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1.0 EXECUTIVE SUMMARY

Maintaining Gloucester Harbor as a working harbor is a primary goal of the recently completed Gloucester Harbor Plan. In support of that goal, the Harbor Plan identifies dredging as a priority action, to support the many commercial and recreational facilities and uses that make the harbor what it is. The following facilities in Gloucester Harbor and the Annisquam River have reported a need to dredge:

- 16 industrial/commercial facilities
- 9 City landings
- 4 marinas
- The Fish Pier, the Annisquam River, and Smith Cove

To dredge these facilities, Gloucester needs a place to safely dispose of the dredged material. However, Gloucester harbor sediments are typical of the urban ports of the Northeast and contain contaminants as a result of years of industrial and commercial activities. These contaminants are potentially harmful to marine life, and much of the sediment therefore cannot be disposed of at the ocean site that was used frequently in the past. State and federal law requires that the sediment that cannot go to the ocean site must be "managed" to remove it from direct contact with the environment. The time and cost required to manage these sediments, by identifying environmentally responsible and cost-effective disposal sites, is often so great that marine facilities cannot afford to dredge.

Because maintaining working ports and harbors is so important in Massachusetts, the state, through Massachusetts Coastal Zone Management, and with funding and support from the Seaport Advisory Council, is working with the City of Gloucester to identify locally acceptable disposal sites for material dredged from Gloucester Harbor.

The purpose of this Draft Environmental Impact Report is to investigate all of the potential options available for the management or disposal of Gloucester Harbor dredged material, and to present for review and comment a recommended approach. Comments from the public, the City, and state and federal regulatory agencies on the information and recommendations in this DEIR will guide our continuing work with the City.

This summary of the Gloucester Harbor DMMP DEIR presents an overview of the full report contents, lists the principal environmental impacts of the alternatives for dredged material management and identifies measures to be implemented to mitigate unavoidable environmental impacts.

1.1 Name and Location of Project

The project described in this DEIR is the Gloucester Harbor DMMP, in Gloucester, Massachusetts. An Environmental Notification Form (ENF) was filed for the Gloucester Harbor DMMP on March 16, 1998, by Massachusetts Coastal Zone Management (MCZM) and the City of Gloucester, the project proponents. The location of Gloucester Harbor is shown in Figure 1-1. The Executive Office of Environmental Affairs (EOEA) file number for the Gloucester Harbor DMMP is 11534.

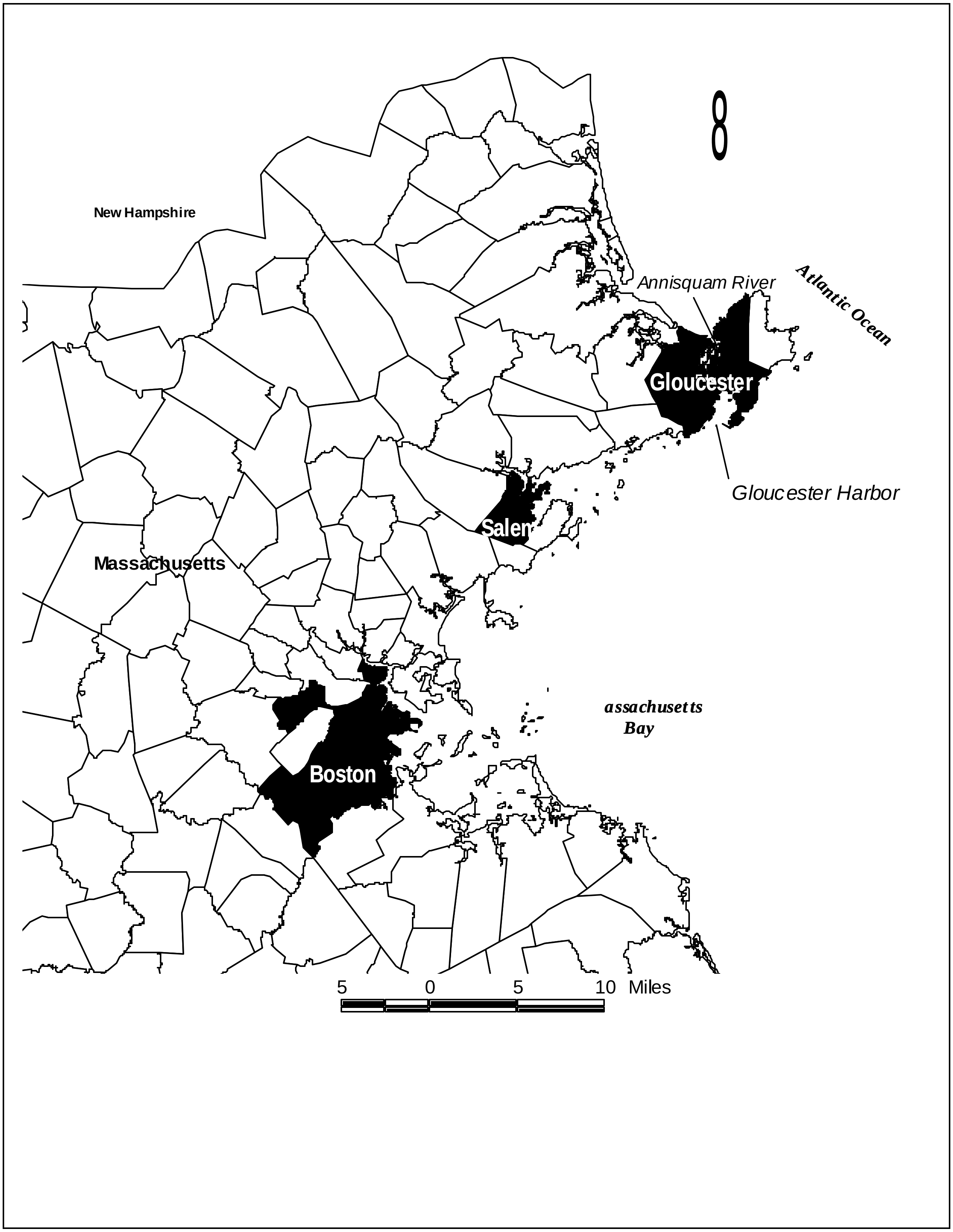

Figure 1-1: Location of Gloucester Harbor

1.2 Project Description

This DEIR includes an analysis of alternative upland and aquatic dredged material disposal sites and alternative technologies to treat sediments that are unsuitable for unconfined open water disposal ("unsuitable dredged material" or "UDM") for eventual disposal or beneficial reuse. The DEIR identifies one preferred alternative for disposal of UDM, consisting of four Confined Aquatic Disposal (CAD) sites.

The DEIR recommends a single preferred alternative, with four aquatic disposal locations. Public comment will be invited on this DEIR in full compliance with the regulations implementing the Massachusetts Environmental Policy Act (MEPA). The preferred alternative will be evaluated by additional site specific analysis in the Final Environmental Impact Report (FEIR).

The Gloucester Harbor DMMP provides a mechanism for balancing existing and future needs for the disposal of UDM associated with the maintenance or improvement dredging of harbor facilities while maintaining existing environmental resources. The framework established in the Gloucester Harbor DMMP provides technical information in support of the harbor management goals of the City of Gloucester and the sound management of Gloucester's environmental and maritime economic resources.

1.2.1 DEIR Development Process

The Gloucester Harbor DMMP DEIR was developed in close coordination with a working group representing diverse local interests. This group, the Gloucester Harbor Dredging Subcommittee, was appointed by the City as a subcommittee to the full Harbor Planning Committee, and now to the Harbor Plan Implementation Committee. Four (4) presentations and nine (9) working meetings and two (2) screening meetings on the management of dredged material were held with the Gloucester Dredging Subcommittee. In addition to the above, six (6) meetings were held with various recreational and commercial fishing interests to gather further local input on their understanding of the Gloucester Harbor and surrounding waters (Massachusetts Bay) marine environment.

This project has also been coordinated closely with State and Federal regulators with review jurisdiction over the disposal of UDM. Reviewing agencies have been involved at key project milestones, and their comments accordingly incorporated. This early coordination has been essential in developing the preferred alternative put forward in this report.

1.2.2 Public Comment Process

This DEIR represents a key milestone in the MEPA (Massachusetts Environmental Policy Act) review process for public comment. Upon notification of receipt of this DEIR by the Secretary of Environmental Affairs, in the *Environmental Monitor*, there will be a thirty-seven (37) day review period from the date of notification of the availability of the report. MCZM will coordinate with the City if an extension of the comment period is necessary. Comments on the Gloucester Harbor DMMP should be directed to MEPA:

Secretary
Executive Office of Environmental Affairs
Attention MEPA Office
EOEA No. 11534
251 Causeway Street, Suite 900
Boston, MA 02114-2150

All comments made on the Gloucester Harbor DMMP DEIR will be addressed in the Final Environmental Impact Report (FEIR), consistent with MEPA's purpose "to provide meaningful opportunities for the public review of potential environmental impacts" associated with the project. MCZM will continue to coordinate closely with the City in the development of the FEIR to provide opportunities for public involvement.

1.2.3 Purpose and Need

The purpose of the DMMP for Gloucester Harbor is to identify, evaluate and permit, within the upland and aquatic Zones of Siting Feasibility (ZSFs) for Gloucester Harbor (see Figures 1-2 and 1-3), dredged material disposal sites or management methods for the disposal, over the next twenty (20) years, of dredged material unsuitable for unconfined ocean disposal. The lack of practicable, cost-effective methods for the disposal of dredged material unsuitable for unconfined ocean disposal in an environmentally sound manner has been a long-standing obstacle to the successful completion of dredging projects in Gloucester Harbor and other harbors throughout the Commonwealth.

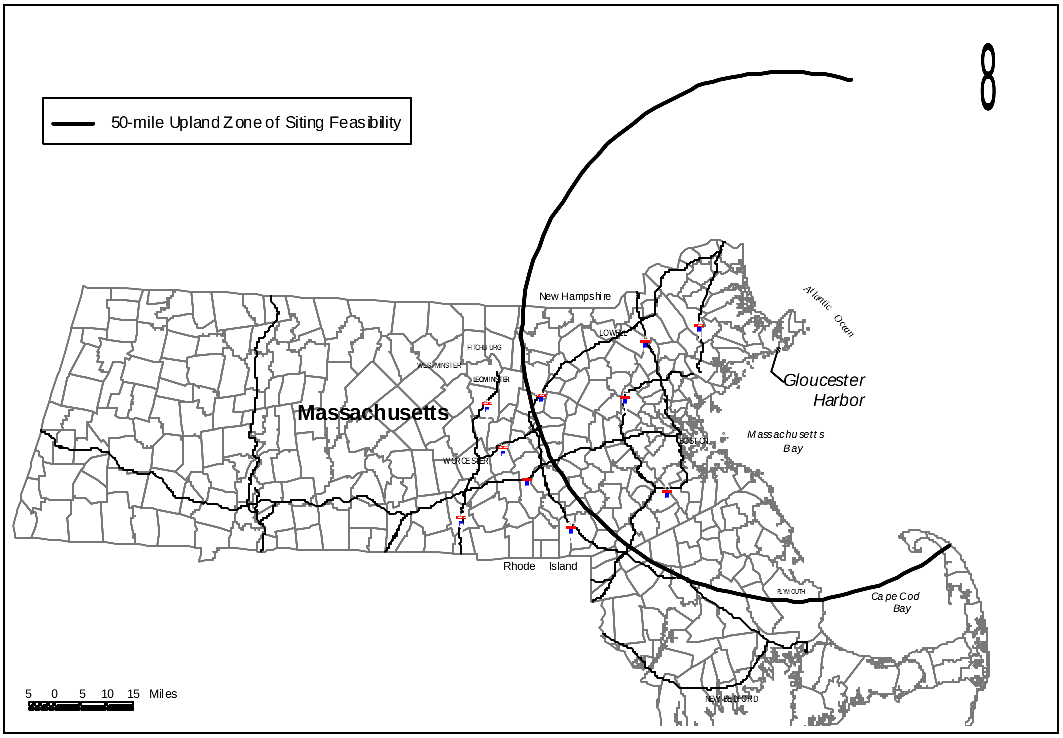

Figure 1-2: Upland Zone of Siting Feasibility

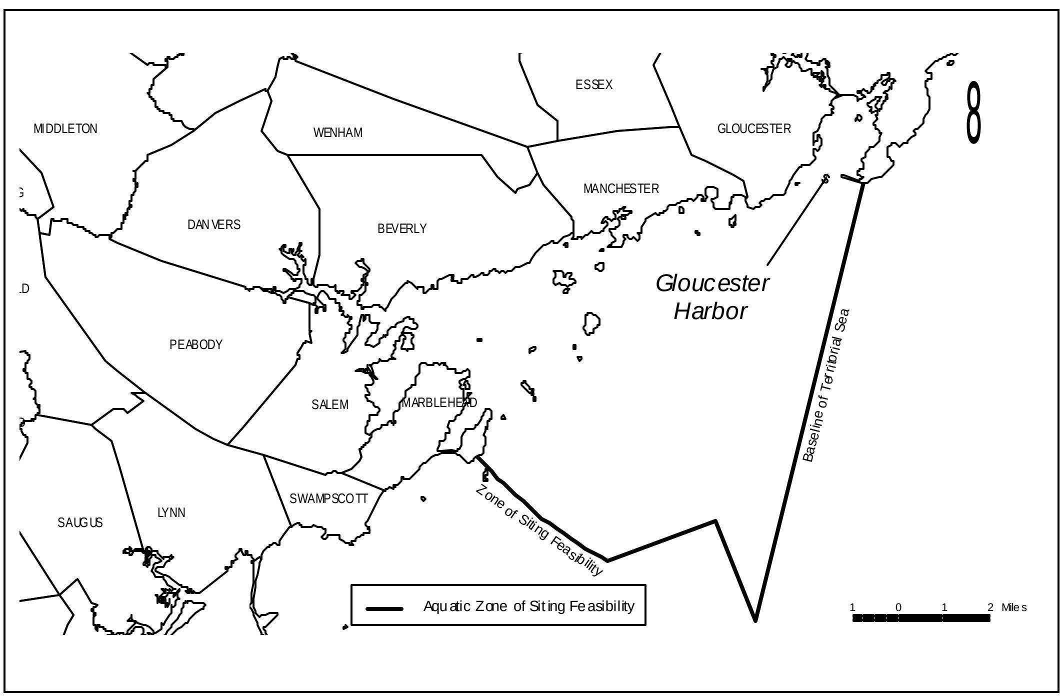

Figure 1-3: Aquatic Zone of Siting Feasibility

Based on dredging records collected in the Massachusetts Navigation and Dredging Management Study that was completed by the USACE for the State of Massachusetts (USACE 1995), a total of 1,178,370 cubic yards (cy) of material has been dredged from Gloucester Harbor and the Annisquam River since 1932. Much of this volume was dredged prior to 1966, when the federal channel and anchorage areas were created. Additional dredging in the harbor since construction of the channel has included USACE maintenance dredging, projects performed by Massachusetts Department of Environmental Management (DEM) at various locations, city dredging and many private dredging operations.

The volume of sediment to be dredged from Gloucester Harbor over the next twenty years has been estimated through surveys conducted by the USACE (1996) and Maguire (1997). The dredged material volume estimates are needed to identify, plan and permit a disposal site(s) with sufficient long-term capacity to accomodate the needs for Gloucester Harbor.

The total volume of sediment to be dredged from Gloucester Harbor over the next 20 years is estimated at 514,440 cy. This figure includes a 20% contingency added to the surveyed volume to account for any uncertainty in the volumes provided by the marine users. The volumes presented in the sub-sections below are *without* the 20% contingency.

During the 1997 survey, all shoreline marina owners, municipalities, utilities, state and federal agencies were contacted via a mail-back questionnaire, with follow-up telephone calls to non-respondents. Marine users were asked to complete a questionnaire, denoting dredging footprints, volumes, and anticipated time schedule over the next 20 years. There were over fifty facilities (i.e. marinas, basins, channels) identified in the inventory, but not all facilities identified a need to dredge. The maintenance dredging of the Annisquam River is the largest project. The USACE has stated that the River is in need of maintenance dredging immediately. The Annisquam River is subject to heavy siltation and, on average, requires dredging every 8 years. Therefore, over the DMMP's 20-year planning period, an additional round of maintenance dredging has been included in the inventory. The inventory represents a planning estimate based upon *reported need*. Neither the inventory nor the DEIR establishes a list of projects that will or will not (by their absence from the inventory) be dredged.

Dredging of private marinas comprises a significant portion of the total material to be dredged from Gloucester (Figure 1-6). However, there are no maintenance or improvement dredging projects planned for the Gloucester Harbor federal channel and anchorage areas. In the original dredging inventory (1997), a proposed deepening of the federal channel from 20 feet to 26 feet was identified as a potential project involving 427,000 cy of dredging in the entrance channel, north channel and anchorage area. Further federal and city review has determined that this dredging is not necessary to support current harbor uses.

Given the assumptions presented above, it is estimated that approximately 276,000 cy of sediment to be dredged from Gloucester Harbor over the next 20 years would be UDM. For planning purposes, a 20% contingency has been added to the unsuitable volume to arrive at a volume of approximately 333,000 cy.

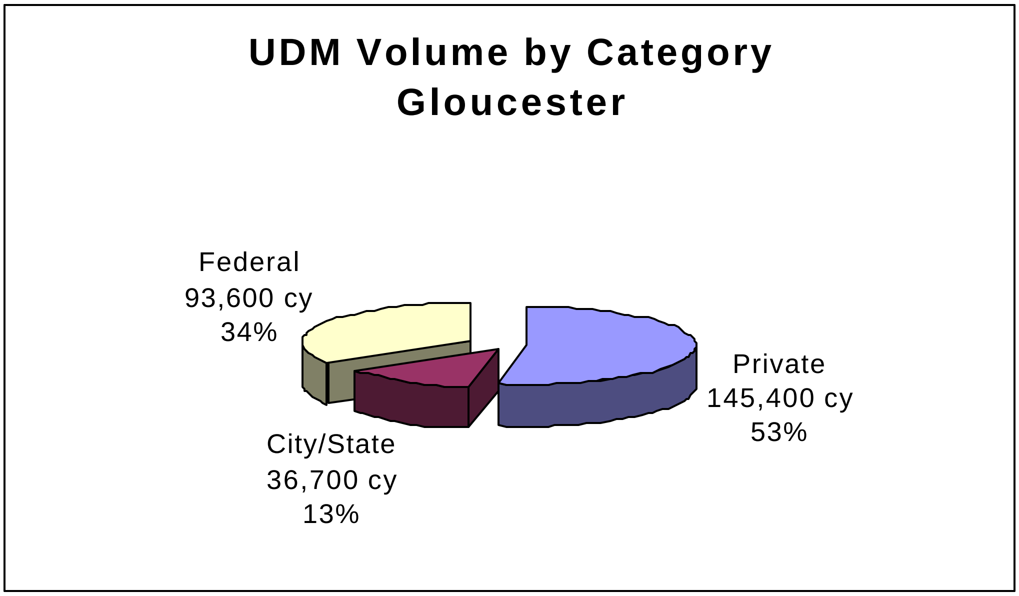

Figure 1-4: UDM Volume for Gloucester by Project Type (does not include 20% contingency)

Table 1-1: Dredged material volumes (cy) for Gloucester Harbor for next 20 years

Inventory Total	Inventory Total with Contingency[1]	Suitable Dredged Material[2] with Contingency	Unsuitable Dredged Material[3] with Contingency
428,700	514,440	183,600	**330,840**

Notes:
[1] Contingency is 20%
[2] Suitable for disposal at MBDS
[3] Not suitable for disposal at MBDS

Depending on the selection of disposal type (upland, aquatic) and location, there may be an additional volume of UDM. For example if a CAD cell footprint contains UDM, then the volume of material excavated for the creation of the CAD cells would also have to be managed as UDM. This scenario is discussed in greater detail in Section 8.0. To put the amount of UDM into perspective, 330,840 cy would cover approximately 205 acres to a thickness of one foot or cover the State Fish Pier to a depth of over sixty feet high.

1.2.4 Alternative Disposal Sites

1.2.4.1 Universe of Sites

Possible geographical locations to implement upland and aquatic disposal alternatives for UDM were investigated within the upland and aquatic ZSFs defined for the Gloucester Harbor DMMP. The logistical basis for each ZSF, described below, established a reasonable search area to develop the universe of potential disposal locations. A description of the development of the upland and aquatic universe of sites considered for the Gloucester Harbor DMMP follows.

Upland Universe

The Upland ZSF was established based upon a reasonable truck travel distance from Gloucester Harbor. A 50-mile ZSF (Figure 1-2) was established because it is the maximum distance a truck could travel to and from the dewatering site in a normal 8-hour working day. This included the time for loading and offloading at the dewatering site and disposal site, respectively. The Upland ZSF includes: most of eastern and southeastern Massachusetts, extending as far west in central Massachusetts as I-495;and most of the New Hampshire coastline to the north. Commercial landfills within these states were also investigated.

All possible upland disposal sites, 1,123 total, were identified by locating areas that could physically accommodate the UDM volume estimated in the DMMP Phase I inventory report. The purpose of this effort was to identify the largest possible universe of potential sites for analysis. The locations evaluated for this effort included all existing landfills (commercial and private), other areas identified by previous upland evaluations (MWRA, Boston Harbor, etc.). In addition, a statewide announcement for interest from landowners to accept the UDM was conducted to complete the comprehensive search for possible sites within the Upland ZSF. No detailed environmental or socioeconomic assessments were performed at this level.

Aquatic Universe

The Aquatic ZSF for Gloucester was defined based on reasonable transit distances from the dredging projects, local jurisdictional boundaries, and evaluation of restricted use areas such as marine sanctuaries. Based on the transit distance criteria, the Aquatic ZSF was defined by an arc extending 10 nautical miles (nm) (12 mi) from the entrance of Gloucester Harbor (Figure 1-3). Ten nm represented a reasonable distance to permit two round trips for a disposal barge towed at less than 5 knots within a 12-hour period. Sites considered further away would place an unreasonable operational cost on projects in the Port of Gloucester, particularly smaller dredging projects. In addition, the zone south of 10 nm has been extensively screened as a result of the Boston Harbor Navigation Improvement Project (NAE and Massport 1995). The Aquatic ZSF in Gloucester also was bounded southerly by the Nearfield Monitoring outfall. To the east the Aquatic ZSF was restricted by the limits of the baseline of the territorial sea based on state jurisdiction and the regulatory oversight of Section 404 CWA (40 CFR Part 230.2[b]). Finally, the Aquatic ZSF was limited to the south by the Massachusetts Water Resources Authority (MWRA) Deer

Island Wastewater Treatment Plant outfall difuser field and the "...reasonable distance to permit two round trips for a disposal barge towed at less than 5 knots within a 12-hour period" criteria of 10 nm.

Within the Aquatic ZSF, a total universe of 41 potential sites were identified. Potential sites were identified by defining areas with suitable bathymetric depressions and/or indications of a depositional area (i.e., containment areas not susceptible to storm wave currents) and existing navigational projects. Again, no detailed environmental or socioeconomic assessments were performed at this level.

1.2.4.2 Screening Process

The goal of the DMMP screening process was to identify the most appropriate sites for the disposal of UDM. There were no numerical thresholds that identified the "best" site; rather, the DMMP screening process was a relational comparison among potential sites and types by which a determination was made regarding which site is "better" than another. Therefore, the screening process was designed to assess a wide range of potential sites and then, through sequential analysis, continually narrow the list until only the most appropriate sites remained. The most appropriate sites were determined to be those that meet local, state and federal permitting standards, are consistent with Gloucester's harbor planning objectives and are capable of being implemented at reasonable cost.

The DMMP screening process consisted of three primary steps:

- Initial screen for feasibility
- Application of site selection screening criteria
- Identification of preferred alternatives

Initial Screen for Feasibility

From the universe of potential sites, MCZM applied a screen for feasibility and eliminated sites that were clearly not suitable for disposal of dredged material. Sites were screened out because of the surrounding land uses (for upland sites), lack of protection from erosive bottom currents (aquatic sites), lack of access for the disposal type, or insufficient capacity as discussed in Section 4.0, alternative treatment technologies were evaluated for capabilities and logistical requirements of the process equipment, current and projected costs. Because new technologies are evolving, alternative treatment technologies are carried forward as an "open" category where practicable technologies will be assessed as they emerge. Sites that were not feasible disposal options were permanently eliminated from further consideration in this DEIR. Feasible sites were identified as Candidate Sites.

Application of Screening Criteria

In preparation for site selection screening, MCZM developed site selection screening criteria based on the United States Army Corps of Engineers (USACE) Providence River Draft Environmental Impact Statement (USACE, 1998). The development of these criteria was coordinated with local, state, and federal agencies for concurrence. Site selection criteria were the standards by which the candidate sites were evaluated.

Site selection criteria were distinguished as either "exclusionary" or "discretionary"**.** Exclusionary criteria reflect a state or federal prohibition on dredged material disposal. For example, Stellwagen National Marine Sanctuary regulations prohibit dredged material disposal within the sanctuary. Had any candidate sites been situated within sanctuary boundaries (none were), this exclusionary criterion would have prohibited further evaluation of that site. Discretionary criteria are those that determine, when applied as a group, which sites are least or best suited for dredged material disposal. For example, the potential impacts to finfish spawning or nursery habitat were evaluated under discretionary criteria: the presence of such habitat in a candidate site would not automatically exclude the site from further consideration, but would identify that site as less desirable than one in which such habitat was absent. The application of various discretionary criteria was the main component of the screening process, and it was the process by which sites were compared, using the quantitative, site-specific information and regional characterizations to make a qualitative decision – which site was "best".

To determine whether a given site included the exclusionary criteria and to determine how it compared to the discretionary criteria, site specific information was developed. Data sheets were developed for each candidate site, listing the environmental, social, political, and economic features of the site.

Candidate sites were screened under the exclusionary criteria. Those that failed were eliminated from further review. Sites that do not have features that are exclusionary became Potential Alternatives**.** Potential Alternatives were, then, reviewed using the discretionary criteria. Each Potential Alternative was assigned a relative ranking. Sites having significant limitations received low rankings; sites with fewer limitations received higher rankings.

The result of the screening process was a continuum of sites, from least to most appropriate for each disposal type evaluated. The least appropriate sites were categorized as reserve sites**,** and, as the name implies, were carried forward in reserve, but subjected to further analysis. More appropriate sites for dredged material disposal were categorized as Proposed Preferred Alternatives**.** Proposed preferred alternatives were presented to the City and federal agencies for comment. Results of the former, resulted in refining and the identification of the Preferred Alternatives Sites The DMMP Disposal Site screening process is shown in Figure 1-5.

The Gloucester Harbor DMMP DEIR investigated the potential for the treatment of UDM with alternative treatment technologies to create material for beneficial uses, disposal in upland and aquatic locations. Additionally, the DMMP evaluated potential dewatering sites, critical to implementing alternative treatment technologies and upland disposal options. The following sections summarize the results of the alternative technology assessment, dewatering, upland and aquatic site screening.

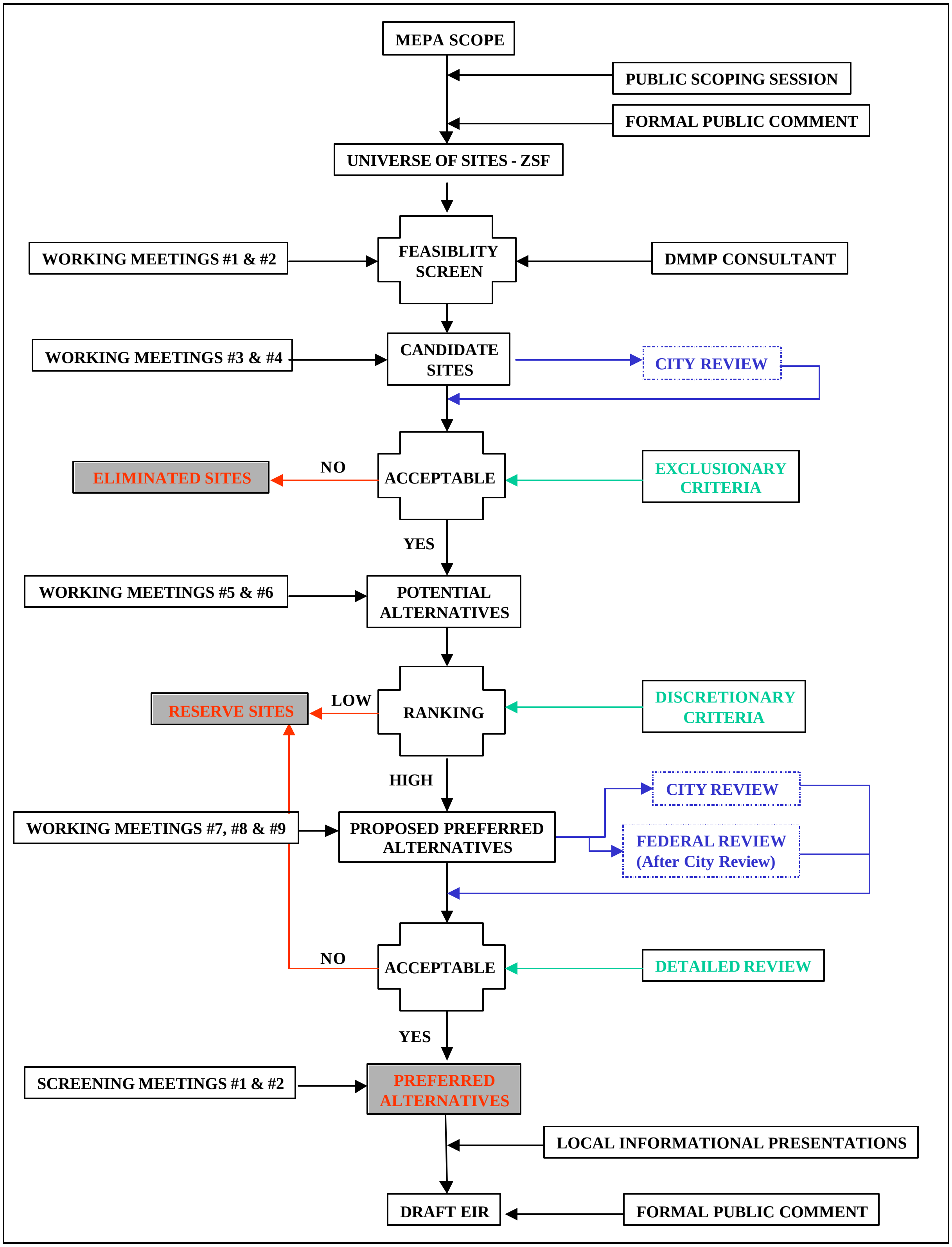

Figure 1-5: DMMP Disposal Site Screening Process

Alternative Technology Assessment

Alternative treatment technologies involve the treatment of UDM, using one or more processes, to allow for reuse of the sediment in a safe manner in the upland environment or for unconfined open water disposal. There are four general types of treatment technologies, categorized based on their effect on the contaminants of concern within the sediment:

- *Destruction*; the removal of contaminants from the sediment via physical, chemical or biological agents;
- *Separation*; the process of removing contaminants from the sediment resulting in a concentrated residual of contaminated sediment of significantly smaller volume;
- *Reduction*; the process of reducing the amount of contaminated dredged material that requires treatment by screening sediments into various particle sizes; and
- *Immobilization*; the fixing of contaminants in the dredged material which keeps the contaminants from being released to the environment.

Fourteen (14) classes of treatment technologies were evaluated within the four broad categories listed above, involving a comprehensive survey of technology vendors. The results of the alternative treatment technology assessment indicate that, at this time, alternative treatment technologies do not appear to be a practicable solution to the management of UDM from Gloucester Harbor, primarily based upon cost effectiveness and market for materials.

However, alternative treatment technologies may prove viable for small projects, those that deal with unique and/or specific type(s) of contaminant(s), or as an element of a larger UDM management technique. Alternative treatment technologies are a rapidly growing and evolving field and it is very likely that as ongoing and future pilot and demonstration projects occur, the universe of technically viable, cost-competitive, and permittable alternatives may emerge.

For this reason, the DEIR carries forward all alternative treatment technologies as "potential future alternatives", and specifies the various general performance standards which alternative treatment technologies must meet to be considered as a practicable alternative (see Section 4.5 for a discussion of Beneficial Use Determination (BUD) process). This flexible approach will provide a baseline from which proponents of alternative treatment technologies can develop and present specific, detailed proposals, and will allow the state to focus its reviews on potentially practicable proposals. This approach is based on the Boston Harbor EIR/EIS. The DMMP will reevaluate, on a five year cycle, the feasibility of alternative treatment technologies for UDM in Gloucester Harbor and other harbors throughout the Commonwealth.

Dewatering Sites

All upland disposal/reuse and most alternative treatment technologies require a shore-front site of adequate size and availability to dewater dredged material prior to transport to an upland site. A total of thirty-eight (38) potential dewatering sites were identified along the shoreline from Manchester-by-the-Sea, north to Rockport. The universe of dewatering sites is shown in Figure 1-6.

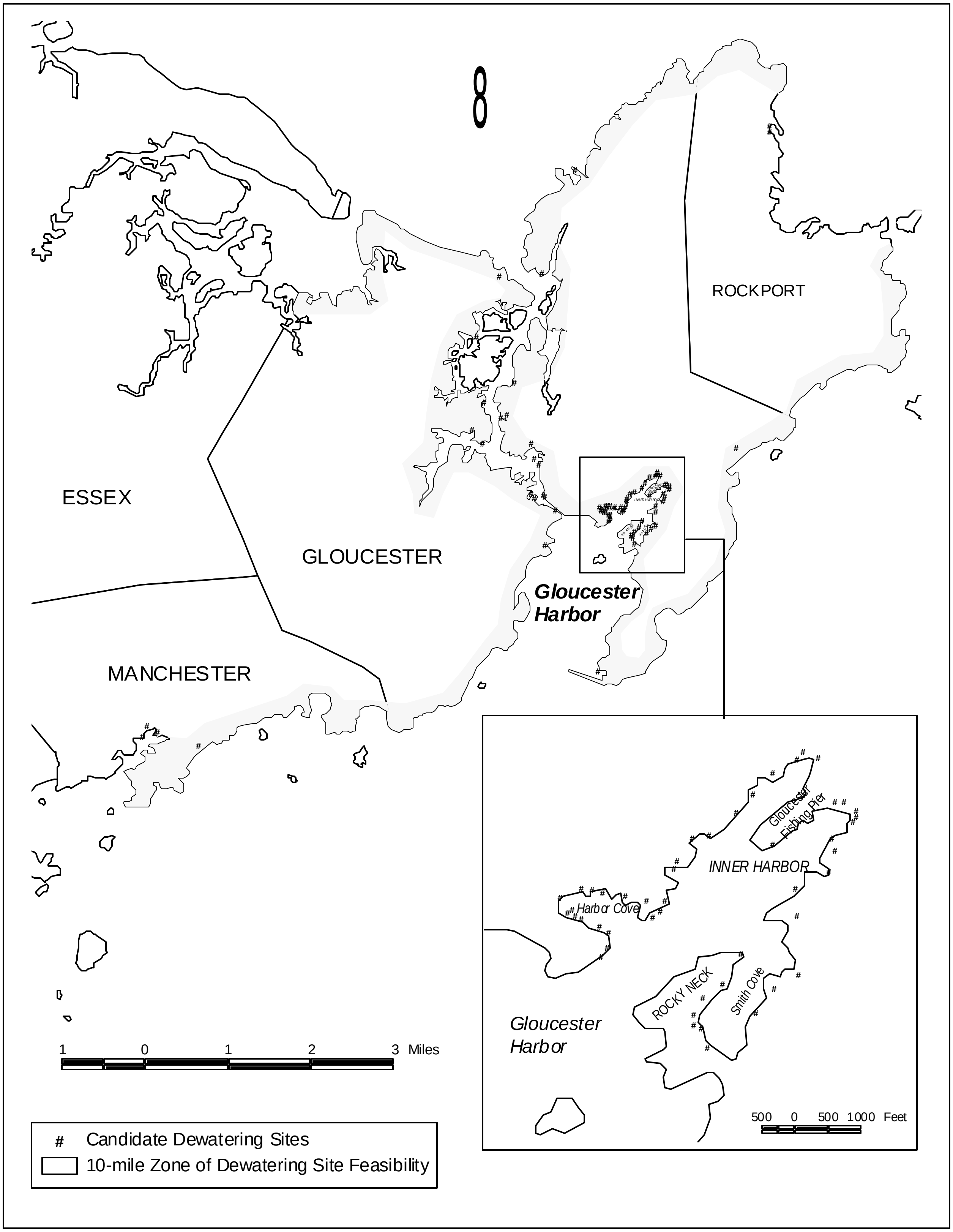

Figure 1-6: Candidate Dewatering Sites

As with the aquatic and upland sites, the 38 candidate dewatering sites were subjected to a two tier process involving the initial screening for exclusionary site factors and a second tier screening for discretionary factors. The exclusionary factors only apply to the harbor side site requirements, all other criteria are discretionary. The minimum site area required for a DMMP dewatering site was estimated to be 3.2 acres. This estimate was based on practical application of DEP policies and guidance, and a minimum project size of 10,000 cy. None of the 38 sites were of sufficient size, nor were the sites practicable for dewatering dredged material.

Upland Sites

Upland reuse and disposal alternatives involve the placement of UDM on land. The site can potentially be an existing active or inactive landfill, or an undeveloped parcel of land. Dredged material can potentially be used as daily cover or grading/shaping material for landfills, provided the material meets the physical and chemical specifications for such use. Dredged material placed on an undeveloped parcel of land could be managed as a monofill (landfill for dredged material only), or could be used as fill or grading material that has a beneficial end use (e.g. ball fields, golf course), provided the physical and chemical properties of the dredged material permit such use. There are currently no regulations in Massachusetts, which specifically apply to the disposal of dredged material in the upland non-landfill environment. Use at active and inactive landfills is based on the requirements and procedures described in DEP Policies COMM-94-037, COMM-97-001 and the July 17, 2000, "Guidelines for Determining Closure Activities at Inactive Unlined Landfill Sites". Monofills for dredged sediment are currently regulated under the Commonwealth's Solid Waste Management Regulations at 310 CMR 16.00 and 19.000).

The total universe of upland sites was subjected to an initial feasibility screen that evaluated the site for a minimum capacity 10,000 cubic yards, and its compliance with setback requirements specified in the Solid Waste Regulations. These factors dictated a minimum site size of twenty-five (25) acres. A total of 270 sites in the upland universe were smaller than 25 acres and were eliminated, leaving a total of 853 candidate disposal sites from an initial universe of 1,123 sites.

These remaining 853 sites were then subjected to an exclusionary screening, based on factors that would effectively prohibit disposal of UDM based on state or federal laws, including the presence of: rare or endangered species; historic or archaeological sites or districts; and drinking water supplies. A total of eleven (11) upland sites within the Gloucester upland ZSF passed the exclusionary screening process. One potential site just outside the ZSF boundary was also carried forward. These sites are illustrated on Figure 1-7.

Additional discretionary screening factors were applied to the remaining 11 sites, including: groundwater and surface water quality; wetlands; accessibility; area of impact; duration of potential adverse impacts; habitat types; terrain; floodplains; agricultural use; ability to contain; potential for odor/dust/noise impacts; consistency with local, regional and state plans; ability to obtain permits; and cost. After the application of the discretionary screening criteria, none of the twelve (12) sites were considered potential preferred alternatives.

