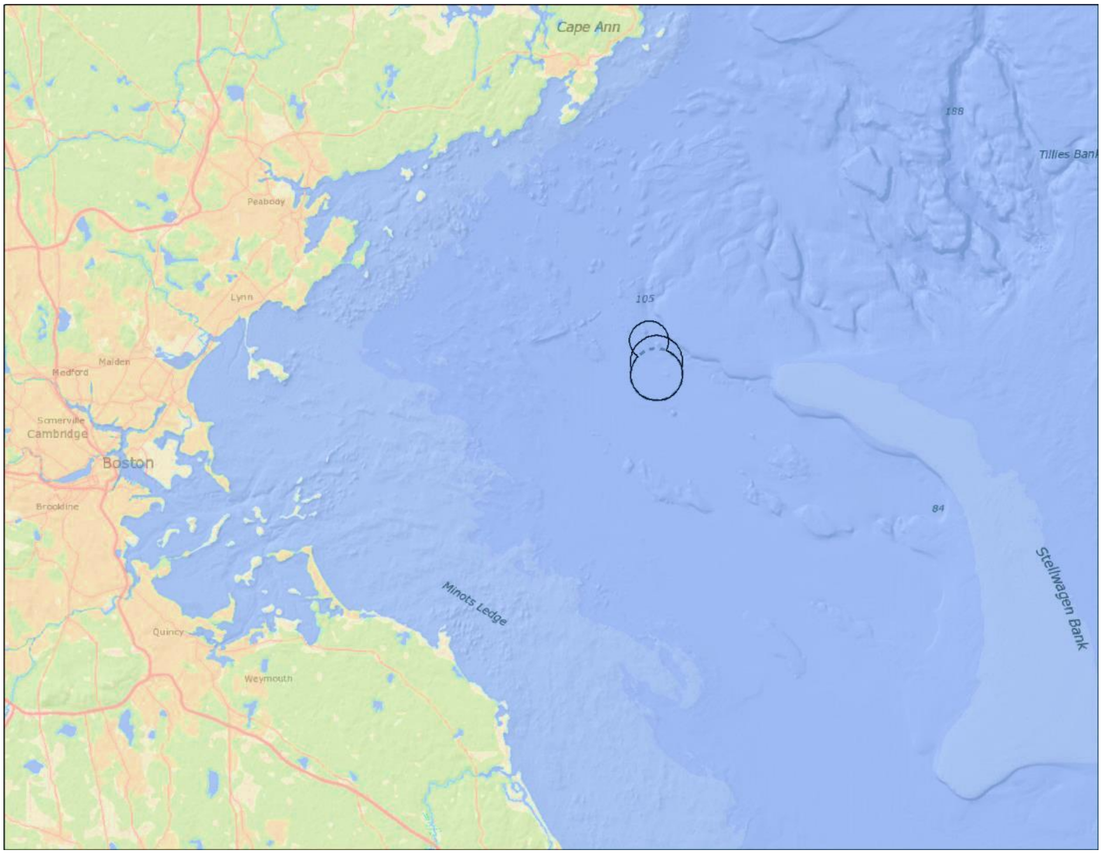
DRAFT ENVIRONMENTAL ASSESSMENT
ON THE
EXPANSION OF THE MASSACHUSETTS BAY
OCEAN DREDGED MATERIAL DISPOSAL SITE (ODMDS)



Lead Agency: U.S. Environmental Protection Agency, Region 1

Cooperating Agency: U.S. Army Corps of Engineers, New England District

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U.S. Environmental Protection Agency
Region 1
Boston, Massachusetts

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Comments must be received no later than:

30 days after publication of the Proposed Rule for the Temporary Modification of an Ocean Dredged Material Disposal Site in Massachusetts Bay and notice of availability for the Draft Environmental Assessment in the Federal Register.

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AEC	Atomic Energy Commission
CAD	Confined aquatic disposal
CFR	Code of Federal Regulations
CZMA	Coastal Zone Management Act
DAMOS	Disposal Area Monitoring System
DO	Dissolved oxygen
EA	Environmental assessment
EFH	Essential Fish Habitat
EIS	Environmental impact statement
EPA	U.S. Environmental Protection Agency
ERL	Effects-range low
ERM	Effects-range median
ESA	Endangered Species Act
FDA	U.S. Food and Drug Administration
DEIS	Draft environmental impact statement
FEIS	Final environmental impact statement
HMW	High molecular weight
Interim MBDS	Interim Massachusetts Bay Disposal Site
IWS	Industrial Waste Site
LMW	Low molecular weight
LNG	Liquid natural gas
MBDS	Massachusetts Bay Disposal Site
MCZM	Massachusetts Office of Coastal Zone Management
MPRSA	Marine Protection, Research, and Sanctuaries Act
MSA	Magnuson-Stevens Fishery Conservation and Management Act
MWRA	Massachusetts Water Resources Authority
NAAQS	National Ambient Air Quality Standards
NEPA	National Environmental Policy Act
NERACOOS	Northeast Regional Association of Coastal Ocean Observing Systems
NERDT	Northeast Regional Dredging Team
NHPA	National Historic Preservation Act
NMFS	National Marine Fisheries Service
NOAA	U.S. National Oceanic and Atmospheric Administration
ODMDS	Ocean dredged material disposal site
PCBs	Polychlorinated Biphenyls
PAHs	Polycyclic Aromatic Hydrocarbons
ppb	Parts per billion
PV	Plan-view imaging
ROV	Remotely operated vehicle
SBNMS	Gerry E. Studds Stellwagen Bank National Marine Sanctuary
SDEIS	Supplemental Draft Environmental Impact Statement
SHPO	State Historic Preservation Officer
SMMP	Site Management and Monitoring Plan
SPI	Sediment profile imaging
TOC	Total organic carbon
USACE	U.S. Army Corps of Engineers
ww	Wet weight

**DRAFT ENVIRONMENTAL ASSESSMENT
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EXECUTIVE SUMMARY

PROJECT PURPOSE AND NEED

Beginning in the early twentieth century, an area within Massachusetts Bay known as the Industrial Waste Site (IWS) was used for the disposal of various waste materials. Disposal at the IWS included barrels of radioactive, chemical and hospital waste; construction debris; contaminated dredged material; derelict vessels; ordnance; etc. The IWS was closed by the U.S. Environmental Protection Agency (EPA) in 1977. The Massachusetts Bay Disposal Site (MBDS) was designated by EPA for the disposal of dredged materials in 1992. The MBDS overlaps the IWS to the south, but avoids the area of greatest concentration of waste containers (known as the 'barrel field'). The MBDS and IWS are west of and directly adjacent to the Stellwagen Bank National Marine Sanctuary (SBNMS), which was also designated in 1992.

The IWS area has been closed to the harvesting of surf clams and ocean quahogs since 1980. There is also a warning against harvesting fish and shellfish from the IWS area on all nautical charts. Despite these warnings, there have been reports of fishermen retrieving barrels from the seafloor, including an instance of a barrel of industrial waste breaking on the deck of a fishing vessel, injuring the captain.

In 2017, the U.S. Army Corps of Engineers (USACE) will perform regular maintenance dredging of Boston Harbor, which includes the expansion of an existing confined aquatic disposal (CAD) cell and will generate approximately 1 million cubic yards of dredged material suitable for ocean disposal. After completion of the maintenance dredging, USACE will initiate the Boston Harbor Deep Draft Navigation Project to allow for the passage of larger cargo vessels, which will generate approximately 11 million cubic yards of dredged material.

EPA and USACE have determined that the dredged material generated during the Boston Harbor maintenance and navigation projects deemed suitable for ocean disposal can be beneficially used to cover the IWS barrel field. This would reduce the risk to fishermen that harvest in the area, despite posted warnings. It is also intended to reduce the risk of contaminants from historic disposal entering the food web. EPA performed surveys to determine the extent of the barrel field and create Priority Areas for restoration. USACE devised a method of disposing dredged material that will minimize the risk of resuspending any potentially contaminated seafloor sediment or breaking any barrels. USACE also devised a Potential Restoration Area based on the EPA's Priority Areas and the thickness of cover material needed to be protective.

In order to undertake this project, EPA is proposing to modify the MBDS by expanding the boundaries into the historic IWS. This would open the area to the disposal of suitable dredged material and allow for the barrel field to be covered and restored using the dredged material generated during the Boston Harbor maintenance and improvement projects.

ALTERNATIVES

This Draft Environmental Assessment considers the following Geographic and Temporal Alternatives for the expansion of the MBDS:

Alternative G-1: Expand the boundaries of the MBDS to include the entirety of the Potential Restoration Area.

Alternative G-2: Expand the boundaries of the MBDS to include only the legal boundaries of the historic IWS.

Alternative T-1: This Temporal Alternative would keep the expansion of the MBDS open only for the duration of the USACE Boston Harbor Deep Draft Navigation Project.

Alternative T-2: This Temporal Alternative would limit the expansion of the MBDS to a set time period of three years, which is the current estimated timeframe for the completion of the Boston Harbor Deep Draft Navigation Project.

Alternative T-3: This Temporal Alternative would permanently expand the boundaries of the MBDS.

No Action Alternative: Under the No Action Alternative, the MBDS will not be expanded and the suitable dredged material generated during the Boston Harbor maintenance and navigation projects will be disposed in the existing MBDS, creating multiple disposal mounds.

The Preferred Alternative is to expand the boundaries of the MBDS in order to include the entirety of the Potential Restoration Area for the duration of the Boston Harbor maintenance and improvement projects (Alternatives G-1 and T-1). This will temporarily expand the size of the MBDS from 3.14 to 4.60 square nautical miles. The distance from the MBDS to SBNMS will remain 0.13 nautical miles. The size, configuration, and duration of the Preferred Alternative will ensure that the entirety of the Potential Restoration Area can be covered. By making the expansion temporary, there will be no disposal events in the portion of the expansion not covered by the Potential Restoration Area. This is intended to prevent any disposal directly onto individual uncovered barrels or disturbing any potentially contaminated seafloor sediment, while protecting the glacial knolls adjacent to the barrel field. If the MBDS is not expanded, the IWS barrel field will remain uncovered and the dredged material generated in Boston Harbor will be disposed in the existing MBDS.

AFFECTED ENVIRONMENT

Physical Environment

The project area is in Massachusetts Bay approximately 20 miles east of Boston. The MBDS and proposed expansion are located in the northeast corner of Stellwagen Basin with depths ranging from 70 – 91 meters. Stellwagen Bank (and the SBNMS) is an underwater shelf rising steeply just to the east of Stellwagen Basin. Bottom currents average 4 – 7 cm/s, flowing from east to west in the fall and in a rotational manner in the winter. Storms capable of causing the resuspension of seafloor sediment are rare in the area. The seafloor within the MBDS and proposed extension is primarily flat and featureless, with the exception of a broad depression in the northwest of the existing MBDS and two glacial knolls within the proposed expansion. The seafloor sediment is made up primarily of silt and clay, with the exception of the knolls, which consist of coarse sand, cobble, and boulders. The area is a depositional environment, accumulating sediment at an estimated 0.1 – 0.2 cm/year. Dredged material placed at the MBDS is generally comprised primarily of fine silt and clays.

Chemical Environment

Studies at the MBDS have detected no impacts of disposal on the water quality. Analysis of metals in the water column have shown them to be well below Water Quality Criteria limits. Analysis of the seafloor sediments have detected some elevated levels of metals, carbon, PAHs, PCBs, and pesticides. This is likely linked to historic disposal of contaminated dredged material at the IWS, as well as the accumulation of sediment from other parts of Massachusetts Bay within Stellwagen Basin, which is a depositional area. Fish and shellfish within the IWS were tested for chemical contamination by the National Oceanic and Atmospheric Administration (NOAA) and the U.S. Food and Drug Administration (FDA) in 1992. Results of their survey did show traces of metals, PAHs, PCBs, and pesticides in fish tissue, but they concluded that there was unlikely to be a significant risk to humans. However, NOAA did recommend continuing the warning to fishermen against harvesting in the IWS area on all nautical charts.

Biological Environment

Abundance of phytoplankton has decreased throughout Massachusetts Bay, while abundance of zooplankton has increased. The benthic infauna on the soft, flat seafloor of the project area is dominated by polychaetes, which is typical of Massachusetts Bay. There are also bivalve mollusks and sea cucumbers. The glacial knolls within the temporary expansion area are home to communities of anemones, tunicates, brachiopods, hydroids, bryozoans, and sponges. The mounds of dredged material typically have higher relative abundance of oligochaetes and other small, opportunistic spionid polychaetes. Monitoring of the MBDS has shown that, with the cessation of dredged material disposal, benthic communities in the area can recover and mirror undisturbed areas.

The predominant fisheries and shellfisheries in the area are groundfish, flatfish, and other bottom dwellers, as well as American lobster and ocean quahog. However, there is a warning against harvesting fish and shellfish in the IWS area. The MBDS and proposed expansion are within the Essential Fish Habitat (EFH) for 28 species. The threatened and endangered species found in Massachusetts Bay include:

Humpback Whale	*Endangered*
Northern Atlantic Right Whale	*Endangered*
Fin Whale	*Endangered*
Sei Whale	*Endangered*
Blue Whale	*Endangered*
Leatherback Sea Turtle	*Endangered*
Kemp's Ridley Sea Turtle	*Endangered*
Loggerhead Sea Turtle	*Threatened*
Shortnose Sturgeon	*Endangered*
Atlantic Sturgeon	*Endangered*

All of Massachusetts Bay, as well as most of the larger Gulf of Maine, is designated as a critical foraging habit for the Northern Atlantic right whale. There are no other critical habitats for threatened or endangered species designated in the project area.

Socioeconomic Environment

Despite the ban against harvesting surf clams and ocean quahogs and the warning against fishing and shellfishing, the IWS area is still used by fishermen as evidenced by trawl marks and active lobster traps. The MBDS and proposed expansion are directly adjacent to the SBNMS, though they are separated by a steep bathymetric rise of approximately 40 meters. The MBDS and proposed expansion have low recreational boater density and the shipping lanes for commercial vessels into Boston Harbor are almost 2 nautical miles south of the MBDS. There are two liquid natural gas (LNG) terminals in Stellwagen Basin, but none overlap with the MBDS or Potential Restoration Area. There are shipwrecks in and around the existing MBDS, but none identified within the Potential Restoration Area.

ENVIRONMENTAL EFFECTS

Environmental Factor	Preferred Alternative
Plankton	As a result of dredged material disposal, localized spatial impacts on plankton of short temporal duration (<4 hours) will potentially result from elevated turbidity. Mortality from physical processes or toxics may occur to a minor extent, but will not have a significant impact.

Environmental Factor	Preferred Alternative
Benthos	Potential impacts of dredged material disposal at the MBDS include localized temporary displacement of the benthic community and possible burial of benthic invertebrates. Dredged material is typically recolonized by the benthic community soon after disposal. By covering the barrel field, benthic exposure to potential contaminants will be reduced. By closing the expansion after the completion of the Boston Harbor maintenance and dredging projects, the benthic communities will have the opportunity to recolonize the dredged material in the temporary expansion without further disturbance.
Fish & Shellfish	Potential impacts of dredged material disposal include localized mortality of some eggs and larvae through shear force or abrasion, high suspended sediment concentrations, or direct burial. There could also be mortality among demersal fish, shellfish, and some pelagic invertebrates through entrainment or burial. No significant impacts to fish and shellfish are expected.
Essential Fish Habitat	Direct effects of sedimentation and turbidity due to dredged material disposal are not expected to be substantial due to the mobility of the majority of federally managed species that may occur in within the site and the lack of geographic constraints within the vicinity of the project area. No significant impacts to EFH are expected.
Marine Mammals, Reptiles & Birds	Potential indirect impacts from dredged material disposal may include ship-following behavior, temporary reductions in prey items and visual impairment of marine birds foraging in the vicinity of the disposal plume. No significant impacts to birds are expected. For marine mammals, see the following section.
Threatened & Endangered Species	Potential impacts to threatened and endangered species associated with dredged material disposal include possible collisions with dredge and support vessels, temporary decreases in foraging due to turbidity and burial of food resources and underwater noise from dredging equipment. Impacts are expected to be short-term and localized. No significant impacts to whales or sea turtles are expected.
Cultural Resources	There are known shipwrecks within the existing MBDS. A USACE archaeologist suggested a buffer of 50 meters surrounding the wrecks for dredged material disposal. Therefore, no significant impacts to these shipwrecks are expected.
Economics	There are no anticipated negative effects related to shipping or commercial fisheries.
Recreation	There will be no significant impact to recreation are expected.
Coastal Barrier Resources	The temporarily expanded MBDS will be approximately 8 nautical miles to the closest shore, there are not anticipated effects to coastal barrier resources.

Environmental Factor	Preferred Alternative
Water Quality	Short-term, localized increases to turbidity due to dredged material disposal will occur in the vicinity of the disposal site during disposal operations. These increases are evaluated by the USACE using a water quality model to prevent any violation of water quality criteria. No significant long-term impacts to water quality are expected.
Hazardous, Toxic & Radioactive Waste	The Potential Restoration Area, which includes most of the historic IWS and barrel field, will be covered by a protective layer of dredged material. This will isolate any potential contaminants, reducing any risk to fishermen in the area and reducing the risk of contaminants entering the food web.
Air Quality	Short-term air quality impacts could be associated with the transport of dredged material to the disposal site. No significant impacts are expected.
Noise	No significant impact from noise during dredged material disposal operations is expected.
Navigation	No significant impact on navigation during dredged material disposal operations is expected.
Energy Requirements & Conservation	Fuel would be consumed during the transport of dredged material to the disposal site.
Natural & Depletable Resources	Fuel would be consumed during the transport of dredged material to the disposal site.
Scientific Resources	No significant impact on scientific resources is expected.

COMPLIANCE WITH GENERAL AND SPECIFIC CRITERIA

EPA has assessed the proposed temporary modification to the MBDS according to the criteria of the MPRSA, with particular emphasis on the general and specific regulatory criteria of 40 CFR 228.5 and 228.6, to determine whether the proposed site modification satisfied those criteria. The Draft Environmental Assessment of the Expansion of the Massachusetts Bay Ocean Dredged Material Disposal Site (ODMDS) provides an extensive evaluation of the site selection criteria and other related factors considered in deciding to propose the modification of the MBDS.

General Criteria (40 CFR § 228.5):

(a) *The dumping of materials into the ocean will be permitted only at sites or in areas selected to minimize the interference of disposal activities with other activities in the marine environment, particularly avoiding areas of existing fisheries or shellfisheries, and regions of heavy commercial or recreational navigation.*

Since it’s designation in 1993, disposal at the MBDS has not interfered with other activities in the marine environment. It is anticipated that this will also be the case for the temporarily modified MBDS. The IWS has been closed by the NOAA National Marine Fisheries Service (NMFS) since 1980 to the harvesting of surf clams and ocean quahogs. There is also a warning from NOAA and the FDA on all nautical charts against harvesting fish and shellfish in the area. The expanded MBDS area has low recreational boater density and does not overlap with the shipping lanes into and out of Boston Harbor.

(b) *Locations and boundaries of disposal sites will be so chosen that temporary perturbations in water quality or other environmental conditions during initial mixing caused by disposal operations anywhere within the site can be expected to be reduced to normal ambient seawater levels or to undetectable contaminant concentrations or effects before reaching any beach, shoreline, marine sanctuary, or known geographically limited fishery or shellfishery.*

The modified MBDS will be used only for dredged material suitable for ocean disposal under the MPRSA. USACE also models disposal projects to evaluate their potential to violate water quality standards. The nearest shoreline to the modified MBDS is approximately 8 nautical miles to the north. The prevailing current is not expected to transport dredged material to surrounding beaches or shores. Temporary changes caused by the physical movement of sediment through the water column will be reduced to ambient conditions before reaching any environmentally sensitive area. SBNMS is immediately east of the site, but a steep bathymetric rise between the two features provides containment of dredged material in the deeper area containing the modified MBDS, known as Stellwagen Basin. There are no known geographically limited fisheries or shellfisheries in the project area.

(d) *The sizes of ocean disposal sites will be limited in order to localize for identification and control any immediate adverse impacts and permit the implementation of effective monitoring and surveillance programs to prevent adverse long-range impacts. The size, configuration, and location of any disposal site will be determined as a part of the disposal site evaluation or designation study.*

The size and configuration of the temporarily modified MBDS is specifically designed to allow for the IWS barrel field to be covered by suitable dredged material generated during the USACE Boston Harbor maintenance and improvement projects. The MBDS area has been monitored under the USACE Disposal Area Monitoring System (DAMOS) program since the late 1970s. This will continue at the MBDS and temporary expansion to prevent adverse long-range impacts.

(e) *EPA will, wherever feasible, designate ocean dumping sites beyond the edge of the continental shelf and other such sites that have been historically used.*

The continental shelf is over 220 nautical miles east of Boston. Therefore, transporting material to, and performing long-term monitoring at, a site located off the continental shelf is not economically or operationally feasible. The project area has been used for ocean disposal since at least the early 1900s.

Specific Criteria (40 CFR §228.6(a)):

(1) *Geographical position, depth of water, bottom topography and distance from coast.*

The temporarily expanded MBDS is located in an area of Massachusetts Bay known as Stellwagen Basin and is approximately 8 nautical miles from the nearest coastline in Gloucester, MA. The depth of the temporarily expanded site ranges from 70 – 91 meters. The seafloor in the area is primarily flat and primarily made up of silt and clay. There are two glacial knolls included within the boundaries of the temporary expansion, both roughly 20 meters high. These knolls are not included in the Potential Restoration Area and no disposal will take place on them.

(2) *Location in relation to breeding, spawning, nursery, feeding, or passage areas of living resources in adult or juvenile phases.*

The MBDS area contains Essential Fish Habitat (EFH) for various fish species, and certain threatened and endangered species of whale and sea turtle have been sighted in the vicinity of the MBDS. Furthermore, the entirety of Massachusetts Bay, and most of the larger Gulf of Maine, are designated as a critical foraging habitat for the North Atlantic Right Whale by NMFS. At the same time, NMFS has previously determined that dredged material disposal at the MBDS would not impact any of these species and restrictions are in place to ensure their safety, including vessel speed and disposal time-of-year limitations and the requirement that marine mammal observers accompany the USACE on vessels during disposal operations. Furthermore, any risk of contaminants entering the food web is expected to be minimized by the covering of the IWS barrel field.

(3) *Location in relation to beaches and other amenity areas.*

The closest beach to the temporarily expanded MBDS is 10 nautical miles away. The SBNMS is just east of the MBDS. Past dredged material disposal has not impacted the SBNMS and no impact to the SBNMS is expected with the temporary expansion of the MBDS.

(4) *Types and quantities of wastes proposed to be disposed of, and proposed methods of release, including methods of packing the waste, if any.*

The MBDS is only to be used for the disposal of dredged material that is suitable for ocean disposal under the MPRSA. The temporary expansion of the MBDS will only be used for suitable dredged material generated during the USACE Boston Harbor maintenance and navigation projects. Disposal within the temporary expansion will utilize a berm-building technique devised by the USACE in order to minimize the risk of barrel breakage or resuspension of potentially contaminated seafloor sediment.

(5) *Feasibility of surveillance and monitoring.*

The MBDS is monitored through the DAMOS program under the guidance of the SMMP. Disposal is also monitored through the National Dredging Quality Management Program to confirm accurate placement of dredged material. The area of temporary expansion will be included in the monitoring of the MBDS under the DAMOS program from the time of first disposal for as long as MBDS monitoring continues.

(6) *Dispersal, horizontal transport and vertical mixing characteristics of the area, including prevailing current direction and velocity, if any.*

Current velocities range from 0 – 30 cm/s in the MBDS area. Currents are influenced by tides in a rotational manner, but net water movement is to the southeast. Regional dredged material is primarily made up of fine sand, silt, and clay. Dredged material generated during the USACE Boston Harbor maintenance and improvement projects is primarily Boston blue clay, which is cohesive and, therefore, settles rapidly. Minimal horizontal mixing or vertical stratification of dredged material occurs, resulting in low suspended sediment concentrations. Previous modeling of initial disposal indicates no adverse impacts in the water column or violations of water quality criteria. Previous studies have demonstrated the relative immobility of dredged material at the MBDS. Storms with the potential to cause sediment resuspension are rare in Massachusetts Bay.

(7) *Existence and effects of current and previous discharges and dumping in the area (including cumulative effects).*

Beginning in the early 1900s, the historic IWS was used for the disposal of industrial, chemical, medical, low-level radioactive, and other hazardous wastes, in addition to contaminated dredged material, construction debris, derelict vessels, etc. An Interim MBDS was designated in 1977 for the disposal of dredged material and it was closed in 1993, which is when the existing MBDS was designated. Studies and monitoring of the area have shown no significant impacts on water quality, sediment quality, or marine resources. The berm-building disposal technique designed by USACE is designed to limit the resuspension of potentially contaminated seafloor sediment or hazardous materials in the area. Furthermore, placing dredged material generated during the USACE Boston Harbor maintenance and improvement projects on top of potentially contaminated materials dumped at the IWS in the past will isolate these potential contaminants under a protective layer of suitable sediments, consisting primarily of clay.

(8) *Interference with shipping, fishing, recreation, mineral extraction, desalination, fish and shellfish culture, areas of special scientific importance and other legitimate uses of the ocean.*

Extensive shipping, fishing, recreational, and scientific research activities take place in Massachusetts Bay throughout the year. Dredged material disposal operations at the MBDS have not interfered with these activities and the temporary expansion of the MBDS would also not interfere with these activities. Due to the hazardous nature of material historically disposed in the IWS, a warning to fishermen against fishing and shellfishing in the area is already included on all nautical charts and the area is closed for the harvesting of ocean quahogs and surf clams. Therefore, disposal operations in the area would not interfere with any existing fishing activity.

(9) *The existing water quality and ecology of the site as determined by available data or by trend assessment or baseline surveys.*

Monitoring at the disposal area has taken place since the late 1970s under the DAMOS program. Surveys at the MBDS have detected no significant differences in water quality or biological characteristics in the disposal site and adjacent reference areas. A Baseline Seafloor Assessment Survey for the Proposed Expansion of the MBDS was completed by the USACE in anticipation of this project and it is available on the USACE DAMOS site at http://www.nae.usace.army.mil/Missions/Disposal-Area-Monitoring-System-DAMOS/.

(10) *Potentiality for the development or recruitment of nuisance species in the disposal site.*

There are no known components of dredged material or consequences of its disposal that would attract or result in the recruitment or development of nuisance species at the expanded MBDS. Nuisance species have not been detected in any survey of the area.

(11) *Existence at or in close proximity to the site of any significant natural or cultural features of historical importance.*

There are two known shipwrecks within the boundaries of the existing MBDS: a Coast Guard vessel and a 55-foot fishing boat. Both were intentionally sunk in 1981 and are not considered to be historically significant. Additional shipwrecks have been revealed in the area during subsequent surveys. There are no identified shipwrecks within the Potential Restoration Area. Disposal operations have avoided and will continue to avoid any shipwrecks in the project area.

CONCLUSION

Based on the analysis provided in this Draft Environmental Assessment and evaluation of the alternatives, Alternatives G-1 and T-1 are recommended as the Preferred Alternative. By temporarily expanding the boundaries of the existing MBDS, we are enabling the beneficial use of the approximately 12 million cubic yards of suitable dredged material to be generated during the Boston Harbor Deep Draft Navigation Project. This dredged material will be used to create a protective cover over the barrel field of the historic IWS, reducing risk to human health and the marine ecosystem.

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1. PROJECT PURPOSE AND NEED

1.1 PROJECT AUTHORITY

1.1.1 Initial Authorization

The Administrator of the U.S. Environmental Protection Agency (EPA) has the authority to promulgate ocean dumping criteria, designate recommended ocean disposal sites, and issue permits for dumping of materials into ocean waters. Under Sections 102 and 103 of the Marine Protection, Research, and Sanctuaries Act (MPRSA) of 1972, as amended (33 U.S.C. 1412), also known as the Ocean Dumping Act, EPA and the U.S. Army Corps of Engineers (USACE) have the responsibility for ensuring that ocean dredged material disposal activities will not unreasonably degrade or endanger human health, welfare, amenities, or the marine environment.

Section 102 of the MPRSA authorizes EPA to designate sites or times at which dumping may occur and establish criteria for reviewing and evaluating permit applications. It also requires EPA, in conjunction with USACE, to develop site management and monitoring plans (SMMPs) for dredged material disposal sites. Section 103 of the MPRSA authorizes USACE to issue permits for the transportation of dredged material, subject to compliance with the EPA environmental criteria (Ocean Dumping Criteria at 40 CFR 227) and EPA concurrence with USACE's finding of compliance. Section 103(b) authorizes USACE, with EPA concurrence, to select alternative project sites of limited duration for disposal of dredged material in ocean waters when the use of a site designated by EPA is not feasible.

The MPRSA provides EPA with site modification authority under 40 CFR 228.11(a):

> *Modification in disposal site use which involve the withdrawal of designated disposal sites from use or permanent changes in the total specified quantities or types of wastes permitted to be discharged to a specific disposal site will be made through promulgation of an amendment to the disposal site designation set forth in this part 228 and will be based on the results of the analyses of impact described in Sec. 228.10 or upon changed circumstances concerning use of the site.*

1.1.2 Massachusetts Bay Disposal Site Background

It is the EPA's policy to prepare a National Environmental Policy Act (NEPA) document for all Ocean Dredged Material Disposal Site (ODMDS) designations (63 FR 58045, October 1998). There are several historic disposal sites in Massachusetts Bay and its adjacent waters of Cape Cod Bay and Salem Sound. Most of these sites are within State waters (inside the territorial sea) and are no longer active, with the exception of the Cape Cod Bay disposal site. Within the waters of Massachusetts Bay outside of the territorial sea are three sites whose boundaries overlap, one of which is the currently active Massachusetts Bay Disposal Site (MBDS), which frequently receives dredged material from the Boston area and eastern Massachusetts. The location of the three overlapping sites is shown in Figure 1.1. The other two sites are the former Interim MBDS to the east, historically known as the Foul Area Disposal Site due to the many wrecks and obstructions, and the Industrial Waste Site (IWS) to the north.

The IWS is a historic disposal site in Massachusetts Bay. Records are scarce, but it is believed that disposal of derelict vessels may have begun in the early 1900s. Disposal of construction debris, commercial waste, and dredged material also likely occurred in the early 1900s. Disposal of radioactive waste is believed to have started in the early 1940s. The IWS is known to contain barrels of radioactive, chemical and hospital waste; derelict vessels; construction debris; contaminated dredged material; etc. The chemical waste was placed in containers that were transported by barge and tugboat to the disposal location by heading and distance (prior to 1952) and later to a fixed Coast Guard Buoy. Disposal of munitions began in 1945 and, in 1952, the Atomic Energy Commission began authorizing the disposal of low-level radioactive waste. Some radiological waste was placed in concrete containers for disposal. The USACE took over permitting in 1953 (various waste) and 1957 (radioactive waste). In 1973, permitting authority was transferred to the EPA, which discontinued use of the IWS in 1977. The site was officially de-designated for disposal in 1990 (55 FR 3688). In 1977, the EPA established an Interim Massachusetts Bay Disposal Site (Interim MBDS) with a center 1 nautical mile east of the IWS for the disposal of dredged material that met the criteria set forth in 40 CFR 227.

On September 29, 1989, a Draft Environmental Impact Statement (DEIS) for the designation of the MBDS was released (EPA, 1989) and a notice of its availability was published in the Federal Register (54 FR 40177). A Supplemental Draft Environmental Impact Statement (SDEIS) was released (EPA, 1990) and a notice of its availability was published in the Federal Register on July 6, 1990 (55 FR 27886). The Final Environmental Impact Statement (FEIS) was released (EPA, 1992) and a final rule was published in the Federal Register on July 24, 1992 (57 FR 32988). In the Public Record of Decision dated January 13, 1993 (EPA, 1993), the designation of the MBDS was approved with a location south of the IWS. This site overlaps the IWS and the Interim MBDS, but the relocation protected the eastern portion of the Interim site, which was never used for disposal and, as such, was left in pristine condition. The portion of the IWS with the highest concentration of waste barrels and debris was also not included in the MBDS. Monitoring of the MBDS occurs on a regular basis as part of the USACE Disposal Area Monitoring Systems (DAMOS) program.

Stellwagen Bank, which is adjacent to the IWS and MBDS, is a rich and diverse marine habitat with a history of recreational uses, including fishing and whale watching. Under MPRSA, the Stellwagen Bank National Marine Sanctuary (SBNMS) was designated on November 4, 1992 (15 CFR 922.140). The boundary of Interim MBDS overlapped the SBNMS, which is another important factor in deciding the final location of the MBDS, as depositing material is prohibited within the boundaries of the SBNMS. Depositing material outside of the SBNMS is also prohibited if the material subsequently enters the Sanctuary, so ensuring that MBDS was a containment site was also an important factor in the designation. The final MBDS location was moved westward, away from the SBNMS, for this reason.

In April 2013, the USACE released an FEIS for the Boston Harbor Deep Draft Navigation Project, which is a plan to deepen Boston Harbor in order to accommodate larger cargo vessels. (USACE & Massport, 2013) The improvement dredging project will generate approximately 11 million cubic yards of dredged material that is suitable for open water disposal under the MPRSA. The improvement project is being preceded by a major maintenance action for Boston Harbor’s inner ship channel reaches, which includes the expansion of an existing confined aquatic disposal (CAD) cell in Boston Harbor. The major maintenance action will generate approximately 1 million cubic yards of suitable dredged material from the CAD cell excavation, which would bring the total of available dredged material to 12 million cy. The USACE has developed a method of covering the IWS barrel field with material from the Boston Harbor maintenance and improvement projects, thereby restoring the IWS. However, much of the barrel field of the IWS is not currently within the boundaries of the existing MBDS. Therefore, the EPA and USACE are working cooperatively on the development of this Environmental Assessment (EA) supporting an expansion of the MBDS.

Per the regulations at 50 CFR 1502.20, EPA is tiering the NEPA analysis associated with the expansion off of the EIS for the designation of the original site. The regulations state that the federal agency shall tier “to eliminate repetitive discussions of the same issues and focus on the actual issues ripe for decision at each level of environmental review.”

1.2 PROJECT LOCATION

The project area is located approximately 20 nautical miles east of Boston (Figure 1.1). The MBDS is a circular site centered at 42° 25.1’N, 70° 35.0’W with a radius of 1 nautical mile. The IWS is a circular site centered at 42° 25.7’ N, 70° 35.0’ W with a radius of 1 nautical mile. The area of the IWS not included in the MBDS is approximately 1 square nautical mile. There was an Interim MBDS (1977-1993), also a circular site, centered at 42° 25.7’N, 70° 34.0’W with a radius of 1 nautical mile. The MBDS has water depths ranging from 82 to 92 meters. There is a steep rise just to the east of the IWS and MBDS leading to Stellwagen Bank, which is shallower by approximately 40 meters.

NOTE: In the literature related to the IWS, the center coordinates have been reported differently in various documents. For the purposes of this action, we will be using the coordinates from the IWS De-Designation Final Rule (42° 25.7’ N, 70° 35.0’ W) (55 FR 3688, February 2, 1990).

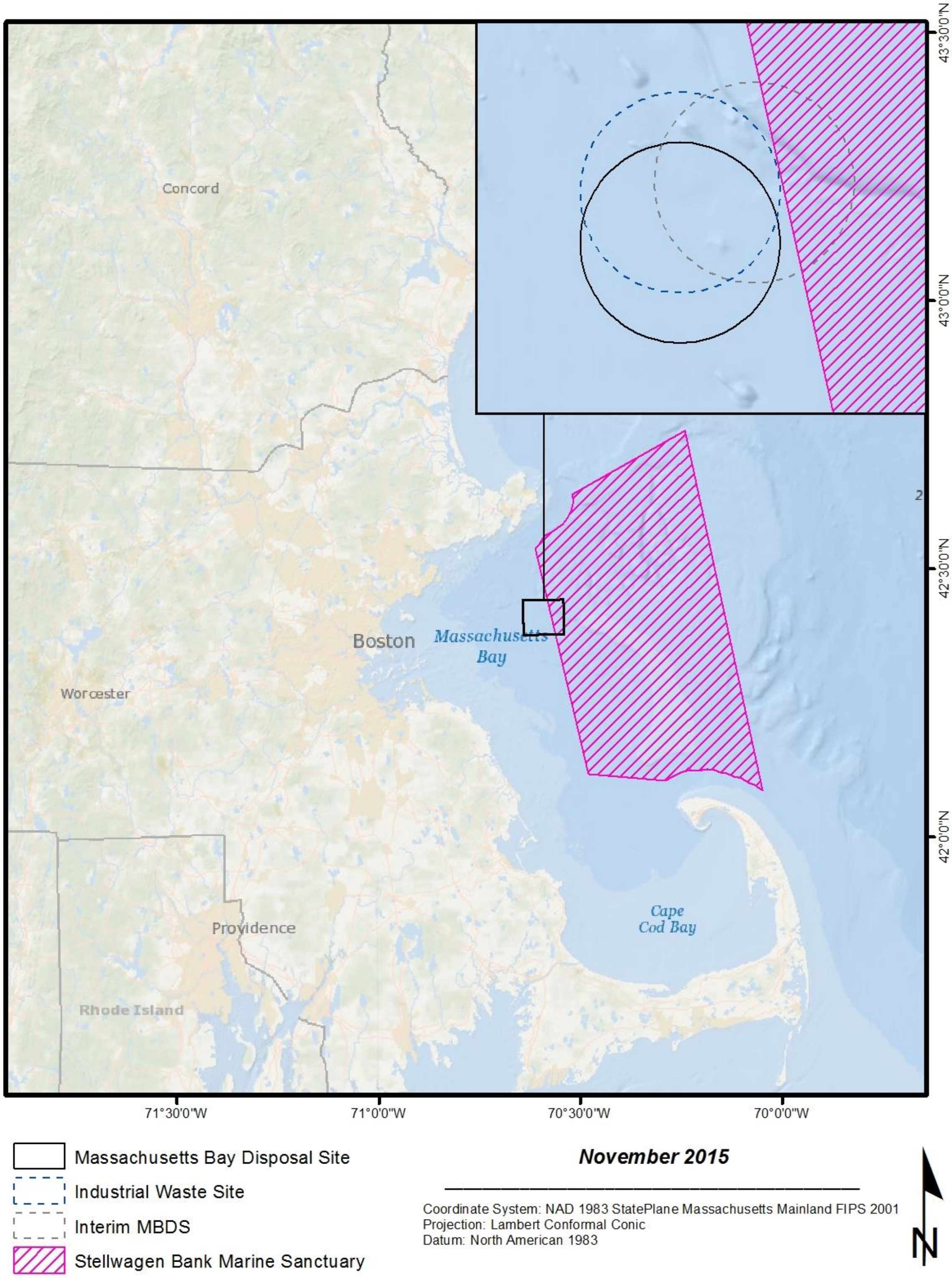


Figure 1.1 - The project area, approximately 20 nautical miles east of Boston

1.3 PROJECT NEED OR OPPORTUNITY

Though there are few records detailing the exact amount or type of materials disposed of in the IWS, it is known to include low-level radioactive wastes, munitions, explosives, ordnance, industrial and chemical waste, construction debris, and derelict vessels. Dredged material that was considered "contaminated" was also disposed of in the area prior to the advent of sediment sampling and testing procedures in the 1970s. Many of the barrels and concrete containers used to hold the waste materials are still visible in side-scan images of the seafloor, though there is evidence that some of the waste containers were shot or otherwise punctured to ensure that they would sink and/or dilute the contents, while others have broken open over time. (NOAA, 1996)

In 1971, the U.S. Food and Drug Administration (FDA) issued a warning that shellfish and other bottom-dwelling marine animals may be contaminated in the area of the IWS. In 1980, The National Oceanic and Atmospheric Administration's (NOAA) National Marine Fisheries Service (NMFS) closed the IWS to the harvesting surf clams and ocean quahogs. NOAA has included a note on the navigational charts for Massachusetts Bay, warning fishermen of the potential dangers in the IWS:

> *The U.S. Food and Drug Administration and the National Marine Fisheries Service advise all commercial and recreational fishermen to avoid harvesting fish and shellfish from the vicinity of the industrial waste site due to the undetermined location of numerous toxic waste and low level radioactive waste containers.*

Despite warnings, several containers have been inadvertently recovered by fisherman, including multiple reported instances from 1960 to 1989 and several anecdotal cases. Trawl marks from fishing vessels have also been identified during surveys of the IWS. In 1989, barrels containing industrial waste were snagged in the nets of a fishing vessel, and caused physical injury to the vessel's captain when those barrels were broken open on the deck. While doing a survey in 1992 for the FDA, a research vessel was approached by commercial lobster boats expressing concern that the survey in the IWS would interfere with their commercial traps, a research trawl area had to be adjusted due to commercial lobster gear in the path, and, when the anchor was raised, it had a lobster trap and part of a barrel entangled on it. In fact, that anchor had been contaminated with Strontium 90 (a radioactive contaminant) after apparently breaking the barrel that left the fragment. (NOAA, 1996) A portion of a 2010 side-scan sonar survey of the area was rendered unusable due to entanglement with fishing gear. (USACE, 2015)

According to a 1991 study conducted by the International Wildlife Coalition using a side-scan sonar survey and targeted ROV work, there may have been approximately 21,000 55-gallon drums disposed of at the IWS along with over 4,000 canisters of low-level radioactive waste. Of those containers, it was estimated that 28% could have still been intact and, therefore, they still posed considerable risk to both the environment and fishermen. (Wiley, et al, 1992) In a 1996 report, NOAA concluded that "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." (NOAA, 1996) The USACE also acknowledged the risks to fishermen in their Deep Draft Feasibility Study in 2013.

(USACE & Massport, 2013) There is also concern for SBNMS, which is located in the immediate vicinity of the IWS, and the potential introduction and spread of contaminants in the food web of the Sanctuary.

Studies within the IWS area have found only background levels of radiation in the sediment and biota (Curtis & Mardis, 1984; NOAA, 1996) and EPA does not believe that the barrels currently pose a significant danger to human health or the environment. However, we are proposing to restore the IWS by temporarily expanding the boundaries of the MBDS to include all or a portion of the IWS that is not currently within its boundaries. This will enable EPA and USACE to cover the areas with the highest concentration of waste barrels with sediment. This action is intended to reduce any remaining risk by preventing the spread of the low-level radioactive and industrial waste as the containment barrels corrode, isolating the contaminants so they do not enter the food web, and preventing any additional recovery of barrels by fishermen. For a number of reasons, including the potential for breaking still-sealed barrels, removal is not an option. EPA is also not recommending that the fishing advisory be lifted as part of this action.

This is a unique opportunity, as this action would require a considerable volume of sediment meeting the criteria for dredged material disposal set forth in 40 CFR 227. In their 2013 FEIS, the USACE estimated that approximately 12 million cubic yards of dredged material could be available from the upcoming Boston Harbor maintenance and improvement projects. (USACE & Massport, 2013) The expansion of the MBDS would enable the restoration of the IWS by depositing this material over the barrels and waste containers, making this a beneficial use of dredged material. The USACE would use a method of covering the barrels that significantly reduces the risk of breakage and the spread of contaminants. This method involves the creation of berms that gradually cover the barrels, preventing the dredged material from dropping directly onto them (see Section 1.7.1.2).

1.4 AGENCY GOAL OR OBJECTIVE

The EPA has identified an opportunity to reduce a potential public health and ecological threat (goal) by expanding the boundaries of the MBDS, thereby allowing the barrels and other waste containers in the IWS to be sequestered under sediment from the Boston Harbor maintenance and improvement projects.

Working cooperatively, the USACE and EPA are preparing this EA to address the alternatives, affected environment, and environmental effects of the proposed expansion (objective).

1.5 RELATED ENVIRONMENTAL DOCUMENTS

This section provides a list of key environmental documents that were used to demonstrate the need for modifying the existing MBDS and describe the existing environmental resources of the project area:

EPA. 1989. *Draft Environmental Impact Statement: Evaluation of the Continued Use of the Massachusetts Bay Dredged Material Disposal Site*. U.S. Environmental Protection Agency, Region 1.

EPA. 1990. *Supplemental Draft Environmental Impact Statement for the Designation of Dredged Material Disposal Site in Massachusetts Bay: Alternate Site Screening*. U.S. Environmental Protection Agency, Region 1.

EPA. 1992. *Final Environmental Impact Statement: Designation of an Ocean Dredged Material Disposal Site in Massachusetts Bay*. U.S. Environmental Protection Agency, Region 1.

EPA. 1993. *Public Record of Decision on the Final Environmental Impact Statement for the Designation of an Ocean Dredged Material Disposal Site in Massachusetts Bay*. U.S. Environmental Protection Agency, Region 1.

EPA. 1996. *Massachusetts Bay Disposal Site Management Plan*. U.S. Environmental Protection Agency, Region 1.

EPA. 2009. *Massachusetts Bay Disposal Site: Site Management and Monitoring Plan*. U.S. Environmental Protection Agency, Region 1.

NOAA. 1996. *The Massachusetts Bay Industrial Waste Site: A Preliminary Survey of Hazardous Waste Containers and an Assessment of Seafood Safety: May and June 1992*. U.S. Department of Commerce, National Oceanic and Atmospheric Administration. Technical Memorandum NOS ORCA 99.

Sturdivant, S; D Carey. 2017. *Baseline Assessment Survey for the Proposed Expansion of the Massachusetts Bay Disposal Site: September/October 2015*. US Army Corps of Engineers, New England District. DAMOS Contribution No. 201.

USACE; Massport. 2013. *Final Feasibility Report and Final Supplemental Environmental Impact Statement and Final Environmental Impact Report (EOEA #12958) for the Federal Deep Draft Navigation Improvement Project, Boston Harbor, Massachusetts*. U.S. Army Corps of Engineers, New England District. Massachusetts Port Authority.

USACE. 2006. *Boston Harbor Inner Harbor Maintenance Dredging Project, Final Supplemental Environmental Impact Statement: June 2006*. U.S. Army Corps of Engineers, New England District.

USACE. 2015. *Massachusetts Bay Disposal Site Restoration Demonstration Report: 2008 – 2009*. U.S. Army Corps of Engineers, New England District. DAMOS Contribution No. 198.

1.6 ISSUES AND SCOPING

1.6.1 Issues and Concerns

1.6.1.1 Capping

Prior to the designation of the MBDS, USACE explored the possibility of disposing of material unsuitable for ocean disposal under the MPRSA in the MBDS and then capping it with suitable sediment. This disposal-and-capping was discussed in the DEIS (EPA, 1989), the FEIS (EPA, 1992), and the Record of Decision (EPA, 1993). EPA determined that, similar to past and current practice at all EPA-designated disposal sites, disposal-and-capping would not be allowed in the MBDS, resulting in the following restriction from 40 CFR 228.14(b)(2)(vi):

> *Disposal shall be limited to dredged material which meets the requirements of the MPRSA and its accompanying regulations. Disposal-and-capping is prohibited at the MBDS until its efficacy can be effectively demonstrated.*

It is important to note that covering the barrels in the IWS is not considered disposal-and-capping, as it does not involve disposing unsuitable material in a designated ocean disposal site and then covering it with clean material. The barrels are already in place and have been since long before the designation of the MBDS. It is also not the intention of this EA or related materials to demonstrate the efficacy of disposal-and-capping in the MBDS. There will be no disposal of unsuitable material allowed in the MBDS as part of this project or in the future.

1.6.1.2 Disposal Procedures

The priorities of the EPA and USACE with regards to this EA are reducing the risk to humans and the ecosystem by covering barrels in the IWS that could potentially contain hazardous materials and depositing the sediment in a manner that will not unintentionally release hazardous materials by breaking barrels or disturbing potentially contaminated seafloor sediment. The USACE has developed and tested a method of disposal that factors in both of those priorities, which involves berm building to protect the barrels and surrounding sediment from direct impact. For more information, see Figure 1.2, Section 4.1.1.1 and the Massachusetts Bay Disposal Site Restoration Demonstration Report 2008 - 2009 (USACE, 2015).

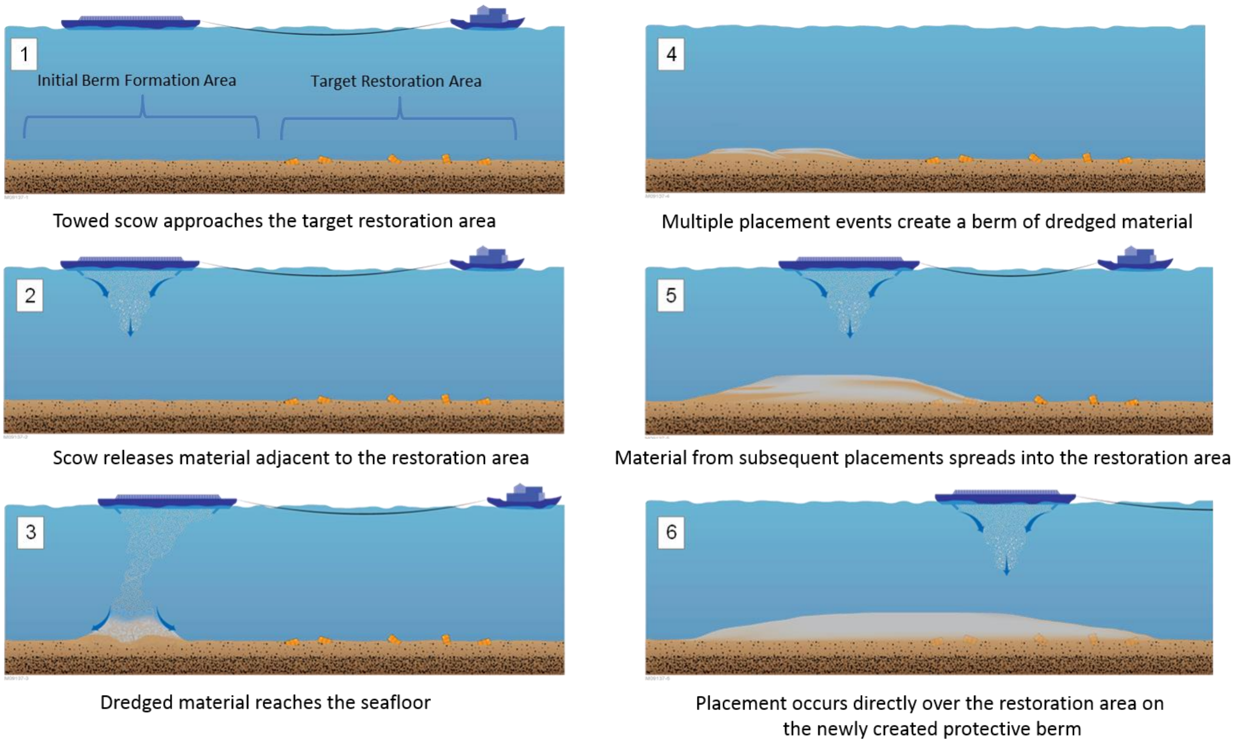


Figure 1.2 - USACE-developed method for berm building for covering barrels in the IWS (Source: USACE, 2015)

1.6.2 Scoping

Prior to issuing this EA, EPA has consulted with various state and federal agencies to solicit input on the proposed action to modify the MBDS and resource concerns associated with that action. Regular project updates have been given at the New England Regional Dredging Team (NERDT) quarterly meetings. The NERDT consists primarily of federal and state agencies. On April 16, 2014, EPA presented the tentative plans for this project at the Massachusetts Bays National Estuary Program Management Committee Meeting, which has members from federal, state, research, and nonprofit organizations. On April 9, 2015, EPA reached out to Massachusetts fishing organizations and harbormasters via e-mail to explain the project and offer to present at a future meeting. On October 19, 2015, EPA presented information about the project at the Environmental Business Council New England 9th Annual Ocean Resource Management Conference: Update on Dredging in New England, the audience for which was primarily business owners and contractors. On March 9, 2016, EPA presented the project to the Stellwagen Bank National Marine Sanctuary Advisory Board, which includes federal, state, local, nonprofit, and fishing organizations. At these meetings, there were questions about potential sediment resuspension, future monitoring the site, proximity to SBNMS, future surveys, etc. USACE presented the project to the Massachusetts Lobstermen's Association Delegates Meeting on April 19, 2017. USACE has also provided regular updates to its Boston Harbor Technical Working Group, which oversees dredging projects in the harbor and has representatives from federal and state agencies, as well as non-profit environmental organizations. No objections were raised to the proposed action or the drafting of this EA for the expansion of the MBDS for the restoration of the IWS during any scoping.

This document is intended to provide sufficient information to determine compliance with NEPA, the National Historic Preservation Act (NHPA), the Coastal Zone Management Act (CZMA), the Endangered Species Act (ESA), and the Magnuson-Stevens Fishery Conservation and Management Act (MSA). (Section 4.19)

1.6.3 Project Coordination

Although a separate Environmental Impact Statement (EIS) document was prepared for the Boston Harbor Deep Draft Navigation Project (USACE & Massport, 2013), it is closely linked to this proposed action of modifying the MBDS because the material generated in Boston Harbor will be used to restore the IWS in the expanded MBDS. Therefore, internal coordination between these projects has been conducted with personnel from USACE New England District and EPA Region 1. The projects and NEPA documents have been planned and coordinated to the extent possible. Also, information has been shared between the two projects with regard to need, classification of dredged material (e.g., volume, grain size, quality), and potential impacts associated with disposal.

1.7 PERMITS, LICENSES & ENTITLEMENTS

In 1972, Congress enacted MPRSA, which controls the transportation and the subsequent dumping of materials into ocean waters. MPRSA disallows the dumping of materials into the ocean except in accordance with permits issued by EPA. In the case of dredged material, permits allowing dumping activities are issued by the USACE. Permits are issued pursuant to criteria required under §103(a). However, the only user of this expansion will be the USACE for the disposal of material dredged generated during the Boston Harbor maintenance and improvement projects, which are Federal projects and will not require a permit.

2. ALTERNATIVES

2.1 DESCRIPTION OF ALTERNATIVES

To be considered as a potential ODMDS, alternatives are considered under the five general and eleven specific criteria of the MPRSA.

The general criteria (40 CFR 228.5) are:

a) The dumping of materials into the ocean will be permitted only at sites or in areas selected to minimize the interference of disposal activities with other activities in the marine environment, particularly avoiding areas of existing fisheries or shellfisheries, and regions of heavy commercial or recreational navigation.

b) Locations and boundaries of disposal sites will be so chosen that temporary perturbations in water quality or other environmental conditions during initial mixing caused by disposal operations anywhere within the site can be expected to be reduced to normal ambient seawater levels or to undetectable contaminant concentrations or effects before reaching any beach, shoreline, marine sanctuary, or known geographically limited fishery or shellfishery.

c) [Reserved]

d) The sizes of ocean disposal sites will be limited in order to localize for identification and control any immediate adverse impacts and permit the implementation of effective monitoring and surveillance programs to prevent adverse long-range impacts. The size, configuration, and location of any disposal site will be determined as a part of the disposal site evaluation or designation study.

e) EPA will, wherever feasible, designate ocean dumping sites beyond the edge of the continental shelf and other such sites that have been historically used.

The eleven specific criteria (40 CFR 228.6(a)) are:

1) Geographical position, depth of water, bottom topography and distance from coast;

2) Location in relation to breeding, spawning, nursery, feeding, or passage areas of living resources in adult or juvenile phases;

3) Location in relation to beaches and other amenity areas;

4) Types and quantities of wastes proposed to be disposed of, and proposed methods of release, including methods of packing the waste, if any;

5) Feasibility of surveillance and monitoring;

6) Dispersal, horizontal transport and vertical mixing characteristics of the area, including prevailing current direction and velocity, if any;

7) Existence and effects of current and previous discharges and dumping in the area (including cumulative effects);

8) Interference with shipping, fishing, recreation, mineral extraction, desalination, fish and shellfish culture, areas of special scientific importance and other legitimate uses of the ocean;

9) The existing water quality and ecology of the site as determined by available data or by trend assessment or baseline surveys;

10) Potentiality for the development or recruitment of nuisance species in the disposal site; and

11) Existence at or in close proximity to the site of any significant natural or cultural features of historical importance.

The general and specific criteria were considered in the SEIS, specifically in Section 4, for the designation of the MBDS and are incorporated here by reference. (EPA, 1990) Consideration of the criteria for the expansion alternatives are not expected to significantly deviate from the findings for the designation of the MBDS. Section 2.4 offers a comparison of the proposed alternatives and compliance with the general and specific criteria.

2.1.1 Geographic Alternatives

2.1.1.1 Alternative G-1: Expansion Covering Potential Restoration Area

Alternative G-1 would expand the MBDS to the north by including the entirety of the footprint of the Potential Restoration Area. (See Figure 2.1)(USACE, 2015) The Potential Restoration Area is based on priority areas created by the EPA using the results of side-scan sonar surveys. (Section 3.10) The MBDS would include the area of two overlapping circles:

- Center 1: 42° 25.1'N, 70° 35.0'W, 1 nautical mile radius
- Center 2: 42° 26.417'N, 70°35.373'W, 0.75 nautical mile radius

This Alternative would increase the area of the MBDS to 4.60 sq. nautical miles. The western edge is approximately 19 nautical miles from Boston. The eastern edge is approximately 0.13 nautical miles from the edge of the SBNMS. Water depths range from 70 to 91 meters.

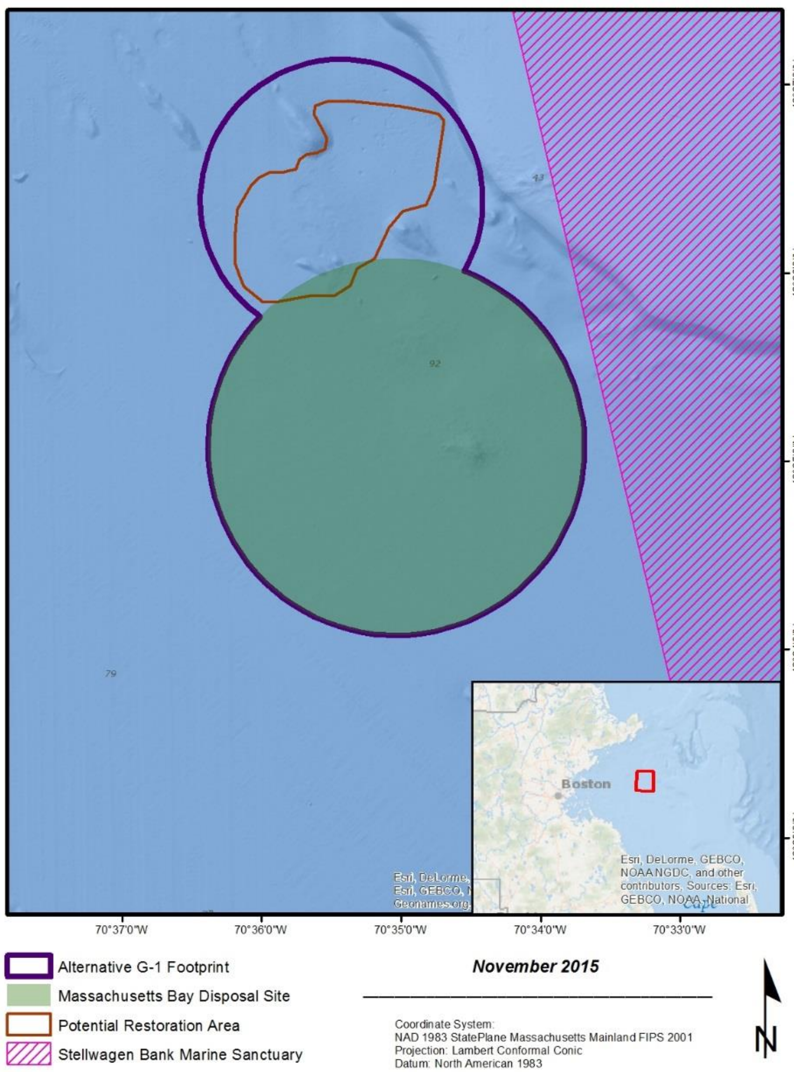


Figure 2.1 - Alternative G-1

2.1.1.2 *Alternative G-2: Expansion into Historic IWS*

Alternative G-2 would expand the MBDS to the north by including the entirety of the historic IWS (Figure 2.2). The MBDS would include the area of two overlapping circles, both with radii of 1 nautical mile:

- Center 1: 42° 25.1’N, 70° 35.0’W (MBDS)
- Center 2: 42° 25.7’N, 70° 35.0’ W (IWS)

This Alternative would increase the area of the MBDS to 4.13 sq. nautical miles. The western edge is approximately 19 nautical miles from Boston. The eastern edge is approximately 0.02 nautical miles from the edge of the SBNMS. Water depths range from 75 to 91 meters.

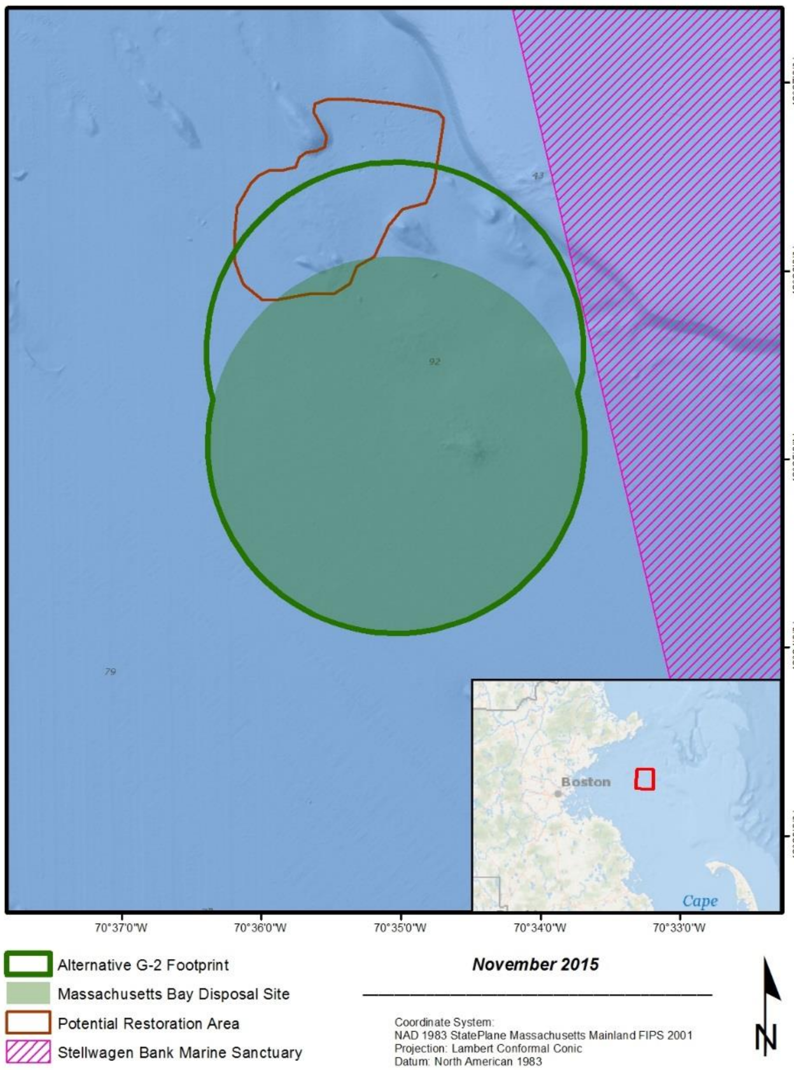


Figure 2.2 - Alternative G-2

2.1.2 Temporal Alternatives

2.1.2.1 Alternative T-1: Expansion for Duration of Boston Harbor Maintenance and Improvement Projects

Currently, the USACE is planning to begin the Boston Harbor maintenance and improvement projects in Fall 2017. Alternative T-1 would keep the expansion open for the duration of the Boston Harbor maintenance and improvement projects. The expansion would open upon the publication of the Final Rule for the temporary modification of the MBDS and automatically close after the last of the available suitable material from the Boston Harbor maintenance and improvement projects is disposed of in the MBDS.

2.1.2.2 Alternative T-2: Expansion for Three Years

Alternative T-2 would open the expansion of the MBDS for a period of three years, October 1, 2017 through September 30, 2020. Under this Alternative, the expansion would close whether the Boston Harbor maintenance and improvement projects or the restoration of the IWS was complete or not.

2.1.2.3 Alternative T-3: Permanent Expansion

Alternative T-3 would open the expansion of the MBDS permanently. The expansion would open upon publication of the Final Rule and remain open as a part of the MBDS from that point forward.

2.1.3 No Action Alternative

The No Action Alternative would mean no expansion, temporary or otherwise, of the MBDS. Material from the Boston Harbor maintenance and improvement projects would be disposed of in the currently designated MBDS and would, therefore, not be used beneficially for the restoration of the IWS.

2.2 ISSUES AND BASIS FOR CHOICE

The expansion of the MBDS is intended to restore the IWS by using dredged material from the Boston Harbor maintenance and improvement projects to cover waste barrels in an attempt to protect the safety of fishermen and the surrounding ecosystem. In order for this restoration to be effective, the expansion must include as many of the barrels as possible, it must be open concurrently with the Boston Harbor maintenance and improvement projects, and it must cover the barrels with sediment at a protective thickness. Expanding the site to cover the entire Potential Restoration Area (Alternative G-1) would ensure that the most barrels are covered and the largest area restored with the Boston Harbor sediment. Alternative G-2 encompasses the entirety of the historical IWS, but side-scan sonar surveys have shown that disposal was not limited to within the boundaries of the site. Creating an expansion that covers the portion of the

IWS not already included in the MBDS (Alternative G-2) would allow a thicker cover, but would restore a smaller area, leaving large portions of the barrel field uncovered.

Since the Boston Harbor maintenance and improvement projects are contingent on the availability of funding, various approvals, technical planning, weather, etc., it is difficult to predict the start date and duration. This uncertainty could mean that with a defined expansion period (Alternative T-2), the dredging window could be missed. Careful planning to ensure that dredged material is not disposed directly onto the waste containers or potentially contaminated seafloor sediment is necessary. In order to limit the risk of disturbing remaining uncovered barrels or potentially contaminated sediment, it would be desirable to cease disposal in the expansion after the restoration project. For this reason, the expansion of the IWS should not be permanent (Alternative T-3).

2.3 PREFERRED ALTERNATIVE

Based on the analysis provided in this EA and the evaluation of alternatives with respect to the potential issues identified, Alternatives G-1 and T-1 are recommended as the Preferred Alternatives based on environmental and operational preference.

2.4 COMPARISON OF ALTERNATIVES

Below is a comparison of the proposed alternatives and compliance with the General Criteria for designation outlined in 40 CFR 228.5 and Specific Criteria for designation outlined in 40 CFR 228.6. Table 2.1 summarizes the major features and consequences of the alternatives that were considered.

General Criteria 40 CFR 228.5:

a) *The dumping of materials into the ocean will be permitted only at sites or in areas selected to minimize the interference of disposal activities with other activities in the marine environment, particularly avoiding areas of existing fisheries or shellfisheries, and regions of heavy commercial or recreational navigation.*

> Since 1980, harvesting of ocean quahogs and surf clams has been banned by NMFS in the historic IWS area. Also since 1980, an advisory has been included in all nautical charts warning fishermen to avoid harvesting bottom-dwelling species in the historic IWS area. Despite these warning, there have been incidents of barrels being caught in trawl nets and brought onto the decks of fishing boats. A large portion of Massachusetts Bay to the west of the project area is designated as a prohibited shellfish growing area. Active lobster traps have also been spotted in the area during monitoring and scientific surveys. The project area is directly adjacent to the SBNMS, which is used for fishing and whale watching, but recreational boater density is low in the immediate vicinity of the project area. There are heavily used shipping lanes into and out of Boston Harbor, but they do not overlap with the MBDS or Geographic Alternatives. The Geographic and Temporal Alternatives are not expected to impact any of these marine activities.

b) *Locations and boundaries of disposal sites will be so chosen that temporary perturbations in water quality or other environmental conditions during initial mixing caused by disposal operations anywhere within the site can be expected to be reduced to normal ambient seawater levels or to undetectable contaminant concentrations or effects before reaching any beach, shoreline, marine sanctuary, or known geographically limited fishery or shellfishery.*

All material dredged disposed in the MBDS, including any expansion, is required to be suitable for ocean disposal pursuant to the MPRSA. USACE uses a model to evaluate all projects before disposal for their potential to violate water quality standards. The closest shoreline to the project area is approximately 8 nautical miles to the north. The prevailing current is not likely to transport dredged material to any surrounding beaches or shores. Temporary changes caused by the physical movement of sediment through the water column will be reduced to ambient conditions before reaching any environmentally sensitive area. The project area is directly adjacent to the SBNMS, but a steep bathymetric rise between the two features provides containment of dredged material in the deeper area containing the MBDS and the Geographic Alternatives, known as Stellwagen Basin. Alternative G-1 will allow for the largest number of barrels to be covered, thereby reducing the risk of potential contaminants entering the food web and potentially impacting marine populations at the SBNMS. Alternative G-1 will also allow for the coverage of a number of barrels, but leave the dense barrel field to the north uncovered. There are no know geographically limited fisheries or shellfisheries in the project area. The duration of expansion (Alternatives T-1, T-2, T-3) is not expected to have an impact.

d) *The sizes of ocean disposal sites will be limited in order to localize for identification and control any immediate adverse impacts and permit the implementation of effective monitoring and surveillance programs to prevent adverse long-range impacts. The size, configuration, and location of any disposal site will be determined as a part of the disposal site evaluation or designation study.*

The MBDS is 3.14 square nautical miles. Alternative G-1 would increase the size of the MBDS to 4.60 sq. nautical miles. Alternative G-2 would increase the size of the MBDS to 4.13 sq. nautical miles. Both Alternatives T-1 and T-2 would reduce the MBDS back to its original size after a certain time period has elapsed. Alternative T-3 would permanently expand the MBDS. Alternative G-1 was configured to allow for the coverage of the entire Potential Restoration Area, which contains the densest concentrations of barrels on the seafloor, at a protective thickness. Alternative G-2 was configured to encompass just the legal boundaries of the historic IWS. Since historic disposal was not limited to these boundaries, this Alternative does not include a large portion of the Potential Restoration Area. The IWS, Interim MBDS, and MBDS have been monitored and surveilled under the DAMOS program since the late 1970s. Monitoring at the site will continue under all Alternatives. Even of the expansion were to close after a certain time under Alternatives T-1 and T-2, the expansion would still be included in future monitoring of the MBDS.

e) *EPA will, wherever feasible, designate ocean dumping sites beyond the edge of the continental shelf and other such sites that have been historically used.*

The continental shelf is over 220 nautical miles east of Boston. Transporting dredged material to and performing long-term monitoring at a site located off the continental shelf is not economically or operationally feasible under any Alternative. Alternative G-1 includes the most heavily used portion of the historic IWS, in addition to an area north of the IWS boundary, which also contains a dense concentration of barrels on the seafloor. Alternative G-2 encompasses the entirety of the IWS, which was a designated and utilized as a disposal site from 1952 – 1977, but historically used for the disposal of various wastes since the early 1900s. The duration of expansion (Alternatives T-1, T-2, T-3) does not apply.

Specific Criteria 40 CFR 228.6(a):

1) *Geographical position, depth of water, bottom topography and distance from coast*	
No Action	**Alternatives**
The existing MBDS is within the geographic area in Massachusetts Bay known as Stellwagen Basin. The depth of the MBDS is approximately 90 meters. There is a steep bathymetric rise of roughly 50 meters to the northeast of the MBDS. The eastern edge of the MBDS is just over 0.13 nautical miles from the boundary of the SBNMS. The seafloor is flat with a makeup of primarily silt and clay. The MBDS is approximately 12 nautical miles from Cohasset, 12 nautical miles from Graves Ledge, 9 nautical miles from Eastern Point in Gloucester.	Alternative G-1: This Alternative has similar geographical position, depth, topography, and distance to coast as the currently designated MBDS. There are two glacial knolls included in this Alternative, both roughly 20 meters high. Alternative G-1 is approximately 0.13 nautical miles from SBNMS, 12 nautical miles from Cohasset, 12 nautical miles from Graves Ledge (the easternmost Boston Harbor Island), and 8 nautical miles from Eastern Point in Gloucester. Alternative G-2: This Alternative has similar geographical position, depth, topography, and distance to coast as the currently designated MBDS. There is one knoll included in this Alternative that is roughly 20 meters high. Alternative G-2 is approximately 0.02 nautical miles from SBNMS, 12 nautical miles from Cohasset, 12 nautical miles from Graves Ledge, and 9 nautical miles from Eastern Point in Gloucester. Alternatives T-1, T-2, T-3: The duration of the expansion will have no impact on the geographical position, depth of water, bottom topography, or distance from coast.

2) *Location in relation to breeding, spawning, nursery, feeding, or passage areas of living resources in adult or juvenile phases*	
No Action	**Alternatives**
There can be short-term, localized spatial impacts on plankton resulting from elevated suspended solids concentrations after disposal events. Mortality may occur to a minor extent, but there will not be a significant impact on the plankton community of Massachusetts Bay. The MBDS contains Essential Fish Habitat (EFH) for various species. Certain threatened or engendered whales and sea turtles have been sighted in the project area and the entirety of Massachusetts Bay. Most of the larger Gulf of Maine is designated as critical foraging habitat for the North Atlantic Right Whale. NMFS has previously determined that dredged material disposal at MBDS will not adversely impact of these species and restrictions are incorporated into the MBDS SMMP to ensure their safety, including speed and time-of-year restrictions.	Alternatives G-1, G-2: Impacts of disposal are expected to be the same within the Geographic Alternatives as within the No Action Alternative. Alternatives T-1, T-2: By closing the expansion after a certain period of time, impacts to plankton communities and living resources within the expansion will be limited to the duration of disposal. Alternative T-3: By permanently expanding the boundaries of the MBDS, dredged material disposal will continue to have short-term, localized impacts within the expansion.

3) *Location in relation to beaches and other amenity areas*	
No Action	**Alternatives**
The nearest beach to the MBDS is Magnolia Harbor Beach in Manchester-by-the-Sea at a distance of 10 nautical miles NNW. The boundary of the SBNMS is 0.13 nautical miles to the east of the MBDS.	Alternative G-1: The nearest beach to Alternative G-1 is Niles Beach in Gloucester at a distance of 9 nautical miles N. The boundary of the SBNMS is 0.13 nautical miles to the east of Alternative G-1. Alternative G-2: The nearest beach to Alternative G-2 is Niles Beach in Gloucester at a distance of 9.5 nautical miles N. The boundary of the SBNMS is 0.02 nautical miles to the east of Alternative G-2. Alternatives T-1, T-2, T-3: The duration of the expansion will have no impact on the location in relation to beaches and other amenity areas.

4) *Types and quantities of wastes proposed to be disposed of, and proposed methods of release, including methods of packing the waste, if any*	
No Action	**Alternatives**
The currently designated MBDS will continue to be used only for the disposal of dredged material deemed suitable for ocean disposal pursuant to the MPRSA, including those materials generated during the Boston Harbor maintenance and improvement projects. Massachusetts dredged material is primarily fine sand, silt, and clay.	Alternatives G-1 and G-2: The area encompassed by the current MBDS will continue to be used for dredged material disposal. The approximately 12 million cubic yards from the Boston Harbor maintenance and improvement projects, which is made up primarily of Boston blue clay, will be disposed of in the expansion using the berm building technique developed by the USACE to minimize the risk of breaking barrels or resuspending potentially contaminated seafloor sediment. (USACE, 2015) Alternatives T-1 and T-2: These Temporal Alternatives are intended to leave the expansion of the MBDS open for the dredged material generated during the Boston Harbor maintenance and improvement projects, which will be primarily Boston blue clay. Alternative T-3: This Alternative would keep the expanded MBDS open permanently, allowing for the disposal of sediments from any future projects permitted for disposal in the MBDS. The first disposal project in the expansion will be the Boston Harbor sediment, disposed using the USACE berm building technique.

5) *Feasibility of surveillance and monitoring*	
No Action	**Alternatives**
The MBDS is currently monitored under the DAMOS program under the guidance of the MBDS SMMP. This monitoring will continue. The National Dredging Quality Management Program is also used to confirm the accuracy of dredged material disposal.	Alternatives G-1, G-2: The expansion will be included in the monitoring of the MBDS under the DAMOS program from the time of first disposal for as long as the MBDS remains open. The close proximity of the Geographic Alternatives to the existing MBDS makes the feasibility of surveillance and monitoring similar to the No Action Alternative. Alternatives T-1, T-2, T-3: Monitoring of the MBDS expansion will continue under the DAMOS program, regardless of the duration of expansion.

6) *Dispersal, horizontal transport and vertical mixing characteristics of the area, including prevailing current direction and velocity, if any*	
No Action	**Alternatives**
Current velocities range from 0 – 30 centimeters per second at the MBDS. Currents are influenced by tides in a rotational manner, but net water movement is to the southeast. Regional dredged material is primarily made up of fine sand, silt, and clay, which is cohesive and, therefore, rapidly settling. Minimal horizontal mixing or vertical stratification of disposal material occurs, resulting in low suspended sediment concentrations. Previous USACE modeling of initial disposal indicates no adverse impacts in the water column or violations in water quality criteria. Previous studies have demonstrated the relative immobility of dredged material at the site. Winds capable of causing resuspension at the site are rare.	Alternatives G-1, G-2: Same as No Action Alternative. Alternatives T-1, T-2, T-3: The duration of the expansion will have no impact on the dispersal, horizontal transport and vertical mixing of the area.

7) *Existence and effects of current and previous discharges and dumping in the area (including cumulative effects)*	
No Action	**Alternatives**
Dredged material disposal at the MBDS has not produced any significant effects on water quality, sediment quality, or marine resources.	Alternatives G-1, G-2: Alternative G-1 encompasses a portion of the historic IWS and an area to the north with a dense concentration of barrels. Alternative G-2 encompasses the entire IWS, but not the area to the north. The IWS was used for the historic disposal of industrial, chemical, medical, radioactive, and other hazardous wastes, in addition to contaminated dredged material, construction debris, etc. Studies of the area have shown no significant impacts on water quality, sediment quality, or marine resources. The USACE berm-building disposal technique to be used when covering the barrels will ensure limited resuspension of potentially contaminated sediments or hazardous materials that are present in the area. Alternatives T-1, T-2: Under Alternatives T-1 and T-2, the expansion of the MBDS would open for a limited time period. The existing MBDS would remain open during and after the expansion period and continue to be used for the disposal of suitable dredged material. Alternative T-3: Under Alternative T-3, the MBDS would be permanently expanded, allowing for future dredged material disposal.

8) *Interference with shipping, fishing, recreation, mineral extraction, desalination, fish and shellfish culture, areas of special scientific importance and other legitimate uses of the ocean*	
No Action	**Alternatives**
Extensive shipping, fishing, recreational activities, and scientific investigations take place in Massachusetts Bay throughout the year. However, dredged material disposal operations at the MBDS have not interfered with such activities and are not expected to interfere in the future. Due to the historic disposal in the IWS, a warning to fishermen was posted on nautical charts regarding fishing and shellfishing in the area.	<u>Alternatives G-1, G-2</u>: Same as No Action Alternative. <u>Alternatives T-1, T-2, T-3</u>: The duration of expansion will have no impact on uses of the ocean.

9) *The existing water quality and ecology of the site as determined by available data or by trend assessment or baseline surveys*	
No Action	**Alternatives**
The IWS and MBDS area has been regularly monitored under the DAMOS program since the late 1970s. Site surveys at the MBDS have detected no significant differences in water quality or biological characteristics in the disposal site and adjacent reference areas.	<u>Alternatives G-1, G-2</u>: A Baseline Seafloor Assessment Survey for the Proposed Expansion of the MBDS was completed by the USACE in anticipation of this project. (Sturdivant & Carey, 2017) <u>Alternatives T-1, T-2, T-3</u>: The duration of expansion will have no impact on the existing water quality and ecology of the site.

10) *Potentiality for the development or recruitment of nuisance species in the disposal site*	
No Action	**Alternatives**
There are no known components of dredged material or consequences of its disposal which would attract or result in the recruitment or development of nuisance species at the MBDS. Nuisance species have not been detected in any study of the site.	<u>Alternatives G-1, G-2</u>: Same as No Action Alternative. <u>Alternatives T-1, T-2, T-3</u>: The duration of expansion will have no impact on the development or recruitment of nuisance species.

11) *Existence at or in close proximity to the site of any significant natural or cultural features of historical importance*	
No Action	**Alternatives**
There are two known shipwrecks within the boundaries of the MBDS: a Coast Guard vessel and a 55-foot fishing boat. Both were intentionally sunk in 1981 and are not historically significant. Additional shipwrecks have been revealed within the boundaries of the MBDS during surveys. (Sturdivant & Carey, 2017) Disposal operations have avoided and will continue to avoid all shipwrecks in the MBDS.	<u>Alternatives G-1, G-2</u>: Shipwrecks will be avoiding during dredged material disposal under both Geographic Alternatives <u>Alternatives T-1, T-2, T-3</u>: The duration of expansion will have no impact on natural or cultural features.

Table 2.1 – Summary of Direct and Indirect Impacts of Alternatives

Environmental Factor	No Action Alternative	Alternatives
Plankton (Section 4.3.1)	As a result of dredged material disposal, localized spatial impacts on plankton of short temporal duration (<4 hours) will potentially result from elevated turbidity. Mortality from physical processes or toxics may occur to a minor extent, but will not have a significant impact.	Potential impacts to plankton under the Geographic and Temporal Alternatives are similar to the No Action Alternative.
Benthos (Section 4.3.2)	Potential impacts of dredged material disposal at the MBDS include localized temporary displacement of the benthic community and possible burial of benthic invertebrates. Dredged material is typically recolonized by the benthic community soon after disposal.	The impacts will be similar to the No Action Alternative within either Alternative G-1 or G-2. The covering of barrels, however, will reduce benthic exposure to potential contaminants. Alternatives T-1 and T-2 would close the MBDS expansion after a period of time, allowing benthic recolonization without further disturbances. Alternative T-3 would keep the expansion open permanently allowing for future disturbance of the benthic community.
Fish & Shellfish (Section 4.3.3)	Potential impacts of dredged material disposal include localized mortality of some eggs and larvae through shear force or abrasion, high suspended sediment concentrations, or direct burial. There could also be mortality among demersal fish, shellfish, and some pelagic invertebrates through entrainment or burial. No significant impacts to fish and shellfish are expected.	Potential impacts to fish and shellfish under the Geographic and Temporal Alternatives are similar as the No Action Alternative.

Environmental Factor	No Action Alternative	Alternatives
Essential Fish Habitat (Section 4.3.3)	Direct effects of sedimentation and turbidity due to dredged material disposal are not expected to be substantial due to the mobility of the majority of federally managed species that may occur in within the site and the lack of geographic constraints within the vicinity of the project area. No significant impacts to EFH are expected.	Potential impacts to EFH under the Geographic and Temporal Alternatives are similar to the No Action Alternative.
Marine Mammals, Reptiles & Birds (Section 4.3.4)	Potential indirect impacts from dredged material disposal may include ship-following behavior, temporary reductions in prey items and visual impairment of marine birds foraging in the vicinity of the disposal plume. No significant impacts to birds are expected. For marine mammals, see the following section.	Potential impacts to birds under the Geographic and Temporal Alternatives are similar to the No Action Alternative.
Threatened & Endangered Species	Potential impacts to threatened and endangered species associated with dredged material disposal include possible collisions with dredge and support vessels, temporary decreases in foraging due to turbidity and burial of food resources and underwater noise from dredging equipment. Impacts are expected to be short-term and localized. No significant impacts to whales or sea turtles are expected.	Potential impacts to threatened and endangered species under the Geographic and Temporal Alternatives are similar to the No Action Alternative.

Environmental Factor	No Action Alternative	Alternatives
Cultural Resources	There are known shipwrecks within the existing MBDS. A USACE archaeologist suggested a buffer of 50 meters surrounding the wrecks for no dredged material disposal. Therefore, no significant impacts to these shipwrecks are expected.	The known shipwrecks occur within the existing MBDS and therefore will not be impacted by either the Geographic or Temporal Alternatives.
Economics	There are no anticipated negative effects related to shipping or commercial fisheries.	Potential impacts to shipping and fisheries under the Geographic and Temporal Alternatives are similar to the No Action Alternative.
Recreation	No significant impacts to recreation are expected.	Potential impacts to recreation under the Geographic and Temporal Alternatives are similar to the No Action Alternative.
Coastal Barrier Resources	The existing MBDS is approximately 9 nautical miles to the closest shore; there are no anticipated effects.	Potential impacts to coastal barrier resources under the Geographic and Temporal Alternatives are similar to the No Action Alternative.
Water Quality	Short-term, localized increases to turbidity due to dredged material disposal will occur in the vicinity of the disposal site during disposal operations. These increases are evaluated by the USACE using a water quality model to prevent any violation of water quality criteria. No significant long-term impacts to water quality are expected.	Potential impacts to water quality under the Geographic and Temporal Alternatives are similar to the No Action Alternative.

Environmental Factor	No Action Alternative	Alternatives
Hazardous, Toxic & Radioactive Waste	No significant impact on hazardous, toxic and radioactive waste is expected if the MBDS is not expanded. The barrel field will remain exposed, leaving the risk of retrieval by fishermen and potential for contaminants entering the food web.	Under Alternative G-1, a significant portion of the IWS and barrel field would be covered with material from the Boston Harbor maintenance and improvement projects. Under Alternative G-2, a smaller area and fewer barrels would be covered. Alternatives T-1 and T-3 would ensure that the entirety of the Potential Restoration Area was covered during the Boston Harbor maintenance and improvement projects. Time constraints of Alternative T-2 could mean a smaller area and fewer barrels covered.
Air Quality	Short-term air quality impacts could be associated with the transport of dredged material to the disposal site. No significant impacts are expected.	Potential impacts to air quality under the Geographic and Temporal Alternatives are similar to the No Action Alternative.
Noise	No significant impact from noise during dredged material disposal operations is expected.	Potential impacts to noise under the Geographic and Temporal Alternatives are similar to the No Action Alternative.
Navigation	No significant impact on navigation during dredged material disposal operations is expected.	Potential impacts to navigation under the Geographic and Temporal Alternatives are similar to the No Action Alternative.
Energy Requirements & Conservation	Fuel would be consumed during the transport of dredged material to the disposal site.	Potential impacts to energy requirements and conservation under the Geographic and Temporal Alternatives are similar to the No Action Alternative.
Natural & Depletable Resources	Fuel would be consumed during the transport of dredged material to the disposal site.	Potential impacts to natural and depletable resources under the Geographic and Temporal Alternatives are similar to the No Action Alternative.
Scientific Resources	No significant impact on scientific resources is expected.	Potential impacts to scientific resources under the Geographic and Temporal Alternatives are similar to the No Action Alternative.

3. AFFECTED ENVIRONMENT

The proposed MBDS expansion area is in Massachusetts Bay, approximately 20 miles east of Boston. The current MBDS and expansion alternatives are within the northeast corner of Stellwagen Basin, a large depression just to the west of Stellwagen Bank. Stellwagen Bank is an underwater shelf made up primarily of sand and gravel and rising approximately 40 meters above Stellwagen Basin. Figure 3.1 shows the project location in relation to major oceanic features. Massachusetts Bay is part of the Gulf of Maine, which extends from Nova Scotia to Massachusetts.

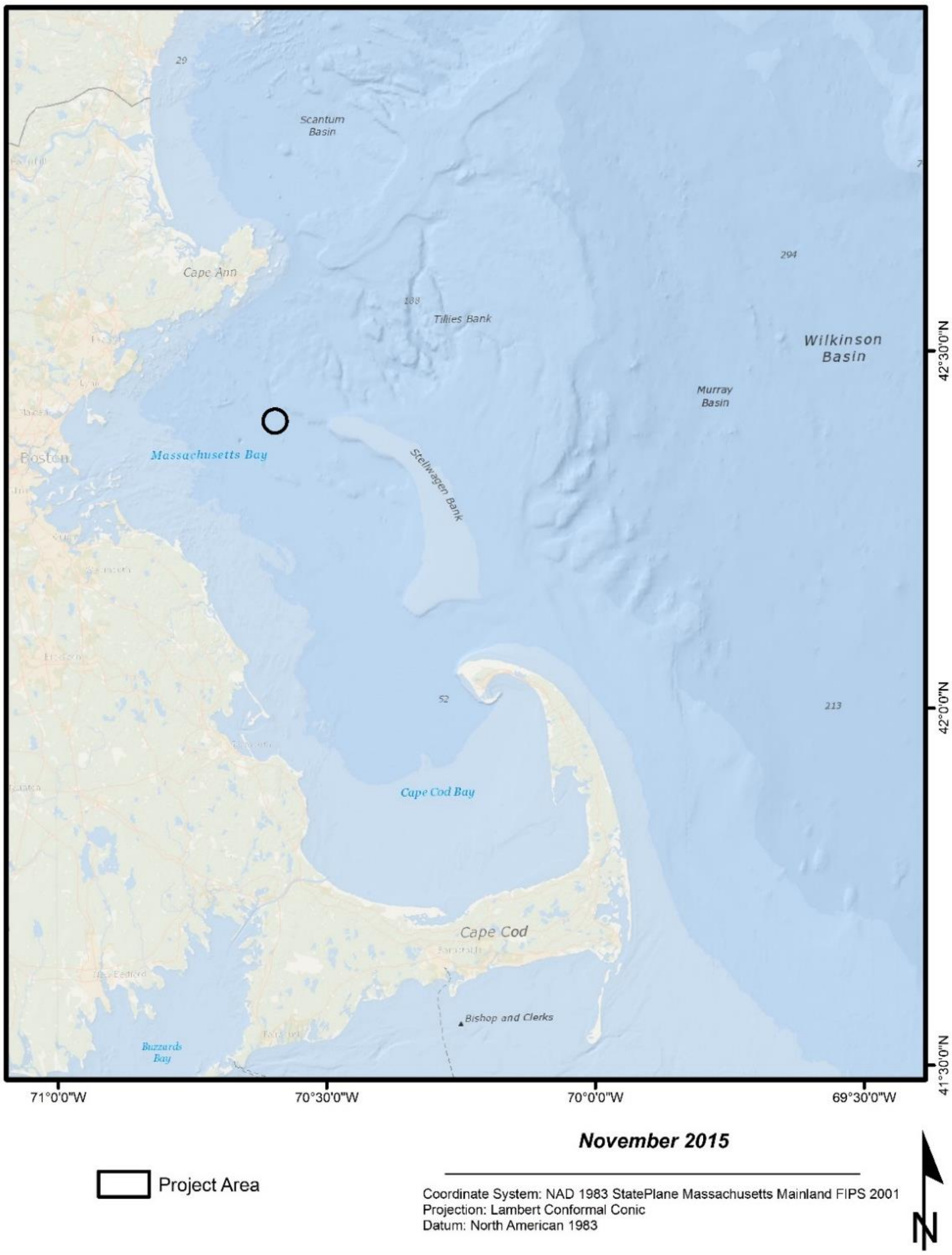


Figure 3.1 - Project location in relation to major oceanic features

3.1 PHYSICAL CHARACTERISTICS

The physical characteristics of the MBDS and surrounding area are discussed at length in the DEIS for the Designation of the MBDS (EPA, 1989 – Sections 3.1.2.1, 3.1.2.2, 3.1.2.3, 3.1.2.4, and 3.2.2.4) and the FEIS for the Boston Harbor Deep Draft Navigation Project (USACE & Massport, 2013 – Sections 3.2.1, 3.2.2, and 3.2.6). These relevant sections are incorporated here by reference. A brief overview of the physical characteristics of the MBDS area is provided below.

