations will occur three times over a 24 hour period. Primary sediment disposal focuses on the "MDA" buoy positioned at **42 25.098°N x 70 34.447'W** (see Annex A, Figure 3). Some other disposal options may be available, however, they will still be within the designated disposal site. Dutra Construction Company is the contractor overseeing disposal operations. Dutra is aware of this survey, and are very willing to extend as much cooperation as is possible for them.

Contact is: Mark Korkowski,

Work Phone: **617 426-8099**
Work FAX: **617 426-8161**

11.2.2 Disposal Studies

The ACOE is sponsoring a dredged materials disposal plume dispersion study. The study is being performed by EA Engineering, Sparks, Maryland. Two vessels are involved in the investigation. The R/V *Onrust* (60-ft) and the M/V *Marlin* (100-ft).

The Principal Investigators for EA Engineering, Mr. Cliff Firstenberg and Mr. Steve Rives (work phone 410 771-4950; FAX 410 771-4204), expect the survey to last from May 25 to May 29, although there are contingencies for weather. The *Marlin* will be using an acoustic doppler current profiler. The *Onrust* will track the plume dispersion for as long as it lasts or up to six hours. Transmissivity measurements, CTD measurements, and Rosette water samples will be taken. Summary information will be made available to the Chief Scientists upon request.

Mr. Tom Fredette is the contact for the ACOE, New England Division. His work phone is **617 647-8291**.

A mobile phone is on the *Onrust* and can be reached by calling **516 383-8234.**

Mr. Firstenberg has a beeper that can be reached by calling: **800 234-8370.** Someone will answer the phone and relay a message.

12.0 Annexes

A. Chart of Station Locations

B. Biological Sampling Protocols, Sediment Sampling Protocols, and Chain-of-Custody

C. FDA Sampling Plan

D. Radiological Health and Safety Plan

ANNEX A

STATION LOCATIONS
(FIGURES 1-3)

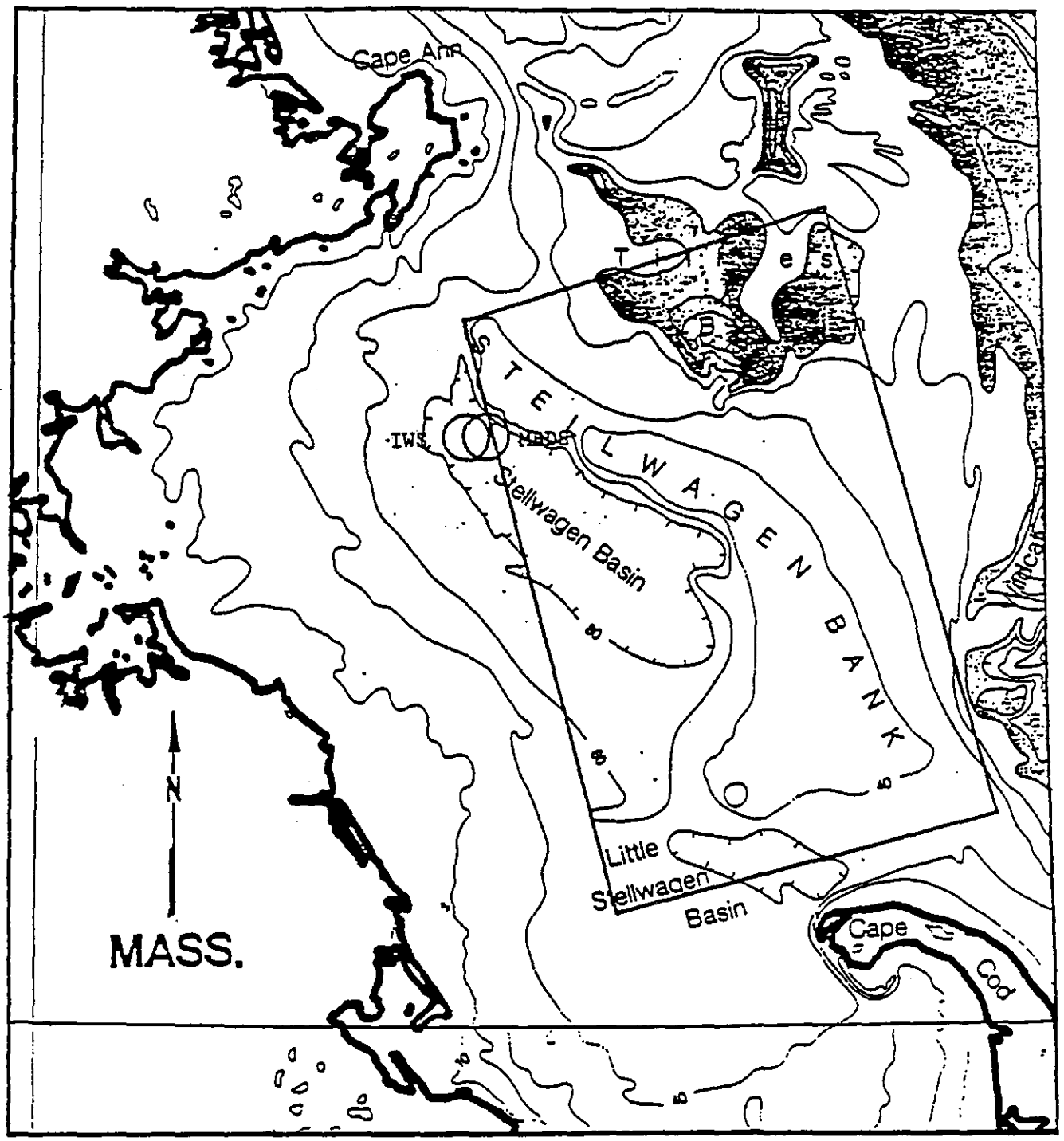


Figure 1. Approximate location of the two disposal sites in Stellwagen Basin (overlapping circles) and the study area for the proposed marine sanctuary at Stellwagen Bank (large quadrangle). The amount of overlap between the disposal sites and the study area is approximate. Depths in meters. Base chart from Backus & Bourne (1987).

From: Dorsey 1990

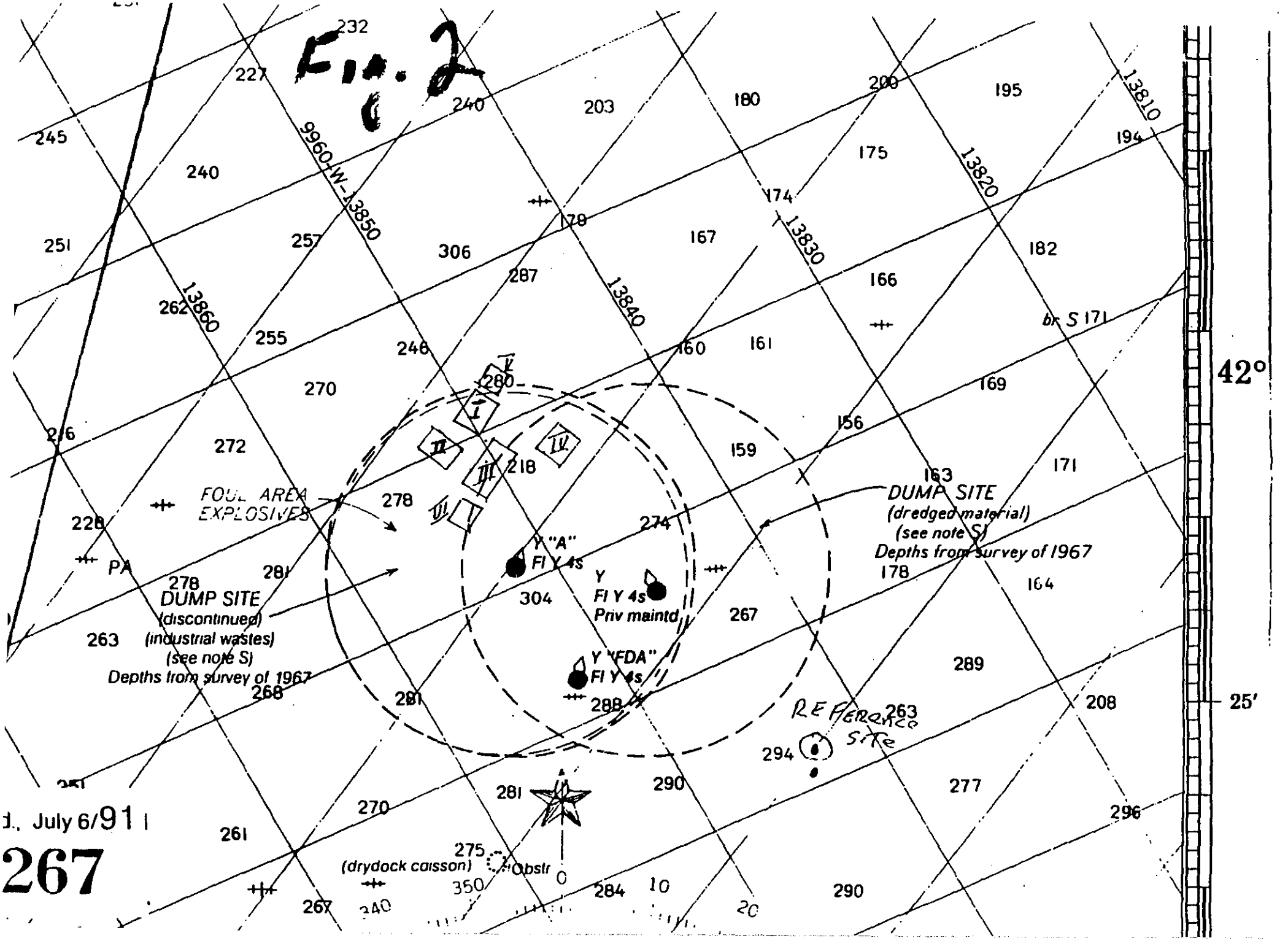


Fig. 2
9960-W-13850
13860
13840
13830
13820
13810
42°
25'
DUMP SITE
(discontinued)
(industrial wastes)
(see note S)
Depths from survey of 1967
FOUL AREA
EXPLOSIVES
PA
DUMP SITE
(dredged material)
(see note S)
Depths from survey of 1967
Y "A"
Fl Y 4s
Y
Fl Y 4s
Priv maintd
Y "FDA"
Fl Y 4s
Reference Site
(drydock caisson)
Obstr
I
II
III
IV
V
VI
VII
232
227
240
203
180
200
195
245
240
175
194
251
257
306
287
167
174
182
262
255
246
270
280
166
160
161
S 171
276
272
218
159
156
169
163
171
228
278
274
304
267
178
164
263
281
268
289
208
294
263
290
277
296
281
270
261
275
350
0
284
10
20
290
267
240

J., July 6/91

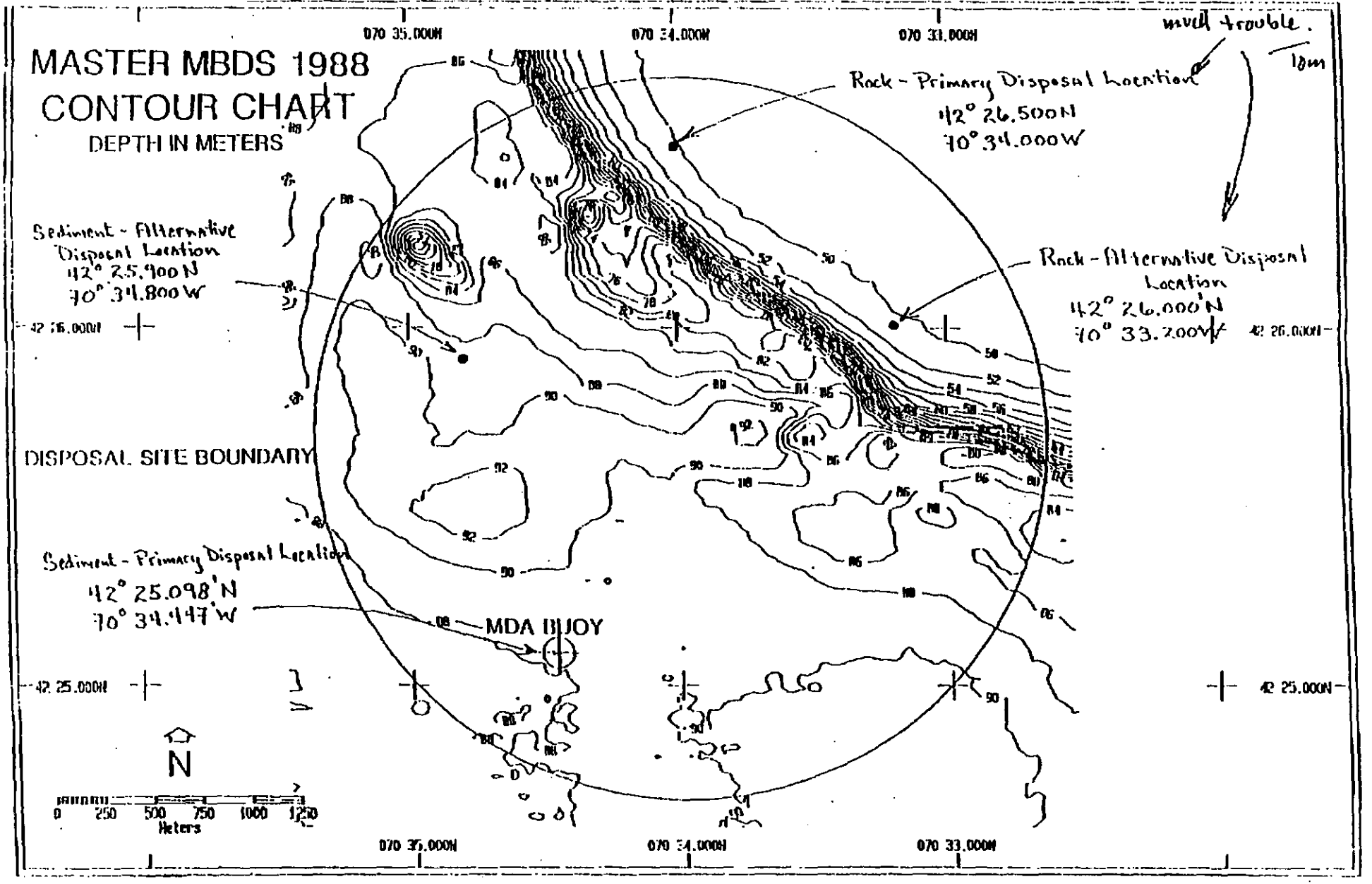


Figure 3 Bathymetric contour chart of the entire MBDS area, November 1988. Contour interval is 2.0 meters.

ANNEX B

BIOLOGICAL SAMPLING PROTOCOLS

SEDIMENT SAMPLING PROTOCOLS

B.1 BIOLOGICAL SAMPLING PROTOCOLS

B.1.2 Introduction

Following uniform, non-contaminating sampling procedures in both reference areas and in the waste dumpsite areas is very important. This document provides sampling procedures for use with biological samples, and the procedures for maintaining chain of custody until the samples are delivered to the appropriate analytical laboratories.

B.1.3 Record Keeping

A page numbered, field logbook consisting of bound pages and separate EPA Traffic Reports (i.e.. Chain-of-Custody Forms) will be maintained by the Chief Scientist and other persons designated by the Chief Scientist. The Chief Scientist will maintain custody of all records. After the cruise, the Chief Scientist will deliver all copies of records to Mr. Thomas Waddell, EPA Regional Scientist for archiving. These records include field logbooks and documents that travel with the samples; e.g., EPA Traffic Reports.

The following information on each specimen should be entered in the field logbook:

station name and number
date &time
latitude and longitude loran delay times
weather conditions
depth (in meters)
gear used, soak time, start and stop
unique specimen number
total length (in millimeters)
weight (in grams)
taxonomic identification
gender and reproduction condition
general condition
location and description of grossly visible anomalies and lesions
other appropriate information, including names of samplers

B.1.4 Sampling Procedures

B.1.4.1 General Overview

At each site, lobster, crabs (*Cancer borealis, C. irroratus.*), and shrimp (*Pandalus borealis*) of appropriate size are selected and placed in holding containers. If fish (primarily redfish) are caught, they should be placed in the fresh seawater checker box until it is time to preserve. The seawater should be running or changed frequently. Dead animals or animals severely damaged during capture should not be used if at all possible. An animal selected for analysis is weighed in grams, measured (carapace length for lobster, carapace width for crabs, total length—tip of rostrum to tip of telson—for shrimp, and fork length for fish), and

assigned a unique specimen number to be entered on the Field Sample Data and Chain-of-Custody Sheets.

All organisms will be wrapped in aluminum foil, dull side up. A portion of each roll used to wrap the specimens will be placed in a plastic bag to serve as a blank for cross-contamination check.

Upon return to Gloucester, the Chief Scientist will determine whether or not to transfer the NOAA portion of the day's catch or several day's catch to either NOAA's National Marine Fisheries Service's Gloucester Laboratory freezer or the U.S. Fish & Wildlife Service's Concord, New Hampshire freezer for short-term storage. Specimens from the -80F freezer should be put into ice coolers packed with sufficient ice to ensure that the specimens do not thaw while being transported from the vessel to another facility. All chain-of-custody requirements should be met; i.e., portable coolers must be sealed with tape and signed for. Following completion of the cruise a sample catalogue will be prepared by the Chief Scientist (John Lindsay) for review by the U.S Fish & Wildlife Service's Patuxent Laboratory that will perform the analytical services. Following Patuxent's review, the sample coolers will be shipped overnight express to the Patuxent Laboratory.

B.1.4.2 Specific Considerations

B.1.4.2.1 Lobsters

Following removal from the traps, all lobsters should be placed in a holding container (they may be placed in the same holding container as crabs—see below). One holding container per trap should be used. Each holding container should be appropriately labeled to allow easy identification of the trap from along the trapline the specimens were taken.

The Chief Scientist will ensure that the FDA Principal Investigator receives from six to eight lobsters, or enough to provide 1,500 grams of edible tissue. Thereafter, if any additional specimens are available, the Chief Scientist will freeze the specimens for future low-level contaminant body burden analysis by NOAA. A minimum of eight ounces (175 grams) of tissue is necessary per analysis. In the unlikely event that more than one lobster per trap is collected per target field for NOAA analysis, the additional lobsters will be given to FDA.

Following removal from the holding containers, specimens should be rinsed in ambient seawater. Individuals should be placed in zip-locked type, new polyethylene bags. The bags should be pre-labeled with a waterproof marker. A waterproof label should also be placed inside each bag. The bag with the specimens should be placed inside the -80F freezer.

Regardless of the number of specimens caught in each trap, all specimens will be counted and notations of general condition written into the log. Only whole specimens should be measured, weighed, sexed, and reproductive condition noted.

Some photographs for documentation should be taken of specimens prior to being placed in bags. Any specimens showing gross external histopathologies should be photodocumented. The appropriate information should be entered into the field log.

B.1.4.2.2 Crabs

Following removal from the traps, all crabs should be placed in a holding container. One holding container per trap should be used. Each holding container should be appropriately labeled to allow easy identification of the trap from along the trapline the specimens were taken.

The Chief Scientist will select the crabs to be frozen for future analysis. A maximum of 10 crabs per trap should be frozen; and only a maximum of 30 crabs per target field should be frozen. Traps offering the maximum number of 10 should be selected first. If insufficient numbers are present to provide the maximum number of 10, the contents of additional traps can be frozen until the maximum number of 30 is attained. However, the contents of separate traps should not be mixed together. Following removal from the holding container, specimens should be rinsed in ambient seawater. Individuals should be placed in zip-locked type, new polyethylene bags. The bags should be pre-labeled with waterproof marker. A waterproof label should also be placed inside each bag. One individual should be placed in each bag. But several individually bagged specimens should be placed in a larger bag to represent a single trap. Consequently, there may be several larger bags per target field sample.

Regardless of the number of specimens caught in each trap, all specimens will be counted with general condition remarks written in the log. Only whole specimens should be measured, weighed, sexed, and reproductive condition noted.

Some photographs for documentation should be taken of specimens prior to being placed in bags. Any specimens showing gross external histopathologies should be photodocumented. The appropriate information should be entered into the field log.

B.1.4.2.3 Fish

Experimental fish traps deployed with the lobster traps hopefully will catch the primary species of interest, the redfish (*Sebastes* sp.). However, other species may be caught. Such species may be indicative of organisms that use the hazardous waste barrels as shelter. Consequently, these specimens may reveal the potential degree of threat to organisms living within the barrel field. Such specimens should be frozen for potential future contaminant analysis.

When handling the fish, surgical gloves should be worn. Sources of contamination such as tobacco smoke, engine exhaust fumes, dust, and dirty hands must be avoided. Surfaces on which fish are lain for measuring or photographing should be covered with aluminum foil, shiny side down. Following measurements, the fish should be individually placed in a zip-locked type, new polyethylene bag and placed into the -80F freezer. The bags should be pre-labeled with waterproof marker. A waterproof label should also be placed inside each bag. One individual should be placed in each bag. But several individually bagged specimens should be placed in a larger bag to represent a single trap. Consequently, there may be several larger bags per target field sample.

The minimum separate sample size for each tissue type from each specimen is approximately 10g (l0cc), but more should be taken if possible.

Some photographs for documentation should be taken of specimens prior to being placed in bags. Any specimens showing gross external histopathologies should be photodocumented. The appropriate information should be entered into the field log.

B.2 SEDIMENT SAMPLING PROTOCOLS

B.2.1 Introduction

This document provides sampling procedures to be used to collect sediment samples during the survey.

Reference Sites

Sediments will be collected onboard the NOAA R/V *Ferrel* using a Smith-McIntyre grab sampler. Six lowerings will be conducted per site. Twelve samples will be collected at each site for sediment chemistry. Twelve samples will be collected at each site for particle size, mineralogy, and radiological analyses. Sufficient material will be collected to provide for triplicate analyses of each of the above analyses.

Target Field Exploration

Sediments will be collected onboard the *JSL-II* using box cores and punch cores as describe in Section 7.3.2.1.

B.2.2 Record Keeping

A Trawl Log and Grab Record will be maintained by the R/V *Ferrel* during sediment collection. This information will be given to the Chief Scientist as a record of sampling activities and transferred to a Field Logbook consisting of bound pages. A Sediment Description notebook will also be maintained by the Chief Scientist and other persons designated by the Chief Scientist. EPA Traffic Reports (i.e., Chain-of-Custody Forms) will be maintained by the Chief Scientist or other persons trained in their completion. The Chief Scientist will maintain custody of all records. After the cruise, the Chief Scientist will deliver all copies of records to Mr. Thomas Waddell, EPA Regional Scientist for archiving. These records include field logbooks and documents that travel with the sample; e.g., EPA Traffic Reports.

The following information will be entered into the Field Logbook:

collection date
site name
grab number
time
latitude
longitude
water depth

The following information will be entered into the Sediment Description notebook:

sample number
location
latitude
longitude
time
date
sampler type
sediment type
sediment color
texture
general description

B.2.3 Sampling Procedures

References Sites

Sediment Chemistry Analysis

At each site, upon retrieval of the grab sampler onboard the R/V *Ferrel*, a stainless steel spatula will be used to remove the top 8 to 10 cm of sediment. These sediments will be placed and homogenized in a stainless steel mixing bowl. The homogenized sediment will be placed in four labeled eight- ounce glass jars with Teflon lids. Samples will be frozen until analyzed. Note: Glass jars will be washed and acid stripped prior to the cruise.

Other Sediment analyses

At each site, after sediments for chemical analysis have been collected, the grab sampler will be again lowered for the collection of material for sedimentological and radiological analyses. Upon retrieval on deck, four Lexan-core tubes will be placed in the sediment. The core samples will be capped, properly labeled and sealed. Those cores collected for radiological analysis will be frozen. Cores collected for particle size and mineralogy will be kept at 4°C until analyzed.

Target Field Exploration

Sediment Chemistry Analysis

For each target field, upon retrieval of box cores onboard the R/V *Seward Johnson*, a stainless steel spatula will be used to remove the top 8-10 cm of sediment. These sediments will be placed and homogenized in a stainless steel mixing bowl. The homogenized sediment will be placed in four labeled eight-ounce glass jars with Teflon lids. Samples will be frozen until analyzed. Note: Glass jars will be washed and acid stripped prior to the cruise. For each target field, punch core samples will be properly labeled and sealed. Those cores collected for radiological analysis will be frozen. Cores collected for particle size and mineralogy will be kept at 4°C until analyzed.

B2.4 Cleaning Procedures

All equipment in contact with sediment samples will be cleaned before each use to prevent cross contamination. Cleaning will be accomplished by washing with detergent, rinsing with seawater followed by a rinse with deionized water.

SAMPLE CUSTODY AND DOCUMENTATION

The possession of samples must be traceable (i.e., their whereabouts must be determinable at all times evidenced by paper to prove it) from the time the samples are collected until they are introduced as civil or criminal evidence in enforcement proceedings, because of the potential evidentiary nature of sample collecting investigations. In addition, all information pertinent to field activities must be recorded in various forms, including logbooks, sample tags, and photographs. Such information, since it is required and used to refresh the investigators memory years later at trial will support the introduction into evidence of a particular sample, and potentially provide field worker must keep detailed records of inspections, investigations, photographs taken, etc., and thoroughly review all notes before leaving the site. Document control is implemented to ensure that all documents for a specific project are accounted for when the project is completed. Accountable documents include items such as logbooks, field data records, and photos. Each document should bear a serial number and should be listed, with the number, in a project document inventory assembled at the project's completion. Waterproof ink should be used in recording all data in documents bearing serial numbers.

Under Rule 803(6) of the Federal Rules of Evidence, written records of regularly conducted business activities may be introduced into evidence as an exception to the "hearsay rule" without the substantive oral testimony of the person(s) who made the record, (IF the author can establish the proper foundation for admissibility (date, time, place, who was there, identify that a document was authored by him (by signature, initials, or handwriting) and be able to state that that type of document is kept in the ordinary course of business). Although it is preferable, it is not always possible for the individuals who collected, kept and analyzed samples to testify in court. In addition, if the opposing party does not intend to contest the integrity of the sample or testing evidence, admission under Rule 803(6) can save a great deal of trial time. For these reasons, it is important to standardize the procedures followed in collection and analysis of evidentiary samples to qualify for the requirement of "regularly conducted activity". Whether or not the team members anticipate that various documents will be introduced as evidence, they should make certain that all documents are as accurate and objective as possible. THE SUCCESS OF FAILURE OF A COURT PROCEEDING COULD DEPEND ON IT.

A. FIELD LOGBOOK

All information pertinent of field activities should be entered in a bound book with consecutively numbered pages. At a minimum, logbook entries must include:

- WHEN (date, time)
- WHERE (county, state, site address, sample location)
- WHO (those present directly involved)
- WHAT (sample numbers, descriptions of observations and actions)
- HOW (equipment used, or procedures followed)

Additional entries, of a WHY nature may be included, particularly if the sampler feels they could act as collateral aids in refreshing his memory at a later date. HOWEVER, caution should be exercised that these are essentially objective in nature as they too would be considered as evidence. Such entries could include:

- Name and address of field contacts (federal, state, or local representatives present but not directly involved in activity)
- Type of process producing the material
- Type of media sampled (drinking water, wastewater, sediment, etc.)
- References such as maps or photographs taken or acquired of the sampling site
- Any field measurements made such as pH, total organic vapors, or explosives

Because sampling situations vary widely, notes should be as descriptive and inclusive as possible. Those reading the entries should be able to reconstruct the sampling situation from the recorded information. Language must be objective, factual and free of personal feelings or opinions or any other inappropriate terminology. If anyone other than the person to whom the logbook was assigned makes an entry, they must date and sign it. Errors should be corrected with a single line drawn through the error, the correct data filled in, and the correction entry initialed and dated.

B PHOTOGRAPHS

Photographs can be the most accurate demonstration of the field worker's observation. They can be significant to the field team during future inspections, informal meetings, and hearings. A photograph should be documented with the entries listed as MUST listed in part A, above, if it is to be valid representation of an existing situation. It is a good idea to sign and date the final print or transparency, to aid in positive identification at a future date. Comments should be limited to an objective description. Photographs should be taken with a camera-lens system with a perspective similar to that afforded by the naked eye.

C. SAMPLE LABELS

Each sample should be labeled using waterproof ink and sealed immediately after it is collected. Labels should be filled out before collection to minimize handling of the sample container. Records should be kept of the assignment of serial sample tags to field personnel if such forms are used. Sample tags must never be discarded. Lost, voided, or damaged tags should be immediately noted in the logbook of the person to whom they were assigned.

Labels must be firmly affixed to the sample containers. Tags attached by string are acceptable when gummed labels are not available or applicable. The container must be dry enough for a gummed label to be securely attached. The label must include at the minimum the assigned sample number. If supporting information, i.e., name of collector, data and time of collection, place of collection are not included on this label, such information MUST be recorded in the bound field logbook at the time of actually taking the sample and directly keyed to the assigned sample number and cross referenced to the appropriate Field Data Sheet and Chain of Custody form, and Analysis Requested form.

D CHAIN-OF-CUSTODY PROCEDURES

As in any other activity that may be used to support litigation, the sample collector must be able to provide documentation of the chain of possession and evidence of the continued custody of any samples which are offered for evidence. Written procedures must b e available and followed whenever evidentiary samples are collected, transferred, store, analyzed, or destroyed. The primary objective of these procedures is to create an accurate written record which can be used to trace the possession and handling of the sample from the moment of its collection through its analysis and to its introduction as evidence.

A sample is considered to be in someone's "custody" if:

- It is in one's actual possession, or
- It is in one's view, after being in one's physical possession, or
- It is in one physical possession and then locked up so that no one can tamper with it, or
- It is kept in a secured area, restricted to authorized and accountable personnel only.

During sampling collection and shipment, specific procedures should be followed to maintain proper chain-of-custody and accurate field inventory sheets, logbooks, and other supporting documentation. DO NOT LOSE THEM!

1. Sample Collection, Handling, and Identification

The number of persons involved in collection and handling samples should be kept to a safe minimum. Field records should be completed at the time the sample is collected and should be signed or initialed, including the data and time, by the sample collector(s). Field records (in addition to those listed in Part A, of this section) should contain the following information:

- Unique sampling or log number
- Custody form numbers, if supplied
- Preservative used
- Name of collector(s)
- Copies of Field Data Sheets, Chain-of-Custody documentation, analysis requested, airbill or waybill documents if shipped by common carrier.

It should be confirmed by the sampler writing in his or her field log that each sample is identified by the approved pressure-sensitive gummed label or standardized tag on the container, and if the individual container is sealed.

The sample container should then be placed in a transportation case, along with the shipping copies of chain-of-custody record form, pertinent field records, and analysis request forms as needed. The transportation case should be sealed or locked. A locked or sealed ice chest eliminates the need for close oversight of the individual samples. However, on those occasions when the use of an ice chest in inconvenient, the collector should seal the cap of the individual sample container in such a way that any tampering would be easy to detect.

When samples are composited over a period of time,. unsealed samples can be transferred from one crew to the next. the transferring crew should list the samples and condition and a member of the receiving crew should verify the condition and sign the list. The receiving crew either transfers the unfinished composite samples to another crew or treats the finished composite sample as described above for samples.

It is desirable to photograph the sample location or any visible pollution to facilitate identification later. At the time the photo is taken, the photographer should record time, date, site location, and a brief description of the subject in the Field Logbook. If Polaroid is uses, the photographer should sign and date on the back of the photo. Film developed negatives, transparencies, photographs, and written records that may be used as evidence should be handled in such a way that chain-of-custody can be established.

2. Transfer of Custody and Shipment

When transferring the samples, the transferee must sign and record the date and time in the chain-of-custody record. Custody transfers in the field should be documented and account for each sample, although samples may be transferred as a group (as long as each individual sample in the group is identified). Every person who takes custody must note if the individual samples or the sealed shipping container is correctly sealed and in the same condition as noted by the previous custodian, and must fill in the appropriate section of the chain-of-custody record. To minimize custody records, the number of custodians in the chain-of-possession should be minimized (if possible).

All packages sent to the laboratory should be accompanied by the chain-of-custody record and other pertinent forms A copy of these forms should be retained by the originating person. Have the designated agent of the common carrier sign and date the field copy of the chain-of-custody form. Mailed packages can be registered with return receipt requested. For packages sent by common carrier, receipts, bills of lading, airbills, or waybills or copies of these documents must be retained as part of the permanent chain-of-custody documentation. If the originals of such documents must be forwarded to finance for payment, be sure to keep a true copy (a true copy is one made or photocopied by an individual who signs and dates the copy to identify it as an accurate reproduction of the original: "True copy of original. Made by John Doe, February 30, 1980.") for the chain-of-custody documentation. Samples to be shipped must be packed so as not to break and the package should be sealed or locked so that any tampering can be readily detected. The EPA shipper and receiving personnel should both note the condition of the container seals (broken or unbroken) each time possession is exchanged. The preferred procedure includes use a custody seal wrapped across filament tape that is wrapped around the package at least twice. the custody seal is then folded over and stuck to itself so that the only access to the package is by cutting the filament tape or breaking the seal to unwrap the tape. The seal is

then signed. As an alternative, tamper proof tape may be used to seal across the filament tape.