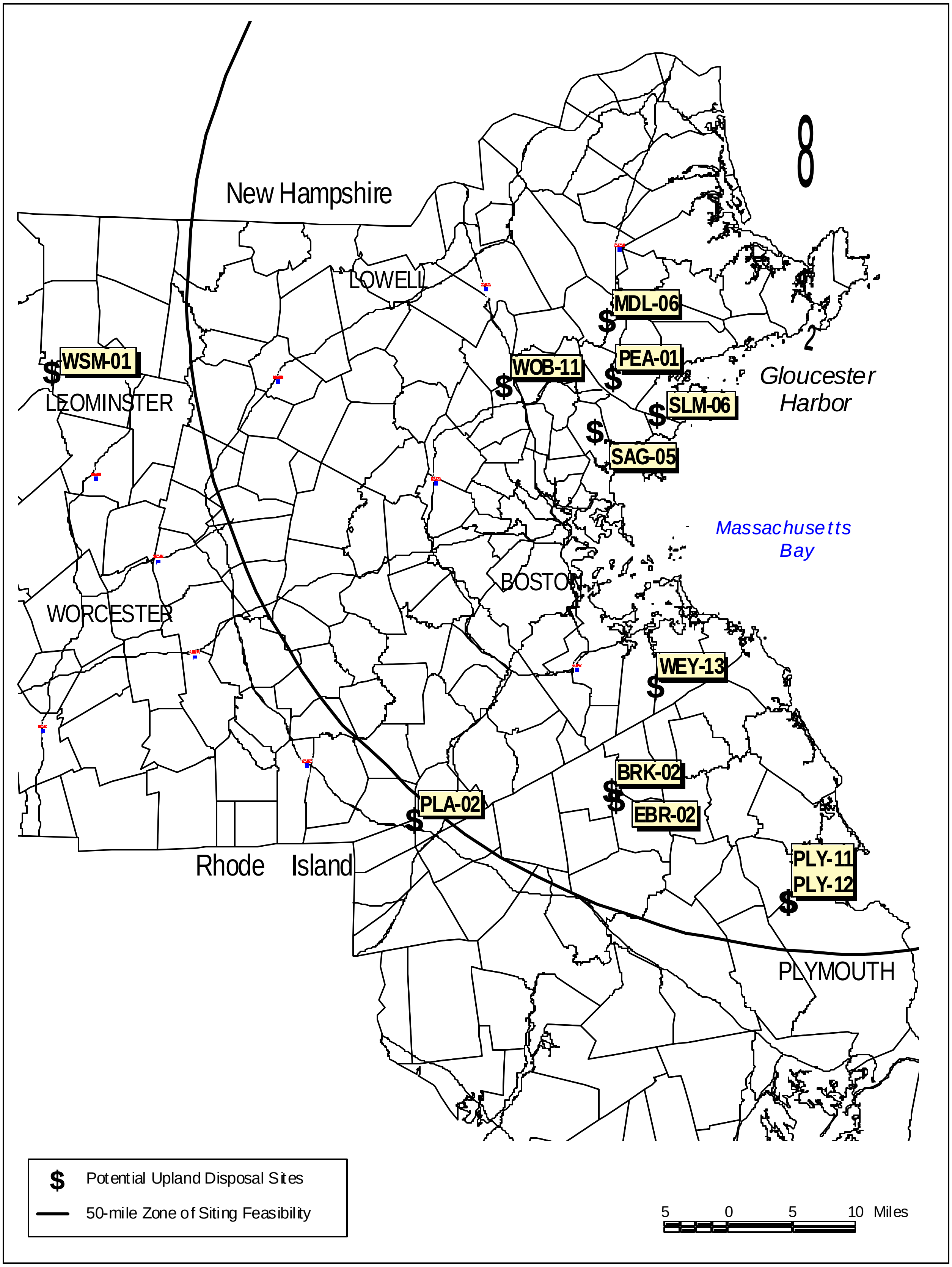

Figure 1-7: Potential Upland Disposal Sites

Aquatic Sites

Two general types of aquatic disposal sites were evaluated for the Gloucester Harbor DMMP: confined aquatic disposal (CAD) and confined disposal facilities (CDF). A CAD is an underwater site where UDM is deposited and then covered (capped) with a layer of clean material to isolate UDM from the environment. A CDF is an aquatic site that is typically an extension of land with constructed walls on the three remaining sides. There are three general types of CADs evaluated in this DEIR:

- Confined aquatic disposal/over dredge (CAD/OD) site: an existing navigation channel is over dredged to a depth sufficient to accommodate both a volume of UDM and a cap of clean material without interfering with navigation (Figure 1-8).

- Open water CAD site: CAD cell is constructed on the ocean bottom, or UDM is deposited in an existing depression in the ocean floor (Figure 1-9).

- Adjacent to channel (ATC) site: a CAD cell constructed in an area immediately adjacent to a navigation channel, where the ocean bottom may be previously disturbed or degraded due to the proximity of the navigation channel and channel dredging activities.

- Confined disposal facility (CDF): a CDF site is constructed by building a wall seaward of an existing land feature and backfilling behind the confinement wall with dredged material. Typical end-use of such facilities include port expansion and open space land creation (Figure 1-10).

- Tidal Habitat (TH): a TH site is a CDF that allows tidal influx, via culverts, over a contained area of dredged material. TH sites can be designed to create mudflat or coastal wetland (Figure 1-11).

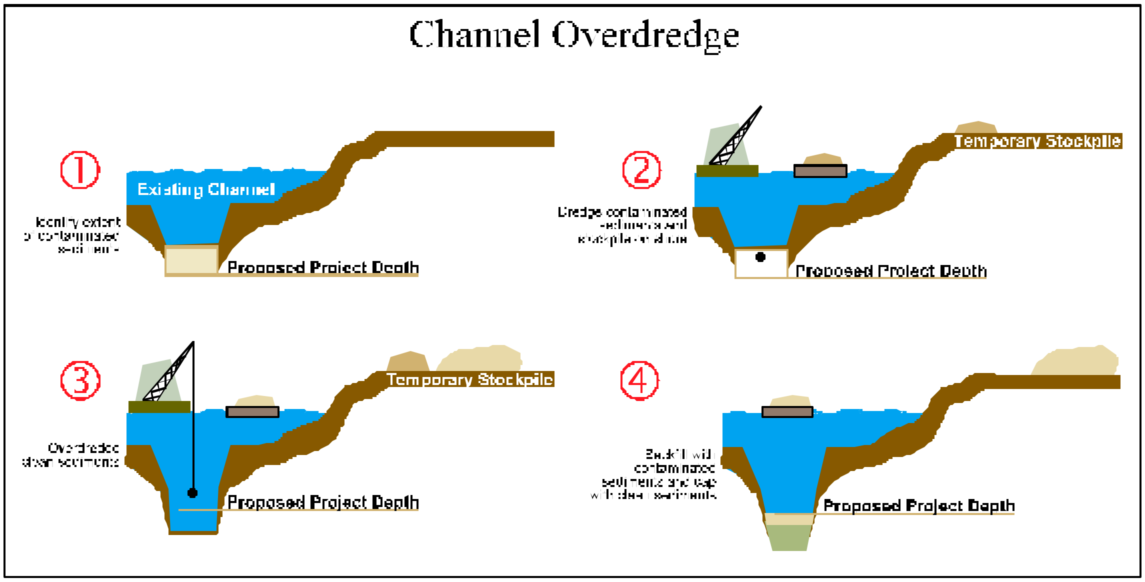

Figure 1-8: Schematic of Channel Overdredge (OD) method

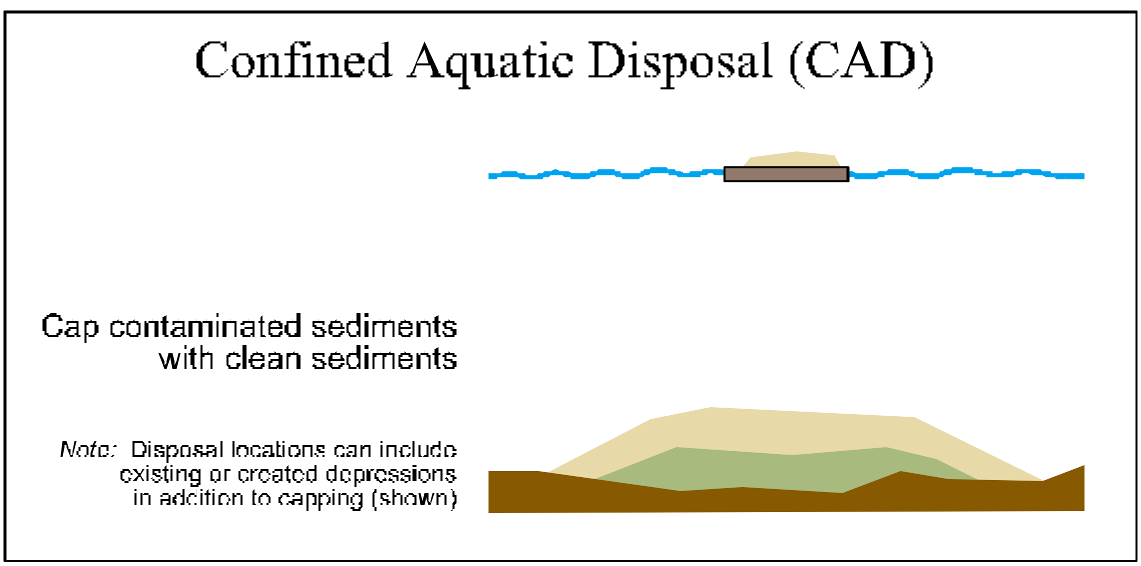

Figure 1-9: Schematic of Confined Aquatic Disposal (CAD) method

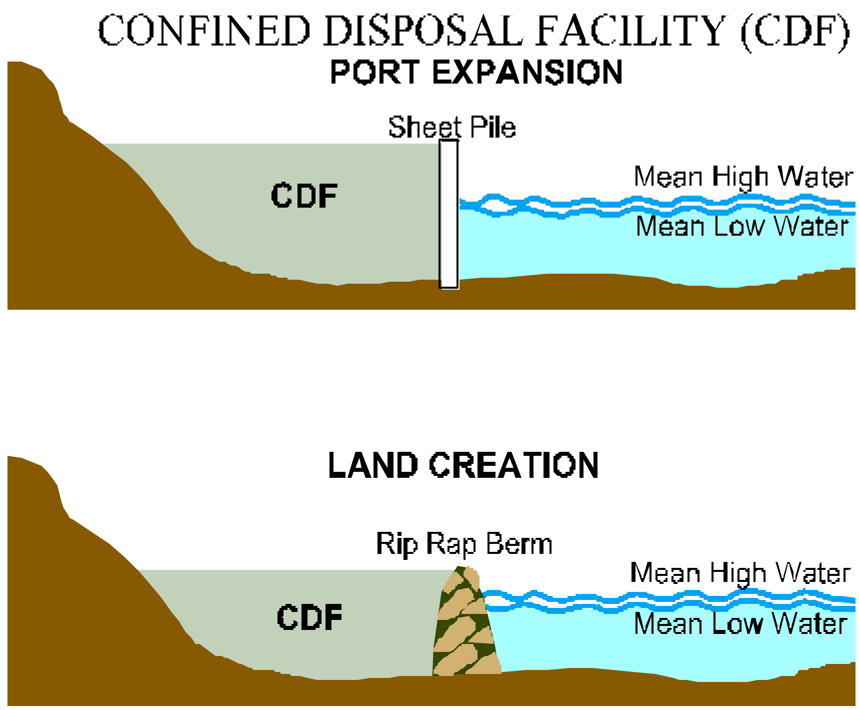

Figure 1-10: Schematic of the Confined Disposal Facility (CDF) method

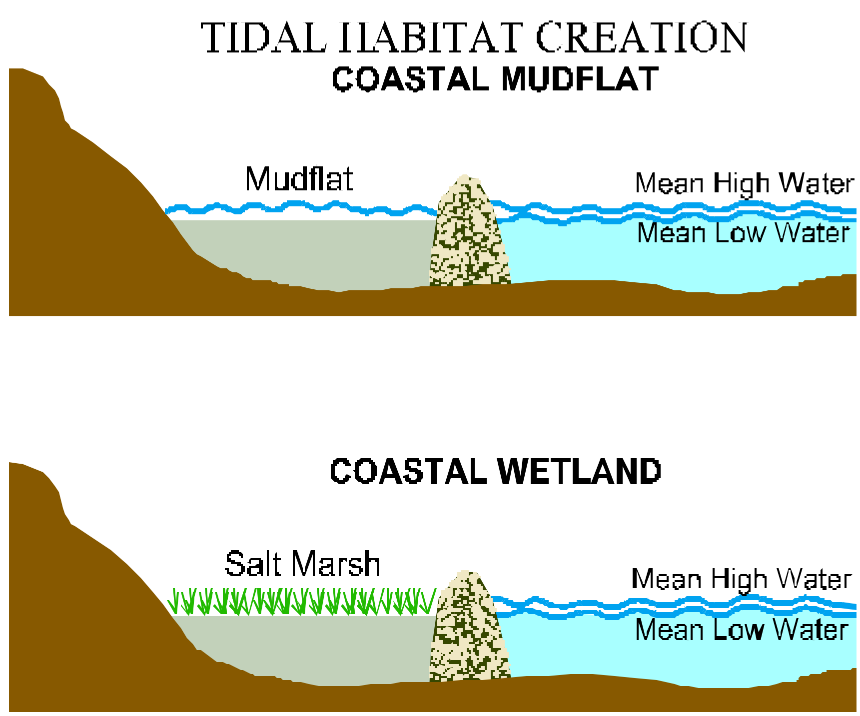

Figure 1-11: Schematic of the Tidal Habitat (TH) creation method.

A multi-step siting process was used to identify and screen aquatic disposal sites for UDM from Gloucester Harbor. The first stage of the siting process was to define the range of disposal options by delineating a ZSF for Gloucester Harbor (Figure 1-12). The technical description and rationale for delineation of the ZSF is fully described in Section 4.8.3.1.

A universe of disposal sites was identified within the ZSF, based primarily on physical characteristics and the potential ability to contain UDM. Additional sites were added at the suggestions of the City Harbor Planning and Dredging Committee. There were a total of 36 sites at this stage of the screening process (Figure 1-13).

Next, the containment potential and capacity of these sites were assessed in detail, which resulted in a reduction of candidate sites from 36 sites to 25 possible sites (Figure 1-13). Sites that were: 1) located in erosional or reworking zones, 2) in areas subject to erosive forces limiting containment potential, or 3) in regions that provided limited capacity were eliminated from further consideration.

The 25 candidate sites were then evaluated based on a series of discretionary criteria. They include considerations of fisheries, shellfish habitat, coastal wetlands, navigation, and others as described in Section 4.8.2. These factors, when applied to the sites, do not necessarily result in sites that are prohibited from receiving UDM. Rather, they help identify which sites are more conducive to accepting UDM than others. Application of the discretionary criteria to the candidate sites resulted in a "short-list" of thirteen potential disposal sites (Figure 1-14).

The thirteen potential disposal sites underwent a more detailed review using the aforementioned discretionary factors. In particular, water depth, presence/absence of submerged aquatic vegetation, proximity to inter- and subtidal resources, and ability to obtain a permit, were the key discretionary criteria that resulted in some sites being placed in reserve status. This resulted in a narrowing of thirteen potential disposal sites to six proposed preferred disposal sites (Figure1-15).

The six proposed preferred disposal sites underwent additional detailed study, using the discretionary criteria. These sites, and the process that resulted in the selection of these sites, were presented to the City and federal regulatory agencies for review and discussion. See Section 1.2.6 for discussion of the identification of the preferred alternative

Summary of Disposal Alternatives Evaluated

Alternative treatment technologies hold promise for future applications, but do not currently appear capable of accommodating large-scale volumes of dredged material. While the conceptual benefits of alternative treatment technologies are significant (using dredged material as a beneficial resource, not disposing of as waste), the inability of alternative treatment technologies to overcome the practical issues of cost, production rates, side-stream emissions and end-market uses limits the current applicability for this alternative. The potential application of solidification/stabilization technology for dredged material is discussed fully in Section 4.5.

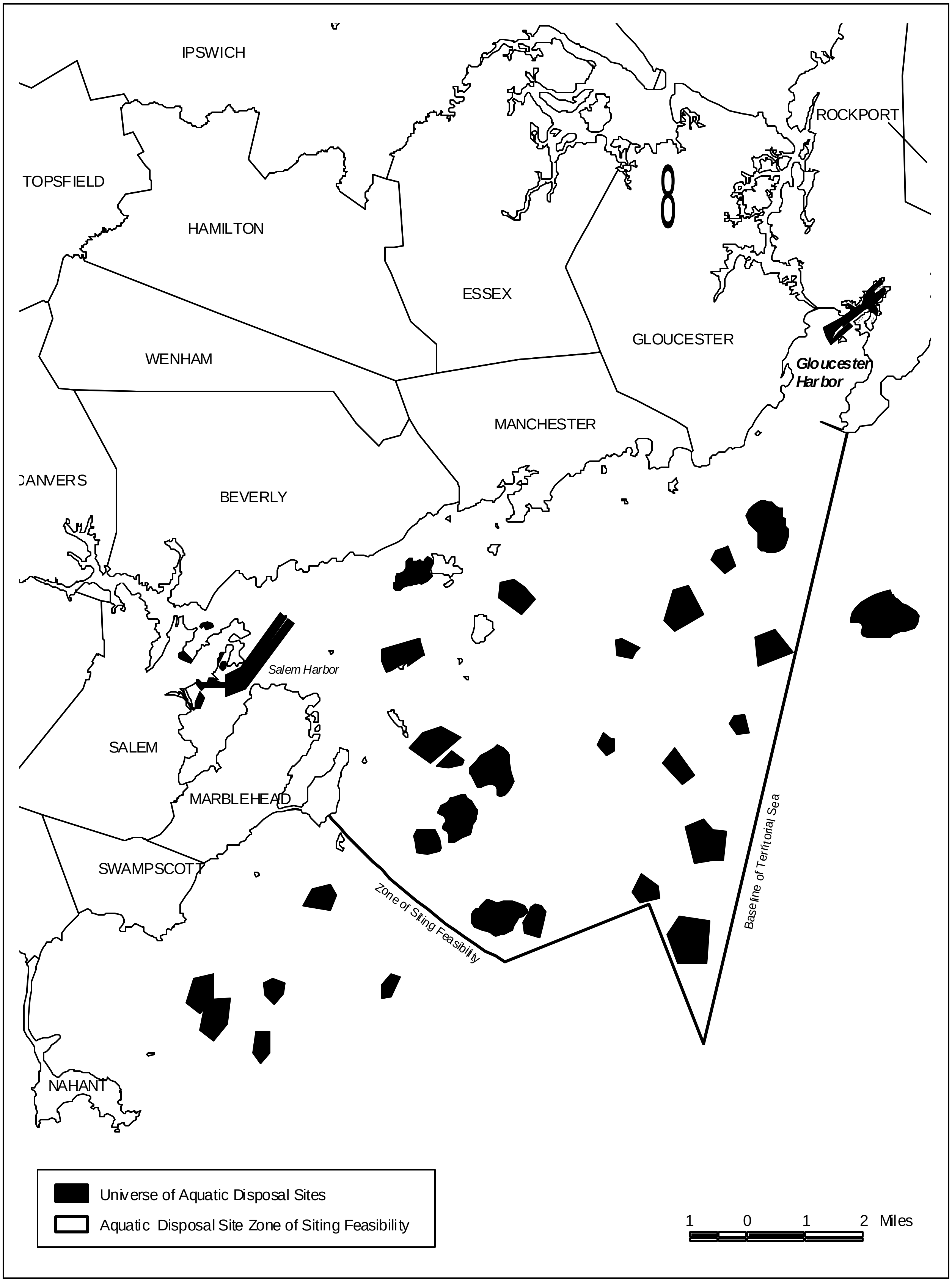

Figure 1-12: Gloucester Universe of Aquatic Disposal Sites

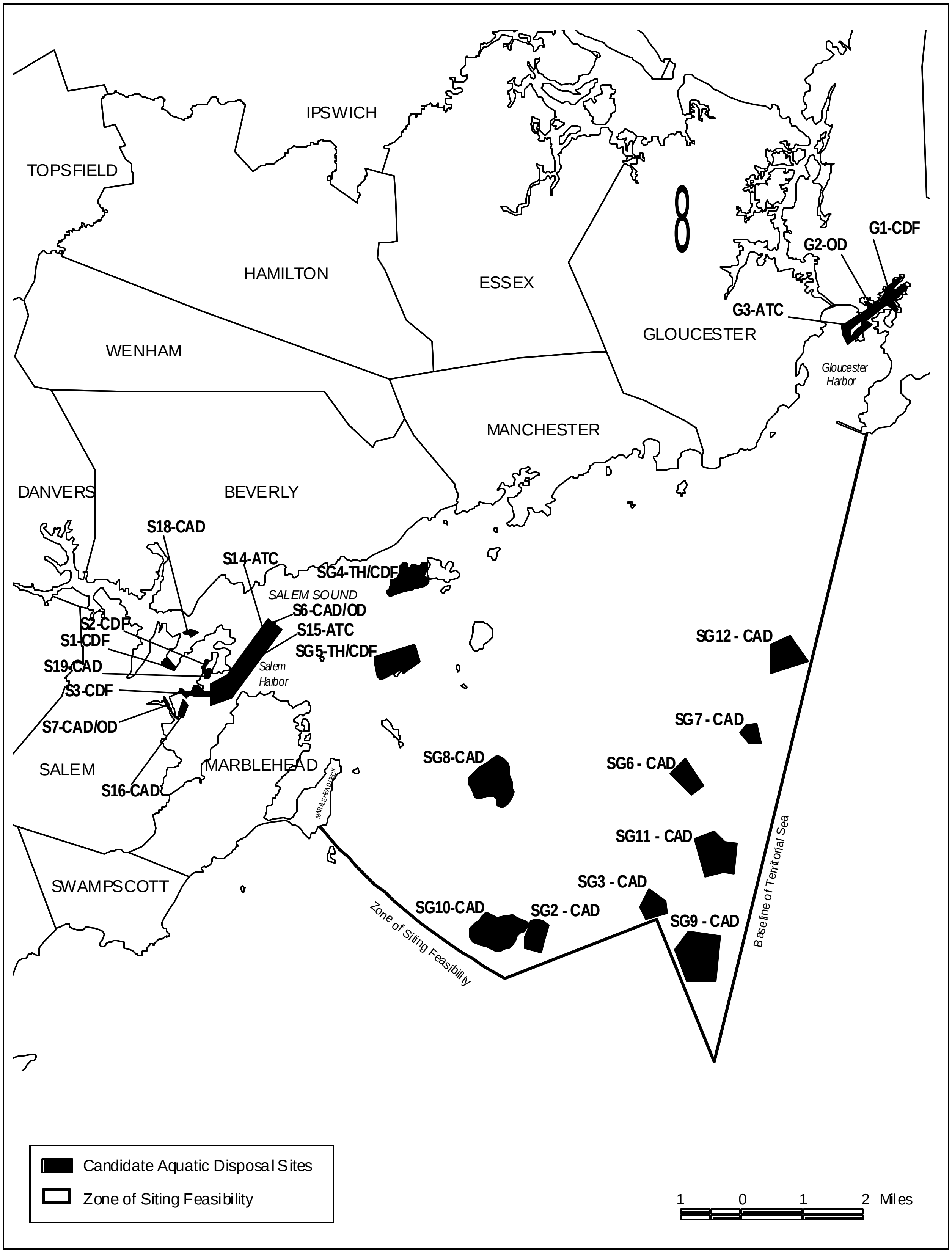

Figure 1-13: Gloucester Candidate Aquatic Disposal Sites

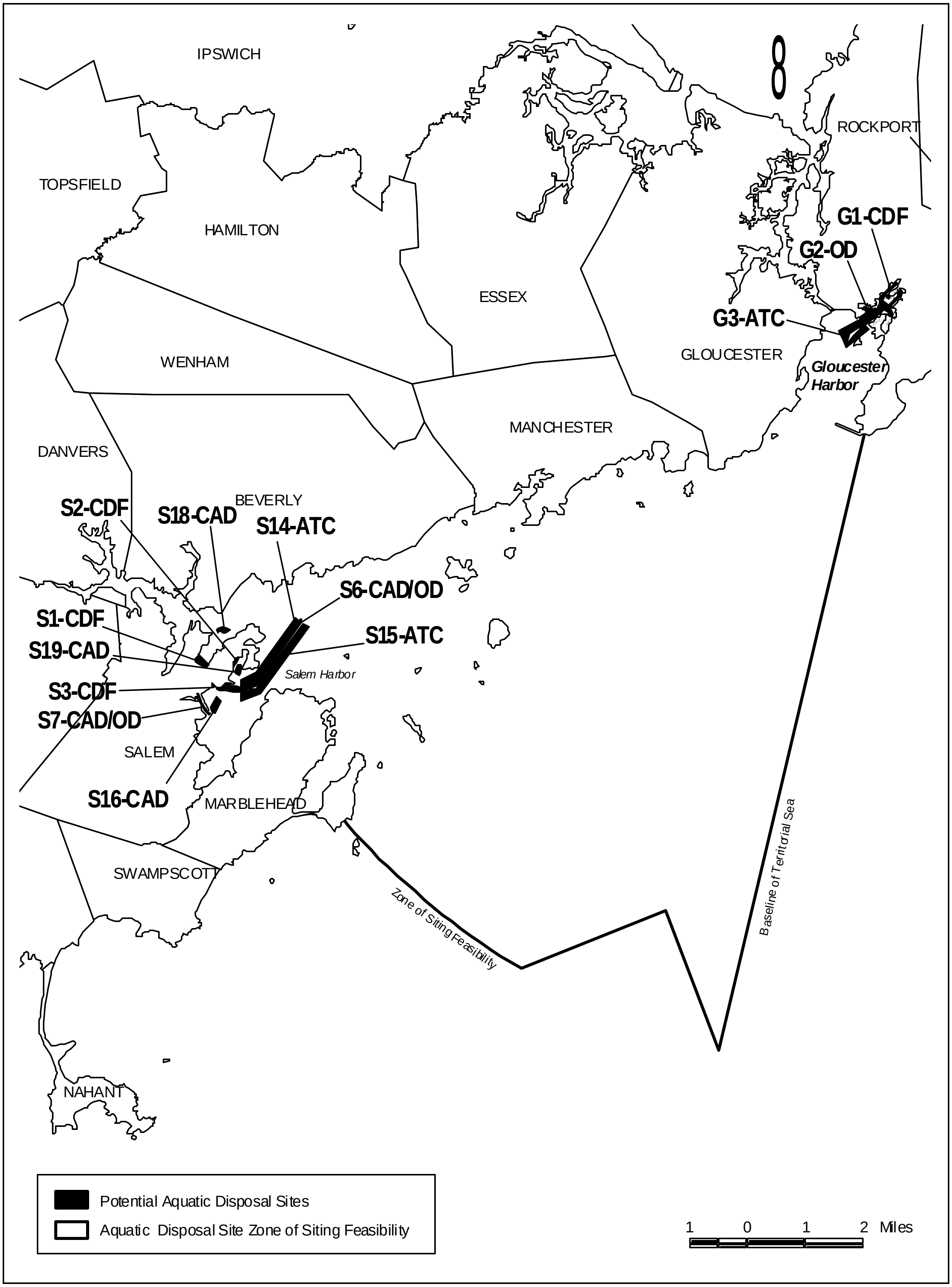

Figure 1-14: Potential Disposal Sites

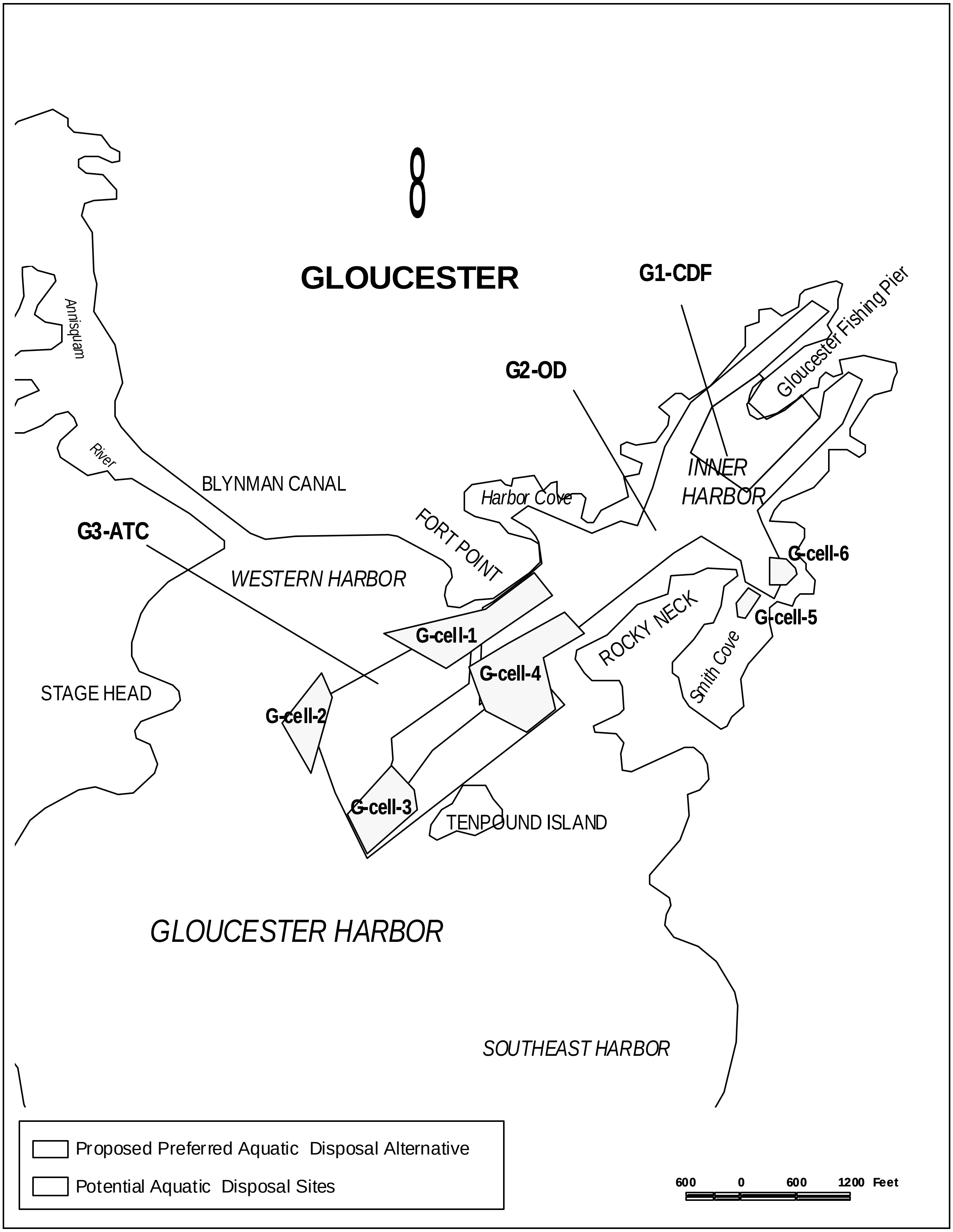

Figure 1-15: Proposed Preferred Aquatic Disposal Sites

Upland disposal and beneficial reuse alternatives did not become preferred alternatives due to limited capacity, practicability and/or cost. While two upland sites have significant capacity, the practicability of site use is low and the cost is high. The limited capacity of the remaining sites render them impracticable as alternatives.

Aquatic disposal sites fell into three general categories: deep-water sites, Salem Harbor sites, and Gloucester Harbor sites. Deep-water sites were screened out because they were subject to erosional bottom currents or because of the likelihood of significant impacts to groundfish resources and fisheries. Salem Harbor sites were screened out for lack of practicability (limited capacity for non-Salem material; site use for Gloucester material conflicts with the Salem Harbor Plan, which establishes a prohibition against use of Salem sites for non-Salem material). Gloucester Harbor sites were carried forward through the screening because they are practicable (close to the harbor; in the general area of existing contaminated sediments), cost-effective, and have associated environmental impacts that are temporary and can be mitigated.

1.2.5 Identification of the Preferred Alternative

The relative merits of each proposed preferred disposal site for accepting UDM were evaluated by comparing existing information and site-specific field data. The proposed preferred alternatives were presented to the Gloucester Harbor Dredging Subcommittee at a meeting held in Gloucester in January, 2000. This resulted in the selection of a preferred aquatic disposal alternative (Figure 1-16). G-Cell-5 and G-Cell-6 were relegated to reserve status for several reasons including: lack of capacity, possible hindrance to navigation in narrow straits to Smith Cove, and potential impacts to intertidal resources in Smith Cove. The remaining 4 areas (G-Cells 1 through 4) comprise the preferred alternative. All four of these areas are needed to accommodate the anticipated dredging volume of 330,000 cy over the next 20 years.

Potential Environmental Impacts and Mitigation Measures

This section summarizes the potential environmental impacts and proposed mitigation measures for each of the Preferred Alternative aquatic disposal sites for the Gloucester Harbor DMMP. A detailed analysis of project impacts is included in Section 6.0 of this document. Sections 8.0, 9.0 and 10.0 include a discussion of construction/management issues and potential mitigation measures for the Preferred Alternatives. The results of the analysis conducted to assess environmental impacts and potential mitigation measures for the preferred alternatives are summarized in Table 1-2. In Table 1-2, specific environmental features are contrasted with the “no action alternative”, the alternative of not undertaking the project, to provide a baseline for comparison. The no action alternative is described in Section 4.2. Both impacts and mitigation measures are grouped by screening criteria for the no action alternative and preferred alternative disposal sites.

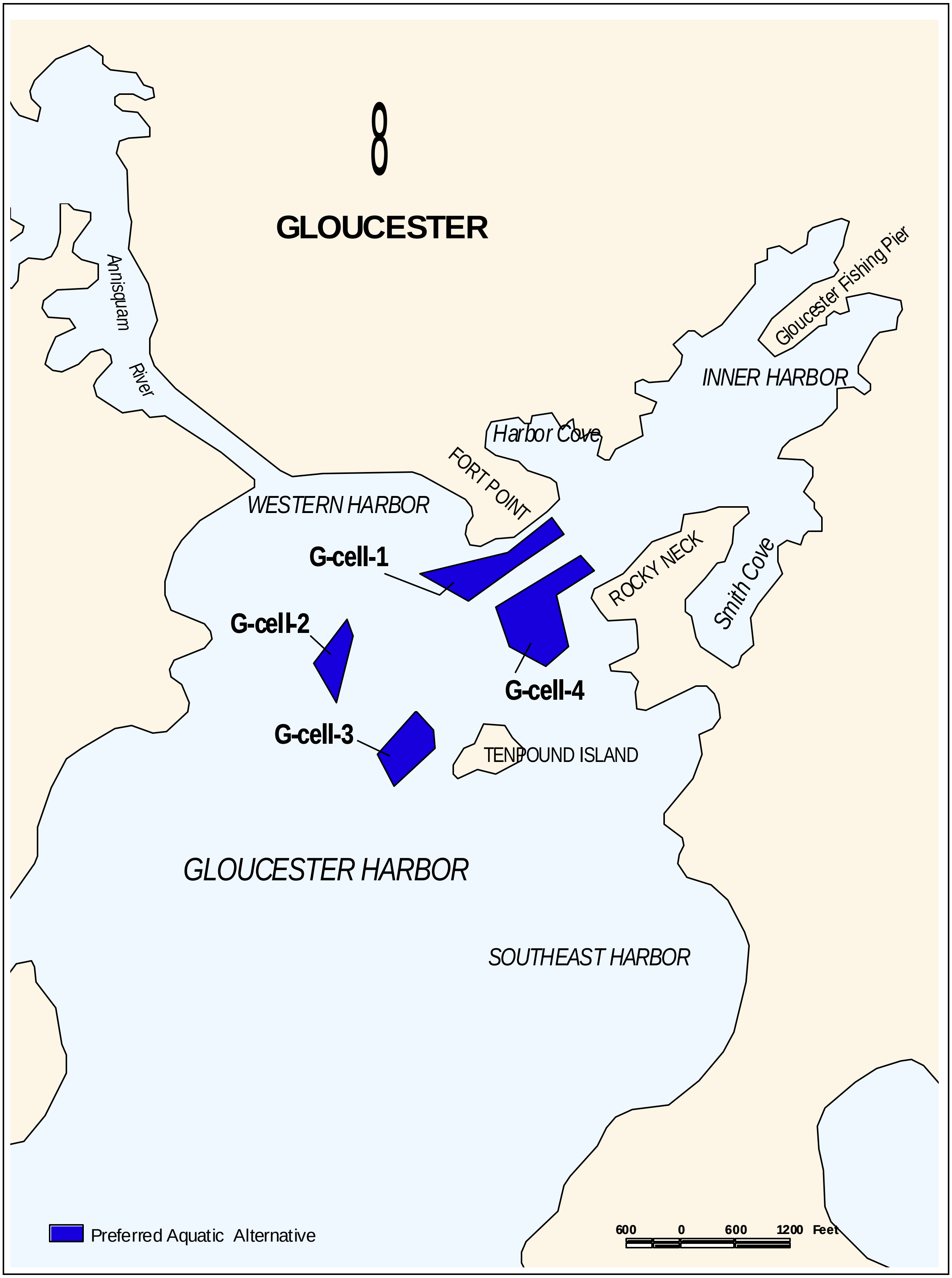

Figure 1-16: The Preferred Disposal Sites

Table 1-2: Potential environmental impacts and mitigation measures for the aquatic disposal preferred alternative: G-Cell-1, G-Cell-2, G-Cell-3 and G-Cell-4

AQUATIC SITES: G-Cell-1, G-Cell-2, G-Cell-3 and G-Cell-4		
Environmental Feature	**No Action Alternative**	**Impact/Mitigation Measures**
Sediments	No Impact	Impact: Change in substrate conditions, from soft silt to sand. Mitigation: Recess final cap material elevation relative to existing elevation in order to encourage active sedimentation over cap if necessary.
Sediment Transport	No Impact	Impact: no permanent impact Mitigation: none required
Water Quality	No Impact	Impact: Short term localized, degradation (e.g. increased turbidity) due to dredged material disposal; Monitoring to ensure compliance with water quality standards Mitigation: Disposal only during favorable tidal conditions to minimize impacts.
Benthos	No Impact	Impact: Mortality of some benthic organisms. Change in substrate conditions will favor organisms that prefer sand. Mitigation: Recess final cap material elevation relative to existing elevation in order to encourage active natural sedimentation over cap, prompting natural recolonization of benthos, if necessary.
Shellfish	No Impact	Impact: No impact to known shellfish beds (field verification required for G-Cell-4). Mitigation: Avoid disposal under high turbidity conditions (e.g. unfavorable weather/tidal conditions)
Lobsters	No Impact	Impact: No impact to sedentary (early benthic phase) life stages. Juveniles and adults will survive by moving from disturbed area. Some mortality will occur during dredging and disposal. Mitigation: Per consultation with DMF and NMFS
Submerged Aquatic Vegetation	No Impact	Impact: No resources within disposal site Mitigation: None Required
Wetlands	No Impact	Impact: No impact to Federally designated wetlands. Impact to State-designated Land Under Ocean from cell construction and disposal activities Mitigation: Allow natural sedimentation of cap. Natural benthic recolonization expected.