3.1.1 Water Masses, Temperature & Salinity

The MBDS is influenced by the coastal New England climate, low riverine inputs to the Massachusetts Bay system and the general circulation pattern of the Gulf of Maine. The water column at the MBDS behaves in a manner typical of northeastern continental shelf regions, usually with isothermal conditions of approximately 5˚ C during the winter, and stratified conditions with a maximum surface temperature near 18˚ C and a strong thermocline at 20 meters in the summer. During the late fall, the water column usually returns to isothermal conditions. (EPA, 1989) Bottom temperatures at the MBDS normally fall in a range of 3 – 5˚ C. (EPA, 1996) Salinity minima occur in the late spring as a result of increased runoff, but vary only minimally with most values ranging from 31 to 33 parts per thousand. (EPA, 1989) Due to the immediate proximity of the Geographic Alternatives to the MBDS, the water masses, temperature, and salinity are effectively identical to the existing MBDS.

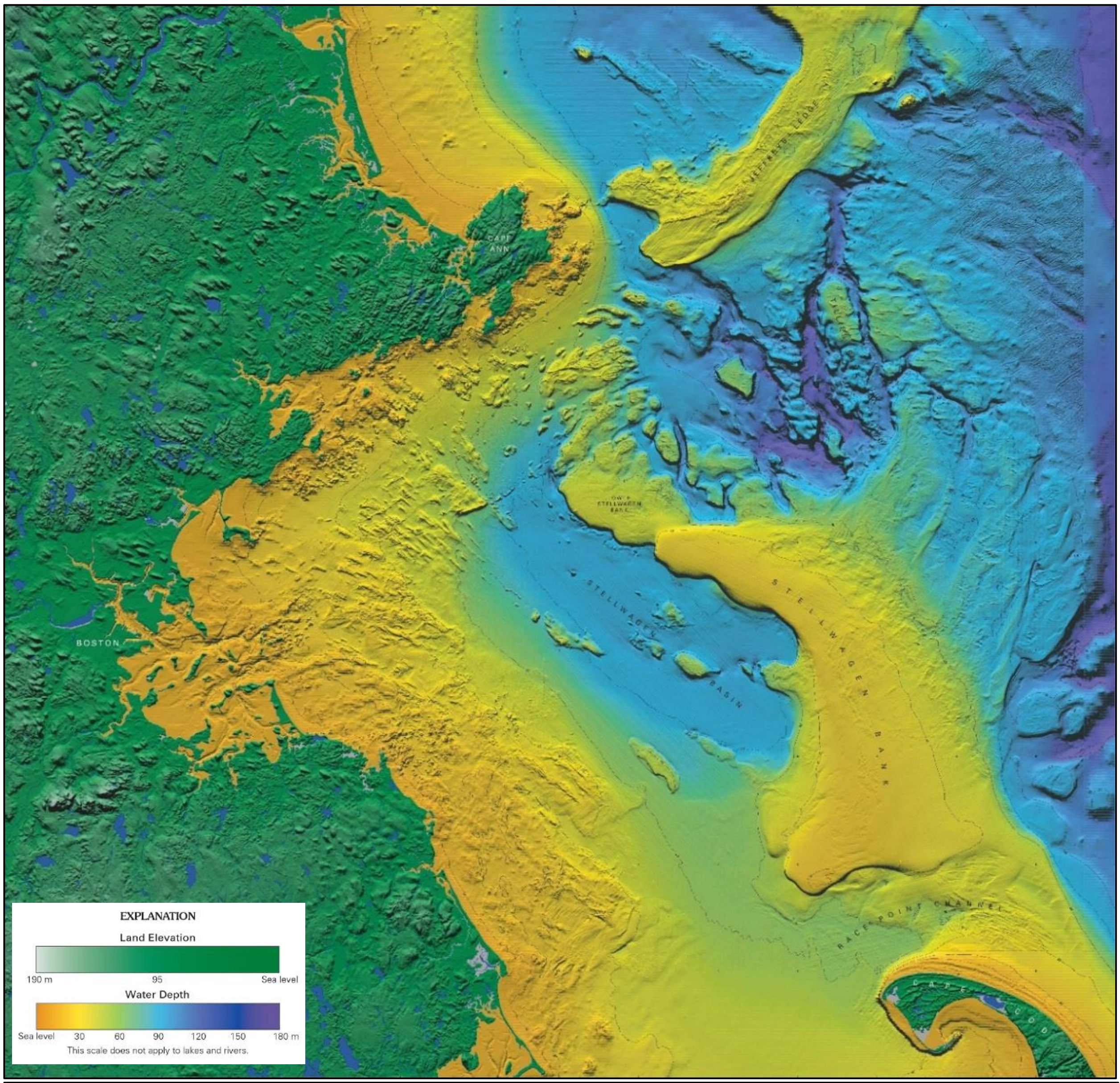
3.1.2 Circulation: Currents, Tides & Waves

Surface currents in the area of the MBDS average 10 – 20 cm/s in a primarily northeast to southwest tidal flow. Bottom currents average 4 - 7 cm/s and flow from east to west during the fall, and in a rotational flow during the winter. Extreme nor’easters or hurricanes with winds greater than 45 mph would be expected to cause resuspension of a small portion of the non-cohesive silty sediments as bottom currents may increase to 30 cm/s. These intense storms are only predicted approximately once every four years. The MBDS area is generally a depositional area, with a rate of sediment accumulation of 0.1 – 0.2 cm/year. (EPA, 1996; EPA, 2009) Due to the immediate proximity of the Geographic Alternatives to the MBDS, the currents, tides and waves are effectively identical to the existing MBDS.

3.1.3 Bathymetry

The MBDS is located in the northeast corner of Stellwagen Basin, a large depression in Massachusetts Bay ranging from 80 – 100 meters in depth. The Basin is separated from the Gulf of Maine by Stellwagen Bank, which is an underwater shelf made up of primarily glacially deposited sand and gravel rising approximately 40 meters above the Basin. The seafloor within the boundaries of the MBDS and proposed expansion areas are primarily flat and featureless, with the exception of a broad depression in the northwest of the current MBDS and two knolls made up of glacial sediments in the expansion area. See Figure 3.2 for a bathymetric map of Massachusetts Bay (Butman, et al., 2004) and Figures 3.3 and 3.4 for bathymetric contours at 5 meters for Alternatives G-1 and G-2.

The bathymetry of the project area has been confirmed by a multibeam survey conducted by the USACE DAMOS program in 2008. (USACE, 2015) A baseline survey of the project area was completed by the USACE using available bathymetric data. This survey included the collection of new multibeam bathymetric data over the Potential Restoration Area. (Sturdivant & Carey, 2017)



SHADED RELIEF, SEA FLOOR TOPOGRAPHY, AND BACKSCATTER INTENSITY
OF MASSACHUSETTS BAY AND THE STELLWAGEN BANK REGION OFFSHORE OF BOSTON, MASSACHUSETTS
By
Bradford Butman, Page C. Valentine, William W. Danforth, Laura Hayes, Laurie A. Serrett, and Tammie J. Middleton
2004

Figure 3.2 – (Source: Butman, et al., 2004)

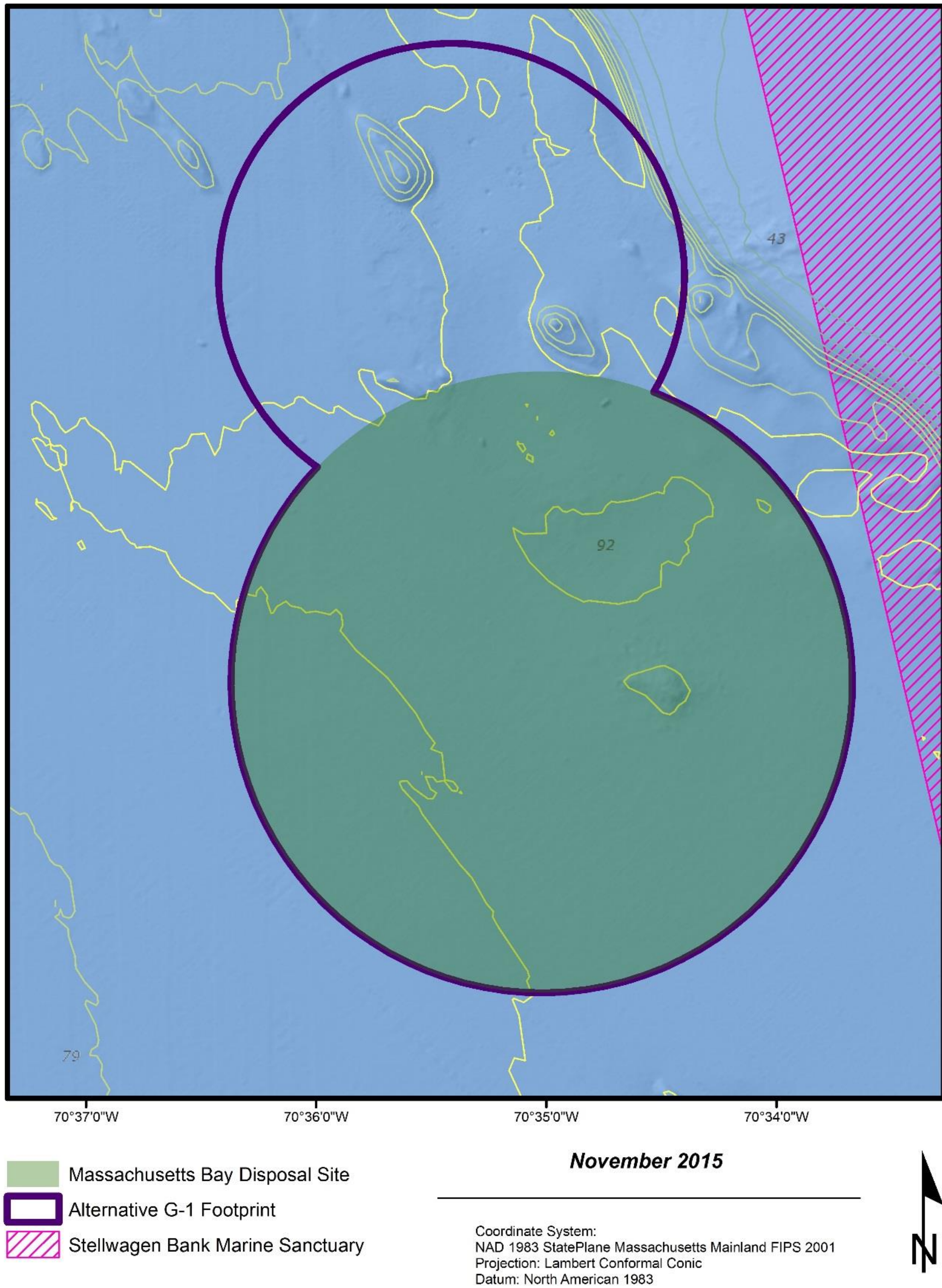


Figure 3.3 - Alternative G-1 Bathymetric Contours (Data Source: USGS)

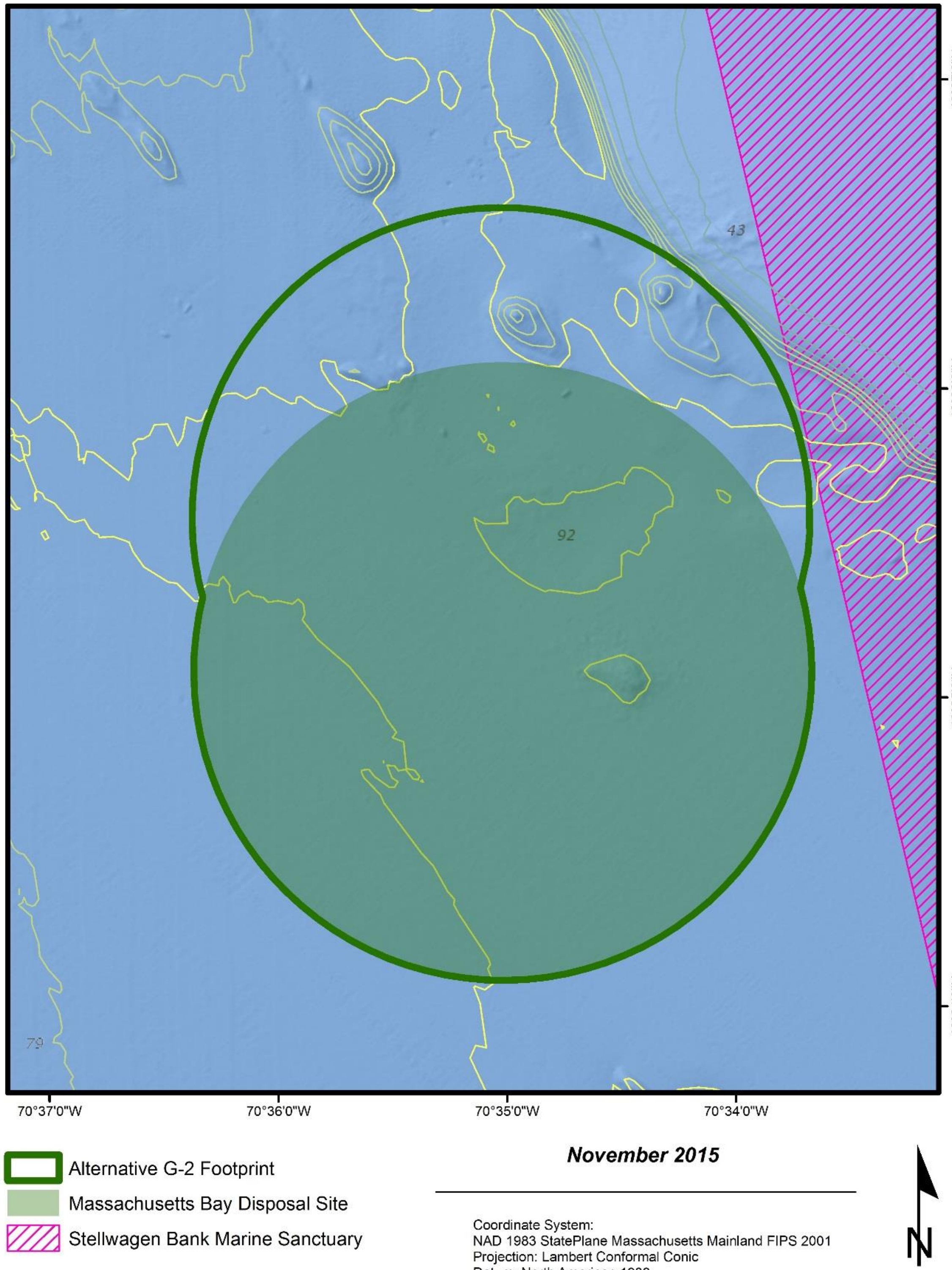


Figure 3.4 - Alternative G-2 Bathymetric Contours (Data Source: USGS)

3.1.4 Sedimentology

The seafloor sediments in the project area are primarily fine-grained silt and clay, making a soft surface. Moving north into the expansion area, the sediment becomes a sandy silt, with a mean grain size of 76μ (very fine sand) to 22μ (medium silt). The knolls within the Alternatives G-1 and G-2 are made up of glacial material, primarily coarse sand and cobble with some exposed boulders. (NOAA, 1996) The sediment becomes coarser to the west of the MBDS, transitioning to primarily sand and gravel within the SBNMS. (Balthis, et al, 2011) The area containing the MBDS and Geographic Alternatives is a depositional environment due to the slow bottom currents and basin topography. The area accumulates fine silt and clay particles at a rate of approximately 0.1 to 0.2 cm/year. (EPA, 1996) Dredged material within the MBDS consists primarily of fine silts and clays. Sediment characteristics were confirmed by the USACE during a Baseline Seafloor Assessment Survey for this project using Sediment Profile and Plan-View Imaging. (Sturdivant & Carey, 2017) (Figure 3.5)

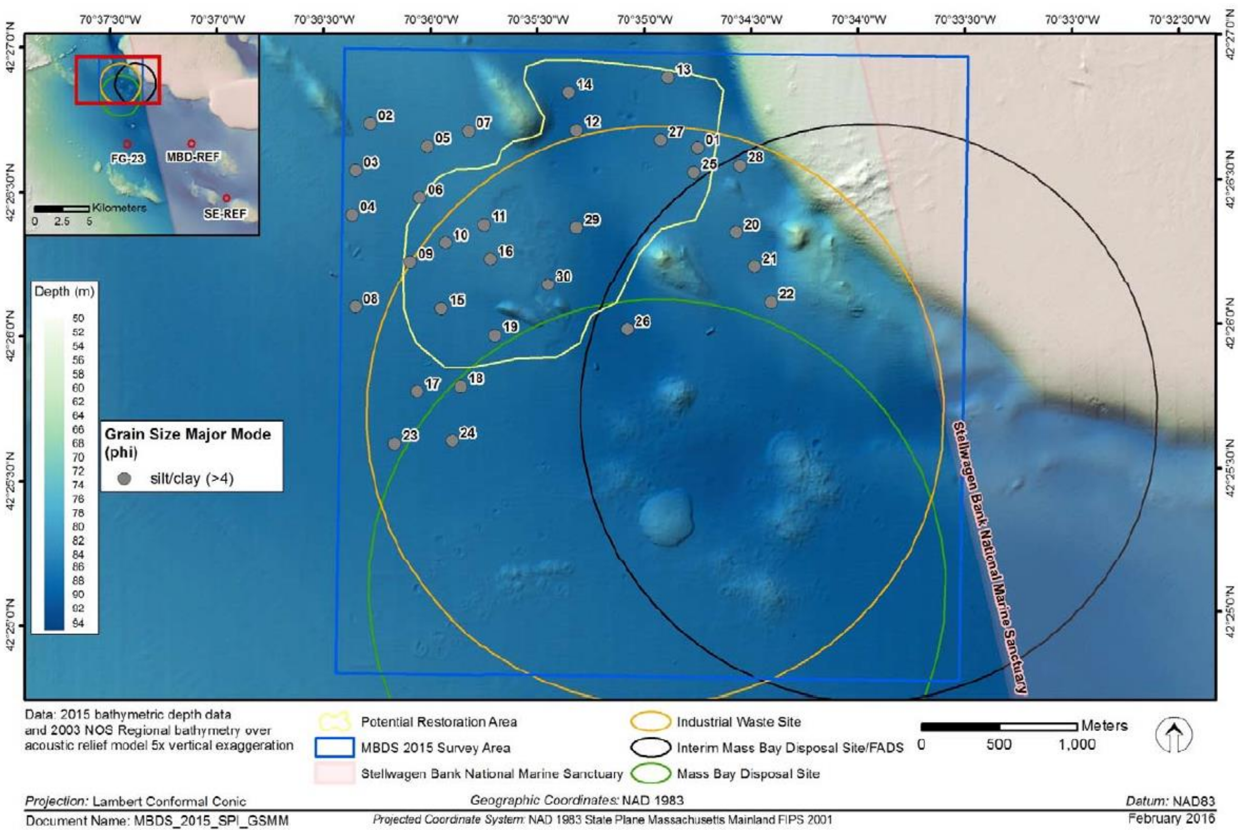


Figure 3.5 – Sample sites of sediment grain size major mode (phi units) (Source: Sturdivant & Carey, 2017)

3.2 CHEMICAL CHARACTERISTICS

3.2.1 Water Column Chemistry/Water Quality

Water quality was discussed at length in the DEIS and FEIS for the Designation of the MBDS (EPA, 1989 – Section 3.2.1; EPA, 1992 – Section 3.3.1) and the FEIS for the Boston Harbor Deep Draft Navigation Project (USACE & Massport, 2013 – Sections 3.2.3, 3.2.4 and 3.2.5). The information contained in those documents is incorporated here by reference. Studies completed after the designation of the MBDS related to the water column chemistry are summarized below.

3.2.1.1 Dissolved Oxygen

Dissolved Oxygen (DO) is monitored by the Massachusetts Water Resources Authority (MWRA) at a site in Stellwagen Basin near the project area. Average DO concentrations have rarely fallen below 6.5 mg/L in the years since monitoring began in 1992 (Libby, et al., 2015). This indicates that the water quality is excellent in this area. (See Figure 3.6) DO levels at SBNMS are also in a healthy range: 8.8 – 10.4 mg/L at the surface and 8.5 – 9.6 mg/L at the bottom. (Balthis, et al., 2011) DO has the tends to decline during the year due to stratification, respiration, and warming of the water. Real-time DO is also monitored in the area by the Northeastern Regional Association of Coastal Ocean Observing Systems (NERACOOS) Buoy A, which is located to the north of the project area within SBNMS.

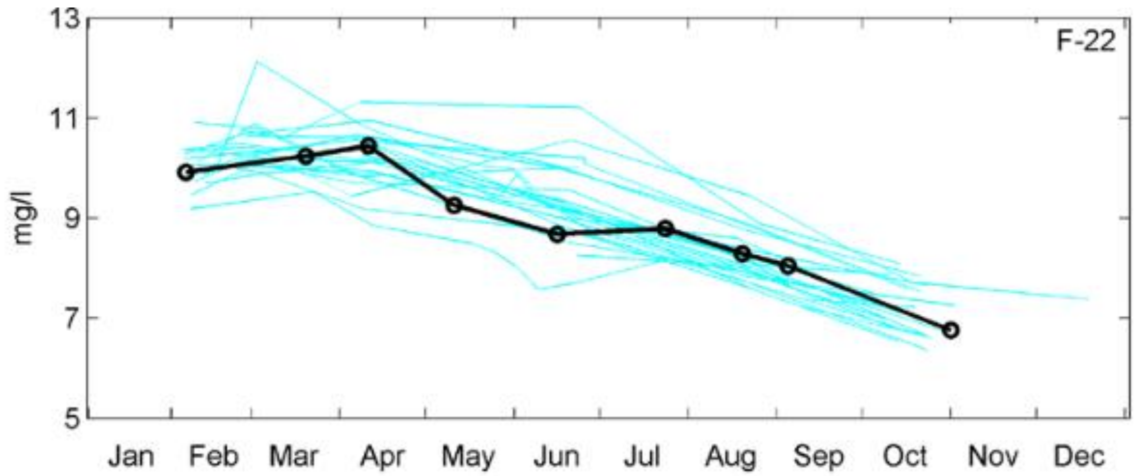


Figure 3.6 – Bottom water DO concentrations (mg/L) at MWRA Stellwagen Basin monitoring station (F22) 1992 - 2013 (light blue) and 2014 (black) (Source: Libby, et al, 2015)

3.2.1.2 pH

In the MBDS area, pH ranges from 7.4 to 8.0 and averages 7.81. (EPA, 1989) At the SBNMS, pH ranges from 7.9 – 8.0 at the surface and 7.6 – 7.8 at the bottom. Both areas are within a normal range for seawater. (Balthis, et al., 2011)

3.2.1.3 Nutrients

According to the MWRA, the outfall pipe that discharges effluent into Massachusetts Bay, might influence waters 10 – 20 km away. The MBDS area is approximately 14 km from the outfall pipe and, therefore, a significant impact is not expected. Monitoring for nitrate and silicate in Massachusetts Bay has shown no significant change since monitoring began in 1992, with a consistent seasonal pattern. Areal chlorophyll fluorescence has shown a similar seasonal pattern with some increase since 2000. (Libby et al., 2015)

3.2.1.4 Turbidity

Water in the MBDS area is generally low in suspended solids, with some higher values occurring near the seafloor caused by resuspension after storm events. (EPA, 1996) The water clarity in the project area is unlikely to be significantly affected by the MWRA wastewater outfall pipe, as it is more than 14 km away.

3.2.1.5 Metals

It is important to note that metals and other contaminants are rarely measured in marine waters. Bioaccumulation testing is commonly used as an alternate method of assessing contamination in the water column.

The annual amount of various metals discharged into Massachusetts Bay through the MWRA outfall has been measured since 1999. Metal loads have decreased over time, with zinc and copper comprising most of the annual discharge. (Figure 3.7) (Werme, et al., 2016)

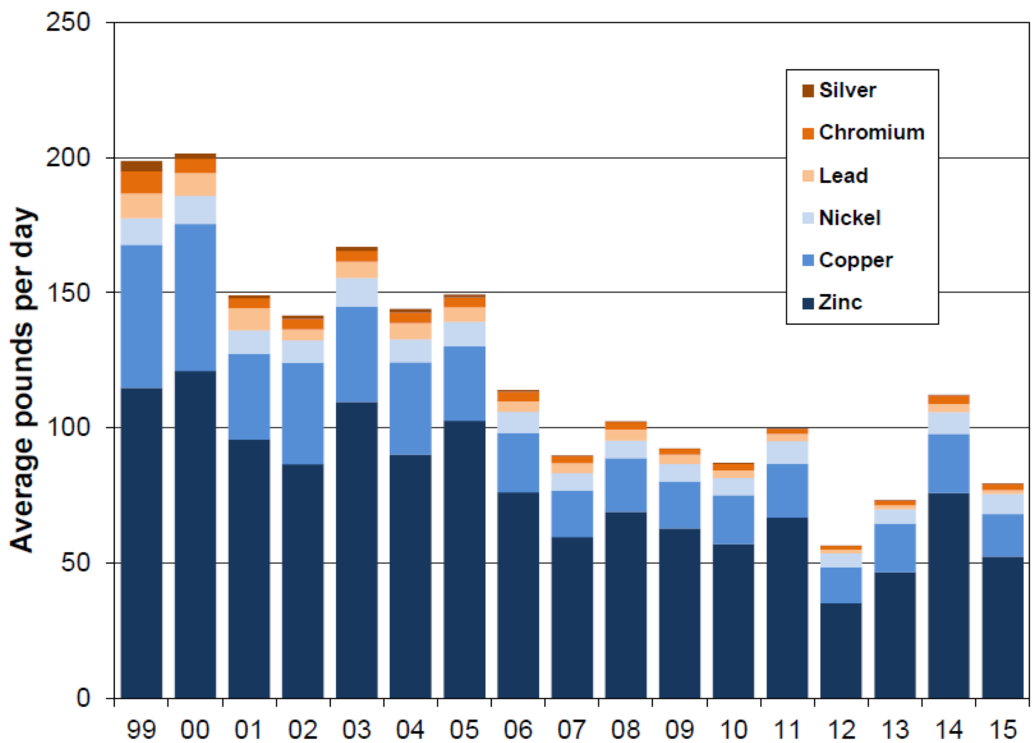


Figure 3.7 – Annual metals discharges through the MWRA effluent outfall, 1999 - 2015 (Source: Werme, et al., 2016)

Arsenic

The 1996 MBDS SMMP contains a comparison of arsenic levels in the water column from the MBDS area, Massachusetts Bay, and the Gulf of Maine. In all three locations, arsenic levels were well below Water Quality Criteria, however the levels at MBDS were slightly higher than those seen elsewhere in Massachusetts Bay. (EPA, 1996)

Cadmium

The 1996 MBDS SMMP contains a comparison of cadmium levels in the water column from the MBDS area, Massachusetts Bay, and the Gulf of Maine. In all three locations, cadmium levels were well below Water Quality Criteria. (EPA, 1996) The MWRA has estimated that cadmium loading from CSOs into Boston Harbor has decreased 84% since 1988. (Hunt, et al., 2006)

Chromium

The 1996 MBDS SMMP contains a comparison of chromium levels in the water column from the MBDS area, Massachusetts Bay, and the Gulf of Maine. In all three locations, chromium levels were well below Water Quality Criteria. (EPA, 1996) The MWRA has estimated that chromium loading from CSOs into Boston Harbor has decreased 28% since 1988. (Hunt, et al., 2006)

Copper

The 1996 MBDS SMMP contains a comparison of copper levels in the water column from the MBDS area, Massachusetts Bay, and the Gulf of Maine. In all three locations, copper levels were well below Water Quality Criteria. (EPA, 1996) The MWRA has estimated that copper loading from CSOs into Boston Harbor has decreased 71% since 1988. (Hunt, et al., 2006)

Lead

The 1996 MBDS SMMP contains a comparison of lead levels in the water column from the MBDS area, Massachusetts Bay, and the Gulf of Maine. In all three locations, lead levels were well below Water Quality Criteria. (EPA, 1996) The MWRA has estimated that lead loading from CSOs into Boston Harbor has decreased 60% since 1988. (Hunt, et al., 2006)

Mercury

The 1996 MBDS SMMP contains a comparison of mercury levels in the water column from the MBDS area, Massachusetts Bay, and the Gulf of Maine. In all three locations, mercury levels were well below Water Quality Criteria. Levels at the MBDS were slightly lower than those seen elsewhere in Massachusetts Bay. (EPA, 1996) The MWRA has estimated that mercury loading from CSOs into Boston Harbor has decreased 76% since 1988. (Hunt, et al., 2006)

Nickel

The 1996 MBDS SMMP contains a comparison of nickel levels in the water column from the MBDS area, Massachusetts Bay, and the Gulf of Maine. In all three locations, nickel levels were well below Water Quality Criteria. (EPA, 1996)

Zinc

The 1996 MBDS SMMP contains a comparison of zinc levels in the water column from the MBDS area, Massachusetts Bay, and the Gulf of Maine. In all three locations, zinc levels were well below Water Quality Criteria. (EPA, 1996) The MWRA has estimated that zinc loading from CSOs into Boston Harbor has decreased 65% since 1988. (Hunt, et al., 2006)

3.2.1.6 Organics

Polycyclic Aromatic Hydrocarbons (PAHs)

In some studies of the MBDS area, individual low-molecular-weight PAHs were detected in the water column at very low concentrations and high-molecular-weight PAHs were rarely detected. (EPA, 1996)

The MWRA reports the annual discharges of low molecular weight (LMW) PAHs and high molecular weight (HMW) PAHs to Massachusetts Bay through the effluent outfall. Annual PAH discharges in 2015 were less than 200 pounds per year, as opposed to an estimated 3,100 pounds per year in 1988. (Figure 3.8)(Werme, et al., 2016)

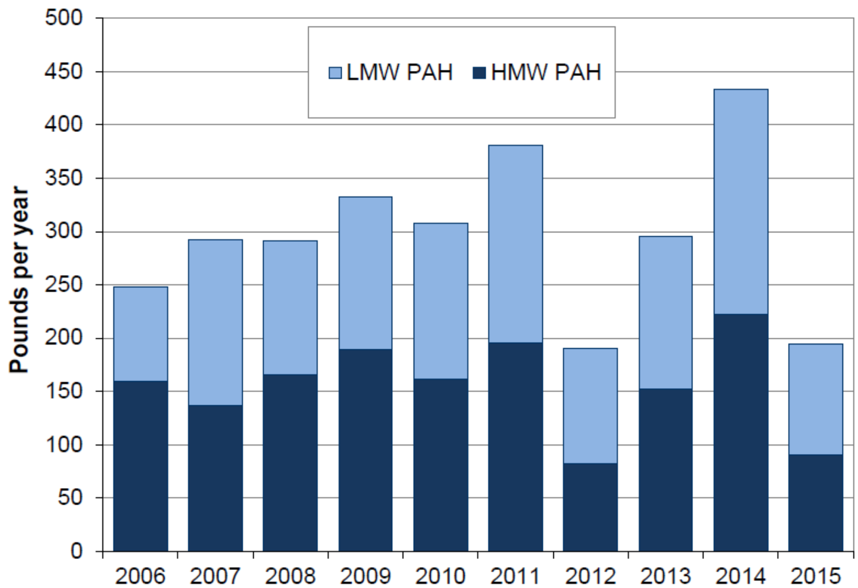


Figure 3.8 – Annual PAH discharges through the MWRA effluent outfall, 2006 - 2015 (Source: Werme, et al., 2016)

Polychlorinated Biphenyl Compounds (PCBs)

In studies of the MBDS area, PCBs and pesticides have been below detection limits in the water column. (EPA, 1996)

3.2.2 Sediment Chemistry

Sediment Chemistry was discussed at length in the DEIS and FEIS for the Designation of the MBDS (EPA, 1989 – Section 3.2.2; EPA, 1992 – Section 3.3.2). The information contained in those documents is incorporated here by reference. Studies completed after the designation of the MBDS related to sediment chemistry are summarized below.

Due to the bathymetry of Stellwagen Basin, suspended sediments and their associated contaminants can settle, resulting in some of the contamination seen in the area. However, most of the sediment contamination in the MBDS area is likely attributed to historic disposal of dredged material. (EPA, 2009) Monitoring at the historically used "BFG" buoy has confirmed higher contaminant levels at this disposal mound. (SAIC, 1997)

The sediment to be dredged during the Boston Harbor improvement project and disposed in the Potential Restoration Area has been determined to be suitable for ocean disposal pursuant to the MPRSA. Most sediment is parent material that has been "far removed from anthropogenic influences," and, therefore, has not been exposed to contaminants. (USACE, 2015) Similarly, all material being removed to form the inner harbor CAD cell, which will receive material from the upper main ship channel maintenance dredging, is also parent material; mainly Boston blue clay that has been determined suitable for ocean disposal. Any material deemed unsuitable for ocean disposal will not be disposed of in the MBDS.

3.2.2.1 Metals

Arsenic

In the Baseline Survey of the Reconfigured Massachusetts Bay Disposal Site conducted in September 1993, arsenic levels were measured using a grid in the northwest of the MBDS (BFG Buoy/12-3 Grid) and at two reference sites. As classified at the time by the New England River Basins Commission, thirteen of nineteen sample results fell within the "moderate" category of contaminated sediments, including two reference area samples. The remaining samples were in the "low" category. Arsenic concentrations in this sampling grid were similar to values seen at one reference area (18-17), but higher than the other (FG-23). (SAIC, 1997)

In a survey conducted by the EPA in 2006, sediment samples were screened for trace metals and compared against the probability of a toxic response according to the logistic regression model of Field, et al. (1999, 2002). P25% are the concentrations that would give a 25% probability of a toxic response. P50% are the concentrations that would give a 50% probability of a toxic response. Arsenic levels were slightly above the P25% level in the highest observed values and the highest observed median values. The highest observed value for arsenic was found at the reference site. (EPA, 2009)

In Massachusetts Bay in general, arsenic levels have shown some increases in Nahant, Dorchester, and Hingham Bays. (Hunt, et al, 2006) Within the SBNMS, arsenic levels were detected in excess of the effects-range low (ERL) guidelines, but below the effects-range median (ERM) guidelines. The ERL exceedances occurred over approximately 36.7% of the SBNMS, but most reflect the natural low to moderate concentration of crustal rocks in the region. The highest concentrations were seen at sampling sites far northeast of the MBDS. (Balthis, et al, 2011)

Cadmium

In the 1993 survey, cadmium levels were measured using a grid in the northwest of the MBDS (BFG Buoy/Station 12-3) and at two reference sites. All sample results fell within the "low" category of contaminated sediments. Cadmium concentrations in this sampling grid were similar to values seen at the reference areas. (SAIC, 1997)

In a 1992 NOAA survey of the IWS, concentrations of cadmium were greater than the ERM at one site in the survey, meaning the ecological risk was considered moderate. It was also determined that the elevated cadmium concentrations were likely of anthropogenic origins. (NOAA, 1996)

In a survey conducted by the EPA in 2006, cadmium levels were above P25%, but well below P50%, in the highest observed values and the highest observed median values. Results show steady cadmium levels in the area since the 1993 baseline survey. (EPA, 2009)

In Massachusetts Bay in general, cadmium levels have significantly decreased from 1994 to 2002 in both the nearfield and farfield sites monitored by the MWRA. (Hunt, et al, 2006) Within the SBNMS, cadmium levels were found to be below the ERL at all sites, including those in Stellwagen Basin. (Balthis, et al, 2011)

Chromium

In the 1993 survey, chromium levels were measured using a grid in the northwest of the MBDS (BFG Buoy/Station 12-3) and at two reference sites. Two of nineteen sample results fell within the "moderate" category of contaminated sediments. The remaining samples were in the "low" category. Chromium concentrations in this sampling grid were similar to values seen at the reference areas. (SAIC, 1997)

In a 1992 NOAA survey of the IWS, four sample areas appeared to be enriched with chromium, but none was detected at the reference site. At one site, chromium concentrations were greater than the ERM, meaning the ecological risk was considered moderate. (NOAA, 1996)

In a survey conducted by the EPA in 2006, chromium levels were above P25%, but well below P50%, in the highest observed values and the highest observed median values. Results show a slight increase in chromium levels in the area since the 1993 baseline survey. (EPA, 2009)

In Massachusetts Bay in general, chromium levels have slightly decreased at both the nearfield (Boston Harbor) and farfield (Massachusetts Bay) sites monitored by the MWRA. (Hunt, et al, 2006) Within the SBNMS, chromium levels were found to be below the ERL at all sites, including those in Stellwagen Basin. (Balthis, et al, 2011)

Copper

In the 1993 survey, copper levels were measured using a grid in the northwest of the MBDS (BFG Buoy/Station 12-3) and at two reference sites. All sample results fell within the "low" category of contaminated sediments. Copper concentrations in this sampling grid were higher than the reference areas. (SAIC, 1997)

In a 1992 NOAA survey of the IWS, some of the sample areas appeared to be enriched with copper, but none was detected at the reference site. However, the copper concentrations did not exceed the ERM, meaning the ecological risk was considered low. (NOAA, 1996)

In a survey conducted by the EPA in 2006, copper levels were above P25%, but well below P50%, in the highest observed values and the highest observed median values. Results show a slight increase in copper levels in the area since the 1993 baseline survey. (EPA, 2009)

In Massachusetts Bay in general, copper levels have remained statistically unchanged at the farfield sites monitored by the MWRA, but have shown a slight increase in the nearfield. (Hunt, et al, 2006) Within the SBNMS, copper levels were found to be below the ERL at all sites, including those in Stellwagen Basin. (Balthis, et al, 2011)

Lead

In the 1993 survey, lead levels were measured using a grid in the northwest of the MBDS (BFG Buoy/Station 12-3) and at two reference sites. One sample result fell within the "moderate" category of contaminated sediments. The remaining samples were in the "low" category. During this survey, lead showed the largest variation around the MBDS, but values were generally above the reference areas. (SAIC, 1997)

In a 1992 NOAA survey of the IWS, lead was detected and determined to likely be from anthropogenic sources. However, concentrations did not exceed the ERM, meaning the ecological risk was considered low. (NOAA, 1996)

In a survey conducted by the EPA in 2006, lead levels were above P25%, but well below P50%, in the highest observed values and the highest observed median values. Results show a slight decrease in lead levels in the area since the 1993 baseline survey. (EPA, 2009)

In Massachusetts Bay in general, lead levels have decreased slightly at the farfield sites monitored by the MWRA, and shown a small increase in the nearfield. (Hunt, et al, 2006) Within the SBNMS, one site did exceed the ERL for lead. This site is located in Stellwagen Basin, approximately four nautical miles to the southeast of the MBDS. (Balthis, et al, 2011)

Mercury

In the 1993 survey, mercury levels were measured using a grid in the northwest of the MBDS (BFG Buoy/Station 12-3) and at two reference sites. All sample results fell within the "low" category of contaminated sediments. Mercury concentrations in this sampling grid were generally higher than the reference areas. (SAIC, 1997)

In a survey conducted by the EPA in 2006, mercury levels were above P25%, but well below P50%, in the highest observed values and the highest observed median values. Results show steady mercury levels in the area since the 1993 baseline survey. (EPA, 2009)

In Massachusetts Bay in general, mercury levels have decreased at the nearfield and farfield sites monitored by the MWRA. (Hunt, et al, 2006) Within the SBNMS, one site did exceed the ERL for mercury. This site is located in Stellwagen Basin, approximately four nautical miles to the southeast of the MBDS. (Balthis, et al, 2011)

Nickel

In the 1993 survey, nickel levels were measured using a grid in the northwest of the MBDS (BFG Buoy/Station 12-3) and at two reference sites. All sample results fell within the "low" category of contaminated sediments. Nickel concentrations in this sampling grid were similar to values seen at the reference areas. (SAIC, 1997)

In a 1992 NOAA survey of the IWS, concentrations of nickel were greater than the ERM at two sites in the survey, meaning the ecological risk was considered moderate. It was also determined that the elevated nickel concentrations were likely of anthropogenic origins. (NOAA, 1996)

In a survey conducted by the EPA in 2006, nickel levels were above P25%, but well below P50%, in the highest observed values and the highest observed median values. Results show steady nickel levels in the area since the 1993 baseline survey. (EPA, 2009)

In Massachusetts Bay in general, nickel levels have decreased at the farfield sites monitored by the MWRA, and shown a slight increase in the nearfield. (Hunt, et al, 2006) Within the SBNMS, nickel levels were found to be below the ERL at all sites, including those in Stellwagen Basin. (Balthis, et al, 2011)

Zinc

In the 1993 survey, zinc levels were measured using a grid in the northwest of the MBDS (BFG Buoy/Station 12-3) and at two reference sites. All sample results fell within the "low" category of contaminated sediments. Zinc concentrations in this sampling grid were slightly higher than values seen at the reference areas. (SAIC, 1997)

In a 1992 NOAA survey of the IWS, zinc was detected and likely from anthropogenic sources. However, concentrations did not exceed the ERM, meaning the ecological risk was considered low. (NOAA, 1996)

In a survey conducted by the EPA in 2006, the highest observed zinc level was above P25%, but well below P50%. The highest observed median zinc level was slightly below P25%. Results show steady zinc levels in the area since the 1993 baseline survey. (EPA, 2009)

In Massachusetts Bay in general, zinc levels have increased at the nearfield and farfield sites monitored by the MWRA. (Hunt, et al, 2006) Within the SBNMS, zinc levels were found to be below the ERL at all sites, including those in Stellwagen Basin. (Balthis, et al, 2011)

3.2.2.2 Organics

Ammonia, Carbon, Hydrogen, and Nitrogen

In the 1993 survey, the mean total organic carbon (TOC) was 2.7%. The reference area mean was 2.4%. (SAIC, 1997) In a study conducted by NOAA in 1992 in the IWS, the mean TOC was 1.63%, with reference area mean of 2.17%. (NOAA, 1996) In a 2006 EPA survey, TOC at dredged material mounds ranged from 0.5% to 2.5%, while reference area TOC ranged from 2.5% to 3.2%. (EPA, 2009) In Massachusetts Bay, using the measurements taken by the MWRA at their farfield monitoring sites, TOC means changed from 1.1% in 1994 to 1.2% in 2002. (Hunt, et al, 2006) In the SBNMS, the mean TOC was 0.48%, with the highest recorded value of 2.57% recorded in Stellwagen Basin. (Balthis, et al, 2011) All values are well below 5%, which is the level associated with a high incidence of effects on benthic fauna.

No studies have been conducted in the project area on Ammonia, Hydrogen or Nitrogen since the designation of the site.

Oil and Grease

No studies have been conducted in the MBDS area on oil, grease, or petroleum hydrocarbons since the designation of the site.

PAHs

In the 1993 survey, PAHs were detected in the highest concentrations at the BFG disposal area with levels decreasing with distance from the mound. Reference areas had low, but detectable, PAH levels. (SAIC, 1997) A 2006 survey also found that the highest levels of PAHs were found at the BFG disposal area, but the levels were below the P50% probability level of a toxic response. In the rest of the MBDS, levels were typically at or below P25%. (EPA, 2009) In the 1992 survey of the IWS, NOAA found that, while PAHs were detected, they were comparable to levels throughout Massachusetts Bay. (NOAA, 1996) In Massachusetts Bay, monitoring done by the MWRA showed an increase in PAH concentrations of approximately 60% in both nearfield and farfield sites from 1994 to 2002. (Hunt, et al, 2006) In the SBNMS, PAHs were detected, but below the ERL at all monitoring sites. (Balthis, et al, 2011)

PCBs

In the 1993 survey, PCBs were detected in the highest concentrations at the BFG disposal area with levels decreasing with distance from the mound. (SAIC, 1997) According to the 2006 EPA survey, PCBs were detected at all disposal mounds in the MBDS at elevated levels compared to the reference areas, but they were generally below the P25% probability level of a toxic response. (EPA, 2009) Concentrations of PCBs in the IWS as measured by NOAA in 1992 were similar to concentrations at many coastal areas. (NOAA, 1996) In Massachusetts Bay, the MWRA monitoring has shown a decrease in the levels of PCBs in their farfield stations from 1994 to 2002, but an increase in the nearfield. (Hunt, et al, 2006) Within the SBNMS, PCBs were below the ERL at all monitoring sites. (Balthis, et al, 2011)

Pesticides

In the baseline survey of the MBDS conducted by the USACE in 1993, DDD, DDE, and DDT were all detected at the BFG disposal area. DDD and DDE were also detected at the reference areas. (SAIC, 1997) According to the 2006 EPA survey, pesticides were detected at all disposal mounds in the MBDS at elevated levels compared to the reference areas, but they were generally below the P25% probability level of a toxic response. (EPA, 2009) During the 1996 NOAA survey, pesticides were detected within the IWS but at levels similar to many coastal areas. (NOAA, 1996) In Massachusetts Bay, DDT concentrations dramatically decreased in both the farfield and nearfield MWRA monitoring stations from 1994 to 2002. (Hunt, et al, 2006) Within the SBNMS, pesticides were below the ERL at all monitoring sites. (Balthis, et al, 2011)

3.2.3 Biotic Residues

Biotic residues were discussed at length in the DEIS and FEIS for the Designation of the MBDS (EPA, 1989 – Section 3.2.3; EPA, 1992 – Section 3.5). The information contained in those documents is incorporated here by reference. Studies completed after the designation of the MBDS related to biotic residues are summarized below.

Surveys of finfish and shellfish were conducted by NOAA and the FDA in 1992 (NOAA, 1996). The focus of these surveys was the evaluation of contaminants in edible seafood and the potential risk, if any, associated with consumption of seafood harvested near the IWS. A secondary survey of whole fish was done to evaluate the contaminant body burdens within fish and shellfish to provide a preliminary estimate of ecological risk at the IWS. Samples were collected from the IWS and a reference site in Massachusetts Bay.

A survey of chemical contaminants in fish tissues was also conducted by NOAA within the boundaries of the SBNMS in 2008 (Balthis, et al, 2011). Samples were collected at 18 stations using hook and line fishing and the edible tissue was tested.

3.2.3.1 Metals

Arsenic

In the 1992 NOAA study, nearly all edible finfish, shellfish, lobster meat, and lobster tomalley samples contained measurable levels of arsenic (0.08 – 8.9 ppm wet weight (ww)). Arsenic was detected at measurable levels in all species of whole fish tested (4.0 – 68.7 ppm ww). Whelk (230 - 775 ppm ww) and spider crab (34.7 – 77.6 ppm ww) also showed measurable levels of arsenic. Some samples collected during this survey contained higher levels of arsenic than found in historical surveys. (NOAA, 1996)

The 2008 NOAA survey within SBNMS measured total arsenic and inorganic arsenic concentrations in fish tissues. The levels of total arsenic ranged from 1.272 – 31.984 µg/g ww. The levels of inorganic arsenic ranged from 0.025 – 0.640 µg/g ww, and three samples fell between the EPA issued human health guidelines lower and upper levels (0.35 – 0.70 µg/g ww) based on concentrations associated with non-cancer health endpoint risk for consumption of four 8-oz. meals per month. (Balthis, et al, 2011)

Cadmium

In the 1992 NOAA study, nearly all edible finfish and shellfish samples had no detectible levels of cadmium, with the exception of three sea scallop samples and one yellowtail flounder sample (0.092 – 0.547 ppm ww). All lobster meat and lobster tomalley samples had measurable levels of cadmium (0.0 – 9.28 ppm ww). Cadmium was detected at measurable levels in all species of whole fish tested (0.03 – 0.13 ppm ww). Whelk (13.9 – 34 ppm ww) and spider crab (2.25 – 77.6 ppm ww) also showed measurable levels of cadmium. All samples collected in this survey were below historical cadmium concentrations. (NOAA, 1996)

The 2008 NOAA survey within SBNMS measured cadmium concentrations in fish tissues, which ranged from 0.000 – 0.005 µg/g ww. No samples exceeded the EPA issued human health guidelines lower level (0.35 µg/g ww) based on concentrations associated with non-cancer health endpoint risk for consumption of four 8-oz. meals per month. (Balthis, et al, 2011)

Chromium

In the 1992 NOAA study, chromium was detected at measurable levels in all species of whole fish tested (1.1 – 10.7 ppm ww). Whelk (1.9 – 2.4 ppm ww) and spider crab (1.6 – 3.0 ppm ww) also showed measurable levels of chromium. (NOAA, 1996)

The 2008 NOAA survey within SBNMS measured chromium concentrations in fish tissues, which ranged from 0.065 – 0.334 µg/g ww. (Balthis, et al, 2011)

Copper

In the 1992 NOAA study, copper was detected at measurable levels in all species of whole fish tested (1.36 – 15.2 ppm ww). Whelk (236 – 546 ppm ww) and spider crab (78.9 – 116 ppm ww) also showed measurable levels of copper. Some samples collected during this survey contained higher levels of copper than found in historical surveys. (NOAA, 1996)

The 2008 NOAA survey within SBNMS measured copper concentrations in fish tissues, which ranged from 0.209 – 1.060 µg/g ww. (Balthis, et al, 2011)

Iron

The 2008 NOAA survey within the SBNMS measured iron concentrations in fish tissues, which ranged from 2.665 – 19.924 µg/g ww. (Balthis, et al, 2011)

Lead

In the 1992 NOAA study, nearly all edible finfish, shellfish, lobster meat, and lobster tomalley samples contained measurable levels of lead (0.0 – 1.030 ppm ww). Lead was detected at measurable levels in all species of whole fish tested (0.09 – 3.11 ppm ww). Whelk (1.48 – 1.93 ppm ww) and spider crab (0.79 – 31.9 ppm ww) also showed measurable levels of lead. Some samples collected during this survey contained higher levels of lead than found in historical surveys. (NOAA, 1996)

The 2008 NOAA survey within SBNMS measured lead concentrations in fish tissues, which ranged from 0.000 – 0.086 µg/g ww. (Balthis, et al, 2011)

Mercury

In the 1992 NOAA study, nearly all edible finfish, shellfish, lobster meat, and lobster tomalley samples had measurable levels of mercury (0.0 – 0.27 ppm ww), which were all well below the FDA Action Level of 1 ppm ww. Mercury was detected at measurable levels in all species of whole fish tested (0.08 – 0.8 ppm ww). Whelk (1.83 – 5.51 ppm ww) and spider crab (0.27 – 0.3 ppm ww) also showed measurable levels of mercury. Some samples collected during this survey contained higher levels of total mercury than found in historical surveys. (NOAA, 1996)

The 2008 NOAA survey within SBNMS measured methylmercury concentrations in fish tissues, which ranged from 0.024 – 0.371 µg/g ww. Six samples fell between the EPA issued human health guidelines lower and upper levels (0.12 – 0.23 µg/g ww) based on concentrations associated with non-cancer health endpoint risk for consumption of four 8-oz. meals per month. One sample exceeded the upper level human health guideline. The exceedance of the upper guideline took place at a station in the northern portion of SMBS, approximately 10 nautical miles from the project area, in the Gloucester Basin. (Balthis, et al, 2011)

Zinc

In the 1992 NOAA study, zinc was detected at measurable levels in all species of whole fish tested (16 – 77 ppm ww). Whelk (1120 - 5710 ppm ww) and spider crab (172 - 203 ppm ww) also showed measurable levels of zinc. (NOAA, 1996)

The 2008 NOAA survey within SBNMS measured zinc concentrations in fish tissues, which ranged from 3.066 – 9.514 µg/g ww. (Balthis, et al, 2011)

3.2.3.2 Organics

PAHs

The NOAA 1992 survey tested for 10 different PAHs. Finfish samples showed non-detectable and trace levels. Sea scallops, lobster meat, and lobster tomalley samples all showed measurable levels of PAHs. This data is comparable to other areas of Massachusetts Bay, which generally has some of the highest levels of PAHs in the country. (NOAA, 1996)

The 2008 NOAA survey within the SBNMS measured the concentration of various PAHs in fish tissues, which ranged from 0.000 – 4.154 ng/g ww. No samples exceeded the EPA issued human health guidelines lower level for benzo[a]pyrene (1.6 ng/g ww) based on concentrations associated with cancer health endpoint risk for consumption of four 8-oz. meals per month. (Balthis, et al, 2011)

PCBs

Of the 55 samples of finfish, lobster meat and shellfish analyzed in the 1992 NOAA study, PCBs were not detected or detected at trace levels in the majority of samples. Five samples (two American Lobster meat samples, one witch flounder sample, and two sea scallop samples) exceeded trace detection between 0.13 ppm ww and 0.62 ppm ww of PCBs. In addition, 12 samples of lobster tomalley were collected and all had measurable levels of PCBs (1.1 ppm ww average). These levels are all comparable to the range of levels of PCBs found throughout Massachusetts Bay. PCBs were detected at measurable levels in nearly every species of whole fish, whelk, and spider crab tested (with the exception of American plaice) with a range of 0.05 – 0.4 ppm ww. (NOAA, 1996)

The 2008 NOAA survey within SBNMS measured PCB concentrations in fish tissues, which ranged from 0.437 – 51.125 ng/g ww. No samples fell between the EPA issued human health guidelines lower and upper levels (23 – 47 ng/g ww) based on concentrations associated with non-cancer health endpoint risk for consumption of four 8-oz. meals per month. One sample did exceed the upper level human health guideline. The exceedance of the upper guideline took place at a station in the southwestern portion of SMBS, more than 10 nautical miles from the project area. (Balthis, et al, 2011)

Pesticides

In the 1992 NOAA study, all fish, shellfish, and lobster meat analyzed for pesticides showed non-detectable or trace levels. Of the lobster tomalley samples, 11 of 12 showed measurable levels of pesticides (0.0 – 1.20 ppm ww), all well below the FDA Action Level of 5 ppm ww. Pesticide concentrations were uniformly low in all samples of whole fish (<1 ppm ww). (NOAA, 1996)

The 2008 NOAA survey within SBNMS measured the concentrations of various pesticides in fish tissues, which ranged from 0.000 – 14.058 ng/g ww. No samples for any pesticide exceeded the EPA issued human health guidelines lower level based on concentrations associated with non-cancer health endpoint risk for consumption of four 8-oz. meals per month. (Balthis, et al, 2011)

3.3 BIOLOGICAL CONDITIONS

3.3.1 Plankton Resources

Plankton resources were discussed at length in the DEIS for the Designation of the MBDS (EPA, 1989 – Section 3.3.1). The information contained in that document is incorporated here by reference. Studies completed after the designation of the MBDS related to the plankton resources of the project area are summarized below.

The MWRA regularly monitors phytoplankton and zooplankton at a site near the project area (Station F22). Throughout Boston Harbor and Massachusetts Bay, there has been a decrease in phytoplankton abundance and an increase in zooplankton abundance. These trends are likely due primarily to large-scale regional patterns. (See Figure 3.9)(Werme, et al., 2016)

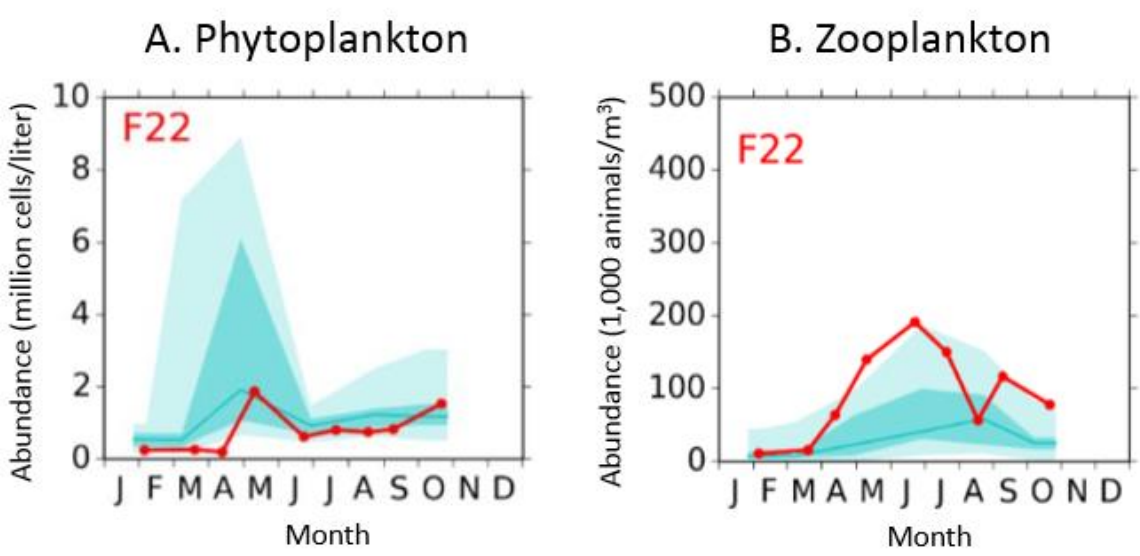


Figure 3.9 - Total plankton abundance at Station F22 in 2015 compared to prior years. Red points and line are results from individual surveys in 2015. Results from 1992 - 2014 are in blue: line is 50th percentile, dark shading spans the 25th to 75th percentile, and light shading spans the range. (Source: Werme, et al., 2016)

3.3.2 Benthos

The benthic community was discussed at length in the DEIS for the Designation of the MBDS (EPA, 1989 – Section 3.3.2). The information contained in that document is incorporated here by reference. Studies completed after the designation of the MBDS related to the benthic community are summarized below.

The benthic infauna in the soft, undisturbed sediments in MBDS are dominated by spionid, paraonid, and capitellid polychaetes, which is typical in Massachusetts Bay. There are also bivalve mollusks (*Yoldia*) and sea cucumbers (*Molpadia*) occurring primarily 2 to 15 cm in depth. The benthic communities on dredged material mounds had higher relative abundances of oligochaetes and other small, opportunistic spionid polychaetes. This is due to the nature of the disturbed sediment with, sometimes, high organic content. Sandy sediments in the northeast of the MBDS are dominated by suspension feeding bivalves and hard bottom species. (EPA, 1996)

Within Alternatives G-1 and G-2, there are glacial knolls (see Figures 3.3 and 3.4). Attached to this cobble substrate, there are flourishing communities of anemones, tunicates, brachiopods, hydroids, bryozoans, and sponges. (NOAA, 1996)

The depositional environments in Massachusetts Bay, like Stellwagen Basin and Gloucester Basin, have lower densities and number of taxa of benthic infauna than in Stellwagen Bank. The dominant species are various polychaete families (Lumbrineridae, Spionidae, Ampharetidae, Paraonidae), bivalve molluscs (Thyasiridae), and other polychaete worms (Maldanidae, Cirratulidae, Trichobranchidae, Cossuridae, Orbiinidae). (Balthis, et al. 2011)

Using sediment profile imaging and plan view (SPI/PV), a benthic characterization of the project area was completed in 2016. Despite the presence of historic dredged material disposal, the majority of sampling stations did not differ from the reference area stations. The Potential Restoration Area had similar physical and biological benthic characteristics with the ambient seafloor, indicating that, with time and a cessation in persistent disposal activity, benthic communities can recover and mirror undisturbed areas. (Sturdivant & Carey, 2017)

3.3.3 Fish & Shellfish

Fish and shellfish were discussed at length in the DEIS for the Designation of the MBDS (EPA, 1989 – Section 3.3.3). The information contained in that document is incorporated here by reference. Studies completed after the designation of the MBDS related to fish and shellfish are summarized below.

The predominant fisheries in the project area are groundfish, flatfish, and other bottom dwelling fish, the most common being the American plaice and the witch flounder. The most important and abundant shellfish are the American lobster and ocean quahog. The commercially and recreationally important finfish and shellfish observed in the project area are listed below. (EPA, 1996)

Bottom-Dwelling Fish:
American plaice
Atlantic cod
Yellowtail flounder
Witch flounder
Ocean pout
Red hake
Silver hake
Longhorn sculpin
Sea raven
Winter flounder
Haddock
Goosefish
Thorny skate
Pollock
White hake
Redfish

Pelagic or Semi-Demersal Fish:
Spiny dogfish
Sandlance
Atlantic herring
Atlantic menhaden

Shellfish:
American lobster
Sea scallop
Longfin squid
Ocean quahog
Northern shrimp

Higher concentrations of fish were noted on the glacial knolls in Alternatives G-1 and G-2. (NOAA, 1996) It is assumed that peak concentrations of planktonic larval fish eggs occur in the area in late spring and early summer, and that larval abundance peaks in spring and summer. (EPA, 1996)

Recent surveys have found increasing numbers of flounder with blind surface ulcers. The incidence rate in Stellwagen Basin ranges from 10% - 40%, which is less than in western Massachusetts Bay. (EPA, 2009)

The 1996 amendments to the Magnuson-Stevens Fishery Conservation and Management Act requires the identification of Essential Fish Habitat (EFH) for federally managed fishery species and the implementation of measures to conserve and enhance this habitat. An EFH describes all waters and substrate necessary for fish spawning, breeding, feeding, or growth to maturity. The list of species with an EFH in the project area is included in Table 3.1.

Table 3.1 - Essential Fish Habitat (EFH) in the project area. Data queried from the NOAA NMFS Habitat Conservation EFH Mapper (http://www.habitat.noaa.gov/protection/efh/efhmapper/index.html) on February 21, 2017.

Species	Eggs	Larvae	Juveniles	Adults
American plaice	X	X	X	X
Haddock	X	X	X	
Thorny skate			X	X
Smooth skate			X	
Ocean pout	X	X	X	X
Witch flounder	X	X	X	X
Yellowtail flounder	X	X	X	X
Sea scallop				
Window Pane flounder	X	X		
Redfish				
Atlantic cod	X	X	X	X
White hake	X	X	X	X
Winter flounder	X	X	X	X
Monkfish	X	X	X	X
Red hake	X	X	X	X
Silver hake	X	X	X	X
Basking shark			X	X
Bluefin tuna			X	
White shark				
Blue shark			X	X
Northern Shortfin squid				X
Longfin Inshore squid			X	X
Atlantic mackerel	X	X	X	X
Atlantic halibut				
Atlantic herring		X	X	X
Atlantic wolffish				
Spiny dogfish				X
Atlantic butterfish				X

3.3.4 Mammals, Reptiles & Birds

Marine mammals, reptiles and birds were discussed at length in the DEIS for the Designation of the MBDS (EPA, 1989 – Section 3.3.4). The information contained in that document is incorporated here by reference. Studies completed after the designation of the MBDS related to marine mammals, reptiles and birds are summarized below.

Several marine mammal species frequent the deep ocean waters of Massachusetts Bay, while others are rarely sighted (listed below). The southern portion of Stellwagen Bank has been designated by NOAA NMFS as a critical habitat for the North Atlantic right whale. Sei whales and juvenile humpback whales have been observed feeding in Stellwagen Basin. Abundance of these whale species often correlates to abundance of sandlance. (EPA, 1996)

Visiting or resident species in Massachusetts Bay (EPA, 1996):

Whales:	*Turtles:*	*Dolphins:*
Humpback whale	Leatherback turtle	Orca
North Atlantic right whale	Kemp's Ridley sea turtle	Pilot whale
Fin whale	Green sea turtle	White-sided dolphin
Sei whale	Loggerhead sea turtle	White-beaked dolphin
Blue whale		Harbor porpoise
Minke whale		Bottle-nose dolphin
		Common dolphin
		Striped dolphin
		Grampus dolphin

Birds:	*Fish:*	*Seals:*
Roseate tern	Shortnose sturgeon	Harbor seal
Piping plover		Grey seal

Additional discussion of marine mammals can be found in the following section, Threatened and Endangered Species (Section 3.3.5).

3.3.5 Threatened & Endangered Species

Threatened and endangered species were discussed at length in the DEIS and FEIS for the Designation of the MBDS (EPA, 1989 – Section 3.3.5; EPA, 1992 – Appendix C). The information contained in that document is incorporated here by reference. Studies completed after the designation of the MBDS related to threatened and endangered species are summarized below.

There are a number of threatened and endangered species found in Massachusetts Bay listed under the ESA. NMFS provides the current population trend information and designated critical habitats for the species below (http://www.nmfs.noaa.gov/pr/species/index.htm).

Humpback Whale (Endangered)

Humpback whales migrate from tropical and subtropical breeding grounds in the winter to temperate and arctic feeding grounds in the summer. Sightings in Stellwagen Bank peak in May and August, though a small number of Humpback whales may be present year round. The abundance of this species are closely linked with the abundance of sandlance in the area. Since the sandlance prey on copepods on the sloping, gravel bottom edges of Stellwagen Bank, the distribution of Humpbacks follows the perimeter. Sightings have been recorded in the project area and throughout Stellwagen Basin, but this is considered a marginal habitat that juveniles may be able to utilize for feeding. (NMFS, 1991) The North Atlantic Humpback whale did show a population increase between 1991 and 1999. (NMFS, 1999) Evidence shows that no Humpback whale populations are known to be declining, with most increasing or remaining stable. (NMFS, 2015)

North Atlantic Right Whale (Endangered)

The North Atlantic right whale is the most endangered of the large whales, with approximately 350 animals in the northwestern Atlantic in the early 1990s. This species is regularly present in Massachusetts and Cape Cod Bay from mid-February through May, feeding on plankton blooms, but they could appear in the area in any season. Sightings of the Northern Right whale do occur in the project area, but they more consistently use areas adjacent to the MBDS. (NMFS, 1991) Recovery rates of the North Atlantic right whale have been uncertain, and were potentially declining by approximately 2.4% per year. (NMFS, 1999) In January 2016, the critical habitat for the North Atlantic right whale was expanded to include all of Massachusetts Bay. (Figure 3.10) Recent analysis of sightings data suggests a slight growth in population size, but they remain critically endangered.

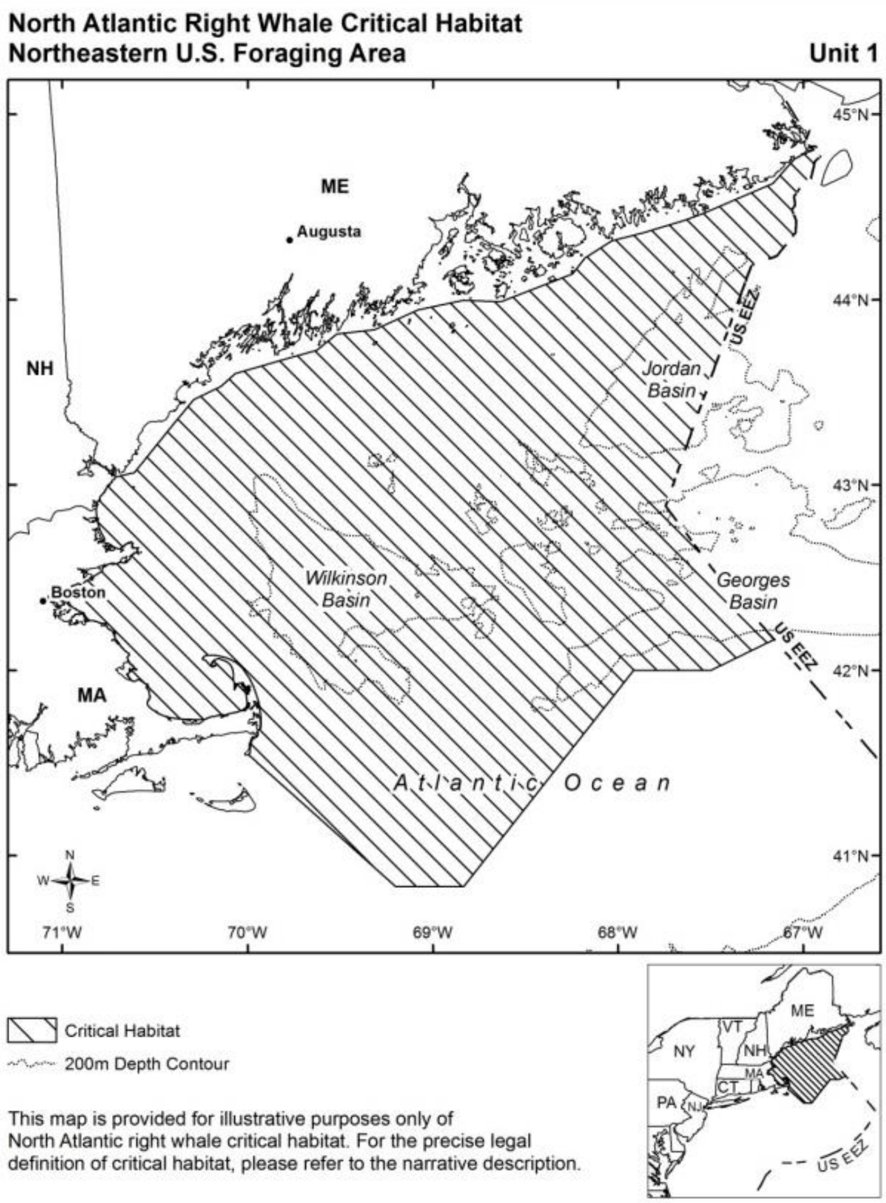


Figure 3.10 – North Atlantic Right Whale Critical Habitat: Northeastern U.S. Foraging Area (Source: http://www.fisheries.noaa.gov/pr/species/mammals/whales/north-atlantic-right-whale.html)

Fin Whale (Endangered)

Fin whales are present in the Stellwagen Bank area year round, peaking in May and July. Fin whales are present in and around the project area, but most sightings were to the north and east in the spring and summer. Fin whales feed in response to abundance of variety of schooling fishes and euphausiids. (NMFS, 1991) There is no current determination of population trends for this species, but, despite their high abundance compared to other species, they remain depleted relative to historic levels. (NMFS, 1999)

Sei Whale (Endangered)

Sei whales were rarely sighted in Massachusetts and Cape Cod Bays prior to 1985, as this was considered their southern feeding range limit. Beginning in 1986, sightings became common as they utilized Stellwagen Basin and deeper areas of Massachusetts Bay to feed. As sand lance populations decrease, copepod abundance increases, bringing Sei whales to the area. (NMFS, 1991) These increases in abundance in the project area is rare and only when copepod abundance increases. (NMFS, 1999)

Leatherback Sea Turtle (Endangered)

Leatherback sea turtles have been reported in New England waters in July through early November. Inshore seasonal movements may be linked to those of the jellyfish *Cyanea capillata*, which periodically occur in the project area, and, therefore, could be used by Leatherbacks for foraging. They could also pass through the area while migrating or seeking prey (NMFS, 1991) The population of Leatherbacks has been declining worldwide, but specific status in the United States is unknown. (NMFS, 1999) Recent data shows an increase in population of Leatherbacks, with some fluctuation.

Blue Whale (Endangered)

The Blue whale is known to occasionally occur in the area of the MBDS. The species is normally distributed from the Gulf of St. Lawrence northward during spring and summer, and suspected to migrate south to temperate waters in fall and winter. Blue whales have been spotted in Stellwagen Bank, likely feeding on krill, but this is not considered a usual habitat. (NMFS, 1991)

Kemp's Ridley Sea Turtle (Endangered)

The Kemp's Ridley sea turtle is the most severely endangered sea turtle in the world. Juveniles regularly strand in Cape Cod Bay in the fall and winter due to cold-stunning, likely while foraging for benthic crustaceans. Due to the cold temperatures in the project area, it is unlikely that the Kemp's Ridley sea turtle would use this as a foraging area. (NMFS, 1991) The Kemp's Ridley sea turtle population showed a slow rebound throughout the 1990s through 2009. Since 2010, the number of Kemp's Ridley nests decreased causing concern about stalled or reversed population growth. However, the population generally seems to be in the early stages of recovery.

Loggerhead Sea Turtle (Threatened)

Juvenile and subadult Loggerhead sea turtles occur in southern Massachusetts waters from midsummer through fall, likely feeding on crabs and benthic invertebrates. Like the Kemp's Ridley, the project area is likely too cold for foraging for the Loggerhead. (NMFS, 1991)

Shortnose Sturgeon (Endangered)

Shortnose sturgeon are anadromous, spawning in freshwater, and living in rivers and estuaries. The closest critical habitat and population of the Shortnose sturgeon to the project area is in the Merrimack River. There is no evidence that the project area is utilized by this species. (NMFS, 1991; NMFS, 2011)

Atlantic Sturgeon (Endangered)

Atlantic sturgeon are anadromous, spawning in freshwater. Subadults and adults can generally be found in shallow nearshore areas, 10 – 50 meters in depth. The closest population of the Atlantic sturgeon to the project area is in the Merrimack River (which is also being proposed as a critical habitat). (NMFS, 2016) There is no evidence that the project area is utilized by this species. (NMFS, 2011)

3.4 FISHING

The fishing industry is discussed at length in the DEIS, SEIS and FEIS for the Designation of the MBDS (EPA, 1989 – Section 3.4; EPA, 1990 – Section 3.6.1; EPA, 1992 – Section 3.4). The information contained in those documents is incorporated here by reference. Studies completed after the designation of the MBDS related to fishing are summarized below.

In 1971, the FDA issued a notice to fishermen, warning against fishing in the IWS. In 1980, NMFS banned the harvesting of surf clams and ocean quahogs in the IWS (45 FR 786). Also in 1980, FDA and NMFS issued a joint advisory to all fishermen requesting that they avoid harvesting bottom-dwelling species in the IWS. This advisory was re-issued in 1992. Despite these advisories, there have been multiple reports of commercial fishermen unintentionally retrieving hazardous and chemical waste containers in the vicinity of the IWS. There are four documented cases from 1960 through 1989 and many anecdotal accounts. There is also evidence of continued fishing in the area, including active lobster traps. In 1996, NOAA concluded that the existing fishing advisory and closure for surf clams and ocean quahogs should continue. (NOAA, 1996)

3.5 MARINE SANCTUARIES

Under MPRSA, the SBNMS was designated on November 4, 1992 (15 CFR 922.140). Pursuant to these regulations for the SBNMS, "discharging or depositing, from within the boundary of the

Sanctuary, any material or other matter" and "discharging or depositing, from beyond the boundary of the Sanctuary, any material or other matter… that subsequently enters the Sanctuary and injures a Sanctuary resource or quality" is a prohibited or otherwise regulated activity. (15 CFR 922.142) Neither the current MBDS nor Alternatives G-1 and G-2 overlap with SBNMS boundaries. Also, the project area is considered a containment site, meaning that dredged material will not move from where it is deposited. Disposal of dredged material in the project area and contaminants from the IWS were determined not to threaten resources within SBNMS. (NOAA, 2010) (Figure 3.11)

Under the Massachusetts Ocean Sanctuaries Act (MGL c. 132A §12-18), five Sanctuaries were designated in Massachusetts waters. The closest to the project area is the South Essex Ocean Sanctuary, which approximately 1.4 nautical miles to the west. (Figure 3.11) The Ocean Sanctuaries Act prohibits any dumping, discharging or filling with any material of any kind that could significantly degrade water quality. It also prohibits changing the temperature, biochemical oxygen demand, or other natural characteristics of the water so that there is more than a negligible adverse effect.

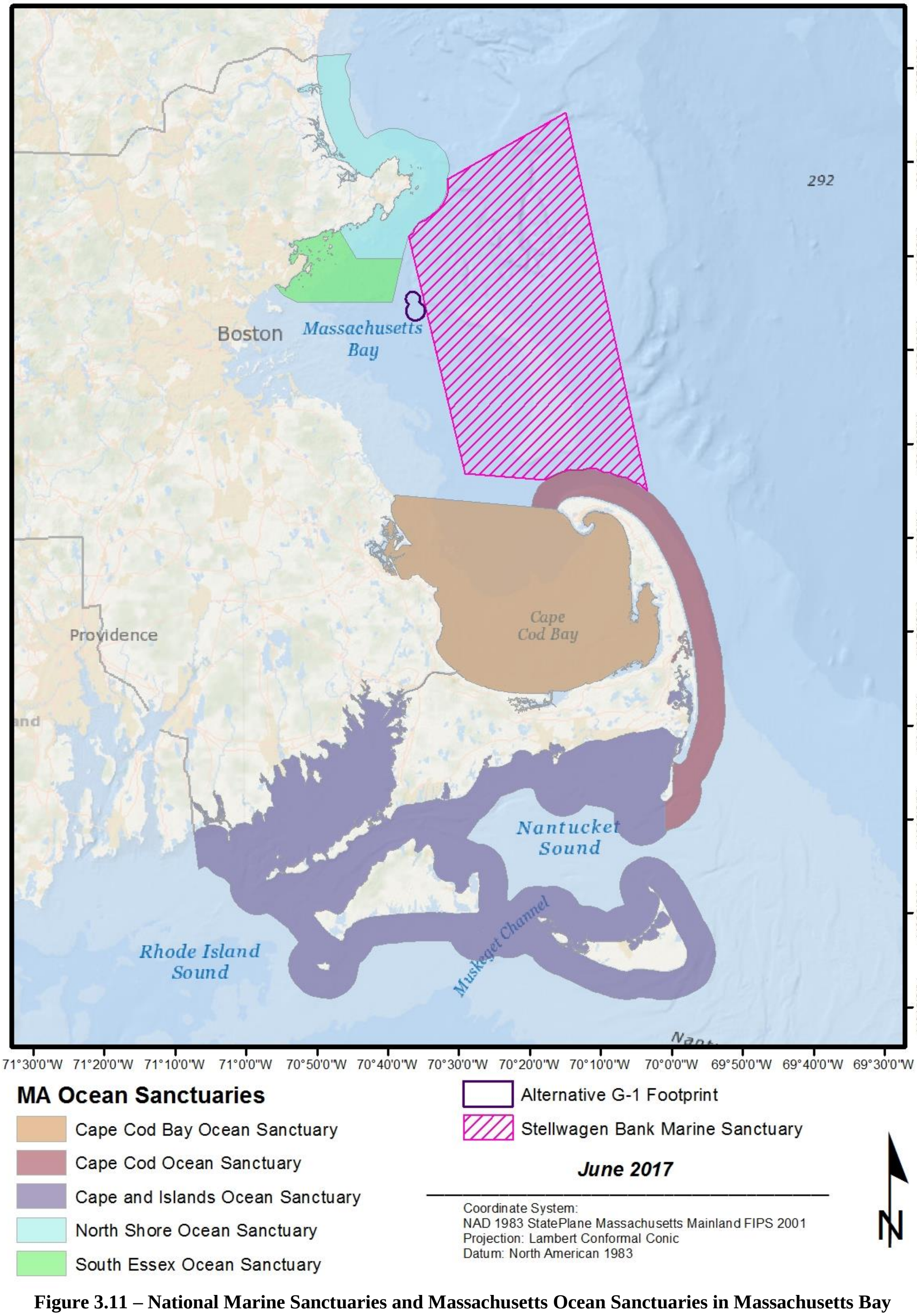


Figure 3.11 – National Marine Sanctuaries and Massachusetts Ocean Sanctuaries in Massachusetts Bay

3.6 RECREATION

The Northeast Ocean Data Portal (http://www.northeastoceandata.org/), which is a repository for maps and data for ocean planning in the northeast U.S., shows that the project area is used for commercial whale watching, but it is dominant in the southern portion of the MBDS and not the proposed expansion. Recreational boater density is low and there are no recreational SCUBA diving areas identified within the project area.

3.7 HISTORIC & CULTURAL RESOURCES

As discussed in the DEIS for the Designation of the MBDS, prehistoric artifacts are unlikely to be found in the project area, as it was below sea level during the last glaciation. There are two known shipwrecks in MBDS: a steel-hulled Coast Guard boat and a 55-foot fishing vessel, both of which were intentionally sunk in 1981. (EPA, 1989)

In a side-scan sonar survey of the IWS area conducted in 2008, six shipwrecks were identified. (Liebman & Brochi, 2008) Two of these shipwrecks were also observed by the USACE in an ROV survey (Sturdivant & Carey, 2017) (see Figure 3.12) A determination of National Register eligibility or any historical significance cannot be made based on the existing information.

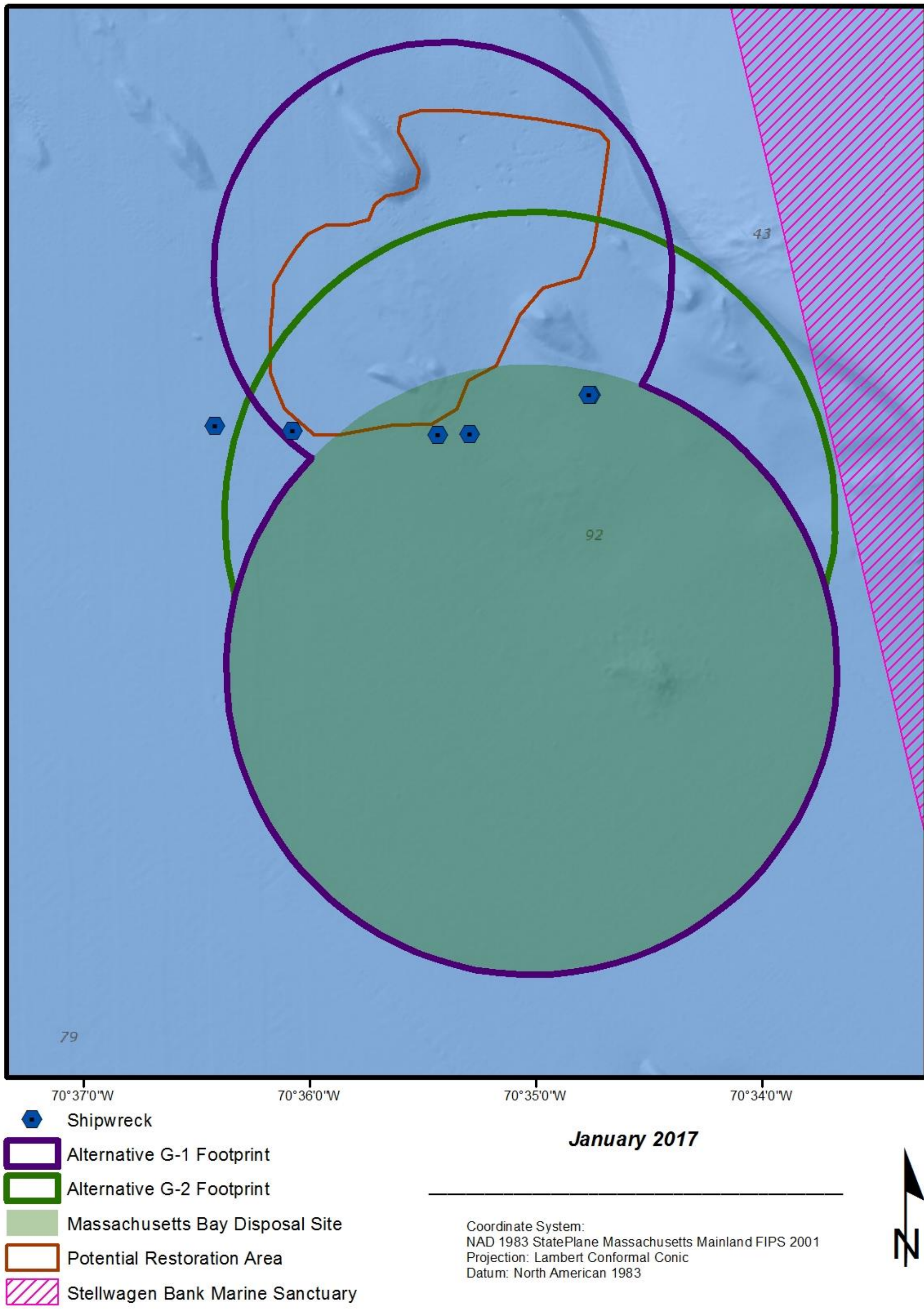


Figure 3.12 - Shipwrecks in and around the project area (Source: Liebman & Brochi, 2008)

3.8 SHIPPING

The southern edge of the MBDS and both Geographic Alternatives are approximately 1.8 nautical miles north of the major shipping lane into Boston Harbor. (see Figure 3.13) The shipping lanes into Boston were altered in 2007 for the protection of whales in the area, but the distance between the project area and shipping lanes did not change. The Northeast Ocean Data Portal (http://www.northeastoceandata.org/) shows low commercial vessel density in the project area.

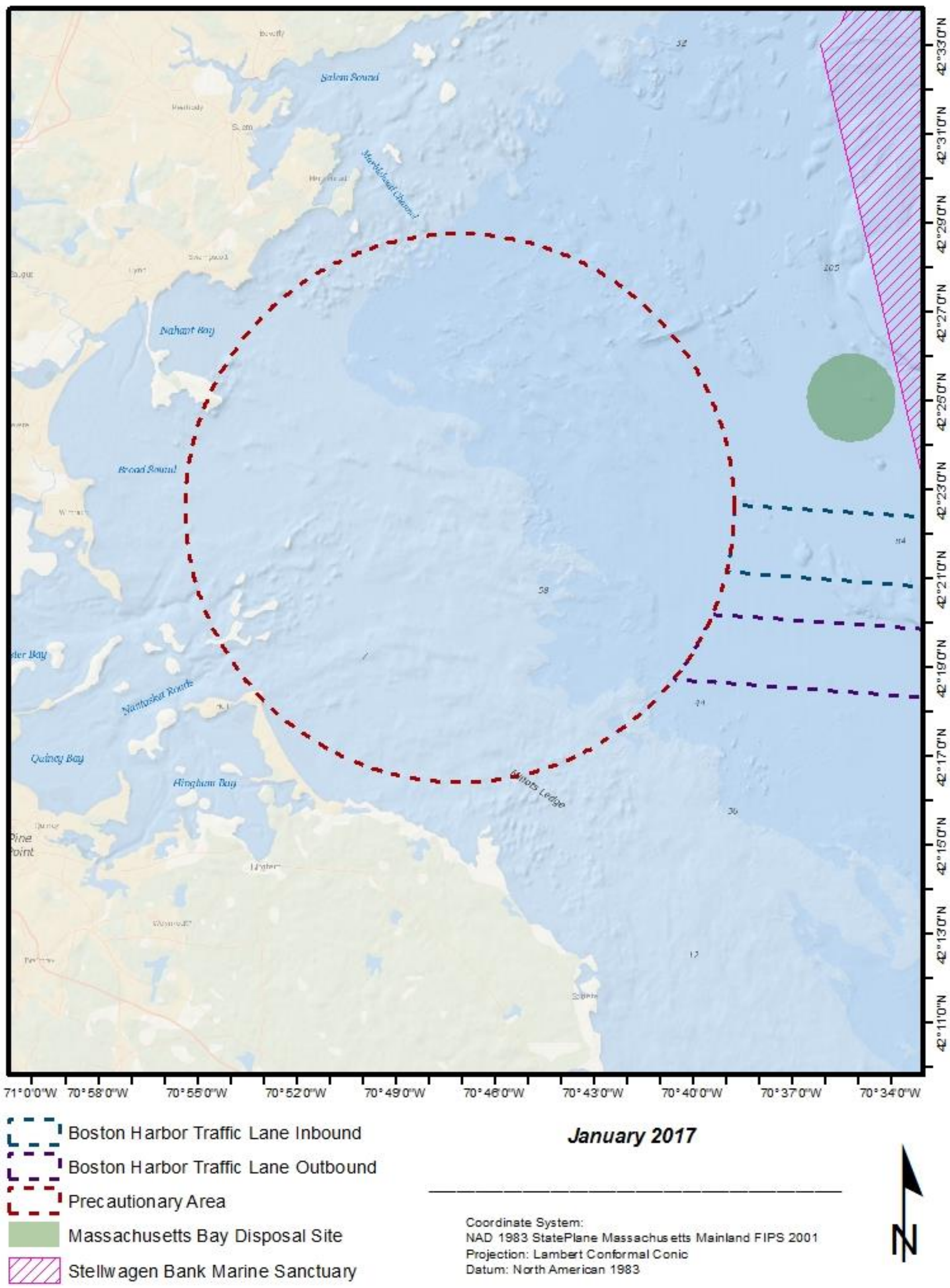


Figure 3.13 - Shipping Lanes in Massachusetts Bay (Data Source: MassGIS)

3.9 MINERAL, OIL & GAS EXPLORATION

There are two liquid natural gas (LNG) terminals in the vicinity of the project area: Neptune (inactive) and Northeast Gateway. (See Figure 3.14) None overlap with Alternatives G-1 or G-2.

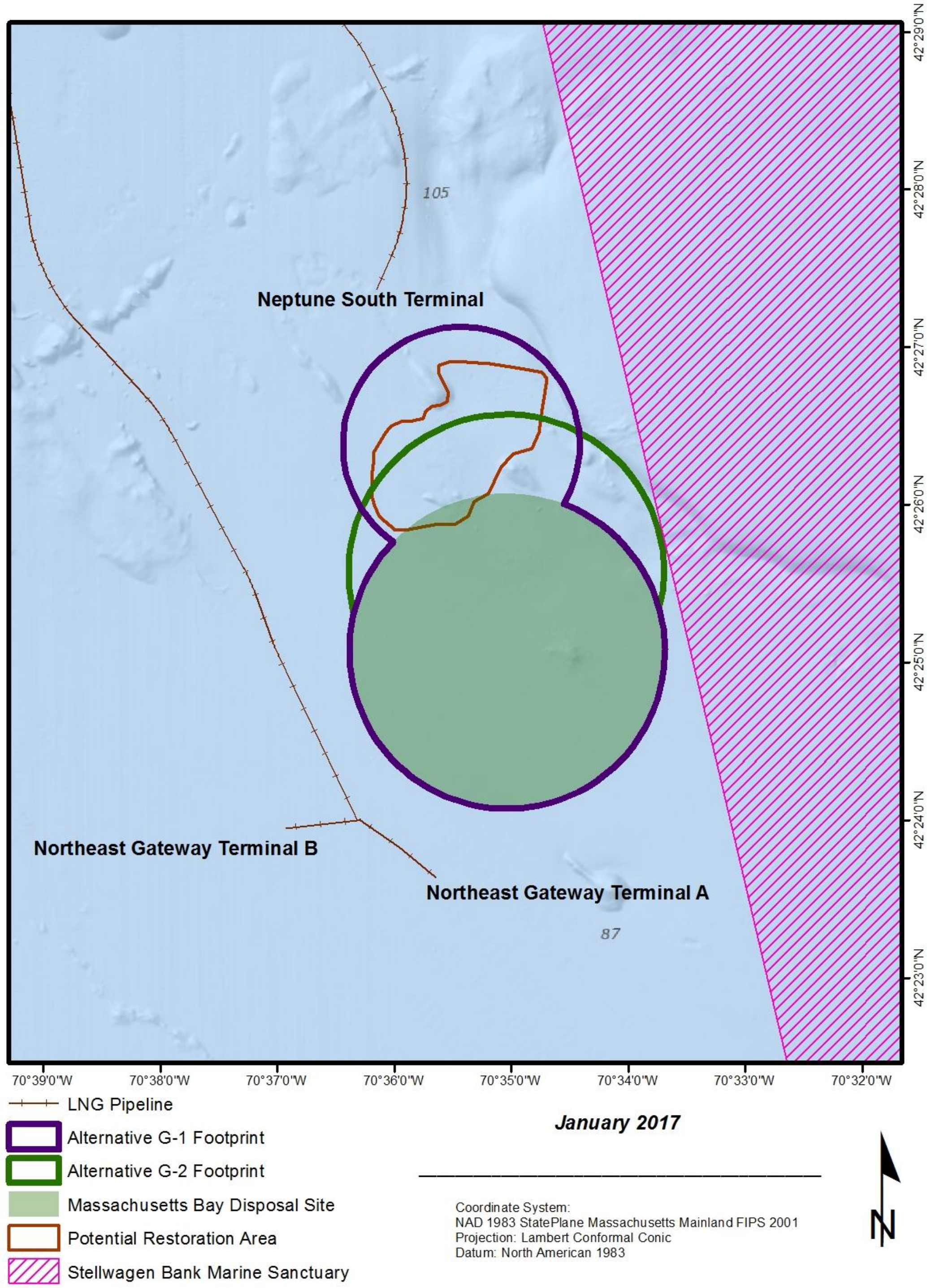


Figure 3.14 - Liquid natural gas (LNG) pipelines and terminals in Massachusetts Bay (Data Source: MCZM)

3.10 HAZARDOUS, TOXIC & RADIOACTIVE WASTE

The disposal of hazardous, toxic and radioactive waste is discussed at length in the FEIS for the Designation of the MBDS (EPA, 1992 – Section 3.9.2.5). The information contained in that document is incorporated here by reference.