Upon receiving the sample container the laboratory will verify the integrity of the custody seals by noting in the "miscellaneous" section of the Field Data Sheet/Chain-of-Custody sheet "seals intact" or "seal broken", initiated and dated. If containers arrive with broken seals, the laboratory will immediately notify the Project Officer and the RQAMO.

E. LABORATORY NOTIFICATION AND REPORTING

It is important to notify the Regional Sample Management Control Center (RSMCC) by phone and verify the shipping schedule before sampling, whenever possible. The caller should indicate that it is a high priority situation (if appropriate) and verify that the lab will be able to receive the samples. Queries about the sample arrival, position in the job stream etc., should be directed to the RSMCC.

In an emergency situation, when the EPA RSMCC or laboratory cannot be notified prior to sampling, the sampler must keep accurate records of sampling procedures and locations. the sampler may use a physical description of the sample location, provided that it is descriptive enough to differentiate between locations. As son as possible following the emergency response, a completed QAP will be submitted to facilitate tracking and response.

All prospective sampler or Project Officers should contact the Sample Control Center prior to any sampling to obtain copies of their required forms. A list of the forms often required by laboratories include:

- Chain-of-Custody Record
- Examples of Custody Seals
- Analysis Required: X-91, Priority Pollutants-Organics
- Analysis Required Sheet: X-92, Metals
- Field Sample Data Sheet, with Chain of Custody
- Analysis Required: X-93, Physical and General Inorganics and Ion Chromatograph
- Analysis Required: X-94, Oxygen Demand, Solids, & Nutrients
- Contract Lab Organic Traffic Report
- Contract Lab Inorganic Traffic Report
- Contract Lab High Hazard Traffic Report

Samplers should find out in advance which of these forms the laboratory requires.

F. CORRECTIONS TO DOCUMENTATION

If an error is made on any accountable document assigned to one individual, that individual may make corrections simply by drawing a line through the error and entering the correct information. The erroneous information should not e obliterated. Any subsequent error discovered on an accountable document should be corrected by the person who made the entry. All corrections must be initialed and dated.

ANNEX C

FDA SAMPLING PLAN

DEPARTMENT OF HEALTH & HUMAN SERVICES — Public Health Service

Memorandum

Date · MAY 21 1992

From Domestic Team Leader
Field Programs Branch, HFF-26

Subject Survey To Determine Chemical Contaminants In Bottom Dwelling Seafood From Massachusetts Bay (FY 92) - FPB 92-22

To
RFDDs: NE
DDs : BOS, BUF, WEAC
DIBs : BOS
DCBs : BOS
DSBs : BUF, WEAC (Analytical Branch)
DRL : NYK-RL

PLEASE DISTRIBUTE COPIES TO ALL ADDRESSEES AND OTHER APPROPRIATE DISTRICT PERSONNEL

OBJECTIVES

- To collect and analyze samples of seafood (American plaice, lobsters, shellfish and finfish) harvested in the vicinity of the Massachusetts Bay Disposal Site for pesticide residues, PCB'S, toxic elements, radionuclides and polynuclear aromatic hydrocarbons (PAH's).

- To review and evaluate the data to assess potential health risks associated with toxic and radioactive materials in bottom-dwelling fish.

BACKGROUND

Regions of the Massachusetts Bay served for many years as a disposal site for toxic and radioactive wastes. Most of the wastes were disposed of in barrels in an area known as the Massachusetts Bay Disposal Site (MBDS), or simply the "foul area". In addition, dredge materials have been disposed of in an area adjacent to (just east) and overlapping, the "foul area". Commercial and recreational fishermen are advised by FDA and the National Marine Fisheries (NMFS) against harvesting bottom dwelling species in the "foul area".

The Subcommittee on Fisheries and Wildlife Conservation and the Environment has been conducting an investigation into the dumping of toxic and radioactive waste in Massachusetts Bay. Up until the early 1970's, a variety of waste (including explosives, toxic and radioactive material) were legally dumped at two areas in the Bay.

Survey To Determine Chemical Contaminants In Bottom Dwelling Seafood From Massachusetts Bay (FY 92)

This past summer, the EPA funded a study by the International Wildlife Coalition in which side-scan sonar and remote cameras were used to survey the waste sites. The study revealed that thousands of barrels, possibly as many as 80,000, lay on the ocean bottom far outside the designated dumping areas.

EPA/Boston, Marine and Estuarine Protection Section, has identified two (2) areas adjacent to the "foul area" where seafood may be commercially harvested. One area, slightly south and east of the "foul area", is part of the Stellwagen Basin. This area is fairly clean of barrels but is heavily affected by dredged materials. The second area, just west of the "foul area", is remote from the dredged materials but is very close to areas with vast numbers of drums. Seafood harvested from either of these areas may be contaminated.

The discovery of these barrels has raised new concerns about possible contamination of the fish harvested by fishermen in Massachusetts Bay. At the present time, it is essential to assure both our fishermen and the consumers that seafood harvested from the Bay is safe to eat.

APPROACH

A. Sample Collection - (All sample collections will be made by BOS-DO personnel in coordination with NOAA aboard their vessels. Sampling is expected to occur the week of May 25, 1992. Gregory Cramer, from the Office of Seafood, is scheduled to be on the NOAA vessels and provide assistance in sampling):

1. Collecting District: BOS

2. American Plaice (Dab):

Samples of Dab should be collected at each of twelve (12) sampling sites (1 sample per site) in the vicinity of the "foul area" using a bottom trawl. Twelve (12) sampling sites should be distributed approximately equidistant along an oval line that circumnavigates and is tangential to the boundary of the foul/dump area. These sampling sites should include areas slightly east and south of the foul/dump area (in the Stellwagan Basin adjacent to the dumping area for dredge material) as well as areas to the west of the foul/dump area in an area very close to drums. Each sampling site should be described by location (latitude and longitude) and an appropriate identifying number.

Survey To Determine Chemical Contaminants In Bottom Dwelling Seafood From Massachusetts Bay (FY 92)

Each sample should consist of eighteen (18) Dab, in order to yield a total of 1500g of edible tissue. If the Dab are less than 12 inches in length, the number of fish per sample should be increased slightly to yield the desired weight of edible tissue.

Lobsters:

Samples of lobster will be collected at eight (8) of the trawl sites taking 1 sample per site. Each sample should consist of eight (8) lobsters, in order to yield a total of 1500g of edible tissue. If inadequate numbers of lobster are collected by trawling, alternative collection methods may need to be pursued. Tom Morrel [(617) 268-6759], head of the Boston Harbor Lobster Association, has offered to assist FDA in collecting lobster from the vicinity of the foul/dump area. The Office of Seafood should be contacted before initiating alternative collection methods.

In addition, four (4) more samples should be collected, one at each of four (4) sites, in the "foul area" that are in close proximity to areas known to have a high density of drums. The location of these sites should be determined in consultation with NOAA using the results of available side scanning sonar work. Two (2) strings of eight (8) lobster pots should be deployed at each site with each string parallel to and separated from the adjoining strings by about 100 yards. Each string of lobster pots should span a distance of about 1/8 of a mile (i.e., adjoining pot should be separated by about 75 feet). These pots should be left in the water for about 2 days before retrieval of trapped lobsters. As with the trawl site samples, location (latitude and longitude) and identifying numbers should be provided for each sample.

Abundant Shellfish (Molluscan Bivalves) and Finfish Species:

Collect one (1) additional shellfish and one (1) additional finfish sample from each site using the most abundant, resident, edible, bottom dwelling species captured collectively at the twelve (12) sites. If sufficient numbers (see below) of a shellfish species are not available, collect the two most abundant, resident, edible finfish species. If needed, contact the Office of Seafood Contact for guidance.

A target composite weight of 1500g should be used to decide how much of the most abundant shellfish species and how much of the most abundant finfish species at each of the sites is needed for a composite. Normally 24 - 48 in-shell shellfish are required to yield at least 500g of drained meat after shucking.

Special note: Due to the low population of shellfish in the "foul area" and the inefficiency of bottom trawls at collecting shellfish, it is expected that the number of shellfish collected at each site may be limited. Molluscan Bivalves are an important indicator organism. Eventhough sufficient numbers of shellfish may not be obtained to do all planned analyses, toxic element analysis has the highest priority. If feasible, toxic element analyses of shellfish should substitute for toxic element analyses planned for a second finfish specie.

NOTE: After separating targeted samples, all remaining seafood collected by NOAA in bottom trawls at each of the sampling sites should be retained for possible analysis and identified by sample site number. Seafood samples should be separated by genus and species, then frozen. **Please note** EPA investigators are interested in obtaining livers from the Dab collected at each of the sites. These tissue samples should be obtained prior to freezing of the fish.

Flag each collection report "Pesticide Surveillance".

3. Refer to IOM 452.53 for instructions on shipping frozen samples and IOM 452.6 for instructions on shipping refrigerated samples.

4. Submit samples to WEAC for initial sample compositing.

5. All samples must be clearly identified regarding sampling site.

B. Analytical:

WEAC will forward appropriate sized frozen composites to BUF and NYK-RL.

Survey To Determine Chemical Contaminants In Bottom Dwelling Seafood From Massachusetts Bay (FY 92)

NOTE: All samples (including lobster meat) will be examined for the analytes indicated below except for the lobster tomalley. WEAC will cook all lobster samples and separately composite the lobster meat and the tomalley. WEAC will retain sufficient composited tomalley to perform PAH analysis and forward the remainder of the composited tomalley to BUF-DO for pesticide and PCB analysis. If sufficient composited tomalley is available, BUF-DO will also perform the lead and cadmium analysis.

1. Analyzing Laboratories:

   BUF - Organohalogen/Organophosphorus pesticide and PCB residues, Lead and Cadmium - All samples

   NYK-RL- Methyl Mercury and Arsenic - All samples except lobster tomalley.

   WEAC - Radionuclides - All samples except lobster tomalley.
   Polynuclear Aromatic Hydrocarbons (PAH's) - All samples

2. Edible portions of the seafood should be analyzed for the presence of chemical contaminants identified below.

3. The following methods should be used to perform each of the analyses:

   a. Organohalogen, Organophosphorus and PCB Residues

      Analyze samples using PAM I, 211.13f *(1) or (2). The method described in AOAC 15th edition, (1990) 983.21 may also be used. Report residue findings in finfish and shellfish on the edible portion basis. Residue findings in fish should be reported on the edible tissue basis. Report results for tomalley separately.

      Evaluate appropriate chromatograms of all samples for PCBs and pesticides. If presence of PCBs is indicated, complete analysis using the necessary treatment of extract prior to GLC determination. See PAM I, 251 for removing interferences of certain organohalogen pesticides such as DDT and its analogs.

b. Methyl Mercury

Analyze samples using AOAC, 15th edition, (1990) 983.20. Alternatively, use AOAC, 15th edition (1990), 988.11, or AOAC, 15th edition (1990), 1st supplement 990.04.

c. Lead and Cadmium

Analyze samples using the Anodic stripping voltammetry method described in AOAC, 15th edition, (1990) 982.23. Alternatively, use Graphite Furnace Atomic Absorption, as described in LIB 3640, with either peak height or peak area absorbance mode.

d. Arsenic

Analyze samples using the hydride generation Atomic Absorption Spectrophotometry method described in AOAC 986.15, 15th edition, 1990. Alternatively, use the method described in LIB 1900, LIB 1900A, or Anal. Letters (1991) 24, 1695-1710.

e. Radionuclides -Including a screen for gamma emitters and an alpha spectroscopy method for plutonium.

NOTE: Initially, examine 16 samples for plutonium. The 16 samples may emphasize the specie determined to be the best indicator of plutonium contamination but should also represent at least one sample from each sampling site and one sample from each of the 4 species captured for the analysis. Report results of the initial 16 samples to the CFSAN assignment contact. The results will be evaluated by CFSAN and ORA to determine if additional plutonium analysis are warranted.

Analyze samples using the following methods and guidelines:

For gamma emitters: Use procedures described in "Measurement of Radionuclides in Food and the Environment". IAEA Technical Report Series, #295, Annex 1, "Method for Determining Gamma Emitters", page 47-69 (1989).

Alpha spectroscopy method for Plutonium: Use procedures described in "Isotopic Analysis of Pu in Food Ash", E. J. Baratta and E. M. Lurnsden, LIB, #2015 (1977).

f. Polynuclear Aromatic Hydrocarbons

Analyze samples using the Food Additives Analytical Manual (FAAM), Volume II,Method II, page 222, "LC Determination in Smoked Foods (PAH's)". Screen for the 13 PAH's determined by method II (page 205) and attempt to achieve a limit of detection of 1 ppb for each.

Alternatively, use "Determination of Polynuclear Aromatic Hydrocarbons in Seafood by Liquid Chromatography with Fluorescence Determination", by G. A. Perfetti, P. J. Nyman, S. Fisher, F. L. Joe Jr. and G. W. Diachenko (Accepted for publication in JAOAC). **This method is available from the Division of Food Chemistry and Technology, Food Formulation Branch, HFF-413.**

REGULATORY/ADMINISTRATIVE FOLLOW-UP

No regulatory or administrative action on these samples is anticipated.

ASSIGNMENT SUMMARY

The Office of Seafood will review the findings for the 4 species from each of the 12 sampling sites. Evidence of elevated contaminant levels will be examined to determine whether analysis of additional seafood samples collected in the trawls is warranted.

DATA REPORTING

Report sample results, including blanks and recoveries, into LMS Compliance Data Reporting System. Instructions, including record format for entering data, are found in the LMS Code Manual. Be sure to report the appropriate LMS extraction, determination and compound codes. Also, report the appropriate subsample code for "tomalley" and "flesh" where applicable.

Note: Report all collections and analyses under PAC 04F077.

Survey To Determine Chemical Contaminants In Bottom Dwelling Seafood From Massachusetts Bay (FY 92)

Product Code:	16AYA16	Flounder
	16JYA04	Lobster
	16EYA__	Shellfish
	16AYA__	Finfish

HARD COPY REPORTING

Send copies of Collection Reports and Analytical Summary Sheet, FDA Form 465, on an **as completed** basis to:

FDA/CFSAN
FIELD PROGRAMS BRANCH, HFF-26
200 C STREET, SW
WASHINGTON, DC 20204
ATTN: DOMESTIC PESTICIDE MONITOR

START/COMPLETION DATES

A. Sample Collection

Coordinate sample collection with EPA, NOAA and the Massachusetts Department of Marine Fisheries upon receipt of this assignment.

B. Sample Analysis

Analyses are to be completed within 60 days after sample receipt by the laboratory.

PROGRAM CONTACTS

CFSAN Assignment Contact:	Raphael A. Davy, Field Programs Branch, HFF-26, FTS/COMM (202) 755-1606
Office of Seafood Contact:	Gregory Cramer, Policy Guidance Branch, HFF-511, FTS/COMM (202) 254-3888
ORA Scientific Contact :	Louis Carson, Division of Field Science, HFC-141, FTS/COMM (301) 443-3320

Survey To Determine Chemical Contaminants In Bottom Dwelling Seafood From Massachusetts Bay (FY 92)

PRIORITY

This assignment has routine priority and should be accomplished within the districts normal workplanning activities.

Resources to accomplish this assignment are to be taken from the Pesticides and Industrial Chemicals in Domestic Foods Program (CP 7304.004) and the Pesticides and Industrial Chemicals in Imported Foods Program (CP 7304.006) - (WEAC and NYK-RL). Resources previously planned for seafood sampling and analysis should be utilized where available. The collecting and analyzing districts have been provided separate collection/analytical time (under CP 7304.004) to accomplish headquarter initiated assignments.

Samples collected under this assignment should be included in the FY 92 Regional Pesticide Plans

This assignment has the concurrence of ORA

Ronald R. Roy

Survey To Determine Chemical Contaminants In Bottom Dwelling Seafood From Massachusetts Bay (FY 92)

cc:

HFC-6 (Wessel)
HFC-102 (Cole)
HFC-130 (Fish)
HFC-140 (Baldwin)
HFC-141 (Carson)
HFR-430 (Winters)
HFF-8 (Rosenthal)
HFF-300 (Lake)
HFF-310 (Oliver)
HFF-326 (Gee)
HFF-413 (Diachenko)
HFF-420 (Corneliussen, Houston)
HFF-421 (Jones)
HFF-426 (Clower)
HFF-500 (Billy)
HFF-510 (Dees)
HFF-511 (Snyder, Cramer)
HFF-512 (Whetstone)
HFF-32 (Schoen)
HFF-25 (Russo)
HFF-26 (RLB, RRR, RAD, CF, MF)

DRAFT:HFF-26:RAD:DTE:3/10,31/92
R$_1$:rad: 4/29/92
R$_2$:rad: 5/15/92

FY'92\WP51\ASSIGNMT\TOXRADCONT.

ANNEX D

RADIOLOGICAL HEALTH & SAFETY PLAN

Radiological Health and Safety Plan

Purpose

The purpose of this plan is twofold. Primarily, it will be used to detect potentially contaminated equipment and samples, allow for decontamination of these items and prevent the unnecessary exposure of personnel involved in the survey to radiation. Secondarily, the plan addresses the need to use radioactive sources for the calibration and operational check of *in situ* radiation detectors which will be utilized the proper methods for handling and securing these sources. The plan will be used during the survey cruises of May 26-29, 1992 and May 30-June 2, 1992.

Responsible Individuals and Duties

James J. Cherniack, CHP; USEPA, will serve as the radiation safety officer during the study. He will be responsible for the development of the radiological health and safety program, procurement of calibrated survey instruments, obtaining necessary clearances to bring sealed radioactive sources aboard ship, and monitoring equipment and samples brought on board during the study. He will also share responsibility for the decontamination of equipment and areas potentially contaminated by radioactive material during the survey..

William G. Phillips, CHP; USEPA, will be responsible for obtaining necessary sealed calibration sources, handling and securing these sources when not in use. He, too, will be responsible for monitoring samples and equipment brought on board ship during the study, and will share responsibility for decontamination, if necessary.

William J. Bell, Radiation Scientist, MDPH, will share responsibility for monitoring and decontamination.

All three of these individuals will be thoroughly knowledgeable with the radiation safety plan and will conduct briefings for members of the study party on radiological health prior to the study.

Survey Equipment

At least four sets of radiation equipment will be available; one on each vessel and at least one back up. These sets will consist of a Ludlum model 19 micro R meter to be used for gamma measurement and a Ludlum model 12 with a 44-9 pancake probe; or the equivalent of this equipment. All monitoring devices will have been calibrated within six months of the survey dates. In addition, filter papers and a scintillator will be on board the $^{R}/_{V}$ Seward Johnson for wipe testing any areas not readily surveyable with radiation monitors.

Radiological Monitoring - Personnel

All personnel handling core samples will be provided with personnel thermoluminescent dosemeters (TLD) provided by ORD/EMSL/Las Vegas through the EPA Regional Office. The TLD provider is DOELAP accredited. All badges will be marked as "spare" and upon issuance a record will be made of the badge number and the individual to whom it was assigned. Individuals assigned badges need to provide their social security number and date of birth for record keeping purposes. When working with samples, badges will be worn on the upper torso in a manner which will protect the badge from being contaminated.

Arrangements have been made with the FDA's Winchester Engineering and Analytical Center for use of that facility's low background, whole body counter in the unlikely event that an individual becomes contaminated with radioactive material either through a wound or via accidental ingestion of a sample portion. The facility is located in Winchester, MA, approximately 10 miles north of Boston.

Prior to sailing, all individuals involved in the handling of samples or the recovery of the ROV and/or the JSL-II will be briefed on proper sampling handling methods and radiation safety by the health physics party.

Equipment Monitoring

It is understood that the $^{R}/_{V}$ Seward Johnson and the JSL-II are classified as radiologically clean vessels and it is the duty

of the health physics party to ensure that this classification is maintained. From May 26 to June 2, 1992, a remotely operated vehicle (ROV) will be used to identify and characterize areas of interest. This will allow the efficient use of the JSL-II. The ROV will be equipped with a radiation detector which will allow the identification of areas with high gamma radiation readings. The JSL-II could then avoid these areas. The JSL-II will also be equipped with a NaI(Tl) detector which would provide the occupants of the submersible with data regarding gamma radiation levels. Should high levels be encountered the chief scientist would abort the mission.

A. ROV

Whenever the ROV is deployed, it will be surveyed upon recovery. This survey will be performed using the micro R meter and pancake probe. All exterior surfaces will be monitored first with uR meter and then with the pancake probe at a distance of about 2 inches from the exterior surface. All cavities will then be monitored with the pancake probe. Any areas not readily accessible with the detector will be swipe tested and counted on the scintillator. All individuals involved with the recovery of the ROV will have their work gloves surveyed prior to their leaving the area. This will be done as soon as practicable after the recovery. Should readings in excess of 100uR/h or 1000 CPM above background be detected the surveyed item (i.e. ROV) will be considered contaminated. The item will then be washed with a fire hose and resurveyed. After successful decontamination, the

deck will be surveyed and if necessary decontaminated.

B. JSL-II

The procedures outlined above for the ROV and recovery personnel will be followed for the JSL-II and its recovery personnel. Additionally, the area of the deck upon which the JSL-II rests will be surveyed each time the JSL-II is launched.

C. SAMPLES

All samples will be monitored by the health physics party prior to release to laboratory personnel. Any sample which reads over 6500 counts per minute will be jettisoned and the area in which it was collected will be marked for later consideration. Alternatively, the sample could be quickly analyzed using the NaI(Tl) detector mounted on the JSL-II in conjunction with a multichannel analyzer to identify the source of the radiation and then jettisoned. All sample containers will be wipe tested prior to release to laboratory personnel.

A reading of 6500 counts per minute is the expected output from a core sample three inches in diameter by two inches deep which contains a uniform concentration of 50 $P^{Ci}/_{g}$. All areas on which samples are handled will be monitored by the health physics party after work on a sample batch is completed.

Radionuclides Brought on Board

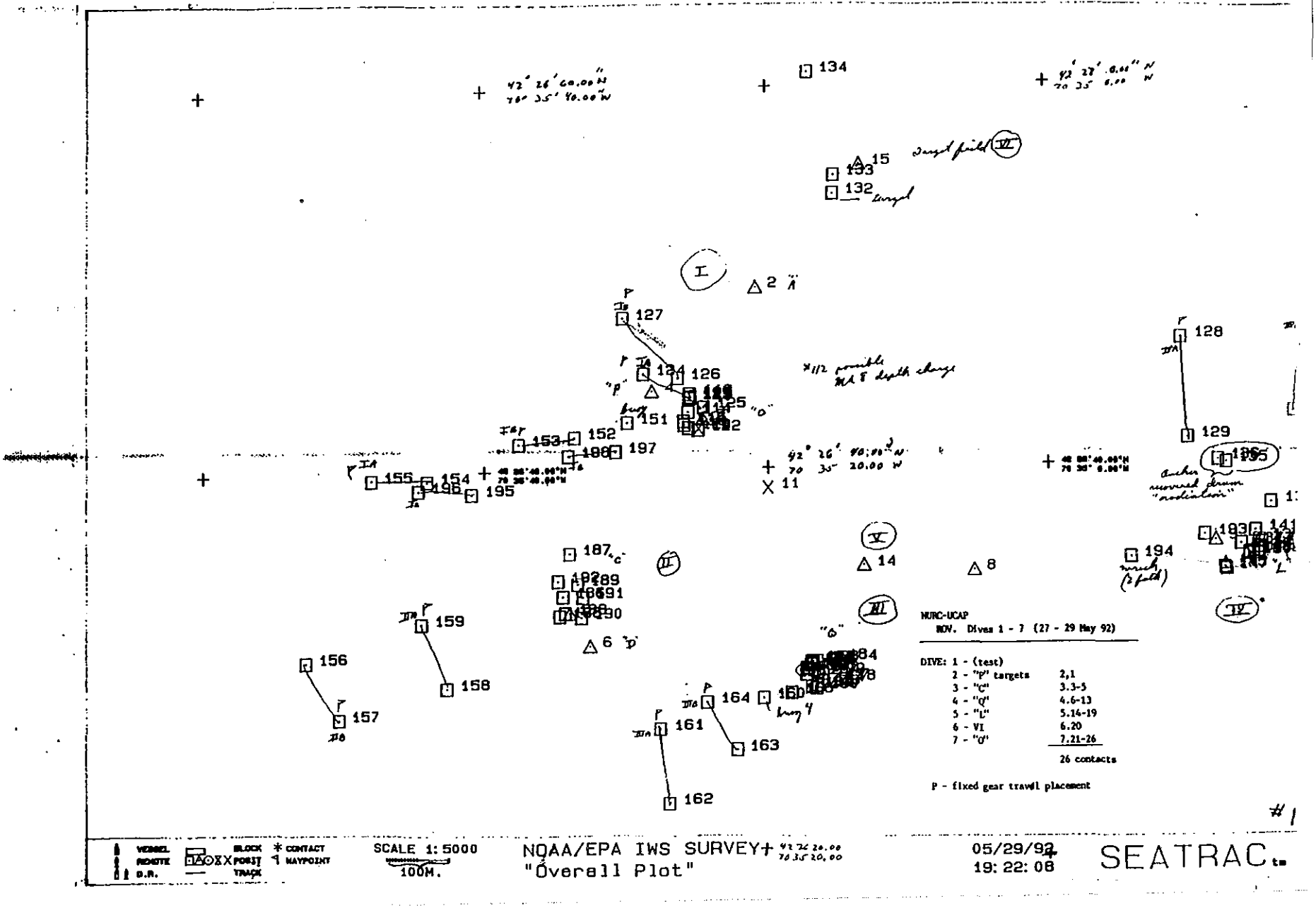
Three radioactive sources will be brought on board by the health physics party. All are sealed sources containing exempt quantities (< 10uCi). These sources will be used to calibrate the in situ gamma spectroscopy system. A ^{60}Co source will be used

for the high-energy range, a ^{137}Cs source for the mid-range and a ^{57}Co source for the low-energy range. The sources will be handled only by members of the health physics party and when not in use will be secured in a properly marked container in an isotope storage locker located in the wet lab of the $^{R}/_{V}$ Seward Johnson.

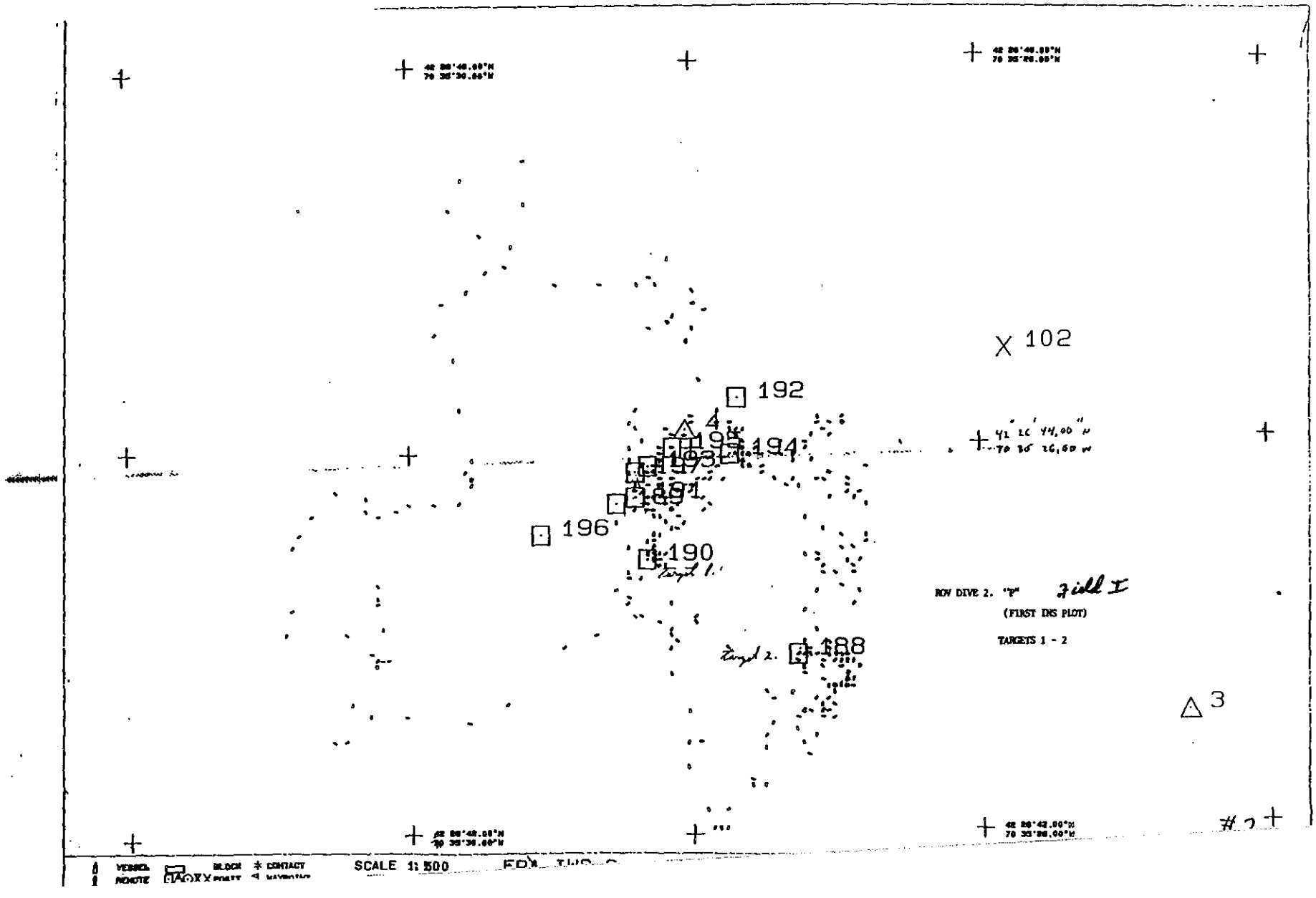
APPENDIX C

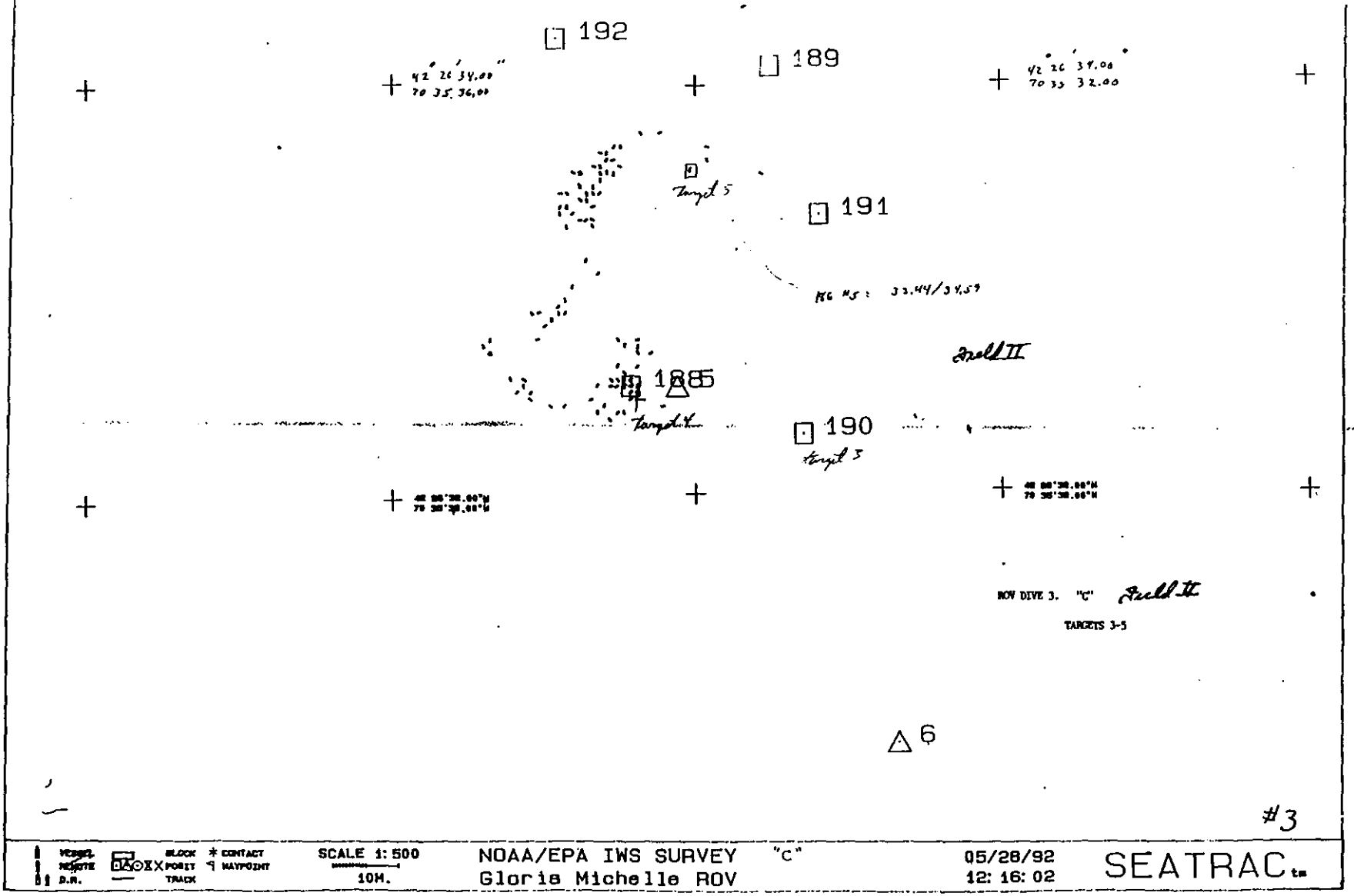
Remotely Operated Vehicle and JSL-II Survey Tracks and Target Positions

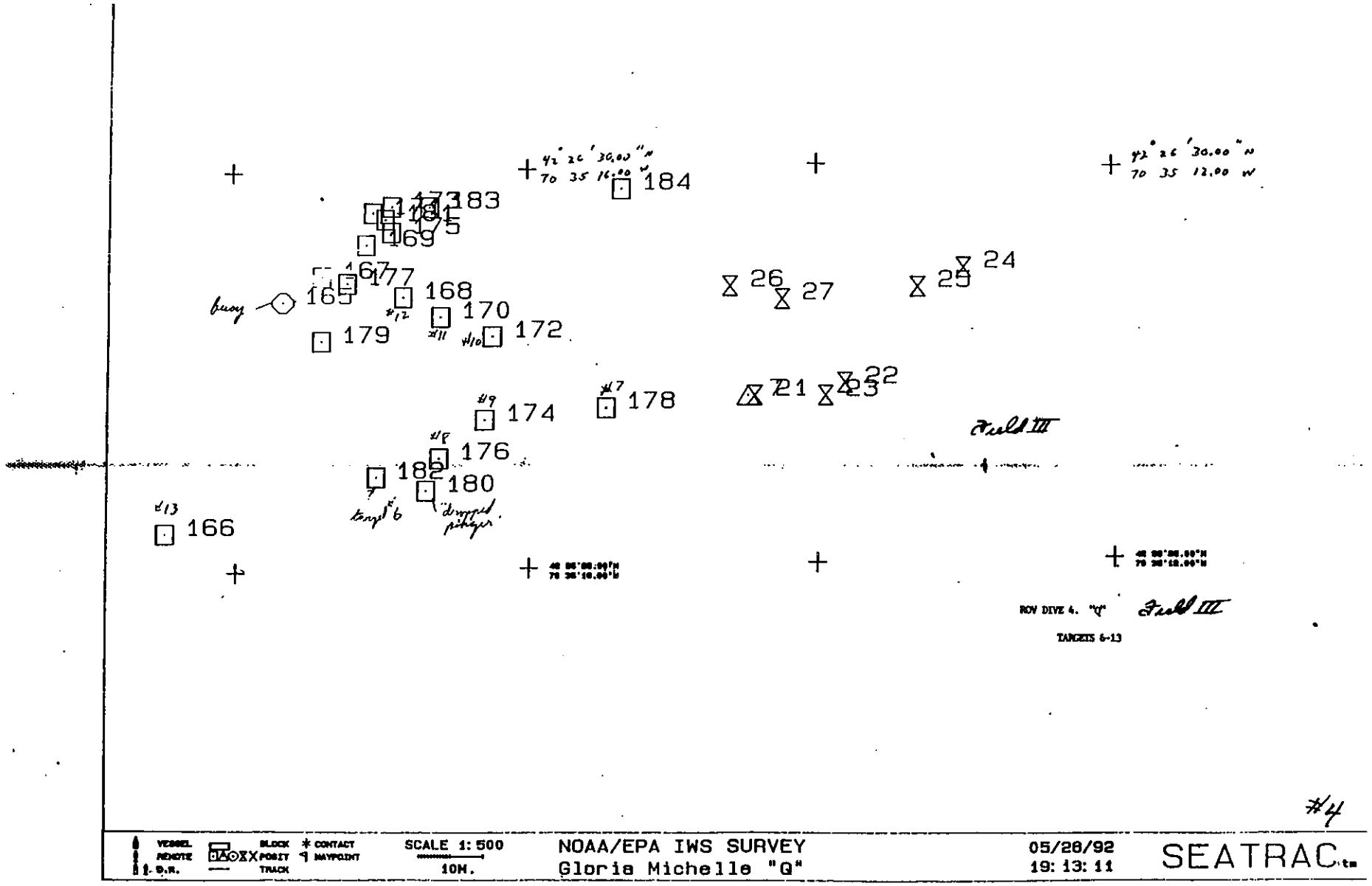
Plot No. 1. Overall survey tracks of ROV and JSL-II at the Massachusetts Bay Industrial Waste Site, May/June 1992.