Table 1-2: Potential environmental impacts and mitigation measures for the aquatic disposal preferred alternative: G-Cell-1, G-Cell-2, G-Cell-3 and G-Cell-4 (continued)

AQUATIC SITES: G-Cell-1, G-Cell-2, G-Cell-3 and G-Cell-4 (continued)		
Environmental Feature	**No Action Alternative**	**Impact/Mitigation Measures**
Finfish	No Impact	Impact: Seafloor habitat will be disturbed. Potential impact to early life history fishes. Mitigation: Time disposal activities to avoid peak spawning periods and other sensitive life stages.
Wildlife	No Impact	Impact: No impact to shorebird, waterfowl or seabird breeding habitat. No impact to shorebird foraging habitat. Minimal impact to waterfowl, and seabird foraging habitat. No impact to marine mammal and sea turtle breeding or foraging habitat. Mitigation: None Required
Endangered Species	No Impact	Impact: No impact to known endangered species habitat at disposal site Mitigation: None required
Lobstering	No Impact	Impact: Lobster habitat will be disturbed at the disposal sites. Lobstering will be disallowed at the sites during disposal. Mitigation: Per consultation with DMF and NMFS.
Recreational Fishing	No Impact	Impact: Fishing in an near disposal cells will be affected during dredging and disposal due to fish movement outside the disturbed area. Mitigation: Construction activities to occur outside of peak fishing season.
Navigation and Shipping	Lack of disposal site may limit dredging activity which will lead to shallower water depths, affecting safe navigation and reducing moorings	Impact: Potential interference with commercial fishing industry shipping. Mitigation: Timing of disposal and cell construction activities to avoid ship movements.
Land Use	Lack of disposal site may lead to loss of water-dependent uses, changing land use patterns, impose limitations on future economic diversifica-tion based on commercial shipping	Impact: No direct impacts; Positive indirect impacts resulting from maintenance of existing land use patterns and maintenance of options for future economic growth based on commercial shipping. Mitigation: None required
Consistency with Gloucester Harbor Plan	Lack of disposal site is not consistent with Harbor Plan	Impact: Positive; disposal site is consistent with Harbor Plan objectives. Mitigation: None required

Table 1-2: Potential environmental impacts and mitigation measures for the aquatic disposal preferred alternative: G-Cell-1, G-Cell-2, G-Cell-3 and G-Cell-4 (continued)

AQUATIC SITES: G-Cell-1, G-Cell-2, G-Cell-3 and G-Cell-4 (continued)		
Environmental Feature	**No Action Alternative**	**Impact/Mitigation Measures**
Air Quality/Noise/Odor	No Impact	Impact: AQ - temporary diesel emissions;, potential volatilization of organic compounds; Noise - temporary increase in disposal site noise levels; some increase expected at nearby land side receptors; Odor-potential odor impact from hydrogen sulfide emanating from dredged material temporarily stockpiled on barges. Mitigation: AQ - use of properly operating equipment and participation in DEP's Voluntary Diesel Retrofit Program (VDRP), Noise- use of properly operating and mufflered equipment, operation during daylight hours; Odor- use lime to control objectionable odors emanating from dredged materials
Historic/Archaeological Resources	No Impact	Impact: Potential historic and archaeological resources to be further investigated; impacts to potential previously undiscovered historic shipwrecks unlikely due to previous dredging activities. Mitigation: Possible discovery, recovery and/or recordation
Recreation	No Impact	Impact: Recreational boaters temporarily diverted from area during cell construction and disposal operations, cell construction and disposal activities may drive fish from nearby recreational fishing areas Mitigation: None required

Disposal Costs

In the DEIR, disposal costs were calculated for each of the preferred alternative disposal sites. The average unit cost of disposal was calculated to range between $42.92 to $45.64 per cy (total cost ÷ UDM disposal volume) of UDM. A range of values was calculated to take into account the potential for the footprints of G-Cell-1 and G-Cell-4 containing UDM. The cell construction unit costs calculated do not include the cost of dredging and transport of UDM from individual facilities. Table 1-3 illustrates the UDM disposal volumes and costs of each preferred alternative disposal site.

Table 1-3: Disposal capacities and costs of preferred disposal alternative sites

PREFERRED ALTERNATIVE (Site Name)	UDM DISPOSAL VOLUME (cy)	CELL CONSTRUCTION COSTS	
		UNIT COST ($/cy)	TOTAL COST ($ million)
G-Cell -1	126,190	$39.13 - $41.95[1]	$4.9 - $5.3
G-Cell -2	22,380	$60.49	$1.4
G-Cell -3	22,575	$70.33	$1.6
G-Cell -4	159,695	$39.17 - $42.81[1]	$6.3 - $6.8
Total	330,840	- - -	$14.2 - $15.1
Average	- - -	$42.92 - $45.64	- - -

Notes:

1. Range of values calculated for G-Cell-1 and G-Cell-4 account for potential UDM within disposal footprints. Lower unit cost assumes 0% UDM in cell footprint and higher value assumes 100% UDM in cell footprint.

To illustrate the relative costs of disposal types considered in the DMMP, estimated costs were calculated to dispose of 1,000 cy of UDM for Gloucester Harbor for comparison purposes (Table 1-4). The range of unit costs calculated for the preferred alternative cells are less than the range of values calculated for upland disposal and reuse of between $60 cy for grading/shaping material to $117 for a new landfill to dispose of UDM (see Section 4.7). The aquatic and upland disposal and reuse unit costs are directly comparable, in that both values do not include dredging and are based upon disposal of volumes of UDM identified in areas of potential dredging identified in the inventory.

Table 1-4: Disposal Cost Comparison example for 1,000 cy of UDM

DISPOSAL TYPE	UNIT COST[1] ($/cy)	ESTIMATED COST ($/1,000 cy)
Aquatic Disposal[2]	$42.00	$42,000
Upland Disposal and Reuse - Shaping/Grading[3]	$60.00	$60,000
Upland Disposal and Reuse - Monofill[3]	$117.00	$117,000
Alternative Treatment Technology[4]	$99.00	$99,000

Notes:
1. UDM disposal costs only; does not include cost of dredging
2. Upper range of unit cost for G-Cell-4 (0-5 year planning horizon) used for aquatic disposal example.
3. Assumes reuse as grading/shaping material. Please note upland disposal of UDM may require amendment of between 2 to 3 parts soil to 1 part of UDM.
4. Alternative treatment technology unit cost is for Solidification/Stabilization, the only technology demonstrating potential feasibility for Gloucester Harbor UDM (see Section 4.5.5)

CAD Cell Sequencing

In order to contrast the planning horizon UDM volumes requiring disposal with the preferred alternative disposal sites, cell capacity calculations were conducted to determine the extent of the predicted disposal volumes occupying the preferred alternative disposal sites (see Section 8.0 for full description of conceptual engineering conducted). By contrasting the ability of each disposal cell to accommodate planning horizon UDM volumes, the following potential phasing sequence was developed:

- ***G-Cell-4*** - Five Year Planning Horizon
- ***G-Cell-1*** - Ten Year Planning Horizon
- ***G-Cell-3*** - Fifteen Year Planning Horizon
- ***G-Cell-2*** - Twenty Year Planning Horizon

Currently, it is envisioned that each of the four disposal cells would be open for one dredging season within a five year window. The dredging window, as specified by DMF and DEP, is usually from late fall to spring and is designed to avoid the sensitive life stages of important fish and shellfish species. Therefore, excavation of the cells, placement of the UDM within the cells, and capping of the cells would likely occur within a period of less than six (6) months.

The five year duration of each phase is intended to provide ample notice of availability of a disposal facility, providing facilities an opportunity to secure the necessary permits and funding to conduct dredging projects. This planned opening of a disposal facility on a regular basis should also provide opportunities for coordinating various harbor projects.

The results of the conceptual engineering exercise and the disposal cell phasing were presented to the Dredging Subcommittee. Based on the Subcommittee's review and discussion, the City's preference for use of the preferred alternative disposal cells is as follows:

- ***G-Cell-4*** - Five Year Planning Horizon
- ***G-Cell-2*** - Ten Year Planning Horizon
- ***G-Cell-3*** - Fifteen Year Planning Horizon
- ***G-Cell-1*** - Twenty Year Planning Horizon

The first scenario described above is based upon matching the projected volumes of UDM identified in the dredging inventory with the estimated cell capacities, based upon the current configurations. Both the DMMP's and the City's preference is to use G-Cell-4 to accommodate the UDM volume identified for the 5 year planning horizon, the planning horizon projection with the greatest level of confidence. As the DMMP moves into the 10, 15 and 20 year planning horizons, the level of confidence in the projections are less certain. The City's preferred approach will determine the design and location of the CAD cells as additional site specific data is developed and out-year disposal volumes are determined.

In the FEIR, detailed site specific data will be collected for the G-Cell sites. These data will be examined and revised cell capacities will be calculated based upon site-specific data and engineered designs. The results of the final design of the disposal cells will take into account the City's cell phasing preference in developing the both the configuration of the final alternative disposal cell footprints and the phasing sequence proposed in the FEIR.

Required Permits and Approvals

Development of any of the preferred alternative disposal sites will require permits and approvals from local, state and federal regulatory agencies. Table 1-5 provides a listing of the required permits and approvals for each of the three Preferred Alternatives. A complete analysis of the permitting requirements and specific regulatory standards for each of the permitting and approval programs is included in Section 7.0 of this DEIR.

Table 1-5: Potential local, state and federal permits and approvals

JURISDICTION	PERMIT/ APPROVAL	AGENCY	AQUATIC DISPOSAL G-Cells, 1-4
FEDERAL	***Section 10 Permit*** - Review of projects in navigable waters of the United States	Corps of Engineers	U
	Section 103 Permit - Approves transport of suitable dredged material to ocean disposal site	Corps of Engineers	U
	Section 404 Permit - Determines compliance with guidelines for discharges of dredged or fill materials into waters of the United States	Corps of Engineers	U
STATE	***MCZM Consistency Concurrence*** - Evaluation of a project's consistency with MCZM's policies and management principles	MA Coastal Zone Management	U
	MEPA Certification on DEIR and FEIR - Decisions of Secretary of Environmental Affairs on DEIR and FEIR and compliance with MEPA	MA Environmental Policy Act	U
	Chapter 91 License - Approves structures/activities below mean low water mark	DEP: Division of Wetlands & Waterways	U
	Water Quality Certification - Controls impacts to water quality and determines compliance with state water quality standards	DEP: Division of Wetlands & Waterways	U
LOCAL	***Wetlands Order of Conditions*** - Protection of Wetland Resource Area and compliance with WPA performance standards.	Local Conservation Commissions	U

Notes: Concurrence required for construction and operation of dewatering site. Structural or use changes associated with harbor-side dewatering may require approval.

1.2.6 Next Steps

The next key milestone in the DMMP Planning process is the development of the FEIR. After public and agency comments are received on this DEIR, and incorporated into the scope of the FEIR, the next phase of the DMMP will commence. The objective of study for the next phase for the Gloucester Harbor DMMP is to collect, analyze, and report site-specific information regarding geological, hydrodynamic, and biological conditions at the preferred alternative site locations. Approval of these sites by federal and state regulators, the City of Gloucester, and the general public requires the collection of additional environmental data to aid in the assessment of each site's suitability. In addition to the collection of site-specific environmental data, key management and policy issues will also be evaluated.

1.2.6.1 Disposal Site Monitoring Plan

A disposal site management and monitoring plan ("management plan") will be developed by a Technical Advisory Committee (TAC) composed of local, state, and federal interests. The purpose of a management plan is to determine the specific actions and responsibilities necessary to ensure that disposal site use protects human and environmental health and resources. A management plan addresses where, when, and how a disposal site can be used, what kind of short and long-term monitoring will be required, and establishes who is responsible for every aspect of site use, management, and monitoring. The management plan will also determine what kind of material can be safely disposed of, and what testing may necessary to determine the nature of the material proposed for disposal.

MCZM anticipates that comments from the City on this DEIR will recommend the appropriate local membership for the TAC. For the recent dredging project in Boston Harbor, the management plan was developed by a TAC composed of a core group of City representatives, state and federal agencies, scientists from UMASS and MIT, and environmental interest groups, and was open to any members of the public who wished to participate. This model may be appropriate to consider for Gloucester.

It is important to note that (1) the final, approved management plan will be the basis for the local, state and federal permits required for use of the disposal sites; and (2) no final approval for any disposal sites will occur until a management plan is developed, presented for public comment in the FEIR, and approved by the City, state and federal regulatory agencies.

1.2.6.2 CAD Cell Best Management Practices

MCZM is developing Best Management Practices (BMPs) for CAD of UDM in Gloucester Harbor based on the experiences and data from the Boston Harbor Navigation Improvement Project (BHNIP). The BMPs will be developed to be applicable as 1) stand alone guidelines, 2) the basis for new dredged material disposal regulations, and 3) the basis for site management recommendations in the DMMP FEIR. The BMPs will be developed to meet state and federal water quality criteria and standards under CWA s. 404, 314 CMR 9.00, other applicable regulations.

The BMPs will be designed to be effective regulatory tools, where ‘effective’ means:

- Appropriately protective of resources and uses;
- Cost-effective;
- Yield unambiguous results to the maximum extent practicable;
- Contribute directly to performance review (decision-making); and
- Applicable by non-specialist regulatory agency staff.

MCZM is also developing a model Water Quality Certificate (WQC) building upon the experiences of the BHNIP. This WQC will be applicable to future CAD projects for UDM. The WQC will include provisions for baseline monitoring and monitoring both during and post construction. Both the CAD BMPs and model WQC are being developed in coordination with the appropriate state and federal agencies.

1.2.6.3 Site-Specific Environmental Data

The expected impacts of the preferred alternative disposal sites were evaluated in this DEIR based upon the following: site-specific information gathered during the DMMP process; previous studies of Gloucester Harbor and the north shore region; studies done at other New England ports (e.g. Boston Harbor) and disposal sites, and laboratory studies of the effects of dredging and related activities. While the selection of the preferred alternative in this DEIR is supported by the above data, the DEIR recognizes that additional site-specific information is needed to complete the MEPA process and subsequent federal and state permitting. The following site-specific efforts will be undertaken in support of continuing the MEPA and/or permitting processes to develop final engineered designs:

C Geotechnical borings to confirm depth to bedrock and determine side slope stability;
C Macrobenthic sampling and identification
C Current meter measurements and basic water column chemistry
C Dredging and disposal event modeling and hydrodynamic analysis
C Underwater archaeological surveys
C Physical and chemical analysis of G-cell surficial sediments

Also in the FEIR, the development of long-term management strategy for UDM disposal will involve further study of: /site ownership/fees, site operations/management, liability and insurance.

2.0 INTRODUCTION

2.1 DEIR Organization

The organization of the Gloucester Harbor DMMP DEIR follows the framework established in MEPA to fully explore alternatives, and is organized into the following sections (see Figure 2-1).

Section 1.0 - Executive Summary, summarizes the report contents, lists the principal environmental impacts of the alternatives and identifies mitigation measures to be implemented to mitigate unavoidable environmental impacts. This section also indicates the steps that will be taken prior to developing a FEIR.

Section 2.0 - Introduction, presents the reader with the background of the DMMP planning process, MEPA procedural history and a summary of "scoping" and coordination involved in developing this DEIR. This section also highlights the process of how issues of concern, identified by public input and agency review, through the DMMP process have been identified and incorporated.

Section 3.0 - Purpose and Need, details the project's purpose, and discusses the need for the project, the relationship between the DMMP with the Gloucester Harbor port planning process, and a discussion of sediment quality and quantity. This section identifies the planning volumes of UDM that will be used as the required capacity baseline for this DEIR.

Section 4.0 - Alternatives Analysis, outlines the application of the DMMP disposal site screening process and criteria. This section presents the evaluation of potential impacts and benefits associated with the candidate sites or alternative treatment methodologies. This section details the potential impacts on specific resources in the vicinity of the disposal sites and in the case of alternative technologies, potential side-stream impacts associated with the implementation of specific treatment options.

Section 5.0 - Affected Environment, is a detailed description of affected environments in the vicinity of the aquatic and upland candidate disposal sites. This section presents a discussion of environmental and cultural resources which will be affected by the alternatives for UDM disposal, providing a baseline against which the impacts of disposal alternatives described in Section 4.0 can be analyzed in Section 6.0.

Section 6.0 - Environmental Consequences, evaluates, in detail, the potential impacts associated with implementation of the preferred alternatives for upland and aquatic disposal. This section outlines the cultural and environmental impacts of aquatic disposal alternative G-Cell-1, G-Cell-2, G-Cell-3 and G-Cell-4. Also contained in this Section is a discussion of secondary impacts from anticipated dredging projects for potential impacts to wetland resources.

Section 7.0 - Compliance with Regulatory Standards, is an overview of the current regulatory framework under which disposal of UDM occurs. This section describes the applicable regulations associated with implementing the Preferred Alternatives.

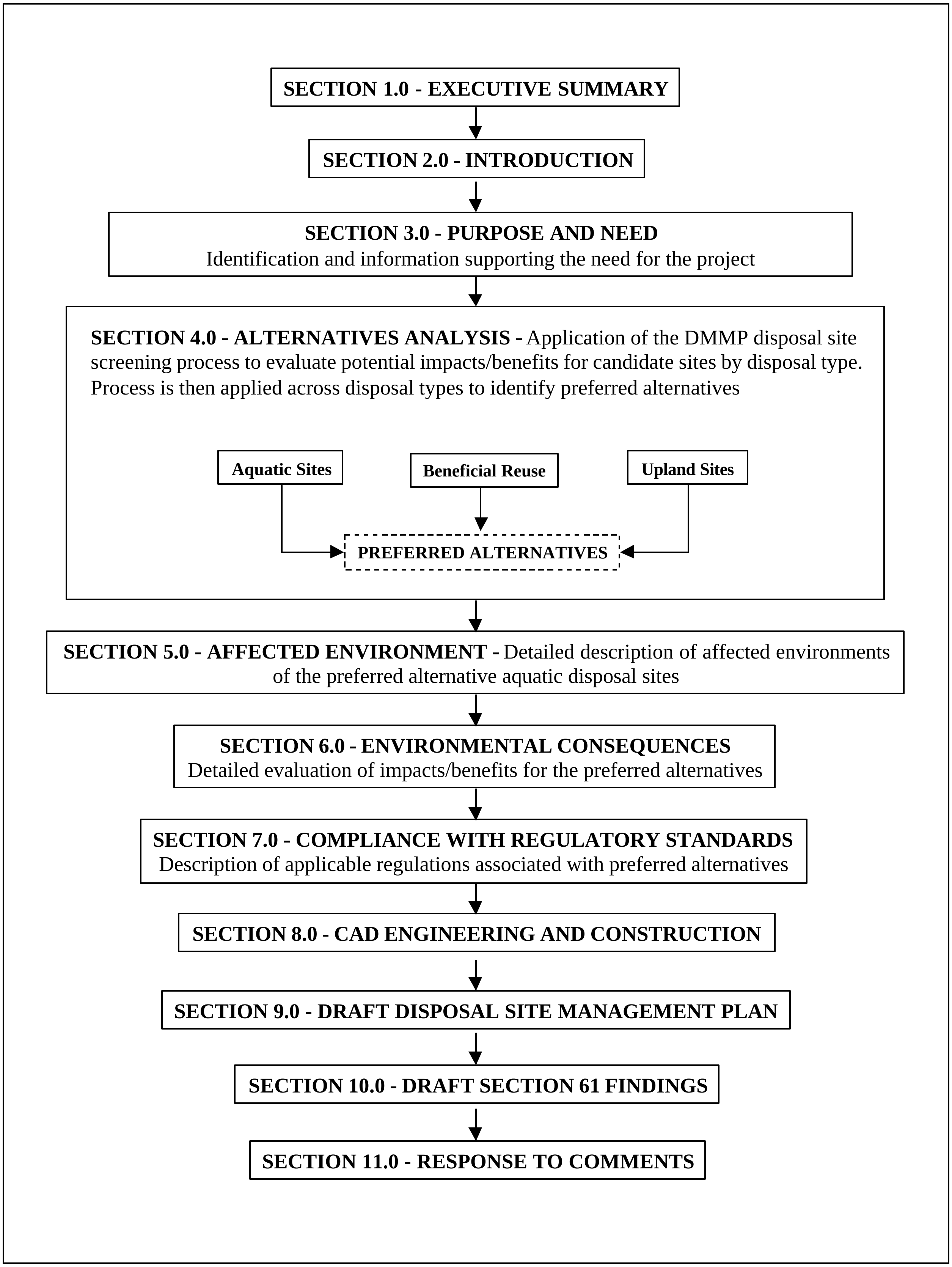

Figure 2-1: Gloucester Harbor DMMP DEIR organizational chart

Section 8.0 - CAD Engineering and Construction, this section describes the basis for conceptual engineering for CAD disposal of Gloucester Harbor UDM and a description of potential construction sequencing associated with the implementation of the aquatic preferred alternative, as identified in this DEIR. Included in the discussion of the construction measures are the steps necessary to minimize negative environmental impacts associated with the disposal of UDM in the marine environment.

Section 9.0 - Draft Disposal Site Management Plan, discusses the issues of monitoring the Preferred Alternatives for long-term environmental impacts and the management of operations for each disposal site. Management options discussed include experiences in other jurisdictions, general liability issues, fees, financing and general operation.

Section 10.0 - Draft Section 61 Findings, are included as required by MEPA, to outline whether the implementation of the Preferred Alternatives is likely to cause either direct or indirect damage to the environment. This section makes findings describing potential environmental impacts confirming that all practicable measures have been taken to avoid or minimize potential damage to the environment.

Section 11.0 - Response to Comments, is a comment by comment response to correspondence received by the MEPA Office regarding the Gloucester Harbor DMMP ENF. The DEIR contains a copy of each comment in a separate appendix. Comments within the MEPA scope are addressed and restated in this section, followed by a response. This section addresses all agency and public comments received.

The structure and content of the Gloucester Harbor DMMP DEIR is directly controlled by three primary sets of regulations. At the state level, the MEPA Scope that identifies the information that must be evaluated as part of the site identification process. This outline will ensure that the requirements of the state's environmental policies are met. At the federal level, the DEIR is subject to the provisions of Section 404 of the Clean Water Act (Section 404), and to the National Environmental Policy Act (NEPA). The Section 404 and NEPA outlines will ensure meeting the requirements of federal environmental policies.

The first task, then, was to integrate the requirements of these three authorities. To do this, previous projects that have faced the same task were investigated. First, site selection processes used by the state to site the Cape Cod Disposal Site (MADEM Generic EIR, 1992), and by the USACE and Massport to site the disposal cells for the Boston Harbor Navigation Improvement Project (USACE & Massport Final EIR, 1996) were evaluated. Then, at the direction of the federal agencies, the process used more recently by the Corps of Engineers for the federal Providence River Navigation Project (USACE DEIR, 1998) was also examined. After extensive discussion with the state and federal agencies, the screening process chosen was modeled after the Providence River project, in large part because the federal agencies reviewing this DEIR have developed the Providence screening, and are therefore familiar with the logic of the document.

Thus, MCZM is using the Providence River document (with some modification to format) as the template for the outline and the logic of the screening process, and is overlaying the MEPA Scope, creating the substance of the document.

2.2 Gloucester Harbor

Gloucester Harbor is located on the northern shore of Massachusetts, approximately 25 miles northeast of Boston. The Harbor is the second largest fishing port in New England, second only to New Bedford, and is a major fish processing center. The Harbor contains numerous seafood dealers, fish processors, and associated businesses, including significant cold storage facilities, with the largest cold storage capacity on the East Coast. Gloucester Harbor also contains a sizable recreational boating fleet in the summer months, and marinas and businesses which support recreational boating. The Annisquam River, also considered in Gloucester Harbor for this report, is used heavily by recreational boaters, and contains a number of recreational marinas and related businesses. Gloucester Harbor and the Annisquam River contain a number of authorized federal dredging projects, including various channels and anchorage areas. (USACE 1996)

Geographically, the Harbor can be described as two distinct segments, the Inner and Outer Harbor (see Figure 2-2). The Harbor Plan describes the Inner Harbor consisting of the following primary areas: Harbor Cove, State Fish Pier, East Gloucester Waterfront, and Smith Cove. Adjacent to downtown, Harbor Cove is the traditional heart of Gloucester's fishing industry. This area is characterized by a mix of industrial and commercial uses, and older finger piers. The State Fish Pier area is devoted to maritime industrial uses. Uses along the East Gloucester Waterfront area contain a wide range of uses from homes to boatyards servicing recreational and fishing vessels. Dominated by residential and tourist commercial uses, the Smith Cove Area has attracted visitors to Gloucester for much of its history. The Western Harbor of the Outer Harbor includes the waters edge along Stacy Boulevard from the Fort to Fort Stage Park. The remainder of the Outer Harbor area is generally characterized by low density residential development on the eastern and western shores (Icon Architecture Inc., 1999).

Founded in 1623, Gloucester is the oldest fishing community in America and one of its most beautiful seaports. Situated on the northeastern coast of Massachusetts, Gloucester is a great import/export point for both Canadian and European ports of call. Direct connection to our interstate road system makes Gloucester the most accessible over-the-road port in Massachusetts. Effective inter-modal transport between all major Canadian and U.S. cities is a key feature of Gloucester's seaport.

Historically a fishing community, Gloucester gained notoriety and business when Clarence Birdseye invented frozen packaging of fish and other food products in 1925. Gloucester has developed into a major import center for frozen seafood products and currently maintains the largest cold storage port facilities of any U.S. port.

Gloucester is a port that concentrates on providing personalized service for small vessel owners. The harbor has two 300-foot vessel berths, one 600-foot berth, and one 800-foot berth. Available deep draft of 16-20 feet alongside the piers at mean low water and vessels of up to 300 feet in length can be accommodated. Ship cargoes are loaded and discharged on a tonnage basis seven days a week, 24 hours a day. Vessel turnaround time is generally very short.

Efforts are underway to revitalize the use of the city's harbor and diversify importing and exporting. Funds are being allocated for renovating the Gloucester State Pier to increase the number of berths and expand the harbor's capabilities.

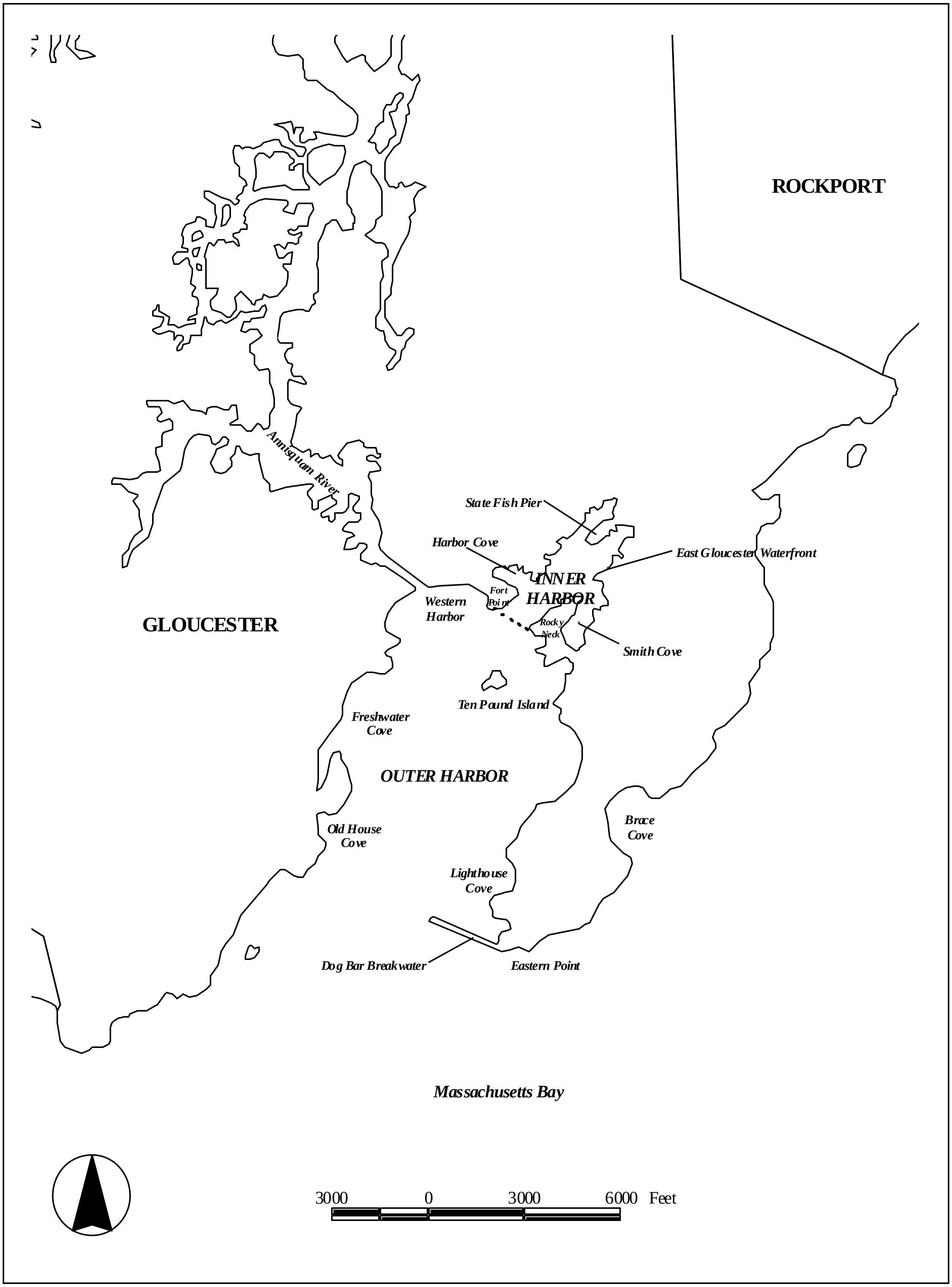

Figure 2-2: Gloucester Inner and Outer Harbor Areas

2.3 Background of the MCZM DMMP

The Executive Office of Environmental Affairs (EOEA), through its office of Coastal Zone Management (MCZM), is providing technical assistance to Gloucester in support of the City's harbor planning objectives through the development of a DMMP for Gloucester Harbor dredged sediments. The development of this Gloucester Harbor DMMP DEIR involved two project phases to address the critical issue of finding environmentally sound and cost effective disposal sites or methodologies for dredged material unsuitable for unconfined ocean disposal. The DMMP has a twenty year planning horizon.

To develop the DMMP, MCZM needed to do the following:

C Collect and analyze information on dredging needs, characteristics of the sediment, cultural and environmental resources and available alternatives for treatment, reuse, and disposal of dredged material from the Gloucester Harbor area for use in support of on-going port planning initiatives;

C Identify and characterize the range of reasonable alternatives for dredged material reuse/disposal and establish a framework for comparison of the alternatives as guidance for compliance with MEPA.

Phase I of the DMMP, conducted in 1996 and 1997, included several discrete tasks, the purpose of which was to provide a baseline assessment of existing conditions related to dredging and dredged material disposal for Gloucester. DMMP Phase I tasks were documented in a report (Maguire Group Inc., 1997a and b.) and included:

- Summary Report - a synopsis of dredging volumes, sediment quality and potential disposal alternatives for Gloucester, Salem , New Bedford and Fall River Harbors;
- Dredging Inventory - an update of the US Army Corps of Engineers inventory of dredging demand for Gloucester, Gloucester, New Bedford and Fall River Harbors;
- Bathymetric Surveys - a review and compilation of existing bathymetric survey information in Gloucester, Gloucester, New Bedford and Fall River Harbors;
- Alternative Technologies - an inventory and assessment of available treatment technologies for contaminated dredged material;
- Natural Resource Inventory - an inventory of all known fish, shellfish and wildlife resources within Gloucester Sound and Gloucester, New Bedford and Fall River Harbors;
- Aquatic and Near-Shore Disposal Site Analysis - an identification and description of potential confined aquatic disposal (CAD), confined disposal facility (CDF) and tidal habitat restoration sites within Salem, Gloucester, New Bedford and Fall River Harbors;
- Upland Disposal Site Inventory - an examination of upland and reuse options for contaminated dredged sediments;

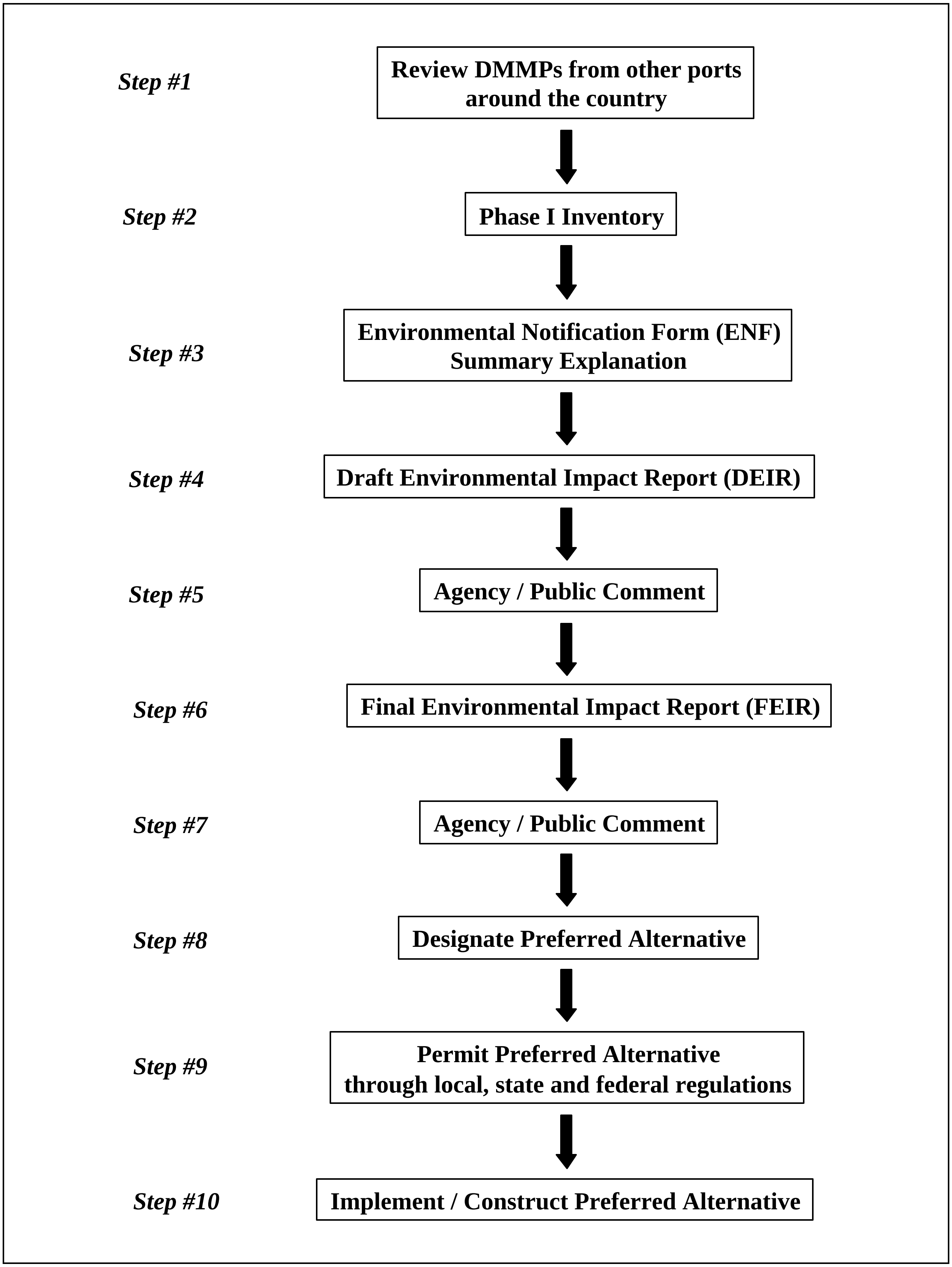

Figure 2-3: Overview of DMMP Planning Process

- Due Diligence - an inventory and data description of pollution sources and historic sediment quality information in Salem, Gloucester, New Bedford and Fall River Harbors;
- Preliminary Geotechnical Investigations - an inventory and assessment of existing geotechnical information within Salem, Gloucester, New Bedford and Fall River Harbors; and
- Sampling Plans - develop sediment sampling and testing plan for Gloucester Harbor dredging projects.

The DMMP Phase I information was used to identify baseline conditions and data gaps, and served as the basis for the preparation of the MEPA ENF for the Gloucester Harbor DMMP.

Phase II of the DMMP has focused on conducting the field work, research, and analysis necessary to undertake a detailed assessment of the potential environmental impacts associated with the dredged material disposal alternative(s) identified through the DMMP process.

The purpose of the DMMP for Gloucester Harbor is to identify, evaluate and permit, within the Zone of Siting Feasibility (ZSF) for Gloucester Harbor, a dredged material disposal site(s) or methodology with sufficient capacity over the next twenty years to accept dredged material unsuitable for unconfined ocean disposal from public and private dredging projects.

The lack of a practicable cost-effective method for the disposal of UDM in an environmentally sound manner has been a long standing obstacle to the successful completion of dredging projects in Gloucester Harbor. The disposal alternative siting process has been closely coordinated with the City of Gloucester, through the Dredging Subcommittee.

The Dredging Subcommittee was established by the Gloucester Harbor Planning Committee to serve in an advisory capacity to represent the interests of the Committee throughout the development of the DMMP. Members of the Subcommittee included representatives of shipping and fishing interests, the Conservation Commission, the Harbormaster, and the State Pier.

Coordination with local port planning interests has also been a critical component of the development of the Gloucester Harbor DMMP DEIR. The simultaneous development of both the DMMP and the Gloucester Harbor Plan has aided the identification of the future dredging needs for the maintenance and improvement in navigation within Gloucester Harbor and with the identification of potential sites for the disposal of UDM.

This Gloucester Harbor DMMP DEIR identifies disposal alternatives with sufficient capacity to accept dredged material unsuitable for unconfined ocean disposal from public and private dredging projects.

2.4 Massachusetts Environmental Policy Act (MEPA) Procedural History

The submission of the ENF for the Gloucester DMMP on March 13, 1998, started the official MEPA review process for the DMMP (a copy of the ENF is included in Appendix A). On April 24, 1998, pursuant to the Massachusetts Environmental Policy Act (M.G.L. c. 30, ss. 61-62H) and the MEPA Regulations (301 CMR 11.00), the Secretary of the Executive Office of Environmental Affairs (EOEA) made the determination that the Gloucester Harbor DMMP requires the preparation of an Environmental Impact Report (EIR). Because the project involves the potential alteration of more than ten acres of Land Under the Ocean (a resource area regulated under the Massachusetts Wetlands Protection Act, M.G.L. c. 131, s. 40) and involves the use of state agency funding through the Seaport Bond Bill (Chapter 28 of the Acts of 1996), the Gloucester Harbor DMMPs exceeded the "categorical inclusion" threshold at Section 11.25(2) of the MEPA regulations in effect in June 1998, requiring by regulation the preparation of an EIR. (Under the current MEPA Regulations, promulgated in July 1998, the Gloucester Harbor DMMP exceeds the 10-acre wetland resource area alteration "Mandatory EIR" threshold at 301 CMR 11.03(a)b. The Mandatory EIR thresholds contained in the July 1998 MEPA Regulations have replaced the Categorical Inclusion thresholds from previous versions of the MEPA regulations.)

2.5 Scoping and Coordination Summary

The MEPA public "scoping" meeting was held at Gloucester City Hall on April 9, 1998. The meeting was conducted by a representative of the MEPA Unit of the EOEA. At the meeting, the Gloucester Harbor DMMP, as described in the ENF, was presented and public comments were received by the MEPA Unit.

The Secretary's ENF Certificate of April 24, 1998 (included in the front matter of this DEIR), establishes the scope for this DEIR. In addition to the DEIR subject matter outline contained in Section 11.07 of the MEPA regulations, several major issues were emphasized as subjects to be addressed in this DEIR:

- Sediment quality and quantity analysis;
- Identification of disposal alternatives, including: alternative technologies and methodologies; upland reuse/disposal; and aquatic disposal;
- A complete description of the screening of disposal alternatives:
- Results of fisheries investigations and monitoring program;
- Effects on shore bird habitat;
- Results of cultural/historical/archaeological investigations;
- Characterization of proposed disposal sites;
- A description of the Preferred Alternative; and
- A proposed disposal site management plan;

2.5.1 Coordination with Harbor Planning Process

MCZM and the City of Gloucester sponsored a series of local presentations with topics related to dredging and dredged material management. The purpose of the presentation series was to provide a mechanism for citizens with an interest in Gloucester Harbor to provide input into the process of developing a preferred disposal alternative. MCZM also conducted a series of working meetings with the Gloucester Dredging Subcommittee. The proposed disposal sites included in the ENF were a starting point, and the continuing input from the Subcommittee was crucial in assisting MCZM in identifying dredging projects and disposal sites that needed to be added, subtracted, or modified from the ENF listing of potential disposal sites.

The meetings also served the function of disseminating DMMP technical information as it became available, so that information could be reviewed as this DEIR was developed. Public presentations conducted included the following topics, as listed in Table 2-1 and described below.

