U.S. Army Corps of Engineers
New England District

Massachusetts Port Authority
Maritime Department

Boston Harbor Navigation Improvement Project Phase 2 Summary Report

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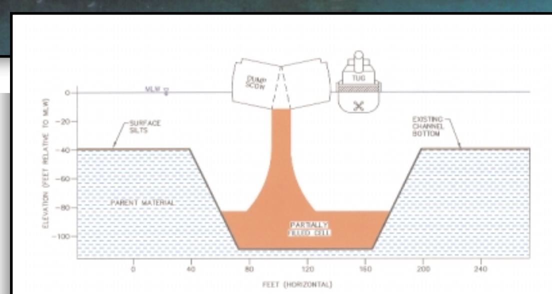

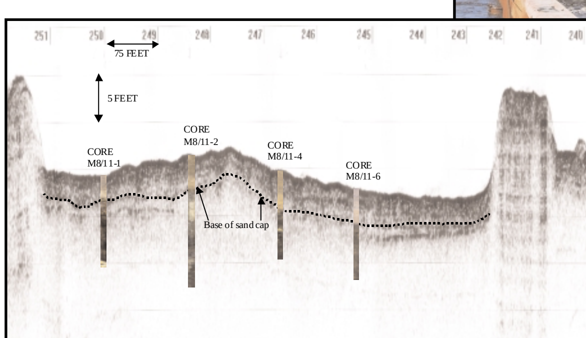

May 2002

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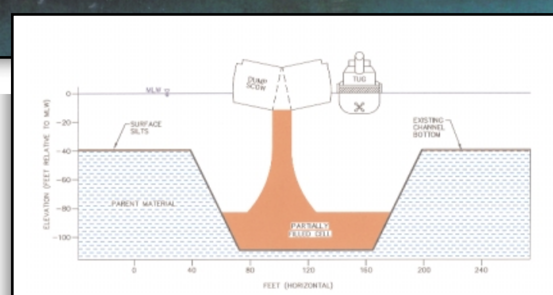

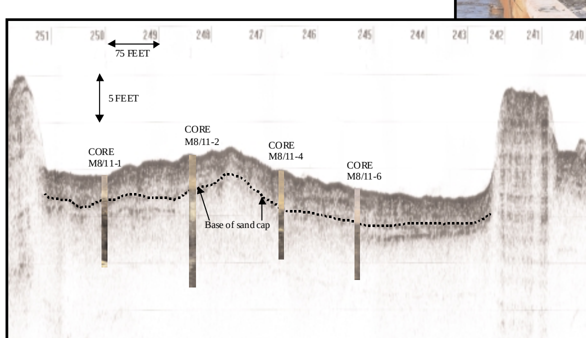

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Executive Summary

E.1 INTRODUCTION

The Boston Harbor Navigation Improvement Project (BHNIP) was a joint project between the Corps of Engineers (Corps) and the Massachusetts Port Authority (Massport). The project consisted of maintenance and improvement dredging in channels and berths within Boston's Inner Harbor and included removal of approximately 1 million cubic yards (cy) of silty maintenance material, 1 million cy of improvement material (also referred to as parent material and composed primarily of Boston blue clay) and an additional 1.4 million cy of parent material in the construction of disposal cells. A portion of the Mystic River, Inner Confluence, and Reserved Federal navigation channels were deepened from 35 feet mean lower low water (MLLW) to 40 feet MLLW while the Chelsea River was deepened from 35 feet MLLW to 38 feet MLLW. A number of berths were also deepened to various depths.

Because of adverse biological testing results likely caused by elevated concentrations of metals and organic compounds, the maintenance material was disposed in confined aquatic disposal (CAD) cells. The CAD cells were located within the dredging project footprint in the Federal navigation channels and were capped with sand following completion of disposal. Improvement material was disposed at a designated offshore disposal site in Massachusetts Bay (the Massachusetts Bay Disposal Site). There were a number of environmental concerns related to dredging and disposal of the maintenance material as well as capping of the cells, and, as a result, the state-issued Water Quality Certification for the project contained numerous conditions for monitoring.

A major partner in the design and permitting process was the project's Dredging Advisory Committee, formed at the beginning of the Environmental Impact Report/Statement process in 1992. This group consisted of representatives from government resource agencies, private environmental groups, academic interests, shipping and other business interests, pilots, and others. This group helped in evaluating the disposal alternatives for the maintenance material during the design process and in commenting on the conditions in the state-issued Water Quality Certification. The Water Quality Certification for the project noted that members of the group would support the project during construction as a Technical Advisory Committee providing review of monitoring data and Water Quality Certification amendments. The Water Quality Certification also required the inclusion of an independent observer funded by the local sponsor of the project (Massport) and managed administratively by Massachusetts Coastal Zone Management. The observer was charged with monitoring project construction, performing quality assurance checks of the contractor's monitoring program, reviewing monitoring data, and making technical recommendations.

The BHNIP was constructed in two phases. Prior to Federal funding of the improvement project, Massport funded limited berth dredging at Conley Terminal to allow for earlier use by deep draft container vessels. This Phase 1 work included the construction of a single CAD cell and was performed by Weeks Marine in June-August 1997. A summary of this work is provided in "Summary Report of Independent Observations Phase 1 – Boston Harbor Navigation Improvement Project (ENSR 1997).

The main portion of the project (including Federal navigation channel and remaining private berth maintenance and improvement work) was completed as Phase 2 of the project and included construction of eight additional CAD cells. This work was performed by Great Lakes Dredge and Dock Company (GLDD) between May 1998 and September 2000 (with limited follow up work in 2001). This Phase 2 summary report has been prepared by ENSR (the independent observer for the project) in conjunction with the Corps under an environmental services contract with the Corps. All of the data and many of the figures represent the efforts of the project sponsors and contractors to the project.

E.2 DESCRIPTION OF DREDGING AND DISPOSAL OPERATIONS

The major components of Phase 2 of the BHNIP included construction of the in-channel CAD cells, dredging of maintenance material with disposal into the CAD cells, capping of the CAD cells, and dredging of improvement material with disposal at a designated offshore site. The eight CAD cells constructed for Phase 2 of the project ranged in capacity from approximately 28,000 to 349,000 cubic yards (cy) with cell depths up to a maximum of 70 feet below the surrounding harbor bottom. Most cells were constructed within relatively stable clay parent material, which supported side slopes of up to 1 vertical on 2 horizontal. Approximately 1.4 million cy of parent material was removed to create the cells.

Maintenance dredging was performed with mechanical dredges using closed environmental buckets (models manufactured by Cable Arm and by GLDD) and was required over all of the areas designated for improvement work. The depth of the maintenance layer varied considerably, but averaged about 1.5 feet in the channels. The dredging included measures to ensure proper segregation of maintenance material (destined for CAD cells) from the improvement material (destined for offshore disposal). The dredged maintenance material was loaded into split-hulled scows. For disposal, the scows were positioned over the desired portion of the CAD cell with a tug alongside. Disposal was limited to a three-hour window around high tide initially, but a two-hour low-tide window was later allowed. GLDD attempted to maintain more than one open cell at a given time to allow for more settling of material between disposal events and for greater flexibility in dealing with harbor operations constraints. The CAD cells were filled within five to eight feet of the surrounding harbor bottom. A total of about 1 million cy of maintenance material was disposed into the CAD cells.

The Water Quality Certification for the project required that the CAD cells be capped with three feet of sand following a consolidation period after disposal was completed. One of the eight Phase 2 cells was not capped during the project as it was only partially filled. The remaining cells were capped in three groups over the course of the project. Based on joint cooperation between the Corps and GLDD, capping material was dredged from portions of the Federal navigation channel in the Cape Cod Canal by hopper dredge, transported to Boston Harbor, and slowly released over the cells through the split hopper. By tracking the position of the hopper over the cell and the release rate of sand, an estimate of cap coverage was generated that guided placement of the multiple hopper loads required for each cell.

The first three cells were capped together in 1998 following consolidation times of 30 to 52 days prior to the initiation of capping. For this set of cells, the hopper dredge's own power (main propulsion and bow thruster) was used. Based on review of the monitoring results of the capping of the first three cells, the capping program was modified to allow for longer consolidation time prior to capping and to use tug assistance for maneuvering the hopper to reduce potential propwash effects during capping. In the second round of capping, two cells were capped in 1999 following approximately 150 days of consolidation, and the monitoring revealed much more consistent capping results. For the last round of capping, two cells were capped in 2000, and the consolidation time was extended further to over 200 days resulting in excellent capping results.

Approximately 1.1 million cy of improvement material was removed during Phase 2 of the project. The majority of the material was clay and was removed using mechanical dredges. Approximately 58,000 cy of rock was removed, primarily using an excavator-type dredge with limited drilling/blasting. Because the ongoing Central Artery project in Boston was generating large quantities of clean material, a beneficial use for the dredged improvement material could not be found, and it was disposed at a designated site (Massachusetts Bay Disposal Site), approximately 22 miles east of the harbor in Massachusetts Bay.

E.3 ENVIRONMENTAL MONITORING

The Final Environmental Impact Report/Statement for the BHNIP identified a number of environmental concerns related to the project, in particular the dredging and disposal of the maintenance material. As a result, the Water Quality Certification issued by the MA Department of Environmental Protection required a relatively extensive monitoring program for the project. The majority of the monitoring focused on disposal into the CAD cells, with monitoring events triggered by specific activities such as initiation of disposal into a given cell or disposal of material from a particular (more contaminated) area of the harbor. The monitoring included real-time tracking of turbidity as well as collection of water samples at a set distance down current of the disposal cell for analysis of specific contaminants of concern. The monitoring revealed only limited transport of suspended solids away from the disposal area, and there were no exceedences of the water quality criteria set for the project.

A limited amount of biological testing was also performed in conjunction with the disposal monitoring. Bioassay tests (mysid shrimp survival/growth and sea urchin fertilization) did not reveal any project related impacts. An assessment of bioaccumulation in blue mussels did not reveal any apparent project-related accumulation of organics. Of the metals tested (arsenic, cadmium, lead, mercury), only lead showed any potential of project related accumulation. Monitoring also included tracking dissolved oxygen levels in near-bottom waters over the capped cells that were depressed up to 15 feet below the surrounding harbor bottom. No apparent impacts to dissolved oxygen levels were noted.

The Water Quality Certification required the use of a closed, environmental bucket for the maintenance dredging, and, as a result, there were only limited requirements for mapping of turbidity associated with dredging. The monitoring and general observations throughout the course of the project did not reveal significant suspended solids impacts associated with the dredging.

Fisheries monitoring was also required during certain project activities, targeting pelagic fish species during the late winter/spring season. The monitoring vessel was equipped with a startle system to deter fish from moving into construction areas. However, the monitoring revealed limited fish in the immediate vicinity of the operation, and the startle system never needed to be engaged.

E.4 CAP MONITORING

Monitoring following cap placement was required to ensure that permit conditions and contract specifications were met regarding cap coverage and thickness. The monitoring included performance of bathymetric, sub-bottom, and side-scan sonar surveys as well as the collection of cores. The monitoring for the first set of three cells capped in 1998 revealed that the caps displayed significant variability, and all showed some mixing between the sand cap material and the dredged maintenance material and/or a significant volume of maintenance material over the sand caps. The elevation of the top of the cells actually decreased with the placement of sand over two of the cells, indicating that the loading of sand caused accelerated consolidation of the disposed material within the cells. The results indicated that the material within the cells had not consolidated sufficiently prior to cap placement.

For the second round of capping (two cells) in 1999, the monitoring revealed a distinct sand cap over the top of the majority of both cells. The monitoring did reveal isolated areas with silty maintenance material at the surface of the CAD cell and sand at depth. These features were not apparent in the first set of cells and were thought to result from localized instabilities where fluidized disposed material at depth within the cell was driven upward through the cap as pressure within the cell increased with the loading of the sand cap on top. For the third round of capping (two cells) in 2000, the monitoring revealed complete cap coverage with no significant accumulation of silty material above the sand cap and no significant mixing of the sand cap material with the cell contents.

E.5 EVALUATION OF THE ENVIRONMENTAL MONITORING PROGRAM

The Final Environmental Impact Report/Statement for the BHNIP noted that impacts to the water column due to dredging would be minimized by the use of a closed or “environmental” clamshell bucket. As a result, the Water Quality Certification for the project specified the use of a closed bucket, but required very limited water quality monitoring associated with its use. However, observations over the course of the project revealed that the operational aspects of dredging (cycle time, scow washing, operator experience) likely outweighed the equipment aspects (requirement for a specific bucket) in terms of potential effects on the water column.

Predictive modeling performed as part of the Final Environmental Impact Report/Statement did reveal the potential for elevated water column suspended solids and water quality criteria exceedences following disposal into CAD cells. As a result, the Water Quality Certification for the project required monitoring of the disposal operations with extensive sampling and analysis. However, the monitoring revealed a very limited suspended solid plume associated with the disposal and no exceedences of the water quality criteria specified for the project. Hence, it appears that the loss rate assumed during the predictive modeling (up to 5% of the scow material lost to the water column during disposal) was overly conservative, i.e., a lower estimate could have been used.

Some of the cell excavation and disposal activities that were performed between 15 February and 15 June required a fisheries observer, sonar detection system, and startle system. Although the observation requirement was triggered numerous times, schools of fish were not apparent in the vicinity of cell excavation or disposal, even though schools of fish had been noted at specific passage areas nearby, and the startle system did not have to be engaged. This suggests that the disturbance associated with project operations was enough of a deterrent to keep schools of fish away from the immediate construction area on their way upstream without being an overall impediment to fish passage.

E.6 EVALUATION OF CAPPING

Although there have been numerous projects that involved assessment and capping of material exposed on the open seafloor, very little was known about the consolidation of dredged material in a confined, subaqueous environment (such as a CAD cell) at the start of the BHNIP. Although only one cell was utilized in Phase 1 of the project, the experience gained was instrumental in amending the Water Quality Certification for the capping of the Phase 2 cells. The three rounds of capping and subsequent assessment during Phase 2 led to further understanding of the processes that govern at what point a consolidating cell could be successfully capped as well as refinement of the techniques for cap placement.

In another setting, the anomalies identified in some of the cells that were capped earlier in the project may have resulted in a requirement for additional cap placement. Had the disposal cells been located in a more pristine area (i.e., away from the contaminated sediments being dredged), the results of the capping (i.e., silty material exposed at the surface) may not have been acceptable. However, given that most of the dredged material was sequestered deep within the cells and that only a small portion of the harbor was actually dredged for this project (i.e., much of the harbor remained intact with contaminated sediments exposed at the surface), there was not a significant environmental concern associated with exposed sediment covering a portion of the tops of some of the cells. Follow-up monitoring of the cells has revealed that initial recolonization with species characteristic of Boston Harbor is taking place over all of the cells and appears to be independent of the type of material exposed at the cell surface.

E.7 ADDITIONAL ISSUES OF NOTE

As with any large project, a number of additional issues arose as the BHNIP progressed. These issues were reviewed by the project's Technical Advisory Committee, which provided input to the Massachusetts Department of Environmental Protection on potential follow up. Issues that were addressed included: increased cell size and depth over original design, use of an alternate environmental bucket than that specified in the Water Quality Certification, residual maintenance material trapped within the improvement material, potential loss of maintenance material from nearly full cells, opening up a low-tide window for disposal into CAD cells, positioning of disposal at the designated offshore disposal site, and potential impacts to the harbor's lobster resource and lobster fishermen's livelihood. All of the issues resulted in some level of operational change for the project, and some resulted in amendments to the Water Quality Certification.

E.8 REVIEW OF THE WATER QUALITY CERTIFICATION

Because the BHNIP was the first major dredging project in Boston Harbor in 30 years and because of the uniqueness of some aspects of the project, the Water Quality Certification contained a large number of conditions and monitoring requirements. As with all large projects that incorporate new technologies, much was learned over the course of the project. Because of the active role of the Technical Advisory Committee, the MA Department of Environmental Projection was able to solicit input on issues that arose during the course of the project and proceed with amendments when needed on a fast track. Larger scale amendments that were issued over the course of the project included changes in CAD cell size and depth, inclusion of additional dredging areas, modification of disposal time and sequencing, changes in dredging equipment, lengthening the required consolidation time for CAD cells, changes in requirements for cap monitoring, and modification to the capping requirements for some cells.

The water quality monitoring that was required for the project focused on the disposal events and included requirements for extensive sampling and analyses. As the project progressed, it became evident that the disposal events had limited impacts to water quality, and that the real-time turbidity monitoring provided a good indication of the potential transport of material away from the disposal area. A more effective monitoring program could include periodic monitoring of all aspects of the project (maintenance and improvement dredging as well as disposal) focusing on real-time measurements to estimate suspended solids generated by project activities with sampling and analysis conditional only on identification of a significant suspended solids plume or specific concerns about dissolved constituents.

GLDD coupled their highly accurate positioning system with navigational software that allowed the operator of the tug maneuvering a scow for disposal over a CAD cell to view the position of the scow in real-time relative to the disposal cell. Although this was not formally required by the Water Quality Certification, it provided a higher level of assurance on accurate placement, especially in the busy harbor area where surface floats marking the disposal cell boundaries were not feasible. Requiring a hardcopy printout of the computer screen showing the orientation of the scow relative to the cell at the time of disposal would provide a valuable piece of information in the event that disposed material is later identified outside of a cell.

The Water Quality Certification specified the inclusion of an independent observer and the continued involvement of the Technical Advisory Committee during performance of the project. The observer kept the Committee informed on project issues and performance through the distribution of detailed, regular updates and provided an independent review and evaluation of project data issues. This allowed the Technical

Advisory Committee to provide informed comments to the MA Department of Environmental Protection and helped the project move forward on schedule.

E.9 RELATED INVESTIGATIONS

The general interest in the BHNIP, in particular the disposal into in-channel CAD cells, sparked a series of related investigations that were not specifically required by the Water Quality Certification for the project. A summary of the individual investigations is provided in Section 9 of this report. The Coastal and Hydraulics Laboratory of the Corps' Engineer Research and Development Center (ERDC) performed a dredge bucket comparison evaluating the sediment resuspension and loading characteristics for two enclosed environmental buckets and one open bucket (Welp et al., 2001). The ERDC also evaluated the consolidation and strength development of material disposed into the CAD cells (Myre et al., 2000; Walter, 2000) and performed field measurements to monitor sediment resuspension over capped and uncapped cells associated with vessel passage (SAIC, 2001).

The U.S. EPA performed a study to determine the potential release of contaminants to the water column during capping of contaminated sediments (Magar et al., 2001). As part of a Sea Grant Marine Center established to study the physical, chemical, and biological processes related to disposal of contaminated material into in-channel CAD cells, researchers and graduate students from the Massachusetts Institute of Technology, the University of Massachusetts – Boston, and the Harvard School of Public Health performed a series of laboratory and theoretical investigations. An overview of lessons learned and recommendations for future projects is presented in Fredette et al. (2000). Massachusetts Coastal Zone Management sponsored an investigation to provide information on capped cell recolonization (ENSR, 2001).

E.10 CONCLUSIONS/ RECOMMENDATIONS FOR FUTURE DREDGING PROJECTS

The BHNIP was a landmark project for its size, innovative design, process, and construction techniques. The project was successful due in large part to the flexibility of all those involved to try new methods and to change direction when needed. The project also attracted researchers who furthered the knowledge of dredging, disposal, capping, and monitoring of dredged material. Below is a summary of the conclusions for the BHNIP along with recommendations for future projects.

- Estimating Dredged Material Volume – Design volumes of maintenance material (requiring disposal into CAD cells) for the project were based on post-dredge surveys performed during the last improvement projects 15 to 32 years prior. As the project progressed, the actual volume of maintenance material in some channels was significantly greater than the estimate, resulting in cost implications for the project (the unit cost for maintenance dredging/disposal was about three times that of improvement dredging). This underestimate was potentially attributed to weathering of the previous improvement surface and overdredging in the previous projects with displaced maintenance material (that had been dredged with a conventional bucket) settling back over the newly dredged area prior to surveying. Given the need for accurately estimating required CAD cell volume, future projects should make use of the advancements in geophysical technologies that can provide more accurate identification of the maintenance/improvement sediment interface over broad areas.

- CAD Cell Size and Depth – The original design for the BHNIP included 52 potential CAD cell locations, but the actual project only required nine cells through the construction of deeper cells and cells with a larger footprint. This provided the project with fewer cells to manage in the future and additional space for future projects. It also allowed more of the material to be sequestered to a greater degree (i.e., material was further removed from the water column in the deeper cells).

- Environmental Dredging – Environmental dredging has two components: equipment (such as a closed bucket) and technique (how the bucket is operated), both of which contribute to an overall reduction in the loss of material to the water column during dredging. During the BHNIP, the Corps' ERDC compared the performance of the two closed buckets used on the project (Cable Arm and GLDD) and a conventional open bucket (Welp, et al., 2001). Although the use of the environmental buckets was shown to reduce the loss of material to the water column during dredging, the closed buckets tested introduced more water to the dredged material. This can be problematic depending on the type of disposal that is planned and may have been a major factor in the lengthy consolidation times needed for the CAD cells in the BHNIP. For future production dredging projects, a traditional open bucket may be capable of meeting overall project performance standards as well as performing the work more efficiently.

- Disposal into CAD Cells – The predictive modeling performed as part of the Environmental Impact Report/Statement for the project assumed a loss rate ranging from 2% to 5% associated with disposal from the split-hulled scows into the CAD cells and predicted a well-defined plume of suspended solids transported away from the cell. Based on this modeling, the Water Quality Certification for the project limited disposal into CAD cells to a 3-hour window around high tide. The monitoring performed as part of the project following disposal revealed very little plume development, suggesting a loss rate less than that assumed in the modeling. Recent research at the Massachusetts Institute of Technology focused on the dynamics of the descent of the disposed material (Ruggaber, 2000) and indicates that for the scale of disposal into the Boston Harbor CAD cells, the transit of the disposed material through the water column occurs as convective descent with entrainment of surrounding water into the disposed material rather than with loss of material to the water column. Future projects should incorporate these findings into predictive modeling to specify the tidal window (if any) that should be used for disposal into CAD cells.

- Environmental Monitoring – The monitoring program required by the Water Quality Certification for the BHNIP focused primarily on the disposal events, with monitoring triggered by specific project activities. As a result, some monitoring events were clustered together within the same week, and some events were separated by a period of months. Most events included extensive sampling and analysis for contaminants of concern. The monitoring revealed no exceedences of the water quality criteria set for the project, and only limited turbidity plume development. A more effective monitoring program for future projects could include limited sampling and analysis at the outset to confirm compliance. Monitoring of real-time parameters to assess plume development could be performed on a periodic basis during the remainder of the project with sampling and analysis triggered only when the real-time measurements exceeded pre-set limits.

- Readiness to Cap – A simplified measurement was devised during the Phase 2 of the BHNIP to provide a rough measure of the consolidation and strength of the surficial material within the cell. However, there was no easy field method to assess the readiness of the material deep within the cell for capping. Clearly, the greatest factor in successful capping was increased consolidation time. However, given the range of variables affecting consolidation (cell size, cell depth, parent material type, dredged material characteristics, dredging and disposal history) no general rule can be given on consolidation, other than “more is better.” However, in other settings, environmental or project constraints may result in a need to advance the capping at the earliest time feasible. Research initiated as part of the BHNIP to better understand material consolidation and strength development in CAD cells should be continued to provide better tools for predicting required consolidation and measuring actual consolidation and strength development.

- Capping Techniques – The use of a hopper dredge and dredged material for capping was very cost-effective, and the technique for applying the cap material appeared to result in good cap coverage.

- Capping Assessment – The decision to cap CAD cells should be made on a case by case basis considering physical, chemical, and biological factors as well as short- and long-term impacts. Disposal into deep cells accomplishes much of the underlying intent of capping as most of the disposed material is sequestered well out of potential contact with the overlying water column. The completed BHNIP CAD cells are still well depressed (5 – 10 feet) below the surrounding harbor bottom, and natural deposition over the cells is expected to further sequester the material. For future projects requiring capping, it is important to develop a mechanism to assess the “success” of a capping effort that takes into account more than just the final thickness and coverage of the cap. A matrix could be developed to score the performance of a given cap which could be compared against a “goal” for successful capping that takes into consideration the level of contamination of the material within the cell, the similarity of the material within the cell to surrounding harbor bottom, movement of water over and through the cell, expected deposition over the cell, and proximity to specific habitats of concern.

- Management of Change – Early in the design of the BHNIP, the Technical Advisory Committee committed itself to working together for a successful project, and the Committee was fully involved throughout the design, permitting, and construction phases of the project. During construction, when a planned approach failed to meet project expectations or requirements, the Technical Advisory Committee worked with the Corps and Massport to expeditiously solve problems and amend permits as needed. For complex projects such as the BHNIP, this approach may be essential to keeping the project on schedule as well as enhancing the project's success.

List of Abbreviations and Acronyms

LIST OF ABBREVIATIONS AND ACRONYMS

BHNIP – Boston Harbor Navigation Improvement Project

CAD – Confined Aquatic Disposal

Corps – U.S. Army Corps of Engineers

CSO – Combined Sewer Overflow

cy – cubic yards

DAC – Dredging Advisory Committee

ERDC – Engineer Research Development Center (part of the U.S. Army Corps of Engineers Waterways Experiment Station)

ft – foot or feet

GLDD – Great Lakes Dredge and Dock Company

GPS – Global Positioning System

MA – Massachusetts

Massport – Massachusetts Port Authority

MLW – Mean Low Water

MLLW – Mean Lower Low Water

MWRA – Massachusetts Water Resources Authority

NTU – Nephelometric Turbidity Units

PAH – Polyaromatic Hydrocarbon

PCB – Polychlorinated Biphenyl

TAC – Technical Advisory Committee

USACE – U.S. Army Corps of Engineers

1

Introduction

1.1 PROJECT DESCRIPTION AND BACKGROUND

The Boston Harbor Navigation Improvement Project (BHNIP) was a joint project between the Corps of Engineers (Corps) and the Massachusetts Port Authority (Massport). The project consisted of maintenance and improvement dredging in channels and berths within Boston's Inner Harbor as shown on Figure 1-1.

The impetus for the BHNIP came from the Federal channel improvements authorized in the Water Resources Development Act of 1990 (P.L. 101-640) which was based on the project recommended in a feasibility report completed in September 1988 (U.S. Army Corps of Engineers, 1988). The authorized project consisted of deepening three tributary channels (Reserved Channel and Mystic River from 35 feet to 40 feet and Chelsea River from 35 feet to 38 feet) and the deepening of a portion of the Inner Confluence from 35 feet to 40 feet (all referenced depths are relative to mean lower low water (MLLW)). The Inner Confluence connects the Mystic River and Chelsea River Channels to the Main Ship Channel. The authorized project also included the establishment of a new Federal navigation channel in the President Roads area. This defined the President Roads anchorage area and connected the inner harbor main ship channel to the outer access channels through the use of navigation aids and revisions to navigation charts.

In addition to the Congressionally authorized project, facilities that would benefit from the navigation improvements sought to have their berths dredged at the same time. Twenty-four berths at nine facilities were included in the dredging project (Figure 1-2 and Figure 1-3).

For accounting and cost sharing purposes, the Federal channel work was further categorized into maintenance dredging and improvement dredging. The accumulation of dredged material since the last navigation improvement projects were completed was considered maintenance material and required removal before the channels could be deepened. Maintenance dredging was funded through the Corps' operations and maintenance authority separately from the Congressionally authorized improvement project. Berth dredging was funded by Massport. All but three of the berths dredged were owned by Massport. Because the Corps cannot provide construction services directly to private concerns, the Corps signed a memorandum of agreement with Massport, a qualifying public agency, to provide design and construction management services for all berth facilities. Massport had agreements with each private berth owner that covered all permitting, design and construction services.

The BHNIP design was initiated in 1990. Below is a summary of key milestones completed during the design phase of the project:

- Navigation improvement authorized (Water Resources Development Act)-November 1990
- Draft Environmental Impact Report/Statement – April 1994 (U.S. Army Corps of Engineers and Massport, 1994)

- Final Environmental Impact Report/Statement – June 1995 (U.S. Army Corps of Engineers and Massport, 1995)
- Water Quality Certification – September 1996, amended during construction (included as Appendix A)

The project was constructed in two phases. Prior to Federal funding of the improvement project, Massport requested that Conley Terminal berths 11 and 12 be dredged in the summer of 1997 to allow for earlier use by a deep draft container vessel. In order to accommodate this request and because berth dredging was funded 100% by Massport, Phase 1 was contracted out directly by Massport. Weeks Marine was awarded the Phase 1 work, and a special agreement between the Corps and Massport gave construction management responsibility to the Corps. Although Phase 1 was separated from the larger Phase 2 project and contracted by Massport, all permit conditions and dredged material disposal requirements had to be met. A separate summary report was prepared for the Phase 1 work (ENSR, 1997).

The main portion of the project (including Federal navigation channel and remaining private berth maintenance and improvement work) was completed as Phase 2 of the project. Phase 2 work was performed under a single construction contract with Great Lakes Dredge and Dock Company (GLDD) and managed by the Corps. This phase included removal of approximately 1 million cubic yards (cy) of silty maintenance material and 1 million cy of improvement material (primarily Boston blue clay). The improvement material was disposed offshore at the Massachusetts Bay Disposal Site.

Because of adverse biological testing results likely caused by elevated concentrations of some metals and organic compounds, the maintenance material was disposed in confined aquatic disposal (CAD) cells. The CAD cells were located within the footprint of the Federal navigation channels and were capped with sand following completion of disposal. There were a number of environmental concerns related to dredging and disposal of the maintenance material, and, as a result, the Water Quality Certification contained numerous conditions for monitoring.

Below is a summary of key milestones accomplished during the construction phase of the project.

- Phase 1 construction May - July 1997
- Water Quality Certification amended (based on Phase 1 experience) – January 1998
- Project cooperation agreement with Massport signed – February 1998
- Construction contract awarded to GLDD – May 1998
- Phase 2 construction initiated on-site – August 1998
- Construction completed – September 2000, with limited additional work from June – December 2001

1.2 PROJECT ROLES AND RESPONSIBILITIES

The main parties involved in performance of Phase 2 of the BHNIP are presented in Figure 1-4. GLDD was contracted to perform all of the Phase 2 work. GLDD subcontracted the environmental monitoring (a requirement of the Water Quality Certification) to Normandeau Associates, Inc. and subcontracted the cap assessment work (also a requirement of the Water Quality Certification) to Science Applications International Corporation (SAIC) and Ocean Surveys, Inc.

A major partner in the design and permitting process as well as during construction was the project's Dredging Advisory Committee (DAC), formed at the beginning of the Environmental Impact Report/Environmental Impact Statement process in 1992. This group consisted of representatives from government resource agencies, private environmental groups, academic interests, shipping and other business interests, pilots, and others. During the design process, the DAC helped in evaluating the disposal alternatives for the maintenance material.

During the permitting process, the DAC continued in a more technical role. The Massachusetts (MA) Department of Environmental Protection relied on comments from the DAC during the development of the Water Quality Certification. The Water Quality Certification granted by the MA Department of Environmental Protection for the project set performance standards for dredging and disposal operations, specified environmental monitoring requirements, and stipulated that an independent observer be included in the project (based on recommendation from the DAC) to monitor dredging and disposal activities from an environmental point of view.

The Water Quality Certification for the project noted that the Department of Environmental Protection would be supported by input from a Technical Advisory Committee (TAC) during the construction. The TAC was chaired by Massachusetts Coastal Zone Management and included many of the DAC members from the design and permitting phases of the project. The Water Quality Certification required that the TAC be supported by an independent observer, funded by the local sponsor of the project (Massport) and managed administratively by Massachusetts Coastal Zone Management. The independent observer was charged with monitoring project construction, performing quality assurance checks of the contractor's monitoring program, reviewing monitoring data, and making technical recommendations.

The TAC met periodically to review monitoring results and discuss recommended amendments to the Water Quality Certification. The independent observer facilitated these meetings and provided project status and monitoring reports to the TAC for comment. A list of the organizations represented on the TAC during the construction phase of the project is provided in Figure 1-4. ENSR International (Westford, MA) filled the independent observer role under contract to Massachusetts Coastal Zone Management during both Phase 1 and Phase 2 of the project.

1.3 REPORT OVERVIEW

The Water Quality Certification for the project required that a summary report be prepared following completion of the project, presenting the dredging and disposal operations and identifying project impacts as determined by monitoring data. A summary report was completed for Phase 1 of the project by the independent observer (ENSR, 1997) under contract to Massachusetts Coastal Zone Management. The independent observer contract ended in June 2000 with the completion of the majority of the project work. This Phase 2 summary report has been prepared by ENSR International in conjunction with the Corps under an environmental services contract with the Corps. The report represents the combined effort of ENSR and the Corps. All of the data and many of the figures represent the efforts of contractors to the project rather than the independent observer. Acknowledgment is given to all of the parties listed in Figure 1-4 (particularly GLDD) for help in supplying information for this report.

This report provides a summary of Phase 2 activities as well as recommendations for future projects. A description of construction and dredging operations is provided in Section 2, and a summary of the associated environmental monitoring is presented in Section 3. Monitoring specifically focused on evaluating CAD cell cap placement is presented in Section 4. An evaluation of the environmental monitoring program is presented in Section 5, and the cell capping is evaluated in Section 6. Additional issues that came up during the project are covered in Section 7. A review of the Water Quality Certification for the project is presented in Section 8. During the course of the project other studies were performed that were not required but have relevance to this and future projects. These additional studies are described in Section 9. Conclusions and recommendations for future dredging projects are included in Section 10. A detailed project reference list is provided in Section 11.

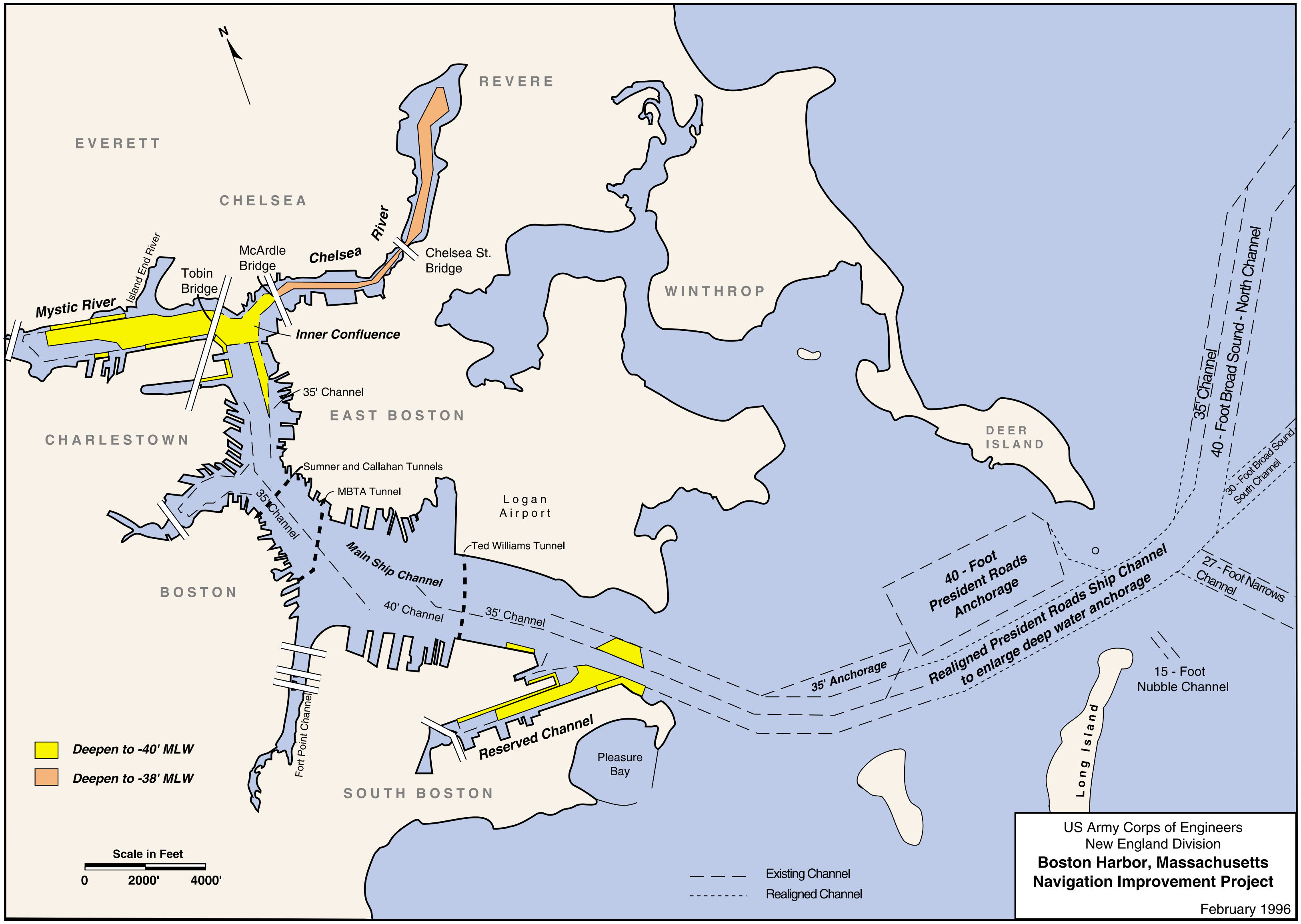


Figure 1-1 BHNIP Dredging Plan Source: U.S. Army Corps of Engineers, New England District

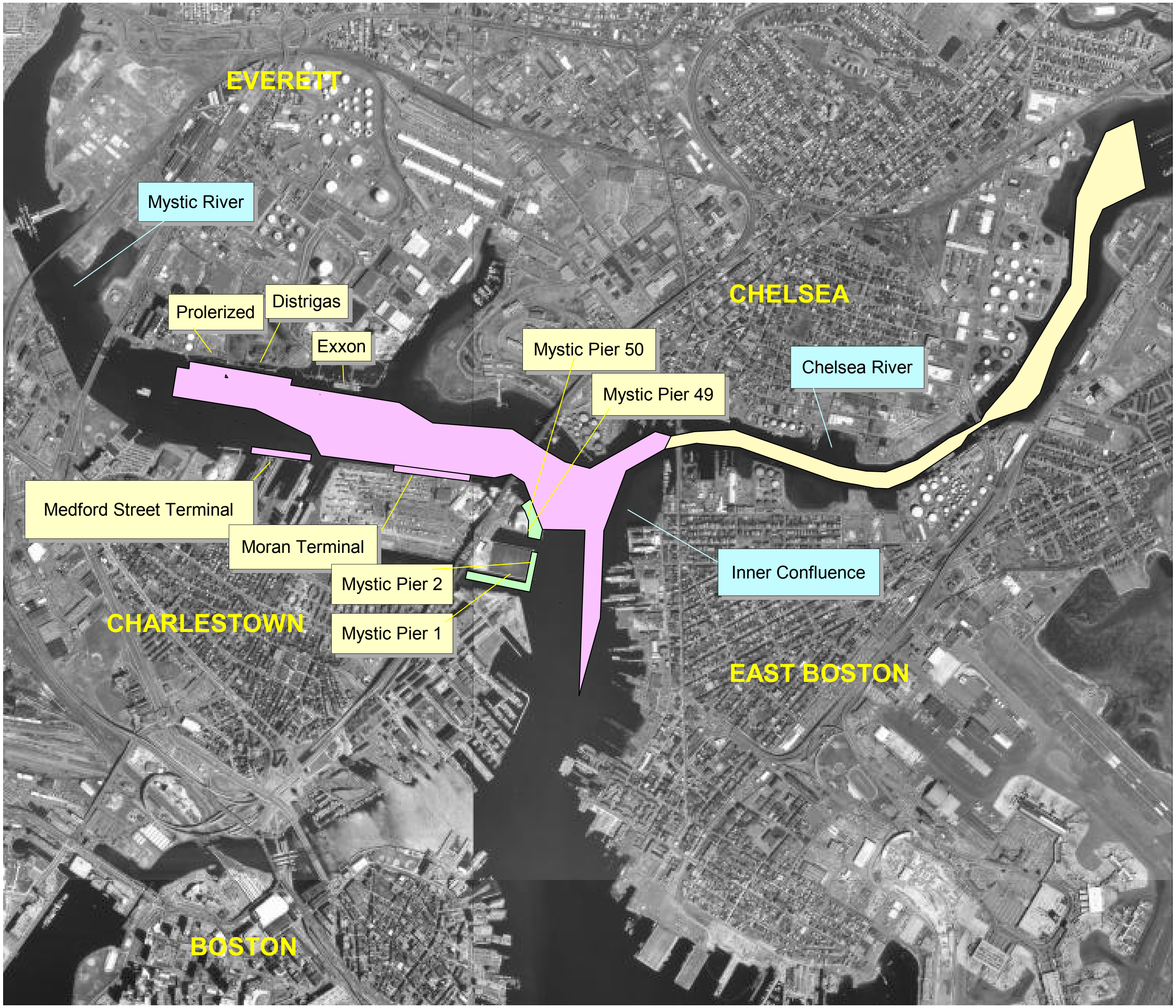


FIGURE 1-2
Dredging Plan with Berth Areas - Inner Confluence, Mystic River and Chelsea River

Boston Harbor Navigation Improvement Project

LEGEND:

- Dredged to -35 ft MLLW
- Dredged to -38 ft MLLW
- Dredged to -40 ft MLLW

Notes:

Yellow boxes identify berth areas.
Blue boxes identify harbor areas.

Sources: MASS GIS/MIT Digital Orthophotos, Cells from Great Lakes Dredge & Dock Co.

Date: 5/22/2002

1000 0 1000 2000 Feet

N W E S

Source: ENSR INTERNATIONAL

FIGURE 1-3
Dredging Plan with Berth Areas - Reserved Channel Area

Boston Harbor Navigation Improvement Project

LEGEND:

- Dredged to -35 ft MLLW
- Dredged to -38 ft MLLW
- Dredged to -40 ft MLLW

Notes:

Yellow boxes identify berth areas.
Blue boxes identify harbor areas.

Sources: MASS GIS/MIT Digital Orthophotos, Cells from Great Lakes Dredge & Dock Co.

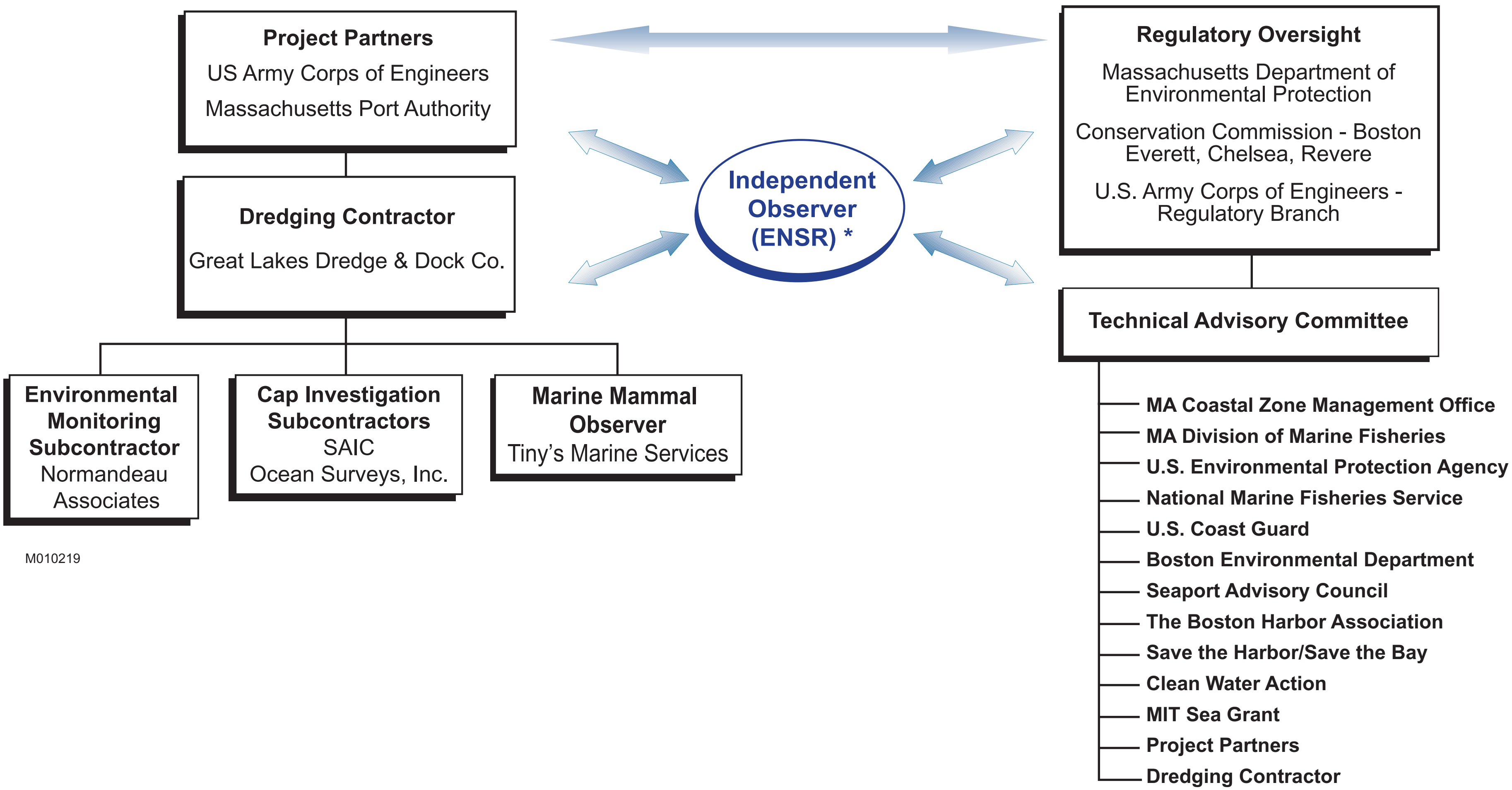
Date: 05/22/2002

800 0 800 Feet

N W E S

Source: ENSR International

Figure 1-4
Phase 2 Project Team
and Associated Organizations



* Independent Observer contracted by MACZM

2

Descriptions of Dredging and Disposal Operations

2.1 GENERAL OVERVIEW

The major components of Phase 2 of the BHNIP included construction of the in-channel confined aquatic disposal (CAD) cells, the dredging and disposal of maintenance material, and the dredging and disposal of improvement material. The maintenance and improvement dredging were performed both within Federal channels and at private vessel berths.

Maintenance material consists of sediment that has accumulated since the last round of dredging was performed. It typically consists of fine-grained material (silt and clay) with a relatively high water content. Typical of most older urban harbors, the maintenance material from Boston had elevated concentrations of some metals and organic compounds that, based on biological testing, made it unsuitable for offshore disposal (see the Water Quality Certification in Appendix A for actual concentrations). All maintenance material from the BHNIP was disposed into in-channel CAD cells as specified in the Water Quality Certification and outlined in the Final Environmental Impact Report/Statement (U.S. Army Corps of Engineers and Massport, 1995).

Improvement material is sediment or rock that needs to be removed and which lies below the depth of a previously dredged area. For Boston, the improvement material consisted primarily of Boston blue clay, with limited amounts of sand, gravel, and rock. Improvement material typically has chemical concentrations similar to native background materials for an area, and is suitable for disposal at a designated offshore site. Beneficial use of the suitable material from the BHNIP was encouraged, but no alternatives were found prior to construction start. It should be noted that the Central Artery/Third Harbor Tunnel project was underway during the same time as the BHNIP and created a surplus of clean material available for others to use. As a result all improvement material from the BHNIP was disposed offshore at the Massachusetts Bay Disposal Site.

The project construction was implemented using plans and specifications issued by the New England District Corps of Engineers (U.S. Army Corps of Engineers, 1998). The dredging contract for Phase 2 was awarded to Great Lakes Dredge and Dock Company (GLDD), of Oak Brook, IL in May 1998, and harbor activities began in August 1998. A summary of the quantities and locations of maintenance and improvement material (including soft material and rock) removed during Phase 2 of the BHNIP is presented in Table 2-1. A description of each component of the dredging and disposal operations is provided in the remainder of this section.