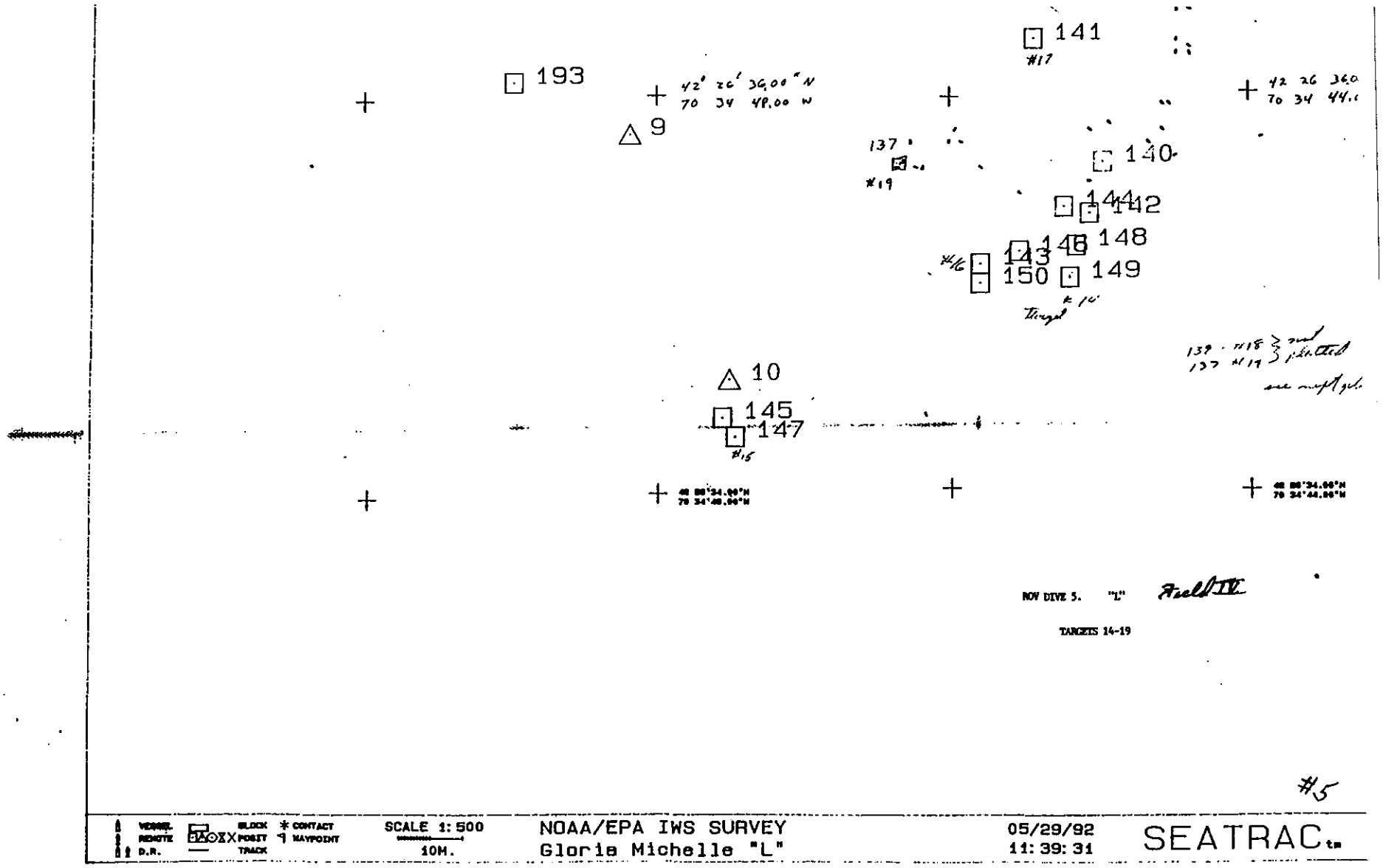


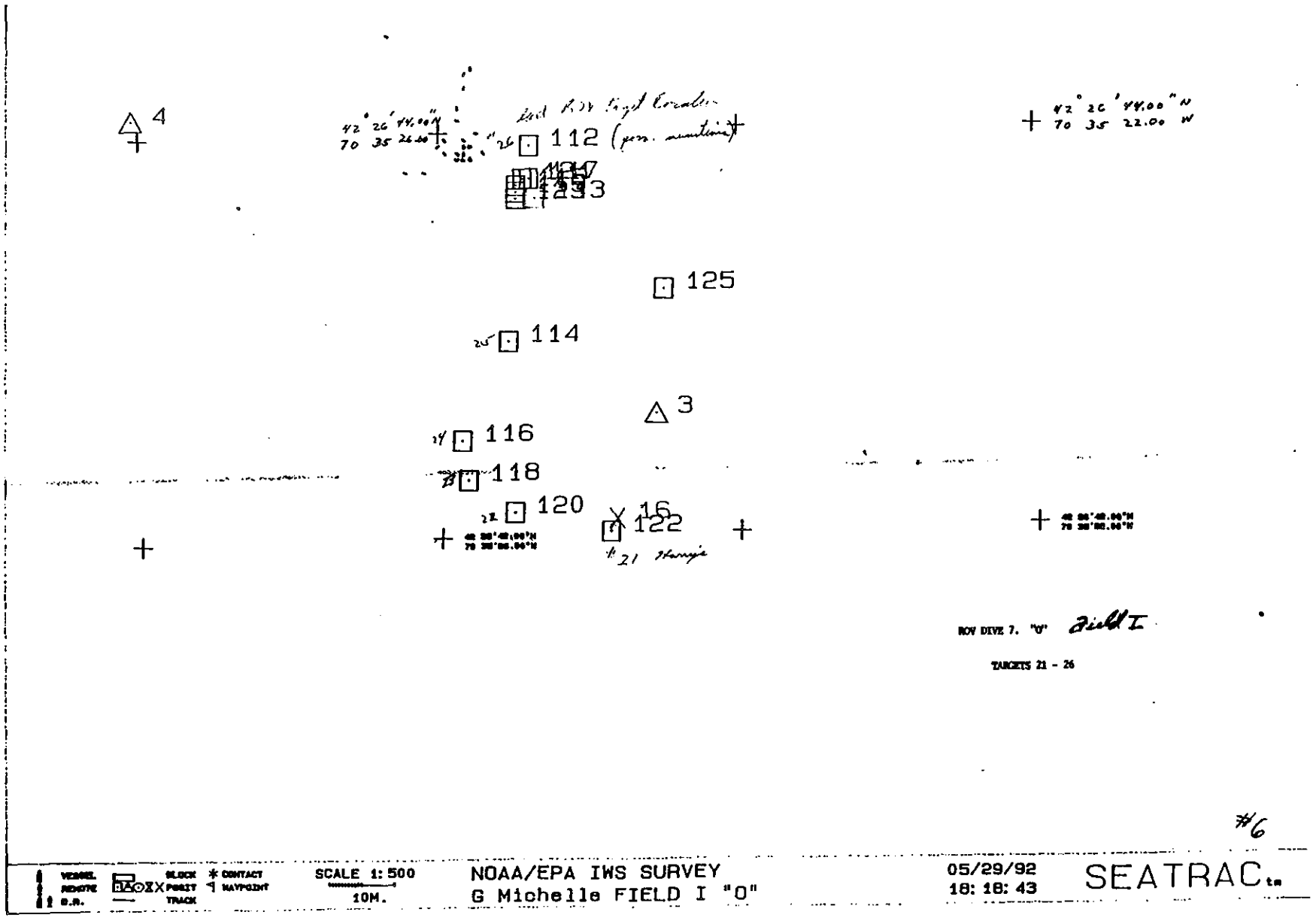
Plot No. 2. ROV survey track in the vicinity of Anchorage Site "P" on May 27, 1992.

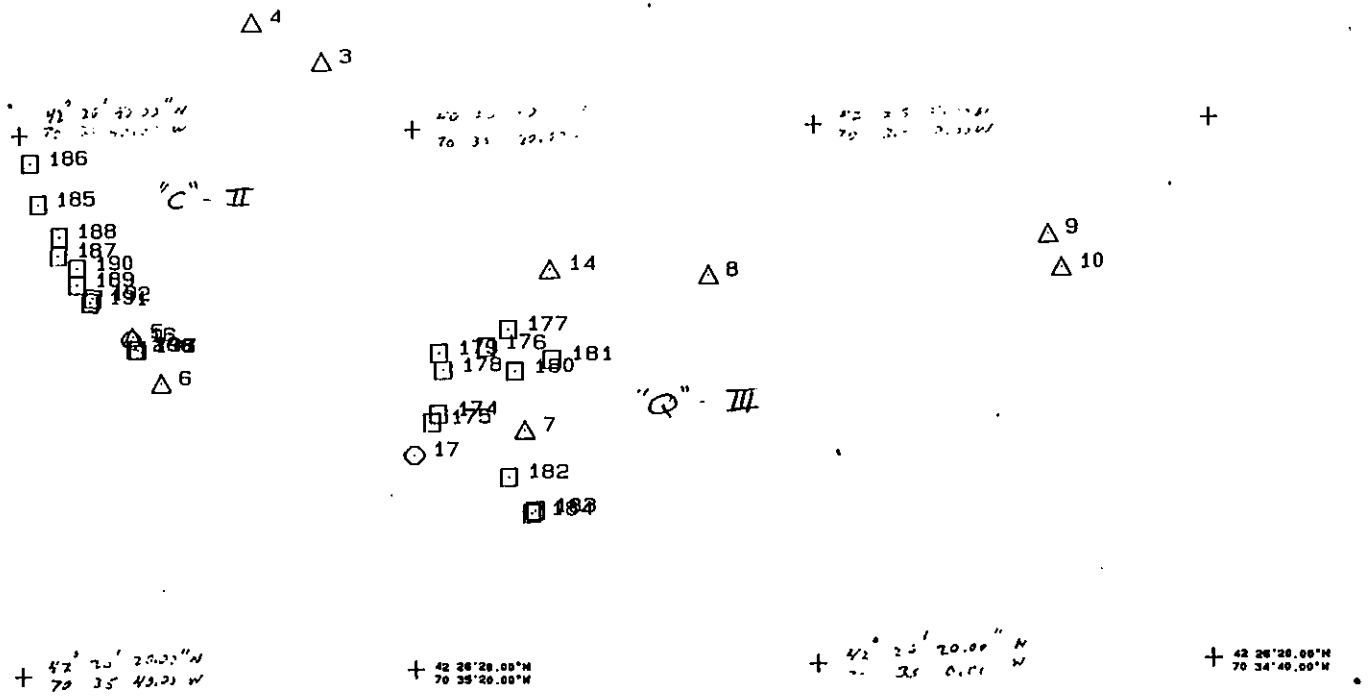



192
189
191
188
190
Target 5
Target 4
Target 3
Drill II
Drill II
NOV DIVE 3. "C"
TARGETS 3-5
6
#3
SCALE 1: 500
10M.
NOAA/EPA IWS SURVEY "C"
Gloria Michelle ROV
05/28/92
12: 16: 02
SEATRAC tm


42° 26' 30.00" N
70 35 16.00 W
42° 26' 30.00" N
70 35 12.00 W
184
183
169
167
177
165
168
170
179
172
26
27
25
24
21
23
22
178
174
176
182
180
166
buoy
#12
#11
#10
#9
#8
#7
#13
target 6
dropped pinger
Field III
ROV DIVE 4. "Q"
Field III
TARGETS 6-13
#4
VESSEL
REMOTE
D.R.
BLOCK
POSIT
TRACK
CONTACT
WAYPOINT
SCALE 1: 500
10M.
NOAA/EPA IWS SURVEY
Gloria Michelle "Q"
05/28/92
19: 13: 11
SEATRAC


141
#17
193
42° 26' 36.00" N
70 34 48.00 W
9
137
#19
140
144
142
148
146
143
#16
150
149
Target ± 10'
139 - #18 } and
137 #19 } plotted
see map/grid
10
145
147
#15
42 26 36.0
70 34 44.0
ROV DIVE 5. "L" Field IV
TARGETS 14-19
#5
VESSEL
REMOTE
D.R.
BUCK
POSIT
TRACK
CONTACT
WAYPOINT
SCALE 1:500
10M.
NOAA/EPA IWS SURVEY
Gloria Michelle "L"
05/29/92
11:39:31
SEATRAC tm


4
112
113
125
114
3
116
118
120
122
16
SCALE 1: 500
10M.
NOAA/EPA IWS SURVEY
G Michelle FIELD I "O"
05/29/92
18: 18: 43
SEATRAC



NURC-UCAP

JSL DIVES 1 - 6 (31 May, 1,2 Jun 92)

DIVE 1 - "C"	TARGETS	1.1-4	Build II & III
2 - "Q"		2.1-3	
3 - "P"		3.1-4	
4 - "L"		4.1-4	
5 - "Anch."		5.1-2	
6 - "SS"		6.1	

19 sample locations

#7

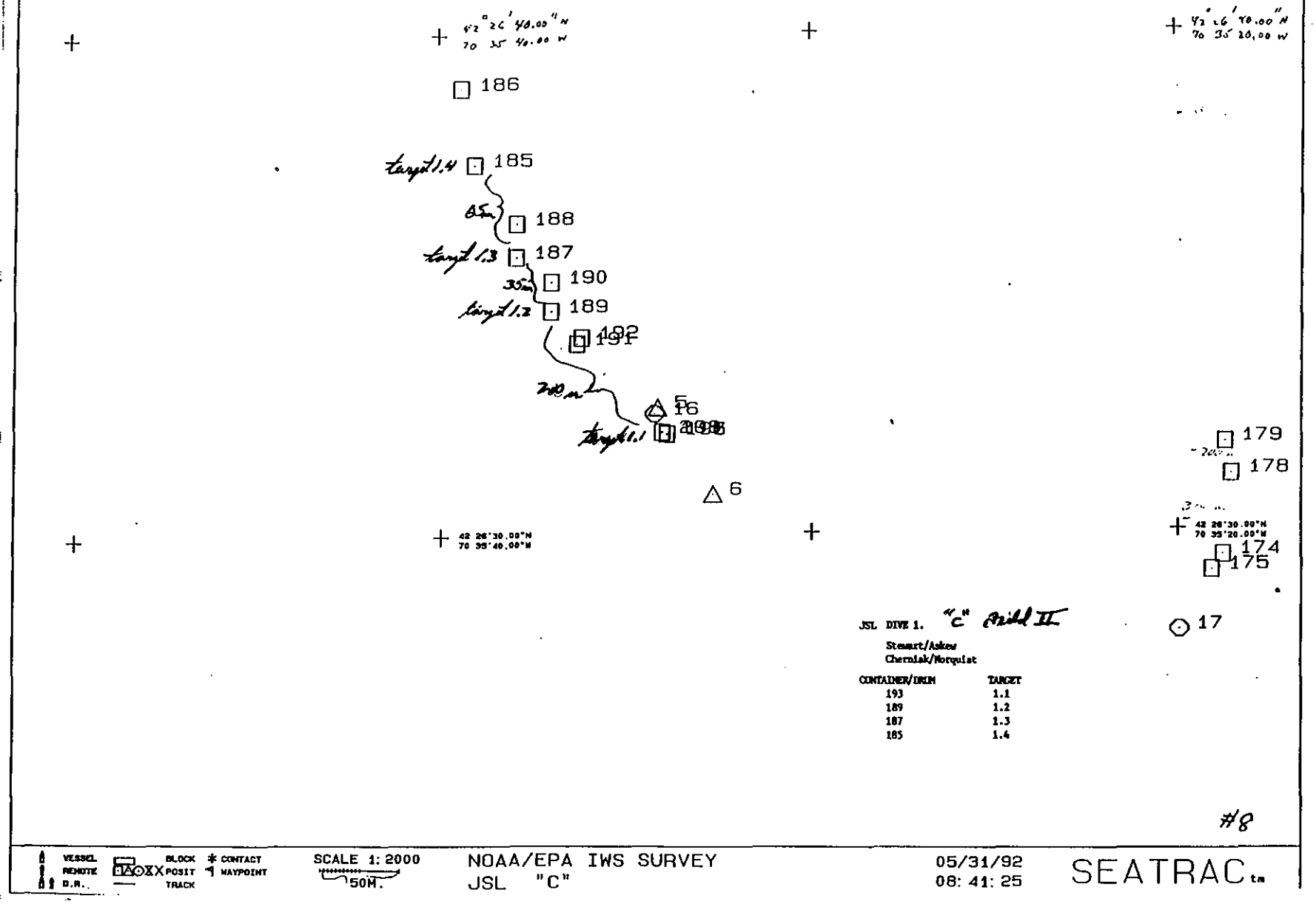
VESSEL
REMOTE
D.R.
BLOCK
POSIT
TRACK
CONTACT
WAYPOINT

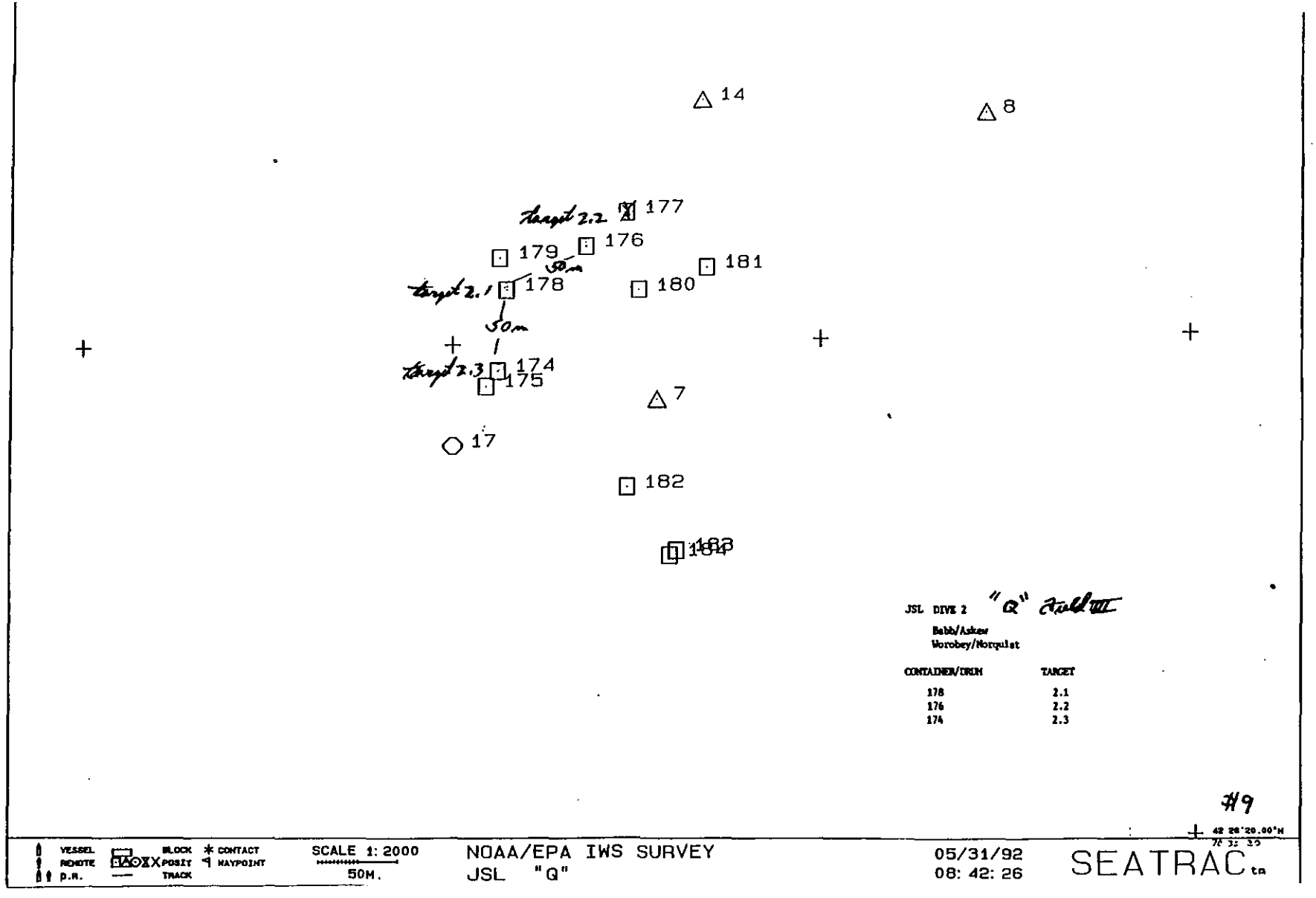
SCALE 1: 5000
100M.

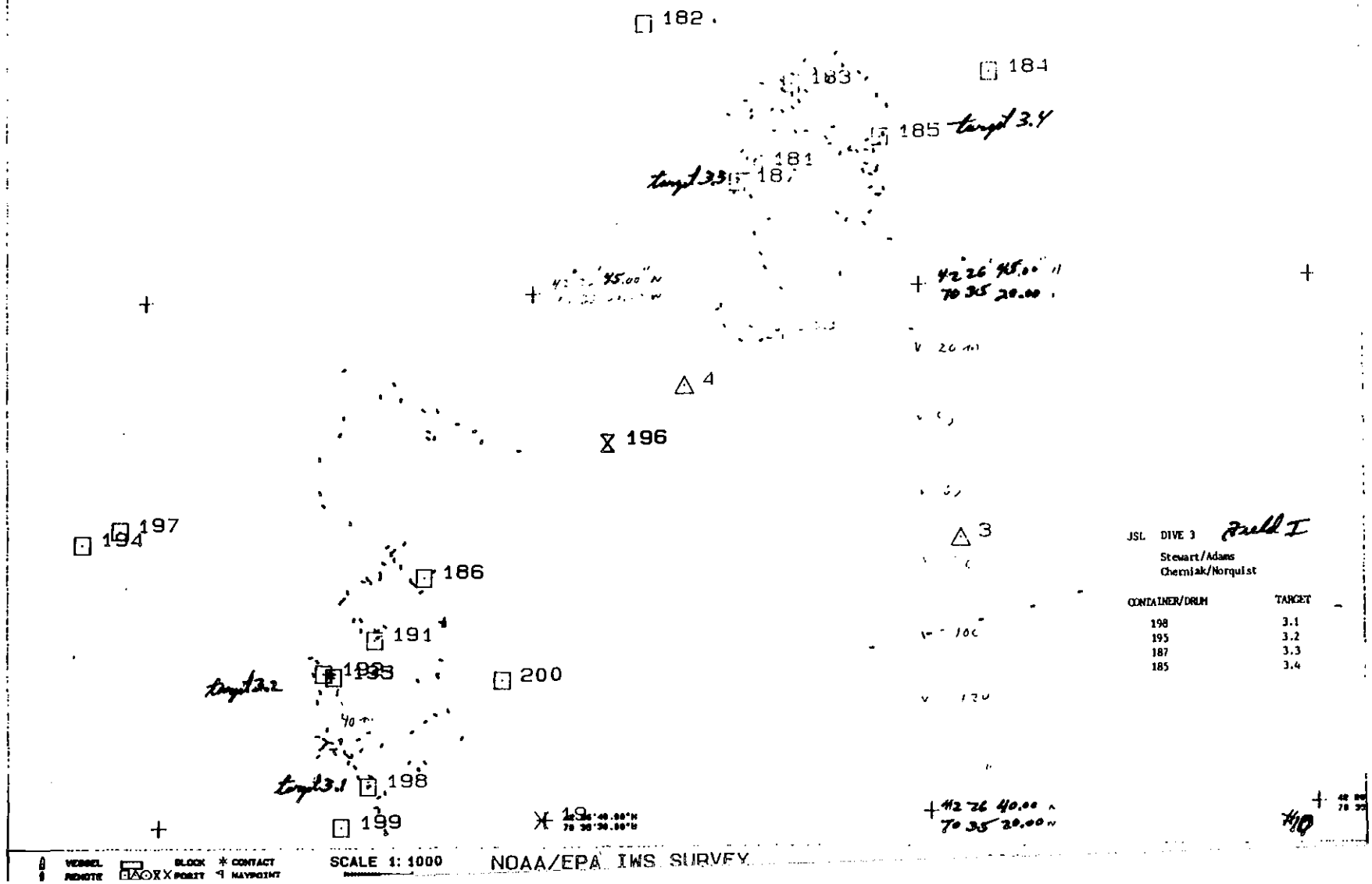
NOAA/EPA IWS SURVEY
JSL "Q" & "C" sites - overall plot - search area.