Evidence suggests that disposal of derelict vessels, construction debris, commercial waste, and potentially contaminated dredged material began in the historic IWS area in the early 1900s. From the 1940s through 1977, there are records of disposal in the IWS of radioactive waste, munitions or ordnance, explosives, industrial and chemical wastes, construction debris, derelict vessels, and contaminated dredged material. The timeline of disposal of the IWS can be found below (NOAA, 1996; Sturdivant & Carey, 2017):

1945	The IWS is designated as a munitions disposal site
1946	Recorded disposal of low-level radioactive wastes
1947	Recorded disposal of industrial wastes
1952	The IWS is designated by the Atomic Energy Commission (AEC) to receive low-level radioactive wastes sealed in drums with 4-6 inch concrete liners
1953	USACE becomes permitting authority for industrial waste in IWS
1957	USACE becomes permitting authority for disposal of radioactive, chemical & toxic wastes in IWS
1959	Disposal of low-level radioactive waste ceases at IWS
1973	EPA becomes permitting authority for all disposal in the IWS
1977	Disposal at IWS terminated by EPA
1990	IWS officially de-designated as a disposal site

Disposal records for the IWS are sparse. Some examples of known disposal include 4,008 containers of low-level radioactive waste disposed of in the IWS (though undocumented disposal before 1952 would cause this number to be much higher). In 1976 and 1977, EPA permitted the disposal of 43 barrels of explosives embedded in concrete; 129 55-gallon drums of metallic sodium, lithium, and magnesium; neutralized acids and bases; small quantities of miscellaneous laboratory chemicals encased in concrete; and other substances known to illicit carcinogenic, neoplastic, mutagenic, or teratogenic effects. (NOAA, 1996)

In 1991, the waste containers in the IWS were surveyed using side-scan sonar and a remotely operated vehicle (ROV) to determine their location and condition. Based on this survey, it was determined that there could be approximately 21,000 barrels of waste disposed of in the IWS. At the time, approximately 28% of barrels were intact and still contained materials that could contaminate the environment. (Wiley, et al, 1992)

During a 1992 survey of the IWS, the anchor of the R/V *Gloria Michelle* became fouled with a lobster trawl, a wire lobster trap containing a lobster, portions of a metal drum, and sediment. The anchor was scanned and Strontium 90 was detected in the sediment. The rest of the survey showed only naturally-occurring radionuclides in the study area. During this survey, waste containers were observed in the area using and ROV and manned submersible. (See Figure 3.15) (NOAA, 1996)

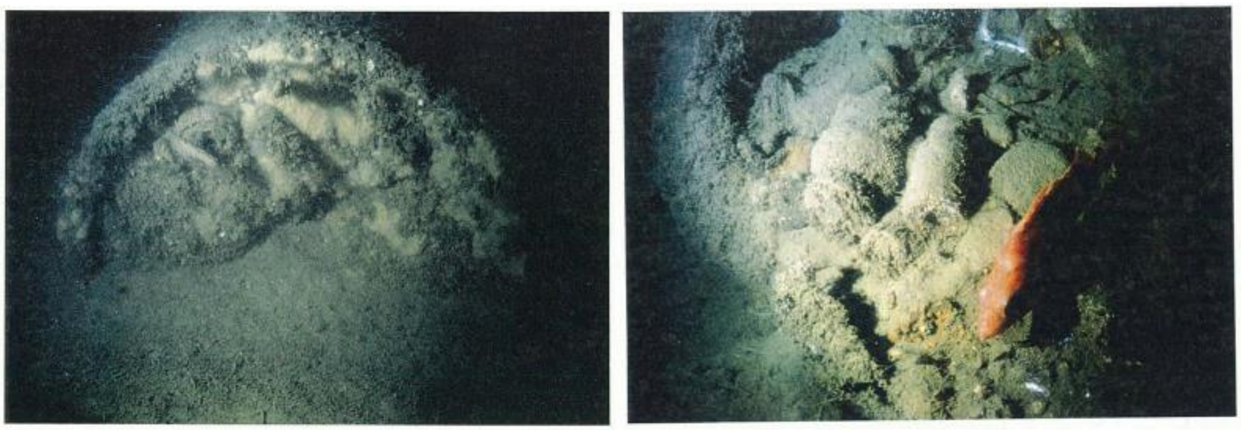
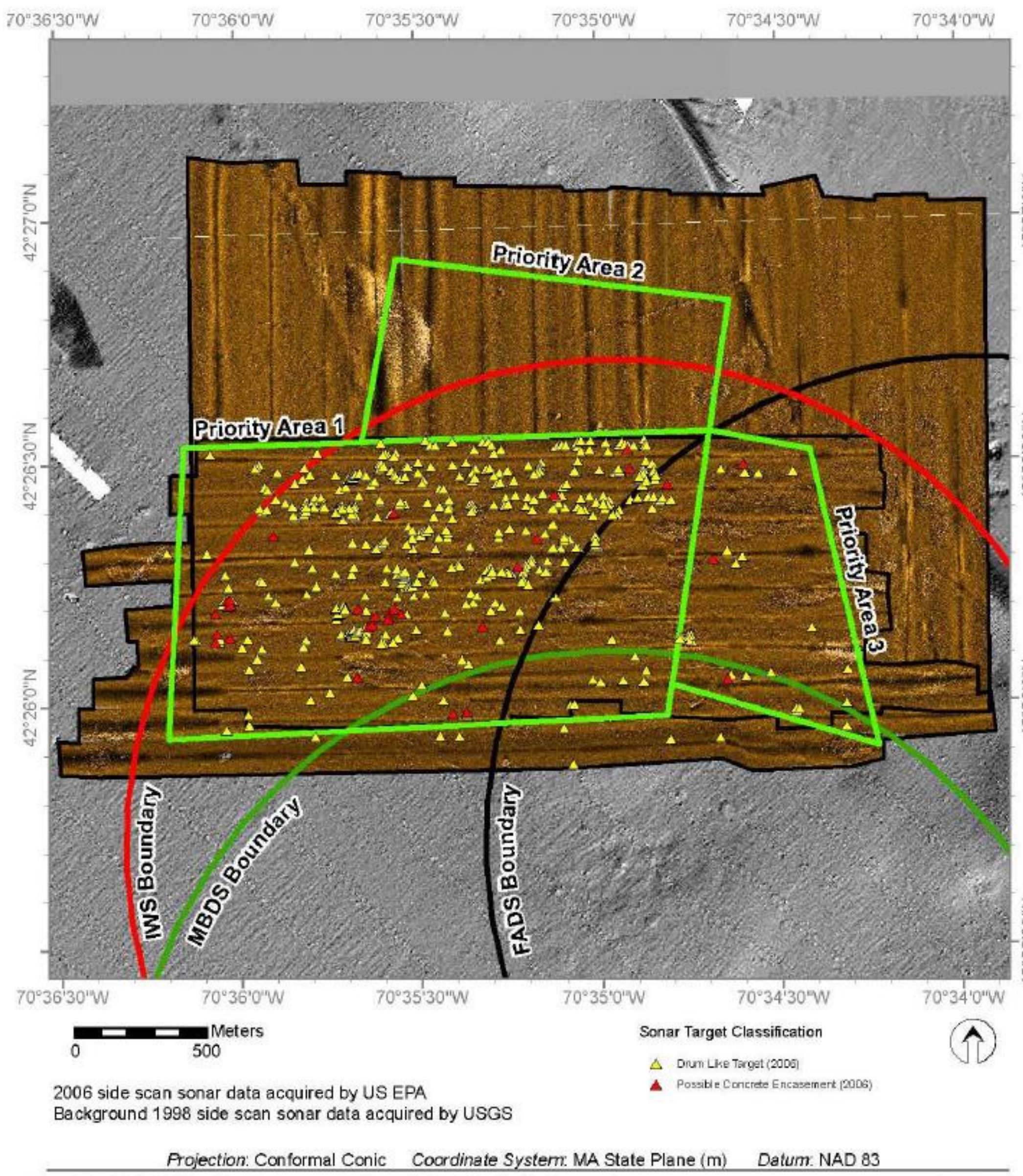


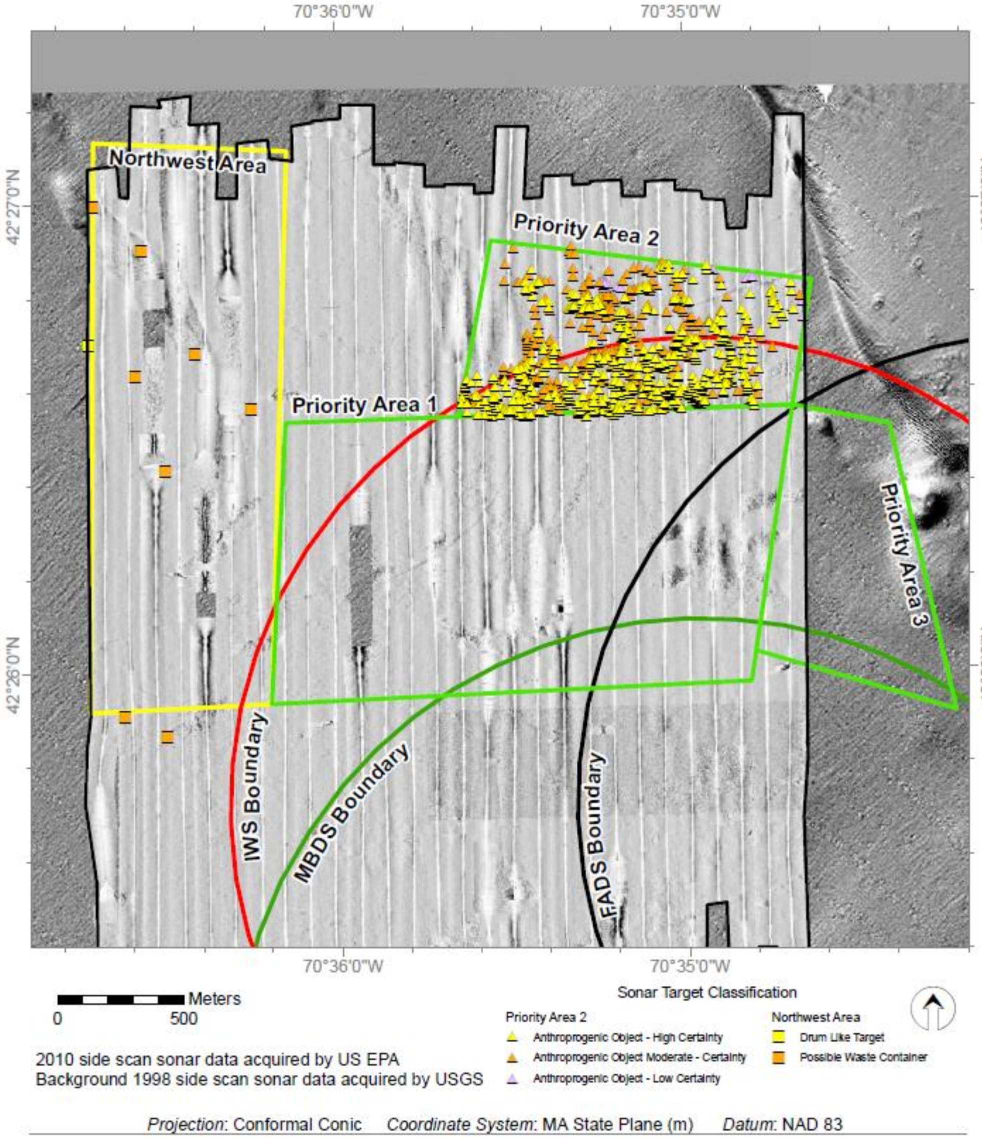
Figure 3.15 – (left) A waste barrel, half buried in the sediment at the IWS. (right) A corroded waste container with contents exposed and redfish. (Source: NOAA, 1996)

In 1998, the EPA hosted a meeting of agencies, researchers, and other organizations working in the IWS area to develop a strategy for the future activities. They determined that the long-term goal was to collect data on the location of waste container concentrations and map them. In 2006 and 2010, side-scan sonar surveys were completed by EPA in the project area to determine the location and concentration of waste containers and other disposed items. Analysis of these surveys resulted in the identification of 1,034 and 716 targets, respectively, and further classified them into categories. An additional 991 high or moderate certainty uncategorized anthropogenic targets were identified in the 2010 survey. These numbers are estimates and could be higher due to poor reflectance from the drums and low resolution. Using the results from these surveys, the project area was delineated into three priority areas. Priority area 1 consists of the area with the highest density of drum-like objects and probably concrete encasement targets. Priority area 2 covers the area to the north where numerous unconfirmed but likely drum-like targets were identified in the 2010 survey. Priority area 3 consists of the eastern portion of the project area where barrel density diminishes significantly. Based on this analysis, the Potential Restoration Area was designed in order to contain these priority areas. (USACE, 2015) (See Figures 3.16 and 3.17)



Contact Category	Count	Description
Drum Like Target	481	Targets with dimensions roughly equivalent to a drum (Approximately 0.9m x 0.6m), a rectangular shadow, and metallic characteristics such as ringing and flaring.
Metallic Debris	325	Targets which exhibit metal characteristics such as ringing or flaring but did not meet the size and shape criteria of a Drum Like Target.
Unknown Material	101	Targets which could not be identified as a Drum Like or Dredge Material/Rocks/Glacial Deposits but did appear to have shape or size characteristics close to drums.
Non-Drum Like Man Made Debris	39	Targets that were apparently man made but clearly not drum like or associated with drums such as the metallic debris
Possible Concrete Encasements	35	Targets having dimensions larger than a drum with a regular rectangular shape.
Rock- Boulder	26	Rocks and boulders only those in proximity to drum like targets or outside the obvious dredge/rock disposal locations
Dredge Material / Glacial Deposit	9	All types of dredge, and rock material deposited in the survey area. Additionally some of the rock material seen on the side-scan may also be naturally occurring glacial deposits.
Lobster Trap	7	Targets which exhibited clean crisp rectangular signatures within the proper size constraints and with fishing gear characteristics.
Shipwreck	6	Sunken vessels were designated as shipwrecks.
Fish	4	Targets which exhibited the classic characteristics of fish schools.
Total No. Contacts	**1034**	

Figure 3.16 - Priority areas and results from 2006 EPA side-scan sonar survey (Source: USACE, 2015)



Contact Category	Count	Description
Object (anthropogenic)	351	Sonar feature with non-random structure or outlying location which indicates man-made origin. Classification was used when man-made features could not be added to a more descriptive category.
Possible Buried Object	168	Classification was used when man-made features could not be added to a more descriptive category and no sonar "shadow" was visible.
Lobster Trap (single)	129	Object with dimensions and characteristics consistent with commercial lobster fishing gear.
Lobster Trap(s) (clustered)	14	Cluster of objects with dimensions and characteristics consistent with commercial lobster fishing gear.
Wreckage (ship)	11	Clearly defined remnants of a sunken vessel.
Waste Container (possible)	8	Object of anthropogenic origin consistent with container descriptions and unlikely to be fishing gear.
Fishing Scour	7	Narrow linear depression of the seafloor associated with trawl doors or dragging of lobster traps.
Construction Debris	6	Mix of irregular and block-like features, signals and apparent relief consistent with disposed material.
Wreckage (unknown)	6	Objects which appear to be associated with a sunken vessel.
Pipeline	5	Linear raised feature. Compared with known structures in CR's database for identification.
Structure (unknown)	4	Feature associated with pipeline or other infrastructure which cannot be further characterized.
Disposed Material Cluster	2	Generally irregular features with signals and apparent relief consistent with coarse disposed material.
Suction Anchor	2	Suction anchors for the Neptune Pipeline
Dredge Material	1	Features with signals consistent with disposed dredge material.
Drum/Barrel	1	Feature with dimensions/signal consistent with a drum. Note that this classification is highly uncertain due to the similarity between the dimensions of commercial lobster gear and weathered containers.
Tire	1	Feature with a low-amplitude signal, dimensions and shape consistent with a tire.
Total No. Contacts	**716**	

Figure 3.17 - Priority areas and results from 2010 EPA side-scan sonar survey (Source: USACE, 2015)

3.11 AIR QUALITY

Air quality is discussed at length in the FEIS for the Boston Harbor Deep Draft Navigation Project (USACE & Massport, 2013 – Section 3.6). This relevant section is incorporated here by reference.

The EPA has established seven criteria pollutants that are of concern with respect to the health and welfare of the general public. Areas that do not meet the National Ambient Air Quality Standards (NAAQS) set by EPA (or state standards that are equal to current or former NAAQS) are considered to be in non-attainment. The area around Massachusetts Bay is currently in attainment of all NAAQS (source: https://www3.epa.gov/airquality/urbanair/sipstatus/reports/ma_areabypoll.html, retrieved March 1, 2017):

Carbon Monoxide (CO)	Attainment/Maintenance
Lead (Pb)	Attainment
Nitrogen Dioxide (NO_2)	Attainment
Ozone (O_3) (2008 standard)	Attainment
Ozone (O_3) (2015 standard)	Not yet designated
Particulate Matter <10µm (PM_{10})	Attainment
Particulate Matter <2.5µm ($PM_{2.5}$)	Attainment
Sulfur Dioxide (SO_2) (annual and 24-hour 1971 standards)	Attainment
Sulfur Dioxide (SO_2) (1-hour 2010 standard)	Not yet designated

3.12 NOISE

Ambient noise levels offshore are generally low, limited to vessels passing through the region. Recreational boaters may contribute minimally to the amount of noise in the area. There are no noise-sensitive institutions, structures, or facilities in the area.

4. ENVIRONMENTAL EFFECTS

By expanding the MBDS to allow for the restoration of the barrel field in the IWS area, dredged material disposal will be taking place in an area not currently open for disposal. Effects of dredged material disposal in this area are discussed below.

4.1 EFFECTS ON PHYSICAL ENVIRONMENT

4.1.1 Short Term Effects

4.1.1.1 Disposal Processes

There are three major phases when dredged material is released from a dredge vessel. During the convective descent phase, the majority of material is transported to the bottom by gravity as a concentrated cloud of material. During the dynamic collapse phase, the vertical momentum present during the convective descent phase is transferred to horizontal spreading of material as it hits the bottom. The passive dispersion phase occurs when the momentum from the disposal is lost and ambient currents and turbulence determine the transport and spread of material. Disposal processes are discussed at length in the DEIS for the Designation of the MBDS (EPA, 1989 – Section 4.1.1.1)

<u>Preferred Alternative</u>

During impact, the disposed sediment interacts with the bottom, dislodging and mixing with in-place sediment, and creating a scour zone or crater. The bottom sediments move radially outward from the point of impact and underlying material is compacted. The radially-moving sediment continues to mixing with ambient water, which continues along with the bottom erosion until all the energy is dissipated. During this process, some of the mixed sediment can deposit in the crater, filling it back in to varying degrees, and some may form a berm ring around the crater, while the remainder distributes as a thinning wedge of sediment in an apron around the central crater. (Figure 4.1)

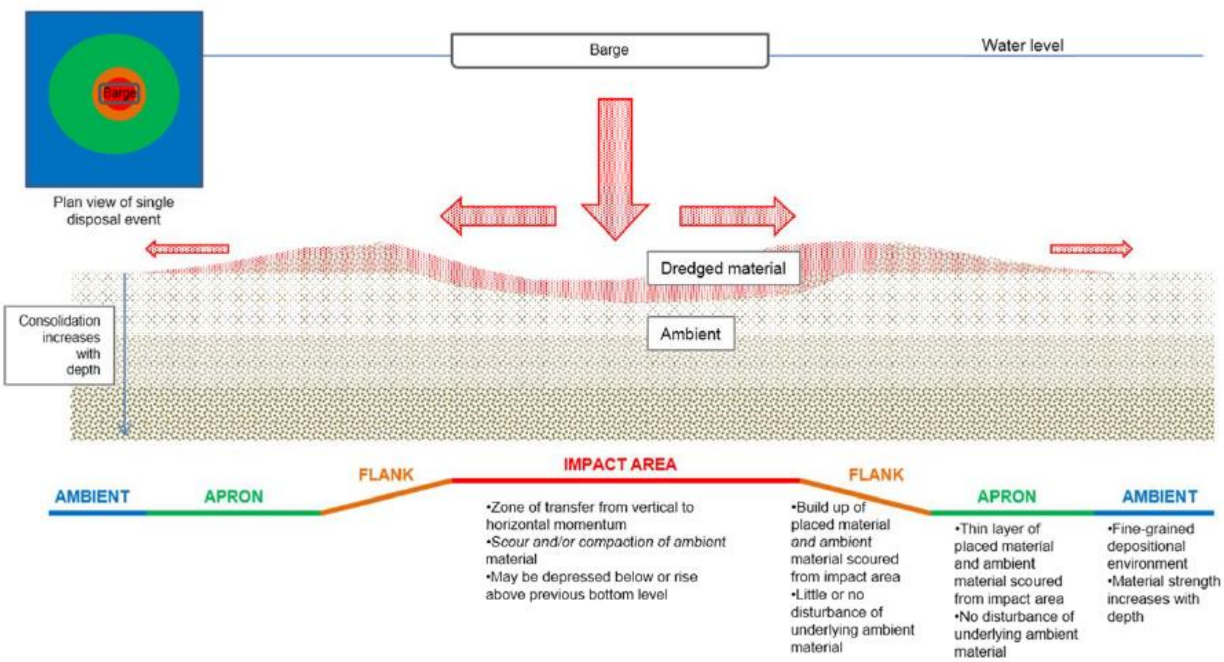


Figure 4.1 - Conceptual site model of impacts to seafloor from dredged material disposal (Source: USACE, 2015)

Due to the presence of various waste containers, contaminated dredged material, and other anthropogenic objects in the IWS area, it is imperative to avoid disturbing the seafloor in the project area. To that end, the USACE developed a method of disposal using the following design:

- Locate an area adjacent to the IWS where there is no evidence of barrels or containers and where disturbance of in-place sediments is unlikely to cause any undesirable impact;

- Begin depositing sediment in this container/barrel-less area with multiple barge loads of dredged material, allowing the lateral spread to build up layer by layer over the edge of the area to be covered until the apron becomes thick enough to protect the underlying in-place sediments from disturbance of direct placement. Thus, the lateral apron is intended to absorb the energy of direct impact from sequential disposal and protect the historic materials from disturbance;

- Gradually shift subsequent placements over this lateral apron area, which will allow the leading, low-energy spreading edge to move farther over the Potential Restoration Area; and

- Continue this process to build the cover material laterally with successive shifts of disposal locations. (Figure 4.2)

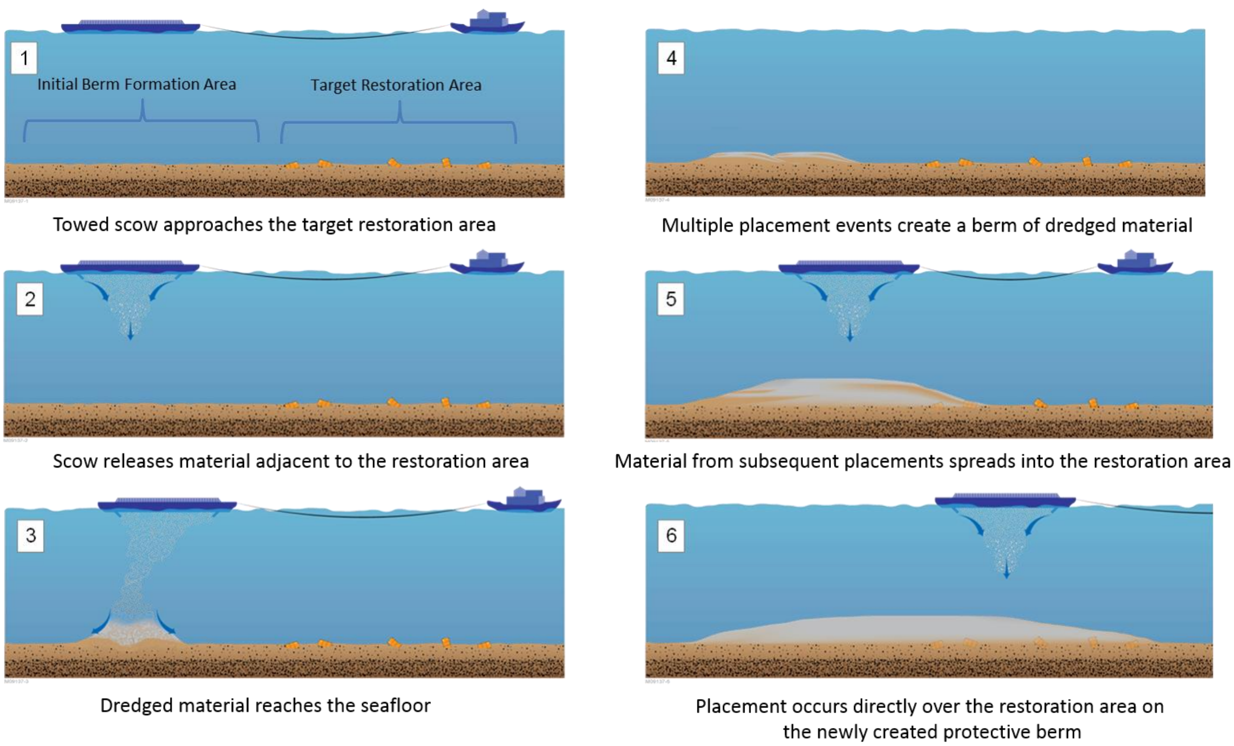


Figure 4.2 - Restoration concept using sequential placements of dredged material (Source: USACE, 2015)

This disposal method and degree of precision in disposal were tested by the USACE in an area of MBDS with no previous disposal events. The demonstration used Boston blue clay, which constitutes much of the material that will be used to cover the project area. A variety of methods were used to monitor, among other things, the changes in bathymetry, accuracy of placement, crater formation, and the sub-bottom profile both during and after the test. The test of this disposal method confirmed that:

- Simple target bearings and coordinates can be used by tug operators to implement the disposal process and place dredged material in precise locations without impacting the schedule or cost of the dredging project;

- Sequenced placement of the Boston blue clay and glacial till generated from the Boston Harbor maintenance and improvement projects can be used to build a berm of material at the IWS; and

- A berm of dredged material provides sufficient protection from subsequent disposal events to limit the disturbance of in-place sediments or waste containers.

This disposal process and results of the restoration demonstration can be found in the USACE DAMOS report #198: Massachusetts Bay Disposal Site Restoration Demonstration Report 2008 – 2009. (USACE, 2015)

<u>No Action Alternative</u>

Under the No Action Alternative, the MBDS would not be expanded to allow for the restoration of the IWS. Therefore, disposal of dredged material from the Boston Harbor maintenance and improvement projects would take place within the existing boundaries of the MBDS using traditional disposal methods as laid out in the EIS for the designation of the site.

4.1.1.2 Mound Formation & Substrate Consolidation

<u>Preferred Alternative</u>

The purpose of expanding the MBDS is restoring the area of the IWS. Using the disposal method laid out in the previous section, there will be a relatively uniform distribution of dredged material generated from the Boston Harbor maintenance and improvement projects across the Potential Restoration Area (Figure 4.3) approximately 1-meter thick, as opposed to a distinct disposal mound. (USACE, 2015)

Bathymetric surveys and sediment cores of the USACE Restoration Demonstration confirmed that when the Boston blue clay is disposed on the ambient sediments of the area, crater formations penetrated over one meter deep. There was also substantial deflection of the original surface beneath the dredged material deposit, meaning ambient sediments were likely disturbed by the placement process. The surveys also showed that disposal on a berm results in much shallower craters that did not erode the original ambient surface. Further, there was no measurable mixing of dredged material with ambient sediments beneath the berm. (USACE, 2015)

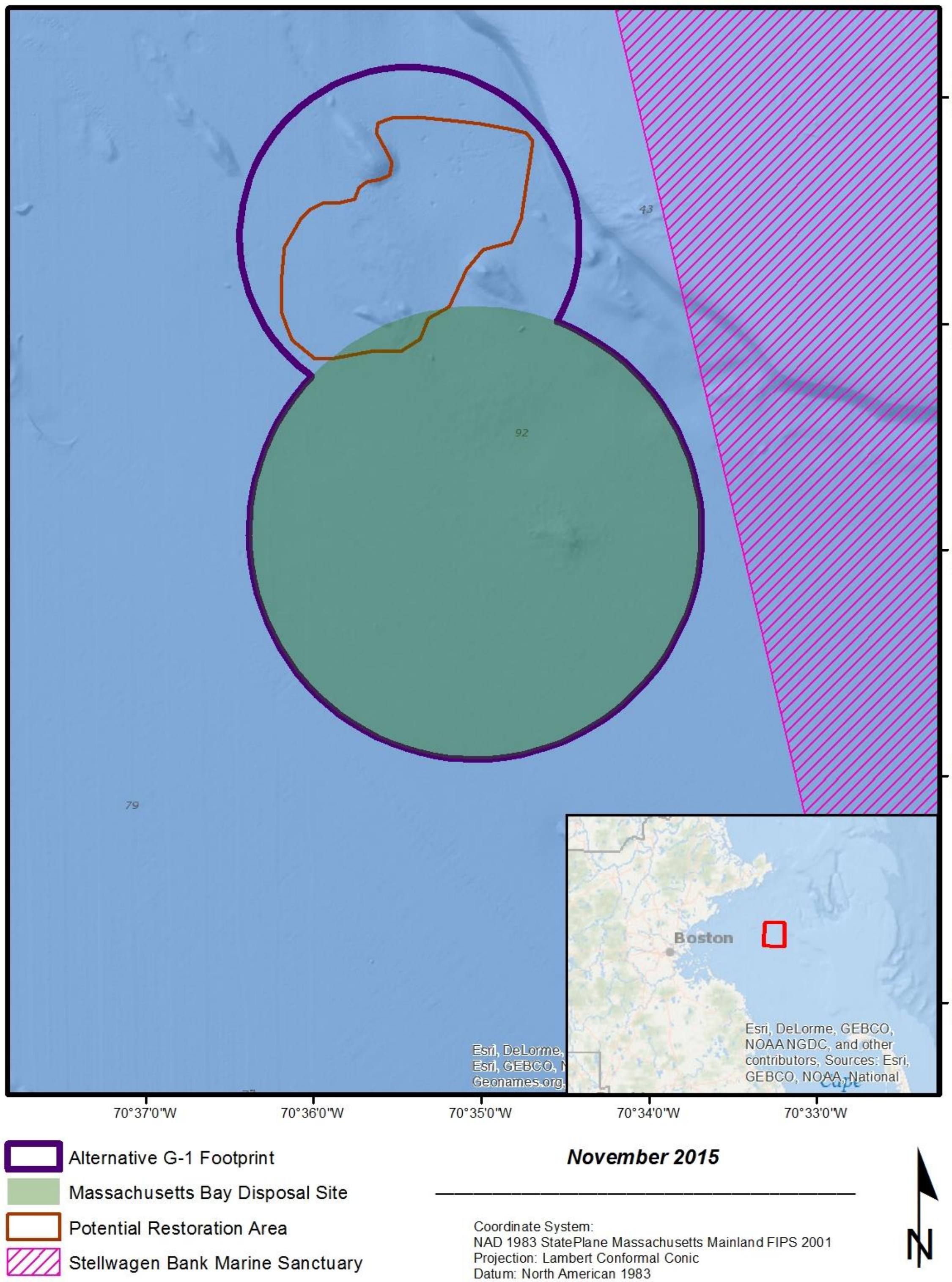


Figure 4.3 - Preferred Alternative and the Potential Restoration Area

No Action Alternative

Under the No Action Alternative, the MBDS would not be expanded to allow for the restoration of the IWS. Therefore, disposal of dredged material from the Boston Harbor maintenance and improvement projects would take place within the existing boundaries of the MBDS as laid out in the EIS for the designation of the site. Multiple mounds would likely be created with the disposal of dredged material.

4.1.2 Long Term Effects

4.1.2.1 Bathymetry & Circulation

Preferred Alternative

Due to the cohesive and consolidated nature of Boston blue clay, there is evidence of intact clay blocks, clumps and clasts on the surface after disposal. Therefore, after disposal over the entire Potential Restoration Area, the surface will likely be irregular and uneven. Bathymetric surveys taken during the USACE Restoration Demonstration confirm this. (USACE, 2015)

There are two significant bathymetric features in the Preferred Alternative, both glacial knolls. (Figure 3.3) These features are not part of the Potential Restoration Area and there will be no disposal on them.

In the DEIS for the Designation of MBDS, there is an analysis of how much disposal would need to occur in the area to impact circulation. (EPA, 1989) Based on this analysis, the restoration of the IWS will have no impact on circulation.

No Action Alternative

Under the No Action Alternative, the MBDS would not be expanded to allow for the restoration of the IWS. Therefore, disposal of dredged material from the Boston Harbor maintenance and improvement projects would take place within the existing boundaries of the MBDS. The dredged material would have minor bathymetric impacts either through the creation of a new mound or the increase in size of an existing mound. There would be no impact on circulation.

4.1.2.2 Potential for Resuspension & Transport

Potential for resuspension and transport is discussed at length in the DEIS for the Designation of the MBDS, including the wave height and duration required to resuspend various particle sizes. The sediment to be used during this restoration project is primarily Boston blue clay. Cohesive sediment like clay form clumps, which are resistant to resuspension due to their size. Large clumps can increase bottom stress so individual particles may erode from the clump and resuspend. (EPA, 1989 – Section 4.1.2.2) Since the dredged material will be disposed in the area under both the Preferred Alternative and No

Action Alternative, there will be no difference in the potential for resuspension and transport of dredged material.

4.1.2.3 Bioturbation

Bioturbation, which is the movement or modification of sediment by benthic organisms, is discussed at length in the DEIS for the Designation of the MBDS. Burrowing organisms can cause pelletization and dilution of fine-grained sediment, which reduces or eliminates the cohesiveness between particles, or break apart clumps of cohesive sediment. This makes the disposed sediment more susceptible to erosion. However, rates of bioturbation are linked to higher temperatures. Since the bottom temperatures in the project area do not vary significantly over the year and the periods of higher temperature are least likely to have strong storm events, the effects of bioturbation should be smaller and less variable over the seasons than in more shallow sites. (EPA, 1989 – Section 4.1.2.3) Since the material will be disposed in the area under both the Preferred Alternative and the No Action Alternative, there should be no difference in the effects of bioturbation.

4.2 EFFECTS ON CHEMICAL ENVIRONMENT

4.2.1 Water Quality

The process of disposal of dredged material has the potential to elute some portion of the various chemical contaminants adsorbed into the sediment particles, usually in the parts per million (ppm) concentration range. Water quality concentrations resulting from elution of those chemicals are typically in the parts per billion (ppb) range. Modeling to determine temporal and spatial variations of water column toxicant levels is discussed at length in the DEIS for the Designation of the MBDS. (EPA, 1989 – Section 4.2.1)

Section 3.2.1 summarizes the water quality surveys done in the area since the designation of the MBDS. For all parameters, there were no exceedances of the Water Quality Criteria. The material being disposed of as part of this project is Boston blue clay, which has been far removed from anthropogenic influences. Therefore, there will be no or very minimal release of contaminants to the water column during dredging. (USACE & Massport, 2013) This is the case for both the Preferred Alternative and the No Action Alternative.

4.2.2 Sediment Chemistry

<u>Preferred Alternative</u>

The material to be disposed of in the project area is parent material, meaning it is taken from a site far removed from known sources of pollution. The sediment being dredged, which is primarily Boston blue clay, was laid down by glaciers before the Industrial Revolution and has been insulated from industrial contaminants by surficial material. Therefore, there are no significant long-term impacts expected from the disposal of this material. (USACE & Massport, 2013) In the Preferred Alternative, this sediment would be used to cover any potentially contaminated dredged material or sediment surrounding waste containers that are currently on the seafloor. Therefore, there will be uncontaminated parent material covering the seafloor at a depth of approximately 1 meter throughout the Potential Restoration Area.

No Action Alternative

In the No Action Alternative, the sediment would be disposed in a series of mounds within the existing MBDS with no significant impact anticipated on sediment chemistry from disposal. (USACE & Massport, 2013)

4.3 EFFECTS ON BIOTA

4.3.1 Plankton

The disposal of dredged material in the project area will not significantly impact the plankton population of Massachusetts Bay. Localized spatial impacts on plankton of short temporal duration (<4 hours) will potentially result from elevated suspended solids concentration. Mortality from physical processes and toxics may occur to a minor extent, but will not have significant impact on the Massachusetts Bay plankton community. (EPA, 1989) This is the case for both the Preferred Alternative and No Action Alternative.

4.3.2 Benthic Resources

When dredged material is disposed in open water, there will be temporary displacement of the benthic community, including possible burial of demersal fish or benthic invertebrates. However, benthic infauna generally recolonize new sediment and fresh dredged material in a relatively predictable sequence, characterized by three stages of succession. Stage I is dominated by small, opportunistic, tube-forming capitellid, spionid, and paraonid polychaetes or oligochaetes, which colonize the disposal mounds within 1 to 2 weeks and do not penetrate the sediment very deeply. These organisms are thought to be recruited to the new habitat from areas near the disposal mound. Stage II is dominated by deeper-penetrating species, which include tubicolous amphipods and mollusks, typically occurring 3 to 6 months after disposal has ceased. These taxa represent a more transitional stage and they may or may not hold permanent positions in the long-term benthic community structure. Stage III animals represent an “equilibrium” level, typically deeper-dwelling, head-down deposit feeding species, such as maldanid, pectinid and predatory polychaetes, holothurians, and nuculid bivalves. Stage III can occur during the first year after disposal has ceased, but additional time for larval recruitment from off-site locations may be required. Some head-down deposit feeders are thought to be capable of migrating up through the fresh dredged material after a disposal event to maintain position in the sediment. (EPA, 2009)

In Boston blue clay, which is cohesive, clumps may initially hinder deeper colonization by Stage III infauna. (EPA, 2009) The closer the clay is to the sediment surface, the greater the resistance of the sediment to burrowing infauna. However, even in dredged material deposits exceeding a meter in depth or consisting of highly cohesive, consolidated material, benthic recolonization and community succession will occur with full ecosystem recovery over time (anywhere from 18 months to five years). This result was confirmed at Mound C in the

MBDS, which contained more Boston blue clay than other mounds in the area. A 2000 survey showed fewer occurrences of mature, deposit-feeding communities present when compared to other mounds. However, by 2004, the resident benthic community had completely recovered and exhibited benthic conditions comparable to the reference sites. (USACE & Massport, 2013)

Preferred Alternative

The USACE regularly monitors the MBDS and has completed a baseline survey of the Potential Restoration Area under its DAMOS program. The results of their sediment profile imaging and plan-view (SPI/PV) surveys determined that, despite the presence of historical dredged material disposal activity, the majority of stations in the Potential Restoration Area did not differ from the reference stations. In addition, mature Stage III benthic assemblages were present at all locations sampled. The project area had similar physical and biological characteristics to the ambient seafloor, indicating that, with time and a cessation of persistent disposal activity, benthic communities can recover and mirror undisturbed sites. (Sturdivant & Carey, 2017)

Under the Preferred Alternative, the short-term disturbance of the benthic community as described above will be expected across the Potential Restoration Area. However, since the Preferred Alternative would require the expansion of the MBDS to close upon completion of the project, there will be no further disturbances from disposal activities, allowing the area to recover.

No Action Alternative

Under the No Action Alternative, the material will be disposed in the existing MBDS. The same short-term benthic impacts are expected as in the Preferred Alternative. The primary difference is that, since the MBDS is an active designated disposal site, disturbance of the benthos could continue through additional dredged material disposal activities.

The recovery of benthic communities will continue to be monitored by the USACE's DAMOS program under both the Preferred Alternative and the No Action Alternative.

4.3.3 Fish & Shellfish

The impacts of dredged material disposal on fish and shellfish resources in the project area are discussed at length in the DEIS for the designation of the MBDS. (EPA, 1989 – Section 4.3.2)

Mortality of some eggs and larvae could occur through shear forces or abrasion from the descending mass of water and dredged material, high suspended sediment concentrations, or direct burial in the case of demersal eggs and larvae. Elevated suspended sediment levels could also potentially reduce the growth rate, survivorship, reproductive potential, or feeding success of larvae. However, these impacts to eggs and larvae are limited to the site of disposal, which is a very small fraction of the total spawning area.

Mortality of demersal fish and shellfish should be limited to those few entrained within or buried by the descending mass of dredged material. Demersal fish, crabs, lobsters and mollusks have a high tolerance to suspended sediments. Since most of the fish inhabiting the MBDS area are demersal or semi-demersal, they are likely somewhat resistant to suspended sediments. Recovery of the demersal fish at a disposal site after the disposal of dredged material will be closely linked to the recovery of the benthic community. The adverse impacts will be insignificant outside the immediate vicinity of the MBDS.

Some pelagic invertebrates like squid or shrimp may be subject to entrainment in the descending dredged material. Since pelagic species are mobile, they are able to avoid localized areas with high concentrations of suspended sediments. There will be short-term reductions in prey, but the impact to pelagic species will be highly localized and ecologically insignificant. (EPA, 1989) This is also the case for federally managed species and EFH.

Within the MBDS expansion in the Preferred Alternative, there are two glacial knolls that act as vibrant habitats for many species. As such, these knolls will be avoided in all disposal activities and are not included in the Potential Restoration Area. Therefore, the impacts to the fish and shellfish in the project area are expected to be the same under both the Preferred Alternative and the No Action Alternative.

4.3.4 Mammals, Reptiles & Birds

Impacts to threatened and endangered species are discussed in Section 4.3.5. There are virtually no anticipated significant adverse impacts to marine mammals, their habitat, or prey species from the disposal of dredged material in the MBDS. (EPA, 1989) Birds in the area of the disposal site would likely avoid the immediate vicinity during disposal operations. (USACE & Massport, 2013)

4.3.5 Threatened & Endangered Species

NOAA NMFS has provided consultation on the designation and management of the MBDS under Section 7 of the ESA in 1991, 1999 and 2011.

Because they are rarely observed there, the Stellwagen Bank area is not considered usual habitat for blue whales, and activities at the MBDS should not affect them. Due to the low temperatures near the seafloor of Stellwagen Basin, which are lethal to Kemp’s Ridley and Loggerhead sea turtles, use of the MBDS as a foraging area is unlikely. Therefore, disposal of dredged material at the MBDS is unlikely to directly impact them. There is no evidence of the shortnose sturgeon or Atlantic sturgeon utilizing the disposal site area so disposal events at the MBDS should not affect them. (NMFS, 1991)

Humpback whales, Northern Right whales, Fin whales, Sei whales and Leatherback sea turtles are known to use the MBDS area. Disposal activities may result in harassment, vessel collisions, exposure of endangered and threatened species to falling sediment and rock, and short-term impacts to prey. To minimize these risks, NMFS, EPA and USACE worked together to reduce the likelihood of a project vessel interacting with a whale or sea turtle. The recommendations include reduced vessel speed, maintaining a safe distance from observed listed species, presence of a NMFS-trained observer on board the disposal vessel. These conservation recommendations were last revised in 2011 and are incorporated in the SMMP for MBDS. (NMFS, 2011; EPA, 2009) These conservation recommendations will continue to be followed under both the Preferred Alternative and the No Action Alternative. EPA has made the preliminary determination that the proposed expansion of the MBDS is not likely to adversely affect any threatened or endangered species and will be initiating a new Section 7 consultation with NMFS as part of this action.

4.4 FISHING

As indicated in Section 4.3.3, impacts to fish are expected to be highly localized at the disposal site and insignificant within Massachusetts Bay. Therefore, minimal impact on fishing is expected under both the Preferred Alternative and the No Action Alternative. The 1971 FDA notice to fishermen, warning against fishing in the IWS, the NMFS ban on the harvesting of surf clams and ocean quahogs in the IWS, and the FDA and NMFS advisory to all fishermen requesting that they avoid harvesting bottom-dwelling species in the IWS will likely remain in place.

4.5 MARINE SANCTUARIES

The MBDS is directly adjacent to the western border of the SBNMS. While dredged material disposal and contaminants from the IWS have the potential to contaminate the sanctuary, both the EPA and NOAA concluded that the MBDS would not threaten the resources of the SBNMS. (NOAA, 2010) EPA has agreed that dredged material disposal activities should not be authorized if they are shown to potentially injure SBNMS resources. (EPA, 1992) There is a Memorandum of Understanding between the USACE and NOAA that requires that NMFS be notified by the USACE when dredged material will be deposited in the MBDS. (NOAA, 2010)

Neither the current MBDS nor the Preferred Alternative overlap with any Massachusetts Ocean Sanctuary. Therefore, there will be no disposal within a Massachusetts Ocean Sanctuary.

Preferred Alternative

Under the Preferred Alternative, the majority of the IWS and barrel field will be covered with Boston blue clay, sequestering any potential contaminants from historic disposal. This is designed to prevent any contamination to the SBNMS in the future. The extent of the expansion and the Potential Restoration Area do not overlap with the SBNMS. (See Figure 2.1)

No Action Alternative

The dredged material will be disposed in the existing boundaries of the MBDS and will not be expected to have any impact on the SBNMS.

4.6 RECREATION

It is not anticipated that marine recreation in the project area, including any recreational boating, will be impacted by either the Preferred Alternative or the No Action Alternative.

4.7 HISTORIC & CULTURAL RESOURCES

There have been shipwrecks identified in the MBDS area. Two in particular are in close proximity to the project area, but within the boundaries of the existing MBDS. They were observed by the USACE during a survey using a remotely operated video (ROV) system. The USACE consulted an archaeologist to provide a cultural resources analysis of the video footage. They were deemed potentially significant historical resources. As a precaution, a buffer of a minimum 50-meter radius from the outside edge of both vessels is recommended during any future disposal activities, including this project. (Sturdivant & Carey, 2017)

<u>Preferred Alternative</u>

The Potential Restoration Area avoids the two potentially significant historical wrecks and, therefore, the Preferred Alternative is expected to have no impact on them.

<u>No Action Alternative</u>

Any future disposal in the existing MBDS, including this project, will avoid the two potentially significant historical wrecks with a 50-meter buffer. Therefore, there is no anticipated impact under the No Action Alternative.

4.8 SHIPPING

As the existing MBDS and proposed expansion are approximately 1.8 nautical miles north of the major shipping lanes into and out of Boston Harbor, no impact to shipping is anticipated under either the Preferred Alternative or No Action Alternative.

4.9 MINERAL, OIL & GAS EXPLORATION

As the existing MBDS and proposed expansion do not overlap with any LNG pipelines or terminals, no impact is expected under either the Preferred Alternative or No Action Alternative.

4.10 HAZARDOUS, TOXIC & RADIOACTIVE WASTE

<u>Preferred Alternative</u>

By temporarily expanding the boundaries of the MBDS under the Preferred Alternative, the Boston blue clay and glacial till dredged during the Boston Harbor maintenance and improvement projects will be used beneficially to sequester the majority of the hazardous, toxic and radioactive waste that was disposed in the IWS. The containers and surrounding sediment will no longer be exposed on the seafloor reducing the risk of future contamination to surrounding areas or recovery by fishermen. This is a unique opportunity to positively impact the IWS area while beneficially using dredged material.

No Action Alternative

Under the No Action Alternative, the dredged material will be disposed in the existing MBDS. The IWS will remain unrestored and the barrels will remain uncovered.

4.11 AIR QUALITY

The disposal of dredged material will require repeated vessel journeys from Boston Harbor to the disposal site. Due to the very close proximity of the proposed expansion and the existing MBDS, there will be little to no difference in travel time or number of trips required, and therefore air emissions, between the Preferred Alternative and the No Action Alternative.

4.12 NOISE

Due to the very close proximity of the Potential Restoration Area and the MBDS, there would be no difference in noise impacts between the Preferred Alternative and the No Action Alternative. That being said, no noise impacts are anticipated for this project.

4.13 ENERGY REQUIREMENTS & CONSERVATION POTENTIAL

The energy requirements for this project are limited to fuel for transportation of dredged material to the disposal site. Due to the close proximity of the Potential Restoration Area and the existing MBDS, the selection of either the Preferred Alternative or the No Action Alternative would essentially require the same amount of energy.

4.14 NATURAL OR DEPLETABLE RESOURCES

The depletable resources would be the fuel for the transportation of dredged material to the disposal site. Due to the close proximity of the Potential Restoration Area and the existing MBDS, as well as the same estimated number of trips for disposal, the selection of either the Preferred Alternative or the No Action Alternative would essentially require the same amount of depletable resources.

4.15 CUMULATIVE IMPACTS

Cumulative impact is the "impact on the environment which results from the incremental impact of the action when added to other past, present, and reasonable foreseeable future actions regardless of what agency (federal or non-federal) or person undertakes such other actions. Cumulative impacts can result from individually minor but collectively significant actions taking place over a period of time." (40 CFR 1508.7)

Past disposal of dredged material has taken place in the proposed expansion area, along with hazardous waste, construction debris, ordnance, etc. Disposal in the IWS was terminated in 1977, but disposal of dredged material continued in adjacent sites (Interim MBDS from 1977 - 1992 and the existing MBDS from 1993 - date). The only upcoming projects that will use the proposed expansion are the Boston Harbor maintenance and improvement projects, which will be undertaken by the USACE. Once these projects are completed, the expansion will be closed under the Preferred Alternative.

Temporary expansion of the MDBS is not expected to result in significant cumulative impacts, although there will be changes in bathymetry and sediment composition, burial of organisms at the disposal area, and changes in the benthic community. These changes have occurred in this area since dredged material disposal began at the IWS. The evaluation conducted in this EA did not find evidence that any of these changes have resulted in significant unacceptable adverse impacts to the region's resources. The MBDS SMMP ensures that short-term and temporary impacts may be minimized or mitigated through management methods and that regular monitoring takes place through the DAMOS program. If significant adverse impacts are documented at the site during monitoring, actions will be taken to address those impacts.

4.16 IRREVERSIBLE & IRRETRIEVABLE COMMITMENT OF RESOURCES

Designation of a dredged material disposal site indirectly requires an irreversible commitment of energy and resources used to dredge, transport and dispose of material at the site; an irreversible commitment related to economic costs associated with site monitoring activities; and, an irreversible commitment related to human labor resources associated with these dredging and disposal activities. Energy and water consumption, as well as demand for services, would not increase significantly as a result of implementation of the proposed action. The commitment of these resources is undertaken in a regular and authorized manner and does not present significant impacts within this EA.

4.17 UNAVOIDABLE ADVERSE ENVIRONMENTAL EFFECTS

Unavoidable effects with either the Preferred Alternative or No Action Alternative include changes in bathymetry and sediment texture, temporary turbidity plumes during disposal operations, and changes in benthic community composition.

4.18 ENVIRONMENTAL COMMITMENTS

The EPA and USACE have made the following environmental commitments consistent with the SMMP:

- Ocean disposal of dredged material will meet the standards set forth in the MPRSA and other federal guidance documents; and

- The modified disposal site will undergo environmental monitoring under the DAMOS program.

4.19 COMPLIANCE WITH ENVIRONMENTAL REQUIREMENTS

4.19.1 National Environmental Policy Act of 1969

This Draft EA was prepared for public review pursuant to NEPA with EPA as the lead agency and the USACE as the cooperating agency. The Draft EA will be circulated to the appropriate local, state and federal agencies, as well as other interested stakeholders and citizens. Comments received will be addressed in the Final EA. Upon completion of the Final EA, the project will be in full compliance with NEPA.

4.19.2 Endangered Species Act of 1973

This Draft EA concludes that the proposed action is unlikely to adversely impact listed species. Concurrence is being requested with this determination and this project will be fully coordinated with NMFS and FWS.

4.19.3 Fish & Wildlife Coordination Act of 1958

This Draft EA concludes that the proposed action is unlikely to adversely impact fish or wildlife. Concurrence is being requested with this determination and this project will be fully coordinated with FWS.

4.19.4 Clean Water Act of 1972

As the proposed expansion areas are located outside the jurisdictional limits of this Act, a Section 404(b) evaluation is not applicable to this project and was not prepared.

4.19.5 Clean Air Act of 1972

The short-term impacts from transportation and construction equipment associated with the disposal of dredged material in the MBDS does not significantly impact air quality. Because all of Massachusetts (with the exception of Dukes County) is designated as an attainment area for Federal air quality standards under the Clean Air Act, a conformity determination is not required.

4.19.6 Coastal Zone Management Act of 1972

Although the project area is outside the coastal zone, transport to the site will be through the coastal zone. This project will be fully coordinated with the Massachusetts Office of Coastal Zone Management and will be in compliance with the Act.

4.19.7 Farmland Protection Policy Act of 1981

No prime or unique farmland would be impacted by implementation of this project. This Act is not applicable.

4.19.8 Wild & Scenic River Act of 1968

No designated wild and scenic river reached would be affected by project related activities. This Act is not applicable.

4.19.9 Marine Mammal Protection Act of 1972

This Draft EA concludes that the proposed action is unlikely to adversely impact marine mammals. Concurrence is being requested with this determination and this project will be fully coordinated with NMFS. This project will be in full compliance with this Act.

4.19.10 Estuary Protection Act of 1968

No designated estuary would be impacted by project activities. This Act is not applicable.

4.19.11 Submerged Lands Act of 1953

This project would not occur on submerged lands of the Commonwealth of Massachusetts. This project will be in compliance with the Act.

4.19.12 Coastal Barrier Resources Act & Coastal Barrier Improvement Act of 1990

There are no designated coastal barrier resources in the project area that would be impacted by this project. These Acts are not applicable.

4.19.13 River & Harbor Act of 1899

The proposed action would not obstruct or pollute navigable waters of the United States. This project will be in compliance with the Act.

4.19.14 Anadromous Fish Conservation Act

This Draft EA concludes that the proposed action is unlikely to adversely impact anadromous fish. This project will be fully coordinated with NMFS and will be in compliance with the Act.

4.19.15 Marine Protection, Research & Sanctuaries Act

The MPRSA regulates the transportation and subsequent disposal of materials, including dredged materials, into ocean waters. The proposed MBDS expansion is being undertaken pursuant to Section 102 of the MPRSA. The five general (40 CFR 228.5) and eleven specific (40 CFR 228.6) criteria for the selection of sites have been discussed and included in Section 2.4. The EPA is responsible for MPRSA compliance of all ocean disposal activities and this project will be in full compliance with the Act.

4.19.16 Magnuson-Stevens Fishery Conservation & Management Act

The project area is located within the jurisdiction of the MSA, and an EFH assessment has been prepared that evaluates potential impacts on NMFS-managed fish species and their essential fish habitats (Section 3.3.3). This Draft EA concludes that any adverse impact to EFH will be minor and temporary. This project will be fully coordinated with NMFS and will be in compliance with the Act.

4.19.17 Executive Order 11593, Protection & Enhancement of the Cultural Environment

Archaeological surveys and consultations have been conducted by the USACE. Compliance with this order will be coordinated with the Massachusetts State Historic Preservation Officer (SHPO).

4.19.18 Executive Order 12898, Environmental Justice

The proposed activity would not result in adverse human health or environmental effects or exclude persons from participating in, deny persons the benefits of, or subject persons to discrimination because of their race, color, or natural origin. Further, the proposed activity would not impact "subsistence consumption of fish and wildlife." This project will be in compliance with this Executive Order.

4.19.19 Executive Order 13045, Protection of Children from Environmental Health Risks & Safety Risks

The proposed action would not result in adverse environmental health risks or safety risks to children. The proposed action will be in compliance with this Executive Order.

4.19.20 Executive Order 13089, Coral Reef Protection

There are no coral reefs in or near the project area, therefore, this Executive Order does not apply.

4.19.21 Executive Order 13112, Invasive Species

There are no components in the dredged material or consequences of its disposal that would be expected to attract or result in recruitment of nuisance species to the area. The proposed action will be in compliance with this Executive Order.

4.19.22 Executive Order 13158, Marine Protected Areas

EPA considered the location of any marine protected areas during the evaluation of the project alternatives. The proposed action will avoid harm to natural and cultural resources protected by any designated marine protected areas. The proposed action will be in compliance with this Executive Order.

4.19.23 Executive Order 13186, Responsibilities of Federal Agencies to the Migratory Bird Treaty Act

Migratory birds are not expected to be adversely impacted by the proposed action. The proposed action will be in compliance with this Executive Order.

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6. REFERENCES

Balthis, W; J Hyland; C Cooksey; M Fulton; E Wirth; D Cobb; D Wiley. 2011. *Ecological Condition of Coastal Ocean Waters within Stellwagen Bank National Marine Sanctuary: 2008*. U.S. Department of Commerce, National Oceanic and Atmospheric Administration. Technical Memorandum NOS NCCOS 129.

Butman, B; M Bothner; J Hathaway; H Jenter; H Knebel; F Manheim; R Signell. 1992. *Contaminant Transport and Accumulation in Massachusetts Bay and Boston Harbor: A Summary of Geological Survey Studies*. U.S. Department of the Interior, Geological Survey. Survey Open-File Report 92-202.

Butman, B; P Valentine; W Danforth; L Hayes; L Serrett; T Middleton. 2004. *Shaded Relief, Sea Floor Topography, and Backscatter Intensity of Massachusetts Bay and the Stellwagen Bank Region Offshore of Boston Massachusetts*. U.S. Geological Survey, Geologic Investigations Series Map I-2734.

Curtis, WR; HM Mardis. 1984. *Data from Studies of Previous Radioactive Waste Disposal in Massachusetts Bay*. U.S. Environmental Protection Agency, Office of Radiation Programs.

EPA. 1989. *Draft Environmental Impact Statement: Evaluation of the Continued Use of the Massachusetts Bay Dredged Material Disposal Site*. U.S. Environmental Protection Agency, Region 1.

EPA. 1990. *Supplemental Draft Environmental Impact Statement for the Designation of Dredged Material Disposal Site in Massachusetts Bay: Alternate Site Screening*. U.S. Environmental Protection Agency, Region 1.

EPA. 1992. *Final Environmental Impact Statement: Designation of an Ocean Dredged Material Disposal Site in Massachusetts Bay*. U.S. Environmental Protection Agency, Region 1.

EPA. 1993. *Public Record of Decision on the Final Environmental Impact Statement for the Designation of an Ocean Dredged Material Disposal Site in Massachusetts Bay*. U.S. Environmental Protection Agency, Region 1.

EPA. 1996. *Massachusetts Bay Disposal Site Management Plan*. U.S. Environmental Protection Agency, Region 1.

EPA. 2009. *Massachusetts Bay Disposal Site: Site Management and Monitoring Plan*. U.S. Environmental Protection Agency, Region 1.

EPA. *Status of Massachusetts Designated Areas: Massachusetts Areas by NAAQS*. https://www3.epa.gov/airquality/urbanair/sipstatus/reports/ma_areabypoll.html.

Field, L; D MacDonald; S Norton; C Severn; C Ingersoll. 1999. *Evaluating sediment chemistry and toxicity data using logistic regression modeling*. Environmental Toxicology and Chemistry 18(6):1311-1322.

Field, L; D MacDonald; S Norton; C Severn; C Ingersoll; D Smorong; R Linkskoog. 2002. *Predicting amphipod toxicity from sediment chemistry using logistic regression models*. Environmental Toxicology and Chemistry 21(9):1993-2005.

Hunt, CD; Hall, M; Pala, S; Dahlen, DT. 2006. *A Review and Summary of Toxic Contaminants in Boston Harbor and Massachusetts Bay: 1990 to 2005*. Massachusetts Water Resources Authority. Report ENQUAD 2006-23.

Libby, P; D Borkman; W Geyer; J Turner; A Costa. 2015. *2014 Water Column Monitoring Results*. Massachusetts Water Resources Authority. Report 2015-09.

Liebman, M; J Brochi. 2008. *US EPA Survey at the Massachusetts Bay Disposal Site and Industrial Waste Site: July 2006*. U.S. Environmental Protection Agency, Region 1, Ocean & Coastal Protection Unit.

NMFS. 1991. *Letter to Julie Belaga, Regional Administrator, EPA, Region 1*. United States Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service.

NMFS. 1999. *Letter to John P. DeVillars, Regional Administrator, EPA, Region 1*. United States Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service. October 4, 1999.

NMFS. 2011. *Letter to Mel Coté, Jr., Ocean & Coastal Protection Unit, EPA, Region 1*. United States Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service. March 7, 2011.

NMFS. 2015. *Status Review of the Humpback Whale (*Megaptera novaeangliae) *Under the Endangered Species Act*. United States Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service. Southwest Fisheries Science Center. March 2015. NOAA-TM-NMFS-SWFSC-540.

NMFS. 2016. *Designation of Critical Habitat for the Gulf of Maine, New York Bight, and Chesapeake Bay Distinct Population Segments of Atlantic Sturgeon*. United States Department of Commerce, National Oceanic and Atmospheric Administration, National Marine Fisheries Service, Greater Atlantic Regional Fisheries Office. June 2016.

NMFS. *EFH Mapper*. http://www.habitat.noaa.gov/protection/efh/efhmapper/index.html.

NOAA. 1996. *The Massachusetts Bay Industrial Waste Site: A Preliminary Survey of Hazardous Waste Containers and an Assessment of Seafood Safety: May and June 1992*. U.S. Department of Commerce, National Oceanic and Atmospheric Administration. Technical Memorandum NOS ORCA 99.

NOAA. 2010. *Stellwagen Bank National Marine Sanctuary Final Management Plan and Environmental Assessment*. U.S. Department of Commerce, National Oceanic and Atmospheric Administration, Office of National Marine Sanctuaries.

SAIC. 1997. *Baseline Survey of the Reconfigured Massachusetts Bay Disposal Site: 14 September 1993*. U.S. Army Corps of Engineers, New England District. DAMOS Contribution No. 115.

Sturdivant, S; D Carey. 2017. *Baseline Assessment Survey for the Proposed Expansion of the Massachusetts Bay Disposal Site: September/October 2015*. US Army Corps of Engineers, New England District. DAMOS Contribution No. 201.

USACE. 2006. *Boston Harbor Inner Harbor Maintenance Dredging Project, Final Supplemental Environmental Impact Statement: June 2006*. U.S. Army Corps of Engineers, New England District.

USACE; Massport. 2013. *Final Feasibility Report and Final Supplemental Environmental Impact Statement and Final Environmental Impact Report (EOEA #12958) for the Federal Deep Draft Navigation Improvement Project, Boston Harbor, Massachusetts*. U.S. Army Corps of Engineers, New England District. Massachusetts Port Authority.

USACE. 2015. *Massachusetts Bay Disposal Site Restoration Demonstration Report: 2008 – 2009*. U.S. Army Corps of Engineers, New England District. DAMOS Contribution No. 198.

Werme, C; K Keay; P Libby; D Wu; D Taylor; D Codiga; K Coughlin. 2016. *2015 Outfall Monitoring Overview*. Massachusetts Water Resources Authority. Report 2015-11.

Wiley, D; V Capone; D Carey; J Fish. 1992. *Location Survey and Condition Inspection of Waste Containers at the Massachusetts Bay Industrial Waste Site and Surrounding Areas*. International Wildlife Coalition.

APPENDIX A:

Massachusetts Bay Disposal Site Management Plan.
December 31, 1996.

U.S. Environmental Protection Agency, Region 1.

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MASSACHUSETTS BAY DISPOSAL SITE MANAGEMENT PLAN

FINAL DECEMBER 31, 1996

PREPARED BY:

U.S. EPA REGION 1 (NEW ENGLAND)
OFFICE OF ECOSYSTEM PROTECTION
WATER QUALITY UNIT

WITH

U.S. ARMY CORPS OF ENGINEERS
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I. OVERVIEW

U.S. EPA Region 1-New England and the U.S. Army Corps of Engineers New England Division (NED) have prepared this site management plan (SMP) for the Massachusetts Bay Disposal Site (MBDS) to ensure that the site is managed to minimize adverse effects of disposal on the marine environment. The MBDS is an open water, ocean disposal site for dredged material designated in 1993. Currently, this site receives more dredged material, about 300,000 cubic meters annually, than any other site in New England north of Long Island Sound.

Management plans for ocean dredged material disposal sites are required pursuant to §102(c) of the Marine Protection, Research, and Sanctuaries Act (MPRSA, or the Act), as amended by §506(a) of the Water Resources Development Act (WRDA) of 1992. In accordance with MPRSA (section 103(a)) disposal activities at the site "will not unreasonably degrade or endanger human health, welfare, or amenities, or the marine environment, ecological systems, or economic potentialities." This plan synthesizes prior site monitoring results, outlines a monitoring program for the site and updates the site management and monitoring agreements between the U.S. Environmental Protection Agency New England (the EPA) and the U.S. Army Corps of Engineers New England Division (the Corps, USACE, or NED). The data gathered from the monitoring program will be routinely evaluated to determine whether modifications in site usage, management, or testing protocols are warranted.

As discussed in the guidance for development of site management plans issued by EPA and the Corps ("Guidance Document for Development of Site Management Plans for Ocean Dredged Material Disposal Sites", February 1996), management of the site involves: regulating the times, quantity, and physical/chemical characteristics of dredged material that is dumped at the site; establishing disposal controls, conditions and requirements; and monitoring the site environment to verify that unanticipated or significant adverse effects are not occurring from past or continued use of the disposal site and that permit terms are met. The organization of this plan includes the six requirements for ocean disposal site management plans discussed in §102(c)(3) of the Act, as amended. These are:

1) consideration of the quantity of the material to be disposed of at the site, and the presence, nature and bioavailability of the contaminants in the material (section II.C);

2) a baseline assessment of conditions at the site (section III);

3) a program for monitoring the site (section IV);

4) special management conditions or practices to be implemented at each site that are necessary for protection of the environment (section V.A);

5) consideration of the anticipated use of the site over the long term, including the anticipated closure date for the site, if applicable, and any need for management of the site after closure (section VI); and

6) a schedule for review and revision of the plan (which shall not be reviewed and revised less frequently than 10 years after adoption of the plan, and every 10 years thereafter) (section VII).

This management plan must be consistent with the Federal Coastal Zone Management Act of 1972. This Act and the 1976 amendments enabled states to develop comprehensive management plans for their coastal regions (subject to Federal approval). For all projects located in Massachusetts' coastal zone that involve Federal action such as funding, permitting, or licensing (e.g., this management plan as well as any dredging and/or disposal activities at the MBDS), a Massachusetts Coastal Zone Management Consistency Review is required to ensure that actions proposed within the coastal zone are consistent with state coastal policies. Consistency certification was granted on December 27, 1996.

Although not formally required, EPA requested that NMFS conduct an Endangered Species Act Section 7 review for the above federal activity. NMFS concurred with EPA's determination that the activities proposed in this plan will not adversely affect threatened or endangered species or adversely modify critical habitat. In addition, because the actions recommended in this plan are in the vicinity of the Stellwagen Bank National Sanctuary, this plan must comply with section 304(e) of the MPRSA as amended, requiring consultation. EPA and NED consulted with Sanctuary staff as required under this act.

II. SITE BACKGROUND

A. Past Usage

The MBDS is a circular area 2 nautical miles (nm) in diameter located approximately 10 nm (approximately 12 miles) south-southeast of Gloucester, and 18 nm from the entrance to Boston Harbor centered at 42°-25.1'N and 70°-35.0'W **(Figure 1)**. It is located in about 90 meters of water in a deep basin called Stellwagen Basin, directly west of Stellwagen Bank, an underwater glacial moraine that rises to 50 meters of the surface within 3 nm of the disposal site, and because of its importance to fish and marine mammal habitat, a National Marine Sanctuary.

The MBDS overlaps with two other historical disposal sites: the Industrial Waste Site, or IWS, which was employed from the 1940s until 1976, and the interim MBDS, which was used from 1977 to 1992. The IWS is a 2 nm circular area centered at 42°-25.7'N, 70°-35.0'W and the interim MBDS is a two nautical mile diameter center circle centered exactly one nautical mile east, at 42°-25.7'N, 70°-34.0'W. In 1977, the EPA's ocean dumping regulations (40 CFR 228.12) established the interim dredged material disposal site (interim MBDS). In 1993, the EPA officially designated the MBDS, reconfiguring the boundaries to overlap with both the IWS and the interim MBDS, avoiding part of the IWS with a high concentration of industrial waste barrels (see below) and the newly designated Gerry Studds Stellwagen Bank National Marine Sanctuary. Since 1977, only dredged material has been disposed at the interim MBDS and the MBDS.

Historically, most dredged material was disposed at sites closer to shore than the MBDS, especially at the Boston Lightship Disposal Area, a site about 15 nmi from Boston, which was closed in 1976. Some dredged material that was considered contaminated (often without any chemical testing) was disposed in the vicinity of the deep water, offshore area termed the "Foul Area", the area including both the IWS and the interim MBDS. "Polluted spoils were barged to the "Foul Area", and relatively clean dredged spoils dumped at the '"Dumping Ground'" (Gilbert, 1975). This area was routinely dubbed the "Foul Area", because the material on the bottom "fouls" or damages commercial fishing nets. From the 1940s to 1977 dredged material, construction debris, barrelled industrial waste, encapsulated low-level radioactive waste, munitions, and intentionally sunken derelict vessels were dumped in the general area of the IWS (Hubbard et al., 1988, SAIC, 1994a and b, NOAA 1996 draft report). Up to 80,000 containers of hazardous and low level radioactive waste may have been disposed at this site (Wiley et al., 1992). The dumping of hazardous and low level radioactive waste was permitted by the Atomic Energy Commission and the Army Corps from 1953 to 1959, after at which time the EPA issued permits for industrial waste only at the Foul Area. Most of the wastes appear to be in 55, 30 or 5 gallon drums, indicative of toxic or hazardous wastes, currently located in the northwest quadrant of the IWS (in an area around the coordinates 42°-26.4'N, 70°-35.4'W), or dispersed around the northern perimeter up to 0.5 nm outside the IWS (Wiley et al., 1992). Few drums are found away from the IWS. Dumping of industrial waste was terminated in 1976 and the IWS was formally de-designated on February 2, 1990.

Because of this area's past use as a dumping ground, the National Marine Fisheries Service (NMFS) closed the IWS to harvesting surf clam and ocean quahogs in 1980. In 1992, the Food and Drug Administration (FDA) and NMFS reissued this advisory, recommending a note be put on nautical charts, and advising all commercial and recreational fisherman to avoid harvesting bottom dwelling species from the area, including the MBDS (NOAA, 1996). There is some trawling activity in the area, but no evidence of otter trawl doors or foot rope sweep marks. In contrast, lobster traps are quite common in the area.

With designation in 1993, the boundary of the newly reconfigured MBDS avoids the area of the IWS that contains a high concentration of waste drums and the Gerry Studds Stellwagen Bank National Marine Sanctuary.

B. Buoy locations

According to records from the U.S. Coast Guard, before 1963, a disposal buoy was located at "an undisclosed location". From August, 1963 to January, 1975, the "A" (sometimes called "BFG") buoy, a conventionally moored buoy with a wide swath, was deployed by the U.S. Coast Guard at 42°-26.8'N and 70°-35.0'W (apparently outside of the IWS, and corresponding to the general area of most of the waste drums identified on the bottom). On January 29, 1975, the buoy was moved (south, about 1.1 nautical miles) to 42°-25.7'N and 70°-35.0'W to the center of the IWS. The disposal buoy remained here after the establishment of the interim dredged material disposal site in 1977. Thus, the disposal buoy remained at the western edge of the interim disposal site. Some dredged material was disposed in 1983 at a temporary buoy -- "Foul Area-South", or "FAS" -- located at 42°-25.39'N, 70°-34.54'W to test hopper dredging disposal.

In November 1985, a second disposal buoy, maintained by the Army Corps of Engineers NED, was deployed near its present location at 42°-25.1'N, 70°-34.45'W in the southwestern quadrant of the interim MBDS (Hubbard et al., 1988). (An April 1992 survey located the "MDA" buoy at exactly 42°-25.086'N, 70°-34.457'W.) From 1985 to about 1991, the "A" buoy was used as a backup disposal location. The new Corps buoy in 1985 is a taut-wired buoy which results in greater precision of dumping. It has been called, "DGD", "FDA" and is now named "MDA". Although the new MBDS was reconfigured in 1993, the buoy was not moved. It is located in the southeastern quadrant of the disposal site.

In addition to a sediment dredged material disposal buoy, a Rock Disposal Location (RDL) was established in 1991 specifically for disposal of rocks generated from downtown Boston's "Central Artery/Third Harbor Tunnel" and two other smaller projects. This location (which was marked only by coordinates, and not by a buoy) was in the northeast quadrant of the interim MBDS (about 500 meters outside of the new MBDS), on the slope of Stellwagen Bank at the coordinates 42°-26.5'N, 70°-34.0' at 50 m depth **(Figure 2)**. This location is now outside the current boundary of the MBDS and will not be used for future disposal.

C. Estimated quantity and quality of dredged material to be disposed

1. Dredged material quantity

Historically, the MBDS has been one of the most active disposal sites in New England, second only to the Central Long Island Sound disposal site. The dredged material has come from a number of harbors, rivers and channels from Gloucester to Plymouth, MA, many of which are industrialized. According to Corps records, Boston Harbor sediments have historically comprised about 67% of the disposed volume, South Shore sediments about 20%, and North Shore sediments about 13% (Hubbard et al., 1988).

From 1976 to 1994, the average annual disposal volume was 346,485 cubic meters **(Table 1)**. About 1.1 million cubic yards of sediment (primarily Boston Blue Clay) and blasted rocks from the Central Artery/Third Harbor Tunnel (now called the Ted Williams Tunnel) project were disposed at the MDA buoy and the Rock Disposal Location in 1992 and 1993. Some of the excavates from this project were disposed in a lined landfill on Spectacle Island. One other major project will likely create a substantial increase in disposal activity in the next 5 years. From 1997 to 2001, an additional 600,000 cubic yards of soft surface sediments and bottom clays from Fort Point Channel in downtown Boston will be dredged for the Central Artery project. Depending on the amount of mixing of surface sediments into the bottom clays during the stabilization process, about 350,000 cubic yards will be disposed at Spectacle Island, and the remaining clean material (mostly clays) will be disposed at the MBDS (Randall, personal communication). About 90,000 cubic yards of sediments determined unsuitable for disposal at the MBDS from the CA/THT project are contained in a lined facility on Governor's Island, adjacent to Logan Airport (Lipman, personal communication). None of these lined landfill facilities are expected to be available for disposal of other sediments in the future.

Second, the Boston Harbor Navigation Improvement Project will provide material for the MBDS from 1996 to 1998, if fully funded. Boston Harbor was last dredged in 1983. MassPort will dredge a total of 4.7 million cubic yards (mcy) including 1.7 mcy of uncontaminated parent (mostly clay) material, 88,000 cubic yards of rock for

1,550,700
+ 105,000
71,600
1,727,300

improvement dredging and 1.1 mcy of unconsolidated silty material for maintenance dredging and local berthing, which were deemed unsuitable for ocean disposal and will be isolated below approximately 1.8 mcy of sediments in the Chelsea and Mystic rivers (in-channel disposal; USACE, 1996). Over the next 50 years, it is estimated that the Corps and MassPort will need to dredge another 4.4 mcy of material from the main channel for future maintenance and 1.8 mcy from the tributaries (Lipman, personal communication).

Table 1. Volume (cubic meters) of dredged material disposed at the Massachusetts Bay Disposal Site on an annual basis from all sources in Massachusetts Bay. Sources: 1982-1994: Tom Fredette, personal communication, NED records 1976-1981: Hubbard et al., 1988

Year	Volume	Year	Volume
1976	239,746	1986	167,950
1977	38,400	1987	94,509
1978	25,320	1988	102,548
1979	70,273	1989	172,374
1980	11,552	1990	181,496
1981	241,004	1991	47,258
1982	678,260	1992	979,646
1983	216,320	1993	520,040
1984	222,730	1994	64,500
1985	135,524		

In 1994, the Cape Cod Bay disposal site (CCBDS) was identified by the Commonwealth of Massachusetts as an inland or nearshore Clean Water Act (CWA) Section 404 disposal site, but it is not anticipated that this site will reduce the projected volume at the MBDS. In 1994, the CCBDS received 135,598 cubic yards, all of it from Wellfleet Harbor. In the fall of 1996, Duxbury will dispose up to 300,000 cubic yards of material there. In both of these cases, these towns had not planned to barge sediments to the MBDS due to cost considerations and had not used the MBDS in the past. The Commonwealth of Massachusetts, with the NED, is currently engaging in a long term management study to estimate future use of the MBDS and the CCBDS (Babb-Brot, personal communication).

2. Dredged material quality and testing protocols

Sediments disposed at the MBDS are typically silt and sand, with occasional consolidated clay chunks (e.g. Boston Blue Clay), or rubble. For example, the majority of the material for the Boston Harbor dredging project is silt (60%) while the remainder (40%) is sand and gravel. In general, the dredged material is more sandy and heterogeneous than the ambient sediments (silt and clay) at the site, and in Stellwagen

Basin.

Surface sediments in Massachusetts harbors and estuaries proposed for future dredging sometimes exhibit high levels of contaminants. For example, Boston Harbor sediments are generally considered high in polycyclic aromatic hydrocarbons (PAHs), and chromium in Salem Sound sediments are among the highest recorded in the nation (Daskalakis and O'Connor, 1994). According to the EPA's National Sediment Inventory, most of the sediments tested from Gloucester to Plymouth have tested as moderately or highly likely to cause adverse effects to aquatic life or human health (EPA, 1996). Other studies have documented elevated concentrations in Boston Harbor and other harbors in Massachusetts Bay (Cahill and Imbalzano, 1991, Fore River Estuary Project, 1994, Hyland and Costa, 1995, Leo et al., 1993, MacDonald, 1991, Moore and Stegemen, 1995).

The dredged material to be disposed at the MBDS in the future will only be that material deemed suitable for ocean water disposal by both the Corps and EPA in accordance with established criteria ("ocean dumping criteria", 40 CFR Part 227). EPA implements its MPRSA statutory authority through the Ocean Dumping Regulations, 40 CFR 220-228. Correspondingly, the USACE's permit regulations are contained in 33 CFR 320-330 and 33 CFR 335-338. The NED and EPA use the procedural and technical guidance recommended by the "Green Book" or "Ocean Testing Manual" (Evaluation of Dredged Material Proposed for Ocean Disposal-Testing Manual, EPA/USACE, 1991) to evaluate the potential environmental effects of dredged material disposal in the ocean. A second manual, the "Regional Protocol",(Guidance for Performing Tests on Dredged Material to be Disposed in Open Waters, EPA-Region I/USACE-NED, 1989), adapts the national procedures to New England situations. It is currently in revision to reflect new guidance and will be available in 1997.

In practice, EPA Region 1 (New England) and the NED evaluate sediments in a tiered procedure **(Figure 3)**. Tier 1 is a data review to determine whether there is reason to believe the sediment is contaminated, and whether the sediment can satisfy exclusion criteria listed in 40 CFR 227.13(b). If chemical information is insufficient, the regional protocol requires bulk sediment analyses for grain size, total organic carbon (TOC), metals, total PCBs, pesticides, and a suite of priority polycyclic aromatic hydrocarbons (PAHs) according to EPA protocols (USEPA, 1986), or other national guidance (e.g. EPA/USACE, 1995). Additional chemical analytes may be required on a case-by-case basis. In Tier 2, EPA and NED evaluate the chemical data to determine whether marine water quality criteria are exceeded, or whether there is a potential for bioaccumulation (uptake of contaminants into an organism's tissues). Based upon the results of these analyses, EPA and NED determine the need for Tier 3 (biological evaluation) which requires that the proposed dredged material be tested for toxicity and bioaccumulation to appropriate marine species. If the test results indicate unacceptable toxicity compared to reference sediments, or bioaccumulation likely to cause adverse effects, then the proposed dredged material is not suitable for unconfined ocean disposal according to 40 CFR 227.6. Thus, dredged materials suitable for unconfined ocean disposal are not expected to cause unacceptable adverse effects to the marine environment.

D. Past Monitoring

Contemporary monitoring of the disposal area and the MBDS began with studies in the early 1970s by Thomas R. Gilbert, of the New England Aquarium for the Commonwealth of Massachusetts Division of Water Pollution Control (Gilbert, 1975). However, the main body of monitoring information stems from the Corps' Disposal Area Monitoring System (DAMOS). Begun in 1977, DAMOS is a multi-site oceanographic systematic monitoring program performed by a Corps contractor. It continues to be and will remain as the main vehicle for site monitoring. EPA Region I (New England) has also studied the site on a more limited basis. A fairly complete summary of these past monitoring efforts is provided in **Table 2**. In addition to the major findings of each survey, this table summarizes the methods used and parameters measured. Most of the studies have focused on the Interim MBDS and the IWS. Recently, studies have been performed on the new MBDS. Other researchers and agencies have investigated these areas on a more limited basis. They include investigations of the conditions of the hazardous wastes dumped at the IWS by EPA and National Oceanic and Atmospheric Administration (NOAA), and work performed by the U.S. Geological Survey (USGS) to map the bottom of Stellwagen Basin and Stellwagen Bank (Knebel and Circe, 1995; Valentine et al., 1996; NOAA, 1996). Results of some of these studies are presented in Section III.

Monitoring studies have employed a wide variety of assessment techniques. These include, among others, a) precision bathymetry (precise mapping of seafloor topography to determine formation of disposal mounds), b) sediment profile cameras to determine the nature and extent of dredged material on the bottom and a simple estimate of the biological community c) sediment chemistry sampling and analysis, d) water column sampling and analysis, e) tissue sampling and analysis, f) fishery resource assessments, g) submersible vehicle video analysis and h) benthic community analysis.

E. General impacts from disposal of dredged material

Overall, dredged material research performed by the Corps and EPA (on a national basis) has demonstrated that disposal-related impacts to the water column are of shorter duration and less concern than impacts to the sediment and benthos (Munns, et al., 1989; USACE, 1986). As a result, any impacts to sediment feeding organisms (e.g., clam worms and amphipods) will be longer lasting than for water filter-feeding organisms (e.g., mussels). Monitoring programs at the site have reflected these findings with an emphasis on benthic related impacts as opposed to water quality.

Dredged material released from a barge descends through the water as a somewhat cohesive dense fluid-like jet, entraining substantial volume of ambient water (called convective descent). Turbulence separates and suspends 3 to 5% of the total material, especially the fine grained sediments into the water column and transports it off-site (USACE, 1986; USEPA Region 1, 1992). The dense material hits the bottom and collapses, in a restricted area. The impact on the bottom creates a surge of sediment into the overlying water column, about 20% of the total water column depth (at MBDS, this would be about 15 meters), spreading several hundred meters radially and eventually settling within about 100 to 200 meters from the impact site. Levels of suspended solids above the bottom are usually temporarily elevated, even above those found in the surface plume.

In 1982, as part of the DAMOS program, researchers tested the transport of a plume from a disposal event at MBDS using a hopper dredge and a taut-wired buoy (SAIC, 1985). They found convective flow to the bottom removed most of the material from the water column within a few minutes. Immediately after disposal, 750 mg/liter of suspended solids was observed in a surface water plume, but decreased to 5 to 12 mg/liter after about 40 minutes of lateral transport (ambient concentration = about 1 mg/liter). Characterizing the plume transport with acoustic devices resulted in an estimate that about 3% of the material had been dispersed in the near surface water column, away from the site. However, bottom suspended solids concentrations from the surge were not measured.

Results of modelling the disposal of material from the Central Artery/Third Harbor Tunnel project concluded that the surge would resuspend sediments 15 feet (5 meters) above the bottom (NMFS, 1991), but settling would occur within three hours. The maximum increase of suspended solids near the bottom would be about 929 mg/liter, and the maximum increase at the *disposal site boundary* would be about 2 mg/l. Dispersal of material from the surface plume 2500 meters away would result in net deposition of sand and silt to the bottom of a virtually undetectable amount. A 3000 cubic meter dump would result in net deposition to the bottom of about 0.003 mm. Finer particles would stay suspended in the water column and be transported off site, but temporary increases in contaminant concentrations clearly would not exceed water quality criteria.

EPA Region 1 modeled the disposal of sediments for the Final Environmental Impact Statement using the Corps' ADDAMS (Automated Dredging and Disposal alternatives Management System) model (USEPA Region 1, 1992). This model, which used conservative assumptions, predicted no exceedances of water quality criteria after the allowed four hour mixing time within the site, providing further evidence that disposal of dredged material does not cause water column impacts to Massachusetts

Bay.

Thus, this monitoring plan will focus on bottom resources affected by the direct disposal of dredged material hitting the bottom, and the spreading of dredged material radially beyond the immediate point of impact.

east) surface flow. EPA Region 1 (1989) stated that storm-induced flow is expected to transport sediments to the west and southwest. However, based on a three-dimensional hydrodynamic model of Massachusetts Bay developed by the USGS, in response to a 35 mph wind from the northeast, bottom currents would be expected to flow to the north and east at less than 10 cm/second (Signell, personal communication). Although coarse grained sands might be transported in this direction, fine grained material could be resuspended into the water column where it could be transported by midwater and surface currents in a variety of directions. In sum, dredged material could be expected to be transported off disposal mounds in probably all directions.

2. Bathymetry

The MBDS is situated in the northwestern corner of Stellwagen Basin, a large depression within Massachusetts Bay ranging from 80 to 100 meters depth, and separated from the Gulf of Maine by Stellwagen Bank, a sand and gravel underwater shelf which rises to the east to within 50 meters of the surface. Glacial events 14,000 to 50,000 years ago scoured the seafloor and eventually deposited till and outwash (pulverized rock, gravel and sand) which now form Cape Cod, Stellwagen Bank, and other prominent features of the land and seascape. The detailed bathymetry within the MBDS is shown in **Figure 4**. In general, the area is a smooth generally featureless area with depths ranging from 82 to 92 meters. There is a slight trough running northwest to southeast along the length of the site. A small circular depression in the northeast quadrant of the site with maximum depths of greater than 90 meters, and a glacial knoll at the northern boundary break up the relatively dull landscape. Within 1000 meters of the northeast edge are the steep flanks of Stellwagen Bank. This slope is the area where rock was disposed from the CA/THT project (the RDL).

3. Benthic environment and sedimentology

Because of slow current speeds and bottom topography, the MBDS is located in a depositional environment and is subject to accumulation of fine grained silt and clay particles. The most common grain size is silty sand, with a phi size of about 4 to 5, but ranging anywhere between 3 to 7. Sediment accumulation rates are about 0.1 to 0.2 cm/year and sediment profiles indicate accumulation of anthropogenic contaminants from distant or regional sources (Wade et al., 1989). Up until 1985, disposal of dredged material did not create any visible mounds at the site. However, dredged material could be detected by a variety of techniques such as side scan sonar, sediment profile imaging and grab sampling. Side scan sonar and sediment profile imaging can detect areas of past and recent dredged material disposal, indicated by either high reflectivity (clumped deposits) or sandier sediments overlying finer sediments. A new type of sediment acoustic characterization system (SACS), which utilizes low frequencies can penetrate sediments further, and detect presence of relic dredged material was employed in 1993, observing a thin layer of fine grained

III. BASELINE SITE CHARACTERISTICS

A. Physical Site Characteristics

Much of the information in this section comes from studies conducted by SAIC from 1985 to 1987 for the NED for the site evaluation studies (Hubbard et al., 1988). Recent studies conducted by the USGS, Massachusetts Bays Program (MBP) and the Massachusetts Water Resources Authority (MWRA) have confirmed and supplemented many of these observations.

1. Physical oceanography

The area near the MBDS receives surface currents from the Gulf of Maine, a weak coastal current which enters Massachusetts Bay over a sill between Stellwagen Bank and Cape Ann. From May through October, the water column is typically stratified, with the pycnocline located at approximately 15 to 20 meters. The greatest stratification is usually in August or September, but the stratification usually breaks down through vertical mixing during October as the winds increase, and the water column is typically isothermal from November until April. Bottom water temperatures at the MBDS vary from about 3 to 5 °C.

During the summer, mixing is generally suppressed across the pycnocline and little exchange of water occurs between the upper and lower layers, although the action of internal waves developed over Stellwagen Bank provides some mixing. Stellwagen Bank blocks the exchange of bottom water with the Gulf of Maine, so most of the water in Stellwagen Basin probably derives from Massachusetts Bay.

Surface currents generally exhibit velocities of 10 to 20 cm/sec, dominated by the northeast to southwest tidal flow in this area. The ebb and flow of the tides is not easily detected in bottom waters, 80 to 90 meters below the surface. Bottom waters have a slight east to west flow orientation during the fall, and a nearly rotational flow during winter. Average bottom currents are generally low, typically less than 10 cm/sec. Flow measurements taken in 1987 showed current velocities less than 4 cm/sec for over 85% of the record.

Although recent weather patterns do not attest to this, severe northeasters or hurricanes of the intensity (greater than 45 mph winds from the east) expected to resuspend bottom sediments in the area can be expected about once every four years. In 1985 and 1986, bottom currents ranged from 4 to 7 cm/sec, except prior to Hurricane Gloria in September 1985 when oscillatory currents on the order of 20 cm/sec were noted. During strong northeast storms, in winds greater than 45 mph, currents generally, though not always, can increase in a southerly and easterly direction to speeds of 30 cm/sec, as a result of back flow from the generally westward (from the sediments (less than 6 cm) accumulating over historical dredged material throughout the new MBDS. Based on work from the 1980s and more recently, the new MBDS can be characterized into 4 major sediment texture groups:

South: silty undisturbed sediments;

Northeast: silty dredged material sediments extending beyond the disposal buoys, with dredged material accumulating up to 15 cm above the bottom. Dredged material found over a large area, up to 1000 meters north, and even to 1 nautical mile away from the disposal buoys, in all directions;

Disposal mounds: two heterogeneous mounds including sandy sediments, or cohesive clay clumps up to 7 meters above the bottom; and

North: silty sediments with scattered industrial waste barrels and other debris.