Table 2-1 Dredged Material Quantities

Area	Required Depth (MLLW)	Maintenance Material (cy)	Improvement Material (cy)
Soft Material Removed from Federal Channels			
Mystic River	-40.0	269,743	337,861
Inner Confluence	-40.0	148,239	193,603
Chelsea River	-38.0	218,413	176,571
Main Ship Channel	-40.0	18,412	No Improvement
Reserved Channel (Includes "Notch")	-40.0	195,268	237,978
Total		850,075	946,013
Rock Material Removed from Federal Channels			
Mystic River	-42.0		24,378
Inner Confluence	-42.0		12,420
Reserved Channel	-42.0		15,190
Chelsea River (approximate volume removed)	-42.0		6,000
The "Notch"	-42.0		480
Total			58,468
Total Soft and Rock Materials Removed from Federal Channels		850,075	1,004,481
Soft Material Removed from Berths			
Prolerized	-40.0	11,170	2,383
Distrigas	-40.0	16,723	5,839
Exxon	-39.7	4,049	No Improvement
Medford Street Terminal	-40.0	23,456	11,335
Moran Terminal	-40.0	4,663	1,400
Mystic Pier 50	-35.0	11,305	1,267
Mystic Pier 49	-35.0	10,947	217
Mystic Pier 2	-35.0	2,375	No Improvement
Mystic Pier 1	-35.0	15,437	2,618
North Jetty	-40.0	3,688	No Improvement
Army Base 1 And 2	-35.0	18,142	5,184
Army Base 3	-35.0	8,930	1,695
Army Base 4 Through 10	-35.0	35,600	No Improvement
Conley Terminal 11	-45.0	3,482	14,735
Conley Terminal 14 And 15	-40.0	17,791	11,295
Conley Terminal 16 And 17	-35.0	1,808	No Improvement
Total		189,566	57,968
Rock Material Removed from Berths			
Army 1 & 2 Area A	-36.7		110
Army 1 & 2 Area B	-36.7		585
Army 1 & 2 Area C	-36.7		521
Total			1,216
Total Soft and Rock Materials Removed from Berths		189,566	59,184
CAD Cell Construction(All Soft Material)			
Total – Eight Phase 2 Cells			1,369,000
Project Totals			
Total Channel and Berth Dredging		1,039,641	1,063,655
Total Channel, Berth, and CAD Cell Dredging		1,039,641	2,432,665
Grand Total - All material dredged	3,472,306 cy		

Note: All volumes are calculated from final Corps surveys, with the exception of material removed to construct the CAD cells. CAD cell material estimates are based on scow loads and geometry of cells.

The first dredging of Phase 2 of the BHNIP began in August 1998, and major operations ended with capping of the last two cells in September 2000. A limited amount of follow up work (removal of rock in the Chelsea River channel, removal of cables and dredging in the vicinity of the McArdle Bridge in Chelsea River, and removal of an abandoned waterline in the Chelsea River) was accomplished in June-December 2001.

The specific construction schedule was complex as a result of the nature of in-channel disposal (located in areas requiring dredging) as well as the environmental restrictions placed on the project and normal weather constraints. The major construction sequences included:

- Construction of disposal cells
- Performance of maintenance dredging with disposal into CAD cells
- Performance of improvement dredging with offshore disposal at the Massachusetts Bay Disposal Site
- Capping of filled CAD cells

Figure 2-1 provides an overall timeline of these major operations. More detailed operations data are included in the project database described in Appendix B.

2.2 EQUIPMENT

GLDD used a variety of dredges and scows for dredging, disposal and capping operations for the project (Table 2-2). Table 2-2 does not include support equipment such as survey boats, tugs and monitoring vessels. Individual scows are not listed, but all were split-hulled with capacities ranging from 2,000 to 7,200 cy. All dredges listed are in GLDD's fleet except *Superscoop* which was leased.

Table 2-2 Dredging Equipment Used in Phase 2 of the BHNIP

Name/Number	Equipment Type	Specifications
51	Mechanical Dredge	Bucket Cap. 7-18 cy, Total Power 1870 hp
53	Mechanical Dredge	Bucket Cap. Up to 32 cy, Total Power 2550 hp
54	Mechanical Dredge	Bucket Cap. Up to 32 cy, Total Power 2340 hp
Superscoop	Mechanical Dredge	Bucket Cap. Up to 24 cy, Total Power 2100 hp
New York	Excavator Dredge	Bucket Cap. Up to 25 cy, Total Power 3818 hp
Sugar Island	Hopper Dredge	Hopper Cap. 3600 cy, Total Power 9395 hp
Manhattan Island	Hopper Dredge	Hopper Cap. 3600 cy, Total Power 7085 hp

2.3 CONSTRUCTION OF DISPOSAL CELLS

The channels in Boston Harbor presented ideal conditions for construction of Confined Aquatic Disposal (CAD) cells. The parent material below the channels was primarily Boston blue clay, a clean and very dense consolidated clay. The clay layer in most areas was deep enough to allow for efficient design of the CAD cells. Because future inner Boston Harbor navigation channel depths (inbound from Reserved Channel) are limited to 40 feet due to the shallow tunnel crossings in the main ship channel, future improvement dredging can not be considered in the areas where the CAD cells were constructed. No CAD cells were proposed in the Reserved Channel because it is located seaward of the tunnel crossings allowing for future deepening beyond 40 feet.

The project was permitted to have up to 52 individual CAD cells. The Environmental Impact Report/Statement and permit documents identified cell locations in the Mystic River, Chelsea River and Inner Confluence channels as shown on Figure 2-2. During construction the contractor, as allowed in the plans and specifications, proposed constructing deeper cells thereby reducing the total number of cells required to accommodate all unsuitable material. The contractor also proposed larger cells to reduce the area lost to separator walls between smaller cells.

A total of eight CAD cells were constructed for Phase 2 and one cell for Phase 1 of the BHNIP as presented in Figure 2-3. The Supercell, cell M8-11, and modified cell M19 all encompass an expanded footprint. The concept of larger cells was approved by the MA Department of Environmental Protection in October 1998. A typical BHNIP CAD cell cross section is shown on Figure 2-4 along with the steps involved in constructing the cell. Table 2-3 presents the dimensions and capacities of each cell as constructed. Approximately 1,369,000 cubic yards of parent material (predominantly Boston blue clay) was removed to create the eight Phase 2 disposal cells. Additional details on the individual cells (coordinates and elevations) are presented in a project database as described in Appendix B.

Table 2-3 Completed Disposal Cell Dimensions

Cell	Length (ft)	Width (ft)	Area (sq ft)	Depth (ft MLLW)	Capacity (cy)
M2	475	167	79,300	-105	165,100
M4	500	167	83,500	-85	55,100
M5	228-274	85-97	22,800	-80	27,600
M8/11	735	225	165,000	-90	138,100
M12	500	158	79,000	-110	85,500
M19 modified	825	300	248,000	-80 to –100	260,000
Supercell	650	500	325,000	-100	349,300
C12	630	240	154,700	-40 to –80	150,500

Construction of the cells typically required removal of maintenance material from the cell footprint prior to deepening. As a result, the first cell constructed (M5) was relatively small because the maintenance material removed from its footprint had to be stored prior to disposal in the completed cell. This maintenance material was stored in a scow during cell construction. Once completed, cell M5 was capable of receiving the maintenance material from the footprints of two larger cells, M4 and M12, in addition to the material covering cell M5 itself.

2.4 MAINTENANCE DREDGING

Maintenance dredging was required over all of the areas authorized for improvement dredging (as presented in Figure 1-1). Berth areas also required removal of maintenance material prior to any improvements. The depth of the maintenance layer varied considerably but averaged about 1.5 feet in the channels. The dredging included measures to ensure proper segregation of maintenance material (destined for CAD cells) from the improvement material (destined for offshore disposal). Maintenance dredging was performed over an expanded area prior to initiation of improvement dredging to limit maintenance material mobilized from adjacent areas settling over the already dredged area. In addition, construction managers allowed maintenance dredging to proceed until buckets began to show evidence of the clean, lighter colored improvement material below. This allowed the inspectors to know when the maintenance material had been removed, yet minimize any improvement material removal with the environmental bucket. A balance was maintained to ensure environmental control (keeping the maintenance material from being removed with improvement dredging and disposed offshore) without excessively increasing project costs (costs for environmental dredging/disposal into CAD cells were higher than traditional dredging/offshore disposal by a factor of four).

The project Water Quality Certification required the use of a Cable Arm brand, closed environmental bucket (Photo 1) or an equivalent that met specified turbidity/total suspended solids performance standards (Note: The Cable Arm bucket was specifically named because the MA Department of Environmental Protection had prior experience with this bucket during dredging of Boston's Third Harbor Tunnel and was satisfied that it met the performance standards). GLDD used a 39 cy capacity Cable Arm bucket. Dredging was performed from spud-mounted dredges such as dredge 54 shown in Photo 2. GLDD also had their own closed bucket with a capacity of 39 cy (Photo 3). This bucket was tested during the project and approved by the MA Department of Environmental Protection for use in dredging maintenance material.

Because the Cable Arm bucket did not have teeth, was lighter than traditional buckets, and closed along a horizontal plane rather than through an arc, it was less likely to significantly "overdig" into the clean, consolidated improvement material below. However, the Cable Arm bucket was very inefficient in removal of material (amount of material removed per bucket). The GLDD environmental bucket was heavier and could remove more maintenance material in a cycle. This bucket was used only when the depth of maintenance material, or face, was more than a few inches. In many areas the depth of maintenance material was less than one foot which meant that the bucket fill efficiency was very low. In most applications, both buckets transmitted a significant amount of water to the scow along with the dredged material (see Photo 5).

2.5 IMPROVEMENT DREDGING

The authorized Federal improvement project included the deepening of three tributary channels. The Mystic River Channel was at 35 feet, and a portion of it was authorized to be deepened to 40 feet. Chelsea River was also at 35 feet and authorized to be deepened to 38 feet for the entire channel. The Inner Confluence and eastern approach was at 35 feet and authorized to be deepened to 40 feet as shown on Figure 1-1. The Reserved Channel was at 35 feet and a portion of it authorized to be deepened to 40 feet. A portion of the main ship channel at the mouth of the Reserved Channel (referred to as the "Notch" in Figure 1-3) was authorized to be deepened from 35 feet to 40 feet to provide maneuvering room for vessels turning before entering or departing the Reserved Channel.

A variety of open buckets were used for the improvement dredging (Photo 7) dependent on the type of material and dredge size. The dredges used for the improvement work included spudded (Photo 8) and anchored (Photo 9) mechanical dredges as well as an excavator dredge (Photo 6, Photo 10) used for the harder material and rock. Boston blue clay (Photo 11) made up the majority of the improvement material with some harder, mixed sediment types (Photo 12) and rock.

The allowed overdepth was 1.7 feet for soft material. For rock, there was a required overdepth (below the authorized design elevation) of not more than 2 feet below project depth and an allowable overdepth of not more than 2 feet below the required overdepth. All dredged volumes used in Table 2-1 and elsewhere in this report include volumes dredged to meet required depths and required and allowable overdepths.

2.6 DISPOSAL INTO CAD CELLS

GLDD used a variety of split-hulled scows for transporting maintenance material to disposal cells. The contract required accurate navigation methods to assure that each scow was located over the CAD cell before release to reduce the potential for missing the cell opening. GLDD used differential GPS with proprietary software that allowed the tug captain to display scow position relative to the disposal cell in real-time on an on-board computer. This was an important feature given that some of the cells were small (very little room for positioning error). In addition, the location of the cells within the active harbor made placement of surface marker floats infeasible (Photo 13).

Once positioned over the CAD cell, the tug captain signaled the scow operator to initiate disposal. The scow was opened, and the material was released into the cell (see Figure 2-5 and Photo 14). The entire disposal event (from the time the scow operator split the hull until all the material left the scow) was very rapid, taking approximately 5 seconds. Little, if any, material remained in the scow following the disposal (Photo 15). After disposal, the scow was closed and then maneuvered away from the cell. A Corps-certified inspector was on board the tug for each disposal event.

The Water Quality Certification for the project specified that disposal take place within a three-hour window extending from one hour before the predicted high tide until two hours after high tide. This specification was included to provide maximum dilution and to minimize transport of fine sediment suspended into the water column during disposal. As described in Section 3, the water quality monitoring identified very limited impacts to the water column associated with disposal. Late in the project, GLDD requested authorization for disposal at low water slack, to allow greater flexibility in scheduling the disposals. The MA Department of Environmental Protection amended the Water Quality Certification to allow for this disposal with monitoring. The results of water quality monitoring at low tide were similar to those at high tide, as discussed in Section 3.

2.7 MANAGEMENT OF DISPOSAL CELLS

GLDD attempted to maintain more than one cell open at a given time allowing for greater flexibility in disposal operations. A particular cell may have not been available during a high tide period because of other harbor activities in the immediate area or because the material within the cell had not sufficiently settled from a previous disposal. Bathymetry measurements were performed over the cell following each disposal (generally on the next day after initial settling) to track the level within the cell. If the bathymetry measurements revealed a high degree of suspended material within the cell, disposal was shifted to an alternate cell.

During the final disposal operations for cells M5 and M12 (in the first set of cells for the project), GLDD noted an accumulation of material outside of the cells along the perimeter. This lead to the conclusion that as the level of disposed material within the cell rose to near the cell rim, some material had escaped during disposal (see Section 7 for more detail). As a result, GLDD set a minimum "freeboard" for the cell (distance between the level of disposed material in the cell and the cell rim) of 8 feet. No additional material was identified outside of the cells for the remainder of the project. A history of operational dates and disposed volumes for each cell is presented in Table 2-4 below, and disposal history for each cell is presented graphically in Figure 2-6.

Table 2-4 Estimated Volumes of Dredged Material in Disposal Cells

Disposal Cell	Disposal Dates	Estimated Volume, (cy)	Source of Dredged Material
M2	23 Oct 1998 – 1 Jun 1999	127,400	Mystic & Reserved Channels
M4	23 Sep 1998 – 10 Oct 1998	49,800	Mystic Channel
M5	17 Aug 1998 – 23 Sep 1998	30,100	Mystic Channel
M8/M11	4 Aug 1999 – 15 Feb 2000; 20 Apr – 2 May 2000	150,000	Inner Confluence, Mystic River, Chelsea River Channels
M12	2 Sep 1998 – 12 Oct 1998	78,100	Mystic Channel
M19 modified	28 Oct 1999 – 14 Feb 2000	160,000	Chelsea River and Inner Confluence Channels, Berths
C12	30 Apr 1999 – remains open	88,500	Chelsea River Channel
Supercell	31 Dec 1998 – 7 Jun 1999	383,700	Reserved and Mystic Channels & Reserved "Notch"

2.8 DISPOSAL AT MASS BAY SITE

The improvement material (also called parent material) and the material removed during construction of the disposal cells were deemed suitable for disposal offshore at the Massachusetts Bay Disposal Site. This site is designated by the U.S. EPA as a dredged material disposal area and is located approximately 22 miles east of Boston's inner harbor (Figure 2-7). The dredged material was loaded onto dump scows (similar to those used for the maintenance material) and towed by tug to the disposal site. The tugs remained alongside the scow or with a short towline through the inner harbor and switched to a longer towline in the outer harbor for the trip offshore.

The tugs used for towing the scows offshore were equipped with a global positioning system and had target coordinates for the disposal. A target buoy is maintained at the disposal site. In addition, a Corps-certified inspector was present on the tug for each disposal event. Cell construction required dredging and disposal of about 1,369,000 cy of material. Improvement dredging included the dredging and disposal of about 1,004,000 cy of soft material and 59,700 cy of rock from the project. A total of 730 trips were made to the Massachusetts Bay Disposal Site over the course of the project.

2.9 CAPPING OF DISPOSAL CELLS

The Water Quality Certification for the project required that the CAD cells be capped with clean sand following a consolidation period after disposal was completed. The goal was to sequester the disposed material with a three-foot thick layer of sand as depicted in Figure 2-8. The cells were capped in groups, and three rounds of capping were performed over the course of Phase 2 of the BHNIP (Figure 2-9).

GLDD tracked material placement during the capping events. Specific investigations were performed following each round of capping to assess coverage and thickness (see Section 4). Based on a review of the capping investigations, the cell consolidation time and cap placement technique were modified for the second round of capping, and the cell consolidation time was again modified for the third round of capping.

Based on joint cooperation between the Corps and GLDD, capping material was dredged from portions of the Federal navigation channel in the Cape Cod Canal by hopper dredges (*Sugar Island* and *Manhattan Island*) and transported to Boston Harbor for cap material (Photo 16). The Cape Cod Canal was already scheduled for maintenance dredging, and the removal of cap material from the navigation channel partially met the maintenance needs of the canal. The hopper dredges were scheduled as needed for each group of cells to be capped. The sand met all specification requirements for capping cells. Approximately 162,000 cy of cap material was dredged from Cape Cod Canal for use in capping.

The hopper dredges were also used for placement of the cap material over the cells. The dredges had the capability to slowly release the cap material through their split hulls while in motion. By opening the hull just enough to allow release and maneuvering the dredge sidewise during release, a uniform layer was deposited. If needed, on-board water jets could be used to wash sand from the sides of the hopper and maintain a uniform flow through the opening (Photo 17). A summary of capping dates and volumes is presented below in Table 2-5. The estimated volume of cap material presented in the table was computed from hopper dredge measurements.

Table 2-5 Disposal Cell Capping Summary

Cell	Capping Dates	Est. Vol. of Cap Placed (cy)
M2	3 – 18 Nov 1999	18,000
M4	12 – 17 Nov 1998	13,200
M5	14 – 15 Nov 1998	5,400
M8/11	15 – 24 Sep 2000	23,200
M12	11 – 18 Nov 1998	13,300
M19 modified	9 – 19 Sep 2000	39,100
C12		(not capped)
Supercell	6 – 19 Nov 1999	50,000

The first three cells (M4, M5 and M12) were capped together in November 1998 (Figure 2-9). The contents of these cells were allowed to consolidate from 30 to 52 days prior to initiation of capping (Figure 2-6). For this set of cells, the hopper dredge's own power (main propulsion and bow thruster) was used. Multiple hopper loads were required to complete capping over each cell. During capping, onboard tracking of the vessel position allowed operators to determine placement location and estimate thickness. Track lines showing the position of the hopper during capping operations for cell M4, representative of this group of cells, are presented in Figure 2-10. Because of the draft of the hopper dredge and the significant thrust required to change directions, the capping operation appeared to mobilize some of the material within the cell (Photo 18). The calculated sand cap thickness over cell M4 is presented in Figure 2-11.

After reviewing the monitoring results of capping the first three cells it was decided to extend the consolidation time prior to capping the second set of cells and to use tug assistance for maneuvering the hopper to reduce propwash effects during capping. Cells M2 and the Supercell were capped together in November 1999 following 155 and 152 days of consolidation, respectively. Figure 2-10 presents the typical track lines for capping cell M2 using tug assistance for maneuvering, and the calculated sand cap thickness over cell M2 is presented in Figure 2-11. This technique appeared to provide more even cap coverage.

The consolidation time prior to capping was again extended for the third round of capping. Modified cell M19 was capped in September 2000 following 232 days of consolidation. After an initial consolidation period of 126 days, cell M8/11 received limited additional disposal, and was then allowed to consolidate another 130 days. Tug assistance was used for maneuvering the hopper dredge as in the second round of capping.

Cell C12 was not capped. This cell, located just upstream of the Chelsea Street Bridge, was constructed to take all maintenance material dredged upstream of the bridge to reduce bridge openings and traffic interruptions that would have been required to transport the material to other cells. The volume of maintenance material from the area upstream of the Chelsea Street Bridge was less than anticipated. As a result, the cell was filled to only 60 % of its estimated capacity. In July 2000, the MA Department of

Environmental Protection amended the Water Quality Certification to allow this cell to remain uncapped and available for future use.

2.10 OTHER ACTIVITIES

In addition to dredging maintenance and improvement materials, there were areas of rock that were specified to be drilled and blasted. The total volume of rock removed was approximately 59,700 cy. Rock areas were found in the Mystic River Channel and in the “Notch” across from the Reserved Channel. During construction GLDD found that their dredges, equipped with rock digging buckets, could remove the fractured rock without drilling and blasting. The dredge *New York*, an excavator type dredge, was also used to remove rock in areas that the conventional barge mounted dredge could not. At the conclusion of the project, an area of rock was discovered in the Chelsea River within the project limits upstream of the Chelsea Street Bridge on the East Boston side. This rock (approximately 6,000 cy) could not be removed by mechanical means and was drilled and blasted in August 2001.

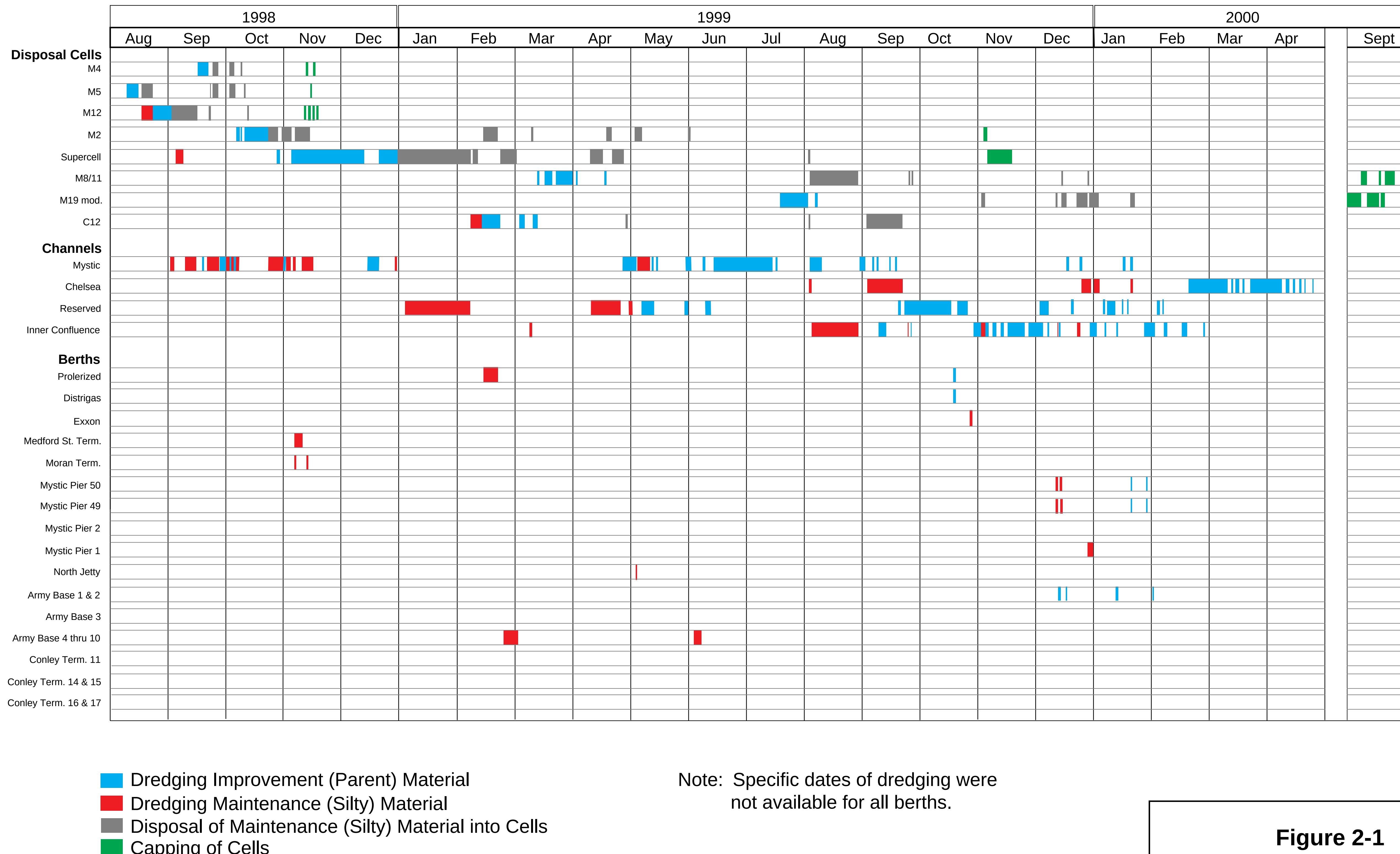
The contract included the removal of an abandoned water tunnel (Massachusetts Water Resources Authority (MWRA) Section 38) in the Chelsea River. Later, the MWRA relocated a major active water line (MWRA Section 8) in the Chelsea River between the McArdle and Chelsea Street bridges. It was believed that the old line did not require removal and could be abandoned in place. However, portions of the old water line were above the new authorized depth. Sections of the water line were removed in December 2001 to meet the required authorized depth.

Utility cables were encountered in several areas. Abandoned AT&T telephone lines were removed from the western side of the Inner Confluence. Cables used in the operation of the McArdle bridge were accidentally severed during dredging and were eventually replaced.

The contract also included removal of a potential navigation hazard near the notch area. This material was a tangled mass of fishing gear that had moved into the main ship channel.

During final operations in June-December 2001 the following work was completed:

- Dredging of parent material from the area over and around the MWRA Section 8 water line in Chelsea River;
- Removal of portions of the MWRA Section 8 water line;
- Removal of damaged electric cable, silt and parent material near the McArdle Bridge in Chelsea River;
- Removal of three small areas of rock in the upper Chelsea River channel by drilling and blasting; and
- Dredging of several small shoals in the Mystic River channel.



Note: Specific dates of dredging were not available for all berths.

Figure 2-1
Overall Schedule for Phase 2
Boston Harbor
Navigation Improvement Project

M020004b.eps

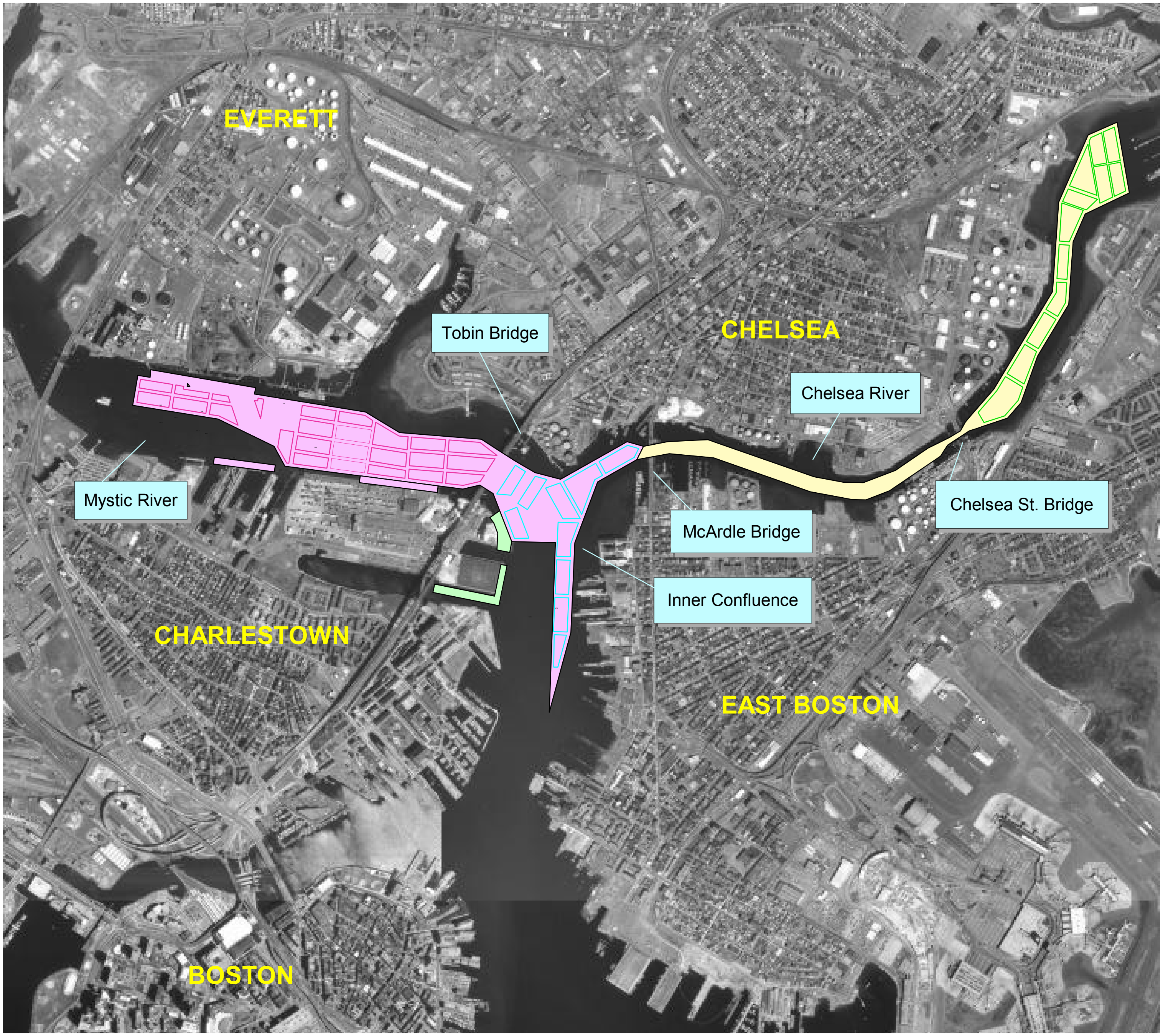


FIGURE 2-2
Potential Disposal Cells Identified in the Original BHNIP Plan

Boston Harbor Navigation Improvement Project

LEGEND:

Mystic River Cells
Inner Confluence Cells
Chelsea River Cells
Dredged to -35 ft MLLW
Dredged to -38 ft MLLW
Dredged to -40 ft MLLW

Sources: MASS GIS/MIT Digital Orthophotos, Cells from Great Lakes Dredge & Dock Co.

Date: 5/22/2002

1000 0 1000 2000 Feet

N W E S

Source: ENSR International

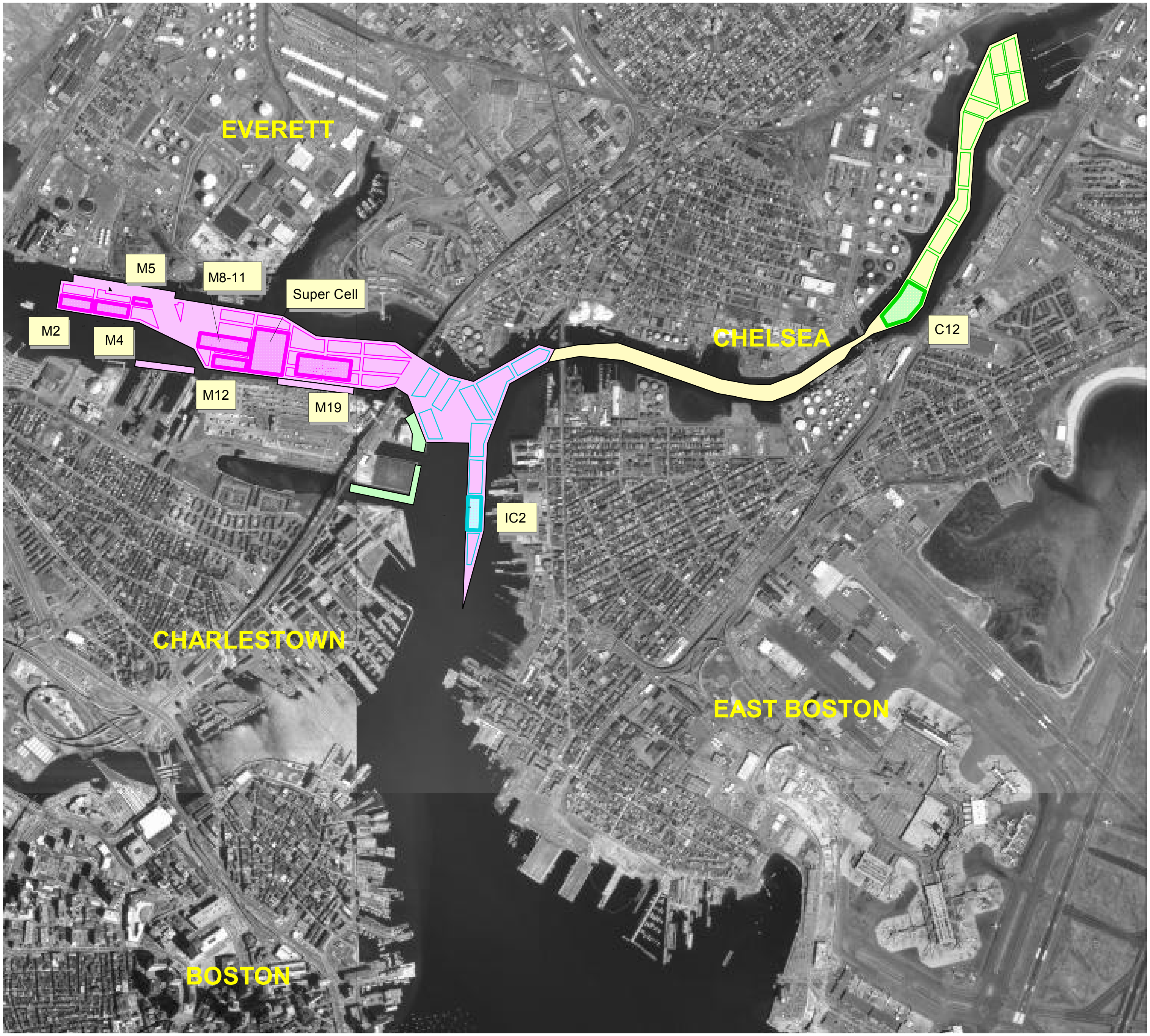


FIGURE 2-3
Actual Disposal Cells Constructed During the BHNIP

Boston Harbor Navigation Improvement Project

LEGEND:

Mystic River Cells
- Unused
- Used

Inner Confluence Cells
- Unused
- Used

Chelsea River Cells
- Unused
- Used
- Dredged to -35 ft MLLW
- Dredged to -38 ft MLLW
- Dredged to -40 ft MLLW

Sources: MASS GIS/MIT Digital Orthophotos, Cells from Great Lakes Dredge & Dock Co.

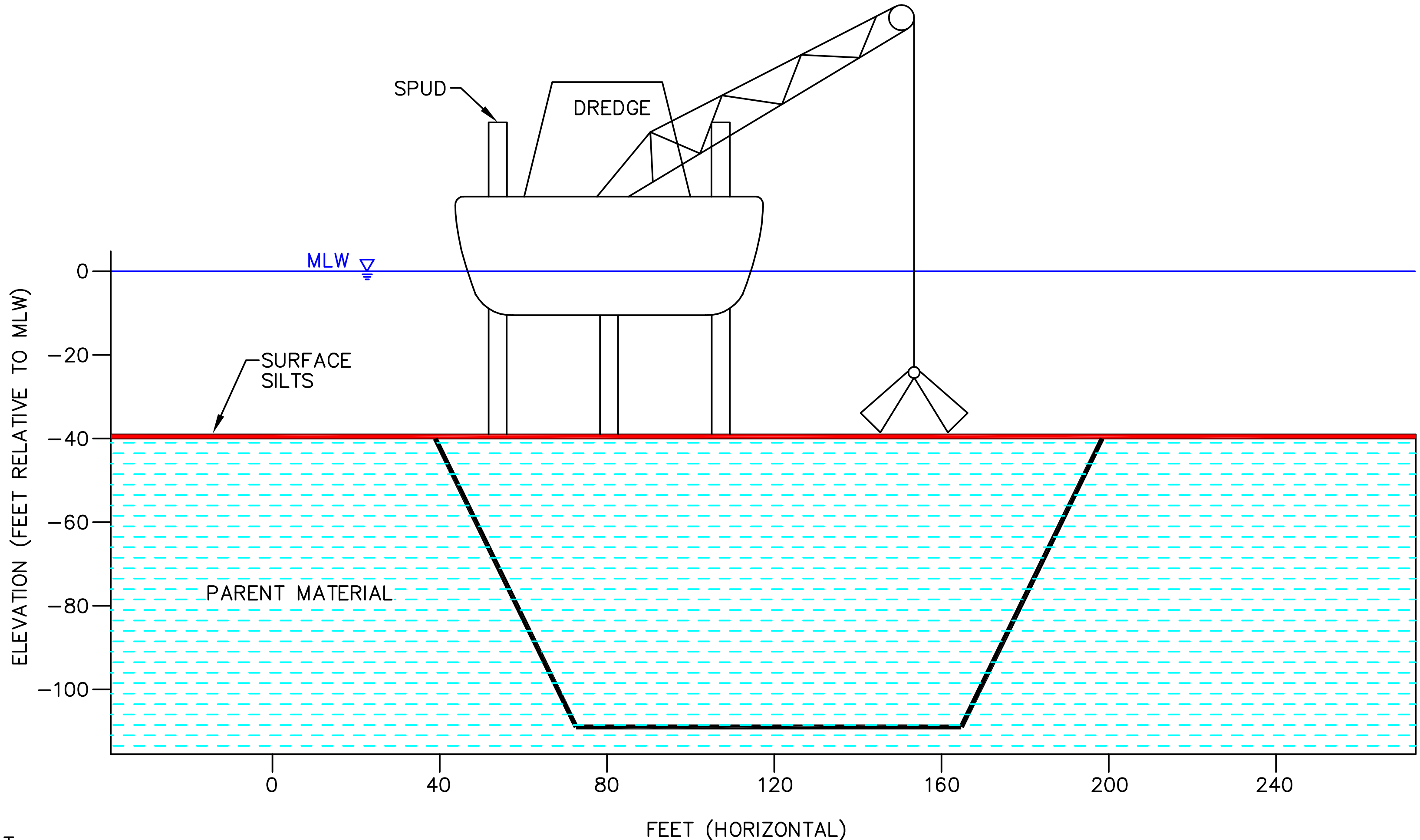
Date: 05/22/2002

1000 0 1000 2000 Feet

N W E S

Source: ENSR INTERNATIONAL

FILENAME: 447910A.DWG



LEGEND

- SILT
- PARENT MATERIAL (CLAY)
- PLANNED CELL OUTLINE (APPROXIMATE DIMENSIONS OF CELL M12)

DISPOSAL CELL CONSTRUCTION STEPS

1. SURFACE SILTS DREDGED WITH ENCLOSED BUCKET (DISPOSED IN EXISTING CELL OR STORED ON SCOWS).
2. PARENT MATERIAL DREDGED WITH CONVENTIONAL BUCKET (DISPOSED OFFSHORE).

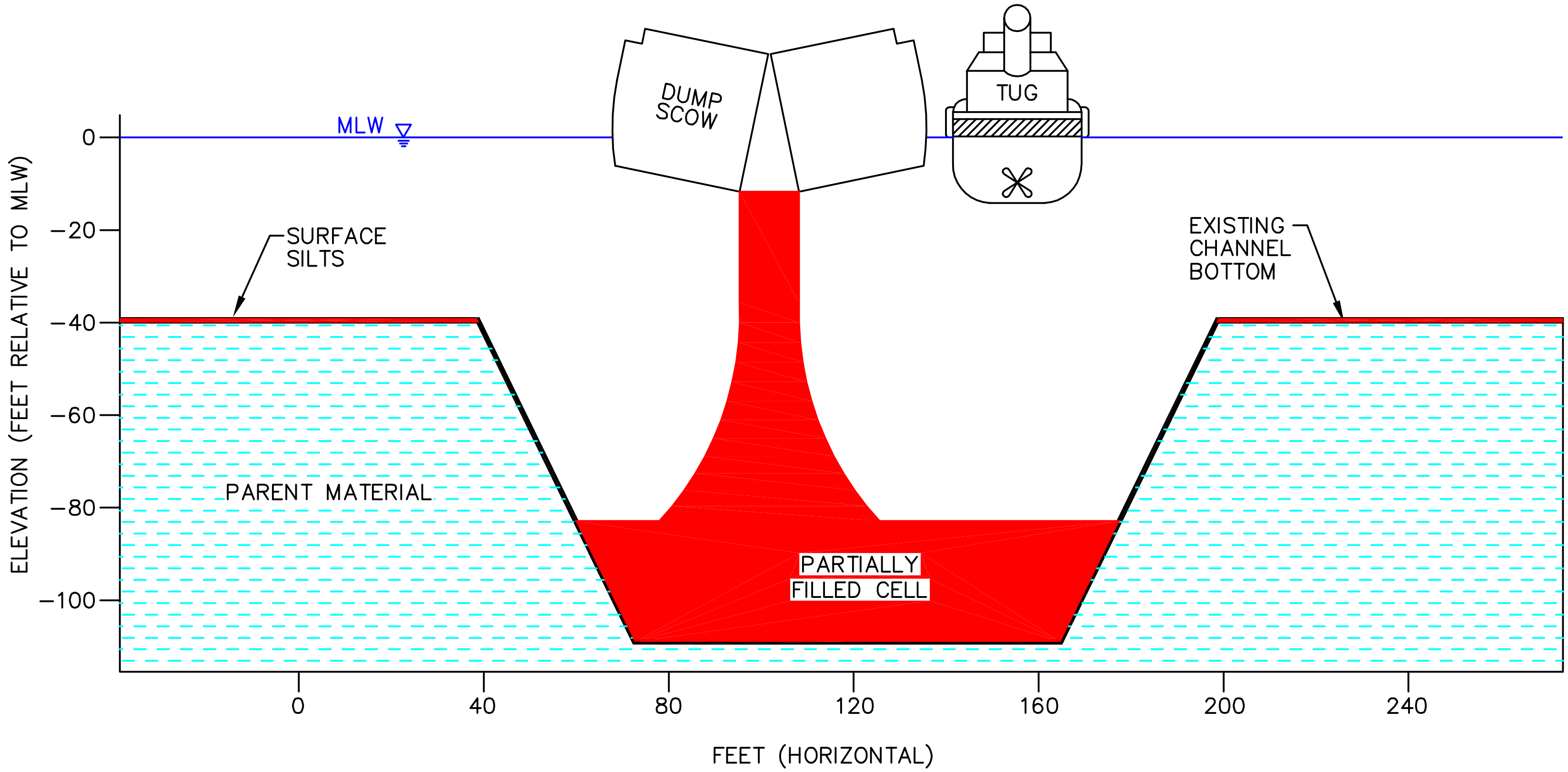
SOURCE: ENSR INTERNATIONAL

2 TECHNOLOGY PARK DRIVE
WESTFORD, MASSACHUSETTS 01886
PHONE: (978) 589−3000
FAX: (978) 589−3100
WEB: HTTP://WWW.ENSR.COM

CROSS−SECTION − DISPOSAL CELL CONSTRUCTION

FIGURE NUMBER:	DRAWN BY:	DATE:	PROJECT NUMBER:	SHEET NUMBER:
2−4	J.E.B.	11/01	09000−278−GA1	1

FILENAME: 447911A.DWG



LEGEND

- SILT
- PARENT MATERIAL (CLAY)
- CELL OUTLINE (APPROXIMATE DIMENSIONS OF CELL M12)

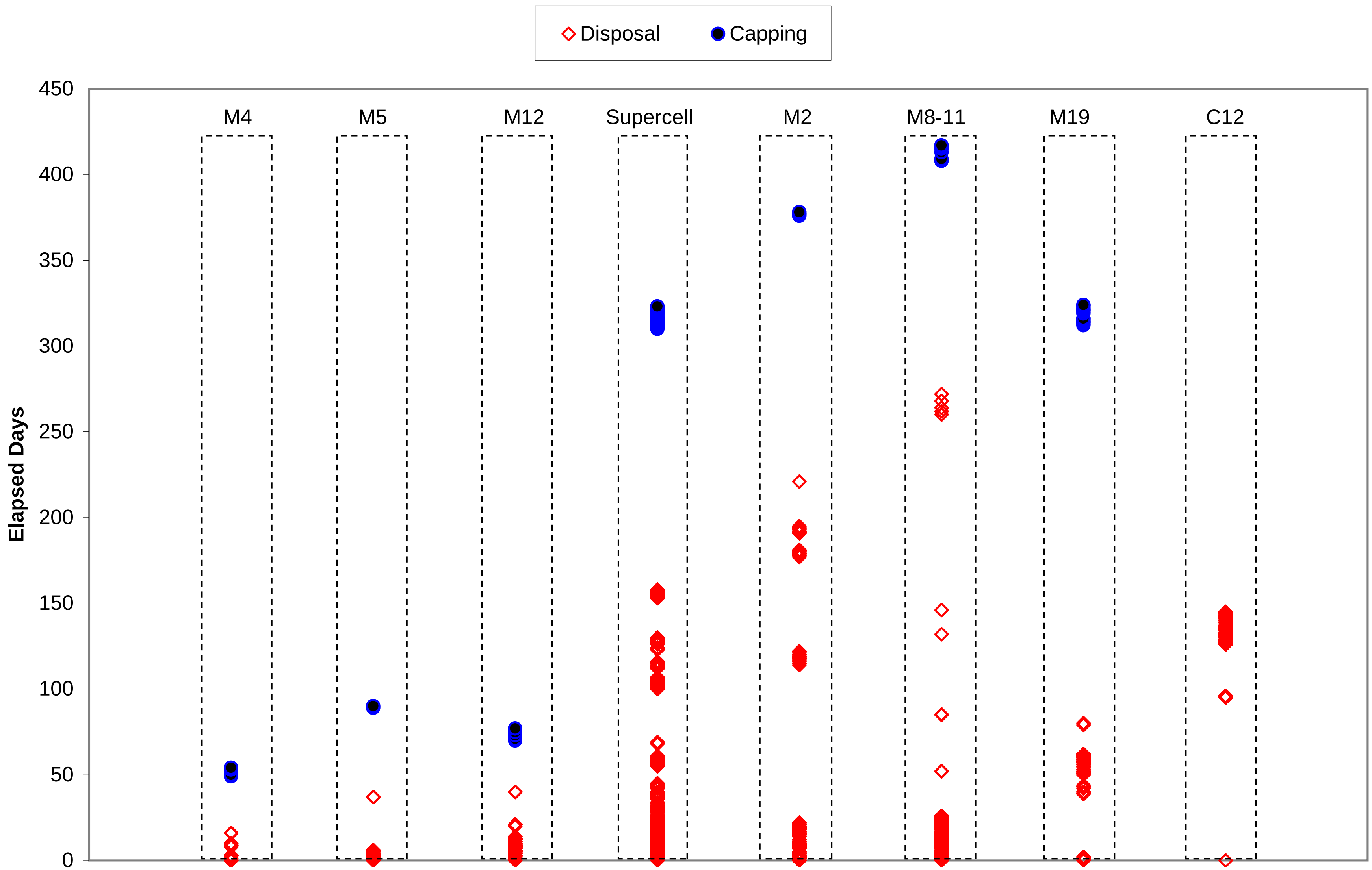
SOURCE: ENSR INTERNATIONAL

2 TECHNOLOGY PARK DRIVE
WESTFORD, MASSACHUSETTS 01886
PHONE: (978) 589-3000
FAX: (978) 589-3100
WEB: HTTP://WWW.ENSR.COM

CROSS-SECTION – DISPOSAL INTO IN-CHANNEL CELL

FIGURE NUMBER:	DRAWN BY:	DATE:	PROJECT NUMBER:	SHEET NUMBER:
2-5	J.E.B.	11/01	09000-278-GA1	1

Figure 2-6 Schedule of Disposal and Capping Events for Individual Cells



Source: ENSR, based on GLDD data

2 May 2002

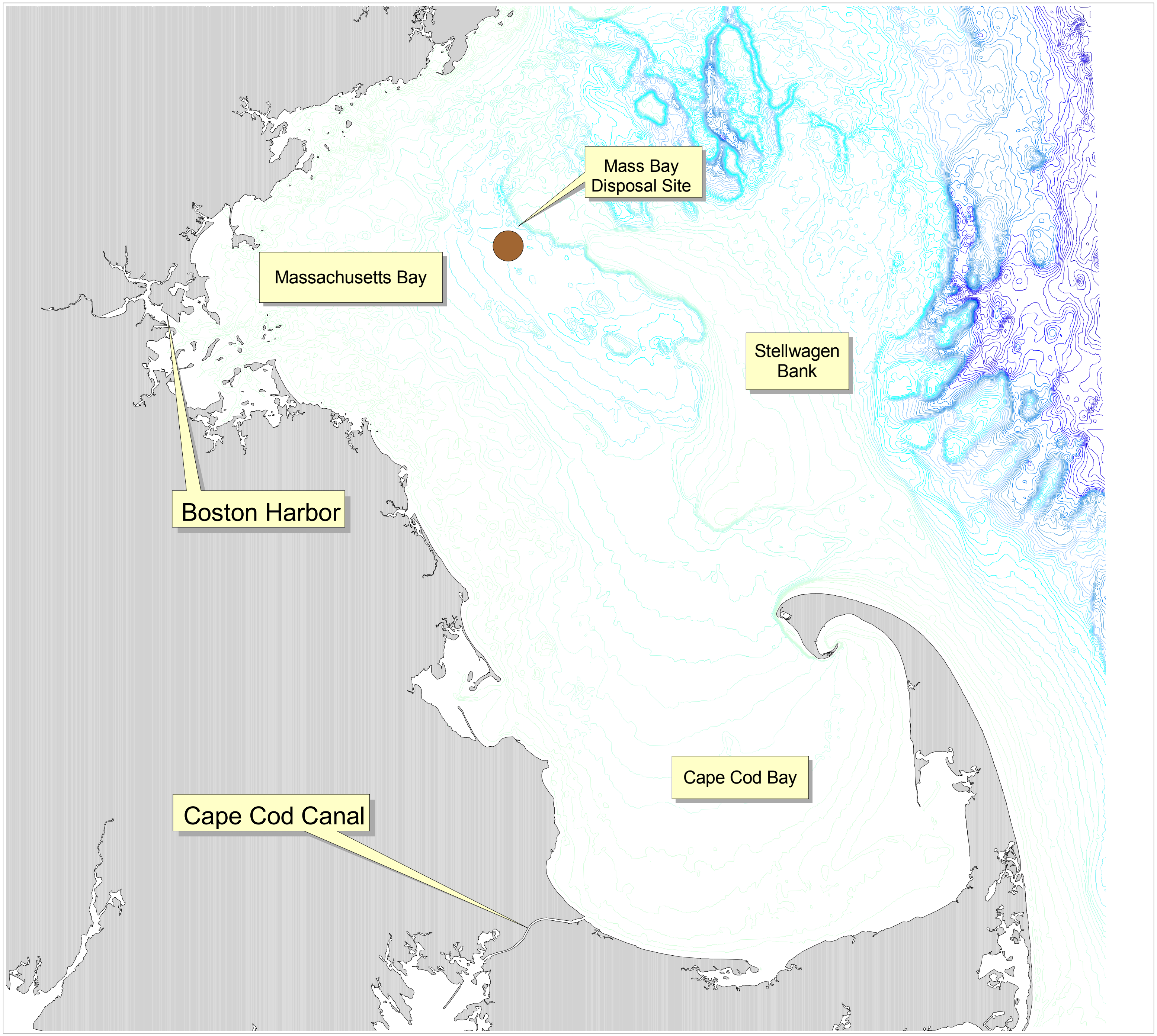


Figure 2-7
Massachusetts Bay
Disposal Site
Boston Harbor Navigation
Improvement Project