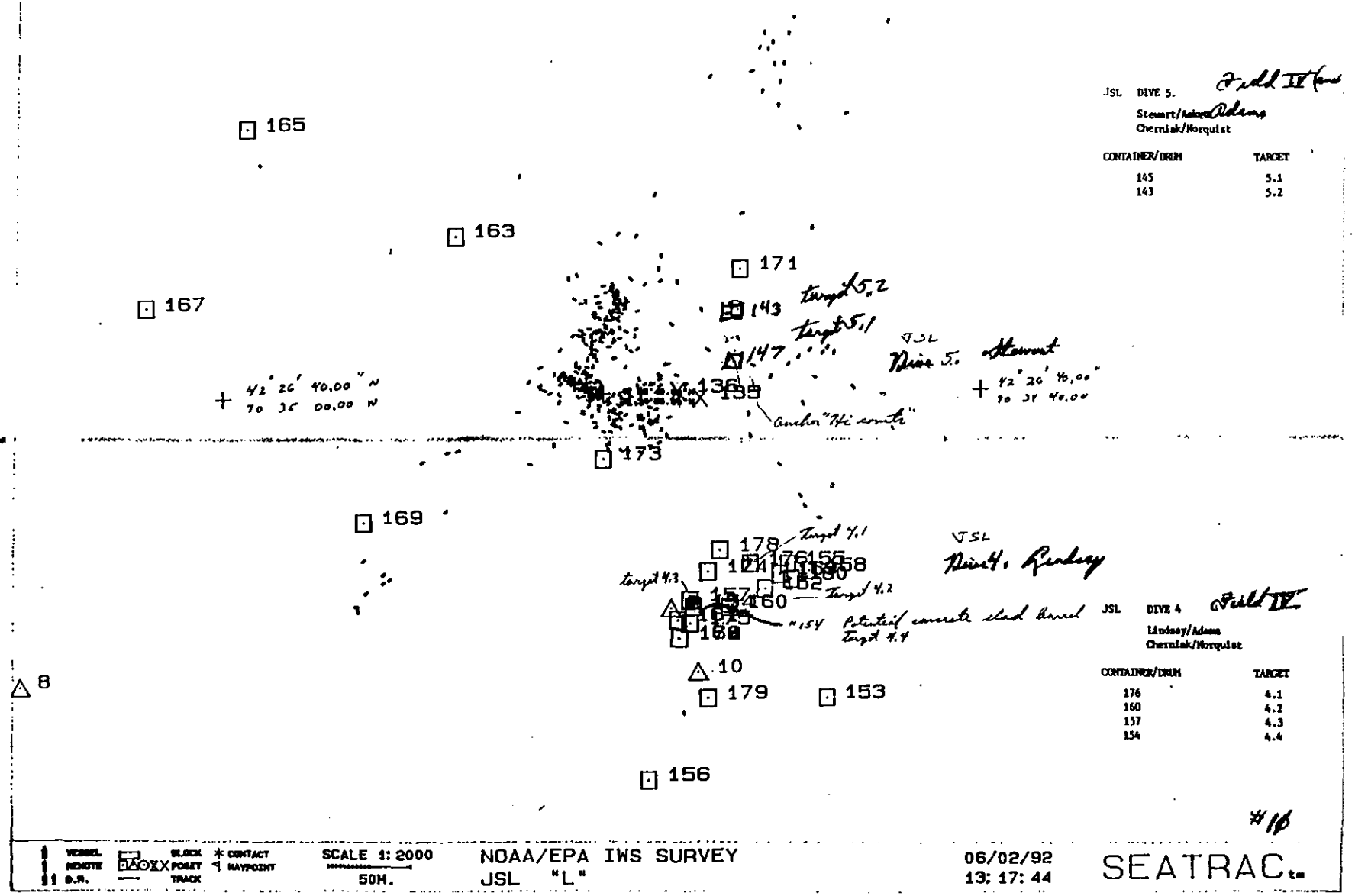
05/31/92
08: 42: 26

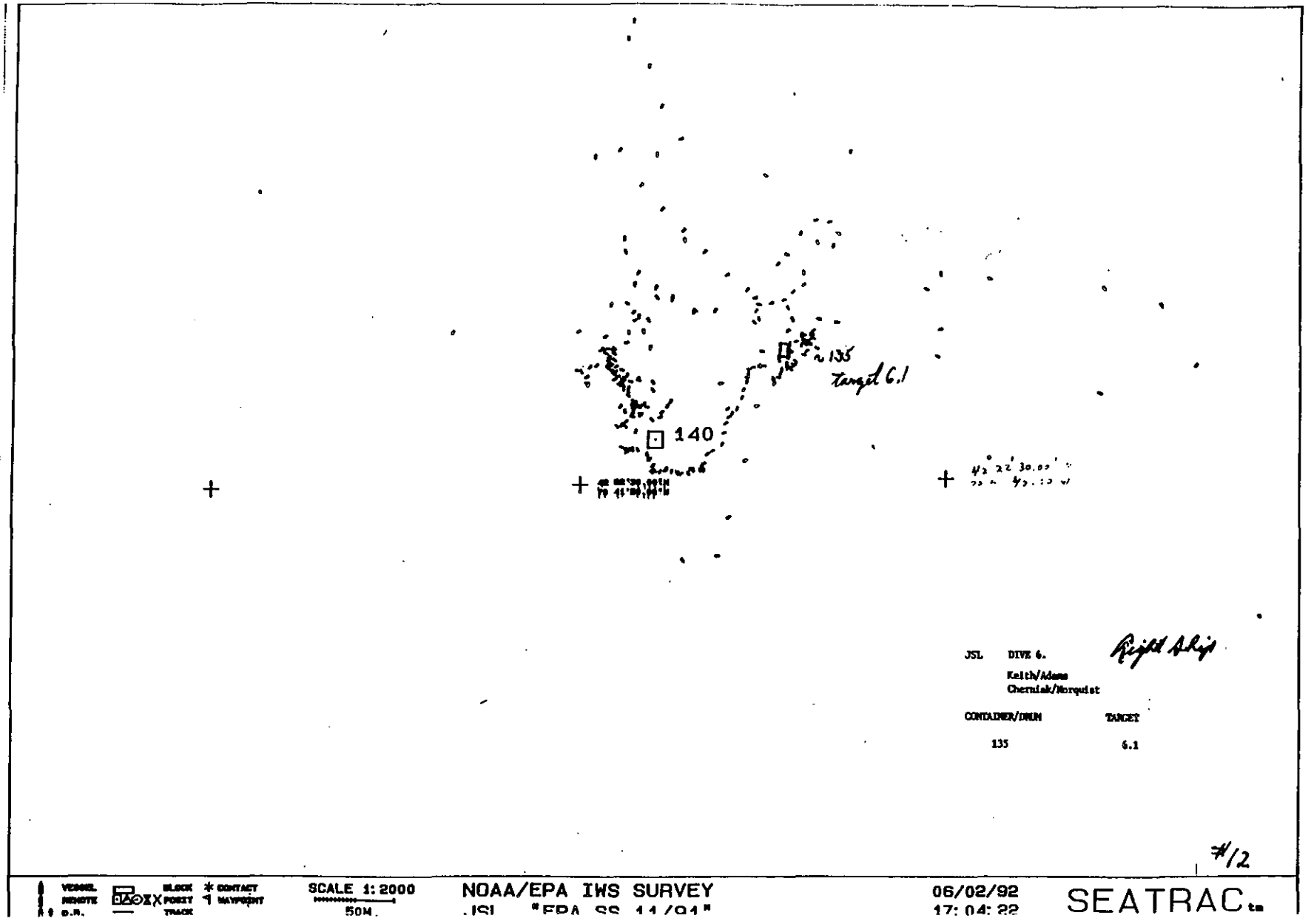
SEATRAC tm


42 26' 40.00" N
70 35' 40.00" W
186
target 1.4
185
85m
188
target 1.3
187
35m
190
target 1.2
189
191
200m
196
target 1.1
6
42 26'30.00"N
70 35'40.00"W
42 26'30.00"N
70 35'20.00"W
179
178
174
175
17
JSL DIVE 1. "C" Grid II
Stewart/Askew
Cherniak/Norquist
CONTAINER/DRUM TARGET
193 1.1
189 1.2
187 1.3
185 1.4
#8
VESSEL
REMOTE
D.R.
BLOCK
POSIT
TRACK
CONTACT
WAYPOINT
SCALE 1: 2000
50M.
NOAA/EPA IWS SURVEY
JSL "C"
05/31/92
08: 41: 25
SEATRAC tm


14
8
target 2.2
177
179
176
181
50m
target 2.1
178
180
50m
target 2.3
174
175
7
17
182
183
184
JSL DIVE 2 "Q" field III
Babb/Asker
Worobey/Norquist
CONTAINER/DRUM TARGET
178 2.1
176 2.2
174 2.3
#9
42 26'20.00"N
VESSEL
REMOTE
D.R.
BLOCK
POSIT
TRACK
CONTACT
WAYPOINT
SCALE 1: 2000
50M.
NOAA/EPA IWS SURVEY
JSL "Q"
05/31/92
08: 42: 26
SEATRAC tm


182
183
184
185
target 3.4
181
target 3.3
180
42 26 45.00 N
70 35 20.00 W
4
196
197
194
186
191
target 3.2
200
target 3.1
198
199
3
JSL DIVE 3 Field I
Stewart/Adams
Chemiak/Norquist
CONTAINER/DRUM TARGET
198 3.1
195 3.2
187 3.3
185 3.4
42 26 40.00 N
70 35 20.00 W
VESSEL
REMOTE
BLOCK
BUOY
CONTACT
WAYPOINT
SCALE 1: 1000
NOAA/EPA IWS SURVEY


JSL DIVE 5.
Stewart/Adams
Chernlak/Norquist
CONTAINER/DRUM TARGET
145 5.1
143 5.2
165
163
171
167
143
target 5.2
target 5.1
147
JSL
Dive 5. Stewart
136
159
173
169
178
target 4.1
JSL
Dive 4. Lindsay
target 4.3
target 4.2
160
154
Potential concrete clad barrel
target 4.4
JSL DIVE 4
Lindsay/Adams
Chernlak/Norquist
CONTAINER/DRUM TARGET
176 4.1
160 4.2
157 4.3
154 4.4
10
8
179
153
156
VESSEL
REMOTE
D.R.
BLOCK
POSIT
TRACK
CONTACT
WAYPOINT
SCALE 1: 2000
50M.
NOAA/EPA IWS SURVEY
JSL "L"
06/02/92
13: 17: 44
SEATRAC


135
Target 6.1
140
JSL DIVE 6.
Keith/Adams
Chernlak/Norquist
CONTAINER/DRUM
TARGET
135
6.1
#12
VESSEL
REMOTE
O.R.
BLOCK
POINT
TRACK
CONTACT
WAYPOINT
SCALE 1: 2000
50M.
NOAA/EPA IWS SURVEY
06/02/92
17: 04: 22
SEATRAC tm

APPENDIX D

Special Analytical Services Protocols

Laboratory Results

faxed to Lone
6-5-92 AE

U.S. Environmental Protection Agency
CLP Sample Management Office
P.O. Box 818 - Alexandria, Virginia 22313
Phone: 703/557-2490 - FTS/557-2490

SAS No. 7338A-C-3

Region I, CLP-TPO, SAS Approval

6-4-92
Date

RECD 4

SPECIAL ANALYTICAL SERVICES

Client Request

_x_ Regional Transmittal ____ Telephone Request

A. EPA Region/Client: Region I/EPA

B. RSCC Representative: Heidi Horahan

C. Telephone Number: (617) 573-5798

D. Date of Request: June 4, 1992

E. Site Name: Mass Bay Industrial Waste Site.

Please provide below description of your request for Special Analytical Services under the Contract Laboratory Program. In order to most efficiently obtain laboratory capability for your request, please address the following considerations, if applicable. Incomplete or erroneous information may result in a delay in the processing of your request. Please continue response on additional sheets, or attach supplementary information as needed.

1. General description of analytical service requested:

   Analysis of sediment samples for target compound list (TCL) base neutrals only (no acid extractables) following U.S. EPA Contract Laboratory Program (CLP) [EPA Doc. NO. OLM01.8].

   As well as the additional compounds listed in Attachment 1.

2. Definition and number of work units involved (specify whether whole samples or fractions; whether organics or inorganics; whether aqueous or soil and sediments; and whether low, medium or high concentration):

   20/low level/sediment samples for the determination of

TCL base/neutrals following the EPA SOW (OLM01.8). modified for the additional compounds specified in Attachment 1.

Note: Samples are sediment/sludge from the bottom of a salt water body.

3. Purpose of analysis (specify whether Superfund (enforcement or remedial action), RCRA, NPDES, etc.):

SARA

4. Estimated date(s) of collection:

May 28 - June 1, 1992

5. Estimated date(s) and method of shipment:

Samples will be shipped upon laboratory award via overnight delivery.

6. Number of days analysis and data required after laboratory receipt of samples:

The samples must be extracted within 7 days of laboratory sample receipt and analyzed within 40 days of sample receipt.

Data must be received by the region within 35 days of sample receipt.

Deliver Data To:

Overnight Delivery
Heidi Horahan
U.S. EPA Region I
90 Canal St
Boston, MA 02114

U.S. Mail
Heidi Horahan
U.S. EPA Region I
JFK Federal Building
Boston, MA 02203-2211

7. Analytical protocol required (attach copy if other than a protocol currently used in this program):

Follow EPA's Organic (OLM01.8) CLP SOW for analysis of TCL base/neutrals plus aniline, benzidine, benzo (e) pyrene, 2-6-Dimethylnaphthalene, 1,2-diphenylhydrazine, N-N-dimethyl aniline, 1-Methylphenanthrene, 1-Methylnaphthalene,P-phenylenediamine, N,N-Dimethyl-dimethyl-phenylenediamine, N-nitrosodimethylamine, and ethylenediamine. Quantitation limits (QL) for additional compounds and recommended quantitation ions are listed in Attachment 1.

8. Special technical instructions (if outside protocol requirements, specify compound names, CAS numbers, detection limits, etc.):

   8.1 Quantitation limits (QL) specified Attachment 1 must be met for the additional compounds. All other compounds must meet the CRQLs specified in the CLP SOW (OLM01.8). Report results to the QL.

   8.2 The percent solids for sediment samples must be determined prior to sample extraction. Weigh 5-10 grams of sediment in a tared crucible. Dry overnight at 105°C. Allow to cool to a constant weight in a desiccator before weighing. If the % solids is below 30%, the sample aliquot must be increased in order to meet the required quantitation limits.

9. Analytical results required (if known, specify format for data sheets, QA/QC reports, Chain-of-Custody documentation, etc.) If not completed, format of results will be left to program discretion.

   All deliverables required in the Basic Ordering Agreement (BOA) and specified in OLM01.8 Organic SOW must be submitted, modified for the additional compounds and detection limit requirements. In addition, the following must be submitted:

   9.1 All shipping receipts.

   9.2 A copy of the SAS request.

10. Other (use additional sheets or attach supplementary information, as needed):

    None

11. Name of sampling/shipping contact:
    Phone:

    Vicki Maynard (617)-860-4614
    Steve Stadola (617)-860-4634

12. Data Requirements

Parameter	Quantitation Limit

See Attachment 1 for list of analytes, quantitation limits(QL), and quantitation ions.

All other TCL Semivolatiles as specified in the organic SOW (OLM01.8).

13. QC Requirements

Audits Required	Frequency of Audits	Limits	Corrective Actions

As required in the EPA Organic CLP SOW [EPA Doc. No.. OLM01.8]. The additional compounds must meet all the QC requirements specified for the CLP semivolatile TAL list.

A laboratory control sample (LCS) which contains the 12 additional compounds specified in Attachment 1 at a QL of 10 ug/L must be analyzed daily prior to sample analysis the percent recovery for these 12 analytes must be within 60 to 140% of the true value.

The minimum response factor for all compounds is 0.01.

The maximum percent relative standard deviation (%RSD) for the IC is 30%.

The maximum percent difference (%D) for the CC is 25%.

All additional compounds must be included in the matrix spiking solution at a concentration of approximately 5 times the quantitation limit. Recovery must be 30-140%. If the results are outside the limits, the compounds must qualified according to Region I guidelines for data validation

No compound shall be present in the method blank at a concentration greater than 1/2 QL. If this limit is not met, the source of the contamination must be identified and all associated samples re-extracted and reanalyzed.

14. Action Required if Limits are Exceeded

Contact sample management office as soon as problems develop. Second contact Vicki Maynard at (617)-860-4300.

Please return this request to the Sample Management Office as soon as possible to expedite processing of your request for special analytical services. Should you have any questions or need any assistance, please contact your Regional representative at the Sample Management Office.

ATTACHMENT 1

ANALYTE	SUGGESTED Quant ION	QUANTITATION LIMIT (ug/Kg)
Aniline	93	330
Benzidine	184	330
Benzo (e) pyrene	252	330
2-6-dimethylnaphthalene	156	330
1,2-diphenylhydrazine	184	330
as (Azobenzene)	105	330
N-N-dimethylaniline	120	330
1-Methylnaphthalene	142	330
1-Methylphenanthrene	192	330
N-nitrosodimethylamine	74	330
P-Phenylenediamine	108	330
N,N-Dimethyl-dimethyl-P-phenylenediamine	136	330
Ethylenediamine	30	330

Faxed to SMO 6-5-92 AL

U.S. Environmental Protection Agency
CLP Sample Management Office
P.O. Box 818 - Alexandria, Virginia 22313
Phone: 703/557-2490 - FTS/557-2490

SAS No. 7338A-05 ~~7338A-04~~

[signature]
Region I, CLP-TPO, SAS Approval

6.4.92
Date

SAS Lab: Emanuel Chem Tech Hedvet

A.Fot not pull 6-2-92 7 identical, but they need 1 lab can't have two labs

SPECIAL ANALYTICAL SERVICES

Client Request

_x_ Regional Transmittal ____ Telephone Request

A. EPA Region/Client: Region I/EPA

B. RSCC Representative: Heidi Horahan

C. Telephone Number: (617) 573-5798

D. Date of Request: June 4, 1992

E. Site Name: Mass Bay Industrial Waste Site.

Please provide below description of your request for Special Analytical Services under the Contract Laboratory Program. In order to most efficiently obtain laboratory capability for your request, please address the following considerations, if applicable. Incomplete or erroneous information may result in a delay in the processing of your request. Please continue response on additional sheets, or attach supplementary information as needed.

1. General description of analytical service requested:

   Analysis of sediment samples for target analyte list (TAL) metals and cyanide using U.S. EPA Contract Laboratory Program (CLP) [EPA Doc. NO. ILMO1].

   Include the additional compounds Titanium and Zirconium.

2. Definition and number of work units involved (specify whether whole samples or fractions; whether organics or inorganics; whether aqueous or soil and sediments; and whether low, medium or high concentration):

   20/low level/sediment samples for the determination of

TAL metals and cyanide following the EPA SOW (ILM02). modified for Titanium and Zirconium following ICP or Direct Aspiration, Atomic Absorbtion.

Note: Samples are sediment/sludge from the bottom of a salt water body. Heavy contributions from chloride, sodium and magnesium are probable.

3. Purpose of analysis (specify whether Superfund (enforcement or remedial action), RCRA, NPDES, etc.):

SARA

4. Estimated date(s) of collection:

May 28 - June 1, 1992

5. Estimated date(s) and method of shipment:

The samples will be shipped upon award of a laboratory via overnight delivery

6. Number of days analysis and data required after laboratory receipt of samples:

The samples must be analyzed for Mercury (Hg) within 28 days of sample of collection and within 180 days for all other metals.

Samples requiring cyanide analysis must be analyzed within 12 days of VTSR.

Data must be received by the region within 35 days of sample receipt.

Deliver Data To:

Overnight Delivery
Heidi Horahan
U.S. EPA Region I
90 Canal St
Boston, MA 02114

U.S. Mail
Heidi Horahan
U.S. EPA Region I
JFK Federal Building
Boston, MA 02203-2211

7. Analytical protocol required (attach copy if other than a protocol currently used in this program):

Follow EPA's Inorganic (ILM02) CLP SOW for analysis of TAL metals plus Titanium and Zirconium. **Quantitation limits (QL) for additional compounds and recommended wavelenghts are listed in Attachment 1.**

8. Special technical instructions (if outside protocol requirements, specify compound names, CAS numbers, detection limits, etc.):

8.1 Quantitation limits (QL) specified in Attachment 1 must be met for the additional compounds. All other compounds must meet the CRQLs specified in the CLP SOW (ILM02). Report results to the QL.

8.2 The 2X IDL standard for ICP must be run at at the QL listed in Attachment 1 for Titanium and Zirconium.

8.3 The percent solids for the sediment samples must be determined prior to sample digestion. Weigh 5-10 grams of sediment in a tared crucible. Dry overnight at 105°C. Allow to cool to a constant weight in a desiccator before weighing. If the % solids is below 30%, the sample aliquot must be increased in order to meet the required detection limits.

9. Analytical results required (if known, specify format for data sheets, QA/QC reports, Chain-of-Custody documentation, etc.) If not completed, format of results will be left to program discretion.

All deliverables required in the Basic Ordering Agreement (BOA) and specified in ILM02 Inorganic SOW must be submitted, modified to include the additional compounds and detection limit requirements. In addition, the following must be submitted:

9.1 All shipping receipts.

9.2 A copy of the SAS request.

10. Other (use additional sheets or attach supplementary information, as needed):

None

11. Name of sampling/shipping contact:
Phone:

Vicki Maynard (617)-860-4614
Steve Stadola (617)-860-4634

12. Data Requirements

Parameter	Quantitation Limit
Titanium	0.05 mg/kg
Zirconium	0.05 mg/kg

All other TAL metals and cyanide as specified in the Inorganic SOW (ILM02).

13. QC Requirements

Audits Required	Frequency of Audits	Limits	Corrective Actions

As required in the EPA Inorganic CLP SOW [EPA Doc. No.. ILM02]. The additional compounds must meet all the QC requirements specified for the CLP TAL metals.

14. Action Required if Limits are Exceeded

Contact sample management office as soon as problems develop. Second contact Vicki Maynard at (617)-860-4614.

Please return this request to the Sample Management Office as soon as possible to expedite processing of your request for special analytical services. Should you have any questions or need any assistance, please contact your Regional representative at the Sample Management Office.

ATTACHMENT 1

ANALYTE	SUGGESTED WAVELENGTH	QUANTITATION LIMIT
Titanium	339.2	0.5 mg/kg
Zirconium	334.94	0.5 mg/kg

faxed to Emie 6-5-92 ak

U.S. Environmental Protection Agency
CLP Sample Management Office
P.O. Box 818 - Alexandria, Virginia 22313
Phone: 703/557-2490 - FTS/557-2490

SAS No. 7338A-C

Region I, CLP-TPO, SAS Approval — Date 6-4-92

SPECIAL ANALYTICAL SERVICES RECMD

Client Request

_X_ Regional Transmittal ____ Telephone Request

A. EPA Region/Client: Region I/EPA

B. RSCC Representative: Heidi Horahan

C. Telephone Number: (617) 573-5798

D. Date of Request: June 4, 1992

E. Site Name: Mass Bay Industrial Waste Site.

Please provide below description of your request for Special Analytical Services under the Contract Laboratory Program. In order to most efficiently obtain laboratory capability for your request, please address the following considerations, if applicable. Incomplete or erroneous information may result in a delay in the processing of your request. Please continue response on additional sheets, or attach supplementary information as needed.

1. General description of analytical service requested:

   Analysis of sediment samples for target compound list (TCL) pesticides and PCBs following U.S. EPA Contract Laboratory Program (CLP) [EPA Doc. NO. OLM01.8].

   Include the additional compound Mirex

2. Definition and number of work units involved (specify whether whole samples or fractions; whether organics or inorganics; whether aqueous or soil and sediments; and whether low, medium or high concentration):

   20/low level/sediment samples for the determination of

TCL pesticides and PCBs following the EPA SOW (OLM01.8). modified for the additional compound Mirex.

Note: Samples are sediment/sludge from the bottom of a salt water body.

3. Purpose of analysis (specify whether Superfund (enforcement or remedial action), RCRA, NPDES, etc.):

SARA

4. Estimated date(s) of collection:

May 28 - June 2, 1992

5. Estimated date(s) and method of shipment:

Samples will be shipped upon laboratory award via overnight delivery

6. Number of days analysis and data required after laboratory receipt of samples:

The samples must be extracted within 10 days of laboratory sample receipt and analyzed within 40 days of sample receipt.

Data must be received by the region within 35 days of sample receipt.

Deliver Data To:

Overnight Delivery
Heidi Horahan
U.S. EPA Region I
90 Canal St
Boston, MA 02114

U.S. Mail
Heidi Horahan
U.S. EPA Region I
JFK Federal Building
Boston, MA 02203-2211

7. Analytical protocol required (attach copy if other than a protocol currently used in this program):

Follow EPA's Organic (OLM01.8) CLP SOW for analysis of TCL pesticides and PCBs plus Mirex.

Quantitation limits as per the CLP SOW plus Mirex as indicated in Section 12

8. Special technical instructions (if outside protocol requirements, specify compound names, CAS numbers, detection limits, etc.):

   8.1 Quantitation limits (QL) specified in Item 12 must be met for the additional compound. All other compounds must meet the CRQLs specified in the CLP SOW (OLM01.8). Report results to the QL.

   8.2 The percent solids for the sediment samples must be determined prior to sample extraction. Weigh 5-10 grams of sediment in a tared crucible. Dry overnight at 105°C. Allow to cool to a constant weight in a desiccator before weighing. If the % solids is below 30%, the sample aliquot must be increased in order to meet the required quantitation limits.

   8.3 The matrix spike will include Mirex at a concentration of 5 times the quantitation limit.

9. Analytical results required (if known, specify format for data sheets, QA/QC reports, Chain-of-Custody documentation, etc.) If not completed, format of results will be left to program discretion.

   All deliverables required in the Basic Ordering Agreement (BOA) and specified in OLM01.8 Organic SOW must be submitted, modified for the additional compound and detection limit requirement. In addition, the following must be submitted:

   9.1 All shipping receipts.

   9.2 A copy of the SAS request.

10. Other (use additional sheets or attach supplementary information, as needed):

    None

11. Name of sampling/shipping contact:
    Phone:

    Vicki Maynard (617)-860-4614
    Steve Stadola (617)-860 4634

12. Data Requirements

Parameter	Quantitation Limit
Mirex	1.7 ug/Kg

All other TCL Pesticides and PCBs as specified in the organic SOW (OLM01.8).

13. QC Requirements

Audits Required	Frequency of Audits	Limits	Corrective Actions

As required in the EPA Organic CLP SOW [EPA Doc. No.. OLM01.8]. The additional compound must meet all the QC requirements specified for the CLP pesticide/PCB TCL list.

Mirex must be less than 1/2 QL in the method blank or the source of the contamination must be identified and all associated samples re-extracted and reanalyzed.

Mirex must be included in all calibration standards.

The recovery of Mirex in the matrix spike must be within 50-150%. If these limits are not met, all associated samples must be re-extracted and reanalyzed. If the limits are still not met, flag all associated data with an asterisk.

A Laboratory Control Sample (LCS) which contains Mirex at the quantitation limit must be analyzed daily prior to sample analysis. The recovery must be within 40-160%. If these limits are not met, contact SMO.

14. Action Required if Limits are Exceeded

Contact sample management office as soon as problems develop. Second contact Vicki Maynard at (617)-860-4614.

Please return this request to the Sample Management Office as soon as possible to expedite processing of your request for special analytical services. Should you have any questions or need any assistance, please contact your Regional representative at the Sample Management Office.

Faxed to SMO
6-5-92 AA

U.S. Environmental Protection Agency
CLP Sample Management Office
P.O. Box 818 - Alexandria, Virginia 22313
Phone: 703/557-2490 - FTS/557-2490

SAS No. 7335A-01

Heidi Horahan
Region I, CLP-TPO, SAS Approval

6.4.92
Date

SPECIAL ANALYTICAL SERVICES

Client Request

_X_ Regional Transmittal ____ Telephone Request

A. EPA Region/Client: Region I/EPA

B. RSCC Representative: Heidi Horahan

C. Telephone Number: (617) 573-5798

D. Date of Request: June 4, 1992

E. Site Name: Mass Bay Industrial Waste Site

Spectr

Please provide below description of your request for Special Analytical Services under the Contract Laboratory Program. In order to most efficiently obtain laboratory capability for your request, please address the following considerations, if applicable. Incomplete or erroneous information may result in a delay in the processing of your request. Please continue response on additional sheets, or attach supplementary information as needed.

1. General description of analytical service requested:

   Analysis of sediment samples for organo-phosphorous pesticides by Method 8140. The specific compounds of interest are listed in Attachment A.

2. Definition and number of work units involved (specify whether whole samples or fractions; whether organics or inorganics; whether aqueous or soil and sediments; and whether low, medium or high concentration):

   20/low level/sediment samples for the determination of organo-phosphorous pesticides will be provided to the laboratory for analysis.

3. Purpose of analysis (specify whether Superfund (enforcement or remedial action), RCRA, NPDES, etc.):

   SARA

4. Estimated date(s) of collection:

   May 28 - June 1, 1992

5. Estimated date(s) and method of shipment:

   Samples will be shipped upon award of a laboratory via overnight delivery

6. Number of days analysis and data required after laboratory receipt of samples:

   The analytical holding times requirements for all pesticide samples must be extracted within 7 days from the receipt by the laboratory and analyzed within 40 days.

   Data must be received by the region within 35 days of sample receipt.

Deliver Data To:

Overnight Delivery
Heidi Horahan
U.S. EPA Region I
90 Canal St
Boston, MA 02114

U.S. Mail
Heidi Horahan
U.S. EPA Region I
JFK Federal Building
Boston, MA 02203-2211

7. Analytical protocol required (attach copy if other than a protocol currently used in this program):

   Pesticides samples must be prepared according to Method 3550, all extracts are to be analyzed according to Method 8140 (9/86), Organophosphorous Pesticides, Test Method for Evaluating Solid Wastes, SW-846, Third Edition.

NOTE: Clean-up may be required using GPC by SW-846, Method 3560.

8. Special technical instructions (if outside protocol requirements, specify compound names, CAS numbers, detection limits, etc.):

- o All recommendations and "should" in the methods must be followed and/or read as must.
- o External standard calibration must be performed following section 7.4.2 of Method 8000.
- o The percent solids for sediment samples must be determined prior to sample extraction. Weigh 5-10 grams of sediment in a tared crucible. Dry overnight at 105 C. Allow to cool to a constant weight in a desiccator before weighing. If the % solids is below 30%, the sample aliquot must be increased in order to meet the required quantitation limits.
- o Retention time windows for analyses must be determined according to section 7.5 of Method 8000 for each GC column used or every time a new column is installed.
- o Section 7.6 in Method 8000 must be followed for analysis sequence, daily retention time window generation, appropriate dilutions, and identification criteria.
- o All samples and blanks must be spiked with Bolstar or an equivalent organophosphorous pesticide prior to extraction. The amount of surrogate to be used should approximate the mid-range of the calibration curve.

9. Analytical results required (if known, specify format for data sheets, QA/QC reports, Chain-of-Custody documentation, etc.) If not completed, format of results will be left to program discretion.

All deliverables required in the Basic Ordering Agreement (BOA) must be supplied. The data package deliverables must resemble as closely as possible the latest organic CLP SOW RAS data package. The forms must be modified where appropriate.

9.1 All shipping receipts.

9.2 A copy of the SAS request.

9.3 The report must be paginated.

9.4 A written narrative describing procedures utilized, problems encountered in receipt or during sample preparation/analysis and corrective actions taken (including telephone logs, etc.) must be provided.

9.5 All chain-of-custody documentation, airbills, and SAS pacing lists must be signed and included along with all sample tags.

9.6 All extraction log book pages, standards preparation log book pages and daily run logs must be included.

9.7 All results should be reported in ug/kg dry weight.

9.8 Raw data including all chromatograms for blanks, spikes standards and samples must be provided. The chromatograms must be labelled with the EPA sample number, the date and time of injection, the volume injected (ul) and the names of the compounds identified. The values and detection limits must be summarized on a form similar to RAS Form I.

9.8 The surrogate results must be provided in a tabulated format similar to the RAS Form II. The compounds which are ot within acceptance criteria must be flagged with an asterick. All blanks, samples and QC samples which were analyzed must be reported on this form.

9.9 MS/MSD results must be reported on standard forms similar to the RAS form III, with raw data provided.

9.10 A report similar to the RAS Form IV must be submitted for each pesticide extraction blank with raw data provided.

9.11 The initial calibration results must be reported in a tabulated format similar to the RAS Form VI-PEST for pesticide analysis. The relative response factors and the percent relative standard deviation must be calculated for each days' calibration. The concentration of the standards analyzed and the raw data must be provided. If additional standards were analyzed due to positive results not within the calibration curve, these standards must also be provided; the raw data and tabulated results.

9.12 The continuing calibration standard must be reported in a tabulated format similar to RAS FORM VII-PEST. The raw data (chromatograms and instrument quantitation results) must be included. The percent difference(%D) and daily response factor(RF) must be reported for all compounds.

9.13 Retention time window criteria must be summarized in a format similar to RAS Pesticide Form VI.

10. Other (use additional sheets or attach supplementary information, as needed):

None

11. Name of sampling/shipping contact:
Phone:

Vicki Maynard (617)-860-4614
Steve Stadola (617)-860-4634

12. Data Requirements

The contract required quantitation limits for the compounds of interest for Method 8140 are listed in Attachment A.

13. QC Requirements

Audits Required	Frequency of Audits	Limits	Corrective Actions

See Attachment B

14. Action Required if Limits are Exceeded

Contact sample management office as soon as problems develop. Second contact Vicki Maynard at (617)-860-4614.

Please return this request to the Sample Management Office as soon as possible to expedite processing of your request for special analytical services. Should you have any questions or need any assistance, please contact your Regional representative at the Sample Management Office.

ATTACHMENT A

ANALYTE	QUANTITATION LIMIT	
Parathion	20	ug/kg
Malathion	20	ug/kg
Guthion	20	ug/kg
Demeton	150	ug/kg

ATTACHMENT B

Method Blanks: One method blank per group of 20 samples or less must be extracted and analyzed. Compounds detected must be less than 1/2 the CRQL. If limits are exceeded, the source of contamination must be investigated and all problems corrected prior to sample analysis. All associated samples must be re-extracted and reanalyzed.

Surrogates: The surrogate specified in item 8, must be spiked prior to analysis into all samples, blanks, and QC samples at a level that approximates the mid-range of the calibration curve. The surrogate recovery must be within 75-125%. If these limits are not met, the sample must be re-extracted and reanalyzed. If the results are still outside of the limits, report all results and flag with an asterisk.

MS/MSD: One MS and MSD for every sample batch of 20 or less must be performed. The spiking solution must contain the compounds of interest. The concentration of the spike must be 10 times the CRQL. The recovery limits must be within 50-150% recovery. If the limits are exceeded samples should be re-extracted and re-analyzed once, if still out, report both values and flag effected data with an asterick(*).

Initial Calibration: The calibration procedures and acceptance criteria are specified in section 7.4 of Method 8000. A five level initial calibration with that contains all the compounds of interest and which brackets the range of the sample concentrations with the lowest standard at the QL must be performed. The % RSD of the 5 level initial calibration must be at or below 20% before any sample analysis can begin.

Continuing Calibration: A continuing calibration standard must be analyzed following the analytical sequence provided. The concentration of the standard must be at the mid-point of the initial calibration curve. The calibration factor percent difference (%D) from the mean of the initial calibration curve must be less than or equal to 20% for the quantitation column and 25% for the confirmational column. If the calibration factor %D does not meet these requirements a new initial calibration curve must be prepared. All sample concentrations reported must be quantitated from the peak height or area response vs. the concentration of the continuing calibration.

Confirmation: All positive results must be confirmed on a second column. The same criteria specified for the ICC, analytical sequence, initial calibration and continuing calibration must be met for the secondary column.

Analytical Sequence: The GC 72 hour calibration/analysis sequence must be followed:

Sequence No:	Description:
1-5	Initial Calibration Standards
6	Method Blank
7-11	Field Samples
12	Continuing Calibration Standard
13	Method Blank
14-18	Field Samples
19	Repeat above sequence starting with 12.

Table D.1. Concentrations (mg/kg, dry weight) of inorganics in sediments collected at the Massachusetts Bay IWS and reference sites, May and June 1992 (reviewed by ERL-N).