Table 2-1: Gloucester Harbor DMMP Presentations/Meetings

Presentation/Meeting	Date
Dredging and Disposal Technologies	June 16, 1998
Siting Criteria and Process for Dredged Material Disposal	July 22, 1998
Regulations Governing Dredged Material Disposal/Reuse	August 20, 1998
Sediment Quality	September 9, 1998
Municipal Working Meeting #1	November 12, 1998
Municipal Working Meeting #2	February 26, 1999
Municipal Working Meeting #3	March 29, 1999
Municipal Working Meeting #4	May 11, 1999
Municipal Working Meeting #5	June 8, 1999
Municipal Working Meeting #6	June 28, 1999
Municipal Working Meeting #7	August 3, 1999
Municipal Working Meeting #8	August 26, 1999
Municipal Working Meeting #9	January 26, 2000
Screening of Potential Disposal Sites Working Meeting #1	February 3, 2000
Screening of Potential Disposal Sites Working Meeting #2	February 25, 2000
Local Informational Presentations (see below)	May - June 2000

Dredging and Disposal Technologies - This presentation provided information on the basic elements of dredging, including potential dredging technologies that could be employed in Gloucester projects, and dredged material disposal. Issues covered included: probable characteristics of dredged material; types of disposal options for dredged material; and management practices to minimize and mitigate environmental impacts. The goal of the workshop was to inform participants of the linkage between minimizing environmental impacts with the proper planning of dredged material disposal.

Siting Criteria and Process for Dredged Material Disposal - In this presentation, the siting criteria were discussed, including avoidance of environmentally sensitive areas, compatibility with adjacent uses and minimizing exposure to important physical features. The linkage between developing comprehensive siting criteria and understanding regulatory requirements with potential locations for siting dredged material disposal within the harbor was developed. This workshop also focused on the idea that selecting potential sites for dredged material disposal should follow a logical process of using important features of the natural and built environment as a means of screening and, finally, choosing the best location to create a dredged material disposal site. This workshop provided an opportunity for local input on screening criteria and the development of City-specific site screening factors.

Regulations Governing Dredged Material Disposal and Reuse - This presentation included the introduction of information on state and federal regulations covering dredging, dredged material disposal and dredged material reuse. State and federal agency representatives gave presentations and provided review materials. Presenting agencies included: DEP, MCZM and the USACE. The intent of the presentation was to provide an explanation of the regulatory process in selecting appropriate disposal options for UDM.

Sediment Quality - The results of marine sediment tests performed under Phase I were presented. Sediment quality data were compared with criteria mandated by the USACE and USEPA. Dredged material that the federal agencies deem suitable for unconfined aquatic disposal, and the probable location of disposal sites and cost of disposal were addressed. Probable dredged material contaminants and degrees of unsuitability of sediment in the harbor were presented. The linkage between the volume of UDM and disposal site alternatives was developed in this workshop.

Working Meeting #1 - For this meeting the subcommittee discussed the specifics of the screening criteria for potential upland, alternative treatment technologies and aquatic disposal options. This meeting also involved discussion of the screening process. A goal of this meeting was to identify any additional criteria needed to address concerns or interests specific to Gloucester. The Subcommittee discussed factors that were important from a local perspective. (11/9/98)

Working Meeting #2 - The meeting involved a presentation of data collected for candidate disposal and dewatering sites. Further information on the sites presented was incorporated into the screening database. The screening criteria were discussed and finalized at this meeting to include the Subcommittee's concerns. A goal of this meeting was to gain insight into candidates disposal and dewatering sites from the City that may not have been apparent to MCZM. (2/26/99)

Working Meeting #3 & #4 - At this meeting the results of the initial screen for feasibility were presented to the Subcommittee for input. This meeting also involved discussion of the screening process and criteria. A goal of these meetings were to provide an opportunity for the Committee to comment on the results of the feasibility screen and the steps necessary to develop preferred alternatives. (3/29/99 & 5/11/99)

Working Meetings #5 & #6 - These meetings presented the results of the application of the discretionary screening criteria. Sites that were placed on the reserve list were discussed in detail. The resultant proposed candidate sites were also discussed. Considerable discussion of regional alternatives were also discussed at these meetings. A goal of these meetings were to incorporate comments on the candidate sites before application of the exclusionary screening criteria (6/8/99 & 6/28/99).

Working Meetings #7 & #8 - At these meetings, the results of the application of exclusionary screening criteria were presented to the Subcommittee. Discussion at these meetings centered around why sites were eliminated from further consideration. These meetings also involved detailed discussion of disposal of UDM at specific "sub-cell" sites (8/3/99 & 8/26/99).

Working Meeting #9 - This meeting was to follow-up on items raised at Working Meetings #7 and #8 regarding geological conditions in the vicinity of the proposed disposal sites. A detailed report of subsequent study conducted was presented. This meetings provided an opportunity for the Subcommittee to review the results of the screening process to date (1/26/00).

In addition to the above presentation and working meetings, six (6) additional meetings were held with various recreational and commercial fishing interests to gather further local input on their understanding of Gloucester Harbor and the surrounding water's (Massachusetts Bay) marine environment.

Screening of Potential Disposal Sites / Proposed Preferred Alternatives #1 & #2 - The proposed preferred alternative was presented to the subcommittee for review. These workshops were hands-on sessions, working with maps of the harbor and its various built and natural features. The use of computer overlays, facilitated the discussion at the presentation, depicting fisheries habitat, water depths, wind/wave exposure, areas of navigation and other data collected and compared it with the siting criteria developed in the Siting Criteria meeting. The intent of the session was to present results of the screening process to find a disposal site(s) of sufficient size, with minimal environmental impacts, for UDM. The subcommittee provided input on the proposed preferred alternative presented. A goal of these meetings was to incorporate final comments from the Subcommittee before presenting the results of the screening process to the federal agencies (2/3/00 & 2/25/00).

After the presentation of screening results to the Subcommittee, and incorporating comments, from the Subcommittee and the federal agencies, the DMMP information was presented by the Dredging Subcommittee Chairman in a series of informational sessions . The purpose of these informational meetings was to introduce the general public to the DMMP process, and to familiarize the public with the more technical information before this DEIR was published The Subcommittee presented DMMP findings to the Gloucester Waterways Board, City Council, Gloucester Fisheries Commission, and Conservation Commission. Other key Gloucester stakeholders presented with DMMP findings included lobstermen, property owners and potential dredgers. The culmination of public input at the City level was the approval by the Mayor, in a letter dated June 7, 2000, which is included in Appendix B.

Additional coordination with the Port Planning process involved attendance at public milestone meetings and interaction with the project coordinator and consultants developing the Gloucester Harbor Plan. Documentation of the above public meetings can be found in Appendix B. The documentation includes meeting notes, presentation handouts and other items.

2.5.2 Coordination with Federal Agencies

The USACE has developed a method of coordinating the review and approval time-lines of the various federal resource agencies charged with reviewing major projects involving discharges of dredged or fill material in waters of the United States, regulated under Section 404 of the Clean Water Act or activities in tidal waters regulated under Section 10 of the Rivers and Harbors Act of 1899. Based upon the mapping overlay planning methodology developed by noted landscape architect Ian McHarg in the 1960s, the USACE's "Highway Methodology" provides a valuable tool for decision making in a coordinated fashion. This methodology integrates the planning and design of a project with the requirements of the USACE permit regulations. The USACE serves as the coordinator of comments from the federal agencies, including the USEPA, the US Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS).

Participation by the USACE in the earliest stages of project planning is a key provision of the Highway Methodology. The evaluation of alternatives to the project is key to the successful completion of the methodology. Alternatives analysis are based upon the determination of the project "purpose and need" (developed under the National Environmental Policy Act (NEPA)) and the "overall/basic project purpose" required under the EPA 404(b)(1) guidelines and used by the Corps in project permitting.

The 404(b)(1) guidelines establish pass/fail environmental tests, to be completed before a determination is made on the balancing of overall project benefits versus detriments. An USEPA/USACE's Memorandum of Agreement, signed in February 1990, mandates a three-step iterative process of avoidance, minimization and mitigation of adverse impacts to wetlands functions and values (USACE, New England Division, 1993).

Application of the Highway Methodology to the Gloucester Harbor DMMP DEIR involved several key milestones including the USACE's concurrence with the DEIR Outline, Basic Project Purpose (BPP), and Aquatic and Upland Zones of Siting Feasibility (ZSFs). Documentation of the USACE's implementation of the Highway Methodology is presented in Appendix B which contains letters presenting the coordinated federal comments.

As part of the effort to coordinate closely with the federal agencies, a meeting to present draft screening results was held. This presentation was to representatives of all reviewing federal agencies, including representatives from USACE, USEPA, NMFS and USFWS, on March 29, 2000. The results of the meeting was a letter from the USACE dated April 21, 2000, (Appendix B), indicating concurrence with the screening process conducted and the proposed preferred disposal alternative put forward.

2.5.3 Coordination with State Agencies

Because of the array of permits required from the state to implement various disposal types and technologies proposed, DMMP planning has also required the close coordination with state regulatory agencies, particularly the Department of Environmental Protection (DEP), Division of Marine Fisheries (DMF) and Massachusetts Historical Commission (MHC). The broad reaching policy issues involved in the disposal of UDM have also been explored with these agencies, and will require continued coordination through the development of the FEIR. Close coordination with state agencies was essential to developing this DEIR. However, all statements and conclusions contain herein are the sole responsibility of MCZM. State agencies will be reviewing and formally commenting to MEPA on the content and conclusion of the DEIR and FEIR pursuant to their regulatory oversight responsibilities.

2.5.3.1 Department of Environmental Protection

Since Massachusetts does not have comprehensive regulations for the disposal of dredged material, DEP Divisions with jurisdiction over UDM disposal including: Wetlands and Waterways, Water Pollution Control, Waste Site Cleanup and Solid Waste Management were approached at key DMMP milestones. DEP agencies reviewed and concurred with the site selection criteria developed to ensure consistency with existing state regulations. Issues regarding upland and aquatic disposal and alternative technologies were discussed at numerous meetings, phone calls and e-mail correspondence. Representatives from DEP divisions also participated in the regulatory forum described above, to inform interested parties of requirements and expectations of the permitting process.

2.5.3.2 Division of Marine Fisheries

DMF participation in, and oversight of, investigations of marine resources conducted in support of the DMMP was invaluable to developing the detailed assessments provided in this DEIR. In its role “to maintain the diversity and abundance of marine habitats” (DMF mission statement), DMF has collected marine resource data for decades, and some of that data has been consulted in the Gloucester DMMP analysis including Fisheries Resources Survey for Gloucester Harbor (1999) and the Early Benthic Phase Lobster Survey for Gloucester Harbor. Because of the overlap of the Gloucester Harbor ZSF with that of Salem Harbor’s the results of the Trawl Surveys (1978-1996) for finfish outside Salem Harbor, Marine Research Study (1967) of adult finfish, shellfish, lobster fishery and marine vegetation were incorporated into the Gloucester Harbor DMMP analysis.

The on-going coordination with DMF has played an integral role in data collection and identification of areas needing further study for the Gloucester Harbor DMMP. This working relationship has involved participation of both MCZM and DMF staff on data review and resource surveys and will continue through the development of the FEIR.

2.5.3.3 Massachusetts Board of Underwater Archaeological Resources

As the sole trustee of the Commonwealth's underwater heritage, the Massachusetts Board of Underwater Archaeological Resources (MBUAR) is committed to promoting and protecting the public's interests in these resources for recreational, economic, environmental, and historical purposes. Under Massachusetts General Law Chapter 6, sections 179-180, and Chapter 91, section 63, the Board is charged with the responsibility of encouraging the discovery and reporting, as well as the preservation and protection, of underwater archaeological resources. Because the Board's jurisdiction extends over the inland and coastal waters of the state, the siting of aquatic disposal alternatives has been sensitive to the MBUAR’s charge. Ongoing communication and with the MBUAR will continue throughout the remainder of the Gloucester Harbor DMMP planning process.

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3.0 PURPOSE AND NEED

3.1 Project Purpose

The linkage between the need for dredging in Gloucester Harbor and the regulatory challenges involved with the disposal of UDM, associated with dredging projects identified in the Gloucester Harbor Plan, forms the basis for the Gloucester Harbor DMMP. While this section describes dredging needs for Gloucester Harbor, the focus of this DEIR is on disposal options for UDM. This section also characterizes the quality and quantity of dredged sediments for dredging projects, establishing the magnitude of UDM requiring disposal and the types of measures and site characteristics required for safe disposal of UDM.

As discussed in Section 2, the lack of a practicable cost-effective method for the disposal of UDM in an environmentally sound and cost effective manner has been a long standing obstacle to the successful completion of dredging projects in Gloucester Harbor. The basic project purpose of the Gloucester Harbor DMMP, is to identify, evaluate and permit, within the Gloucester Harbor upland or aquatic Zones of Siting Feasibility (ZSFs) a site (or sites) or alternative treatment technology, for the disposal of UDM over the next twenty year planning horizon for both public and private dredging projects.

The inability to find a practicable, environmentally sound, cost-effective method for disposal or management of UDM will restrict the maintenance and improvement of Gloucester's waterways (Figures 3-1 and 3-2) and ultimately, implementation of the Gloucester Harbor Plan.

3.2 Harbor Planning Context

The February 1996, passage of the Seaport Bond Bill, included a provision for funding assistance to the state's major commercial ports to conduct comprehensive harbor development and management plans. This "Four Ports Initiative," undertaken by Gloucester, Salem, New Bedford and Fall River with technical assistance from MCZM, on behalf of the Secretary of the EOEA, is being closely coordinated with the DMMP. As part of the local harbor planning process, Gloucester has developed a Harbor Plan to guide the development of the harbor over the planning horizon, providing a framework for future decisions related to port development.

A harbor plan, approved by the Secretary of the EOEA, is a document having significant impact upon the viability of planning initiatives in the port. The plan allows Gloucester to have greater flexibility in implementing a development strategy tailored to its port's needs and the City's visions of economic development and environmental quality. The plan also identifies funding needs which are critical to its implementation. The development option put forward in the plan represents the City's harbor planning goals and vision for the next five years.

The preparation of the Gloucester Harbor DMMP, also funded through the Seaport Bond Bill, has been coordinated with local planning efforts. Coordination with local harbor planning interests has been a critical component of the development of this DEIR. The simultaneous preparation of the harbor plan and the DMMP has helped with the identification of Gloucester Harbor's future dredging needs as well as potential sites for the disposal of UDM.

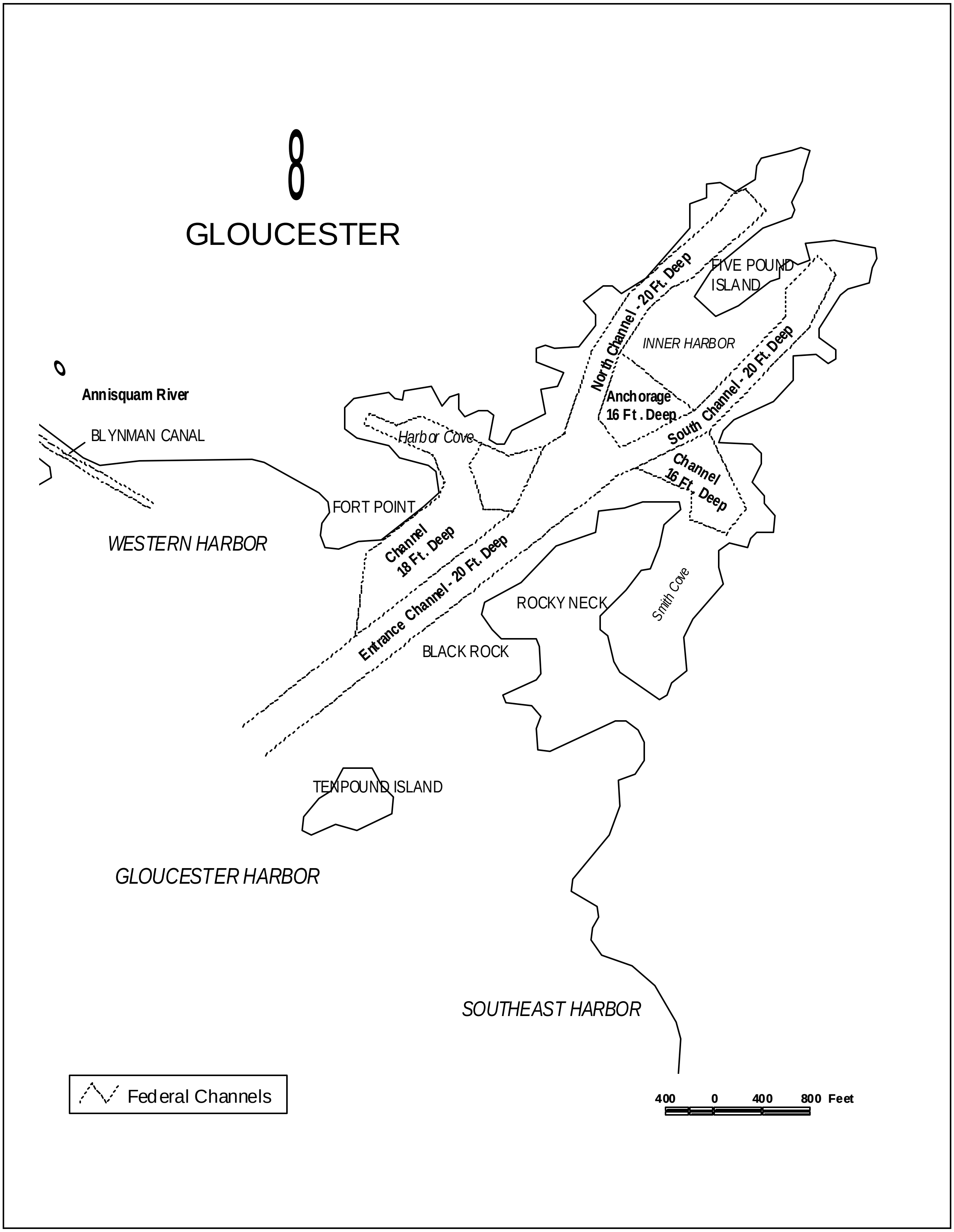


Figure 3-1: Federal navigation channels in Gloucester Harbor.

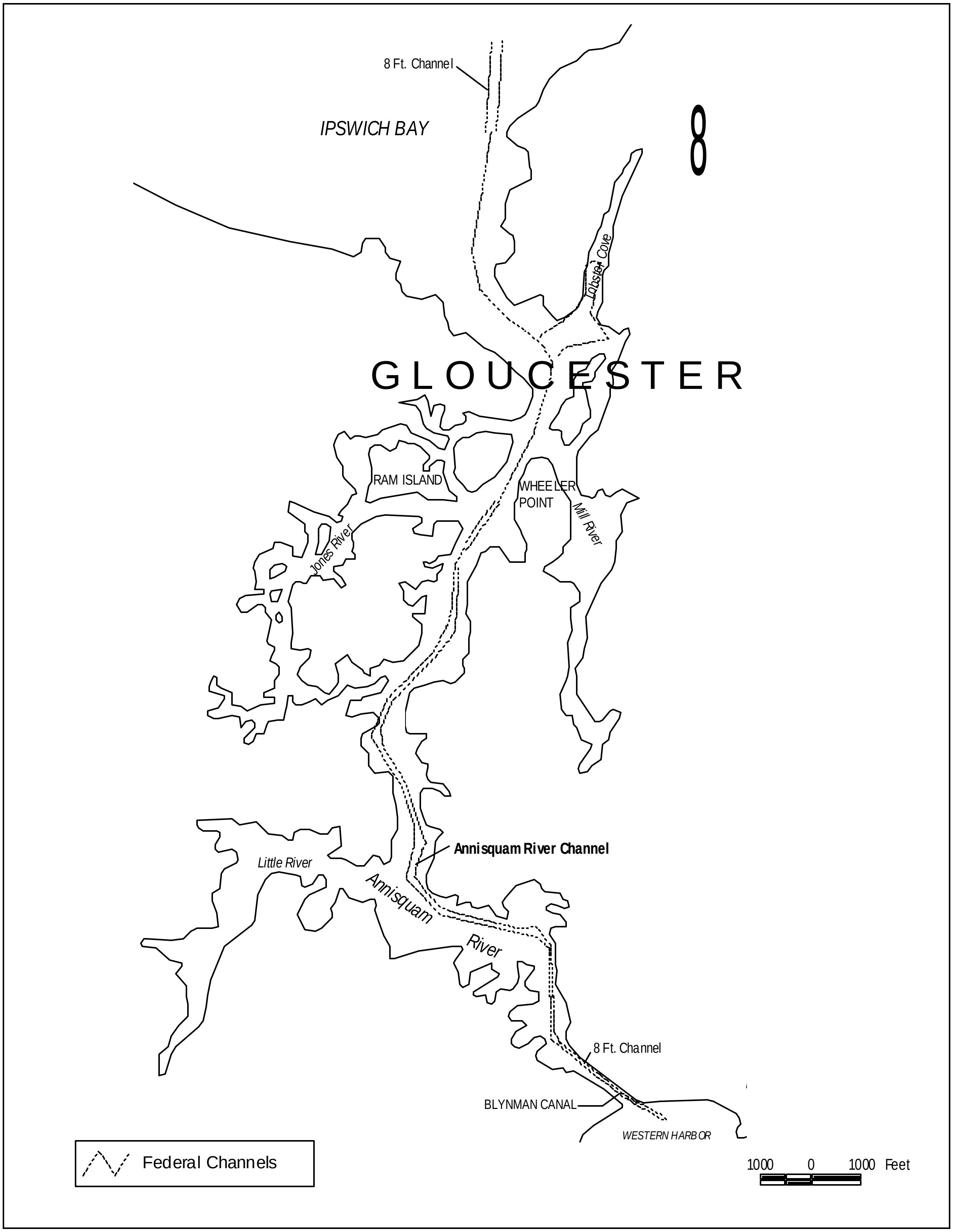


Figure 3-2: Annisquam River federal channel limits.

Gloucester has prepared a Harbor Plan, that has been submitted to and approved by MCZM. The development of the Gloucester Harbor Plan has been guided by the following mission statement to achieve:

> *"a publicly accessible Gloucester Harbor that expands its position as a vital economic asset to the City and the Commonwealth, while retaining its natural beauty and historic character. Above all the Plan seeks to continue the Harbor as a working, productive port".*

The goals of the Plan, which were developed with public input, articulate the Plan's broad scale intentions. The goals defined in the Gloucester Harbor Plan include the following:

- Promoting economic diversity and sustainable employment
- Strengthening commercial fishing/marine industry
- Developing historical, cultural and natural assets
- Benefitting the downtown and other areas of the city
- Providing infrastructure and navigation improvements
- Developing a viable implementation and management strategy

The Plan identifies the challenges the Harbor faces in achieving the above mission statement and goals. The plan presents the following "three-pronged approach" to planned, coordinated future development:

- **Rebuild the Harbor Infrastructure** - on land and water as a baseline to benefit all users and activities. The Plan defines fundamental public improvements to be undertaken by the City that are needed to sustain the function of the Harbor and to support needed development.
- **Strengthen the traditional port** - including facilities and businesses on historic finger piers, by providing assistance to private owners through a non-profit partnership. While the details of the partnership remain to be worked out, it is intended to advocate for investments and improvements in traditional small-medium scale sites and activities of the Harbor that are important to economic diversity, entrepreneurship, and the image of the City as a working port.
- **Develop historical and cultural assets** - by establishing the Gloucester Marine Museum on the downtown waterfront as a gateway to Gloucester and centerpiece for an organized network of visitor sites and businesses. These activities can help to support existing downtown businesses as well as attract beneficial new private investment into the area.

The Gloucester Harbor Plan, establishes a framework to using the "three-pronged" approach to implement the Plan's recommendations. Dredged material disposal alternatives for Gloucester Harbor identified in this DEIR have been screened for their consistency with the Gloucester Harbor Plan mission statements and planning goals listed above, to ensure that the preferred disposal alternatives assist in the achievement of the goals of the Harbor Plan.

Throughout the MEPA process and the development of this DEIR, MCZM provided the technical information necessary to identify the preferred alternative disposal sites and will make recommendations based upon that information; however, it is the responsibility of the City of Gloucester to determine the appropriateness of any site selected. The identification of the preferred alternative disposal site(s) has been coordinated with the City of Gloucester throughout the harbor planning process.

3.3 Project Need

This section describes the need to find an appropriate suitable dredged material disposal site. This section is divided into three primary areas: dredging history; dredging inventory; and, sediment quality and quantity. The dredging history portion of this section describes historical harbor dredging. The dredging inventory documents the current dredging needs of private and public entities in Gloucester Harbor and the Annisquam River. Finally, sediment chemistry data from recent and historical sampling and testing efforts are summarized, and the suitability of dredged material for ocean disposal is assessed.

3.3.1 Dredging History

Based on dredging records collected in the Massachusetts Navigation and Dredging Management Study that was completed by the USACE for the State of Massachusetts (USACE 1995), a total of 1,178,370 cubic yards (cy) of material has been dredged from Gloucester Harbor and the Annisquam River since 1932. Much of this volume was dredged prior to 1966, when the federal channel and anchorage areas were created. Additional dredging in the harbor since construction of the channel dredging has included USACE maintenance dredging, projects performed by MDEM at various locations, city dredging and many private dredging operations.

3.3.2 Dredging Inventory

The volume of sediment to be dredged from Gloucester Harbor over the next twenty years has been estimated through surveys conducted by the USACE (1996) and Maguire (1997). The dredged material volume estimates are needed to identify, plan and permit a disposal site(s) with sufficient long-term capacity to accomodate the needs for Gloucester Harbor.

The total volume of sediment to be dredged from Gloucester Harbor over the next 20 years is estimated at 514,440 cy. This figure includes a 20% contingency added to the surveyed volume to account for any uncertainty in the volumes provided by the marine users. The volumes presented in the sub-sections below are *without* the 20% contingency.

During the 1997 survey, all shoreline marina owners, municipalities, utilities, state and federal agencies were contacted via a mail-back questionnaire, with follow-up telephone calls to non-respondents. Marine users were asked to complete a questionnaire, denoting dredging footprints, volumes, and anticipated time schedule over the next 20 years.

There were over fifty facilities. The maintenance dredging of the Annisquam River is the largest project. The USACE has stated that the River is in need of maintenance dredging immediately. The Annisquam River is subject to heavy siltation and, on average, requires dredging every 8 years. Therefore, over the 20-year planning horizon, an additional maintenance dredging of the river has been included in the inventory. Of the 106,000 cy of dredging in the Annisquam, the USACE is currently planning to dredging only the 47,000 cy of sediment in the main channel that has been deemed suitable for ocean disposal or beach nourishment. The remaining 59,000 cy of sediment from Lobster Cove and the Blynman Canal, which are likely unsuitable for ocean disposal, would be dredged at a later time in the 20-year planning horizon.

Dredging of privatefacilities comprises a significant portion of the total material to be dredged from Gloucester (Figure 3-3). There are no maintenance or improvement dredging projects planned for the Gloucester Harbor federal channel and anchorage areas. In the original dredging inventory (1997), a proposed deepening of the federal channel from 20 feet to 26 feet was identified as a potential project involving 427,000 cy of dredging in the entrance channel, north channel and anchorage area (Figure 3-1) . A USACE study showed that this deepening project would not be cost effective. The 70,000 cy of maintenance dredging was researched and was also found not to be cost effective at this time.

Because no major rivers empty into Gloucester Harbor, and off-shore drift does not transport significant amounts of sediment into the basin, sediment accumulation (i.e. shoaling) within the federal channel and anchorage areas occurs at a very slow rate. The USACE has calculated an accumulation rate of only 22,000 cy over a 10-year period. Accumulation rates in marina areas, however, are higher because of several factors including resuspension of sediments from boat propellers and slower water currents.

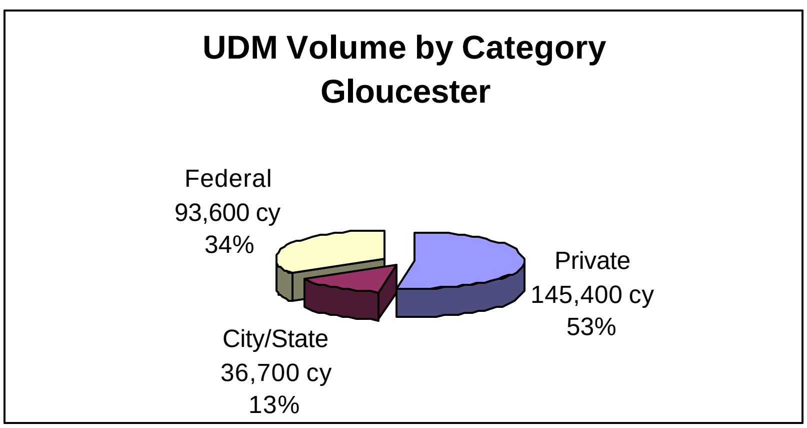


Figure 3-3: UDM Volume for Gloucester by Project Type
(does not include 20% contingency)

3.3.3 Sediment Quality and Quantity

3.3.3.1 Sediment Quality - Conformance with Regulatory Requirements

USEPA Protocol

The evaluation of sediments proposed for dredging is conducted by federal and state regulatory agencies. The USEPA, USACE, NMFS, and USFWS, through an inter-agency agreement, are responsible for development and review of all sampling and testing for dredging and dredged material disposal in Massachusetts. At the state level, DEP and MCZM review sampling and testing under the purview of the Coastal Zone Management Act (CZMA) and Section 401 of the Clean Water Act (CWA). The federal agencies jurisdiction comes from Section 404 of the CWA. Sampling and sediment testing for the Gloucester Harbor DMMP DEIR followed published protocol of the USEPA and USACE. The protocol (Evaluation of Dredged Material Disposal for Ocean Disposal, USEPA/USACE, Feb. 1991) involves a tiered approach. Tier I involves a literature search on potential contaminant sources, history of dredging, natural harbor features and other factors.

The first step of Tier II involves the physical analysis of samples (grain size, organic carbon content). These results are reported to the USACE, which, in turn determines which samples are to be composited for bulk chemical analysis. The only sediments that would not require further testing are those that consist of greater than 90% sand and/or are in areas of high currents and no major pollution sources as determined by USACE. In Gloucester, there are no sediments that meet this “exclusionary” criteria. The harbor has numerous point and nonpoint pollution sources and is almost entirely a depositional area because of relatively slow currents and tidal action.

After the bulk chemical analysis is complete, results are presented to the federal agencies for their review and evaluation. According to USEPA, if a substance is detected in sediments above “trace amounts”, biological-effects testing (Tier III) is required. USEPA interprets “trace amount” as being any concentration that is above laboratory detection levels. If all substances are below trace levels, then no additional testing is required and sediments are deemed suitable for ocean disposal.

An inventory of potential pollution sources and historic sediment quality data in and near Gloucester Harbor was conducted as part of the DMMP Phase 1 (Maguire 1997). This information was used by the regulatory agencies to develop site-specific sampling and testing plans for the Gloucester Federal Channel Deepening Project and the Annisquam River maintenance dredging. As mentioned in Section 3.3.2 above, the deepening of the federal channel is no longer desired, therefore the associated sediment data is not specific to any planned project in Gloucester Harbor. However, the data is representative of the Harbor as a whole, and as such, can be used to indicate the type of relative levels of contaminants present in any one of the facilities in the Harbor area.

A management strategy will be developed by the appropriate state and federal regulatory agencies as to the sampling and testing requirements for specific dredging projects in the harbor.

Sampling and testing plans for the federal channel and the Annisquam River were developed in a coordinated effort by USEPA, USACE, NMFS and USFWS with input from DEP. The plans for

Gloucester Harbor were completed in early 1998. Sampling and testing was conducted in the spring/summer of 1998. A summary of the results is presented below and detailed information is contained in Appendix E.

Physical Testing

Surficial sediments in the entrance channel and north channel are fine-grained, generally grey to black in color and anoxic, with some sulfur odor. Organic carbon content is moderate to high.

Deeper sediments in the channel areas (3-6 ft. below the surficial sediments) are also fine-grained but they are composed of lean clays that are grey and homogenous. Thin sand layers are found in some of the deeper sediment layers.

Conversely, Annisquam River sediments are composed primarily of sands. In fact, of the ten samples taken from the river, only one, LC-B, had greater than 10% fines. The LC-B sample was taken in Lobster Cove, a backwater area where patches of sand and silt accumulate.

Bulk Chemistry

Sediments were analyzed for a list of contaminants determined by USACE/USEPA policy including: metals, polycyclic aromatic hydrocarbon (PAH), pesticides and polychlorinated biphenyl (PCB) content. All these classes of chemical have been detected in previous samples in the harbor and have the potential to occur in the sediments due to the presence of several point and non-point pollution sources in the area.

Although a direct comparison of chemistry test results to ocean disposal site reference values is not used to determine sediment suitability for ocean disposal, chemistry results are compared to the MBDS reference site values so that the nature of the sediments in Gloucester Harbor can be viewed in a useful context. The MBDS reference values reflect sediment samples taken near the MBDS. As previously described, dredged material deemed suitable for unconfined open ocean disposal may be taken to MBDS (Figure 3-4).

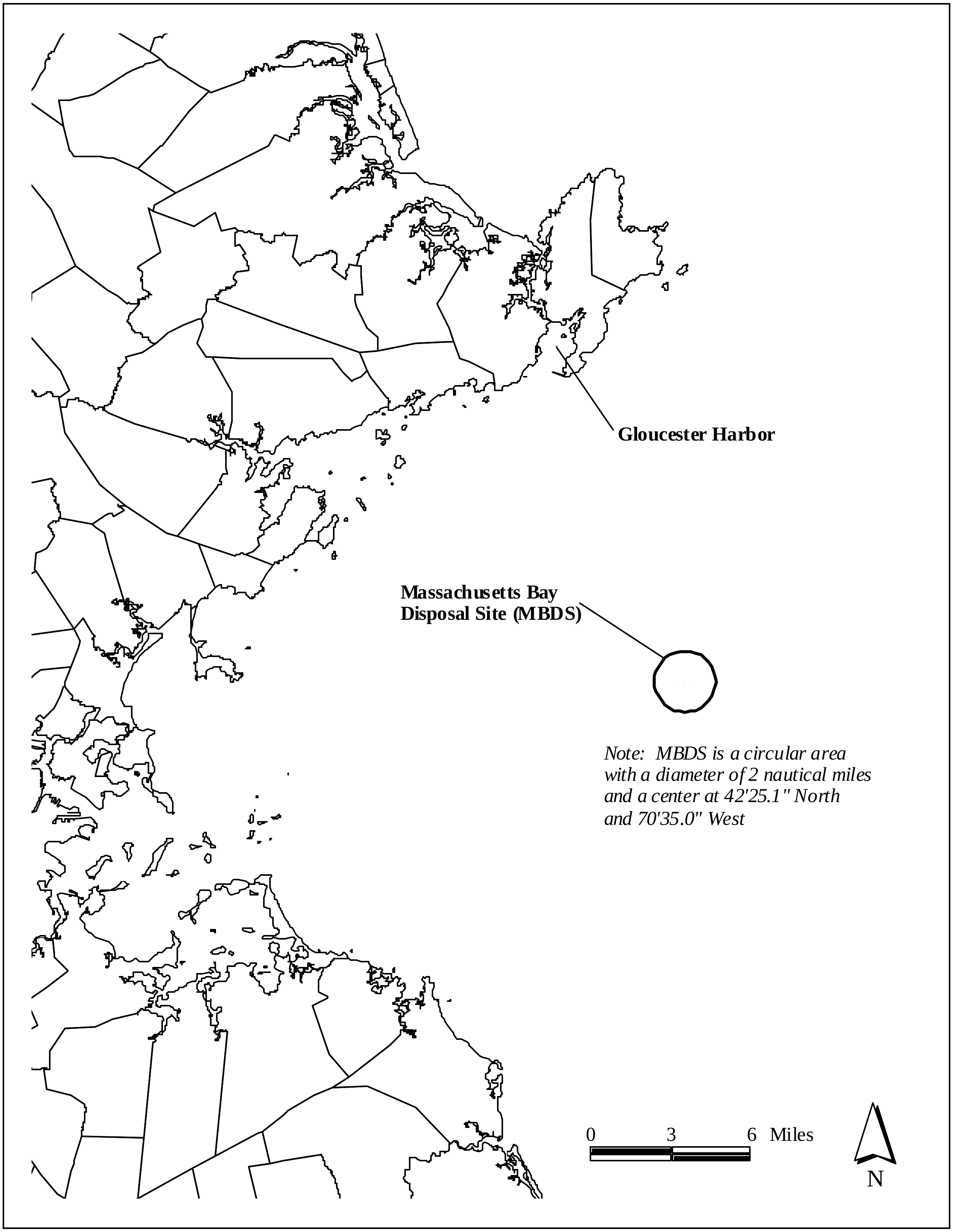


Figure 3-4: Location of Massachusetts Bay Disposal Site (MBDS)

Table 3-1 summarizes the mean (average) concentrations of selected substances found in measurable quantities in the sediments from the major dredging projects.

Table 3-1: Summary of concentration of selected contaminants in Gloucester sediments.

Analytes	Annisquam River		Federal Channel		MBDS Reference
	Mean	*Range*	*Mean*	*Range*	
Arsenic	0.965 ppm	0.25 - 3.2	12 ppm	1.9 - 24	28.7 ppm
Cadmium	0.17 ppm	0.05 - 1.1	0.98 ppm	0.15 - 2.4	2.74 ppm
Chromium	0.13 ppm	4 - 70	35 ppm	11 - 41	152 ppm
Copper	9.71 ppm	0.5 - 35	<u>62</u> ppm	10 - 140	31.7 ppm
Mercury	0.053 ppm	0.025 - 0.23	0.24 ppm	0.025 - 0.43	0.277 ppm
Nickel	4 ppm	1 - 10	16.7 ppm	8 - 27	40.5 ppm
Lead	19.3 ppm	1 - 71	<u>86</u> ppm	7 - 190	66.3 ppm
Zinc	55.6 ppm	7 - 350	127.8 ppm	48 - 310	146 ppm
Total PAH	2,670 ppb	15-6,803	<u>12,372</u> ppb	14 - 32,670	2,996 ppb
Total PCBs	38 ppb	6 - 136	113 ppb	0 - 259	ng

Notes:
<u>Underline</u> denotes greater than MBDS Reference
MBDS Reference is mean plus 2 standard deviations
ng = no guideline

The chemical found in sediments are indicators of the present and past marine activities in Gloucester Harbor which include boat paints, fuel and oils, bulk chemicals, and other marine cargo.

Of the eight metals studied, copper and lead are the most prevalent in Gloucester Harbor. Mean concentrations in surface sediments of the entrance channel and north channel are slightly elevated above the MBDS reference value. Sediments in the Annisquam River contain low levels of metals, all below the MBDS reference values. Copper and lead are common pollutants in estuaries, because they are common substances in the upland environment. Lead was once used in gasoline as an “anti-knocking” agent before it was banned from use in the 1980s. Lead is also a common soldering material in older plumbing. Copper is the most common material used for piping since the 1950s. In addition to their use in plumbing components, copper and lead are also commonly used in manufacturing processes. Most metals have a tendency, once entering the water, to adsorb to suspended sediment particles which then settle to the harbor bottom.

Total PAH concentrations in Gloucester Harbor are, on average, four times higher than the MBDS reference guideline (Figure 3-5). Concentrations in the Annisquam River sediments are generally near or

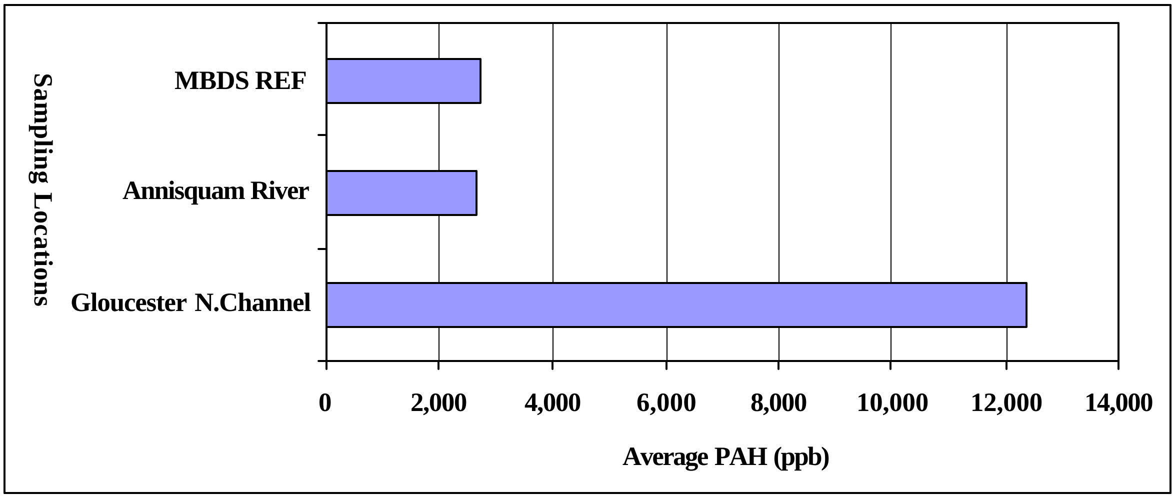


Figure 3-5: Average PAH concentrations (ppb) in sediment samples collected from Gloucester Harbor, Annisquam River and MBDS Reference Site.

below the MBDS reference guideline, with the exception of Lobster Cove, where total PAH levels were measured at about 5,000 ppb.