LEGEND:

- Mass Bay Disposal Site
- Coastline
- Bathymetry (5m)

Source: MassGIS

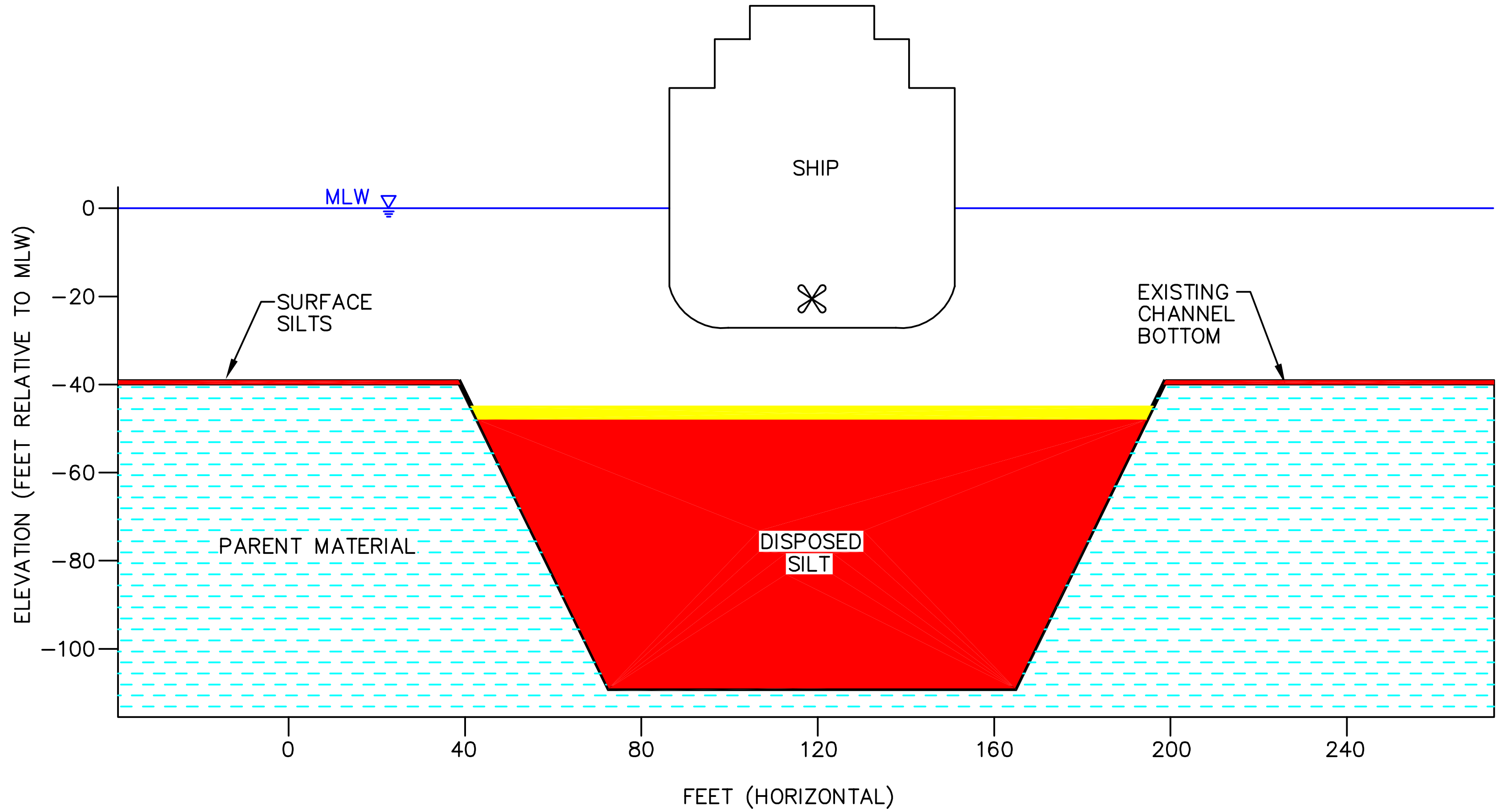
Date: 05/22/2002

4 0 4 8 12 Miles

N W E S

Source: ENSR INTERNATIONAL

FILENAME: 447912A.DWG



LEGEND

- SILT
- PARENT MATERIAL (CLAY)
- SAND CAP
- CELL OUTLINE (APPROXIMATE DIMENSIONS OF CELL M12)

SOURCE: ENSR INTERNATIONAL 2 TECHNOLOGY PARK DRIVE WESTFORD, MASSACHUSETTS 01886 PHONE: (978) 589-3000 FAX: (978) 589-3100 WEB: HTTP://WWW.ENSR.COM	CROSS-SECTION CAPPED CELL	FIGURE NUMBER: 2-8

DRAWN BY:	DATE:	PROJECT NUMBER:	SHEET NUMBER:
J.E.B.	11/01	09000-278-GA1	1

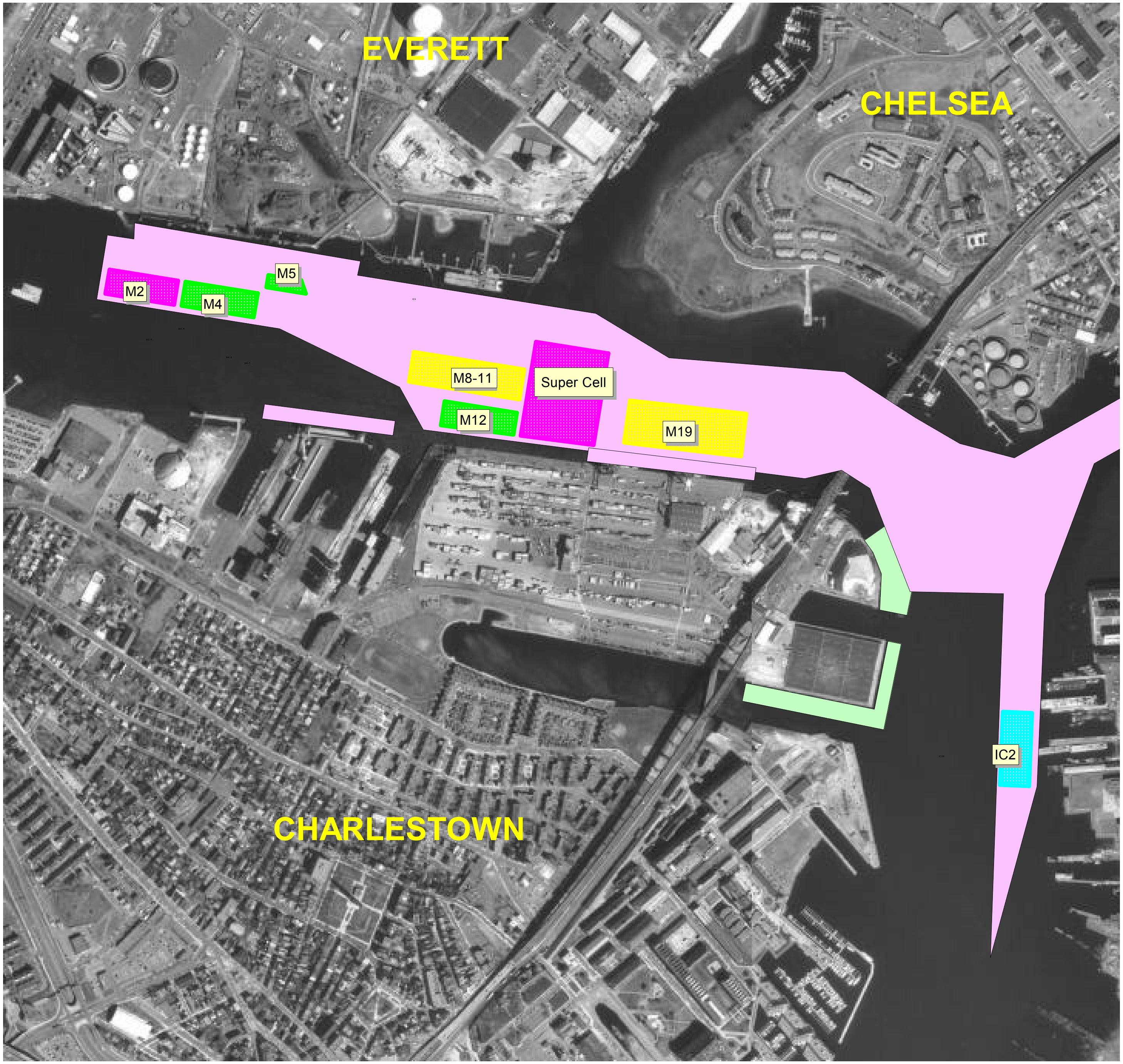


FIGURE 2-9
Mystic River/Inner Confluence Disposal Cell Capping History

Boston Harbor Navigation Improvement Project

LEGEND:

Cell Capping Date
- August 1997 (Phase 1)
- November 1998
- November 1999
- September 2000

- Dredged to -40 ft MLLW
- Dredged to -35 ft MLLW
- Dredged to -38 ft MLLW

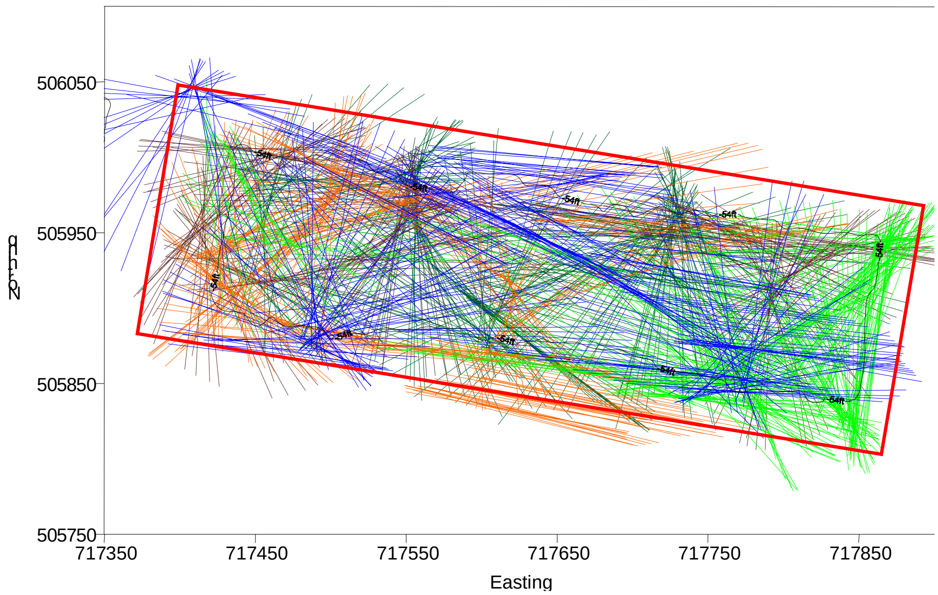
Sources: MASS GIS/MIT Digital Orthophotos, Cells from Great Lakes Dredge & Dock Co.

Date: 5/22/2002

500 0 500 1000 Feet

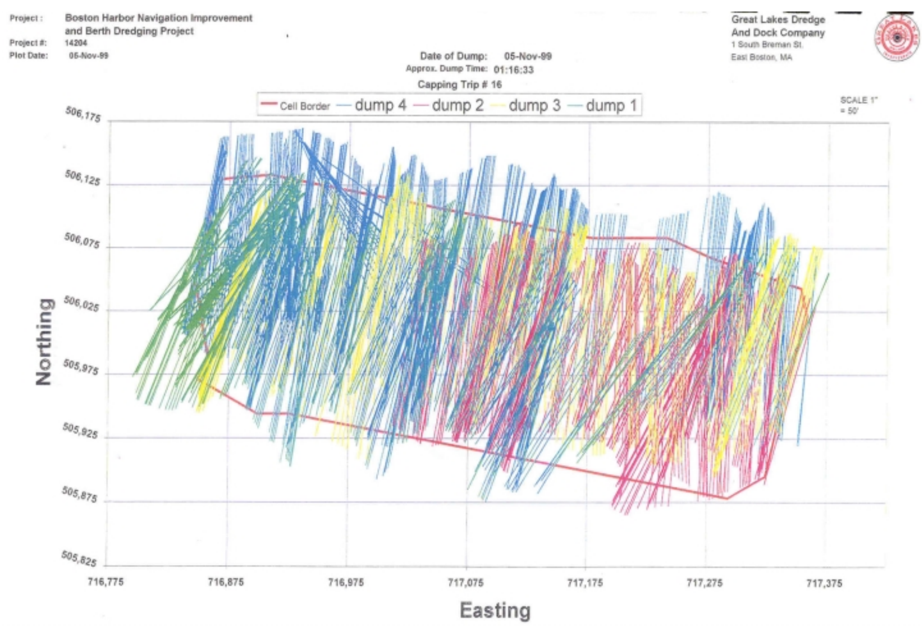
N W E S

Source: ENSR INTERNATIONAL



Cell M4 - Composite of All Capping Loads

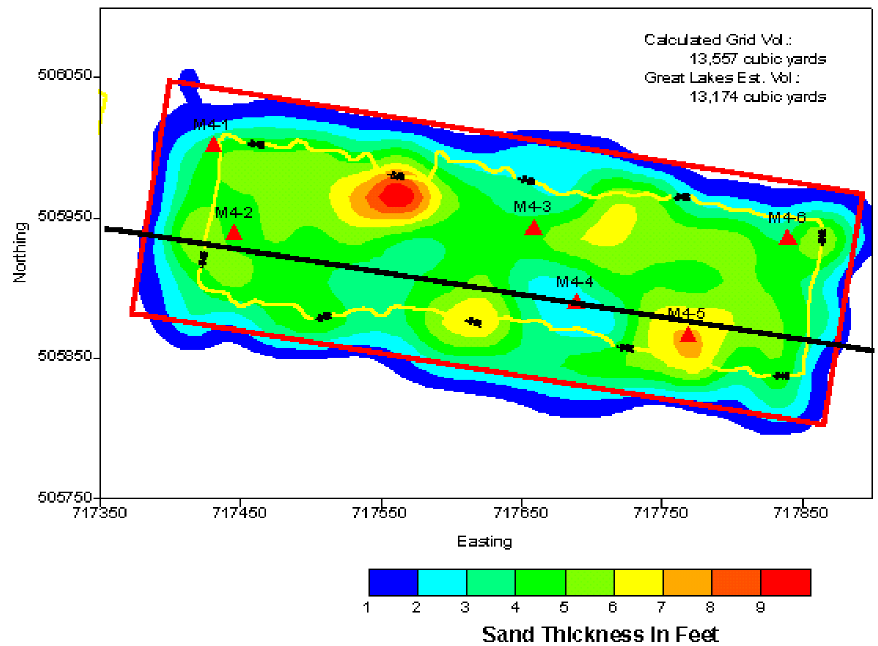
(Source: Science Applications International Corp.)



Cell M2 – Composite of Capping Loads 1 through 4

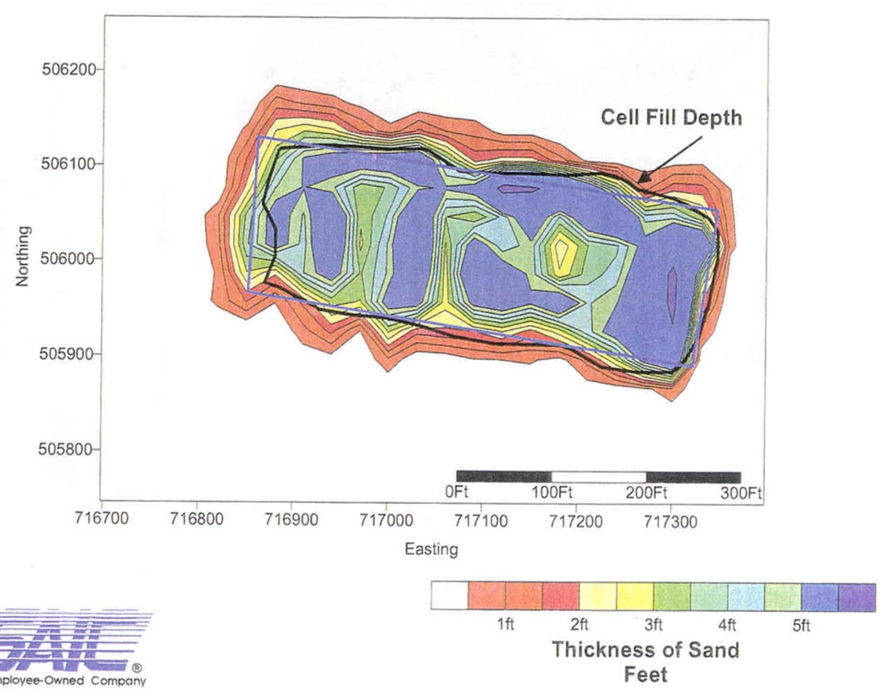
(Source: Great Lakes Dredge and Dock Co.)

Figure 2-10 Hopper Dredge Position During Capping M4, M2



Cell M4 – Calculated Sand Cap Thickness

(Source: Science Applications International Corp.)

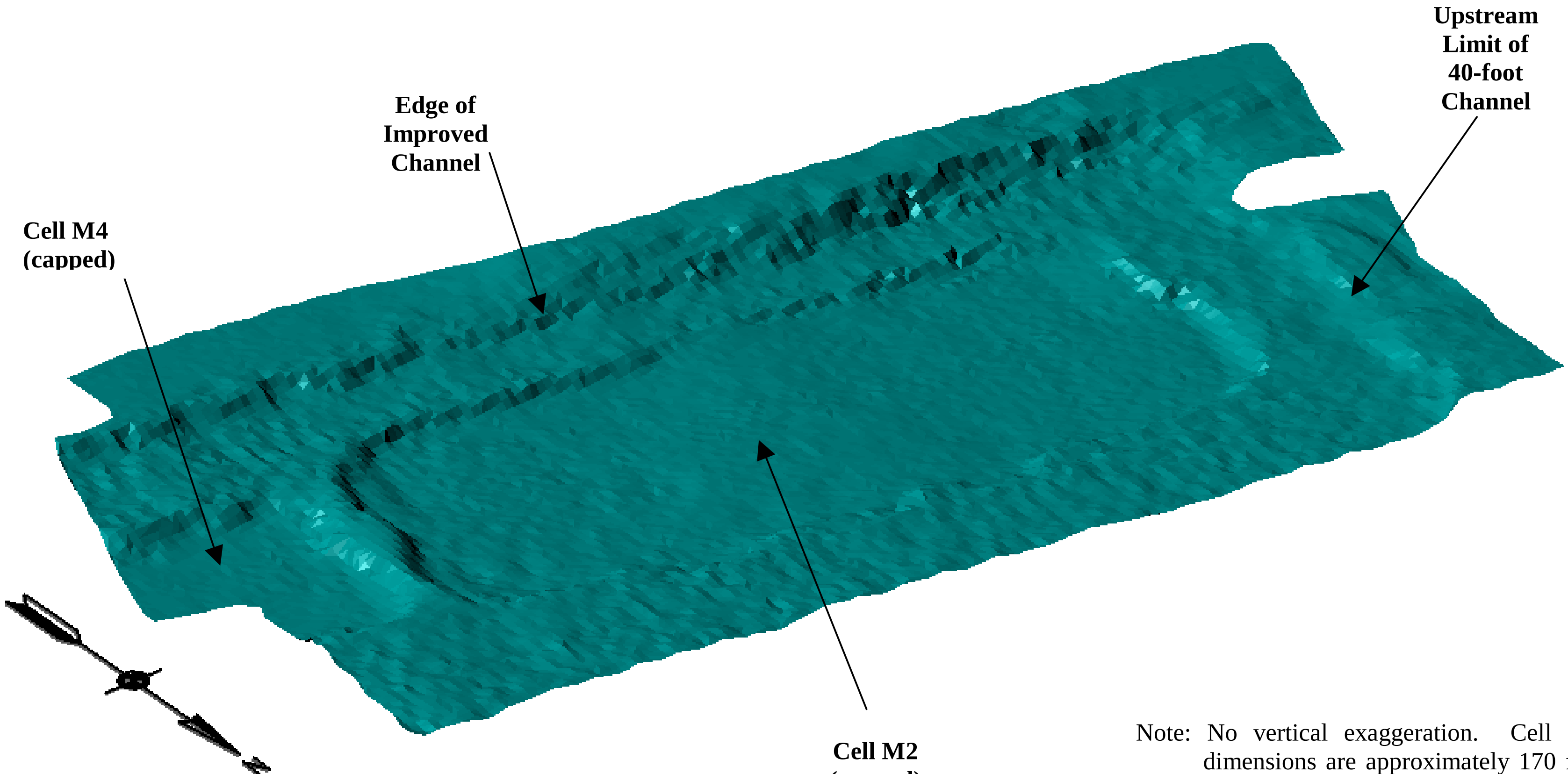


SAIC
An Employee-Owned Company

Cell M2 – Calculated Sand Cap Thickness

(Source: Science Applications International Corp., Great Lakes Dredge and Dock Co.)

Figure 2-11 Calculated Sand Cap Thickness M4, M2



Note: No vertical exaggeration. Cell M2 dimensions are approximately 170 feet by 480 feet. Top of cap is depressed approximately 10 feet below the surrounding channel bottom.

Figure 2-12 Bathymetry of Completed Cells M4 and M2
Source – U.S. Army Corps of Engineers, New England District

3

Environmental Monitoring

3.1 GENERAL OVERVIEW

As detailed in the Final Environmental Impact Report/Statement for the BHNIP (U.S. Army Corps of Engineers and Massport, 1995), there were a number of environmental concerns related to the project, in particular the dredging and disposal of the maintenance material. The Water Quality Certification issued by the MA Department of Environmental Protection for the project required the following types of environmental monitoring, each of which is described in the remainder of this section:

- Water quality monitoring following disposal
- Plume tracking following disposal
- Plume tracking during dredging
- Biological testing
- Dissolved oxygen monitoring
- Fisheries monitoring

Monitoring events were generally triggered by specific construction activities such as initiation of disposal into a given CAD cell or disposal of material from a particular (more contaminated) area of the harbor. Locations of where monitoring was performed are presented in Figure 3-1, and a list of the individual monitoring events and related conditions of the Water Quality Certification are presented in Table 3-1. The full Water Quality Certification is included in Appendix A. All of the environmental monitoring, with the exception of the fisheries monitoring was performed by Normandeau Associates, Inc. under contract to GLDD. Normandeau Associates initiated the fisheries monitoring, and GLDD carried out much of it with an observer provided by Tiny's Marine Service.

In addition to the above monitoring list, there were requirements for marine mammal observations set forth by the National Marine Fisheries Service for the offshore disposal. This work was performed by Tiny's Marine Service under contract to GLDD.

3.2 WATER QUALITY - DISPOSAL

The specific requirements for water quality monitoring following disposal are detailed in Conditions A and E of the Water Quality Certification (included in Appendix A). The monitoring was designed to assess potential impacts associated with individual disposal events. The following criteria were set in the Water Quality Certification:

Description of Effort

- Acute water quality criteria were required to be met for specific parameters at a location 300 feet down current of the disposal cell for individual water samples collected 0.5 and 1.0 hours following disposal. An exceedence was defined as any value above the criteria that was also 30% higher than the relevant reference value.
- Chronic water quality criteria were required to be met for specific parameters at a location 300 feet down current of the disposal cell for composite water samples collected 4 to 6 hours following disposal. An exceedence was defined as any value above the criteria that was also 30% higher than the relevant reference value.

Table 3-1 Summary of Water Quality Monitoring

Type of Monitoring (Water Quality Certification Condition)	Date(s) Performed	Report Reference
Disposal at first CAD cell filled with Mystic River Sediments (E1)	20-Aug-98	Normandeau 1998c
	21-Aug-98	Normandeau 1998c
	5-Jan-99	Normandeau 1999a
	5-May-99	Normandeau 1999g
	1-Jun-99	Normandeau 1999h
Disposal in each tributary in which >3000 cy disposed per tidal cycle (E1)	10-Sep-98	Normandeau 1998f
Disposal occurring in first CAD cell in the Chelsea River (E2)	6-Sep-99	Normandeau 1999i
	7-Sep-99	Normandeau 1999i
	15-Sep-99	Normandeau 1999m
	21-Sep-99	Normandeau 1999k
	22-Sep-99	Normandeau 1999k
	23-Sep-99	Normandeau 1999k
Sediment from Prolerized, Distrigas, Mystic Terminal Berths 2, 49, 50 make up >50% disposed load (E4)	15-Feb-99	Normandeau 1999d
	16-Feb-99	Normandeau 1999d
	17-Feb-99	Normandeau 1999d
	15-Dec-99	Normandeau 1999n
	28-Dec-99	Normandeau 2000a
Bioassays – Mysid and sea urchin (E5)	20-Aug-98	Normandeau 1998a
	16-Feb-99	Normandeau 1999c
Bioaccumulation - mussel (E6)	5-Jan-99	Normandeau 1999j
	17-Mar-99	Normandeau 1999j
Plume tracking following disposal (E7)	13-Sep-98	Normandeau 1998e
	14-Sep-98	Normandeau 1998e
	27-Jan-99	Normandeau 1999b
	15-Apr-99	Normandeau 1999e
	22-Apr-99	Normandeau 1999f
Disposal into Supercell with scows with 7000 cy capacity (E8)	5-Jan-99	Normandeau 1999a
Plume tracking during dredging (F2)	12-Sep-98	Normandeau 1998d
Bucket Qualification Study (Additional Requirement)	17-Aug-98	Normandeau 1998b
Dissolved oxygen monitoring at disposal cells and adjacent sites in the Mystic River (Additional Requirement)	1-Aug-99	Normandeau 2000b
Low tide monitoring (Additional Requirement)	25-Sep-99	Normandeau 1999l

- For dissolved oxygen, the water quality standard is 5 mg/L. An exceedence was defined as a mean value below the standard that was also statistically lower than the mean value at the reference station.
- For total suspended solids, a performance goal of 200 mg/L was set at distance of 500 feet down current of the disposal cell.

The specific requirements for an individual water quality monitoring event are presented below. Refer to Figure 3-2 for the general configuration of sampling locations.

1) Reference (Background) – A reference water sample was collected prior to the disposal event in the vicinity of the disposal cell, but outside of the influence of any ongoing work. Sampling depths for this and all other samples included mid depth and bottom (within 3 feet). The two samples were composited.

2) Disposal - Timing for sampling collection was keyed by the disposal event. Immediately following disposal, the monitoring contractor began real-time turbidity measurements to track the movement of any potential plume and confirm current direction.

3) 0.5 and 1.0 Hours Following Disposal – Water samples were collected along the line 300 feet down current of the CAD cell at a location determined to be along the axis of any identified turbidity plume. Samples from each time were analyzed separately, and analytical results were to be compared with acute criteria.

4) Plume Cross Section – Following collection of the 1.0 hour samples, turbidity measurements were performed along the 300-foot down current line in order to generate a cross section of water column turbidity.

5) 4 to 6 Hours Following Disposal – Two sets of samples were collected at least one hour apart at the 300 foot down current line. The samples were composited into one set, to be compared with chronic criteria.

6) Dissolved Oxygen – Dissolved oxygen measurements were performed at each sampling location/depth.

7) Analysis – Samples were analyzed for the following parameters: total suspended solids, copper (dissolved), cadmium (dissolved), lead (dissolved), mercury (total), and PCBs (total arochlors) for all monitoring events. For monitoring following disposal of material from specific berths, the following additional parameters were analyzed for: arsenic (dissolved), cadmium (dissolved), chromium (dissolved), and zinc (dissolved).

8) Reporting – The results of the analyses were required to be reported within 36 hours of sample delivery to the lab (with additional time allotted for the weekend).

The monitoring described above was triggered at various times throughout the project by disposal of specific types of material or disposal into specific CAD cells as noted in Table 3-1. Normandeau Associates performed much of the monitoring from the survey vessel shown in Photo 20. A YSI multi-parameter water quality probe was towed behind the vessel at varied depths, providing a real-time readout of depth and turbidity (Photo 21). Sample tubing was married to the probe to allow simultaneous collection of pumped water samples.

Results

A total of 18 monitoring events following disposal were performed during Phase 2 of the BHNIP. Specific dates and report references for each event are presented in Table 3-1. Despite the concerns at the outset of the project, the monitoring revealed no exceedences of the criteria set in the Water Quality Certification for the project. A brief summary of the monitoring results for each parameter is provided below:

- Turbidity – Following the disposal event and departure of tug/scow, turbidity measurements were generally performed directly over the CAD cell to assess plume potential and verify current direction. Values greater than 1000 NTU were often detected below the rim of the cell, with elevations of 100-200 NTU in the water column above the cell. Down current from the cell, at the 300 foot compliance point, elevations of turbidity above 100 NTU were detected in only a limited number of events and were short term (minutes) in duration. In general, highest turbidity measurements at the 300-foot down current location were 20-30 NTU above background at the 0.5 and 1.0 hour sampling times. The highest values were generally found in the lower half of the water column. Turbidity generally returned to near-background levels by the 4-6 hour sampling time. A typical cross section of turbidity at the 300-foot down current location is presented in Figure 3-3.
- Total Suspended Solids – Background concentrations of total suspended solids generally ranged from 5-15 mg/L. Concentrations at the 300-foot down current location were generally higher than background by a factor of two to four at the 0.5 and 1.0 hour sampling times. Concentrations at this location returned to near-background levels at the 4-6 hour sampling time.
- Metals
  - Arsenic (dissolved) – not detected in any samples.
  - Cadmium (dissolved) – not detected in any samples.
  - Chromium (dissolved) – detected on one occasion at ~10 ug/L with similar background/down current concentrations.
  - Copper (dissolved) – detected in approximately half of the samples ranging from 0.5-2.6 ug/L (with one anomalous sample of 69 ug/L). The highest concentrations were found at background locations.
  - Lead (dissolved) – detected in most samples at <0.3 ug/L with similar background/down current concentrations.

  - Mercury (total) – detected in most samples generally <0.02 ug/L. On four occurrences, concentrations exceeded the chronic water quality criterion (0.025 ug/L), with values ranging from 0.030-0.036 ug/L. These concentrations all occurred at the 300-foot down current location at 0.5 or 1.0 hour after disposal, and the elevations were apparently the result of disposal. In each of these cases, concentrations in the 4-6 hour samples had dropped below the chronic criterion.
  - Zinc (dissolved) – detected in all samples at concentrations ranging from 2-6 ug/L with similar background/down current concentrations.
- PCBs (total arochlors) – PCBs were only detected during two monitoring events, with the highest concentration (0.19 ug/L) occurring at a background station.
- Dissolved Oxygen – Dissolved oxygen concentrations varied widely (ranging from 4-11 mg/L) as the monitoring was performed throughout the year. However, during any given monitoring effort, background and down current concentrations were very similar.

3.3 PLUME TRACKING – DISPOSAL

Description of Effort

The Water Quality Certification for the project required that more detailed mapping be performed of the turbidity plume that might be generated following disposal (Condition E7). The mapping required generation of plan views of post disposal turbidity at the surface, mid depth, and near bottom extending from 200 feet up current to 1000 feet down current of the disposal cell at 1-2 hours following disposal. Normandeau Associates performed the monitoring with the same vessel/setup as used in the disposal monitoring described above.

Results

Plume tracking following disposal into a CAD cell was performed 5 times during Phase 2 of the BHNIP. Specific dates and report references for each event are presented in Table 3-1. The more detailed plume monitoring further supported the results of turbidity measurements that were part of the disposal monitoring described above in Section 3.2, i.e., elevations of turbidity generally remained within the boundaries of the disposal cell itself, with limited down current transport.

Figure 3-4 presents a plan view of turbidity contours generated from a series of transect measurements made within about 3 feet of the bottom following the disposal of three scows over the Supercell within one 3-hour, high-tide disposal window. Approximately 7200 cy of maintenance material was disposed on this tidal cycle, making it one of the largest events of the project. Although this was not a formal "plume tracking" event (the measurements were made during water quality sampling), it is one of the most distinct plumes noted during the monitoring. The measurements were performed approximately 1 hour after the last disposal into the cell, well into ebb tide conditions. Elevated turbidity extended beyond the cell boundaries, but a significant plume was not identified beyond 300 feet down current of the cell.

Also apparent in Figure 3-4 are the confusing aspects of tracking the plume in a system with other potential turbidity inputs. Elevations of turbidity are noted to the north of the cell and at the northern end of the 1000-foot down current line. These elevations were not attributed to disposal operations, but were likely the result of discharge from the tributary to the north of the cell and vessel activity adjacent to shallow areas along the north of the channel.

3.4 PLUME TRACKING - DREDGING

Description of Effort

The Water Quality Certification required mapping of turbidity associated with use of the environmental bucket to dredge maintenance material (Condition F2). Monitoring was performed during periods of high and low water slack and during maximum flood and ebb tides. The mapping required generation of plan views of turbidity at mid depth and near bottom extending from 300 feet up current to 1000 feet down current of continuous dredging operations. Generation of a cross section of turbidity located 300 feet down current of the dredging was also required. Normandeau Associates performed the monitoring with the same vessel/setup as used in the disposal monitoring.

Results

Monitoring of the turbidity plume associated with dredging of maintenance material (using the environmental bucket) was performed on one occasion during the project in September 1998. Near-bottom turbidity values were highest for all the measurements with values as high as 100 NTU approximately 300 feet down current of the dredging operation. Mid-depth turbidity was much less, and all values returned to background levels (10-20 NTU) between 600 and 1000 feet down current. When GLDD proposed to use their own environmental bucket (in addition to the approved Cable Arm bucket), a separate monitoring trial was performed by Normandeau Associates to evaluate the bucket's effectiveness at limiting suspended solids as described in Section 7. More detailed monitoring of the water column impacts of dredging was performed as part of an independent study by the U.S. Army Corps of Engineers' Research and Development Center and is described in Section 8.

3.5 BIOLOGICAL TESTING

Description of Effort

A limited amount of biological testing was required to further investigate water quality impacts associated with disposal of maintenance material into CAD cells (Conditions E5 and E6 of the Water Quality Certification). Bioassays were performed in conjunction with the disposal monitoring described above in Section 3.2. Water samples collected from 4 to 6 hours following disposal at a location 300 feet down current of the disposal cell were used for the following tests:

- Sea Urchin *(Arbacia punctulata)* – fertilization test
- Mysid Shrimp *(Mysidopsis bahia)* – 7 day test to chronic endpoint

Bioaccumulation of metals (arsenic, cadmium, lead, mercury) and organics (PCBs, PAHs) was assessed in the blue mussel (*Mytilus edulis*) following protocols used in the ongoing Massachusetts Water Resources Authority harbor assessment. Mussel deployment locations were set to further identify impacts associated with disposal into the CAD cells.

Results

Two sets of bioassay tests were performed during the project (August 1998 and February 1999). The mysid shrimp test revealed at or near 100% survival for all samples and no differences in growth between the reference site and down current of the disposal cell for both sets of tests. For the sea urchin test, fertilization was approximately 90% for all samples in the February 1999 test. For the August 1998 test, low fertilization (<33%) was recorded for both the down current location and the reference site, indicating an impact unrelated to the project.

One deployment of mussels was performed during the project (January – March 1999) with locations upriver and down river of the Mystic River disposal cells and a reference location further down river at Central Wharf (Figure 3-1). Cadmium was not accumulated at any of the stations. Mercury concentrations in the mussels were similar at all stations. Arsenic concentrations varied with no discernable pattern. Lead concentrations varied by a factor of four. The distribution of concentrations at some stations showed a pattern consistent with potential impacts due to disposal cells, but the investigation was not wide enough in scope to identify project-specific impacts versus impacts associated with normal harbor processes.

Bioaccumulation of organics showed a consistent pattern of highest concentrations upstream decreasing to lowest concentrations further out of the harbor for both PAHs and PCBs. This pattern is consistent with an upriver source, such as a CSO discharge, unrelated to the project.

3.6 DISSOLVED OXYGEN

Description of Effort

After completion of the first round of capping, the elevations of the tops of capped cells M4, M5, and M12 ranged from 9 to 15 feet below the surrounding harbor bottom. Previous harbor water quality monitoring (independent of the BHNIP) had documented depressed dissolved oxygen levels in the Mystic River in the late summer/early fall. Because of concerns that dissolved oxygen levels might be further lowered due to reduced circulation over the depressed CAD cells, the MA Department of Environmental Protection amended the Water Quality Certification to require measurement of dissolved oxygen in near-bottom (within 3 feet) waters over the three cells and in surrounding harbor areas during the months of July-October 1999. Normandeau Associates performed the monitoring with the same vessel/setup as used in the disposal monitoring described above.

Results

Dissolved oxygen levels displayed a clear decrease as water temperatures increased in the late summer (Figure 3-5), with values dropping below the State's 5.0 mg/L standard. However, the decrease was similar to that noted in the surrounding areas beyond the boundaries of the cells. Although the high organic content of the newly exposed dredged material in the cells was expected to cause anoxic conditions at the sediment-water interface, the depressed nature of the cells did not appear to affect dissolved oxygen content of the immediate overlying waters.

3.7 FISHERIES PROTECTION

The areas of the harbor that were scheduled for dredging and disposal cells included habitat for demersal and pelagic fish species, with a large population of winter flounder and seasonal runs of rainbow smelt, blueback herring, and alewife. In an effort to limit impact to fisheries, the following requirements were included in the Water Quality Certification (Condition H):

Description of Effort

- Blasting – Blasting was prohibited in the Mystic River and Inner Confluence (areas with anadromous fish runs) from 15 February to 15 June. All blasting was to be performed with techniques designed to minimize potential impacts to overlying waters and fish. A MA Division of Marine Fisheries approved observer and fish-detecting sonar system were required for all blasting operations to ensure schools of fish were not present at the time of blasting.
- CAD Cell Excavation and Disposal – Construction and disposal activities at particular cells required the presence of a fisheries observer, sonar system, and fish startle system if work was performed between 15 February and 15 June.

Results

No blasting was required during the main portion of Phase 2 of the BHNIP. A limited amount of blasting was performed in the upper portion of the Chelsea River in August 2001, and no fisheries impacts were noted.

CAD cell excavation and disposal was performed during much of the 15 February to 15 June period in 1999, and a limited amount of disposal was performed in 2000 that required fisheries monitoring. During construction activities, the vessel equipped with sonar and a high frequency fish deterrent system surveyed the area periodically. For disposal events, the vessel surveyed the area around the cell just prior to disposal. The deterrent system was to be engaged only upon encountering large numbers of fish. Very few fish were detected in the colder months, although a number of harbor seals were noted periodically observing the construction efforts. As water temperatures warmed in the spring, more individual fish were detected with the sonar, but the schools of fish known to be moving up through the harbor were not observed within the immediate dredging/disposal areas.

3.8 MARINE MAMMALS

Offshore transit and disposal at the Massachusetts Bay Disposal Site during daylight hours required a marine mammal observer, approved by the National Marine Fisheries Service for the period between 01 February and 30 May. The role of the observer was to ensure that threatened or endangered species were not approached during transit or present in the immediate vicinity of the disposal site. The marine mammal observers for the project were provided by Tiny's Marine Service under contract to GLDD. No incidents involving marine mammals (or turtles) were reported during the project.

FIGURE 3-1
Water Quality Monitoring Locations

Boston Harbor Navigation Improvement Project

LEGEND:

Mystic River Cells
Used
Inner Confluence Cells
Used
Chelsea River Cells
Used

0 Water Quality Monitoring Following Disposal
\# Plume Tracking Following Disposal
$ Plume Tracking During Dredging
\# Mussel Bioaccumulation
\# Toxicity Testing
0 Dissolved Oxygen Monitoring

Note: Symbols denote cells at which monitoring took place. Actual sampling locations varied.

Sources: MASS GIS/MIT Digital Orthophotos,
Cells from Great Lakes Dredge & Dock Co.

Date: 5/22/2002

1000 0 1000 Feet

N
W E
S

Source: ENSR INTERNATIONAL

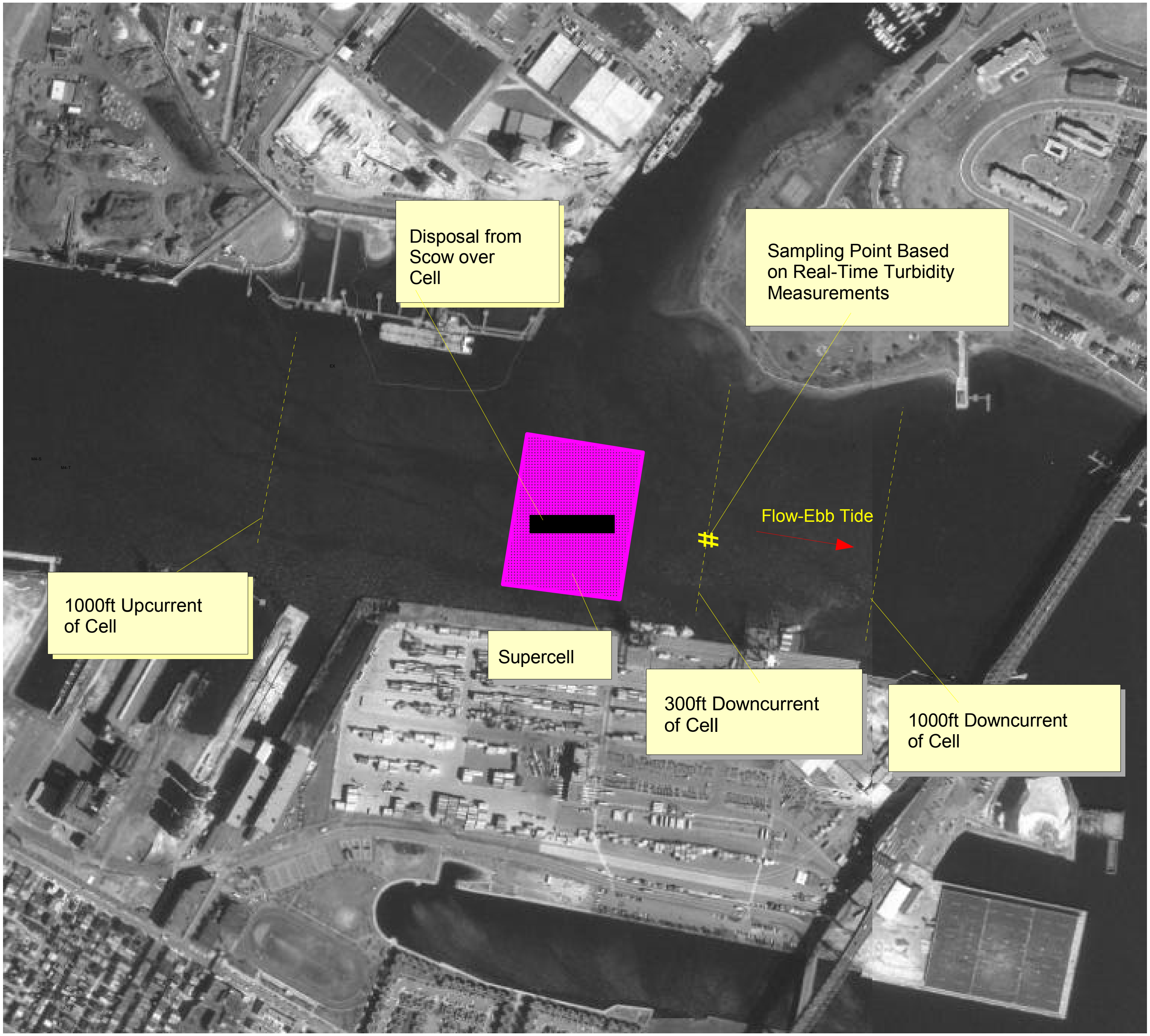


FIGURE 3-2 Configuration of Water Quality Monitoring Folllowing Disposal

Boston Harbor Navigation Improvement Project

LEGEND:

Cell Capping Date
November 1999
Cell Capping Date

Sources: MASS GIS/MIT Digital Orthophotos,
Cells from Great Lakes Dredge & Dock Co.

Date: 5/22/2002

500 0 500 Feet

N
W E
S

Source: ENSR INTERNATIONAL

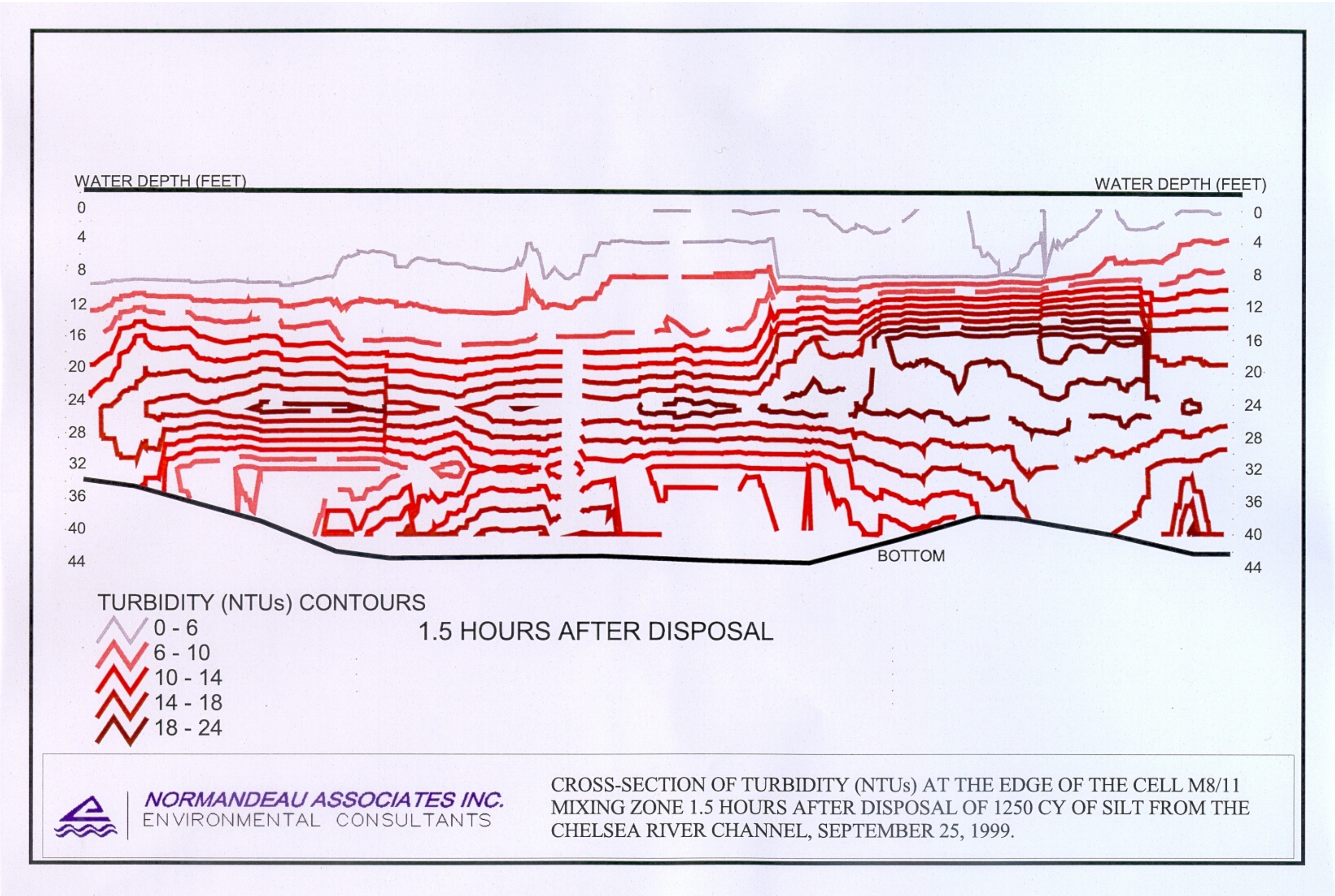


Figure 3-3 Cross-Section of Turbidity Plume Following Disposal into Cell M8-11

(Source: Normandeau Associates, Inc.)