Trawl marks have been observed in the soft sediments by side scan sonar in the 1985 surveys. A side scan sonar and video survey by the USGS in 1995 describes the seafloor as a "soft watery mud represented by low backscatter" (Valentine et al., 1996). However, within the site and general area, there are many observations of knolls, sunken vessels, rock debris, dredged material, anchor scars, possible exploded munitions, and other man-made objects. The knolls orient in a NW-SE direction reflecting movement of glacial ice, in various stages of burial in mud, rising up to 15 meters above the seafloor and covered with a thin veneer of mud. One such knoll is located at the northern edge of the new MBDS. This feature potentially provides habitat for groundfish, shrimp and burrowing organisms. In contrast, Stellwagen Bank, rising 30 to 40 meters above the basin, is characterized by hard gravelly sand with scattered cobbles and boulders supporting anenomes, sponges and other hard bottom attached organisms.

The USGS has reported finding glass shards, metal fragments, slag, old pill bottles and leather gasket material in sediments collected from western Massachusetts Bay (Butman et al., 1992). Descriptions of the IWS indicate that the basin is a former dumping ground for a variety of hazardous and inert material. And, because much of Massachusetts Bay and Stellwagen Bank are fished using bottom gear, otter trawls and lobster traps, one could characterize the environment in and around the MBDS as permanently altered, or constantly disturbed.

B. Chemical Site Characteristics

1. Water quality

Salinity values at the MBDS generally range between 28 and 33 parts per thousand (o/oo), depending on season and depth, reflecting the influences of coastal runoff from Maine, New Hampshire and Massachusetts rivers, and continental shelf waters from the Gulf of Maine. Bottom water salinities are fairly stable, varying only slightly, at around 32 parts per thousand (o/oo). Near-bottom dissolved oxygen concentrations in the site vicinity typically vary from 6 to 12 mg/l, with minima occurring in September or October (Hubbard et al. 1988, Geyer et al., 1992).

The water at the disposal site is generally very low in suspended solids. Recent measurements of suspended solids indicate values ranging from 0.2 to 3 mg/liter, (at the subsurface chlorophyll maxima, near the pycnocline), with most observations below 1 mg/liter. In contrast, suspended solids measured in Boston Harbor routinely exceed 2 mg/liter ranging from 0.1 to 25 mg/liter (Robinson et al., 1990). MBDS bottom waters sometimes exhibit elevated suspended solids levels (up to 2 mg/liter), probably due to resuspension of bottom sediments (Geyer et al., 1992). Levels of trace metals in the water column are also generally very low. Recent measurements performed for EPA Region 1 in 1992 found very low levels of trace metals and organics compounds in the water column (Battelle, 1992). Stations at the MBDS did not differ significantly from a reference site about 23 nautical miles east, in the Gulf of Maine **(Table 3)**. Individual low molecular weight PAHs were detected at very low concentrations and high molecular weight PAHs were rarely detected. The sum of 16 priority pollutant PAHs ranged from 51 -- 97 ng/liter at the MBDS and 41 -- 58 at the Gulf of Maine station. Total PCBs and pesticides were consistently below detection limits (2 to 10 ng/liter) at both the MBDS and the Gulf of Maine stations.

Table 3. Range of concentrations of trace metals and PAHs (micrograms per liter, or parts per billion, ppb) in whole (dissolved plus particulate) water samples collected at the interim MBDS and the Gulf of Maine (Battelle, 1992), and compared to a range of values from two stations in Massachusetts Bay (Battelle, 1987) and EPA Chronic Water Quality Criteria values. Samples were collected from a variety of depths.

	Mass Bay	MBDS	GOM	Water Quality Criteria
Arsenic	0.41 – 0.55	1.14 – 1.29	1.15 – 1.25	36
Cadmium	0.024 – 0.031	0.020 – 0.033	0.025 – 0.031	9.3
Chromium	0.26 – 0.42	0.099 – 0.617	0.121 – 0.117	50
Copper	0.33 – 0.52	0.163 – 0.301	0.105 – 0.211	2.9
Lead	0.078 – 0.189	0.029 – 0.190	0.054 – 0.133	8.5
Mercury	0.0018 – 0.0041	0.0004 – 0.0014	0.0006 – 0.0007	0.025
Nickel	0.35 – 1.1	0.262 – 1.604	0.323 – 0.538	8.3
Zinc	0.73 – 1.60	0.118 – 0.573	0.082 – 0.325	86

2. Sediment quality

Marine sediments in general are characterized by a redox potential discontinuity (RPD) layer which denotes the depth of sediment where chemical reduction/oxidation (redox) potentials change from positive to negative. The sediments above this zone are generally aerobic and supportive of diverse benthic organisms, while those below are generally anaerobic and less diverse. At the MBDS, sediment unaffected by dredged material, apparent RPD depths (measured using the sediment profile camera) have ranged from 2 to 7 cm with a majority in the 4 to 6 cm range (SAIC, 1990a). Areas with freshly disposed dredged material typically exhibit lower apparent RPD depths (0.5 to 2 cm) than fully recolonized mounds or reference areas. Recent measurements of TOC on dredged material mounds, and in the vicinity of the MBDS usually range from 0.5% to 2.5%, with a mean of about 1.0% (SAIC, 1990b, SAIC, 1994a). Measurements in 1985 and 1986 in and out of the MDA buoy area and in reference areas exhibited higher levels, ranging from 2.5 to 3.2% (Hubbard et al., 1988).

Background sediment contaminant concentrations are generally low, but detectable (**Table 4**). Most contaminants are at or below NOAA's "Effects Range-Low" levels -- a level below which toxicological effects are rarely observed (Long et al., 1995). Because the MBDS is located in a settling basin, sediments accumulate particle-derived contaminants from regional sources. Vertical sediment profiles reflect this phenomenon of the long-term history of contamination in Massachusetts Bay (Wade et al., 1989). Detectable levels of contaminants such as PCBs and DDTs were found up to 200 cm below the surface sediment in Stellwagen Basin cores, indicating affinity for fine particles, regional sources and persistence of these, now banned, contaminants. A detailed discussion of sediment chemistry at disposal sites and reference areas is included in **Section E.**

Table 4. Levels of selected contaminants in MBDS reference sediments (mean plus 2 standard deviations; SAIC, 1995b) compared to estuarine sediment quality concentration ranges proposed by NOAA (Long et al., 1995)[1]. Metals – parts per million (ppm) dry weight; PCBs, DDTs, PAHs – parts per billion (ppb) dry weight. Sum of PAHs may differ based on which individual PAHs measured.

	MBDS Ref	Effects Range	
	Mean+2SD	Low	Medium
Arsenic	28.7	8.2	70
Cadmium	2.74	1.2	9.6
Chromium	151.6	81	370
Copper	31.7	34	270
Lead	66.3	46.7	218
Mercury	0.277	0.15	0.71
Nickel	40.5	20.9	51.6
Zinc	146	150	410
LMW PAHs	449	552	3160
HMW PAHs	2730	1700	9600
Total PAHs	3080	4022	44792

[1] *These values are not used for regulatory purposes.*

C. Biological Site Characteristics

1. Benthos

At disposal sites in New England, benthic infauna generally recolonize fresh dredged material in a relatively predictable sequence, characterized by three stages of succession (Rhoads and Germano, 1986). The first stage (Stage I) is dominated by small, opportunistic, tube-forming, capitellid, spionid, and paraonid polychaetes or oligochaetes which rapidly (i.e., within 1-2 weeks) colonize new disposal mounds and which do not penetrate into the sediments very deeply. These organisms are thought to be recruited to the new habitat from off the disposal mound. Stage II is dominated by deeper penetrating species, which include tubicolous amphipods (e.g., Ampelisca abdita), and molluscs, typically occurring 3-6 months after disposal has ceased. These taxa represent a more transitional stage, and they may or may not hold permanent positions in the long term benthic community structure. Stage III animals represent an "equilibrium", or "mature" level, typified by deeper-dwelling, head-down deposit feeding species [e.g., maldanid (Clymenella zonalis) and pectinid polychaetes, holothurians, and nuculid bivalves (Yoldia spp.), and predatory polychaetes, such as Nephtys incisa]. This stage can also occur during the first year after dumping, but additional time for larval recruitment from off-site locations may be required. Some head-down deposit feeders are thought to be capable of migrating up through the fresh dredged material after a disposal event to maintain position in the sediment. It is not uncommon to find more than one successional stage present at any one location (e.g., a Stage I community coexisting above a Stage III community). These communities can be "remotely" observed with a sediment profile camera, but more accurate community analysis requires sieving, sorting and identification of all taxa in a grab sample.

Based on samples in 1985 and 1986, the benthic infauna in the soft undisturbed sediments near the disposal mounds are dominated by spionid (e.g. Spio limicola), paraonid (e.g. Levinsenia=Paraonis gracilis) and capitellid (e.g. Heteromastus filiformis) polychaetes, typical of Massachusetts Bay and Stellwagen Basin (Hubbard et al., 1988). These species may be categorized as primarily Stage I or Stage II organisms. Taxa associated with undisturbed mud bottom sediments include the bivalve Yoldia and the holothurian Molpadia, typical large stage III organisms, occurring primarily from 2 to 15 cm depth.

In contrast, the benthic community on dredged material exhibited higher relative abundance of oligochaetes, and other small opportunistic spionid polychaetes, reflecting the nature of dredged material as a disturbed habitat with, sometimes, high organic content. The sediments affected by dredged material were dominated by individuals in the surface 0 to 5 cm.

A station outside the influence of dredged material, but still within the MBDS, appears to be dominated by organisms of intermediate size and occurring at intermediate depths (Lunz, 1988). Although not formally calculated at the MBDS, species diversity at sites affected by dredged material appears to be generally less than at undisturbed sites.

Sandy sediments to the northeast of the MBDS at the rise of Stellwagen Bank, are dominated by a totally different fauna, such as suspension feeding bivalves and hard bottom species.

No benthic community analyses have been conducted at MBDS since 1986. However, community analyses at muddy stations greater than 60 meters near the MBDS collected for the MWRA monitoring program in May and August 1992 found the dominant infaunal taxa were spionid polychaetes (Spio limicola -- composing 20 to 60% of the community in some samples), paraonid polychaetes (Levinsenia gracilis and Aricidea quadrilogata), capitellid polychaetes Mediomastus californiensis, cirratulid polychaetes Chaetozone and the oligochaete Tubificoides apectinatus. Deposit-feeding bivalves such as Nucula delphinodonta were also found. Although not dominant taxa, indications of stage 3 organisms were observed with a sediment profile camera at these stations.

In sum, based primarily on sediment profile camera imaging, community succession in areas affected by dredged material within the MBDS appears to be occurring, although traditional benthic community analyses of recolonized dredged material has not been conducted.

2. Fisheries

The Gulf of Maine supports over 200 resident and migratory species of fish. Although considered overexploited by NMFS, the predominant fishery in the disposal site area are groundfish, flatfish or other bottom dwelling fish, harvested by trawling gear **(Table 5)**. The American plaice, or dab, is consistently found as the most common bottom fish in the Stellwagen Basin area in surveys by MA Division of Marine Fisheries (MA DMF) and National Marine Fisheries Service (NMFS), and in surveys specifically targeted at the disposal site (e.g. Lunz, 1985). This fish is probably the most common fish caught in deep water (>55 m) trawls in the Gulf of Maine (Hubbard et al., 1988). In 1992, landings of this fish in New England were about 6700 metric tons, approximately one third of the landings in the early 1980s (NMFS, 1995). The other most abundant fish species is the witch flounder, or gray sole.

The most important and abundant shellfish in the vicinity of the disposal site is the American lobster. Lobster gear have been observed in and around the disposal site boundaries, and are probably more prevalent at the site in late fall, winter and spring. Landings of American lobster in Massachusetts alone averaged about 6,800 metric tons in 1993 and 1994. The ocean quahog is also commercially harvested in Massachusetts Bay, and is known to occur in the MBDS area.

Table 5. Commercially and recreationally important finfish and shellfish observed in the vicinity of the MBDS. Sources: Hubbard et al., 1988, NMFS, 1995.

Bottom-dwelling fish	
American plaice	Hippoglossoides platessoides
Atlantic cod	Gadus morhua
Yellowtail flounder	Limanda ferruginea
Witch flounder	Glyptocephalus cynoglossus
Ocean pout (hardbottom)	Macrozoarces americanus
Red hake	Urophycis chuss
Silver hake	Merluccius bilinearis
Longhorn sculpin	Myoxocephalus octodecimspinosus
Sea raven	Hemitripterus americanus
Winter flounder	Pseudopleuronectes americanus
Haddock	Melanogrammus aeglefinus
Goosefish	Lophius americanus
Thorny skate	Raja radiata
Pollock	Pollachius virens
White hake	Urophycis tenuis
Redfish (hardbottom)	Sebastes fasciatus
Pelagic or semi-demersal fish	
Spiny dogfish	Squalus acanthius
Sandlance	Ammodytes americanus
Atlantic herring	Clupea harengus
Atlantic menhaden	Brevoortia tyrannus
Shellfish	
American lobster	Homarus americanus
Sea scallop	Placopecten magellanicus
Longfin squid	Loligo pealei
Ocean quahog	Arctica islandica
Northern shrimp	Pandalus borealis

American plaice and witch flounder feed primarily on small prey, such as brittle stars, amphipods, polychaetes, pandalid shrimp, and to a lesser extent, bivalve molluscs. Observations in 1985 indicate that fewer fish inhabit the disposal site near the dredged material and of those present, are generally smaller than those found away from the disposal area (Hubbard et al., 1988). In addition, for American plaice and witch flounder, larger fish tend to feed on larger prey; fish inhabiting the disposal areas apparently fed on smaller prey. Continuous dredged material disposal appears to maintain habitat for small dab and sole by maintaining a disturbed condition and increasing the abundance of small infauna in surface sediments.

Although not caught commercially in high quantities, the semi-demersal sandlance is important as food for marine mammals, such as the humpback and fin whales. Adult sandlance occur primarily in sandier sediments, preferring the sloping, gravel bottom edges of Stellwagen Bank, but larval and adult fish have been observed by submersible vehicles near the soft sediments of the MBDS (Hubbard et al., 1988; NMFS, 1991).

Peak concentrations of planktonic larval fish eggs probably occur in the area in late spring and early summer. Larval abundance peaks in spring and summer.

3. Marine mammals and endangered species

Several species of marine mammals regularly frequent the deeper open waters of Massachusetts and Cape Cod Bays as well as Stellwagen Bank, and there are rare sightings of other species **(Table 6)**. Of these species, the National Marine Fisheries Service believes the Fin, Sei, Humpback, and Right whales, and the Leatherback sea turtle deserve special attention because they occur in and around the MBDS (NMFS, 1991).

Cape Cod Bay and the southern portion of Stellwagen Bank have been designated by NMFS as critical habitat for the endangered North Atlantic right whale Eubalaena glacialis. These whales enter the bay in late winter and spring and feed on the large concentrations of calanoid copepods present at that time. Sei whales also feed on calanoids and their abundance often corresponds with the Right whale. Sei whales have been observed feeding in the deep waters of Stellwagen Basin (NMFS, 1991).

Humpback and Fin whales are piscivirous, feeding primarily on sandlance, but also on herring, Atlantic mackerel, and euphausiid shrimp (krill). Juvenile Humpbacks have been observed feeding at depth in Stellwagen Basin, although this area is not considered the preferred feeding habitat (NMFS, 1991). Occurrence of these species in this area is limited to spring to late summer, and often corresponds to abundance of sandlance. Sandlance and whale abundance in this area varies from year to year. In 1994 and 1995, abundance declined, but sightings have rebounded in 1996. These species have also been observed more recently to the north, in Jeffrey's Ledge, where abundant stocks of herring are present.

Table 6. Visiting or resident marine mammals, turtles, fish and birds in Massachusetts Bays including endangered (**) and threatened (*) species (Source: NOAA, 1991; NMFS, 1991).

Humpback whale (**)
North Atlantic Right whale (**)
Fin whale (**)
Sei whale (**)
Blue whale (**)
Leatherback sea turtle (**)
Kemp's Ridley sea turtle (**)
Green sea turtle (**)
Shortnose sturgeon (**)
Roseate tern (**)
Loggerhead sea turtle (*)
Piping plover (*)
Minke whale
Pilot whale
Orca whale
White-sided dolphin
White-beaked dolphin
Harbor porpoise (proposed to be listed)
Bottle-nose dolphin
Common dolphin
Striped dolphin
Grampus dolphin
Harbor seal
Grey seal

D. Tissue burdens of toxicants

Tissue burdens for metals, PCBs, pesticides and PAHs and other toxicants (e.g. radionuclides) were assessed in American plaice, winter flounder, lobster, sea scallop and ocean quahog collected from the MBDS in 1985 and most recently in 1991 (Gardner and Pruell, 1991) and 1992 (NOAA, 1996; including the IWS). Results of the 1991 surveys are also presented in the Final Environmental Impact Statement (FEIS) for the designation of the new MBDS (US EPA Region1, 1992). In general, the results show low but detectable levels of contaminants in fish and shellfish tissues **(Table 7).** Collections of fish and shellfish tissue from the IWS also exhibited concentrations within ranges for coastal Massachusetts and below levels of concern for public health (NOAA, 1996). However, PAHs and PCBs were elevated in the tomalley (not the meat) of lobster collected from the IWS. It is not known whether these tissue levels have any effects on the health of the individual organisms, or on local populations.

Radionuclides were not found above background levels in any organisms at the IWS.

Tissue burdens from marine mammals have also been collected in the area. These are currently being analyzed by U.S. EPA Environmental Health and Effects Research Laboratory in Narragansett, and results are not available at this time.

E. Disposal mound and Reference station characteristics

1. "A" buoy/Coast Guard buoy

This buoy site is located in the north of the site, in an area of gently sloping bottom on the northern margin of the small circular depression. Because this buoy was not a taut-wired buoy, and because dumping practices were not as rigorously monitored in the past, the areal extent of detectable historic deposits of dredged material appears to be an area almost one quarter the size of the disposal site, mostly to the west of the buoy location **(Figure 5)**. Other recent observations using side-scan sonar characterize this area as an irregularly shaped elliptical "subtle" mound, with the longest dimension in the northeast to southwest direction of 1000 meters (Valentine et al., 1996).

In 1983, this buoy area was surveyed by precision bathymetry, side scan sonar, and sediment grab samples to determine the fate of Boston Harbor dredged material from the previous year's disposal (SAIC, 1985). Bathymetry could not pick up formation of a disposal mound, but side scan sonar could detect the areal extent of disposal, which was estimated as about 25 cm thick. The signature of sediments, elevated in trace metals (copper, lead, mercury and zinc) from Boston Inner Harbor, were clearly distributed up to 700 meters away from a temporary taut-wire disposal buoy set up specifically for that disposal season. Sediment samples two months later documented the approximate extent of the disposal event to within about 500 meters of the buoy.

The first sediment profile camera survey at MBDS was conducted in October 1984 after two disposal operations totalling 95,000 cubic yards (SAIC, 1985). The presence of dredged material 11 to 19 cm thick was detected near the "A" buoy. Further away from the buoy, especially in stations east of the buoy, little dredged material was detected (although few stations were measured to the west of the buoy). Most of the dredged material was apparently similar to the ambient silty clay sediments with a high (about 7 cm) apparent RPD layer in both dredged material and nearby sediments leading scientists to hypothesize that the dredged material was not organically enriched. Many of the dredged material stations photographs indicated the presence of both stage I (colonizing) and stage III (head-down deposit feeders) polychaetes. The stage III worms may have burrowed up through the sediment or laterally from adjacent sites to reestablish their positions. An active bottom community apparently recolonized and bioturbated the sediments, only 3 to 6 weeks after disposal.

Based on sediment profile camera surveys in June and September of 1985, dredged material extended up to 1 nautical mile away from the buoy in all directions, and up to 18 to 20 cm thick in some places, with no obvious disposal mound (Hubbard et al., 1988). It was probably best described as a "pancake". Dredged material appeared to be relatively stable, because it was persistently detected in similar spots, and the areal coverage of dredged deposits was not increasing.

After 1985, this buoy site was no longer used on a regular basis. In November 1988 to January 1989, this area was surveyed to determine whether recolonization of the historically disposed dredged material had occurred (SAIC, 1990a). Benthic recovery appeared to be occurring, as apparent RPD depths ranged from 2 to 7 cm, and Stage III organisms were prevalent throughout the site, similar to undisturbed sediments.

In June 1989, sediment quality at sites near the "A" buoy, and the IWS indicated some elevated levels of trace metals, especially copper, but most were similar to reference stations (SAIC, 1994a). A station labelled "12-3", west of the buoy, often exhibited the highest values, especially for total, high molecular weight, and individual PAHs, although still below current EPA draft sediment quality criteria, after normalization for TOC **(Figure 6)**. Few pesticides and PCBs were detected compared to measurements made in 1985. A sediment profile camera survey in August 1994 indicated the presence of stage 3 organisms along transects radiating from the 12-3 station, although some of the sediment appeared to have lower apparent RPD depths, below 4 cm. Thus, although this area contains elevated levels of certain chemical contaminants, benthic recolonization appears to be occurring (SAIC, 1996b).

Because of the historical contamination at this site, in September 1994 EPA collected sediments from the "12-3" area and from a site within the IWS and a reference station to test for bioaccumulation and toxicity using methodologies recommended for testing dredged material for ocean disposal (Metcalf & Eddy, 1995). Concentrations of trace metals, PCBs, DDTs and PAHs in sediments at "12-3" and the IWS were elevated above the 1994 reference station **(Table 8)**. Results were consistent with prior results showing elevated levels of PAHs near buoy "A" **(Table 9; Figure 7)**. There was evidence of statistically significant bioaccumulation of individual PAHs, PCB congeners, DDTs and trace metals into two test species -- the bivalve Macoma, and the polychaete Nereis **(Tables 10 and 11)**. Levels of bioaccumulation were usually lower than tissue burdens in another polychaete (Nephtys) collected from near the "MDA" buoy during the site evaluation studies **(Table 12)**. In addition, the sediments were not acutely toxic to two species of amphipods, Ampelisca and Leptocheirus **(Figure 8)**. In sum, it appears that contaminants in these sediments exhibit the potential to bioaccumulate although they do not appear to be causing unacceptable impacts at or beyond the mound (see data on fish tissue concentrations in IWS section).

2. *"MDA" Buoy*

This buoy was established in November 1985 and has been named DGD, FDA, and most recently, MDA. A temporary experimental buoy, the FAS buoy, was located nearby in 1983, to determine the fate of disposal of dredged material. The depths in this area range from 87 to 89 meters and the buoy location lies in a trough running northwest to southeast, just to the southwest of Stellwagen Bank **(see Figure 4)**.

Sediment profile camera and bathymetric surveys conducted from 1986 to 1992 consistently found that this mound continuously grew vertically, and to a small degree, laterally. In January 1987, the sediment profile camera survey indicated a 20 to 50 cm thick "pancake-like" deposit developed with a radius of about 500 meters. Areal coverage of the deposit was estimated as 792,400 square meters. Disposal events in 1988 had formed a mound characterized by a "chaotic mixture of rubble, sand and clay clasts" (SAIC, 1990b). By August 1990, when compared with predisposal bathymetry, a definite mound measuring 0.8 m in (maximum) height and 420 m in diameter, was centered just to the east of the buoy (SAIC, 1994b). Dredged material extended about 400 to 500 meters on all sides, with up to 800 meters to the west of the buoy, and the areal coverage was estimated as 661,000 square meters. The depth of fresh dredged material, which was sandier than the ambient sediment, was about 10 to 20 cm at the flanks. Stations near the mound did not generally exhibit signs of Stage III infauna, and apparent RPDs were also very low, 1 to 3 cm. In contrast, RPD depths ranged from 5 to 7 cm at moderately or unimpacted stations away from the developing mound.

By 1992, two distinct mounds had formed west of the buoy, dominated by the Boston Blue Clay deposited from the CA/THT project (Wiley and Charles, 1995). This is a very consolidated and primarily homogeneous greenish gray clay. The maximum height of the mound was 2 meters with an area extending in an ellipse 200 to 400 meters from buoy. These surveys were conducted after two major storms in 1991 (Hurricane Bob and Halloween Nor'easter), and although most of the Boston Blue Clay was disposed after the storm events, the present mound appeared to be persistent, because relic dredged material can still be detected up to 900 m west of the buoy. The storms may have resuspended and redistributed some relic dredged material to the west as predicted (EPA Region 1, 1989). Stage III taxa were present throughout, except at the center of the mound, where only Stage I occurred on fresh dredged material.

Recent observations after a high level of activity in 1992 and 1993 from the CA/THT project indicate that the dredged material mound is smaller, steeper and better defined than the "A" buoy "mound", extending approximately 6 to 7 meters above the seabed to a maximum depth of about 80 meters (Valentine et al., 1996; DeAngelo and

Murray, 1996). The longest dimension is approximately 800 meters in an E-W direction, but is generally a 500 x 250 meter irregularly shaped mound. It is more highly reflective by side scan sonar, indicating the surface has not yet been colonized as much as the "A" buoy mound. Anchor scars, from the taut-wire buoys, some 600 meters apart, can also be observed in the side scan sonar traces. The most fresh dredged material appears to be primarily fine grained sediment with about 15% sand. Disposal appears to be occurring within 200 meters of the buoy, so lateral extent of the mound is limited. Some stations in 1993 near the mound exhibited signs of Stage II amphipods but most stations exhibited evidence of both Stage I and Stage III fauna.

The chemical quality of the dredged material at this mound has been measured on a number of occasions, and summarized in SAIC, 1990b, SAIC, 1994a, and DeAngelo and Murray, 1996 **(Table 9)**. In general, contaminant levels at and around the mound are only slightly elevated above background or reference stations. For example, total PCBs since 1985 have remained below 400 ppb. Evaluation of PAH data has been difficult because of high detection limits. Nevertheless, indications are that levels at this mound are more similar to reference station levels than to the higher levels reported at station '12-3' west of buoy "A". Compared to regional sediment quality, mean levels of contaminants from most of the northern and central area of the new MBDS are similar to NOAA's National Status and Trend mean data, and intermediate between clean (Cape Ann, Duxbury) and contaminated (Quincy Bay, Salem Harbor) sites in Massachusetts Bay (SAIC, 1994a).

In 1987, body burdens in Nephtys incisa (the red-lined worm), were measured (Hubbard et al., 1988). In general, no correlation was found between sediment contamination levels and tissue concentrations for most compounds. However, despite relatively high detection limits, maximum PAH levels were found in both sediments and animals at the disposal mound with fresh dredged material. It is not known whether these levels could cause adverse effects to individuals or populations of these species.

3. Reference areas (or stations)

Reference areas, or stations, are important for comparison to conditions at the disposal mounds, and are used in the testing protocols (see section II.C.2). Four reference stations have been sampled frequently since 1985 **(Table 13)**. "Ref-A" is the current reference station used in the biological testing protocols.

In general, these areas appear to be free of contaminants, and exhibit healthy benthic communities representative of Stellwagen Basin. Dredged material at these stations has never been detected by sediment profile camera surveys, apparent RPDs are usually around 5 to 7, and the benthic community, as assessed by the sediment profile imaging only, is usually healthy, with Stage I and Stage III organisms present. However, some variations exist, possibly due to seasonal effects.

Concentrations of contaminants in the sediments at all the reference areas are generally lower than at the disposal mounds. At stations 18-17 and FG-23, concentrations have appeared to remain relatively stable over time from 1985 to present (SAIC, 1994a; **Table 9**). However, concerns for potential of impacts to station 18-17 (high TOC content, slightly elevated contaminants, lack of Stage III fauna, and proximity to the mound) prompted moving the reference area to a new location, "REF-A", when the new MBDS was designated in 1993. Recent sediment profile images from this new station indicate occasional low apparent RPD depths to 1 cm, so further monitoring of the "REF-A" area is warranted.

4. Rock disposal location (RDL)

The RDL was established in 1991 as the point location for disposal of rocks from the CA/THT project. It is located on the slope of Stellwagen Bank in the northeast quadrant of the interim MBDS in an area of gravel, sand and cobble **(see Figure 2)**. Rock debris primarily lies within a 200 meter radius of the location, but there is some evidence (from side scan sonar and video images) of debris to the east and west, possibly indicating poor positional control (Valentine et al., 1996). No buoy was deployed at the RDL. Although observer logs indicate that 99% of the disposal events were at the proper coordinates, it is possible that some barges did not dump at the exact location.

Preliminary observations utilizing remotely operated video cameras revealed that fresh rock disposed in 1992 and 1993 is not yet colonized by hard bottom epifauna, but is providing habitat for lobster, redfish, cunner, cod, ocean pout, longhorn sculpin and other fish (Peter Auster, National Undersea Research Center, personal communication). Lobster pot buoys have been observed near these rock areas, so the rocks may be potential lobster habitat. Clearly, monitoring the colonization of these sites is important because of disposal of rocks from future projects.

5. Industrial waste site

Most of the waste drums are currently located in the northwest quadrant of the IWS (in an area around the coordinates 42°-26.4'N, 70°-35.4'W), or dispersed around the northern perimeter up to 0.5 nm outside the IWS (Wiley et al., 1992). Few drums have been observed away from the IWS or at the old Boston Lightship Disposal Site (US EPA, 1992). In 1992, EPA, NOAA, the Food and Drug Administration (FDA), and the Massachusetts Department of Public Health (MADPH) collaborated on a survey to determine whether hazardous and low level radioactive waste had leaked from the containers and accumulated in the IWS sediments, infauna and resident fish (NOAA, 1996). Underwater cameras confirmed earlier studies that most of the wastes appear to be encased in 55 gallon drums, indicative of toxic or hazardous wastes, not concrete "coffins", which was the most common method for disposal of low level radioactive waste. Radionuclides were not found in the sediments above background levels. Contaminants in sediments and tissue were similar to reference areas, except for some industrially related inorganic compounds -- antimony, beryllium, cadmium, cobalt and cyanide. In the majority of samples, levels of contaminants in fish (American plaice) and shellfish (quahog and lobster) tissue were similar to background, or reference concentrations **(Table 7)**. However, two composites of lobster tomalley collected at or near the site exhibited elevated PCB levels.

IV. SITE MONITORING PROGRAM

A. Conceptual model of impacts of disposal at the MBDS

Based on monitoring to date, impacts of dredged material disposal at MBDS are primarily restricted to the disposal mound itself where an altered, primarily Stage I benthic community occurs, and apparent RPD depths are shallow. The continuous dumping of dredged material at the "MDA" buoy appears to have maintained a disturbed habitat, which is constantly recolonized by opportunistic benthic epi- and infauna. It is expected that proper disposal at a defined mound will result in these conditions. Although the level of sediment contamination is slightly above background, or reference station levels, benthic infauna are not affected. Beyond the current disposal mound, no impacts have been noted. However, historical use of the "A" buoy area and the IWS has resulted in 1) slightly elevated toxicant levels and bioaccumulation in sediments west of the "A" buoy and in the IWS, and 2) elevated PAH and PCB levels in lobster tomalley collected from the IWS and MBDS area. Tissue burdens in edible fish are low and, based on present knowledge, do not pose a human health risk. There is evidence that a healthy benthic fauna is recolonizing the "A" mound. Levels of radionuclides in sediments and biota are not above background.

Although the ocean dumping criteria prevent unconfined disposal of unacceptable sediments, the disposal site is potentially the locus for the accumulation of contaminants in a relatively confined area, i.e. at the buoy location. Because of the recolonization of disposal mounds at the site and the constant disposal of dredged material, biota may accumulate contaminants. This is the major monitoring concern at the MBDS. Benthic organisms, from polychaetes to groundfish will be exposed to toxicants at and within 400 to 500 meters of the mound from the surge of sediments resuspended and settling during a disposal event. Direct bioaccumulation of particle-attached toxicants into bivalve molluscs, such as the filter-feeding ocean quahog and the deposit-feeding Yoldia is possible. The most likely food chain effect is accumulation (and possible biomagnification) of contaminants from sediments to benthic epi- and infauna (e.g. polychaetes, pandalid shrimp) to groundfish (e.g. American plaice). Another species at risk is the American lobster, an omnivorous feeder of bottom-dwelling fauna. A less likely, but important from a resource protection perspective, scenario is the transfer of contaminants from suspended particles to sandlance and then to humpback or sei whales.

B. The Ocean Dumping Act regulations and the DAMOS Tiered Monitoring Approach

In conducting a monitoring program, the Ocean Dumping regulations at 40 CFR §228.10 suggest the following types of effects, among others, to consider:

1) Movement of materials into estuaries or marine sanctuaries (e.g., the Gerry Studds Stellwagen Bank National Marine Sanctuary), or onto oceanfront beaches, or shorelines;

2) Movement of materials toward productive fishery or shellfishery areas;

3) Absence from the disposal site of pollution-sensitive biota characteristic of the general area;

4) Progressive, non-seasonal, changes in water quality or sediment composition at the disposal site, when these changes are attributable to materials disposed of at the site;

5) Progressive, non-seasonal, changes in composition or numbers of pelagic, demersal, or benthic biota at or near the disposal site when these changes can be attributed to the effects of materials disposed at the site; and

6) Accumulation of material constituents (including without limitation, human pathogens) in marine biota at or near the site (i.e., bioaccumulation).

Many of these issues have been incorporated into the DAMOS Integrated Tiered Monitoring Approach for monitoring capped and uncapped dredged material disposal mounds in New England (Germano, Rhoads and Lunz, 1993). The recommended sequence of monitoring activities for uncapped mounds is presented in flowchart form in **Figure 9**. Conceptually, this tiered approach is prospective, in that it attempts to identify early warning indicators of adverse effects, and is based on hypothesis testing using sampling technologies with rapid data return. Monitoring is used to test whether:

1) dredged material disposal is complying with the regulations;

2) assumptions in our model of impacts are correct; and

3) trends exist in impacts that would suggest a change in dredged material management.

In general, recolonization status and sediment quality (as monitored by sediment profile cameras) are used as measures of the overall physical, chemical and biological status of the disposal mound. The assumption is that benthic recolonization indicates compliance with dredged material disposal regulations. If the sediment profile camera documents slower than predicted recolonization rates, a more intensive evaluation and sampling effort would be triggered. Reliance on the sediment camera as a screening tool is advocated primarily due to cost-effectiveness; large numbers of sampling locations can be evaluated with a quicker data-turnaround and at lower cost than other sampling techniques (e.g., sediment chemistry analyses, conventional benthic community analyses, diver surveys).

The sediment profile camera can gauge sediment grain-size, relative sediment water content, sediment surface boundary roughness, seafloor disturbance, apparent RPD depth, sediment methane, and infaunal successional stage (Germano, Rhoads and Lunz, 1994). The DAMOS program uses many of these parameters to calculate an Organism-Sediment Index (OSI), a measure of the overall quality of the benthic environment, for each station. This sediment camera-based approach, however, cannot determine whether bioaccumulation of tissue contaminants is occurring, and requires some amount of "ground-truthing" (e.g., traditional benthic community surveys) to verify reliance on the photo-interpreted results (see below).

The DAMOS tiered approach recommends considerably more monitoring effort for capped mounds than for uncapped mounds in order to ensure the physical and chemical isolation of the problematic underlying sediments. The tiered approach for monitoring capped mounds is briefly discussed in section IV.D.

The DAMOS approach also recommends monitoring frequencies for both confined (i.e., capped) and unconfined disposal mounds. For uncapped mounds, an annual survey, with a gradually declining monitoring frequency is suggested if benthic recolonization rates are acceptable. It should be noted that this tiered monitoring approach is not intended to be an overly rigid monitoring scheme, but allows for flexibility as additional issues or objectives become identified.

C. Proposed monitoring program

The evaluation of impacts from disposal at the site will be accomplished through a comparison of the conditions at the disposal mound to conditions at historical and unimpacted nearby reference stations. Effects suggested in 40 CFR §228.10 will be considered. The tiered DAMOS approach will be followed, with some modifications. Timing of monitoring surveys and other activities will be governed by funding resources, the frequency of disposal at the site, and the results of previous monitoring surveys.

1. Objectives

The five objectives of the monitoring plan proposed here are to determine whether:

<u>1) dredged material remains within a confined mound</u>

This will be accomplished by annual or biennial monitoring of the site with precision bathymetry, side scan sonar or sediment acoustic characterization, and sediment profile imaging.

2a) benthic recolonization of the mound occurs
2b) the benthic community beyond the mound is not altered

This will be accomplished by annual or biennial sediment profile imaging, and biennial or triennial benthic community analyses to ground-truth the sediment profile camera results. (The first benthic community analysis should be conducted immediately.) These surveys should be performed within several months after specific disposal events. A benthic community analysis would also determine the spatial influence of disposal activities on Stage III fauna, or determine whether pollution-sensitive taxa are absent beyond the mound. If the results of these tests indicate that recolonization is not occurring, or that Stage III fauna are absent away from the mound, then sediment toxicity tests should be conducted immediately. (When available, *in situ* toxicity testing will be performed.)

3a) contaminants are not accumulating in sediments at the disposal site and the reference areas

This will be accomplished by annual or biennial (depending on amount of sediments disposed) sampling of sediments for chemical analysis, and screening for bioaccumulation (see 3b). If levels of many (e.g. >5) contaminants are significantly greater than recently disposed sediments than bioaccumulation tests should be performed (see 3b).

To test hypotheses 1, 2a, 2b and 3a, samples will be collected routinely from a) the "MDA" disposal mound, b) transects radially away from the disposal mound up to 1000 meters from the center, c) station 18-17, outside the MBDS, but suspected to be impacted by dredged material, and d) the three reference areas -- "FG-23", "SE" and "Ref-A". An analysis of variance statistical approach may be utilized to compare stations or areas to reference conditions or disposed sediment.

3b) contaminants are not accumulating in biological resources beyond the mound

Based on the sediment chemistry monitoring, the theoretical bioaccumulation potential (TBP) will be calculated as described in Section 10.2 of EPA/Corps (1991). If the TBP model results in concentrations above acceptable levels (see below), biennial or triennial sampling of tissue from four resident species --

ocean quahog, lobster, American plaice, (and humpback whales[2]) -- and important forage species, such as Nephtys (or other polychaetes) and sandlance, in and around the MBDS should be explored. To relate contaminant levels to biological effects, a baseline study of histopathology of American plaice will also be considered.

4) the benthic community at the "A" mound is recovering from historical dredged material disposal

This should be accomplished by biennial or triennial sediment profile imaging, bottom grabs with benthic community analysis, and toxicity testing at the "A" mound, and radially away from the center, including station "12-3". Results of these surveys will assist in verifying assumptions of the conceptual model of benthic impacts of dredged material disposal.

5) the Rock Disposal Location, and nearby rock debris, are colonized by a healthy hard rock epifaunal and fish community

This should be accomplished by biennial video or trawl sampling of the community at the RDL and appropriate reference areas to be determined in cooperation with the Gerry Studds Stellwagen Bank National Marine Sanctuary and the National Undersea Research Center (NURC).

D. Issues for monitoring methods

The DAMOS program methods are generally accepted techniques with an adequate amount of testing to verify assumptions. These methodologies include sediment profile imaging, precision bathymetry, and side scan sonar. New technologies to observe the ocean bottom remotely, such as sediment acoustic characterization and laser line scanning, are also being tested by NED. Other methodologies are discussed below.

1. Traditional Benthic Assessments

The DAMOS tiered monitoring approach does not recommend traditional benthic community assessment methods (i.e., collecting and counting numbers of species and individuals), relying instead on sediment profile imaging technology extensively as a surrogate for benthic recolonization. This monitoring plan recommends that traditional benthic assessments be performed immediately, and once every two to three years

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[2]This will require a special permit under the Endangered Species Act from the National Marine Fisheries Service.

thereafter. There does not appear to be adequate sediment profile camera ground-truthing in sediments north of Long Island Sound. This assessment would confirm the assumptions employed by the sediment profile imaging system, and support the regulatory requirement to consider the "absence from the disposal site of pollution-sensitive biota characteristic of the general area" as a possible effect of dredged material disposal.

2. Sediment toxicity testing

To date, the only sediment toxicity testing performed on sediments from the MBDS has been near the "A" buoy (see above). The DAMOS tiered monitoring approach calls for sediment toxicity testing (Tier 3) only in the case of abnormal benthic recolonization rates, as observed via sediment camera. Results in 1994 at the "12-3" station indicate no sediment toxicity. However, this test, requires manipulation of sediments (i.e. collection, homogenization, and screening) which may alter the bioavailability of some sediment contaminants compared to *in situ* conditions. EPA will collaborate with NED in promoting research and development of *in situ*, or other appropriate tests, and study the effects of manipulation on toxicity (and bioaccumulation).

3. Bioaccumulation Testing

Bioaccumulation of contaminants into resident species has been identified as the most important monitoring concern at MBDS, because of its importance in assessing potential risks to human health via the marine food chain. However, bioaccumulation is recommended by the DAMOS tiered monitoring approach as a measure of upward contaminant migration at capped sites only. The analytical costs for bioaccumulation testing are expensive, and the collection of sufficient tissue for statistical testing is difficult. Interpretation of bioaccumulation results for post-disposal monitoring is problematic because existing scientific knowledge is inadequate in determining whether a given tissue concentration is harmful. As in toxicity testing, laboratory tests are difficult to interpret since manipulation of the sediments may change the bioavailability of some of the sediment contaminants.

The use of the theoretical bioaccumulation potential model, as described in Section 10.2 of EPA/Corps (1991), can provide useful screening data to assess the accumulation potential of non-polar organics such as polychlorinated biphenyls (PCBs), polycyclic aromatic hydrocarbons (PAHs) and pesticides. PCBs and pesticides are particularly problematic as they may be biomagnified in the food web. Based on sediment chemistry, total organic carbon and lipid levels of the organism of concern, concentrations in tissues can be predicted and compared to reference values, FDA action/tolerance levels, state advisory levels or used in a risk assessment without incurring large costs. If the TBP exceeds acceptable values which would be determined at the time, further monitoring could be pursued. While existing scientific knowledge is generally lacking in determining whether a given tissue concentration is at a harmful level, EPA and the Corps have been making efforts to develop interpretive guidance for assessing bioaccumulation data at both the regional and national levels. When appropriate, risk assessment techniques will be used to determine the potential for adverse effects. Thus, tissue sampling or lab testing can be used to supplement sediment monitoring at a later tier.

The Corps and EPA have and will continue to strive to progressively resolve bioaccumulation issues and ways to best integrate bioaccumulation assessments in future monitoring.

4. Fisheries Habitat Studies

Studies should be conducted at the RDL to determine whether bottom habitat has been sufficiently altered by disposal of hard rocks onto a gravelly sand and cobble environment. The rocks provide habitat for hard bottom or rock-dependent fish species at the expense of soft bottom dependent species. The hypothesis is that the fish community is not significantly altered beyond the influence of the RDL. Trawls and video transects should be conducted at the RDL and in appropriate hard and soft bottom reference areas. The results may provide information for effects of disposal of hard rocks onto a gravelly sand and cobble, and soft bottom environments.

5. Capping Studies

Capping contaminated sediments at the MBDS is currently not allowed. The Record of Decision for the Designation of the MBDS states that "if capping pilot studies are proposed, they should utilize clean dredged material to ensure the protection of the marine environment in case of failure" (EPA Region 1, 1993). However, NED has proposed a demonstration project to test whether clean sediments from Cohasset Harbor can be capped effectively at MBDS. In 1997, NED and EPA, with NMFS and Stellwagen Bank Sanctuary personnel, will develop an appropriate monitoring plan to determine whether capping is effective. This will include monitoring the spatial extent and permanence of the cap using principles outlined above and in Germano et al., 1993. (EPA and the Corps have developed a draft capping guidance document, which may be released in the near future). Measurements of bottom currents may be performed to better characterize the response of capped sediments to storm conditions.

E. Quality Assurance

An important part of any monitoring program is a quality assurance (QA) regime to ensure that the monitoring data are reliable. Quality assurance has been described as consisting of two elements: quality control and quality assessment. Quality *control* activities are those taken to ensure that the data collected are of adequate quality given the study objectives and the specific hypothesis to be tested, and include standardized sample collection and processing protocols and technician training (National Research Council, 1990). Quality *assessment* activities are implemented to quantify the effectiveness of the quality control procedures, and include repetitive measurements, interchange of technicians and equipment, use of independent methods to verify findings, exchange of samples among laboratories and use of standard reference materials, among others (NRC, 1990).

Site monitoring to date has included many of these QA components, especially the use of replicate sampling for sediment chemistry, sediment camera, and benthic community analyses. QA issues for the MBDS which the Corps and EPA will discuss and resolve include:

1) DAMOS sediment chemistry analyses have been performed almost exclusively by the NED laboratory, mainly due to cost-effectiveness. While this promotes analytical standardization and precision, assessments of analytical accuracy and inter-laboratory variability could be made by splitting samples with other laboratories for comparison;

2) the use of standard reference materials (SRMs) for sediments and tissues as discussed in the Green Book would provide an additional measure of analytical accuracy;

3) verification of sediment camera results by ground-truthing with traditional benthic community assessments as discussed above; and

4) the use of positive control sediments ($CdCl_2$) as well as negative (clean) control sediments for sediment toxicity testing.

F. Data and information management

EPA and NED will set up a computerized database to keep track of the results of the reference area sediment chemistry, toxicity and bioaccumulation tests required for Tier 3 permit review. In addition, EPA and NED will produce and distribute a site map which will include detailed bathymetry, locations of disposal mounds and priority sampling stations, reference areas, selected geologic and anthropogenic features, and the Stellwagen Bank Sanctuary boundary. The DAMOS program will continue to publish results of disposal site monitoring, in response to monitoring objectives, in a series of NED reports. Other reports will be published periodically on special management or monitoring issues.

G. Independent Peer Review

An important part of the DAMOS Program is its reliance on a Technical Advisory Panel that meets periodically to review program results and recommend program changes. This panel is made up of five internationally recognized experts and meets at least every three years, although at times has met more frequently when NED has been developing major program elements. This approach is consistent with good marine monitoring program management (NRC, 1990). EPA plans to work with NED to support this continuing effort.

Briefly, the mission of the panel is to perform an independent assessment of the DAMOS and EPA site monitoring activities, and to provide recommendations for restructuring or modifying the site monitoring process as necessary. Topics for review include recent monitoring results, and new (or different) monitoring techniques, among others.

This peer review process is also an opportunity to discuss overall site management strategies. For example, should consideration be given to the concept of disposing dredged material on existing, successfully recolonized mounds (depth permitting) as opposed to the creation of new mounds on the ambient seafloor? Should some limited areas be left uncapped for additional research needs? Perhaps recommendations could be made for progress on the "comparative risk assessment" issue. That is, what are the comparative risks of leaving problematic sediments in near shore areas used for spawning and nurseries, as opposed to dredging and disposing them in off shore, open water areas?

H. Public Involvement

The New England Division has and continues to inform and involve the public. The DAMOS Program holds periodic symposia to report results and seek comment on the program. These symposia have typically been held every three years. DAMOS monitoring results are published in an ongoing series of technical reports which are mailed to interested people and organizations and also distributed at various public meetings. NED also has prepared and distributed several Information Bulletins and brochures. On a regular basis NED fulfills requests for speakers on this topic. To better meet this need, a series of presentations on different aspects of the dredging and disposal process is being prepared. These presentations are being structured to be thought provoking and to encourage discussion. Once complete, these presentations will be made available to interested groups or organizations throughout New England. Libraries which receive the DAMOS technical reports are listed in Appendix A. In addition, site related reports can be reviewed at both the NED Technical Library and the EPA regional library:

U.S. EPA Region 1 (New England)
Library
One Congress St., 11th Floor
Boston, MA
Hours: Monday-Friday 8:00-5:00
Telephone: (617) 565-3300

U.S. ACE
NED Technical Library
424 Trapelo Road
Waltham, MA 02254-9149
Hours: Mon-Fri 7:30-4:00
Telephone: (617) 647-8118

Any party interested in being added to the DAMOS mailing list should mail the appropriate information to NED at:

U.S. Army Corps of Engineers, New England Division
Regulatory Division
Marine Analysis Section
424 Trapelo Road
Waltham, MA 02254-9149

V. SITE MANAGEMENT STRATEGY AND INTER-AGENCY COORDINATION

A. Routine Site-Specific Management Practices for Protection of the Marine Environment

To ensure a disposal program which minimizes impacts to the marine environment, the following management practices will continue to be implemented at the MBDS as a matter of routine policy. First and foremost, as discussed in section II.C (Estimated quantity and quality of dredged material to be disposed), all proposed dredging projects will be reviewed for suitability for ocean disposal by both the Corps and EPA.

An interagency dredged material management review group composed of representatives from EPA, NED, NMFS and USFWS (U.S. Fish and Wildlife Service) and occasionally with state representatives meets approximately every two months to discuss management and monitoring of New England dredged material disposal sites.

In order to assess compliance with applicable permit conditions and to track overall site usage, permittees will continue to be required to provide written documentation of disposal activities to the Corps during disposal operations and after dredging is complete. Disposal permits will continue to include standardized requirements for this reporting to include the source of the dredged material, the amount of the material disposed, the rate of disposal, the date, time and LORAN-C coordinates (or differential GPS, if available) of disposal as well as the due-date for the documentation itself.

The Corps will provide EPA with summary information on each project at two stages of the dredging and disposal process. A Summary Information Sheet will be provided when dredging operations begin, and a Summary Report will be submitted when dredging operations have been completed.

Point dumping will continue to be practiced using a taut-wire buoy to ensure that ultimate disposal locations are known and that post-disposal monitoring is effective. On-board inspectors will be used by the Corps for all disposal activities at the MBDS to ensure compliance with this policy. These inspectors are trained and certified by the Corps specifically for the dredged material disposal program. Any instances of non-compliance observed by the inspectors must be reported to the Corps within 24 hours and in writing to both the Corps and EPA within five working days of the observed violation. Both agencies will cooperate to ensure effective enforcement of all disposal requirements. §105 of the MPRSA gives authority to EPA to enforce permit conditions. Egregious violations of permit conditions may be referred by the Corps or EPA to the Department of Justice for criminal prosecution. Disposal activities will not generally be performed during poor sea conditions. Inspectors have been issued specific guidance on disposal under these conditions ("Guidance for Inspectors on Open-Water Disposal of Dredged Material, NED, January 1996).

Survey cruises will be conducted at least annually, provided funding is available. EPA and NED will coordinate their monitoring efforts to ensure at least one monitoring survey per year. The monitoring objective for each survey will be based on prior monitoring results and recommendations of the interagency dredged material management review group, in consultation with MA Massachusetts Department of Environmental Protection (DEP), Coastal Zone Management (CZM) and Stellwagen Bank Sanctuary personnel.

B. Management, Distribution and Review of Monitoring Information

In addition to a strong enforcement effort, the overall credibility of the open water dredged material disposal program depends on a robust monitoring and data evaluation program. Timely receipt and review of the monitoring data and information is critical in order to either validate hypotheses of acceptable impact or to trigger remedial action to mitigate unreasonable impact. It is therefore an overall goal of this plan to shorten the lag time between generation of the survey data and receipt and review of it by the applicable public agencies.

To this end, and consistent with the DAMOS program's tiered monitoring approach, EPA and NED will meet annually with Massachusetts DEP, CZM, NMFS and Stellwagen Bank Sanctuary personnel to review and discuss recent monitoring results and recommend future monitoring activities. Because of limited funding, monitoring activities must be ranked in order of priority. EPA will take the lead role in organizing these meetings, and NED and EPA will ensure availability of all pertinent survey data in advance of the meetings. These meetings are expected to occur within six months of each survey cruise, and about six months in advance of an upcoming survey (assuming annual cruises). Meetings may be scheduled more or less frequently, if warranted. Follow-up recommendations for more intensive sampling or corrective action as a result of these meetings should generally be consistent with the DAMOS tiered monitoring approach and the site management and monitoring plan described in this document.

The interagency dredged material management review group will also discuss important issues specific, or unique to MBDS. In 1997, the following issues will be discussed:

Capping: A monitoring plan for a demonstration project on deep water capping using clean sediments from Cohasset Harbor is being developed.

Seasonal restrictions: At this time, there are no seasonal restrictions on dredged material disposal. A workgroup will be convened to discuss whether restrictions should be in place to avoid and protect marine mammals or other sensitive species.

C. Corrective Site Management Practices in the Event of Unacceptable Impacts

Effective implementation of the dredged material permit program as discussed above should prevent adverse impacts to the site environment. However, it is important to have contingency plans in place. The DAMOS tiered monitoring program includes early warning indicators of potential environmental impacts so that corrective actions can be implemented in a timely fashion.

If site monitoring demonstrates that disposal activities are causing unacceptable impacts to the marine environment, EPA and NED, in consultation with NMFS, USFWS, MA DEP and MA CZM will place appropriate limitations on site usage to reduce the impacts to acceptable levels. These limitations can range from withdrawal of the site's designation as a disposal area to various limitations on the amounts and types of dredged material permitted to be disposed and on the specific method, location or schedule of their disposal. Other potential corrective measures include, but are not limited to:

1) follow the tiered monitoring protocol, initiate more intensive benthic sampling (sediment chemistry, sediment toxicity, body burdens, etc.) to verify the impact, refine the spatial extent of the problem and attempt to find a causative agent(s) in order to prevent future occurrences;

2) implementation of more protective judgements on whether sediments proposed for dredging are suitable for open water disposal (i.e., to allow less material to be disposed);

3) stricter definition and enforcement of disposal permit conditions;

4) specific changes in the method, location or time of disposal in response to any questionable impacts observed;

5) placement of suitable material on top of an area or mound of concern in appropriate thickness and spatial extent to physically and chemically isolate the problem sediments;

6) excavation and removal of any highly toxic sediments from the disposal site (an unlikely, worst-case scenario given that the permitting program should exclude such material from the site to begin with, and since excavation could make matters worse by releasing contaminants during the process); and

7) closure of the site as an approved dredged material disposal area (i.e., to forbid any additional disposal at the site).

D. Protection of Endangered Species

Table 6 lists the threatened and endangered species occurring in the general vicinity of the MBDS. Endangered species potentially impacted by the MBDS are best protected by ensuring compliance with the ocean dumping criteria. In preparing the Environmental Impact Statement/Designation of the MBDS, the EPA initiated a Section 7 consultation with the National Marine Fisheries Service. Based on a review of the Draft EIS, the NMFS concluded in a November 7, 1991 letter and Biological Opinion to EPA that "final designation of the MBDS will not jeopardize the continued existence of any endangered or threatened species under our jurisdiction. However, disposal activities associated with the MBDS may adversely affect some of the species. Therefore, NMFS has developed conservation recommendations to minimize adverse effects." Some of these recommendations have been incorporated into the Corps' training program for on-board inspectors, which includes information to increase the inspectors' awareness of and ability to identify threatened and endangered species expected to be found in the general site area. If any of these species are sighted during site activities the vessels will be controlled to avoid interference with the animals, and the sighting will be reported to the National Marine Fisheries Service as soon as possible.

VI. LONG TERM SITE USAGE, ANTICIPATED CLOSURE DATE AND THE NEED FOR POST-CLOSURE MANAGEMENT

The MBDS is expected to continue to receive dredged material from coastal Massachusetts Bay. The disposal buoy will generally stay in the area of the current "MDA" buoy, although it may be moved to cover, with fresh dredged material, areas within the MBDS where sediments have higher chemical concentrations due to historical disposal.

Dredged materials for disposal are expected to be generated primarily from maintenance dredging (i.e., dredging to return navigational areas to previously existing depths). However, advances in naval architecture may lead to deeper-draft ships and the need for deeper channels to accommodate them. This is the motivation for the proposed improvement dredging in Boston Harbor.

A specific closure date for the MBDS site has not been assigned as of the date of this management plan. Because of its depth, the capacity of the site is clearly greater than current or historical use. Assuming that continued use of the site does not result in unacceptable impacts, it is anticipated that the site will be available for disposal of dredged material well into the next millenium. Based on an average disposal volume of 340,000 cubic meters, it would take about 130 years to raise the average depth of the site five meters, from about 90 meters to 85 meters.

If the MBDS continues to be managed in such a way that promotes and documents benthic recolonization, and if the potential for bioaccumulation has been addressed to a point where it is not a significant concern, then the amount of monitoring or management required after the cessation of all disposal activities at the site is expected to be reduced. The specifics of the post-closure monitoring plan will be determined and agreed upon in advance of site closure by the interagency dredged material management review group.

VII. SCHEDULE FOR REVIEW AND REVISION OF THIS PLAN

Consistent with §102(c)(3)(F) of MPRSA, as amended, EPA and NED agree to review this site management plan every ten years, and to revise it as necessary. This revision process may be undertaken more frequently if warranted by results of monitoring, or technical advances in site assessment methods. Revisions may be made in the form of amendment(s) to this plan, or by the execution of entirely new plans to supersede this one. In either case, all revisions must be signed by both the Corps and EPA, and notification must be given to other governmental agencies (e.g., MA CZM, MA DEP, NOAA, NMFS, USFWS, Stellwagen Bank Sanctuary, etc.) involved in marine protection.

VIII. REFERENCES

Battelle. 1987. Marine Ecology and Water Quality Field Program: Deer Island Secondary Treatment Facilities Plan -- Water Column Chemistry. Battelle Ocean Sciences Report, quoted in Battelle, 1992.

Battelle. 1992. Contaminant Concentrations in the Water Column at the Massachusetts Bay Disposal Site. Battelle Ocean Sciences, Duxbury, MA.

Butman, B., M.H. Bothner, J.C. Hathaway, J.L. Jenter, H.J. Knebel, F.T. Manheim, and R.P. Signell. 1992. Contaminant transport and accumulation in Massachusetts Bay and Boston Harbor: a summary of U.S. Geological Survey studies. USGS Open File report 92-202. Woods Hole, MA.

Cahill, J. and K. Imbalzano. 1991. An inventory of organic and metal contamination in Massachusetts Bay, Cape Cod Bay, and Boston Harbor sediments and assessment of regional sediment quality. U.S. Environmental Protection Agency Office of the Administrator. EPA 171-R-92-013.

Durell, G.S., L.C. Ginsburg, and D. Shea. 1991. CSO Effects on Contamination of Boston Harbor Sediments. MWRA Technical Report No. 91-8. Massachusetts Water Resources Authority, Boston, MA.

Feng, S.Y. 1982. Monitoring of the "capping" procedure using Mytilus edulis at the Central Long Island Sound disposal site 1980-1981. DAMOS contribution #22 submitted to New England Division, Corps of Engineers.

Bajek, J.J., R.W. Morton, J.D. Germano, and T.J. Fredette. 1987. Dredged material behavior at a deep water, open ocean disposal site. 20th Annual Dredging Seminar, September 1987, Toronto, Canada.

Blake, J.A., D.C. Rhoads, and B. Hilbig. 1993. Soft-bottom benthic biology and sedimentology 1992 baseline conditions in Massachusetts and Cape Cod Bays. MWRA Technical Report No. 93-10. Massachusetts Water Resources Authority, Boston, MA. 108 pp. +4 appendices.

DeAngelo, E. and P. Murray. 1996. DRAFT Baseline survey of the reconfigured Massachusetts Bay Disposal Site 14 September 1993. DAMOS contribution submitted to New England Division, Corps of Engineers. (SAIC, 1996a).

Daskalakis, K.D. and O'Connor, T.P. 1994. Inventory of chemical concentrations in coastal and estuarine sediments. NOAA Technical Memorandum NOS ORCA 76. National Oceanic and Atmospheric Administration, Silver Spring, MD.

Fore River Estuary Project. 1994. Baseline environmental assessment of the Fore River. Submitted to the Massachusetts Bays Program, January, 1994. Town of Braintree, City of Quincy, Town of Weymouth, and Tellus Institute, Boston, MA.

Gardner, G.R. and R.J. Pruell. 1991. Chemical contamination and environmentally related diseases in aquatic organisms at the Massachusetts Bay Disposal Site. Submitted to U.S. EPA Region 1, Boston, MA. December 31, 1991.

Germano, J.D., D.C. Rhoads, and J.D. Lunz. 1993. An integrated, tiered approach to monitoring and management of dredged material disposal sites in the New England region. SAIC Report No. SAIC-90/7575&234 submitted to New England Division, Corps of Engineers.

Geyer, W.R., G.B. Gardner, W.S. Brown, J. Irish, B. Butman, T. Loder, and R. Signell. 1992. Physical oceanographic investigation of Massachusetts and Cape Cod Bays. MBP-92-03. Massachusetts Bays Program, Boston, MA.

Gilbert, T.R. 1975. Studies of the Massachusetts Bay Foul Area. New England Aquarium Report No. 1-75 prepared for the Commonwealth of Massachusetts.

Hubbard, W.A., J.M. Penko, and T.S. Fleming. 1988. Site Evaluation studies of the Massachusetts Bay Disposal Site for Ocean Disposal of Dredged Material. US Army Corps of Engineers New England Division

Hyland, J.L., and H. Costa. 1995. Examining linkages between contaminant inputs and their impacts on living marine resources of the massachusetts bay ecosystem through application of the sediment quality triad method. MBP-95-03. Massachusetts Bays Program, Boston, MA.

Knebel, H.J. and Circe', R.C. 1995. Seafloor environments within a glaciated estuarine-inner shelf system: Boston Harbor and Massachusetts Bay. Marine Geology 110:7-30.

Leo, W.S, M. Alber, M.S. Connor, K.E. Keay and A.C. Rex. 1994. Contaminated sediments in Boston Harbor. MWRA Environmental Quality Department Technical Report No. 93-9. Massachusetts Water Resources Authority, Boston, MA.

Long, E.R., D.D. MacDonald, S.L. Smith, and F.D. Calder. 1995. Incidence of adverse biological effects within ranges of chemical concentrations in marine and estuarine sediments. Environmental Management 19(1):81-97.

Lunz, J.D. 1986. Application of the Benthic Resources Assessment Technique (BRAT) to the Foul Area Disposal Site. Draft report for the U.S. Army Corps of Engineers

Waterways Experiment Station. June 1986.

MacDonald, D.A. 1991. Status and Trends in concentrations of selected contaminants in Boston Harbor sediments and biota. NOAA Technical Memorandum NOS OMA 56, National Oceanic and Atmospheric Administration, Seattle, WA.

Menzie-Cura & Associates. 1995. Organic loadings from the Merrimack River to Massachusetts Bay. MBP-95-04. Massachusetts Bays Program, Boston, MA.

Metcalf & Eddy. 1989. Massachusetts Bay Dredged Disposal Site Sediment Analysis Stations REF-A and REF-B. Draft report submitted to U.S. Environmental Protection Agency Region 1. July 5, 1989.

Metcalf & Eddy. 1995. Chemical, Physical and bioaccumulation analyses of sediments from Massachusetts Bay and Central Long Island Sound. Draft report submitted to U.S. Environmental Protection Agency Region 1. April, 1995.

Moore, M. J. and J.R. Stegeman. 1993. Liver pathology of winter flounder: Boston Harbor, Massachusetts Bay, and Cape Cod Bay -- 1992. MWRA Environmental Quality Department Technical Report No. 93-7. Massachusetts Water Resources Authority, Boston, MA.

Munns, W.R., Jr., J.F. Paul, V.J. Bierman, Jr., W.R. Davis, W.B. Galloway, G.L. Hoffman, P.F. Rogerson, and R.J. Pruell. 1989. Exposure assessment component of the field verification program: overview and data presentation. USEPA, Office of Research and Development, Environmental Research Laboratory, Narragansett, RI, ERL-N Contribution 751.

Murray, P. E. DeAngelo, J. Parker, and T.J. Fredette. 1994. Integrated Acoustic Seafloor Characterization. DREDGING '94. Proceedings of the Second International Conference. November 13-16, 1994. Lake Buena Vista, Fl.

NMFS. 1991. National Marine Fisheries Service Endangered Species Act Section 7 Consultation - Biological Opinion for the Final Designation for Ocean Disposal at the Massachusetts Bay Disposal Site. NMFS Northeast Region. November 7, 1991.

NMFS. 1995. Northeast Fisheries Science Center News, NR 95-3. October 2, 1995. National Marine Fisheries Service/Northeast Fisheries Science Center, Woods Hole, MA.

National Oceanic and Atmospheric Administration (NOAA). 1991. Stellwagen Bank National Marine Sanctuary: Draft Environmental Impact Statement/Management Plan. NOAA Sanctuaries and Reserves Division, U.S. Department of Commerce, Washington, DC.

National Oceanic and Atmospheric Administration (NOAA). 1996. The Massachusetts Bay Industrial Waste Site: A Preliminary Survey of Hazardous Waste Containers and an Assessment of Seafood Safety. (May and June 1992). NOAA Technical Memorandum NOS ORCA 99. Edited by John Lindsay.

National Research Council (NRC), 1990. Managing troubled waters, the role of marine environmental monitoring. National Academy Press. 95 pp.

Randall, Alan. 1996. Personal communication. CA/THT Project Manager for Bechtel Parsons Brinckerhoff.

Rhoads, D.C. and J.D. Germano. 1986. Interpreting long-term changes in benthic community structure: a new protocol. Hydrobiologia 142: 291-308.

Rhoads, D.C., I. Williams, and P. Murray. 1996. Bioaccumulation in Stage I polychaetes/oligochaetes: a field feasibility study. DAMOS Contribution #101 submitted to New England Division, Corps of Engineers. January, 1996.

Robinson, W.E., T.J. Coffey and P.A. Sullivan. 1990. New England Aquarium's Ten Year Boston Harbor Monitoring Program. First Report (March 1987-July 1989). New England Aquarium, Boston, MA. 108 pp. plus appendices.

SAIC (Science Applications International Corporation). 1984. Dredged material disposal operations at the Boston Foul Ground. June 1982-February 1983. DAMOS contribution #41 submitted to New England Division, Corps of Engineers. April 18, 1984. DRAFT.

SAIC. 1985. DAMOS Disposal Area Monitoring System Summary of Program Results 1981-1984. Volume III Part C. Final Report April 1985. DAMOS contribution #46 submitted to New England Division, Corps of Engineers.

SAIC. 1988. Monitoring surveys at the foul area disposal site February 1987. DAMOS contribution #64 submitted to New England Division, Corps of Engineers.

SAIC. 1990a. Monitoring cruise at the Massachusetts Bay Disposal Site November 1988 - January 1989. DAMOS contribution #73, submitted to New England Division, Corps of Engineers.

SAIC. 1990b. Analysis of sediment chemistry and body burden data obtained at the Massachusetts Bay Disposal Site October 1987. DAMOS contribution #75 submitted to New England Division, Corps of Engineers.

SAIC. 1994a. Chemical analyses of sediment sampling at the Massachusetts Bay Disposal Site 5-7 June 1989. DAMOS contribution #91 submitted to New England Division, Corps of Engineers. (Murray, 1994).

SAIC. 1994b. Monitoring cruise at the Massachusetts Bay Disposal Site, August 1990. DAMOS contribution #92 submitted to New England Division, Corps of Engineers. (Germano, Parker and Charles, 1994).

SAIC. 1995a. Monitoring cruise at the Massachusetts Bay Disposal Site March 31 - April 4, 1992. DAMOS contribution #100 submitted to New England Division, Corps of Engineers. (Wiley and Charles, 1995).

SAIC. 1995b. DAMOS Reference Area Data Analysis. Work Order #14, Task 4. submitted to the Army Corps of Engineers, New England Division, October 3, 1995.

SAIC. 1996a. DRAFT Baseline survey of the reconfigured Massachusetts Bay Disposal Site 14 September 1993. DAMOS contribution submitted to New England Division, Corps of Engineers. (DeAngelo and Murray, 1996).

SAIC. 1996b. DRAFT Monitoring cruise at the Massachusetts Bay Disposal Site, August 1994. DAMOS contribution submitted to New England Division, Corps of Engineers. (Murray, 1996).

SAIC. 1996c. DAMOS summary report 1985-1990. SAIC Report No. SAIC-91/7610&C97. DAMOS contribution #109 submitted to New England Division, Corps of Engineers. January, 1996. (Wiley, M.B., J. Charles, C. Eller and R. Williams, 1996).

U.S. Army Corps of Engineers. 1986. Fate of dredged material during open-water disposal. Environmental Effects of Dredging Technical Note EEDP-01-2. Waterways Experiment Station. September 1986.

U.S. Army Corps of Engineers. 1996. Boston Harbor, Massachusetts Navigation Improvement Project. Design Memorandum. April 1996. New England Division.

U.S. Environmental Protection Agency. 1986. SW-486 Test methods for evaluating solid waste. U.S. EPA, Office of Solid Waste and Emergency Response, Washington, DC.

U.S. 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 19, 1992) ERL-N Contribution No. 1405. US EPA Environmental Research Laboratory-Narragansett. Narragansett, RI. 76 pp. (Referenced in NOAA, 1996).

U.S. Environmental Protection Agency. 1996. The National Sediment Quality Survey: A Report to Congress on the extent and severity of sediment contamination in surface waters of the United States. DRAFT January 16, 1996.

U.S. Environmental Protection Agency Region 1. 1988b. Assessment of Quincy Bay contamination: summary report. U.S. EPA Region 1, Boston, MA.

U.S. Environmental Protection Agency Region 1. 1989. Evaluation of the continued use of the Massachusetts Bay Dredged Material Disposal Site. Draft Environmental Impact Statement. September 1989.

U.S. Environmental Protection Agency Region 1. 1992. Designation of an Ocean Dredged Material Disposal Site in Massachusetts Bay. Final Environmental Impact Statement. July 1992.

U.S. Environmental Protection Agency Region 1. 1993. Public Record of Decision on the Final Environmental Impact Statement for the Designation of an Ocean Dredged Material Disposal Site in Massachusetts Bay. January, 1993.

U.S. Environmental Protection Agency Region I/U.S. Army Corps of Engineers, New England Division. 1989. Regional guidance for performing tests on dredged material to be disposed of in open waters.

U.S. Environmental Protection Agency/U.S. Army Corps of Engineers. 1991. Evaluation of dredged material proposed for ocean disposal. EPA-503/8-91/001.

U.S. Environmental Protection Agency/U.S. Army Corps of Engineers. 1995. QA/QC Guidance for sampling and analysis of sediments, Water and tissues for dredged material evaluations. EPA-823/B-95/001.

Valentine, P.C., W.W. Danforth, E.T. Roworth, and S.T. Stillman. 1996. Maps showing topography, backscatter, and interpretation of seafloor features in the Massachusetts Bay Disposal Site region off Boston Massachusetts. USGS Open-File Report 96-273, 2 sheets, including 3 side scan images. In press

Wade, M.J., C.D. Hunt, M.H. Bothner, G.A. Jones, and P.D. Boehm. 1989. Vertical profiles of radionuclides, selected metals, and hydrocarbons in Massachusetts Bay sediments. Draft report to Camp Dresser and McKee, Inc. January 13, 1989.

Wallace, G.T., J.H. Waugh, and K.A. Garner. 1988. Metal distributions in a major urban estuary (Boston Harbor) impacted by ocean disposal, pp. 67-78, *in* Wolfe, D.A. and T.P. O'Connor [eds.], Oceanic processes in marine pollution, Vol. 5, Urban Wastes in Coastal Environments. Krieger Malabar, FL.

Wiley, M.B. and J.B. Charles. 1995. Monitoring cruise at the Massachusetts Bay Disposal Site March 31 - April 4, 1992. DAMOS contribution #100 submitted to New England Division, Corps of Engineers. (SAIC, 1995a).

Wiley, M.B., J. Charles, C. Eller and R. Williams. 1996. DAMOS summary report 1985-1990. SAIC Report No. SAIC-91/7610&C97. DAMOS contribution #109 submitted to New England Division, Corps of Engineers. January, 1996. (SAIC, 1996).

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 US EPA Region 1. International Wildlife Coalition, Falmouth, MA. 59 pp.

IX. FIGURE LEGENDS

Figure 1. Major bathymetric features in Massachusetts Bay, including the ***approximate boundary*** of the Stellwagen Bank National Marine Sanctuary, Former Industrial Waste Site (IWS), Interim (former) MBDS and new MBDS.

Figure 2. Figure 1-2 from SAIC, 1996b.

Figure 3. Tiered protocol for evaluation of dredged material based on EPA/Corps Regional Protocol.

Figure 4. Figure 1-3 from SAIC, 1996b.

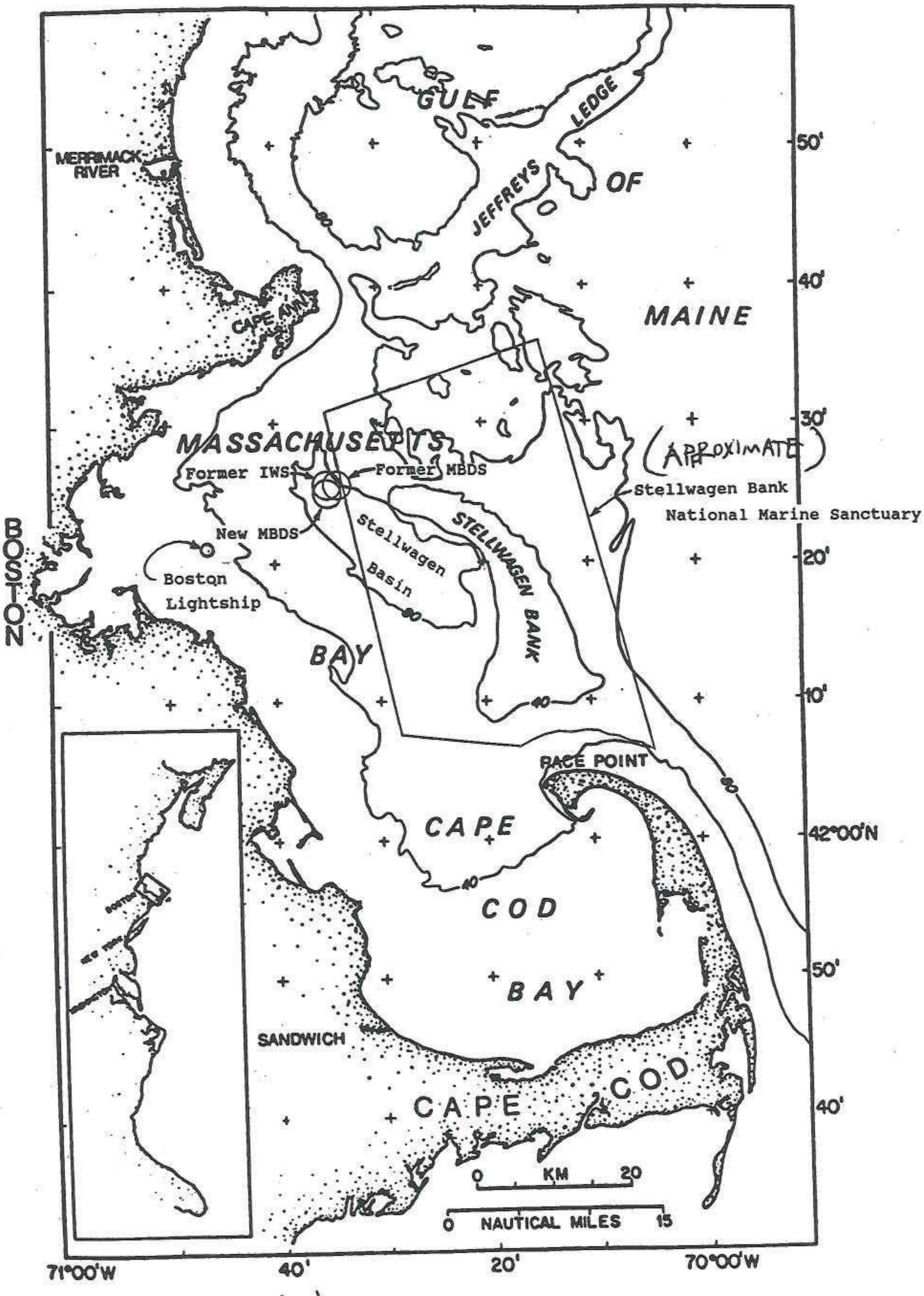
Figure 5. Figure 3-2 from SAIC, 1996b.

Figure 6. Figure 4-2 from SAIC, 1994.

Figure 7. HMW PAHs near Buoy "A". Sum of high molecular weight PAHs (ppb dry weight) collected from surface sediments at the MBDS. "Mean Ref 1989-1993" is the mean of reference areas (outside MBDS) collected from 1989 to 1993. "Mean MBDS 1989" is the mean of samples from within the interim MBDS only. "12-3" 1989, 1993 and 1994 is a sample from an area (near buoy "A" site) within the MBDS exhibiting elevated PAHs. "IWS" 1994 is from a sample within the IWS, west of buoy "A".

Figure 8. Toxicity of MBDS sediments. Number of amphipods (from two species) surviving after 10 day exposure to sediments from 1994 reference area, "IWS", "12-3" and control sediments.

Figure 9. Figure 2 from Germano et al., 1994. Tiered monitoring protocol for uncapped disposal mounds.



approximate

Figure 1 - Major bathymetric features in Massachusetts Bay, including the locations of the Stellwagen Bank National Marine Sanctuary and past and present disposal areas (depth countours in meters)

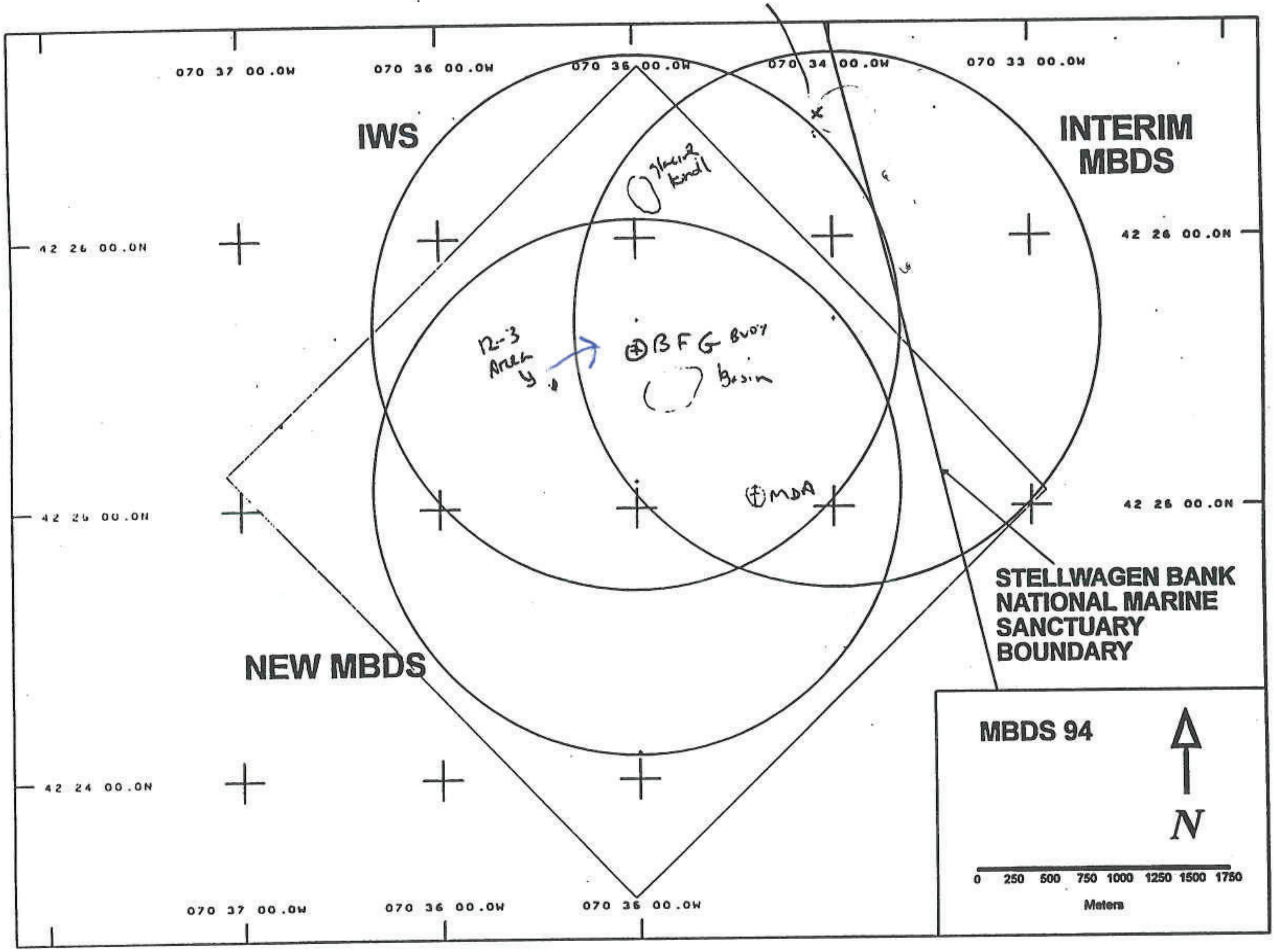


Figure 1-2. Location of MBDS in relation to the interim MBDS, the IWS, and the Stellwagen Bank National Marine Sanctuary boundary

FIGURE 2

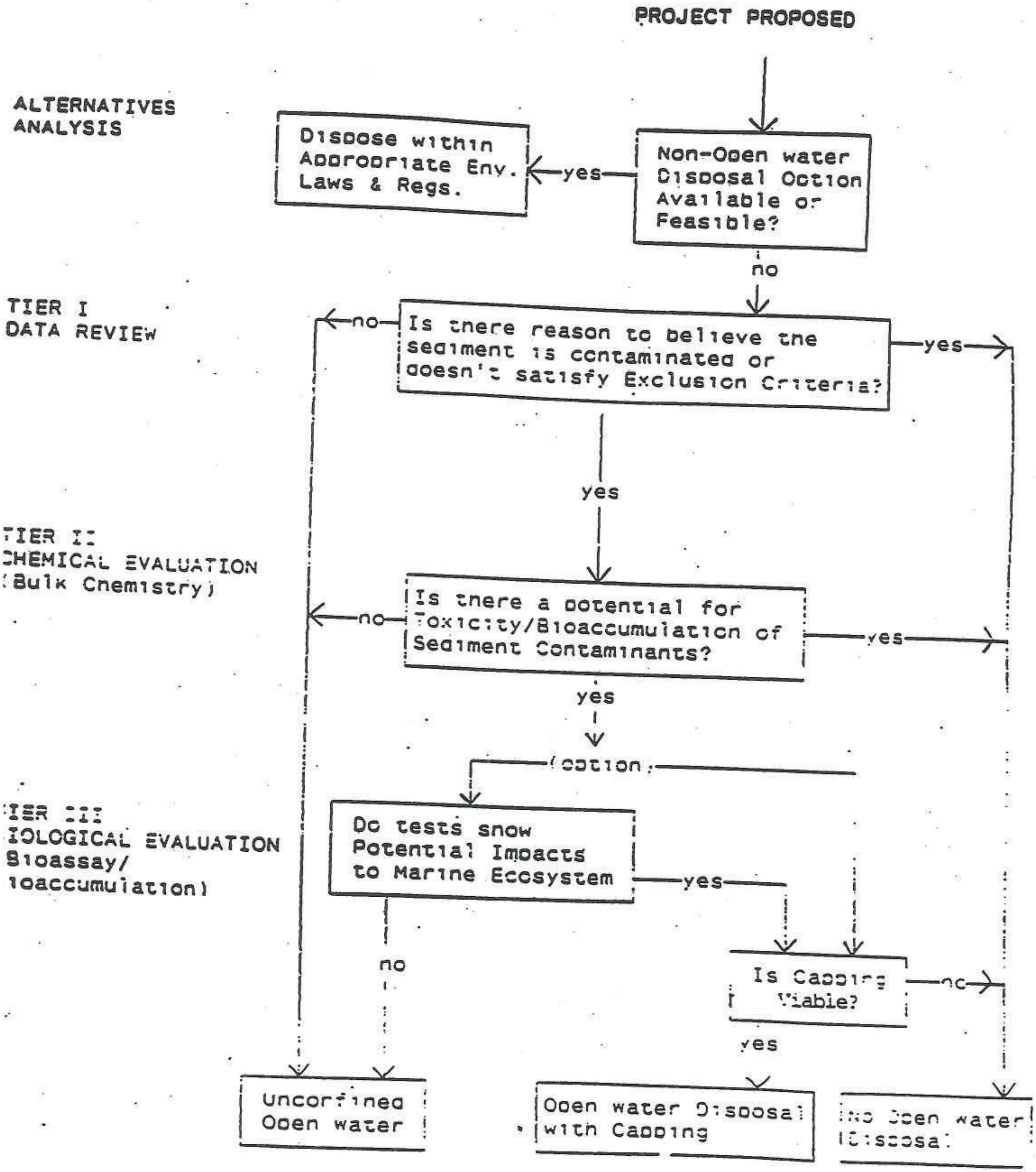


Figure 3 - Generic Flow Diagram for the Tiered Testing and Decision Protocol for the Open Water Disposal of Dredged Material

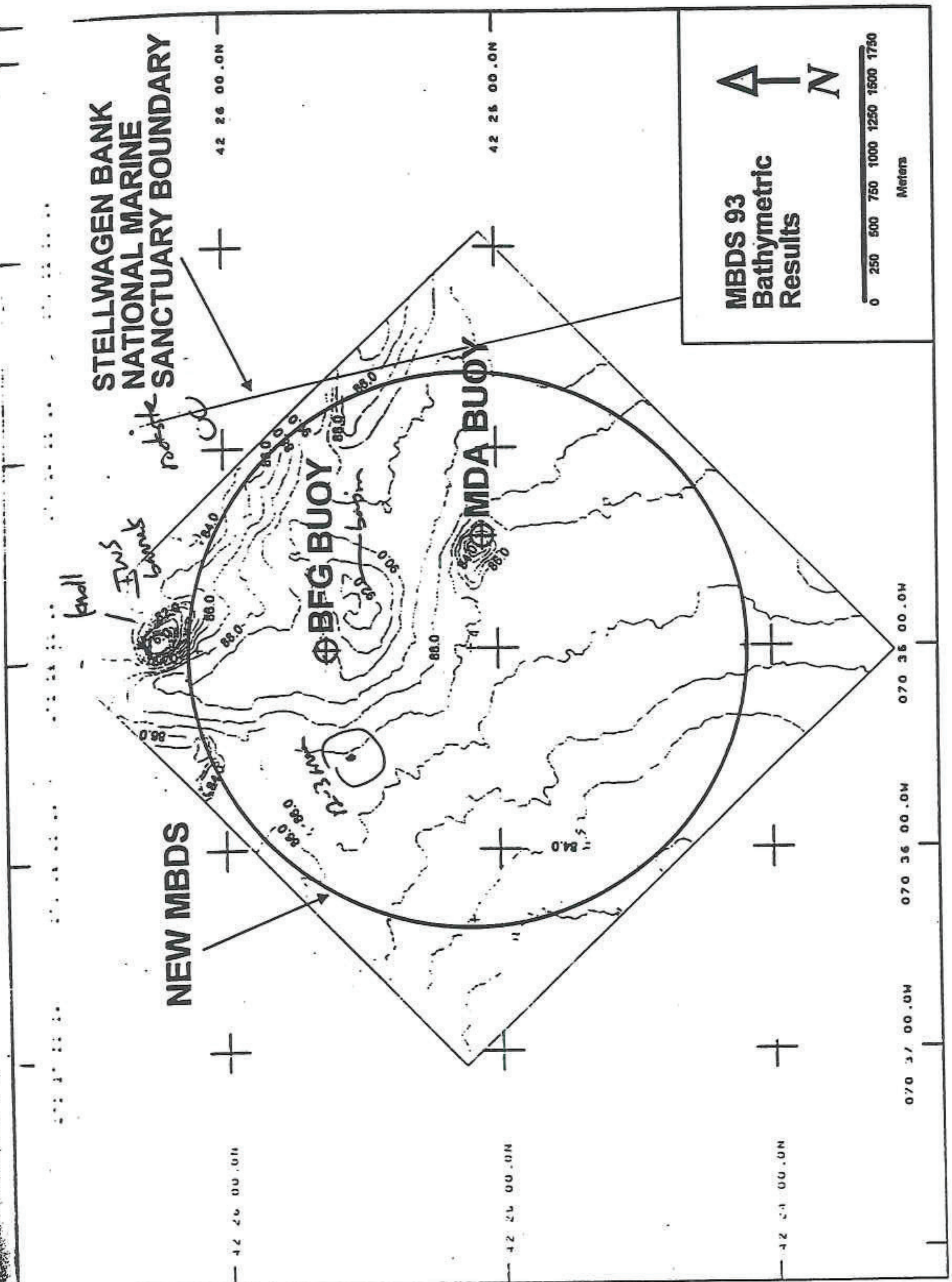


Figure 1-3. Bathymetric results from the 1993 MBDS baseline survey (depth in meters)

FIGURE 4

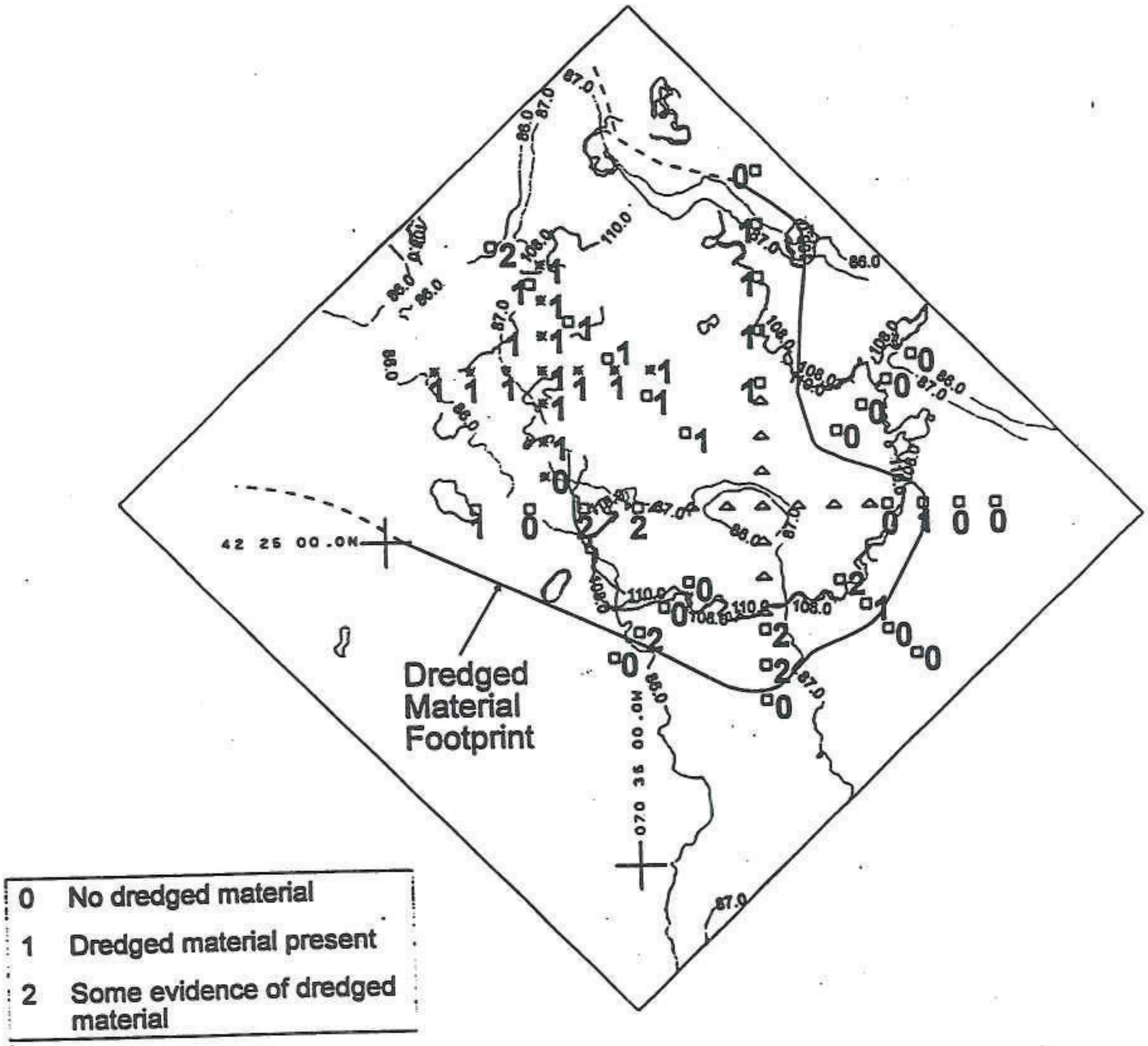


Figure 3-2. SACS REMOTS® stations showing the areal extent of historical dredged material, relative to the 110 dB SACS contour