Polycyclic aromatic hydrocarbons (PAH) are a class of chemicals that are formed by the incomplete combustion of fuel. Sources of PAH include power generation, stormwater runoff, industrial discharge and dry deposition from the atmosphere.

There are no MBDS reference values for pesticides, but there are some numerical guidelines that have been developed by National Oceanic and Atmospheric Administration (NOAA) and the New England River Basins Commission (NERBC). Pesticide concentrations harbor-wide are generally low compared to these guidelines, however, elevated DDT and DDT-derivative compounds were found in the federal channel. This is consistent with the spatial distribution of other contaminants such as metals and PAHs within the harbor. Pesticides, as the name implies, are used to control weeds, fungi, rodents and other undesirable organisms. While many chlorinated pesticides have been banned from use in the United States, their historic production and chemical stability have allowed them to persist in the environment.

Polychlorinated biphenyls (PCBs) were detected in most federal channel and Annisquam River sediment samples. The highest PCB readings in the federal channel samples were in the North Channel and the highest measurements in the Annisquam River were in Lobster Cove. There are no sediment quality guidelines for PCBs (congener-specific) so the toxicological and ecological significance of the concentrations in Gloucester Harbor sediments cannot be assessed without further biological testing.

PCBs were once used as cooling fluids in transformers and other electrical equipment. Since 1976, PCBs have been banned from manufacturing and use in the United States due to their potential acute and chronic effect on the environment. PCBs were widely used and their chemical stability has allowed them to remain in the environment.

Biological Testing

In accordance with the EPA protocol discussed in the above section, Tier III biological-effects testing would be required if disposal at the MBDS is proposed. Any private or public dredging project that proposes ocean disposal at the MBDS must undergo biological testing to determine if sediments are suitable. The biological testing requirements (if any) for disposal at any of the preferred aquatic disposal sites within the Harbor, will be determined at a later date by the appropraté regulatory (state and federal) agencies.

1) Suspended particulate phase bioassays; this test is used to determine the short-term effect of dredging and disposal on sensitive water column organisms. If significant short-term effects are anticipated, then dredging and disposal management restrictions can be employed to minimize impacts. This testing is required for disposal at MBDS, but it can also be used to estimate impacts at the point of dredging. It has not yet been determined whether these tests will be required for dredging or disposal within the Harbor.

2) Solid phase toxicity test; over a 10-day period, sensitive marine amphipods are exposed to test sediments to determine the acute toxicity (lethality) of the sediment.

3) Solid phase bioaccumulation test; sediment dwelling organisms are exposed to test sediments over a 28-day period to determine acute and chronic effects of the sediment. The tissues of surviving organisms are then analyzed for the chemicals of concern.

No biological tests were undertaken as part of the Gloucester Harbor DMMP. Testing requirements for dredging projects proposing to use a CAD cell will be determined as one component of the management plan to be developed.

3.3.3.2 Sediment Quantity - Suitable versus Unsuitable Volumes

The determination of the suitability for sediments for ocean disposal is made by the federal agencies on a case-by-case basis. As stated earlier, the dredging projects identified in the dredging inventory must undergo the full suite of tests necessary to determine if the sediments are suitable for ocean disposal. Nevertheless, the sediment sampling and testing of the Gloucester Harbor entrance and north channels and the Annsiquam River during DMMP Phase 1 (Maguire 1997) gives insight into the characteristics of sediments to be dredged in the harbor channels, anchorages, marinas and boat basins. This information has been used to estimate the suitability of sediments at proposed dredging locations in the harbor.

Sediment chemistry data presented in this section for the federal channel in Gloucester Harbor and the Annisquam River were used to evaluate other nearby projects in those areas. Those facilities that are distant from any sampling locations were assessed based on: historic sediment quality data (if any); proximity to pollution sources; and, general oceanographic conditions, i.e. is the site within a high or low energy environment.

Given the sediment chemistry data presented above, it is likely that sediments in Gloucester Harbor marinas, boat launches and other facilities would be unsuitable for ocean disposal at MBDS because of their elevated PAH and metals content, primarily.

Most reaches of the Annisquam River contain contaminant levels well below the MBDS reference values. These sediments are primarily sand and are likely suitable for ocean disposal or beach nourishment. However, there are two areas of the river, Lobster Cove and Blynman Canal, that contain a higher silt fraction and correspondingly higher metals and organic contaminant concentrations. These areas are assumed to be unsuitable for ocean disposal. Once the UDM sediments from these two areas have been removed during the initial maintenance dredging, the sediments that accumulate in these areas should be low in contaminant levels because no major ongoing sources of contamination were noted in the Due Diligence study (Maguire 1997a).

Several marinas in the Annisquam River are located near channel sediment sample locations that are suitable for ocean disposal. While these facilities may contain suitable dredged material, it is assumed, to be conservative in planning for the sizing of potential disposal sites, that these sediments are also unsuitable for ocean disposal.

Given the assumptions presented above, it is estimated that approximately 276,000 cy of sediment to be dredged from Gloucester Harbor over the next 20 years would be UDM. For planning purposes, a 20% contingency has been added to the unsuitable volume to arrive at a volume of approximately 333,000 cy.

Table 3-2: Dredged material volumes (cy) for Gloucester Harbor for next 20 years

Inventory Total	Inventory Total with Contingency[1]	Suitable Dredged Material[2] with Contingency	Unsuitable Dredged Material[3] with Contingency
428,700	514,440	183,600	**330,840**

Notes:
[1] Contingency is 20%
[2] Suitable for disposal at MBDS
[3] Not suitable for disposal at MBDS

Depending on the selection of disposal type (upland, aquatic) and location, there may be an additional volume of UDM. For example if a CAD cell footprint contains UDM, then the volume of material excavated for the creation of the CAD cells would also have to be managed as UDM. This scenario is discussed in greater detail in Section 8.0.

As part of the dredging inventory, marine users were asked to estimate the time frame for their anticipated dredging projects. Table 3-3 portrays the timing estimates for disposal of UDM from Gloucester Harbor. As shown, the majority of the UDM would be dredged in the first 10 years. The timing of the dredging projects may change over time depending on many factors including the availability of dredged material disposal sites. Nevertheless, the dredging breakdown by 5-year increments demonstrates the immediate need for dredging.

Table 3-3: Twenty year dredged material volume[1] (cy) breakdown in 5-year increments

Years 1-5	Years 6-10	Years 11-15	Years 16-20	Total
159,695	126,190	22,575	22,380	330,840

Notes:
[1] Includes 20% contingency

3.4 Harbor Plan Implementation

The implementation recommendations in the Gloucester Harbor Plan have been grouped as follows: navigation improvements, public use and access, streets and parking, program to strengthen the working port and developing cultural and visitor use potentials, outlines the projects, initiatives development opportunities, and studies to be accomplished in a five to seven year period. This implementation schedule establishes the blueprint for “making the vision happen”. The proposed Harbor Infrastructure improvements to navigation including public dredging and private piggy back dredging projects have been identified as the foundation of the action items identified necessary to realize the vison established in the Gloucester Harbor Plan.

The formal identification of the need for dredging by the City, as defined in the Gloucester Harbor Plan, and the characterization of a portion of that proposed dredged material in the DMMP planning process as UDM, underscores the importance of locating a long-term cost-effective, environmentally sound disposal option. The technical assistance provided by MCZM to the City in developing a disposal solution for UDM will help the City and the Commonwealth meet the mission statement and goals of the Gloucester Harbor Plan and achieve the Basic Project Purpose of the DMMP. Identification of a practicable UDM disposal option will help attain the City’s vision of maintaining a vibrant seaport, while preserving Gloucester’s maritime heritage, and furthering economic development.

4.0 ALTERNATIVES ANALYSIS

4.1 Introduction

This section of the Gloucester Harbor DMMP DEIR presents the alternatives for the disposal or management of UDM as well as a comparative assessment of the environmental impacts of each alternative. Both state and federal laws guide the development of the alternatives analysis contained in this section of the DEIR. The two principal statutes are:

(1) Massachusetts Environmental Policy Act (MEPA), Massachusetts General Laws (MGL) Chapter 30, Sections 61 and 62A-H. MEPA is the environmental review statute of the Commonwealth, and is the law under which this DEIR is being prepared. MEPA provides an opportunity for public review of potential environmental impacts of projects for which state agency actions (e.g., permits, funding, or agency-sponsored projects) are required. Most important, MEPA functions as a vehicle to assist state agencies in using: "... all feasible means to avoid damage to the environment or, to the extent damage to the environment cannot be avoided, to minimize and mitigate damage to the environment to the maximum extent practicable." (MEPA, 1998)

MEPA requires an analysis of "reasonable alternatives and methods to avoid or minimize potential environmental impacts" (301 CMR 11.07(6)) and that all "feasible" alternatives be analyzed in an EIR. Feasible alternatives means those alternatives considered: "... in light of the objectives of the Proponent and the Mission of the Participating Agency, including relevant statutes, regulations, executive orders and other policy directives, and any applicable Federal, municipal, or regional plan formally adopted by an Agency or any Federal, municipal or regional governmental entity" (301 CMR 11.07(6)(f)).

(2) Clean Water Act (CWA), in particular the Section 404(b)(1) guidelines of the US Environmental Protection Agency (Title 40, Code of Federal Regulations (CFR), Part 230), require that "practicable" alternatives to a proposed discharge to waters of the United States be considered, including avoiding such discharges, and considering alternative aquatic sites that are potentially less damaging to the aquatic environment. The goal of the Section 404(b)(1) guidelines is to provide a framework for arriving at the Least Environmentally Damaging Practicable Alternative (LEDPA). While the alternative selected for implementation needs to be the least environmentally damaging, i.e. resulting in the least amount of human and natural environment impact of the alternatives studied, it also needs to be practicable. The term "practicable" means "available and capable of being done after taking into consideration cost, existing technology, and logistics in light of overall project purposes."

In consideration of the above, the alternatives for Gloucester Harbor included in this section of the DEIR are those alternatives for the disposal and/or reuse of UDM.

4.2 No Action Alternative

Consideration of the No Action Alternative for the Gloucester Harbor DMMP is required under the MEPA Regulations at 301 CMR 11.07(6)(f). The No Action alternative is used to provide a future baseline against which the impact of the Preferred Alternative(s) is (are) measured, compared and contrasted. It is representative of future conditions in Gloucester Harbor, without the changes or activities that would result from the implementation of the Preferred Alternative(s) for disposal of UDM.

The No Action alternative assumes that dredging activities involving the removal of sediments that are unsuitable for unconfined open water disposal would not occur. It is estimated that approximately 330,000 cy of sediment to be dredged from Gloucester Harbor over the next 20 years is unsuitable for unconfined open water disposal. Therefore, under the No Action alternative, this 330,000 cy of sediment would not be dredged.

Existing sedimentation rates in Gloucester Harbor would continue unabated and the navigation channels would slowly fill in. The USACE estimates that the federal navigation channels in Gloucester receive a net volume of 2,200 cy of sediment per year, which equates to approximately 0.25 inches within the channels. The approximately 50 dredging projects and activities which have been identified to continue economic growth in the City of Gloucester in their Harbor Plan would not occur. Specifically, for the Gloucester Harbor DMMP, no aquatic or upland disposal sites for UDM would be constructed and future environmental impacts which would result from their construction and use would be avoided.

4.3 Description of Disposal Alternatives

4.3.1 Aquatic Disposal Alternatives

The following describes several types of aquatic disposal methods considered for the disposal of dredged material. Generally speaking, the primary advantages of open water disposal over other disposal alternatives are typically the large disposal capacity, relatively short-term environmental impacts, and lower relative cost (Carey et al., 1999). The primary disadvantages of aquatic disposal include potential changes in benthic habitat quality and temporary water quality degradation, as well as complex logistics associated with certain types of aquatic disposal. The complexity of aquatic disposal is due to the interdependence, sequencing and timing of dredging, storage and disposal operations.

4.3.1.1 Confined Aquatic Disposal

Confined aquatic disposal (CAD) is the process where dredged material that is unsuitable for unconfined open water disposal is deposited into the marine environment within a confined area, and then covered with suitable material (Figure 4-1). There are basically two methods of constructing a CAD site. Most commonly, CAD sites are created by placing unsuitable material on the existing seabed, and then covering it with clean dredged material which is considered suitable for open-water disposal. The overlying layer is commonly referred to as a cap, typically constructed using either dredged silt or sand. This method has been used in open-water disposal sites in New England (e.g., DAMOS 1994), New York (SAIC 1998), and elsewhere, and requires that sufficient suitable material be available to provide complete capping of UDM. In exposed

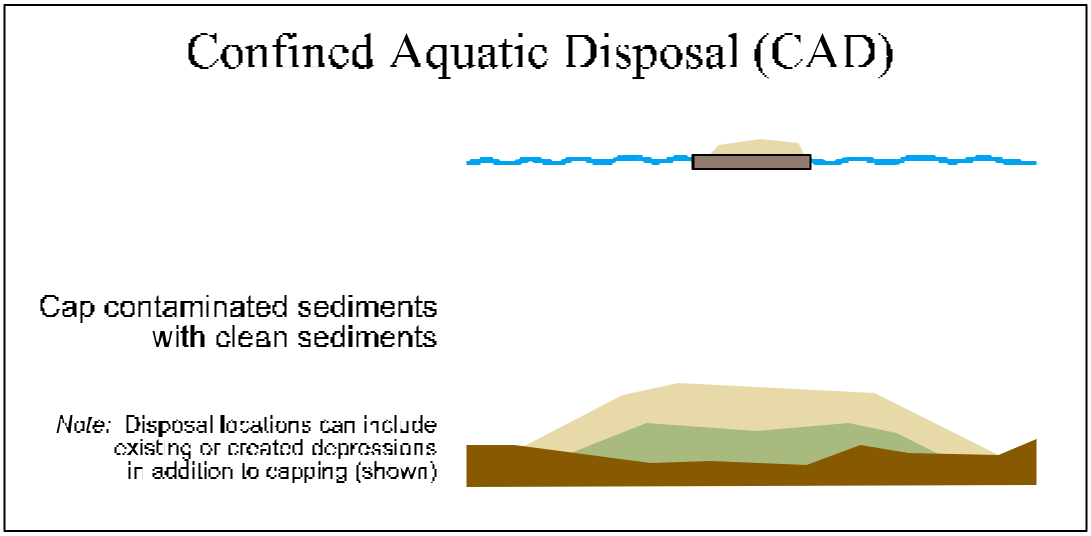


Figure 4-1. Schematic of Confined Aquatic Disposal (CAD) Mound Method

offshore regions in Massachusetts Bay, sites with topography conducive to confinement were preferred, in water depths of at least 65.6 feet (20 meters) to maximize protection against storm-driven waves.

The second method of constructing a CAD site is to excavate a confined area, or pit, which is then filled with UDM and capped. In general, these sites can be created in shallower water, but require water depths in excess of 20 feet (6.1 m), so that dredges and barges which are used to create the pit can access the area. Two types of CAD pits are presented for possible use:

Overdredge (OD) - CAD sites located within an existing channel that are dredged below the proposed navigational depth, then filled with dredged material and capped to the proposed navigational depth (Figure 4-2);

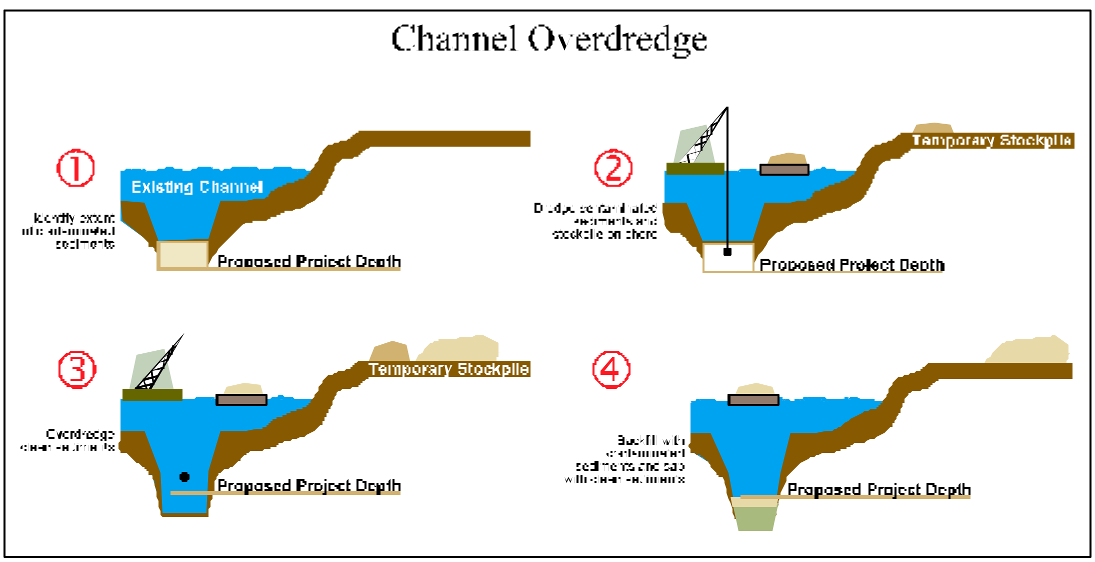


Figure 4-2. Schematic of Channel Overdredge (OD) Method

Adjacent-to-Channel (ATC) - CAD sites that are created along-side existing channels and/or anchorage areas.

The **OD** method is presently being employed for the BHNIP (NAE and Massport 1995; DADOS 1999). In this method, the pits are excavated in the channel, and then filled and capped up to or below the existing maintenance depth. If the overlying sediments in the channel are unsuitable, these are first removed and stockpiled. Dredging then continues into underlying suitable sediments, creating a pit below the designed channel depth. Suitable material is disposed of in an approved offshore disposal site (e.g. MBDS). UDM (including the stockpiled channel cover) is then deposited in the pit and covered with suitable material. In the BHNIP, the cap design was for three feet of sand, although alternative cap material can be considered. The selection of an appropriate cap material is dependent upon the environmental objectives of the CAD design, as well as the geotechnical properties of the sediment to be capped.

The **ATC** method is similar to the OD method, except that the pits are excavated in areas near, but outside, the project dredging area. The ATC can be dredged into existing bottom, but is limited only by the existing water depth rather than the maintenance depth of the channel. As with OD sites, if the overlying sediments prove to be unsuitable, the removed material also needs to be stockpiled for eventual deposition into the ATC pit.

The OD and ATC CAD alternatives have the advantages of locating the disposal site near an existing dredged area (the channel), causing only temporary disturbance of the bottom resulting in rapid biological recovery of the sea floor, and disposing of the material in an inner harbor area that is already impacted by human activity. When the OD site is located near the area being dredged, the additional advantages include (NAE and Massport 1995):

1) confinement of the disposal impacts to areas impacted by dredging;
2) sequestering the material near the point of origin; and,
3) compartmentalizing dredging and disposal operations.

Relative to the first type of CAD site in which no pre-dredging is required, the OD and ATC methods have the disadvantages of requiring additional dredging, longer project duration, greater material handling, larger disposal volumes (the material removed to create the pits), and increased costs. In addition, for OD sites, if the top-of-cap elevation is set as the channel depth, this method precludes future dredging of the channel to deeper design depths without first removing the previously deposited contaminated sediments. Where future navigational improvement projects are being contemplated, the OD top-of-cap elevation must include an adequate depth contingency to accommodate additional channel depth associated with planned future navigational improvement projects. One advantage of the ATC design is that there is no concern that the material will be disturbed by future maintenance dredging of existing navigational dredging projects.

4.3.1.2 Confined Disposal Facility

UDM may also be disposed in confined disposal facilities (CDFs), illustrated in Figure 4-3. Creation of a CDF requires construction of confinement walls, typically steel sheet pile, or a confinement berm of earth or stone. Stone reinforcement (rip-rap) may be required on the seaward side of confinement walls and berms to protect them from wave action and tidal scouring. An impermeable liner and cap may also be required, depending on the chemical characteristics of the dredged material. The liner and cap may be made of impermeable soils, such as clay, synthetic materials such as high density polyethylene (HDPE), or some combination of these two. Leachate collection, treatment and disposal may be necessary for lined cells during the construction period to control rainwater infiltration until the cap can be placed over the cell. CDFs have the advantage of isolating UDM from the environment, while at the same time creating new land which can be put to constructive uses, such as port expansion, development, open space, parkland, or upland wildlife habitat. Alternatively, the CDF can be left as a subaqueous area, creating additional wetlands , as discussed in the section on Tidal Habitat, below. CDFs have the disadvantages of: permanently displacing existing tidal and subtidal habitat; being relatively expensive to construct; and, requiring periodic maintenance to ensure the long-term structural integrity of the CDF.

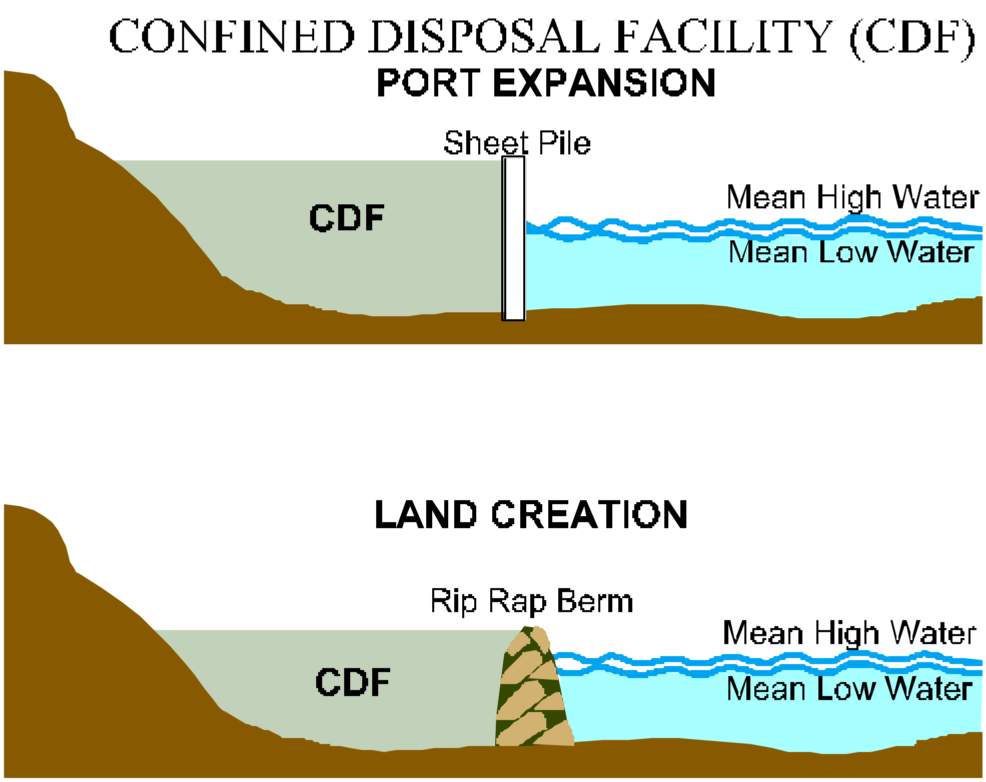


Figure 4-3: Schematic of the Confined Disposal Facility (CDF) Method

4.3.1.3 Tidal Habitat

A tidal habitat site is a special type of CDF, developed specifically for creation of tidal habitats such as mudflats and coastal wetlands (Figure 4-4). The tidal habitat method requires a cap of material that is chemically and physically able to support biological activity. The tidal habitat method requires creation of an impoundment to retain the dredged material and protect the newly created habitat from scouring currents and wave action. This is typically accomplished by building a berm or breakwater of stone, or of soil armored with stone, up to an elevation above high water. The berm would be penetrated by one or more culverts, enabling sea water to flow through the berm and equalize tide elevations on both sides. The area inside the berm can then be filled with dredged material. The surficial sediments that will be exposed to biological activity must be suitable material (similar to a CAD cap) in order to prevent bioaccumulation/biomagnification and bioturbation of contaminants.

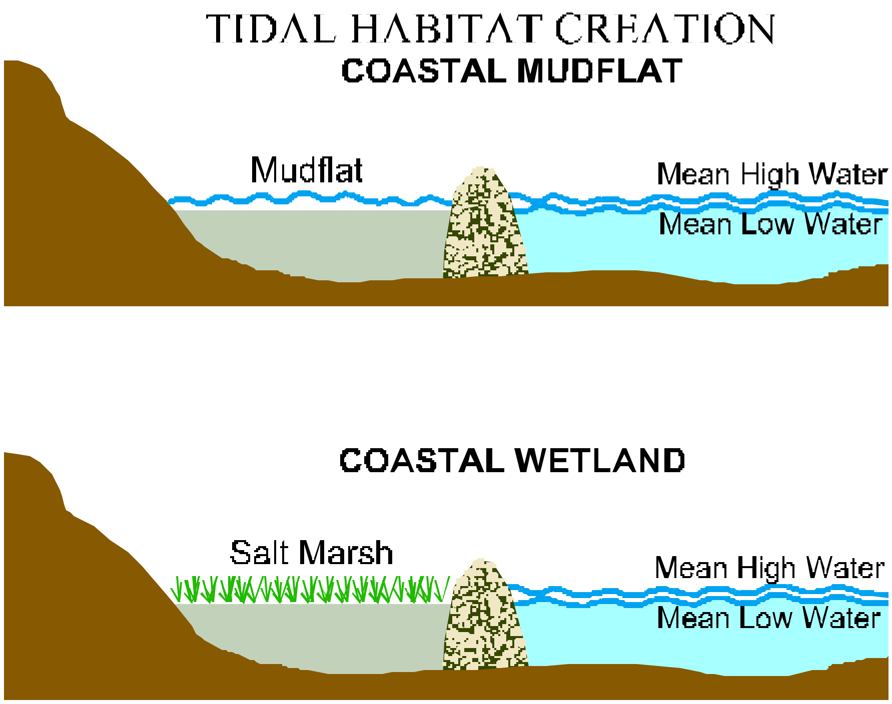


Figure 4-4: Schematic of the Tidal Habitat (TH) Creation Method

To create an intertidal mudflat, the area is filled to the elevation of mean sea level. This ensures that the surface will be covered with water at high tide and will be exposed at low tide. Tidal mudflats provide habitat for a wide range of invertebrate organisms, which, in turn, are an important source of food for shorebirds. To create tidal wetlands (i.e. salt marsh), the area is filled to an elevation that ensures that the surface will be flooded periodically, saturated most of the time, and exposed at low tide. Once the surface has stabilized, it is planted with species such as salt marsh cordgrass (*Spartina alterniflora*), salt meadow cordgrass (*Spartina patens*), and big cordgrass (*Spartina cynosuroides*). Salt marsh wetlands provide habitat for a wide range of invertebrate organisms, and are used as nurseries for many species of marine fish. These organisms are an important food source for shorebirds, waders and certain waterfowl.

Tidal habitat alternatives have the advantage of creating additional habitat in, or proximal to, densely developed urban areas (thereby restoring the functions and values of a natural coastline). They have the disadvantages of: displacing existing tidal and subtidal habitat; having low capacity relative to the total quantity of material to be dredged; being relatively expensive to construct; and requiring on-going monitoring and maintenance to ensure the integrity of confinement and the success of the created habitats.

4.3.2 Relationship of Alternative Treatment Technologies, Dewatering and Upland Disposal

Alternative treatment of marine sediment , dewatering and upland disposal are often components of a single logistical system for the handling/disposal of UDM. Depending on the characteristics of the sediment (its composition and mixture of contaminants), UDM must be handled, stored and transported several times before its ultimate disposal or reuse in the upland environment.

As illustrated in Figure 4-5, UDM first leaves the barge for storage, dewatering and/or treatment at a shore-side location. This location is referred to as a dewatering site. While at the dewatering site, the sediment will be placed in piles where the sediment will dry and the water will evaporate and run-off. This dewatering process may also be accelerated by use of mechanical devices such as a belt filter press. Sediment may be processed through a number of treatment methods to eliminate adverse impacts from contaminants. Treatment may be as simple as adding other substances to the sediment to solidify or chemically stabilize the dredged material. Treatment may also be quite complex involving incineration or a series of other processes which in themselves create environmental impacts. For upland disposal, a range of locations is possible: from active landfills to vacant parcels that may be converted to environmentally sound disposal sites for UDM. Each of these components of a non-aquatic disposal system have alternative choices within them. There are numerous types of alternative treatment technologies; several shore-side locations as potential dewatering sites and many locations as potential disposal sites for UDM. The following sections address alternatives within each of these non-aquatic disposal system components.

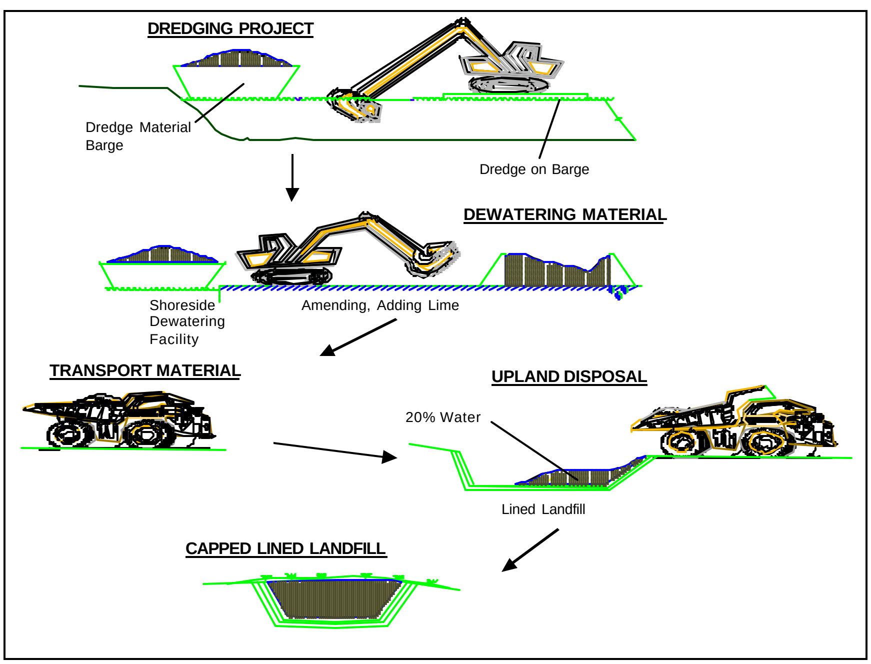


Figure 4-5: Upland Disposal Process

4.3.3 Alternative Treatment Technologies

Alternative treatment technologies involve the treatment of contaminated sediment, using one or more processes, to allow for reuse of the sediment in a safe manner in the upland environment or for unconfined open water disposal. There are four general types of treatment technologies, categorized based on their effect on the contaminants of concern within the sediment:

1) *Destruction*: the removal of contaminants from the sediment via physical, chemical or biological agents;

2) *Separation*: the process of removing contaminants from the sediment resulting in a concentrated residual of contaminated sediment of significantly smaller volume;

3) *Reduction*: the process of reducing the amount of contaminated dredged material that requires treatment by screening sediments into various particle sizes; and,

4) *Immobilization*: the fixing of contaminants in the dredged material which keeps the contaminants from being released to the environment.

Destructive methods are generally the most complex and expensive forms of treatment. Some of the destructive methods assessed in the DMMP include: incineration, pyrolysis, solvent extraction, thermal desorption and vitrification. The costs for such technologies range from $161-420/cy (Maguire Group Inc., 1997a).

Separation of contaminants from the sediment can be accomplished by solvent extraction and other techniques. These processes result in a residual material that requires disposal and/or further treatment. The average cost for solvent extraction is $182/cy (Maguire Group Inc., 1997a).

The primary method of reduction used today is soil washing, a process where water is used to separate the sediments by particle size into a reusable bulk fraction, and a smaller fraction containing concentrated contaminants. Because organic contaminants are often sorbed (adhered) to the finer sediment particles such as silts and clays, separation of this fine soil fraction from the coarser, sandy sediments allows for the reuse of the sand and an overall reduction in the volume of UDM. The average cost for this technology is $89/cy (Maguire Group Inc., 1997a).

Immobilization techniques evaluated in the DMMP include chelation and solidification/stabilization. Costs for such processes range from $75-$90/cy (Maguire Group Inc., 1997a). Some of these processes, such as solidification/stabilization, can produce a material with sufficient structural bearing strength to allow for use as structural fill in construction projects.

4.3.4 Dewatering Alternatives

In order to implement an upland disposal or alternative treatment option, a shore front site with adequate land area to dewater the dredged material is required. A dewatering site (or sites) is necessary to provide an area to reduce the moisture content of dredged material, allowing it to be processed and transferred to an upland disposal site for final disposal or reuse. The process to prepare dredged material for final upland disposal or reuse may involve one or more of the following site functions: off-loading (always required); material screening; lime treatment; soil amendment; and transfer to disposal/reuse site.

Off-loading of the dredged material requires that the barge be tied to a pier or seawall along the shore front. Front end loaders or cranes are used to unload the dredged material from the barge and place it on the site or in dump trucks which move the material to a specific location on the site. If the dredged material has a high water content, water-tight crane buckets and dump trucks may be required to minimize the uncontrolled discharge of sea water and suspended sediment into the water.

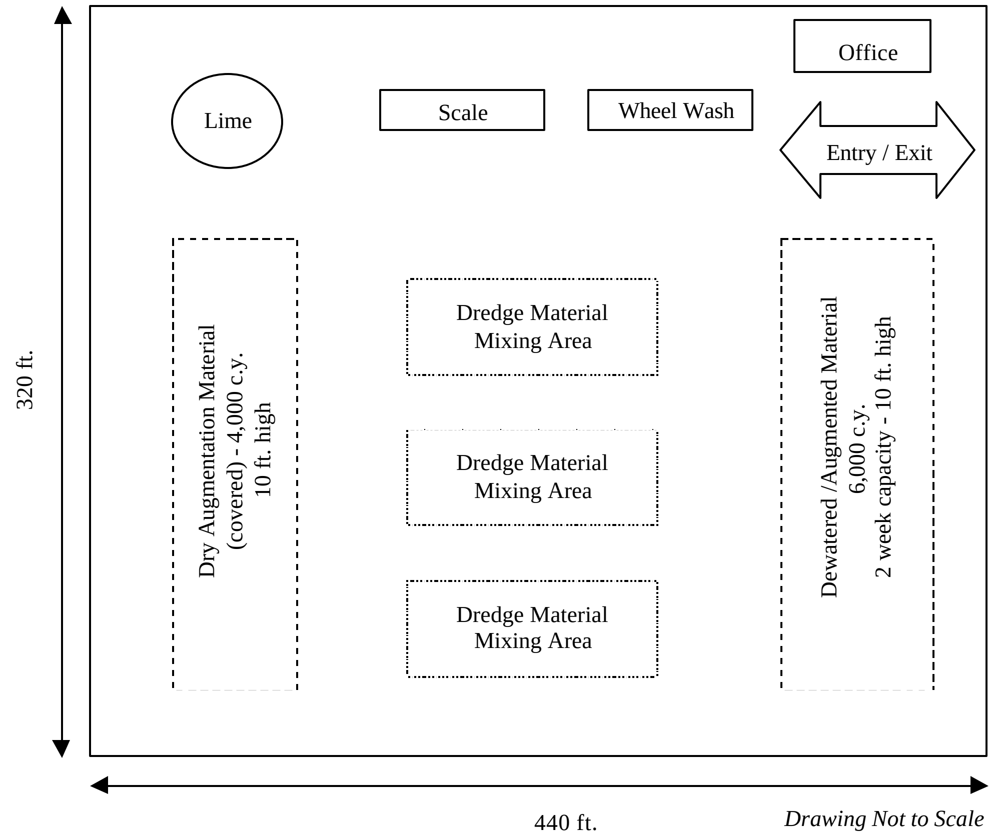
Material screening is often required to screen out large pieces of debris, such as piling fragments, fishing gear, and other debris typically encountered in an urban harbor environment. This material must be removed from the dredged material and disposed of separately.

Lime treatment is often required to reduce the moisture content of the dredged material and to control odors Anaerobic decomposition results in the production of a strong, sulfur odor that may be controlled via lime additions to the dredged material. Dredged sediment with a high organic content has often undergone long term anaerobic (without oxygen) decomposition in the marine environment. Lime treatment also reduces the moisture content of the dredged material, and results in a material which is easier to handle and spread.

Soil amendment of the dredged material is often required to produce a final product that is suitable for various end uses. UDM is typically a fine grained, silty material. Mixing or amending UDM with a coarser material such as sand improves the workability of the material. Depending on the water content and intended final use of the sediment, amendment of the dredged material may be required at the dewatering site before it is transported upland.

Transport of the dredged material to the final disposal or reuse site is required. Truck transport is the most common method. Water transport via barge or alternative land transport such as rail is also possible, but less common. Space must be available within the dewatering site to allow for loading of the transport vehicles.

Ideally, the performance of all the above functions are conducted at one dewatering site, minimizing the number of times the material is transported and reducing overall costs. To determine the minimum area required to process dredged material for upland/reuse disposal from a 10,000 cy dredging project, dewatering site logistics and area requirements were investigated for the DMMP. The site area requirements developed included the application of lime to control sulfide reactivity. Amendment of the material may also be done at the dewatering site. The typical dewatering site requires adequate area for mixing, lime storage, augmenting material storage, truck scale and wheel wash, and approximately a one week storage capacity for dewatered material.



Site Area Required:
Approximately 3.2 acres

Process:
UDM is mixed with augmentation material and a drying agent (quick lime etc.) to create workable material to be transported off-site for upland disposal/reuse.

Assumptions:
10,000 c.y. to be removed, 50 c.y./hr.dredge production rate, 10 hr. work day, 6 days/week based upon Central Artery Project CO9A8 contract dredge rate using similar augmentation process.

Advantages:
Short schedule
Workable material in short duration

Disadvantages:
Cost of augmenting material to workable consistency
Labor intensive, multiple re-handling.
Smell - hydrogen sulfide escaping material, spray with lime to control odor
Weather dependent.

Figure 4-6. DMMP dewatering site conceptual layout

Assuming a facility through-put capacity of 400 cy per day, based upon a typical workday (50 cy per hour times 8 hours per day), a 3.2 acre site (approximately 320-feet by 440-feet) is required. Figure 4-6 illustrates a conceptual site layout and requirements for the facility. When mobilization and construction of containment structures (4 weeks), duration of dredging (5 weeks) and restoration of the site (3 weeks) are factored in, the total time required to process 10,000 cy of material is approximately 12 weeks, or 3 months.

The projected volume of UDM from Gloucester Harbor in the first five year planning horizon is 159,695 cy. The theoretical 3.2 acre dewatering site could process the material for upland disposal/reuse in 87 weeks (159,695 cy X 5 weeks per 10,000 cy + 7 weeks mobilization/demobilization). The above numbers represent the best-case scenario; scheduling conflicts and weather delays will extend the processing time.

Seasonal dredging restrictions imposed to protect fish spawning would require dredging to be spread out over several years, given the limited throughput capability of a small dewatering site. Dredging in most areas is limited to the late fall and winter months, a 5-month (22-week) period. With one dewatering site, 3.2 acres in size, the maximum volume of dredging that can occur in any one dredging season is about 30,000 cy.