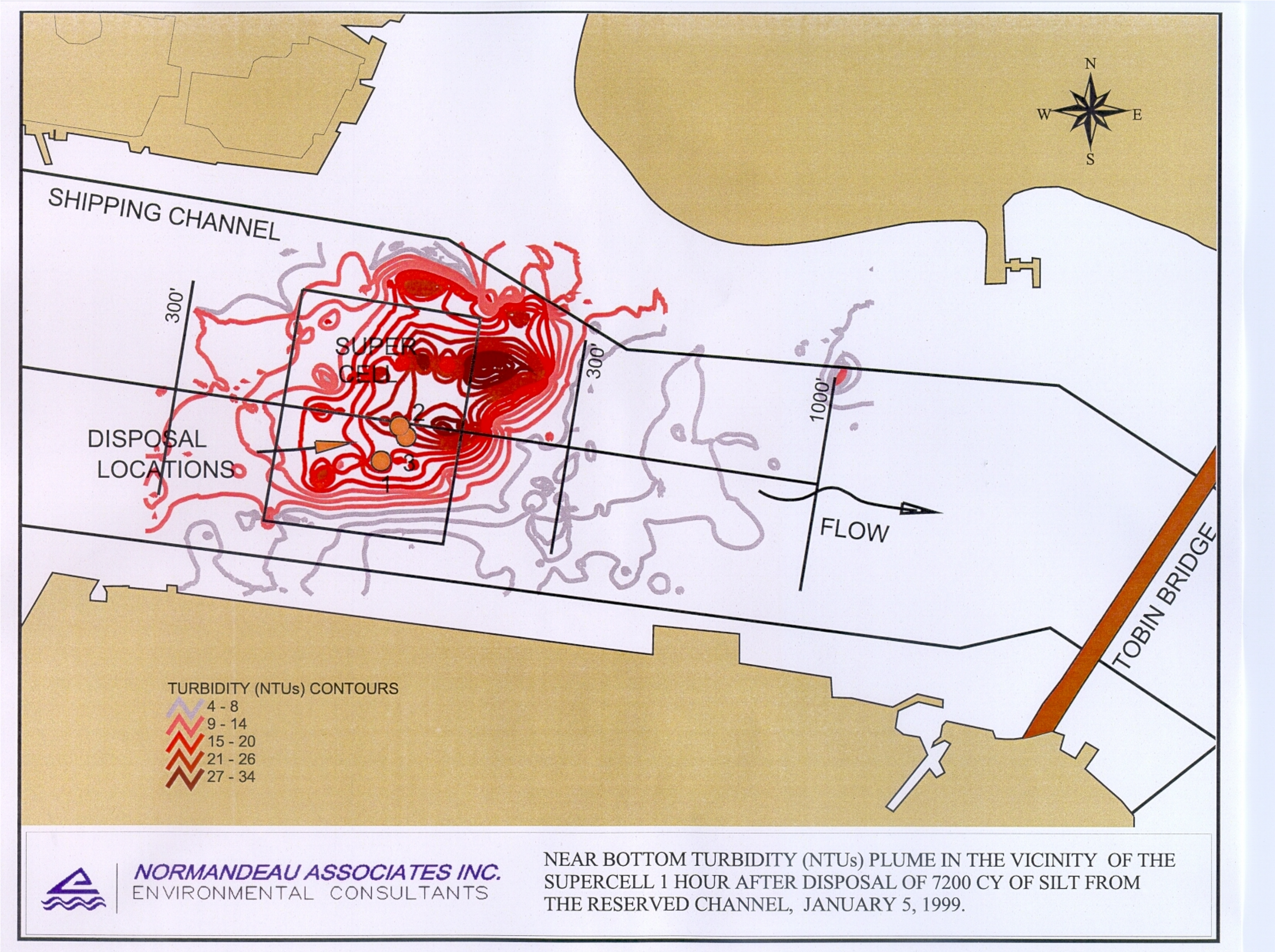
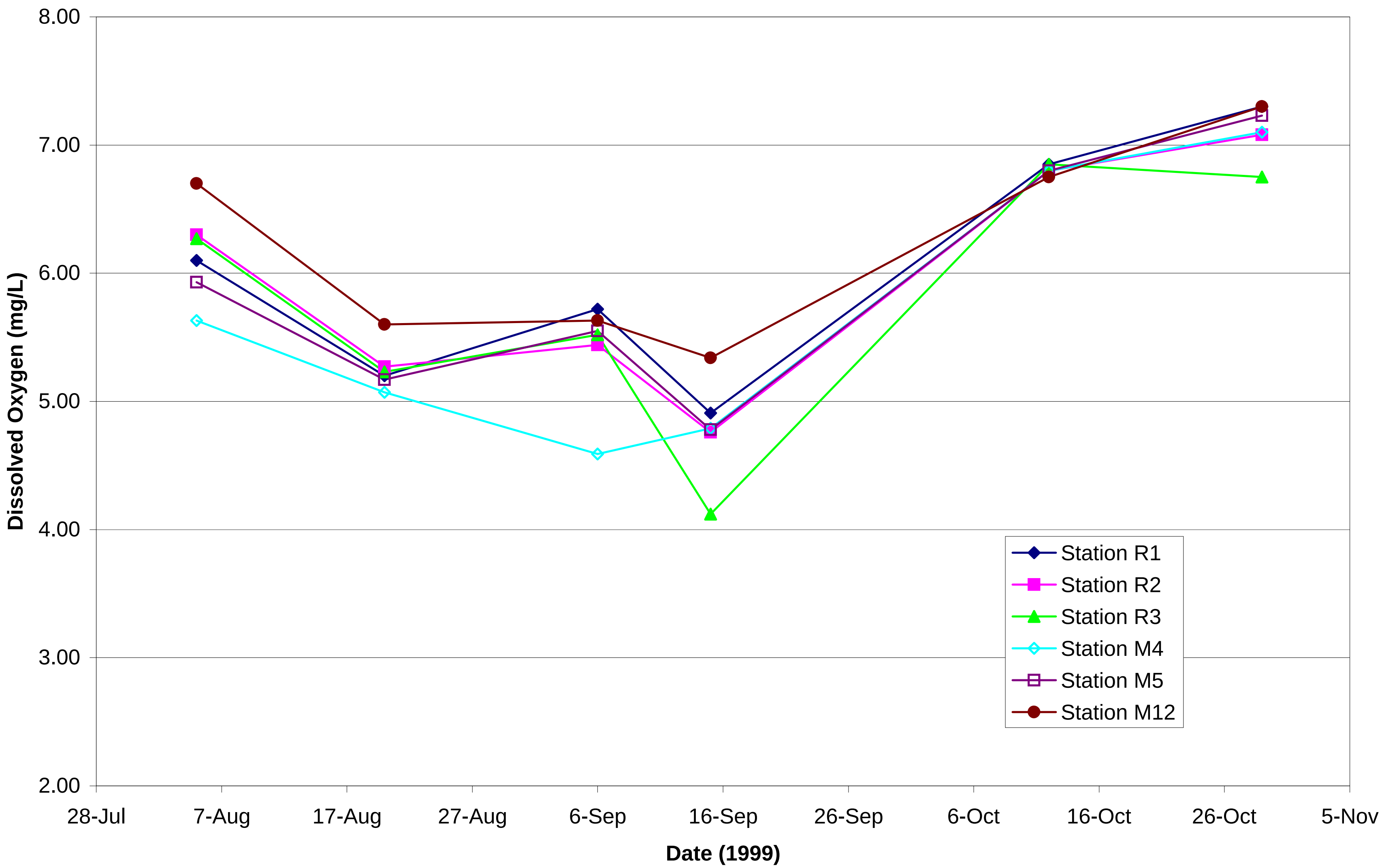


Figure 3-4 Near Bottom Turbidity Plume Following Disposal into Supercell

(Source: Normandeau Associates, Inc.)

Figure 3-5 Near Bottom Dissolved Oxygen Measurements Over Mystic River Cells (Source: Normandeau Associates)



ENSR November 2001

4

Cap Monitoring

4.1 GENERAL OVERVIEW

The construction plans and specifications and the Water Quality Certification for the BHNIP required the contractor to verify cap coverage and thickness to assure the Corps' contracting officer and regulatory agencies that contract and permit conditions were met. The specifications required corings, side scan sonar, and sub-bottom surveys as well as bathymetric surveys. The contractor was given the option of proposing other methods as long as the required methods were used to substantiate the accuracy of the proposed method. GLDD did not propose an alternative and used the required methods for all CAD cells.

The remainder of this section provides a summary of the capping results and the verification studies. The tables include measured and calculated factors relevant to cap assessment. The consolidation time, as used for this report, is determined as the interval from the last disposal into the cell to initiation of cap placement. The pre-capping top of cell elevation is the estimated elevation of the dredged material within the cell prior to capping based on average values from bathymetric surveys. The calculated cap thickness is based on hopper dredge load estimates (taken from Table 2-4) for volume and cell area (taken from Table 2-2). Actual cap thickness varied considerably over some cells and is better described in the cap verification reports referenced in the following paragraphs. The post-capping top of cell elevation is the estimated elevation of the top of the cell after capping.

4.2 CAD CELLS M4, M5, M12

CAD cells M4, M5, and M12 were capped in November 1998. Evaluation of the dredged material within the cells was performed by SAIC just prior to capping (Photo 22, Photo 23), and follow-up cap monitoring was performed by SAIC/Ocean Surveys in December 1998 (Photo 26, Photo 30). As presented graphically in Figure 2-6 and in Table 4-1, the disposal sequence and consolidation time varied somewhat among the cells, but all three were filled and capped within a relatively short time period. The capping methodology (hopper dredge under its own propulsion) was the same for all three cells.

Table 4-1 First Capping Series - Results

Cell	Consolidation Time (days)	Elevation of Top of Cell (Pre-Capping) (feet below MLLW)	Computed Cap Thickness (feet)	Elevation of Top of Cell (Post-Capping) (feet below MLLW)
M4	33	-54	4.3	-55
M5	52	-52	6.4	-49
M12	30	-51	4.6	-54

The monitoring revealed that the caps for CAD cells M4, M5, and M12 displayed significant variability, and all showed some mixing between the sand cap material and the dredged maintenance material within the cell and/or a significant volume of silty maintenance material over the sand caps. The elevation of the top of the cell actually decreased with the placement of sand for two cells (M4 and M12), indicating that the loading of sand caused accelerated consolidation of the disposed material within the cells. The results of the cap monitoring for the first three cells are presented in SAIC (1999a) and Ocean Surveys (1999a) reports, and a summary for each of the cells is presented below.

M4 – CAD cell M4 had the shortest total disposal/consolidation period of the three cells. All disposal into the cell was completed in 16 days, and capping commenced following 33 days of consolidation. Grab samples collected from the surface of the disposed material just prior to capping revealed that surficial material was quite fluid in nature. With placement of an estimated 4+ feet of cap material over the cell, the elevation of the top of the cell was 1 foot lower than that prior to capping. Sub-bottom profiling performed after capping was completed did not reveal a distinct sand layer at the surface of the cell (Figure 4-1). Rather, an acoustically transparent layer was apparent in the upper 3-6 feet, with a thicker, more reflective layer residing underneath. This suggests that the deposited sand had mixed somewhat with the silty dredged material in the cell, with some of the cell material displaced over the top of the sand layer. The post-cap cores that were collected from cell M4 supported the sub-bottom profiling. As presented in Figure 4-2, fluid silty material is apparent at the top of the core, with an increasing sand content deeper in the core.

M5 – CAD cell M5 was the smallest cell of the project. It had the longest disposal/consolidation period of the set of three cells capped in November 1998. Initial disposal was completed in 6 days. After 31 days of consolidation, a limited amount of additional disposal was performed. The cell contents were allowed to consolidate an additional 52 days prior to capping. A grab sample collected from the surface of the disposed material just prior to capping revealed a lower water content and much more strength to the surficial material (Photo 25). With the placement of an estimated 6+ feet of cap material over the cell, the elevation of the top of the cell was 3 feet higher than that prior to capping. Sub-bottom profiling performed after capping was completed was similar to that for cell M4 (silt overlying sand cap), but the sand layer was much more distinct. The post-cap cores that were collected from cell M5 supported the sub-bottom profiling. The fluid, silty material found in the upper 3-5 feet of the cell is shown in Photo 27, and the sharp transition from the bottom of the sand layer to the underlying silty maintenance material within the cell is shown in Photo 28. It appears that the capping sand placed over cell M5 remained as an intact layer, with minimal mixing into the silty material within the cell. However, it appears that the loading of the sand to the top of the cell displaced fluid, silty material from deeper within the cell, resulting in the silty cell material over sand sequence identified by the monitoring.

M12 – CAD cell M12 was the largest of the first three cells capped and the deepest cell of the entire project. The majority of disposal into the cell was completed in an intensive 21 day period. Following 19 days of consolidation, a limited amount of additional disposal was performed. Capping was initiated following an additional 30 days of consolidation . With placement of an estimated 4+ feet of cap material over the cell, the elevation of the top of the cell was 3 feet lower than that prior to capping. The post-cap sub-bottom profiling and coring performed at cell M12 did not reveal a consistent sand layer with overlying silty material as in the other two cells. Sand was apparent at the surface over some of the cell, but it did not appear as an intact layer. The cores were highly variable with intervals of intact sand (some at the bottom of the 10 foot cores), mixed sand/silt, and silt with little or no sand (Photo 29).

As the cap monitoring for all three cells did not reveal a distinct, 3-foot cap residing on the tops of the cells and because of concerns of continued instability within the cells (sand continuing to mix/sink within the cells), the MA Department of Environmental Protection required that additional monitoring be performed. Follow up sub-bottom profiling was performed in June 1999 with results revealing no significant changes in the cell structure (Ocean Surveys, 1999b). Samples of sediment residing on the surface of the cells were collected in June 1999 and analyzed for specific organic and inorganic contaminants of concern to assess if the capping had displaced more highly contaminated material to the tops of the cells. The results of the analyses revealed no apparent concentration of contaminants at the cell surface. Based on the results of these additional investigations and given that the majority of the disposed material was sequestered deeper within the cells, the MA Department of Environmental Protection accepted the caps for the three cells and amended the Water Quality Certification to allow longer consolidation time prior to capping (60 to 120 days) and to require minimal maneuvering of the hopper dredge over the CAD cell during cap placement.

4.3 CAD CELLS M2, SUPERCELL

The second capping operation was performed in November 1999 and included CAD cell M2 and the Supercell. Cell M2 had been filled over a 221-day period that included several extended periods of consolidation and was allowed an additional 155 days of consolidation prior to capping. The Supercell was filled over a 158-day period that included some periods of consolidation and distribution of disposal over its large surface area. The Supercell was allowed to consolidate 152 days prior to capping.

Follow up cap monitoring was performed in November and December 1999 by Ocean Surveys and was similar in scope to that performed for the first three CAD cells. With the additional consolidation time, the cap monitoring revealed a marked improvement over the first set of cells. A distinct sand cap was identified at the surface over the majority of both cells. Photos of three cores from cell M2 are presented in Figure 4-4. As presented in Table 4-2, the elevation of the top of the cell increased for both cells with placement of the capping sand.

Table 4-2 Second Capping Series - Results

CAD Cell	Consolidation Time (days)	Elevation of Top of Cell (Pre-Capping) (feet below MLLW)	Computed Cap Thickness (feet)	Elevation of Top of Cell (Post-Capping) (feet below MLLW)
M2	155	-51	5.4	-49
Super -cell	152	-48	4.7	-46

The monitoring did reveal isolated areas with silty material at the surface of the CAD cell and sand at depth. These areas, termed diapirs, were not evident in the first set of cells. Example sub-bottom profile lines from cell M2 illustrating the sand cap coverage and a diapir are presented in Figure 4-3. The Corps surmised that the diapirs were likely the result of localized instabilities where fluidized silty material within the cell was driven upward through the cap as pressure within the cell increased with the loading of the sand cap on top.

Based on the results of the monitoring, the capping for CAD cell M2 and the Supercell was approved by the MA Department of Environmental Protection. However, because of the presence of the diapirs, the Water Quality Certification was amended to allow increased consolidation time prior to capping (90-180 days).

4.4 CAD CELLS M8/11, M19

The last project capping operation was performed in September 2000 and included CAD cells M8/11 and M19 (modified). Cell M8/11 was primarily filled over a 146-day period with most of the disposal occurring in the first 26 days. A limited amount of additional disposal was performed after 126 days of consolidation. Capping was initiated following an additional 130 days of consolidation after the last disposal event. Cell M19 (modified) was filled over an 80-day period and was allowed to consolidate 232 days prior to the initiation of capping (Table 4-3).

Follow-up cap monitoring was performed by Ocean Surveys in October 2000 and was similar in scope to the previous efforts. The increased consolidation time resulted in caps approximating that envisioned in the project Environmental Impact Report/Statement and Water Quality Certification. An example sub-bottom profile line with imbedded core photos is presented in Figure 4-5 for cell M8/11, and additional core photos and logs are presented in Figure 4-6. No significant accumulation of silty material was found above the sand cap, limited mixing of the sand cap and silty cell contents occurred, and no diapirs were identified.

Table 4-3 Final Capping Series - Results

CAD Cell	Consolidation Time (days)	Elevation of Top of Cell (Pre-Capping) (feet below MLLW)	Computed Cap Thickness (feet)	Elevation of Top of Cell (Post-Capping) (feet below MLLW)
M8/11	130 (+126)[1]	-50 to –57	2.8 to 4.1	-48 to -53
M19 (modified)	232	-52 to -60	2.2 to 4.0	-49 to -57

[1]There were two extended consolidation periods for cell M8/11 with limited disposal between.

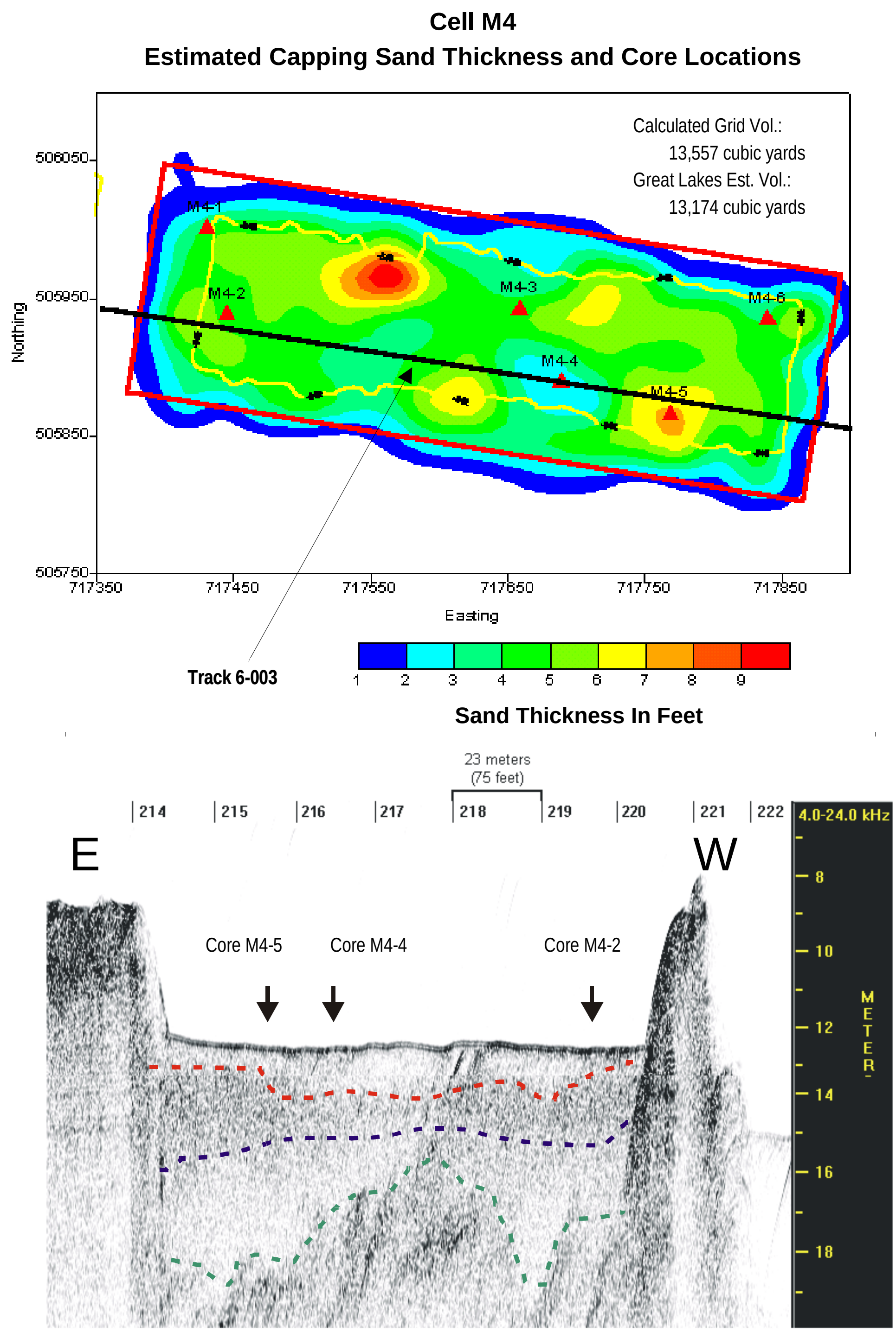
4.5 FOLLOW-UP MONITORING

The Water Quality Certification required follow-up monitoring of the CAD cell caps at one year after all cells were capped. That monitoring was performed by SAIC in July-August 2001 and included the following components:

- Collection of 10-foot cores from each of the eight capped CAD cells. Each core was split, visually classified, photographed, and sub-sampled for analysis of bulk density, grain size, and Atterberg limits.
- Collection of surface grabs from CAD cells M2, M5, M8/11, IC2 (the Phase 1 cell), and C12 as well as reference areas. Each sample was visually assessed, sub-sampled for grain size analysis, and sieved through a 0.5-mm mesh screen to remove organisms for benthic community assessment.
- Performance of sediment profile imaging over each of the eight capped CAD cells, the uncapped cell (C12), and reference areas. Image analysis included sediment type determination, surface roughness, determination of infaunal successional stage, determination of apparent redox potential discontinuity depth, and determination of organism-sediment index.

A detailed account of this study is presented in SAIC (2001). In summary, the coring investigation revealed no significant changes in the cell structure from cores collected immediately after capping was completed, i.e., the sand layer remains at the same strata and with the same level of mixing. No significant deposition was noted over the cells that had sand residing at the top of the cap. The biological assessment revealed that the capped cells are being recolonized mainly by Stage I organisms, and the community structure is not all that different from the surrounding harbor bottom.

The Water Quality Certification for the project also required coring and multi-beam bathymetry to be performed at five years following completion of the project. This work is currently scheduled to be performed in summer 2005.



Subbottom line 6-003 from cell M4 (OSI 1999), annotated at bottom showing location of cores, fluidized mud layer (above red dashed line), sand zone (between red and blue dashed lines), and approximate bottom of cell (green dashed line). Note reversal of East and West.

Figure 4-1 Estimated Cap Thickness and Post-Cap Subbottom Profile Over Cell M4

(Source: Science Applications International Corp.)

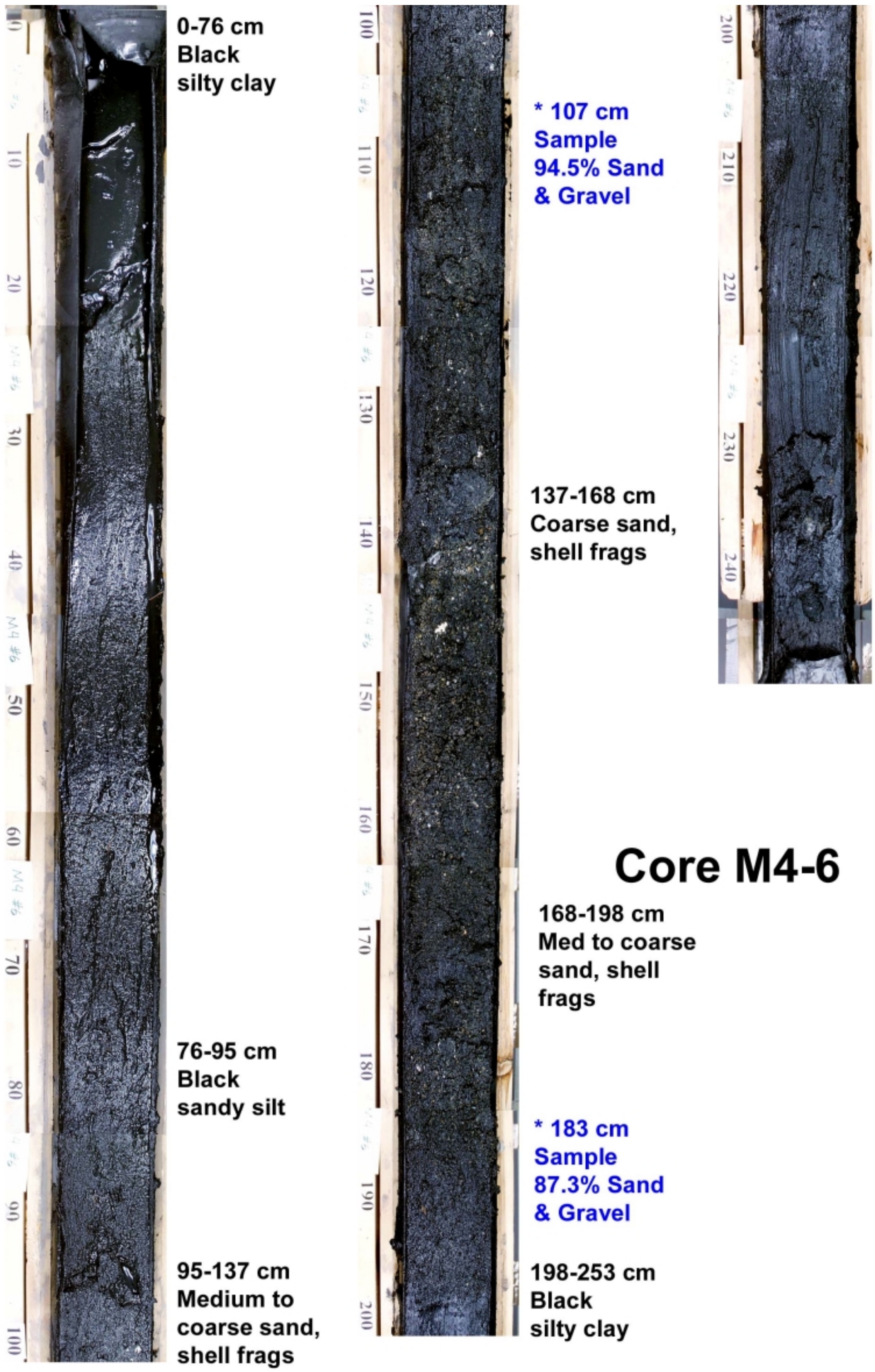
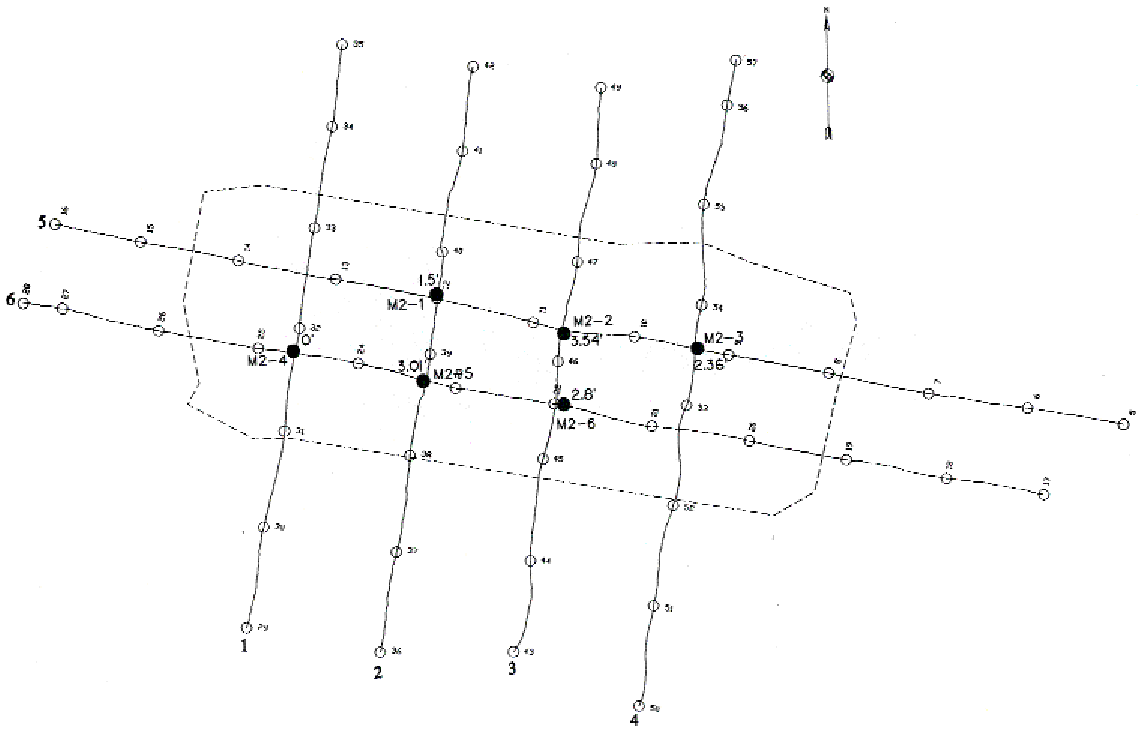


Figure 4-2 Post-Cap Core from Cell M4

(Source: Science Applications International Corporation)

CELL M2 – Subbottom Tracklines and Core Locations



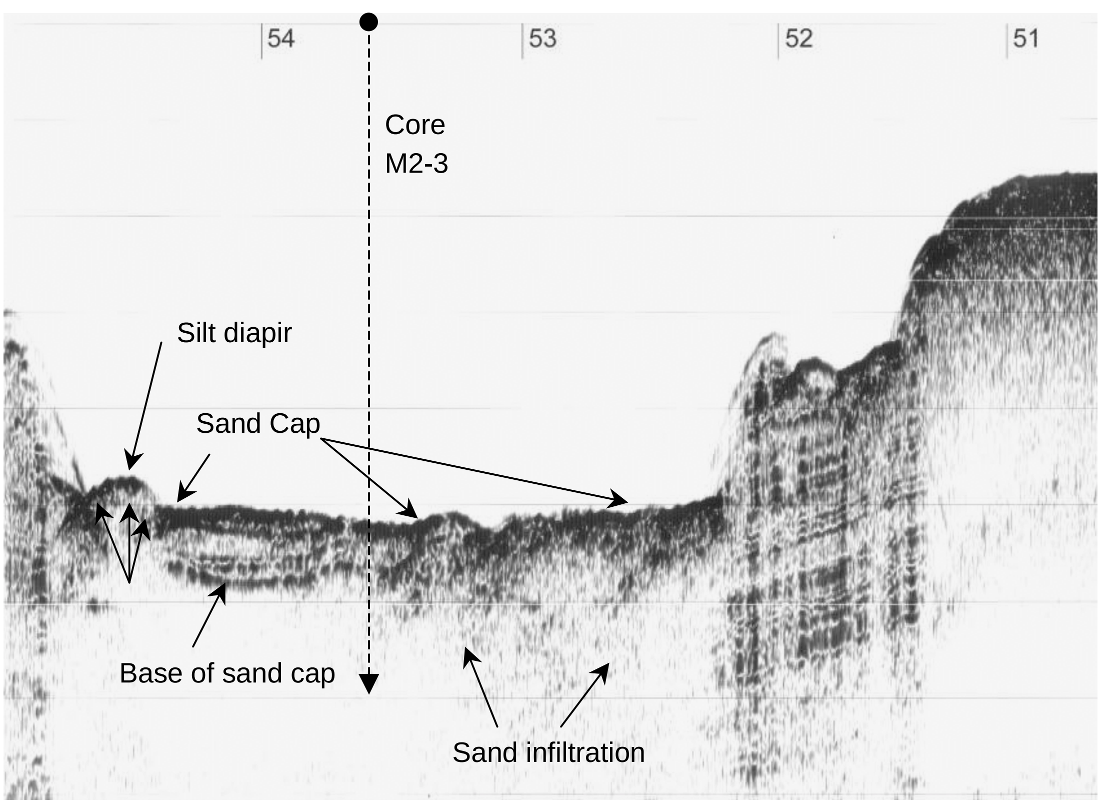


Figure 4-3 Post-Cap Subbottom Profile Over Cell M2

(Source: Ocean Surveys, Inc.)

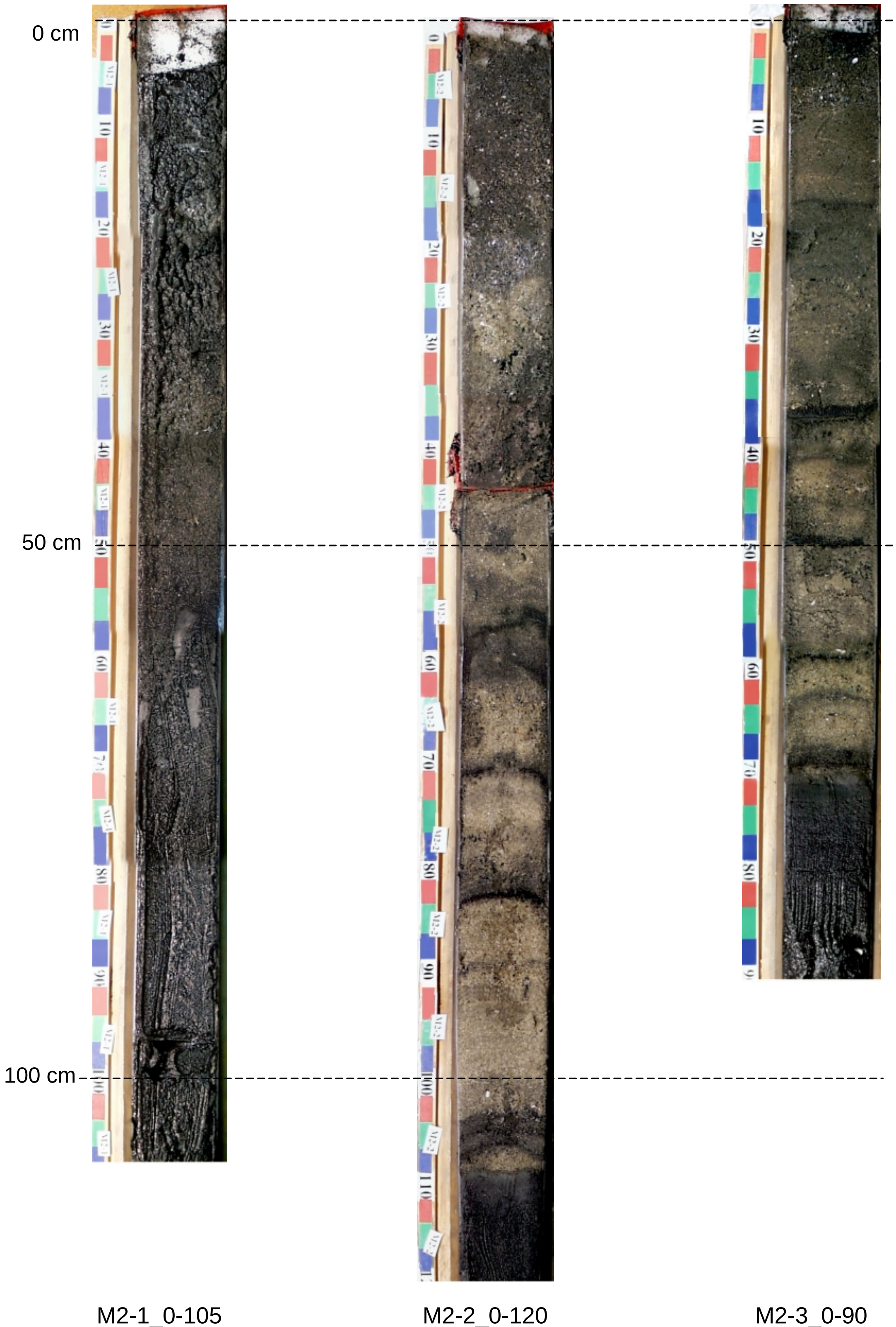


Figure 4-4 (a) Post-Cap Cores from Cell M2
(Source: Cores collected by Ocean Surveys, Inc; photographed by SAIC)

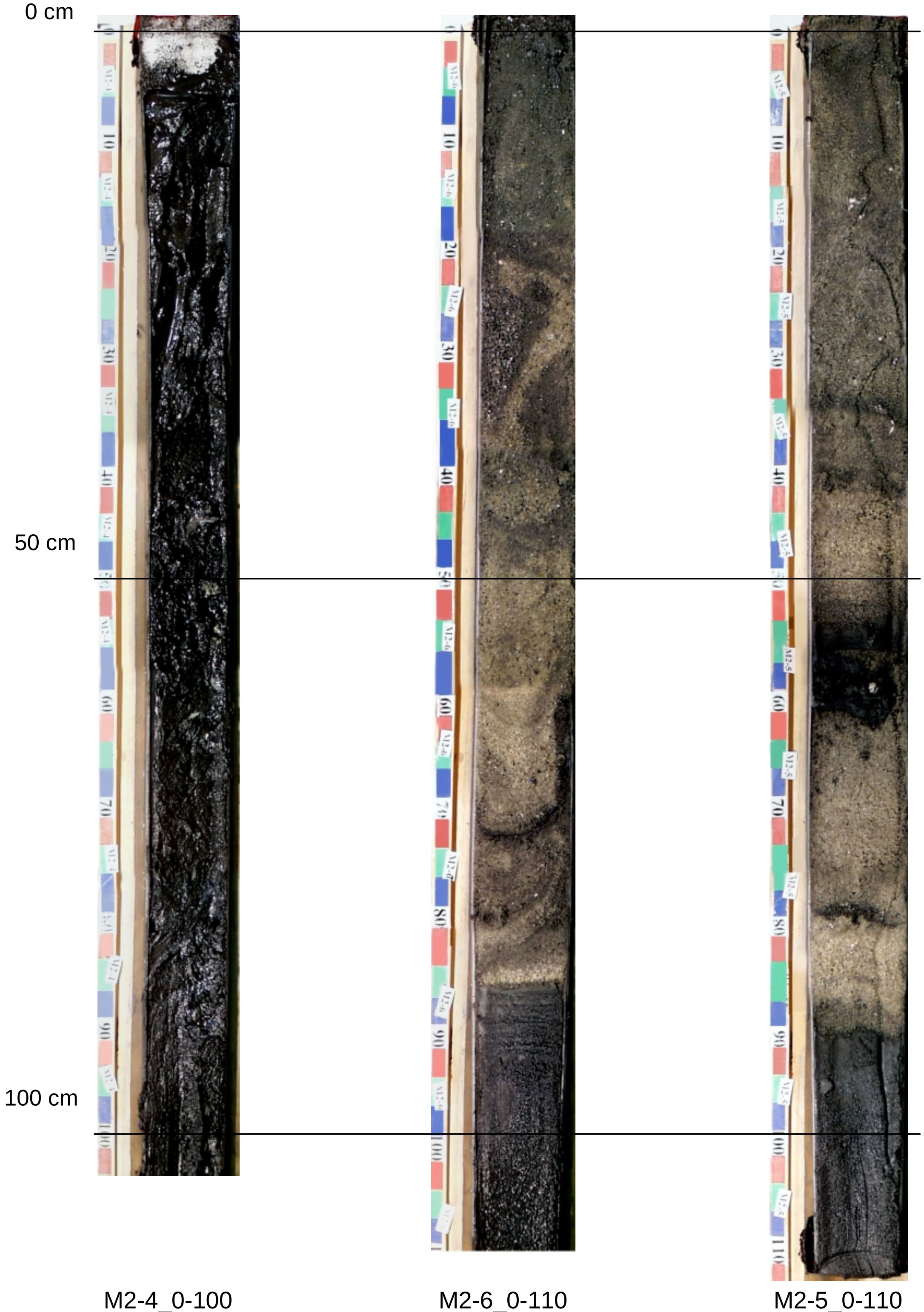
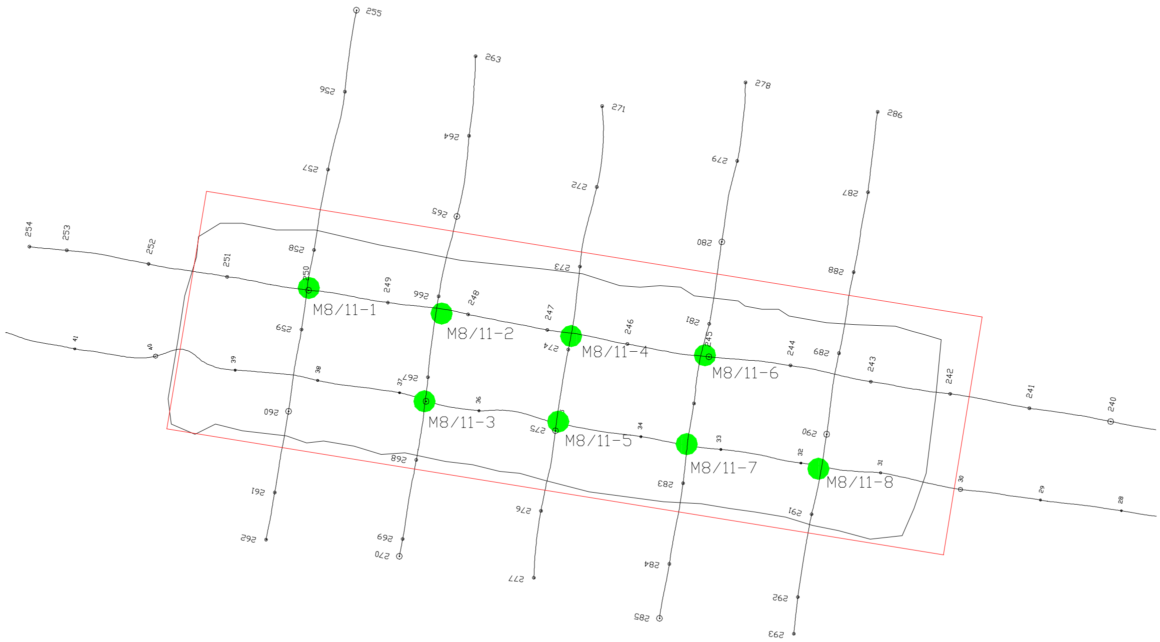
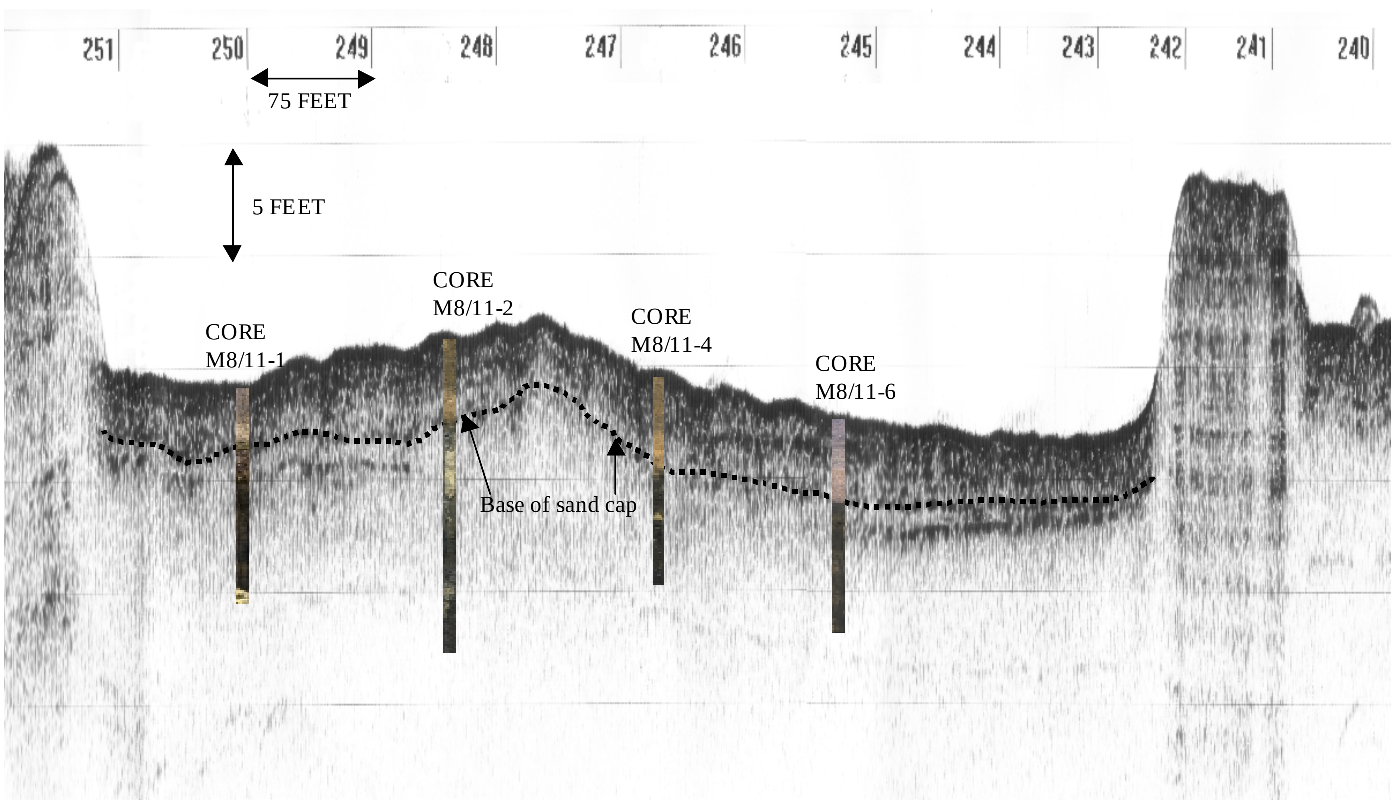


Figure 4-4 (b) Post-Cap Cores from Cell M2

(Source: Cores collected by Ocean Surveys, Inc; photographed by SAIC)



Cell M8-11 - Subbottom Profile Lines and Core Locations



Cell M8-11 – Subbottom Profile – Line 6

Figure 4-5 – Post-Cap Subbottom Profile Over Cell M8-11

(Source: Ocean Surveys, Inc.)