FIGURE 5

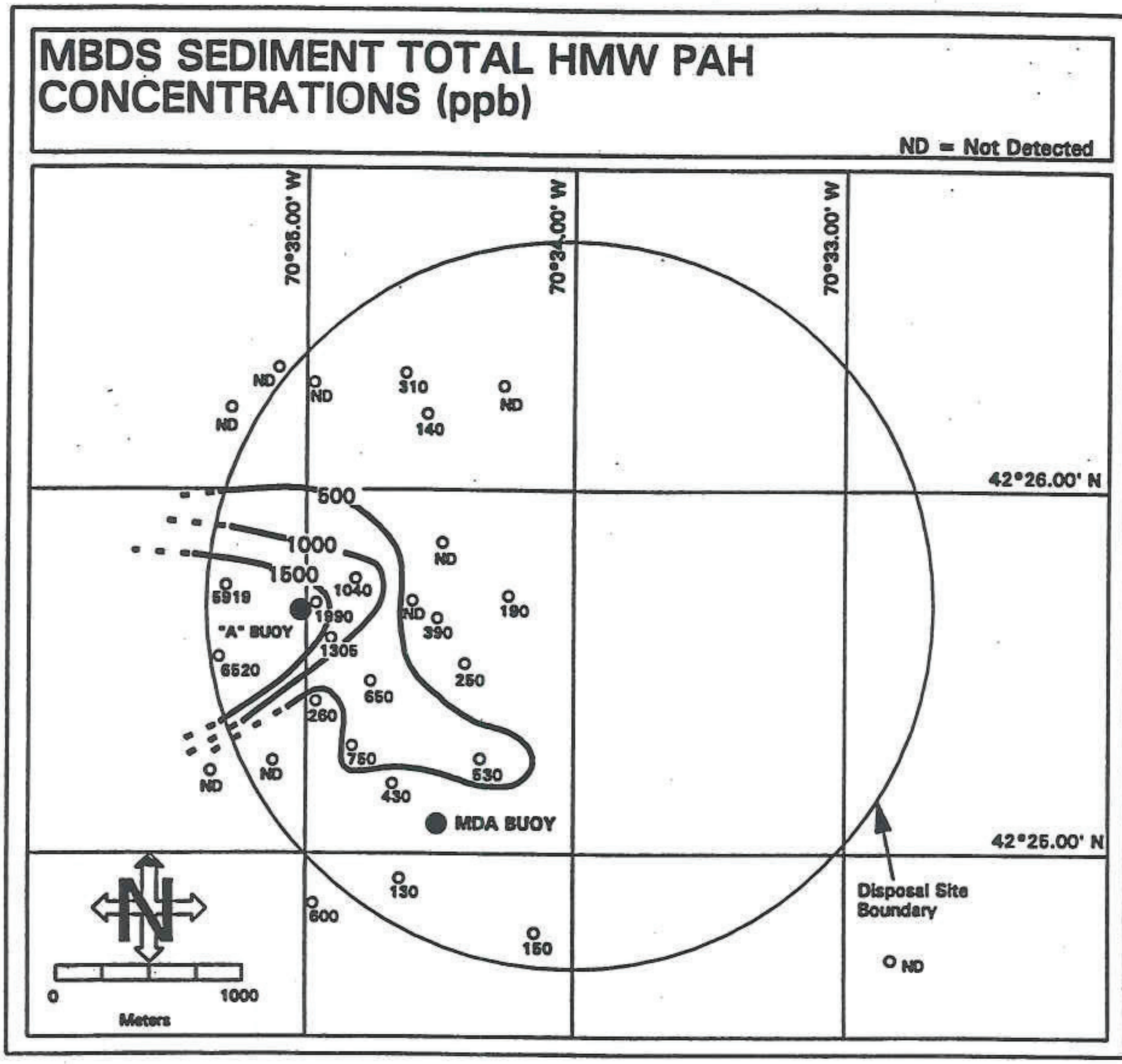


Figure 4-2. Contour map of total high molecular weight PAH concentrations (ppb)

FIGURE 6

Figure 7. HMW PAHs near buoy "A"

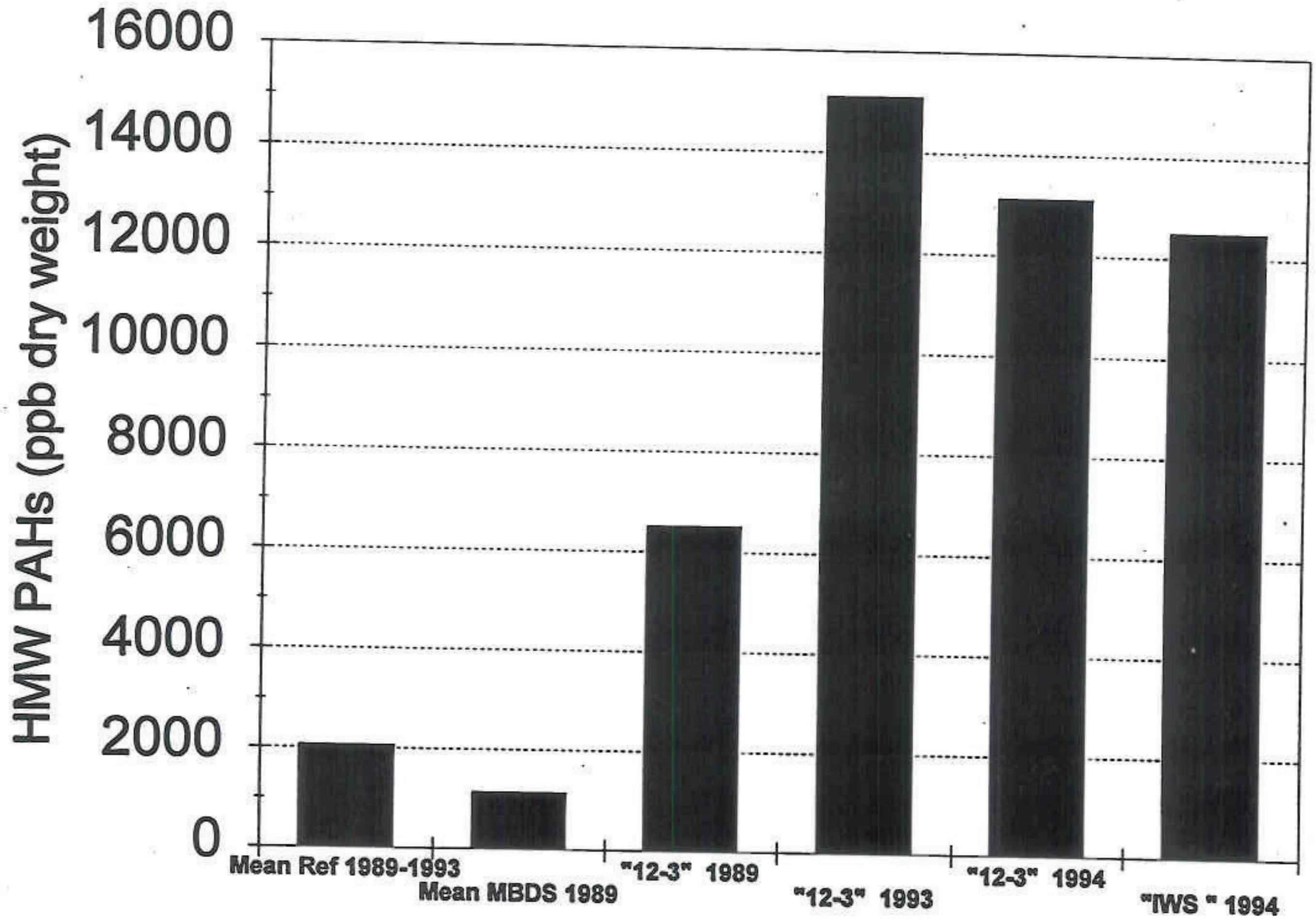


Figure 8. Toxicity of MBDS Sediments

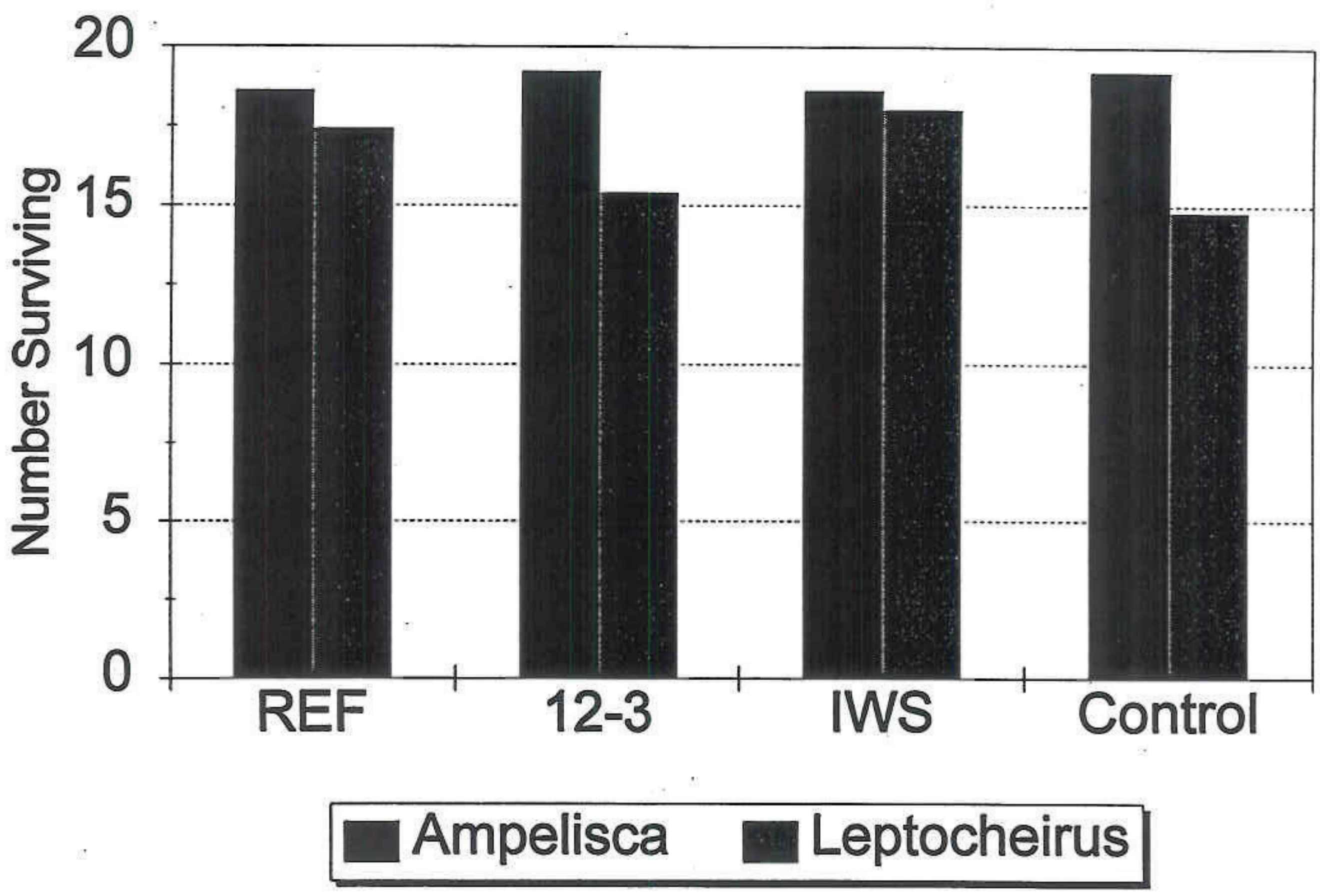


FIGURE 2. H_o1: ON AN UNCONFINED DISPOSAL MOUND, DREDGED MATERIAL DISPOSAL WILL RESULT IN BENTHIC POPULATION DENSITY GREATER THAN AMBIENT CONDITION

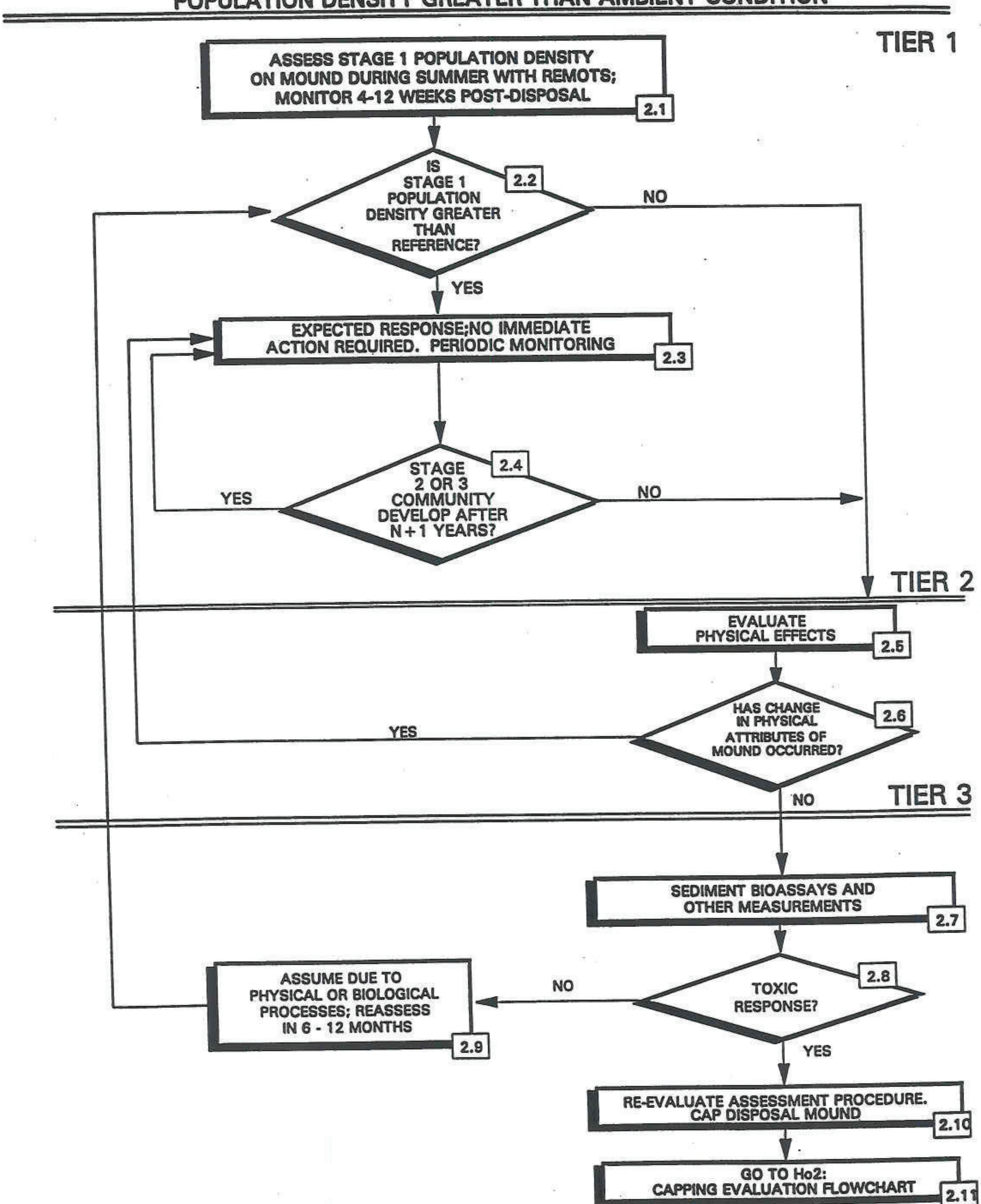


FIGURE 9

X. TABLES 2,7,8,9,10,11,12, AND 13

Table 7. Mean (and standard deviation) of tissue concentrations in fish and shellfish collected at the MBDS and the IWS

AMERICAN PLAICE

	MBDS, n=3 [1] EPA, 1991 (dry wt)	MBDS, n=3 [1] EPA, 1991 (wet wt)	MBDS, n=3 [2] NOAA, 1992 (wet wt)	IWS Site6, n=5 [3] NOAA, 1992 (wet wt)	Stellwagen Basin, n=1 [4] ADL, 1990 (wet wt)	MBDS, n=1 [4] ADL, 1990 (wet wt)
Metals (ug/g)						
Arsenic	—	—	1.03 (0.69)	24.12 (25.12)	1.784	1.561
Cadmium	0.012 (0.03)	0.023	<0.02	0.054 (0.023)	0.002	0.001
Chromium	0.36 (0.55)	0.07	—	3.0 (1.32)	0.04	0.012
Copper	1.580 (0.295)	0.306	—	5.22 (5.62)	0.245	0.379
Lead	0.100 (0.020)	0.019	0.030 (0.005)	1.73 (0.79)	0.089	0.134
Mercury	—	—	0.023 (0.015) [5]	0.188 (0.065)	<0.001	<0.001
Nickel	0.133 (0.188)	0.023	—	—	0.067	0.022
Zinc	60.30 (0.701)	5.04	—	42.4 (11.4)	4.683	5.798
Organics (ng/g)						
Sum PCB [6]	122.89	23.84	<20	<0.06	46.83	102.58
Sum PAHs [7]	19.37 (2.55)	3.79	<12	—	2.832	2.1185

1 mean from 3 individual fish
2 mean from three sites, each site a composite of 24 or 25 individual fish
3 mean from five individual fish
4 one individual fish
5 Methyl mercury
6 Sum of 18 individual PCB congeners (EPA), Aroclor 1254 (NOAA), or Total PCBs (ADL)
7 Sum of 19 (EPA) or 10 (NOAA) or 21 (ADL) individual PAHs

Table 7. Mean (and standard deviation) of tissue concentrations in fish and shellfish collected at the MBDS and the IWS

LOBSTER	MUSCLE	MUSCLE	TOMALLEY	TOMALLEY	MUSCLE	TOMALLEY
	MBDS, n=3 [1]	MBDS, n=3 [1]	MBDS, n=3 [1]	MBDS, n=3 [1]	MBDS, n=3 [2]	MBDS, n=3 [2]
	EPA, 1991	EPA, 1991	EPA, 1991	EPA, 1991	NOAA, 1992	NOAA, 1992
	(dry wt)	(wet wt)	(dry wt)	(wet wt)	(wet wt)	(wet wt)
Metals (ug/g)						
Arsenic	—	—	—	—	4.286 (3.794)	—
Cadmium	0.055 (.03)	0.011	11.1 (0.6)	5.34	0.11 (0.06)	5.09 (1.38)
Chromium	0.29 (.09)	0.059	0.1 (0.02)	0.05	—	—
Copper	106.93 (21.0)	21.82	111.2 (35.9)	53.6	—	—
Lead	0.163 (.03)	0.033	0.057 (0.05)	0.027	0.053 (0.054)	0.038 (0.06)
Methy mercury	—	—	—	—	0.20 (0.05)	—
Nickel	0.47 (.046)	0.095	0.47 (0.08)	0.23	—	—
Zinc	151.0 (3)	30.8	57.7 (11.7)	27.7	—	—
Organics (ng/g)						
Sum PCBs [3]	49.79 (25.9)	10.151	2359.9 (567.5)	1132.8	<100	623 (340)
Sum PAHs [4]	81.4 (33.0)	13.666	1186.5 (335.1)	569.5	0.10 (0.07)	1114 (1001)

1 mean from 3 individual lobsters
2 mean from three sites, each site a composite of 15 or 20 individual lobsters
3 Sum of 18 PCB congeners (EPA) or Aroclor 1254 (NOAA)
4 Sum of 19 (EPA) or 10 (NOAA) individual parent PAHs

Table 7. Mean (and standard deviation) of tissue concentrations in fish and shellfish collected at the MBDS and the IWS

QUAHOG		
	MBDS, n=1 [1]	MBDS, n=1 [1]
	EPA, 1991	EPA, 1991
	(dry wt)	(wet wt)
Metals (ug/g)		
Cadmium	3.46	0.401
Chromium	1.26	0.146
Copper	48.6	5.63
Lead	5.8	0.673
Mercury	—	—
Nickel	28.2	3.271
Zinc	236	27.376
Organics (ng/g)		
Sum PCBs [2]	66.63	7.72908
Sum PAHs [3]	279.18	32.38488

1 one individual
2 Sum of 18 PCB congeners (EPA) or Aroclor 1254 (NOAA)
3 Sum of 19 (EPA) or 10 (NOAA) individual PAHs == this will be standardized

Table 8. 1994 EPA sampling of MBDS for sediment chemistry

	REFERENCE	Q	STATION1 (12-3)	Q	STATION1-DUP	Q	STATION1 AVG	STATION2 (IWS)	Q
COORDINATES	42 21.6'N, 70 25.1'W		42 25.5'N, 70 35.4'W					42 25.5'N, 70 35.9'W	
TOC (%)	1.98		2.8		2.8		2.8	3.3	
TOTAL SOLIDS (% w/w)	46.4		40.9		42.5		41.7	35.5	
METALS (ug/g):									
Arsenic	10.8		10.7		13.5		12.1	14.4	
Cadmium	0.05	U	0.07	U	0.05	U	0.06	0.06	U
Chromium	59	E	74.4	E	86.9	E	80.65	92.5	E
Copper	16.4	E*	35.4	E*	48.8	E*	42.1	34.7	E*
Lead	30.6	E	57.5	E	70.4	E	63.95	59.7	E
Mercury	0.12	N	0.32	N	0.27	N	0.295	0.24	N
Nickel	20.7	E	20	E	25	E	22.5	31.4	E
Zinc	74.5	EN	90.4	EN	115	EN	102.7	110	EN

QUALIFIERS (Q)

U - Entered if the analyte was analyzed for but not detected, less than Instrument Detection Limit (IDL).

E - The reported value is estimated because of the presence of interference.

* - Duplicate analysis not within control limits.

N - Matrix spiked sample recovery not within control limits.

B - Entered if the reported value is less than the Contract Required Detection Limit (CRDL), but greater than the IDL

< - less than detection limit

11/5/96

Table 8. 1994 EPA sampling of MBDS for sediment chemistry

	REFERENCE	Q	STATION1 (12-3)	Q	STATION1-DUP	Q	STATION1 AVG	STATION2 (IWS)	Q
COORDINATES	42 21.6'N, 70 25.1'W		42 25.5'N, 70 35.4'W					42 25.5'N, 70 35.9'W	
PAHs (ug/kg):									
Napthalene	29	U	387		435		411	871	
2-Methylnaphthalene	29	U	92		126		109	130	
1-Methylnaphthalene	29	U	55		79		67	82	
1,1-Biphenyl	29	U	39		36		37.5	37	U
2,6-Dimethylnaphthalene	29	U	61		66		63.5	41	
Acenaphthylene	29	U	92		71		81.5	107	
Acenaphthene	29	U	97		140		118.5	71	
2,3,5-Trimethylnaphthalene	29	U	64		36		50	37	U
Fluorene	29	U	201		193		197	37	U
Phenanthrene	105		1466		1293		1379.5	760	
Anthracene	29	U	754		502		628	286	
1-Methylphenanthrene	29	U	276		193		234.5	160	
Fluoranthene	184		2808		2250		2529	2196	
Pyrene	166		2772		2369		2570.5	2210	
Benz(a)anthracene	74		1605		1252		1428.5	1361	
Chrysene	101		1441		1113		1277	1184	
Benzo(b)fluoranthene	130		1563		1113		1338	1407	
Benzo(k)fluoranthene	52		1127		979		1053	1047	
Benzo(e)pyrene	68		999		778		888.5	915	
Benzo(a)pyrene	94		1686		1225		1455.5	1475	
Perylene	29	U	379		287		333	297	
Indeno(1,2,3-cd)pyrene	74		848		666		757	827	
Dibenzo(a,h)anthracene	29	U	196		156		176	200	
Benzo(g,h,i)perylene	62		617		481		549	593	

Table 8. 1994 EPA sampling of MBDS for sediment chemistry

	REFERENCE	Q	STATION1 (12-3)	Q	STATION1-DUP	Q	STATION1 AVG	STATION2 (IWS)	Q
COORDINATES	42 21.6'N, 70 25.1'W		42 25.5'N, 70 35.4'W					42 25.5'N, 70 35.9'W	
PCBs (ug/kg):									
BZ#8	1.7	U	12		12		12	2.4	U
BZ#18	1.7	U	29		29		29	2.4	U
BZ#28	1.7	U	67		71		69	6.7	
BZ#44	1.7	U	33		35		34	3.5	
BZ#52	1.7	U	29		29		29	4.2	
BZ#66	1.7	U	30		31		30.5	9	
BZ#101	1.7	U	20		24		22	7.7	
BZ#105	1.7	U	11		9.8		10.4	8.1	
BZ#118	1.7	U	20		19		19.5	14	
BZ#126	1.5	U	6.3		3.2		4.75	5.2	
BZ#128	1.5	U	3.9		3.3		3.6	3	
BZ#138	1.5	U	20		12		16	14	
BZ#153	1.7	U	17		13		15	18	
BZ#170	1.5	U	6.3		2.7		4.5	5.5	
BZ#180	1.5	U	9.3		5.4		7.35	12	
BZ#187	1.5	U	3.9	U	1.8	U	2.85	2.3	U
BZ#195	1.5	U	3.9	U	1.8	U	2.85	2.3	U
BZ#206	1.5	U	3.9	U	1.9		2.9	2.3	U
BZ#209	1.5	U	3.9	U	1.8	U	2.85	2.3	U

Table 8. 1994 EPA sampling of MBDS for sediment chemistry

	REFERENCE	Q	STATION1 (12-3)	Q	STATION1-DUP	Q	STATION1 AVG	STATION2 (IWS)	Q
COORDINATES	42 21.6'N, 70 25.1'W		42 25.5'N, 70 35.4'W					42 25.5'N, 70 35.9'W	
Pesticides (ug/kg):									
Hexachlorobenzene	1.7	U	4	U	1.9	U	2.95	2.4	U
gamma-BHC	1.7	U	4	U	1.9	U	2.95	2.4	U
Heptachlor	1.7	U	4	U	1.9	U	2.95	2.4	U
Aldrin	1.7	U	4	U	1.9	U	2.95	2.4	U
Heptachlor Epoxide	1.7	U	4	U	1.9	U	2.95	2.4	U
alpha-Chlordane	1.7	U	4	U	1.9	U	2.95	2.4	U
gamma-Chlordane	1.7	U	4	U	1.9	U	2.95	2.4	U
Technical chlordane	42	U	98	U	88	U	93	110	U
Endosulfan I	1.7	U	4	U	1.9	U	2.95	2.4	U
2,4-DDT	1.7	U	4	U	1.9	U	2.95	2.4	U
4,4-DDT	1.5	U	140		1.8	U	70.9	2.3	U
2,4-DDD	1.7	U	9.6		8.5		9.05	3.9	
4,4-DDD	1.7	U	26		15		20.5	7.7	
2,4-DDE	1.7	U	4	U	1.9	U	2.95	2.4	U
4,4-DDE	1.7	U	6.7		5.1		5.9	3	
trans-Nonachlor	1.7	U	4	U	1.9	U	2.95	3.3	
Dieldrin	1.7	U	4	U	1.9	U	2.95	2.4	U
Endrin	3.3	U	7.9	U	3.7	U	5.8	4.7	U
Endosulfan II	3.3	U	7.9	U	3.7	U	5.8	4.7	U
Endosulfan sulfate	3.3	U	7.9	U	3.7	U	5.8	4.7	U
Methoxychlor	15	U	39	U	18	U	28.5	23	U
Mirex	1.5	U	3.9	U	1.8	U	2.85	2.3	U
Toxaphene	170	U	390	U	350	U	370	440	U

Table 9. Sediment quality at Massachusetts Bay Disposal Site stations and Reference Areas compared to regional sediment quality.

LOCATION	DATA SOURCE	DATE	Metals (ug/g dry wt) ARSENIC	CADMIUM	CHROMIUM	COPPER	LEAD	MERCURY	NICKEL	ZINC	Organics (ng/g dry wt) Total PCBs [1]	Total DDTs [3]	Total PAHs	LMW PAHs [4]	HMW PAHs [7]
Reference Stations															
Mean Ref. Stations	SAIC, 1994	1985-1987			56	20.8	56.3		27.8	98.8					
Mean Ref. Stations	SAIC, 1994	June, 1989			73.5	29	50		23.5	116	nd [2]	7.45	65	nd	65
Mean Ref. Stations	SAIC, 1995	1989-1993	15.7	1.08	79.8	19.7	46.7	0.121	25.1	90			2352	268	2060
1994 Ref. Station	M&E, 1995 (EPA)	Sept, 1994	10.8	0.03	59	16.4	30.6	0.12	20.7	74.5	15.3	5.1	1130	178	952
Disposal Site Stations															
Mean MBDS	SAIC, 1994	June, 1989			70	44	72		21	127			1308	164 [5]	1144
Station 12-3	SAIC, 1994	June, 1989			139	74	110	0.47	16	221	nd [2]		8002	1500 [5]	6520
Station 12-3	SAIC, 1996	Sept, 1993	12	1.7	95	44	71	0.101	26	129			21600	6500 [6]	15100
MBDS South	Gardner and Pruell, 1991 (EPA) [8]	May, 1991		0.54	35.7	15.7	3.08		25.9	72.7	2.3	4.1	178.3	27.3	151
IWS North	Gardner and Pruell, 1991 (EPA) [8]	May, 1991		0.36	40.8	18.4	3.19		26.2	78.4	1.2	1.1	32.4	6.6	25.8
Station 12-3	M&E, 1995 (EPA)	Sept, 1994	12.1	0.03	80.7	42.1	64	0.3	22.5	102.7	318.1	112.3	15950	2816	13134
IWS	M&E, 1995 (EPA)	Sept, 1994	14.4	0.03	92.5	34.7	59.7	0.24	31.4	110	117.9	16.7	14614	2114	12500
Regional or local levels															
NS&T National Mean	SAIC, 1994	1985-1989			110	35	43	0.17	34	140					
NS&T National "High"	SAIC, 1994	1985-1989			230	84	89	0.49	69	270					
Boston Harbor	Long et al., 1996 (NOAA)						144.4				268		14804		

1 Sum of 18 or 19 congeners
2 Total PCBs
3 Sum of DDT, DDE and DDD
4 Sum of six 2 and 3 ring parent PAHs
5 Napthalene and phenanthrene only
6 Phenanthrene only
7 Sum of nine, 4 and 5 ring parent PAHs only
8 Organics levels extremely low, probable outliers

Table 10. Bioaccumulation in *Macoma* (dry weight)

	REFERENCE			12-3 (Station 1)			IWS (Station 2)			p	Significant
	Average	Std Dev.	Qualifiers (a)	Average	Std Dev.	Qualifiers	Average	Std Dev.	Qualifiers	Value	Differences (b,c)
METALS (mg/kg):											
Arsenic	3.5	0.100		3.54	0.270		3.38	0.217		0.4719	
Cadmium	0.044	0.005	B	0.048	0.004	B	0.042	0.008	B	0.3444	
Chromium	0.348	0.045	B	0.462	0.039		0.376	0.093	B	0.0383	REF<12-3
Copper	2.12	0.084		3.04	0.344		2.18	0.409		0.0008	REF<12-3
Lead	2.08	0.217	E*	2.38	0.192	E*	1.68	0.110	E*	0.0002	IWS<REF
Mercury	0.032	0.027		0.534	1.100		0.02	0.000		0.3746	
Nickel	0.5	0.039	B	0.82	0.556	B	0.426	0.033	B	0.1637	
Zinc	13.66	0.770	E	14.42	1.266	E	14.06	1.399	E	0.6062	

(a) Predominant qualifiers among the five replicates, if any
(b) Means, standard deviations and statistical differences were calculated using one half detection limits for concentrations below detection limits
(c) Denotes stations significantly different from the Reference station at the 0.050 level
(d) Merged with benzo(b)fluoranthene
U - Analyte was analyzed for but not detected, less than Instrument Detection Limit (IDL).
E - The reported value is estimated because of the presence of interference.
* - Duplicate analysis not within control limits.
N - Matrix spiked sample recovery not within control limits.
B - Entered if the reported value is less than the Contract Required Detection Limit (CRDL)
but greater than the Instrument Detection Limit (IDL).

Table 10. Bioaccumulation in *Macoma* (dry weight) (continued)

	REFERENCE			12-3 (Station 1)			IWS (Station 2)			p	Significant
	Average	Std Dev.	Qualifiers (a)	Average	Std Dev.	Qualifiers	Average	Std Dev.	Qualifiers	Value	Differences (b,c)
PAHs (ug/kg):											
Napthalene	14.8	3.114		26.4	2.608		23	7.969		0.0113	REF<12-3
2-Methylnaphthalene	19.4	4.561		25.2	2.387		25.8	15.287		0.5065	
1-Methylnaphthalene	6.4	2.104	U	12	1.000		U		U	0.0007	REF<12-3
1,1-Biphenyl	U		U	7.3	2.950	U	8.3	7.678	U	0.6313	
2,6-Dimethylnaphthalene	6.4	2.104		12.4	6.618		U		U	0.0629	
Acenaphthylene	U		U	U		U	U		U		
Acenaphthene	U		U	6.1	2.191	U	U		U	0.8363	
2,3,5-Trimethylnaphthalene	U		U	38	37.222		11.9	11.404	U	0.0910	
Fluorene	U		U	18.6	7.021		U		U	0.0006	REF<12-3
Phenanthrene	54	6.819		158.2	30.671		87.4	26.369		0.0001	REF<12-3
Anthracene	U		U	81	21.726		35	11.937		0.0000	REF<12-3, IWS
1-Methylphenanthrene	6.6	2.535	U	38	13.435		16.6	8.503		0.0006	REF<12-3
Fluoranthene	61	11.937		414	53.111		301.4	67.300		0.0000	REF<12-3, IWS
Pyrene	106	105.155		1105	191.068		1057.6	187.153		0.0000	REF<12-3, IWS
Benz(a)anthracene	18	5.657		348	43.338		325.8	73.053		0.0000	REF<12-3, IWS
Chrysene	21.8	5.586		224	25.733		211.6	32.455		0.0000	REF<12-3, IWS
Benzo(b)fluoranthene	48	10.700		283	65.930		443	116.780		0.0000	REF<12-3, IWS
Benzo(k)fluoranthene (d)											
Benzo(e)pyrene	98.8	172.881		113	27.468		218.6	59.589		0.1950	
Benzo(a)pyrene	93	168.287		147	32.784		275.4	86.869		0.0608	
Perylene	48.8	80.627		28	8.689		55.4	17.644		0.6508	
Indeno(1,2,3-cd)pyrene	60	94.525		48	12.239		74.4	24.141		0.7612	
Dibenzo(a,h)anthracene	U		U	15.7	6.140		20.3	7.887		0.0046	REF<12-3, IWS
Benzo(g,h,i)perylene	93.8	187.411		14.7	7.068		59.8	15.991		0.5315	

Table 10. Bioaccumulation in *Macoma* (dry weight)

		REFERENCE			12-3 (Station 1)			IWS (Station 2)			p	Significant
		Average	Std Dev.	Qualifiers (a)	Average	Std Dev.	Qualifiers	Average	Std Dev.	Qualifiers	Value	Differences (b,c)
PCBs (ug/kg):												
BZ#8		3.93	2.141		202	85.849		5.76	2.466		0.0000	REF<12-3
BZ#18		1.6	0.552		250	168.671		2.6	0.735		0.0021	REF<12-3
BZ#28		3.8	0.534		1428	707.050		11.5	3.841		0.0001	REF<12-3
BZ#44		U		U	212	139.714		2.1	0.731		0.0017	REF<12-3
BZ#52		2.96	0.937		650	367.219		10.2	2.877		0.0005	REF<12-3
BZ#66		1.82	0.694		626	276.460		13	2.550		0.0001	REF<12-3
BZ#77		U		U	111.6	85.912		2.633	2.943		0.0057	REF<12-3
BZ#101		1.92	0.614		346	154.693		11.88	1.781		0.0001	REF<12-3
BZ#105		1.83	1.005		128.6	58.153		5.28	1.167		0.0001	REF<12-3
BZ#118		2.72	0.887		292	133.116		11.44	1.752		0.0001	REF<12-3
BZ#126		U		U	U		U	6.45	12.047	U	0.3737	
BZ#128		U		U	U		U	5.08	3.897		0.0101	REF<12-3
BZ#138		4.82	1.934		214	40.373		27.2	9.445		0.0000	REF<12-3
BZ#153		3.42	1.050		163.6	76.778		13.6	2.074		0.0001	REF<12-3
BZ#170		U		U	U		U	2.58	2.287		0.0007	REF<12-3
BZ#180		1.55	0.887	U	U		U	5.32	1.057		0.0002	REF<12-3, IWS
BZ#187		1.32	0.375		U		U	11.98	12.337		0.1058	
BZ#195		U		U	U		U	U		U		
BZ#206		U		U	U		U	U		U		
BZ#209		U		U	U		U	U		U		

Table 10. Bioaccumulation in *Macoma* (dry weight)

		REFERENCE			12-3 (Station 1)			IWS (Station 2)			p	Significant
		Average	Std Dev.	Qualifiers (a)	Average	Std Dev.	Qualifiers	Average	Std Dev.	Qualifiers	Value	Differences (b,c)
Pesticides (ug/kg):					U		U	U		U	0.0011	REF<12-3
Hexachlorobenzene		1.03	0.994	U	10.83	14.685	U	U		U	0.1557	
gamma-BHC		0.79	0.270		40.4	36.295		3.258	6.005	U	0.0204	REF<12-3
Heptachlor		U		U	U		U	U		U		
Aldrin		U		U	U		U	U		U		
Heptachlor Epoxide		U		U	128	95.934		1.5	0.543		0.0044	REF<12-3
alpha-Chlordane		U		U	U		U	U		U		
gamma-Chlordane		U		U	U		U	U		U		
Technical chlordane		U		U	U		U	1.532	0.754		0.0870	
Endosulfan I		U		U	U		U	U		U		
2,4-DDT		U		U	U		U	U		U		
4,4-DDT		U		U	U		U	1.495	2.020	U	0.0020	REF<12-3
2,4-DDD		U		U	332	126.372		17.6	4.980		0.0000	REF<12-3
4,4-DDD		U		U	113.2	59.222		2.82	0.421		0.0003	REF<12-3
2,4-DDE		U		U	139.6	70.088		7.26	1.587		0.0002	REF<12-3
4,4-DDE		0	5.751		U		U	U		U		
trans-Nonachlor		U		U	142	133.626		6.272	3.568		0.0222	REF<12-3
Dieldrin		0	2.566		U		U	U		U		
Endrin		U		U	29.3	31.555	U	U		U	0.0511	
Endosulfan II		U		U	U		U	U		U		
Endosulfan sulfate		U		U	U		U	U		U		
Methoxychlor		U		U	U		U	U		U		
Mirex		U		U	U		U	U		U		
Toxaphene		U		U								

Table 11. Bioaccumulation in *Nereis* (dry weight)

	REFERENCE			12-3 (Station 1)			IWS (Station 2)			p	Significant
	Average	Std Dev.	Qualifiers (a)	Average	Std Dev.	Qualifiers	Average	Std Dev.	Qualifiers	Value	Differences (b, c)
METALS (mg/kg):											
Arsenic	2.86	0.152	E	2.66	0.195	E	2.64	0.207	E	0.1610	
Cadmium	0.06	0.017	B	0.058	0.004	B	0.058	0.004	B	0.9431	
Chromium	0.152	0.019	B	0.168	0.016	B	0.148	0.013	B	0.1684	
Copper	1.68	0.409	E	1.96	0.055	E	1.66	0.114	E	0.1421	
Lead	0.5	0.058		0.506	0.040		0.354	0.173		0.0773	
Mercury	0.032	0.004		0.036	0.005		0.044	0.005		0.0097	REF<IWS
Nickel	0.542	0.061	B	0.476	0.034	B	0.398	0.029	B	0.0008	REF<IWS REF>IWS
Zinc	16.04	6.280	EN*	33.98	7.257	EN*	29.22	13.420	EN*	0.0301	REF<12-3

(a) Predominant qualifiers among the five replicates, if any
(b) Means, standard deviations and statistical differences were calculated using one half detection limits for concentrations below detection limits
(c) Denotes stations significantly different from the Reference station at the 0.050 level
(d) Merged with benzo(b)fluoranthene
U - Analyte was analyzed for but not detected, less than Instrument Detection Limit (IDL).
E - The reported value is estimated because of the presence of interference.
* - Duplicate analysis not within control limits.
N - Matrix spiked sample recovery not within control limits.
B - Entered if the reported value is less than the Contract Required Detection Limit (CRDL)
but greater than the Instrument Detection Limit (IDL).

Table 11. Bioaccumulation in *Nereis* (dry weight)

	REFERENCE			12-3 (Station 1)			IWS (Station 2)			p	Significant
	Average	Std Dev.	Qualifiers (a)	Average	Std Dev.	Qualifiers	Average	Std Dev.	Qualifiers	Value	Differences (b, c)
PAHs (ug/kg):											
Napthalene	29.1	28.732		15.2	3.271		72.8	49.777		0.0442	
2-Methylnaphthalene	22.5	13.766		18.4	3.507		17.2	11.432		0.7127	
1-Methylnaphthalene	11.1	5.296	U	8.2	3.194	U	10.1	5.177	U	0.6184	
1,1-Biphenyl	U		U	U		U	18.2	12.276		0.0523	
2,6-Dimethylnaphthalene	U		U	U		U	U		U		
Acenaphthylene	U		U	U		U	U		U		
Acenaphthene	U		U	8.2	3.194	U	U		U	0.9294	
2,3,5-Trimethylnaphthalene	U		U	U		U	U		U		
Fluorene	9.5	5.123	U	U		U	U		U	0.4500	
Phenanthrene	18	10.271		30.6	2.966		31.8	11.713		0.1473	
Anthracene	U		U	11.8	8.843	U	U		U	0.5817	
1-Methylphenanthrene	U		U	U		U	U		U		
Fluoranthene	9.9	5.962	U	24.2	9.121		33.8	28.613		0.1412	
Pyrene	20.4	7.956		63.6	8.081		106.6	40.470		0.0004	REF<12-3, IWS
Benz(a)anthracene	U		U	8	2.828	U	U		U	0.9380	
Chrysene	U		U	28.8	4.438		41.2	9.808		0.0000	REF<12-3, IWS
Benzo(b)fluoranthene	9.5	5.123	U	26.6	7.987		32.8	10.663		0.0021	REF<12-3, IWS
Benzo(k)fluoranthene (d)											
Benzo(e)pyrene	U		U	14.8	3.834	U	25.4	9.209		0.0016	REF<IWS
Benzo(a)pyrene	U		U	12	5.701		18.7	12.122		0.0949	
Perylene	10.3	6.815	U	8.2	3.194	U	12.4	9.959	U	0.6635	
Indeno(1,2,3-cd)pyrene	U		U	U		U	U		U		
Dibenzo(a,h)anthracene	U		U	U		U	U		U		
Benzo(g,h,i)perylene	U		U	U		U	U		U		

Table 11. Bioaccumulation in *Nereis* (dry weight)

	REFERENCE			12-3 (Station 1)			IWS (Station 2)			p	Significant
	Average	Std Dev.	Qualifiers (a)	Average	Std Dev.	Qualifiers	Average	Std Dev.	Qualifiers	Value	Differences (b, c)
PCBs (ug/kg):											
BZ#8	U		U	U		U	1.72	0.382	U	0.0508	
BZ#18	U		U	13.6	1.817		U		U	0.0000	REF<12-3
BZ#28	2.07	0.931	U	12.98	2.480		6.46	1.062		0.0000	REF<12-3, IWS
BZ#44	U		U	4.42	1.165		U		U	0.0000	REF<12-3
BZ#52	1.49	0.621	U	35.6	3.286		9.98	0.642		0.0000	REF<12-3, IWS
BZ#66	U		U	34.2	5.541		17.6	1.817		0.0000	REF<12-3, IWS
BZ#77	U		U	4.84	3.087		3.17	2.832	U	0.2210	
BZ#101	U		U	18	5.148		9.7	1.292		0.0000	REF<12-3, IWS
BZ#105	U		U	12.6	1.673		5.44	2.732		0.0000	REF<12-3, IWS
BZ#118	U		U	11.76	1.841		6.7	1.598		0.0000	REF<12-3, IWS
BZ#126	2.24	0.429	U	U		U	5.14	6.334	U	0.3241	
BZ#128	U		U	7.36	1.258		5.27	2.910		0.0020	REF<12-3, IWS
BZ#138	4.78	2.678		29	8.803		37.8	14.167		0.0005	REF<12-3, IWS
BZ#153	8.23	3.453		15.93	20.591	U	38.6	7.701		0.0075	REF<IWS
BZ#170	U		U	7.38	1.040		9.18	2.825		0.0001	REF<12-3, IWS
BZ#180	2.34	0.612	U	14.6	3.647		17.8	4.970		0.0000	REF<12-3, IWS
BZ#187	2.54	1.027	U	11	1.838		18.8	7.918		0.0006	REF<12-3, IWS
BZ#195	U		U	U		U	U		U		
BZ#206	U		U	U		U	4.07	1.362	U	0.0018	REF<IWS
BZ#209	U		U	U		U	3.67	1.338	U	0.0070	REF<IWS

Table 11. Bioaccumulation in *Nereis* (dry weight)

	REFERENCE			12-3 (Station 1)			IWS (Station 2)			p	Significant
	Average	Std Dev.	Qualifiers (a)	Average	Std Dev.	Qualifiers	Average	Std Dev.	Qualifiers	Value	Differences (b, c)
Pesticides (ug/kg):											
Hexachlorobenzene	1.86	1.567	U	U		U	U		U	0.5311	
gamma-BHC	U		U	2.58	1.043		U		U	0.0259	REF<12-3
Heptachlor	1.62	1.135	U	2.84	1.379		U		U	0.1357	
Aldrin	U		U	U		U	U		U		
Heptachlor Epoxide	U		U	3.68	0.396		U		U	0.0063	REF<12-3
alpha-Chlordane	U		U	6.8	0.458		4.01	2.088		0.0002	REF<12-3
gamma-Chlordane	U		U	U		U	U		U		
Technical chlordane	U		U	U		U	U		U		
Endosulfan I	U		U	3.88	1.787		1.96	0.243	U	0.0243	
2,4-DDT	U		U	U		U	U		U		
4,4-DDT	5.28	3.311		U		U	U		U	0.0744	
2,4-DDD	U		U	5.52	4.125		4.39	3.217		0.2146	
4,4-DDD	U		U	15.92	8.083		U		U	0.0005	REF<12-3
2,4-DDE	U		U	5	2.281		2.34	0.484	U	0.0092	REF<12-3
4,4-DDE	U		U	7.72	1.003		2.36	0.463	U	0.0000	REF<12-3
trans-Nonachlor	U		U	U		U	4.92	3.400		0.0331	
Dieldrin	U		U	9.92	1.184		5.04	0.799		0.0000	REF<12-3, IWS
Endrin	U		U	U		U	U		U		
Endosulfan II	U		U	U		U	U		U		
Endosulfan sulfate	U		U	4.42	1.923	U	U		U	0.5022	
Methoxychlor	U		U	U		U	U		U		
Mirex	U		U	U		U	U		U		
Toxaphene	U		U	U		U	U		U		

Table 12. Range of tissue concentrations (dry weight) in polychaetes collected at MBDS

	Nephtys	Nephtys	Nephtys	Nephtys	Nereis
	Reference	Reference	Disposal mound	Off disposal mound	Bioaccumulation test
	1990	1985 - 1987	1985 - 1986	1985 - 1986	(See Table 11)
	ADL, 1990	Hubbard, 1988	Hubbard, 1988	Hubbard, 1988	M&E, 1994
METALS (mg/kg)					
Arsenic	nd[1] - 43	6.23 - 89.7	18.9 - 19.7	31	2.64 - 2.86
Cadmium	0.45 - 0.70	0.68 - 1.12	0.53 - 0.97	0.67 - 0.78	0.04 - 0.06
Chromium	0.51 - 1.17	0.64 - 0.66	0.78 - 1.39	0.65	0.14 - 0.17
Copper	5.1 - 12.3	6.30 - 13.4	7.3 - 15.7	7.18 - 14.1	1.66 - 1.96
Lead	2.3 - 4.1	3.84 - 4.6	3.27 - 6.08	4.69 - 9.6	0.35 - 0.51
Mercury	0.037 - 0.068	nd - 0.07	nd - 0.08	nd - 0.03	0.03 - 0.04
Nickel	2.3 - 3.8	--	--	--	0.39 - 0.54
Zinc	121 - 252	177 - 223	181 - 216	233	16.04 - 33.98
Total PCBs (mg/kg)	0.026 - 0.17	0.15 - 0.475	0.70 - 2.5	0.43 - 1.05	0.02 - 0.23[2]
Sum DDTs (mg/kg)	0.001 - 0.011	0.02 - 0.03	--	--	0.005 - 0.034
PAHS (ug/kg)					
Fluorene	nd	10.9 - 11.0	25	nd - 17.5	nd - 9.5
Phenanthrene	7.1 - 20	37.5 - 64.2	61.4	nd - 42.6	18 - 31.8
Anthracene	nd - 19	4.2 - 22.4	114.6	33.7 - 91.3	nd - 11.8
Fluoranthene	19 - 49	4.48 - 51.9	408.3	135.7 - 139.6	9.9 - 33.8
Pyrene	24 - 71	58.1 - 50.5	365.2	158.3 - 327.0	20.4 - 106.6
Benz(a)anthracene	4.1 - 15	nd - 118.4[3]	1089.6[3]	nd - 1192.7[3]	nd
Chrysene	14 - 29	---	---	---	nd - 53
Benzo(b and k)fluoranthene	5.2 - 32	nd - 9.9	35.7	nd - 41.7	9.5 - 32.8
Benzo(a)pyrene	19 - 59	nd - 53.8	261.9	nd - 394.5	nd - 18.7
Indeno(1,2,3-cd)pyrene	nd - 9.5	nd	nd - 65.7	nd	nd
Benzo(g,h,i)perylene	10 - 34	nd	93.4	nd - 77.0	nd
Dibenzo(a,h)anthracene	nd	nd	nd	nd	nd

1 nd = not detected
2 Sum of measured PCB congeners
3 Benz(a)anthracene and Chrysene

MBDSPOLY.XLS

4/5/96

Table 13. MBDS Reference Stations

STATION	LATITUDE [1]	LONGITUDE [1]	LOCATION	DEPTH (M)	DATES SAMPLED
MUD-REF (18-17)	42 24.7	70 32.8	1.2 nmi SE from MBA buoy	80	1985 - 1992
FG-23	42 22.8	70 34.4	2.5 nmi S from MBA buoy	85	1987 - 1992
SE	42 20.0	70 28.0	6.8 nmi SE from MBA buoy	90	1987 - 1992
REF-A	42 22.7	70 30.3	3.9 nmi SE from MBA buoy	90	1988 - 1994
1994 REF	42 21.6	~~70 30.3~~ 70° 25.1	7.6 nmi SE from MBA buoy	90	1994

1 Decimal degrees

11/5/96

MBDS_REF.XLS

XI. APPENDIX A -- LIBRARIES WHICH RECEIVE DAMOS TECHNICAL REPORTS

BOSTON UNIVERSITY LIBRARY
CAMBRIDGE MA 02138

GEORGE PERKINS MARSH INSTITUTE LIBRARY
CLARK UNIVERSITY
WORCESTER MA 01610-1477

HARVARD UNIVERSITY LIBRARY
CAMBRIDGE MA 02138

HEALEY LIBRARY-STANDING ORDERS
UNIVERSITY OF MASSACHUSETTS
BOSTON HARVARD CAMPUS
BOSTON MA 02125-3393

MASSACHUSETTS INSTITUTE OF TECHNOLOGY
CAMBRIDGE MA 02139

NORTHEASTERN UNIVERSITY LIBRARY
MARINE SCIENCE AND MARITIME
STUDIES CENTER
NAHANT MA 01908

SOUTHESTERN MASSACHUSETTS UNIVERSITY LIBRARY
NORTH DARTMOUTH MA 02747

Table 2. Massachusetts Bay Disposal Site summary of past monitoring

Survey Date	Bathy-metry	Sediment Profile Imaging	Sediment Chemistry Metal	Sediment Chemistry PAH	Sediment Chemistry PCB	Sediment Chemistry Pest	O&G	TOC	Water Column Chemistry Metal	Water Column Chemistry PAH	Water Column Chemistry PCB	Water Column Chemistry Pest	DO	CTD	Tissue Chemistry Metal	Tissue Chemistry PAH	Tissue Chemistry PCB	Tissue Chemistry Pest	Benthic Comm. Analyses	Major Findings
1974	Y	N	8	N	Y	N	Y	N	Y	N	N	N	Y	Y	N	N	N	N	Y	N. E. Aquarium benthic surveys included 6 stations in the IWS. Gilbert, 1975.
1975-76	N	N	N	N	N	N	N	?	Y	N	N	N	N	N	Y	N	N	N	Y	Additional surveys by the Aquarium. Stations around the perimeter of the IWS had the lowest mean number of species (44) and individuals (15,000/m2).
1978	Y	N	9	N	N	N	Y	?	N	N	N	N	N	N	D	N	N	N	Y	All metals relatively low. Cu and Pb decreased significantly from baseline in deployed mussels. 16 predominant species and 179 total benthic individuals in 3 samples, but no reference site to compare to. DAMOS Annual Report-1978, Supplement D.
1982-83	Y	N	6	N	N	N	Y	N	N	N	N	N	N	N	N	N	N	N	N	Comparative study of hopper versus scow disposal: bathymetry accuracy unable to detect a mound assumed to be 25 cm thick. Poor positional control of scow barges, better point-dumping control with the hopper dredge (at least for this project). Elevated levels of As, Hg, Pb and Zn. D#41 (Draft only), summarized in In DAMOS summary report #46.
Jul 84	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	Submersible & ROV surveys: visual indications of mound limits correlated with bathymetry. Notable near bottom (10m) turbidity layer present. No sign. difference in distribution of benthic fin-fish on or off the mound. Dense, patchy distribution of mysid and clusters of pandalid shrimp did not indicate avoidance of DM. D#46??
Oct 84 - Apr 86	Y	246	Y	Y	T	N	Y	Y	9	Y	Y	N	Y	Y	F	F	F	F	Y	Site evaluation studies; included REMOTS, BRAT survey, fish trawls, side scan sonar, current meters, etc. Cr, Cu, Pb & Zn (but not As) and PCBs significantly higher on site compared to ref. Tissue PCB conc. slightly elevated in organisms on dredged material compared to reference. Commercially important bottom-feeding fish inhabit the site; American plaice, cod and witch flounder were caught in greatest numbers. First REMOTS survey of interim MBDS. Dredged material depth detected 11 to 19 cm. Most DM observed to east and south of "A" buoy. Active recolonization hypothesized. Stage 1 on Stage 3 observed. Hubbard et al., 1988.
Feb 87	Y	73	8	N	T	1	Y	Y	N	N	N	N	N	N	N	N	N	N	N	Area surveyed was the active disposal area: two camera stations were azoic, but all others given a Stage 1 on Stage 3 status. Low RPDs and OSIs compared to reference. 1987 OSIs lower than in 1986. No detectable mounds, but increase in spatial extent of DM in the N-S direction detected from REMOTS (radius estimated to be 500-600 m). Depth of fresh DM estimated as 20 to 30 cm. Spatial coverage of fresh DM estimated as 792,400 sq.meters. Moderate levels of As, low levels of Hg, but Hg high compared to previous site monitoring. No obvious chemical signature of dredged material detected. D#64.

11/5/96

Table 2. Massachusetts Bay Disposal Site summary of past monitoring

Survey Date	Bathy-metry	Sediment Profile Imaging	Sediment Chemistry Metal	PAH	PCB	Pest	O&G	TOC	Water Column Chemistry Metal	PAH	PCB	Pest	DO	CTD	Tissue Chemistry Metal	PAH	PCB	Pest	Benthic Comm. Analyses	Major Findings
Oct 87	N	N	8	Y	T	N	Y	Y	N	N	N	N	N	N	F	F	F	N	N	Sediment parameters all relatively low, except for moderate As levels both on- and off-site. The station with fresh DM had the highest means of PHC, PCB, PAH, Pb, Zn, and Cu, but the lowest means of TOC, As, Ni and %fines. Only Zn at one station was sign. greater in top 2 cm than in bottom 2-10 cm. Maximum PAH levels in both sediments & Nephtys were at the station with fresh DM, but a strong statistical difference between on-site and off-site tissue levels was not found. D#75.
Nov 88 - Jan 89	Y	117	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	Both old (A) and new (FDA) buoy areas surveyed. At FDA, only 3 stations (100N, CTR, 100S) did not have Stage III taxa; at A, all stations had some Stage III. Compared to reference, OSIs and RPDs were significantly lower at FDA, but not at A. Radius of fresh DM at FDA estimated at 300-350m, with 0.3 m depth of fresh DM detected acoustically since 1/87 survey, but still within DS boundaries. Extent of buoy "A" deposits not mapped, but benthic recovery high, stage 3 communities at all sites near buoy. RPD depths similar to reference areas. D#73.
Dec 88	N	N	9	T	T	N	N	Y	N	N	N	N	N	N	N	N	N	N	N	Sediment chemistry measured at two stations, REF-A and REF-C, in Stellwagen Basin. In general, values were very low, below other MBDS reference levels. PAHs and PCBs were below detection limits. Draft Report from M&E to EPA, 1989.
Jun 89	N	N	7	Y	Y	Y	N	Y	N	N	N	N	N	N	N	N	N	N	N	26 random stations analyzed from the western half of MBDS. Station 12-3 had the highest means of Cr, Cu, Hg and Zn and highest PAHs (8 ppm). Pb (29-155 ppm) was the highest metal relative to regional data. Mean metal values calculated using all site stations were within historic reference site ranges (and national mean from NS&T program), except fo copper. Decrease in PCBs with time noted (only 20 ppb at one station detected). Pesticides detected both on site and at reference. Spatially centered maxima of Cu and PAHs near "A" buoy. Good summary of overall conditions and synthesis with historical sediment chemistry studies. D#91. (~~Murray, 1989~~). Murray 1994 SAIC
Aug 90	Y	80	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	At MDA buoy, a mound 0.8 m high and app. 420 m in diameter was detected with bathymetry. REMOTS detected new DM 400-600 m from center. 260,000 c.m. disposed since 11/88 survey. All stations but 100E supported Stage III benthos. Dominant sere on site and at ref was Stage I on Stage III. Surface roughness sign. greater and RPDs sign. lower on DM compared to ref. OSI values on site generally higher than in Nov. 88, but sign. lower than at ref. Formation of mound said to support use of capping at site. D#92.
Jun-Jul 91	N	N	Y	Y	Y	Y	N	N	N	N	N	N	N	N	Y	Y	Y	Y	N	EPA-Narragansett study of sediment and tissue chemistry. Indication that MBDS does not have a major impact on tissue chemistry. Sediment levels generally low from the two stations tested. Trend noticed of decreasing tissue concentrations with distance from shore, with MBDS falling between Quincy Bay and Georges Bank. Gardner and Pruell, 1991.

need to include May 1990 EPA ... survey

Table 2. Massachusetts Bay Disposal Site summary of past monitoring

Survey Date	Bathy-metry	Sediment Profile Imaging	Sediment Chemistry				O&G	TOC	Water Column Chemistry				DO	CTD	Tissue Chemistry				Benthic Comm. Analyses	Major Findings
			Metal	PAH	PCB	Pest			Metal	PAH	PCB	Pest			Metal	PAH	PCB	Pest		
Mar-Apr 9	Y	Y	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	Survey of MDA buoy after 1991 storms. 2 distinct mounds formed. Fresh disposal of Boston Blue Clay from CA/THT observed within 200-400 meters of disposal buoy. Relic dredge material observed to 600 m especially to the west. Mound height 2 meters. Stage 1 only found on fresh dredged material (although fresh deposits were devoid of fauna). Stage 3 infauna found away from buoy and throughout area. No evidence of dredged material at any of the three reference areas. Wiley and Charles, 1995. D#100
May 92	N	N	N	N	N	N	N	N	Y	Y	Y	Y	N	N	N	N	N	N	N	EPA cruise for whole water (dissolved and particulate) column toxics. At three water depths at MBDS and in the Gulf of Maine. Very low concentrations of trace metals, PAHs, PCBs and pesticides. Battelle, 1992.
Sep 93	Y	N	8	Y	T	Y	N	Y	N	N	N	N	N	N	N	N	N	N	N	Baseline survey of the relocated disposal site. Side scan sonar and SACS studies observed geological features (knolls) and waste barrels, especially in the north, near the old IWS. General area is featureless, sloping to northeast, fine grain silts and clays. MDA buoy is now located in the northeast of the site. Resampling high PAH area, but detection limits still too high. Mound at MDA buoy now 7 meters high. Draft report, DeAngelo and Murray, 1996.
Aug-94	N	76	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	N	Follow up of Sep 93 survey to map areal limits of historical dredged material and benthic recolonization around station 12-3. Includes plan view photos of bottom. MDA buoy shows good recolonization, especially Stage 2 amphipods. Apparent RPD at buoy 1 to 4 cm. Usually Stage 1 on Stage 3. Draft report Murray, 1996.
Sep 94	N	N	8	Y	Y	Y	N	Y	N	N	N	N	Y	Y	L	L	L	L	N	EPA sampling of high PAH area near station 12-3 and IWS for sediment chemistry, toxicity and bioaccumulation. Data presented here in the site management plan. (M&E, 1995)

Legend: #=number of REMOTS stations, or analytes, D#=DAMOS number, DM=dredged material, D=animal deployed in field, F=animal collected in field, L=animal exposed in lab,
N=no, PHC=petroleum hydrocarbons, T=total, Y=yes, BRAT=benthic resource assessment technique

APPENDIX B:

Massachusetts Bay Disposal Site Management and Monitoring Plan.

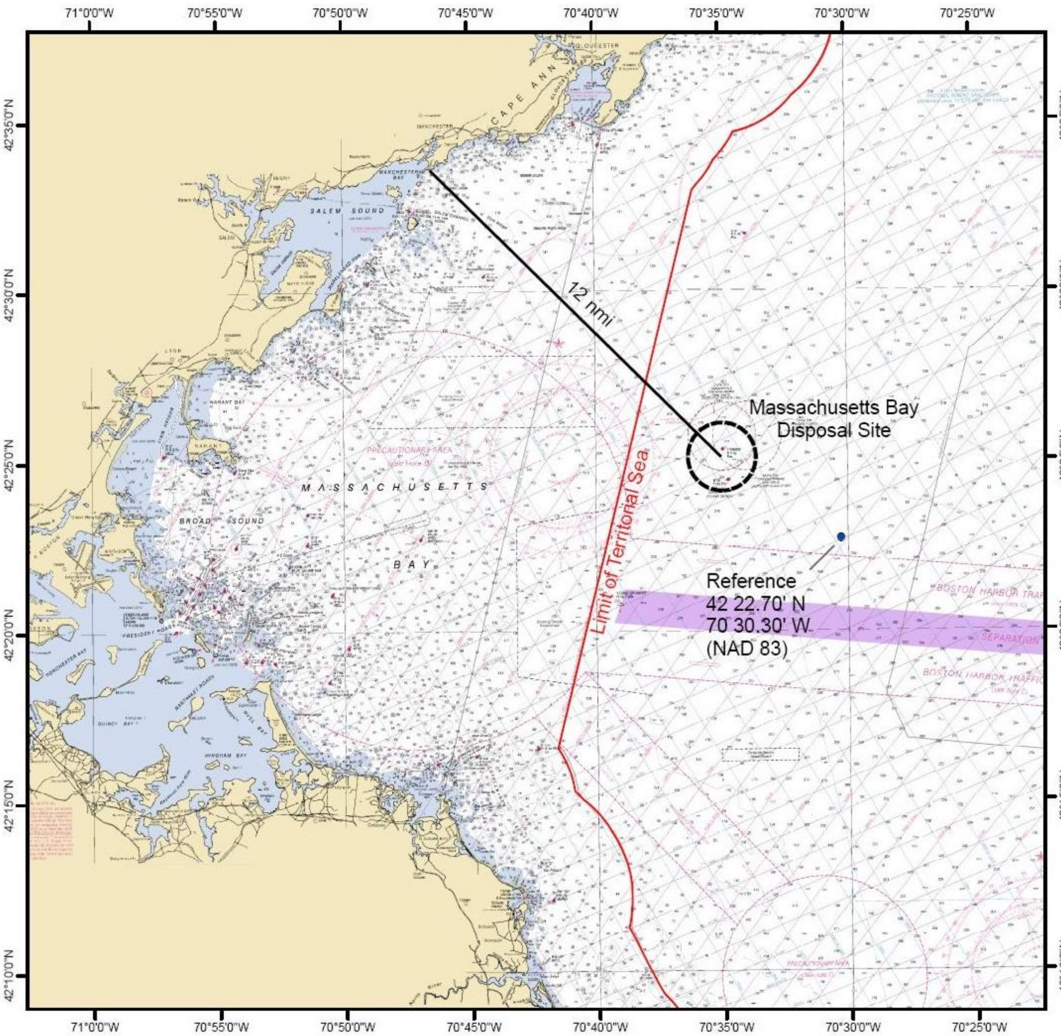
November 2, 2009.

U.S. Environmental Protection Agency, Region 1.

MASSACHUSETTS BAY DISPOSAL SITE

SITE MANAGEMENT AND MONITORING PLAN

FINAL NOVEMBER 2 2009



United States Environmental Protection Agency New England

US ARMY CORPS OF ENGINEERS
New England District

TABLE OF CONTENTS

ACRONYMS AND KEYWORDS

AIS	Automatic Identification System
ANOVA	Analysis of Variance
CAD	Confined Aquatic Disposal
CFR	Code of Federal Regulations
CPUE	Catch per Unit Effort
CWA	Clean Water Act (Federal Water Pollution Control Act)
CY	cubic yards
CZM	Coastal Zone Management
DAMOS	Disposal Area Monitoring System
DDT	1, 1, 1-trichloro-2, 2-bis (p-chlorophenyl)ethane
DEIS	Draft Environmental Impact Statement
DMMP	Dredged Material Management Plan
DMSMART	Dredged Material Spatial Management Record Tool
DO	dissolved oxygen
EIS	Environmental Impact Statement
EFH	Essential Fish Habitat
EPA	U.S. Environmental Protection Agency
EPA NE	U.S. Environmental Protection Agency New England
EPA Region 1	U.S. Environmental Protection Agency Region 1
ESA	Endangered Species Act
IWS	Industrial Waste Site
LNG	Liquefied Natural Gas
MA DEP	Massachusetts Department of Environmental Protection
MA DMF	Massachusetts Division of Marine Fisheries
MA CZM	Massachusetts Coastal Zone Management Office
MBDS	Massachusetts Bay Disposal Site
MCY	million cubic yards
mg/L	milligrams per liter
mg/kg	milligrams per kilogram
MPRSA	Marine Protection, Research, and Sanctuaries Act of 1972
MSA	Magnuson-Stevens Fishery Conservation and Management Act
NAD83	North American Datum 1983
NAE	US Army Corps of Engineers New England District
nm	Nautical Mile
NMFS	National Marine Fisheries Service (aka NOAA Fisheries Service)

NE RDT	New England Regional Dredging Team (Sudbury Group)
NEG	Northeast Gateway
NOAA	National Oceanic and Atmospheric Administration
NRC	National Research Council
OSI	Organism Sediment Index
PAH	Polycyclic Aromatic Hydrocarbons
PCB	Polychlorinated Biphenyls
ppb	parts per billion (= ug/g)
ppt	parts per thousand
pptr	parts per trillion
psu	Practical Salinity Unit
RDT	Regional Dredging Team
QA	Quality Assurance
RHA	Rivers and Harbors Act
RIM	Regional Implementation Manual
RPD	Redox Potential Discontinuity
SAIC	Science Applications International Corporation
SBNMS	Stellwagen Bank National Marine Sanctuary
SMMP	Site Management and Monitoring Plan
SPI	Sediment profile imaging
TBP	Theoretical Bioaccumulation Potential
TOC	Total Organic Carbon
TOY	Time of Year
TSS	Total Suspended Solids
USACE	U.S. Army Corps of Engineers
USACE-NAE	U.S. Army Corps of Engineers New England District
USCG	U.S. Coast Guard
USFWS	U.S. Fish and Wildlife Service (Department of the Interior)
WRDA	Water Resources Development Act
wt	weight

1. INTRODUCTION

1.1 PURPOSE

The U.S. Environmental Protection Agency Region 1 (aka EPA New England) designated the Massachusetts Bay Disposal Site (MBDS) in 1993 (EPA Region 1, 1992; EPA Region 1, 1993), to meet the long-term needs of dredged material disposal in the Massachusetts Bay area. To ensure that ocean dredged material disposal sites are managed to minimize adverse effects of disposal on the marine environment, the Marine Protection, Research, and Sanctuaries Act (MPRSA) §102(c) as amended by §506(a) of the Water Resources Development Act (WRDA) of 1992 requires the completion of Site Management and Monitoring Plans (SMMPs).

This plan updates the SMMP completed in 1996 by EPA Region 1 (US EPA Region 1, 1996) in partnership with the U.S. Army Corps of Engineers New England District (USACE-NAE, or NAE). As part of this update, this document evaluates the site monitoring results and disposal activities from the previous twelve years, and outlines a management plan and monitoring program that complies with the requirements of the MPRSA. The SMMP serves as a framework to guide the development of future project-specific sampling and survey plans created under the monitoring program. The data gathered from the monitoring program will be routinely evaluated by EPA, NAE, and other agencies such as the National Marine Fisheries Service (NMFS) and state regulatory agencies (see sections 8 and 10) to determine whether modifications in site usage, management, testing protocols, or additional monitoring are warranted.

Only dredged material from Federal and private projects that satisfy the requirements of the MPRSA may be disposed of at the site. Each project must receive a permit issued by NAE under Section 103 of the MPRSA [33 USC 1413] with concurrence by EPA New England. In accordance with MPRSA §103(a) disposal activities at the site "will not unreasonably degrade or endanger human health, welfare, or amenities, or the marine environment, ecological systems, or economic potentialities."

1.2 OBJECTIVES

As discussed in the Ocean Dumping Regulations at 40 CFR §228.3 and the guidance for development of site management plans issued by EPA and USACE[1], management of the site involves regulating the times, quantity, and physical/chemical characteristics of dredged material that is dumped at the site; establishing disposal controls, conditions and requirements; and monitoring the site environment to verify that unanticipated or significant adverse (or unacceptable) impacts are not occurring from past or continued use of the disposal site and that permit terms and conditions are met.

[1] EPA/USACE, 1996. Guidance Document for Development of Site Management Plans for Ocean Dredged Material Disposal Sites.

Thus, this SMMP has two overarching objectives:

- Management of disposal activities to ensure compliance with the MPRSA; and
- Monitoring of the disposal site to determine whether significant adverse (or unacceptable) impacts have occurred or are occurring.

If monitoring of the site detects significant adverse (unacceptable) impacts, changes in dredged material and/or disposal site management will be considered by NAE and EPA New England.

1.3 ORGANIZATION OF THE SMMP

The organization of this plan includes the six requirements for ocean disposal site management plans discussed in §102(c)(3) of the MPRSA, as amended. These are:

1) a baseline assessment of conditions at the site (Section 4);

2) consideration of the quantity of the material to be disposed of at the site, and the presence, nature and bioavailability of the contaminants in the material (sections 3 and 6);

3) special management conditions or practices to be implemented at each site that are necessary for protection of the environment (Section 7);

4) a program for monitoring the site (sections 5 and 8);

5) consideration of the anticipated use of the site over the long term, including the anticipated closure date for the site, if applicable, and any need for management of the site after closure (Section 6); and

6) a schedule for review and revision of the plan (which shall not be reviewed and revised less frequently than 10 years after adoption of the plan, and every 10 years thereafter) (Section 9).

1.4 STATE-WIDE DREDGED MATERIAL AND OCEAN PLANNING

The Commonwealth of Massachusetts recognizes the importance of water-dependent activities such as commercial fisheries, shipping, and energy infrastructure at developed port and harbor areas. Recreational industries (e.g. marinas) also rely on the utility of such areas. To ensure continued use, economic viability and safety of the region's navigational channels and navigation-dependent facilities, periodic dredging must be performed to remove accumulated sediment, or deepen existing channels to accommodate the next generation of deeper draft vessels. New England's largest port, Boston Harbor, is the hub for shipping in New England; over 15 million tons of containerized cargo was handled at the Port of Boston in both 2006 and 2007 (MassPort, 2008). Because of recent dredging in Boston Harbor, the MBDS has been the most active disposal site in New England averaging over 600,000 cubic yards per year in the last 15 years (Table 1).

Boston is not the only harbor area that is expected to utilize the MBDS. With funding from the Seaport Bond bill and in coordination with the USACE-NAE, the Massachusetts Coastal Zone Management office (MA CZM) recently developed dredged material management plans (DMMPs) for two important ports – Gloucester and New Bedford. These DMMPs focused on identifying upland or in-harbor disposal sites for dredged material deemed unsuitable for disposal at an ocean disposal site. In the Gloucester DMMP for example, the total volume of sediment to be dredged from Gloucester Harbor over the next 20 years was estimated at 514,440 CY. MA CZM estimated that about half of these sediments would be considered suitable for disposal at the MBDS (MA CZM, 2000). Because of the need to communicate technical issues regarding dredging projects among many state agencies, in 2005 the Commonwealth established the Massachusetts Dredging Team to coordinate dredging activities within the Commonwealth, and with the New England Regional Dredging Team (see below).

Further recognizing the need for coordinated and appropriate management of ocean resources, the Commonwealth established an Ocean Management Task Force in 2004 to develop recommendations for a comprehensive approach to managing ocean resources. The recommendations released in 2004 formed the foundation for the Oceans Act of 2008, which requires the Commonwealth to develop a stakeholder-driven ecosystem-based Ocean Management Plan that addresses the siting of energy infrastructure, identification of marine protected areas, and other conflicting uses of the coastal ocean. Although the jurisdiction of the Ocean Management Plan is in state waters only, it is possible that the implementation of this plan may have influence on dredged material disposal at the Massachusetts Bay Disposal Site, which is in Federal waters.

1.5 REVIEW AND CONSULTATION WITH OTHER FEDERAL AGENCIES

The New England Regional Dredging Team (NE RDT) is one of eleven national Regional Dredging Teams (RDTs) established to improve dredged material management by fostering communication and planning, and providing a forum for issue resolution, technical transfer, and community involvement. The Massachusetts Dredging Team coordinates directly with the NE RDT. We have requested that the Massachusetts Dredging Team review this plan.

In addition, we have submitted this plan to MA CZM for advice on whether the plan needs Consistency review. The Federal Coastal Zone Management Act of 1972 and 1976 amendments enabled states to develop comprehensive management plans for their coastal regions (subject to Federal approval). For all projects located in Massachusetts' coastal zone that involve Federal action such as funding, permitting, or licensing, a Massachusetts Coastal Zone Management Consistency Review is required to ensure that actions proposed within the coastal zone are consistent with state coastal policies.

The 1996 amendments to the Magnuson-Stevens Fishery Conservation and Management Act (MSA) requires the identification of Essential Fish Habitat (EFH) for federally managed fishery species and the implementation of measures to conserve and enhance this habitat. The MSA requires Federal agencies to consult with the NMFS on federal actions that may adversely affect EFH. We have submitted this plan to NMFS to determine whether this plan needs EFH consultation.

EPA has also requested that NMFS review this plan to determine whether an Endangered Species Act Section 7 consultation is necessary. NMFS routinely conducts ESA and ESF consultation on a project-by-project basis, not for management plans.

In addition, because the actions recommended in this plan are in the vicinity of the Stellwagen Bank National Sanctuary, this plan must comply with Section 304(e) of the MPRSA as amended, requiring consultation with the Stellwagen Bank National Marine Sanctuary office. This plan has been submitted to the SBNMS for review.

2. ROLES, RESPONSIBILITIES AND AUTHORITIES

The primary Federal environmental statute governing transportation of dredged material for the purpose of dumping it into ocean waters (seaward of the baseline of the territorial sea) is the Marine Protection, Research, and Sanctuaries Act (MPRSA, also called the Ocean Dumping Act, 33 USC 1401 et seq.). The MPRSA assigns authority to both EPA and USACE in managing disposal sites and issuing permits for ocean disposal.

2.1 FEDERAL REGULATORY/STATUTORY RESPONSIBILITIES

Under Section 103 (33 USC 1413) of the MPRSA, USACE is responsible for issuing permits for disposal of dredged material, subject to EPA review and concurrence. The EPA, however, is charged with developing ocean dumping criteria to be used in evaluating permit applications [MPRSA §102(a)]. Disposal must not "unreasonably degrade or endanger human health, welfare, or amenities, or the marine environment, ecological systems, or economic potentialities". The ocean dumping regulations in 40 CFR Parts 227 and 228 provide a testing framework to apply these criteria and determine whether dredged material is environmentally acceptable (or suitable) for open ocean disposal. USACE is required to use EPA designated open-water disposal sites for dredged material disposal to the maximum extent feasible[2]. Proposed ocean disposal of dredged material also must comply with USACE permitting and dredging regulations in 33 CFR Parts 320 to 330 and 335 to 338.

Other primary authorities that apply to the disposal of dredged material in the United States are the Rivers and Harbors Act of 1899 (RHA), and the Water Resources Development Act (WRDA) of 1992 (and subsequent legislation). The RHA regulates dredging and discharge of material in navigable waters and WRDA addresses research and funding in support of specific water resource projects for various needs (i.e., transportation, recreation). WRDA also modifies other Acts, as necessary (e.g., MPRSA).

[2] If a designated disposal site is not feasible, the USACE can "select" an alternative ocean disposal site under Section 103 of the MPRSA for two successive five year periods.

2.2 SURVEILLANCE AND ENFORCEMENT

All dredging, dredged material transport, and disposal must be conducted in compliance with USACE permits issued for these activities. Under the MPRSA§105 (33 USC 1415), the EPA takes the lead in surveillance and enforcement responsibilities at the disposal site with assistance from the USACE and the U.S. Coast Guard (see 33 USC Sec 1417[c]). The permittee is responsible for ensuring compliance with all project conditions including placement of material at the correct location and within applicable site use restrictions. An example of permit conditions is included in Section 7.2.

Disposal locations are marked with a taut-wire buoy or specified coordinates to ensure that disposal locations are known and that post-disposal monitoring is effective. The USACE-NAE Disposal Area Monitoring System (DAMOS) Manager determines the specific location for disposal of dredged material at the site (see Section 7.3).

2.2.1 SILENT INSPECTOR

Certified and trained on-board inspectors have traditionally been used by the USACE-NAE for all disposal activities at ocean disposal sites. Beginning in 2009, however, an automated inspector system will replace human inspectors. This system, called Silent Inspector, is run by the USACE from the Mobile Alabama District office. SI is an automated disposal vessel monitoring system comprised of both hardware and software developed by the USACE. It consists of 1) government-furnished software developed through the U.S. Army Engineer Research and Development Center (ERDC), 2) on-dredge hardware owned or leased and operated by dredging contractors, 3) a centralized SI database, and 4) desktop SI software developed by ERDC. In 2008 SI was required on USACE Civil Works dredging projects using hopper dredges and scows for disposal operations. Beginning January 1, 2009, Silent Inspector was required for all dredging permits.

As deployed in New England, Silent Inspector will automatically monitor dredging parameters such as the location and tracking of the position of a scow as it heads to the disposal site, and the location at which dredged material is discharged – in real-time on a 24 hours/7 days a week basis in a standard format. This information is recorded onto an on-board computer where it is then available for download and review by the USACE for automatic transmittal to the appropriate USACE District office during permitted dredging and disposal operations. Desktop computer tools are available to examine the data and monitor compliance with the terms and conditions of USACE permits.

In addition, some of the larger dredging vessels will be equipped with the AIS (Automatic Identification System), which allow shipboard radar or electronic navigation charts to display identification and course of vessels in real time. Some shore-based facilities, such as the Stellwagen Bank National Marine Sanctuary Office in Scituate, MA can monitor AIS equipped vessels.

Because of the proximity of the MBDS to Stellwagen Bank, however, marine mammal observers will still be required on all disposal activities between February 1 and May 30 (See permit conditions in Section 7.2).

2.2.2 MONITORING

The USACE and EPA share responsibility for monitoring of the site and will use the SMMP to guide the monitoring at the site. Monitoring data from other agencies will be utilized as appropriate to maximize the availability of information at the site. Under MPRSA, EPA has the responsibility for determining if an unacceptable impact has occurred as a result of dredged material disposal at the site and for determining any modification to site use or de-designation. Such determinations, however, will be made in consultation with other agencies. The USACE and EPA share responsibility for developing any necessary mitigation plan.

Monitoring surveys at and near the site will be conducted periodically as available funding permits. The monitoring objective for each survey will be based on the SMMP, prior monitoring results and, if appropriate, recommendations of the New England Regional Dredging Team or Massachusetts Dredging Team.

3. BACKGROUND

3.1 LOCATION

The MBDS is a circular area 2 nautical miles (nm) in diameter and centered at 42° 25.1'N and 70° 35.0'W (all coordinates are in NAD83). It is located approximately 10 nm south-southeast of Eastern Point in Gloucester (MA), 12 nm southeast from Gales Point (Manchester, MA) and 18 nm from the entrance to Boston Harbor (Figure 1). It is located in 90 to 100 meters of water in a deep basin called Stellwagen Basin, directly west of Stellwagen Bank, an underwater glacial moraine that rises to 50 meters of the surface within 3 nm of the disposal site. Because of its importance to fish and marine mammal habitat, Stellwagen Bank was designated a National Marine Sanctuary in 1992. The reference area for the disposal site is located at 42° 22.70'N and 70° 30.30'W, about 4 nm southeast in a relatively undisturbed area of Stellwagen Basin. This reference area was selected in 1993 when the disposal site was designated because sediments were determined to reflect similar grain size to the disposal site and sediment chemistry reflected unimpacted conditions (EPA Region 1, 1996). Sediments from the reference area are used to evaluate dredged material for disposal at the disposal site and as a point of comparison to identify potential effects of contaminants in the dredged material.

3.2 BRIEF HISTORY OF DISPOSAL AT THIS SITE

The MBDS overlaps with two other historical disposal sites: the Industrial Waste Site, or IWS, which was employed from the 1940s until 1977 and the interim MBDS, which was used from

1977 to 1992 (Figure 2). The IWS is a 2 nautical mile (nm) diameter circle centered at 42° 25.7'N, 70° 35.0'W and the interim MBDS is a two nm diameter center circle centered about 0.75 nm east, at 42° 25.7'N, 70° 34.0'W.

In 1977, the EPA's ocean dumping regulations (40 CFR §228.12) established the interim dredged material disposal site (interim MBDS). In 1993, the EPA officially designated the MBDS, reconfiguring the boundaries to overlap with both the IWS and the interim MBDS, avoiding part of the IWS with a high concentration of industrial waste barrels (see below) and the newly designated Stellwagen Bank National Marine Sanctuary, or SBNMS (EPA Region 1, 1992 and 1993). In the Final Record of Decision, EPA specified that this location was the best alternative because of its historical use, its avoidance of the SBNMS, and it is in an area of sediment accumulation, so disposal mounds are not expected to suffer erosion. Since 1977, only dredged material has been disposed at the interim MBDS and the MBDS.

The history of disposal at the IWS and the interim MBDS is outlined in more detail in Site Evaluation studies (Hubbard *et al.*, 1988), the Draft EIS for Designation of the Site (EPA, 1989), baseline monitoring surveys (SAIC, 1994a and b), studies of the IWS (Wiley *et al.*, 1992; NOAA, 1996), and the 1996 SMMP (EPA Region 1, 1996). Briefly, the IWS was routinely called the "Foul Area", because the material on the bottom "fouls" or damages commercial fishing nets. From the 1940s to 1977 dredged material, construction debris, barreled industrial and medical waste, encapsulated low-level radioactive waste, munitions, and intentionally sunken derelict vessels were dumped in the general area of the IWS. Most of the wastes appear to be in 55, 30 or 5 gallon drums, currently located in the northwest quadrant of the IWS (in an area around the coordinates 42° 26.4'N, 70° 35.4'W), or dispersed around the northern perimeter up to 0.5 nm outside the IWS (Wiley *et al.*, 1992). Few drums are found away from the IWS[3]. Dumping of industrial waste was terminated in 1976 and the IWS was formally de-designated on February 2, 1990.

Because of this area's past use as a dumping ground, NMFS closed the IWS to harvesting surf clam and ocean quahogs in 1980. In 1992, the Food and Drug Administration (FDA) and NMFS reissued this advisory, recommending a note be put on nautical charts, and advising all commercial and recreational fishermen to avoid harvesting bottom dwelling species from the area, including the MBDS (NOAA, 1996). There is, however, some evidence of trawling activity within the site (Valentine *et al.*, 1996).

3.3 BUOY LOCATIONS

Disposal of dredged material prior to 1977 was generally at the northern edge of the IWS and corresponding to the general area of most of the waste drums identified on the bottom. From 1975 to 1985 disposal was centered in the middle of the IWS, now the northern part of the MBDS. During this period, disposal buoys were moored typically with a long scope which contributed to disposal of dredged material over a wide area. This old disposal mound, formed at

[3] Several studies using side scan sonar and sediment profile imaging (e.g. Keith et al., 1992; SAIC, 1994c) have been conducted to determine whether containers were disposed more inshore of the IWS, but none of these surveys have documented presence of containers.

the location of the old “BFG” buoy from 1975 to 1985 (see the 1996 SMMP for locations and names of former buoys) is slightly visible in Figure 2.

In November 1985, a taut-wired disposal buoy called MDA, maintained by NAE, was deployed near 42° 25.1'N, 70° 34.45'W in the southwestern quadrant of the interim MBDS (Hubbard *et al.*, 1988). Although the new MBDS was reconfigured in 1993, the buoy was not moved at that time. This buoy and all subsequent taut wire buoys have provided greater precision in disposal, and defined mounds on the bottom have resulted.

Mound A was formed from dredged material disposal through 1994 at the MDA buoy and is clearly seen (Figure 3) in an acoustic survey of the sea floor in 1996. This figure is based on composite images in which backscatter and sun-illuminated images have been combined to show the composition of the sea bed and the topographic relief. Sun-illumination is from the north. Blue represents low backscatter mud of Stellwagen Basin, and orange represents high backscatter gravelly sand and cobbles and boulders of Stellwagen Bank. Green represents moderate backscatter deposits of dredged material and similarly reflective materials on many of the higher geologic pinnacles. The green mound in the middle of the image is located at the disposal point being used during that time period. Red represents very high backscatter deposits of rock debris from the excavation of the Ted Williams Tunnel beneath Boston Harbor.

In addition to a sediment dredged material disposal buoy, a Rock Reef Site (called the Rock Disposal Location in the 1996 SMMP) was established in 1991 specifically for disposal of rocks generated from downtown Boston's "Central Artery/Third Harbor Tunnel" and two other smaller projects. The purpose of this disposal was to provide habitat diversity over a homogeneous silty sand substrate at the western edge of Stellwagen Bank (SAIC, 2004). This location (which was marked only by coordinates, and not by a buoy) was in the northeast quadrant of the interim MBDS (about 500 meters outside of the new MBDS), on the slope of Stellwagen Bank at the coordinates 42° 26.5'N, 70° 34.0'W at 50 m depth (Figures 2 and 3). This location is now outside the current boundary of the MBDS and will not be used for future disposal.

Since 1994 the buoy, renamed as the MBDA buoy, has been moved to create a ring of defined disposal mounds surrounding a shallow depression in the northeast quadrant of the site. The purpose of this strategy is to construct a boundary of a “containment cell” that would potentially limit the lateral spread of future dredged material (ENSR, 2005). Six mounds have been created, Mounds A to F and CHCP (Cohasset Harbor Capping Project), revealed in Figures 4 and 5 based on bathymetry collected in 2004.

3.4 ESTIMATED QUANTITY OF DREDGED MATERIAL DISPOSED IN LAST 15 YEARS

Because of the recent navigation improvement dredging in Boston Harbor, MBDS has been the most active disposal site in New England. From 1994 to 2008, over 700,000 cubic yards have been disposed at the MBDS on an annual basis (over 10.5 million cubic yards in total; Table 1). In addition to Boston Harbor, the dredged material has come from a number of harbors, rivers and channels from Cape Ann to Plymouth, MA some of which are industrialized, such as Salem and Weymouth, MA. By far the most dredged material disposed at MBDS comes from Boston

Harbor and this trend is expected to continue. Below is a recent history of major dredging projects in Boston Harbor.

1992 to 1993: About 1.5 million cubic yards of sediment (primarily Boston Blue Clay) and blasted rocks from the Central Artery/Third Harbor Tunnel (now called the Ted Williams Tunnel) project were disposed at the MDA buoy and the Rock Reef Site.

1997 to 2001: Over 300,000 cubic yards of soft surface sediment material and bottom clays from Fort Point Channel in downtown Boston was dredged for the Central Artery/THT project. Unsuitable material was disposed at Spectacle Island, and the remaining clean material (mostly clays from parent material) was disposed at the MBDS (SAIC, 2002).