As part of the DMMP DEIR process of exploring potential dewatering site options, the screening process focused on a universe of potential sites within the municipal boundaries of Cape Ann communities from Rockport to Manchester. A total of 37 potential dewatering sites were identified in Cape Ann. The sites were identified by examining aerial photographs and via windshield surveys conducted in 1997 and 1999. Also, meetings were held with local municipal officials to aid in the process of identifying vacant, open or undeveloped waterfront site as a potential location for dewatering.

4.3.5 Upland Disposal/Reuse Disposal Alternatives

Upland reuse disposal alternatives involve the placement of UDM on land. The land site can be an existing active or inactive landfill, or a raw parcel of land. Dredged material can be used as daily cover or grading/shaping material for landfills, provided the material meets the physical and chemical specifications for such use. Dredged material placed on a raw parcel of land could be managed as a landfill, or could be used as a grading material that has some end use (e.g. ball fields, golf course, etc.), provided the physical and chemical properties of the dredged material permit such use. There are currently no comprehensive regulations in Massachusetts which specifically apply to the disposal of dredged material in the upland environment, although DEP has issued a series of Policies and Interim Management Requirements. In general, upland disposal is regulated under the Commonwealth's Solid Waste Management Regulations @ 310 CMR 16.00 and 19.000 (See DEP's July 8, 1999 Dredged Sediment Interim Management Requirements in Appendix B, Volume 1). Dredged material, when amended with other material such as Portland cement, could potentially be beneficially used, the current permitting procedure being a Benefial Use Determination under 310 CMR 19.060.

The cost for upland disposal ranges from $117 - $683/cy for silty UDM that is not suitable as final cover for landfills. Clayey sediments that could be used as final cover material would be slightly less expensive to dispose of in a landfill.

Table 4-1, provides a descriptive summary of all disposal alternatives considered for UDM for Gloucester Harbor.

Table 4-1: Disposal Types - General Summary Matrix

Disposal Type	**Benefits**	**Drawbacks**	**Contaminant Pathways**
CDF	Contaminated sediment sequestered from marine environment; creation of new land for port expansion, recreation, commerce, etc..	Permanent loss of subtidal and intertidal habitat; fine sediments may require extensive dewatering time, restricting use of the site for extended period.	Birds and small mammal can be temporarily exposed to contaminants in soil and potentially ingest contaminated organisms before cap placement.
CAD - In Channel	Contaminated sediment sequestered from marine environment; impact occurs within already disturbed area; relatively low cost	Technology of capping not perfected; limits potential future dredging depths; short-term water quality impacts; permanent change to bathymetry of disposal site	Suspended particulate matter released during disposal can affect water column
ATC-CAD	Contaminated sediment sequestered from marine environment; relatively low cost; close to channel dredging areas	Technology of capping not perfected; ATC areas may not be degraded, therefore high value bottom habitat can be impacted; short-term water quality impacts	Suspended particulate matter released during disposal can affect water column; potential change in substrate type.
CAD	Contaminated sediment sequestered from marine environment; relatively low cost;	Technology of capping not perfected; CAD areas may not be degraded, therefore bottom habitat can be impacted; short-term water quality impacts; large volume of capping material required to cover mound	Suspended particulate matter released during disposal can affect water column; potential change in substrate type.
TH	Creation of salt marsh or tidal flats beneficial to water quality and wildlife.	Contaminated sediments cannot be used for habitat creation because of potential bioaccumulation/biomagnification/bioturbation of contaminants.	Benthic organism and plants living in contaminated sediments can transfer pollutants within food web.
Upland	Removal of contaminants from marine environment into a well engineered and monitored situation.	Large dewatering area required; air quality, noise, traffic impacts; high cost; future use of disposal site permanently affected due to material placement and land use changes and restrictions.	Potential groundwater contamination from leachate; potential contaminated stormwater runoff; air quality impacts from fugitive dust and odor
Alternative Treatment Technology	Removal of contaminants rendering sediment potentially suitable for ocean disposal or beneficial reuse (tidal habitat creation)	Cost prohibitive, particularly for small projects. Residuals may require treatment. Potential air emissions.	Air and wastewater emissions from processes.

4.4 Disposal Site Screening Process

The disposal site screening process is designed to assess all possible alternatives through the sequential application of environmental, social and economic criteria. As sites with significant conflicts are removed from consideration, the assessment of remaining sites becomes more detailed. Ultimately, only those sites with minimal or no conflict with the criteria are subjected to intensive evaluation to determine which remaining sites best meet the goals of the Gloucester Harbor DMMP.
A universe of disposal sites was developed during Phases I and II of the DMMP, including sites recommended by the Gloucester Harbor Dredging Subcommittee. These were evaluated in a tiered process. The result of this process is the identification of a range of practicable and reasonable disposal site alternatives. These sites, determined through the evaluation process described below, are evaluated in detail in this DEIR.

The types of disposal sites and methods identified through this process include: Adjacent to Channel (ATC), Channel Over Dredging, Confined Aquatic Disposal (CAD), Capping (CAP), Confined Disposal Facility (CDF) for land creation, Tidal Habitat Creation (mudflat or marsh), upland (reuse or disposal), and alternative treatment technologies.

The disposal site screening criteria described in this DEIR were developed independently, based on published federal and Massachusetts disposal siting criteria and conforming with the Providence River and Harbor Maintenance Dredging Project Draft Environmental Impact Statement (USACE, 1998). The evaluation factors used in the Providence River DEIS were reviewed by the USEPA, USFWS, NMFS and Massachusetts regulatory agencies to obtain their concurrence with the criteria that would be the basis for disposal site decisions. The evaluation factors were also reviewed by the Gloucester Harbor Dredging Subcommittee.

The disposal site screening process includes four categories of evaluation criteria: criteria for all sites, criteria for aquatic disposal sites, criteria for upland disposal sites, and criteria for beneficial reuses. The process of site screening is generically illustrated in Figure 4-7. Each disposal alternative category listed above underwent this screening analysis, with some variation during one or more stages of the process to account for the unique issues associated with each type of alternative. The site screening process for these categories is described in Sections 4.5 through 4.8.

The screening criteria were applied in sequential phases to each of the two major disposal site option groups (i.e., upland and aquatic). The first phase of the screening process ("Feasibility Screen") was to eliminate sites that are clearly a poor choice for disposal of dredged material because of one or more of the following: the surrounding land uses (for upland sites), their inaccessibility relative to the type of disposal proposed, their inability to contain a sufficient volume of material. Sites that are not feasible disposal options are permanently eliminated from further consideration under the DMMP.

In order to facilitate involvement with the City and the Gloucester Harbor Dredging Subcommittee, and to provide a concise framework for evaluation and comparison of each disposal site, data sheets were developed which provided information from each site relative to the evaluation criteria. These data sheets were reviewed with the Subcommittee during various phases of the screening process. Maps depicted the location of these sites and summary comparison matrices were also disseminated with the data sheets.

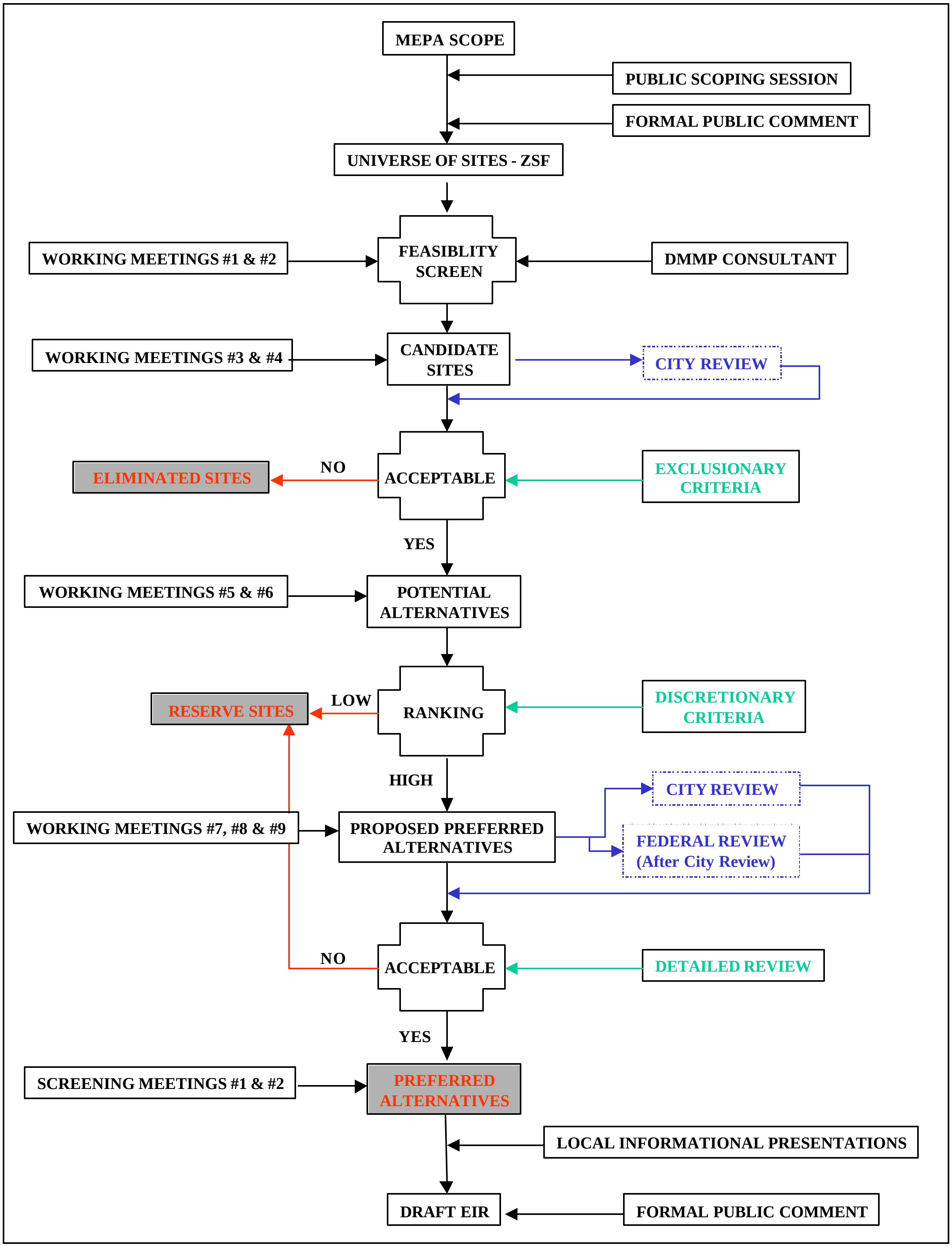


Figure 4-7: DMMP Disposal Site Screening Process

Sites that survived the feasibility screen, i.e. candidate sites, in addition to be being presented to the City and the Harbor Plan Dredging Subcommittee, underwent exclusionary criteria analysis. For example, sites that were located in areas inhabited by federally or state-designated endangered species were eliminated from further consideration. In some cases, such as for the upland disposal analysis, exclusionary criteria significantly reduced the number of sites for further study. In other cases, such as for the aquatic disposal analysis, exclusionary criteria had no effect on the screening process. Where it was deemed useful and practicable, such as with the candidate aquatic sites, site-specific field investigation was conducted to better characterize and distinguish the sites. Those sites that survived this screen were deemed potential alternatives.

A series of discretionary criteria were applied to each of the potential alternatives. Each potential site was evaluated with respect to these criteria and the result was a ranking of sites. At this stage in the process, each of the sites had potential as a dredged material disposal site but some sites had attributes that clearly distinguished them from the other sites. These "higher ranking" sites were then elevated to "proposed preferred" status. These sites, and the process whereby they were selected, were presented to the City and federal resource agencies for review. These sites also underwent more detailed field analysis and the result was the selection of a preferred alternative, which is the alternative that is evaluated for environmental consequences in Section 6.0 of this DEIR.

The following sections of this DEIR are divided to correspond with the four categories of disposal alternatives considered for the Gloucester Harbor DMMP. Sections 4.5 through 4.8, describe the procedures, screening criteria and results of alternative treatment technology, dewatering, upland and aquatic disposal siting analyses.

4.5 Alternative Treatment Technology Alternatives

This section describes the available alternative technologies for treatment of UDM, the process for evaluating these technologies, the factors used in the evaluation, and the results of this evaluation with respect to applicability to the Gloucester Harbor DMMP. As discussed in Section 3.0, sediments tested and determined to be unsuitable for open ocean disposal, contain primarily metals and PAHs that exceed MBDS reference values. Alternative treatment technologies were evaluated in the context of their ability to 'treat' these constituents of the Gloucester Harbor UDM.

4.5.1 Screening Process

Alternative treatment technologies and their applicability to the DMMP were evaluated in Phase 1 of the DMMP (Maguire 1997a) and updated in this DEIR.

Data on the technologies were gathered from several sources including the USEPA, US Department of Defense, USACE, Environment Canada, and technology vendors. In addition, the findings of other dredging projects involving contaminated sediments were reviewed including the BHNIP, various projects conducted by the Port Authority of New York and New Jersey, Boston Harbor projects, and several projects in European countries.

The inventory included technology description, treatment cost, and site demonstration information for 14 classes of treatment technologies including: chelation, chemical reduction/oxidation, dehalogenation, fungal remediation, incineration, in-situ bioremediation, pyrolysis, slurry bioreactor, solid-phase bioremediation, solidification/stabilization, solvent extraction, thermal desorption, and vitrification (see Appendix D). An overview of pretreatment, sidestream treatment, and residuals management options was also presented.

As part of this technology assessment, a survey of vendors was conducted to gather current information in several major comparative categories including: ability to treat various contaminant types, effects of sediment characteristics on the treatment process, potential role of the vendor in a sediment decontamination project, capabilities and logistical requirements of the process equipment, and information on current and projected costs. The results of the vendor survey allowed for a comparative evaluation of the technologies using standard criteria.

Specific regulations governing the recycling or reuse of treated sediment have yet to be promulgated in Massachusetts, however DEP has issued an Interim Policy for the management of dredged material proposed for upland disposal (see Appendix B). Currently, proposals for reuse and alternative treatment technologies are evaluated under 310 CMR 16.00 and 19.00 (Appendix J). A Beneficial Use Determination (BUD) process (Figure 4-8) as described in 310 CMR 19.060 determines the acceptability reusing contaminated media (including sediments). Under a separate permitting process, there may also need to be a demonstration of need (Figure 4-9) for the treated product.

The UDM that is treated must have a beneficial end use in order for approval to be granted. The product must be viable, i.e. there must be a practical and marketable use. Also, the product and the treatment process itself must be demonstrated to have no adverse effect on the environment.

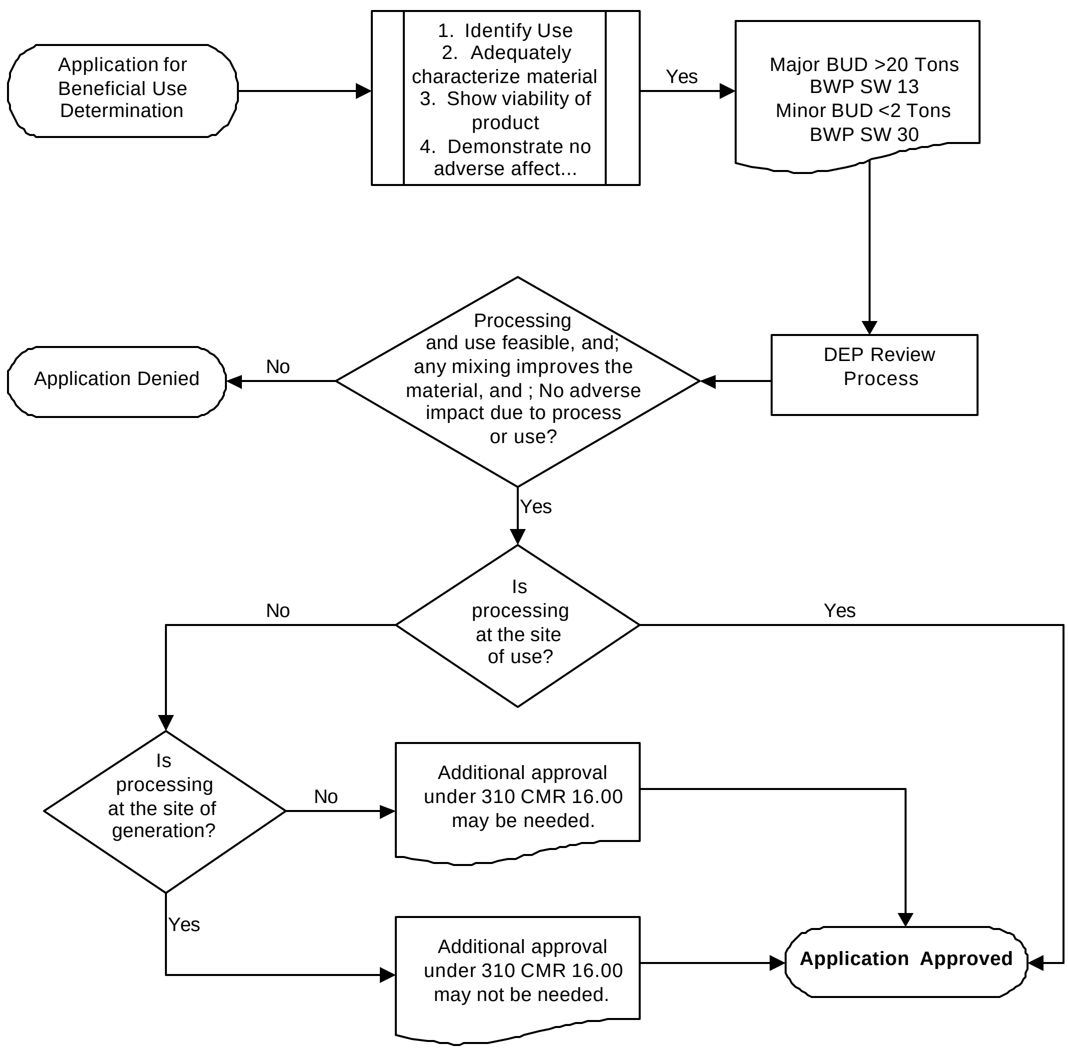


Figure 4-8: Beneficial Use Determination Process

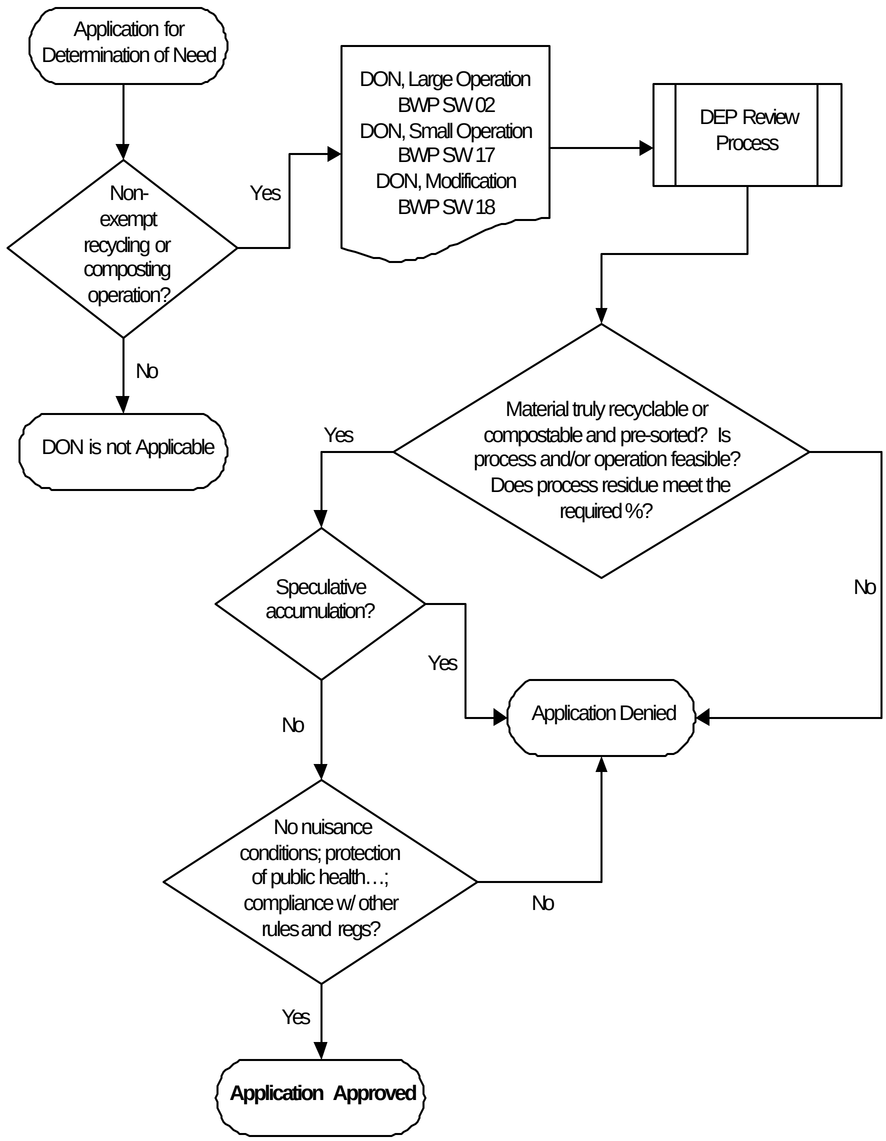


Figure 4-9: Determination of Need Process

4.5.2 Description of Treatment Technologies

This section describes existing sediment decontamination technologies. For each technology, distinct categories of the sediment decontamination process including: pretreatment technologies, treatment technologies, sidestream treatment technologies, and residuals management are also considered.

Pretreatment of the sediment typically involves removal of oversized materials and dewatering prior to treating the contaminated sediment. The control of objectionable odors (which are typically emitted when anaerobic sediment is disturbed), may also be required during pretreatment. Odor control may also be required during the treatment stage of UDM management.

Treatment of the sediment involves application of the primary decontamination process (e.g., physical, chemical, biological, and/or thermal) to reduce, destroy, or immobilize the target contaminants present in the sediments. Treatment may include use of a single technology or use of multiple technologies (i.e., treatment "train" or sequence) in order to address the widely-varying contamination and sediment types.

Sidestream treatment is often required for sidestream wastes (e.g., offgas, particulate emissions, and wastewater) generated during the primary sediment treatment process. These sidestream wastes typically require special handling, treatment, and/or disposal.

Residuals management involves the special handling of treated solids from the primary sediment treatment process that may be acceptable for reuse or contain residual contamination which warrants special management and disposal.

The capabilities and costs of the treatment technology are the main consideration in the selection of a sediment decontamination method. Because sediments often contain a mixture of contaminants, the ability of a treatment technology to handle widely-varying contaminant and sediment types is very important. There are many technologies that will treat a specific contaminant in a relatively inexpensive manner, but require the addition of other technologies in a treatment train to handle a range of contaminants. Use of a treatment train increases the costs, handling requirements, potential environmental exposure, and complexity of sediment decontamination. On the other hand, some individual technologies may be more expensive, but can treat a full range of contaminants. Although the treatment process normally represents the major portion of the costs of sediment decontamination, the total costs including pretreatment, sidestream treatment, and residuals management must be considered when choosing between treatment alternatives. Public concerns about sidestream discharges, especially air emissions, can preclude the selection of certain treatment technologies.

As mentioned in Section 2.1, the treatment technology information contained in this section was gathered from previously-published sources. All data on costs, treatment efficiencies, and reference sites were taken from the SEDTEC (Environment Canada, 1996) and VISITT (EPA, 1996) databases. For those technologies without costs or reference sites, no datum was available in VISITT or SEDTEC.

Table 4-2 presents average values of the treatment rates and costs for the treatment technologies described in this section as well as the total number of vendors for each technology listed in the SEDTEC and VISITT databases. The average treatment costs range from $42/cy for in-situ bioremediation to $462/cy for vitrification. The average cost for all of the technologies considered was $179/cy. These costs are strictly for comparative use and should be considered preliminary estimates only. Costs are subject to high variability based on the uncertainties associated with the widely-varying contaminant and sediment types, concentrations, and site-specific conditions.

Table 4-2: Cost and Production Rates of Treatment Technologies

Technology	Treatment Rate (tons/hr)	Average Cost (per cubic yard)	# Technologies per Category
Chelation	16	$83	1
Chemical Reduction/Oxidation	172	$232	8
Dehalogenation	76	$263	15
Fungal Remediation	ND	$215	2
Incineration	10	$243	8
In-Situ Bioremediation	135	$42	22
Pyrolysis	9	$262	3
Slurry Bioreactor	17	$223	12
Soil Washing	32	$89	19
Solid-Phase Bioremediation	62	$62	51
Landfarming	ND	$48	2
Composting	40	$73	7
In-Vessel Bioremediation	1	$154	3
Solidification/Stabilization	40	$99	1
Thermal Desorption	27	$177	52
Vitrification	3	$462	17
Solvent Extraction	37	$182	21

ND = Not enough data
Source: Environment Canada, 1996 and EPA, 1996

4.5.2.1 Chelation

This process is a form of chemical stabilization that immobilizes metals. Chelation, or complexation, is the process of forming a stable bond or complex between a metal cation and a ligand (chelating agent). Chelating agents, or ligands, may form a single bond (monodentate) or multiple bonds (polydentate) with the target cation. The more bonds formed, the more stable the resulting complex and the greater degree of immobilization of the metal contaminant within the complex. Edetic Acid (also known as Ethylenediamine- tetraacetic acid, or EDTA) is a commonly used polydentate chelating agent. Process efficiency is ion-specific depending upon the chelating agent, pH, and dosage.

The chelation process for metal immobilization may reduce the leachable metal concentrations adequately to meet the Toxicity Characteristic Leaching Procedure (TCLP) requirements. The TCLP determines the leachability of contaminants from a waste material. This testing procedure is used to determine if a waste is classified as "hazardous" based on its potential toxicity. Treated sediments are the only residuals generated by the chelation treatment process. Sidestream waste produced from this treatment strategy consists of wastewater generated during the dewatering of the treated sediments. Costs given by the vendor listed for chelation treatment are $83 per cy.

4.5.2.2 Chemical Reduction/Oxidation

Chemical Reduction/Oxidation technology uses chemical additives to detoxify target contaminants by conversion into less toxic or immobile forms. Chemical oxidation processes work by transferring electrons from the contaminant to the oxidizing agent. During this process the oxidizing agent, itself, becomes reduced. Typical oxidizing agents used in this remediation strategy include various forms of chlorine, potassium permanganate, hydrogen peroxide, persulfate, and ozone. These chemical oxidants may be catalyzed by ultraviolet radiation or other transitional metal additives to form free radicals, thereby enhancing their oxidation potential.

Typical treatment efficiencies for selected organic contaminants may attain 90 to 95% removal. Sediment residuals contain excess chemical agents, reaction by-products including dissolved gases that may require post-treatment monitoring prior to backfill. Sidestream wastes include wastewater from dewatering of the treated sediments and off-gas from the treatment vessel. Wastewater can be recycled into the extraction process. Costs for reduction/oxidation treatment range from $39 to $2,805 per cubic yard ($35 to $2,550 per ton) with an average cost of $232 per cubic yard ($211 per ton) (neglecting the highest value). In Europe, reduction/oxidation is only used as part of a soil washing train, after removal of fine particles. Treatment residual consists of treated sediment.

Limitations include:

- Incomplete oxidation may lead to the formation of intermediate contaminants that are more toxic than the original;
- Dewatering is required before and after treatment;
- High organic matter content increases the required reagent dosage;
- Potential foaming and gas emissions of treated products; and,
- Presence of non-target compounds may react with the reagent additives to increase the treatment cost.

4.5.2.3 Dehalogenation

Dehalogenation is a process which destroys or removes some of the halogen atoms from halogenated aromatic compounds such as polychlorinated biphenyls (PCBs), dioxins, furans, and pesticides by substitution of bicarbonate or glycol for the halogen (usually chlorine) atoms. The two most common dehalogenation treatment processes are base-catalyzed decomposition (BCD) and glycolate dehalogenation. The BCD treatment process combines a sodium bicarbonate reagent with the dewatered UDM within a heated oil matrix to remove the halogen atoms from the target compound (e.g. chlorine atoms on the compound are exchanged for sodium atoms). The glycolate dehalogenation process uses a combination of alkali metal and polyethylene glycol reagents to degrade halogenated organic compounds such as PCBs, dioxins, pesticides, and chlorobenzenes.
Costs for dehalogenation range from $220 to $330 per cubic yard with an average of $263 per cubic yard. Sidestream wastes generated by the BCD process include the reaction media (oil with biphenyls, olefins, and sodium chloride and steam vapor that may contain volatile organic compounds. Sidestream wastes generated by the glycolate dehalogenation process include process water containing water-soluable glycol ethers, hydroxylated compounds, alkali metal salts, and water (steam) vapor that may contain volatile organic compounds. Incomplete or ineffective dehalogenation can produce intermediate toxic daughters which can be more persistent than the original contaminant.

4.5.2.4 Fungal Remediation

Fungal remediation is a particular subset of bioremediation that employs fungi rather than bacteria to degrade the contaminant. White rot fungus is the most commonly studied fungus because the enzymes secreted by the white rot fungus can degrade lignin, the complex organic building block of wood. White rot fungus has shown the ability to destroy complex organic compounds such as explosives, pesticides, PAHs, and PCBs. Although the potential of white rot fungus has been known for over 20 years, there have been few commercial applications of this remedial technology.

Treatment efficiencies of approximately 50% have been reported. Costs for the two vendors offering fungal remediation are $165 to $264 per cubic yard. Residuals include the treated sediments. No sidestream wastes are generated during this treatment process.

Limitations include:
- High contaminant concentrations may be toxic to the fungus;
- Does not treat metals;
- Unknown how salt water will effect white rot fungus;
- Short life of cultured fungi may require frequent reactor replacement; and,
- Removal efficiencies of approximately 50% are considered too low to effectively treat contaminated sediments (the concentration of contaminants may not meet upland disposal criteria).
- Need for continuous monitoring to ensure that fungal population is thriving

4.5.2.5 Incineration

Incineration is one of the most commonly-used remediation technologies. Incineration, or thermal oxidation, destroys contaminants using high temperatures in the presence of oxygen and is effective in destroying a wide range of organic contaminants. Currently in Massachusetts, incineration of wastes is not looked on favorably by the DEP, environmental groups, or the public. It would be very difficult to site an incineration facility in Massachusetts as evidenced by recent efforts to site a portable thermal oxidizer for treatment of 30,000 cy of soil near Logan Airport. Other efforts, such as the proposed incineration of PCB-laden sediments from New Bedford Harbor in the early 1990s were also thwarted due to potential air quality impacts.

Treatment efficiency of the incineration process generally exceeds 99.99% and can be as high as 99.9999% when required for PCBs and dioxin. Costs for incineration range from $55 to $880 per cubic yard with an average cost of $243 per cubic yard. Incineration costs increase for PCBs and dioxins. Ash is produced as a residual material. This ash typically contains high heavy metal concentrations and therefore may require further management/ treatment. Sidestream wastes produced include air emissions and waste water (the latter generated as a by product of the air emission control systems required to operate an incinerator).

Limitations include:
- Requires a very low moisture content in sediments;
- Strict feedstock particle size limitations (1 - 2 inches maximum);
- Gaseous discharges are a major potential contaminant emission pathway;
- Heavy metals are not removed or destroyed and are more leachable after incineration;
- Metals can react with chlorine or sulfur to form more toxic compounds;
- Incomplete combustion of PCBs may produce more toxic dioxins;
- Public opposition;
- Permitting difficulties;
- Large area required for equipment layout; and,
- Residual material requires further management.

4.5.2.6 In-situ Bioremediation

In-situ bioremediation is a process in which indigenous or inoculated microorganisms (i.e., fungi, protozoa, bacteria, and other microbes) degrade organic contaminants found in the sediments. In the presence of sufficient oxygen, microorganisms may ultimately convert many organic contaminants to carbon dioxide, water, and microbial cell mass. In the absence of oxygen, the contaminants may be ultimately reduced to methane, carbon dioxide, and trace amounts of hydrogen gas. In-situ bioremediation processes have been successfully used to treat petroleum hydrocarbons, certain solvents, pesticides, and other organic chemicals. No residuals or sidestream wastes are produced since the treatment occurs in-place. However, sometimes contaminants may be degraded to intermediate products that may be equally, or more hazardous and persistent than the original contaminant.

Treatment efficiency of the in-situ bioremediation process generally exceeds 90% and can be as high as 99%. Costs for in-situ bioremediation range from $6 to $116 per cubic yard with an average cost of $42 per cubic yard.

Limitations include:
- Extended remediation times on the order of years to decades;
- High concentrations of heavy metals and contaminants may be toxic to microorganisms;
- Bioremediation slows at low temperatures;
- Not all organic compounds are biodegradable;
- Bioremediation rates are limited by the concentrations and bioavailability of PAHs, PCBs and pesticides in the sediments; and,
- Heterogenous geological conditions and low permeability soils (less than 10^{-5} cm/sec) are not favorable for in-situ bioremediation.

4.5.2.7 Pyrolysis

Pyrolysis involves the destruction of organic material in the absence of oxygen. The absence of oxygen allows separation of the waste into an organic fraction (gas) and an inorganic fraction (salts, metals, particulates) as char material. Pyrolysis is normally used to treat high concentrations of organics (e.g., semivolatile organic compounds and pesticides) that are not conducive to conventional incineration. Residuals produced by the pyrolysis process consist of ash, often containing heavy metals. Sidestream wastes include air and wastewater. Air emissions typically contain carbon monoxide, hydrogen and methane. Wastewater is via pretreatment dewatering and via the second stage of the pyrolysis process when pyrolytic gases (produced during primary treatment) are destroyed in a secondary reaction chamber. The wastewater is generated by a scrubber system which removes particulate contaminants from the pyrolytic gases prior to release to the atmosphere. The wastewater may contain hydrogen, methane and some hydrocarbons.

Treatment efficiency for the pyrolysis technology generally exceeds 99%. Costs for the two vendors offering pyrolysis are $248 and $275 per cubic yard. Major factors affecting this estimate are the condition and properties of the feed sediment (i.e., moisture, total contamination, and soil characterization).

Limitations include:
- Requires a very low moisture content (<1%) in sediments (which requires pretreatment dewatering and sidestream wastewater requiring further treatment);
- Strict feedstock particle size limitations;
- Gaseous discharges are a major potential contaminant emission pathway;
- Heavy metals are not removed or destroyed, but are not more leachable after pyrolysis;
- Public opposition;
- Permitting difficulties; and,
- Site space limitations.

4.5.2.8 Slurry Bioreactor

A slurry bioreactor is a controlled biological treatment vessel where the contaminated sediments are treated in a slurry form at a low solids content. The sediment is mixed with water to a predetermined concentration dependent upon the concentration of the contaminants, the rate of biodegradation, and the physical nature of the sediments. Slurry bioreactors can treat a variety of organic contaminants including chlorinated and non-chlorinated volatile organics, PAHs, PCBs, and pesticides.

Typical treatment efficiencies of greater that 90% can be attained in a slurry bioreactor. Treatment costs range from $6 to $825 per cubic yard with an average cost of $223 per cubic yard. Treatment residuals include processed soils. Sidestream wastes include wastewater from dewatering the treated slurry and off-gas from the treatment vessel.

Limitations include:

- Heavy metals at high concentrations can inhibit microbial degradation;
- Treatment and disposal of wastewater from slurry dewatering;
- Dewatering is required after treatment;
- Equipment operation and maintenance is intensive;
- Higher energy costs than solid-phase bioremediation;
- Organic destruction efficiencies are generally low at low concentrations; and,
- Low cleanup standards may be difficult to meet for recalcitrant organics.

4.5.2.9 Soil Washing

Soil washing refers to the process of using water to physically separate the sediments by particle size into a reusable bulk fraction and a smaller fraction containing concentrated contaminants. Since organic contaminants are often sorbed to the finer silt and clay particles, separation of this fine fraction from the sandy sediments allows reuse of the typically non-contaminated sands and accomplishes a volume reduction of the total contaminated sediment mass. It is also possible to amend the wash water with surfactants to aid in dispersing soil particles; and chelating agents, acids, or bases to separate the contaminants from the sediment. Soil washing has the potential to treat a variety of contaminants including PAHs, PCBs, fuel oil, heavy metals, radionuclides, and pesticides.

Typical treatment efficiencies are greater than 90% for volatile organics, 70 to 95% for metals, and 40% to 90% for semivolatile organics. The cost of soil washing ranges from $20 to $220 per cubic yard with an average cost of $89 per cubic yard. Residuals include a sand fraction, a suspended fine particle fraction and a remaining soil fraction. The waste stream includes wash water with amendments and suspended fines.

Limitations include:

- Soil washing is only marginally effective for sediments composed primarily of clays and silts;
- Maximum particle size typically 0.5 cm;
- Removal of fines from wastewater may require the addition of polymer flocculent;
- Treatment and disposal of water from pre-treatment dewatering;
- Treatment and disposal of amended washwater,
- Treatment and disposal of post-treatment dewatering.

4.5.2.10 Solid-Phase Bioremediation

Biological degradation of contaminants is a naturally-occurring process. Bioremediation is the acceleration of the natural biodegradation processes by controlling moisture content, temperature, nutrients, oxygen, and pH to create the optimal environment. For purposes of this discussion, the varieties of solid-phase biological treatment processes have been divided into three categories based on level of engineering:

landfarming, composting, and in-vessel bioremediation. Solid-phase biological treatment technologies are used primarily to treat VOCs and petroleum hydrocarbons. It is also possible to treat PAHs, PCBs, halogenated organic compounds, explosives and pesticides to some degree, especially in the more highly-engineered in-vessel systems.

Costs for all solid-phase bioremediation technologies range from $3 to $264 per cubic yard with an average cost of $62 per cubic yard. Solid-phase bioremediation is used on a production scale in Europe, especially in The Netherlands, Germany, and France.

4.5.2.11 Landfarming

Landfarming is the least engineered of the solid-phase bioremediation treatment processes. Landfarming consists of spreading the contaminated sediments over a large area of land and periodically tilling the sediments for aeration. Environmental conditions are controlled by watering (moisture content), fertilizing (nutrient concentration), tilling (oxygen concentration), and lime addition (pH) to accelerate natural bioremediation. Organic matter is usually added to retain moisture, provide additional nutrients, and as a supplemental food source (bacterial bioremediation). However, the addition of organic matter may increase the volume of the UDM. Temperature cannot be regulated to a great extent, limiting the applicability of landfarming in cold climates. Since oxygen is added by tilling, the thickness of the spread contaminated sediments is limited to the tilling depth; therefore, a large area of land is required for landfarming. Landfarming may also incorporate the use of polyethylene liners to control leaching of contaminants.

Treatment efficiencies are highly variable but generally greater than 90% for contaminants amenable to aerobic bioremediation. The effectiveness in remediating petroleum hydrocarbons has been widely demonstrated. The costs for the two vendors offering landfarming are $44 and $52 per cubic yard.

Limitations of Landfarming include:
- Open landfarming may not be practical in regions of heavy annual rainfall precipitation and/or cold climate;
- Does not remediate inorganic contaminants;
- Inorganic contaminants may leach from contaminated sediments into ground;
- Ineffective for treatment of high molecular weight PAHs and highly chlorinated PCBs;
- Anaerobic bioremediation processes can generate odors;
- Of the solid-phase bioremediation treatment processes, landfarming offers the least control over environmental conditions;
- Of the solid-phase bioremediation treatment processes, landfarming offers the least control over collection of off-gas;
- Of the solid-phase bioremediation treatment processes, landfarming requires the largest space; and,
- Of the solid-phase bioremediation treatment processes, landfarming requires the longest cleanup time.

4.5.2.12 Composting

Composting is the middle level of the engineering hierarchy of the solid-phase bioremediation treatment processes. The two major variations of the composting process discussed here are windrow and aerated static pile. The windrow is a pile typically 6-10 feet high, 15-20 feet wide and hundreds of feet long. Windrows are mechanically turned twice a week to once a year to aerate the pile, control the temperature, and create a more uniformly mixed material. Turning of the pile releases odors. Composting is completed in one month to a few years depending on the contaminants and the level of maintenance of the windrow. Maintenance typically includes maintaining optimal moisture content, temperature, oxygen and nutrient concentrations. Depending on the soil particle size distribution and organic matter content, additional organic matter may need to be added to the UDM prior to composting. This could significantly increase the volume of the UDM to be treated. The treatment residual produced by composting is the treated UDM. Sidestream wastes include off-gas and leachate, each of which may require further treatment/management. Off-gases with objectionable odors may be controlled by composting within an enclosed dome or structure to allow for off-gas collection and control.