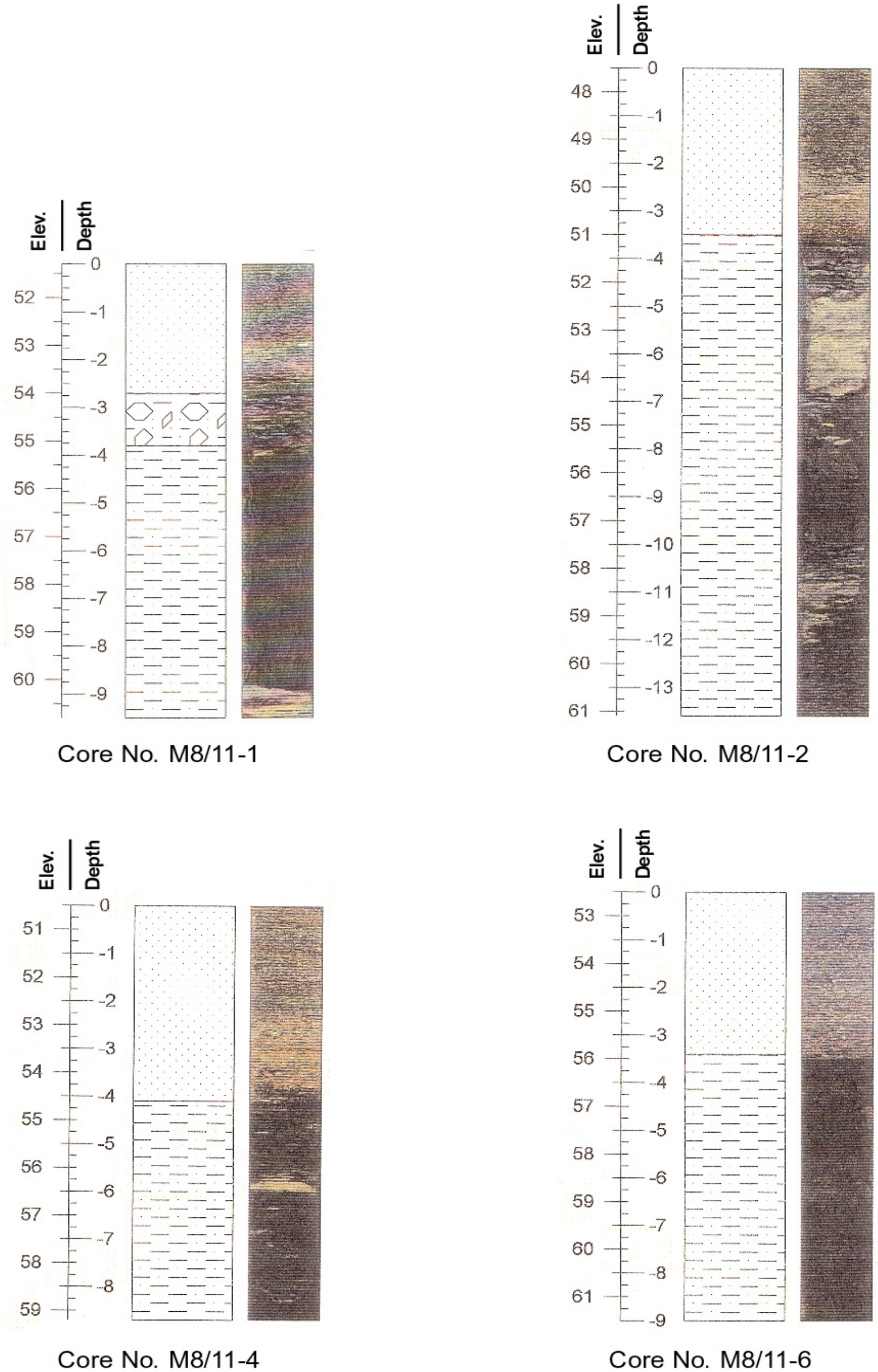


Figure 4-6 Post-Cap Cores from Cell M8-11

(Source: Ocean Surveys, Inc.)

5

Evaluation of the Environmental Monitoring Program

The Final Environmental Impact Report/Statement for the BHNIP (USACE, 1995) identified potential environmental impacts to the water column associated with project dredging and disposal operations. The Water Quality Certification for the project required a relatively extensive monitoring program focused primarily on disposal of contaminated sediments into CAD cells. The results of the environmental monitoring have been presented in Section 3. In this section, the environmental monitoring is discussed in the context of the pre-project concerns and observations of the actual project.

5.1 DREDGING

The Final Environmental Impact Report/Statement for the BHNIP (USACE and Massport, 1995) noted that impacts to the water column due to dredging would be minimized by the use of a closed or "environmental" clamshell bucket. Because of this, the Water Quality Certification for the project required only very limited water quality monitoring during dredging (only one monitoring event for the entire Phase 2 operation). The monitoring revealed that project performance standards for suspended solids were being met, and there were no observed issues (such as a large visual plume or fish kill) associated with dredging throughout the project. However, observations did reveal that the operational aspects of the dredging likely outweighed the equipment aspects (requirement for a specific bucket) in terms of potential effects on the water column. These operational aspects of dredging included the following:

- Cycle Time – Cycle time is the amount of time required for the dredge to complete one full cycle of sediment retrieval from the bottom and disposal into the scow. For navigational dredging, a goal of increased production means a focus on reducing the cycle time for dredging. This translates to an increased speed of the bucket impacting the bottom, of retrieval through the water column, and of the bucket exiting the water, all of which result in an increase of material loss to the water column. Photo 31 and Photo 32 illustrate the open and closed buckets, respectively, exiting the water in a high production mode.
- Scow Washing – As the bucket swings over the scow during retrieval and deployment, sediment occasionally falls from the bucket, landing on the side of the scow. Periodically, the operator will retrieve a bucket of water only and release it on the side of the scow to "wash" off the deposited material (see Photo 33 and Photo 34). This practice can release a slug of suspended material to the water column.
- Operator Experience – Perhaps the operational aspect of dredging with the greatest potential impact on water quality is the experience level of the dredge operator. This experience pertains to the dredge, the particular bucket, and the type of material being removed. There appears to be as much art as science to retrieving a full (but not overfull) bucket and maintaining a short cycle time. With an experienced operator, the bucket moves through the water at an even speed, and lateral movement is gradual and integrated into the retrieval resulting in more limited impacts to the water column (Photo 35).

Variations in the operational aspects of dredging for the BHNIP may have resulted in pulses of suspended load to the water column even though a closed "environmental" bucket was being used. However, given the high level of experience demonstrated by most of the operators that were observed and the low to moderate contaminant load of the sediments being dredged, any impacts to water quality were likely minimal in duration and intensity.

5.2 DISPOSAL

Predictive modeling was performed as part of the Final Environmental Impact Report/Statement (Appendix F, U.S. Army Corps of Engineers and Massport, 1995) to evaluate the transport of contaminants released to the water column during disposal of sediments into CAD cells located within the harbor. As summarized in the Water Quality Certification (Appendix A to this document), the modeling identified that suspended solids would be elevated for several hours following a disposal event and that the chronic water quality criterion for PCBs (0.030 ug/L) could be exceeded within several hundred feet of the disposal under average disposal conditions. Because of the modeling results, the Water Quality Certification for the project required that disposal take place in a window around the high tide to provide the maximum water column for dilution of suspended material and contaminants and to minimize transport away from the disposal cell (with the reduced current around high water slack).

In addition to the modeling results, there was also the general perception of a harbor disposal event; a dump scow containing several thousand cubic yards of soupy contaminated sediment is opened in the harbor over a disposal cell, and within a matter of seconds, the entire contents of the scow disappears into the water below. The general conceptualization of the disposal event involves the disposed material falling through a deep water column with segregation of particle sizes and stripping away of finer material by ambient currents.

As a result of the modeling predictions and the general perception of disposal, the Water Quality Certification for the project required monitoring with extensive sampling and analysis of disposal operations. However, as presented in Section 3, the turbidity plume generated by disposal events was minimal, and there were no exceedences of the performance standards/criteria set for the project. Hence, it appears that the loss rate assumed in the predictive modeling (5% of scow material lost to water column during disposal) was overly conservative, i.e., a lower estimate could have been used.

Recent research at the Massachusetts Institute of Technology focused on the dynamics of the descent of the disposed material (Ruggaber, 2000). For the scale of the disposal into the Boston Harbor cells (with less than 50 feet separating the bottom of the scow from the top of the opening into the disposal cell), the transit of the disposed material through the water column occurs as convective descent with entrainment of surrounding water into the disposed material rather than with loss of material to the water column. This appears to be an accurate representation of the disposal process as actual loss of material during disposal is estimated at < 1%.

5.3 FISHERIES

Cell excavation and disposal activities that were performed in the Mystic River and Inner Confluence between 15 February and 15 June required a fisheries observer, sonar detection system, and startle system. This requirement was triggered numerous times in 1999, but no large schools of fish were encountered, and the fish startle system did not have to be engaged. With the colder water temperatures in February and March, few fish at all were detected with the sonar system, and the Division of Marine Fisheries allowed monitoring on a two-hour cycle during periods of continuous cell excavation. As water temperature increased, more individual fish were detected with the sonar, but schools of fish were not apparent in the vicinity of the cell excavation or disposal, even though schools of fish had been noted at specific passage areas nearby. This suggests that the disturbance associated with cell excavation and with maneuvering a scow over a cell for disposal was enough of a deterrent to keep the schools of fish away from the immediate construction area on their way upstream, but there was no evidence that the construction presented an overall impediment to fish passage.

6

Evaluation of Capping

During preparation of the Environmental Impact Report/Statement and permitting phases of the project, significant concerns were raised about the overall capping process, particularly with the CAD cells located within the navigable channel. Going into the project, the New England District Corps had experience in capping of offshore disposal sites in Long Island Sound and off of Portland, Maine. While these sites were level bottom sites, some of the aspects of capping and monitoring were applicable to the confined cells as well. However, at the time the project was designed, very little was known about the consolidation of dredged material in a confined, subaqueous environment. At the start of the project there were still specific concerns about consolidation time, material properties of both the dredged material and the cap, the method of placing the cap, techniques for monitoring the cap thickness and coverage for permit condition verification, and long-term performance of underwater caps located within shipping channels.

Although only one cell was utilized in Phase 1 of the BHNIP, the experience gained was instrumental in amending the Water Quality Certification for the capping of Phase 2 cells. Specific changes related to capping that emanated from Phase 1 experience included the following:

- Capping material released from a moving rather than stationary platform.
- Capping material released wet.
- No spudding down allowed over the cap.
- No mechanical disturbance of the cap after placement (movement of cap material with the dredge or by drag bar).
- Performance of multi-beam bathymetric surveys to assess consolidation prior to and during capping.
- Extension of the consolidation time prior to capping to a minimum 2-week period (this was extended to a minimum of 60 days and then to a minimum of 90 days later in the project).

As presented in Section 2.9, there were three rounds of capping performed during Phase 2 of the project. Although a minimum of 30 days consolidation was allowed prior to capping the first set of three cells and the cap material appeared to be deposited relatively uniformly, the post-cap monitoring indicated that the material within the cells had not been ready for capping (see Section 4.2). Researchers at the Massachusetts Institute of Technology and the Corps' Engineer Research and Development Center were conducting laboratory analyses of dredged material behavior for future project use, but there was a need to develop an easy field method that could be used to determine when the dredged material in the remaining Phase 2 cells was sufficiently stable for successful capping.

The BHNIP project designers developed a method that could be applied easily in the field to roughly track the strength characteristics of the surficial material within the cells. A 4-foot by 4-foot sheet of plywood was painted with concentric circles resembling a target. Grab samples of dredged material from the surface of the disposal cell were deposited at the center of the target board. The material was allowed to spread out on the board to equilibrium, and its spread was measured and photographed (Photo 42). Comparing the relative measurements of material spread over time was a good tool for tracking consolidation of the surface material. This method was used during consolidation of the second set of cells prior to capping. The measurements revealed a rapid initial decrease in water content followed by a slower increase in material strength until stability was reached. While further consolidation was no doubt continuing deeper within the cell, it could not be detected by the visual observations of the surficial material from the cell.

Capping of the second set of cells was performed following over 150 days of consolidation. As presented in Section 4.3, the monitoring for the second set of cells revealed that the capping was much more successful. However, the apparent displacement of disposed material to the surface of the cells in limited areas indicated that the material deeper within the cells was still not sufficiently consolidated at the time of capping. For the third set of cells, consolidation was allowed for over 200 days prior to capping, and the resulting caps appeared to meet or exceed all design specifications.

In another setting, the anomalies identified in the first and second sets of cells may have resulted in a requirement for additional cap placement. Had the disposal cells been located in a more pristine area (away from the contaminated sediment being dredged), the results of capping (with cell material exposed at the surface) may have not been acceptable. However, given that most of the dredged material was sequestered deep within the cells and that only a small portion of the harbor was actually dredged for this project (much of the harbor remained intact with contaminated sediment exposed at the surface), there was not a significant environmental concern associated with exposed sediment covering a portion of the tops of some of the cells. Follow-up monitoring of the cells has revealed that initial recolonization is taking place over all of the cells and appears to be independent of the type of material exposed at the cell surface (Section 4.5).

The construction of the cells much deeper than originally planned likely contributed to the cap anomalies noted for the first and second sets of cells and the requirement for a longer consolidation time. However, the deeper and larger cells provided an overall net benefit to the project in terms of the reduction in the number of filled cells to manage, the preservation of additional harbor bottom for potential use in future cells, and the reduction of overall project costs. In addition, the deeper cells (with the added requirement that the more contaminated material be placed in the bottom half of the cells) provided the benefit of sequestering more material far from any potential contact with the overlying waters.

7

Additional Issues of Note

As with any large project, a number of additional issues arose as the BHNIP progressed. These issues were presented to the Technical Advisory Committee for the project mainly through electronic mail summaries and discussion at the periodic meetings. For issues that required specific action, the Technical Advisory Committee members provided input to the Department of Environmental Protection directly at meetings, through direct letters or electronic mail, or through summary by the independent observer. This section summarizes the larger issues that arose during the project.

7.1 LARGER AND DEEPER CAD CELLS

Initially, a series of CAD cells was planned for the Mystic and Chelsea Rivers and the Inner Confluence (Figure 2-2). The depth and size of the cells were based on existing information on parent material and depth to bedrock. As part of preparation of their proposal for the work, Great Lakes Dredge and Dock Company (GLDD) performed investigations to better estimate depth to bedrock in some of the proposed CAD cell locations. Based on those investigations, GLDD proposed deepening the cells and combining some cells into larger footprints to gain efficiency. Geotechnical backup for the changes was presented to the Corps, and potential environmental merits and drawbacks were discussed by the Technical Advisory Committee. The MA Department of Environmental Protection allowed the larger CAD cells with the requirement for additional monitoring if larger volumes of material were disposed into the cells over a single tidal window.

7.2 ENVIRONMENTAL BUCKET

The Water Quality Certification for the project required the use of a closed environmental bucket for maintenance dredging. The bucket manufactured by Cable Arm was specified as acceptable, and other closed buckets could be used if they could meet specified performance standards (suspended solids not to exceed 25 mg/L over background and turbidity not to exceed background by more than 30% at 75 feet from the dredge).

GLDD wanted the option of using their own closed bucket in addition to the Cable Arm bucket, and Normandeau Associates monitored the performance of the GLDD bucket near the beginning of the project in September 1998. The bucket met the performance standard for total suspended solids, but not for turbidity. It was noted that the turbidity standard (not to exceed 30% above background at 75 feet) was a much more stringent standard for the conditions of this test. With the background turbidity of 3 NTU, the resulting performance standard at 75 feet was only 4 NTU. The MA Department of Environmental Protection allowed the use of the bucket based on the performance of the bucket related to suspended solids. A more detailed bucket comparison was performed by the Corps' Engineer Research Development Center and is described in Section 9.

7.3 RESIDUAL SILT

The first cut of improvement material following maintenance dredging sometimes still had remaining pockets of maintenance material (Photo 37). Similar to Phase 1 of the project, the residual maintenance material was attributed to the following sources:

- Bottom depressions that trap silt – Deposition of the silty maintenance material on the harbor bottom tends to fill in irregularities over time. As the previous dredging of the harbor was performed with a clamshell bucket, it can be assumed that the dredging left an irregular, scalloped bottom and that the depressions filled with silt over time. The Cable Arm environmental bucket is designed to scrape across the bottom and not cut into the harder parent material. Hence, it likely scraped across the top of depressions and left pockets of silty material that were removed with the first cut of improvement material with a conventional clamshell bucket.

- Transport of fine-grained material – After the maintenance dredging was completed in an area, weeks or months may have passed before the dredge returned for the improvement dredging. During that time the normal harbor processes that resuspend sediment could result in a thin veneer of fine-grained material being redeposited over the area.

It was understood that a limited amount of maintenance material would be left behind after the maintenance dredging was completed and would be removed during the improvement work. Because of the color difference between the maintenance and improvement material, the presence of large quantities or a consistent layer of maintenance material being removed with the improvement work would have been apparent to the dredge operator and Corps inspector. This would have triggered a return use of the environmental bucket over the area (as occurred during construction of the CAD cell in Phase 1 of the project).

7.4 MATERIAL OUTSIDE CAD CELL M5

CAD cell M5, the first cell constructed during Phase 2 of the project had a small footprint to minimize the amount of maintenance material that had to be removed and stored prior to disposal in the constructed cell. The completed cell had dimensions of approximately 95 feet by 250 feet, only slightly larger than the scows used to dispose material into the cell. There were 14 disposal events into the cell over an 8-day period, totaling approximately 27,000 cy. For each event, the scow was aligned along the center of the cell using very accurate global positioning system coupled with GLDD software allowing the support tug operator to view the position of the scow relative to the cell in real-time.

Bathymetry measurements performed after the last disposal into the cell revealed that an estimated 1100 cy of material had been deposited adjacent to the cell, mostly along the two longer sides. At the time of the last disposal, the existing level of material in the cell was approximately 48 feet below MLW or approximately 8 to 10 feet below the rim of the cell. GLDD postulated that the last disposal event created a wave in the denser, but still fluid material within the cell that caused material to be deposited outside of the cell. Within two weeks following the last disposal, the material within the cell consolidated rapidly with the surface of the material within the cell dropping by more than 5 feet.

The material that had been deposited outside of the cell was removed, and two additional disposal events were performed into cell M5 following further consolidation time. No additional material was noted outside of the cell boundaries. The specifications for the project called for a maximum elevation of material within the cell of –45 feet MLW prior to capping (leaving about 5 feet of "freeboard" within the cell relative to the surrounding harbor bottom). However, because of this event, GLDD set a maximum of –48 feet MLW (prior to capping) for future cells.

7.5 MATERIAL OUTSIDE CAD CELL M12

CAD cell M12 had dimensions of approximately 160 by 500 feet with an estimated capacity of 86,000 cy. There were 58 disposal events into the cell, totaling an estimated 78,000 cy. Most of the disposal occurred over an intensive 2-week period. Following this intensive disposal period, an accumulation of maintenance material was discovered extending several hundred feet down-river of cell M12 over an area recently dredged for construction of the Supercell. GLDD measured the thickness of the redeposited material at up to 2 feet in some areas and estimated the volume of material at 5000 cy.

The distribution of the redeposited material was very patchy, and the material appeared to have filled in existing depressions in the bottom. Because of this patchiness, a source for the material was not clear. A review of port records revealed a lot of activity during the final days of the intensive disposal period into cell M12, with eleven departures or arrivals in the immediate area of the cell over a 6-day period. It was postulated that at least a portion of the redeposited material came from maintenance material resuspended from the cell. Another possible source was the berth areas. Maintenance dredging had recently been completed in the main channel areas of the Mystic, and vessel activity at the berths could have mobilized material along the boundary of the newly dredged area. The material down-river of cell M12 was later removed and found to be very fluid. No additional material was detected in this area as the project progressed.

7.6 TIME OF DISPOSAL

The Water Quality Certification for the project specified that disposal into CAD cells occur during a 3-hour window around the high tide (1 hour prior to 2 hours following the predicted high tide). The aim of this requirement was to have the disposal occur during a lower current portion of the tidal cycle and to maximize the available water column for dilution of any contaminants released during disposal.

A drawback with this requirement was that vessels transiting the port often schedule their arrival or departure with the high tide to provide extra water depth for maneuvering. As a result, the dredging contractor would sometimes accelerate their schedule to ensure that a disposal would take place prior to the scheduled arrival or departure of a vessel. If disposal was postponed until after the vessel finished maneuvering in the area (which sometimes was a lengthy process for turning and docking), the disposal time window may have closed.

The Water Quality Certification required that the disposal not be performed when vessels were within 1000 feet of the disposal cell. However, there were no requirements for timing the disposal in relation to vessel passage. As a result, accelerating the schedule to complete a disposal event prior to the arrival/departure of a vessel meant that vessels were occasionally maneuvered over the cell within a very short time (minutes) following a disposal event before much of any settling had occurred within the cell. This could potentially result in an increased loss of suspended material from the cell, and was presented as a potential cause of the cell material discovered down river of cell M12 (as described above).

As the monitoring performed during disposal did not reveal any water quality issues as the project progressed, GLDD requested that disposal be allowed during a low-tide window to allow for greater flexibility in disposal and to aid in avoiding disposal/vessel passage conflicts. A conditional 2-hour window was granted (from predicted low tide until 2 hours after) with provisional monitoring. The results of the monitoring were similar to that performed during high tide (limited turbidity plume development with no criteria exceedences), and low-tide disposal was allowed for the remainder of the project.

7.7 OFFSHORE DISPOSAL

As discussed in Section 2, material removed during improvement dredging was disposed offshore at the Massachusetts Bay Disposal Site. The Corps set target disposal coordinates and a surface buoy to focus the disposal within the overall 2-mile diameter designated disposal site. Scows were towed offshore by tugboat. Upon reaching the targeted disposal location (based on the tug's navigation system and a visual check by the Corps certified inspector on board the tug), the operator of the scow was contacted by radio and instructed to open the scow for disposal.

On two occasions later in the project, material was not disposed at the intended target location (referred to as a "short dump"). In January 2000, because of radio problems and confusion over a backup light signal from the tug, the scow operator released the material approximately 1 mile from the target buoy just outside of the boundary of the overall disposal area. In February 2000, scow operator error resulted in disposal approximately 1 mile from the target buoy, this time just inside of the boundary of the overall disposal area. Because of these incidents, a new protocol (requiring definitive radio contact) was initiated. There were no further incidents for the remainder of the project. It should be noted that there were a total of 730 to the Massachusetts Bay Disposal Site over the course of the project.

7.8 LOBSTER

Lobster were identified in the Water Quality Certification for the project as a resource within the harbor. However, based on the limited area of the overall harbor that was impacted by the dredging operation and the fact that the impact was transient, no conditions were placed on project operations relative to lobster. It should be noted that although there is no permit mechanism to allow fishing within the federal channel limits, it has been tolerated only when it does not interfere with navigation or navigation support operations (such as dredging and construction). Notification was given to the local lobstermen association at the outset of the project (both Phase 1 and Phase 2), and the association and MA Division of Marine Fisheries were both represented at the early Technical Advisory Committee meetings. General concerns about resource and potential gear loss were noted at the meetings, but no specific issues arose at the start of Phase 2.

Phase 2 work was initiated in August 1998 and was initially restricted to CAD cell construction and maintenance dredging in the Mystic River, an area not identified as a high resource area for lobster (and as a result not heavily fished). Dredging did not progress to the more heavily fished Reserved Channel area until January 1999 when the lobster fishing gear had been pulled for the season. Dredging proceeded in this area throughout much of the winter and spring. As lobster fishing began to increase in the harbor once again in later spring, the following issues arose :

- Resource/Livelihood – 1999 turned out to be an exceptional year in terms of a large lobster population and associated catch. There were concerns amongst the lobstermen that the dredging would impact less mobile lobsters during the molt, juvenile lobsters, and egg-bearing females. There were also concerns that the dredging precluded the lobstermen from setting traps in some of their most productive areas.
- Gear Loss Due to Dredge Relocation – As shown in Figure 1-1, there were a number of specific dredging areas for the BHNIP. Dredging activities were often curtailed at one particular area of focus because of unexpected material being encountered, vessel activity, weather delays, or mechanical problems; and the dredge was redirected to another area. Because there was very little advance warning for the dredging operations being moved, lobstermen did not have time to relocate gear from the area, and some damage and loss occurred.
- Gear Loss Due to Barge Movement – With the increase in improvement dredging, there was an increase in the number of scow trips offshore to dispose of material at the Massachusetts Bay Disposal Site. Transiting the inner harbor, dump scows were maneuvered with a tug alongside or on a short tow. The transition to a longer tow for the trip offshore was made in the outer harbor, away from the project, but in an area heavily fished for lobster. In lengthening or shortening the towline, slack would sometime develop, causing the heavy wire towline to drag the bottom. Although this generally occurred for a short distance, lines of traps on the bottom were occasionally dragged or damaged.

The relocation of the dredge back to the Reserved Channel area in June 1999 triggered the initial outcry from lobstermen, particularly related to the resource/livelihood issue. The Corps directed GLDD to relocate the dredge back to the Mystic River. A series of meetings took place as the summer progressed focusing on the lobster issue. The meetings included participation by the lobstermen impacted by the work; the Boston Harbor Lobstermen Cooperative; the Massachusetts Lobstermen Association (and legal counsel); expanded participation by the MA Division of Marine Fisheries, Department of Environmental Protection, and Coastal Zone Management Office; as well as the project partners. A compromise was reached amongst the various parties allowing the project to move forward without litigation. The compromise included the following elements:

- Increased Fisheries Observer Presence – The MA Division of Marine Fisheries increased the number of lobster fishing trips that its observers were present on, and the independent observer also began a separate program. The goal was to document the catch in the Reserved Channel area. If lobster numbers began to increase again later in the summer beyond pre-set thresholds, the Division of Marine Fisheries would have requested that the area be temporarily closed to dredging.

- Investigations Related to the Presence of Juvenile Lobster – The Division of Marine Fisheries authorized several of the fishermen to set traps without the required vents that normally allow smaller lobster to escape. Although juvenile lobster were found to be present, they were not found in extremely large numbers. The independent observer also initiated investigations including increased observations of improvement dredging (Photo 38), screening of dredged maintenance material (Photo 39), and an underwater video survey of areas to be dredged (Photo 40). No lobster were observed during any of the dredging oversight or in any of the screened dredged material.
- Increased Communication – A protocol for communicating upcoming relocation of the dredge was developed with communication to a number of different parties via phone, radio, and fax. Dredging updates (including a copy of a chart noting specific areas) were also hand delivered to a mailbox installed at the main lobster boat dock.
- Towline Practices – GLDD instructed tugboat operators to keep scows on a short tow until further out of the harbor in deeper water and to minimize the amount of slack wire during transitions.

Implementation of these actions allowed the project to move forward without any significant delays. Dredging and lobster fishing were performed almost side-by-side with only a limited amount of gear damage and loss, and no additional major issues arose during the remainder of the project.

8

Review of the Water Quality Certification

Although a number of dredging projects occur each year in Massachusetts' waters, the BHNIP was the first major project in Boston Harbor in over 30 years. In addition, it was the first major project in Massachusetts to utilize disposal of contaminated sediments into CAD cells located in active navigation channels. Because of the uniqueness of the project, the Water Quality Certification contained a large number of conditions and extensive monitoring as described in Section 3. This section presents a hind-sight view of the Water Quality Certification in terms of required amendments as well as recommendations for future projects.

8.1 AMENDMENTS

As with all large projects that incorporate new technologies, much was learned over the course of the project. Because of the active role of the Technical Advisory Committee, the MA Department of Environmental Protection was able to solicit input on issues that arose during the course of the project and proceed with amendments when needed on a fast track. The following larger scale amendments were issued during the course of the BHNIP.

CAD Cell Size – A total of 52 potential CAD cells were identified in the Environmental Impact Report/Statement, permit applications, and specifications for the project. GLDD proposed creating deeper and larger cells to gain efficiency. This raised concerns regarding the length of time cells would be open, both for filling and for consolidation. There was also concern about the potential use of much larger scows (7200 cy capacity) for disposal than the 3000 cy disposal volume that had been considered in the predictive modeling. The MA Department of Environmental Protection decided that the benefits of larger and deeper cells (fewer cells with material sequestered deep within the cells) outweighed the concerns on having the cells open for longer periods of time. The Water Quality Certification was amended to allow the larger cells with a provision for additional monitoring with the use of the larger capacity scows for disposal. Although the 7200 cy scows were used for some portion of the project, the actual volume of solids disposed was typically far less because of the large amount of water captured during dredging with the environmental bucket.

Additional Dredging – As the project progressed, Exxon requested that dredging at its Mystic River terminal be included in the BHNIP, with surficial sediments disposed into the CAD cells. This work was reviewed by the MA Department of Environmental Protection and the Technical Advisory Committee, and the Water Quality Certification was amended to include the additional work.

Disposal – The Water Quality Certification for the project required disposal into the CAD cells be performed within a 3-hour window around high tide (1 hour prior to 2 hours after the predicted high tide). As presented in Section 3, monitoring of the disposal events revealed no significant impacts to water quality. GLDD requested to perform disposal around the low water slack tide later in the project to increase flexibility in the dredging operation (having to wait until high tide once the available scows were full) and to avoid potential interactions with vessels that typically schedule their arrival and departure times around the high tide. In light of the high tide disposal monitoring results, the MA Department of Environmental Protection allowed a trial disposal event at low tide with monitoring. The results of the monitoring were favorable, and the Water Quality Certification was amended to allow disposal during a 2-hour window at low tide (from the predicted low tide until 2 hours after). Low tide disposals were performed occasionally during the latter portions of the project.

There were no conditions in the Water Quality Certification regarding the order of placement of material into the cells. However, following the discovery of disposed material outside of cells M5 and M12 (as discussed in Section 7), the Water Quality Certification was amended to require that the more contaminated berth material be disposed in the lower half of the cell.

Dredging Equipment – Both the maintenance and improvement work were proposed to be performed mechanically with clamshell buckets. Late in the project, improvement dredging over a small segment of the Chelsea River overlying an active water tunnel was thought to be better performed by a hopper dredge rather than the larger mechanical dredge that was currently in use on the project. After review by the Technical Advisory Committee and the MA Department of Environmental Protection, the Water Quality Certification was amended to allow improvement work by the hopper dredge with overflow with the work limited to a small footprint to be dredged. It should be noted that in the end, the work was actually performed by a smaller mechanical dredge.

CAD Cell Consolidation Time – At the start of Phase 2, the Water Quality Certification specified initiation of capping after a minimum 2-week/maximum 2-month consolidation time. Following review of the results of capping, the Water Quality Certification was amended to include 60 to 120 days of consolidation time and then later amended again to include 90 to 180 days of consolidation time. The final set of cells were allowed to consolidate over 200 days.

Cap Monitoring – At the start of Phase 2, the Water Quality Certification specified that investigations be performed for the first three CAD cells capped to verify cap coverage and thickness. Following review of the results from the first three cells, this was amended to require verification investigations for all capped cells. The Water Quality Certification also required monitoring of cap coverage and recolonization one year and five years after completion of the project. The monitoring was specified to include 30% of the cells, assuming the large number of smaller cells envisioned at the start of the project. Because the number of cells was reduced, the Water Quality Certification was amended to require follow up monitoring for all of the capped cells.

Cap Status – The Water Quality Certification required that additional capping be performed on the Phase 1 cell IC2 (approximately 20% of this cell had been identified as having little/no cap) and that all Phase 2 cells be capped. Based on review with the Technical Advisory Committee, the MA Department of Environmental Protection decided that additional capping was not required for cell IC2 (because the area was limited in size and recolonization was already progressing over the uncapped area) and that cell C12 did not require capping as part of the BHNIP (cell C12 had significant remaining capacity that would be used for future projects).

8.2 WATER QUALITY MONITORING REQUIREMENTS

Because the BHNIP was the first major dredging project with in-channel CAD cell disposal of contaminated sediments in Massachusetts, the Water Quality Certification for the project contained relatively extensive requirements for monitoring. With completion of the project and review of the results of monitoring, the following recommendations have been made to help streamline monitoring and make it more effective for future projects.

Dredging – The Water Quality Certification for the BHNIP required that a closed environmental bucket be used for removal of maintenance material. Monitoring of dredging-related impacts to water quality was required at the beginning of Phase 1 of the project for both maintenance and improvement dredging. Limited monitoring of maintenance dredging was required with the start up of a new contractor at the beginning of Phase 2. However, no additional monitoring of dredging operations was required during the remainder of Phase 2 (nearly two years in length), a period that included multiple changes in dredge plant, buckets, location, operating conditions and operators.

The requirement for a sealed environmental bucket for maintenance material removal should be critically evaluated during the design phase of a project. As presented in Section 9, the Corps' Engineer Research and Development Center compared the performance of two environmental buckets and an open bucket during the BHNIP (Welp, et al., 2001). Although the use of the environmental buckets was shown to reduce the loss of material to the water column during dredging, the closed buckets tested introduced more water to the dredged material. This can be problematic depending on the type of disposal that is planned and may have been a major factor in the consolidation times needed for the CAD cells in the BHNIP. In addition, GLDD reported that the overall efficiency of dredging was reduced using the environmental bucket. Hence, use of an environmental bucket could extend the length of a given project. .

If an environmental bucket is required for use on a project, its use should be governed by the performance standards set for the project, rather than performance specifications reported by a particular brand bucket. The conditions under which a particular bucket's performance was measured may have included a very controlled remediation application atypical for navigation dredging projects.

The manner in which the dredge is operated can have a greater impact on release of material to the water column than the type of bucket used. A push to increase production and decrease the cycle time (time to remove one bucket, empty into a scow, and return to the water) can significantly increase suspension of sediments as the bucket impacts the bottom, as it leaves the bottom, and as it exits the water. Rather than specifying the operation itself, periodic monitoring should be performed to ensure that turbidity/total suspended solids performance goals are being met at the compliance point.

Because of the variable nature of the dredging process and the associated variable release of suspended material, water column effects from dredging can be very transient. Monitoring should incorporate real-time measurements to identify the presence of a suspended solids plume with conditional sampling. Specific components should include the following:

- Equipment – Measurements of turbidity, light transmittance, and particle backscatter can all be used to provide real-time assessment of the presence of a plume. The key is that the equipment be able to provide a snapshot view of suspended material in real time over a spatial/depth scale relevant to the particular project and resources of interest.
- An optical backscatter turbidity sensor (such as D&A Instrument's OBS-3) can provide accurate and reliable point measurements of turbidity within the water column. When interfaced with the appropriate software, real-time measurements can be displayed in graphical format. Using an array of sensors or towing one obliquely through the water column allows for identification of a turbidity plume in three dimensions. A broad band acoustic Doppler current profiler (such as the 5-beam model manufactured by RDI) can image suspended material throughout the water column from a single surface or moored location. Although the imaging is more qualitative in nature than the turbidity measurements, it can be performed quickly allowing for identification of the spatial distribution of a transient or evolving suspended solids plume.
- Location – Although the monitoring will focus on the compliance point at a particular distance down current of the operation, it should also include measurements as near to the dredging operation as safe and practical as well as detailed background measurements. The goal is to be able to infer suspended solids source strength at the dredge and attenuation down current without the influence of non-project sources.
- Timing - Monitoring of dredging should be performed periodically throughout the project, focusing on changes of equipment, operators, or conditions of dredging (such as a move to a higher current or debris area). If the dredging is located adjacent to a sensitive area, continuous monitoring can be performed with a moored sensor. Data can be physically downloaded on a regular basis or collected via telemetry.
- Supplemental Sampling – Collection of water samples for laboratory analysis of total suspended solids should be performed at a limited number of locations to supplement the real-time measurements. Analysis for other parameters should only be performed if the real-time measurements identify a significant plume or if there is a particular concern about dissolved constituents being released during the dredging (potentially causing a water quality issue without a related suspended solids plume).

Disposal into CAD Cells – The Water Quality Certification for the BHNIP specified a very intensive monitoring program for disposal into the CAD cells. However, much of the monitoring occurred early in the project and/or was grouped into a series of sequential events. There were significant time periods (2-5 months) where project activities did not trigger any monitoring, and very little monitoring was performed as cells neared capacity. Sampling and analysis were hardwired into each event, regardless of the results of real-time monitoring. The analytical costs significantly increased the cost of the overall monitoring program.

The recommended monitoring following disposal events is very similar to that associated with dredging as described above. Because the disposal is a short-term event with potential generation of a pulse-type plume, real-time measurements are key to identifying any water column impacts. Specific components of the monitoring could include the following:

- Equipment – Measurements of turbidity, light transmittance, and particle backscatter can all be used to provide real-time assessment of the presence of a plume. The key is that the equipment be able to provide a snapshot view of suspended material in real time over a spatial/depth scale relevant to the disposal cell and down current areas of interest.
- Location – Although the monitoring will focus on the compliance point at a particular distance down current of the operation, it should also include measurements directly over the disposal cell prior to and following the disposal event (immediately after the scow has been moved from the CAD cell) to aid in identifying if the event actually produced a plume.
- Timing – For an individual event, monitoring should begin immediately following disposal into the cell (with background measurements performed prior to disposal). If the real-time monitoring identifies a plume moving away from the cell, monitoring/sampling at the compliance point should be timed to intercept the plume. Overall, the disposal monitoring should be performed periodically throughout the project, with emphasis on initial disposal, disposal of the material with highest contamination, and disposal as the cell nears capacity. If the cell is located adjacent to a sensitive area, continuous monitoring can also be performed with a moored sensor. Data can be physically downloaded on a regular basis or collected via telemetry.
- Supplemental Sampling – Collection of water samples for laboratory analysis of total suspended solids should be performed at a limited number of locations to supplement the real-time measurements. Analysis for other parameters should only be performed if the real-time measurements identify a significant plume or if there is a particular concern about dissolved constituents being released during the dredging (potentially causing a water quality issue without a related suspended solids plume).

Exceedences of Water Quality Criteria – The Water Quality Certification for the BHNIP required that an exceedence of a specified water quality criterion trigger a resampling effort to verify the results. However, as the analytical results were received 1-2 days following the original effort and scheduling the resampling would have taken another 1-2 days, the activity generating the exceedence would likely have been completed. Setting performance standards for the real-time measurements such as turbidity allows for real-time feedback on the operation. Sampling and follow up laboratory analysis can be conditional, triggered only by an exceedence of performance standards for the real-time measurements.

8.3 DISPOSAL INTO CAD CELLS

The Water Quality Certification for the BHNIP required the use of an accurate positioning system to allow for proper placement of the disposed material. GLDD coupled their highly accurate differential global positioning system with navigational software that allowed the operator of the tug that was maneuvering the disposal scow to view the position of the tug and the disposal scow in real time relative to the outline of the disposal cell. Although this was not required by the Water Quality Certification, this real-time view allowed for accurate positioning (in terms of center location and orientation) of very large disposal scows. Requiring a hardcopy printout of the computer screen showing the orientation of the scow relative to the cell at the time of disposal would provide a valuable piece of information in trying to unravel potential issues regarding disposed material outside of the cell.

The Water Quality Certification for the BHNIP also required that disposal not occur when vessels were passing within 1000 feet of the disposal cell. In addition to specifying a distance, a time requirement may help in ensuring that disposed material remains in the cell. Specifying that disposal only take place when no vessel traffic is expected for a set time window (as practicable for a given location) would allow for initial settling of the material within the cell. Allowing the disposal to occur outside of the specified disposal window occasionally may be more protective of water quality than constraining the contractor such that a disposal event is performed just prior to a vessel arrival or departure to ensure that the disposal is achieved within the given window. This requirement is more critical as the cell nears capacity.

As noted above, the Water Quality Certification was amended during the project to require that the more contaminated berth sediments be disposed in the lower half of the cell. This not only reduced the potential for loss of the more contaminated material both during and immediately following disposal, it also provided a greater degree of long-term isolation from the overlying water column for the more contaminated material.

8.4 CAPPING

As presented in Sections 4 and 6, much was learned over the course of the BHNIP about the methodology for capping the CAD cells as well as techniques for verifying cap coverage. The Water Quality Certification specified that the cap should have 3 feet of thickness with less than 12 inches of mixed cap/cell materials, and that the cap should cover at least 90% of the cell. The first set of cells capped during Phase 2 of the BHNIP presented a confusing picture with layers of intact sand beneath or layered with cell material as well as cap material mixed with cell material. The caps did not meet the specific performance standard set in the Water Quality Certification. However, the use of fewer, but much deeper cells had accomplished the underlying intent of sequestering much of the material, and the MA Department of Environmental Protection did not require additional capping for the cells.

For future projects, it is important to develop a mechanism to assess the “success” of a capping effort that takes into account more than just the final thickness and coverage of the cap. A matrix could be developed to score the performance of a given cap, with points specified for coverage, thickness, mixing of capping/capped material, and material on top of the cap. The “goal” for the number of points that would establish the effort as successful, i.e., not needing additional capping, could be based on factors such as the level of contamination of the material within the cell, similarity of the material within the cell to the surrounding harbor bottom, movement of water over the cell, expected natural deposition over the cell, and the proximity of the cell to specific habitats or other resources of concern.

The techniques for predicting/monitoring when material within a CAD cell is ready for capping were refined over the course of the BHNIP. Techniques for monitoring cap coverage and placement were also refined during the project. Further advances in these technologies may provide better tools for assessing cap readiness as well as verifying cap placement for future projects.

8.5 TECHNICAL ADVISORY COMMITTEE & INDEPENDENT OBSERVER

The Dredging Advisory Committee/Technical Advisory Committee played a key role in helping the permitting of the BHNIP to move forward as well as commenting on the issues that arose during performance of the project. If such a group is included in future projects, its role should be clearly defined in the Water Quality Certification or a related agreement. In particular, a specific format and mechanism for communicating recommendations to the appropriate regulatory agency should be defined.

The inclusion of an independent observer position within the BHNIP provided a mechanism to keep all interested parties informed on project issues and performance through the distribution of detailed, regular updates and allowed for a third-party review of the collected monitoring data. The position also provided a facilitator to help keep meetings focused on balancing the construction and environmental aspects of the project.

Finally, through the involvement of the TAC and independent observer, the MA Department of Environmental Protection allowed for amendment of the Water Quality Certification on an accelerated schedule as the project progressed. This allowed for operational and equipment changes that increased the overall efficiency of this complex project as more was learned while maintaining confidence that the Water Quality Certification remained protective.

9

Related Investigations

The general interest in the BHNIP, in particular the disposal into in-channel CAD cells sparked a series of related investigations by others that were not specifically required as part of the Water Quality Certification for the project.

9.1 U.S. ARMY CORPS OF ENGINEERS

The Coastal and Hydraulics Laboratory of the Corps' Engineer Research and Development Center (ERDC) performed several studies through their Monitoring of Completed Navigation Projects Program. The studies involved both field and laboratory components, and summary reports can be found on their website at www.erdc.usace.army.mil.

Dredge Bucket Comparison – Sediment resuspension and loading characteristics were evaluated for three clamshell dredge buckets – the Cable Arm enclosed environmental bucket, Great Lakes Dredge and Dock Company (GLDD) enclosed bucket, and a conventional open-faced bucket. Near field and far field sediment resuspension was evaluated for each bucket under similar operating and environmental conditions as the dredge worked the Inner Confluence in August 1999. The GLDD enclosed bucket generated the lowest overall turbidity (substantially less in the middle of the water column), but sediment dredged by this bucket had the highest water to solids ratio. This study was performed in conjunction with SAIC, and the results are reported in Welp et al. (2001).

Sediment Resuspension over Capped and Uncapped Cells – The ERDC had originally planned to model resuspension of sediments over the capped cells and perform field-validation measurements. The proposal to leave cells open longer for consolidation prior to capping coupled with the discovery of the material down river of cell M12 led to an additional Water Quality Certification requirement to evaluate resuspension over an uncapped cell. The two investigations were performed in conjunction with each other with participation by ERDC, SAIC, and Battelle. The field component of this study included assessment of sediment resuspension resulting from the passage of a 900-foot long liquefied natural gas tanker over a capped and uncapped cell (Photo 41). Sediment resuspension over the capped and uncapped cells was generally similar to or lower than that noted over other channel areas. The results of this study are presented in SAIC (2000).

Consolidation and Strength Development of Material Disposed in CAD Cells – Grab samples and cores were collected of the dredged material disposed into the cells prior to capping. Geotechnical analyses of the samples indicated that the natural cohesion and strength of the sediments were altered by the dredging, resulting in sediments in the CAD cells that were unstable due to high water content and low shear strength. The results of this study are reported in Walter (2000) and Myre et al. (2000).

9.2 U.S. EPA

The U.S. EPA performed a study to determine the potential release of contaminants to the water column during capping of contaminated sediments. Water column samples were collected for analysis of PAH, PCB, and total suspended solids in conjunction with capping of cells M8 and M19 in September 2000. Overall contaminant resuspension levels were generally low, but a spike in both PAH and PCB concentrations was noted following the first round of capping. This work was performed by the U.S. EPA in conjunction with Battelle and is reported in Magar et al. (2001).

9.3 SEA GRANT

Because of the interest generated during permitting of the BHNIP, a Sea Grant Marine Center was established in 1996 to study the physical, chemical, and biological processes related to disposal of fine-grained contaminated material into in-channel CAD cells with subsequent capping by coarse-grained material. The investigations involved researchers and graduate students from the Massachusetts Institute of Technology, the University of Massachusetts – Boston, and the Harvard School of Public Health and included the following topics:

- Evaluation of the impact of submarine groundwater discharge on metal transport from capped contaminated sediment (Liu, 1999).
- Assessment of the fate of PAH in Boston Harbor (Flores et al., 1998).
- Predicting dredged-material cap thickness based on benthic community structure data (Shull and Gallagher, 1997).
- Evaluation of the dynamics of particle clouds related to open-water discharge of dredged and capping materials (Ruggaber, 2000).
- Strength development in dredged Boston Harbor maintenance material (Pahuja, 2001).
- Application of Geographic Information Systems to aid in siting dredged material disposal areas (FitzGerald, 1998).
- Assessment of the application of decision analysis in determining the optimum capping level in the disposal of contaminated sediments in Boston Harbor (Gao, 1999).
- Application of decision analysis to management of contaminated sediments in Boston Harbor (Sommaripa, 2000).

9.4 COASTAL ZONE MANAGEMENT

The assessment of cap recolonization specified in the Water Quality Certification for the BHNIP was not required to be performed until one year following completion of the entire project. As described in Section 4.5, this assessment was performed in July-August 2001. At that time, the last set of cells had been capped just about one year, but other sets of cells had been capped earlier (ranging from 20 months to 4 years). In an effort to provide an earlier data point on cap recolonization, MA Coastal Zone Management sponsored an assessment of recolonization in June 2000. Sediment profile imaging was performed in a subset of the cells along with collection of grab samples for biological analysis. Recolonization was apparent over cells that had been capped approximately seven months earlier. Recolonization was also apparent over an uncapped cell that was in its consolidation period prior to capping. This investigation was performed under the independent observer contract and has been reported in ENSR (2000).

10

Conclusions/Recommendations for Future Dredging Projects

The BHNIP was a landmark project for its size, innovative design, process, and construction techniques. The project was successful due in large part to the flexibility of all those involved as they were willing to try new methods and willing to change direction when needed. The project also attracted researchers who furthered the knowledge of dredging, disposal, capping, and monitoring of dredged material. During the two-year construction period much was learned related to navigation dredging projects that involve removal of contaminated sediments and disposal within CAD cells. Below is a summary of the conclusions for the BHNIP along with recommendations for future projects.

10.1 ESTIMATING DREDGED MATERIAL VOLUME

The BHNIP was a combined maintenance and improvement project which required segregation of contaminated (maintenance) material and clean (improvement) material. The volume of maintenance material dredged (requiring disposal into the CAD cells) was significantly greater than that estimated at the start of the project. This resulted in overall cost implications for the project (the unit cost for maintenance dredging/disposal was about three times that of improvement dredging) as well as cost sharing implications (maintenance costs were funded separately from improvement costs).

Design volumes of maintenance material were based on post-dredge surveys performed during the last improvement projects 15 to 32 years prior. It was assumed that the post-improvement project bottom surface resulting from those projects was composed of clean clay or other consolidated material. This was considered the base surface for all maintenance material to be removed in the BHNIP. Two potential factors were not considered when making this assumption. First, as the last improvement projects were performed so long ago, some weathering of the improvement surface (clay for Boston Harbor) likely took place. In the highly traveled areas, disturbance by the passage of vessels may have resulted in cycles of erosion and redeposition, transforming what was once hard bottom into sediment with the characteristics of maintenance material.

Second, contractors using conventional buckets for both the maintenance and improvement materials during previous projects may have displaced some of the softer maintenance material during high production dredging. The displaced material may have settled back over the newly dredged area, i.e., more mobile maintenance material may have replaced some of the harder improvement material during the dredging. The post-dredge survey measured a surface that may have been the top of a redeposited maintenance layer rather than the top of parent material.

Sub-bottom profiling used during design to locate rock also offered new technology to make some estimates of the maintenance and improvement volumes. However, this application of the technique was experimental at the time of design and was not used for final quantity estimates. Given advancements in this technology, future projects should consider its use. The cost-effective broad coverage of geophysical technologies such as this coupled with some level of field verification would allow for a more accurate estimation of maintenance and improvement material that is critical for the design of a project.

10.2 CAD CELL SIZE AND DEPTH

The original design and permitting for the BHNIP included 52 potential CAD cell locations. A total of eight CAD cells were constructed during Phase 2 of the project. Three of the cells were constructed with a larger footprint than originally designed, and all were constructed deeper than originally designed. The use of larger/deeper cells contributed to the performance of the project at reduced cost. In addition, the larger/deeper cells offered a number of other benefits including:

- Material disposed into the CAD cells was sequestered to a greater degree (deeper with more material above) than in the originally planned shallower and more numerous cells.
- The potential for loss of material from the CAD cells was reduced for much of the time the cells were in use because the material was so far below the surrounding harbor bottom and less influenced by currents and vessel passage.
- Additional harbor space was preserved for potential use in future projects requiring CAD cells.
- The long-term monitoring and management of the CAD cells is more efficient because of the reduced number.

10.3 ENVIRONMENTAL DREDGING

Environmental dredging has two components: equipment and techniques. Equipment used on the BHNIP related to the environmental protection included the closed environmental bucket used for maintenance dredging, the split-hulled scows used for disposal into CAD cells, and the hopper dredge used for capping the cells. Of these, only the environmental bucket was not commonly used by dredging contractors. The other equipment is typical, and environmental use of it included close inspection and monitoring in some instances to assure proper performance.