SITE: *Core Index		REF 1 REP 1		REF 1 REP 2		REF 1 REP 3		REF 2 REP 1		REF 2 REP 2		REF 2 REP 3		TF II, T 1 BC 1		TF II, T 2 BC 2		TF II, T 3 BC 3		TF III, T 5 PC 7		Contract Required Detection Limit	Instr. Detection Limit
INORGANIC ELEMENTS		mg/kg (dw)		mg/kg (dw)		mg/kg (dw)		mg/kg (dw)		mg/kg (dw)		mg/kg (dw)		mg/kg (dw)		mg/kg (dw)		mg/kg (dw)		mg/kg (dw)		mg/kg (dw)	mg/kg (dw)
aluminum	P	20700.0		18400.0		18700.0		19100.0		17300.0		18500.0		16700.0		21000.0		19100.0		23700.0		40	22
antimony	P	20.0		20.2	U	20.6	U	18.6	U	15.9	U	16.9	U	14.5	U	15.6	U	15.8	U	13.7	U	12	7
arsenic	F	38.6	J	28.5	J	32.9	J	32.8	J	28.8	J	38.6	J	35.2	J	42.2	J	37.4	J	36.7	J	2	0.8
barium	P	87.0		83.7		87.0		87.2		76.0		80.5		77.3		91.3		85.4		98.9		40	2.8
beryllium	P	2.3		2.2		2.3		2.4		2.1		2.1		1.9		2.1		2.5		2.6		1	0.2
cadmium	P	1.7	U	1.7	U	1.8	U	1.6	U	1.4	U	1.4	U	7.6		7.2		11.5		1.2	U	1	0.6
calcuim	P	5280.0		4980.0		4970.0		11500.0		4400.0		4600.0		12500.0		13100.0		5820.0		5930.0		1000	64.2
chromium	P	95.7		84.4		89.6		69.6		65.3		51.9		70.1		66.4		71.4		80.6		2	1.8
cobalt	P	11.3		9.2		11.8		6.4		9.0		8.5		14.4		12.4		16.4		16.9		10	1.0
copper	P	8.0	UJ	8.1	UJ	8.3	UJ	7.4	UJ	6.4	UJ	6.8	UJ	41.1		6.2	UJ	6.3	UJ	22.6		5	2.8
iron	P	33500.0		30600.0		30700.0		28400.0		26000.0		30700.0		45500.0		26000.0		31200.0		40700.0		20	3.6
lead	F	46.0		56.4		60.8		45.4		39.0		28.0		37.6		32.10		35.8		31.6		0.6	0.4
magnesium	P	12600.0		11600.0		12000.0		10800.0		9850.0		10800.0		12600.0		14700		10900.0		13600.0		1000	42
manganese	P	332.0		307.0		305.0		304.0		272.0		290.0		335.0		298.0		296.0		401.0		3	2
mercury	CV	0.29	UJ	0.48	J	0.37	J	0.54	J	0.23	UJ	0.24	UJ	0.21	UJ	0.37	J	0.54	J	0.20	UJ	0.1	0.10
nickel	P	34.7		48.6		33.6		53.8		50.9		29.9		82.6		34.8		52.4		42.5		8	1.8
potassium	P	6100.0		5910.0		6040.0		5840.0		5500.0		5310.0		4920.0		5380.0		6140.0		8090.0		1000	96
selenium	F	1.7	UJ	1.7	U	1.8	U	1.6	U	1.4	U	1.4	UJ	12.4	U	1.3	U	1.4	U	1.2	U	1	0.6
silver	P	5.1	U	5.2	U	5.3	U	4.8	U	4.1	U	4.3	U	5.1		4.0	U	4.1	U	3.5	U	2	1.8
sodium	P	25500.0		23900.0		25000.0		20300.0		17600.0		17900.0		13800.0		14600.0		18000.0		22500.0		1000	78
thallium	F	2.3	U	2.3	UJ	2.4	UJ	2.1	UJ	1.8	UJ	1.9	UJ	1.7	U	1.8	U	1.8	U	1.6	U	2	0.8
vanadium	P	85.5		65.5		75.5		67.7		59.3		68.7		64.4		56.3		67.9		84.7		10	3.2
zinc	P	112.0		103.0		108.0		94.9		96.5		84.4		106.0		166.0		120.0		123.0		4	1.2
titanium	P	1150.0		1050.0		1010.0		1150.0		1090.0		1050.0		905.0		1030.0		1030.0		1290.0		0.6	0.6
zirconium	P	13.8		23.6		14.3		12.8		11.0		11.7		24.2		18.7		21.3		18.6		0.6	0.6
cyanide	C	2.9	U	2.9	U	2.9	U	2.7	U	2.3	U	2.4	U	2.1	U	2.2	U	2.3	U	2.0	U	1	1.0
% Solids		35.0		34.7		33.9		37.7		43.9		41.4		48.4		44.8		44.4		51.0			

KEY:
- J - Quantitation is approximate due to limitations identified in the quality control review (data review)
- U - Value is nondetected and detection limit is raised.
- UJ - Value is nondetected and detection limit is estimated
- TF - target field
- T - target number
- BC - box core
- PC - punch core
- REF - reference site

ANALYTICAL METHOD
- F - furnace
- P - ICP/flame AA
- CV - cold vapor

*EPA Core Index see Table 5.8

Table D.1. (continued)

SITE: *Core Index		TF III, T 6 PC 8		TF III, T 7 PC 9		TF III, T 8 PC 10/ 11		TF I, T 10 BC 4		TF I, T 11 BC 5		TF I, T 12 BC 6		TF IV, T 17 BC 10		TF IV, T 15 BC 9		TF IV, T 13 BC 7		TF IV, T 14 BC 8		Contract Required Detection Limit	Instr. Detection Limit
INORGANIC ELEMENTS		mg/kg (dw)		mg/kg (dw)		mg/kg (dw)		mg/kg (dw)		mg/kg (dw)		mg/kg (dw)		mg/kg (dw)		mg/kg (dw)		mg/kg (dw)		mg/kg (dw)		mg/kg (dw)	mg/kg (dw)
aluminum	P	18700.0		17400.0		20800.0		8150.0		22400.0		17200.0		27300.0		18200.0		15500.0		18600.0		40	22
antimony	P	17.5	U	17.4	U	17.1	U	9.8	U	19.4	U	16.7	U	18.6	U	17.4	U	17.0	U	17.7	U	12	7
arsenic	F	38.0	J	32.2	J	39.4	J	25.7	J	35.1	J	36.6	J	39.8	J	41.7	J	31.6	J	34.9	J	2	0.8
barium	P	65.3		60.0		95.0		38.9		92.5		65.5		123.0		89.4		74.6		88.4		40	2.8
beryllium	P	2.4		2.3		2.9		1.2		3.0		2.4		3.6		2.6		2.5		2.7		1	0.2
cadmium	P	1.5	U	1.5	U	1.5	U	0.84	U	1.7	U	1.4	U	1.6	U	1.5	U	1.5	U	1.5	U	1	0.6
calcuim	P	6920.0		4620.0		5070.0		2590.0		5750.0		8110.0		8120.0		4790.0		4180.0		5710.0		1000	64.2
chromium	P	68.7		90.1		91.2		36.8		110.0		80.2		153.0		106.0		77.8		89.0		2	1.8
cobalt	P	11.9		12.1		11.7		4.4		11.4		9.2		25.8		13.4		8.3		8.4		10	1.0
copper	P	7.0	UJ	33.9		26.8		3.9	UJ	56.6		32.5		175.0		32.6		25.5		7.1	UJ	5	2.8
iron	P	34600.0		28400.0		30100.0		17600.0		32900.0		36200.0		79300.0		31000.0		28700.0		38000.0		20	3.6
lead	F	37.8		53.5		63.1		23.1		56.2		46.7		45.6		58.5		38.9		47.6		0.6	0.4
magnesium	P	10500.0		10700.0		10900.0		5000.0		11800.0		9560.0		15900.0		11300.0		9800.0		11100.0		1000	42
manganese	P	299.0		285.0		319.0		173.0		349.0		487.0		496.0		306.0		273.0		315.0		3	2
mercury	CV	0.38	J	0.25	UJ	0.24	UJ	0.23	J	0.28	UJ	0.39	J	0.27	UJ	0.25	UJ	0.38	J	0.25	UJ	0.1	0.10
nickel	P	41.6		38.4		35.6		17.9		37.8		41.4		77.3		32.0		35.9		58.3		8	1.8
potassium	P	5780.0		5210.0		6030.0		2560.0		6980.0		5530.0		6980.0		5600.0		5030.0		5580.0		1000	96
selenium	F	1.5	U	1.5	U	1.5	U	0.84	UJ	1.70	U	4.10		1.8	UJ	1.5	U	1.5	U	1.5	UJ	1	0.6
silver	P	4.5	U	4.5	U	4.7		2.5	U	5.0	U	4.3	U	4.8	U	4.5	U	4.4	U	4.6	U	2	1.8
sodium	P	18800.0		19600.0		18300.0		8020.0		22000.0		16800.0		26700.0		18900.0		18600.0		19400.0		1000	78
thallium	F	2.0	U	2.0	U	2.0	U	1.1	U	2.2	U	1.9	U	2.1	U	2.0	U	1.9	U	2.0	U	2	0.8
vanadium	P	62.6		70.8		74.7		36.7		82.3		70.6		111.0		76.7		68.5		75.8		10	3.2
zinc	P	105.0		127.0		110.0		48.6		155.0		113.0		164.0		129.0		101.0		112.0		4	1.2
titanium	P	1100.0		963.0		1190.0		455.0		1240.0		1040.0		1620.0		1040.0		969.0		1120.0		0.6	0.6
zirconium	P	15.3		16.2		17.2		6.8		13.4		12.9		17.3		12.0		11.8		12.2		0.6	0.6
cyanide	C	2.5	U	2.5	U	2.4	U	1.4	U	2.8	U	2.4	U	2.7	U	2.5	U	2.4	U	2.5	U	1	1.0
% Solids		40.0		40.2		41.0		71.6		36.1		41.8		37.7		40.2		41.1		39.5			

*EPA Core Index see Table 5.8

Table D.2. Concentrations (µg/kg, dry weight) of organophosphorous pesticides collected at the MBIWS and references sites in May and June 1992. (Reviewed by ERL-N.)

SITE:	REF 1		REF 1		REF 1		REF 2		REF 2		REF 2		TF2, T1		TF2, T2		TF2, T3	
*Core Index	REP 1		REP 2		REP 3		REP 1		REP 2		REP 3		BC 1		BC 2		BC 3	
COMPOUND	µg/kg (dw)		µg/kg (dw)		µg/kg (dw)		µg/kg (dw)		µg/kg (dw)		µg/kg (dw)		µg/kg (dw)		µg/kg (dw)		µg/kg (dw)	
Demeton	330	UJ	430	UJ	430	UJ	420	UJ	290	UJ	340	UJ	330	UJ	330	UJ	340	UJ
Methyl Parathi	44	UJ	57	UJ	57	UJ	56	UJ	38	UJ	45	UJ	44	UJ	44	UJ	45	UJ
Melathion	44	UJ	57	UJ	57	UJ	56	UJ	38	UJ	45	UJ	44	UJ	44	UJ	45	UJ
Ethyl Parathior	44	UJ	57	UJ	57	UJ	56	UJ	38	UJ	45	UJ	44	UJ	44	UJ	45	UJ
Guthion	73	UJ	94	UJ	94	UJ	92	UJ	63	UJ	73	UJ	73	UJ	73	UJ	73	UJ
Percent Solids	45		35		35		36		52		44		45		45		44	

SITE:	TF3, T8		TF1, T10		TF1, T11		TF1, T12		TF4, T17		TF4, T15		TF4, T13		TF4, T14		Contract
GRAB:	PC 10/11		BC 4		BC 5		BC 6		BC 10		BC 9		BC 7		BC 8		Required
COMPOUND	µg/kg (dw)		µg/kg (dw)		µg/kg (dw)		µg/kg (dw)		µg/kg (dw)		µg/kg (dw)		µg/kg (dw)		µg/kg (dw)		Quant. Limit
Demeton	350	UJ	320	UJ	430	UJ	300	UJ	390	UJ	390	UJ	370	UJ	260	UJ	150
Methyl Parathi	47	UJ	43	UJ	57	UJ	40	UJ	53	UJ	53	UJ	49	UJ	35	UJ	20
Melathion	47	UJ	43	UJ	57	UJ	40	UJ	53	UJ	53	UJ	49	UJ	35	UJ	20
Ethyl Parathior	47	UJ	43	UJ	57	UJ	40	UJ	53	UJ	53	UJ	49	UJ	35	UJ	20
Guthion	77	UJ	70	UJ	94	UJ	66	UJ	87	UJ	87	UJ	80	UJ	58	UJ	33
Percent Solids	43		47		35		50		38		38		41		57		

J - Quantitation is approximate due to limitations identified in the quality control review (data review).
UJ - Value is nondetected and detection limit is estimated.
REP - Smith-McIntyre sample
PC - punch core sample
BC - box core sample

*EPA Core Index see Table 5.8

Table D.3. Concentrations (µg/kg, dry weight) of PCBs and pesticides collected at the MBIWS and reference sites in May and June 1992. (Reviewed by ERL-N.)

SITE: *Core Index COMPOUND	REF 1 REP 1 ug/kg (dw)		REF 1 REP 2 ug/kg (dw)		REF 1 REP 3 ug/kg (dw)		REF 2 REP 1 ug/kg (dw)		REF 2 REP 2 ug/kg (dw)		REF 2 REP 3 ug/kg (dw)		TF II, T 1 BC 1 ug/kg (dw)		TF II, T 2 BC 2 ug/kg (dw)		TF II, T 3 BC 3 ug/kg (dw)		TF III, T 7 PC 9 ug/kg (dw)		Contract Required Quantitation Limit
alpha-BHC	4.5	UJ	4.7	UJ	4.6	UJ	0.51	J	3.9	UJ	3.8	UJ	3.6	UJ	3.9	UJ	3.4	UJ	4.2	UJ	
beta-BHC	4.5	UJ	4.7	UJ	4.6	UJ	4.3	UJ	3.9	UJ	3.8	UJ	3.6	UJ	2.2	J	1.8	J	4.2	UJ	1.7
delta-BHC	4.5	UJ	4.7	UJ	4.6	UJ	4.3	UJ	3.9	UJ	3.8	UJ	3.6	UJ	3.9	UJ	3.4	UJ	4.2	UJ	1.7
gamma-BHC	4.5	UJ	4.7	UJ	4.6	UJ	4.3	UJ	3.9	UJ	3.8	UJ	3.6	UJ	3.9	UJ	3.4	UJ	4.2	UJ	1.7
heptachlor	4.5	UJ	4.7	UJ	4.6	UJ	4.3	UJ	3.9	UJ	3.8	UJ	3.6	UJ	3.9	UJ	3.4	UJ	4.2	UJ	1.7
aldrin	4.5	UJ	4.7	UJ	4.6	UJ	4.3	UJ	3.9	UJ	3.8	UJ	3.6	UJ	3.9	UJ	3.4	UJ	0.55	J	1.7
heptachlor epoxide	4.5	UJ	4.7	UJ	4.6	UJ	4.3	UJ	3.9	UJ	3.8	UJ	3.6	UJ	3.9	UJ	3.4	UJ	4.2	UJ	1.7
endosulfan I	4.5	UJ	4.7	UJ	4.6	UJ	4.3	UJ	3.9	UJ	3.8	UJ	0.46	J	3.9	UJ	3.4	UJ	4.2	UJ	1.7
dieldrin	8.7	UJ	9.2	UJ	8.9	UJ	8.4	UJ	7.7	UJ	7.4	UJ	7.0	UJ	7.5	UJ	6.6	UJ	8.2	UJ	3.3
4,4'-DDE	1.1	J	0.93	J	1.2	J	8.4	UJ	7.7	UJ	7.4	UJ	1.0	J	0.80	J	6.6	UJ	1.4	J	3.3
endrin	8.7	UJ	9.2	UJ	8.9	UJ	8.4	UJ	7.7	UJ	7.4	UJ	7.0	UJ	7.5	UJ	6.6	UJ	8.2	UJ	3.3
endosulfan II	8.7	UJ	9.2	UJ	1.0	J	8.4	UJ	7.7	UJ	7.4	UJ	7.0	UJ	1.1	J	6.6	UJ	8.2	UJ	3.3
4,4'-DDD	1.4	U	1.1	J	1.8	J	8.4	UJ	0.95	J	7.4	UJ	1.2	J	0.90	J	0.89	J	2.2	J	3.3
endosulfan sulfate	8.7	UJ	9.2	UJ	8.9	UJ	8.4	UJ	7.7	UJ	7.4	UJ	7.0	UJ	7.5	UJ	6.6	UJ	8.2	UJ	3.3
4,4'-DDT	8.7	UJ	9.2	UJ	4.1	J	8.4	UJ	7.7	UJ	7.4	UJ	7.0	UJ	7.5	UJ	6.6	UJ	1.0	J	3.3
methoxychlor	45	UJ	47	UJ	46	UJ	43	UJ	5.1	J	38	UJ	36	UJ	39	UJ	34	UJ	42	UJ	17
endrin ketone	8.7	UJ	9.2	UJ	8.9	UJ	8.4	UJ	7.7	UJ	7.4	UJ	7.0	UJ	7.5	UJ	6.6	UJ	8.2	UJ	3.3
endrin aldehyde	8.7	UJ	9.2	UJ	8.9	UJ	8.4	UJ	7.7	UJ	7.4	UJ	7.0	UJ	7.5	UJ	6.6	UJ	8.2	UJ	3.3
alpha-chlordane	4.5	UJ	4.7	UJ	4.6	UJ	4.3	UJ	3.9	UJ	3.8	UJ	3.6	UJ	3.9	UJ	3.4	UJ	4.2	UJ	1.7
gamma-chlordane	4.5	UJ	4.7	UJ	4.6	UJ	4.3	UJ	3.9	UJ	3.8	UJ	3.6	UJ	3.9	UJ	3.4	UJ	4.2	UJ	1.7
toxaphene	450	UJ	470	UJ	460	UJ	430	UJ	390	UJ	380	UJ	360	UJ	390	UJ	340	UJ	420	UJ	170
aroclor 1016	87	UJ	92	UJ	89	UJ	84	UJ	77	UJ	74	UJ	70	UJ	75	UJ	66	UJ	82	UJ	33.0
aroclor 1221	180	UJ	190	UJ	180	UJ	170	UJ	160	UJ	150	UJ	140	UJ	150	UJ	130	UJ	170	UJ	67.0
aroclor 1232	87	UJ	92	UJ	89	UJ	84	UJ	77	UJ	74	UJ	70	UJ	75	UJ	66	UJ	82	UJ	33.0
aroclor 1242	87	UJ	92	UJ	89	UJ	84	UJ	77	UJ	74	UJ	70	UJ	75	UJ	66	UJ	82	UJ	33.0
aroclor 1248	87	UJ	92	UJ	89	UJ	84	UJ	77	UJ	74	UJ	70	UJ	75	UJ	66	UJ	82	UJ	33.0
aroclor 1254	87	UJ	92	UJ	89	UJ	84	UJ	77	UJ	74	UJ	70	UJ	75	UJ	66	UJ	82	UJ	33.0
aroclor 1260	87	UJ	92	UJ	89	UJ	84	UJ	77	UJ	74	UJ	70	UJ	75	UJ	66	UJ	82	UJ	33.0
mirex	4.5	UJ	4.7	UJ	4.6	UJ	4.3	UJ	3.9	UJ	3.8	UJ	3.6	UJ	3.9	UJ	3.4	UJ	4.2	UJ	1.7
% Solid:	38		36		37		39		43		44		47		44		50		40		

KEY

*EPA Core Index see Table 5.8

J - Quantitation is approximate due to limitations identified in the quality control review (data review).
U - Value is nondetected and detection limit is raised.
UJ - Value is nondetected and detection limit is estimated.
TF - target field
T - target number
BC - box core
PC - punch core
REP - Smith-McIntyre

Table D.3. (continued)

SITE:	TF I, T 10		TF I, T 11		TF I, T 12		TF IV, T 17		TF IV, T 15		TF IV, T 13		TF 4, T14		Contract
CORE INDEX:	BC 4		BC 5		BC 6		BC 10		BC 9		BC 7		BC 8		Required
	ug/kg		ug/kg		ug/kg		ug/kg		ug/kg		ug/kg		ug/kg		Quant.
COMPOUND	(dw)		(dw)		(dw)		(dw)		(dw)		(dw)		(dw)		Limit
alpha-BHC	2.6	UJ	4.5	UJ	0.43	J	4.2	UJ	4.3	UJ	4.0	UJ	4.0	UJ	1.7
beta-BHC	2.6	UJ	4.5	UJ	3.8	UJ	4.2	UJ	4.3	UJ	4.0	UJ	4.0	UJ	1.7
delta-BHC	2.6	UJ	4.5	UJ	3.8	UJ	4.2	UJ	4.3	UJ	4.0	UJ	4.0	UJ	1.7
gamma-BHC	2.6	UJ	4.5	UJ	3.8	UJ	4.2	UJ	4.3	UJ	4.0	UJ	4.0	UJ	1.7
heptachlor	2.6	UJ	4.5	UJ	3.8	UJ	4.2	UJ	4.3	UJ	4.0	UJ	4.0	UJ	1.7
aldrin	2.6	UJ	0.87	J	3.8	UJ	4.2	UJ	4.3	UJ	4.0	UJ	4.0	UJ	1.7
heptachlor epoxide	2.6	UJ	4.5	UJ	3.8	UJ	4.2	UJ	4.3	UJ	0.85	J	4.0	UJ	1.7
endosulfan I	2.6	UJ	4.5	UJ	3.8	UJ	4.2	UJ	4.3	UJ	0.45	J	4.0	UJ	3.3
dieldrin	5.0	UJ	8.7	UJ	1.3	J	8.2	UJ	8.4	UJ	7.9	UJ	7.8	UJ	3.3
4,4'-DDE	5.0	UJ	1.4	J	1.8	J	1.1	J	1.6	J	1.2	J	0.91	J	3.3
endrin	5.0	UJ	8.7	UJ	7.3	UJ	8.2	UJ	8.4	UJ	7.9	UJ	7.8	UJ	3.3
endosulfan II	5.0	UJ	8.7	UJ	7.3	UJ	8.2	UJ	1.5	J	1.1	J	7.8	UJ	3.3
4,4'-DDD	0.62	J	1.8	J	0.98	J	1.7	J	2.6	J	1.9	J	1.5	J	3.3
endosulfan sulfate	5.0	UJ	8.7	UJ	7.3	UJ	8.2	UJ	8.4	UJ	7.9	UJ	7.8	UJ	3.3
4,4'-DDT	5.0	UJ	8.7	UJ	7.3	UJ	8.2	UJ	8.4	UJ	7.9	UJ	1.1	J	17
methoxychlor	26	UJ	45	UJ	38	UJ	42	UJ	43	UJ	40	UJ	40	UJ	3.3
endrin ketone	5.0	UJ	8.7	UJ	7.3	UJ	8.2	UJ	8.4	UJ	7.9	UJ	7.8	UJ	3.3
endrin aldehyde	5.0	UJ	8.7	UJ	7.3	UJ	8.2	UJ	8.4	UJ	7.9	UJ	7.8	UJ	1.7
alpha-chlordane	2.6	UJ	4.5	UJ	3.8	UJ	4.2	UJ	4.3	UJ	4.0	UJ	4.0	UJ	1.7
gamma-chlordane	2.6	UJ	0.69	J	1.5	J	4.2	UJ	0.79	J	4.0	UJ	4.0	UJ	170
toxaphene	260	UJ	450	UJ	380	UJ	420	UJ	430	UJ	400	UJ	400	UJ	33.0
aroclor 1016	50	UJ	87	UJ	73	UJ	82	UJ	84	UJ	79	UJ	78	UJ	67.0
aroclor 1221	100	UJ	180	UJ	150	UJ	170	UJ	170	UJ	160	UJ	160	UJ	33.0
aroclor 1232	50	UJ	87	UJ	73	UJ	82	UJ	84	UJ	79	UJ	78	UJ	33.0
aroclor 1242	50	UJ	87	UJ	73	UJ	82	UJ	84	UJ	79	UJ	78	UJ	33.0
aroclor 1248	50	UJ	87	UJ	73	UJ	82	UJ	84	UJ	79	UJ	78	UJ	33.0
aroclor 1254	50	UJ	87	UJ	73	UJ	82	UJ	84	UJ	79	UJ	78	UJ	33.0
aroclor 1260	50	UJ	87	UJ	73	UJ	82	UJ	84	UJ	79	UJ	78	UJ	33.0
mirex	2.6	UJ	4.5	UJ	3.8	UJ	4.3	UJ	4.3	UJ	4.0	UJ	4.0	UJ	1.7
% Solid:	66		38		45		40		39		42		42		

Table D.4. Concentrations (mg/kg dw) of semi-volatile organics collected in sediments at the IWS and Reference Site, May/June 1992. (reviewed by ERL-N).

Compound	CRQL	Site: Grab:*	TFIII,T6 PC8	TFIII,T7 PC9	TFIII,T8 PC10/PC11	TFI,T10 BC4	TFI,T11 BC5	TFI,T12 BC6	TFIV,T17 BC10	TFIV,T15 BC9	TFIV,T13 BC7	TFIV,T14 BC8
Bis(2-chloroethyl) ether	330		330UJ	330 UJ	340 UJ	310 UJ	290 UJ	280 UJ	270 UJ	290 UJ	290 UJ	320 UJ
1,3-dichlorobenzene	330		330UJ	330 UJ	340 UJ	310 UJ	290 UJ	280 UJ	270 UJ	290 UJ	290 UJ	320 UJ
1,4-dichlorobenzene	330		330UJ	330 UJ	340 UJ	310 UJ	290 UJ	280 UJ	270 UJ	290 UJ	290 UJ	320 UJ
1,2-dichlorobenzene	330		330UJ	330 UJ	340 UJ	310 UJ	290 UJ	280 UJ	270 UJ	290 UJ	290 UJ	320 UJ
Bis(2-chlorisopropyl) ether	330		330UJ	330 UJ	340 UJ	310 UJ	290 UJ	280 UJ	270 UJ	290 UJ	290 UJ	320 UJ
N-nitroso-di-n-propylamine	330		330UJ	330 UJ	340 UJ	310 UJ	290 UJ	280 UJ	270 UJ	290 UJ	290 UJ	320 UJ
hexachloroethane	330		330UJ	330 UJ	340 UJ	310 UJ	290 UJ	280 UJ	270 UJ	290 UJ	290 UJ	320 UJ
nitrobenzene	330		330UJ	330 UJ	340 UJ	310 UJ	290 UJ	280 UJ	270 UJ	290 UJ	290 UJ	320 UJ
isophorone	330		330UJ	330 UJ	340 UJ	310 UJ	290 UJ	280 UJ	270 UJ	290 UJ	290 UJ	320 UJ
carbazole	330		330UJ	330 UJ	16 J	310 UJ	290 UJ	280 UJ	270 UJ	290 UJ	91J	320 UJ
bis(2-chloroethoxy)methane	330		330UJ	330 UJ	340 UJ	310 UJ	290 UJ	280 UJ	270 UJ	290 UJ	290 UJ	320 UJ
1,2,3-trichlorobenzene	330		330UJ	330 UJ	340 UJ	310 UJ	290 UJ	280 UJ	270 UJ	290 UJ	290 UJ	320 UJ
naphthalene	330		16 J	26 J	22 J	310 UJ	290 UJ	280 UJ	18 J	14 J	290 UJ	320 UJ
4-chloroaniline	330		330UJ	330 UJ	340 UJ	310 UJ	290 UJ	280 UJ	270 UJ	290 UJ	290 UJ	320 UJ
hexachlorobutadiene	330		330UJ	330 UJ	340 UJ	310 UJ	290 UJ	280 UJ	270 UJ	290 UJ	290 UJ	320 UJ
2-methylnaphthalene	330		330UJ	330 UJ	340 UJ	310 UJ	290 UJ	280 UJ	270 UJ	290 UJ	290 UJ	320 UJ
hexachlorocyclopentadiene	330		330UJ	330 UJ	340 UJ	310 UJ	290 UJ	280 UJ	270 UJ	290 UJ	290 UJ	320 UJ
2-chloronaphthalene	330		330UJ	330 UJ	340 UJ	310 UJ	290 UJ	280 UJ	270 UJ	290 UJ	290 UJ	320 UJ
2-nitroaniline	800		810UJ	810 UJ	820 UJ	760 UJ	710 UJ	690 UJ	660 UJ	710 UJ	710 UJ	770 UJ
dimethylphthalate	330		330UJ	330 UJ	340 UJ	310 UJ	290 UJ	280 UJ	270 UJ	290 UJ	290 UJ	320 UJ
acenaphthylene	330		330UJ	330 UJ	340 UJ	310 UJ	290 UJ	280 UJ	270 UJ	290 UJ	290 UJ	320 UJ
2,6-dinitrotoluene	330		330UJ	330 UJ	340 UJ	310 UJ	290 UJ	280 UJ	270 UJ	290 UJ	290 UJ	320 UJ
3-nitroaniline	800		810UJ	810 UJ	820 UJ	760 UJ	710 UJ	690 UJ	660 UJ	710 UJ	710 UJ	770 UJ
acenaphthene	330		20J	29J	33J	310 UJ	290 UJ	280 UJ	270 UJ	290 UJ	290 UJ	320 UJ
dibenzofuran	330		330UJ	330 UJ	340 UJ	310 UJ	290 UJ	280 UJ	270 UJ	290 UJ	290 UJ	320 UJ
2,4-dinitrotoluene	330		330UJ	330 UJ	340 UJ	310 UJ	290 UJ	280 UJ	270 UJ	290 UJ	290 UJ	320 UJ
diethylphthalate	330		330UJ	330 UJ	340 UJ	310 UJ	290 UJ	280 UJ	270 UJ	290 UJ	290 UJ	320 UJ
4-chlorophenyl-phenylether	330		330UJ	330 UJ	340 UJ	310 UJ	290 UJ	280 UJ	270 UJ	290 UJ	290 UJ	320 UJ
fluorene	330		330UJ	330 UJ	340 UJ	310 UJ	290 UJ	280 UJ	270 UJ	290 UJ	290 UJ	320 UJ
4-nitroaniline	800		810UJ	810 UJ	820 UJ	760 UJ	710 UJ	690 UJ	6670 UJ	710 UJ	710 UJ	77 UJ
N-nitrosodiphenylamine	330		330UJ	330 UJ	340 UJ	310 UJ	290 UJ	280 UJ	270 UJ	290 UJ	290 UJ	320 UJ
4-bromophenyl-phenylether	330		330UJ	330 UJ	340 UJ	310 UJ	290 UJ	280 UJ	270 UJ	290 UJ	290 UJ	320 UJ
hexachlorobenzene	330		330UJ	330 UJ	340 UJ	310 UJ	290 UJ	280 UJ	270 UJ	290 UJ	290 UJ	320 UJ

* EPA Core Index Table 5.8.

Table D.4 continued

Compound	CRQL	Site: / Grab:*	TFIII,T6 PC8	TFIII,T7 PC9	TFIII,T8 PC10/PC11	TFI,T10 BC4	TFI,T11 BC5	TFI,T12 BC6	TFIV,T17 BC10	TFIV,T15 BC9	TFIV,T13 BC7	TFIV,T14 BC8
			1314	1754	2112	824	493	358	648	873	519	443
phenanthrene	330		100 J	140 J	160 J	310 UJ	48 J	29 J	56 J	100 J	43 J	34 J
anthracene	330		20 J	27 J	31 J	310 UJ	290 UJ	280 UJ	12 J	14 J	290 UJ	320 UJ
di-n-butylphathalate	330		330 UJ	330 UJ	340 UJ	310 UJ	290 UJ	280 UJ	270 UJ	290 Uj	290 UJ	320 UJ
fluoranthene	330		200 J	290 J	310 J	180 J	80 J	54 J	100 J	97 J	80 J	63 J
pyrene	330		200 J	270 J	310 J	160 J	83 J	52 J	270 UJ	130 J	74 J	61J
butylbenzylphthalate	330		330 UJ	330 UJ	340 UJ	310 UJ	290 UJ	280 UJ	270 UJ	290 UJ	290 UJ	320 UJ
3,3'-dichlorobenzidine	330		330 UJ	330 UJ	340 UJ	310 UJ	290 UJ	280 UJ	270 UJ	290 UJ	290 UJ	320 UJ
benzo(a)anthracene	330		100 J	130 J	160 J	77 J	38 J	25 J	61 J	60 J	46 J	37 J
chrysene	330		110 J	150 J	180 J	92 J	47 J	33 J	66 J	60 J	45 J	38 J
Bix(2-ethylhexylphthalate	330		330 UJ	330 UJ	340 UJ	310 UJ	290 UJ	280 UJ	270 UJJ	290 UJ	290 UJ	320 UJ
Di-n-octylphthalate	330		330 UJ	330 UJ	340 UJ	310 UJ	290 UJ	280 UJ	270 UJJ	290 UJ	290 UJ	320 UJ
benzo(b)fluorenthene	330		230 J	240 J	280 J	140 J	75 J	41 J	86 J	80 J	55 J	49 J
benzo(k)fluorenthene	330		330 UJ	110 J	130 J	69 J	28 J	22 J	38 J	47 J	29 J	28 J
benzo(a)pyrene	330		110 J	150 J	180 J	88 J	43 J	30 J	63 J	69 J	45 J	39 J
indeno (1,2,3-cd)pyrene	330		52 J	330 UJ	73 J	310 UJ	290 UJ	25 J	41 J	46 J	31 J	29 J
dibenz(a,h)anthracene	330		330 UJ	330 UJ	340 UJ	310 UJ	290 UJ	280 UJ	7 J	290 UJ	290 UJ	320 UJ
benzo(g,h,i)perylene	330		34 J	41 J	54 J	310 UJ	290 UJ	19 J	38 J	38 J	26 J	24 J
anitine	330		R	R	R	R	R	R	R	R	R	R
1-methylnaphthalene	330		330 UJ	330 UJ	340 UJ	310 UJ	290 UJ	280 UJ	270 UJ	290 UJ	290 UJ	320 UJ
2,6-dimethylnapthalene	330		330 UJ	330 UJ	340 UJ	310 UJ	290 UJ	280 UJ	270 UJ	290 UJ	290 UJ	320 UJ
1,2-diphenylthydruzine	330		330 UJ	330 UJ	340 UJ	310 UJ	290 UJ	280 UJ	270 UJ	290 UJ	290 UJ	320 UJ
1-methylphanthrene	330		23 J	31 J	39 J	18 J	12 J	280 UJ	13 J	65 J	10 J	9 J
N-nitrosodimethylamine	330		330 UJ	330 UJ	340 UJ	310 UJ	290 UJ	280 UJ	240 UJ	290 UJ	290 UJ	320 UF
benzidine	330		R	R	R	R	R	R	R	R	R	R
benzo(e)pyrene	330		99 J	120 J	150 J	74 J	39 J	28 J	49 J	53 J	35 J	32 J
N,N-dimethylaniline	330		330 UF	330 UJ	340 UJ	310 UJ	290 UJ	280 UJ	270 UJ	290 UJ	290 UJ	320 UJ
P-phenylenediamine	330		R	R	R	R	R	R	R	R	R	R
ethylenediamine	330		R	R	R	R	R	R	R	R	R	R
N,N,N,N-tetramethyl P-phenylenediamine	330		R	R	R	R	R	R	R	R	R	R
% SOLIDS:			39	39	39	42	45	46	48	45	46	41
DILUTION FACTOR:			1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
DATE SAMPLED:			5/28/92	5/28/92	5/28/92	5/28/92	5/28/92	5/28/92	5/31/92	5/31/92	5/31/92	5/31/92
DATE EXTRACTED:			7/9/92	7/9/92	7/9/92	7/9/92	7/9/92	7/9/92	7/9/92	7/9/92	7/9/92	7/9/92
DATE ANALYZED:			7/23/92	7/23/92	7/23/92	7/23/92	7/23/92	7/23/92	7/23/92	7/23/92	7/23/92	7/23/92

* EPA Core Index Table 5.8.