1997 to 2000: Over 2 million cubic yards of sediment and clean parent material ("Boston Blue Clay") from the inner harbor was dredged as part of the Boston Harbor Navigation Improvement Project (BHNIP) and disposed at the MBDS. Confined Aquatic Disposal (CAD) cells were constructed within the Mystic and Chelsea rivers and inner harbor to contain approximately one million cubic yards of unsuitable material contaminated with metals and organic compounds (ENSR, 2007).

1998 to 2000: The US Army Corps of Engineers New England District conducted a demonstration project to evaluate the feasibility of capping a discrete mound of sediment on the seafloor of the MBDS. Two distinct types of dredged material, one from Cohasset Harbor, and "capping material" from the Chelsea River, were dredged and sequentially disposed at a location within the MBDS in an area removed from the ongoing mounds in the center of the disposal site. The Cohasset Harbor Capping Project (CHCP) mound was centered at about 42° 24.45'N and 70° 34.73'W in the southern part of the MBDS and received about 74,250 cubic yards of sandy silt and clay material from Cohasset Harbor, and about 201,900 cubic yards of acceptable material, mostly clumps of Boston Blue Clay and sand and gravel, from the Chelsea River as part of the BHNIP. Results of several surveys using side scan sonar, bathymetry and sediment cores determined that the capped material appeared to sufficiently cover the "unsuitable" material (SAIC, 2003)[4].

2004 and 2005: Approximately 1.1 million cubic yards of maintenance material was removed from the Broad Sound North Channel, President Roads Channel and Anchorage and portions of the Main Ship Channel in the outer harbor (USACE/MassPort, 2006).

2008: Over 1,700,000 cubic yards of material were dredged in the inner harbor as part of the Boston Harbor Navigation Improvement Program. About 900,000 cubic yards were disposed at Mound F and about 800,000 cubic yards were disposed at the demonstration site in the western part of the MBDS (see section 6.1).

[4] Unsuitable material is prohibited from disposal at the MBDS. See section 6.3.

Table 1. Estimated volume and sources of dredged material for disposal mounds at MBDS since 1994. Sources: SAIC, 2002; SAIC, 2003; Tom Fredette, NAE, on October 7, 2008 (NAE, 2008) and October 19, 2009.

Mound formed	Disposal Years	Estimated Volume (cubic yards)	Dredged material locations	Type of dredging and sediment classification	Source of data
B	1994 to 1998	1,110,871	BHNIP, marine terminals and surrounding communities	Boston Blue Clay	SAIC, 2002
C	1998 to 1999	1,802,230	BHNIP, marine terminals and Central Artery/Third Harbor Tunnel (e.g. Fort Point Channel)	Boston Blue Clay	SAIC, 2002
Capping Demo Project (CHCP)	1998 to 2000	257,350	Cohasset Harbor Chelsea River parent material	Parent material	SAIC, 2003
D	1999	504,860	BHNIP, marine terminals and CA/THT	Boston Blue Clay	SAIC, 2002
E	1999	981,150	BHNIP, marine terminals and CA/THT	Boston Blue Clay	SAIC, 2002
F	2000	674,075	BHNIP Hull Harbor Winthrop Harbor Saugus River Hingham Bay	Excludes disposal at Cohasset Harbor Capping Demo site	NAE, 2008
F	2001	127,125	Hull Harbor Quincy Bay Chelsea River		NAE, 2008
F	2002	333,800	Scituate Harbor	Maintenance dredging	NAE, 2008
F	2003	35,050	Port Norfolk Yacht Club, Neponset River		NAE, 2008
F	2004	767,900	Boston Harbor	Maintenance dredging in outer harbor	NAE, 2008
F	2005	1,379,585	Boston Harbor	Maintenance dredging in outer harbor	NAE, 2008
F	2006	408,149	Salem Harbor Weymouth Fore River		NAE, 2008
F	2007	355,999	Weymouth Fore River Salem Harbor		NAE, 2008
F and demo site	2008	1,780,586	Boston Inner Harbor Danvers Harbor		NAE, 2008, 2009
Totals		10,518,730			

Figure 1. General Location of the Massachusetts Bay Disposal Site (MBDS), about 12 nm southeast of Gales Point (Manchester), MA. Reprinted with permission from USACE-NAE. The reference area is also displayed.

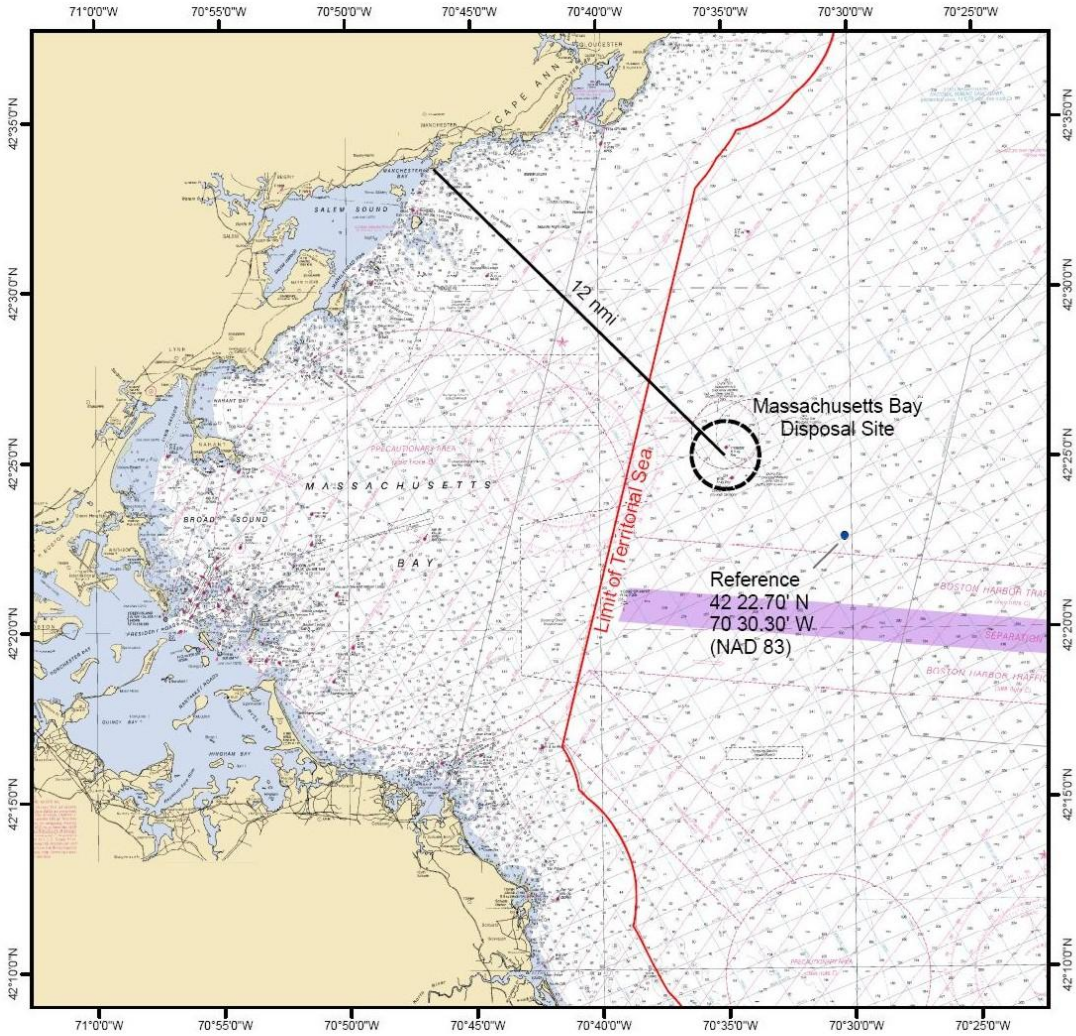


Figure 2. Location of Massachusetts Bay Disposal Site (Black circle) in relation to the Interim Massachusetts Bay Disposal Site (Blue circle) and Industrial Waste Site (Red circle). Base map source: Sun-illuminated backscatter topography of Massachusetts Bay Disposal Site, with Industrial Waste Site and interim MBDS identified, Butman and Lindsay, 1999.

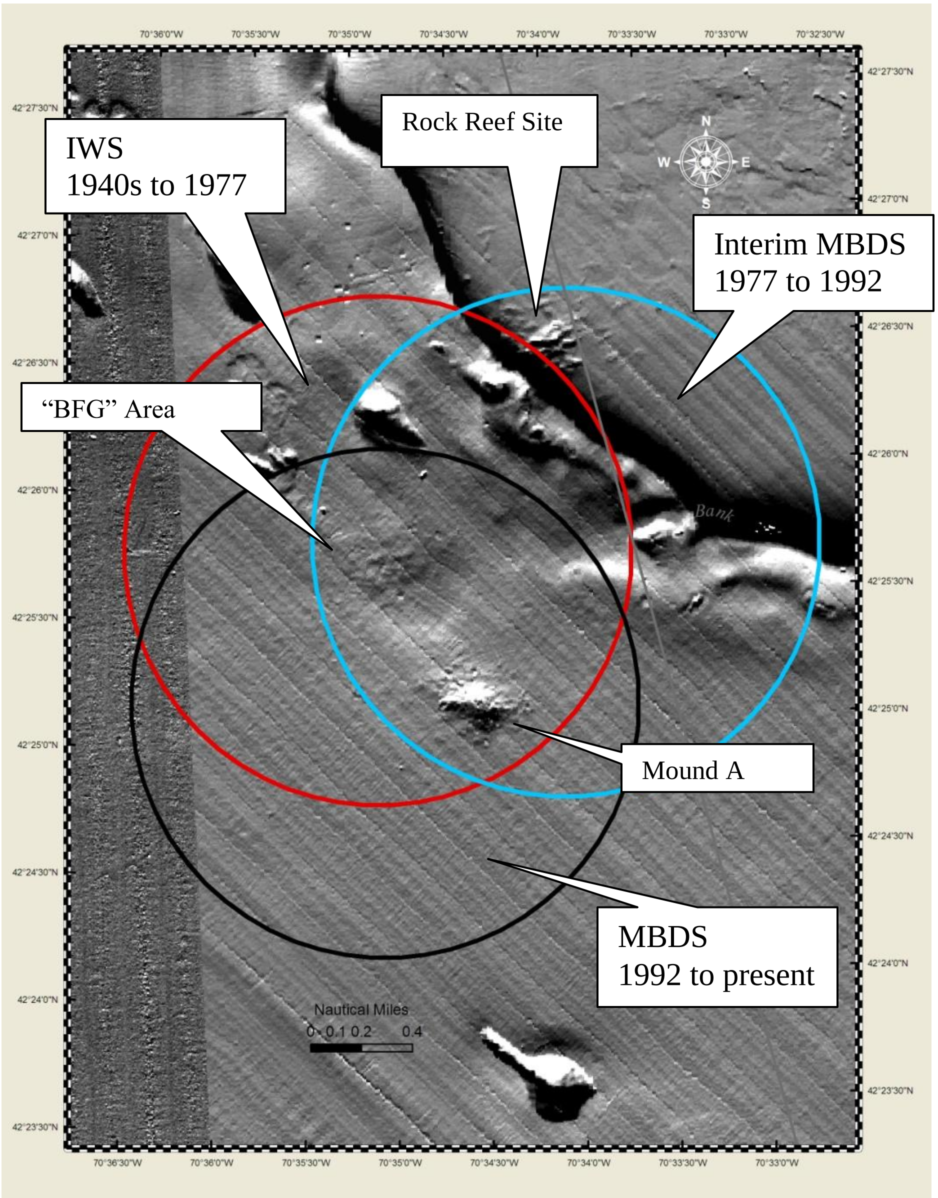


Figure 3. Backscatter image of Massachusetts Bay Disposal Site created from multibeam bathymetric data in 1996. Note that in this image, the "mound at the active disposal point" is Mound A formed from 1985 to 1996 and the "mound at the old disposal site" is the old "BFG" area. These mounds are also visible in some of the images generated by USGS (see Figure 2). This is the location for disposal from 1975 to 1985. Source: Valentine *et al.* (1998). The *approximate* boundary of the current MBDS has been placed on this image.

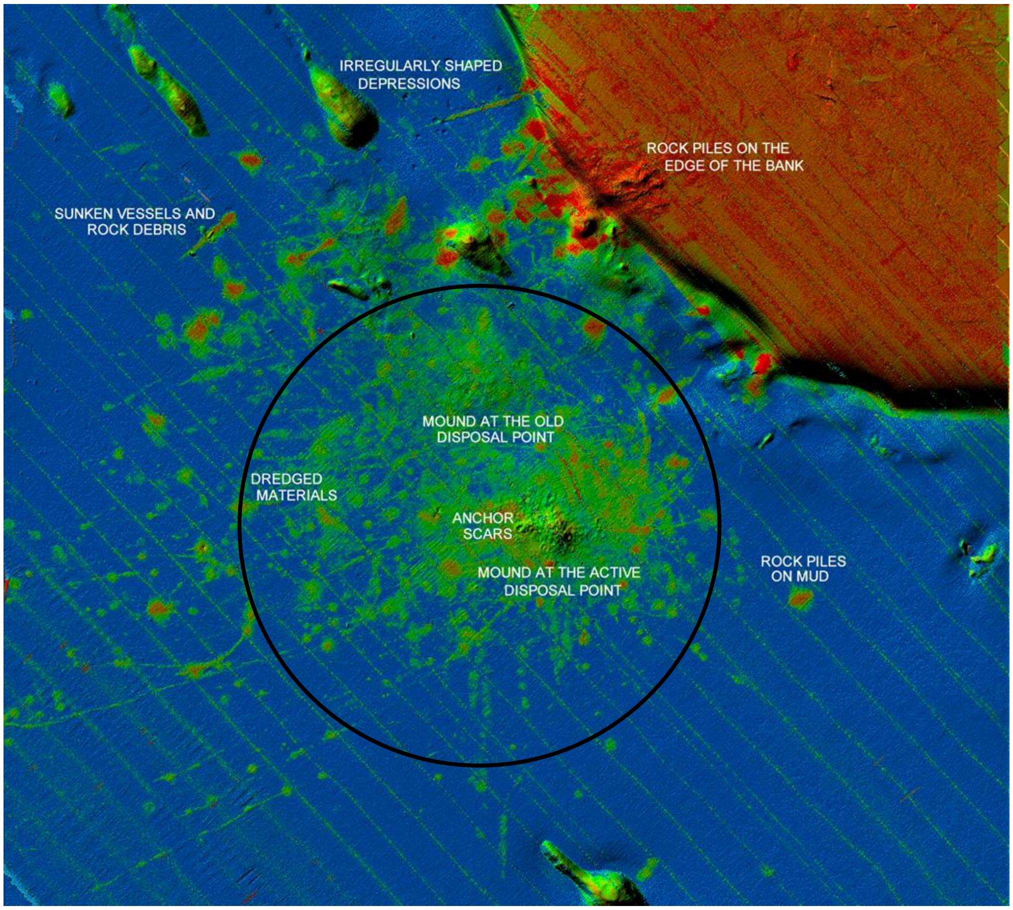


Figure 4. Bathymetric contour map of MBDS survey area, September 2004 (2-m contour interval) showing disposal buoy positions between 1993 and 2004 and resulting disposal mounds formed on the MBDS seafloor. Source: ENSR, 2005. Reprinted with permission.

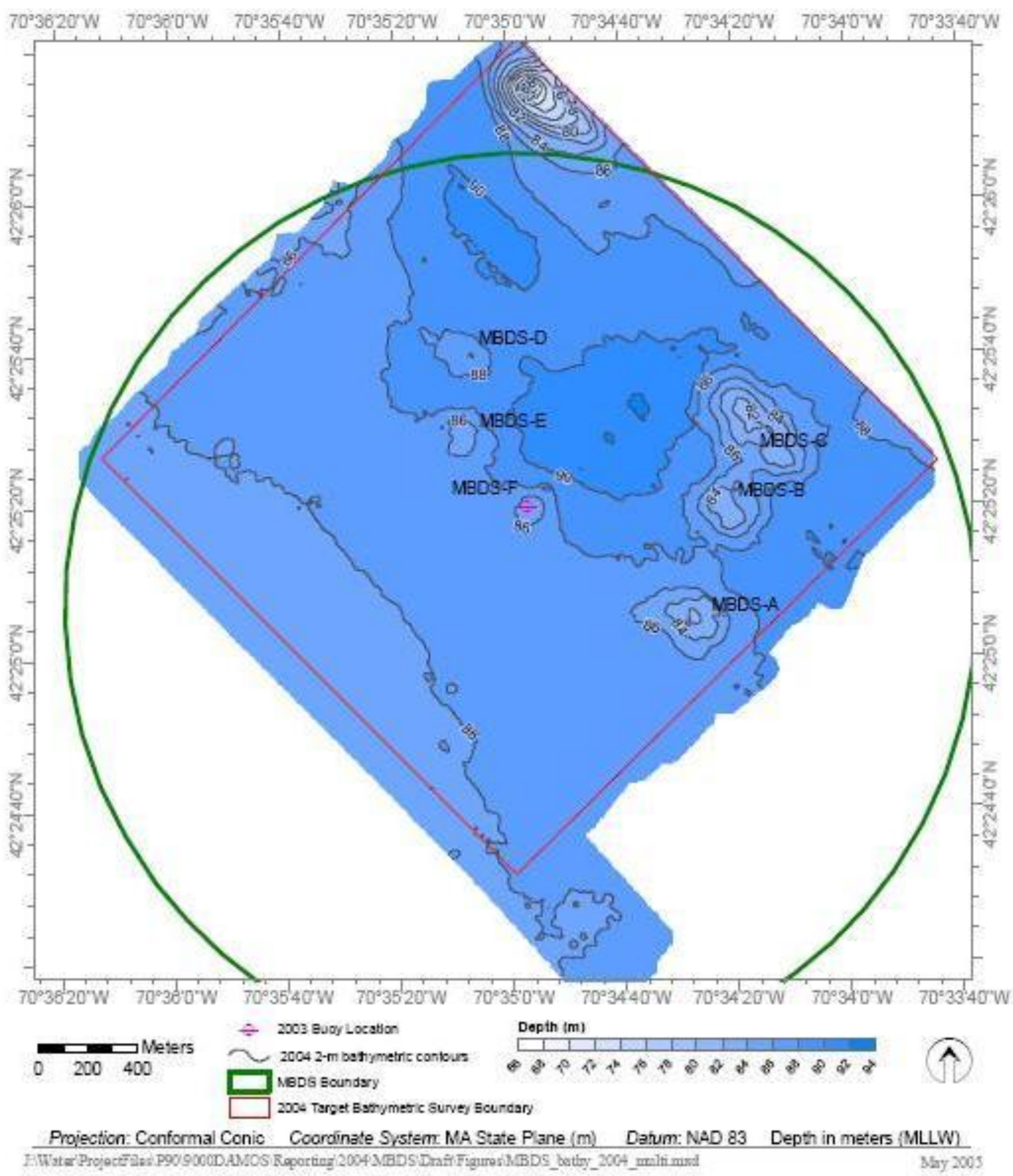
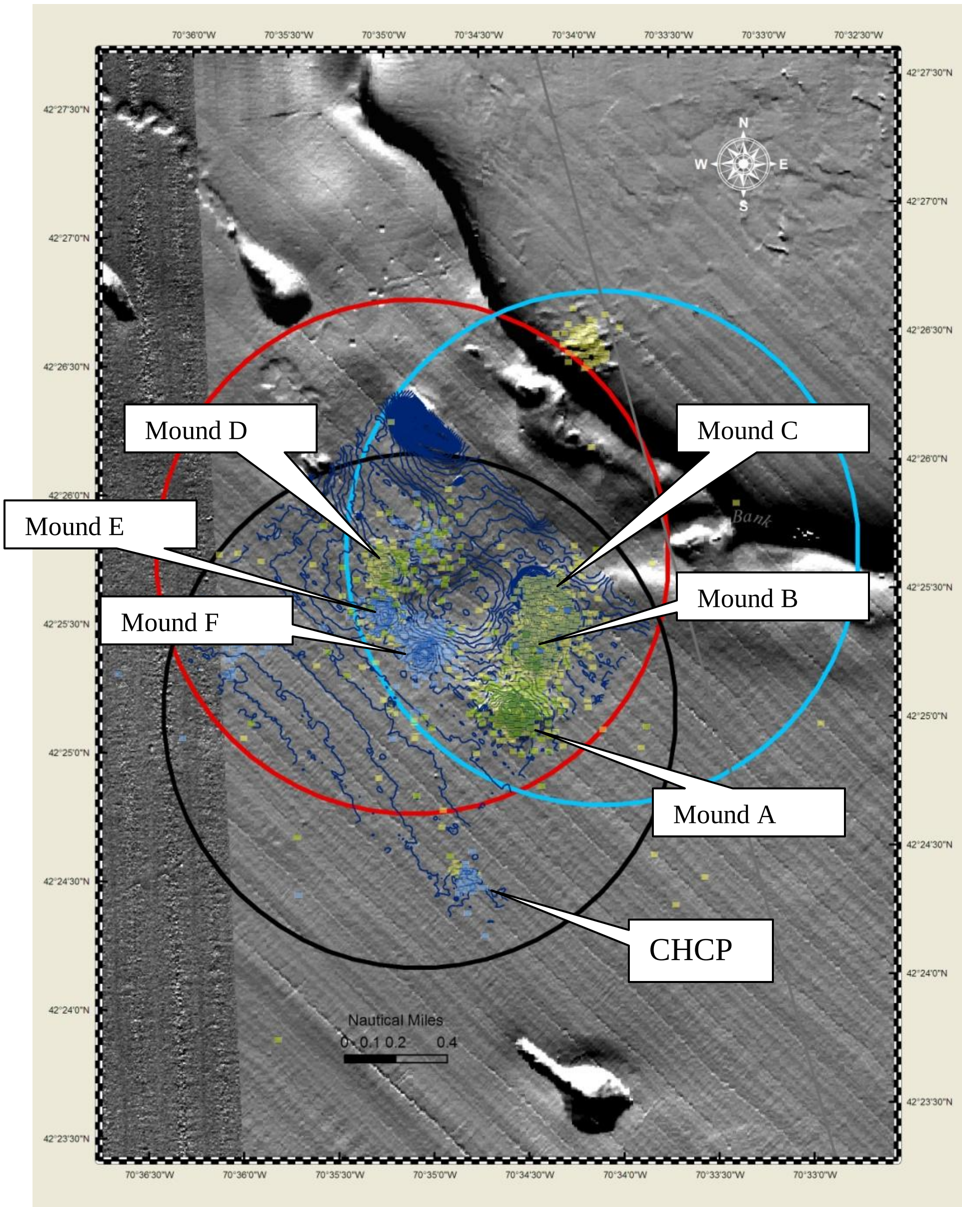


Figure 5. Locations of disposal events in MBDS from 1984 to 2007 (shown as green dots) overlain on bathymetry of MBDS determined in 2004 using a narrow beam echosounder (shown by the blue contours at 0.5 meter intervals). The solid blue area near the northern intersection of black and blue circles is a natural topographic high (drumlin) shown in Figure 2. Source of data: personal communication from Stephanie Wilson, ENSR based on coordinates from NAE scow logs and bathymetry from ENSR, 2005.



4. BASELINE ASSESSMENT

4. 1 GENERAL PHYSICAL, CHEMICAL AND BIOLOGICAL CHARACTERISTICS

Much of the basic physical, chemical, and biological characteristics of the MBDS have been evaluated and described in previous documents, such as Hubbard *et al.* (1988), EPA Region 1 (1989) and Butman *et al.* (1992) and summarized in the 1996 SMMP (EPA Region 1, 1996). Recent studies by the MWRA, USGS, NOAA and EPA (respectively Hunt *et al.*, 2006, Bothner and Butman 2005 and 2007; NOAA NCCOS, 2006; Liebman and Brochi, 2008) corroborate many of these observations, and provide additional information.

4.1.1 PHYSICAL SETTING AND CIRCULATION

The Massachusetts Bay Disposal Site lies in 90 to 100 meters of water in the northwest corner of Stellwagen Basin -- a large depression within Massachusetts Bay separated from the Gulf of Maine by Stellwagen Bank, a sand and gravel underwater shelf which rises to the east to within 50 meters of the surface (Figure 6). From side scan sonar and bathymetry images, the bottom is generally flat with a small circular depression in the northeast quadrant of the site and a glacial knoll at the northern boundary. Within 1,000 meters of the northeast edge are the steep flanks of Stellwagen Bank. Because of the topography of the bank, nutrient rich deep water mixes with shallower bank water resulting in heightened seasonal productivity and a rich fishing area. Stellwagen Bank is habitat, feeding ground, and a nursery area for 22 species of marine mammals, 34 species of seabirds, and over 80 fish species (NOAA NMSP, 2008).

Because of the semi-enclosed geometry of Massachusetts Bay caused by Stellwagen Bank and Cape Cod, local bottom currents are relatively slow, averaging about four to seven cm/second. Modeling and measurements of bottom circulation in Stellwagen Basin during storm events from the northeast suggest that bottom currents would increase to 30 cm/sec over a short period of time (i.e. one to two days once every four years or so). These flows are not high enough to cause significant resuspension of dredged material; only a small portion of the non-cohesive silty sediments are expected to be resuspended under these conditions. MBDS is located in an area of Massachusetts Bay most buffered from the effects of winter storms (Butman *et al.*, 2004). Based on hydrodynamic and sediment transport modeling of Massachusetts Bay, the MBDS is in a depositional area (Figure 7). Fine-grained sediments accumulate after transport by storm-driven wind and circulation patterns (Bothner and Butman, 2007). Based on vertical profiles, sediments accumulate at about 0.1 to 0.2 cm/year (Wade, 1989).

Figure 6. Topography of Massachusetts Bay, in shaded relief view, colored by water depth, based on multibeam surveys and the NOAA Coastal Relief Model. The image accentuates small features that could not be effectively shown by contours alone at this scale. From Bothner and Butman, 2007. Reprinted with permission.

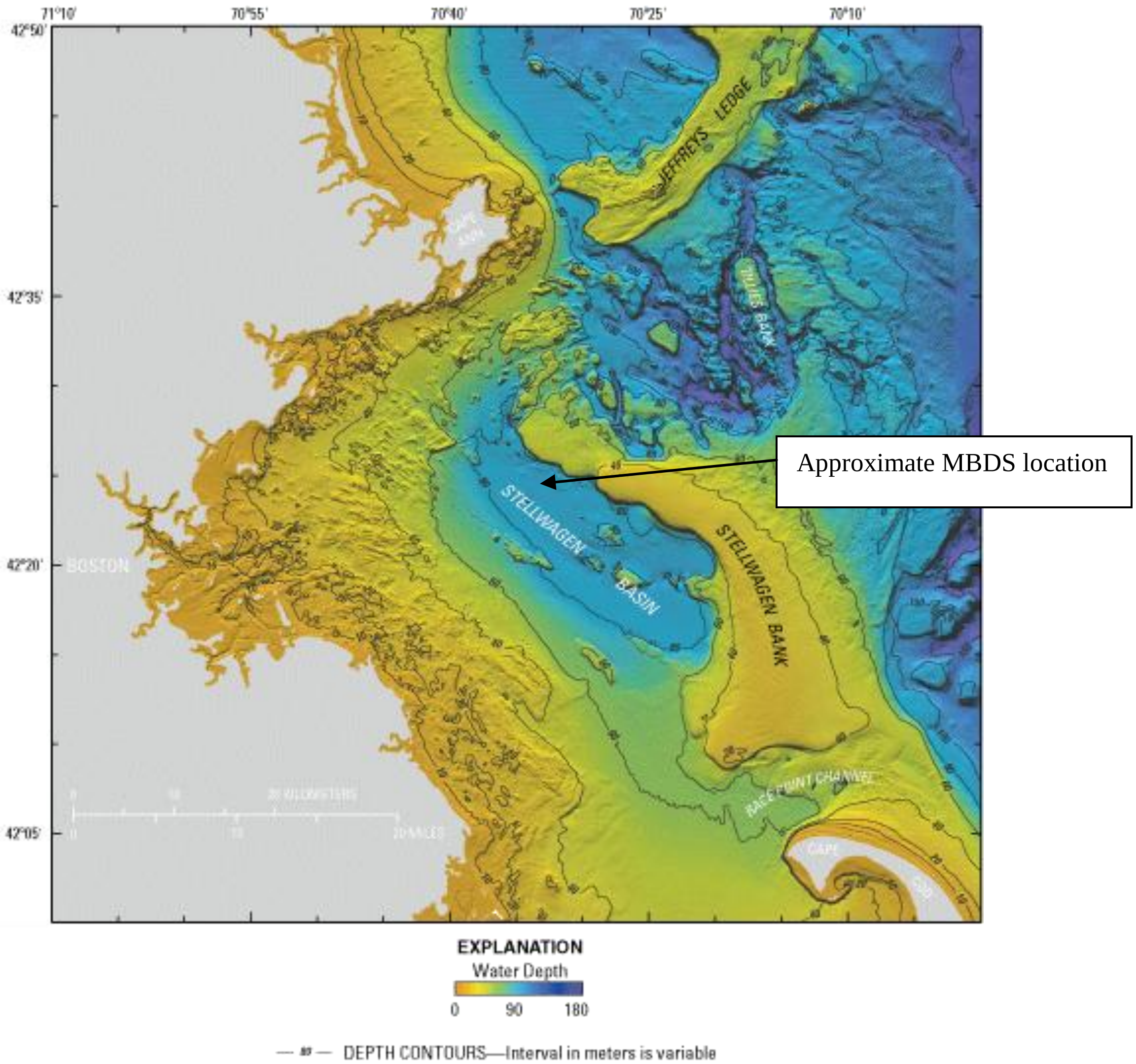
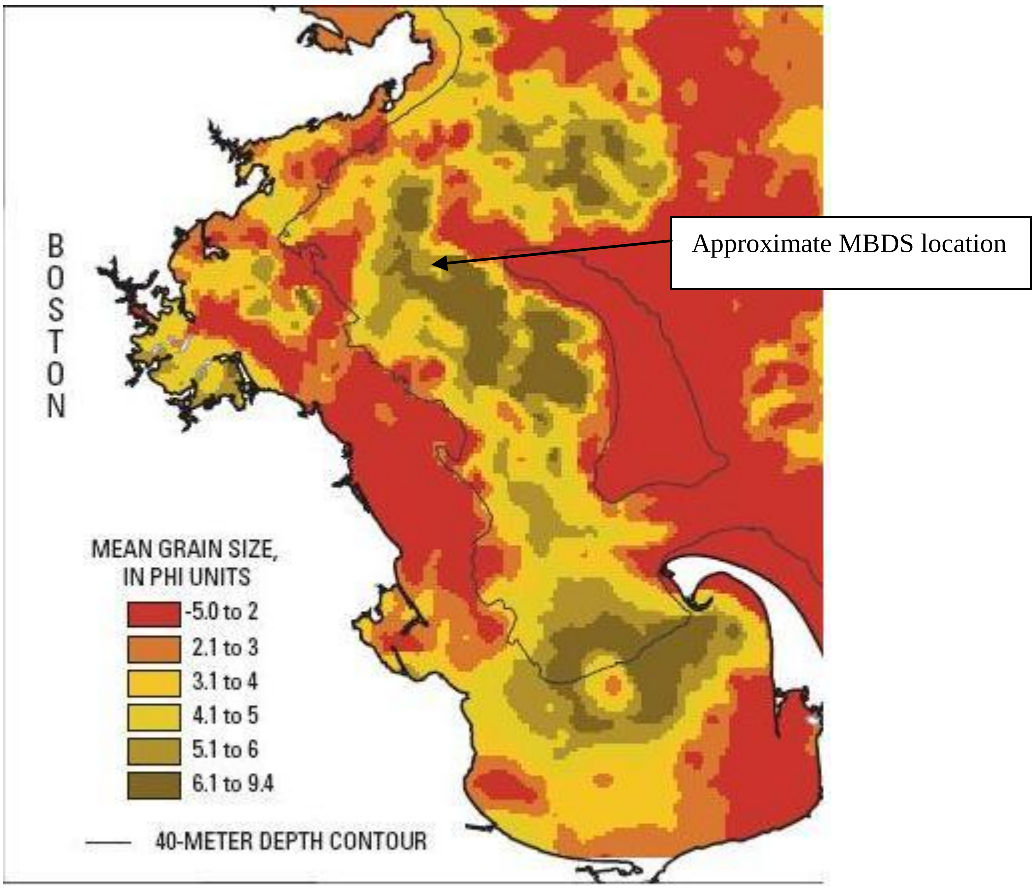


Figure 7. Observed surficial sediment grain size distribution in Massachusetts Bay. The MBDS is in an area of 5 to 6 phi units, which is considered medium silts (larger phi units are associated with finer sediments). From Figure 6.5 in Bothner and Butman, 2007, based on Poppe, 2003. Reprinted with permission.



4.1.2 SEDIMENT CHARACTERISTICS

The most common grain size at the MBDS and surrounding area is silty-sand, with a mean phi size of 4 to 5 but ranging from 3 to 7. Recent observations of the sediments in the disposal mound and reference areas undisturbed by dredged material disposal ranged from about 75 to 90% silt-clay (Liebman and Brochi, 2008).

Marine sediments in general are characterized by an oxidized surface later that transitions to a redox potential discontinuity (RPD) to the underlying anoxic sediments. The RPD denotes the depth where chemical reduction/oxidation (redox) potentials decrease rapidly, in some areas to negative values. The aerobic sediments above this zone are generally supportive of diverse benthic organisms, while the anaerobic sediments below are generally less diverse. For sediment unaffected by dredged material at the MBDS, apparent RPD depths (measured using the sediment profile camera) range from two to seven cm with a majority in the four to six cm range. Areas with freshly disposed dredged material typically exhibit shallower apparent RPD depths (0.5 to 2 cm) than fully recolonized mounds or reference areas (SAIC, 1990b, SAIC, 1994a). Measurements of total organic carbon (TOC; a measure of organic matter content) in reference areas range from 2.5 to 3.2%, but on dredged material mounds with the presence of cohesive clumps of clay material, TOC ranges from 0.5% to 2.5%, with a mean of about 1.0% (Hubbard *et al.*, 1988, SAIC, 1990b, SAIC, 1994a, Liebman and Brochi, 2008).

Benthic nutrient and sediment oxygen measurements at a station in Stellwagen Basin exhibit "highly oxic conditions" and have not changed significantly in the last ten years (Tucker *et al.*, 2006). Compared to sediments collected in shallower waters in Massachusetts Bay which experienced a coarsening of grain size and decreases in organic matter, sediments collected from Stellwagen Basin showed little effects of the two significant storms in May 2005.

4.1.3 SEDIMENT CHEMISTRY

Because the MBDS is located in a settling basin, suspended sediments and associated (adsorbed) contaminants transported from regional sources can accumulate there (Bothner and Butman, 2005 and 2007). Vertical sediment profiles from cores in Stellwagen Basin reflect the long-term history of contamination in Massachusetts Bay (Wade *et al.*, 1989). Sediment contamination at the MBDS, however, is likely attributed to historic disposal of dredged material.

Monitoring prior to 1996 reveals the history of disposal at the MBDS and the IWS. Historical use of the old "BFG" buoy area and the IWS resulted in 1) slightly elevated toxicant levels and bioaccumulation in sediments west of the old "BFG" buoy (Station 12-3 in SAIC, 1997) and in the IWS (EPA Region 1, 1996), and 2) elevated polycyclic aromatic hydrocarbon (PAH) and polychlorinated biphenyl (PCB) levels in lobster tomalley collected from the IWS and MBDS area (Hubbard et al., 1988; NOAA, 1996). Tissue burdens in edible fish, however, were low and do not appear to pose a human health risk. Levels of radionuclides in sediments and biota are not above background (NOAA, 1996).

Levels of trace metals, polycyclic aromatic hydrocarbons (PAHs), PCB congeners and pesticides were recently measured at the MBDS reference area, disposal mounds A, C and F, and the historically contaminated areas within the site near the old "BFG" buoy (also known as Station 12-3; Liebman and Brochi, 2008). Results from that survey indicated that contaminant levels at the reference areas are generally low but detectable (Figure 8). The values for trace metals and PAHs are generally at or below the level expected to cause a 25% probability of a toxic response according to the logistic regression model of Field *et al.* (1999, 2002). Sediment contamination levels were generally higher near the old "BFG" buoy or the adjacent depression, reflecting the influence of past disposal, but some samples at mounds C and F exhibited elevated levels (Table 2). The levels, however, are typically below the 50% probability of a toxic response according to the logistic regression model of Field *et al.* (1999, 2002). Levels of some pesticides (e.g. DDTs) and PCB congeners on the disposal mounds and historically disposed areas were also elevated compared to the reference areas, but generally at or below the 25% probability level of a toxic response (Liebman and Brochi, 2008).

Although some sediments exhibited elevated contaminant levels, sediments collected from historically contaminated areas within the disposal site, as well as from active disposal mounds, were not acutely toxic to amphipods as measured by the standard 10 day *Ampelisca abdita* acute toxicity test (Liebman and Brochi, 2008).

Figure 8. Box plot of sum of PAHs from sediments of three to five samples from each station type, including sediments collected from the Boston Harbor maintenance project (President Roads East and West). PR-reference is collected from the same reference area as the reference station in the 2006 survey (Ref). Source: Liebman and Brochi, 2008. Note that the term "Hotspot" refers to the old BFG area.

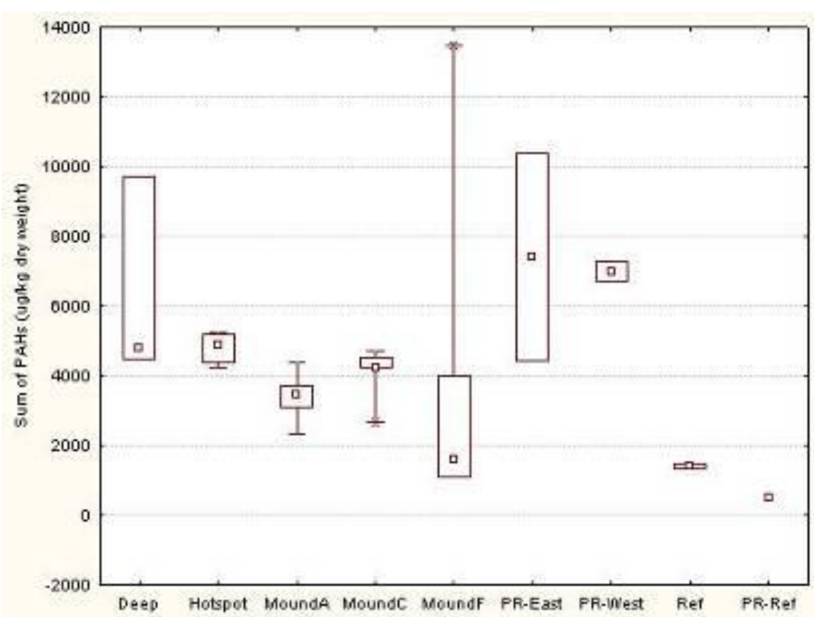


Table 2. Highest observed levels of metals (ug/g) and sum PCBs (ug/g) compared to sediment screening levels applied in US EPA, 2004. P25% and P50% are the concentrations that would give a 25% or 50% probability of a toxic response according to the logistic regression model of Field *et al.* (1999, 2002).

Analyte	Highest observed value (ug/g dry weight)	Mound or area	Highest observed median value (ug/g dry weight)	Mound or area	P25% (ug/g dry weight)	P50% (ug/g dry weight)
Arsenic	14	Ref	13	C	11.29	32.61
Cadmium	1.9	C	1.65	BFG	0.65	2.49
Chromium	170	C	150	Deep	76.00	233.27
Copper	87	C	75	Deep	49.98	157.13
Lead	75	C	66	Deep	47.82	161.06
Mercury	0.63	Deep	0.43	Deep	0.23	0.87
Nickel	34	F	30	F	23.77	80.07
Zinc	240	F	140	Deep	140.48	383.81
Sum PCBs	0.336	F	0.207	F	0.09	1.12
Sum PAHs	13.469	F	4.884	Deep	n/a	n/a
DDT	0.0057	F	0.002	BFG	0.004	0.03

4.1.4 BIOLOGICAL CHARACTERISTICS OF BENTHIC COMMUNITIES

Stellwagen Basin sediments are dominated by benthic infauna characterized by polychaetes and mollusks (EPA Region 1, 1996). At disposal sites in New England, benthic infauna generally recolonize new sediment and fresh dredged material in a relatively predictable sequence, characterized by three stages of succession (Rhoads and Germano, 1986). The first stage (or “sere”; Stage I) is dominated by small, opportunistic, tube-forming, capitellid, spionid, and paraonid polychaetes or oligochaetes which rapidly (i.e., within 1 to 2 weeks) colonize new disposal mounds and which do not penetrate into the sediments very deeply. These organisms are thought to be recruited to the new habitat from off the disposal mound. Stage II is dominated by deeper penetrating species, which include tubicolous amphipods (e.g., *Ampelisca abdita*), and mollusks, typically occurring 3-6 months after disposal has ceased. These taxa represent a more transitional stage, and they may or may not hold permanent positions in the long term benthic community structure. Stage III animals represent an "equilibrium" level, typified by deeper-dwelling, head-down deposit feeding species [e.g., maldanid (*Clymenella zonalis*) and pectinid polychaetes, holothurians, and nuculid bivalves (*Yoldia* spp.), and predatory polychaetes, such as *Nephtys incisa*]. This stage can also occur during the first year after dumping, but additional time for larval recruitment from off-site locations may be required. Some head-down deposit feeders are thought to be capable of migrating up through the fresh dredged material after a disposal event to maintain position in the sediment. It is common to find more than one successional stage present at any one location (e.g., a Stage I community coexisting above a Stage III community). Repeated disposal at one location in the site may keep the benthic community in a Stage I or II community; less frequent disposal may allow a Stage III community to develop. These communities can be "remotely" observed with a sediment profile imaging camera (see Section 5.3), but more accurate community analysis requires sieving, sorting and identification of all taxa in a grab sample.

4.1.5 WATER COLUMN CHARACTERISTICS

From May to October, the water column is typically stratified, with the pycnocline located at approximately 15 to 20 meters. Bottom water temperatures vary from about 3 to 5 °C. There is little exchange of water between the bottom waters of Stellwagen Basin and the surface waters of adjacent Stellwagen Bank, especially during the summer stratified period.

Recent studies conducted by the Massachusetts Water Resources Authority (MWRA) and the USGS have confirmed and supplemented many of the observations made in the early 1990s (Werme and Hunt, 2006; Bothner and Butman, 2005 and 2007). The MWRA has collected water quality and benthic samples near (about 2.5 and 3 nm respectively) the MBDS. These samples indicate that since monitoring began in 1992, average dissolved oxygen levels in the bottom waters of Stellwagen Basin rarely go below 6.5 mg/liter indicating excellent water quality (Libby *et al.*, 2006). Levels of nutrients (specifically nitrate) in surface waters of offshore Massachusetts Bay, however, have increased slightly over the last 12 years (Libby *et al.*, 2006). This increase has been seen regionally, and is not attributed to the discharge of the MWRA outfall in western Massachusetts Bay (or disposal of dredged material). Although these increases in nutrients are not associated with increases in annual chlorophyll levels in the Bay, there has been an increase in the incidence or duration of harmful algal blooms – specifically *Alexandrium*, and *Phaeocystis* -- in the last decade (Werme and Hunt, 2006; Libby *et al.*, 2006). The *Alexandrium* blooms in Massachusetts Bay have been strongly influenced by several “Nor’easters”, storms which brought significant amounts of cells into Massachusetts Bay in May 2005, and then again in May 2008. The causes of increased frequency and duration of the regional *Phaeocystis* blooms are not well understood.

4.1.6 EPIFAUNA AND FISHERIES

The 1996 SMMP (EPA Region 1, 1996) describes in detail important epifauna and fisheries at the MBDS. Dominant epifauna include brittle stars, and flatfish, such as the American plaice, plus commercially and recreationally important winter flounder, cod and spiny dogfish. Hard bottom species include bryozoans, sponges and tunicates (SAIC, 2004).

Based on recent spring and fall bottom trawls conducted by the Massachusetts Division of Marine Fisheries (MA DMF) in Massachusetts Bay, the most dominant (by weight and abundance) demersal fishery species observed in Massachusetts Bay near the MBDS are

American plaice, Atlantic cod, ocean pout, yellowtail flounder, spiny dogfish, red hake, haddock, American lobster, winter flounder, longhorn sculpin, silver hake, white hake, Atlantic herring, witch flounder, goosefish, and butterfish (King *et al.*, 2007).

Similarly, the bottom trawl surveys performed by NMFS (aka NOAA Fisheries Service) near the MBDS in Stellwagen Basin in the fall of 2005 and 2006 yielded similar demersal species dominated by spiny dogfish and American plaice (NOAA Fisheries Service, 2005, 2006). An additional species not observed in the MA DMF surveys was the Acadian redfish (*Sebastes fasciatus*) which is often observed among the barrels at the IWS (NOAA, 1996).

In recent years, researchers at NMFS and MA DMF began to observe a number of flounder with blind surface ulcers (surficial lesions) beginning in 2002 and 2003 (Moore *et al.*, 2005). These ulcers were observed only rarely prior to 2001. Surveys by the MWRA, in association with other agencies, and partly funded by the EPA New England, found continued prevalence of the ulcers in the spring, with the severity and incidence decreasing into the summer. The highest prevalence of ulcers was found in flounders collected in western Massachusetts Bay, but flounders collected in Stellwagen Basin also exhibited high prevalence (ranging from 10 to 40%). In-depth microbiological studies of the ulcer lesions to attempt to correlate specific organisms with the lesions suggest that bacteria, fungi or viral particles are not the primary agents in this syndrome (Moore *et al.*, 2005). It is hypothesized that prior insult to the dermis of the fish likely allowed the opportunistic and normal (indigenous) bacteria flora isolated from the ulcers to infect tissues but further studies are currently being conducted (Hunt *et al.*, 2006).

Although not caught commercially in high quantities, the semi-demersal northern sand lance (*Ammodytes dubius*) is important as food for marine mammals, such as the humpback and fin whales (NOAA NCCOS, 2006). Adult sand lance occur primarily in sandier sediments, preferring the sloping, gravel bottom edges of Stellwagen Bank, but larval and adult fish have been observed by submersible vehicles near the soft sediments of the MBDS (Hubbard *et al.*, 1988; NMFS, 1991).

The 1996 amendments to the Magnuson-Stevens Fishery Conservation and Management Act (MSA) requires the identification of Essential Fish Habitat (EFH) for federally managed fishery species and the implementation of measures to conserve and enhance this habitat. The list of species in essential fish habitat in Massachusetts Bay within which the MBDS lies is listed in Table 3.

4.1.7 MARINE MAMMALS AND SEA TURTLES

Several species of marine mammals regularly frequent the deeper open waters of Massachusetts and Cape Cod Bays as well as Stellwagen Bank, and there are rare sightings of sea turtles. Stellwagen Bank serves as a critical feeding ground for numerous whales. Of these species, NMFS believes the endangered Fin, Sei, Humpback, and Right whales, and the Leatherback sea turtle (endangered), Kemp's Ridley (endangered) and loggerhead (threatened) turtles deserve special attention because they occur in the Stellwagen Bank area. The Endangered Species Act (ESA) requires the Federal government to designate "critical habitat" for any species it lists under the ESA. Northern right whales were listed in 1970. This species was relisted in March 6, 2008 to distinguish between North Atlantic right whales and North Pacific right whales. In 1994, critical habitat, including Cape Cod Bay, was designated for this species and NMFS is currently in the process of designating critical habitat for North Atlantic right whales. More information on marine mammals and sea turtles in this area is available at NOAA NCCOS, 2006.

Table 3. List of species with essential fish habitat in Massachusetts Bay within which the MBDS lies. This area is defined by a 10 minute by 10 minute square with a northeast corner located at 42° 30.0' N/70° 30.0' W and the southwest corner located at 42° 20.0' N/70° 40.0' W. Source: NMFS http://www.nero.noaa.gov/hcd/webintro.html accessed on September 16, 2008. EFH is listed for various life stages of each species. (X indicates EFH has been designated for that life stage, n/a indicates no data available or lifestage not present.)

Species	Eggs	Larvae	Juveniles	Adults
American plaice (*Hippoglossoides platessoides*)	X	X	X	X
Atlantic butterfish (*Peprilus triacanthus*)	X	X	X	X
Atlantic cod (*Gadus morhua*)	X	X	X	X
Atlantic halibut (*Hippoglossus hippoglossus*)	X	X	X	X
Atlantic mackerel (*Scomber scombrus*)	X	X	X	X
Atlantic sea herring (*Clupea harengus*)		X	X	X
Atlantic sea scallop (*Placopecten magellanicus*)	X	X	X	X
bluefin tuna (*Thunnus thynnus*)			X	X
haddock (*Melanogrammus aeglefinus*)	X		X	
long finned squid (*Loligo pealei*)	n/a	n/a	X	X
monkfish (*Lophius americanus*)	X	X	X	X
ocean pout (*Macrozoarces americanus*)	X	X	X	X
ocean quahog (*Artica islandica*)	n/a	n/a		
red hake (*Urophycis chuss*)	X	X	X	X
redfish (*Sebastes fasciatus*)	n/a	X	X	X
scup (*Stenotomus chrysops*)	n/a	n/a		
short finned squid (*Illex illecebrosus*)	n/a	n/a	X	X
spiny dogfish (*Squalus acanthias*)	n/a	n/a		
surf clam (*Spisula solidissima*)	n/a	n/a		
white hake (*Urophycis tenuis*)	X	X	X	X
whiting (*Merluccius bilinearis*)	X	X	X	X
windowpane flounder (*Scopthalmus aquosus*)	X	X		
winter flounder (*Pleuronectes americanus*)	X	X	X	X
witch flounder (*Glyptocephalus cynoglossus*)	X	X	X	X
yellowtail flounder (*Pleuronectes ferruginea*)	X	X	X	X

4.1.8 CULTURAL RESOURCES

A number of shipwrecks, some of potential significance, are located within the site or in adjacent waters in the Basin. Location of these wrecks was determined using side scan sonar by US EPA in July 2006. Disposal activities and siting of disposal mounds are accomplished in a manner that avoids disposal on these areas.

4.2 SIGNIFICANT PROJECTS WHICH MAY INFLUENCE MANAGEMENT OF THE MBDS

Two companies -- Northeast Gateway Energy Bridge, LLC (NEG) and Neptune LNG, LLC -- recently received licenses in December 2006 from the U.S. Coast Guard to construct and operate a deepwater port for the regasification of liquefied natural gas (LNG) at sites adjacent to the MBDS. The Northeast Gateway project has finished construction and began operation in 2008. The pipeline was commissioned in February and the first delivery of cargo was conducted in May 2008.[5] The pipeline route is as close as 400 meters from the MBDS boundary, and two NEG port sites are planned for about 200 meters at the southern boundary of the MBDS (USCG, 2006). The two NEG ports include a deepwater port terminal that receives and regasifies LNG on specially designed Energy Bridge Regasification Vessels, and sends the natural gas to the shore via a new 24-inch pipeline lateral approximately 16.5 miles in length constructed, owned, and operated by Algonquin Gas Transmission, LLC (Algonquin). This pipeline lateral (which is buried to at least 1.5 feet) connects to the existing HubLine Pipeline System that traverses Massachusetts Bay and integrates with the New England natural gas grid. The Neptune port site is less than one nautical mile from the northern boundary of the Industrial Waste Site, and is under construction as of June, 2009.

Each NEG port consists of a subsea Submerged Turret Loading™ buoy (STL Buoy), a flexible riser, a subsea manifold, and a subsea flowline to connect to Algonquin's pipeline lateral. The STL Buoy connects to a LNG tanker for delivery of LNG and then connects to the subsea manifold using the flexible riser assembly. The subsea manifold will then be tied into the subsea flowline, subsequently connecting to Algonquin pipeline lateral. The STL buoy will be anchored by a radial system of eight suction type anchors, and connected to the anchors by an eight inch thick cable. Each anchor is estimated to disturb approximately 100 square meters of the ocean floor. Installation of the anchors involved temporarily laying mooring chains ranging in length up to 750 meters in length. A total of approximately 5 acres (or 20,000 square meters) of seabed was estimated to have been disturbed temporarily. After final installation the 16 chain segments occupy about 1 acre of the seabed (4,000 square meters). The diameter of each anchor spread is 0.91 miles (or about 1.5 km). Thus, the footprint of the permanent structures on the seabed and the floating lines in the water column are significant, and may require occasional changes in transport routes to the MBDS. The USCG has authorized safety zones of about 800 meters around the STL buoy and a No Anchor Area (NAA) of about 1000 meters radius from the buoy.

[5] Letters from Tetra Tech EC, Inc to US EPA dated March 18, 2008 and June 16, 2008 as required by Northeast Gateway Deepwater Port National Pollution Discharge Elimination System Permit Number MA0040266 Discharge Monitoring Report May 2008 and January/February 2008.

Speed and access (e.g. bottom trawling, lobstering) restrictions are also applied. An "Area to be avoided" would be about 1250 meters radius around each buoy.

5. EVALUATION OF USACE AND EPA MONITORING RESULTS SINCE 1996

5.1 CONCEPTUAL MODEL OF IMPACTS OF DISPOSAL AT THE MBDS

The 1996 SMMP reviewed the expected impacts of disposal at the MBDS. When dumped, most dredged material hits the bottom, but up to 5% of fine-grained sediments can persist in the water column and be transported away from the disposal site. Dumps of dredged material create small craters on the bottom, and temporary re-suspension of sediment. Fine-grained sediments can resuspend into the water column and be transported several meters away, before deposition onto the ocean floor.

It is expected that proper and continuous disposal of dredged material at a defined mound will result in a disturbed habitat which is constantly recolonized by opportunistic Stage I benthic infauna and epifauna with relatively shallow penetration of oxygen into the sediments (Rhoads and Germano, 1986; Germano *et al.*, 1994). Monitoring at disposal mounds appears to have confirmed these expectations, with impacts primarily restricted to the disposal mounds. As described in Section 3, levels of sediment contamination are elevated beyond historic disposal mounds, reflecting less stringent testing requirements prior to 1977, and placement beyond intended disposal locations. Historic impacts, however, are primarily within the disposal site boundaries.

Although the ocean dumping criteria regulate unconfined disposal of unsuitable dredged material, the disposal site is potentially the locus for the accumulation of contaminants in a relatively confined area, i.e. at the buoy location. Because of the recolonization of benthic infauna on disposal mounds at the site and the constant disposal of dredged material, biota may accumulate contaminants. Continuous disposal of dredged material appears to maintain habitat for small flatfishes by maintaining a disturbed condition and increasing the abundance of small infauna in surface sediments.

The major monitoring concern at the MBDS is that benthic organisms, from polychaetes to groundfish, will be exposed to contaminants at and within 400 to 500 meters of the mound from the surge of sediments re-suspended and settling during a disposal event. Direct bioaccumulation of particle-attached toxicants into bivalve mollusks, such as the filter-feeding ocean quahog and the deposit-feeding *Yoldia* is possible. The most likely food chain effect is accumulation (and possible biomagnification) of contaminants from sediments to benthic infauna (e.g. polychaetes) and epifauna (e.g. pandalid shrimp) to groundfish (e.g. American plaice), spiny dogfish, or Acadian redfish. Another species at risk is the American lobster, an omnivorous feeder of bottom-dwelling fauna. A less likely, but important from a resource protection perspective (NOAA NCCOS, 2006) scenario is the transfer of contaminants from suspended particles to Northern sand lance (*Ammodytes dubius*) and then to humpback or finback whales.

5.2 ENVIRONMENTAL MONITORING OBJECTIVES

The objectives of the SMMP are to manage disposal activities to ensure compliance with the MPRSA and to determine whether significant adverse (or unacceptable) impacts have occurred or are occurring.

Environmental monitoring is used to meet both of those objectives. The Ocean Dumping Regulations (40 CFR §228.9, §228.10 and §228.13) provides guidance on conducting disposal site monitoring and trend assessments and evaluating impacts. Specifically 40 CFR §228.10 requires that the impact of disposal at a designated site be a) evaluated periodically and b) consider the following types of potential:

- Movement of materials into sanctuaries or onto beaches or shorelines, or towards productive fishery of shellfishery areas;
- Absence from the disposal site of pollutant-sensitive biota characteristic of the general area;
- Progressive, non-seasonal changes in water quality or sediment composition at the disposal site when these changes are attributable to materials disposed of at the site;
- Progressive, non-seasonal changes in composition or numbers of pelagic, demersal, or benthic biota at or near the disposal site when these changes can be attributed to the effects of materials disposed at the site; and
- Accumulation of material constituents (including without limitation, human pathogens) in marine biota at or near the site (i.e., bioaccumulation).

Many of these issues have been incorporated into the DAMOS Integrated Tiered Monitoring Approach for monitoring capped and uncapped dredged material disposal mounds in New England (Germano *et al.*, 1994) and in the 1996 SMMP[6]. Conceptually, this tiered approach is prospective, in that it attempts to identify early warning indicators of adverse effects, as described in the conceptual model, and is based on hypothesis testing using sampling technologies with rapid data return.

5.3 KEY SAMPLING TECHNOLOGIES AND EVALUATION APPROACHES

The key sampling technologies that have been utilized include high resolution (multibeam) bathymetry, side scan sonar, sediment profile imaging (SPI), and sediment collection to measure chemistry or toxicity. These technologies are discussed in more detail in Germano *et al.* (1994) and other DAMOS or EPA documents (e.g. ENSR, 2005; Liebman and Brochi, 2008).

High resolution bathymetry, supplemented with side scan sonar or subbottom profiles detect the presence, height and location of disposal mounds. With an experienced operator and analyst, the sediment profile camera also detects the presence of dredged material extending in thinner layers around the disposal mound. Side scan sonar supplements this information with detail of sediment characteristics and anomalies such as shipwrecks or debris.

[6] The DAMOS program, which has been in operation for 30 years, was developed and is funded primarily by NAE.

To evaluate bathymetric information, depth measurements will be gridded into small cells using contouring software programs (e.g. Surfer®) and depth differences from a previous survey will be calculated and displayed in a geographic information system (GIS). For new mounds, depth differences will be compared to estimated height and diameter based on the volume of dredged material disposed at the buoy. For existing mounds, height of the mound is expected to decrease over time due to consolidation, but the footprint shouldn't change dramatically. SPI images can determine whether lag deposits have formed on the top of the mound, indicating a winnowing of fine particles with subsequent armoring of surface.

Analysis of sediment profile images can determine whether benthic organisms have recolonized disposal mounds. It is assumed that expected, progressive benthic recolonization indicates no adverse effects from the dredged material disposal (see Section 5.1). The sediment profile imaging camera is a screening tool; large numbers of sampling locations can be evaluated with a quicker data-turnaround and at lower cost than other sampling techniques (e.g., sediment chemistry analyses, conventional benthic community analyses, diver surveys). If the sediment profile imaging camera documents slower than predicted recolonization rates, a more intensive evaluation and sampling effort would be triggered.

The sediment profile imaging camera can be used to evaluate several sediment property measures: sediment grain-size, relative sediment water content, sediment surface boundary roughness, seafloor disturbance, apparent redox potential discontinuity (RPD) depth, sediment methane, and infaunal successional stage (Germano *et al.*, 1994). The DAMOS program has standardized interpretation of these parameters through calculation of the Organism-Sediment Index (OSI), a measure of the overall quality of the benthic environment for each station. Photo-interpreted results from the sediment profile imaging camera can also provide information on biological processes such as bioturbation and biogenic irrigation. The SPI technology complements, but does not replace traditional benthic community surveys (Wilson *et al.*, 2009). In addition, sediment profile imaging cannot determine whether bioaccumulation of tissue contaminants is occurring.

Statistical evaluation of SPI data typically involves comparison to reference stations, and to stations unimpacted by disposal of dredged material. Statistical tests have traditionally been based on point-null hypothesis tests, which postulate the null hypothesis that there is no difference in benthic conditions between the mean values of the disposal mound and the mean values of the reference area (called point-null hypothesis testing). Additional statistical testing involves "equivalence tests", where the true difference between means is postulated to lie within, or beyond, a prescribed equivalence interval. This allows for evaluation of both proof of hazard, and proof of safety (ENSR, 2005).

Other technologies that will be employed are bottom grabs to collect sediments for measurements of sediment chemistry and texture; and bioassays, such as toxicity and bioaccumulation tests to assess responses of benthic organisms to toxicants and bioavailability of toxicants, respectively. In addition, video observations, using plan view cameras or remote operating vehicles can be employed in some cases to make direct observations of physical texture of the sediment, or biological features on both hard and soft sediments.

Surface grab samples of the sediments are collected and analyzed for grain size, total organic carbon, and selected contaminants such as trace metals (e.g., mercury, lead, zinc, arsenic, iron, cadmium, copper), PCB congeners, individual PAHs, and pesticides (e.g. DDT). The methods of collection and analysis are described in EPA/USACE, 1995, EPA, 2001 and EPA/USACE, 2004. The locations and number of stations and QC samples will be defined during survey planning and will be designed to characterize within and among station variability. Randomly selected stations, complemented with historical SPI stations will be sampled. If necessary, sediment cores will be collected to evaluate historical deposition of contamination. Levels of contaminants in dredged material mounds will be visually and statistically compared to levels in reference areas and to historical results. Statistical tests will include standard null hypothesis testing using parametric (e.g. ANOVA) and non-parametric tests (e.g. Kruskal-Wallis).

Sediments will also be collected to test for toxicity and bioaccumulation in the laboratory. The specific test will be selected from among approved tests used to evaluate dredged material proposed for disposal published in the Regional Implementation Manual (see Section 6.3 for description of the RIM; EPA/USACE, 2004). The locations and number of stations and quality control (QC) samples will be defined during survey planning and will be designed to characterize within and among station variability.

If necessary, measures of bioaccumulation of benthic infauna may be conducted. Sufficient biomass to enable quantifications of contaminants that bioaccumulate in filter feeders and sediment feeders will be obtained from grab samples (or other appropriate sample collections device) and genus level species aggregated into field replicates. Tissue will be prepared and analyzed using methods consistent with EPA/USACE (2004). Alternative field bioaccumulation methods (Valente *et al.*, 2006) will also be evaluated.

5.4 MONITORING SURVEYS IN PAST 15 YEARS

Several monitoring surveys were conducted in the past fifteen years to meet the objectives of the 1996 SMMP. These surveys, and the type of monitoring conducted, are listed in Table 4.

Table 4. Monitoring conducted in surveys since 1993.

Survey	*Reference*	*Bathymetry*	*Side scan sonar*	*Video Camera*	*Sediment Chemistry*	*Biological sampling*	*Sediment Profile Imaging*	*Comments*
1993	SAIC, 1997b	X	X		X			
1994	SAIC, 1997a						X	**Mound A**
1994	EPA, 1996				X	Tissue Chemistry/ Bioaccumu-lation		
1998 to 2000	SAIC, 2003	X	X		Grain size and tracers only		X	**Capping Demo site**
2000	SAIC, 2002	X					X	**Mounds B and C**
2002 Rock Reef Site	SAIC, 2004	X	X	X at Rock Reef Site				
2004	ENSR, 2005	X					X	**Mounds C and D**
2006	EPA, 2008[7]		X		X	Toxicity		**Mounds A, C and F**
2008	**In prep**	**X**	**X**					**Demo for IWS Capping**

The five monitoring objectives from the 1996 SMMP and results of surveys designed to meet these objectives are summarized below, with recommendations for future monitoring. These recommendations are incorporated into the plan outlined in Chapter 6.

1) Dredged material remains within a confined mound

Sediment profile imaging, bathymetric and side scan sonar surveys have confirmed that defined mounds were formed at locations intended for disposal. All mounds have formed at locations expected by buoy locations (Figures 4 and 5; Figure 1-4 in SAIC, 2002). The height of the mounds appears to be stable, with some consolidation over time (Table 5). There appears to be little change in mound height and shape in the four years between surveys, indicating that dredged material is persistent (SAIC, 2004). Although no SPI camera measurements are typically performed beyond the mound, based on the resolution of the bathymetric measurements, the apron of the dredged material mound typically extended about 200 meters beyond the 0.25 meter contour interval detected by bathymetry (See Figure 4-3 in SAIC, 2002).

7 EPA, 2008 is Liebman and Brochi, 2008.

In addition, the Rock Reef Site was clearly formed at the intended location. Some material, however, was deposited away from the intended location, but still within the disposal site boundaries (Valentine *et al.*, 1996).

Table 5. Approximate height (meters) of disposal mound above ambient area, or baseline measurement, after last disposal event. Based on bathymetric measurements performed in 2000 and 2004 (SAIC, 2002; ENSR, 2005).

Mound	***Year of last disposal event***	***Mound Width***	***Mound Height (m) Years after last disposal event***				
			0 to 1	***2***	***4 to 5***	***6***	***10***
A	1994	400 to 500 meters	6 to 7			6	5
B	1998	350 to 500 meters	--	6		6	
C	1999	600 to 750 meters	9		8		
D	1999	250 to 300 meters	3.5		3		
E	1999	250 to 300 meters	5		3		
F	2005	450	4				

2a) Benthic infauna recolonize disposal mounds
2b) The benthic community beyond the mound is not altered

Based on sediment profile imaging camera observations of mounds B, C and D taken in 2000 and 2004 benthic recolonization is occurring as expected (SAIC, 2002 and ENSR, 2005). At Mound C one year after the last disposal event, dense populations of Stage I opportunistic polychaetes were typically observed at the sediment surface. Stage III head down deposit-feeding infauna were only observed at some outlying stations less influenced by the cohesive Boston Blue Clay clumps. RPD depths were about 2 to 4 cm. SPI camera observations from Mound C four years later in 2004 indicate little change in apparent RPD depths (values ranged from 2 to 3.5 cm), but an increase in prevalence of Stage III infauna. It appears that the cohesive Boston Blue Clay clumps are refractory to deeper colonization by Stage III infauna.

Five years after the last disposal event, Mound D appears to have fully recovered. Mean RPD depths ranged from 3.5 to 4.9 cm, which is similar to reference sediments. There was no Boston Blue Clay disposed at this mound. Both Stage I and Stage III communities were observed.

SPI camera observations were not collected from areas beyond the mounds in 2000 or 2004. SPI camera measurements from reference areas, however, indicate normal (or expected) benthic communities, with RPD depths of about 3 to 5 cm with Stage I and III communities and no evidence of dredged material.

3a) Contaminants are not accumulating in sediments at the disposal site and the reference areas
3b) Contaminants are not accumulating in biological resources beyond the mound

Based on a comparison to sediment quality guidelines (Field *et al.*, 1999, 2002), levels of contaminants collected from historically contaminated areas and recently disposed mounds do not appear to be causing adverse impacts to the marine environment (see Section 4.1.3 and Liebman and Brochi, 2008). In fact, sediments collected from the depression appear to be declining for several individual PAHs and lead, although not for most other trace metals. At Mound A, however, it appears that levels of chromium, copper, and some individual PAHs have increased slightly since 1989, and there are no obvious decreases in sediment contamination (Liebman and Brochi, 2008).

Dredged material at the disposal sites (Mounds A, C and F) and sediment at the reference areas were not toxic to marine organisms, as measured by the *Ampelisca abdita* 10 day toxicity test. This is consistent with the results of sediment contaminant levels, compared to sediment quality guidelines.

No measurements of contaminants in bottom fish or lobsters from the MBDS or IWS have been performed since 1992 (NOAA, 1996).

4) The benthic community at the old "BFG" buoy area is recovering from historical dredged material disposal

The 2006 EPA survey found that many of the individual PAHs exhibited significant declines at this site and no evidence of toxicity, but that most metals showed no significant downward trend in contaminant levels (Liebman and Brochi, 2008).

5) The Rock Reef Site, and nearby rock debris, are colonized by a diverse hard rock epifaunal and fish community

The Rock Reef site exhibits a relatively diverse community of colonizing sponges, anemones and other epifauna (SAIC, 2004).

6. QUANTITY AND QUALITY OF MATERIAL TO BE DISPOSED

MPRSA 102(c)(3)(D) and (E) requires that the SMMP include consideration of the quantity of the material to be placed in the site, and the presence, nature, and bioavailability of the contaminants in the material as well as the anticipated use of the site over the long term.

6.1 RECENT AND UPCOMING PROJECTS

The primary future use of the MBDS is from the Boston Harbor Inner Harbor Maintenance Project and the proposed Deep Draft Navigation Improvement Project. The USACE began dredging Boston Inner Harbor in April 2008 with completion in November 2008. About 900,000 cubic yards were disposed at Mound F and about 800,000 CY were disposed at a demonstration site in the western part of the MBDS to evaluate whether dredged material can effectively isolate historically disposed waste containers in the IWS. This material came from shoal material and underlying parent material dredged to create CAD cells in the Mystic River and the main shipping channel. Unsuitable material was disposed in the CAD cells (Michael Keegan, NAE personal communication October 10, 2008; USACE/MassPort, 2006).

The U.S. Army USACE New England District in partnership with MassPort are also proposing a project (Boston Harbor Federal Deep Draft Navigation Improvement Project) to deepen the main channels in the Port of Boston, the Conley Container Terminal and other marine terminals to at least -45 feet to -50 feet depth to accommodate the next generation of deep draft vessels (USACE 2008). Based on the draft Feasibility Report (USACE/MassPort, 2008), the recommended plan would result in about 1 million cubic yards of rock and 11.1 million cubic yards of ordinary material, which has been determined to be suitable for ocean disposal in Massachusetts Bay. If no upland use for this material is found, the rock and other hard material are suitable for beneficial use to create hard bottom habitat. This project would likely be constructed no earlier than 2012 and take about four years to complete.

NAE has suggested, and EPA has concurred, that some of this material be disposed at the old IWS to cover up the containers and sediments exposed to contaminants from historic disposal at the IWS. Disposal at the IWS, however, is outside of the current boundaries of the MBDS. To dispose dredged material at the IWS areas would require a site selection process under the MPRSA, or an expansion of the disposal site boundaries.

NAE is currently conducting a demonstration project in the western portion of the MBDS to evaluate whether dredged material disposal in a sequential approach can cover up the containers, without extensive impact to the in-place contaminated sediments, or barrel fragments. This demonstration project is an integral component of the monitoring program.

6.2 CAPACITY

Although Boston Harbor is the primary harbor expected to utilize the MBDS in the next decade, other harbors are expected to utilize the site. Thus, for planning purposes, it is expected that the MBDS will receive more dredged material in the next decade than in the previous decade. A specific closure date for the MBDS has not been considered. Because of its depth (300 feet) and size (2,662 acres), the potential capacity of the MBDS is far in excess of the potential site use over the next 20 years, and does not pose a hazard to navigation.

6.3 DREDGED MATERIAL QUALITY: EVALUATION AND TESTING REQUIREMENTS

As is the case for all EPA designated ocean disposal sites, the MBDS is designated to only receive suitable dredged material. All dredged material projects proposed for disposal at the MBDS must meet the ocean dumping criteria under the MPRSA and deemed suitable for unconfined disposal. The projects will be evaluated on a project-specific basis under the rigorous chemical and biological testing framework outlined in the Ocean Dumping Regulations (40 CFR Parts 227 and 228) and guidance developed by EPA and the USACE (EPA/USACE, 1991; "the Green Book"). This guidance is further implemented in New England under the EPA and USACE Regional Implementation Manual (EPA and USACE, 2004[8]). The RIM provides New England-specific guidance on: permit application and coordination requirements; sampling methodologies; updated reference site locations; contaminants of concern and analytical reporting limits; and species and test conditions for biological testing.

The national guidance document is currently being updated by EPA and the USACE and the final version is expected to be completed in 2010. Although this updated guidance will describe modified approaches for interpretation of test results, it is unlikely that both the methods of testing and the quality of dredged material acceptable for disposal will change significantly.

7. MANAGEMENT APPROACH

Dredged material disposal will be managed by the EPA and the USACE to meet the overall objectives:

- Management of disposal activities to ensure compliance with the MPRSA; and
- Monitoring of the disposal site to determine whether significant adverse (or unacceptable) impacts have occurred or are occurring.

[8] The RIM is available at: http://www.nae.usace.army.mil/reg/rim.htm and http://www.epa.gov/region1/topics/water/dredging.html

To meet these objectives, the following specific management practices will be implemented:

- All dredged material disposed at the MBDS must meet the ocean dumping criteria;
- All general and specific permit conditions are implemented and enforced;
- Disposal locations are specified to minimize environmental impact from sediments placed at the site including establishing a containment cell of dredged material;
- Disposal locations are also specified to avoid impact of sediments on identified cultural resources (wrecks) in the site;
- Disposal technologies are conducted to minimize loss of sediment from the disposal site;
- Timing of disposal minimizes conflicts with other uses of the area;
- Dredged material disposal information is recorded in an information management system;
- Environmental and compliance monitoring is designed to recognize and correct conditions before unacceptable impact occurs; and
- Modifications to disposal practices and the site if necessary.

7.1 ALL DREDGED MATERIAL DISPOSED AT THE MBDS MUST MEET THE OCEAN DUMPING CRITERIA

As described in Section 6.3, the MBDS is designated to only receive suitable dredged material. All dredged material projects proposed for disposal at the MBDS must meet the ocean dumping criteria under the MPRSA.

7.2 IMPLEMENTATION AND ENFORCEMENT OF ALL GENERAL AND SPECIFIC PERMIT CONDITIONS

The following general conditions will be applied to all projects using the MBDS for disposal[9]. These conditions may be modified on a project-by-project basis, based on factual changes (e.g., administrative changes in phone numbers, points of contact) or when deemed necessary as part of the individual permit review process.

The following general permit conditions apply to all open water disposal in Massachusetts, Maine, New Hampshire, Rhode Island and Vermont.

1. Periodic maintenance dredging to the area and depth limits described herein is authorized for ten years from the date of issuance of this permit, **provided disposal of the dredged material is at an upland site**. However, the permittee must notify this office, in writing, 60 days before the intended date of any such dredging and shall not begin such dredging until written authorization has been obtained. This 60-day notification is not required for the initial new and/or maintenance dredging authorized by this permit. A separate authorization

[9] These are the standard general conditions for dredging permits issued by NAE (Gregory Penta, Regulatory Division, personal communication). Conditions related to protection of marine mammals are based on conservation recommendations issued by NMFS in 1999 (Knowles, 1999) and modified by Julie Crocker, NMFS Northeast Regional Office Protected Resources Division, 2009.

shall be required for such dredging if the material to be dredged is to be deposited in open or ocean waters and/or wetlands.

2. At least ten working days in advance of the start date, the First Coast Guard District, Aids to Navigation Office, (617) 223-8355, shall be notified of the location and estimated duration of the dredging and disposal operations.

3. For the initiation of disposal activity and any time disposal operations resume after having ceased for one month or more, the permittee or the permittee's representative must notify the Corps (see Special Condition 7 below) at least ten working days before the date disposal operations are expected to begin or resume. The information to be provided in this notification is: permit number, permittee name, address and phone number, dredging contractor name, address and phone number, towing contractor name, address and phone number**,** estimated dates dredging is expected to begin and end, name of all disposal vessels to be employed in the work and copies of their certification documents, name of the disposal site, and estimated volume of material to be dredged. **Disposal operations shall not begin or resume until the Corps issues a letter authorizing the initiation or continuation of open-water disposal.** The letter will include disposal point coordinates to use for this specific project at that time. These coordinates may differ from those specified for other projects using the same disposal site or even from those specified earlier for this project. It is not necessary to wait ten days before starting disposal operations. They may start as soon as this letter is issued. For each dredging season during which work is performed, the permittee must notify the Corps upon completion of dredging for the season by completing and submitting the form that the Corps will supply for this purpose when disposal-point coordinates are specified.

4. Except when directed otherwise by the Corps for site management purposes, all disposal of dredged material shall adhere to the following. These requirements must be followed except when doing so will create unsafe conditions because of weather or sea state, in which case disposal with the scow moving only fast enough to maintain safe control (generally less than one knot) is permitted. Disposal is not permitted if these requirements cannot be met due to weather or sea conditions. In that regard, special attention needs to be given to predicted conditions prior to departing for the disposal site.

a. The permittee shall release the dredged material at a specified set of coordinates within the disposal site with the scow at a complete halt.

b. When a disposal buoy is present at the specified coordinates, disposal shall occur with the side of the scow at least 100 feet and no greater than 200 feet from the buoy to minimize collisions with the buoy.

5. Silent Inspector System Requirements

a. Every discharge of dredged material at the disposal site requires monitoring by the contractor. This disposal monitoring of dredging projects must be performed using the Silent Inspector (SI) software and hardware system developed by the Corps. The SI system must have been certified by the Corps within a year of the disposal activity. See the National SI Support Center site https://si.usace.army.mil for additional SI information. Questions regarding certification should be addressed to the SI Point of Contact at the Corps New England District (Norm Farris, (978) 318-8336).

b. The permittee is responsible for ensuring that the system is operational throughout the project and that project data are submitted to the National SI Support Center in accordance with the specifications provided at the aforementioned website. If any component of the system is inoperable, disposal may not take place unless otherwise authorized by the Corps New England District SI Point of Contact.

c. The SI system used by the permittee must be capable of providing the information necessary for the Scow Monitoring Profile Specification. The permittee is also responsible to provide the Corps (see Special Condition 7 below) with a record of estimated barge volume for each trip. If barge volume information is not provided through the SI system utilized, the permittee must submit a weekly report to Corps that provides estimated volume (cubic yards), date and disposal time for each trip. The data collected by the SI system shall, upon request, be made available to the Corps (see Special Condition 7 below).

d. For the initiation of disposal activity and any time disposal operations resume after having ceased for one month or more, the permittee or the permittee's representative must notify the Corps (see Special Condition 7 below) at least ten working days before the date disposal operations are expected to begin or resume. The information to be provided in this notification is: permit number, permittee name, address and phone number, phone number of the dredging contractor, name, address and phone number of towing contractor**,** estimated dates dredging is expected to begin and end, name of all disposal vessels to be employed in the work and copies of their certification documents, name of the disposal site, and estimated volume of material to be dredged. **Disposal operations shall not begin or resume until the Corps issues a letter authorizing the initiation or continuation of open-water disposal.** The letter will include disposal point coordinates to use for this specific project at that time. These coordinates may differ from those specified for other projects using the same disposal site or even from those specified earlier for this project. It is not necessary to wait ten days before starting disposal operations. They may start as soon as this letter is issued.

6. If any material is released beyond the limits specified in this permit, the Captain or the permittee must notify the Corps immediately by phone (see Special Condition 7 below). Information provided shall include disposal coordinates, permit number, volume disposed, date and time of disposal, circumstances of incident, disposal vessel name, name of caller, and phone number of caller. If no person is reached at the number above, a voice message with the relevant information should be provided. In addition, a detailed written report must be provided to the Corps within 48 hours following any such incident.

7. Unless otherwise stated (e.g., as in Special Condition 5b above), all submittals and coordination related to these special conditions shall go to the Corps, New England District. ADDRESS: Policy, Analysis and Technical Support Branch, Regulatory Division, U.S. Army Corps of Engineers, 696 Virginia Road, Concord, MA 01742-2751; Phone: (978) 318-8292 or (978) 318-8338; Fax: (978) 318-8303.

The following additional permit conditions apply specifically to MBDS disposal permits.

1. The U.S. Coast Guard, Sector Boston, Waterways Management Division, (617) 223-5750, shall be notified prior to the start of this project.

2. From February 1 through May 30 of any year, disposal vessels including tugs, barges, and scows transiting between the dredge site and the Massachusetts Bay Disposal Site shall operate at speeds not to exceed 5 knots after sunset, before sunrise, or in daylight conditions where visibility is less than one nautical mile. Disposal shall not be permitted if these requirements cannot be met due to weather or sea conditions. In that regard, the permittee and contractor should be aware of predicted conditions before departing for the disposal site. The intent of this condition is to reduce the potential for vessel collisions with endangered species, including right whales.

3. From February 1 through May 30 of any year, a marine mammal observer [i.e. meeting the attached National Marine Fisheries Service (NMFS) criteria on observer qualifications, including the specified skill sets for sea turtles and whales, ***and in receipt of written approval from NMFS***] must be present aboard disposal vessels transiting between the dredge site and the Massachusetts Bay Disposal Site during daylight hours. The permittee shall submit to the Corps of Engineers for approval a statement of qualifications for each observer. The observer(s) shall be contracted and paid for by the permittee.

4. When threatened or endangered species are observed to be present, the vessel captain shall, except when precluded by safety considerations, avoid harassment of or direct impact to individual animals in consultation with the marine mammal observer.

5. The permittee (or designee) shall report any interactions with listed species to NMFS within 24-hours at (978) 281-9328 and immediately report any injured or dead marine mammals or sea turtles to NMFS Stranding Hotline at (978) 281-9351.

6. The permittee shall ensure that a separate NMFS Marine Mammal Observation Report is fully completed by the observer for every sighting and that this report is received by the Corps, (978) 318-8303 fax, within one week of the trip date. The permittee shall require the observer to maintain contact with NMFS, Habitat and Protected Resources Division, (978) 281-9328 and other recognized experts to provide and receive information regarding the presence and distribution of threatened and endangered species in Massachusetts Bay. The intent of this condition is to reduce the potential for vessel collisions with threatened and endangered species, including right whales, and to minimize potential impacts of dredged material disposal on threatened and endangered species.

7. Marine mammal observers shall use the following guidelines to minimize conflicts with threatened or endangered species:

a. A marine mammal observer shall be posted on lookout at all times during daylight hours when disposal vessels have left the harbor and are traveling to, at or returning from the disposal site.

b. Disposal vessels shall not approach threatened or endangered species closer than 100 feet (see additional condition below for approaching right whales).

c. Disposal vessels shall adhere to the attached NMFS regulations for approaching right whales, 50 CFR Part 222.32, which restrict approaches within 500 yards of a right whale and specify avoidance measures for vessels that encounter right whales.

d. If threatened or endangered species are sighted within 500 feet from the disposal point, dredged material shall not be released. In this case, the vessel captain may elect to wait until the animals move away from the disposal point prior to disposal, or subject to consultation with the observer, may dispose at a Corps-authorized alternative disposal location under the same restrictions noted herein for disposal at the primary disposal location.

e. If threatened or endangered species are sighted between 500 feet and 1500 feet from the disposal point, the observer shall note the animals' behavior, relative position, and direction and speed of movement to assess if release of dredged material is likely to harass or endanger the animals. For example, whales actively feeding at or near the disposal point are more likely than resting whales to interact with released sediments. If the observer assesses that disposal is likely to harass or endanger the animals, the observer shall consult with the vessel captain and disposal shall be delayed until the animals change their behavior or move away such that the observer assesses that no danger to the animals will likely result from disposal.

Other special management practices may exist at the site for individual projects to improve site management, anticipate future disposal requirements, or improve the conditions at the site.

7.3 DISPOSAL LOCATIONS AND COORDINATES

The USACE deploys a taut wire buoy at the specific coordinates for the disposal location. If a buoy is not available, specified coordinates are provided to the permittee. Disposal locations are specified to minimize environmental and cultural resource impacts from sediments placed at the site. The MBDS is currently being managed to develop a containment cell around which dredged material is disposed in a ring of mounds. The containment cell is located in a natural depression near the northeast quadrant of the disposal site. The depression is expected to accumulate contaminants from the disposal mound, and from natural sediment deposition in Stellwagen Basin[10]. It is expected that this depression will eventually be contained with additional dredged material.

In 2008, coordinates were provided for disposal in the western portion of the MBDS to evaluate whether dredged material disposal in a sequential approach can cover up the containers, without an unacceptable disturbance of in-place contaminated sediments, or barrel fragments (See Section 6.3). This demonstration project is an integral component of the monitoring program.

7.4 ALLOWABLE DISPOSAL TECHNOLOGIES AND METHODS

Dredging and dredged material disposal in Massachusetts Bay has historically been accomplished using a bucket dredge to fill split hull or pocket scows for transport to the disposal site. Typically, 1,000 to 6,000 CY vessels are used for disposal. The volume of material allowed

[10] Unsuitable dredged material cannot be disposed at MBDS.

in a barge may be restricted depending upon the results of the USACE water quality model[11] used during evaluation of dredged material for any given dredging project (see Section 6.3).

7.5 TIMING OF DISPOSAL MINIMIZES CONFLICTS WITH OTHER USES OF THE AREA

At this time, there are no seasonal restrictions on disposal of dredged material at the site. After consultation with NMFS and MA DMF time of year (TOY) windows are typically established, however, to protect sensitive fish species at the dredge site. As described in Section 4, a LNG port has been constructed (NEG) adjacent to the disposal site and another port (Neptune) is currently under construction. Although the presence of a LNG tanker in the area may require occasional changes in transport routes to the MBDS there are no restrictions on disposal when an LNG tanker is on station at either of the offshore terminals.

7.6 DREDGED MATERIAL DISPOSAL COMPLIANCE INFORMATION IS RECORDED IN AN INFORMATION MANAGEMENT SYSTEM

See Section 8.1.

7.7 ENVIRONMENTAL AND COMPLIANCE MONITORING ARE DESIGNED TO RECOGNIZE AND CORRECT CONDITIONS BEFORE UNACCEPTABLE (SIGNIFICANT ADVERSE) IMPACT OCCURS

See Sections 8.1 and 8. 2.

7.8 MODIFICATIONS TO DISPOSAL PRACTICES AND THE SITE

Based on the findings of the monitoring program, no modifications to the site use are contemplated. Corrective measures such as those listed below, however, may be developed by EPA New England and the USACE-NAE if necessary. These measures may include:

- Stricter definition and enforcement of disposal permit conditions;
- Implementation of more protective judgments on whether sediments proposed for dredging are suitable for open-water disposal;
- Implementation of special management practices to prevent any additional loss of sediments to the surrounding area;
- Closure of the site as an available dredged material disposal site (i.e., to prevent any additional disposal at the site).

[11] NAE evaluates all disposal projects with potential to violate water quality standards at the MBDS using the STFATE model, which is described in the RIM and is available at: http://el.erdc.usace.army.mil/products.cfm?Topic=model&Type=drgmat

In addition, other management considerations may be determined on a project-by-project basis through consultation with the NMFS, USFWS and MA DMF, and coordination with other state and Federal agencies. These may include the following:

- Use of marine mammal observers during disposal operations outside of the February 1 to May 30 time period;
- Establishment of dredging windows;
- Compliance with Essential Fish Habitat (EFH) recommendations; and
- Endangered Species Act (ESA) concerns.

Any changes to special permit conditions may be discussed at the Regional Dredging Team or Massachusetts Dredging Team meetings.

As described in Section 6.1 some of the future Boston Harbor dredged material is proposed for disposal at the old IWS. Disposal at the IWS, however, is outside of the current boundaries of the MBDS and would necessitate an expansion (perhaps temporary) of the disposal site boundaries or a specific time-limited site selection.

8. MONITORING PROGRAM

The monitoring program is organized into two complementary parts: compliance monitoring and environmental monitoring.

8.1 COMPLIANCE MONITORING

Compliance monitoring includes evaluation of information and data relevant to the conditions in permits and authorizations and will be gathered separately from the environmental data. Disposal operations will be routinely reviewed to determine whether the requirements of the issued permits and authorizations have been met. This includes review of the Silent Inspector logs, and any observations by the USACE project managers on a project-specific basis to determine the potential magnitude of effect and the appropriate action.

All dredged material disposal compliance information is recorded in an electronic database called Dredged Material Spatial Management and Resolution Tool [DMSMART]). DMSMART is designed to incorporate results from the dredged material sediment analyses and scow logs. DMSMART includes the following fields for each disposal record: permit number, disposal load volume, and disposal location. The database assists the USACE to evaluate projects from the same or nearby areas, and compliance with conditions in disposal permits and authorizations.

It is assumed that testing information from projects authorized to use the site for dredged material disposal and from the reference area can provide key information about the expected quality of material that has been placed in the site.

8.2 ENVIRONMENTAL MONITORING OBJECTIVES

As described in Section 5.2, the monitoring program is prospective, in that it attempts to identify early warning indicators of adverse effects, as described in the conceptual model, and is based on hypothesis testing using sampling technologies with rapid data return. The monitoring described below is typically Tier 1 monitoring in the Tiered Monitoring Protocol recommended by Germano *et al.* (1994) and generally followed by the DAMOS program for many years. If results of the first tier hypothesis indicate an adverse effect or unacceptable impact, then a second tier monitoring test is triggered.

The timing of monitoring surveys and other activities will be governed by funding resources, the frequency of disposal at the site, and the results of previous monitoring data. Measurement of certain conditions in the site can be performed at a lower frequency (e.g., sediment chemistry) or only in response to major environmental disturbances such as the passage of major storms.

The specific objectives of the monitoring plan proposed here are slightly modified from the original objectives in 1996 and incorporate the demonstration project to evaluate in-place sediment capping and continuation of the development of a containment cell and the potential continued disturbance by operation of the nearby LNG ports. In addition, we added another objective to evaluate the suitability of the reference area. These objectives are posed as testable hypotheses.

1) Dredged material remains within a confined mound

Tier 1 monitoring: This will be accomplished by periodic high resolution multibeam bathymetry, side scan sonar or sediment acoustic characterization, supplemented with sediment profile imaging. SPI measurements will be collected from transects radially away from the disposal mound up to 1,000 meters from the center. Because mounds are being formed at distinct locations in the disposal site to create a containment cell, it is recommended that these surveys be conducted about six months to one year after the end of disposal at each mound, and a follow-up three to five years later.

Response: A confined mound is defined as a mound located at the disposal buoy with no significant change in height or shape. Mounds are expected to consolidate (lose height) over time, but to not change shape significantly. Changes in height and shape can be detected by comparison of bathymetric observations from previous surveys, within the resolution of the equipment. Height and diameter of newly formed mounds can be estimated based on the volume of material disposed. If these measurements indicate that a disposal mound is confined within an expected area, no management action is required. If these measurements indicate that a disposal mound is not confined within an expected area, a review of disposal permits and silent inspector records will be conducted. Additional SPI camera measurements will be performed to determine the magnitude and spatial extent of movement of material.

2a) Benthic infauna recolonize disposal mounds
2b) The benthic community beyond the mound is not adversely impacted

Tier 1 monitoring: This will be accomplished by sediment profile imaging performed six months to about one year after the cessation of mound formation, and a follow up three to five years later. SPI camera measurements should be conducted to the edge of each mound to ensure that biological observations are consistent with the bathymetric surveys. Samples will be collected routinely from recently formed mounds; transects radially away from the disposal mound up to 1,000 meters from the center, and randomly selected stations from the disposal mound and the MBDS reference area. Sampling using radial transects are employed to measure a gradient of impact from disposal mounds. Following completion of disposal, a SPI camera survey should be performed over the new Mounds E and F and the demonstration mounds to confirm that the expected pattern of benthic recolonization is occurring. Evaluation of recolonization and adverse impacts will be made based on statistical evaluation of the parameters measured by SPI cameras.