The Water Quality Certification named the environmental bucket manufactured by Cable Arm as acceptable for use on the project and specified the performance standards for suspended solids that other potential closed buckets had to be capable of achieving. Great Lakes Dredge and Dock Company (GLDD) used a Cable Arm bucket throughout the project. GLDD also used its own closed bucket after a specialized monitoring event was performed to demonstrate its potential performance.

Because the Cable Arm bucket was light in weight (relative to a traditional bucket), the dredge operators had to adapt to its performance. Most obvious was the longer drop time required to reach the bottom than for the heavier conventional buckets. Also, the operators had to develop a "feel" for when the bucket reached the bottom and during closure. After a short time, operators felt confident and were able to work more efficiently with the bucket. However, they felt that the overall cycling was less efficient than conventional equipment.

The GLDD environmental bucket was heavier and more familiar to the operators (it was modified from a standard open clamshell bucket). However, because of its weight and rounded shape, it had the potential to remove more material per cycle. If the operators were not careful, dredging with this bucket could cause disturbance of the underlying clay during maintenance material removal. Operators had to be reminded of the importance of segregating the maintenance from improvement material.

The requirement for a sealed environmental bucket for maintenance material removal should be critically evaluated during the design phase of a project. As presented in Section 9, the Corps' Engineer Research and Development Center compared the performance of two environmental buckets and an open bucket during the BHNIP (Welp, et al., 2001). Although the use of the environmental buckets was shown to reduce the loss of material to the water column during dredging, the closed buckets tested introduced more water to the dredged material. This can be problematic depending on the type of disposal that is planned and may have been a major factor in the consolidation times needed for the CAD cells in the BHNIP. In addition, GLDD reported that the overall efficiency of dredging was reduced using the environmental bucket. Hence, use of an environmental bucket could extend the length of a given project. .

Future projects should consider setting specific performance standards for each project operation (in terms of total suspended solids or turbidity at a given distance from the operation) rather than specifying the equipment to be used. For production dredging, a traditional bucket may be capable of meeting overall project performance standards as well as performing the work more efficiently.

10.4 DISPOSAL INTO CAD CELLS

The predictive modeling performed as part of the Environmental Impact Statement/Report for the BHNIP assumed a loss rate ranging from 2% to 5% associated with disposal from the split-hulled scows, i.e. during each disposal event, 2% to 5% of the mass of material within the scow was assumed suspended in the water column above the CAD cell. With this assumed loss, the modeling predicted a well-defined plume of suspended material transported away from the cell. Based on this modeling, the Water Quality Certification for the BHNIP required that disposal occur within a 3-hour window around high tide to provide the maximum water column depth for dilution of the suspended solids and to minimize transport away from the cell. As many vessels schedule their port arrival/departure to coincide with the high tide, this requirement sometimes resulted in schedule delays for disposal or in disposal occurring minutes prior to vessel passing near or over the cell.

As described in Section 3, the water quality monitoring performed following disposal revealed very little plume development, suggesting a loss rate less than that assumed in the modeling. Recent research at the Massachusetts Institute of Technology focused on the dynamics of the descent of the disposed material (Ruggaber 2000). The results of this research indicates that for the scale of the disposal into Boston Harbor CAD cells, the transit of the disposed material through the water column occurs as convective descent with entrainment of surrounding water into the disposed material rather than with loss of material to the water column.

Future projects involving split-hulled scow disposal into CAD cells should incorporate the findings of Ruggaber (2000) into predictive modeling. The updated modeling should be the basis for determining the specified tidal window (if any) for disposal into the cells.

10.5 ENVIRONMENTAL MONITORING

The monitoring program required by the Water Quality Certification for the BHNIP focused primarily on the disposal events. The monitoring was triggered by specific project activities. As a result, some monitoring events were clustered together within the same week, and some events were separated by a period of months. Most events included extensive sampling and analysis for metals and organic compounds. As presented in Section 3, there were no exceedences of any of the water quality criteria set for the project. In addition, the turbidity plume generated by disposal events was very limited in extent and duration.

Modeling performed for future projects should incorporate updated assumptions of material loss, both during dredging and disposal to provide more accurate predictions of potential water quality impacts. A more effective monitoring program for future projects could include limited sampling and analysis at the outset to confirm compliance. Monitoring of turbidity or acoustic backscatter could be performed on a periodic basis during the remainder of the project with sampling and analysis triggered only when the real-time measurements exceeded pre-set limits. The reduction in sampling and analysis would allow for a more cost-effective monitoring program. The periodic real-time monitoring would provide greater assurance that any environmental impacts are held to acceptable, pre-established limits.

10.6 READINESS TO CAP

There were no standard field measurements to gauge the readiness of disposed material for capping during performance of the BHNIP. Periodic bathymetric surveys following the last disposal event into the cells indicated rapid initial consolidation followed by continued very gradual consolidation. However, it was evident after monitoring the caps for the first three cells (capped after approximately one month consolidation) that the bathymetric surveys alone were not sufficient in gauging the readiness to cap.

For the second set of CAD cells capped, a simple field measurement was devised to provide a rough measure of the consolidation and strength of the surficial material within the cell (measuring the spread of a grab sample of material released on a flat surface). These cells were capped following approximately five months consolidation. Capping was much more successful for these cells, but there was still displacement of disposed material to the surface of the capped cells in limited areas (termed as diapirs). This indicated that the material deeper within the cells was still not sufficiently consolidated at the time of capping.

The third set of CAD cells was allowed to consolidate approximately eight months prior to capping. Caps for these cells appeared to meet or exceed all design specifications.

Clearly, the greatest factor in successful capping was increased consolidation time. However, given the range of variables affecting consolidation (cell size, cell depth, parent material type, groundwater discharge, dredged material type, disposal history), no general rule can be given on consolidation, other than "more is better." However, in other settings, environmental or project constraints may result in a need to advance the capping at the earliest time feasible. Research initiated as part of the BHNIP to better understand material consolidation and strength development (see ERDC and Sea Grant work described in Section 9) in CAD cells should be continued to provide better tools for predicting required consolidation. In addition, this work should be expanded to include field techniques (such as an extension of the simple grab sample technique described in Section 6) to provide verification of the readiness of material for capping.

10.7 CAPPING TECHNIQUES

Capping during Phase 2 of the BHNIP was performed using sand dredged from the Cape Cod Canal. The sand was dredged and transported by hopper dredge, and capping was performed by discharge of the sand from a moving hopper dredge. The capping technique was modified only slightly over the course of Phase 2, shifting from self propulsion by the hopper dredge (using main propulsion and bow thruster which resulted in a rotational track) to a tug pushing the hopper broadsides (resulting in a track perpendicular to the axis of the hopper). The use of dredged material for capping was very cost-effective, and the technique for applying the cap material appeared to result in good cap coverage.

10.8 CAPPING ASSESSMENT

During the course of the design and permit phases of the BHNIP there were many discussions about the need to cap the disposal cells and, if capped, how thick it should be to prevent migration of contaminants or penetration by organisms. The decision to cap or not should be made on a case by case basis considering physical and biological factors as well as short- and long-term impacts. Disposal into deep cells accomplishes much of the underlying intent of capping as most of the disposed material is sequestered well out of potential contact with the overlying water column. The completed BHNIP CAD cells are still well depressed (5-10 feet) below the surrounding harbor bottom, and natural deposition over the cells is expected to further sequester material. Future monitoring should include measurement of the rate of deposition over these cells.

For future projects, it is important to develop a mechanism to assess the “success” of a capping effort that takes into account more than just the final thickness and coverage of the cap. A metric could be developed to score the performance of a given cap, with points specified for coverage, thickness, mixing of capping/capped material, and material on top of the cap. The “goal” for the number of points that would establish the effort as successful, i.e., not needing additional capping, could be based on factors such as the level of contamination of the material within the cell, similarity of the material within the cell to the surrounding harbor bottom, movement of water over and through the cell, expected natural deposition over the cell, and the proximity of the cell to specific habitats of concern.

10.9 MANAGEMENT OF CHANGE

Complex projects with sensitive environmental issues such as the BHNIP require continual oversight and intensive monitoring. Review of the oversight/monitoring results often leads to suggested changes to the design or construction process. Early in the design of the BHNIP, the Technical Advisory Committee committed itself to working together for a successful project. During the design and construction process the Technical Advisory Committee was fully involved. Any changes to the design or procedures were fully disclosed to the Technical Advisory Committee which included all the key regulatory agencies involved with the project. By maintaining this involvement the Technical Advisory Committee was willing to be flexible and approve innovative approaches. During construction, when methods or techniques failed to meet expectations or requirements, the Technical Advisory Committee worked with the Corps and Massport to expeditiously solve problems and amend permits as needed to avoid costly delays. For complex projects such as BHNIP, this approach may be essential to keep the project on schedule.

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Appendix A

Water Quality Certification Issued by the Massachusetts Department of Environmental Protection

NOTE: PAGE NUMBERS MAY NOT BE ACCURATE DUE TO CONVERSION TO ADOBE ACROBAT PDF

AMENDED WATER QUALITY CERTIFICATION

BOSTON HARBOR NAVIGATION IMPROVEMENT AND BERTH DREDGING PROJECT

Berth locations

Mystic River: Distrigas, Medford St. Terminal, Moran Terminal, Prolerized
Chelsea River: (none)
Inner Confluence: Mystic Terminal Pier 1, 2, 49, 50
Reserved Channel: Army Base, Conley Terminal
Main Ship Channel: North Jetty Terminal

COMMONWEALTH OF MASSACHUSETTS
EXECUTIVE OFFICE OF ENVIRONMENTAL AFFAIRS
DEPARTMENT OF ENVIRONMENTAL PROTECTION
ONE WINTER STREET, BOSTON, MA 02108 617-292-5500

ARGEO PAUL CELLUCCI
Governor

TRUDY COXE
Secretary

DAVID B. STRUHS
Commissioner

16 January 1998

Ralph F. Cox, Maritime Director
Maritime Department
Massachusetts Port Authority
East Building II, Fish Pier
Northern Avenue
Boston, MA 02210

and

Richard D. Reardon, Chief of Engineering/Planning
New England District
Corps of Engineers
424 Trapelo Road
Waltham, MA 02254-9149

re: **Amended** WATER QUALITY CERTIFICATION
BOSTON HARBOR NAVIGATION IMPROVEMENT
AND BERTH DREDGING PROJECT - Phase II
dredging and in-channel disposal

at: FEDERAL NAVIGATION CHANNELS AND
ABUTTING PRIVATE BERTHS
Boston Harbor, Chelsea Creek,
Mystic River, Inner Confluence, and
Reserved Channel

DEP Transmittal Number: 114030

Dear Sirs:

The Department reviewed your consolidated application for Water Quality Certification, as referenced above, and issued a Certification on September 30, 1996. Following the completion of Phase I of the project in July 1997 with the dredging of sediments from Conley Terminal and disposal at an in-channel cell located in the Inner Confluence of Boston Harbor, the Certification conditions have been revised in light of the experience gained with Phase I. About 23,000 cubic yards of silt and 43,500 cy of parent material was dredged from the Conley Terminal berth. About 3,500 cy of silt and 99,000 cy of parent material was dredged from the in-channel disposal cell The Certification also includes changes in estimated volumes of dredged sediments based on recent surveys and on the proponents' decision to

dredge to depths referenced to mean lower low water instead of mean low water.. The Department acknowledges the contributions of: the Independent Observer/ENSR, the Technical Advisory Committee, Coast Line Engineering/Phase I Monitoring Contractor, SAIC/Cap Monitoring Contractor, Weeks Dredging/Phase I dredging contractor, the Corps of Engineers, Massport, and Coastal Zone Management in the revised conditions included in this Certification.

In accordance with the provisions of Section 401 of the Federal Clean Water Act as amended (33 U.S.C. §1251 et seq.), MGL c.21, §§ 26-53, and 314 CMR 9.00, it has been determined there is reasonable assurance the project or activity will be conducted in a manner which will not violate applicable water quality standards (314 CMR 4.00) and other applicable requirements of state law.

The waters of Boston Harbor referenced above are designated as Class SB Waters in the Massachusetts Surface Water Quality Standards. Such waters are intended "as habitat for fish, other aquatic life and wildlife and for primary and secondary contact recreation". Anti-degradation provisions of these Standards require that "existing uses and the level of water quality necessary to protect the existing uses shall be maintained and protected".

PROJECT DESCRIPTION

The Boston Harbor Navigation Improvement Project is jointly sponsored by the Massachusetts Port Authority and the U.S. Army Corps of Engineers.

Federal Channels

Boston Harbor federal channels will be deepened in selected areas of the Reserved Channel, Mystic River, and Inner Confluence to -40 ft. **mean lower low water (MLLW).** The Chelsea River channel will be deepened to -38 ft. MLLW, resulting in a total volume of about 2.50 million (cy) of sediment and underlying parent material being removed for navigation improvement purposes.(This figure includes allowable overdepth dredging of **1.7** feet; actual depths with allowable overdepth dredging will therefore be -42 ft and -40ft **MLLW** in the respective channels.) In addition, deep cells for the disposal of the contaminated surface silts will be dredged within the boundaries of the federal channels resulting in removal of about 1.84 million cy of parent material, destined for disposal at the Massachusetts Bay Disposal Site. The total volume of material to be removed from the federal channels is about 4.34 million cy of which about 3.37 million cy is parent material, about 88,000 cy is rock, and about 887,000 cy is contaminated silt.

The Mystic and Chelsea River channels were last dredged in 1983, the Main Ship Channel in 1974, and Reserved Channel in 1966.

Reserved Channel

The Reserved Channel will be deepened from the currently authorized depth of -35 ft MLW to -40 ft **MLLW** for a distance of 3160 ft from the entrance; the upper 1340 ft will not be dredged. In addition the maneuvering area across the Main Ship Channel will also be deepened to -40 ft **MLLW**. This dredging will result in a total of 610,600 cy of material, of which 151,800 cy is silt, 424,800 cy is parent material, and 34,000 cy is rock. Dredging in the Reserved Channel is expected to occur over a five month period.

Mystic River, Inner Confluence, Main Ship Channel

From just east of the Tobin Bridge, the Mystic River Channel extends some 6570 ft upstream. Of this, 5670 ft will be dredged. This channel is about 700 ft wide under the Bridge, widens to 930 ft upstream, and then narrows to 440 ft at its upper end. The federal channel at the Inner Confluence is an area about 960 ft by 1400 ft at the confluence of the Mystic and Chelsea Rivers and also includes the adjoining part of the Chelsea River channel (300 ft wide) up to the McArdle Bridge. An 1860 ft section of the 35-foot Main Ship Channel just south of the Inner Confluence is also to be dredged and is included in the total dredge volume of about 1,338,600 cy for this part of the project. Of this, approximately 54,000 cy is rock, 497,900 is silt, and 787,800 is parent material. All areas are to be deepened to -40 ft **MLLW** from the current authorized depth of -35 ft MLW. Dredging is expected to occur over a 16 month period.

Recent surveys have indicated that an area in the Main Ship Channel needs some maintenance dredging to bring the area to project depth (-40 MLLW). This area is located to the west of the southern end of the improvement dredging for the Inner Confluence. An additional 30,000 cy of silt will need to be dredged from the Main Ship Channel to facilitate the movement of ships into the Mystic River.

Chelsea River Channel

This channel is some 10,000 ft long and varies in width from only 70 ft at the Chelsea Street Bridge, to about 230 ft for much of its length and widening to over 1000 ft at the upstream turning area. Because of the limitations on vessel size imposed by the Chelsea Street Bridge, and because of the unfeasibility of lowering certain major utility lines under the channel, this channel will be deepened only to -38 ft **MLLW** rather than -40 ft. The federal project will involve relocation or removal of existing utility lines crossing the river; these utilities include Boston Edison cables , MBTA cables, and MWRA water tunnels. The volume of material to be dredged in this channel will be 557,400 cy, of which 237,300 cy is silt, and 320,100 cy is underlying parent material (no rock). Dredging is expected to occur over a 7 month period.

Existing conditions in the federal channel areas

Physical -
The average tidal range in Boston Inner Harbor is 9.5 ft, which increases to over 11 ft with spring tides. Current velocities average less than 0.5 knot (Mystic channel 0.1 kt, Chelsea channel 0.2 kt and Main Ship Channel 0.7 kt). Bottom currents may be higher and vessel traffic causes large short term increases in current velocities. Depth averaged dissolved oxygen (D.O.)is frequently below the 5 mg/l water quality standard during the summer in the project area. Bottom water

D.O. is occasionally below 0.2 mg/l, a condition particularly likely in the more restricted waters, such as Reserved Channel, where combined sewer overflows have a greater impact. Oil pollution is more common in the Chelsea River, where many of the regional marine oil terminals are located.

Biological

The benthos is dominated by opportunistic species able to inhabit the shallow layer of oxygenated sediments. The highest abundances of these species is seen in the spring to early summer. Lobsters were found in project areas in both spring and fall surveys, fewer in the Mystic and Chelsea Rivers than in the Reserved Channel. Shellfish exist along the East Boston shore at the Inner Confluence, but harvesting is prohibited. The closest harvested beds (soft shelled clams, blue mussels) are open only to Master Diggers and are located along the outer edges of Logan Airport, over five miles from proposed dredging in the Mystic and Chelsea River navigation channels. Numerous finfish species are resident in Boston Harbor year round with seasonal population shifts in several species. In the spring and fall sampling done for the EIRs for this project in 1994-95, 14 demersal species and 19 pelagic species were found by trawling and gill netting. Many of these fish were young, in the 0 Age Class. Catches were 14 and 20 times higher in the Reserved Channel than at other locations sampled. Particularly numerous species include winter flounder, and the anadromous rainbow smelt and blueback herring. According to the Massachusetts Division of Marine Fisheries (Brad Chase to MEPA, 6/6/94), the Mystic River supports a large run of alewives, the Charles River supports runs of alewives, rainbow smelt and its blueback herring run is one of the largest in Massachusetts Bay.

Sediment

The average grain size of the surface silty sediments in the channel areas (18 sampling stations) is 86.5% silt and clay, 11.2 % sand, 2.3% rock.

Sediment contaminants - federal channels

Metal concentrations in the surface sediments are elevated in the federal channels based on two samples each from the Mystic, Chelsea and Reserved Channels obtained for bioassay testing in 1990. The highest values for several metals were found in the Mystic samples (in mg/kg dry weight): arsenic 27, cadmium 2.9, copper 180, lead 210, mercury 1.1, nickel 39, zinc 420. Chromium values were similar in all channels samples, but the highest value, 210 mg/kg, was reported from the Chelsea sample. The highest PAH value (13.1 mg/kg) was found in one of the Chelsea River sediment samples. PAHs in the other (5) samples ranged from 1.39 to 7.1 mg/kg. These concentrations do not exceed a probable bio-effect level established by Long et al (1995) using a national database. PCBs were not detected in the 1990 samples and are reported as less than .10 mg/kg (highest value, rounded).

Biological test results for the federal channel surface (silty) sediments indicated acute toxicity to amphipods *(Ampelisca abdita)* in the Mystic and Chelsea samples and significant bioaccumulation in clams exposed to sediments from the Mystic (cadmium), Chelsea (chromium and lead) and Reserved channels (chromium and lead). PCBs, pesticides and PAHs were not significantly accumulated in either clams or worms *(Macoma nasuta and Nereis virens)*. As a result of these tests the federal channel sediments are deemed by federal agencies to be unsuitable for unconfined ocean disposal.

Parent material underlying the surface silts was also assessed for chemical constituents and, as the results indicated generally low values, this material has been found acceptable for ocean disposal by the federal agencies. For example, Mystic River parent material (1986, sample C) was found to be lean clay containing 4.8 ppm arsenic, 3 ppm cadmium, 42 ppm chromium, 35 ppm copper, 23 ppm lead, 0.14 ppm mercury, 37 ppm nickel, 102 ppm zinc, 53 ppm oil and grease, and 95 % silt/clay.

In-Channel Disposal

The Corps of Engineers has determined that silts from all channel and berth project areas are unsuitable for unconfined ocean disposal. As a result of a comprehensive review of other available disposal options for this project conducted during the environmental review process, in which borrow pits in the ocean, aquatic fill sites in Boston Harbor, and upland sites such as landfills and quarries were considered, in-channel disposal with capping within the footprint of the channels was selected as the least environmentally damaging alternative. The 54 cells will occupy 116 acres located entirely within portions of channel to be dredged, and will be constructed as deep as possible depending on the firmness and stability of the native parent material. Two to nine cells are expected to be open and active at any time. No cells will be located in Reserved Channel.

The following possible impacts to waters have been considered in this review to ensure that Massachusetts surface water quality standards, both numeric and narrative, are met. The sand cap will provide a substrate of a coarser material than presently exists on the harbor bottom and as a result it will be suitable for different benthic organisms. Winter flounder may find it more suitable habitat. Where rock armoring is provided to cover cells in the Inner Confluence to protect the cap from severe erosion due to vessel propeller wash, a different benthic assemblage is likely to colonize this area. These project impacts are not considered adverse by the Department.

Possible impacts to water quality associated with dredging and disposal have been estimated using 1987 elutriate test results, which found releases of copper, mercury and PCBs were possible. (Sediment and site water are mixed in the elutriate test in a 1:4 ratio by volume and the resulting settled supernatant is removed for contaminant analyses.) These test results were used as one of the inputs in water column modeling studies run under various scenarios. The 1986 sediment samples used in the elutriate tests had contaminant concentrations similar to those found during 1990 sediment tests in the project areas.

Modeling was conducted in which a few of the assumptions were that 5% of the disposed sediment is dispersed in the water column on the way to the bottom of the cell, that dredging is continuous and results in 2% of the sediment dredged being released, that the volumes of sediment disposed will average, according to Corps of Engineers estimates, 6000 c.y. per day except for an occasional few days when 10,000 cy per day will be disposed, and that disposal releases occur at high tide only . The Corps of Engineers estimates that the greatest volume of sediment disposed during any one day will be 11,000 cy, which will not occur on more than 12 days out of the 19 months of the construction. On about 160 days volumes between 4000 cy and 6000 cy will be disposed, and for over 300 days, no contaminated silt dredging occurs. (Deeper sediments will be dredged, however, and disposed at the Massachusetts Bay Disposal Site.) The model predicts a plume of suspended sediments (TSS) exceeding 50 mg/l to occupy certain areas, for example in the Mystic River with average disposal volumes per day the plume would extend 400 ft (about one third of the width of the river) by about 900 ft long. (A background figure of 8 mg TSS per liter was used in these calculations). Under average disposal volumes, the model predicts the water quality criterion for PCBs (30 ng/l as a 24 hour average) will be exceeded in a plume 200 ft wide by 240 ft long, using a Boston Harbor background PCB value of 7 ng/l.

If disposal were to occur repeatedly at slack low tide when there is less dilution for resuspended sediments, and when freshwater inputs to the rivers are lowest (10 percent of average flow), then the size of the plumes and the concentrations of concern may be increased. Some of these "worst case" conditions were also modeled and show larger plumes. However, even under some of these "worst case" conditions the maximum exceedence of the PCB criterion lasts no more than two hours. Other contaminants of potential concern, copper, mercury, and the PAH naphthalene, are not expected to exceed any water quality criteria, according to the model.

Impacts to the water column during dredging will be minimized by the applicants' proposal to use an environmental "closed" clamshell bucket. This bucket is one designed (and operated) to minimize contact between the dredged sediment and the water column. (Other dredge equipment may be used if it meets conditions in this Water Quality Certification.) Some resuspension of contaminated silts in the disposal cells is expected if a metal bar is dragged over the surface to level the sediment prior to placement of sand for the cap. While dredged sediment is stored on the dump scows, no dewatering discharges of water or sediment are proposed.

Impacts to fish and other aquatic life could occur due to sediment resuspension during dredging and disposal. Homing abilities of anadromous fish during spawning runs may be reduced, and disruption of aquatic respiration may cause direct mortalities. Disposal activities are conditioned below to protect water quality during important fish spawning periods.

Impacts to aquatic life in general can be reduced if disposal does not occur while large cargo vessels and tug boats are passing. Estimated bottom currents may exceed 240 cm/sec at these times for a distance of up to 400 feet from the vessel. This velocity is well in excess of the 20 cm/sec necessary to resuspend silt particles.

Actual water column sampling during project operations is required in the conditions below in order to determine water quality during construction.

ARMY BASE BERTHS 1 - 10

Massport's Boston Army Base berths 1 through 10 are proposed to be dredged as part of the Boston Harbor Navigation Improvement Project. Berths 1, 2, and 3 (1170 ft x 125 ft) front the main ship channel and the adjacent berths 4 - 10 (3725 ft x 80 ft) are located at the mouth of Reserved Channel. All ten berths will be dredged to -35 feet mean lower low water(**MLLW**) plus a **1.7** foot allowable overdepth dredging. The volume of sediment from the ten berths is estimated at 98,100 cubic yards, of which 47,300 cy is silt and 50,800 is parent material. There is no rock to be removed from the ten berths.

Surface silts will be dredged with an environmental "closed" clamshell bucket designed to limit loss of sediment in the water column. A conventional toothed clamshell will be used on deeper glacial till, clay and other parent material. (Other dredge equipment may be used if it meets conditions in this Water Quality Certification.) The silts will be disposed of in cells dredged within the federal channels in the Mystic and Chelsea Rivers and the Inner Confluence and then will be capped with clean sand. Impacts from the disposal activities are discussed in the Certification for the federal channels.

Biological resources located in Boston Inner Harbor waters include opportunistic benthic species able to inhabit the shallow layer of oxygenated sediments. The highest abundances of these species is seen in the spring to early summer. Lobsters were found in all project areas in both spring and fall surveys, fewer in the Mystic and Chelsea Rivers than in the Reserved Channel.
Numerous finfish species are resident in Boston Harbor year round with seasonal population shifts in several species. In the spring and fall sampling done for the EIRs for this project in 1994-95, 14 demersal species and 19 pelagic species were found by trawling and gill netting. Many of these fish were young, in the 0 Age Class. Particularly numerous species include winter flounder, and the anadromous rainbow smelt and blueback herring. Fisheries resources in the Reserved Channel, including lobster, bottom fish and other fish, were generally more plentiful in species and number of individuals than in other project waters sampled. The closest active shellfish beds, open only to Master Diggers, are located along the shores at Logan Airport, about 1.5 miles from Navigation Improvement Project areas at Reserved Channel.

Sources of pollution to the waters at the Army Base berths include historic inputs from primary wastewater treatment plant discharges to Boston Harbor and the activities associated with any large urban port.

Sediment samples were obtained to dredge depth at six stations in 1992, three from berths 1 - 3, and 3 from berths 4 - 10. Based on an average of these six samples the surface sediments contained up to 79% silt/clay and contaminant values as follows (ppm dry weight): arsenic 10, cadmium 2.7, chromium 147, copper 125, lead 111, mercury 0.99, nickel 39, zinc 213, PCBs 0.63, PAHs 6.3, TPH 2811. Percent water was reported as 48%. These values are similar to those reported for sediments from the federal channel and the Conley Terminal at Reserved Channel, except for somewhat elevated PCBs and PAHs.

These sediments were subjected to bioassay tests with the result that acute toxicity to amphipods was evident (49% survival of the test animals), and significant bioaccumulation of mercury in worms *(Nereis virens*), lead, PAHs, and PCBs in clams *(Macoma* nasuta) was found. As a result of these tests, the Corps of Engineers has determined that these sediments are unsuitable for unconfined ocean disposal.

The deeper parent material was sampled at Conley Terminal Berth 11 and found to contain considerably lower concentrations of contaminants: As 3.0, Cd 0.1, Cr 16.5, Cu 17.7, Pb 5.4, Hg 0.02, Ni 14.7, Zn 36.4, PAH 0.02, PCBs not reported. The Corps has determined that this material is suitable for unconfined dispoal at the Massachusetts Bay Disposal Site.

Maintenance dredging is expected to be necessary in 10 to 20 years.

The conditions below are the same as for the federal navigation channels. No additional conditions specific to this project dredging location have been added.

CONLEY TERMINAL BERTHS 11, 12, 14,15, 16, and 17

Massport's Conley Terminal berths 11 through 15 are proposed to be dredged as part of the Boston Harbor Navigation Improvement Project. **[Note: some of the Conley Terminal berth numbers have been changed, as indicated.]** Berths 11, 12, 14 and 15 (berths 14 and 15 were formerly 13) are located at the mouth of Reserved Channel. Berths 11 and 12 were dredged in Phase I of the joint project and were dredged to -40 and-45 feet mean lower low water(**MLLW**) respectively plus a **1.7** foot allowable overdepth dredging in each case. Some 23,000 cy of silt and 43,500 cy of parent material were removed. A 40 ft depth is proposed for berths 14 and 15 with a similar allowable overdepth dredging. For berth 13 alone, 32,200 cy of sediment will be removed, of which 8,500 is silt and 23,700 cy is parent material.

Conley berths 16 and 17 (formerly 14 and 15) are adjacent to berths 11 -15 but they front on the main ship channel. These berths will be dredged to -35 ft **MLLW** with resulting volumes of 3900 cy of silt, 3200 cy of parent material totalling 7100 cy. There is no rock to be removed from any of the Conley Terminal berths. These areas were last dredged in 1974.

Surface silts will be dredged with an environmental "closed" clamshell bucket designed to limit loss of sediment in the water column. A conventional toothed clamshell will be used on deeper glacial till, clay and other parent material. (Other dredge equipment may be used if it meets conditions in this Water Quality Certification.) The silts will be disposed of in cells dredged within the federal channels in the Mystic and Chelsea Rivers and the Inner Confluence and then will be capped with clean sand. Impacts from the disposal activities are discussed in the Certificationn for the federal channels.

Fisheries resources in the Reserved Channel, including lobster, bottom fish and other fish, were generally more plentiful in species and number of individuals than in other project waters sampled in the spring and fall sampling done for the EIRs for this project in 1994-95. Other survey findings were that biological resources located in Boston Inner Harbor waters include opportunistic benthic species able to inhabit the shallow layer of oxygenated sediments. The highest abundances of these species is seen in the spring to early summer. Lobsters were found in all project areas in both spring and fall surveys, fewer in the Mystic and Chelsea Rivers than in the Reserved Channel.

Numerous finfish species (14 demersal species and 19 pelagic) are resident in Boston Harbor year round with seasonal population shifts in several species. Many of these fish, found by trawling and gill netting, were young, in the 0 Age Class. Particularly numerous species include winter flounder, and the anadromous rainbow smelt and blueback herring. The closest active shellfish beds, open only to Master Diggers, are located along the shores at Logan Airport, about 1.5 miles from Navigation Improvement Project areas at Reserved Channel.

Sources of pollution to the Conley berth waters include a combined sewer discharge (CSO) at the west end of berth 11, eight storm drain outfalls, and other historic inputs from primary wastewater treatment plant discharges to Boston Harbor and the activities associated with any large urban port.

Sediment samples were obtained to dredge depth six stations from the Conley berths in 1992. The surface sediments averaged 70% silt/clay and contaminant average values as follows (ppm dry weight): arsenic 9, cadmium 3.5, chromium 189, copper 170, lead 141, mercury 0.52, nickel 39, zinc 258, PCBs 1.05 (maximum value 3.1), PAHs 12, TPH 1890. Percent water was reported as 53%. The samples from berth 14 (stations 1 and 2) generally contained the highest concentrations of several contaminants (As 13, Cd 5.4, Cr 289, Cu 341, Pb 183, Hg 0.86, Ni 43, Zn 321, PAH 26.9, PCBs 1.5), except that the highest TPH concentration occurred in the sample from berth 15. The average contaminant values from this project area are not much higher than those found in the federal channel samples from Reserved Channel, except for PAHs (1.4 ppm in the federal channel samples) and PCBs (less than 0.1 ppm in channel samples). No comparison can be made for TPH, which was not assessed in the federal channel samples.

These sediments were subjected to bioassay tests with the result that no acute toxicity to amphipods was evident. Even though no significant accumulation of PCBs, chromium, lead, or zinc was found in the test animals, significant bioaccumulation of mercury and certain PAHs was found in clams (Macoma). As a result the Corps of Engineers has determined that these sediments are unsuitable for unconfined ocean disposal.

The deeper parent material was sampled at Berth 11 and found to contain considerably lower concentrations of contaminants: As 3.0, Cd 0.1, Cr 16.5, Cu 17.7, PB 5.4, Hg 0.02, Ni 14.7, Zn 36.4, PAH 0.02. PCBs and TPH were not reported. The Corps of Engineers has determined that this material is suitable for unconfined ocean disposal.

Sediment testing done in 1992 was not done to the depths now proposed for Conley Terminal Berths 11 and 12 (Reserved Channel); however, much of the deeper material is expected to be parent material, which has been characterized.

Maintenance dredging is expected to be necessary in 10 to 20 years.

DISTRIGAS

Distrigas Corporation is engaged in importing and storing liquid natural gas. The Mystic River facility is proposed to be dredged as part of the Boston Harbor Navigation Improvement Project. A 425 foot section of the berthing area will be dredged to -45 feet mean lower low water(**MLLW**) plus a **1.7** foot allowable overdepth dredging, whereas a 40 ft depth is proposed for an adjacent 315 foot section with similar allowable overdepth dredging. The volume of sediment to be dredged is estimated at 39,400 cubic yards, of which 1300 cy is silt and 38,100 cy is parent material. There is no rock to be removed from this area, last dredged in 1976.

Silts will be dredged with an environmental "closed" clamshell bucket designed to limit loss of sediment in the water column. A conventional toothed clamshell will be used on deeper glacial till, clay and other parent material. (Other dredge equipment may be used if it meets conditions in this Water Quality Certification.) The silts will be disposed of in cells dredged within the federal channels in the Mystic and Chelsea Rivers and the Inner Confluence and then will be capped with clean sand. Impacts from the disposal activities are discussed in the Certification for the federal channels.

Biological resources located in the Boston Inner Harbor including the lower Mystic River include opportunistic benthic species able to inhabit the shallow layer of oxygenated sediments. The highest abundances of these species is seen in the spring to early summer. Lobsters were found in all project areas in both spring and fall surveys, fewer in the Mystic and Chelsea Rivers than in the Reserved Channel. Numerous finfish species are resident in Boston Harbor year round with seasonal population shifts in several species. In the spring and fall sampling done for the EIRs for this project in 1994-95, 14 demersal species and 19 pelagic species were found by trawling and gill netting. Many of these fish were young, in the 0 Age Class. Particularly numerous species include winter flounder, and the anadromous rainbow smelt and blueback herring. According to the MADMF (Brad Chase to MEPA, 6/6/94), the Mystic River supports a large run of alewives. The closest active shellfish beds, open only to Master Diggers, are located along the shores at Logan Airport, about five miles from the Distrigas project site.

Sources of pollution to the waters in the vicinity of the Distrigas berth include four storm drain outfalls, and other historic inputs from the primary wastewater treatment plant and the activities associated with any large urban port. Historic uses of the Distrigas site have included storage of coal and creosote prior to 1967.

Sediment samples were obtained to dredge depth from three stations at the Distrigas project area in 1992. The surface sediments averaged 75% silt/clay with contaminant concentrations (maximum values in parentheses) as follows (ppm dry weight): arsenic 27.7 (34.7), cadmium 3.6, chromium 149, copper 225, lead 657 (1120), mercury 0.78, nickel 40, zinc 568, PCBs 4.83 (5.45), PAHs 42.9 (49), TPH 4393 (5280). Percent water was reported as 60%. Concentrations of lead, zinc, PCBs, and PAH are significantly higher than concentrations found in the Mystic federal channel samples. Arsenic, however, is generally high in all Mystic River samples within the Navigation Improvement Project. No comparison can be made for TPH, which was not assessed in federal channel samples.

These sediments were combined with sediments from the nearby Prolerized of New England site and subjected to bioassay tests with the result that acute toxicity to amphipods *(Ampelisca abdita)* was evident (3% survival of the test animals). These sediments were the most toxic of all the Navigation Project sediments tested. No bioaccumulation tests were done since on the basis of amphipod toxicity alone these sediments are unsuitable for open ocean disposal according to federal regulations.

The deeper parent material was sampled at the Prolerized site but not at Distrigas, and was found to contain considerably lower concentrations of contaminants: As 12.6, Cd 0.1, Cr 49.2, Cu 44.9, Pb 20.5, Hg 0.02, Ni 34.7, Zn 91.9, PAH 1.09, PCBs 0.01, TPH 390. Several parameters are noticeably higher than was reported for the parent material in the Reserved Channel sampled at Conley Terminal, specifically arsenic and PAH (respectively 3.0 and 0.02 ppm at Conley). The Corps of Engineers has determined that this material is suitable for unconfined disposal at the Massachusetts Bay Disposal Site.

Sediment testing done in 1992 was not done to the -45 ft depth now proposed for a portion of the site; however, much of the deeper material is expected to be parent material, which has been characterized.

Maintenance dredging is expected to be necessary in 10 to 20 years.

The conditions below are the same as the Water Quality Certification conditions for the federal navigation channels. Monitoring for water quality during the disposal of the Distrigas and Prolerized sediments is required.

MEDFORD STREET TERMINAL

Massport's Medford Street Terminal at the former Revere Sugar facility on the Mystic River is proposed to be dredged as part of the Boston Harbor Navigation Improvement Project. The site, vacant since 1986, was formerly used for transferring bulk sugar for several decades. A 900 foot berthing area will be dredged to **-40** feet mean lower low water(**MLLW**) plus a 1.7 foot allowable overdepth, except for a ten foot wide trench close to the pile supported wharf which will be dredged to **-45** ft **MLLW.** The volume of sediment to be dredged is estimated at 36,500 cubic yards, of which 9700 cy is silt and 26,800 cy is parent material. There is no rock to be removed from this area, last dredged in 1976.

Silts will be dredged with an environmental "closed" clamshell bucket designed to limit loss of sediment in the water column. A conventional toothed clamshell will be used on deeper glacial till, clay and other parent material. The silts will be disposed of in cells dredged within the federal channel areas and capped with three feet of sand. Impacts from the disposal activities are discussed in the Certification for the federal channels.

Biological resources located in the Boston Inner Harbor including the lower Mystic River include opportunistic benthic species able to inhabit the shallow layer of oxygenated sediments. The highest abundances of these species is seen in the spring to early summer. Lobsters were found in all project areas in both spring and fall surveys, fewer in the Mystic and Chelsea Rivers than in the Reserved Channel. Numerous finfish species are resident in Boston Harbor year round with seasonal population shifts in several species. In the spring and fall sampling done for the EIRs for this project in 1994-95, 14 demersal species and 19 pelagic species were found by trawling and gill netting. Many of these fish were young, in the 0 Age Class. Particularly numerous species include winter flounder, and the anadromous rainbow smelt and blueback herring. According to the MADMF (Brad Chase to MEPA, 6/6/94), the Mystic River supports a large run of alewives. The closest active shellfish beds, open only to Master Diggers, are located along the shores at Logan Airport, over five miles from the Medford Street Terminal project site.

Sources of pollution to the waters in the vicinity of the Medford Street Terminal berth include a combined sewer overflow located several hundred feet upstream and other historic inputs from primary wastewater treatment plant discharges to Boston Harbor and the activities associated with any large urban port.

Sediment samples were obtained to dredge depth from three stations at this project area in 1992. The surface sediments contained an average of 71% silt/clay and contaminant average values (maximum values in parentheses) as follows (ppm dry weight): arsenic 23 , cadmium 3.7, chromium 178, copper 245, lead 501 (693), mercury 0.47, nickel 50, zinc 451, PCBs 4.5, PAHs 36.5 (46), TPH 3000 . Percent water was reported as 61%. Concentrations of lead, PCBs, and PAH, are significantly higher than concentrations found in the Mystic federal channel, which contains the most contaminated sediments generally of all the federal channel areas. Arsenic, however, is generally high in all mystic River samples within the Navigation Improvement Project. No comparison can be made for TPH, which was not assessed in federal channel samples.

These sediments were subjected to bioassay tests with the result that acute toxicity to amphipods was evident (29% survival of the test animals). No bioaccumulation tests were done since on the basis of amphipod toxicity alone these sediments were determined by the Corps of Engineers to be unsuitable for open ocean disposal according to federal regulations.

The deeper parent material was not sampled at this site.

Maintenance dredging is expected to be necessary in 10 to 20 years.

The conditions below are the same as for the federal navigation channels. No additional conditions specific to this project dredging location have been added.

MORAN TERMINAL

Massport's Moran Terminal on the Mystic River is proposed to be dredged as part of the Boston Harbor Navigation Improvement Project. The site has been used since 1972 for off-loading containerized cargo; prior to that it was used for scrap and coal storage. A 1190 by 150 foot berthing area will be dredged to -40 feet mean lower low water(**MLLW**) plus a 1.7 foot overdepth allowance, except for a ten foot wide trench close to the pier which will be dredged to -45 ft **MLLW**. The volume of sediment to be dredged is estimated at 4,400 cubic yards, of which 500 cy is silt and 3900 cy is parent material. There is no rock to be removed from this area. The remaining volume to be dredged is low because the berth was dredged in 1993.

Silts will be dredged with an environmental "closed" clamshell bucket designed to limit loss of sediment in the water column. A conventional toothed clamshell will be used on deeper glacial till, clay and other parent material. (Other dredge equipment may be used if it meets conditions in this Water Quality Certification.) The silts will be disposed of in cells dredged within the federal channel areas and capped with three feet of sand. Impacts from the disposal activities are discussed in the Certification for the federal channels.

Biological resources located in the Boston Inner Harbor including the lower Mystic River include opportunistic benthic species able to inhabit the shallow layer of oxygenated sediments. The highest abundances of these species is seen in the spring to early summer. Lobsters were found in all project areas in both spring and fall surveys, fewer in the Mystic and Chelsea Rivers than in the Reserved Channel. Numerous finfish species are resident in Boston Harbor year round with seasonal population shifts in several species. In the spring and fall sampling done for the EIRs for this project in 1994-95, 14 demersal species and 19 pelagic species were found by trawling and gill netting. Many of these fish were young, in the 0 Age Class. Particularly numerous species include winter flounder, and the anadromous rainbow smelt and blueback herring. According to the MADMF (Brad Chase to MEPA, 6/6/94), the Mystic River supports a large run of alewives. The closest active shellfish beds, open only to Master Diggers, are located along the shores at Logan Airport, about five miles from the Moran Terminal project site.

Sources of pollution to the waters in the vicinity of Moran Terminal berth include 3 on-site storm drains and historic inputs from activities associated with any large urban port.

Sediment samples were obtained to dredge depth from three stations at this project area in 1992. The surface silty sediments contained an average of 49% silt/clay and contaminant average values as follows (ppm dry weight): arsenic 24 , cadmium 2.5, chromium 100, copper 159, lead 350, mercury 0.58, nickel 25, zinc 255, PCBs 1.8, PAHs 34.7, TPH 3035 . Percent water was reported as 53%. Concentrations of PCBs and PAH, are significantly higher than concentrations found in the Mystic federal channel, which contains the most contaminated sediments generally of all the federal channel areas. Arsenic, however, is generally high in all mystic River samples within the Navigation

Improvement Project. No comparison can be made for TPH, which was not assessed in federal channel samples.

These sediments were subjected to bioassay tests prior to the 1993 dredging with the result that acute toxicity to amphipods was evident (29.3% survival of the test animals). Bioaccumulation tests resulted in significant accumulation of PAHs in clams and accumulation of PCBs in both clams and worms. The Corps of Engineers has determined that these sediments are unsuitable for open ocean disposal according to federal regulations.

The deeper parent material was not sampled at this site.

Maintenance dredging is expected to be necessary in 10 to 20 years.

The conditions below are the same as for the federal navigation channels. No additional conditions specific to this project dredging location have been added.

MYSTIC TERMINAL PIER 1

Massport's Mystic Terminal Pier 1, located in the Inner Confluence of Boston Inner Harbor and also bordering Little Mystic Channel, is proposed to be dredged as part of the Boston Harbor Navigation Improvement Project. The site was used for general cargo and warehousing for several decades prior to 1987 and is now vacant. A 900 by 125 foot berth in Little Mystic Channel will be dredged to -35 feet mean lower low water(**MLLW**) plus **1.7** foot allowable overdepth dredging. In addition a 10 foot wide trench to -40 ft **MLLW** will be dredged close to the pier. The volume of sediment to be dredged is estimated at 10,200 cubic yards, of which 3900 cy is silt and 6300 cy is parent material. There is no rock to be removed from this area. This berth was last dredged in 1970. Adjacent berths at Mystic Terminal Piers 2, 49 and 50 are also to be dredged as part of this Navigation Improvement Project. Impacts from the disposal activities are discussed in the Certification for the federal channels.

As with the larger project, silts will be dredged with an environmental "closed" clamshell bucket designed to limit loss of sediment in the water column. A conventional toothed clamshell will be used on deeper glacial till, clay and other parent material. (Other dredge equipment may be used if it meets conditions in this Water Quality Certification.) The silts will be disposed of in cells dredged within the federal channel areas and capped with three feet of sand.

Biological resources located in Boston Inner Harbor waters include opportunistic benthic species able to inhabit the shallow layer of oxygenated sediments. The highest abundances of these species is seen in the spring to early summer. Lobsters were found in all project areas in both spring and fall surveys, fewer in the Mystic and Chelsea Rivers than in the Reserved Channel.
Numerous finfish species are resident in Boston Harbor year round with seasonal population shifts in several species. In the spring and fall sampling done for the EIRs for this project in 1994-95, 14 demersal species and 19 pelagic species were found by trawling and gill netting. Many of these fish were young, in the 0 Age Class. Particularly numerous species include winter flounder, and the anadromous rainbow smelt and blueback herring. According to the MADMF (Brad Chase to MEPA, 6/6/94), the Mystic River supports a large run of alewives. The closest active shellfish beds, open only to Master Diggers, are located along the shores at Logan Airport, over five miles from this project site.

Sources of pollution to the waters in the vicinity of Moran Terminal berth include 3 on-site storm drains and historic inputs from activities associated with any large urban port.

Sediment samples were obtained to dredge depth from three stations at this project area in 1992 and from four stations at neighboring Mystic Terminal Piers 2, 49 and 50. Based on an average of values for the seven stations, the surface silty sediments contained 71% silt/clay and contaminant average values as follows (ppm dry weight): arsenic 19, cadmium 4.0, chromium 164, copper 212, lead 299, mercury 0.65, nickel 35, zinc 403, PCBs 0.9, PAHs 14.9 (maximum 29.8 from Berth 1), TPH 3231. Percent water was reported as 53%. Concentrations of PCBs and PAH, are significantly higher than concentrations found in the Mystic and Chelsea River federal channels. Arsenic has been found to be generally high in all Mystic River sites sampled within the Navigation Improvement Project. No comparison can be made for TPH, which was not assessed in federal channel samples.

These sediments (a composite of all seven samples) were subjected to bioassay tests prior to the 1993 dredging with the result that acute toxicity to amphipods (*Ampelisca abdita)* was evident (21% survival of the test animals). Bioaccumulation tests resulted in significant accumulation of PAHs and PCBs in both clams and worms (*Macoma nasuta* and *Nereis virens*) , and of mercury in worms. The Corps of Engineers has determined that these sediments are therefore unsuitable for open ocean disposal according to federal regulations.

The deeper parent material was not sampled at this site .

Maintenance dredging is expected to be necessary in 10 to 20 years.

The conditions below are the same as for the federal navigation channels. No additional conditions specific to this project dredging location have been added.

MYSTIC TERMINAL PIERs 2, 49, and 50

Massport's Mystic Terminal Piers 2, 49 and 50, located in the Inner Confluence of Boston Inner Harbor, are proposed to be dredged as part of the Boston Harbor Navigation Improvement Project. These sites were used for garbage storage and are currently used for salt storage. Pier 2 (400 ft by 125 ft) adjoining Pier 1 and the nearby Piers 49/50 (635 ft x 150 ft) will be dredged to -35 feet mean lower low water(**MLLW**) plus **1.7** foot allowable overdepth dredging. In addition a 10 foot wide trench to -40 ft **MLLW** will be dredged close to Pier 2 (only). The volume of sediment to be dredged is estimated at 45,000 cubic yards, of which 5800 cy is silt and 39,200 cy is parent material. There is no rock to be removed from this area. Mystic Terminal Berths 49 and 50 were last dredged in 1979; there is no record of dredging at Berth 2. Adjacent Pier 1 will also be dredged as part of the Navigation Improvement Project; a description follows below.

As with the larger project, silts will be dredged with an environmental "closed" clamshell bucket designed to limit loss of sediment in the water column. A conventional toothed clamshell will be used on deeper glacial till, clay and other parent material. (Other dredge equipment may be used if it meets conditions in this Water Quality Certification.) The silts will be disposed of in cells dredged within the federal channel areas and capped with three feet of sand. Impacts from the disposal activities are discussed in the Certification for the federal channels.