Treatment efficiencies are highly variable but generally greater than 90% for contaminants amenable to aerobic bioremediation. The cost of composting ranges from $25 to $198 per cubic yard with an average cost of $73 per cubic yard.

Limitations of composting include:
- A large space is required;
- Questionable effectiveness for treatment of high molecular weight PAHs and highly chlorinated PCBs;
- Requires months of remediation/treatment time;
- Can generate odors; and,
- Collection of off-gas is difficult.

4.5.2.13 In-Vessel Bioremediation

In-vessel bioremediation is the most engineered of the solid-phase bioremediation treatment processes. In-vessel biological treatment is often referred to as in-vessel composting. Here it is discussed separately since this treatment technology allows for easier maintenance of anaerobic conditions. Anaerobic microbial pathways are typically used to degrade aliphatic halocarbons (e.g. trichloroethylene, perchloroethylene, etc.). Treatment consists of placing the contaminated sediment mixture in engineered treatment enclosures, or "bioreactors" with leachate collection systems and aeration equipment. In-vessel composting is completed in a couple of weeks and the pile is normally allowed to cure for an additional one to three months. In-vessel systems allow stricter environmental controls, faster composting times, odor collection and treatment, smaller area requirements, and can handle a wider variety of contaminants. In-vessel techniques also allow for added security measures at the treatment site (i.e.: access to the bio-reactor can be controlled). The treatment residual is the treated UDM. Sidestream wastes include off-gas and leachate, each of which may require further treatment/management.

Typical treatment efficiencies range from 70 to 95%. Typical costs range from $33 to $220 per cubic yard ($30 to $200 per ton) with an median cost of $154 per cubic yard.

Limitations of In-Vessel Bioremediation include:
- Ineffective for remediating inorganic contaminants;
- Difficult to treat high molecular weight PAHs and highly chlorinated PCBs;

- Most expensive of the solid-phase bioremediation treatment processes; and,
- Emission controls for off-gas may be required.

4.5.2.14 Solidification/Stabilization

Solidification/stabilization is effective at immobilizing contaminants and are among the most commonly used remediation technologies. Solidification/stabilization involves mixing reactive material with contaminated sediments to immobilize the contaminants. Contaminants are physically bound or enclosed within a stabilized mass (solidification), or undergo chemical reactions with the stabilizing agent to reduce their mobility (stabilization). Binding of the contaminants to the sediment reduces contaminant mobility via the leaching pathway. A typical treatment process includes homogenization of the feed material followed by mixing of solid or liquid reagents with the feed material in a pug mill. Three specific categories examined in this screening include asphalt, cement, and lime solidification/stabilization.

Solidification is the process of eliminating the free water in a semisolid by hydration with a setting agent or binder. Typical binder materials include cements, kiln dust, and pozzolans such as lime/fly ash. Binders used in Germany and France are bentonite and Portland cement. Solidification usually provides physical stabilization but not necessarily chemical stabilization. Physical stabilization refers to improved engineering properties such as bearing capacity, trafficability, and permeability. Although solidification/stabilization technologies are not generally applied to organic contaminants, physical stabilization can also immobilize contaminants since the contaminants tend to be bound to the fines, which are physically bound in the solidified matrix. Chemical stabilization is the alteration of the chemical form of the contaminants to make them resistant to aqueous leaching. The solubility of metals is reduced by formation of metal complexes, chelation bonds, or crystalline precipitates within the solid matrix, using chemical additives and through control of pH and alkalinity. Anions, which are more difficult to bind as insoluble compounds, may be immobilized by entrapment or microencapsulation. Chemical stabilization of organic compounds is not very reliable. Results of reactions of binders to the contaminated sediment are not always predictable due to varying contaminant types and concentrations within the test material. Therefore, laboratory leach tests must be conducted on a sediment-specific basis.

Asphalt Batching

Asphalt batching is a commonly used technology in Massachusetts and has been proven effective in immobilizing TPH, VOC, and PAH compounds. Contaminated solids are blended with asphalt emulsions in a pug mill. The asphalt-emulsion-coated material is stockpiled and allowed to cure for approximately 2 weeks. Pretreatment requirements include dewatering and size classification by screening or crushing to less than 3-inch diameter. End product can be recycled as a stabilized base material for parking lots or roadways.

Cement Solidification/Stabilization

Cement solidification/stabilization involves mixing the contaminated sediments with Portland cement and other additives to form a solid block of stabilized waste material with high structural integrity. Silicaceous materials such as fly ash may be added to stabilize a wider range of contaminants than cement alone. Cement solidification/stabilization is most effective for inorganic and metallic contaminants.

Lime Stabilization

Lime/fly ash pozzolanic processes combine the properties of lime and fly ash to produce low-strength cementation. Lime stabilization involves mixing the contaminated sediments with lime in a sufficient quantity to raise the pH to 12 or higher. Raising the pH results in chemical oxidation of the organic matter, destruction of bacteria, and reduction of odor. Lime stabilization is commonly used to treat wastewater sludge and is primarily effective for organic contaminants and microbial pathogens.

Typical treatment efficiency of the solidification/stabilization process ranges from 75% to 90%. Costs range from $48 to $330 per cubic yard with an average cost of $99 per cubic yard. Residuals produced from treatment are stabilized blocks of sediment material. Air emissions are the main sidestream waste produced during the treatment operation

Limitations include:
- May not be particularly effective for organic contaminants, particularly VOCs;
- Fine particles may bind to larger particles preventing effective bonding of the binder material;
- Inorganic salts may affect curing rates and reduce strength of stabilized product;
- Organic contaminants may volatilize due to heat generated during the reaction (possibly prompting the need for air emission permits); and,
- High moisture content requires increased amounts of reagent.

4.5.2.15 Solvent Extraction

Solvent extraction is similar to soil washing in that the technology produces a volume reduction of the total contaminated material, however, solvent extraction focuses on extracting the contaminants from the sediments using organic solvents. Contaminated material volume reductions of 20 times or more are attainable. Solvent extraction is targeted primarily at organic contaminants including PCBs, PAHs, VOCs, petroleum hydrocarbons, and chlorinated solvents. This technology is not particularly applicable to inorganics, with the exception of organically-bound metals, which can be extracted. Residuals include the treated UDM, often with traces of extraction solvent. Sidestream wastes include waste water from pretreatment and post-treatment dewatering, off-gas from the treatment vessel, and spent solvent used during the extraction. The solvent is usually purified and recycled.

Treatment efficiencies for the solvent extraction process generally exceed 90% and are typically in the 98-99% range. The costs ranges from $21 to $567 per cubic yard with an average cost of $182 per cubic yard.

Limitations include:
- Less effective for sediments composed primarily of clays and silts;
- Not typically effective for removal of inorganic compounds;
- Treated soil may contain residual concentrations of solvent;
- Maximum particle size 0.5 cm;
- Treatment and disposal of wastewater from dewatering; and,
- Dewatering is required after treatment.

4.5.2.16 Thermal Desorption

The thermal desorption technology employs high temperature to volatilize organic contaminants. Thermal desorption technologies are divided into high temperature and low temperature categories. Thermal desorption is a removal process that applies to contaminants that are volatile at the process operating temperatures. Primary targets of treatment are organic contaminants including PAHs, VOCs, pesticides, and chlorinated solvents. This technology is not applicable to inorganic compounds; however, volatile metals, such as mercury, can be extracted.

High-Temperature Thermal Desorption

The high-temperature process uses temperatures between 600 °F and 1,000 °F. At these temperatures, a greater range of contaminants are volatilized including some metals (which may not be desirable).

Low-Temperature Thermal Desorption

The low-temperature process uses temperatures between 200 °F and 600 °F. The lower temperatures do not volatilize metals. Most commercial low-temperature thermal desorption units are of the rotary dryer or thermal screw design.

Treatment residual is the treated sediment. Sidestream wastes include air and water emissions. Pollution control devices are required to reduce particulates in the air emissions. Water wastes include pretreatment dewatering and wastewater produced by the air pollution control system. Costs for thermal desorption range from $11 to $908 per cubic yard with an average cost of $177 per cubic yard.

Limitations include:

- Optimal moisture content less than 60%;
- Gaseous discharges are a major potential contaminant emission pathway;
- Feedstock particle size limited to 2 inches maximum;
- Tightly bound contaminants in clayey and silty sediments increase residence time requirements; and,
- Most heavy metals are not removed or destroyed.

4.5.2.17 Vitrification

Vitrification technology uses high temperatures, above 2,900 °F, to melt and convert contaminated sediments into oxide glasses, thus achieving destruction of organic contaminants and stabilization of inorganic contaminants. The resulting glass is nontoxic and suitable for recycling or landfilling as a non-hazardous material. Vitrification technology is applicable to all types of contaminants. Vitrification immobilizes inorganic contaminants in a solidified glass matrix and destroys organic contaminants with the high temperature involved in glass production.

The treatment efficiencies range approach 99% or greater for most target contaminants. Vitrification is one of the most expensive technologies; however, since vitrification can act as a stand-alone technology, the cost of vitrification can compete when a treatment train of other technologies is required. The cost of vitrification ranges from $66 to $1540 per cubic yard with an average cost of $462 per cubic yard.

Limitations include:
- Gaseous discharges are a major potential contaminant emission pathway;
- Creates a glass material that must be reused or disposed;
- More expensive than incineration; and,
- Molten product requires long cooling period.

4.5.3 Screening Factors

To evaluate alternative sediment decontamination technologies, a survey was performed of potential vendors of treatment systems. Potential vendors were identified from the VISITT and SEDTEC databases. Each vendor was provided with a sediment decontamination technology vendor questionnaire to complete either on-line or through the mail. A copy of the questionnaire is provided in Appendix D. The questionnaire was developed and administered in order to obtain information for a comparative analysis of treatment technologies. Results of this questionnaire allowed development of a consistent set of results including site conditions, sediment characteristics, target cleanup levels, treatment options, and cost elements to evaluate sediment decontamination processes and vendors.

The vendor questionnaire was divided into several comparative categories. The major categories included: Business Information, Ability to Treat, Effects of Sediment Characteristics, Vendor Involvement, Process Information, and Cost. These elements, as well as several practicability criteria were applied to each technology. In addition, DEP Solid Waste Management staff were consulted regarding specific case-studies and experience in the application of alternative treatment technologies to dredged material and other media within the Commonwealth (see Appendix K for DEP comments and Section 4.5.4 below for detailed screening).

4.5.3.1 Ability to Treat

The ability of the technology to treat the contaminants that may potentially be present in the dredged sediments such as metals, PAHs, PCBs, and TPH is a primary consideration in evaluating treatment technologies. The vendor was asked to categorize their technology for its ability to provide immobilization, removal, destruction, or no effect on the target contaminants. In addition, the typical treatment efficiencies and operating ranges (i.e., low and high contaminant levels) were to be identified. Specific individual contaminant exceptions within each of the four major contaminant groups were also to be identified in this section.

4.5.3.2 Effects of Sediment Characteristics

This category contains information about the sensitivity of the treatment technology to variations in the physical and chemical properties and characteristics of the dredged sediments. Requested information included the maximum particle size accepted by the treatment system and the optimal solids content recommended for the treatment system by the vendor. More detailed information was requested on the effects of specific sediment characteristics on the treatment technology. These characteristics included sandy, silty, clayey, low and high moisture content, low and high organic content, and high metals content. Choices provided for describing the effects of the sediment characteristics on the treatment technology included favorable, no effect, impedes, or unknown.

4.5.3.3 Process Information

This category contains information specific to the design and implementation of the vendor's technology. The most critical piece of information in this category is the current scale of development of the technology. Choices included laboratory, pilot, or full/commercial scale. The total number and site-specific references were requested of those vendors with full scale operations. Process-specific information requested included pretreatment requirements, treatment batch size and treatment time, maximum system throughput, residuals generated (e.g., liquid, solid, gas, none), and residual disposal requirements. In addition, any special site- or process-specific needs such as power, water, safety, or permits were to be identified in this section. Other process-specific information included mobilization and demobilization times and layout space required.

4.5.3.4 Cost

The capabilities and costs of the treatment technology, in combination with the time required to process a given volume of sediment (see throughput below), are a key consideration in the selection of a sediment decontamination method. The average cost of sediment decontamination technologies is relatively high ranging from $70 to $170 per cubic yard. In comparison, contaminated sediments from the BHNIP will be disposed of in CAD cells within the footprint of the area to be dredged at an estimated disposal cost of $36 per cubic yard.

4.5.3.5 Throughput

The vendor survey found that the treatment technologies generally have low throughput ranging from 30 to 2,000 cy per day. The treatment technologies evaluated for the BHNIP were rejected partially because the low throughput would constrain the viability of the project. Throughput rates must be considered along with the number of days allowed for dredging and the volume of material to be dredged. In Gloucester Harbor, dredging is allowed only in the late fall and winter months to protect sensitive spawning activities. There are approximately 100 working days (Monday through Friday) in any one dredging season. For a project of 100,000 cy, 1,000 cy of sediment would need to be dredged each day. For smaller projects, slower throughput rates could be adequate, but for large projects, dredging rates of 5,000 - 10,000 cy per day are typical. Ten of the vendors reported throughput rates equal to or greater than 1,000 cubic yards per day, but the majority of processes have much lower throughput rates, in the hundreds of cubic yards per day range .

4.5.3.6 Demonstrated Success

The results of the vendor survey and pilot-scale testing for the Port of NY/NJ cast doubt on the assertion that technologies are not available and proven. The vendors surveyed reported an average of 32 reference sites for full-scale implementation, and approximately half of the vendors reported 5 or more full-scale implementations of their technology. However, the ability of a treatment system to handle widely-varying sediment and contaminant types remains a challenging issue.

4.5.3.7 Logistics

The availability of space, utilities, time, and other logistics are site-specific issues not addressed in this report other than to mention the importance of considering such issues.

4.5.3.8 Permitting Issues

Two issues make permitting of treatment facilities particularly difficult in Massachusetts: sidestreams and residuals management. Public concerns about sidestreams such as gaseous emissions can bring overwhelming opposition to the siting of a treatment facility. Residuals management is discussed separately below.

4.5.3.9 Residuals Management

The costs incurred while managing residuals can easily result in a treatment option that is not economical. In the best case, the residuals can potentially have a commercial value to help offset treatment costs. Based on the documents contained in Appendix C, it appears that there is limited applicability of the following residuals management options: landfill disposal, recycling as landfill cover, and recycling as asphalt material. In addition, the uncertainties associated with the reuse option will greatly limit its applicability until regulations/policies have been promulgated. Although 88% of the vendors claimed that the treated sediments could be reused, it appears based on discussions of specifics with the vendors that many of the potential reuse options are still conceptual and not actually available.

4.5.4 Screening Results

The results of the alternative treatment technology inventory (presented below) were used to evaluate the potential for application of these technologies to sediments to be dredged from the Gloucester Harbor. The survey results are as follows:

- 77% of the technologies are at the full scale/commercial scale of development;
- Vendors offering full scale/commercial technologies have an average of 32 reference sites per vendor;
- Average throughput for all technologies is 754 cubic yards/day (838 tons/day);
- Average treatment costs for all technologies range from $70 to $167 per cubic yard; and,
- The top 4 factors affecting price are: 1) quantity of sediments, 2) moisture content, 3) target contaminant concentration, and 4) characteristics of sediments.

The following is a summary of the practicability of each technology for treating UDM from Gloucester Harbor. Table 4-3 summarizes each technology with respect to the screening factors described above.

4.5.4.1 Chelation

This process is used mainly as a means of controlling leaching of metals but it is not particularly effective on organic compounds or dredged material consisting of silts and clays (which make up a significant portion of the sediments to be dredged from Gloucester Harbor). After chelation, metals leaching, even in sediments containing relatively high heavy metal concentrations, is typically not a problem following upland disposal. Also, chelation is not effective in treating organic contaminants such as PAHs, which are prevalent in Gloucester Harbor sediments. Chelation is relatively inexpensive compared to other treatment technologies ($83/cy), but it requires extensive pretreatment and residuals management.

Table 4-3: Summary of Treatment Technology Characteristics

Technology	Major Advantages	Major Disadvantages
Chelation	relatively moderate cost; excellent for metals treatment	not effective for organics
Chemical Reduction/Oxidation	effective for most organics and inorganics	cost, ineffective for some PAHs, potential toxic residuals
Dehalogenation	excellent removal efficiency for PCBs and chlorinated pesticides	cost, ineffective for metals and PAHs
Fungal Remediation	low technology requirements	low treatment efficiencies, cost
Incineration	high treatment efficiency	permitability, air emissions, cost
In-Situ Bioremediation	high treatment efficiency, relatively low cost	long treatment time, not effective for all organics
Pyrolysis	high treatment efficiency	requires low moisture content, cost, permitability, air emissions
Slurry Bioreactor	effective for treating metals and organics, contained within vessels	cost, ineffective for some organics at low levels
Soil Washing	low technology, relatively low cost	not appropriate for silts and clays
Solid Phase Bioremediation	relatively low cost, low technology	slow process, large land area requirement
Landfarming	relatively low cost, low technology	slow process, large land area requirement, metals not treated
Composting	relatively low cost, low technology	slow process, large land area requirement, low effectiveness for PAHs
In-Vessel Bioremediation	good treatment efficiencies	not effective for inorganics or HMW PAHs, cost
Solidification/Stabilization	reusable residuals (ie: as structural fill), relatively moderate cost, proven track-record for large UDM volumes	ineffective for some organics
Thermal Desorption	high treatment efficiency	requires low moisture content, cost, permitability, air emissions
Vitrification	high treatment efficiency	requires low moisture content, cost, permitability, air emissions
Solvent Extraction	effective in treating organics	not effective for metals, possible toxic residuals, not effective for silts/clays

Key:
HMW= High Molecular Weight
PAH= Polycyclic Aromatic Hydrocarbon
PCB= Polychlorinated Biphenyls
UDM= Unsuitable Dredge Material

4.5.4.2 Chemical Reduction/Oxidation

This process is effective in removing inorganics and organics that are present in dredged material. Throughput (172 tons per hour) is relatively high compared to other technologies, however, its cost is high ($232 per cy). For example, a typical marina dredging project containing 10,000 cy of UDM would cost about $2.3 million for treatment alone. Removal rates of 90 - 95% have been reported. Full scale operations have reported relatively low throughput rates of 200 tons/day.

4.5.4.3 Dehalogenation

Dehalogenation processes are engineered to destroy or remove some of the halogen atoms from halogenated organic compounds such as PCBs, dioxins, furans, some solvents and some pesticides, thereby rendering them less toxic. However, these are not the chemicals of concern in the majority of the Gloucester Harbor sediments.

4.5.4.4 Fungal Remediation

This remediation process is relatively inefficient in its remediation capacity (50% removal). The process is not effective in treating heavy metal contaminants and its effectiveness in salt-water media is poorly known. In addition, the average cost is $215 per cy.

4.5.4.5 Incineration

Incineration is one of the most commonly-used remediation technologies. However, there are several disadvantages to this technology, particularly the air emissions generated from the process. Public opposition to incineration has been strong. A small portable thermal oxidizer was proposed to treat 30,000 cy of on-site generated soils (contaminated with petroleum products only) at an isolated area over a mile from the nearest resident near Logan Airport. Public opposition was so strong that the proposal was withdrawn.

There are several technical shortcomings as well: heavy metals are not destroyed and may become more leachable after incineration; the technology is not effective on high moisture content (like sediments); and, gaseous discharges are created as a new contaminant pathway. The average cost is also high at $243 per cy.

4.5.4.6 In-Situ Bioremediation

In-situ bioremediation technologies have been utilized in Massachusetts for treatment of oil and hazardous materials at contaminated upland sites and could potentially be used for contaminated sediment if the intent is to only remediate the sediments in-place. This is not the case for the DMMP as sediments need to be removed to provide safe navigation. Therefore in-situ bioremediation techniques were not considered as a viable alternative treatment technology. Ex-situ bioremediation techniques involve subjecting the UDM to bioremediation techniques at a remote location, following removal from the dredge site. Ex-Situ bioremediation is considered a viable alternative treatment technology. Fungal remediation and various solid phase bioremediation techniques were found to have potential application for treatment of UDM and are discussed individually in this document.

4.5.4.7 Pyrolysis

Pyrolysis is very similar to incineration discussed above, except that it is used to treat very high levels of organics that are not conducive to conventional incineration. Like incineration, low throughput rates and high unit costs as with incineration are encountered with the use of pyrolysis.

4.5.4.8 Slurry Bioreactor

This technology would require pre and post-treatment actions and extensive sidestream controls. Also, its effectiveness in treating low levels of organic contaminants is minimal. Treatment and disposal of wastewater from slurry dewatering is also required. The average cost of this treatment system is $223/cy.

4.5.4.9 Soil Washing

Soil washing is one of the most common methods for treatment of dredged material. It has been used in the United States and is extensively used in Europe. This technology involves two main stages; particle separation, and, washing by water. Wash water amendments such as chelating agents, acids or surfactants can be added to the process to aid in contaminant removal, soil particle dispersal/separation, or both. Despite its real world usage for large volumes of dredged material, soil washing is not effective in treating silt and clay sediments, which comprise the majority of sediments to be dredged from Gloucester Harbor. Sediments that contain a high sand fraction, such as the Annisquam River Channel, could benefit from this technology, but at a cost of $89 per cy.

4.5.4.10 Solid-Phase Bioremediation

This technology includes three basic categories of processes: landfarming, composting, and in-vessel bioremediation. Landfarming and composting require large areas of land to be effective, because the sediment requires thinning and spreading. Landfarming does not remediate metals and is ineffective for high molecular weight PAHs, which is one of the primary contaminant types in Gloucester Harbor sediments. The same limitations are noted for composting. At an average cost of $62 per cy, this is the least complicated and among the least expensive of the treatment technologies.

In-vessel bioremediation is more than twice as expensive as landfarming or composting because it involves engineered treatment enclosures with leachate collection systems and aeration equipment. It too is not effective in remediating metals and is only marginally effective in treating high molecular weight PAHs.

4.5.4.11 Solidification/Stabilization

Solidification is effective at immobilizing inorganic contaminants and is one of the most commonly used remediation technologies. It has been used in New Jersey at several shoreline sites including a site in Elizabeth, where the treated dredged material is being used as structural fill for a new shopping mall.

Solidification/Stabilization technologies are potentially viable treatment strategies for UDM. However, the end product still requires proper disposal/reuse/recycling. That end product can be of a significantly higher volume than the original dredged material because of bulking and the amendments (fly ash, cement, bentonite, lime) that are required to immobilize the contaminants and/or control pH, odor, and sulfide reactivity.

Lime has been used as an additive to dredged material to control nuisance odors and sulfide reactivity in Massachusetts sediments that were dredged and then used as daily or intermediate cover at landfills. This was done on dredged sediments from the Central Artery/Tunnel project in Boston.

These processes are also relatively inexpensive compared to other treatment technologies. Average cost is estimated at $99 per cy, although the unit cost at the aforementioned New Jersey mall site was $56 per cy (ECDC Laidlaw, 1998).

Solidification/Stabilization technologies appear to be the most viable of all available treatment technologies. However, its applicability to the DMMP depends on the large-scale demand for construction fill. Currently, there is no large-scale demand for fill material that cannot be supplied by upland sources. The costs for upland fill material are significantly less than that of solidified dredged material. If the demand for fill material increases over the next 20 years, and the supply of upland fill material decreases, then solidified/stabilized dredged material could become a marketable, cost-competitive commodity.

4.5.4.12 Solvent Extraction

This technology is similar to, and could be used in conjunction with, soil washing technologies to treat contaminated sediments. However, it has a slow production rate (37 tons/hr) and is expensive (average cost $192 per cy). Its effectiveness in treating organic contaminants such as PAHs, PCBs, petroleum hydrocarbons and chlorinated solvents is good, but only for coarse grained materials such as sand. This precludes the use of this treatment strategy for Gloucester Harbor UDM the majority of which is fine-grained (silts and clays) sediment.

4.5.4.13 Thermal Desorption

Thermal desorption is very similar to incineration and pyrolysis and has many of the same characteristic (low throughput rates, high cost). This technology is not effective in destroying inorganics, such as metals. Off-gas from the process needs to be treated before release to the atmosphere.

4.5.4.14 Vitrification

Vitrification is the most effective treatment system available for treating a media that contains a wide variety of contaminants, such as dredged material. Through exposure to 2,900EF heat, the soil/sediment is melted and converted into an oxide glass-like slag that would be suitable for landfilling or recycling. Vitrification, however, is one of the most expensive treatment technologies at an average cost of $462 per cy. Throughput rates are fairly high, with one full scale operation processing 1,500 tons/day.

4.5.5 *Summary of Alternative Treatment Technology Practicability*

Alternative treatment technologies, unto themselves, do not offer any practicable solution to the management of 330,000 cubic yards of UDM from Gloucester Harbor. This is due to several factors, most notably cost and the inability of siting an acceptable dewatering facility. But the costs for some technologies such as solidification and landfarming, even though comparable to the cost of CAD disposal, do not overcome the fact that there needs to be a permanent receiving site for the treated sediment. It is not known at this time, whether treatment of the UDM would be required for disposal at the proposed preferred upland sites. Therefore, more tests need to be conducted. The rationale for deeming the alternative treatment technologies evaluated in the Gloucester Harbor DMMP DEIR impracticable are shown in Table 4-4.

Solidification/Stabilization and soil washing are the only forms of treatment that demonstrate potential feasibility for treatment of Gloucester Harbor UDM, but a receiving site, such as an industrial or commercial development that requires large quantities of construction fill, would need to be identified. Also, the treated UDM must be competitively-priced with upland sources of fill material in order for the use of treatment technologies to be a practicable solution for the DMMP. Currently, the supply of upland fill material exceeds the demand for construction fill, and at a much lower price (approximately $20/cy) than that of even the lowest-priced treatment technology.

4.5.5.1 Potential Future Alternatives

Alternative treatment technologies may prove viable for small projects, those that deal with unique and/or specific type(s) of contaminant(s), or as an element of a larger UDM management technique. Alternative treatment technology is a rapidly growing and evolving field and it is very likely that as ongoing and future pilot and demonstration projects occur, the universe of technically viable, cost-competitive, and permitable alternatives will emerge.

For this reason, the DEIR carries forward all alternative treatment technologies as "potential future alternatives", and specifies through the BUD and DON process, the various general performance standards which an alternative treatment technologies must meet to be seriously considered as a practicable alternative. This flexible approach will provide a baseline from which proponents of alternative treatment technologies can develop and present specific, detailed proposals, and will allow the State to focus its reviews on potentially practicable proposals. This approach is based on the Boston Harbor EIR/EIS. The DMMP will reevaluate, on a five year cycle, the feasibility of alternative treatment technologies for UDM in Gloucester Harbor and other harbors throughout the Commonwealth.

Table 4-4: Reasons Why Alternative Treatment Technologies were Deemed Impracticable

Technology	Rationale
Chelation	Inability to treat PAHs, sidestream wastes, high cost
Chemical Reduction/Oxidation	Inability to treat metals and PAHs, sidestream wastes, high cost
Dehalogenation	Inability to treat metals and PAHs, sidestream wastes, high cost
Fungal Remediation	Inability to treat metals, low removal efficiencies, high cost
Incineration	Inability to treat metals, sidestream wastes, high costs, permitting difficulties
In-Situ Bioremediation	Inability to treat PAHs, sidestream wastes, limited temp. range
Pyrolysis	Inability to treat metals, sidestream wastes, low sediment moisture content required, high cost, permitting difficulties
Slurry Bioreactor	Inability to treat metals, sidestream wastes, dewatering required after treatment, high cost
Soil Washing	Marginally effective for clay and silt sediments, dewatering after treatment required, high cost
Solid-Phase Bioremediation	
Landfarming	Inability to treat metals and PAHs, not suited for cold climates, ineffective on PCBs, sidestream wastes, space intensive, long duration
Composting	Inability to treat metals, space intensive, sidestream wastes, questionable effectiveness PAHs and PCBs, high cost
In-Vessel Bioremediation	Inability to treat metals, sidestream wastes, questionable effectiveness high molecular weight PAHs and highly chlorinated PCBs , high costs
Solidification/Stabilization	Final product volume significantly larger than original dredged material, market demand, high costs
Solvent Extraction	Inability to treat metals, sidestream wastes, dewatering after treatment required, low effectiveness for silt and clay sediments, high cost
Thermal Desorption	Inability to treat metals, sidestream wastes, low sediment moisture content required, long processing time for clay and silty sediments, high cost
Vitrification	Sidestream wastes, long processing time, extremely high cost

4.6 Dewatering Site Selection

In order to consider upland disposal/reuse as a viable option for the disposal of dredged material, adequate land area is required to accommodate the process to prepare dredged material for final disposal or reuse. A site or series of sites is needed to process and dewater dredged material to reduce the moisture content before transfer to an upland disposal or reuse site. As part of the DMMP DEIR process of exploring potential disposal options, harbor-side and upland site requirements were examined for transferring dredged material from the marine environment to the upland environment for final disposal/reuse.

4.6.1 Screening Process

An initial windshield survey of waterfront accessible areas throughout the south side of Cape Ann, from Rockport to Manchester By-the-Sea, was conducted to produce a list of potential dewatering sites. Dewatering site criteria such as size, topography and accessibility were the main factors considered during the initial windshield survey. The potential dewatering sites produced during the initial windshield survey were examined against specific screening factors so that feasible dewatering site alternatives could be identified. Input from local municipal officials and the Gloucester Harbor Dredging Subcommittee were also incorporated into the search for dewatering sites.

The DMMP dewatering screening process is a two tier process involving the first tier or initial screening of *exclusionary* site factors and a second tier screening of *discretionary* factors. The exclusionary factors only apply to the harbor-side site requirements, all other criteria are discretionary. The harbor-side requirements are exclusionary because, being the first link in the "dewatering/upland disposal process train", dewatering is the limiting factor for consideration of upland disposal. Thus, if a harbor-side site meeting the minimum requirements for dewatering could not be located, then upland disposal options are not feasible.

4.6.2 Screening Factors

The exclusionary factors for first tier dewatering process screening are described below:

D-1. Proximity to Dredging Site - Located within 10 miles of dredging projects. A typical scow (2,000 to 4,000 cy capacity) would be filled within about 2 hours at the dredge site. Scows typically travel at a speed of 5 miles per hour and, therefore, would take 2 hours to arrive at a dewatering site 10 miles away. Another 2 hours would be required for off-loading and another 2 hours for transit back to the dredge site. The total time elapsed for this process would be about 8 hours, a normal working day.

D-2. Pier Requirements - Pier or bulkhead with a minimum length of 120 feet. The harbor-side site adjacent to the pier must be adequately sized to provide an off-loading area and be capable of accommodating two way truck traffic. An area that does not have a pier/bulkhead was considered if construction of a temporary structure would be practicable.

D-3. Water Depth - The pier must have a minimum water depth of 12 feet during all tides. If an area is shallower than 12 feet, but has other positive attributes which could make it a suitable dewatering site, then the site may be considered. This would be possible only if minimal dredging is required to obtain the necessary water depth.

D-4. Dewatering Area - A minimum area of 3.2 acres is needed to provide for a diked dewatering facility for a 10,000 cy project (Figure 4-5). This includes adequate area to allow the treatment of effluent and/or connection to local sewer system.

Second tier discretionary screening factors include the following:

D-5. Timing/Availability - The site (or sites) must be available for the time frame required by the particular dredging project(s) to process dredged material.

D-6 - Access to Transportation Network - The site(s) should be located in an area that has adequate land-side access provided by the existing transportation network. Sites requiring minor upgrading, such as re-paving or constructing a temporary access road may be considered, provided the connecting transportation network is adequate to accommodate the trucking needs associated with the transportation of dredged material.

D-7. Haul Routes - Selected haul routes should avoid lateral or vertical obstructions or any other restrictions. Evaluation of sensitive receptors passed on the haul route should be considered. Other potential logistical problems/conflicts that might be encountered accessing a site should also be identified.

D-8. Present Habitat Types - Sites shall be evaluated for general vegetation cover, presence of wetlands, rare plant/wildlife habitat, and the surrounding landscape.

D-9. Existing Terrain (suitability to diking) - Site examination to determine potential for dike construction.

D-10. Flood Plains - National Flood Insurance Program, Flood Insurance Rate Maps will be consulted for each site to determine if a site is in or partially in a designated flood plain.

D-11. Agricultural Use - Determination of prime agricultural soils on the site.

D-12. Surrounding Land Use - Evaluation of adjacent ownership, present and projected land use. Sites located in industrial or commercial areas are preferred over sites in or adjacent to residential or recreational areas.

D-13. Odors/Dust/Noise Receptors - Evaluation of potential impacts and distance to sensitive receptors of odors, dust and noise from dewatering process methods selected. Sites at a distance from sensitive receptors are preferred over sites adjacent to sensitive receptors.

D-14. Consistency with Port Plan - Each proposed site was reviewed for consistency with the Gloucester Harbor Plan, specifically to determine whether the site(s) enhance(s) the values articulated in the Plan and conform to projected site-specific uses. This criteria is only applicable to potential dewatering sites identified within the municipal boundary of Gloucester.

D-15. Local, Regional, State Plans - Evaluation of consistency with Local, Regional and State long-range plans.

D-16. Ability to Obtain Permits - Likelihood of local, state, and federal regulatory approval.

D-17. Cost - The cost of the construction, operation, and restoration of the site was calculated for comparative purposes.

4.6.3 Screening Results

A total of 37 candidate dewatering sites were identified (Figure 4-10), including 31 candidate sites within or near Gloucester Harbor. Dewatering sites from Rockport in the east to Manchester By-the-Sea to the west were identified, with a majority of the potential sites in Gloucester.

All sites were subject to a windshield survey and review of existing information. Each dewatering site was evaluated against the evaluation factors listed above, and this information was recorded on data sheets (Figure 4-11) for each site. The dewatering site screening evaluation is summarized below.

4.6.3.1 Exclusionary Screening

A strict interpretation of the exclusionary screening criteria resulted in all candidate sites failing the screen. Twenty-seven (27) sites were eliminated because they did not meet the minimum size criteria. The remaining 10 sites had one or more of the following constraints: required access dredging (9 sites); had no existing piers or bulkheads located on-site (same nine sites); and/or, had use conflicts (one site). However, the Cape Ann Forge site was further considered due to its proximity to the dredging areas, the fact that it was a former industrial site, and that site dewatering operations could have little aesthetic or land use impacts to the site and adjacent areas.

4.6.3.2 Discretionary Screening

The Cape Ann Forge Site, (the sole site to survive the exclusionary screen, Figure 4-12) was eliminated as a candidate dewatering site in the discretionary screening phase. This was based largely on the fact that existing shellfish resources along the Annisquam River could be impacted by both temporary pier construction activity at Cape Ann Forge, and by access dredging activity along the Annisquam River Channel. The potential impact to the shellfish resources along the Annisquam River was considered significant since considerable effort has been spent to restore this resource to the Annisquam River over the years. Another issue raised included potential scow or barge travel limitations posed by crossing under the bridge structures over the Annisquam River.