Response: If the results of these tests indicate that recolonization on the disposal mounds is occurring, no management action is required. If the results of these tests indicate that recolonization is not occurring, then SPI camera measurements from off the disposal mound will be examined to determine whether this biological response is widespread or is not related to disposal. If SPI camera measurements determine that Stage III fauna are absent away from the disposal mounds after three to five years, the SPI camera photographs should be evaluated to determine whether grain size or other sediment properties may be hindering recolonization or the expected succession sequence. If neither of these hypotheses explains the pattern observed, sediment toxicity tests should be conducted as soon as feasible.

3a) Contaminants are not accumulating in sediments at the disposal site and the reference areas

Tier 1 monitoring: Sediments should be collected and measured for contaminants once every five to ten years, or whenever benthic community appears to be altered based on results of sediment profile imaging. Samples will be collected from recently formed mounds at randomly selected stations on the mounds and at the MBDS reference area, but may include stations with historical SPI observations. Statistical approaches to compare mounds to reference areas are described in Section 5. Levels of contaminants in disposal site sediments will be compared to reference area sediments and to previously measured disposal site sediment contaminant levels.

Response: If levels of many (e.g. >5) contaminants are not significantly greater than (as determined by an ANOVA or non-parametric test) recently disposed sediments, reference sediments, unimpacted sites within the disposal site, or previous measurements in the same area, then no management action is required. If levels of many contaminants are significantly greater than recently disposed sediments, then results of dredged material suitability determinations should be re-examined for possible explanations. If statistically significant increases in sediment chemistry above permitted dredged material project data are found, then theoretical bioaccumulation potential (TBP) calculations will be performed. If TBP calculations suggest significant potential for bioaccumulation, direct bioaccumulation tests should be performed (see hypothesis 3b).

3b) Contaminants are not accumulating in biological resources beyond the mound

Tier 2 monitoring: Based on the sediment chemistry monitoring and application of the theoretical bioaccumulation potential model (using highest replicates), levels of contaminants in fish can be predicted.

Response: If the bioaccumulation model results in concentrations above acceptable levels for ecological and human health, sampling of tissue from resident species such as the ocean quahog, lobster and American plaice (and if feasible, the Acadian redfish) should be conducted. To relate contaminant levels to biological effects a baseline study of histopathology of American plaice, or the dominant benthic fish or shellfish, may be considered.

4) The benthic community at the old "BFG" buoy area is recovering from historical dredged material disposal

Tier 1 monitoring: This should be accomplished by periodic sediment profile imaging, bottom grabs with benthic community analysis, and toxicity testing at the old "BFG" buoy area conducted with transects radially up to 1,000 meters away from the center of the area. Sampling using radial transects are employed to measure a gradient of impact from the former disposal area. Because SPI camera measurements have not been conducted at this site since 1994, it is recommended that SPI camera measurements be performed at this site if funding is available. Results of these surveys will assist in verifying assumptions of the conceptual model of benthic impacts of dredged material disposal. The EPA survey in 2006 demonstrated elevated, but moderate levels of contaminants at this site, and that the sediments were not toxic to amphipods.

Response: If the measurements indicate an unexpected benthic community based on our understanding of impacts of dredged material disposal to the biological community (see section 4) then sampling of tissue from resident species such as the ocean quahog, lobster and American plaice (and if feasible, the Acadian redfish) should be conducted to determine the extent of the effects. If ecological and potential human health effects are observed, further capping of these sediments should be contemplated[12].

5) The Rock Reef Site, and nearby rock debris, are colonized by a diverse hard rock epifaunal and fish community

Tier 1 monitoring: Although this site appears to exhibit a relatively unaltered community of colonizing sponges, anemones and other epifauna periodic (e.g. every five to ten years) video observations of the benthic community should be conducted. This should be performed in association with the Stellwagen Bank National Marine Sanctuary program.

Response: if video observations indicate an altered or unexpected benthic community, a more intense research and monitoring effort should be contemplated to determine the potential cause. The expected benthic community will be based on observations from other areas in Stellwagen Bank.

[12] Based on the EPA survey results in 2006 (Liebman and Brochi, 2008), this action is not likely.

6) Evaluation of re-suspension of bottom sediments from disposal of dredged material

Special study: At the time this plan was under revision, NAE was conducting a demonstration project in the western portion of the MBDS to evaluate whether dredged material disposal in a sequential approach can cover up the historically disposed waste containers, without unacceptably impacting the in-place sediments or barrel fragments. This study was investigating the feasibility of using the large volume of sediments that will be available when Boston Harbor is deepened in the coming years (see Section 6.1) to cap portions of Massachusetts Bay that received industrial wastes from the 1940s to 1970s (see Section 3.2). The sediments used in the study were from creation of confined aquatic disposal cells in the harbor; sediments similar to those expected from the deepening. Barge loads of the sediment were directed to a series of placement lines and points in a simulation of capping. The investigation focused on methods to minimize disposal impacts on the in-place sediments. Surveys were being conducted to map the distribution of the disposed sediment and assess its disturbance of the in-place sediments. Survey tools included high resolution bathymetry, sediment profile and plan view camera photographs, side scan sonar, sub-bottom profiling, and sediment coring.

Response: If results of this study suggest that in-place sediments were not significantly disturbed, this approach would be utilized to cap the containers.

7) Evaluation of suitability of reference area

Mapping the location of the reference area onto a base map of the topography of Massachusetts Bay prepared by the USGS (Butman *et al.*, 2004) indicated that the reference area may be located on and around a drumlin. The drumlin is a topographic high and may influence grain size and other sediment properties. In comparing sediment collected from the reference area in 2006 to previous years Liebman and Brochi (2008) identified significant variability in grain size and TOC content of the sediments from the reference area. A review of reference area data will be conducted and a survey will be performed to better map the seafloor in the area and determine whether a more suitable reference area can be selected to reduce this variability.

8.3 EVALUATION OF DATA AND MANAGEMENT RESPONSES

The identification of unacceptable impacts from dredged material disposal at the site will be accomplished in part through comparisons of the monitoring results to historical (baseline) and previous conditions, and to unimpacted nearby reference locations measured concurrently with site measurements. If site monitoring data demonstrates that the disposal activities are causing unacceptable impacts to the marine environment as defined under 40 CFR §228.10(b), EPA and the USACE may place appropriate limitations on site usage to reduce the impacts to acceptable levels. Such responses may include: limitations on the amounts and types of dredged material permitted to be disposed; limitations on the specific disposal methods, locations, or timing; isolation of sediments with elevated contaminants or de-designating the site for unconfined ocean disposal of dredged material.

8.4 MONITORING TECHNOLOGIES AND TECHNIQUES

The technologies used for this monitoring plan have already been described in Section 5; these technologies and approaches are typically used to evaluate dredged material disposal sites in the northeast United States. Use of consistent techniques increases comparability with future and historic data; monitoring methods used at the MBDS, however, are not limited to these technologies. New technology and approaches may be used as appropriate to address questions that arise in the future. For example, 40 CFR §228.9(b) states that surveys may be supplemented, "where feasible and useful, by data collected from the use of automatic sampling buoys, satellites or in situ platforms, and from experimental programs."

8.5 QUALITY ASSURANCE

An important part of any monitoring program is a quality assurance (QA) regime to ensure that the monitoring data are reliable. Quality assurance has been described as consisting of two elements:

1. Quality Control - activities taken to ensure that the data collected are of adequate quality given the study objectives and the specific hypothesis to be tested, and include standardized sample collection and processing protocols and technician training (National Research Council [NRC], 1990).

2. Quality Assessment - activities implemented to quantify the effectiveness of the quality control procedures, and include repetitive measurements, interchange of technicians and equipment, use of independent methods to verify findings, exchange of samples among laboratories and use of standard reference materials, among others (NRC, 1990).

All EPA organizations that collect, evaluate, or use environmental data or design, construct, or operate environmental technology are covered by the EPA Quality System. Data collected by EPA must meet the requirements in the EPA Directive CIO 2105-P-01-0 (Quality Manual for Environmental Programs) and develop an approved Quality Assurance Project Plan[13]. All USACE monitoring must meet QA requirements as specified in contract award documents. This usually involves the contractor providing a QA plan for the various types of work requested.

8.6 COORDINATION WITH COMPLEMENTARY OR REGIONAL MONITORING PROGRAMS

The regulation 40 CFR §228.10(c) requires that a disposal site be periodically assessed based on the entire available body of pertinent data and that any identified impacts be categorized according to the overall condition of the environment of the disposal site and adjacent areas. Some aspects of the impact evaluation required under MPRSA §102(c)(3) can be accomplished using data from regional monitoring programs (e.g., fisheries impact).

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[13] EPA QA guidance documents are found at <http://www.epa.gov/quality/qs-docs/g5-final.pdf>.

Thus, EPA and the USACE will review ongoing regional monitoring programs that can provide additional data to inform the periodic assessment of impact, such as the MWRA outfall monitoring program, the Stellwagen Bank National Marine Sanctuary programs, NMFS or MA DMF trawl surveys for fisheries resources (See Section 3 Baseline Assessment), and monitoring associated with the LNG ports.

9. REVIEW AND REVISION OF THIS PLAN

The MPRSA requires that the SMMP include a schedule for review and revision of the SMMP, which shall not be reviewed and revised less frequently than ten years after adoption of the plan, and every ten years thereafter. The next revision of this SMMP will be completed by 2019. The EPA, the USACE, and other federal and state agencies have agreed to review this plan yearly as part of the annual agency planning meeting agenda (Section 3.2). Reassessment of the EFH and endangered species issues will also be conducted on a ten year basis with NMFS.

10. COORDINATION AND OUTREACH

The EPA and the USACE coordinate closely on management of the disposal site, and evaluation of permit applications for disposal of dredged material disposal. The EPA and the USACE also coordinate closely with the Massachusetts and Regional Dredging teams. Coordination and outreach will be continuous and include state and Federal agencies, scientific experts, and the public. These teams may provide recommendations on management of the MBDS. Other meetings may be called in response to unusual physical events or unexpected monitoring observations. During these meetings, monitoring data will be evaluated and the SMMP will be revised as necessary depending on current conditions and available site-specific and scientific information.

To ensure communications are appropriate and timely, site management activities and monitoring findings will be communicated through many mechanisms: scientific reports, peer reviewed publications, participation in symposia, the USACE and EPA websites, public meetings, and fact sheets. For example, the DAMOS Program holds periodic symposia (typically every three years) to report results and seek comments on the program. In addition, DAMOS monitoring results are published in an ongoing series of technical reports that are mailed to interested parties and organizations, are distributed at various public meetings, and published on the DAMOS website[14]. The USACE also has prepared and distributed several Information Bulletins and brochures on different aspects of the dredged material management. Site-related reports can also be reviewed at both the USACE Technical Library and the EPA regional libraries:

U.S. EPA New England

U.S. Army Corps of Engineers

[14] http://www.nae.usace.army.mil/damos/index.asp

Regional Library
John W. McCormack Federal Bldg
Five Post Office Square
Boston, MA 02109
Hours: Monday-Thursday 9:30 to 3:30 pm
Tel: 617-918-1990
http://www.epa.gov/libraries/region1.html

NAE Technical Library
696 Virginia Road

Concord, MA 01742-2751
Hours: Monday-Friday 7:30-4:00
Tel: 978-318-8118

Any party interested in being added to the DAMOS mailing list should provide their contact information to the USACE at:

U.S. Army Corps of Engineers, New England District
Regulatory Division
Marine Analysis Section
696 Virginia Road
Concord, MA 01742-2751

11. FUNDING

The costs involved in site management and monitoring will be shared between EPA New England and USACE-NAE and are subject to the availability of funds. This SMMP will be in place until modified or the site is de-designated and closed.

These recommendations do not necessarily reflect program and budgeting priorities of the Federal government in the formulation of EPA's national Water Quality program or the USACE national Civil Works water resources program. Consequently, any recommendations for specific activities or annual programs in support of efforts in the waters of coastal Massachusetts may be modified at higher levels within the Executive Branch before they are used to support funding level recommendations. Requests for funding are also subject to review and modification by Congress in its deliberations on the Federal budget and appropriations for individual programs. Similarly, state agency programs will depend solely on funds allocated to the programs by those agencies or other supporting agencies.

12. REFERENCES

Bothner, M.H. and B. Butman (eds.). 2005. Processes influencing the transport and fate of contaminated sediments in the coastal ocean—Boston Harbor and Massachusetts Bay: U.S. Geological Survey Open-File Report 2005-1250. Created October 17, 2005.

Bothner, M.H. and B. Butman (eds.). 2007. Processes influencing the transport and fate of contaminated sediments in the coastal ocean—Boston Harbor and Massachusetts Bay: U.S. Geological Survey Circular 1302, 89 pp. (Available online at http://pubs.usgs.gov/circ/2007/1302/.)

Butman, B., M.H. Bothner, J.C. Hathaway, J.L. Jenter, H.J. Knebel, F.T. Manheim, and R.P. Signell. 1992. Contaminant transport and accumulation in Massachusetts Bay and Boston Harbor: a summary of U.S. Geological Survey studies. USGS Open File report 92-202. Woods Hole, MA.

Butman, B. and J.A. Lindsay (eds). 1999. A Marine GIS Library for Massachusetts Bay: Focusing on Disposal Sites, Contaminated Sediments, and Sea Floor Mapping. U.S. Geological Survey Open-File Report 99-439. October 1999. U.S. Geological Survey, Woods Hole, MA and NOAA Office of Response and Restoration, Seattle, WA.

Butman, B., P. C. Valentine, W. W. Danforth, L.Hayes, L. A. Serrett, and T. J. Middleton. 2004. Shaded Relief, Sea Floor Topography, and Backscatter Intensity of Massachusetts Bay and the Stellwagen Bank Region Offshore of Boston, Massachusetts. U.S. Geological Survey Geologic Investigations Series Map I-2734. Version 1.0. Prepared in cooperation with the National Oceanic and Atmospheric Administration. (Available online at http://pubs.usgs.gov/imap/i2734/).

Butman, B., P. C. Valentine, T. J. Middleton, and W. W. Danforth. 2007. A GIS Library of Multibeam Data for Massachusetts Bay and the Stellwagen Bank National Marine Sanctuary, Offshore of Boston, Massachusetts. U.S. Geological Survey Data Series 99, Version 1.0. (Available online at http://woodshole.er.usgs.gov/pubs/ds-99/).

ENSR. 2005. Monitoring Survey at the Massachusetts Bay Disposal Site, September 2004. DAMOS Contribution No. 162. U.S. Army Corps of Engineers, New England District, Concord, MA, 64 pp.

ENSR. 2007. Monitoring Survey at Boston Harbor CAD Cells, August 2004. DAMOS Contribution No. 168. U.S. Army Corps of Engineers, New England District, Concord, MA, 112 pp.

Field, L.J., D.D. MacDonald, S.B. Norton, C.G, Severn, and C.C. Ingersoll. 1999. Evaluating sediment chemistry and toxicity data using logistic regression modeling. Environmental Toxicology and Chemistry 18(6):1311-1322.

Field, L.J., D.D. MacDonald, S.B. Norton, C.G, Severn, C.C. Ingersoll, D. Smorong, and R. Linkskoog. 2002. Predicting amphipod toxicity from sediment chemistry using logistic regression models. Environmental Toxicology and Chemistry 21(9):1993-2005.

Germano, J.D., D.C. Rhoads, and J.D. Lunz. 1994. An integrated, tiered approach to monitoring and management of dredged material disposal sites in the New England region. DAMOS Contribution No. 87. May 1994. U.S. Army Corps of Engineers, New England Division. Waltham, MA. 81 pp.

Hubbard, W.A., J.M. Penko, and T.S. Fleming. 1988. Site Evaluation studies of the Massachusetts Bay Disposal Site for Ocean Disposal of Dredged Material. U.S. Army Corps of Engineers New England Division.

Hunt C.D., M. Hall, S. Pala, and D.T. Dahlen. 2006. A Review and Summary of Toxic Contaminants in Boston Harbor and Massachusetts Bay: 1990 to 2005. Boston: Massachusetts Water Resources Authority. Report ENQUAD 2006-23. 136pp.

Keith, D., J. Schoenherr, J. Cook, D. Carey, and G. Tracey. 1992. U.S. Environmental Protection Agency. Final cruise report: Location survey and condition inspection of waste containers at the Boston Lightship dumping ground and surrounding area. ERL-N Contribution No. 1405. US EPA Environmental Research Laboratory-Narragansett. Narragansett, RI. 76 pp.

King, J., M. Camisa, V. Manfredi and S. Correia. 2007. MA DMF 2007 Annual Performance Report, Project Title: Massachusetts Fishery Resource Assessment. Available online at http://www.mass.gov/dfwele/dmf/programsandprojects/f56r15_resource_2007_web1.pdf

Knowles, D. 1999. Letter from Donald Knowles, Director of Office of Protected Resources, National Marine Fisheries Service, to John DeVillars, EPA Region 1 Regional Administrator. Amendment to 1991 Biological Opinion on the MBDS Designation. October 18, 1999.

Libby, P.S., W.R. Geyer, A.A. Keller, A.D. Mansfield, J.T. Turner, D. Borkman and C.A. Oviatt. 2006. 2004 Annual Water Column Monitoring Report. Boston: Massachusetts Water Resources Authority. Report ENQUAD 2006-15. 177p.

Liebman, M. and J. Brochi. 2008. US EPA Survey at the Massachusetts Bay Disposal Site and Industrial Waste Site July 2006. U.S. EPA Region 1 (New England) Office of Ecosystem Protection, Ocean and Coastal Protection Unit. Draft Report. September 11, 2008. Boston, MA. 55 pp.

Massachusetts Office of Coastal Zone Management (MA CZM). 2000. Dredged Material Management Plan (DMMP) EOEA No. 11534. Draft Environmental Impact Report (DEIR) for Gloucester, Massachusetts. Prepared by Maguire Group Inc., Foxborough, Massachusetts. Prepared for Massachusetts Office of Coastal Zone Management. Boston, Massachusetts. (Available online at http://www.mass.gov/czm/gloudmmp.htm).

Massport, 2008. Web site accessed September 16, 2008. http://www.massport.com/ports/about_ports.html

Moore, M.J., R. Smolowitz, K. Uhlinger, L. Lefkovitz, J. Ziskowski, G. Sennefelder, J. King, M. Hall, J. Schwartz and D. Pierce. 2005. Ulcerative Dermatitis in Massachusetts Bay Winter Flounder, Pseudopleuronectes americanus. Presentation to the MWRA Outfall Monitoring Science Advisory Panel Flounder Focus Group, March 31, 2005. (Available online at http://www.epa.gov/region1/omsap/omsapm.html.)

National Research Council (NRC), 1990. Managing troubled waters, the role of marine environmental monitoring. National Academy Press. 95 pp.

National Oceanic and Atmospheric Administration (NOAA). 1996. The Massachusetts Bay Industrial Waste Site: A Preliminary Survey of Hazardous Waste Containers and an Assessment of Seafood Safety. (May and June 1992). NOAA Technical Memorandum NOS ORCA 99. Edited by John Lindsay.

NOAA Fisheries Service. 2005. Resource survey report Bottom Trawl Survey. NOAA Fisheries Service, Northeast Fisheries Science Center, Woods Hole, MA 02543. Cape Hatteras – Gulf of Maine September 6 – November 4, 2005.

NOAA Fisheries Service. 2006. Resource survey report Bottom Trawl Survey. NOAA Fisheries Service, Northeast Fisheries Science Center, Woods Hole, MA 02543. Cape Hatteras – Gulf of Maine September 5 – October 26, 2006.

NOAA Fisheries Service. 2008. Resource survey report Bottom Trawl Survey. NOAA Fisheries Service, Northeast Fisheries Science Center, Woods Hole, MA 02543. Cape Hatteras – Gulf of Maine March 6 – May 3, 2008. (Available online at http://www.nefsc.noaa.gov/femad/ecosurvey/mainpage/rsr/sbts/sbts_2008/large_file.pdf).

NOAA National Marine Sanctuary Program. 2008. Stellwagen Bank National Marine Sanctuary Draft Management Plan/Environmental Assessment. Silver Spring, MD. 366 pp.

NOAA National Centers for Coastal Ocean Science (NCCOS) 2006. An Ecological Characterization of the Stellwagen Bank National Marine Sanctuary Region: Oceanographic, Biogeographic, and Contaminants Assessment. Prepared by NCCOS's Biogeography Team in cooperation with the National Marine Sanctuary Program. Silver Spring, MD. NOAA Technical Memorandum NOS NCCOS 45. 356 pp. (Available online at http://ccma.nos.noaa.gov/ecosystems/sanctuaries/stellwagen_nms.html).

NMFS. 1991. National Marine Fisheries Service Endangered Species Act Section 7 Consultation - Biological Opinion for the Final Designation for Ocean Disposal at the Massachusetts Bay Disposal Site. NMFS Northeast Region. November 7, 1991.

Poppe, L.J., V.F Pakevich, S.J. Williams, M.E. Hastings, J. T. Kelley, D.F. Belknap, L.G. Ward, D.M. FitzGerald and P.F. Larsen. 2003. Surficial Sediment Data from the Gulf of Maine, Georges Bank, and Vicinity: A GIS Compilation. U.S. GEOLOGICAL SURVEY Open-File Report 03-001. Available on CD-ROM.

Rhoads, D.C. and J.D. Germano. 1982. Characterization of organism-sediment relations using sediment profile imaging: An efficient method of Remote Ecological Monitoring of The Seafloor (REMOTS® System). Mar. Ecol. Prog. Ser. 8:115-128.

Rhoads, D.C. and J.D. Germano. 1986. Interpreting long-term changes in benthic community structure: a new protocol. Hydrobiologia 142: 291-308.

Rhoads, D.C., I. Williams, and P. Murray. 1996. Bioaccumulation in Stage I polychaetes/oligochaetes: a field feasibility study. DAMOS Contribution No. 101. U.S. Army Corps of Engineers New England Division. January 1996.

SAIC. 1990b. Analysis of sediment chemistry and body burden data obtained at the Massachusetts Bay Disposal Site October 1987. DAMOS contribution No. 75. U.S. Army Corps of Engineers, New England Division. Waltham, MA.
SAIC. 1994a. Chemical analyses of sediment sampling at the Massachusetts Bay Disposal Site 5-7 June 1989. DAMOS contribution No. 91. U.S. Army Corps of Engineers New England Division. Waltham, MA. 43 pp.

SAIC. 1994b. Monitoring cruise at the Massachusetts Bay Disposal Site, August 1990. DAMOS contribution No. 92. U.S Army Corps of Engineers New England Division. Waltham, MA.

SAIC. 1994c. Monitoring Cruise at the Historic Boston Lightship Disposal Site August 1994. DAMOS No. 113 , U.S Army Corps of Engineers, New England Division. Waltham, MA.

SAIC. 1995. Monitoring cruise at the Massachusetts Bay Disposal Site March 31 - April 4, 1992. DAMOS contribution No. 100. U.S Army Corps of Engineers, New England Division. Waltham, MA.

SAIC. 1997a. Baseline survey of the reconfigured Massachusetts Bay Disposal Site 14 September 1993. DAMOS Contribution No. 115. U.S. Army Corps of Engineers, New England Division. Waltham, MA.

SAIC. 1997b. Monitoring cruise at the Massachusetts Bay Disposal Site, August 1994. DAMOS Contribution No. 116. U.S. Army Corps of Engineers, New England Division. Waltham, MA.

SAIC. 2002. Monitoring Cruise at the Massachusetts Bay Disposal Site, Fall 2000. DAMOS Contribution No. 134. U.S. Army Corps of Engineers, New England District, Concord, MA

Science Applications International Corporation. 2003. The Massachusetts Bay Disposal Site Capping Demonstration Project 1998 to 2000. DAMOS Contribution No. 147. U.S. Army Corps of Engineers, New England District, Concord, MA, 159 pp.

Science Applications International Corporation. 2004. Monitoring Survey at the Massachusetts Bay Rock Reef Site, Summer 2002. DAMOS Contribution No. 151. U.S. Army Corps of Engineers, New England District, Concord, MA, 42 pp.

Tucker, J, S. Kelsey, A. Giblin and C. Hopkinson. 2006. 2005 Annual Benthic Nutrient Flux Monitoring Report. Boston: Massachusetts Water Resources Authority. Report ENQUAD 2006-17. 69 pp.

U.S. Army Corps of Engineers New England District (NAE). 2008. Boston Harbor Massachusetts Feasibility Study for Navigation Improvement. Public Notice April 18, 2008 and

Project Fact Sheet. (Available online at
http://www.nae.usace.army.mil/projects/ma/bhnip/bharbor.htm).

U.S. Army Corps of Engineers and Massachusetts Port Authority (USACE/MassPort). 2006. Final Supplemental Environmental Impact Statement for the Boston Harbor Inner Harbor Maintenance Dredging Project. Concord, MA and East Boston, MA. May 2006. 424 pp.

U.S. Army Corps of Engineers and Massachusetts Port Authority (USACE/MassPort). 2008. Draft Feasibility Report and Supplemental Environmental Impact Statement/Massachusetts Environmental Impact Report for Deep Draft Navigation Improvement Boston Harbor Boston, Chelsea and Revere Massachusetts April 2008. 295 pp. (Available online at http://www.nae.usace.army.mil/projects/ma/bhnip/bharbor.htm).

U.S. Coast Guard. 2006. Final Environmental Impact Statement and Environmental Impact Report, Northeast Gateway Deepwater Port.
U.S. EPA and U.S. Army Corps of Engineers (EPA/USACE). 1991. Evaluation of Dredged Material Proposed for Ocean Disposal: Testing Manual (The "Green Book"). EPA Report No. EPA-503/8-91/001. February 1991. U.S. Environmental Protection Agency, Office of Marine and Estuarine Protection and Department of the Army, U.S. Army Corps of Engineers, Washington, DC. Available online at http://www.epa.gov/OWOW/ oceans/gbook/index.html).

U.S. EPA and U.S. Army Corps of Engineers (EPA/USACE). 1995. QA/QC Guidance for Sampling and Analysis of Sediments, Water, and Tissues for Dredged Material Evaluations. Chemical Evaluations. April 1995. EPA 823-B-95-001. U.S. Environmental Protection Agency, Office of Water and Department of the Army, U.S. Army Corps of Engineers, Washington, DC.

U.S. EPA and U.S. Army Corps of Engineers (EPA/CorpsUSACE). 1996. Guidance Document for Development of Site Management Plans for Ocean Dredged Material Disposal Sites. February 1996. (Available online at http://www.epa.gov/owow/oceans/ndt/siteplan.html).

U.S. Environmental Protection Agency. 2001. Methods for Collection, Storage and Manipulation of Sediments for Chemical and Toxicological Analyses: Technical Manual. October 2001. EPA 823-B-01-002. U.S. Environmental Protection Agency, Office of Science and Technology, Office of Water, Washington, DC.

U.S. Environmental Protection Agency Region 1. 1989. Evaluation of the continued use of the Massachusetts Bay Dredged Material Disposal Site. Draft Environmental Impact Statement. September 1989.

U.S. Environmental Protection Agency Region 1. 1992. Designation of an Ocean Dredged Material Disposal Site in Massachusetts Bay. Final Environmental Impact Statement. July 1992.

U.S. Environmental Protection Agency Region 1. 1993. Public Record of Decision on the Final Environmental Impact Statement for the Designation of an Ocean Dredged Material Disposal Site in Massachusetts Bay. January, 1993.

U.S. Environmental Protection Agency Region 1 (New England). 1996. Massachusetts Bay Disposal Site Management Plan. U.S. EPA Region 1 (New England). Final December 31, 1996. Boston, MA. 49 pp.

US EPA New England and US Army Corps of Engineers New England District (EPA/USACE). 2004. Regional Implementation Manual for the Evaluation of Dredged Material Proposed for Disposal in New England waters. April, 2004. Boston, MA and Concord, MA. (Available at http://www.epa.gov/region1/topics/water/dredging.html)

Valente, R.M, D.C. Rhoads, P.L. Myre, L.B. Read and D.A. Carey. 2006. Evaluation of Field Bioaccumulation as a Monitoring Tool. DAMOS Contribution No. 169. U.S. Army Corps of Engineers, New England District, Concord, MA. 40 pp.

Valentine, P.C., W.W. Danforth, E.T. Roworth, and S.T. Stillman. 1996. Maps showing topography, backscatter, and interpretation of seafloor features in the Massachusetts Bay Disposal Site region off Boston Massachusetts. USGS Open-File Report 96-273, scale 1:10,000 and 1:12,500, 2 sheets. (Available online at http://pubs.usgs.gov/of/of98-344/)

Valentine, P., J. Baker, T. Evans and C. Polloni. Sea-Floor Topographic, Backscatter, and Interpretive Maps and Bottom Photos of the Massachusetts Bay Disposal Site Region off Boston, MA. USGS. 1998. USGS Open-File Report 98-344. Woods Hole, MA. (Available online at http://pubs.usgs.gov/of/1998/of98-344/).

Wade, M.J., C.D. Hunt, M.H. Bothner, G.A. Jones, and P.D. Boehm. 1989. Vertical profiles of radionuclides, selected metals, and hydrocarbons in Massachusetts Bay sediments. Draft report to Camp Dresser and McKee, Inc. January 13, 1989.

Werme, C. and C.D. Hunt. 2006. 2005 outfall monitoring review. Boston: Massachusetts Water Resources Authority. Report ENQUAD 2006-18. 104p.

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 US EPA Region 1. International Wildlife Coalition, Falmouth, MA. 59 pp.

Wilson, S.J.K. T. J. Fredette, J.D. Germano, J.A. Blake, P.L.A. Neubert and D.A. Carey. 2009. Plan-view photos, benthic grabs, and sediment-profile images: Using complementary techniques to assess response to seafloor disturbance. Marine Pollution Bulletin 59: 26-37.

APPENDIX C:

U.S. Environmental Protection Agency Survey
at the Massachusetts Bay Disposal Site and
Industrial Waste Site.

July, 2006.

U.S. Environmental Protection Agency, Region 1.

US EPA Survey at the Massachusetts Bay Disposal Site and Industrial Waste Site July 2006

FINAL September 12, 2008

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US EPA New England, Office of Ecosystem Protection, Ocean and Coastal Protection Unit

Introduction

The Massachusetts Bay Disposal Site (MBDS) is the most frequently used disposal site in northern New England (Figure 1). Since 1992, over 7 million cubic yards of material has been dumped at discrete mounds within the site (EPA, 2008, based on data from NAE).

The disposal of dredged material in ocean waters, including the territorial sea, is regulated under the Marine Protection, Research and Sanctuaries Act (MPRSA, also known as the Ocean Dumping Act). The MPRSA also requires that Site Management and Monitoring Plans (SMMPs) for ocean dredged material disposal sites be completed and updated every ten years; the MBDS SMMP was last completed in December 1996 (US EPA New England, 1996) and must be reviewed and updated every 10 years.

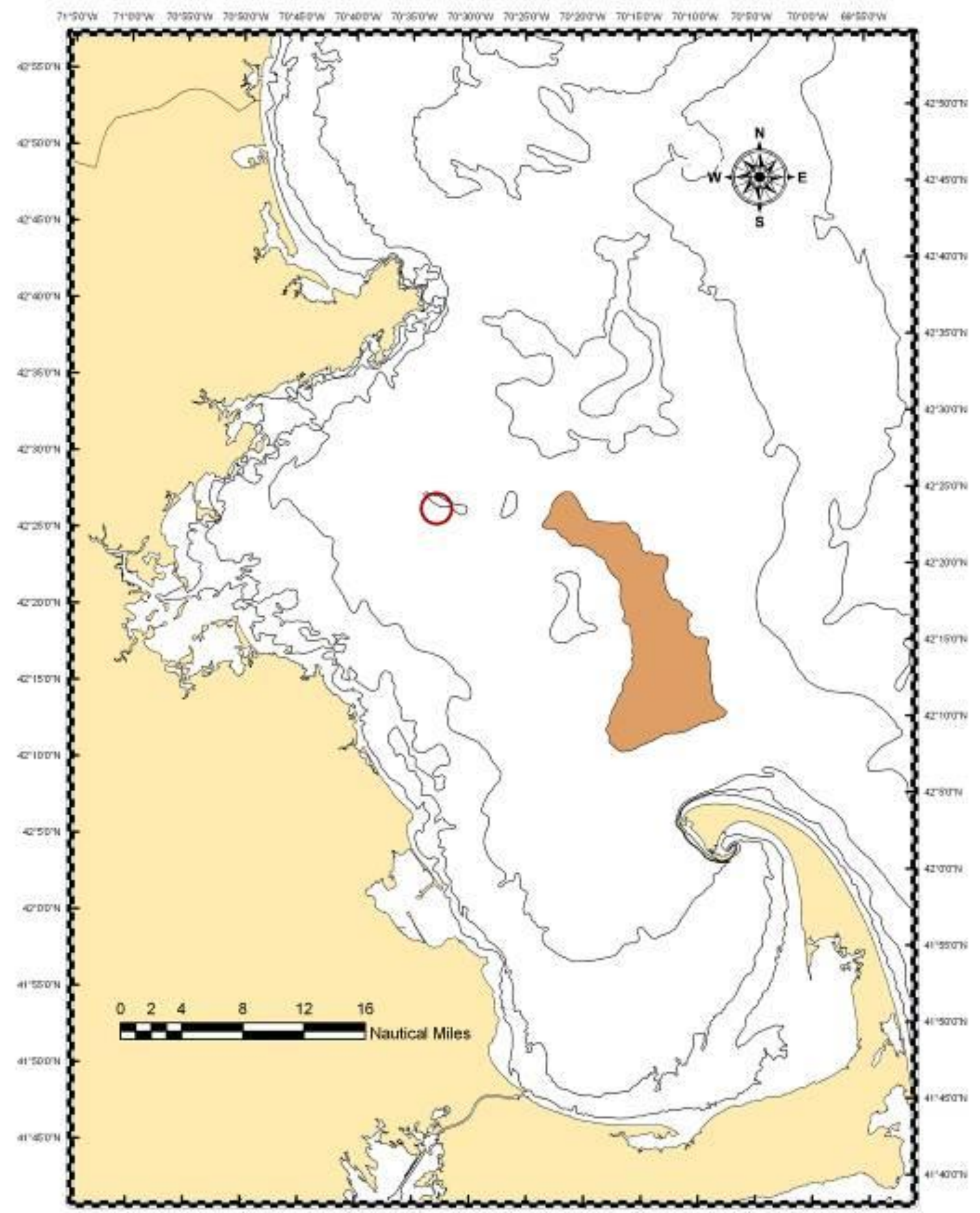
The US EPA conducted a survey in July 2006 at the Massachusetts Bay Disposal Site (MBDS) and historic Industrial Waste Site (IWS) to provide information to evaluate the current management of the site, and further characterize the site for the updated SMMP. Specifically, our objectives were to determine:

1) whether dredged material disposal causes adverse effects to the marine environment; and
2) whether the new OSV Bold digital dual-frequency side scan sonar can detect historically disposed waste containers known to be located at the IWS.

The 1996 SMMP called for several types of monitoring, including high resolution bathymetry, sediment profile imaging and sediment chemistry, based on a tiered monitoring program -- the Disposal Area Monitoring System (DAMOS; Germano *et al.*, 1994) -- established by the Army Corps of Engineers New England District (NAE). A baseline characterization of sediment chemistry, sediment properties and bathymetry was conducted in 1993 and 1994 by NAE (DeAngelo and Murray, 1997; Murray, 1997) and EPA (EPA, 1996). NAE has conducted two surveys that addressed the first tiers of the monitoring program (SAIC, 2002; ENSR, 2005) and another set of surveys to evaluate the feasibility of capping in deep water (SAIC, 2003). These included surveys for sediment profile imaging and high resolution bathymetry to determine whether disposal mounds are forming at locations intended within the disposal site, and that benthic recolonization is occurring at an appropriate pace. No measures of sediment chemistry or toxicity, however, have been conducted from sediments influenced by dredged material at the disposal site.

A significant amount of the dredged material disposed at the MBDS is clay from the Boston Harbor Navigation Improvement Project, but surface sediment from many harbors in the Boston and Salem, MA area are also disposed at the site. Although all of this material was deemed

Figure 1. Location of Massachusetts Bay Disposal Site.



suitable for disposal, it is important to determine whether the "predictions" made by the suitability determinations – that dumping poses no adverse effects to the biological community and to human health – are correct. These predictions are based partly on an evaluation of levels of contaminants in sediments, bioaccumulation of these contaminants by benthic animals (clams and worms) exposed to sediments proposed for disposal, and testing for acute toxicity (EPA New England/US Army Corps New England District 2004). Thus, to complement the bathymetric and sediment profile imaging studies conducted by NAE, it is important to measure the levels of contaminants at the disposal site. Because NAE maintains records of specific locations for disposal of each project, we collected sediments (dumped in defined mounds) from among three categories of sites: dredged material from the Boston Harbor maintenance dredging project disposed within the last four years; material disposed within the last 10 years; and sediments disposed more than 10 years ago. In addition, sediments from the reference sites were evaluated. The results of this monitoring were compared to the baseline sediment characterization and previous measures of sediment chemistry, as well as to project-specific test material.

We hypothesize that levels of contaminants in sediments will reflect levels in sediments deemed suitable for disposal at the site, and that no toxicity should be exhibited. If these hypotheses are correct, then current site management and project evaluation approaches should be continued. Sediments were collected at the MBDS and reference areas to test the following questions:

1. Are levels of contaminants at disposal mounds created within the last four years within the range predicted by testing of dredged material projects for suitability?
2. Are levels of contaminants at a historically (>20 years) contaminated site within the MBDS declining?
3. Are levels of contaminants in disposal mounds declining compared to the reference areas?
4. Is dredged material disposed at the disposal site and reference areas toxic to marine organisms, as measured by the *Ampelisca* 10 day toxicity test?
5. Do levels of contamination in the disposal site pose a risk to aquatic life due to bioaccumulation?

An additional purpose of this survey was to evaluate whether the new OSV Bold digital dual-frequency Klein 3000 side scan sonar system could detect historically disposed containers at the adjacent Industrial Waste Site. Massachusetts Bay was used as a disposal site for industrial, chemical, and low-level radioactive wastes, construction debris, ordnance, and dredged material from the 1940s until 1977, and has continued to be used for dredged material disposal since then. The former Industrial Waste Site (IWS), located 20 miles east of Boston at 290 feet depth, overlapping with the current MBDS is the primary known location for disposal of containers. It was routinely called the "Foul Area," because the material on the bottom "fouls" or damages commercial fishing nets. The history of disposal at the former IWS is outlined in more detail in the Massachusetts Bay Disposal Site evaluation studies (Hubbard *et al.*, 1988), the Draft EIS for Designation of the Massachusetts Bay Disposal Site (EPA, 1989), an assessment of the risks at the former IWS (NOAA 1996), and the 1996 Massachusetts Bay Disposal Site Management and Monitoring Plan (SMMP; EPA, 1996). Radioactive waste disposal ceased in 1959 and industrial waste and construction material disposal ceased in 1977 when the overlapping interim Massachusetts Bay Disposal Site (MBDS) was designated by EPA for dredged material disposal only. The IWS was formally de-designated on February 2, 1990 (40 CFR 228.12).

Because of this area's past use as a dumping ground, the National Marine Fisheries Service (NMFS) closed the former IWS to harvesting of surf clam and ocean quahogs in 1980 (NOAA, 1996). In 1992, the Food and Drug Administration (FDA) and NMFS reissued this advisory, recommending a note be put on nautical charts, and advising all commercial and recreational fishermen to avoid harvesting bottom dwelling species from the area, including the MBDS (NOAA, 1996). There is, however, evidence of trawling activity within the site as revealed in imagery from a multibeam echosounder (Valentine *et al.*, 1996).

From the 1940s to 1977 dredged material, construction debris, barreled industrial waste in 55 gallon drums, waste buckets, encapsulated low-level radioactive waste (in concrete and coffin-shaped containers), munitions, and intentionally sunken derelict vessels were dumped in the northwest quadrant of the former IWS or dispersed around the northern perimeter up to 0.5 nm outside the former IWS (Wiley *et al.*, 1992). Few drums are found farther away from the former IWS.

Beginning in 1973, several federal and state agencies have assessed the threats of chemical and low level radioactive wastes at the former IWS to the marine environment (e.g. Curtis and Mardis, 1984). Two surveys have positively identified waste containers and the remains of containers in and around the former IWS. In 1991, the International Wildlife Coalition (Wiley *et al.*, 1992) conducted a study (partially funded by EPA) to prioritize targets from side-scan sonar records and visually investigated them using a video camera on a remotely operated vehicle (ROV). The ROV videos verified that most of these barrels were corroded or broken and it is assumed that most of the constituents have dispersed. No concrete coffins were observed in the 1991 survey. Based on the side scan, and visual observations, the IWC estimated that 10,000 to 20,000 barrels were scattered on the seafloor, centered near the northern edge of the former IWS.

The side scan methodologies employed in 1991 were limited compared to technologies available today. The 1991 side scan sonar results were available only on paper; the 2006 results are in digital format, and the new digital Klein system is able to resolve and detect containers on the seafloor better than the 1991 system (Vince Capone, personal communication).

NOAA led a multi-agency risk assessment in 1992 to collect sediments, fish, and shellfish at sites identified in the 1991 survey for *in situ* and laboratory analyses of chemical contaminants and radioisotopes. Except for one sediment sample, no radioactivity above background levels was detected (NOAA, 1996). Observations from a ROV confirmed that most of the barrels or drums are corroded or broken. Direct radiation measurements from barrels, or from sediments adjacent to barrels, are at background levels or do not pose risks to human health. The contributing agencies concluded that the low-level radioactive waste or the hazardous substances investigated did not pose 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 area of the IWS, pose potentially significant occupational risks to users of bottom-tending mobile gear” (NOAA, 1996).

The purpose of this survey is to confirm observations made in 1991 and 1992, and determine the locations and spatial extent of historic waste containers proposed for capping by dredged material from a navigation improvement project. The Corps and EPA New England (EPA) are evaluating whether 10 to 11 million cubic yards (CY) of unconsolidated dredged material (mainly “Boston Blue Clay”) generated by the Boston Harbor Navigation Improvement Project can be used to cap several of the historically disposed waste container concentrations in the former IWS. At a cap thickness of five feet, 6 million CY would cover about 1.2 square miles of bottom, while 15 million CY would cover 2.9 square miles (Mark Habel, NAE, personal communication). This proposed beneficial use represents a one-time opportunity to cap and isolate the bottom sediments and remaining containers and debris at the former IWS.

Sediment Chemistry and Toxicity Methods

Survey period

The OSV Bold visited the MBDS and IWS from July 13 to July 17, 2006. Sediments were collected on board the OSV Bold on July 13 and 14, and side scan sonar data were collected July 15, 16 and 17.

Sediment sampling design

Sediment samples were collected at five kinds of stations within the MBDS, and from the reference site about 5 nautical miles southeast of the MBDS in Stellwagen Basin (Table 1). Within the MBDS, samples were collected from material disposed within the previous four years (Mound F), from material dumped from eight to twelve years ago (Mounds A and C) and material dumped more than twenty years ago near the old buoy “A”, which was used from 1975 to 1985. A survey in 1989 (Murray, 1994) identified an area of contamination (“Station 12-3”, or “Hotspot”) just west of this buoy location. Sediment profile imaging in and around Station 12-3 in 1994 indicated that dredged material is still present (Murray, 1997). Finally, sediment was collected from a depression (“Deep”) in the center of the disposal site, within the ring of dredged material mounds **(see Figures 2, 3 and 4).** This is an area expected to accumulate contaminants from nearby disposal operations or from natural sedimentary processes. Station locations (Table 2) were designed to target stations previously sampled by the EPA or Army Corps New England District as part of the DAMOS program, for sediment chemistry or sediment profile imaging (SPI) at the Reference area, and Mounds A and C. Before this survey, Mound F and the Deep site had never been sampled for chemistry or sediment profile imaging.

Figure 2. Station locations for sediment chemistry sampling from the MBDS and reference stations from Nobeltec electronic navigation chart on board the OSV Bold.

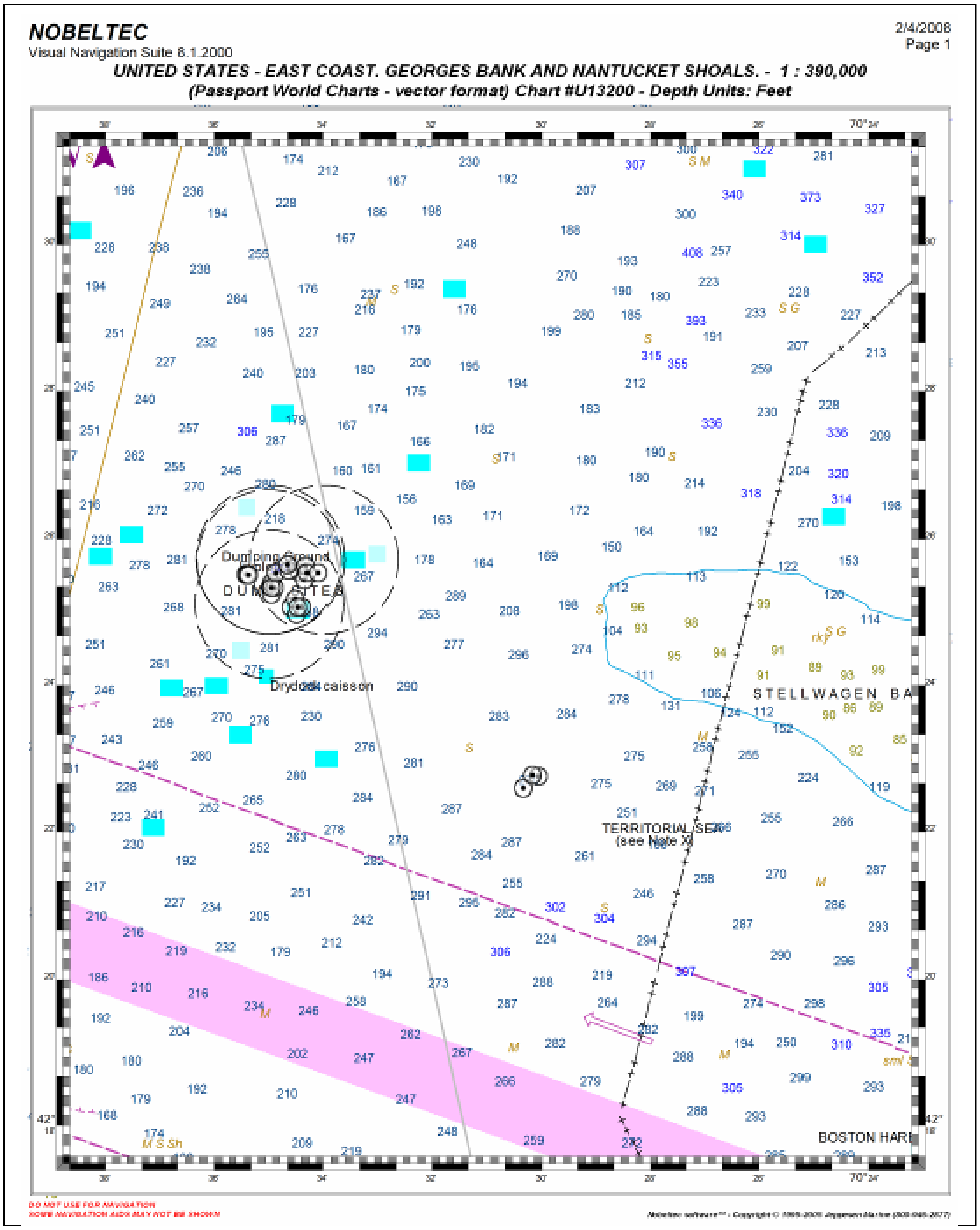


Figure 3. Sediment chemistry stations at the Massachusetts Bay Disposal Site. The former Industrial Waste Site (Black circle), Interim Massachusetts Bay Disposal Site (Yellow circle) and current Massachusetts Bay Disposal Site (Red Circle). Data Sources: Shaded Reliefs for Northern and Southern Stellwagen Bank (1:60,000); Shaded Relief of Western Massachusetts Bay (1:25,000); Bathymetry for the Gulf of Maine; and Massachusetts Bay Industrial Waste Site by US Geological Survey. Locations of dredged material disposal by Army Corps of Engineers New England District.

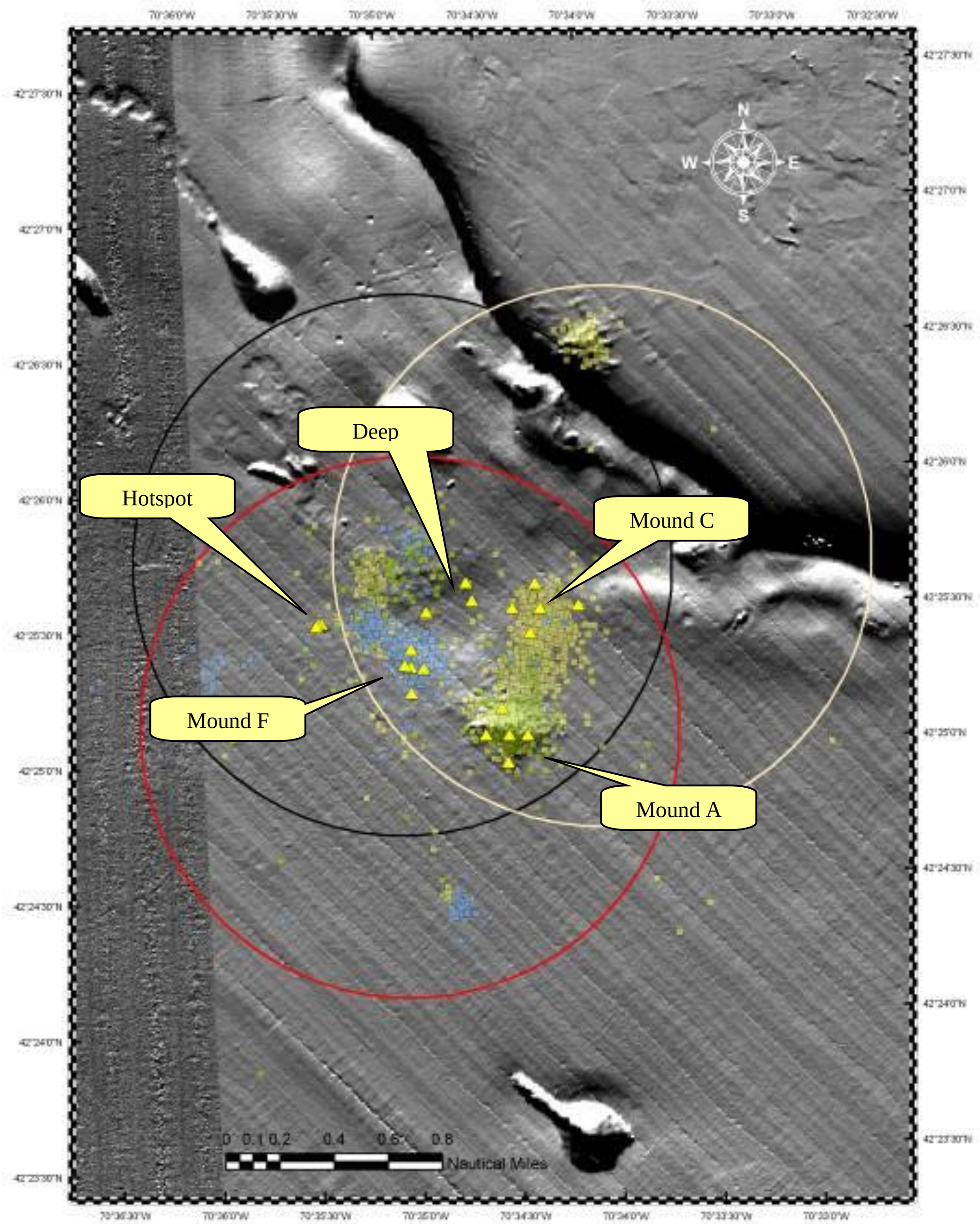


Table 1. Types of stations sampled for sediment chemistry and toxicity at the Massachusetts Bay Disposal Site and reference site. *The Deep station included a field duplicate, which was considered a replicate.

Station Type	Description	Citation for previous monitoring	Number of stations	Number of Toxicity stations
Reference	reference site; sediment chemistry frequently measured by project applicants; sediment profile imaging performed most recently in 2004	ENSR, 2005	3	3
MBDS Mound A	dredged material disposed through 1994, includes “Boston Blue Clay” material, observed by sediment profile imaging in 1994	SAIC, 1997	5	none
MBDS Mound C	dredged material disposed in 1998 and 1999; includes “Boston Blue Clay” material, but a mature biological community observed by sediment profile imaging in 2004	ENSR, 2005	5	3
MBDS Deep	Depression in center of disposal site	none	3	none
MBDS Mound F	dredged material disposed 2004 to 2005; most recently includes maintenance material from Boston Harbor (President Roads area)	none	5	3
Station 12-3 (“Hotspot”)	represents historic contamination, observed by sediment profile imaging and sediment chemistry in 1989, 1993 and 1994	Murray, 1994; DeAngelo and Murray, 1997; Murray, 1997, EPA New England, 1996	4*	3

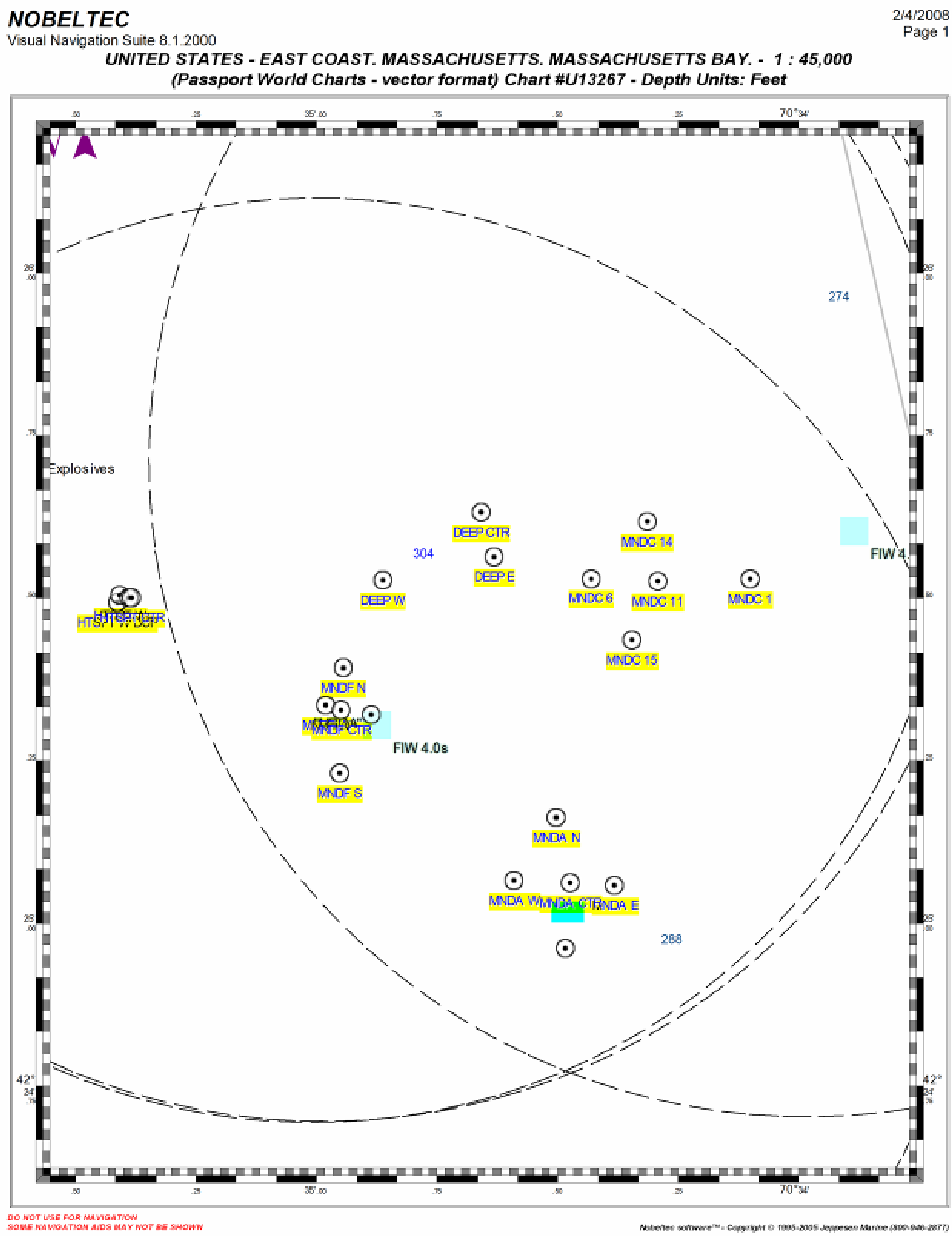
Table 2. Locations of stations sampled for sediment chemistry and acute toxicity. Latitude and Longitude in decimal minutes (NAD 83). SPI station numbers for Reference and Mound C are from ENSR, 2005.

Station Number	Latitude	Longitude	Station Type and Name	Targeted location or SPI station	Acute Toxicity measured?
1	42 22.769 N	070 30.161 W	Reference	SPI station 1	Yes
2	42 22.753 N	070 30.052 W	Reference	SPI station 3	Yes
3	42 22.598 N	070 30.321 W	Reference	SPI station 5	Yes
4	42 25.062 N	070 34.474 W	Mound A	Mound center	
5	42 25.059 N	070 34.382 W	Mound A	200 m east	
6	42 24.961 N	070 34.484 W	Mound A	200 m south	
7	42 25.066 N	070 34.591 W	Mound A	200 m west	
8	42 25.163 N	070 34.502 W	Mound A	200 m north	
9	42 25.436 N	070 34.346 W	Mound C	SPI station C15	Yes
10	42 25.525 N	070 34.292 W	Mound C	SPI station C11	
11	42 25.530 N	070 34.100 W	Mound C	SPI station C1	
12	42 25.618 N	070 34.313 W	Mound C	SPI station C14	Yes
13	42 25.530 N	070 34.431 W	Mound C	SPI station C6	Yes
14	42 25.631 N	070 34.658 W	Deep center	center	
15	42 25.563 N	070 34.631 W	Deep east	200 m east	
16	42 25.528 N	070 34.861 W	Deep west	200 m west	
17	42 25.328 N	070 34.949 W	Mound F	Center	Yes
18	42 25.321 N	070 34.886 W	Mound F	100 m east	
19	42 25.232 N	070 34.953 W	Mound F	200 m south	Yes
20	42 25.335 N	070 34.980 W	Mound F	100 m west	Yes
21	42 25.392 N	070 34.945 W	Mound F	100 m north	
22	42 25.500 N	070 35.383 W	Hotspot center	Center of "12-3"	Yes
23	42 25.501 N	070 35.388 W	Hotspot east	200 m east	Yes
24	42 25.504 N	070 35.408 W	Hotspot west	200 m west	Yes
26	42 25.493 N	070 35.413 W	Hotspot west dup	200 m west dup	

Each sample represented a replicate and is considered representative of the respective disposal mounds or areas. The replicates were used to characterize variability of the sediments disposed at the mound. Additional samples were collected for quality control. Specifically, a duplicate sample was collected at one station (Hotspot west) and one sample was split in the field (Mound F south). In addition, a comparison of surface (0 to 2 cm) and whole grab (0 to 15 cm) samples was performed on two samples to evaluate variability within the sediments.

The locations of the mounds have been documented by DAMOS studies (SAIC, 2002, SAIC 2003, ENSR 2005) using high resolution bathymetry and sediment profile imaging. Locations of disposal of specific projects are logged by NAE and were provided to EPA in an electronic format (see Figure 3).

Figure 4. Station locations for sediment chemistry sampling within the MBDS (excluding reference stations) from the Nobeltec electronic navigation chart on board the OSV Bold.



Navigation

Positional data was acquired by the OSV Bold Raytheon Differential GPS unit, linked to the electronic navigation software package Nobeltec Visual Navigation Suite 8.1. The coordinate system used was NAD 83. Positions were logged electronically by the scientific crew onto a computer when the bottom grab hit the bottom. The GPS receiver is located 50 meters forward of the ship's stern, so locations of stations are off by 50 meters in various directions depending on the heading of the ship's bow.

Sampling Methods

Sediment samples for chemistry and toxicity analyses were collected using a 0.04 m^2 "Ted Young modified" Van Veen grab sampler, a standard bottom grab used on oceanographic research vessels (U.S. EPA 2001). The grab's surface area is 900 cm^2 and typically penetrates about 15 cm into the sediments; thus, its volume is approximately 14 liters. Before sampling, the grab was scrubbed with a brush and salt water. Before each sample, the grab was power washed with salt water to remove any remaining sediment from previous samples.

Because dredged material is typically disposed in dumps of 3,000 to 5,000 cubic yards of a mixture of material, and dumping creates disposal mounds up to five meters in height above the bottom, the contents of each grab were homogenized and placed into jars for analyses. At two stations, a surface sample of the top two centimeters was collected from the grab to evaluate variability between the surface sediments and the homogenized grab reflecting sediments up to 15 centimeters depth. For the field split sample, one person filled the second bottle with a spoonful from the same homogenized sample used to fill the first bottle.

Each grab sample was inspected for signs of leakage, for overfilling or for sufficient penetration; unacceptable grabs were in some cases re-performed. Each grab sample was emptied into a stainless steel container, and homogenized using a stainless steel spoon. The sediment was scooped into pre-labeled bottles using a stainless steel spoon. Between samples, the grab, spoons, and containers were thoroughly cleaned with high pressure sea water and a brush, and then rinsed with de-ionized water.

Sample Handling and Custody

Sample jars for chemical analyses were pre-cleaned four ounce (125 ml) and eight ounce (250 ml) amber glass jars with Teflon screwed caps. Approximately 100 grams of sediment were needed for each analysis. We filled sample bottles with small stainless steel spoons. For each sample, two jars and one double bagged zip-lock bag was filled. The 250 mL jar was dedicated to metals and organic compound analyses, and the 125 mL jar was dedicated to percent moisture and organic carbon analyses. The zip-lock bags were for the grain size analysis. For the ten stations where toxicity was performed, a five gallon HDPE bucket was filled.

All sediment was visually observed for texture and odor, and described in a sample log book. Additional observations, such as depth of water, weather conditions and time, were also collected by OSV Bold crew or scientific team members and were added to the log book.

We filled the bottles in a systematic fashion. The metals/organics bottles were filled first, then the TOC/moisture bottle, and then the grain size zip-lock bag. Care was taken to not mix bottle tops. The bottles were not filled to the top, to allow for expansion when frozen. The bottles and the containers were wiped clean and rinsed with de-ionized water. All bottles were labeled and secured with tape and plastic bubble wrap and placed immediately in the OSV Bold dry lab refrigerator (4° C) or freezer according to the Quality Assurance Project Plan (US EPA New England, 2006) and supporting standard operating protocols. Toxicity samples were refrigerated, not frozen.

The samples were transported in a cooler packed with dry ice or ice cubes. At Alpha Woods Hole Labs, the laboratory placed the samples in a refrigerator or freezer, depending on when analyses were to occur. The grain size zip-lock bags were placed in a refrigerator. Table 3 provides the sample handling and preservation requirements from the Quality Assurance Project Plan (US EPA New England, 2006). These requirements are consistent with those from the Regional Implementation Manual for the Evaluation of Dredged Material Proposed for Disposal in New England waters, or RIM (US EPA New England and Army Corps New England District, 2004).

Samples were stored with Chain of Custody (COC) forms for pick up by Alpha Woods Hole Labs personnel, who transported the samples to the chemistry laboratory in Raynham, MA and the toxicity testing facility (Aquatec Laboratories) in Vermont.

Table 3. Sample handing and preservation requirements as required by the Regional Implementation Manual (US EPA New England and Army Corps New England District, 2004), and US EPA/US Army Corps, 1995.

Analyte	Container	Holding time	Temperature
Metals	250 ml amber glass jar	six months	≤ 4°C
Mercury	250 ml amber glass jar	analyze within 28 days	≤ 4°C
PAHs	250 ml amber glass jar	extract within fourteen days, analyze within 40 days	≤ 4°C
PCB Congeners	250 ml amber glass jar	extract within fourteen days, analyze within 40 days	≤ 4°C
Pesticides	250 ml amber glass jar	extract within fourteen days, analyze within 40 days	≤ 4°C
Grain size	double zip lock bag	n/a	≤ 4°C
Percent Moisture	125 ml amber glass jar	n/a	≤ 4°C
Total Organic Carbon	125 ml amber glass jar	14 days	≤ 4°C
Toxicity	HDPE 5 gallon bucket	14 days	4° C

Analytical Methods

Samples were analyzed for metals, polycyclic aromatic hydrocarbons (PAHs), polychlorinated biphenyls (PCBs), pesticides, total organic carbon, grain size, and toxicity according to the requirements of the RIM. A Quality Assurance Project Plan (QAPP) was prepared for this survey (EPA New England, 2006). The standard operating protocols (SOPs) attached to the QAPP provide detailed description of the methods, but summaries are provided here (Table 4).

Table 4. Methods and reporting limits for sediment chemistry and toxicity.

Analyte	Analytical method	Citation	Analytical/Achievable Laboratory Reporting Limit
Metals	ICP/MS; EPA Method 6020A	US EPA OSWER 1998b	.02 to 1.0 ppm (see RIM)
Mercury	CVAA; EPA Method 7471B	US EPA OSWER 1998a	0.02 ppm
PAHs	GCMS/SIM; EPA Method 8270 modified	US EPA OSWER 1998b	10 ppb
PCB Congeners	GC/ECD EPA Method 8270 and 8000B	US EPA OSWER 1996	1 ppb
Pesticides	GC/ECD; EPA Method 8081A and 8000B	US EPA OSWER 1996	1 ppb Toxaphene 25 ppb
Grain size	Sieving, hydrometer; ASTM 422	ASTM, 1998	N/A
Percent Moisture	gravimetric	Plumb, 1981	1.0%
Total Organic Carbon	Carbonaceous analyzer; EPA Method 9060	US EPA OSWER 1996	0.1%
Acute toxicity	10 day *Ampelisca abdita*	EPA, 1994	

Metals were analyzed by Inductively Coupled Plasma – Mass Spectrometry. The sample is first digested in acid, and then nebulized to an aerosol. The resulting aerosol is transported to the plasma torch by argon gas; the ions produced in the plasma are sorted according to their mass-to-charge ratios and quantified with a channel electron multiplier.

Total Mercury was analyzed by Cold Vapor Atomic Absorption (CVAA). The sample is digested in an acidic, oxidizing solution, autoclaved for fifteen minutes to convert all forms of mercury to inorganic Hg (II). CVAA is based on absorption of radiation at 253.7 nm by mercury vapor. The oxidized mercury is reduced to insoluble elemental mercury, aerated as a vapor, and detected with an atomic absorption spectrometer. Absorbance is measured as a function of mercury concentration based on peak height measured.

PAHs and PCB congeners were extracted using methylene chloride. The extract is concentrated, an internal standard is added and then the extract is analyzed by GC/MS-SIM. The target analytes are resolved on the GC and detected using a mass selective detector. Concentrations are determined using mean relative response factors from a multi-level calibration curve. Response factors for target analytes and surrogate compounds are determined relative to the internal standards.

Samples analyzed for pesticides were extracted with methylene chloride. The extract is analyzed on a GC which is fitted with two capillary columns for differing polarities each employing separate detectors. The analytes are resolved on each column and detected using an electron capture detector. Concentrations are calculated from the ECD response using internal or external standard techniques. Identification of multiple peak components is made by comparison to analytical standards.

Grain size was measured by a combination of sieving and gravimetric settling. Percent moisture is measured by gravimetric determination of material remaining after it has been dried at a specified temperature. Total Organic carbon is measured using a carbonaceous analyzer. This instrument converts the organic carbon to carbon dioxide (CO_2) be either catalytic combustion or wet chemical oxidation. The carbon dioxide formed is then either measured directly by a detector or converted to methane (CH_4) and measured by a flame ionization detector. The amount of CO_2 or CH_4 in a sample is directly proportional to the concentration of carbonaceous material in the sample.

Acute toxicity of the sediments was measured using the 10 day amphipod test, using the estuarine species *Ampelisca abdita* (EPA, 1994). The test is conducted for ten days in 1 liter glass chambers containing 175 ml of sediment and 800 mL of overlying water. Test organisms are not fed during the test. Overlying water is typically not renewed, but may be renewed to maintain water quality parameters (e.g., dissolved oxygen, salinity, and pore water or overlying water ammonia) within the acceptance ranges for the species, as described in the RIM. Each sample is composed of five replicates of twenty animals per chamber. The endpoint is survival at ten days. Additional QC requirements, such as testing for ammonia, are specified in the RIM. Results are compared to reference sediments (collected in this survey), and control sediments.

Laboratory quality control is described in the SOPs. Generally, for each batch of up to twenty samples the following is performed: a matrix spike and sample duplicates to evaluate precision; a laboratory control sample, or standard, to evaluate accuracy; a method blank to evaluate contamination in the laboratory; surrogates to evaluate percent recovery; and a matrix spike to evaluate percent recovery. A method detection limit study is performed annually. Acceptance criteria are listed in the QAPP and in the respective SOPs. For example, the typical surrogate recovery criteria are 30% to 150%.

Sediment chemistry results from two composite sediment samples (called PR-ABCDE, or PR-West and PR-FGHI, or PR-East) in Boston Harbor representing the most recently dredged and disposed source material at Mound F were acquired electronically from the NAE. Based on scow logs provided by NAE, the most recent and predominant disposal activity at Mound F occurred from August 24, 2004 to May 6, 2005 and was dredged from the President Roads Anchorage area in Boston Harbor. This is maintenance material to 41 feet depth. The total volume dumped was 2,107,535 cubic yards, over 476 trips. The methods of analyses, reporting limits and quality control discussions for these sediments are reported in Battelle, 2001. Sediments were collected using a vibracore, and composited in the field. Analytical methods and reporting limits including extractions and QC requirements were similar to methods described above. Reporting limits were as follows: metals (ranged from 0.2 to 1 ppm); mercury (.02 ppm); PAHs (20 ppb); pesticides (2 ppb); and PCB congeners (1 ppb). Except for some PCB congeners and pesticides, contaminants were detected routinely in the sediment samples (Battelle, 2001).

Sediment Chemistry Results and Discussion

All samples, including QC samples, were collected successfully. The only major QC issue was for PAHs, where surrogate recoveries were slightly below acceptable limits in the first extraction. The samples were re-extracted just outside the 14 day holding time limit, and were acceptable. Because of this holding time issue, it is possible that the PAHs are slightly underestimated, especially the lower molecular weight PAHs, like naphthalene. The split samples performed to evaluate variability within the sediments demonstrated low relative percent differences (RPD). The typical RPD for analytes for the split sample was between 5% and 15%. The typical RPD for the two samples to compare surface to whole grab heterogeneity exhibited similar variability, although in one sample the surface sample exhibited a slight bias high. Finally, the field duplicate for the Hotspot west sample was not taken spatially close enough to the first sample, so the duplicate sample was treated as the fourth replicate of the Hotspot area.

The specific locations for each station in the MBDS are displayed in Figure 4. Field observations are described in Table 5. Field observations of sediment texture generally matched measurements from the laboratory (see below).

Table 5. Field observations from sediment samples collected at the MBDS.

Station number	Station Type and Name	Water depth (feet)	Dominant color	Sediment texture	Comments
1	Reference SPI station 1	297	grey	silty	none
2	Reference SPI station 3	290	greenish olive	silty	none
3	Reference SPI station 5	292	olive grey	silty	worm tubes; odor
4	Mound A center	280	grey	silty	none
5	Mound A east	281	grey	silty	worms
6	Mound A south	291	grey	silty	none
7	Mound A west	289	olive grey	silty	slight odor
8	Mound A north	288	dark green	silty	one worm
9	Mound C SPI station C15	287	blue grey/green	lumpy silty clay	odor present
10	Mound C SPI station C11	278	grey/green	lumpy silty clay	clam
11	Mound C SPI station C1	299	grey	silty with clay lumps	odor present
12	Mound C SPI station C14	295	olive grey	silty with clay lumps	none
13	Mound C SPI station C6	307	olive green	silty/clay	large worm with feather features
14	Deep center	314	very dark olive black	fine silt	odor present
15	Deep 200 meters east	315	olive	silty	slight odor
16	Deep 200 meters west	313	dark olive	silty	worm tubes; odor present
17	Mound F center	274	light brown	clay	worm
18	Mound F east	274	light brown	clay	worms
19	Mound F south	289	black olive	fine gritty	strong sulfur odor
20	Mound F west	274	dark grey	clay, poorly sorted clumps	none
21	Mound F north	270	dark grey	sand with one cm lumps of clay	fan worms
22	Hotspot center	291	olive grey	gritty sand	worms
23	Hotspot east	291	dark olive grey	silty	none
24	Hotspot west	292	dark brown with olive	silty with some sand	none
26	Hotspot west dup	291	dark brown with olive	silty with some sand	none

Most of the sediments, including the reference stations, were predominantly silt and clay with a total organic carbon (TOC) level of about 1% **(Figure 5).** Most stations exhibited similar silt and clay fractions. Silt fraction ranged from 50 to 65%, and clay ranged from 18 to 25%. In contrast, sediments from Mound F exhibited a higher clay fraction, a lower silt fraction, and a lower total organic carbon level than other stations. This may reflect newer dredged material dredged primarily from the President Roads anchorage area in Boston Harbor in 2004 and 2005.

Boxplots exhibiting the distribution of results for metals, PAHs and PCBs by station type and source material, are displayed in **Figures 6 through 8.** Several patterns emerge. First, sediments in the MBDS appear to be influenced by contamination from recent and historically disposed dredged material. As expected, contaminant levels were consistently higher in the Deep stations and Hotspot stations (due to their locations near historical dumping sites). These were followed sequentially by stations from Mound A, Mound C, Mound F, and then the reference stations. Arsenic and nickel, however, did not follow this pattern. It is known that arsenic is elevated in marine sediments in the Gulf of Maine **(need reference),** but it is unclear why concentrations of nickel in the reference sediments were similar to those in the disposal site sediments.

Although contaminant levels in the disposal site and on the mounds were significantly higher than at the reference stations, the levels were generally below concentrations expected to cause toxicity to benthic invertebrates. For metals, the highest observed values were all below the 50% probability level of the logistic regression screening model developed by Field et al., (1999, 2002) used as a screening level in the National Sediment Inventory (US EPA, 2004). The highest observed median values were typically closer to the 25% probability level than the 50% probability level **(Table 6).** For PAHs, the highest observed levels were usually below the 50% probability limit of the logistic regression model, but significantly above the 25% level **(Table 7**). Station 19 at Mound F consistently exhibited the highest values of PAHs, but median levels at the Hotspot and the Deep stations were higher than at any other station type.

The levels of PCBs and pesticides were very low, but disposal site stations were elevated compared to the reference stations. Many results were either below the reporting limits, or estimated. As was the case for metals and PAHs, the most contaminated station types for the sum of the PCB congeners were the Deep site, followed by the Hotspot, Mound A, Mound F and Mound C. For DDT and the metabolites DDD and DDE, the concentrations were generally very low, and sometimes qualified as estimated, or there were occasional interferences in the analysis. The highest observed values were again typically found at one of the stations at Mound F, but the highest observed median values were found at the Deep site or the Hotspot **(Table 8)**. The median concentrations were typically close to or below the 25% probability level for biological effects.

For all the contaminants except arsenic and nickel, all the reference stations were consistently below the 25% probability level, indicating a low likelihood that these sediments would cause toxicity to benthic invertebrates. Thus, the current reference area continues to be an appropriate area for disposal site monitoring and evaluation of dredged material for suitability.

Table 6. Highest observed levels of metals (ug/g) compared to sediment screening levels applied in US EPA, 2004. P25% and P50% are the concentrations that would give a 25% or 50% probability of a toxic response according to the logistic regression model of Field et al. (1999, 2002).

Analyte	Highest observed value (ug/g dry weight)	Mound or area	Highest observed median value (ug/g dry weight)	Mound or area	P25% (ug/g dry weight)	P50% (ug/g dry weight)
Arsenic	14	Ref	13	Mound C	11.29	32.61
Cadmium	1.9	Mound C	1.65	Hotspot	0.65	2.49
Chromium	170	Mound C	150	Deep	76.00	233.27
Copper	87	Mound C	75	Deep	49.98	157.13
Lead	75	Mound C	66	Deep	47.82	161.06
Mercury	0.63	Deep	0.43	Deep	0.23	0.87
Nickel	34	Mound F	30	Mound F	23.77	80.07
Zinc	240	Mound F	140	Deep	140.48	383.81

Table 7. Highest observed levels of PAHs (ug/kg) compared to sediment screening levels applied in US EPA, 2004. P25% and P50% are the concentrations that would give a 25% or 50% probability of a toxic response according to the logistic regression model of Field et al. (1999, 2002).

Analyte	Highest observed value (ug/kg dry weight)	Mound or area	Highest observed median value (ug/kg dry weight)	Mound or area	P25% (ug/kg dry weight)	P50% (ug/kg dry weight)
Acenaphthene	99	Mound F	27	Ref	40	270
Acenaphthylene	100	Mound F	63	Deep	40	420
Anthracene	400	Mound F	110	Deep	80	800
Benzo(a)anthracene	1200	Mound F	440	Deep	140	1210
Benzo(a)pyrene	1200	Mound F	450	Deep	160	1340
Benzo(b)fluoranthene	750	Mound F	380	Deep	320	3030
Benzo(g,h,i)perylene	780	Mound F	375	Hotspot	150	1280
Benzo(k)fluoranthene	730	Mound F	350	Hotspot	160	1400
Chrysene	1200	Mound F	430	Deep	190	1730
Dibenzo(a,h)anthracene	280	Mound F	115	Hotspot	40	260
Fluoranthene	2200	Mound F	750	Hotspot	286	2860
Fluorene	180	Mound F	40	Deep	40	260
Indeno(1,2,3-cd)pyrene	700	Mound F	325	Hotspot	160	1230
Naphthalene	740	Mound C	160	Mound C	70	550
Phenanthrene	1400	Mound F	310	Hotspot	150	1120
Pyrene	2100	Mound F	810	Deep	290	2410
SUM PAHs	13469	Mound F	4884	Deep	n/a	n/a

Table 8. Highest observed levels of DDD, DDE and DDTs (ug/kg) compared to sediment screening levels applied in US EPA, 2004. P25% and P50% are the concentrations that would give a 25% or 50% probability of a toxic response according to the logistic regression model of Field et al. (1999, 2002).

Analyte	Highest observed value (ug/g dry weight)	Mound or area	Highest observed median value (ug/g dry weight)	Mound or area	P25% (ug/g dry weight)	P50% (ug/g dry weight)
DDD	33	Mound F	12.0	Deep	10	50
DDE	11	Mound F	7.7	Deep	10	50
DDD	5.7	Mound F	2.45	Hotspot	4	30

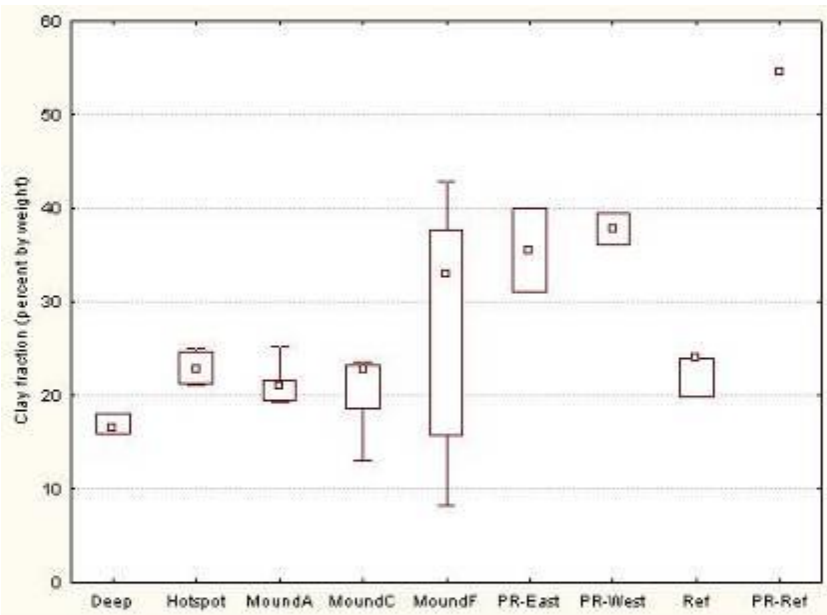
Are levels of contaminants at disposal mounds created within the last four years within the range predicted by testing of dredged material projects for suitability; comparison of Mound F to President Roads source material

Although Mound F appears to be similar in sediment silt and clay fraction to the President Roads source material, it exhibited a much lower TOC level **(Figure 5)**. Source material exhibited TOC concentrations of about 2.6% compared to 0.6%. Levels of contaminants at the disposal mounds created within the last four years are also not within the range predicted by testing of dredged material for suitability. Contaminant levels for cadmium, chromium, copper, lead, mercury, zinc, PAHs and PCBs were clearly higher in the source material than at the disposal mound. There are two possible reasons for this. First, it is difficult to collect sediments at a disposal site representative of recently dredged material. Second, it is possible that the lower TOC and clay content at the disposal mounds reflects loss of organic rich fine grained sediments enriched in contaminants during the disposal process. This would assume, however, significant amounts of disaggregation of particles during the disposal process, which is unlikely given the nature of disposal process.

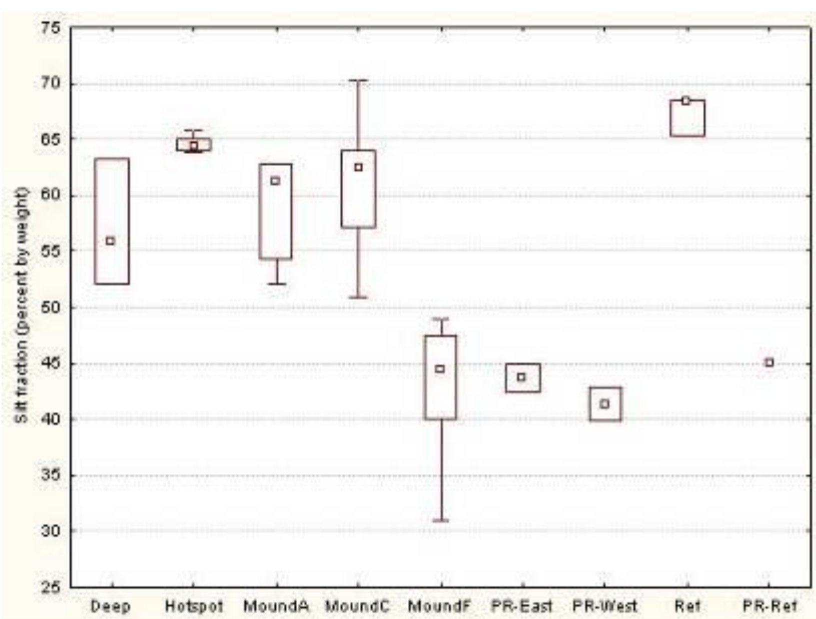
It is also important to note that the samples from the reference stations differed from the results of the reference stations collected in 2001; our observations yielded a TOC of 1.1%, Battelle measured TOC at 2.5%, we measured silt fraction at about 68%, Battelle measured 45%, we measured clay fraction at about 25%, Battelle at about 55%. A review of the survey report from Battelle (2001) indicated that the reference location sampled was 0.281 to 0.496 nautical miles southwest from our three samples. Although Stellwagen Basin is considered a fairly uniform area in terms of sediment properties, it is possible that the significant differences observed can be accounted for by the differences in sampling locations. (The analytical methods for TOC were the same; both laboratories used EPA method 9060, a carbonaceous analyzer). Based on the shaded relief of bathymetry of Stellwagen Basin (USGS, data not shown) it appears that the reference area is located on a small sandy drumlin. This suggests that small differences in sampling location may introduce potential differences in sediment characteristics.

Figure 5. Box plots of physical properties from sediments of three to five samples from each station type, including sediments collected from the Boston Harbor maintenance project (President Roads East and West). PR-reference is from the same reference station as this survey (see text). Each box plot displays the median (▫), the estimated 25% and 75% values (box), non-outlier ranges (bars), outliers (◦) and extremes (*).

Clay fraction



Silt fraction



Total organic carbon

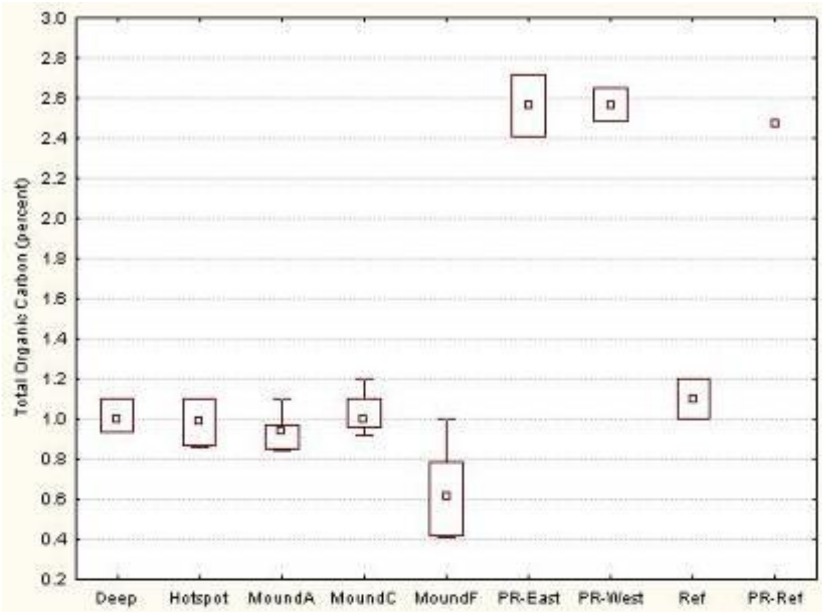
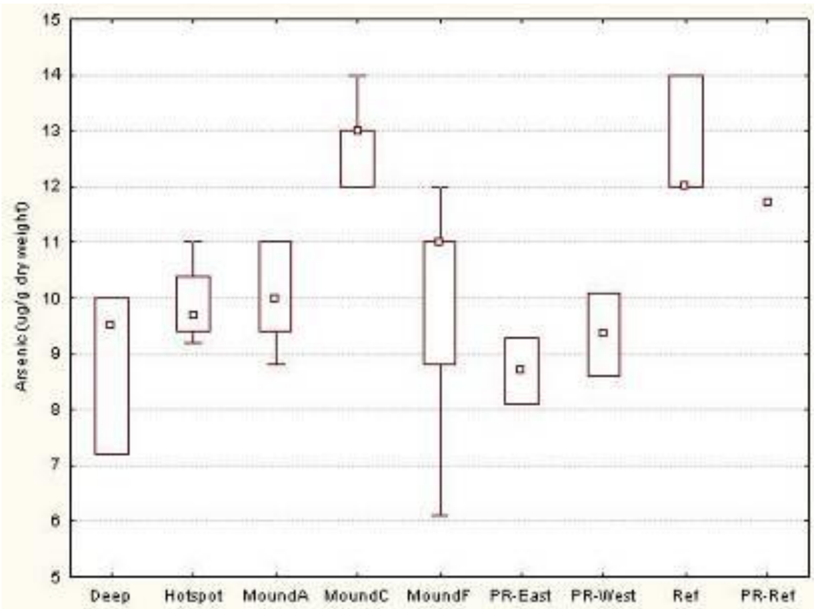
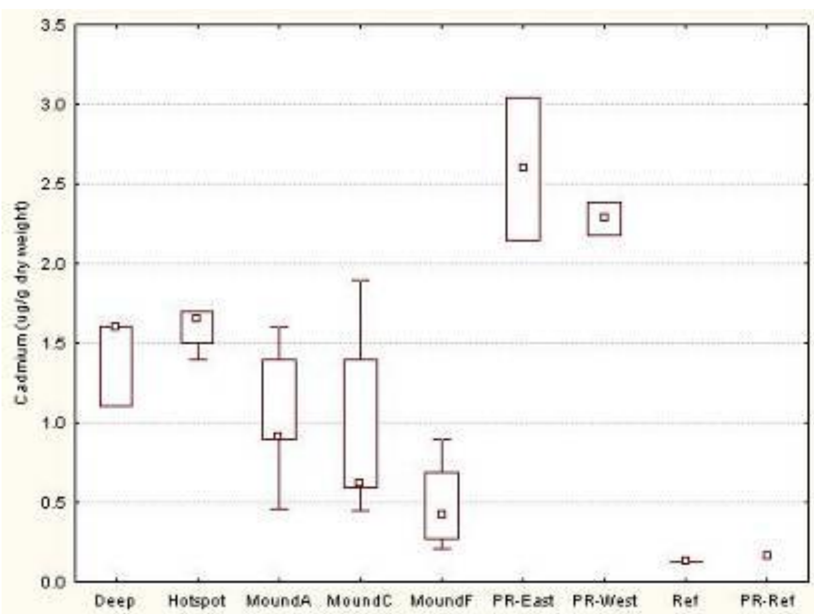


Figure 6. Box plot of metals from sediments of three to five samples from each station type, including sediments collected from the Boston Harbor maintenance project (President Roads East and West). PR-reference is from the same reference station as this survey.