Table D.4 continued

Compound	CRQL	Site: Grab:*	REF 1 REP 1	REF 2 REP 1	REF 2 REP 2	REF 2 REP 3	TFII,T1 BC1	TFII,T2 BC2	TFII,T3 BC3	TFIII,T5 PC7
Bis(2-chloroethyl) ether	330		330 UJ	170 UJ	340 UJ	290 UJ	320 UJ	330 UJ	320 UJ	330P UJ
1,3-dichlorobenzene	330		330 UJ	170 UJ	340 UJ	290 UJ	320 UJ	330 UJ	320 UJ	330P UJ
1,4-dichlorobenzene	330		330 UJ	170 UJ	340 UJ	290 UJ	320 UJ	330 UJ	320 UJ	330P UJ
1,2-dichlorobenzene	330		330 UJ	170 UJ	340 UJ	290 UJ	320 UJ	330 UJ	320 UJ	330P UJ
Bis(2-chlorisopropyl) ether	330		330 UJ	170 UJ	340 UJ	290 UJ	320 UJ	330 UJ	320 UJ	330P UJ
N-nitroso-di-n-propylamine	330		330 UJ	170 UJ	340 UJ	290 UJ	320 UJ	330 UJ	320 UJ	330P UJ
hexachloroethane	330		330 UJ	170 UJ	340 UJ	290 UJ	320 UJ	330 UJ	320 UJ	330P UJ
nitrobenzene	330		330 UJ	170 UJ	340 UJ	290 UJ	320 UJ	330 UJ	320 UJ	330P UJ
isophorone	330		330 UJ	170 UJ	340 UJ	290 UJ	320 UJ	330 UJ	320 UJ	330P UJ
carbazole	330		330 UJ	170 UJ	340 UJ	290 UJ	320 UJ	330 UJ	320 UJ	330P UJ
bis(2-chloroethoxy)methane	330		330 UJ	170 UJ	340 UJ	290 UJ	320 UJ	330 UJ	320 UJ	330P UJ
1,2,3-trichlorobenzene	330		330 UJ	170 UJ	340 UJ	290 UJ	320 UJ	330 UJ	320 UJ	330P UJ
naphthalene	330		330 UJ	170 UJ	25 J	39 J	28 J	68 J	38 J	39 J
4-chloroaniline	330		330 UJ	170 UJ	340 UJ	290 UJ	320 UJ	330 UJ	320 UJ	330 UJ
hexachlorobutadiene	330		330 UJ	170 UJ	340 UJ	290 UJ	320 UJ	330 UJ	320 UJ	330 UJ
2-methylnaphthalene	330		330 UJ	170 UJ	340 UJ	290 UJ	320 UJ	9 J	320 UJ	330 UJ
hexachlorocyclopentadiene	330		330 UJ	170 UJ	340 UJ	290 UJ	320 UJ	330 UJ	320 UJ	330 UJ
2-chloronaphthalene	330		330 UJ	170 UJ	340 UJ	290 UJ	320 UJ	330 UJ	320 UJ	330 UJ
2-nitroaniline	800		790 UJ	410 UJ	830 UJ	690 UJ	780 UJ	800 UJ	770 UJ	790 UJ
dimethylphthalate	330		310 UJ	170 UJ	25 J	290 UJ	320 UJ	330 UJ	320 UJ	330 UJ
acenaphthylene	330		19 J	170 UJ	340 UJ	40 J	28 J	55 J	32 J	37 J
2,6-dinitrotoluene	330		330 UJ	170 UJ	340 UJ	290 UJ	320 UJ	13 J	320 UJ	330 UJ
3-nitroaniline	800		790 UJ	410 UJ	830 UJ	690 UJ	780 UJ	800 UJ	770 UJ	790 UJ
acenaphthene	330		330 UJ	170 UJ	340 UJ	290 UJ	320 UJ	330 UJ	320 UJ	330P UJ
dibenzofuran	330		330 UJ	170 UJ	340 UJ	290 UJ	320 UJ	330 UJ	320 UJ	330P UJ
2,4-dinitrotoluene	330		330 UJ	170 UJ	340 UJ	290 UJ	320 UJ	330 UJ	320 UJ	330P UJ
diethylphthalate	330		330 UJ	170 UJ	340 UJ	290 UJ	320 UJ	330 UJ	320 UJ	330P UJ
4-chlorophenyl-phenylether	330		330 UJ	170 UJ	340 UJ	290 UJ	320 UJ	330 UJ	320 UJ	330P UJ
fluorene	330		330 UJ	170 UJ	340 UJ	290 UJ	320 UJ	330 UJ	320 UJ	330P UJ
4-nitroaniline	800		790 UJ	410 UJ	830 UJ	690 UJ	780 UJ	800 UJ	770 UJ	790 UJ
N-nitrosodiphenylamine	330		330 UJ	170 UJ	340 UJ	290 UJ	320 UJ	330 UJ	320 UJ	330P UJ
4-bromophenyl-phenylether	330		330 UJ	170 UJ	340 UJ	290 UJ	320 UJ	330 UJ	320 UJ	330P UJ
hexachlorobenzene	330		330 UJ	170 UJ	340 UJ	290 UJ	320 UJ	330 UJ	320 UJ	330P UJ

* EPA Core Index Table 5.8

Table D.4 continued

Total PAH 874 463 1217 1923 2222 3181 ~~3205~~ 2011 2456

Compound	CRQL	Site: / Grab:*	REF 1 REP 1	REF 2 REP 1	REF 2 REP 2	REF 2 REP 3	TFII,T1 BC1	TFII,T2 BC2	TFII,T3 BC3	TFIII,T5 PC7
phenanthrene	330		46 J	30 J	92 J	140 J	140 J	230 J	140 J	160 J
anthracene	330		13 J	6 J	25 J	45 J	320 J	66 J	42 J	53 J
Di-n-butylphthalate	330		330 UJ	170 UJ	340 UJ	290 UJ	320 UJ	24 J	320 UJ	330 UJ
fluorenthene	330		110 J	56 J	180 J	280 J	320 J	410 J	300 J	350 J
pyrene	330		130 J	58 J	180 J	260 J	290 J	480 J	320 J	380 J
butylbenzylphthalate	330		330 UJ	170 UJ	340 UJ	290 UJ	320 UJ	330 UJ	320 UJ	330 UJ
3,3'-dichlorobenzidine	330		330 UJ	170 UJ	340 UJ	290 UJ	320 UJ	330 UJ	320 UJ	330 UJ
benzo(a)anthracene	330		75 J	31 J	100 J	160 J	160 J	270 J	160 J	220 J
chrysene	330		79 J	35 J	110 J	140 J	150 J	250 J	160 J	200 J
Bis(2-ethylhexyl)phthalate	330		330 UJ	170 UJ	340 UJ	440 UJ	320 UJ	1300 UJ	720 UJ	940 UJ
Di-n-octylphthalate	330		330 UJ	32 J	340 UJ	290 UJ	320 UJ	330 UJ	320 UJ	330 UJ
benzo(b)fluoranthene	330		100 J	46 J	140 J	230 J	260 J	420 J	270 J	340 J
benzo(k)fluoranthene	330		55 J	26 J	66 J	120 J	100 J	180 J	100 J	130 J
benzo(a)pyrene	330		84 J	34 J	100 J	170 J	160 J	280 J	170 J	210 J
ideno(1,2,3-cd) pyrene	330		48 J	24 J	52 J	63 J	59 J	110P J	71 J	82 J
dibenz(a,h)anthracene	330		330 UJ	170 UJ	340 UJ	290 UJ	320 UJ	330 UJ	320 UJ	330 UJ
benzo(g,h,i)perylene	330		37 J	19 J	39 J	45 J	43 J	78 J	47 J	54 J
aniline	330		R	R	R	R	R	R	R	R
1-methylnaphthalene	330		330 UJ	170 UJ	340 UJ	290 UJ	320 UJ	330 UJ	320 UJ	330 UJ
2,6-dimethylnapthalene	330		330 UJ	170 UJ	340 UJ	9 J	320 UJ	330 UJ	320 UJ	330 UJ
1,2-diphenylhydruzine	330		330 UJ	170 UJ	340 UJ	290 UJ	320 UJ	330 UJ	320 UJ	330 UJ
1-methylphanthrene	330		16 J	7 J	29 J	52 J	34 J	55 J	31 J	41 J
N-nitrosodimethylamine	330		330 UJ	170 UJ	340 UJ	290 UJ	320 UJ	330 UJ	320 UJ	330 UJ
benzidine	330		R	R	R	R	R	R	R	R
benzo(e)pyrene	330		62 J	31 J	79 J	130 J	130 J	220 J	130 J	160 J
N,N-dimethylanitine	330		330 UJ	170 UJ	340 UJ	290 UJ	320 UJ	330 UJ	320 UJ	330 UJ
P-phenylenediamine	330		R	R	R	R	R	R	R	R
ethylenediamine	330		R	R	R	R	R	R	R	R
N,N,N,N-tetramethyl	330		R	R	R	R	R	R	R	R
P-phenylenediamine	330		R	R	R	R	R	R	R	R
% SOLIDS:			40	78	38	46	41	40	41	40
DILUTION FACTOR:			1.0	1.0	1.0	1.0	1.0	1.0	1.0	1.0
DATE SAMPLED:			5/31/92	6/1/92	6/1/92	6/1/92	6/2/92	6/2/92	6/2/92	6/2/92
DATE EXTRACTED:			7/9/92	7/9/92	7/9/92	7/9/92	7/9/92	7/9/92	7/9/92	7/9/92
DATE ANALYZED:			7/23/92	7/23/92	7/23/92	7/23/92	7/23/92	7/23/92	7/23/92	7/23/92

* EPA Core Index Table 5.8

Table D.5. Summary of tentatively identified compounds (TIC) collected at the Massachusetts Bay IWS in May and June 1992 (reviewed by ERL-N).

Compound	Site *Core Index	TFIII,T6 PC8	TFIII,T7 PC9	TFIII,T8 PC10/11	TFI,T10 BC4	TFI,T11 BC5	TFI,T12 BC6	TFIV,T17 BC10	TFIV,T15 BC9	TFIV,T13 BC7
unknown acid		X	X	X	X	X	X	X	X	X
unknown hydrocarbon		X	X	X	X	X	X	X	X	--
long-chain hydrocarbon		X	X	X	X	X		X	--	--
suspected alcohol condensation product			X	X	X	X	X	--	--	X
aromatic derivative		--	--	-	X	--	-	X	--	X
saturated hydrocarbon		--	--	--	--	--	--	-	X	X
long-chain saturated hydrocarbon		--	--	--	--	--	--	X	X	X
phosphoric acid derivative		--	--	--	--	--	--	--	--	X

Compound	Site *Core Index	TFIV,T14 BC8	REF 1 REP 1	REF 2 REP 1	REF 2 REP 2	REF 2 REP 3	TFII,T1 BC1	TFII,T2 BC2	TFII,T3 BC3	TFIII,T5 PC7
unknown acid		X	X	X	X	X	X	X	--	--
unknown hydrocarbon		X	X	X	X	X	X	X	X	--
long-chain hydrocarbon		--	--	-	X	X	X	--	--	--
suspected alcohol condensation product		X	X	X	X	X	X	X	X	X
aromatic derivative		--	--	--	--	--	--	-	X	--
saturated hydrocarbon		--	--	--	--	--	--	--	-	--
long-chain saturated hydrocarbon		--	X	X	--	--	-	X	X	X
phosphoric acid derivative		--	-	--	--	X	--	--	-	X

*EPA Core Index see Table 5.8

X = positive hit

Region

FEB 08 1993

Appendix Table D.6

MEMORANDUM:

SUBJECT: Final Sample Results - Massachusetts Bay

FROM: Terence M. Grady, Chief
Radioanalysis Branch
Nuclear Radiation Assessment Division

THRU: Paul J. Weeden, Director
Nuclear Radiation Assessment Division

TO: James Cherniak, Certified Health Physicist
Air, Pesticides and Toxics Management Division
Pesticides and Toxic Substances Branch

As I was reviewing our files, I noticed that since our last report to you concerning the Massachusetts Bay samples, we had completed the results for Pu-238 and Pu-239. Previous editions did not include those results.

The attached report is a complete listing of all results from the Massachusetts Bay samples. We did not detect any significant levels of plutonium isotopes, Cs-137, or I-131 in any of the samples tested. Only three sediment samples contained significant amounts of Sr-90; the sample descriptions are given below.

Sample No.	Description	Sr-90 Result,
689568	Sediment - Boston MA Harbor Atlantic Ocean, 1st Sample	85.3 pCi/g
689602	Sediment - Boston MA Harbor Atlantic Ocean, 2nd Sample	133 pCi/g
689603	Sediment - Boston MA Harbor Atlantic Ocean, 3rd Sample	671 pCi/g

If you need any additional information concerning this report, please contact me at (702) 798-2136.

Attachment

NRA/Grady/2136/mlh 2/8/93
for NRD Weeden

Appendix Table D.6

--FOR INTERNAL USE ONLY-- PAGE 1
BOSTON MA - MASSACHUSETTS BAY

REPORTED 5-FEB-93

	ANALYSIS	RESULT	2SIGMA	MDA	UNITS
BOSTON MA - MASSACHUSETTS BAY	IWS DIVE 4(JSL DIVE #2346)				
19 00100 025 25 01 79	REF SITE 2-REPLICATE 1-SEDIMENT - 0-5CM				
689735 BOSTN 000010 OFF - 92 05 28 1247	Cs-137	2.52E+00	1.54E+00		pCi/g
SIZE- g	I-131	0.00E+00	0.00E+00	7.54E+01	pCi/g
	Pu-238	1.36E-03	1.93E-03	2.25E-03	pCi/g
	Pu-239	5.15E-02	9.98E-03	2.25E-03	pCi/g
	Sr-90	6.54E-02	1.02E-01	1.82E-01	pCi/g
BOSTON MA - MASSACHUSETTS BAY	IWS DIVE 4(JSL DIVE #2346)				
19 00100 025 25 01 79	REF SITE 2-REPLICATE 2-SEDIMENT - 0-5CM				
689736 BOSTN 000010 OFF - 92 05 28 1322	Cs-137	1.99E+00	1.51E+00		pCi/g
SIZE- g	I-131	0.00E+00	0.00E+00	6.93E+01	pCi/g
	Sr-90	-1.13E-02	9.36E-02	1.69E-01	pCi/g
BOSTON MA - MASSACHUSETTS BAY	IWS DIVE 4(JSL DIVE #2346)				
19 00100 025 25 01 79	REF SITE 2-REPLICATE 3-SEDIMENT - 0-5CM				
689737 BOSTN 000010 OFF - 92 05 28 1348	Cs-137	0.00E+00	0.00E+00	2.24E+00	pCi/g
SIZE- g	I-131	0.00E+00	0.00E+00	7.05E+01	pCi/g
	Pu-238	1.37E-03	1.45E-03	1.50E-03	pCi/g
	Pu-239	4.27E-02	7.14E-03	1.50E-03	pCi/g
	Sr-90	-4.02E-03	6.04E-02	1.22E-01	pCi/g
BOSTON MA - MASSACHUSETTS BAY	IWS DIVE 4(JSL DIVE #2346)				
19 00100 025 25 01 79	REF SITE 1-REPLICATE 1-SEDIMENT - 0-5CM				
689732 BOSTN 000010 OFF - 92 05 28 1418	Cs-137	0.00E+00	0.00E+00	2.67E+00	pCi/g
SIZE- g	I-131	0.00E+00	0.00E+00	6.39E+01	pCi/g
	Pu-238	2.38E-03	2.81E-03	3.55E-03	pCi/g
	Pu-239	5.61E-02	9.33E-03	1.59E-03	pCi/g
	Sr-90	2.29E-02	8.48E-02	1.72E-01	pCi/g
BOSTON MA - MASSACHUSETTS BAY	IWS DIVE 4-JSL DIVE #2346)				
19 00100 025 25 01 79	REF SITE 1-REPLICATE 2-SEDIMENT - 0-5CM				
689733 BOSTN 000010 OFF - 92 05 28 1442	Cs-137	0.00E+00	0.00E+00	4.05E+00	pCi/g
SIZE- g	I-131	0.00E+00	0.00E+00	1.12E+02	pCi/g
	Sr-90	-1.80E-02	1.90E-01	4.45E-01	pCi/g
BOSTON MA - MASSACHUSETTS BAY	IWS DIVE 4(JSL DIVE #2346)				
19 00100 025 25 01 79	REF SITE 1-REPLICATE 3-SEDIMENT - 0-5CM				
689734 BOSTN 000010 OFF - 92 05 28 1504	Cs-137	4.65E+00	2.60E+00	.	pCi/g
SIZE-	I-131	0.00E+00	0.00E+00	8.06E+01	pCi/g
	Pu-238	5.07E-03	2.54E-03	1.31E-03	pCi/g
	Pu-239	6.39E-02	9.68E-03	1.31E-03	pCi/g
	Sr-90	4.65E-02	9.03E-02	1.77E-01	pCi/g
BOSTON MA - MASSACHUSETTS BAY	TRAWL#3 - LOBSTER - 2.8"CARAPACE LENGTH				
19 00100 025 25 01 51	Sr-90-Ash ASH/WET RATIO= 0.09607				
3621 BOSTN 000010 OFF - 92 05 31 0900	Cs-137	9.78E-02	9.61E-02	.	pCi/g
SIZE- g	I-131	0.00E+00	0.00E+00	9.92E-01	pCi/g
	Sr-90-Ash	1.48E-02	4.26E-02	6.88E-02	pCi/g

Appendix Table D.6

REPORTED 5-FEB-93

	ANALYSIS	RESULT	2SIGMA	MDA	UNITS
BOSTON MA - MASSACHUSETTS BAY	TRAWL#3 - LOBSTER - 2.8"CARAPACE LENGTH				
19 00100 025 25 01 51	Sr-90-Ash ASH/WET RATIO= 0.09393				
689622 BOSTN 000010 OFF - 92 05 31 0900	Cs-137	0.00E+00	0.00E+00	1.16E-01	pCi/g
SIZE- g	I-131	0.00E+00	0.00E+00	7.85E-01	pCi/g
	Sr-90-Ash	2.66E-02	7.10E-02	1.17E-01	pCi/g
BOSTON MA - MASSACHUSETTS BAY	TRAWL#4 - LOBSTER - 2.8"CARAPACE LENGTH				
19 00100 025 25 01 51	Sr-90-Ash ASH/WET RATIO= 0.10153				
689623 BOSTN 000010 OFF - 92 05 31 0900	Cs-137	1.51E-01	8.75E-02		pCi/g
SIZE- g	I-131	0.00E+00	0.00E+00	7.66E-01	pCi/g
	Sr-90-Ash	9.00E-03	2.60E-02	4.30E-02	pCi/g
BOSTON MA - MASSACHUSETTS BAY	TRAWL#4 - LOBSTER - 3.1"CARAPACE LENGTH				
19 00100 025 25 01 51	Sr-90-Ash ASH/WET RATIO= 0.09444				
689624 BOSTN 000010 OFF - 92 05 31 0900	Cs-137	5.93E-02	5.21E-02		pCi/g
SIZE- g	I-131	0.00E+00	0.00E+00	8.93E-01	pCi/g
	Sr-90-Ash	1.60E-02	2.40E-02	3.90E-02	pCi/g
BOSTON MA - MASSACHUSETTS BAY	TRAWL#4-ROCK CRAB-89MM-CARAPACE WIDTH				
00100 025 25 01 51	Sr-90-Ash ASH/WET RATIO= 0.17047				
89625 BOSTN 000010 OFF - 92 05 31 0900	Cs-137	1.30E-01	1.14E-01		pCi/g
SIZE- g	I-131	0.00E+00	0.00E+00	1.84E+00	pCi/g
	Sr-90-Ash	7.00E-03	2.10E-02	3.40E-02	pCi/g
OSTON MA - MASSACHUSETTS BAY	SEDIMENT-BOSTON MA HARBOR-ATLANTIC OCEAN				
00100 025 25 01 79	1ST SAMPLE				
9568 BOSTN 000010 OFF - 92 06 01 0900	Pu-238	1.00E-03	8.70E-04	7.93E-04	pCi/g
SIZE- g	Pu-239	1.11E-02	2.45E-03	7.93E-04	pCi/g
	Sr-90	8.53E+01	1.48E+00	2.44E+00	pCi/g
STON MA - MASSACHUSETTS BAY	SEDIMENT-BOSTON MA HARBOR-ATLANTIC OCEAN				
00100 025 25 01 79	2ND SAMPLE				
602 BOSTN 000010 OFF - 92 06 01 0900	Sr-90	1.33E+02	1.33E+00	2.19E+00	pCi/g
IZE- g					
TON MA - MASSACHUSETTS BAY	SEDIMENT-BOSTON MA HARBOR-ATLANTIC OCEAN				
00100 025 25 01 79	3RD SAMPLE				
603 BOSTN 000010 OFF - 92 06 01 0900	Sr-90	6.71E+02	4.84E+00	6.65E+00	pCi/g
IZE- g					
ON MA - MASSACHUSETTS BAY	TRAWL#6-AMERICAN PLAICE-47CM TOT LENGTH				
0100 025 25 01 51	Sr-90-Ash ASH/WET RATIO= 0.02767				
26 BOSTN 000010 OFF - 92 06 02 0900	Cs-137	2.23E-01	1.15E-01		pCi/g
ZE- 28.200 g	I-131	0.00E+00	0.00E+00	9.63E-01	pCi/g
	Sr-90-Ash	1.20E-02	4.10E-02	6.70E-02	pCi/g

Anchor Samples

Appendix Table D.6

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	ANALYSIS	RESULT	2SIGMA	MDA	UNITS
BOSTON MA - MASSACHUSETTS BAY	TRAWL#6-AMERICAN PLAICE-35CM TOT LENGTH				
19 00100 025 25 01 51	Sr-90-Ash ASH/WET RARIO= 0.03017				
689627 BOSTN 000010 OFF - 92 06 02 0900	Cs-137	2.03E-01	2.25E-01		pCi/g
SIZE-	I-131	0.00E+00	0.00E+00	2.38E+00	pCi/g
	Sr-90-Ash	-3.10E-02	5.90E-02	9.70E-02	pCi/g
BOSTON MA - MASSACHUSETTS BAY	TRAWL#8-AMERICAN PLAICE- 33CM TOT LENGTH				
19 00100 025 25 01 51	Sr-90-Ash ASH/WET RATIO= 0.03414				
689629 BOSTN 000010 OFF - 92 06 02 0900	Cs-137	0.00E+00	0.00E+00	3.77E-01	pCi/g
SIZE- g	I-131	0.00E+00	0.00E+00	4.05E+00	pCi/g
	Sr-90-Ash	1.90E-02	7.80E-02	1.28E-01	pCi/g
BOSTON MA - MASSACHUSETTS BAY	TRAWL#8-AMERICAN PLAICE-33CM TOT LENGTH				
19 00100 025 25 01 51	Sr-90-Ash ASH/WET RATIO= 0.04234				
689630 BOSTN 000010 OFF - 92 06 02 0900	Cs-137	1.58E-01	1.88E-01		pCi/g
SIZE- g	I-131	0.00E+00	0.00E+00	3.33E+00	pCi/g
	Sr-90-Ash	2.00E-02	4.90E-02	8.00E-02	pCi/g
BOSTON MA - MASSACHUSETTS BAY	TRAWL#8-AMERICAN PLAICE-35CM TOT LENGTH				
19 00100 025 25 01 51	Sr-90-Ash ASH/WET RATIO= 0.03718				
689631 BOSTN 000010 OFF - 92 06 02 0900	Cs-137	2.70E-01	2.01E-01		pCi/g
SIZE- g	I-131	0.00E+00	0.00E+00	3.86E+00	pCi/g
	Sr-90-Ash	4.30E-02	4.90E-02	8.10E-02	pCi/g
BOSTON MA - MASSACHUSETTS BAY	IWS DIVE 4(JSL DIVE #2346)				
19 00100 025 25 01 79	PUNCH CORE 1-TARGET 1-SEDIMENT - 0-10CM				
689726 BOSTN 000010 OFF - 92 06 02 0924	Cs-137	0.00E+00	0.00E+00	2.47E+00	pCi/g
SIZE- g	I-131	0.00E+00	0.00E+00	3.10E+01	pCi/g
	Pu-238	-7.22E-00	1.23E-03	2.03E-03	pCi/g
	Pu-239	3.00E-02	4.41E-03	1.00E-03	pCi/g
	Sr-90	2.02E-03	5.79E-02	1.39E-01	pCi/g
BOSTON MA - MASSACHUSETTS BAY	IWS DIVE 4(JSL DIVE #2346)				
19 00100 025 25 01 79	PUNCH CORE 2-TARGET 1-SEDIMENT - 0-5CM				
689727 BOSTN 000010 OFF - 92 06 02 0936	Cs-137	0.00E+00	0.00E+00	3.14E+00	pCi/g
SIZE- g	I-131	0.00E+00	0.00E+00	4.66E+01	pCi/g
	Pu-238	7.00E-04	8.83E-04	1.16E-03	pCi/g
	Pu-239	3.31E-02	4.09E-03	9.43E-04	pCi/g
	Sr-90	-4.69E-03	5.27E-02	1.29E-01	pCi/g
BOSTON MA - MASSACHUSETTS BAY	IWS DIVE 4(JSL DIVE #2346)				
19 00100 025 25 01 79	PUNCH CORE 3-TARGET 2-SEDIMENT - 0-5CM				
689728 BOSTN 000010 OFF - 92 06 02 0954	Cs-137	0.00E+00	0.00E+00	2.21E+00	pCi/g
SIZE- g	I-131	0.00E+00	0.00E+00	3.62E+01	pCi/g
	Pu-238	3.33E-04	8.01E-04	1.16E-03	pCi/g
	Pu-239	3.03E-02	4.09E-03	5.18E-04	pCi/g
	Sr-90	-1.41E-02	5.54E-02	1.34E-01	pCi/g

Appendix Table D.6

BOSTON MA - MASSACHUSETTS BAY

REPORTED 5-FEB-93

	ANALYSIS	RESULT	2SIGMA	MDA	UNITS
BOSTON MA - MASSACHUSETTS BAY	IWS DIVE 4(JSL DIVE #2346)				
19 00100 025 25 01 79	PUNCH CORE 4-TARGET 2-SEDIMENT - 0-5CM				
689729 BOSTN 000010 OFF - 92 06 02 1006	Cs-137	2.48E+00	1.83E+00		pCi/g
SIZE- g	I-131	0.00E+00	0.00E+00	4.20E+01	pCi/g
	Pu-238	1.02E-03	1.25E-03	1.19E-03	pCi/g
	Pu-239	4.06E-02	7.16E-03	1.19E-03	pCi/g
	Sr-90	-8.38E-03	5.34E-02	1.27E-01	pCi/g
BOSTON MA - MASSACHUSETTS BAY	IWS DIVE 4(JSL DIVE #2346)				
19 00100 025 25 01 79	PUNCH CORE 5-TARGET 4-SEDIMENT - 0-5CM				
689730 BOSTN 000010 OFF - 92 06 02 1036	Cs-137	0.00E+00	0.00E+00	3.04E+00	pCi/g
SIZE- g	I-131	0.00E+00	0.00E+00	5.28E+01	pCi/g
	Pu-238	5.00E-04	2.84E-03	4.48E-03	pCi/g
	Pu-239	6.23E-02	9.58E-03	2.34E-03	pCi/g
	Sr-90	-4.91E-03	5.56E-02	1.37E-01	pCi/g
BOSTON MA - MASSACHUSETTS BAY	IWS DIVE 4(JSL DIVE #2346)				
19 00100 025 25 01 79	PUNCH CORE 6-TARGET 4-SEDIMENT - 0-5CM				
689731 BOSTN 000010 OFF - 92 06 02 1036	Cs-137	0.00E+00	0.00E+00	2.54E+00	pCi/g
SIZE- g	I-131	0.00E+00	0.00E+00	4.14E+01	pCi/g
	Pu-238	1.20E-03	9.37E-04	1.05E-03	pCi/g
	Pu-239	4.24E-02	4.50E-03	8.55E-04	pCi/g
	Sr-90	-1.85E-02	5.46E-02	1.28E-01	pCi/g

Total number of processed samples = 25

Table D.7a. Inventory of fish and shellfish collected by net trawl with the R/V *Gloria Michelle* around the perimeter of the Massachusetts Bay IWS, 1992. Sample numbers refer to composite samples analyzed for contaminants (see Table 8.13)

Date: 31 May 1992 (Sunday) Collection Area: Site 1

Sample Number	Species	Weighed Part of Catch (pounds)	Sample Weight (pounds)	Average Length of Sample (cm)	Number of Fish Sampled
INV 92-660-628	American plaice	120	25	35	24
INV 92-660-629	lobster	19 (F=7,M=12)	19	7 (carapace)	14
INV 92-660-630	scallops	1.5*	1.5	——	2
INV 92-660-661	witch flounder	3.5*	3.5	31	7
INV 92-660-662	yellowtail flounder	7	7	34	3
INV 92-660-663	cod	5*	5	48	2
INV 92-660-664	goosefish	23	23	49	2
INV 92-660-665	redfish	8	8	25	7
	ocean pout	2.5			
	winter flounder	1.5*			
	Atlantic herring	1.5*			
	longhorn sculpin				
	blue back herring				

* Fish were weighed in a bucket; tare weight .5 pounds.
If not otherwise noted, fish were weighed in a basket; tare weight 4 pounds

Table D.7b. Inventory of fish and shellfish collected by net trawl with the R/V *Gloria Michelle* around the perimeter of the Massachusetts Bay IWS, 1992. Sample numbers refer to composite samples analyzed for contaminants.