Biological resources located in the Boston Inner Harbor including the Inner Confluence include opportunistic benthic species able to inhabit the shallow layer of oxygenated sediments. The highest abundances of these species is seen in the spring to early summer. Lobsters were found in all project areas in both spring and fall surveys, fewer in the Mystic and Chelsea Rivers than in the Reserved Channel. Numerous finfish species are resident in Boston Harbor year round with seasonal population shifts in several species. In the spring and fall sampling done for the EIRs for this project in 1994-95, 14 demersal species and 19 pelagic species were found by trawling and gill netting. Many of these fish were young, in the 0 Age Class. Particularly numerous species include winter flounder, and the anadromous rainbow smelt and blueback herring. According to the MADMF (Brad Chase to MEPA, 6/6/94), the Mystic River supports a large run of alewives. The closest active shellfish beds, open only to Master Diggers, are located along the shores at Logan Airport, over five miles from Mystic Terminal.

Sources of pollution to the waters in the vicinity of Mystic Piers 2, 49 and 50 are limited to the activities associated with any large urban port.

Sediment samples were obtained to dredge depth from four stations at this project area in 1992 and from three stations at neighboring Mystic Terminal Pier 1. Based on an average of values for the seven stations, the surface silty sediments contained 71% silt/clay and contaminant average values as follows (ppm dry weight): arsenic 19, cadmium 4.0, chromium 164, copper 212, lead 299, mercury 0.65, nickel 35, zinc 403, PCBs 0.9, PAHs 14.9 (maximum 29.8 from Berth 1), TPH 3231. Percent water was reported as 53%. Concentrations of PCBs and PAH, are significantly higher than concentrations found in the Mystic and Chelsea River federal channels. Arsenic, however, is generally high in all Mystic River samples within the Navigation Improvement Project. No comparison can be made for TPH, which was not assessed in federal channel samples.

These sediments (all seven samples composited) were subjected to bioassay tests prior to the 1993 dredging with the result that acute toxicity to amphipods (*Ampelisca abdita)* was evident (21% survival of the test animals). Bioaccumulation tests resulted in significant accumulation of PAHs and PCBs in both worms and clams (*Nereis virens and Macoma nasuta)*, and of mercury in worms. The Corps of Engineers has determined that these sediments are therefore unsuitable for open ocean disposal according to federal regulations.

The deeper parent material was not sampled at this site .

Maintenance dredging is expected to be necessary in 10 to 20 years.

The conditions below are the same as for the federal navigation channels. Water column monitoring is required during disposal of sediments from Mystic Terminal Piers 2, 49, and 50.

NORTH JETTY TERMINAL

Massport's North Jetty Terminal berth is proposed to be dredged as part of the Boston Harbor Navigation Improvement Project. This berth (900 ft x 155 ft) fronts the main ship channel near Reserved Channel and will be dredged to -40 feet mean lower low water(**MLLW**) plus **1.7** foot allowable overdepth dredging. A ten foot wide trench close to the pier will be dredged to -45 ft **MLLW**. The volume of sediment from this berth is estimated at 12,100 cubic yards, of which 3900 cy is silt and 8200 is parent material with no rock. This project area was last dredged in 1982.

Surface silts will be dredged with an environmental "closed" clamshell bucket designed to limit loss of sediment in the water column. A conventional toothed clamshell will be used on deeper glacial till, clay and other parent material. (Other dredge equipment may be used if it meets conditions in this Water Quality Certification.) The silts will be disposed of in cells dredged within the federal channels in the Mystic and Chelsea Rivers and the Inner Confluence and then will be capped with clean sand. Impacts from the disposal activities are discussed in the Certification for the federal channels.

Biological resources located in Boston Inner Harbor waters include opportunistic benthic species able to inhabit the shallow layer of oxygenated sediments. The highest abundances of these species is seen in the spring to early summer. Lobsters were found in all project areas in both spring and fall surveys, fewer in the Mystic and Chelsea Rivers than in the Reserved Channel. Numerous finfish species are resident in Boston Harbor year round with seasonal population shifts in several species. In the spring and fall sampling done for the EIRs for this project in 1994-95, 14 demersal species and 19 pelagic species were found by trawling and gill netting. Many of these fish were young, in the 0 Age Class. Particularly numerous species include winter flounder, and the anadromous rainbow smelt and blueback herring. Fisheries resources in the Reserved Channel, including lobster, bottom fish and other fish, were generally more plentiful in species and number of individuals than in other project waters sampled. The closest active shellfish beds, open only to Master Diggers, are located along the shores at Logan Airport, about 1.5 miles from Navigation Improvement Project areas at Reserved Channel.

Sources of pollution to the waters at the North Jetty berth include three storm drains, historic inputs from primary wastewater treatment plant discharges to Boston Harbor and the activities associated with any large urban port.

Sediment samples were obtained to dredge depth at three stations at this berth in 1992. Based on an average of the three samples the surface sediments contained 73% silt/clay and contaminant values as follows (ppm dry weight): arsenic 12, cadmium 3.6, chromium 189, copper 164, lead 321, mercury 0.68, nickel 44, zinc 579, PCBs 2.36, PAHs 10.2, TPH 2627. Percent water was reported as 51%. The values for PCBs, lead, and zinc are higher than those reported for sediments from the federal channel and other Navigation Improvement project berths at Reserved Channel. No comparison can be made for TPH, which was not assessed in federal channel samples.

These sediments were subjected to bioassay tests with the result that acute toxicity to amphipods *(Ampelisca abdita*) was evident (51% survival of the test animals), and significant bioaccumulation of mercury, PCBs, and PAHs occurred in worms *(Neries virens)* and clams *(Macoma nasuta*). As a result of these tests, the Corps of Engineers has determined that these sediments are unsuitable for unconfined ocean disposal.

The deeper parent material was sampled at Conley Terminal Berth 11 representing this part of Boston Harbor and was found to contain considerably lower concentrations of contaminants: As 3.0, Cd 0.1, Cr 16.5, Cu 17.7, Pb 5.4, Hg 0.02, Ni 14.7, Zn 36.4, PAH 0.02, PCBs not reported. The Corps of Engineers has determined that this material is suitable for unconfined ocean disposal at the Mass Bay Disposal Site.

Maintenance dredging is expected to be necessary in 10 to 20 years.

The conditions below are the same as for the federal navigation channels. No additional conditions specific to this project dredging location have been added.

PROLERIZED OF NEW ENGLAND

Prolerized of New England is a scrap metal facility on the Mystic River proposed to be dredged as part of the Boston Harbor Navigation Improvement Project. An 800 foot section of the berthing area will be dredged to -45 feet mean lower low water(**MLLW**) plus a **1.7** foot allowable overdepth dredging. The volume of sediment to be dredged is estimated at 34,000 cubic yards, of which 1300 cy is silt and 32,700 cy is parent material. There is no rock to be removed from this area, last dredged in 1985.

Silts will be dredged with an environmental "closed" clamshell bucket designed to limit loss of sediment in the water column. A conventional toothed clamshell will be used on deeper glacial till, clay and other parent material. (Other dredge equipment may be used if it meets conditions in this Water Quality Certification.) The silts will be disposed of in cells dredged within the federal channels in the Mystic and Chelsea Rivers and the Inner Confluence and then will be capped with clean sand. Impacts from the disposal activities are discussed in the Certification for the federal channels.

Biological resources located in the Boston Inner Harbor including the lower Mystic River include opportunistic benthic species able to inhabit the shallow layer of oxygenated sediments. The highest abundances of these species is seen in the spring to early summer. Lobsters were found in all project areas in both spring and fall surveys, fewer in the Mystic and Chelsea Rivers than in the Reserved Channel. Numerous finfish species are resident in Boston Harbor year round with seasonal population shifts in several species. In the spring and fall sampling done for the EIRs for this project in 1994-95, 14 demersal species and 19 pelagic species were found by trawling and gill netting. Many of these fish were young, in the 0 Age Class. Particularly numerous species include winter flounder, and the anadromous rainbow smelt and blueback herring. According to the MADMF (Brad Chase to MEPA, 6/6/94), the Mystic River supports a large run of alewives. The closest active shellfish beds, open only to Master Diggers, are located along the shores at Logan Airport, about five miles from the Distrigas project site.

Sources of pollution to the waters in the vicinity of the Prolerized berth include four storm drain outfalls, and other historic inputs from primary wastewater treatment plant discharges to Boston Harbor and the activities associated with any large urban port. The Prolerized site contained a steel plant in 1947.

Sediment samples were obtained to dredge depth from three stations at the Prolerized project area in 1992. The surface silty sediments contained an average of 58% silt/clay with 72% found at two sampling stations, and contaminant average values (maximum values in parentheses) as follows (ppm dry weight): arsenic 28.9 (44), cadmium 6.4, chromium 151, copper 234, lead 476 (667), mercury 0.73, nickel 66, zinc 676 (841), PCBs 7.64 (9.24), PAHs 45 (71) , TPH 3970 (5140). Percent water was reported as 57%. Concentrations of arsenic, lead, zinc, PCBs, and PAH, are significantly higher than concentrations found in the Mystic federal channel, which contains the most contaminated sediments generally of all the federal channel areas. Arsenic, however, is generally high in all Mystic River samples within the Navigation Improvement Project. No comparison can be made for TPH, which was not assessed in federal channel samples.

These sediments were combined with sediments from the nearby Distrigas site and subjected to bioassay tests with the result that acute toxicity to amphipods *(Ampelisca abdita)* was evident (3% survival of the test animals). These sediments were the most toxic of all the Navigation Project sediments tested. No bioaccumulation tests were done since on the basis of amphipod toxicity alone these sediments are unsuitable for open ocean disposal according to federal regulations.

The deeper parent material was sampled at the Prolerized site to represent Mystic River parent material and was found to contain considerably lower concentrations of contaminants: As 12.6, Cd 0.1, Cr 49.2, Cu 44.9, Pb 20.5, Hg 0.02, Ni 34.7, Zn 91.9, PAH 1.09, PCBs 0.01, TPH 390. Several parameters are noticeably higher than was reported for the parent material in the Reserved Channel sampled at Conley Terminal, specifically arsenic and PAH (respectively 3.0 and 0.02 ppm at Conley). This material has been determined to be suitable for unconfined ocean disposal by the Corps of Engineers.

Sediment testing done in 1992 was not done to the -45 ft depth now proposed for a portion of the site; however, much of the deeper material is expected to be parent material, which has been characterized.

Maintenance dredging is expected to be necessary in 10 to 20 years.

The conditions below are the same as for the federal navigation channels. Monitoring for water quality during the disposal of the Distrigas and Prolerized sediments is required.

TECHNICAL ADVISORY COMMITTEE

The Department's review of and response to project construction activities and monitoring data will be supported by the Boston Harbor Navigation Improvement Project (BHNIP) Technical Advisory Committee (TAC). The TAC is chaired by MCZM, and is composed of representatives of the following interests:

> contractor, applicant (Massport, Corps of Engineers) state agencies (DEP, Division of Marine Fisheries, Coastal Zone Management), federal agencies (Environmental Protection Agency, National Marine Fisheries Service, Corps of Engineers Regulatory), City of Boston conservation commission, environmental interest groups (Coastal Advocacy Network), and an independent academic participant.

The TAC will meet weekly or as necessary to review field activities and monitoring data, and will recommend construction and/or permit modifications to the Department. The TAC is an advisory body only; the Department exercises sole state permitting authority over the project.

The TAC will be supported by the services of an Independent Observer (I/O), funded by the applicant(s) and managed administratively by MCZM. The I/O will monitor project construction, perform quality assurance checks of the contractor's monitoring equipment and field operations, review monitoring data submitted by the applicant, and make technical recommendations to the TAC. Qualifications for the I/O will include physical and chemical oceanographic expertise and demonstrated experience monitoring dredging and dredged material disposal activities.

<u>Section 61 Findings</u>: Pursuant to M.G.L. Chapter 30, Sections 61 to 62H inclusive (M.E.P.A.) the Boston Harbor Navigation Improvement and Berth Dredging Project was reviewed as EOEA # 8695 and the Secretary's Certificate issued September 14, 1995 indicated that the Final Environmental Impact Report complied with the Massachusetts Environmental Policy Act and its implementing regulations 301 CMR 11.00.

<u>Comments were received by the Department</u> during the public comment period for this application from

> EOEA Marine Science Advisory Board, c/o Marie Studer, CZM
> Phil Colarusso, EPA Office of Ecosystem Protection
> Mason Weinrich, Co-chair, Coastal Advocacy Network
> Jodi Sugerman, Policy Director, Save the Harbor Save the Bay
> Vivien Li, Executive Director and Joan LeBlanc, Deputy Director, Boston Harbor Association
> Judith Pederson, Sea Grant College Program, MIT
> Lorraine M. Downey, Director, The Environment Department, City of Boston
> Vern Lang, New England Field Office, U.S. Fish and Wildlife Service.

Therefore, based on information currently in the record, the Department grants a 401 Water Quality Certification for this project subject to the following conditions to maintain water quality, to minimize impact on waters and wetlands, and to ensure compliance with appropriate state law:

A. General

A1. These conditions shall be referenced in the project specifications and included as an attachment to the specifications. These specifications shall be forwarded to the EOEA agencies (DEP, CZM, DMF) for informational purposes.

A2. The applicants and their contractors shall meet with the Department prior to undertaking any field work to review the conditions of this Certification. At a minimum attendees shall include the Corps of Engineer's project manager and contract officer, the Massport project manager, the construction contractor's project manager, the monitoring contractor's project manager, and any other contractor staff who will hold a supervisory position in the field. [The purpose of this condition is to provide the opportunity for regulatory and project staff responsible for the project to clarify any misunderstandings and resolve any differences in interpretations concerning these Certification conditions.]

A3. Dredging

a) Dredging of all soft surface sediments in the Mystic and Chelsea Rivers, the Inner Confluence and the Reserved Channel federal channels and in the associated non-federal project berth areas shall be done using a closed environmental clamshell bucket as proposed by the applicant, such as the CableArm bucket. This dredge bucket shall be designed to completely enclose the dredged sediment and water captured. The bucket shall be equipped with escape valves which shut when the bucket is withdrawn from the water column. The environmental dredge bucket shall have demonstrated the capability of meeting the following water quality performance standards: (a) Suspended solids not to exceed 25 mg/l over background at 25 m (75 ft) from operation when ambient levels are lower than 100 mg/l; (b) Turbidity not to exceed ambient levels by more than 30% at 25 m (75 ft) from operation. **An equivalent alternative dredging technology may be used if performance data is submitted to clearly demonstrate to DEPs satisfaction that the technology can meet the water quality performance standards noted above for silty sediments at depths similar to those expected to be encountered on the project. Condition I (Alternative Technology Requirements) provides additional requirements related to use of an alternative silt dredging technology.** Massport and the DEP will review performance data for all equipment designs submitted in response to the solicitation for the dredging contract.

b) The contractor shall demonstrate to the Department's satisfaction that for silt dredging the dredge operator has sufficient control over bucket depth in the water and bucket closure so that sediment resuspension from bucket contact with the bottom and due to bucket over-filling can be minimized.

c) The contractor shall follow an approved Debris Management Plan. Where pilings or other debris is found to interfere with environmental bucket closure or equipment operation, a conventional clamshell bucket may be used to extract the pilings/debris. Sediment removal during such activity shall be minimized to the greatest extent practicable. [Berths adjacent to pile structures include but are not limited to Conley berths 11-15, Moran Terminal, Mystic Terminal 1, and North Jetty; historic pilings or debris may exist at other project sites.]

A4. No future maintenance dredging is authorized; this permit is for one-time activity only in the federal channels and berth areas described in application to the Department, Transmittal Number referenced on page one.

A5. Any oily material released during dredging or any other project activity shall be promptly collected and disposed at a licensed facility.

A6. Any barge used shall be the best reasonably available technology and in good operating condition and shall contain the sediment and water placed in it so that minimal discharge of sediment or water occurs until the barge has been transported to the authorized disposal location(s). Deck barges shall not be used to contain channel or berth dredged sediments unless the barge has been modified to provide for complete containment of the sediments.

A7. Monitoring requirements may be added or deleted by the Department after consultation with the project applicants following Department review of the initial monitoring data for each type of activity.

A8. Monitoring data and reports:

a) All monitoring data and reports shall be forwarded to the Department, attention Judith Perry and Steven Lipman, 1 Winter Street, Boston, MA 02108, and to the Independent Observer c/o Deerin Babb-Brott, CZM, 100 Cambridge St., Boston, 02202. Samples shall be taken to an analytical laboratory at the end of each sampling day. Data required within 36 hours of receipt of the samples by the analytical laboratory shall be FAXed to the same individuals at DEP at 617-292-5696, and at CZM at 617-727-2754, or made available electronically.

b) Monitoring data shall be made available to DEP, CZM, and to other members of the project's Technical Advisory Committee in electronic form (disk or e-mail) or through World Wide Web access and updated on a weekly basis.

A9. Reports:

a) At the completion of each monitoring event (see attached table listing monitoring events) a monitoring report shall be submitted to the Department within 10 business days and shall include: date, time, and tide time of sample collection; time that disposal occurred; sample locations shown on a plan of reasonable scale, depth of sample; laboratory report of analytical results for contaminants and including appropriate QA/QC test results for blanks, duplicates, spikes, and matrix spikes. The source of the barge-load of sediment shall also be acknowledged in the monitoring report for any disposal event.

b) Summary tables of all data for each monitoring event shall be provided. The tables shall be designed to allow easy comparison of (a) all parameters measured at a given site and at a given time together with the appropriate reference site values, and (b) individual parameters at a given site over all time for the event together with reference site values.

c) A summary report shall be prepared at the completion of the navigation and berth dredging project presenting in concise form the project purpose, operational methods for dredging and disposal, and project impacts as determined by monitoring data. [See also condition B(6).]

A10. a) The laboratory contracted for the chemical analyses specified in this Certification shall be certified by the Department for wastewater analysis of the metals of concern and PCBs. Alternative documentation of proficiency may be accepted by the Department following our review.

b) The laboratory contracted for the biological tests (bioassays) specified in this Certification shall adhere to approved EPA test protocols in all respects including demonstration of species sensitivity to reference toxicants, and attainment of required endpoints for control bioassays. Failure to adhere to approved EPA test protocols as determined by the Department in consultation with EPA shall invalidate the test and a repeat test(s) shall be run.

A11. The laboratory detection limits for the analyses specified in this Certification shall be sufficiently low so as to provide reliable data at the following chronic water quality criteria for dissolved metals, total recoverable mercury and PCB aroclors (ug/l) (from the Massachusetts Surface Water Quality Standards): arsenic 36, cadmium 9.2, chromium (VI) 50, copper 2.4, lead 8.1, nickel 8.2, zinc 81, total recoverable mercury .025, PCB aroclors .030. It shall be the responsibility of the permittees to ensure that the contract laboratory provides evidence/data indicating that the laboratory can provide clean sampling and handling techniques, that the analytical methods used (for example, EPA 1600 series) shall include a preconcentration step using gold amalgamation for mercury or equivalent and a chelate (APDC-DDDC) preconcentration step or equivalent for other metals, as well as that contract personnel obtain sufficient sample in order to achieve good data at the necessary low detection limits to meet this condition.

A12. Exceedences of water quality criteria:

a) The mixing zone for dredging and disposal of project sediments shall be 300 feet downcurrent from the activity. At this point, both acute and chronic water quality criteria * shall be met. Acute criteria shall be met within the mixing zone at all times. Monitoring for water column contaminants is detailed in section E and F below and the requirements are designed to allow the Department to determine whether water quality standards and criteria are being met;

b) Exceedences of contaminant Water Quality Standards shall be attributed to project activities when the sample concentration obtained down-current from the project activity exceeds the particular standard and the sample concentration is at least 30% higher than the appropriate reference sample concentration. In the case of dissolved oxygen, real time measurements of D.O. shall be used and failure to meet water quality standards shall be deemed evident when there is a statistical difference at the 95% confidence interval between the down-current sample mean and the appropriate reference sample mean.

c) If water samples collected at the edge of the mixing zone fail to meet water quality standards and this effect is attributed to project activities as specified in A12(b) above, repeat samples shall be obtained under similar conditions within 24 hours after the laboratory obtains the results of the first set of samples. The repeat samples shall be analyzed for the parameter(s) of concern and for TSS. Verification that the samples were obtained within the sediment plume or that there was no plume shall be provided (see condition E(1)(g). The analytical data shall be submitted to EOEA as specified in condition A (8) within 36 hours after the sample is received by the laboratory.

d) If two consecutive water samples collected in accordance with A12(c) fail to meet acute water quality criteria as specified in A12(b), the project applicants shall take the following actions designed to limit such exceedences: the mitigation measures included in the contingency plan, as pre-approved by the Department, shall be immediately implemented or all disposal activities shall cease in the affected work area until an alternative proposal is provided to and approved by the Department, which approved proposal shall then be immediately implemented.

(e) If two consecutive water samples collected in accordance with A12(c) fail to meet chronic water quality criteria as specified in A12(b), then the following action shall be implemented: work may continue provided chronic bioassay tests as specified in condition E(5) below are undertaken within 48 hours, or the Department receives proposed mitigation measures within 48 hours and mitigation measures approved by the Department are implemented within 48 hours of the Department's approval. Such measures may include operational controls such as reductions in dredge production rate, silt curtain containment of the disposal cell or activity, and/or other mitigation measures to be determined by the Department in consultation with the project applicants. The Department will require water column testing to establish the effectiveness of any operational controls implemented.

* acute criteria are defined as the one hour average concentration which should not be exceeded more than once every three years on average; chronic criteria are defined as the 4 day average concentration which should not be exceeded more than once every three years, except that the PCB chronic criterion is a 24 hour limit of exposure.

f) If TSS exceeds the performance goal of 200 mg/l at 500 ft downcurrent of the disposal cell, the applicants and DEP will evaluate the significance of the TSS data and determine the requirements for additional mitigation, if any.

A13. The disposal contractor shall provide the sampling /monitoring contractor with a signal acceptable to both parties indicating when the dumping of sediment from the barge begins. This is essential since monitoring events are timed relative to the dumping event.

A14. All waters including wetlands are protected by anti-degradation provisions of the Massachusetts Surface Water Quality Standards. The Contractor shall take all steps necessary to assure that the proposed activities will be conducted in a manner which will avoid violations of said standards.

A15. The Department, attention Judith Perry or Steven Lipman (617-292-5655 or 292-5698) , shall be notified one week prior to the start of dredging so that Department staff may inspect the activity for compliance with the terms and conditions of this Certification.

A16. The project as described above shall be completed within a period of five years from the date of this Certification. At least sixty days prior to that time the applicants may request an extension of this Amended Certification; however the Department's experience with the project may result in some amendment to the conditions.

A17. Dredging may begin following the 21 day appeal period and once all other permits have been received.

B. Regarding disposal into the cells

ALL CELLS B1. Prior to undertaking disposal of sediment the dredge contractor shall submit a plan approved by the U.S. Army Corps of Engineers, and reviewed by Massport and the Department, to assure that during sediment discharge the disposal barges are within the boundaries of the disposal cell.

INITIAL CELLS

B2. Visual indicators shall be deployed clearly delineating the disposal cell(s) during all periods of active disposal into the cell, until the accuracy of electronic positioning equipment is verified by the Department. **Use of differential global positioning system (DGPS) accurate to five (5) meters**

or better, with real time graphic display will satisfy this condition. [The purpose of this condition is to enable the dredge operator and regulatory agency inspectors to verify that disposal occurs into the permitted cells.]

ALL CELLS B3. Sediment disposal into any cell shall occur only during high tide, defined for this activity as the time from one hour before to two hours after the predicted Boston high tide time. [The purpose of this condition is to provide maximum dilution and minimal dispersion and transport of fine contaminated sediment during disposal operations.] **If an alternative technology is proposed (and approved) that allows the material to be placed directly in the disposal cell without passing through the water column, disposal may occur at any time during the tidal cycle. [See condition I for alternative technology requirements.]**

All CELLS B4. (a) Bathymetric surveys shall be conducted: prior to cell construction, after the cell is constructed, after the disposal of silt material, and after the sand cap is placed. For the first cell, the range of the survey shall be one barge length (up to 300 feet) beyond the perimeter of the cell. For subsequent cells, the range of the survey shall be at least 50 feet beyond the perimeter of the cell. If a placement problem is detected, then the contractor shall be required to remove any misplaced material and deposit it in the cell and to submit a revised positioning plan for Corps approval. Further surveys may be required to verify accurate placement.

b) Multi-beam bathymetry surveys shall be done of the first three <u>Phase II</u> cells prior to cap placement and following completion of cap placement. If DEP determines that standard bathymetric surveys are not adequate to provide regulatory oversight of permitted activities, multi-beam surveys shall be required for subsequent cells as appropriate. [See condition C4 for reporting requirements.]

ALL CELLS B5. No cell shall be filled during passage of tug boat in escort or tanker vessels while the vessel is within 1000 ft of the disposal cell.

ALL CELLS B6. The origin of the last barge load of sediment placed in each cell shall be documented and provided to the Department with the final project report (conditions A(8) and A(9).

C. Cap Placement and Integrity

ALL CELLS C1. As proposed by the applicant, all dredged material unsuitable for unconfined ocean disposal shall be placed in cells dredged beneath the federal channels and the unsuitable material shall be capped with a minimum of three feet of clean granular material. The final elevation of the cap shall not exceed the elevation of the as-dredged channel. **Cap placement shall commence no sooner than two weeks and no later than two months after all silt is placed in the cell in order to ensure silt consolidation in the cell prior to**

capping. Capping of any cell shall be completed within one month of the start of cap placement.

ALL CELLS C2. The disposal cell cap shall be placed gradually so as to minimize disturbance to the unconsolidated silts in the disposal cells. **Further, there shall be no mechanical disturbance of the sand cap by means including but not limited to drag bar, clamshell bucket, and barge spudding, unless such disturbance is pre-approved by the Department. Obtaining core samples shall not be considered "mechanical disturbance".**

ALL CELLS C3. The material used to cap the silts in the disposal cells shall be clean well-graded granular material which is primarily sand having less than 10% of the material passing a #200 sieve and less than 10% of the material retained by a #4 sieve. Grain size data of representative samples of cap material shall be made available to the Department on request.

ALL CELLS C4. The results of bathymetric surveys specified in condition B4(a) and (b) shall be provided for all cells as follows:

a) average bottom elevation and status (i.e., active disposal, completed disposal, completed capping, etc.) of all cells shall be shown in matrix chart form;

b) the matrix chart shall be provided to DEP within 10 business days of completion of caps at the first three Phase II cells;

c) the matrix chart shall be updated and provided to the Department every three months thereafter throughout the remainder of the project;

d) multi-beam or standard bathymetric survey data (as provided in condition B4(a and b)) shall be shown in graphic form for each cell where disposal has occurred. This graphic report shall be provided to the Department within 30 days of completion of each cap .

C5. Cap Thickness and coverage determination:

FIRST CELL - PHASE I:

(a) Two months after the first cell (containing Phase I Conley Terminal sediment) is filled and capped, three core samples shall be obtained so that the interface between the dredged material and the cap can be determined and the thickness of the sand cap can be verified. **[Note: This portion of this condition has been met and the Department has determined that approximately 25% of the cell (in the southern portion) is not capped.]** Deficiency in the cap coverage or thickness shall be remedied within two months of the completion of channel deepening in the Inner Confluence during Phase II of the project. The method of capping shall satisfy condition C5(b).

FIRST THREE CELLS - PHASE II:

(b) Within two weeks of capping, each of the first three Phase II cells shall be surveyed using a combination of methods to verify to the Department's satisfaction that the cap has three feet of thickness over at least 90% of the cell and that the zone of mixed dredged silt and cap material (i.e., within the three foot cap) is less than 12 inches. Methods used to provide this verification may include acoustic sub-bottom profiling, vibracore sampling, and/or other proven technologies. Unproven technologies are acceptable with validation.

(condition C5 continued)

(c) No subsequent Phase II cells shall be capped until condition C5(b) has been satisfied.

(d) The Department will determine and acknowledge in writing as soon as the data indicates that the performance standard in condition C5(b) has been met.

(e) If data collected per condition C5(b) does not provide the required verification, the Department will specify further measures to ensure compliance with this Certification, after consultation with the project applicants and with the TAC.

(f) If the performance standard provided in condition C5(b) has not been met within three months of completion of the first Phase II cell cap, then dredging and disposal of silt in all other project CAD cells shall cease (unless otherwise approved by the Department) pending compliance with condition C5(b).

(g) Twelve months after all cells have been capped, five cores per cell, in thirty (30) percent of the cells selected according to a random distribution among all cells, shall be obtained and the cap thickness and interface layer determined. **The applicant may propose an alternative cap monitoring technique or combination of techniques for Department approval based on monitoring results from the first three Phase II cells**.

(h) Twelve months after the last cell is capped, a multi-beam bathymetry survey shall be conducted at 30% of the cells determined by random distribution of all capped cells. [The purpose of this condition is to determine the elevation within the cell relative to the surrounding harbor bottom, to determine whether measurable consolidation of the dredged material has occurred in the cells, and whether the cap surface has indications of erosion.

(i) Where cap material (plus any newly deposited sediment) in cells monitored in C5(g) above is found to be less than 2.0 feet thick as determined in 2 or more of the 5 core samples from a given cell, the Department, after consultation with the project applicants and with the Technical Advisory Committee (TAC), will determine what course of action, is required.

(j) If 50% or more of cells in a given waterbody surveyed in condition C5(g) are found to have less than two feet of cap material (as evidenced by at least 2 of the 5 cores), all cells in that waterbody (Inner Confluence, Mystic River, or Chelsea River) which were not surveyed shall be monitored according to condition C5(g).

(k) A report containing the core sampling locations, core analysis data, and survey data from conditions C5(g) and C5(h), and a discussion of these results shall be provided to the Department along with any other relevant data within 30 days of completion of the core sampling.

ALL CELLS C6. Five years post construction:

a) Three cores per cell, in thirty (30) percent of the cells selected according to a random distribution among all cells, shall be obtained to determine the long term integrity and thickness of the cap material (and overlying silts). **The applicant(s) may propose an alternative cap monitoring technique or combination of techniques for Department approval based on monitoring results from the first three Phase II cells capped.**

b) **Multi-beam bathymetric condition surveys shall be conducted on all cells.**

c) A report including the data and an assessment of the data shall be submitted to the Department's appropriate 401 Certification office and CZM within 60 days of completion of the sampling. Following review of this report, the Department, after consulting with the applicants, will determine the extent of any necessary cap restoration measures.

D. Recolonization of Cap

D1. Recolonization of benthic species on the surface of the cell shall be assessed one year after completion of the project, as proposed by the applicant.

a) Sediment profile imaging (SPI, such as REMOTS) shall be used to document status of all caps . From this data, typical caps shall be selected and sediment grab samples obtained. Full interpretation of SPI data shall be provided on anomalous caps.

b) At least two sites shall be sampled (with sediment grabs) in the Mystic, the Chelsea, and the Inner Confluence.

c) Two sites within the dredge project area in Reserved Channel (where there are no cells) or at another appropriate reference location approved by the Department shall also be assessed for benthic species for purposes of comparison.

d) Sediment grain size shall be determined in each sediment grab sample.

e) The applicants shall submit the proposed Recolonization assessment plan to the Department for review and approval prior to implementation.

E. Water column monitoring - disposal operations

0.5. [formerly condition E1(g)] Plume location equipment, for example a transmissometer, shall be used to ensure that all downcurrent samples are located within the maximum density (lateral dimension only) of any sediment plume. **The instrumentation used to locate the plume shall be capable of providing real-time display and data capture of light transmittance or turbidity as a depth profile. Measurements shall be of sufficient spatial and temporal coverage such that the following requirements can be met: 1) A plan view figure (similar to figure 3.5, Appendix F, FEIR/S) can be generated depicting contours of turbidity or light transmittance values over an area extending a minimum of 300 feet upcurrent and 1000 feet downcurrent and 200 feet laterally from the project activity at a specified depth; 2) A figure in cross-section can be generated depicting contours of turbidity or light transmittance along a line 300 feet downcurrent of the project activity and perpendicular to the general current direction extending 200 feet laterally from the project activity.**

E1. Water column sampling and analysis for total PCBs, dissolved copper, cadmium, lead, total mercury and TSS (total suspended solids) shall be conducted when soft surface sediments from Mystic River federal channel are disposed in channel bottom disposal cells, as follows:

a) construction events and frequency of sampling - this condition (E(1)(a through i) shall apply to disposal activity at the first cell(s) filled with Mystic River soft surface sediments, and to the first three disposal events in each tributary in which more than 3000 cy of Mystic River sediments are disposed per tidal cycle.

Monitoring at the first cell shall occur during two days in the first week that disposal occurs in the cell. Monitoring shall also occur during three days that disposal occurs once the cell is at least 50 percent filled to its design capacity. A record of the number of scow loads and the volume of each shall be provided to the monitoring contractor for inclusion with the monitoring report required by section (f) of this condition.

In order to allow the contractor to safely monitor disposal events, this condition shall apply to one disposal event (or

series of events if more than one disposal event occurs in a given tidal cycle) per day. When disposal events occur during both high tide periods in a day, the contractor shall monitor the event associated with the most favorable weather and light conditions.

E1. b) depth of sample - all samples (including reference samples) shall be obtained from within 3 feet of the harbor bottom outside the cell and from the mid-water column. These samples may be combined. Alternatively, a depth integrated composite sample may be obtained from the same depths.

c) location of plume samples - plume samples shall be obtained 300 feet downcurrent from the cell. Distances shall be measured from the closest boundary of the cell.

For all water column samples required in all conditions of this Certification downcurrent and upcurrent shall be determined relative to the bottom current direction as indicated for the specific tide time on NOAA Tidal Charts for Boston Harbor.

d) Location of Reference samples- Reference samples shall be obtained to represent local background water conditions outside the affect of sediment disposal events. Acceptable locations for reference samples include: (1) a point 1000 feet upcurrent (with respect to bottom current direction) of any active disposal cell, and (2) a point 300 ft downcurrent from the disposal cell prior to disposal, provided there has been no dredging at the cell for 12 hours and that no disposal into the cell (or into an upcurrent adjacent cell) occurred on the same tidal cycle. Other locations may be approved by the Department upon request.

e) time of sampling:

At 0.5 and 1.0 hours post disposal: Plume samples shall be obtained 0.5 hours and 1.0 hours after the disposal event. Location of samples must be 300 feet downcurrent as specified; however, time may be modified slightly in order to meet the requirement to obtain the sample from the plume. **If multiple dumps will occur on any one tidal cycle, timing for the plume sample shall be measured from the last dump. These samples shall be analyzed separately and will be used for determining whether acute criteria are met. One reference sample shall be obtained prior to disposal and analyzed for comparison to the 0.5 and 1.0 hour plume samples.**

At 4 to 6 hours post disposal: Two additional plume samples shall be collected one hour apart during the period four to six hours after disposal, and a single composite sample prepared for analysis. This sample represents the average disposal plume for the period up to twelve hours after disposal. Tidal conditions are expected to be approximately slack low. Two upcurrent reference samples shall be obtained during the 4 to 6 hour post-disposal period and combined for one analysis. These samples will be used to determine whether chronic criteria are met.

f) Reporting: The resulting monitoring data for this condition shall be reported to the Department within 36 hours from the time the analytical laboratory receives the samples. **If the 36 hour deadline occurs after 5 pm or during the weekend, the data may be reported by 9 AM the following business day.** Failure to meet this requirement may result in a Stop Work Order from the Department.

g) The need for continued monitoring as described in this condition shall be determined by the Department after consultation with the project applicants following review of the data. The DEP will consider allowing chronic bioassays as specified in condition E(5) below to be substituted for the chemical analyses of the 4 to 6 hour composite samples, upon request.

h) A cross sectional figure of the plume at 300 ft down current from the cell shall be generated with the plume location equipment as specified in condition E0.5 immediately following the collection of the 1.0 hour plume sample for each monitoring event. (This condition replaces the requirement for lateral samples at 1.5 hours post-dump.)

i) A series of at least three dissolved oxygen measurements shall be made with real time instrumentation at all locations, depths and times specified above in this condition.

E2. Water column sampling and analysis as described in condition (E(1) above) shall also be conducted during five (5) days of disposal occurring in cell(s) in the Chelsea River and in the Inner Confluence. (Note that this requirement may be met simultaneously with E(1), E(3) and/or E(4)). **[This condition has been met with respect to the Inner Confluence.]**

E3. a) Phase I: Water column sampling and analysis described in condition (E(1) above) shall also be conducted for the first five (5) days or the duration of disposal, whichever is shorter, in which sediment from the first berth dredged is placed in any cell. **This condition has been satisfied for Phase I by the monitoring of Conley Terminal disposal.**

b) Phase II: Monitoring for TSS and turbidity is required during the first week of disposal *into any cell* performed by any new dredging contractor in Phase II of this project . Sampling shall occur during three days. Requirements for sample locations, timing, depth, reporting and cross-section figure are as described in condition E1 above.

E4. Monitoring as specified in condition E(1) shall be conducted when sediment from Prolerized, Distrigas, and Mystic Terminal Berths 2, 49 and 50 comprises more than 50% of the material in any barge load disposed in harbor bottom cells. Samples shall be analyzed for dissolved chromium, arsenic, nickel, zinc, and total mercury as well as dissolved copper, cadmium, lead, total PCBs, TSS and D.O..

E5. a) Bioassays shall be conducted to monitor (1) disposal of sediments from the first berth dredged, (2) disposal of Mystic

River sediments, and (3) disposal of sediment from Prolerized, Distrigas, and Mystic Terminal Berths 2, 49 and 50. [Monitoring for item (1) of this condition has been completed with the Phase I (Conley) project.] Water samples shall be obtained on one day during the first two days of monitoring for normal disposal operations as required in conditions E(1), E(3), and E(4). The tests shall be run using a composite of two (or more) water samples collected one hour apart at a location 300 ft downcurrent from the cell during the period four to six hours following disposal. Water samples from the appropriate reference sites shall be tested likewise.

b) Two bioassays shall be conducted on each required sample as follows. The sea urchin fertilization test shall be conducted according to EPA protocols for chronic end point(s). Likewise the seven- day *Mysidopsis bahia* (shrimp) test shall be conducted according to EPA protocols for chronic end points. The purpose of this condition is to assess the biological effects of a combination of pollutants which may be present; water quality criteria alone do not address this factor. In addition, where chemical criteria are exceeded and biological tests indicate no adverse effect, the Department will consider the biological test results as more significant in determining whether any operational mitigation measures are to be required.

E6. Bioaccumulation of metals arsenic cadmium, lead, and mercury (As, Cd, Pb, Hg,) and organics (PCBs, PAHs) shall be assessed in blue mussels *[Mytilus edulis]* in Boston Harbor using MWRA protocols for deployment and analysis of contaminants (as approved by EPA). The MWRA's reference station at Central Wharf shall be used. (Timing of this test may be coordinated with MWRA in order to avoid an additional deployment of mussels at this reference site). This test shall be conducted during the first six months of Phase II of the project. At a minimum caged mussels shall be deployed for at least 60 days at four sites at mid water column depth approximately 1000 ft from the area occupied by all the disposal cells, as follows: two sites beyond the most southerly disposal cell in the Inner Confluence and two sites upstream of the most upstream cell in the Mystic River. The details of this task shall be provided in advance to the Department for review and approval. The purpose of this condition is to determine longer term impacts to biological resources within a likely zone of impact from the project than can be determined with chemical analysis of water samples alone.

E7. During the first month of Phase II disposal activity, plan views of the post-disposal plume shall be generated using the plume tracking equipment described in condition E 0.5. Such plan views shall be provided showing areal extent of the plumes at the water surface, at mid-water column and within a foot of the bottom. Data shall be gathered between one and two hours following a disposal event on five occasions. This documentation shall be provided to the Department within 10 business days following the final plume tracking occasion.

F. Water Column Monitoring - Dredging of Disposal Cells

F1. This condition has been met with Phase I (Conley) monitoring.

F2. Spatial and temporal distribution of the sediment plume shall be documented (see condition E 0.5) under conditions of slack tide and maximum tidal current within the first month of dredging surface silts from the cell(s). **Dredging shall have been on-going for at least two hours and dredge cycle time shall be recorded and reported for this period. Documentation for each tidal condition shall include: 1) A plan view figure (similar to Figure 3.5, Appendix F, FEIR/S) depicting contours of turbidity or light transmittance values over an area encompassing the dredging activity and extending a minimum of 300 feet upcurrent and 1000 feet downcurrent and 200 feet laterally from the dredging activity; depths depicted shall be mid water column and within three feet of the bottom; 2) A figure in cross section depicting contours of turbidity or light transmittance along a line 300 feet downcurrent of the dredging activity and perpendicular to the general current direction extending 200 feet laterally from the dredging activity; full depth of** the water column shall be represented.

The documentation shall be reported to the Department within 10 business days.

See also conditions A(7),(8),(9), (10), (11) (12) and (13) above for general requirements for monitoring and reporting to the Department.)

G. Water Column Monitoring - Baseline

G1 If baseline water column data is collected, the Department recommends that it be obtained from a representative location in each federal channel (Mystic, Chelsea, Inner Confluence, and Reserved) prior to the start of dredging. Recommended analyses include: dissolved metals (arsenic, cadmium, copper, chromium, lead, mercury, nickel, zinc) and PCBs, as well as TSS and dissolved oxygen (D.O). Relevant results shall be included in the first written report to the Department concerning construction period water column monitoring.

H. Protection of Fisheries -

H1. No blasting shall occur in the Mystic River or Inner Confluence during the period February 15 to June 15 in order to protect winter flounder spawning and anadromous fish.

H2. All blasting shall be conducted using inserted delays of a fraction of a second per hole, and stemming, in which rock is placed into the top of the borehole to damp the shock wave reaching the water column, thereby reducing fish mortalities from blasting.

H3. All blasting operations are contingent upon using sonar, and with a fisheries observer present who is approved by the Massachusetts Division of Marine Fisheries (and National Marine Fisheries).

There shall be no blasting during passage of schools of fish as determined by the fisheries observer.

H4. Cell excavation and disposal activities **located upstream of the Tobin Bridge in the Mystic River and at cells #1, #2, and #3 in the Inner Confluence** occurring from February 15 to June 15 shall be conducted with fish startle system, sonar and an approved fisheries observer. [**Should the DEP and Massachusetts Division of Marine Fisheries approve a study of fisheries and dredged material plumes in the Mystic River by the Corps' Waterways Experiment Station, following a TAC review and discussion of the study, then these protective measures may be temporarily suspended.]** No restriction is placed on work in the Chelsea River upstream of the McArdle Bridge (Meridian Street).

H5. Cell excavation and disposal activities shall be avoided for certain cell locations during the period February 15 to June 15. Those cell locations are cells 3A, 4, 5, 6, 7, 8, and 9 in the Inner Confluence, as shown on Plate 4B in the 401 WQC application (and the FEIR).

H6. The Department in consultation with the Division of Marine Fisheries shall determine if and when fisheries protection measures will be no longer required.

I. Alternative Technology Requirements for Silt Dredging and Disposal

If an alternative dredging technology that meets the documentation requirements of A.3.a will be used to dredge the surface silt material in lieu of a closed environmental bucket, the following additional requirements shall be met:

I1. For the first two days of dredging of surface silts, monitoring shall be conducted in accordance with Condition F.2.

I2. Prior to capping the first cell (which will be designated by the Army Corps of Engineers), and approximately 10 days after the final addition of silt material to the cell, the following measurements and analyses shall be conducted:

a) Estimate the thickness of the "fluidized layer" that overlies the silt material in the cell by comparing bathymetry data from a fathometer (i.e., top of fluidized layer) with that from a lead line (i.e., top of more dense silt material). Collect bathymetry data from two or more lines along the length and width of the cell.

b) Collect 3- to 4-foot deep gravity cores from 6 random locations within the cell. Visually examine and document the character of each core; and analyze each discrete layer in each core for water content, grain size, and liquid and plastic limit.

I3. One week after capping the first cell, multibeam bathymetry

or traditional bathymetry and side scan sonar shall be conducted at the cells in accordance with condition C5(h) [formerly C(4)] of the Water Quality Certificate, and three core samples shall be obtained from the cap in order to determine cap thickness and the nature of the interface between dredged silt and cap material. Methods used to provide this information about cap thickness and the nature of the interface may include acoustic sub-bottom profiling, vibracore sampling, and/or other proven technologies. This monitoring will replace the respective 12 month monitoring requirements -- all other cap monitoring required by the Certificate will be conducted at 12 months post-construction.

I4. No additional silt dredging and disposal using an alternative disposal technology shall occur until the applicant and the Department are satisfied, based on the results of Condition I.2, that the silt material is likely to support a cap. No additional cell capping shall occur until the applicant and the Department are satisfied, based on the results of Condition I.3, that the silt material did support the cap. If satisfactory performance of the technology cannot be demonstrated in a timely fashion, the alternative technology will not be allowed and the closed environmental clam shell bucket must be used for dredging of all surface silt material.

Any changes made to the project as described in the previously submitted the Notice of Intent, 401 Water Quality Certification application, or supplemental documents will require further notification to the Department.

The applicant or property owner; or any person aggrieved by this certification, any group of ten persons, or any governmental body or private organization with a mandate to protect the environment who has submitted written comments during the public comment period have a right to appeal this certification. A notice of claim to an Adjudicatory Hearing must be accompanied by the filing fee specified in 310 CMR 4.00, and the enclosed Departmental Action Fee Transmittal Form submitted to: the Office of Administrative Appeals, DEP, P.O. Box 4062, One Winter Street, Boston, MA 02108, by hand delivery or certified mail postmarked within twenty-one days of the date of this certification. A copy must also be sent to the DEP Division of Wetlands and Waterways in Boston. The notice of claim must comply with the requirements of 314 CMR 9.10(3). Failure to submit comments before the end of the public comment period may result in the loss of the right to an adjudicatory hearing.

No activity may begin prior to the expiration of the appeal period or until a final decision is issued by the Department if an appeal is filed.

Failure to comply with this certification is grounds for enforcement, including civil and criminal penalties, under MGL c.21 §42, 314 CMR 9.00, MGL c. 21A §16, 310 CMR 5.00, or other possible actions/penalties as authorized by the General Laws of the Commonwealth.

If you have further questions on this decision, please contact Judith Perry at 617-292-5655.

Sincerely,

Pamela D. Harvey
Acting Director
Wetlands and Waterways Program

cc: Boston Conservation Commission
Chelsea Conservation Commission
Everett Conservation Commission
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bhnidp file
bhnidp-2.doc
bh-toc.doc

Appendix B

BHNIP Operations Database

Boston Harbor Navigation Improvement Project
Phase 2 Operations Database

A database of Boston Harbor Navigation Improvement Project (BHNIP) operations and associated information was compiled by ENSR based on data received from Great Lakes Dredge and Dock Company (GLDD). The database was compiled using Microsoft Access 97™ and includes a record of dredging and disposal activities during Phase 2 of the BHNIP. This introduction provides a summary of the information contained within the database as well as guidance on how to manipulate the database records and query the database. For general information on Access97™ software, refer to documentation provided by Microsoft.

B.1 Data Sources

Data contained within this database were obtained from two primary sources:

- GLDD logbooks
- National Oceanographic and Atmospheric Administration website

It should be noted that a limited number of inconsistencies were identified in the sequential data packages received from GLDD. Efforts were made to ensure that the data compiled are complete and accurate. However, given that the project is now completed and the project field office is closed and records archived, verification of all of the data was not feasible and complete data accuracy cannot be guaranteed. The original datasheets received from GLDD (Excel format) have been provided separately and are identified by disposal area and date received.

B.2 Data Structure

A database is a collection of related information. The BHNIP Phase 2 operations database functions as a relational database utilizing Microsoft Access 97™. The database has multiple tables, as well as other components, including forms and queries.

In general, a table contains a collection of records that relate to a given organizational level or category of information. A query lists specific fields and records from a table based on given criteria. A form displays data stored in underlying tables one record at a time. The BHNIP Phase 2 operations database includes all the tables collected from various sources as well as some example queries to provide specific information. Additional queries, forms, and reports may be developed as necessary.