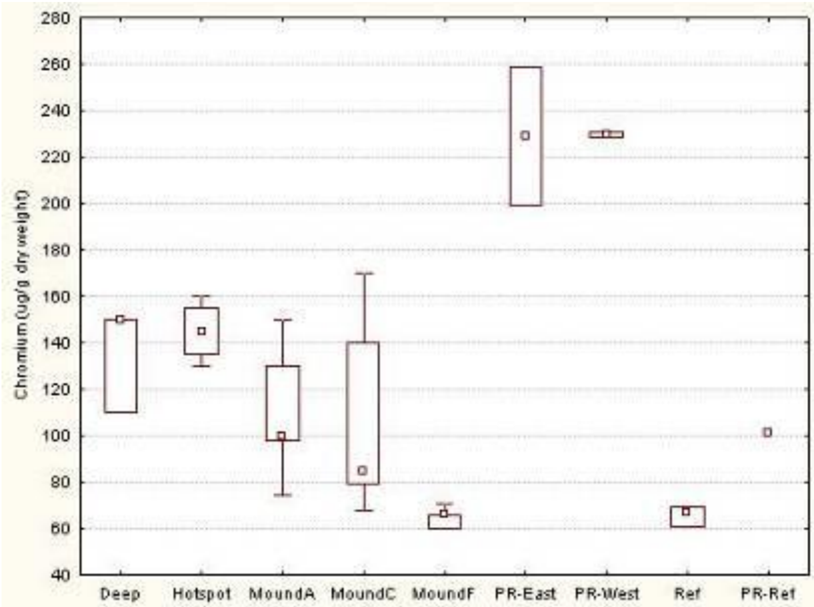
Arsenic



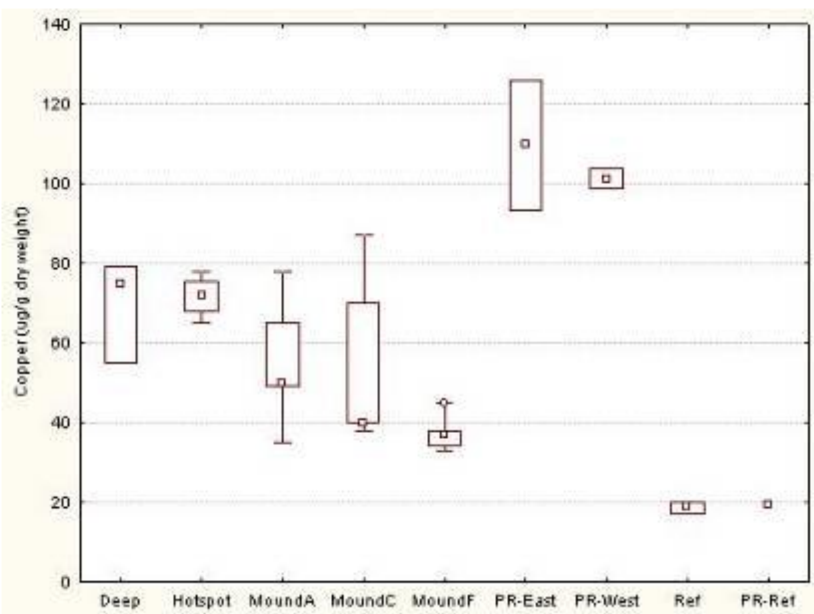
Cadmium



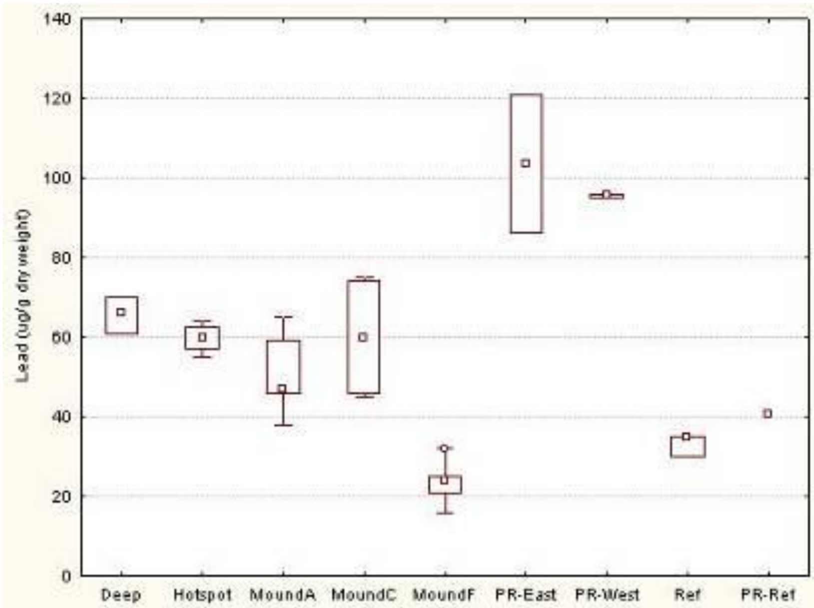
Chromium



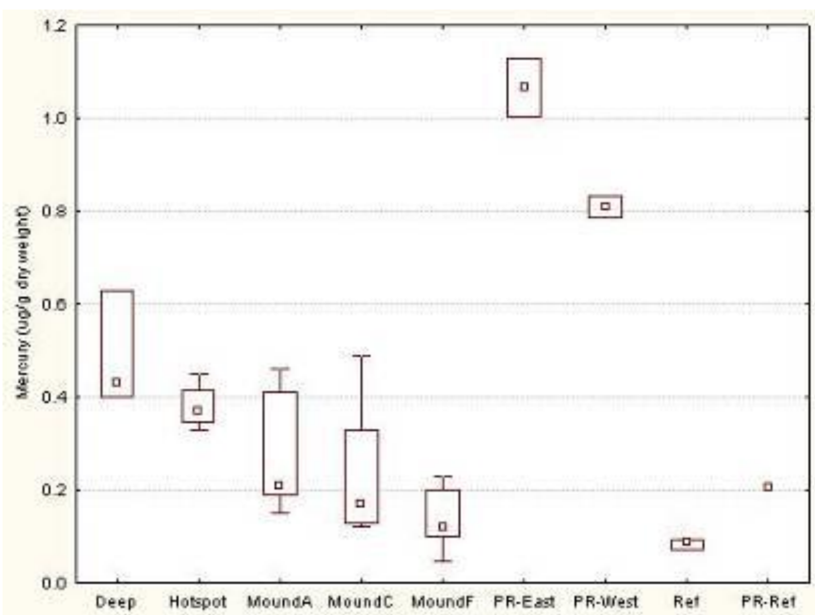
Copper



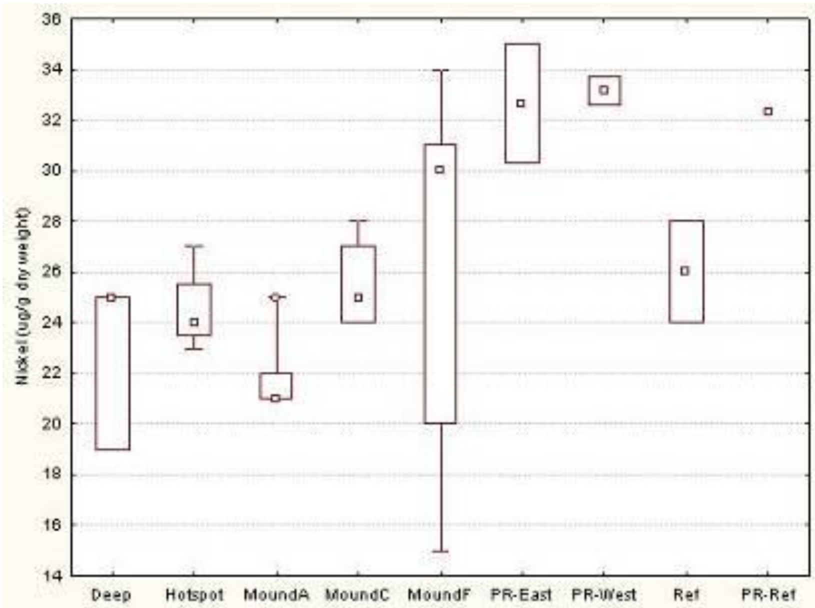
Lead



Mercury



Nickel


Nickel (ug/g dry weight)
36
34
32
30
28
26
24
22
20
18
16
14
Deep
Hotspot
MoundA
MoundC
MoundF
PR-East
PR-West
Ref
PR-Ref

Zinc

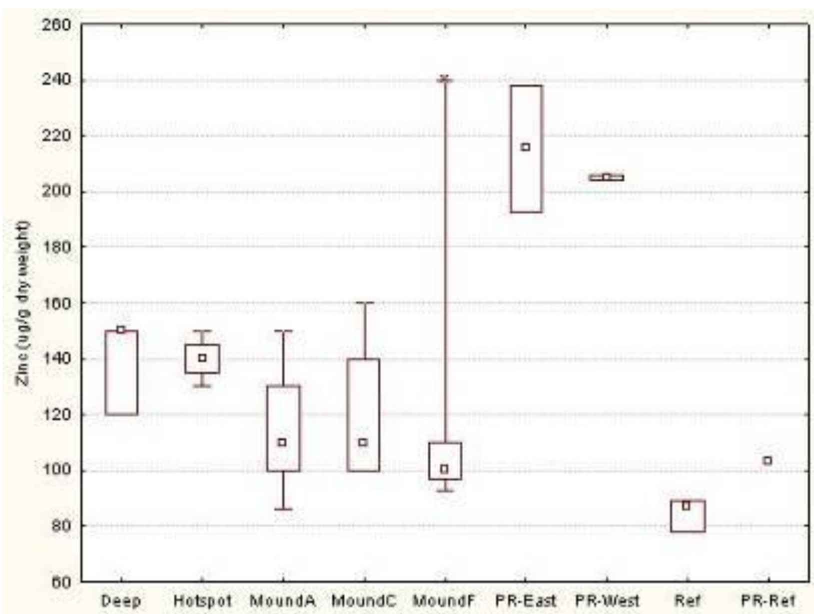

Zinc (ug/g dry weight)
260
240
220
200
180
160
140
120
100
80
60
Deep
Hotspot
MoundA
MoundC
MoundF
PR-East
PR-West
Ref
PR-Ref

Figure 7. Box plot of sum of PAHs from sediments of three to five samples from each station type, including sediments collected from the Boston Harbor maintenance project (President Roads East and West). PR-reference is from the same reference station as this survey.

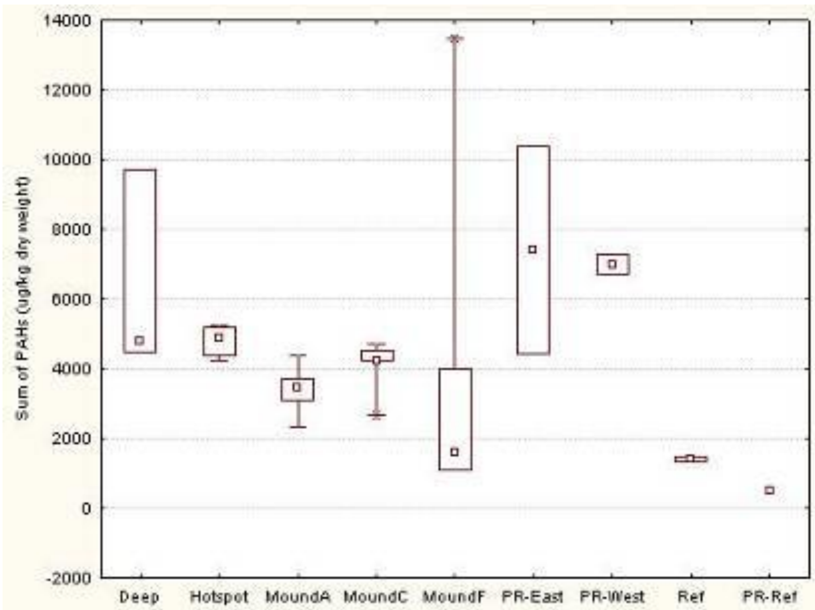
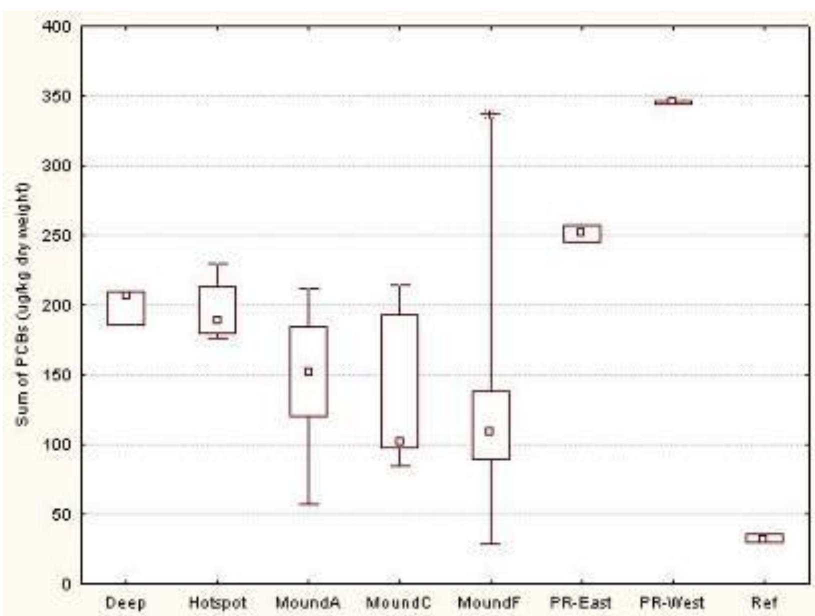


Figure 8. Box plot of sum of PCBs from sediments of three to five samples from each station type, including sediments collected from the Boston Harbor maintenance project (President Roads East and West). PR-reference is from the same reference station as this survey.

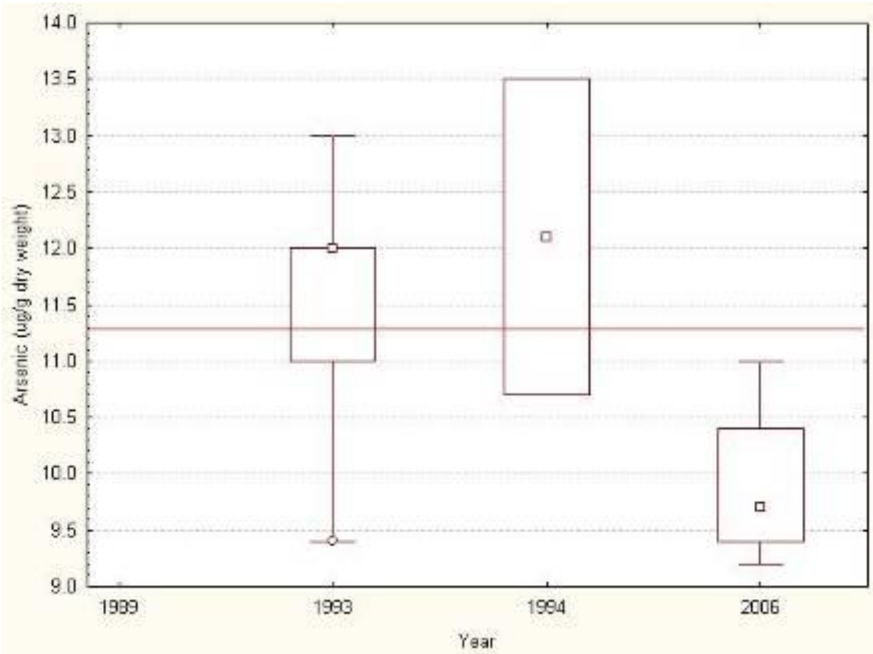


Are levels of contaminants at a historically (>20 years) contaminated site within the MBDS declining? Did concentrations change from 1989 to 2006 from the Hotspot?

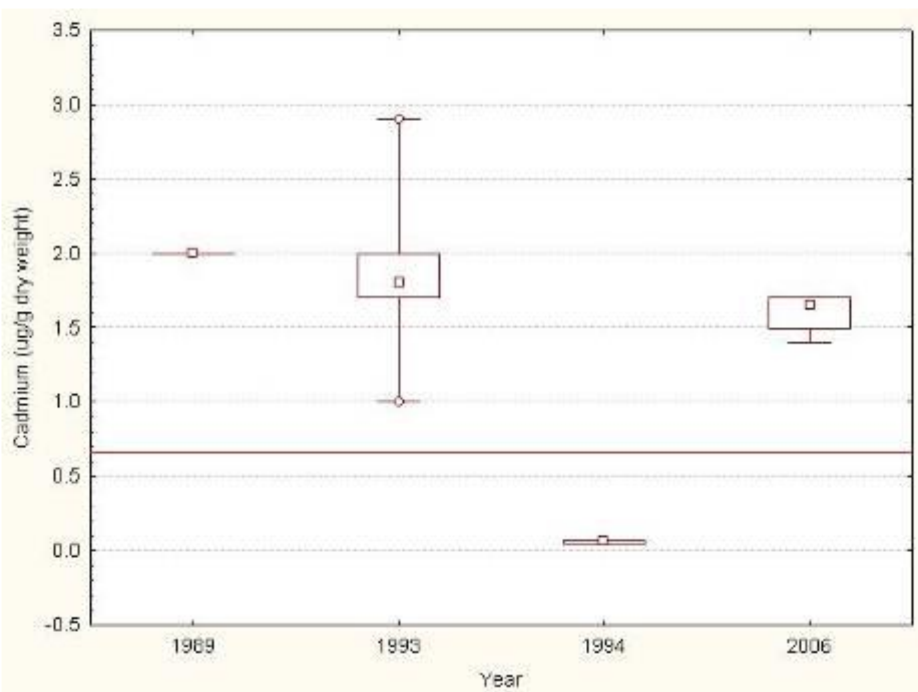
We compared the results from four sampling events when samples were collected at or near station 12-3 in the MBDS. In 1989, three replicates were collected from Station 12-3 by NAE (Murray, 1994; the replicates were composited into one sample for PAH analysis only); in 1993 five replicates were sampled within 200 meters of Station 12-3 by NAE (DeAngelo and Murray, 1997), in 1994 two replicates were sampled at Station 12-3 by EPA (EPA, 1996) and in this study, four replicates were collected within 200 meters of Station 12-3. Except for lead, no metals show a significant downward trend in contaminant levels **(Figure 9)**. In contrast, many of the individual PAHs, exhibit significant declines from the 1989 and 1993 sampling surveys (**Figure 10**).

Figure 9. Box plot of metals (ug/g dry weight) from sediments collected at the Hotspot area (station 12-3) in 1989, 1993, 1994 and 2006 (this survey). Red line is the 25% probability of a toxic response according to the logistic regression model of Field et al. (1999, 2002).

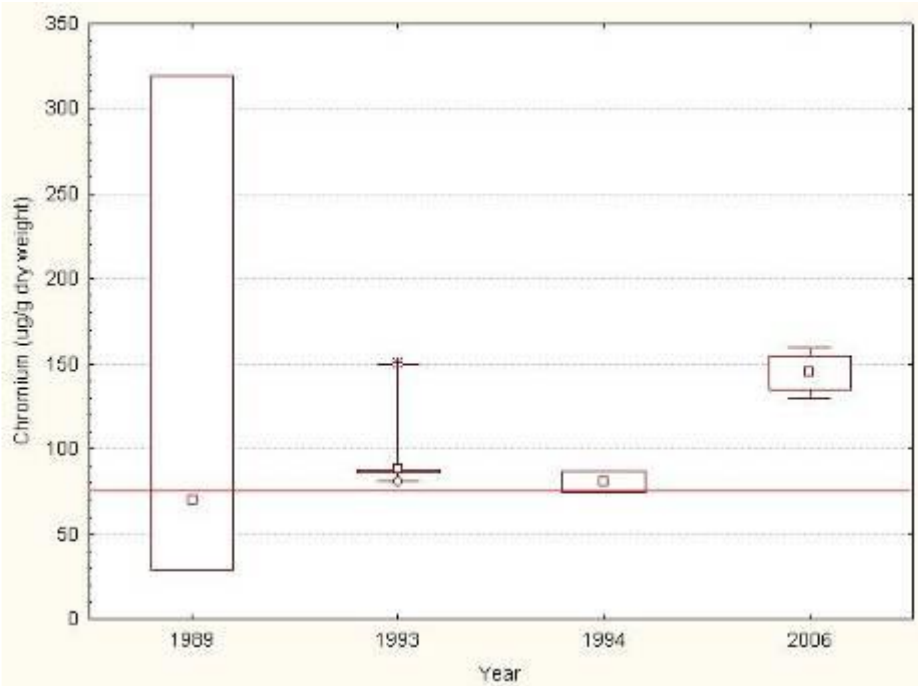
Arsenic



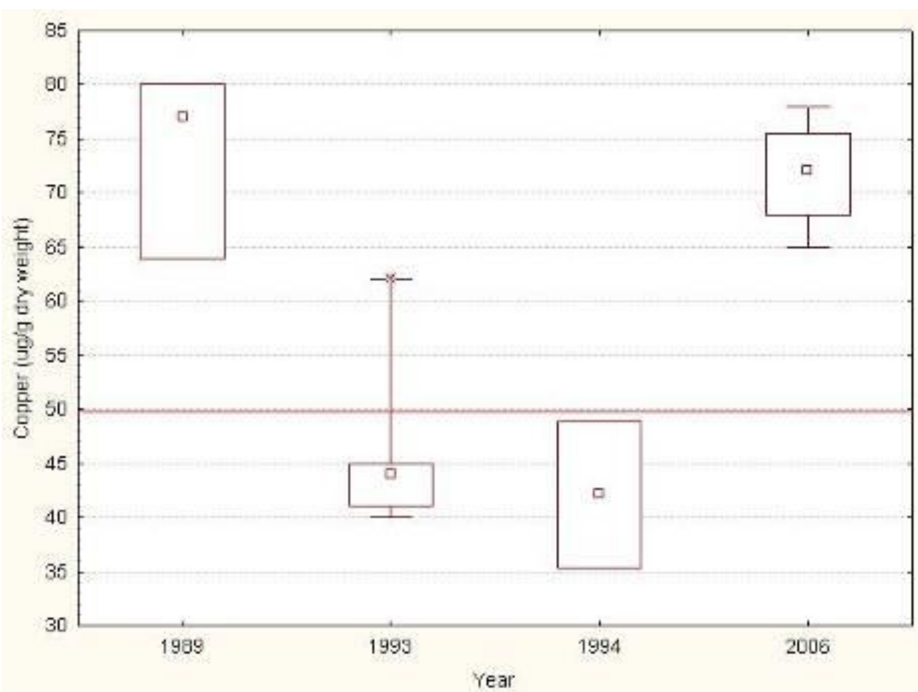
Cadmium



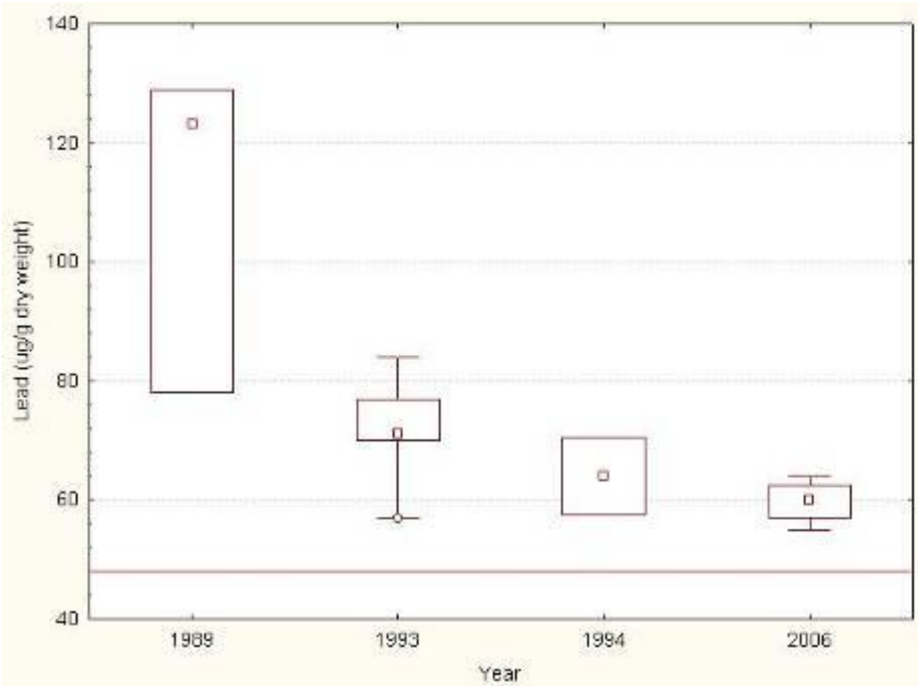
Chromium



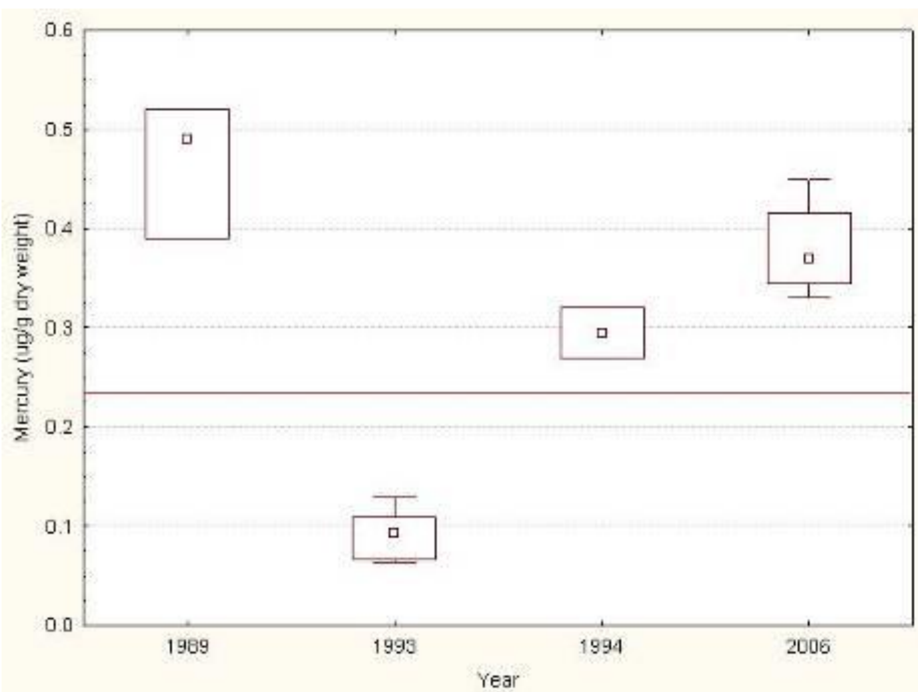
Copper



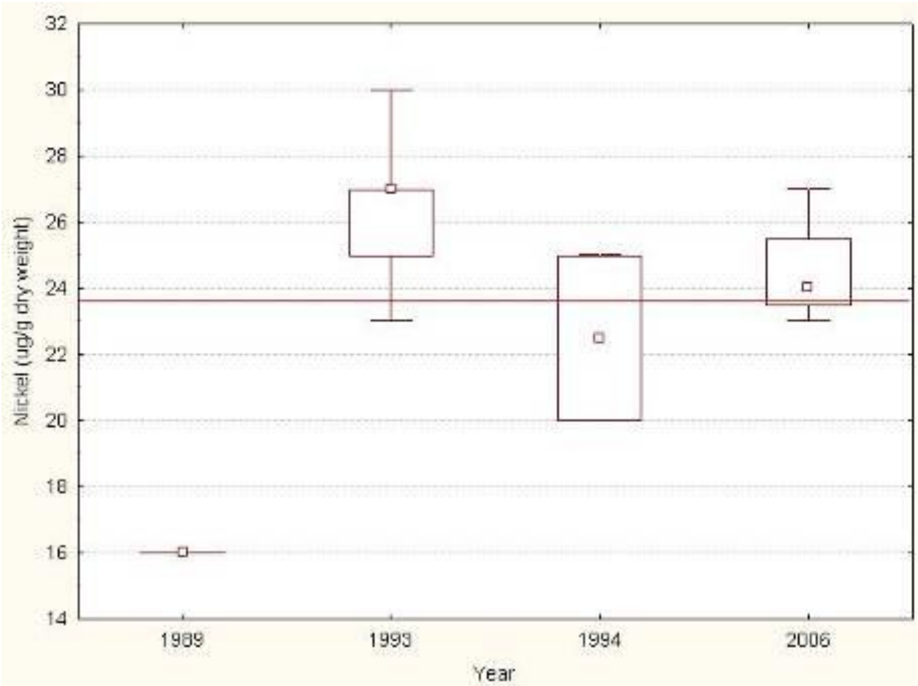
Lead



Mercury

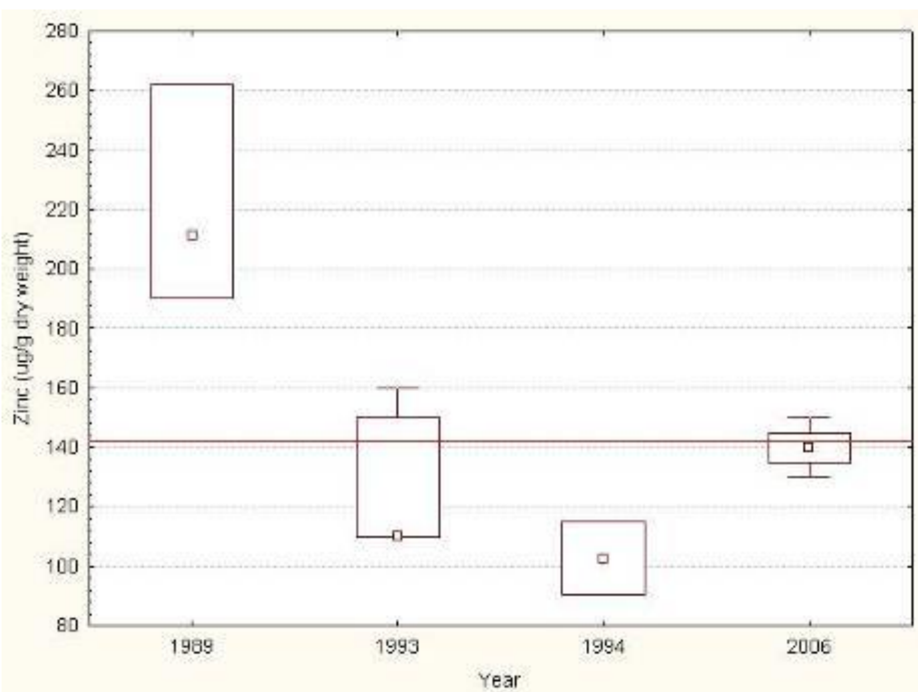


Nickel



Nickel (ug/g dry weight)
32
30
28
26
24
22
20
18
16
14
1989
1993
1994
2006
Year

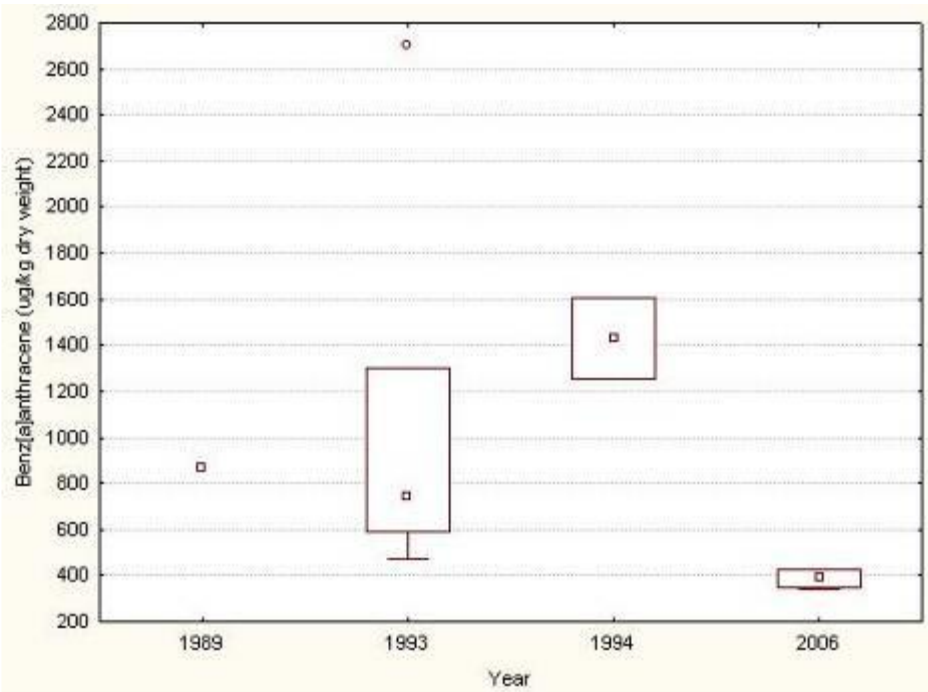
Zinc



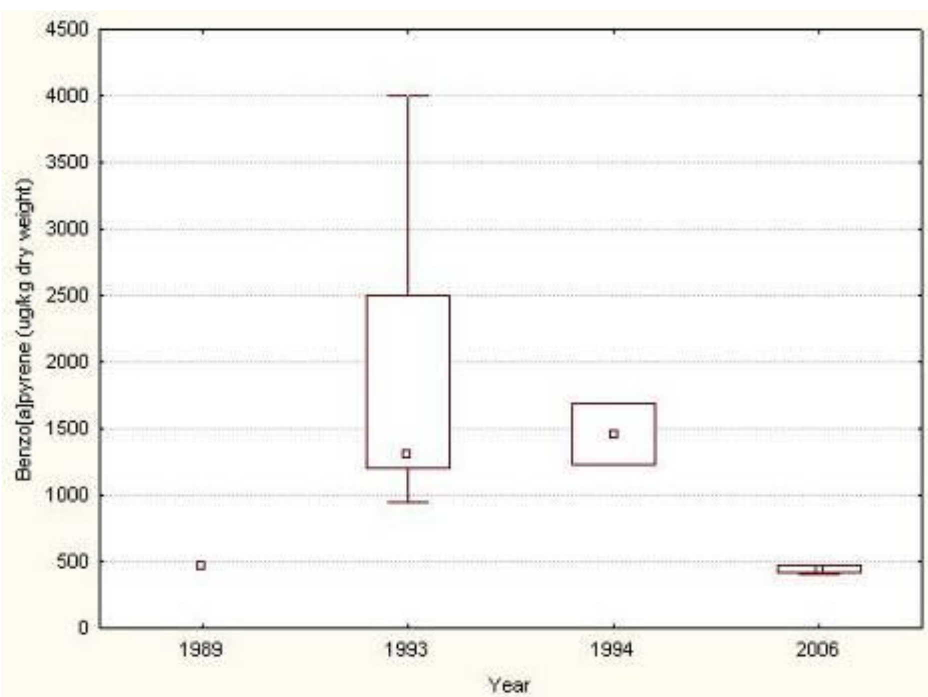
Zinc (ug/g dry weight)
280
260
240
220
200
180
160
140
120
100
80
1989
1993
1994
2006
Year

Figure 10. Box plot of PAHs (ug/kg dry weight) from sediments collected at the Hotspot area (station 12-3) in 1989, 1993, 1994 and 2006 (this survey).

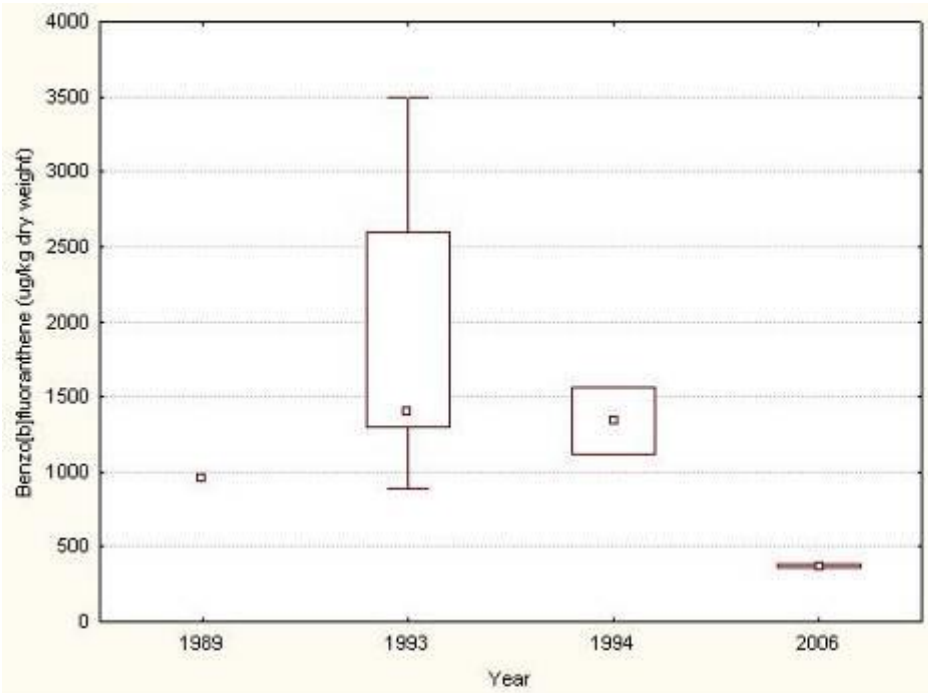
Benz[a]anthracene



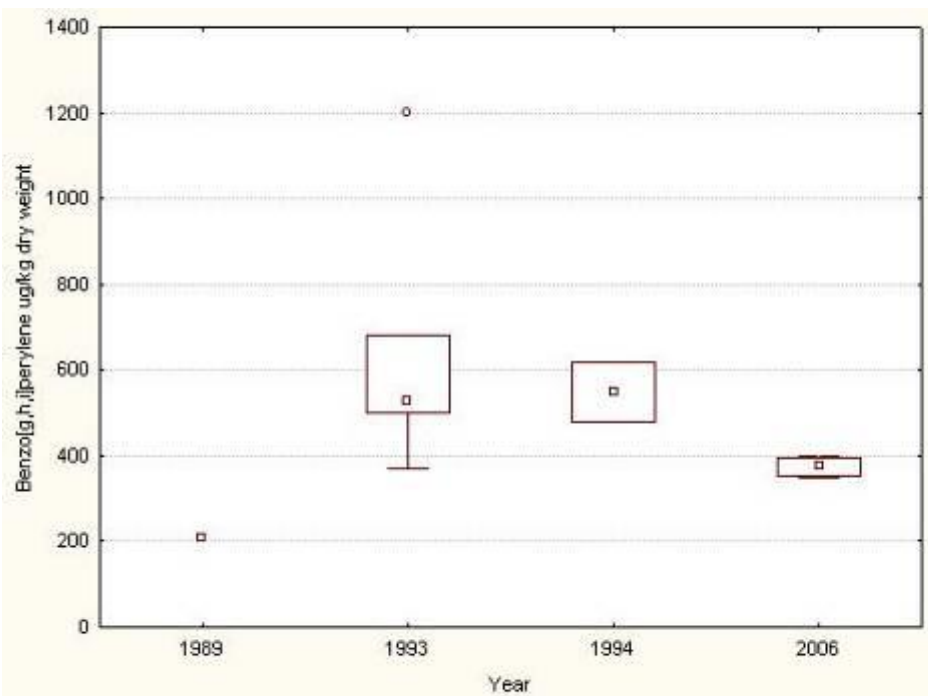
Benzo[a]pyrene



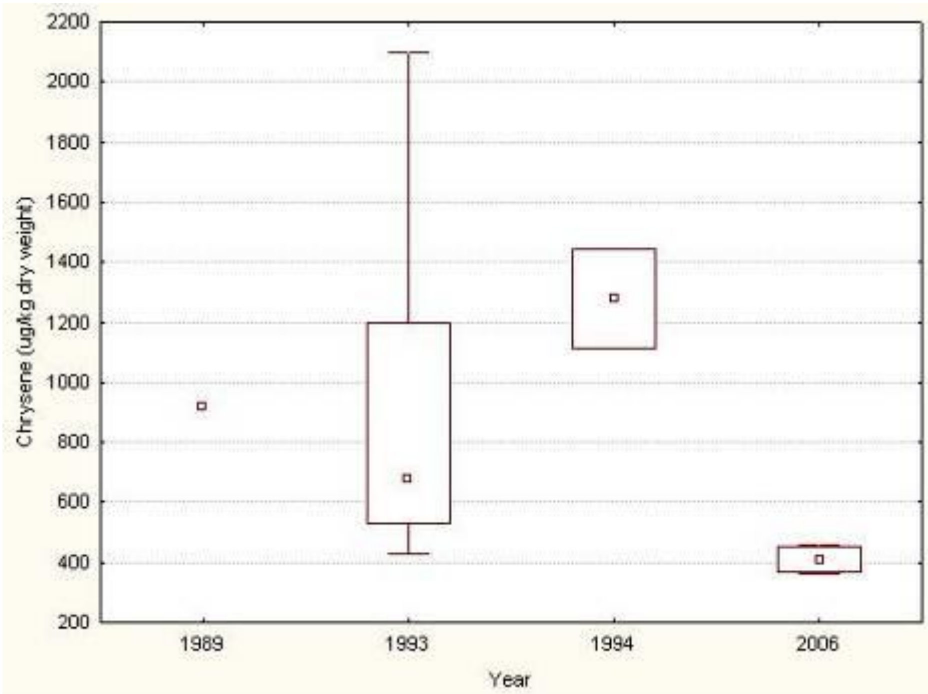
Benzo[b]fluoranthene



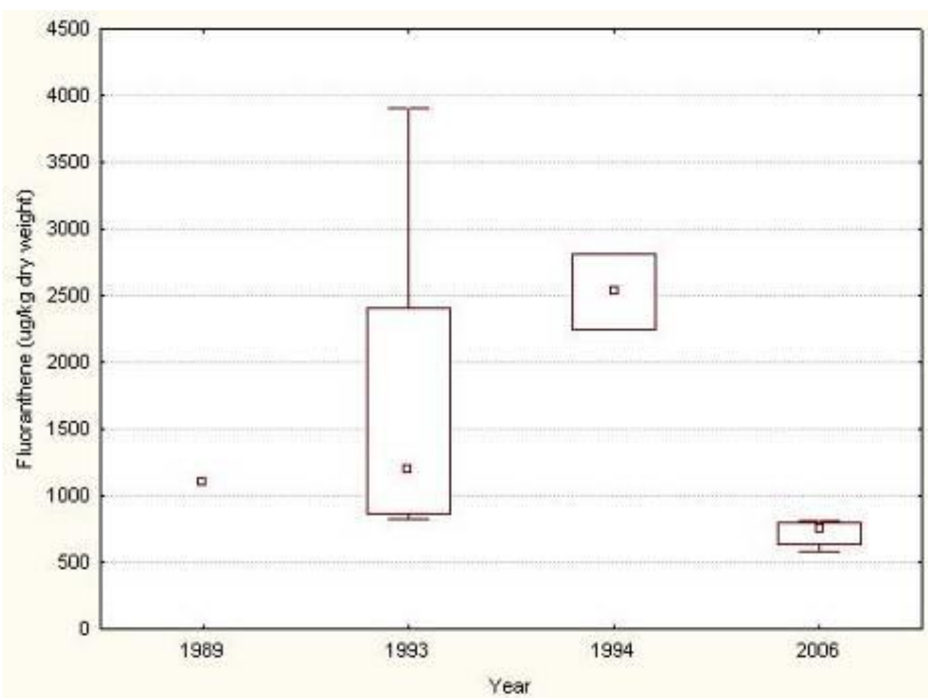
Benzo[g,h,i]perylene



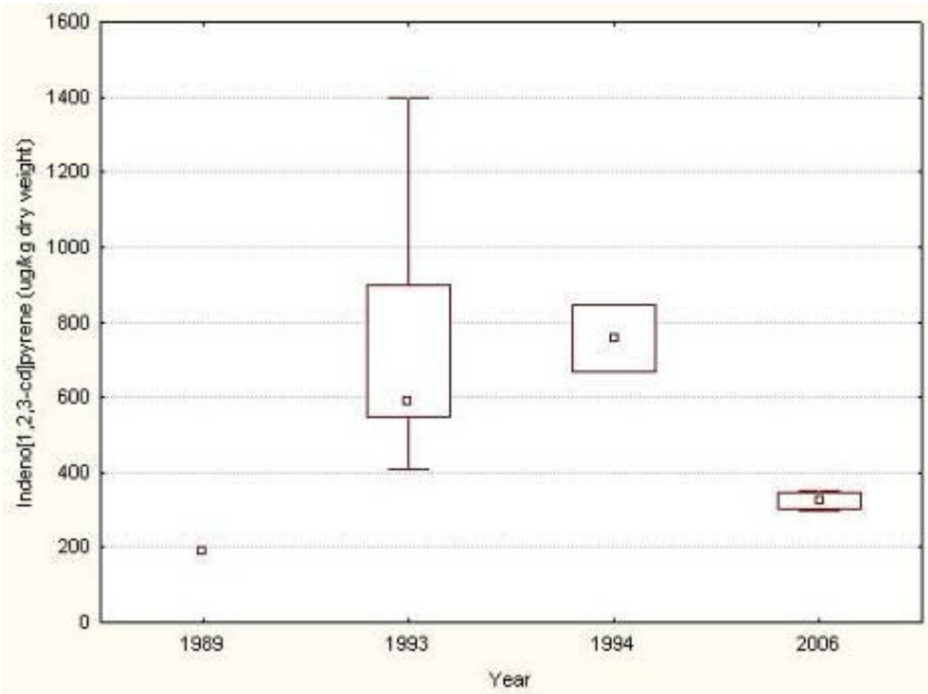
Chrysene



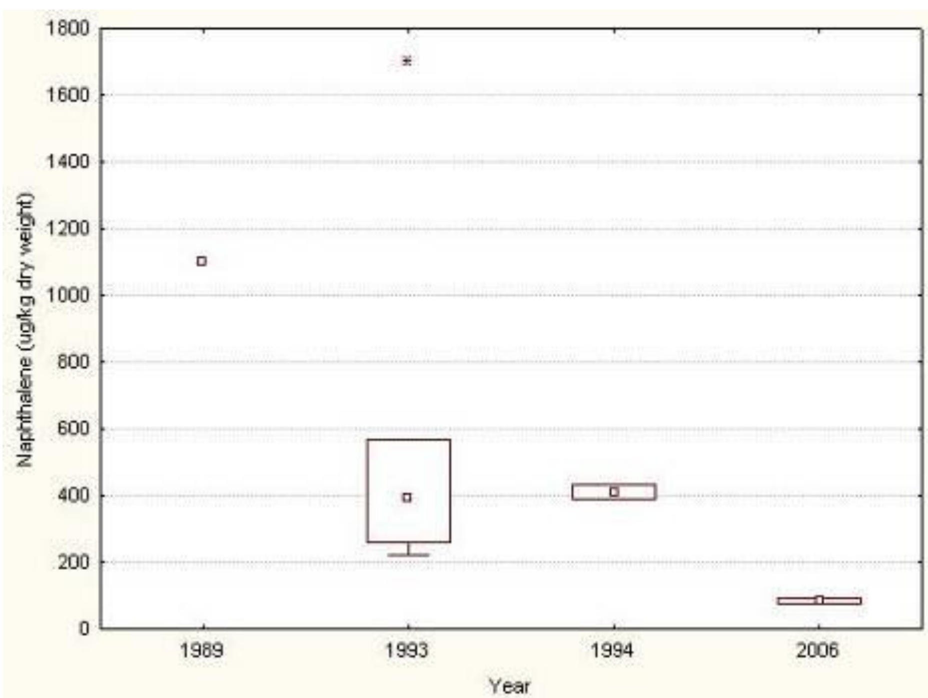
Fluoranthene



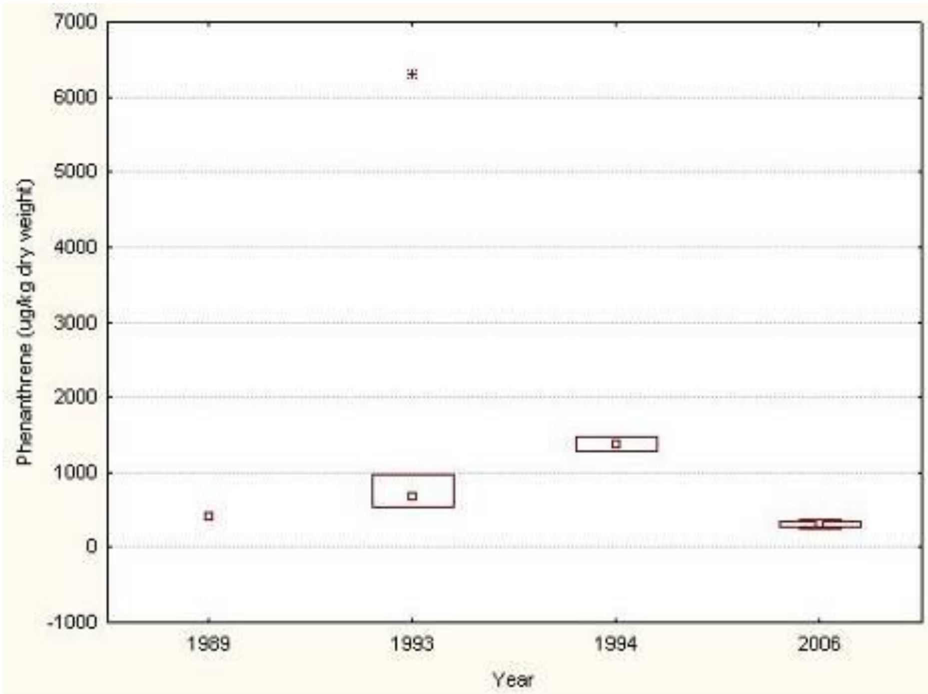
Indeno[1,2,3]pyrene



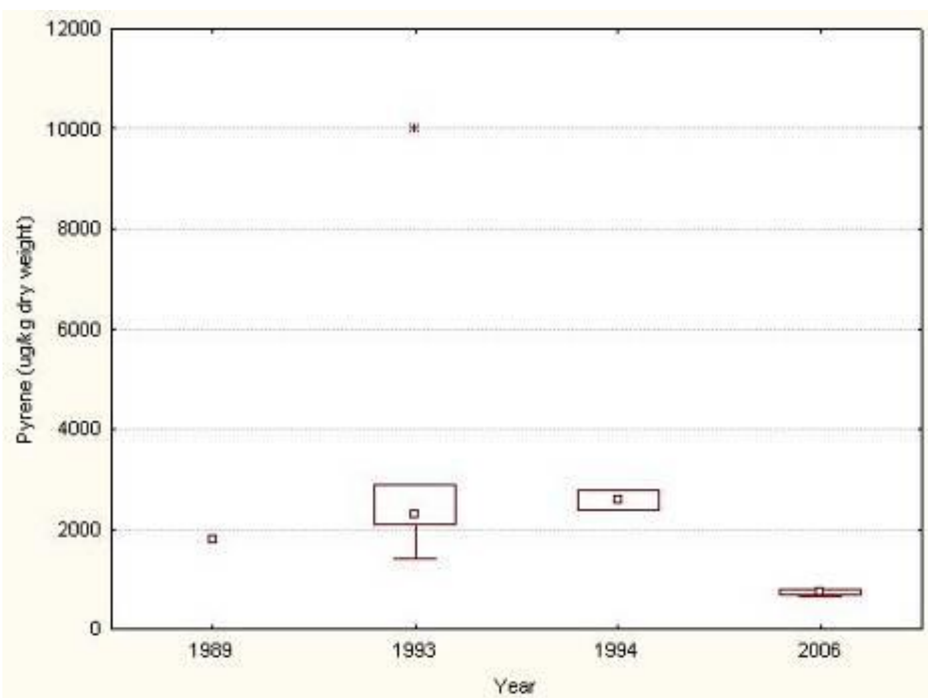
Naphthalene



Phenanthrene (fix this!)



Pyrene



Are levels of contaminants in disposal mounds declining compared to the reference areas?

The only Mound where historical sediment contamination data exists is Mound A. Three replicates from stations collected in 1989 near the old MDA buoy (14-7, 16-7 and 14-9, as described in Figure 2-1 in Murray, 1994) were compared to five stations collected in this survey at Mound A. This is not a direct comparison because in the intervening period, additional sediment was disposed at Mound A, after the 1989 samples were collected. Nevertheless, it might be instructive to determine if the results are comparable. In 1989, detection limits for the PAHs were higher than this survey, and many of the analytes were estimated. Table 9 compares results for 6 metals and three individual PAHs that were measured in both years. It appears that levels of chromium, copper, and the individual PAHs have increased since 1989. There are no decreases in sediment contamination. Most of the levels are near the 25th percentile of the logistic regression.

Table 9. Comparison of average of three stations (14-7, 14-9 and 16-7) from samples collected in 1989 (Murray, 1994) in and around Mound A (formerly MDA buoy), and of five stations collected at Mound A in July 2006. P25% is the concentration that would give a 25% or 50% probability of a toxic response according to the logistic regression model of Field et al. (1999, 2002).

Analyte	Average of three samples collected in 1989 (ug/g dry weight)	Average of five samples collected in 2006 (ug/g dry weight)	P25% (ug/g dry weight)
Chromium	55.33	110.4	76.0
Copper	31.67	55.4	49.98
Lead	45.67	51.0	47.82
Mercury	0.32	0.28	0.23
Nickel	15.67	22.0	23.77
Zinc	90.67	115.2	140.48
Fluoranthene	175	522	286
Phenanthrene	110	230	150
Pyrene	246.67	590	290

Is dredged material disposed at the disposal site and reference areas toxic to marine organisms, as measured by the Ampelisca 10-day toxicity test?

Based on the standard 10-day toxicity test, toxicity was not observed at any station (Table 10). This is consistent with all the results of the sediment profile imaging stations, which indicate that biological activity is present at all stations. SPI images at the 12-3 stations in 1994 typically demonstrated Stage I or Stage II on Stage III biological communities (Murray, 1997). SPI images in 2004 at the reference areas and Mound C typically demonstrated Stage I on Stage III biological communities (ENSR, 2005). Stage I communities are typically dominated by small, opportunistic, tube-forming polychaetes which rapidly (i.e., within 1-2 weeks) colonize new disposal mounds and which do not penetrate into the sediments very deeply. These organisms are thought to be recruited to the new habitat from off disposal mounds. Stage II is dominated by deeper penetrating species, which include tubiculous amphipods (e.g., *Ampelisca abdita*) and mollusks, typically occurring 3 to 6 months after disposal has ceased. These taxa represent a transitional stage, and may not hold permanent positions in the long term benthic community structure. Stage III animals represent an "equilibrium" level, typified by deeper-dwelling, head-down deposit feeding species. It is common to find more than one successional stage present at any one location (e.g., a Stage I community coexisting above a Stage III community).

Table 10. Results of toxicity measurements at twelve stations, and laboratory control.

Station number	Station Type and Name	Percent surviving
1	Reference SPI station 1	97
2	Reference SPI station 3	97
3	Reference SPI station 5	96
9	Mound C SPI station C15	93
12	Mound C SPI station C14	93
13	Mound C SPI station C6	97
17	Mound F center	97
19	Mound F south	97
20	Mound F west	95
22	Hotspot center	97
23	Hotspot east	97
24	Hotspot west	93
Control		91

Do levels of contamination in the disposal site pose a risk to aquatic life due to bioaccumulation?

Sediment contaminant levels were not evaluated for bioaccumulation related risks.

Side scan sonar methods

Side scan sonar was conducted using a Klein 3000 digital, dual frequency (100 and 500 KHz) side scan sonar towfish (**Figure 11**). Side scan tracks and grids were calculated and planned in Klein Sonarpro software, transferred to the OSV Bold onboard Nobeltec Navigation system for ship navigation purposes (**Figure 12**). Side scan playback and acquisition was processed using Klein Sonarpro software (**Figure 13**). Preliminary post processing was conducted using the Chesapeake Technology software SonarWiz Map. Navigation for the side scan transects was conducting using the OSV Bold Raytheon Differential GPS with vessel positioning to an accuracy of +/-5 m. The Klein digital side scan system allows the operator to mark targets during data acquisition. A "target" can then be recalled in playback mode. Length and width and other dimensions of the targets can be measured.

Side scan was performed on three separate days, in three transects, after two days of sediment sampling at the MBDS were completed **(Figure 14**). The surveys were designed to cover the area of the Massachusetts Bay Disposal Site where dredging disposal mounds were located and the Industrial Waste Site where previous surveys had discovered waste containers (Wiley, *et al.*, 1992; NOAA, 1996).

Figure 11. Picture of Klein tow fish attached to electronic cable on OSV Bold stern

Figure 12. Grid lines laid out in Nobeltec.

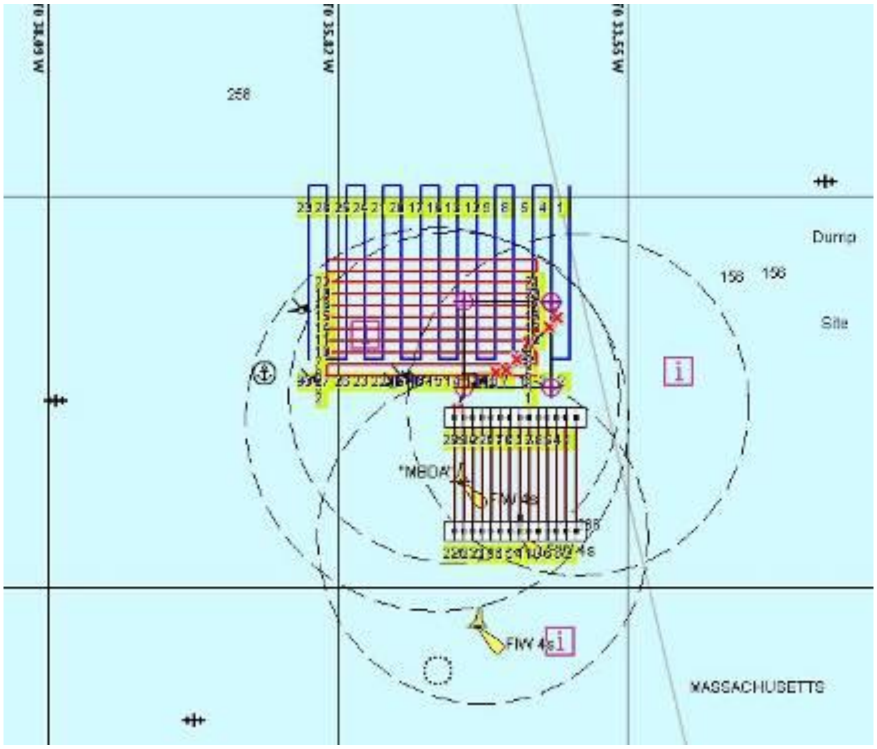


Figure 13. Mosaics of three areas overlain on electronic navigation chart.

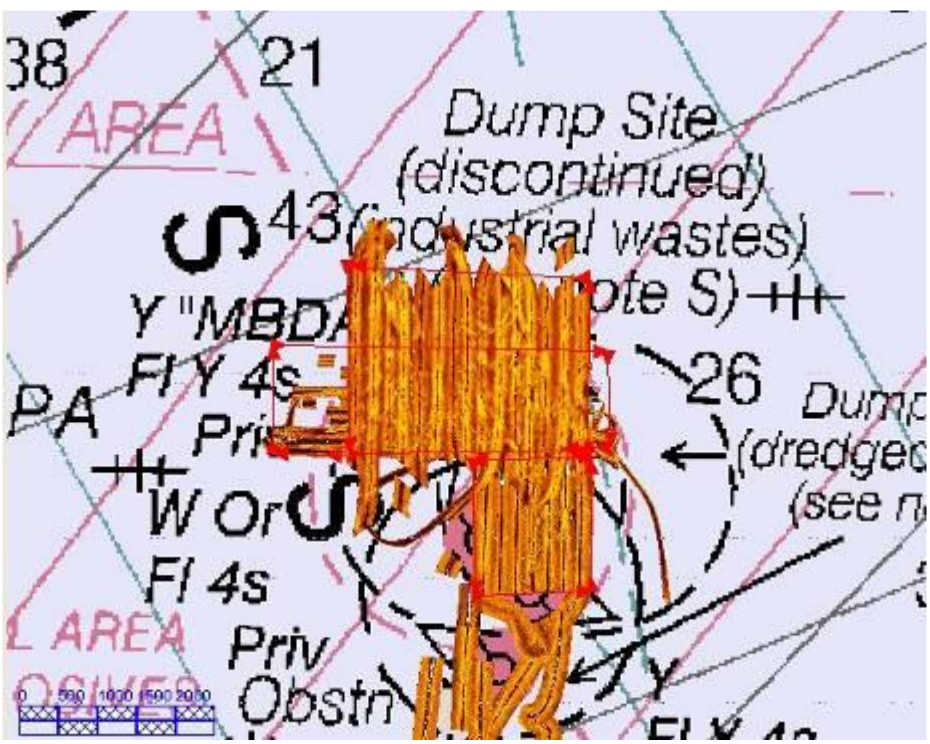
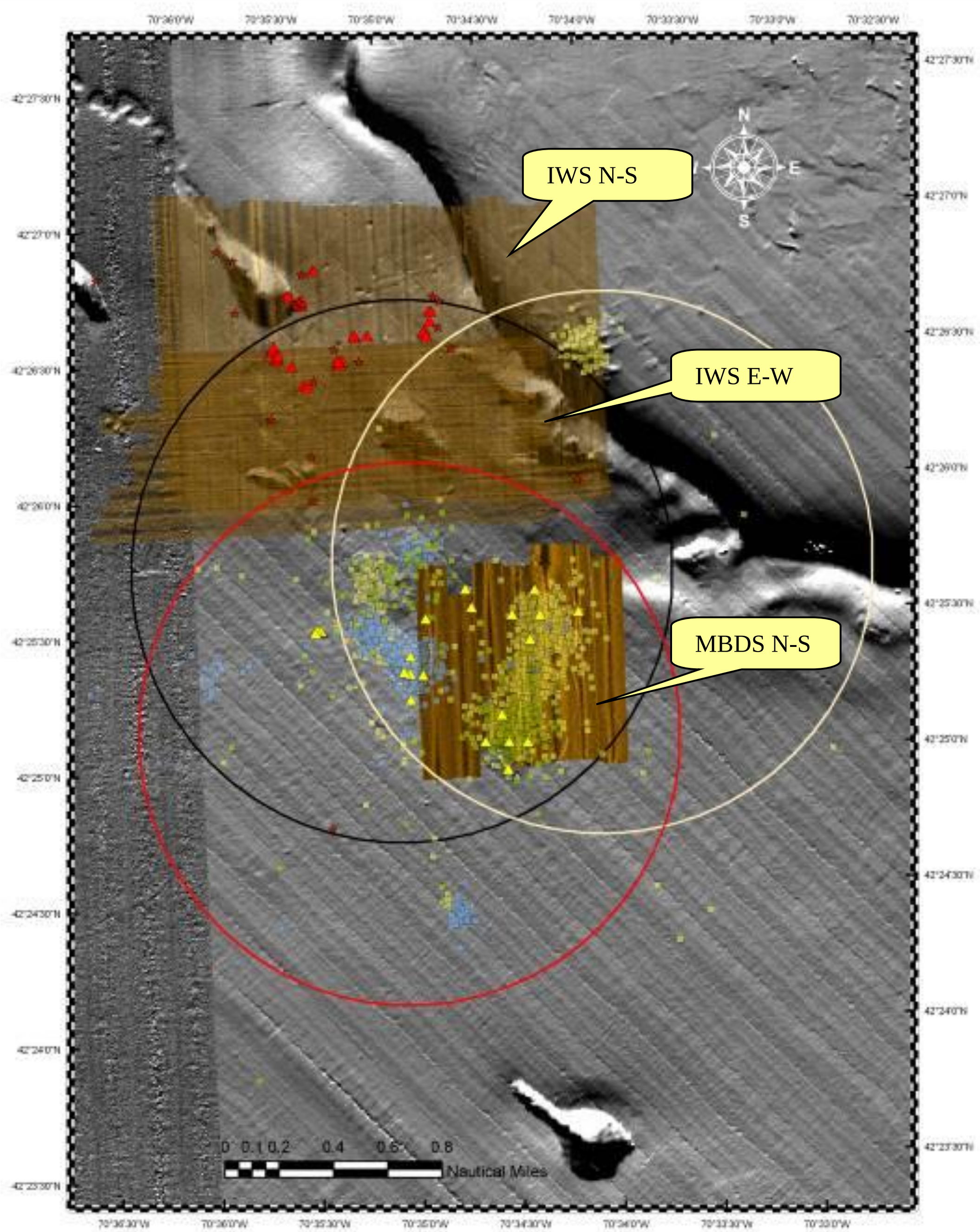


Figure 14. Side scan sonar mosaics (in copper color) for the 2006 side scan sonar surveys at the Massachusetts Bay and Industrial Waste disposal sites. Red triangles and stars are areas of known or suspected drums identified in 1991 (Wiley et al, 1992). Yellow triangles are sediment chemistry stations in 2006. Blue and green boxes are location of dredged material disposal from 1984 to 2007. Data Sources: Shaded Reliefs for Northern and Southern Stellwagen Bank (1:60,000); Shaded Relief of Western Massachusetts Bay (1:25,000); Bathymetry for the Gulf of Maine; and Massachusetts Bay Industrial Waste Site by US Geological Survey. Locations of dredged material disposal by Army Corps of Engineers New England District.



Transects

Area 1. Massachusetts Bay Disposal Site North-South transects. July 15, 2006

These transects were performed to characterize the ocean sediment, ocean floor anomalies, and presence of dredged material in an area of sediment sampling and recent dredged material disposal where sediment sampling had just been completed on the first leg of the survey. This survey was designed to provide 75% coverage in an N-S orientation, with a 150-meter range. Survey parameters were set as follows:

Line length: 1210 meters
Line spacing: 100 meters
Number of lines: 14
First line heading (180 degrees True)
Max layback: 200 Meters
Survey origin: 42′ 25.6530″N 70′ 33.9570″W
Speed: ranged from 3.7 to 4.5 knots
Depth: ranged from 88 to 92 meters

Table 11. MBDS North-South Transects. July 15, 2006.

Date	Transect #	Time of transect
07/15/2006	1	09:36 - 10:41
07/15/2006	3	10:41 - 10:52
07/15/2006	5	11:16 - 14:52
07/15/2006	7	15:07 - 15:13
07/15/2006	9	15:37 - 15:49
07/15/2006	11	16:09 - 16:20
07/15/2006	13	16:42 - 18:09

There were mechanical problems with the cable during this first survey. Therefore, only seven lines were completed (odd numbered transects) in the south direction only. The survey started at 09:36 and was completed at 16:42 (for a total of about 8.5 hours). To make sure the mechanical problems with the cable were fixed before heading to the IWS site, the survey continued beyond the end of transect #13 for two additional hours. Targets initially identified in these transects were primarily geologic features or shipwrecks.

Area 2. Industrial Waste Site North-South transects. July 16, 2006

These transects were performed in a North-South orientation in the IWS and the northwest section of the MBDS in areas where targets had previously been observed. Coordinates for possible targets were based on field investigations conducted in 1992 (NOAA, 1996). The transects were designed to provide 100% coverage at 150-meter range.

Survey parameters were set as follows:
Line length: 1852 meters
Line spacing: 200 meters
Number of lines: 15
First line heading (180 degrees True)
Max layback: 200 Meters
Survey origin: 42′ 27.000″N 70′ 33.999″W
Speed: ranged from 3.4 to 4.2 knots
Depth: ranged from 49.6 to 94.1 meters

Table 12: IWS North-South transects. July 16, 2006.

Date	Transect #	Time of Transect
07/16/2006	1	08:42 - 08:58
07/16/2006	3	09:08 - 09:25
07/16/2006	5	09:35 - 09:52
07/16/2006	7	10:03 - 10:23
07/16/2006	9	10:28 - 10:46
07/16/2006	11	10:58 - 11:19
07/16/2006	13	12:17 - 12:55
07/16/2006	15	12:55 - 13:21
07/16/2006	14	13:45 - 14:02
07/16/2006	12	14:14 - 14:37
07/16/2006	10	14:39 - 15:10
07/16/2006	8	15:24 - 15:42
07/16/2006	6	15:54 - 16:13
07/16/2006	4	16:22 - 16:43
07/16/2006	2	16:57 - 17:13

This survey started at 08:42 and was completed at 17:13 (for a total of about 8.25 hours). Fifteen lines were completed. Each line took about 24 minutes to complete. Targets initially identified in these transects included: drums, geological features; trawl marks; shipwrecks; construction debris; dredged material debris; pipes; tires; physical trawl marks; lobster pots; vehicles; and unidentifiable objects.

The Klein side scan sonar system allows the user to identify targets in real time during data acquisition. Targets were ranked according to their likelihood to be a barrel, drum or shipwreck.

Targets were assigned to a high, medium or low priority category based on whether the shape and size of the object suggested a high, medium or low likelihood that the target was a barrel or drum, or shipwreck. Targets were assigned a medium priority if the object seemed to be degraded in physical condition or it appeared that the barrel field could be other debris. Targets were assigned a low priority if the objects were identified as construction debris. Other targets, such as construction debris or lobster pots were not included in the ranking process. Once targets were prioritized, coordinates were reviewed in Nobeltec and recorded in Microsoft Excel spreadsheets. The third survey was designed to further examine the high priority targets from the IWS N-S survey.

Area 3. Industrial Waste Site E-W transects. July 17, 2006

The third survey was conducted to further investigate the priority targets with the expectation that barrel fields could be investigated at a slower speed and a lower altitude resulting in greater resolution of the targets. These transects were also designed to fly over barrel fields as defined by the coordinates from Wiley *et al.* (1992). The transects were designed to provide 100% coverage at 75-meter range. Side scan survey parameters were set as follows:

Line length: 2242 meters
Line spacing: 125 meters
Number of lines: 11
First line heading (270 degrees True)
Max layback: 200 Meters
Survey origin: 42′ 25.900″N 70′34.2599″W
Speed: ranged from 3.5 to 5.0 knots
Depth: 49.6 to 94.1 meters

Table 13: IWS East-West transects July 17, 2006 to July 18, 2006.

Date	Transect #	Time of Transect
07/17/2006		09:18 - 12:31
07/17/2006	1	12:31 - 12:51
07/17/2006	7	13:15 - 13:40
07/17/2006	2	14:43- 15:07
07/17/2006	3	16:16 - 16:39
07/17/2006	4	17:33 - 17:57
07/17/2006	5 westbound	18:45 - 19:14
07/17/2006	6 westbound	19:50 - 20:12
07/17/2006	7 westbound	21:20 - 22:38
07/17/2006	8 westbound	22:38 - 22:57
07/18/2006	9 westbound	23:38 - 0:10:14
07/18/2006	11 westbound	0:51:52 - 01:16

This survey started at 09:18 on July 17 and was completed at 01:16 on July 18. Eleven transects were completed in about 8.5 hours. Currents were strong and data acquisition was not accurate in the eastbound transects, as the heading of the tow fish and the ship were not concordant. After six transects, only westbound transects were conducted and the transect numbers were re-set. The westbound only portion of the survey commenced at 1845 and was completed at 0100 on July 18. Of the targets initially identified, most appeared to be shipwrecks, drums and geological features, physical disturbances and construction debris.

All side scan images were saved as a series of .xtf format files, and viewed using SonarPro, Klein's data recording, playing and viewing software compatible with the Klein 3000.
Side scan data from the 100 and 500 kHz frequencies and the navigation data were stored on an internal hard drive, and transferred to an external hard drive for post-survey analysis. Following the survey, the raw side scan and vessel position data stored on disks were played back and processed in order to obtain a file of digital side scan data that is fully geo-referenced. In this process, the position of the side scan tow fish is computed from the vessel position and heading information, and the cable layback, and then the position of each side scan return signal (many independent side scan return signals are acquired perpendicular to the vessel track for each outgoing "ping") is determined.

Sonar images processing

Vince Capone of Barkentine, Inc. imported all raw xtf files into Chesapeake Technologies, Inc. SonarWiz.MAP sonar processing software to create three independent georeferenced mosaics (Capone, 2008). Turns and data from outside the survey area were removed from the project leaving only contiguous survey lines covering the IWS/MBDS locations. The individual survey lines were aggregated, and subjected to a navigation smoothing process. Errant GPS fixes were removed and the positional data were subjected to a three hundred (300) point splining function that smoothed the data track. Each aggregated and smoothed file was further processed by manually tracing the first bottom return. The SonarWiz.MAP software then removed the water column and applied Time Varied Gain (TVG) to each file. The files were then combined into a high resolution mosaic for each data set.

Barkentine, Inc. also identified and classified targets from the high resolution shorter 75-meter range images (IWS E-W). The longer range 150 meter images only provided general enumeration of targets or identification of large features, such as dredged material. Priorities for identification and classification were drum and encasement targets, lobster traps and construction debris. Based on Mr. Capone's experience as a sonar analyst[1], he was able to provide levels of confidence to discriminate drums from other targets such as rocks, boulders, lobster traps and construction debris. Each target was analyzed and classified into one of ten different categories: drum-like target, metallic debris, possible concrete encasement, non-drum-like man-made debris, shipwreck, lobster trap, fish, dredge material/glacial deposit, rock/boulder, and unknown. Each classification was represented by a color and icon on subsequent figures. Every target was electronically logged into a digital database which included its sonar image, position and measurements as well as its classification and probability of identification. Identification of

[1] Vincent J. Capone, M. Sc. has over 20 years and thousands of hours of side scan sonar experience. He was the ROV pilot for the 1991 survey which investigated dozens of sonar targets in the IWS/MBDS. He also participated in the later sonar/ROV surveys conducted by SAIC and Deep Sea Systems.

targets as drums was based on an evaluation of size and shape, metal characteristics (e.g. flaring and ringing), and neighboring targets. For example, based on results of the 1991 ROV Survey (Wiley *et al.*, 1992) targets within the boundaries of dredge material/rock disposal areas or amongst glacial deposits were more likely to be boulders, rocks or construction debris; targets outside of these areas were more likely to be drums. Targets aligned linearly are more likely to be lobster traps than drums. High probability drum-like targets had dimensions roughly equivalent to a drum (approximately 0.9m x 0.6m) and exhibited a rectangular shadow. Targets with only the dimensions or only the shadow were usually given a moderate probability of being a drum target. Due to navigation errors during the collection of the data, target locations could be off from the actual location from up to 25 to 40 meters.

Results and Discussion

There were 1034 targets classified into ten categories in the IWS E-W transects. Because of the high number of targets in the area, Vince Capone focused on drum-like, metallic debris and encasement targets and did not record every possible rock, dredge material or non native target. Drum-like targets and metallic debris dominated the north center of the IWS E-W survey area. See **Figure 3 from Capone, 2008.** This concentration of drum-like and metallic debris targets most likely continues further north as indicated by the large number of unidentified point targets found in the IWS N-S sonar records. Two areas of possible encasement targets were observed in the center and western section of this area. Of the 1034 targets analyzed, 806 were classified as either drum like or metallic debris.

Table 14. Results of classification of 1034 targets in the IWS E-W transect.

Classification type	Number of targets
Drum like	481
Metallic debris	325
Concrete encasements	35
Non-drum like Man-made debris	40
Shipwreck	6
Lobster trap	7
Fish	4
Dredge material/glacial deposits	9
Rock/Boulder	26
Unknown	101

The eastern side of the area was dominated by dredge material and glacial deposits.

BI also examined the long range data in IWS N-S and MBDS N-S for large targets. Large objects such as shipwrecks and dredge material were observed **(see Figures 9 and 10 from Capone, 2008).** The locations of glacial deposits and dredge material in these areas are consistent with known locations of glacial deposits from topographic surveys, from historically disposed dredged material, and from mounds sampled in this survey. Specifically, the dredged material outlined in Figure 10 of Capone, 2008 are Mounds A, B and C at the MBDS.

The results of the detailed target analysis provide a good representation of the distribution of drum like targets and metallic debris within the IWS E-W survey area. The actual number of drum related targets within the survey area was probably much higher than quantified in this analysis for three reasons. First, based upon sonar and visual analysis of the targets in 1991 almost all the targets outside the dredge material/glacial deposit areas were drum related, but there may be additional drums within the dredge material areas. Second, because the area directly under the sonar towfish ("nadir zone") has substantially less resolution than other portions of the sonar record, the total number of drum like targets may be higher than reported. Finally, many drum-like targets have corroded significantly, and may not have provided sufficient reflectance for a confident classification. During the IWC ROV survey in 1991, targets which appeared as a few bright pixels on the sector sonar were often found to be remnants of drums.[2] Thus, unidentified targets in the IWS N-S transects provide additional information on likely locations of fields of drums.

The digital sonar data on this survey exhibited a higher resolution than the sonar data from the 1991 survey (Wiley *et al.*, 1992) because of a smaller beam angle at the 75-meter range, and advancements in signal processing. Because of this increased resolution, we have identified (with a reasonable probability) for the first time the locations of concrete encasements thought to have been disposed at the IWS. The 1991 IWC ROV survey located a few drums which had been partially filled with concrete, but no concrete encasements[3]. The two clusters of potential encasement targets identified in this survey may represent a small percentage of the total since burial, colonization by marine organisms and other factors can easily obscure encasement characteristics. Only those targets which strongly resembled a concrete encased drum were included in this category. None of the targets were marked as a high probability, however, since no video verification has been completed on this type of target.

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[2] Based on Vince Capone personal recollection from field operations at the IWS and MBDS sites.

[3] Based on Testimony by David Wiley before the Subcommittee on Fisheries and Wildlife Conservation, November 4, 1991.

Figures 3, 9 and 10 from Capone, 2008

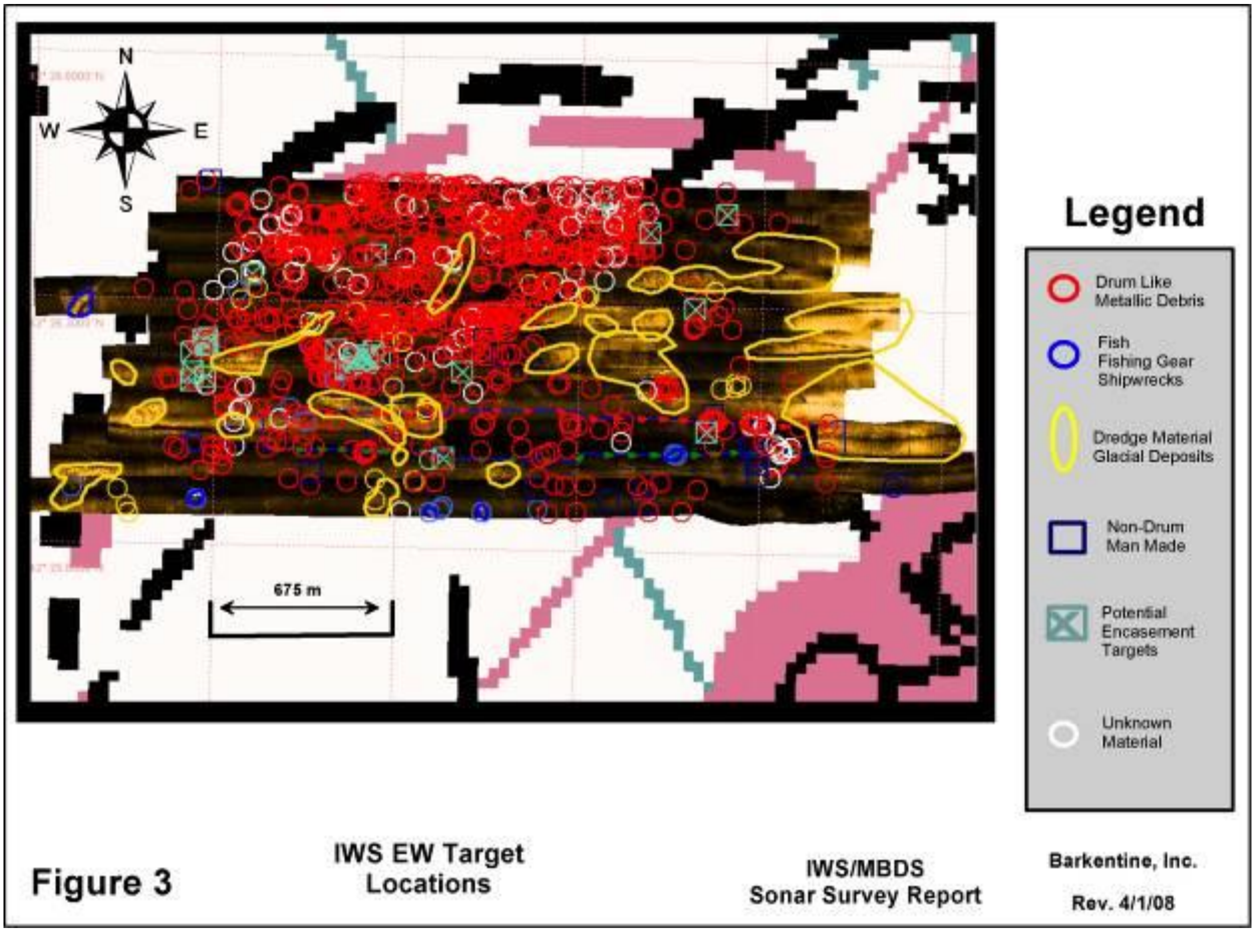

Figure 9 — IWS N-S Mosaic Dredge Material — IWS/MBDS Sonar Survey Report — Barkentine, Inc. Rev. 4/1/08

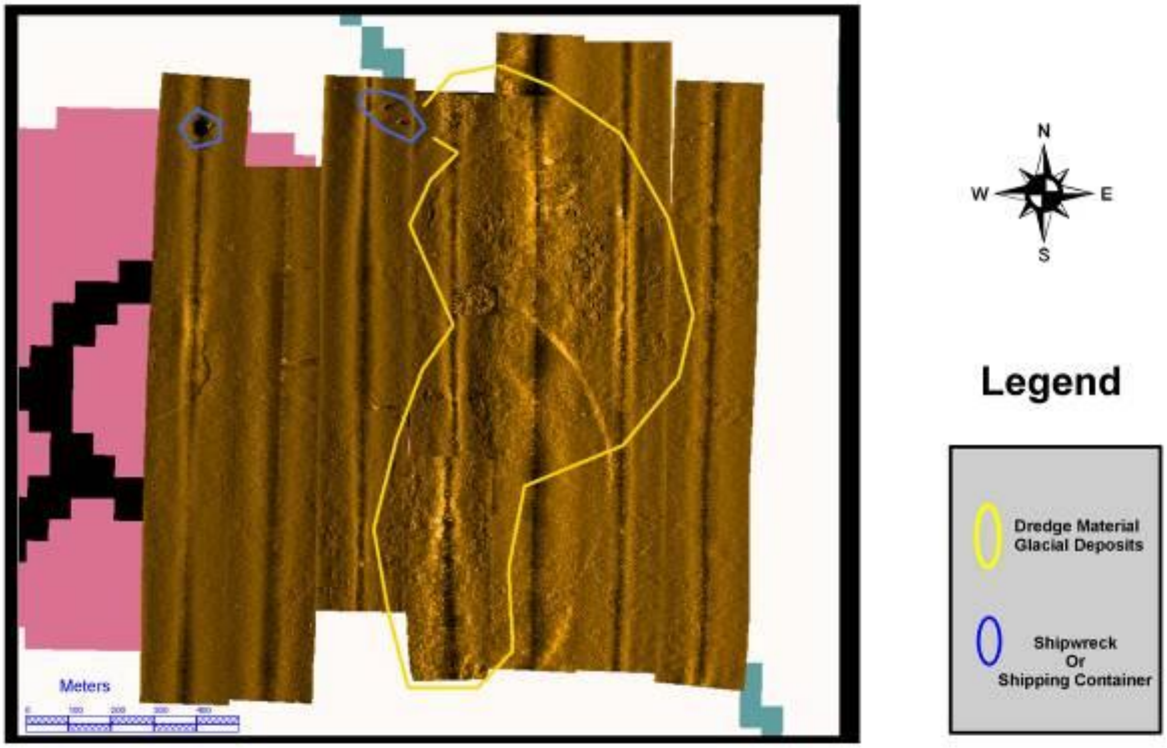

Figure 10 MBDS N-S Mosaic Dredge Material

IWS/MBDS Sonar Survey Report

Barkentine, Inc.

Rev. 4/1/08

Conclusions

Based on sediment chemistry results, the Massachusetts Bay Disposal Site is meeting environmental objectives as specified in the 1996 Site Management and Monitoring Plan. Side scan sonar images clearly located significant dredged material mounds in the Massachusetts Bay Disposal Site. Based on a comparison to sediment quality guidelines, levels of contaminants collected from historically contaminated areas and recently disposed mounds do not appear to be causing adverse effects to the marine environment. In addition, in response to the questions posed by the study design:

Levels of contaminants at the disposal mounds created within the last four years are not within the range predicted by testing of dredged material for suitability. Contaminant levels for cadmium, chromium, copper, lead, mercury, zinc, PAHs and PCBs were clearly higher in the source material than at the disposal mound. In addition, the disposal mound was lower in organic content and had slightly less fine grained sediments. It is unclear whether this is due to the variability associated with sampling both the source material and the disposal mound, or loss of contaminants associated with high organic content fine grained material during the disposal process.

Many of the individual PAHs exhibited significant declines from the 1989 and 1993 sampling surveys at the historically contaminated "Hotspot" or site "12-3". PAHs are expected to decline as they are mobilized and metabolized by benthic processes. In contrast, except for lead, no metals show a significant downward trend in contaminant levels. At Mound A, it appears that levels of chromium, copper, and the individual PAHs have increased since 1989, and there are no obvious decreases in sediment contamination. It is important to stress, however, that additional dredged material was disposed on this site through 1994. This suggests that either additional disposal, or lack of removal processes have stabilized the contaminant levels at this disposal mound. This is somewhat surprising for PAHs, since PAHs appeared to have declined at other stations where no disposal has occurred (Hotspot and site "12-3".) Despite this lack of trend, most of the contaminants are at levels not expected to cause significant adverse effects to benthic organisms.

Dredged material disposed at the disposal site and the reference areas are not toxic to marine organisms, as measured by the *Ampelisca* 10-day toxicity test. This is consistent with the results of sediment contaminant levels, compared to sediment quality guidelines, and to results of sediment profile imagery which indicated healthy stage I or stage III biological communities at Mound C and the reference area (ENSR, 2005).

Sediment contamination levels were not evaluated for risks to aquatic life associated with bioaccumulation.

The new OSV Bold digital dual-frequency side scan sonar detected dredged material and historically disposed waste containers known to be located at the IWS. For the first time, locations of clusters of concrete encasements have been located with a moderate level of probability. Over one thousand targets were identified in the high resolution transects in the IWS, of which more than 80% were drum like targets or metallic debris. These data provide sufficient information to determine priorities for potential capping of the drums with new dredged material.

In sum, current site management and project evaluation approaches should be continued.

Citations

ASTM. 1998. Standard Methods for Particle-Size Analysis of Soils. In 1998 Annual Book of ASTM Standards Vol. 4.08. Philadelphia, PA. (D 422-63, D421-85, D2217-85).

Battelle, 2001. Final Data Report for Boston Harbor Contract Number DACW33-96-D-0005. Delivery Order No. 56. Submitted to the U.S. Army Corps of Engineers, New England District.

Capone, V.J. 2008. Side Scan Sonar Data Processing and Analysis of USEPA IWS/MBDS Survey 2006. Barkentine, Inc. January 31, 2008.

DeAngelo, E. and P. Murray. 1997. Baseline Survey of the Reconfigured Massachusetts Bay Disposal Site, 14 August 1993. DAMOS contribution #115. February 1997. U.S. Army Corps of Engineers New England Division, Corps of Engineers. (SAIC, 1997).

ENSR. 2005. Monitoring Cruise at the Massachusetts Bay Disposal Site – September 2004. DAMOS Contribution #162. September 2004. U.S. Army Corps of Engineers New England Division.

Field, L.J., D.D. MacDonald, S.B. Norton, C.G, Severn, and C.C. Ingersoll. 1999. Evaluating sediment chemistry and toxicity data using logistic regression modeling. Environmental Toxicology and Chemistry 18(6):1311-1322.

Field, L.J., D.D. MacDonald, S.B. Norton, C.G, Severn, C.C. Ingersoll, D. Smorong, and R. Linkskoog. 2002. Predicting amphipod toxicity from sediment chemistry using logistic regression models. Environmental Toxicology and Chemistry 21(9):1993-2005.

Germano, J.D., D.C. Rhoads, and J.D. Lunz. 1994. An Integrated, Tiered Approach to Monitoring and Management of Dredged Material Disposal Sites in the New England Region. DAMOS Contribution No. 87. U.S. Army Corps of Engineers, New England Division, Waltham, MA, 81 pp.

Murray, P. 1994. Chemical Analyses of Sediment Sampling at the Massachusetts Bay Disposal Site, 5-7 June 1989. DAMOS contribution #91. November 1994. U.S. Army Corps of Engineers New England Division, Corps of Engineers. (SAIC, 1994).

Murray, P. 1997. Monitoring Cruise at the Massachusetts Bay Disposal Site, August 1994. DAMOS contribution #116. February 1997. U.S. Army Corps of Engineers New England Division, Corps of Engineers. (SAIC, 1997).

National Oceanic and Atmospheric Administration (NOAA). 1996. The Massachusetts Bay Industrial Waste Site: A Preliminary Survey of Hazardous Waste Containers and an Assessment of Seafood Safety. (May and June 1992). NOAA Technical Memorandum NOS ORCA 99. Edited by John Lindsay.

Plumb, R.H., Jr. 1981. Procedure for Handling and Chemical Analysis of Sediment and Water Samples. Tech. Rep. EPA/CE-81-1. Prepared by Great Lakes Laboratory, State University College at Buffalo, Buffalo, NY, for the Environmental Protection Agency/U.S. Army Corps of Engineers Technical Committee on Criteria for Dredged and Fill Material. U.S. Army Engineer Waterways Experiment Station, Vicksburg, MS.

Science Applications International Corporation. 2002. Monitoring Cruise at the Massachusetts Bay Disposal Site – Fall 2000. DAMOS Contribution #134. March 2002. U.S. Army Corps of Engineers New England Division.

Science Applications International Corporation. 2003. Massachusetts Bay Disposal Site Capping Demonstration Project 1998 - 2000. DAMOS Contribution #147. U.S. Army Corps of Engineers New England Division.

Test Methods for Evaluation of Solid Waste, SW-846. 1996. Third Edition, Final Update III. December 1996. EPA Office of Solid Waste and Emergency Response. Washington DC.

Test Methods for Evaluation of Solid Waste, SW-846. 1998a. Third Edition, Revision 2. January 1998. EPA Office of Solid Waste and Emergency Response. Washington DC

Test Methods for Evaluation of Solid Waste, SW-846. 1998b. Third Edition, Revision 1. September 1998. EPA Office of Solid Waste and Emergency Response. Washington DC.

U.S. EPA. 1994. Methods for Assessing the Toxicity of Sediment-Associated Contaminants with Estuarine and Marine Amphipods. EPA/600/R-94/025. U.S. Environmental Protection Agency. Office of Research and Development. Washington D.C.

U.S. EPA. 2001. Methods for Collection, Storage and Manipulation of Sediments for Chemical and Toxicological Analyses: Technical Manual. EPA 823-B-01-002. U.S. Environmental Protection Agency, Office of Water, Washington, DC.

U.S. EPA. 2004. The Incidence and Severity of Sediment Contamination in Surface Waters of the United States. EPA 823-R-04-007. U.S. Environmental Protection Agency, Office of Water, Washington, DC. November 2004.

U.S. EPA and U.S. Army Corps of Engineers. 1995. QA/QC Guidance for Sampling and Analysis of Sediments, Water, and Tissues for Dredged Material Evaluations: Chemical Evaluations. EPA 823-0B-95-001. U.S. Environmental Protection Agency, Office of Water, Washington, DC. April 1995.

US EPA Region 1 (New England). 1996. Massachusetts Bay Disposal Site Management Plan. US EPA Region 1 (New England). December 31, 1996.

US EPA New England. 2006. Massachusetts Bay Disposal Site Sediment chemistry and toxicity Quality Assurance Project Plan. July 6, 2006. Prepared by Matthew Liebman, US EPA New England, One Congress Street, Suite 1100 COP, Boston, Massachusetts 02114-2023

US EPA New England. 2008. DRAFT Massachusetts Bay Disposal Site Management Plan. US EPA Region 1 (New England). February 2008

US EPA New England and US Army Corps of Engineers New England District. 2004. Regional Implementation Manual for the Evaluation of Dredged Material Proposed for Disposal in New England waters. April, 2004.

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 US EPA Region 1. International Wildlife Coalition, Falmouth, MA. 59 pp.