Date: 31 May 1992 (Sunday) Collection Area: Site 2

Sample Number	Species	Weighed Part of Catch (pounds)	Sample Weight (pounds)	Average Length of Sample (cm)	Number of Fish Sampled
INV 92-660-631	American plaice	106	29	36	24
INV 92-660-632	American lobster	26 (F=10, M=16)	26	8 (carapace)	20
INV 92-660-633	sea scallops	3.5*	3.5	——	3
INV 92-660-666	redfish	6*	6	24	9
INV 92-660-667	witch flounder	6.5*	6.5	31	11
INV 92-660-668	cod	55	45	53	12
	skate	41			
	goosefish	.5*			
	sea raven	.5*			
	longhorn sculpin				

* Fish were weighed in a bucket; tare weight .5 pounds.
If not otherwise noted, fish were weighed in a basket; tare weight 4 pounds

Table D.7c. Inventory of fish and shellfish collected by net trawl with the R/V *Gloria Michelle* around the perimeter of the Massachusetts Bay IWS, 1992. Sample numbers refer to composite samples analyzed for contaminants (see Table 8.13)

Date: 31 May 1992 (Sunday) Collection Area: Site 3

Sample Number	Species	Weighed Part of Catch (pounds)	Sample Weight (pounds)	Average Length of Sample (cm)	Number of Fish Sampled
INV 92-660-631	American plaice	106	29	36	24
INV 92-660-632	American lobster	26 (F=13, M=12)	25	8 (carapace)	20
INV 92-660-633	sea scallops	3.5*		——	1
INV 92-660-666	redfish	6*	3.5	31	11
INV 92-660-667	witch flounder	6.5*	6.5	31	12
INV 92-660-668	cod	55			
	skate	41			
	goosefish	.5*			
	sea raven	.5*			
	longhorn sculpin				

* Fish were weighed in a bucket; tare weight .5 pounds.
If not otherwise noted, fish were weighed in a basket; tare weight 4 pounds

Table D.7d. Inventory of fish and shellfish collected by net trawl with the R/V *Gloria Michelle* around the perimeter of the Massachusetts Bay IWS, 1992. Sample numbers refer to composite samples analyzed for contaminants (see Table 8.13)

Date: 31 May 1992 (Sunday) Collection Area: Site 4

Sample Number	Species	Weighed Part of Catch (pounds)	Sample Weight (pounds)	Average Length of Sample (cm)	Number of Fish Sampled
INV 92-660-637	American plaice	64	23	33	25
INV 92-660-638	American lobster	33 (F=16, M=17)	19	8 (carapace)	15
INV 92-660-672	redfish	12	12	25	13
INV 92-660-673	gray sole	2*	2	28	4
INV 92-660-674	cod	15	15	55	3
INV 92-660-668	skate	16			
	winter flounder	3*			
	yellowtail flounder	3*			
	shrimp	1*			
	rock crab (M)	.5*			
	goosefish	.5*			
	longhornsculpin	.5*			

* Fish were weighed in a bucket; tare weight .5 pounds.
If not otherwise noted, fish were weighed in a basket; tare weight 4 pounds

Table D.7e. Inventory of fish and shellfish collected by net trawl with the R/V *Gloria Michelle* around the perimeter of the Massachusetts Bay IWS, 1992. Sample numbers refer to composite samples analyzed for contaminants (see Table 8.13)

Date: 31 May 1992 (Sunday) Collection Area: Site 5**

Sample Number	Species	Weighed Part of Catch (pounds)	Sample Weight (pounds)	Average Length of Sample (cm)	Number of Fish Sampled
INV 92-660-639	American lobster	2 (F)*	2	9 (carapace)	1
INV 92-660-675	ocean pout	98	29	59	10
INV 92-660-676	cod	44	15	47	37
INV 92-660-668	yellowtail flounder	1*			
	longhorn sculpin	31			
	winter flounder	5*			

* Fish were weighed in a bucket; tare weight .5 pounds.
If not otherwise noted, fish were weighed in a basket; tare weight 4 pounds

** The net was ripped out during this trawl.

Table D.7f. Inventory of fish and shellfish collected by net trawl with the R/V *Gloria Michelle* around the perimeter of the Massachusetts Bay IWS, 1992. Sample numbers refer to composite samples analyzed for contaminants (see Table 8.13)

Date: 31 May 1992 (Sunday) Collection Area: Site 6

Sample Number	Species	Weighed Part of Catch (pounds)	Sample Weight (pounds)	Average Length of Sample (cm)	Number of Fish Sampled
INV 92-660-641	American plaice	209	23	35	24
INV 92-660-642	lobster	33 (F=14, M=19)	29	8 (carapace)	13
INV 92-660-643	sea scallops	.5*	.5	—	1
INV 92-660-677	medium cod	46	26	50	7
INV 92-660-678	gray sole	23*	23	33	27
INV 92-660-79	ocean pout	7*	7	51	4
INV 92-660-680	yellowtail flounder	10*	10	34	11
INV 92-660-649	large cod	20	20	100	1
INV 92-660-650	redfish	60	22	32	18
	skate	32			
	dogfish	15			
	sea raven	3*			
	longhorn sculpin	2*			
	winter flounder	1*			
	silver hake	>.5*			

* Fish were weighed in a bucket; tare weight .5 pounds.
If not otherwise noted, fish were weighed in a basket; tare weight 4 pounds

Table D.7g. Inventory of fish and shellfish collected by net trawl with the R/V *Gloria Michelle* around the perimeter of the Massachusetts Bay IWS, 1992. Sample numbers refer to composite samples analyzed for contaminants (see Table 8.13)

Date: 2 June 1992 (Tuesday) Collection Area: Site 7

Sample Number	Species	Weighed Part of Catch (pounds)	Sample Weight (pounds)	Average Length of Sample (cm)	Number of Fish Sampled
INV 92-660-644	American plaice	2*	2	23	5
INV 92-660-645	American lobster	2 (F)*	2	8 (carapace)	2
INV 92-660-651	redfish	2*	2	24	3
INV 92-660-652	yellowtail flounder	4*	4	33	4
INV 92-660-653	ocean pout	83	32	59	12
INV 92-660-654	cod	23	23	38	14
INV 92-660-655	winter flounder	18*	18	32	16
	ocean pout	2.5			
	skate	13			
	wolf fish	29			
	longhorn sculpin	42			
	spider crab	2*			

* Fish were weighed in a bucket; tare weight .5 pounds.
If not otherwise noted, fish were weighed in a basket; tare weight 4 pounds

Table D.7h. Inventory of fish and shellfish collected by net trawl with the R/V *Gloria Michelle* around the perimeter of the Massachusetts Bay IWS, 1992. Sample numbers refer to composite samples analyzed for contaminants (see Table 8.13)

Date: 2 June 1992 (Tuesday) Collection Area: Site 8

Sample Number	Species	Weighed Part of Catch (pounds)	Sample Weight (pounds)	Average Length of Sample (cm)	Number of Fish Sampled
INV 92-660-646	American plaice	63	23	35	24
INV 92-660-647	American lobster	19 (F=4; M=15)	16	7 (carapace)	12
INV 92-660-656	winter flounder	49	32	35	19
INV 92-660-657	cod	16	16	46	6
INV 92-660-658	redfish	2*	2	25	2
INV 92-660-659	yellowtail flounder	21	21	32	22
INV 92-660-660	ocean pout	36	32	59	12
INV 92-660-681	gray sole	1.5*	1.5	30	1
	longhorn sculpin	16			
	silver hake	2*			
	shrimp				
	sea raven	3*			
	skate	13			

* Fish were weighed in a bucket; tare weight .5 pounds.
If not otherwise noted, fish were weighed in a basket; tare weight 4 pounds

Table D.8. PAH analytical results on fish and shellfish collected at the Massachusetts Bay IWS, Otter Trawl Stations, (sites 1-8) May 31 and June 2, 1992, (FDA).

Determined PAH Concentration (ppb)

Sample Number	Species	Site #	Fluor-anthene	Pyrene	B(a)A	Chrysene	B(b)F	B(k)F	B(a)Py	DiB(a,h)A	B(g,h,i)P	I(1,2,3-cd)P
92-660-628	American plaice	1	ND	ND	TR	ND	TR	ND	ND	ND	TR	TR
92-660-630	sea scallops	1	5.9	4.2	1.4	1.2	2.4	1.3	1.5	TR	TR	TR
92-660-661	witch flounder	1	ND	ND	ND	ND	0.9	ND	ND	ND	ND	TR
92-660-662	yellowtail	1	TR	TR	TR	ND	0.9	ND	ND	ND	ND	TR
92-660-663	cod	1	ND	ND	ND	ND	0.8	ND	ND	ND	ND	ND
92-660-665	redfish	1	ND	ND	ND	ND	ND	TR	ND	ND	ND	ND
92-660-629	American lobster	1	11.0	13.7	1.7	2.3	4.1	1.6	3.6	2.8	3.8	4.2
	tomalley	1	201.4	195.3	19.5	27.5	52.8	30.7	44.8	72.8	42.5	47.8
92-660-631	American plaice	2	ND	ND	ND	ND	ND	TR	ND	ND	ND	ND
92-660-233	sea scallops	2	TR	3.2	0.9	0.8	2.0	1.1	1.1	ND	TR	ND
92-660-666	redfish	2	ND	ND	ND	ND	TR	ND	ND	ND	ND	ND
92-660-667	witch flounder	2	ND	ND	ND	ND	0.6	ND	ND	ND	ND	ND
92-660-668	cod	2	ND	ND	ND	ND	0.5	ND	ND	ND	ND	ND
92-660-632	American lobster	2	30.9	28.2	3.4	3.5	4.9	2.4	4.9	3.7	4.2	4.9
	tomalley	2	794.6	695.6	74.9	85.1	108.9	71.1	94.9	160.6	82.9	101.8
92-660-634	American plaice	3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
92-660-636	sea scallops	3	10.5	12.3	3.0	2.9	4.7	2.3	2.7	TR	0.8	TR
92-660-669	cod	3	ND	ND	ND	ND	0.6	ND	TR	ND	ND	ND
92-660-670	redfish	3	ND	ND	ND	ND	0.6	ND	TR	ND	ND	TR
92-660-671	witch flounder	3	ND	ND	ND	ND	0.7	ND	TR	ND	ND	ND
92-660-635	American lobster	3	10.7	8.7	1.5	1.5	3.2	1.5	2.4	3.9	3.0	3.0
	tomalley	3	153.2	110.2	17.9	24.1	35.7	21.7	24.5	52.0	28.9	36.4

Table D-8 continued

Determined PAH Concentration (ppb)

Sample Number	Species	Site #	Fluor-anthene	Pyrene	B(a)A	Chrysene	B(b)F	B(k)F	B(a)Py	DiB(a,h)A	B(g,h,i)P	I(1,2,3-cd)P
92-660-637	American plaice	4	ND	ND	ND	ND	ND	ND	TR	ND	ND	ND
92-660-672	redfish	4	ND	ND	ND	ND	ND	ND	TR	ND	ND	ND
92-660-673	witch flounder	4	ND	ND	ND	ND	ND	ND	TR	ND	ND	ND
92-660-674	cod	4	ND	TR	ND	ND	ND	ND	TR	ND	TR	TR
92-660-638	American lobster	4	43.0	43.5	5.5	7.2	13.8	7.7	10.1	20.9	11.6	12.2
	tomalley	4	167.2	166.8	19.1	20.6	36.0	18.5	23.5	48.5	27.5	39.8
92-660-675	ocean pout	5	ND	ND	ND	ND	ND	ND	TR	ND	ND	TR
92-660-676	cod	5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
92-660-677	cod	6	28.8	9.5	TR	ND	ND	ND	ND	ND	ND	ND
92-660-678	witch flounder	6	TR	3.5	0.8	0.9	1.8	1.1	1.2	4.2	1.8	2.7
92-660-649	cod (large)	6	ND	ND	ND	ND	TR	ND	TR	ND	0.7	ND
92-660-650	redfish	6	ND	ND	ND	ND	TR	ND	TR	ND	0.8	ND
92-660-679	ocean pout	6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
92-660-680	yellowtail	6	11.5	3.8	ND	ND	ND	ND	ND	ND	ND	ND
92-660-641	American plaice	6	ND	ND	ND	ND	TR	ND	TR	ND	1.0	ND
92-660-643	sea scallops	6	TR	3.7	1.5	1.5	2.7	1.5	1.5	ND	TR	ND
92-660-642	American lobster	6	25.2	25.4	3.1	3.2	3.9	1.8	3.7	3.1	3.2	4.4
	tomalley	6	436.0	354.2	44.3	50.3	26.2	33.4	40.5	36.2	33.1	58.0
92-660-644	American plaice	7	ND	ND	TR	ND	ND	ND	ND	ND	ND	ND
92-660-651	redfish	7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
92-660-652	yellowtail	7	TR	TR	ND	ND	0.8	ND	ND	ND	ND	ND
92-660-653	ocean pout	7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
92-660-654	cod	7	TR	ND	ND	ND	0.5	ND	TR	ND	ND	TR
92-660-655	winter flounder	7	ND	ND	ND	ND	0.6	ND	TR	ND	TR	1.1

Table D.8 continued

Determined PAH Concentration (ppb)

Sample Number	Species	Site #	Fluo-anthene	Pyrene	B(a)A	Chrysene	B(b)F	B(k)F	B(a)Py	DiB(a,h)A	B(g,h,i)P	I(1,2,3-cd)P
92-660-646	American plaice	8	ND	ND	ND	ND	TR	ND	TR	ND	TR	ND
92-660-659	yellowtail	8	ND	ND	ND	ND	ND	ND	ND	ND	ND	TR
92-660-660	ocean pout	8	ND	9.2	TR	ND	TR	ND	0.3	ND	ND	TR
92-660-481	witch flounder	8	20.1	9.2	TR	ND	0.5	ND	0.3	ND	0.9	ND
92-660-656	winter flounder	8	ND	ND	ND	ND	0.7	ND	ND	ND	ND	ND
92-660-657	cod	8	ND	ND	ND	ND	TR	ND	TR	ND	ND	1.1
92-660-658	redfish	8	ND	ND	ND	ND	0.9	ND	ND	ND	ND	ND
92-660-647	American lobster	8	12.2	14.4	1.2	2.0	3.1	1.6	3.1	2.6	3.1	4.5
	tomalley	8	140.9	173.5	12.4	18.5	27.7	18.1	24.1	47.1	29.0	48.8
92-660-621	American lobster	TA#1	10.3	9.8	3.3	3.3	5.0	2.2	4.8	3.9	3.4	6.4
92-660-622	American lobster	TA#2	NO ANALYSIS									
92-660-623	American lobster	TA#2	5.6	5.1	0.7	0.8	2.0	0.9	1.6	2.6	1.8	1.9
	tomalley	TA#2	147.3	117.1	15.0	20.1	33.9	19.0	21.5	44.5	26.2	35.6
92-660-624	American lobster	TA#4	NO ANALYSIS									
	tomalley	TA#4	261.5	232.5	31.0	41.5	63.2	37.5	45.1	81.0	48.1	57.9

ND = not detected
TR = compound detected, below limit of quantitation

Limits of quantitation (ppb): fluorothene, 4.40; pyrene, 1.96; B(a)A, 0.51; chrysene, 0.63; B(b)F, 0.44; B(k)F, 0.27; B(a)P, 0.20; DiB(a,h)A, 1.83; B(g,h,i)P, 0.69; I(1.2.3-cd)Py, 1.00

Table D-9. Metals in fish and shellfish tissue (ppm ww)collected near the Massachusetts Bay IWS May/June 1992 (analyzed by NOAA).

	As	Cd	~~Cd~~ CR	Cu	Pb	Hg	Zn	% Total Solids	Percent Lipids
EPA Method	200.8	200.8	200.8	200.8	200.8	7471	7950		413.1 Mod
Reporting Limit	0.2	0.02	0.1	0.05	0.02	0.02	1		0.1
Wrymouth-1	28.5	0.08	2.1	2.98	0.46	0.52	60	23.2	4.7
Wrymouth-2	38.8	0.05	2.8	2.36	1.03	0.22	58	21.8	2.3
Wrymouth-3	8.4	0.04	1.1	1.36	0.30	0.59	46	23.8	3.9
Wrymouth-4	22.4	0.11	4.2	3.77	1.57	0.76	65	17.6	0.7
Wrymouth-5	25.2	0.05	1.2	1.75	0.33	0.80	56	18.5	2.1
Wrymouth-6	10.6	0.05	1.6	1.36	0.42	0.44	51	23.0	3.3
Whelk-1	775	13.9	2.4	236	1.48	5.51	1120	21.8	5.1
Whelk-2	230	34.0	1.9	549	1.93	1.83	5710	21.1	4.6
Spider Crab-1	70.9	2.25	1.6	78.9	31.9	0.30	201	19.8	1.8
Spider Crab-2	77.6	4.05	3.0	110	0.79	0.27	172	19.3	2.6
Spider Crab-3	34.7	3.48	2.3	116	0.98	0.27	203	19.0	2.8
Cod-1	8.4	0.03	1.3	2.87	0.17	0.58	52	21.7	1.1
Winter Flounder-1	23.4	0.12	4.1	2.63	1.43	0.17	56	23.3	1.6
Winter Flounder-2	13.5	0.04	2.0	2.17	0.61	0.08	55	23.0	1.4
Winter Flounder-3	25.2	0.09	2.1	2.02	3.11	0.22	16	23.7	1.5
Winter Flounder-4	14.2	0.12	2.3	2.44	0.85	0.14	68	21.4	1.1
Winter Flounder-5	10.8	0.06	3.3	3.13	1.71	0.10	41	22.3	1.7
Oceanpout-1	13.0	0.13	10.7	2.80	0.55	0.16	60	22.7	2.2
Oceanpout-2	18.4	0.10	2.3	2.67	0.64	0.26	77	22.1	2.3
American plaice-1	10.1	0.05	3.5	2.51	1.35	0.11	35	20.8	1.9
American plaice-2	12.7	0.05	4.0	2.87	2.46	0.14	49	21.1	1.3
American plaice-3	19.7	0.06	3.4	3.47	1.53	0.23	45	20.8	1.9
American plaice-4	8.9	0.04	3.2	2.64	1.72	0.10	40	22.2	2.3
American plaice-5	10.8	0.05	4.6	3.27	2.08	0.09	47	23.6	1.6
American plaice-6	7.9	0.06	1.6	1.94	0.78	0.09	61	23.5	2.7
American plaice-7	15.8	0.04	3.9	3.34	1.60	0.19	43	19.9	1.0
American plaice-8	68.7	0.05	2.1	15.2	2.89	0.26	33	19.2	1.2
American plaice-9	12.8	0.03	2.6	2.27	1.37	0.23	33	24.0	1.9
American plaice-10	15.4	0.09	4.8	3.33	2.03	0.17	42	22.0	1.4
Redfish-1	12.0	0.07	1.8	3.05	0.15	0.45	41	25.3	1.7
Redfish-2	6.2	0.08	1.9	2.41	0.29	0.33	43	20.8	1.5
Redfish-3	5.9	0.10	2.1	3.47	0.20	0.47	44	23.8	1.5
Redfish-4	5.3	0.05	1.7	2.13	0.41	0.22	47	23.0	1.9
Redfish-5	4.8	0.07	1.7	2.16	0.29	0.10	52	23.4	1.9
Redfish-6	6.1	0.08	4.5	1.72	0.12	0.10	41	26.3	2.5
Redfish-7	6.5	0.09	1.5	3.37	0.12	0.11	50	25.6	2.2
Redfish-8	4.3	0.07	1.7	1.70	0.13	0.09	51	23.7	0.7
Redfish-9	4.0	0.06	7.0	1.72	0.09	0.09	44	25.2	1.8
Redfish-10	4.7	0.06	1.6	1.90	0.11	0.10	44	22.9	1.9
Redfish-11	5.3	0.08	4.9	2.52	0.12	0.10	44	24.5	2.3
Redfish-12	5.2	0.06	2.9	1.83	0.10	0.13	43	26.7	2.0

Total 1,152 — Fat Fish 246

Table D.10. Summary of individual sample analyses for pesticides in fish and invertebrate tissues (ppm ww) collected near the Massachusetts Bay IWS, . May and June 1992 (analyzed by NOAA).

	a-BHC	g-BHC	b-BHC	Heptachlor	d-BHC	Aldrin	Heptachlor Epoxide	Endosulfan I	4,4'-DDE	Dieldrin	Endrin	4,4'-DDD	Endosulfan II	4,4'-DDT	Aldehyde	Endrinsulfan Sulfate	Methoxychlor	Toxaphene	Chlordane
Reporting Limit	0.002	0.002	0.01	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.002	0.004	0.03	0.01
Wrymouth-1								<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	1.0		
Wrymouth-2								<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.1		
Wrymouth-3								<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.1		
Wrymouth-4	<0.01	<0.01	<0.03	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.02	<0.15	<0.05
Wrymouth-5								<0.01	0.010	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.02	<0.15	<0.05
Wrymouth-6	<0.01	<0.01	<0.03	<0.01	<0.01	<0.01	<0.01	<0.01	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.4	<0.3	<0.1
Whelk-1	<0.04	<0.04	<0.12	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.08	<1.2	<0.4
Whelk-2	<0.04	<0.04	<0.12	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	<0.08	<1.2	<0.4
Spider Crab-1																			
Spider Crab-2	0.005							<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.02	<0.15	<0.05
Spider Crab-3																			
Cod-1									0.04				0.02	0.02					
Winter Flounder-1								<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.02	<0.15	<0.05
Winter Flounder-2								<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.009	<0.15	<0.05
Winter Flounder-3								<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.04	<0.15	<0.05
Winter Flounder-4								<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.009	<0.15	<0.05
Winter Flounder-5								<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.02	<0.15	<0.05
Oceanpout-1								<0.01	0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.02	<0.15	<0.05
Oceanpout-2								<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.1		
American plaice-1								<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.02	<0.15	<0.05
American plaice-2	<0.01	<0.01	<0.03	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.02	<0.15	<0.05
American plaice-3	<0.01	<0.01	<0.03	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.02	<0.15	<0.05
American plaice-4	<0.01	<0.01	<0.03	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.02	<0.15	<0.05
American plaice-5	<0.01	<0.01	<0.03	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.02	<0.15	<0.05
American plaice-6	<0.01	<0.01	<0.03	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.02	<0.15	<0.05
American plaice-7	<0.01	<0.01	<0.03	<0.01	<0.01	<0.01	<0.01	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.04	<0.15	<0.05
American plaice-8	<0.01	<0.01	<0.03	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.02	<0.15	<0.05
American plaice-9	<0.01	<0.01	<0.03	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.02	<0.15	<0.05
American plaice-10	<0.01	<0.01	<0.03	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.02	<0.15	<0.05
Redfish-1	<0.01	<0.01	<0.03	<0.01	<0.01	<0.01	<0.01	<0.01	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	<0.04	<0.3	<0.05
Redfish-2								<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.02	<0.15	<0.05
Redfish-3								<0.01	<0.02	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.02	<0.15	<0.05
Redfish-4								<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.02	<0.15	<0.05
Redfish-5								<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.02	<0.15	<0.05
Redfish-6								<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.02	<0.15	<0.05
Redfish-7								<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.02	<0.15	<0.05
Redfish-8								<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	<0.01	<0.06	<0.02
Redfish-9								<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.02	<0.15	<0.05
Redfish-10								<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.02	<0.15	<0.05
Redfish-11								<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.02	<0.15	<0.05
Redfish-12								<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.02	<0.15	<0.05

Table D.11. PCBs in fish and shellfish tissues (ppm ww) collected near the Massachusetts Bay IWS May/June 1992 (analyzed by NOAA).

	1016	1221	1232	1242	1248	1254	1260	Total PCBs
EPA Method	3550	3550	3550	3550	3550	3550	3550	
Wrymouth-1							0.2	0.2
Wrymouth-2							0.4	0.4
Wrymouth-3							0.2	0.2
Wrymouth-4	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.10	0.1
Wrymouth-5	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	0.11	0.11
Wrymouth-6	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.35	0.35
Whelk-1	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	bd
Whelk-2	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	<0.4	bd
Spider Crab-1								
Spider Crab-2	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	0.10	0.1
Spider Crab-3	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	bd
Cod-1	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	bd
Winter Flounder-1	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.08	bd
Winter Flounder-2	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	bd
Winter Flounder-3	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.14	0.14
Winter Flounder-4	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	bd
Winter Flounder-5	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.08	0.08
Oceanpout-1	<0.05	<0.05	<0.05	<0.05	<0.05	0.05	0.08	0.08
Oceanpout-2							0.2	0.2
American plaice-1	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.06	0.06
American plaice-2	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.09	0.09
American plaice-3	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.08	0.08
American plaice-4	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.12	0.12
American plaice-5	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.09	0.09
American plaice-6	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	bd
American plaice-7	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.18	bd
American plaice-8	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	bd
American plaice-9	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	bd
American plaice-10	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.08	bd
Redfish-1	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.12	0.12
Redfish-2	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.06	0.06
Redfish-3	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.11	0.11
Redfish-4	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.08	0.08
Redfish-5	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.07	0.07
Redfish-6	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.09	0.09
Redfish-7	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.10	0.1
Redfish-8	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.04	0.04
Redfish-9	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.06	0.06
Redfish-10	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.08	bd
Redfish-11	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.08	0.08
Redfish-12	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.08	0.08

Table D.12a. Radionuclide analysis results on fish and shellfish tissues collected at the Massachusetts Bay IWS, otter trawl stations, May 31, 1992, (FDA).

Site 1

FDA Sample Number/ Product	I-131 pCi/kg	Ru-106 pCi/kg	Cs-134 pCi/kg	Cs-137 pCi/kg	Ba-140 pCi/kg	Sr-90 pCi/kg	Pu-239 pCi/kg
INV 92-660-628 American plaice	None Detected	None Detected	None Detected	None Detected	None Detected	Not Analyzed	0.0943 +/- 0.0450
INV 92-660-630 sea scallop	Not Analyzed	Not Analyzed	Not Analyzed	Not Analyzed	Not Analyzed	Not Analyzed	Not Analyzed
INV 92-660-661 witch flounder	None Detected	None Detected	None Detected	None Detected	None Detected	Not Analyzed	Not Analyzed
INV 92-660-662 yellowtail flounder	None Detected	None Detected	None Detected	None Detected	None Detected	Not Analyzed	Not Analyzed
INV 92-660-663 cod	None Detected	None Detected	None Detected	None Detected	None Detected	Not analyzed	Not analyzed
INV 92-660-664 goosefish	Not Analyzed	Not Analyzed	Not Analyzed	Not Analyzed	Not Analyzed	Not Analyzed	Not Analyzed
INV 92-660-665 Redfish	Not Analyzed	Not Analyzed	Not Analyzed	Not Analyzed	Not Analyzed	Not Analyzed	Not Analyzed
INV 92-660-629 American lobster	None Detected	None Detected	None Detected	None Detected	None Detected	Not Analyzed	0.0215 +/- 0.0421

Table D.12b. Radionuclide analysis results on fish and shellfish tissues collected at the Massachusetts Bay IWS, Otter Trawl Stations, May 31, 1992 (FDA).

Site 2

FDA Sample Number/ Product	I-131 pCi/kg	Ru-106 pCi/kg	Cs-134 pCi/kg	Cs-137 pCi/kg	Ba-140 pCi/kg	Sr-90 pCi/kg	Pu-239 pCi/kg
INV 92-660-631 American plaice	None Detected	None ..Detected	None Detected	None Detected	None Detected	Not Analyzed	Not Analyzed
INV 92-660-633 sea scallop	Not Analyzed	Not Analyzed	Not Analyzed	Not Analyzed	Not Analyzed	Not Analyzed	Not Analyzed
INV 92-660-667 yellowtail	None Detected	None Detected	None Detected	None Detected	None Detected	Not Analyzed	Not Analyzed
INV 92-660-668 cod	None Detected	None Detected	None Detected	None Detected	None Detected	Not Analyzed	0.0533 +/- 0.0427
INV 92-660-666 redfish	None Detected	None Detected	None Detected	None Detected	None Detected	Not Analyzed	Not Analyzed
INV 92-660-632 American lobster	None Detected	None Detected	None Detected	None Detected	None Detected	Not Analyzed	0.1492 +/- 0.0800

Table D.12c. Radionuclide analysis results on fish and shellfish tissues collected at the Massachusetts Bay IWS, Otter Trawl Stations, May 31, 1992 (FDA).

Site 3

FDA Sample Number/Product	I-131 pCi/kg	Ru-106 pCi/kg	Cs-134 pCi/kg	Cs-137 pCi/kg	Ba-140 pCi/kg	Sr-90 pCi/kg	Pu-239 pCi/kg
INV 92-660-634 American plaice	None Detected	None Detected	None Detected	None Detected	None Detected	Not Analyzed	Not Analyzed
INV 92-660-636 sea scallop	Not Analyzed	Not Analyzed	Not Analyzed	Not Analyzed	Not Analyzed	Not Analyzed	Not Analyzed
INV 92-660-671 witch flounder	None Detected	None Detected	None Detected	None Detected	None Detected	Not Analyzed	Not Analyzed
INV 92-660-669 cod	None Detected	None Detected	None Detected	None Detected	None Detected	Not Analyzed	Not Analyzed
INV 92-660-666 redfish	None Detected	None Detected	None Detected	None Detected	None Detected	Not Analyzed	Not Analyzed
INV 92-660-635 American lobster	None Detected	None Detected	None Detected	None Detected	None Detected	Not Analyzed	0.2115 +/- 0.0873

Table D.12d. Radionuclide analysis results on fish and shellfish tissues collected at the Massachusetts Bay IWS, Otter Trawl Stations, May 31, 1992 (FDA).

Site 4

FDA Sample Number/ Product	I-131 pCi/kg	Ru-106 pCi/kg	Cs-134 pCi/kg	Cs-137 pCi/kg	Ba-140 pCi/kg	Sr-90 pCi/kg	Pu-239 pCi/kg
INV 92-660-637 American plaice	None Detected	None .. Detected	None Detected	None Detected	None Detected	Not Analyzed	0.0909 +/- 0.0397
INV 92-660-673 witch flounder	Not Analyzed	Not Analyzed	Not Analyzed	Not Analyzed	Not Analyzed	Not Analyzed	Not Analyzed
INV 92-660-674 cod	None Detected	None Detected	None Detected	None Detected	None Detected	Not Analyzed	Not Analyzed
INV 92-660-672 redfish	None Detected	None Detected	None Detected	None Detected	None Detected	Not Analyzed	0.0800 +/- 0.2932
INV 92-660-638 American lobster	None Detected	None Detected	None Detected	None Detected	None Detected	Not Analyzed	0.0881 +/- 0.0608

Table D.12e. Radionuclide analysis results on fish and shellfish tissues collected at the Massachusetts Bay IWS, Otter Trawl Stations, May 31, 1992 (FDA).

Site 5

FDA SampleNumber/ Product	I-131 pCi/kg	Ru-106 pCi/kg	Cs-134 pCi/kg	Cs-137 pCi/kg	Ba-140 pCi/kg	Sr-90 pCi/kg	Pu-239 pCi/kg
INV 92-660-675 ocean pout	None Detected	None .. Detected	None Detected	None Detected	None Detected	Not Analyzed	0.0483 +/- 0.0333
INV 92-660-676 cod	None Detected	None Detected	None Detected	None Detected	None Detected	Not Analyzed	Not Analyzed
INV 92-660-639 American lobster	Not Analyzed	Not Analyzed	Not Analyzed	Not Analyzed	Not Analyzed	Not Analyzed	Not Analyzed

Table D.12f. Radionuclide analysis results on fish and shellfish tissues collected at the Massachusetts Bay IWS, Otter Trawl Stations, May 31, 1992 (FDA).

Site 6

FDA Sample Number/ Product	I-131 pCi/kg	Ru-106 pCi/kg	Cs-134 pCi/kg	Cs-137 pCi/kg	Ba-140 pCi/kg	Sr-90 pCi/kg	Pu-239 pCi/kg
INV 92-660-641 American plaice	None Detected	None Detected	None Detected	None Detected	None Detected	None Detected	0.0405 +/- 0.0318
INV 92-660-643 sea scallop	Not Analyzed	Not Analyzed	Not Analyzed	Not Analyzed	Not Analyzed	Not Analyzed	Not Analyzed
INV 92-660-678 witch flounder	None Detected	None Detected	None Detected	None Detected	None Detected	Not Analyzed	Not Analyzed
INV 92-660-680 yellowtail	None Detected	None Detected	None Detected	None Detected	None Detected	Not Analyzed	Not Analyzed
INV 92-660-677 cod	None Detected	None Detected	None Detected	None Detected	None Detected	Not Analyzed	Not Analyzed
INV 92-660-649 large cod	None Detected	None Detected	None Detected	None Detected	None Detected	Not Analyzed	Not Analyzed
INV 92-660-650 redfish	None Detected	None Detected	None Detected	None Detected	None Detected	Not Analyzed	Not Analyzed
INV 92-660-679 ocean pout	None Detected	None Detected	None Detected	None Detected	None Detected	Not Analyzed	Not Analyzed
INV 92-660-642 American lobster	None Detected	None Detected	None Detected	None Detected	None Detected	None Detected	0.1249 +/- 0.0608

Table D.12g. Radionuclide analysis results on fish and shellfish tissues collected at the Massachusetts Bay IWS, Otter Trawl Stations, June 2, 1992 (FDA).

Site 7

FDA Sample Number /Product	I-131 pCi/kg	Ru-106 pCi/kg	Cs-134 pCi/kg	Cs-137 pCi/kg	Ba-140 pCi/kg	Sr-90 pCi/kg	Pu-239 pCi/kg
INV 92-660-644 American plaice	Not Analyzed	Not Analyzed	Not Analyzed	Not Analyzed	Not Analyzed	Not Analyzed	Not Analyzed
INV 92-660-655 witch flounder	None Detected	None Detected	None Detected	None Detected	None Detected	Not Analyzed	0.2025 +/- 0.0731
INV 92-660-652 yellowtail	Not Analyzed	Not Analyzed	Not Analyzed	Not Analyzed	Not Analyzed	Not Analyzed	Not Analyzed
INV 92-660-654 cod	None Detected	None Detected	None Detected	None Detected	None Detected	Not Analyzed	Not Analyzed
INV 92-660-651 redfish	Not Analyzed	Not Analyzed	Not Analyzed	Not Analyzed	Not Analyzed	Not Analyzed	Not Analyzed
INV 92-660-653 ocean pout	None Detected	None Detected	None Detected	None Detected	None Detected	Not Analyzed	Not Analyzed
INV 92-660-645 American lobster	Not Analyzed	Not Analyzed	Not Analyzed	Not Analyzed	Not Analyzed	Not Analyzed	Not Analyzed

Table D.12h. Radionuclide analysis results on fish and shellfish tissues collected at the Massachusetts Bay IWS, Otter Trawl Stations, June 2, 1992 (FDA).