B.3 Table Descriptions

Each category of information in this database is stored as a table. For example, dredge disposal locality information is stored in the table "Disposal_Tbl". The list of tables is provided below:

Area_Tbl
Capping_Tbl
Cell_Tbl
Climate_Tbl
Disposal_Tbl
Dredge_Tbl
Tide_Tbl
Tug_Tbl

In addition to standard Access97 menus and commands, a simplified menu with interactive buttons was created to facilitate the use of the database. Upon launching the application, the user is presented with a main menu that allows a choice among events likely to be used most frequently. This main menu gives the user the following choices:

- Dredging Event
- Disposal Event
- Capping Event
- Climatic Information
- Exit Database

Area_Tbl

Area Dug	Description
A/3	Area 3
A1/2	Area ½
B10	Berths 4-10 in Reserve Channel
C12	Chelsea cell 12
CC	Cable Crossing

Columns (2): Area Dug; Description
Area Dug – Abbreviation of area dug
Description – Identification of abbreviated area dug

Capping_Tbl

Capping ID	Date	Run ID	Cell	CY	Minutes	Sand Source	Notes
3	11/11/98	1	M12	2550	20	Cape Cod Canal - Hog Island Channel	
4	11/12/98	1	M12	2700	29	Cape Cod Canal - Hog Island Channel	
5	11/12/98	2	M4	2494	29	Cape Cod Canal - Hog Island Channel	
6	11/13/98	1	M4	2693	31	Cape Cod Canal - Hog Island Channel	
7	11/14/98	1	M5	2783	19	Cape Cod Canal - Hog Island Channel	

Columns (8): Capping ID, Date, Run ID, Cell, CY, Minutes, Sand Source, Notes
Capping ID - Automatically assigned unique number to each record.
Date – Date of capping event
Run ID – Run of the day
Cell – Cell being capped
CY – Volume of cell in cubic yards
Minutes – Time spent capping cell
Sand Source – Source of sand used to cap cell

Cell_Tbl

Cell ID	Description
M5	M5
M6	M6
m8/11	Combination of M8 and M11
MBDS	Massachusetts Bay Disposal Site
S1	Super Cell

Columns (2): Cell ID, Description
Cell ID – Cell identification
Description – Description of cell

Climate_Tbl

Climate ID	Date	Tide T1	Tide L1	Tide T2	Tide L2	Tide T3	Tide L3	Tide T4	Tide L4
1	8/17/98	1:35 AM	0	7:52 AM	9.3	1:51 PM	0.7	8:13 PM	10.6
2	8/18/98	2:38 AM	0	8:56 AM	9.3	2:52 PM	0.7	9:13 PM	10.6
3	8/19/98	3:38 AM	-0.1	9:55 AM	9.5	3:49 PM	0.6	10:09 PM	10.7
4	8/20/98	4:31 AM	-0.2	10:48 AM	9.6	4:41 PM	0.5	11:00 PM	10.8
5	8/21/98	5:19 AM	-0.3	11:35 AM	9.8	5:30 PM	0.3	11:47 PM	10.8

Min Air Temperature	Max Air Temperature	Water Temperature	Water Temperature Location	PPT Type	PPT Amount	Wind Speed	Wind Direction	Notes
63	70	16.85	Boston Harbor	Rain	1.52	5.6	NE	
61	87	16.20833	Boston Harbor	Rain	0.58	7	N	
59	69	15.51667	Boston Harbor		0	10.6	N	
57	71	15.82083	Boston Harbor		0	9.4	SW	
64	76	16.25238	Boston Harbor	Rain	Trace	7.3	SW	

Columns (19): Climate ID, Date, Tide T1, Tide L1, Tide T2, Tide L2, Tide T3, Tide L3, Tide T4, Tide L4, Min Air Temperature, Max Air Temperature, Water Temperature, Water Temperature Location, PPT Type, PPT Amount, Wind Speed, Wind Direction, Notes
Climate ID – Automatically assigned unique number to each record
Date – Date of reported information
Tide T1 – Time of first tide of day; Reference: NOAA (http://co-ops.nos.noaa.gov/)
Tide L1 – Level of first tide; feet above MLLW
Tide T2 – Time of second tide of day
Tide L2 – Level of second tide; feet above MLLW
Tide T3 – Time of third tide of day
Tide L3 – Level of third tide; feet above MLLW
Tide T4 – Time of fourth tide of day
Tide L4 – Level of fourth tide; feet above MLLW
Min Air Temperature – Minimum air temperature in degrees Fahrenheit; Reference: National Weather Service (http://tgsv5.nws.noaa.gov/er/box/)
Max Air Temperature – Maximum air temperature in degrees Fahrenheit
Water Temperature – Average water temperature in degrees Centigrade; Reference: NOAA (http://co-ops.nos.noaa.gov/)
Water Temperature Location – Location of water temperature measurement
PPT Type – Precipitation type; Reference: National Weather Service (http://tgsv5.nws.noaa.gov/er/box)
PPT Amount – Precipitation amount in inches
Wind Speed – Wind speed in miles per hour (mph); Reference: National Weather Service (http://tgsv5.nws.noaa.gov/er/box/)
Wind Direction – Average direction of wind
Notes

Disposal_Tbl

Disposal ID	Date Dug	Time Dug	Date Disposal	Time Disposal	Scow ID	Tug
99	10/10/98	2:50 AM	10/10/98	2:57 AM	401	
100	10/10/98	8:00 AM	10/10/98	3:27 PM	401	
101	10/10/98	12:50 PM	10/10/98	4:10 PM	402	
1545	8/9/98	5:00 PM	8/9/98	10:15 PM	401	1
1546	8/10/98	10:00 AM	8/10/98	3:17 PM	401	1

Scow Capacity	Estimated Volume	Origin Cell ID	Disposal Cell ID	Notes
3500	1400	CE	M4	
3500	1400	CE	M4	
3500	1400	CE	M4	
3500	2000	M5	MBDS	
3500	3000	M5	MBDS	

Columns (12): Disposal ID, Date Dug, Time Dug, Date Disposal, Time Disposal , Scow ID, Tug, Scow Capacity, Estimated Volume, Origin Cell ID, Disposal Cell ID, Notes
Disposal ID – Automatically assigned unique number to each record
Date Dug – Date when material dug
Time Dug – Time when material dug
Date Disposal – Date when material disposed of
Time Disposal – Time when material disposed of
Scow ID – Identification of scow involved in disposal
Tug – Identification f tug that assisted scow
Scow Capacity – Theoretical capacity of scow measured in cubic yards
Estimated Volume – Estimated volume of disposal cell
Origin Cell ID – Identification of cell that material originated from
Disposal Cell ID – Identification of cell that is being disposed into
Notes

Dredge_Tbl

Dredge ID	Date	Time	Dredge	Location	Material Type	Bucket	Notes
518	8/14/98	2:45 PM		M5	PARENT		
519	8/15/98	4:15 AM		M5	PARENT		
857	8/17/98	2:00 PM	Dredge 54	M12	SOFT	env26	
858	8/17/98	8:58 PM	Dredge 54	M12	SOFT	env26	
859	8/18/98	2:25 AM	Dredge 54	M12	SOFT	env26	

Columns (8): Dredge ID, Date, Time, Dredge, Location, Material Type, Bucket, Notes
Dredge ID – Automatically assigned unique number to each record
Date – Date when material dredged
Time – Time when material dredged
Dredge – Identification of dredge involved in dredging
Location – Location of dredging activities
Material Type – Type of material dredged; parent or soft
Bucket – Bucket used in dredging activities
Notes –

Tide_Tbl

TimeOfTide	TideHeight
8/18/98 2:38 AM	0
8/18/98 8:56 AM	9.3
8/18/98 2:52 PM	0.7
8/18/98 9:13 PM	10.6
8/19/98 3:38 AM	-0.1

Columns (2): TimeOfTide, TideHeight
TimeofTide – Date and time of tide; Reference: NOAA (http://co-ops.nos.noaa.gov/)
TideHeight – Height of tide in feet above MLLW; Reference: NOAA (http://co-ops.nos.noaa.gov/)

Tug_Tbl

Tug ID	Description
1	MOLLY
2	ALEX C
3	IONA
4	LEMON
5	COLNON
6	VINCENT
7	BOYS

Columns (2): Tug ID, Description
Tug ID – Automatically assigned unique number to each record
Description – Description of tugs used during activities

B.4 Queries

Data can be organized in customized ways in order to emphasize particular concerns or compare specific attributes of the BHNIP Phase 2 operations. Data can be selectively extracted using queries, which similar to filters, extract and sort records according to specified parameters. Contrary to filters, query definitions may be saved and reused.Some examples of queries are included within the form “Query Menu”:

- History_CappingEvents
- History_DisposalEvents

Appendix C

Project Photographs

BHNIP Summary Report - List of Photographs

Photo 21 – Water Quality Monitoring Set Up

Photo 22 – Cap Monitoring Being Performed Over Cell M5 in the Mystic River from the Vessel *Cyprinodon*

Photo 23 – Grab Sampler in Use in the Mystic River

Photo 24 – Pre-Capping Grab Sample from Surface of Cell M4

Photo 25 – Pre-Capping Grab Sample from Surface of Cell M5

Photo 26 – Ocean Surveys Coring Platform Over Cell M5

Photo 27 – Upper 20 cm Section of Post-Cap Core from Cell M5

Photo 28 – Transition from Sand to Silt at 150 cm Depth in Post-Cap Core from Cell M5

Photo 29 – Mixed Sand-Silt Section at 110 cm Depth in Post-Cap Core from Cell M12

Photo 30 – Instrumentation Used in Post-Capping Evaluation

Photo 31 – Bucket Exiting Water During Improvement Dredging

Photo 32 – Cable Arm Bucket Exiting Water During Maintenance Dredging

Photo 33 – Scow “Washing” During Improvement Dredging

Photo 34 – Scow “Washing” During Environmental Dredging

Photo 35 – View from Dredge Operator’s Station of Turbidity Generated During Maintenance Dredging

Photo 36 – Turbidity Generated Behind Tug Maneuvering Over Cell Following Disposal

Photo 37 – Pocket of Maintenance Material Removed During Improvement Dredging

Photo 38 – Surface of “First Cut” of Improvement Material Exposed Within Dump Scow

Photo 39 – Maintenance Material Screened for Presence of Lobster Within the Inner Confluence

Photo 40 – Underwater Video Sled Being Deployed from Vessel *Cyprinodon* in the Inner Confluence

Photo 41 – LNG Tanker *Matthew* Passing Over Supercell Within the Mystic River

Photo 1
Cable Arm Environmental Bucket in Use in the Mystic River

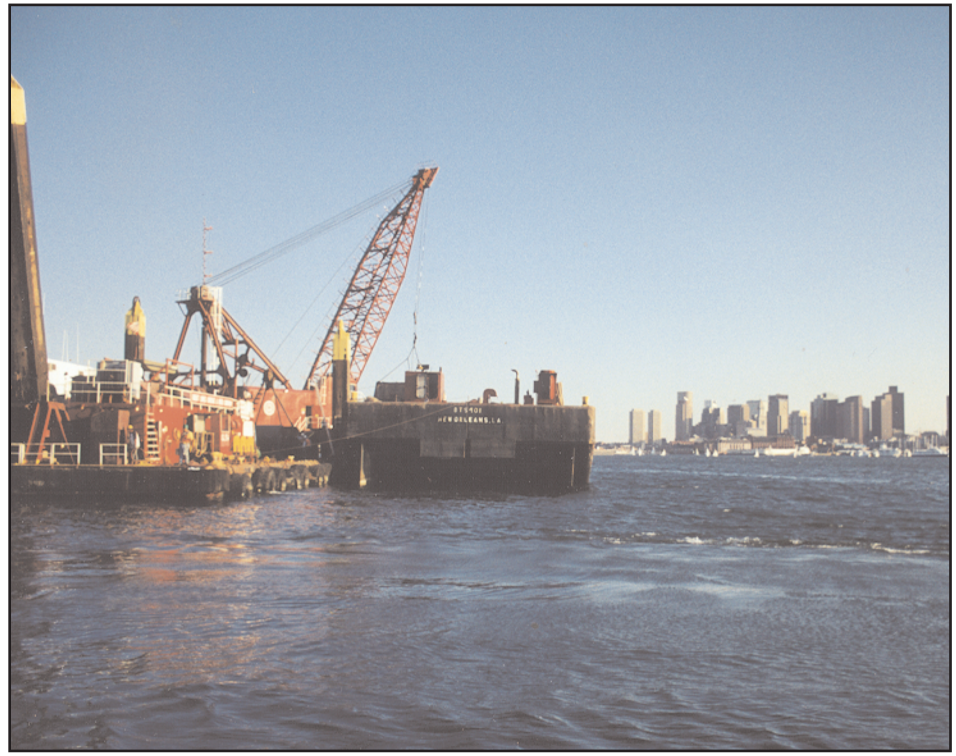

Photo 2
Great Lakes Dredge 54 in the Inner Confluence

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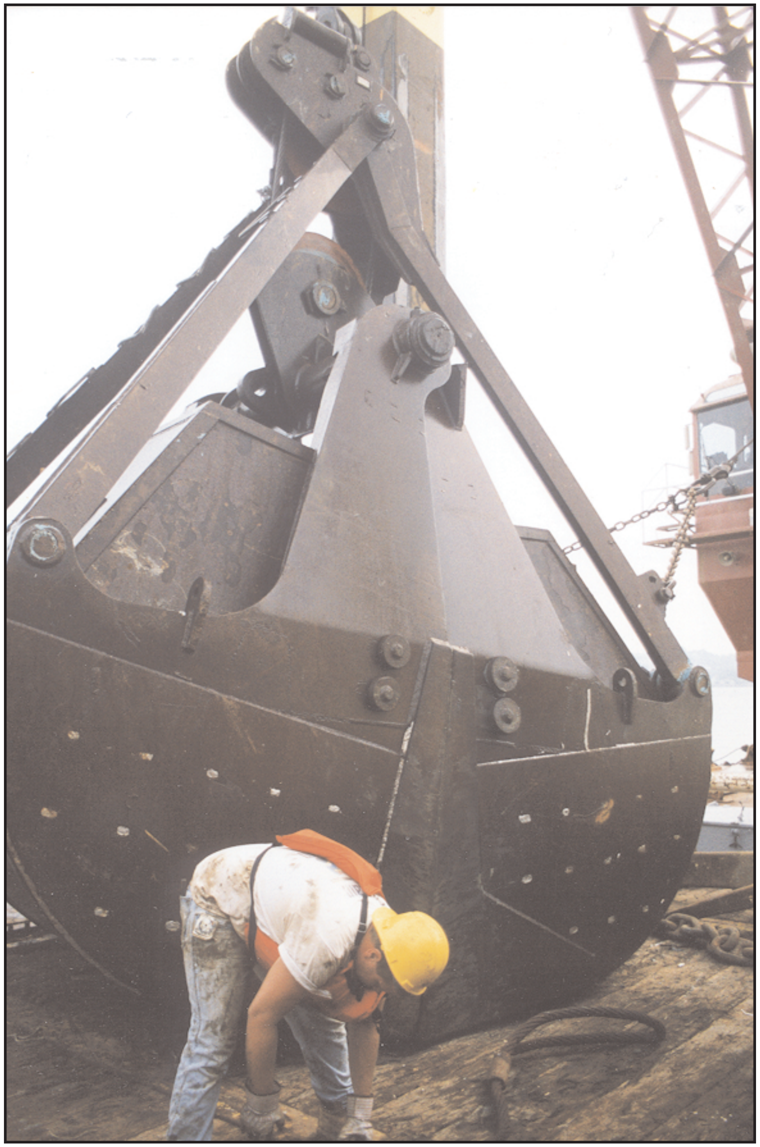

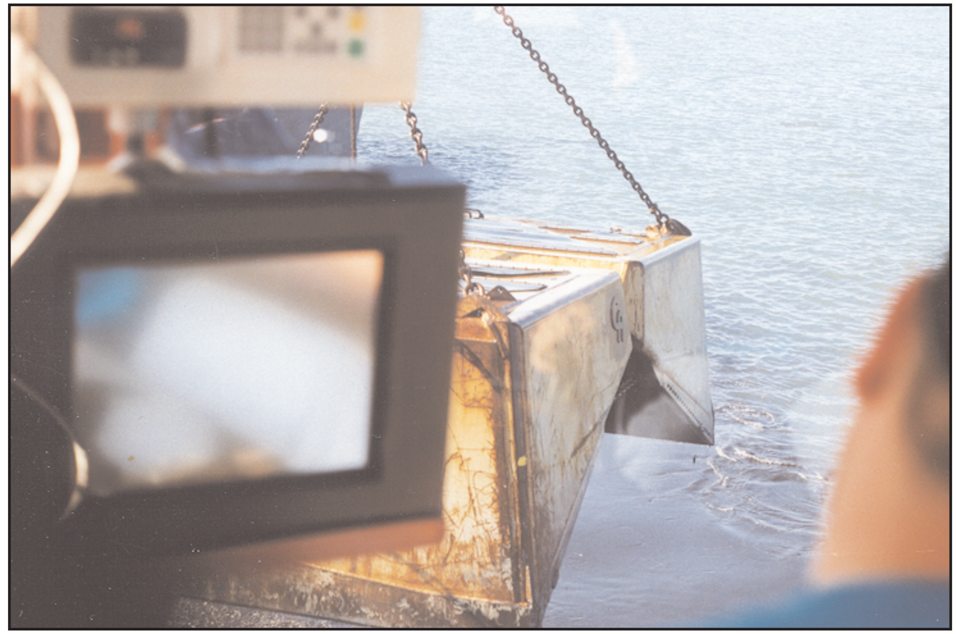

Photo 3
Great Lakes Enclosed Bucket

Photo 4
View from the Dredge Operator's Station of
Cable Arm Environmental Bucket Used in Maintenance Dredging

Photo 5
Maintenance Dredging - Cable Arm Environmental Bucket Being Emptied into a Full Scow

Photo 6
Great Lakes Excavator Dredge *New York* (Foreground) and Mechanical Dredge 54 (Background)
(Photo Source: Great Lakes Dredge & Dock)

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Photo 7
Variety of Buckets Used for Improvement Dredging

Photo 8
Toothed-Bucket in Use on Great Lakes Dredge 54

Photo 9
Dutra Mechanical Dredge *Superscoop*

Photo 10
Great Lakes Excavator Dredge *New York*

Photo 11
Improvement Material from the Mystic River

Photo 12
Improvement Material from Reserved Channel

Photo 13
Conceptualized Cell Boundry Within the Mystic River

Photo 14
Dump Scow Opening Over Cell Within the Mystic River

Photo 15
Disposal of Maintenance Material from Dump Scow Over Cell Within the Mystic River

Photo 16
Great Lakes Hopper Dredge *Sugar Island* Loaded with Capping Sand Approaching Cell in the Mystic River

Photo 17
Hopper Dredge Discharging Capping Sand Over Cell M12

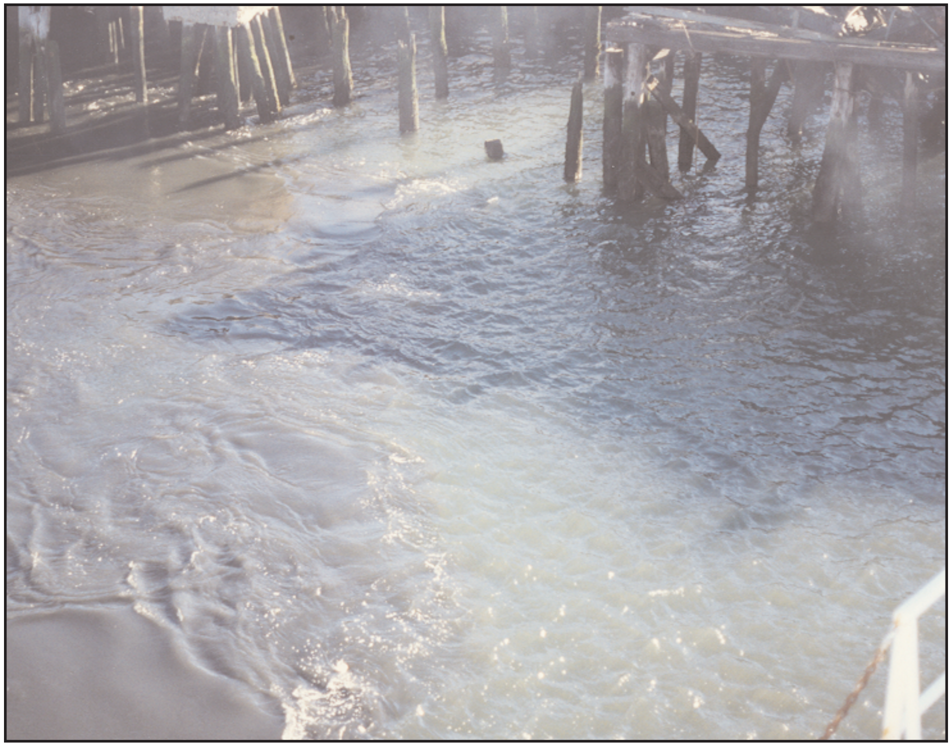


Photo 18
Turbidity Generated by Hopper Dredge During Capping of Cell M12

Photo 19
Hopper Dredge Being Pushed Sideways by Tug While Discharging Capping Sand Over Supercell

Photo 20
Survey Vessel Used for Water Quality Monitoring by Normandeau Associates

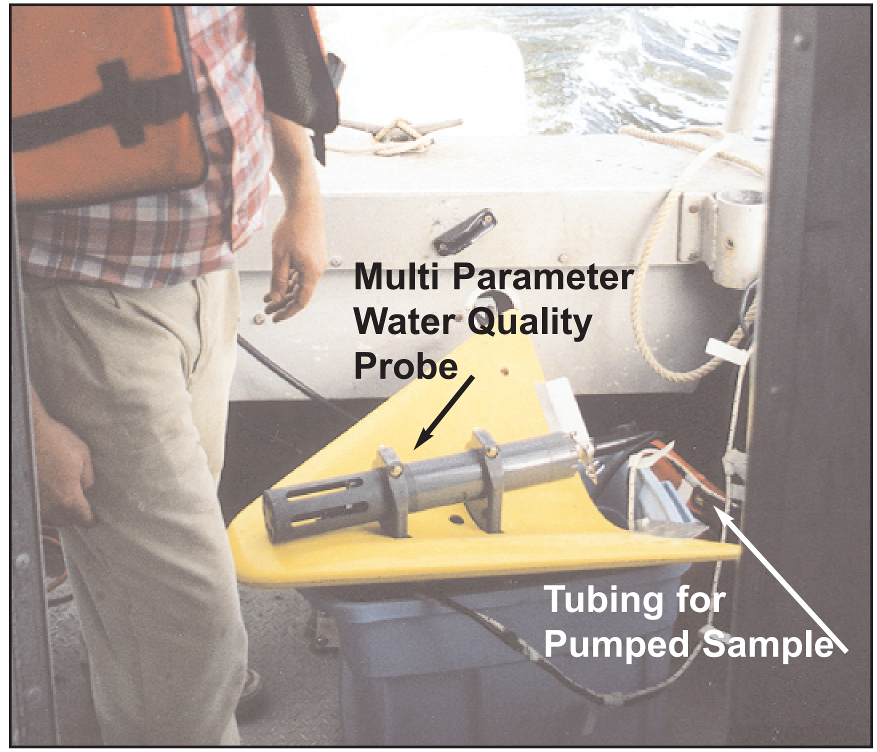
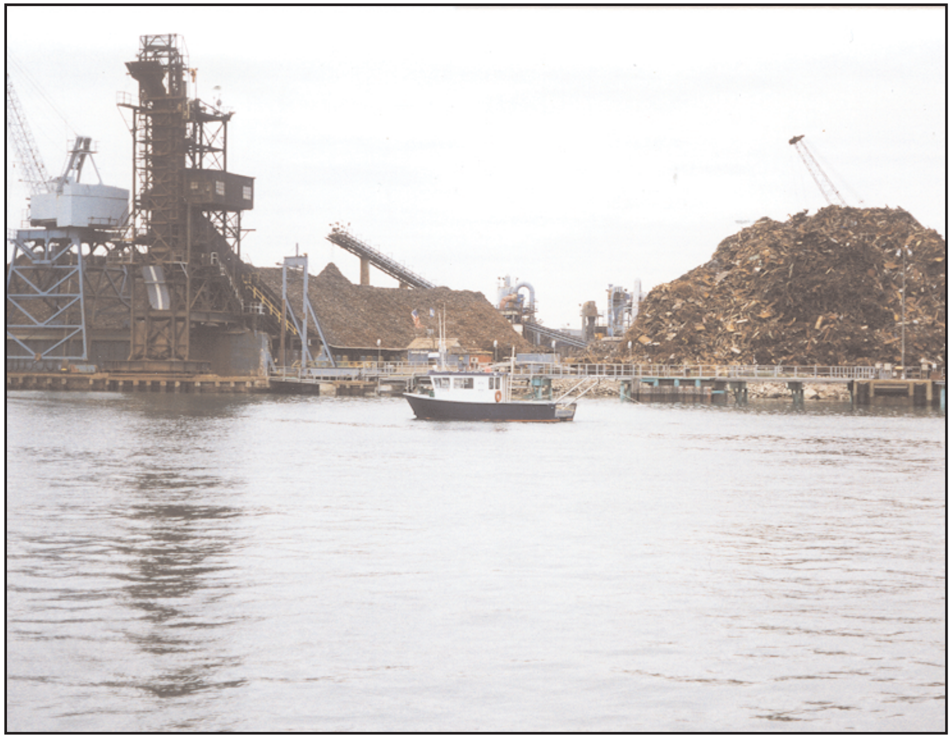
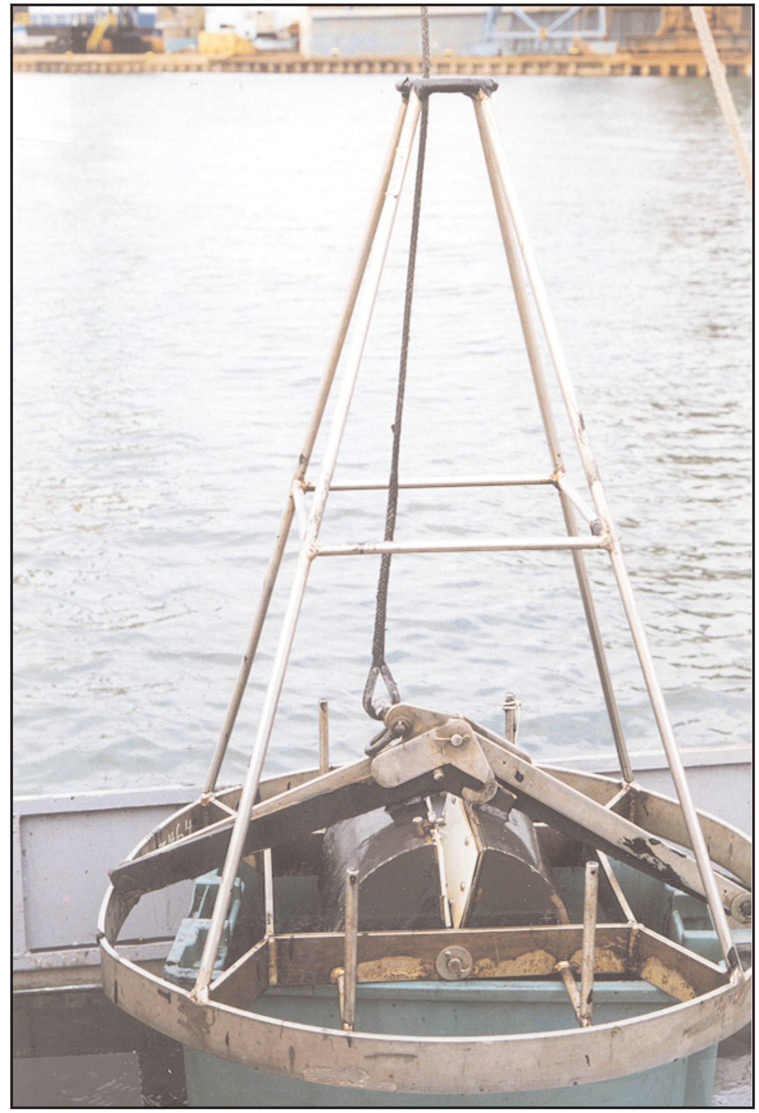


Photo 21
Water Quality Monitoring Set Up





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Upper 20 cm Section of Post-Cap Core from Cell M5

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Transition from Sand to Silt at 150 cm Depth in Post-Cap Core from Cell M5

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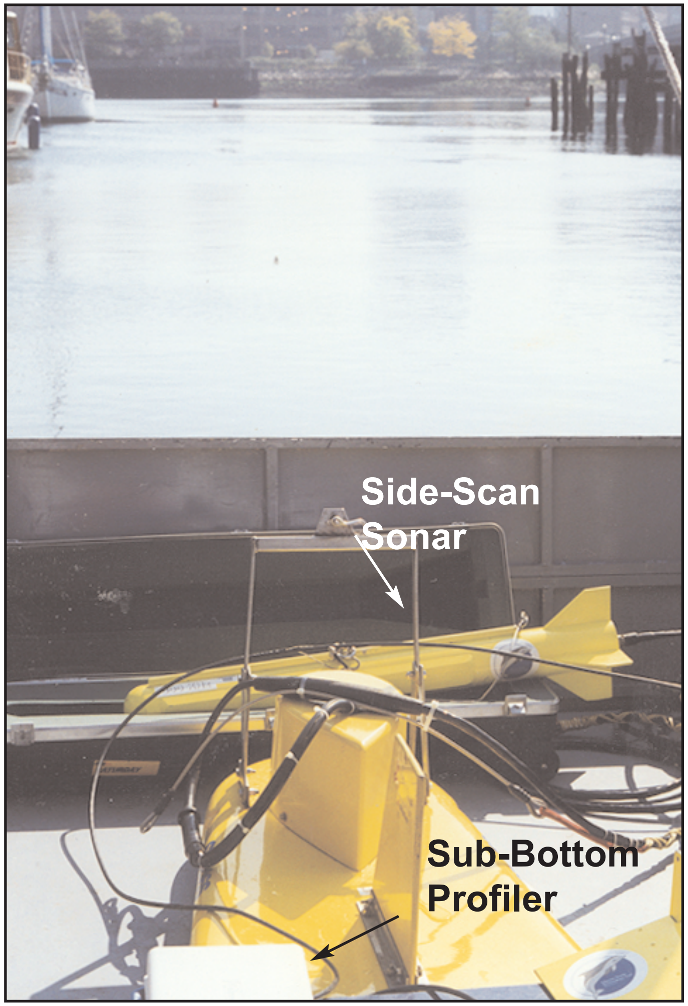
Mixed Sand-Silt Section at 110 cm Depth in Post-Cap Core from Cell M12



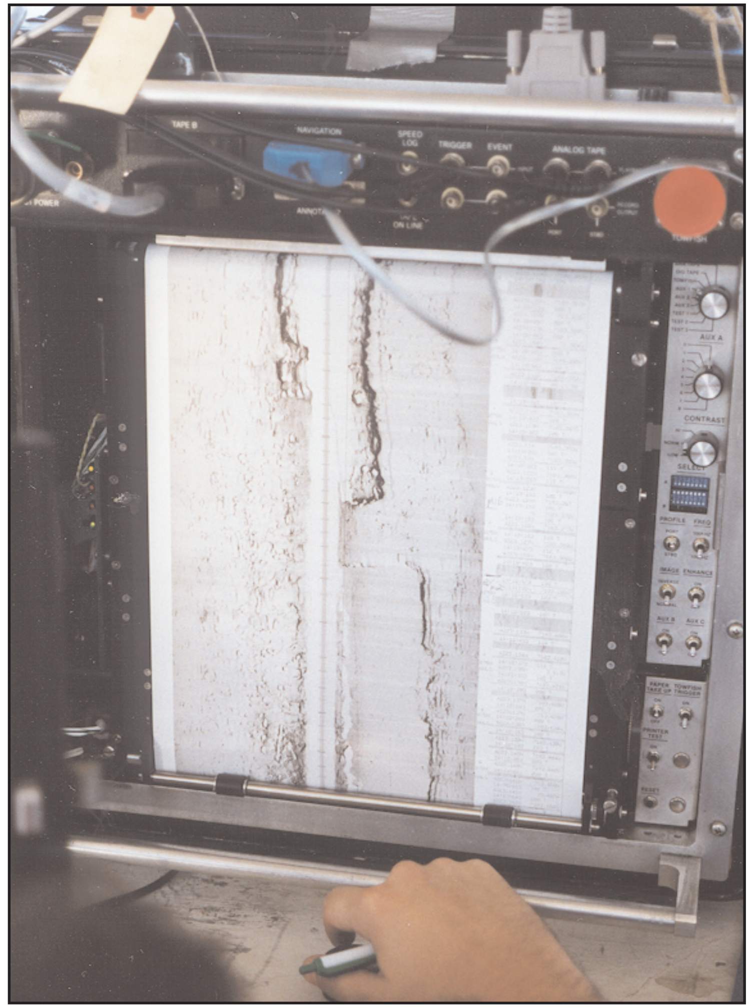
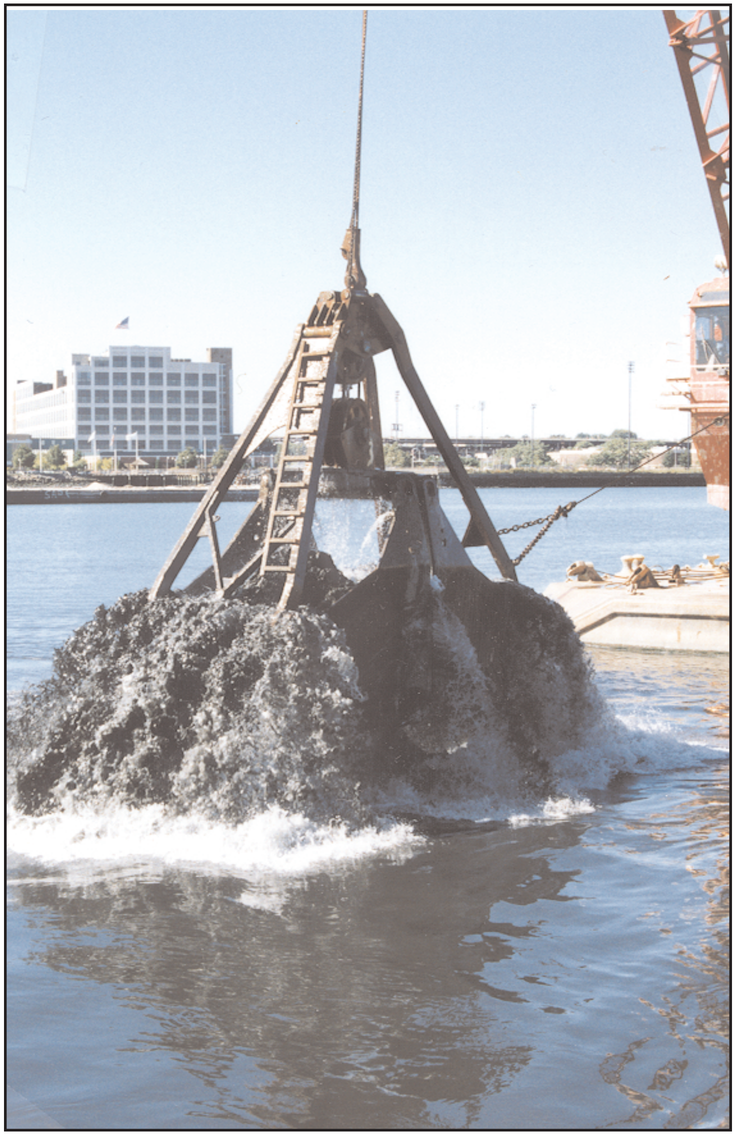


Photo 30
Instrumentation Used in Post-Capping Evaluation



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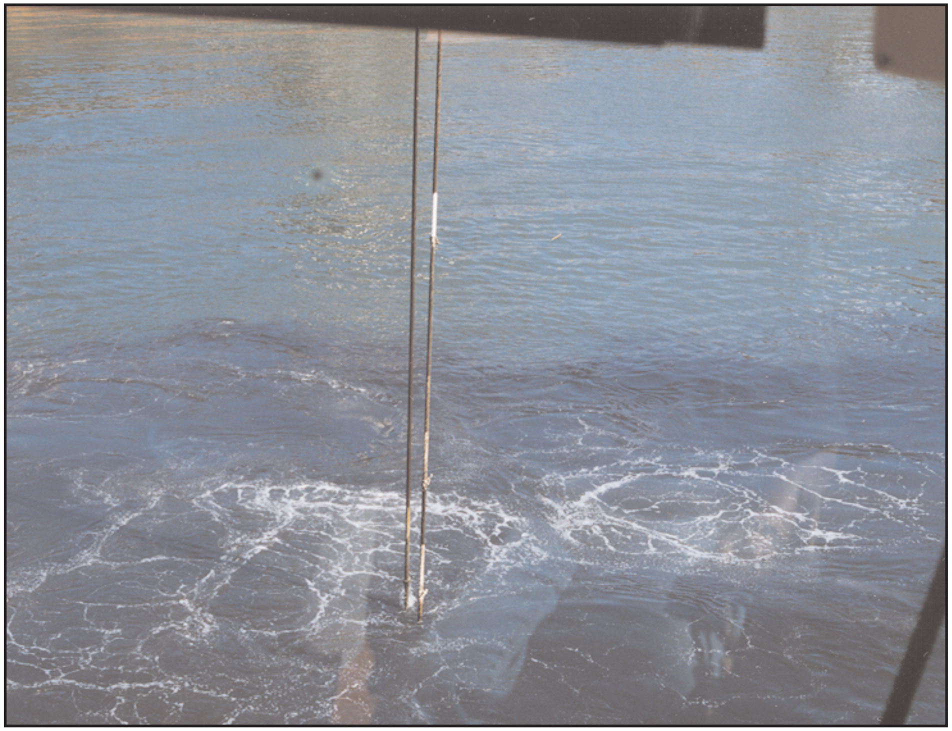

Photo 35
View from Dredge Operator's Station of Turbidity Generated During Maintenance Dredging

Photo 36
Turbidity Generated Behind Tug Maneuvering Over Cell Following Disposal

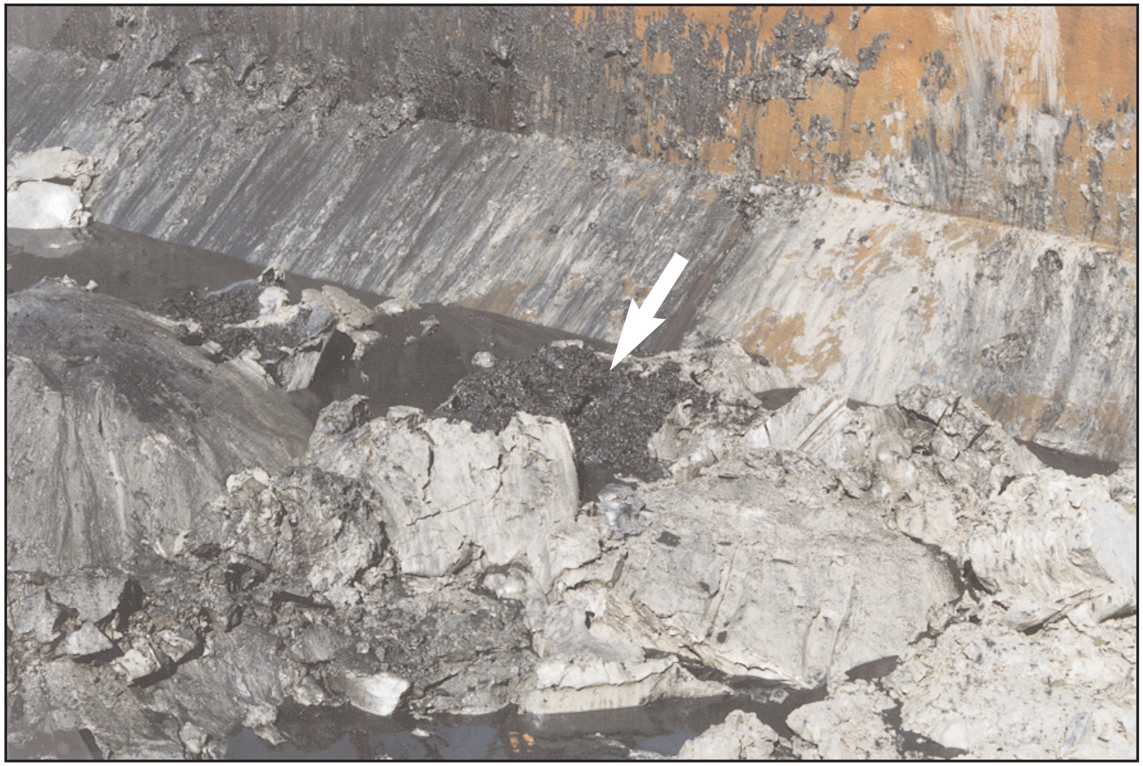

Photo 37
Pocket of Maintenance Material Removed During Improvement Dredging

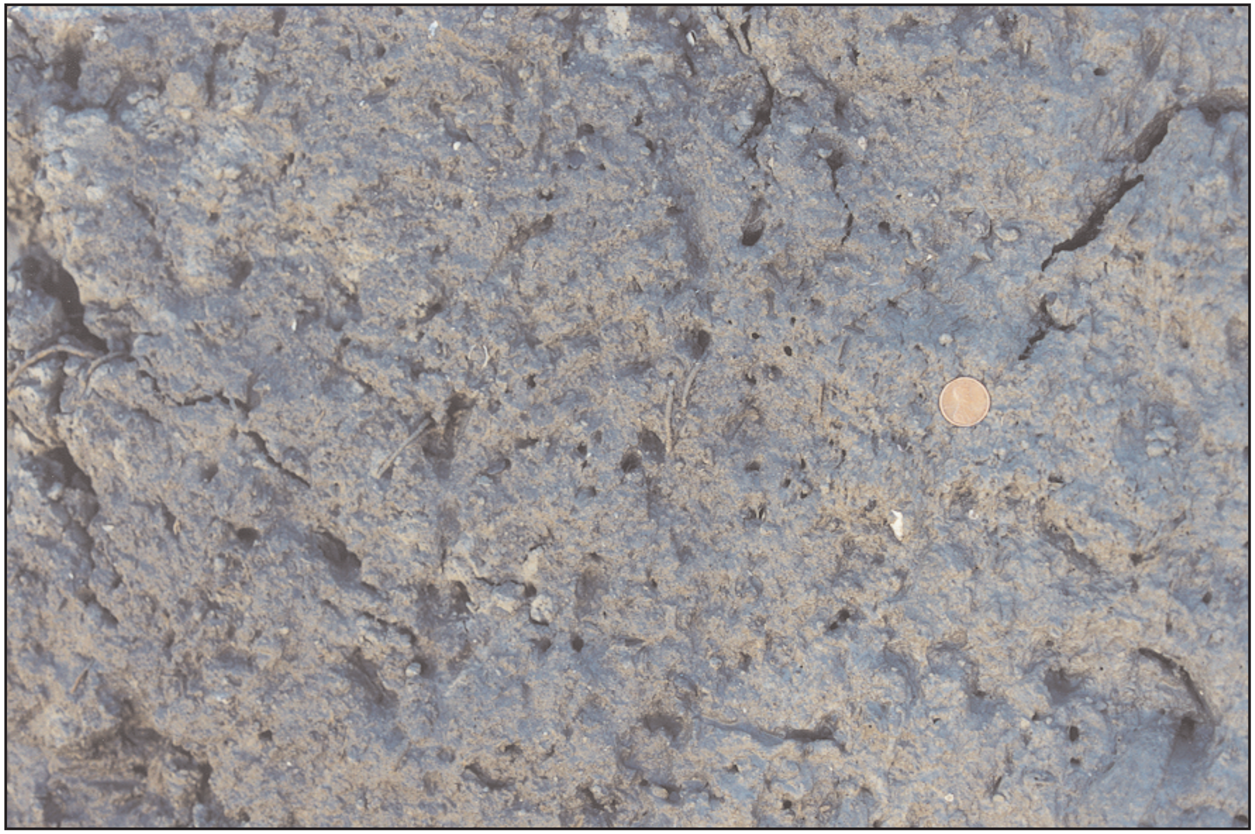

Photo 38
Surface of "First Cut" of Improvement Material Exposed Within Dump Scow

Photo 39
Maintenance Material Screened for Presence of Lobster Within the Inner Confluence

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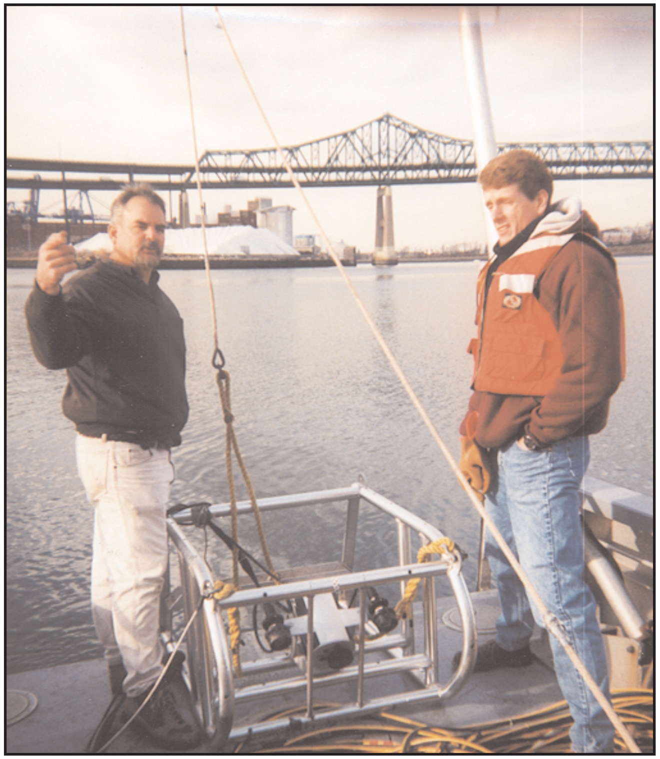

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Underwater Video Sled Being Deployed from Vessel *Cyprinodon* in the Inner Confluence

Photo 41
LNG Tanker *Matthew* Passing Over Supercell Within the Mystic River

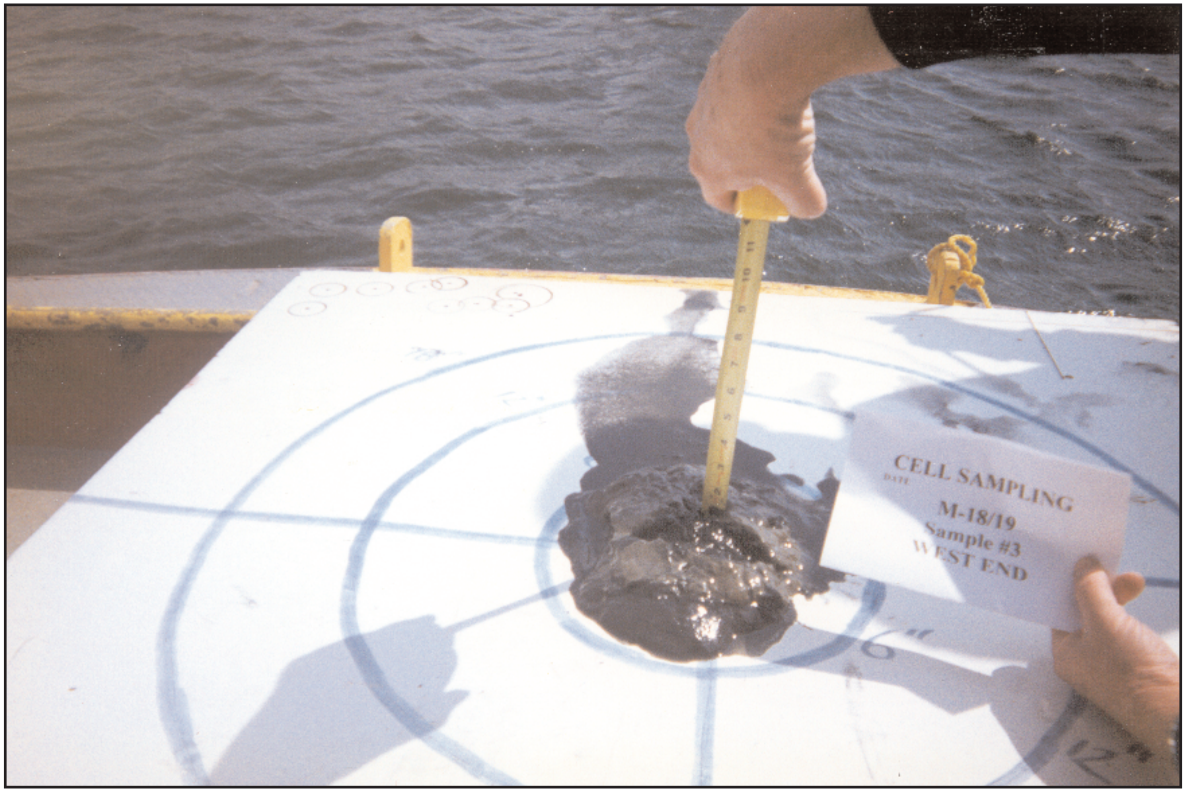

Photo 42
Grab Sample Collected from Surficial Material
Within Cell Prior to Capping