Site 8

FDA Sample Number /Product	I-131 pCi/kg	Ru-106 pCi/kg	Cs-134 pCi/kg	Cs-137 pCi/kg	Ba-140 pCi/kg	Sr-90 pCi/kg	Pu-239 pCi/kg
INV 92-660-646 American plaice	None Detected	None Detected	None Detected	None Detected	None Detected	None Detected	0.0692 +/- 0.1355
INV 92-660-656 witch flounder	None Detected	None Detected	None Detected	None Detected	None Detected	Not Analyzed	Not Analyzed
INV 92-660-652 yellowtail	None Detected	None Detected	None Detected	None Detected	None Detected	Not Analyzed	Not Analyzed
INV 92-660-657 cod	Not Analyzed	Not Analyzed	None Detected	None Detected	None Detected	Not Analyzed	Not Analyzed
INV 92-660-658 redfish	Not Analyzed	Not Analyzed	Not Analyzed	Not Analyzed	Not Analyzed	Not Analyzed	Not Analyzed
INV 92-660-660 ocean pout	None Detected	None Detected	None Detected	None Detected	None Detected	Not Analyzed	0.0511 +/- 0.0474
INV 92-639-481 witch flounder	Not Analyzed	Not Analyzed	Not Analyzed	Not Analyzed	Not Analyzed	Not Analyzed	Not Analyzed
INV 92-660-647 American lobster	None Detected	None Detected	None Detected	None Detected	None Detected	None Detected	0.0953 +/- 0.0658

APPENDIX E

SUMMARY OF MASSACHUSETTS BAY CHEMICAL AND RADIATION CONTAINER SURVEYS

SUMMARY OF MASSACHUSETTS BAY CHEMICAL AND RADIATION CONTAINER SURVEYS

Prior to the present survey, only four surveys have focused on the identifying the locations of low level radioactive waste (LLW), or hazardous waste containers in Massachusetts Bay. Several other investigations focused on hazardous substance contaminant concentrations in sediments and biota. In order to place the present investigation in context with historical investigations, the four container surveys are summarized below.

LLW and Hazardous Waste Container Investigations

1973 COE Survey

The Army Corps of Engineers sponsored an underwater television survey in 1973 of the "Massachusetts Bay Foul Area" which foscused on disposed ordnance. The two day survey yeilded a brief report describing "...numerous signs of partially disintegrated concrete containers possibly used as waste chemical containment."

1981-82 NOAA/EPA/FDA Survey

Curtis and Mardis (1984) reported on a collaborative four part study by NOAA/EPA/FDA in and about the IWS (Figure E.1) during 1981-1982. The primary objectives of the study included: identification of bottom debris with emphasis on LLW containers; and, the recovery of sediment and biota samples, including commercial seafood, for radiochemical analysis.

A side-scan sonar survey of the Boston Foul Area revealed "extensive amounts of bottom objects, both grouped and dispersed" (Figure E.2). The side-scan survey did not positively identify any of the detected objects. However, an underwater television deployed in the Boston Foul Area identified "six metallic-looking drums or barrels," with one drum appearing to be encased in concrete and holding "a lifting eye-hook .... as had been observed on LLW disposal drums during EPA surveys of other radioactive waste disposal sites in the Pacific and Atlantic oceans". An underwater gamma radiation detector was towed from the surface vessel at nine locations for 50 minutes each in an attempt to locate potential radiation sources. None were detected. The survey revealed that the majority of debris was located in the north, west, and south sectors of the IWS.

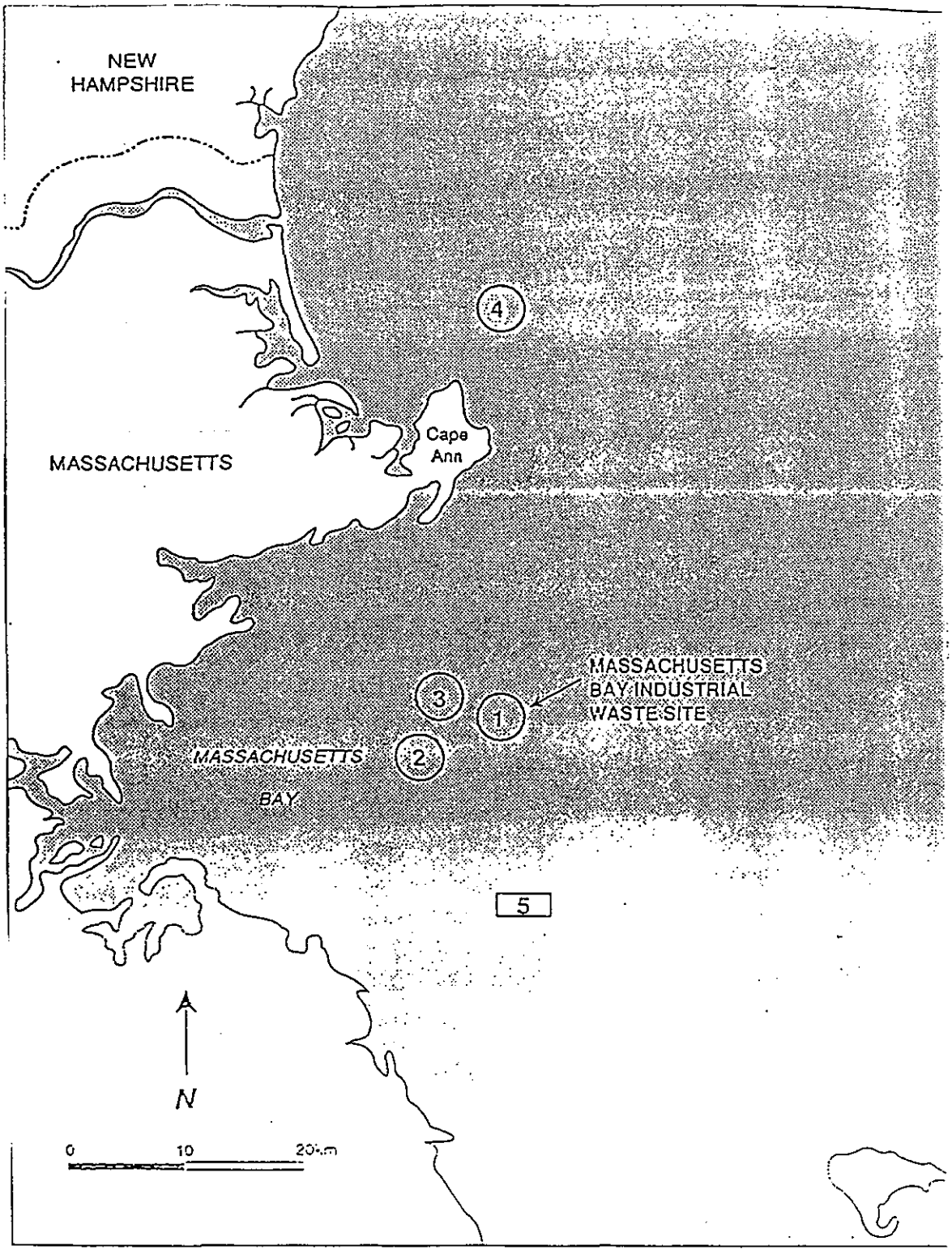

Figure E.1. Location of five radiological sampling areas for sediments and biota (Curtis and Madris 1984).

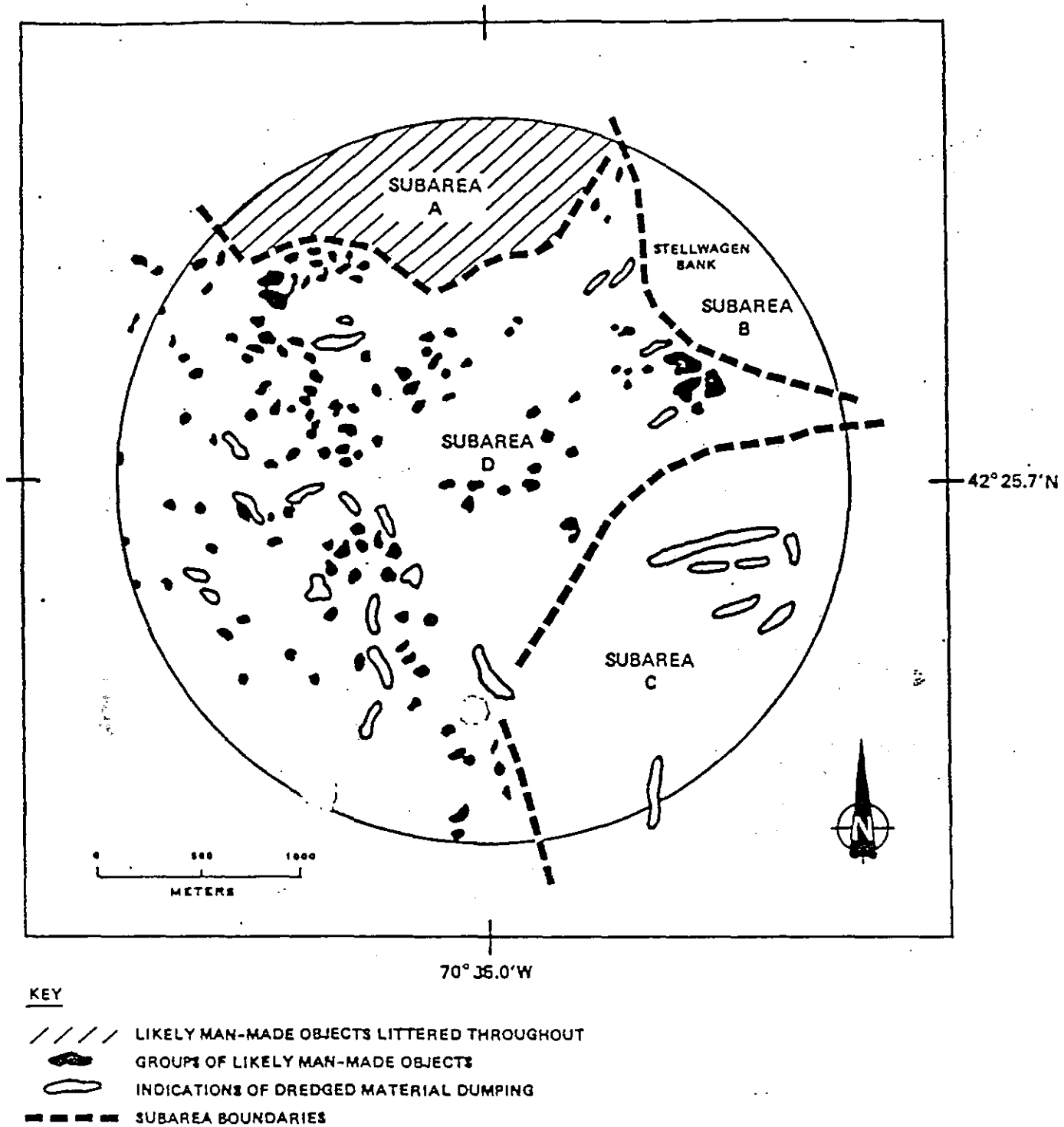

Figure E.2. Side-scan sonar data plot—Area 1 (Boston "Foul Site") Massachusetts Bay

The bottom was characterized as giving the appearance of an "underwater forest of anemones" in some portions. Other general notes on the benthic diversity included eels, squid, motile and bottom resting fish, flounders, starfishes, small crustaceans, and small fish lying partially immersed in sediment.

The report concluded that "the data show no evidence that past disposal of LLW in Massachusetts Bay are resulting in contamination of the area with waste-related radionuclides."

International Wildlife Coalition Survey

In August of 1991, the International Wildlife Coalition sponsored in part by EPA, undertook a two phase investigation: Phase I; Side-scan Sonar Operation, and Phase II; Remotely Operated Vehicle (ROV) Operations. The ROV system provided video recordings of bottom objects in locations within and immediately outside the IWS (Wiley et al. 1992). The ROV surveyed 18 sites and observed 93 objects; 64 of the objects were identified as containers. According to the report, only 37 of the 64 containers (characterized as "55-gallon in size") were inspected adequately with an ROV to discern that 18 containers contained intact glassware, plastic liners, or concrete. Wiley et al. (op. cit.) speculated that of the thousands of allegedly disposed waste containers in and about the IWS, many likely remain intact. Subsequent to the release of the survey report, Dr. Wiley estimated barrel density at the IWS to be as high as 5,194 barrels per square nautical mile (nm) (Wiley et al. 1992).

1991 EPA Lightship Area Survey

In December 1991, the EPA Region I with technical support from the Office of Research and Development, and the Environmental Research Laboratory, Narragansett, engaged in a side scan sonar mapping survey of an area of Massachusetts Bay (USEPA 1992b)suspected by some to be a major dump site of wastes of concern—toxic chemicals and LLW (Figure E.3). The study area, commonly referred to as the former Boston Lightship Dumping Ground, lies southwest of the IWS. The agency mapped areas of concern, and prioritized their likely importance.This area is heavily fished and trapped for lobsters. Whales are also a valuable natural resource in the area.

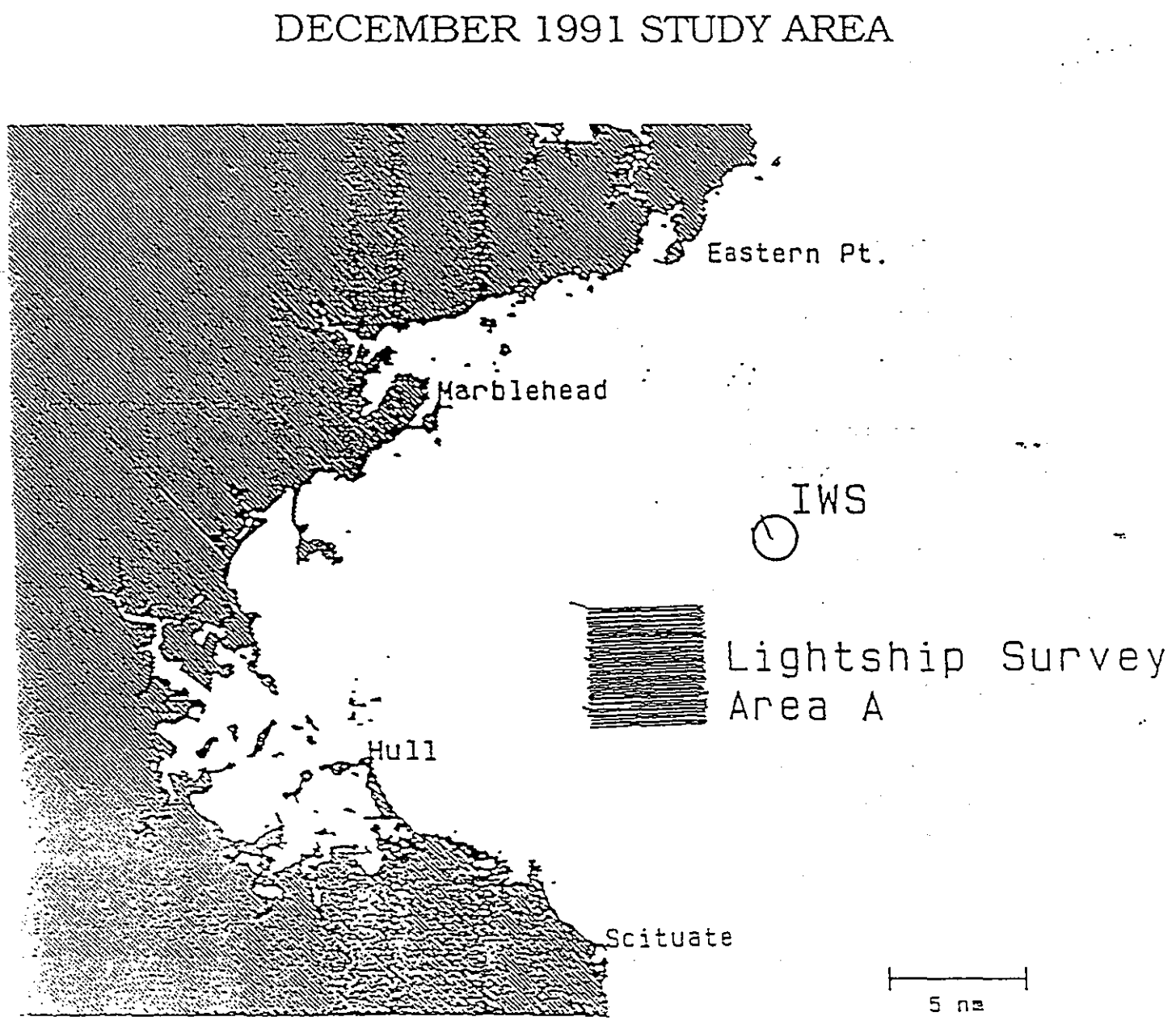

Figure E.3. Boston Lightship Survey Area

The survey intended to determine the identity, location, and condition of waste containers in the survey area. Prior to surveying the lightship area, a side-scan sonar survey was undertaken in the IWS as a control area to "establish the quality of detection of barrel targets" using the side-scan technology. Three side-scan lines previously surveyed by Wiley et al. (1992) were repeated at the IWS. This QA check in a 0.1 nm^2 area of the IWS identified 12 probable barrel fields of which 8 were characterized as "high density," one as intermediate, and three as sparse barrel fields.

Subsequently, the side-scan survey in the former Boston Lightship Survey Area revealed 39 "sparse" (i.e., 1-4 targets/0.1 km^2) and 4 "intermediate" (i.e., 5-10 targets/0.1 km^2) density barrel fields. No areas of high density were identified. The investigators estimated 196 barrels based on a characteristic "ringer" signature for 55-gallon drums that had been observed in the Wiley et al. 1991 IWS study. Targets that did not have this acoustic signature but exhibited a return of the appropriate size and intensity were categorized as "unidentified targets;" there were about 100 of these unidentified targets. Dredged material mounds, geological formations, shipwrecks, lobster-trap lines, construction debris, and dragger scars were also readily identifiable from the side-scan sonar record. Poor weather conditions and poor visibility reduced the effectiveness of the ROV portion of the survey.

REFERENCES

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United States Environmental Protection Agency. 1992. Final Cruise Report: location survey and condition inspection of waste containers at the Boston Lightship Dumping Ground and Surrounding Area (Draft November 18, 1992) ERLN Contribution No. 1405. USEPA Environmental Research Laboratory-Narragansett. Narragansett, RI. 76 pp.

Wiley, D.N., V. Capone, D.A. Carey, and J.P. Fish. 1992. Location survey and condition inspection of waste containers at the Massachusetts Bay Industrial Waste Site and surrounding areas, Internal Report submitted to USEPA Region I by the International Wildlife Coalition. 59 pp.

ACRONYMS

LLW	low level radioactive waste
nm	nautical mile
ROV	remotely operated vehicle

APPENDIX F

MARINE BIOTOXINS IN THE GULF OF MAINE

Marine Biotoxins in the Gulf of Maine

Marine biotoxins are naturally occurring chemical compounds produced by some species of oceanic microorganisms. Molluskan shellfish may accumulate biotoxins as the result of filter-feeding on toxin-producing phytoplankton and herbivorous zooplankton. Predatory species of shellfish, crustacea, and finfish may bioconcentrate the toxins providing a mechanism for food web transfer of the poisons. Accumulation of biotoxins in seafood is a serious, persistent public health problem. It is an annual occurrence in some areas and has been implicated in a variety of acute seafood borne intoxications and more recently has been associated with chronic health effects. Two biotoxin induced syndromes of particular concern in New England are paralytic shellfish poisoning (PSP) and amnesiac shellfish poisoning (ASP).

PSP is an acute seafood intoxication resulting from consumption of molluskan shellfish contaminated with a suite of potent neurotoxins known collectively as saxitoxins. PSP symptoms usually develop within 30 minutes of eating contaminated shellfish beginning with tingling, numbness or burning of the lips, tongue, gums, and face. These preliminary signs are typically followed by paresthesia and muscle weakness gradually progressing to the neck, arms, and legs and may result in complete paralysis of the extremities. In mild to moderate cases, PSP is a self-limiting intoxication with affected individuals completely recovering within 48 hours. In more severe cases, these symptoms are followed by ataxia or loss of muscular coordination and death due to respiratory paralysis. There is no known antidote for any of the toxins. Therefore, medical treatment of PSP affected individuals is symptomatic consisting of evacuation of the stomach contents to prevent further absorption of the toxin and artificial respiration to facilitate breathing.

Saxitoxins are alkaloid compounds that differ from one another with respect to their functional group substitution and toxicity. The toxins are produced by marine dinoflagellates of the genus *Alexandrium*. Several species with widespread geographical distribution have been shown to synthesize the toxins: *A. fundyense, A. tamarense, A. catenella* and *A. minutum*. Toxic isolates have been identified from many parts of the world. The proportion and distribution of the individual toxins vary spatially indicating subspecies variation in dinoflagellate populations. For example, in New England, shellfish harvested from Massachusetts northward primarily contain the highly potent carbamate toxins whereas southern isolates from Connecticut and Long Island typically contain the weaker N-sulfocarbamoyl toxins.

In New England, *Alexandrium tamarense* is the dinoflagellate responsible for the production of saxitoxins and the subsequent contamination of local shellfish. Several species of molluskan shellfish accumulate saxitoxins. Mussels are most often implicated in PSP due to their inherent capacity to absorb and retain the toxins earlier in a bloom event than other species. However, laboratory data indicate that soft-shell clams, surf clams, ocean quahogs and sea scallop viscera accumulate toxin levels capable of inducing human illness.

More recent research and monitoring efforts show that lobster tomalley can also accumulate marine biotoxins after ingestion of contaminated mollusks, thereby providing another potential source of human exposure. In 1991, the FDA funded the states of Massachusetts and Maine to conduct coastal and offshore monitoring projects to assess the magnitude of PSP contamination in lobster tomalley. Data from these studies were consistent with those from Canada that showed saxitoxin levels in lobster tomalley were reflective of ambient shellfish levels indicating that during toxic episodes lobster tomalley could be a source of PSP intoxication.

ASP is a severe seafood intoxication associated with the consumption of domoic acid contaminated molluskan shellfish. Domoic acid is produced by the pennate diatom *Nitzschia pungens*, forma multiseries, and more recently, to other species in that genus. The organism has a broad thermal tolerance and is found in most oceans of the world. However, *N. pungens* does not always produce domoic acid as a by-product of its growth. Research to determine the environmental and climatic conditions favorable for the production of domoic acid by these diatoms is underway in Canada and the United States

The first reported outbreak of the illness was from Atlantic Canada during November and December 1987. After eating mussels harvested from a localized area in eastern Prince Edward Island, 153 people became acutely ill. Acute ASP developed within 24 hours of ingestion of contaminated shellfish. The initial illness is characterized by gastrointestinal distress including vomiting, abdominal cramps, and diarrhea. Neurological manifestations associated with ASP emerge within 48 hours and include confusion, disorientation, and memory loss. Due to respiratory insufficiency, cardiovascular trauma, or coma, 10 of the 22 seriously ill patients from the Canadian incident were admitted to the intensive care unit. Three elderly individuals died as a result of the intoxication; postmortem examination of their brain tissue indicated cerebral scarring and lesions. Unlike PSP, there can be chronic effects associated with ASP intoxication. These include apparently permanent loss of short-

term memory and debilitating CNS dysfunction. To date, 10 individuals from the Canadian outbreak remain mentally and physically incapacitated.

In 1991, the West Coast of the United States was closed to shell fishing and the harvest of anchovies due to domoic acid contamination of these products. A retrospective epidemiological survey conducted by the California Department of Health Services identified 17 mild to moderate cases of ASP linked to seafood consumption. Laboratory examination of multiple species of marine life showed the potential for crustacean contamination when the hepatopancreas of Dungeness crab were found to accumulate the toxin.

The MDPH has been monitoring molluskan shellfish from selected coastal and offshore sampling sites for domoic acid since 1990 with funding provided by the FDA. Low levels of domoic acid have been detected in whole bay scallops, mussels, and whole sea scallops. In the summer of 1991, the study was temporarily expanded to include the analysis of lobsters. Measurable levels of domoic acid in the tomalley were found in nine percent of the lobster samples tested. None of the muscle tissue had detectable domoic acid concentrations. None of the seafood tested had levels exceeding the action limit of 20 ug/g; however, the potential for a significant public health problem exists in the area.

ACRONYMS

ASP	amnesiac shellfish poisoning
CNS	central nervous system
PSP	paralytic shellfish poisoning

APPENDIX G

Laser-Line Scanner

Laser-Line Scanner System

On April 24, 1993, an additional advanced technological survey technique was applied for comparison to those employed during the May-June 1992 survey. The Laser-Line Scanner System (LLSS) was operated by SAIC, Newport, Rhode Island, and tested by U.S. Army Corps of Engineers, New England Division's DAMOS Program at the IWS as part of overall ongoing investigations within Massachusetts Bay.

The LLSS uses a laser light housed in a tow fish to scan the seafloor. The laser track on the seafloor is simultaneously observed by a receiving sensor unit mounted with the tow fish. The signal is recorded digitally and processed to produce a real-time, television-like video image.

Over the course of the track through the IWS, the LLSS unequivocally provided observations of barrels on the seafloor. In addition, numerous other objects and life forms were readily apparent including rocks, concrete rubble, timbers, buckets, chains, reagent bottles, lobster traps, lobsters, starfish, flounder, cod, and redfish (Figures G1 through G.3).

The LLSS offers a number of advantages over other survey systems including unequivocal real-time, video-quality images observable on a surface platform. This system offers the potential to fill the void between side-scan sonar and conventional video platforms such as ROVs and submersibles. The advantage of LLSS over side-scan is the clarity of images that are produced, although the swath width of bottom that can be surveyed on a single lane is much less. The advantage of LLSS over ROVs or submersibles is that images can be obtained during relatively turbid conditions, swath widths are larger, survey speeds are faster, and surveying can be conducted under a wider range of sea-surface conditions. Precision navigation technology can enable the revisitation of objects of interest with the LLSS, ROV, or manned submersible.

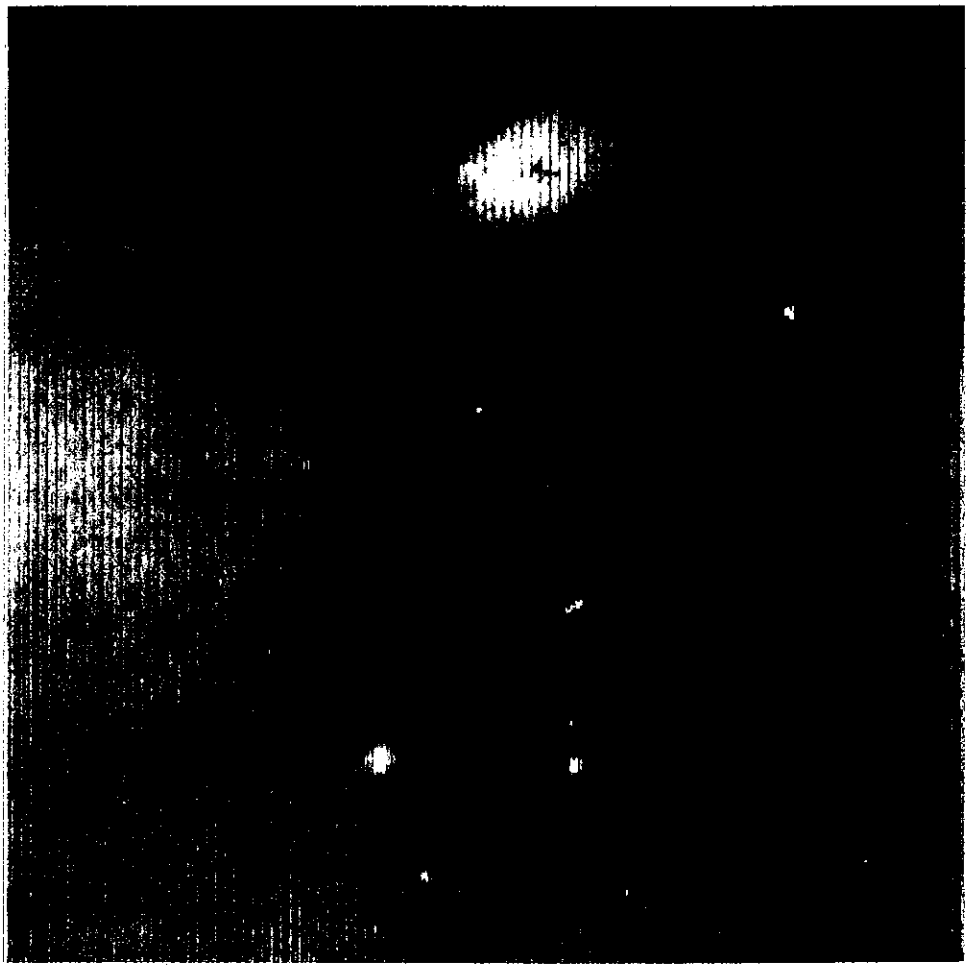

Figure G.1. Laser-line scan image taken within the IWS, April 24, 1993. Image depicts a corroded waste barrel in the IWS with sea anemones (*Cerianthus* sp.) protruding through the sediment in the barrel outline. (Image provided by SAIC, Newport, RI under contract to ACOE, New England Division, Waltham, MA).

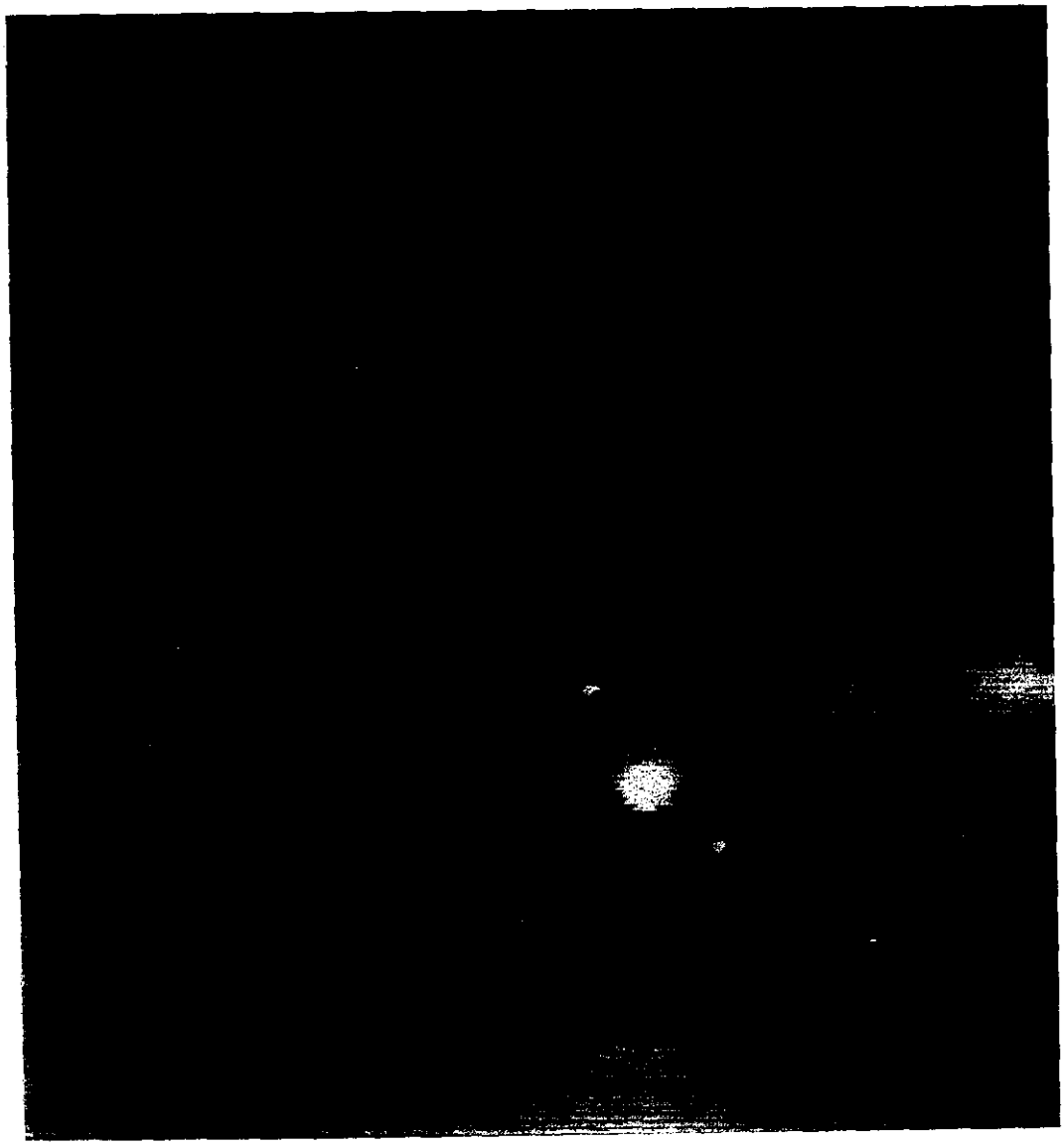

Figure G.2. Laser-line scan image taken within the IWS, April 24, 1993. Image depicts numerous fish (Gadidae) around a piling and a waste container. (Image provided by SAIC, Newport, RI under contract to ACOE, New England Division, Waltham, MA).

Figure G.3. Laser-line scan image taken in the vicinity of the Boston Lightship area, April 24, 1993. Image depicts two lobster traps and entangled trawl lines. (Image provided by SAIC, Newport, RI under contract to ACOE, New England Division, Waltham, MA).