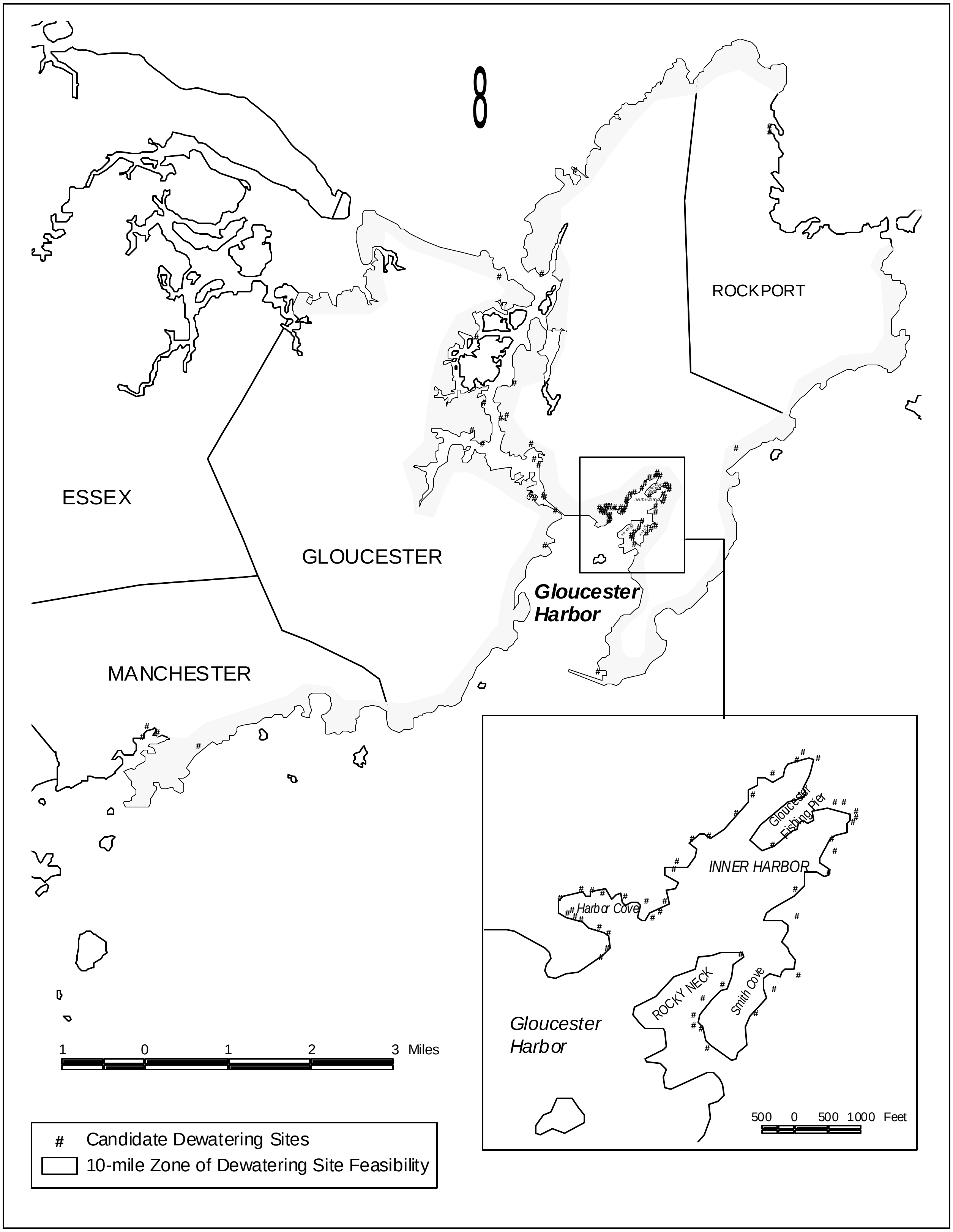


Figure 4-10: Candidate Dewatering Sites

DEWATERING SITE SCREENING

SITE LOCATION 1

HARBOR: SITE NAME:

CITY/TOWN: Lynn SITE ADDRESS:

GENERAL DESCRIPTION:

SITE CHARACTERISTICS

Proximity to Dredging Site (D-1):

Miles from Dredging Projects
Comments:

Pier Requirements (D-2):

Length (Feet)	Able to Accommodate Two Way Truck Traffic
Possible to create Pier:	

Water Depth (D-3):

Minimum Water Depth (Feet)
Possible to dredge to 12 feet:

Dewatering Area (D-4):

Area (Acres)	Dewatering Method
Comments:	

Timing / Availability (D-5):

Availability	Time Frame	Ownership

Access to Transportation (D-6):

Proximity to Highways (Miles)	Proximity to Rail (Miles)
Comments:	

Dredged Material Haul Route (D-7):

Restrictions /Obstructions	Sensitive Receptors
Comments:	

Figure 4-11: Example of Dewatering Site Data Sheet

Present Habitat Types (D-8):

Summary Type:

Successional Stage (D-8.a):	
Disturbance (degree) (D-8.b):	
Plant/Animal Diversity (D-8.c):	
Plant/Animal Integrity (D-8.d):	
Landscape Position (D-8.e):	
Wildlife Function/Use (D-8.f):	

Existing Terrain - suitability for diking (D-9):

Topographical Characteristics	Comments

Flood Plains (100 year) (D-10):

% Coverage	Comments

Agricultural Use (D-11):

Description	Comments

Surrounding Land (D-12):

Existing Land Use	Projected Land Use
Comments:	

Odor/Dust/Noise Receptors (D-13):

Name/Description	Distance	Comments

Consistency with Port Plan (D-14):

Consistency with Stated Goals	Relationship to Preferred Alternative
Comments:	

Local, Regional, State Plans (D-15):

Local	Regional	State
Comments:		

Ability to Obtain Permit (D-16):

Consistency with Federal Regulations	Consistency with State Regulations
Comments:	

Cost (D-17):

Construction	Operation	Restoration
Approx		

Figure 4-11: Example of Dewatering Site Data Sheet (Continued)

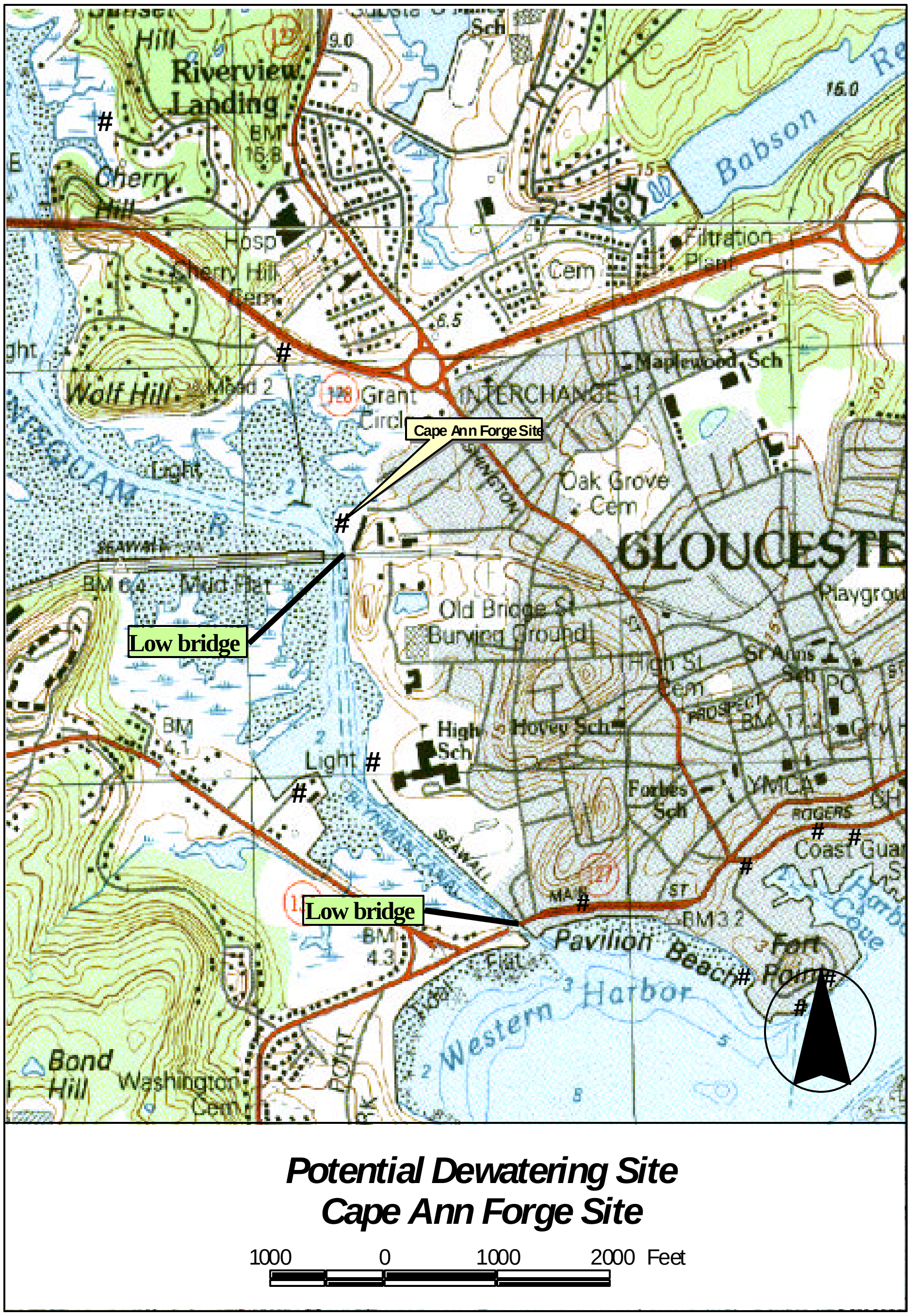


Figure 4-12. Cape Ann Forge Site

The dredging/dewatering/upland disposal process is a dynamic one, with numerous variables that can affect each element of the process. The size of the dewatering site will dictate the dredging rate (throughput). Larger dewatering sites can accommodate higher dredging rates. The dredging rate could be increased if the dredged material can be dewatered more quickly than expected, thereby allowing for removal of piles to the upland site to make room for new dredged material. So as described above, it is clear that the alteration of any of the key variables (dredging rate, pile height, dewatering area size and configuration) can significantly affect the entire dredging/dewatering/upland disposal operation. Addressing the dewatering constraints would be required prior to selection of an upland disposal site or alternative treatment technology as a Preferred Alternative for the DMMP.

Use of the Cape Ann Forge site as a dewatering site illustrates this concept: Use of this site would require construction of a temporary pier. Access and maintenance dredging of the Annisquam River Channel would also be required to provide unimpeded access to the pier under all tidal conditions for a 3,000 cy barge. The potential impacts to existing shellfish resources associated with these activities would need to be avoided, minimized or mitigated to the satisfaction of shellfish protection proponents and appropriate regulators.

4.7 Upland Disposal/Reuse Alternatives

4.7.1 Screening Process

The purpose of the upland disposal site screening process is to identify sites where disposal of dredged material would be feasible and be the least environmentally damaging to the natural and human environment. This was accomplished by employing a tiered screening process depicted in Figure 4-7. The screening follows the guidelines of 40 CFR Part 230, established under Section 404(b)(1) of the Clean Water Act (CWA) and complies with 310 CMR 16.00 (Site Suitability Regulations) for dredged materials classified as solid waste by DEP (MDPW, 1990).

The first tier involved the establishment of a Zone of Siting Feasibility (ZSF), which determined the general area that was to be studied for site selection. The ZSF was established based upon a reasonable truck travel distance from Gloucester Harbor. A 50-mile ZSF (Figure 4-13) was established because it is the maximum distance a truck could travel to and from the dewatering site in a normal 8-hour working day. This included the time for loading and offloading at the dewatering site and disposal site, respectively. The upland ZSF includes: most of eastern and southeastern Massachusetts, extending as far west in central Massachusetts as I-495;and most of the New Hampshire coastline to the north. Commercial landfills within these states were also investigated.

The universe of upland sites was compiled from the following sources, including several previous siting studies that have been conducted for dredged material disposal and disposal/reuse of other materials:

- Boston Harbor Navigation Improvement Project
- Central Artery/Tunnel Project
- MWRA Residuals Management Facility Plan
- DEP Active Municipal Solid Waste Landfills and Active Demolition Landfills in Massachusetts
- DEP Inactive or Closed Solid Waste Landfills in Massachusetts
- Massachusetts Division of Capital Asset Management Inventory of State-Owned Properties
- Lists of active landfills in Connecticut, Maine, New Hampshire and Rhode Island
- Meetings and conversations with local, state and federal agencies
- Requests for Expressions of Interest in major newspapers
- Requests for Expressions of Interest mailed to every municipality within the ZSF

This compilation resulted in a universe of 1,123 sites within the ZSF. These sites were then subjected to a feasibility screen, where sites that were smaller than the minimum size required to accommodate a certain volume of dredged material were eliminated.

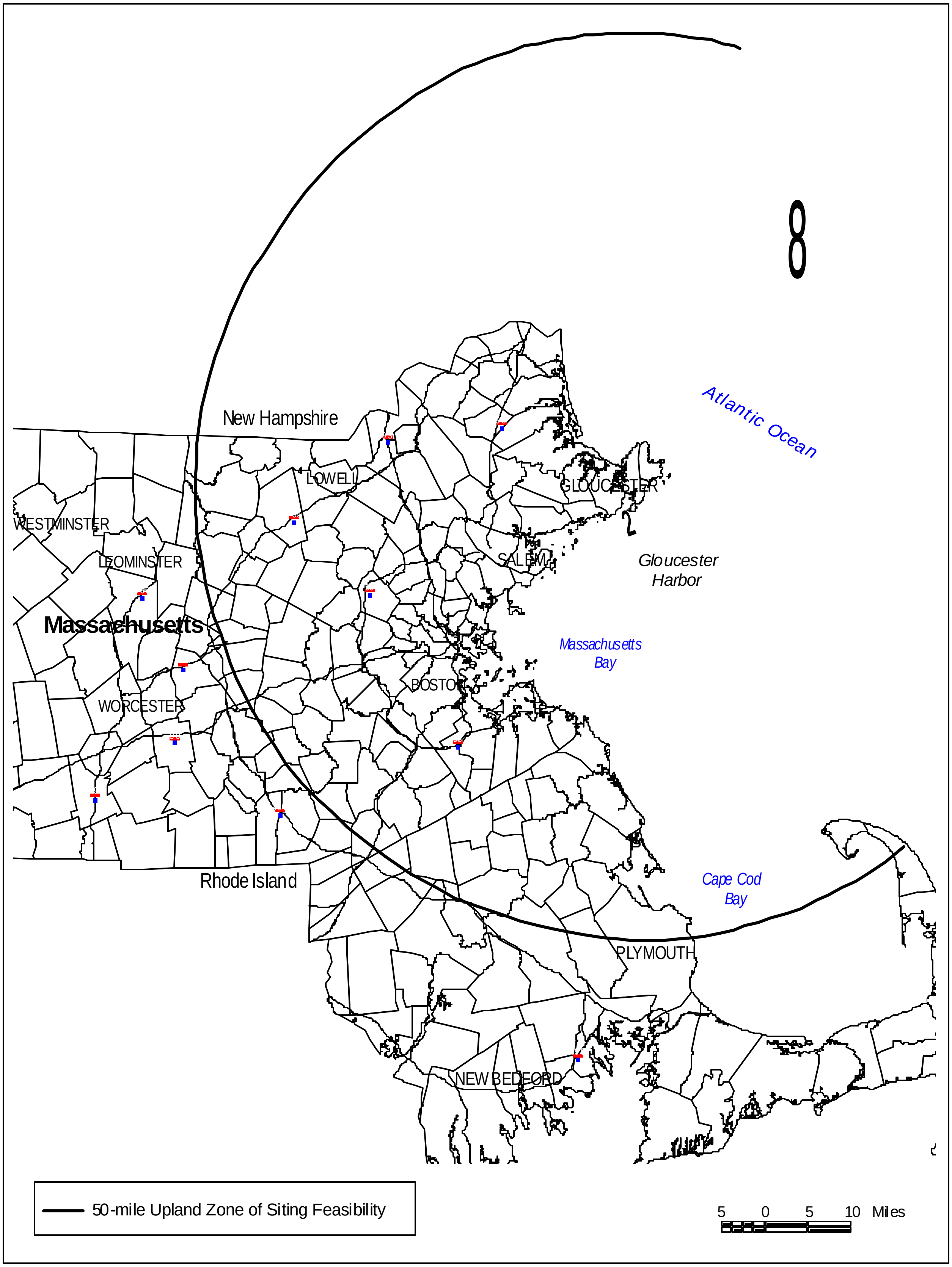


Figure 4-13. Upland Zone of Siting Feasibility

The criteria for determining the minimum disposal site size was based upon two primary factors: 1) the minimum area required to accommodate 10,000 cy of dredged material; and, 2) setback distances for solid waste management facilities as specified in the Massachusetts DEP Solid Waste Management Regulations at 310 CMR 19.000. The 10,000 cy minimum volume was selected because it is the threshold for triggering environmental review under MEPA and it is a volume that is typical of smaller marina dredging projects along the North Shore. A 500-foot buffer distance from the potential disposal area to adjacent properties was assumed as per DEP regulations. This resulted in a minimum disposal area of 25 acres. Any of the 1,123 sites less than 25 acres in size were eliminated. There were 270 sites eliminated based upon this criteria, leaving 853 remaining candidate sites.

The candidate sites were screened through a series of exclusionary criteria that examined factors that would essentially prohibit upland disposal based upon state or federal law or regulation. The close proximity to drinking water supplies, is an example of an exclusionary criteria which, would precludes the area from use as a disposal site. After applying the five exclusionary criteria (discussed in Section 4.7.2.1) 837 additional sites were eliminated, leaving 9 potential alternatives within the 50-mile ZSF. Two additional sites located just outside the ZSF were added because one is an active landfill and the other, although inactive, has accepted dredged material in the recent past. Therefore, 11 potential alternatives are carried forward for further analysis.

The potential alternatives were then evaluated based upon a set of secondary or discretionary criteria, consisting of 15 factors that could affect the feasibility and potential impacts of a disposal site. These factors are shown in the upland site data sheets (Figure 4-14) and are described in Section 4.7.2.1.

Each of the potential alternative sites (Figure 4-15) were then compared, relative to one another, using the discretionary criteria. Finally, DEP policies and regulations related to waste disposal were applied to the set of potential alternatives to determine the relative feasibility of each site for accepting dredged material.

4.7.2 Screening Factors

In conclusion, after sites were eliminated based upon size and capacity in the feasibility screen , the candidate sites were then screened using a set of exclusionary criteria. The potential sites still remaining after these two initial screening processes were then evaluated using a set of discretionary criteria, which included the feasibility of obtaining approvals for these sites based upon existing DEP policies and regulations regarding waste management.

UPLAND DISPOSAL SITE SCREENING

SITE LOCATION

HARBOR: SITE NAME:

SITE COORDINATES:

PHYSICAL CHARACTERISTICS

Disposal Type(s):
Potential Capacity (cy x10^3):
Present Land Use:
Adjacent Land Use (U-15):
Physical Area of Impact (acres) (U-9):

Site Accessibility (U-8):

Route	Distance	Logistics
		[Including time of transport, road types, rehandling, and storage]
Trucking Limitations:		

Duration of Potential, Adverse Long-term Impacts (U-10):

Duration	Severity	Comments

Existing Terrain (U-12):

Topographical Characteristics	Comments
	[Including suitability for diking]

DESIGN CHARACTERISTICS

Ability to Obtain Permit (U-19):

Consistency with Federal Regulations	Consistency with State Regulations

Risk of Containment Facility Failure (U-16):

Geotechnical Stability	Foundation Stability	Comments

Consistency with Local, Regional, and State Plans (U-18):

Values	Site-specific Uses

Figure 4-14: Example of Upland Disposal Site Data Sheet

Estimated 20 year Cost (U-20):

Construction	Maintenance	Monitoring

EXCLUSIONARY USE FACTORS

Critical Habitat for Federal or State, Rare and Endangered Species (U-1):

Species	Designation (S/F)	Habitat Use	Seasonality
		[Breeding/Resident/ Migratory/Habitat]	

Historic/Archeological Sites or Districts (U-2):

Type of Site	Significance of Features

Drinking Water Supply – Groundwater (U-3):

Zone II	Sole Source Aquifer

Drinking Water Supply – Surfacewater (U-4):

More than 0.5 Miles Upgradient nearest source	Comments

National Seashore (U-5.a):

Name	Distance	Comments

Wilderness Area (U-5.b):

Name	Distance	Type	Comments

ACEC's (Areas of Critical Concern) (U-5.c):

Name	Distance	Type	Comments

Figure 4-14: Example of Upland Disposal Site Data Sheet (continued)

DISCRETIONARY USE FACTORS

Groundwater – General (U-6):

Depth to Groundwater	Comments

Surface Water - Rivers (U-7.a):

Name	Distance	Potential for Water Quality Degradation

Surface Water - Wetlands (U-7.b):

Name	Distance	Potential for Water Quality Degradation

Flood Plains (U-13):

Percent Coverage, 100 year	Comments

Agricultural Use (U-14):

Description	Comments

Odor/Dust/Noise Receptors (U-17):

Name/Description	Distance	Comments

BIOLOGICAL USE FACTORS

Present Habitat Types (U-11):

Summary Type:

Recovery Potential:

Successional Stage (U-11.a):
Disturbance (degree) (U-11.b):
Plant/Animal Diversity (U-11.c):
Plant/Animal Integrity (U-11.d):
Landscape Position (U-11.e):
Wildlife Function/Use (U-11.f):

Figure 4-14: Example of Upland Disposal Site Data Sheet (continued)

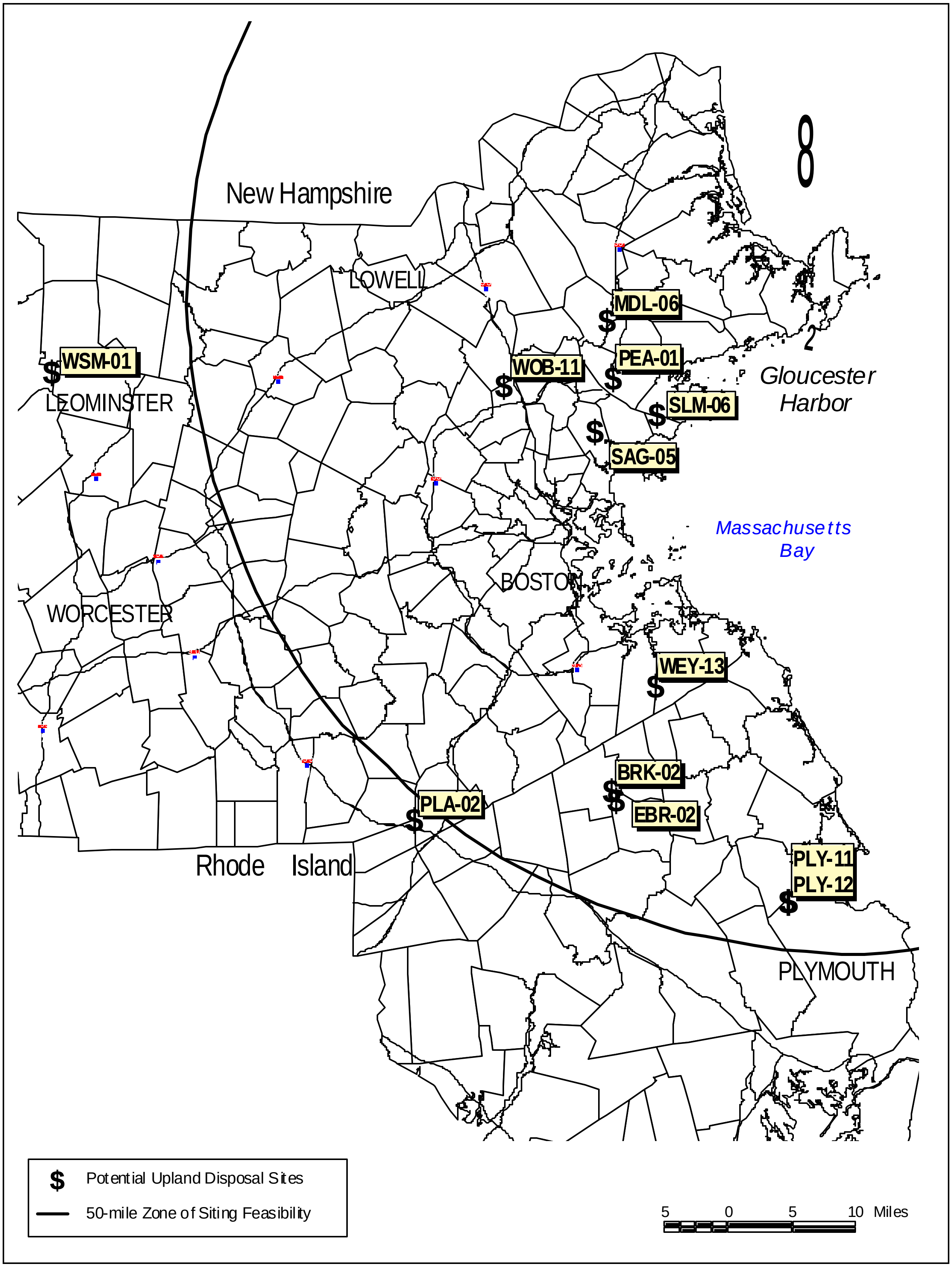


Figure 4-15. Potential Upland Disposal Sites

4.7.2.1 Exclusionary Factors

The following exclusionary factors were applied to those sites 25 acres in size or greater, i.e. the candidate disposal sites:

U-1. Threatened and Endangered Species - (Critical habitat or resource-use area for federal or state listed threatened or endangered species or species of special concern) **-** The locations of the sites identified in the initial screening were identified in the Massachusetts Natural Heritage Atlas which utilizes information from the USFWS to map and list these state and federal species.

U-2. Historic/Archeological Sites or Districts - The sites were evaluated for potential cultural resource constraints through consultation with the Massachusetts Historical Commission and review of any local, State or National designations for the site.

U-3. Drinking Water Supply - Groundwater - Sites were evaluated for proximity to an area with groundwater with Zone II or III designation (DEP) and Sole Source Aquifer (SSA) designation (EPA). Under 310 CMR 22.00, local zoning regulations are required to prohibit certain land uses, including landfills, from being sited within Zone II and III wellhead protection areas. Under 310 CMR, there are allowance for variances from these strict land use controls depending on a variety of factors including water supply status (public or private), population served, and frequency of use. Also, there are a range of setback considerations that could affect the feasibility of siting a landfill. For a macroscale study such as this upland disposal analysis, these potential variables were not factored into the analysis, therefore, areas with a Zone II or III designation were excluded from siting a dredged material disposal facility.

A SSA is an aquifer designated by the United States EPA as the sole or principal source of drinking water for a given aquifer service area and which is needed to supply 50% or more of the drinking water from that area and for which there are no reasonably available alternative sources if that aquifer became contaminated (United States Environmental Protection Agency, 2000).

U-4. Drinking Water Supply - Surface Water - Sites were evaluated for proximity to public drinking water supplies, location within one-half mile upgradient of a surface water supply, potential pollutant pathways to a water supply, and potential for water quality degradation.

U-5. Land Designation

U.5.a - National Seashore - Sites were evaluated for federal designation as a National Seashore. Massachusetts Solid Waste Regulations, 310 CMR 19.000, prohibit placement of unsuitable material in a designated National Seashore area.

U.5.b - Wilderness Area - Sites were evaluated for federal designation as a Wilderness Area. Massachusetts Solid Waste Regulations, 310 CMR 19.000, prohibit placement of unsuitable material in a designated Wilderness Area.

U.5.c - Area of Critical Environmental Concern (ACEC) - Sites were evaluated for state designation as an Area of Critical Environmental Concern (ACEC). ACECs are areas containing concentrations of highly significant environmental resources that have been formally designated by the Commonwealth's Secretary of Environmental Affairs for preservation and enhancement of the land's natural assets (Massachusetts Department of Environmental Management, 2000) (301 CMR 12.00). Massachusetts Solid Waste Regulations, 310 CMR 19.000, prohibit placement of unsuitable material in an ACEC.

4.7.2.2 Discretionary Factors

The following discretionary factors were used to evaluate the 11 potential upland disposal sites that survived the exclusionary criteria screening process.

U-6. Groundwater - General - Evaluation of the types of aquifers in the vicinity and depth to groundwater at the site.

U-7. Surface Water Quality

U.7.a - Water Bodies and Rivers - Evaluation of the sites' setback (distance of the site from the shoreline) from waterbodies and rivers.
U.7.b - Wetlands - Evaluation of setback of sites from wetland resource areas.

U-8. Site Accessibility - Description of the most practical route to transport dredged material to the disposal site, including any potential logistical problems that might be encountered during use or construction of the proposed site. Sites should be directly accessible from a regional highway, have a rail or navigable waterway nearby, have a local access route that does not include lateral or vertical obstructions or restrictions, and have a local access route that does not pass by sensitive receptors.

U-9. Physical Area of Impact - Evaluation of the amount of land area in acres that would be directly affected by disposal activities.

U-10. Duration of Potential, Adverse Impacts - Estimation of recovery time based on the type of disposal and present site conditions.

U-11. Present Habitat Types

U-11.a - Successional Stage - Evaluation of vegetation stage (e.g., forest, grass) and whether wetlands were present.

U-11.b - Degree of Disturbance - Evaluation of the visual evidence of site disturbance, including physical disruptions such as land clearing or development; and ephemeral disturbances such as noise or temporary land usage.

U-11.c - Diversity of Plant and Animal Species - Evaluation of the type and amount of vegetative cover to estimate species diversity, highlighting the presence of wetlands on or adjacent to the site, and considering influence of topography and soil types.

U-11.d - Integrity of Plant and Animal Communities - An evaluation of the plant and animal community integrity by considering the degree of disturbance that the site and the surrounding landscape conditions, and their potential impact on the habitat and species of native flora and fauna at the site.

U-11.f - Wildlife Function - Assessment of wildlife value by considering degree of disturbance and landscape position as well as the presence of breeding, feeding, resting/roosting areas, presence or connectivity to dispersal areas, presence of food and cover, and other wildlife attributes.

U-12. Existing Terrain (suitability for diking) - Determination of ability to construct a dike around disposed sediment in light of existing terrain.

U-13. Flood Plains - Determination whether site is within or partially within a designated floodplain, consulting National Flood Insurance Program (NFIP) Flood Insurance Rate Maps (FIRMs).

U-14. Agricultural Use - Determination of prime agricultural soils on or near the site.

U-15. Adjacent Land Use - Evaluation of adjacent ownership, present and projected land use.

U-16. Risk of Containment Facility Failure - Review of characteristics and engineering requirements for each site to assess the potential stability of material disposed of at the site.

U-17. Odors / Dust / Noise - Evaluation based on proximity of odors, dust and noise generated on-site to sensitive receptors such as residential areas, schools, cemeteries, etc.

U-18. Local, Regional, State Plans - Evaluation of consistency with local, regional and state long range plans.

U-19. Ability to Obtain Permits - Evaluation of likelihood of local, state, and federal regulatory approval.

U-20. Cost - Estimation of comparative costs for construction, maintenance, and monitoring of proposed sites.

Table 4-4: Summary of Exclusionary (E) and Discretionary (D) Screening Factors for Upland Disposal/Reuse

SCREENING FACTORS	EVALUATION CRITERIA	GOAL
PRE-SCREENING		
Geographic Area	50-mile radius; Beyond MA state boundaries, only commercial opportunities were considered	Maximize proximity to dredging activity
Capacity	>10,000 c.y	Maximize capacity
INITIAL SCREENING (E)		
U-1. Rare and Endangered Species 310 CMR 16.00, 19.00	Rare or endangered species habitat	Avoid rare or endangered species habitat
U-2. Historical/Archaeological Sites 310 CMR 16.00, 19.000	Presence of Local, State, or National Historic Site	Avoid Local, State, or National Historic Sites
U-3. Drinking Water Supply - Groundwater 310 CMR 16.00, 19.000, 22.21	Proximity to Zone II and Sole Source Aquifer	Avoidance of Zone II and Sole Source Aquifer
U-4. Drinking Water Supply - Surface Water 310 CMR 16.00, 19.000, 22.21	Setback greater than ½ mile up gradient of water supply	Beyond ½ mile upgradient
U-5. Land Designation ***U-5.a - National Seashore*** **E** - 310 CMR 16.00, 19.000 ***U-5.b - Wilderness Area*** **E** - 310 CMR 16.00, 19.000 ***U-5.c - Area of Critical Environmental Concern(ACEC)*** **E** - 310 CMR 12.00, 16.00, 19.000	National Sea Shore Designation (Federal) Wilderness Area Designation (Federal) ACEC Designation (State)	Avoid designated sites. Avoid designated sites. Avoid designated sites.
SECOND TIER SCREENING (D)		
U-6. Groundwater - General **D**	Depth to groundwater	Maximize separation distance
U-7. Surface Water ***U-7.a - Water Bodies and Rivers*** **D** ***U-7.b - Wetlands*** **D**	 Setback from river, water quality degradation Setback from wetland, water quality degradation	 Protect river quality Protect wetland quality
U-8. Site Accessibility **D**	Trucking limitations, length, time to transport, road types, re-handling, storage	Minimize disruptions Maximize efficiency Reduce risks of re-handling
U-9. Physical Area of Impact **D**	Size of area affected	Minimize area adversely affected
U-10. Potential Adverse Long-term Impacts **D**	Time, severity, recovery period	Minimize impacts

Table 4-4: Summary of Exclusionary (E) and Discretionary Screening Factors for Upland Disposal/Reuse (Continued)

SCREENING FACTORS	EVALUATION CRITERIA	GOAL
U-11. Present Habitat Types		
D ***U-11.a - Successional Stage***	Existing conditions	Long-term protection of advanced stage or climax communities and utility over pioneers
D ***U-11.b - Disturbance (degree)***	Existing conditions	Long-term protection of undisturbed sites or sites with least disturbance
D ***U-11.c - Plant/Animal Diversity***	Existing conditions	Long-term protection of sites with greatest diversity.
D ***U-11.d - Plant/Animal Integrity***	Existing conditions	Long-term protection of sites with stable populations of native, non-invasive and diverse flora and fauna
D ***U-11.e - Landscape Position***	Existing conditions	Assure long-term compatibility with adjacent environment types and land use
D ***U-11.f - Wildlife Function /Use***	Existing conditions	Long-term protection of sites which support the greatest number of critical life functions
U-12. Existing Terrain **D**	Existing terrain suitable for diking	Maximize long-term secure containment
U-13. Flood Plains **D**	Avoid impacting flood plain	Retain flood storage capacity
U-14. Agricultural Use **D**	Existence of prime agricultural soils/ agricultural use	Avoid impacting resources
U-15. Adjacent Land Use	Ownership, present and projected use	Maximize long-term retention of greenspace/retain long-term availability
U-16. Facility Failure **D**	Geotechnical stability, foundation stability	Maximize stability/containment of material
U-17. Odors / Dust / Noise **D**	Proximity to receptors of odors, dust and noise.	Maximize distance to receptors
U-18. Local, Regional, State Plans **D**	Consistency with applicable plans	Avoid conflict with long range plans
U-19. Ability to Obtain Permit **D**	Likelihood of obtaining local, state, and federal approvals	High probability of obtaining necessary approvals
U-20. Cost **D**	Estimated 20-year cost of construction, maintenance, monitoring	Minimize long-term costs.

4.7.3 Screening Results

Using the methodology and criteria described above, the initial screening narrowed the universe of sites. This initial screening of the Massachusetts sites was conducted using the following reference sources:

- Massachusetts Geological Information Systems (MassGIS),
- United States Geologic Survey Topographic Maps,
- Massachusetts National Heritage Atlas,
- Massachusetts Historic Commission maps,
- Bureau of Waste Site Cleanup Sites Transition and Reportable Releases Lists,
- Information gathered in previous reports and databases, and
- Information obtained about sites within the municipal limits of the harbors at meetings with town officials.

Over 1,000 sites within Massachusetts had exclusionary constraints, causing them to be eliminated. Table 4-5 summarizes the results of the initial screening.

The remaining 11 sites either did not have exclusionary constraints or were active commercial landfills or contaminated sediment treatment facilities and therefore could potentially be used as a disposal site for dredged material.

Because the 50-mile ZSF extended into portions of New Hampshire, active commercial landfills within this state were considered. There are no active commercial landfills in New Hampshire within the ZSF, however the Waste Management Turnkey facility in Rochester, NH has expressed interest in accepting UDM from Gloucester Harbor for use as grading/shaping material. This facility is about 80 miles from Gloucester. It has three landfills; two are closed and the third is in the process of being capped. The fourth will be constructed to take material until 2002. The rate of disposal at the 3rd and 4th is 750,000 - 900,000 tons/year. UDM may be suitable as internal slope cover. Under New Hampshire regulations, out-of-state material that has been rejected for disposal within the state of orgin cannot be accepted at the facility. Additional testing would be needed on the UDM to determine its acceptability for landfill disposal.

Waste Management also operates the Crossroads facility in Norridgewalk, ME. This landfill is licenses to accept dredged material, but it is about 190 miles from Gloucester Harbor.

Table 4-5: DMMP Upland Disposal Site Exclusionary Screening Summary

Site Sources:	Active Landfills	BHNIP	CA/T	DCAM	Planning Depts.	Inactive Landfills	RMFP	UR Parcels	Total Sites
Candidate Sites	37	12	6	380	3	368	312	5	1,123
Sites Failing Exclusionary Criteria:									
Capacity/Status	25	4	0	11	0	162 (2)	67	1	270 (2)
Rare and Endangered Species	0	0	0	37	0 (1)	23	21	0	81 (1)
Zone II Aquifer	1	2	1	19	0	30	71	0	124
Sole Source Aquifer	2	0	1	4	0	17	15	0	39
Surface Water Source	0	0	0	2	0	9	5	0	16
National/Historical Monument	2 (1)	0	0	11	1	62 (1)	68	0	144 (2)
National Seashore	0	0	0	0	0	0	0	0	0
Wilderness Area	1	1 (1)	1	280	1 (1)	37 (1)	59	2	382 (3)
ACEC	0	2	0	31	0	15	14	2	64
21E Site	3 (1)	2	3	4	0 (1)	16 (1)	13	0	41 (3)
Screened by Agency Action	2	1	1	0	0	56	16	0	76
Sites Eliminated	35 (1)	10 (1)	6	378	2 (1)	362 (4)	309	5	1107 (7)
Potential Alternatives:									
in Massachusetts[4]	2	2	0	2	1	6	3	0	16
outside Gloucester ZSF									-7
outside ZSF but considered									+2
within Gloucester ZSF									**11**

Notes:

1. Sites in parentheses failed the exclusionary screening, but were not eliminated because of their potential as disposal sites.
2. Some sites failed more than one criterion.
3. A site would fail due to capacity/status if: site is smaller than 25 acres, site has capacity less than 10,000 cu yd, site is too narrow to accommodate landfill construction, site has been developed (e.g. residences, industrial park, highway), landfill is closed and capped, landfill only accepts MSW, or site is no longer part of database that included it in this list.
4. Within the overlapping ZSFs of MA North Shore and South Shore Harbors.

Site Sources:

Active Landfills - Active MSW Landfills and Active Demolition Landfills in Massachusetts (DEP, April 1998), Connecticut Active Landfill Sites (CT DEP, February 1998), Rhode Island Licensed Solid Waste Landfills (RI DEM March 1996). Landfills Operating - 1997 (NH DES, November, 1997), and Maine: Operating Landfills (Maine DEP).
BHNIP - Boston Harbor, Massachusetts: Navigation Improvement Project and Berth Dredging Project (April 1994).
CA/T - Central Artery/Tunnel Project: Results of Upland Disposal Site Screening Study (November 1990).
DCAM - Massachusetts Division of Capital Assets Management (formerly Division of Capital Planning Operations) Sites.
Planning Depts. - Suggested during meetings with members of Salem Planning Office (December 8, 1998) and Gloucester Planning Office (December 15, 1998).
Inactive Landfills - Inactive or Closed Solid Waste Landfills in Massachusetts (DEP, April 1998).
RMFP - MWRA Residual Management Facilities Plan (MWRA, 1986 and Black and Veatch, 1987).
UR Parcels - Massachusetts Highway Department Uneconomic Remainder Parcels.

4.7.4 Potential Alternatives

The 11 potential upland sites in Table 4-6 have been identified based on the initial screening. Detailed information about each of these sites can be found on data sheets in Appendix C. The detailed screening of these sites is presented below.

4.7.4.1 Detailed Screening of Potential Upland Disposal Sites

Map analyses, file reviews, and site visits were used to acquire more detailed information for each potential upland disposal site identified during the initial screening. Detailed information about each of these sites was recorded on the data sheets (see example, Figure 4-14 located in Appendix C. DMMP team members and representatives of local, state, and federal governments met and reviewed this information to review potential alternatives. Discretionary factors were discussed to determine the benefits and constraints of using each site.

The sites that survived the detailed screening are "Proposed Preferred Alternatives". The discretionary evaluation criteria used during the second tier upland disposal site screening are outlined below, with more detailed discussion in section 4.7.2.

Existing Site Uses

Of the 11 potential sites, only one, WSM-01, is an active landfill. This site is currently being impacted by ongoing disposal activities, so the disposal of dredged material at the site would not greatly change the current land use. WSM-01 is surrounded by a state forest on three sides, with residences and undeveloped land abutting the other.

Five of the sites, EBR-02, PLA-02, BRK-02, WOB-11, SAG-05 and PEA-01 are either inactive or closed landfills. These sites are not pristine, having already been impacted by previous disposal activities. The streets leading to them have been used by heavy trucks during past disposal use, so truck access is relatively good. SAG-05 is an exception, because at this site, trucks would need to negotiate residential roads. Most of the sites are in commercial and industrial areas, with some residences nearby. Three sites, EBR-02, PEA-01, and SAG-05, have abutting residences. PLA-02 also has cranberry bogs northwest of the site.

There are four sites that would be new disposal areas, SLM-06, WEY-13, PLY-11/12, and MDL-06. Both SLM-06 and WEY-13 are active quarries in industrial areas, with some residences nearby. MDL-06 is mostly covered with cropland, and there are residences that abut to the north. PLY-11/12 is an undeveloped wooded site, with residences abutting the south side of the site.

Table 4-6: Potential Upland Disposal Site Characteristics

Site ID	Site Name	City	Present Site Usage	Distance from Gloucester (mi)	Capacity[8] (cy)	Cost [1,2] ($/cy)
SLM-06	Bardon Trimount Quarry	Salem	active quarry	16	849,400	$ 60-117
EBR-02	Northern Disposal BFI	E. Bridgewater	inactive lined landfill	42	711,100	$60- 137
WOB-11[3]	Woburn Landfill	Woburn	unlined inactive	31	500,000	$60 - 130
WSM-01	Westminster Landfill	Westminster	active lined landfill	68	282,700	$60 - 134
WEY-13[5]	Bates Quarry	Weymouth	active quarry	44	189,600	$60 - 169
PLA-02	Plainville Landfill	Plainville	inactive lined landfill	60	172,800	$60 - 217
PLY-11/12	MHD ROW Parcel	Plymouth	undeveloped woods	47	124,400	$60 - 238
MDL-06	DFA Middleton Colony	Middleton	open field	20	51,400	$60 - 238
BRK-02[7]	Brockton Landfill	Brockton	unlined inactive	52	42,500	$60 - 333
SAG-05[4]	Saugus Landfill	Saugus	inactive landfill	40	29,600	$60 - 403
PEA-01[6]	NESWC Ash Landfill	Peabody	inactive landfill	25	10,900	$60 - 683

[1] Cost includes dewatering, hauling, landfill construction and monitoring (does not include dredging)
Costs are for the creation of a new landfill or landfill area in accordance with MA Solid Waste Management Regulation guidelines.
[2] Cost for using UDM as grading/shaping material in active and inactive landfills is approximately $60/cy
[3] Landfill to be closed in 2 years per an administrative consent order
[4] In process of closing. UDM not needed for closure.
[5] Viable quarrying likely for the duration of the DMMP (20 yrs). Ponds (wetlands) present throughout quarry.
[6] No longer accepting material
[7] Landfill is closed

Groundwater

To avoid potential impacts to groundwater, sites located atop important groundwater resources were eliminated. Sites located within the Zone II (Zone of Contribution) of a public water supply well, within an Interim Wellhead Protection Area (IWPA), or within a Sole Source Aquifer failed the initial screening, in accordance with the Massachusetts Site Assignment Regulations for Solid Waste Facilities (310 CMR 16.00). None of the potential disposal sites are located above a Zone II, IWPA, or Sole Source Aquifer. The locations of potentially productive and other aquifers at or near the site were considered in the discretionary screening.

To further minimize the potential for the disposal of dredged materials to impact groundwater, the Site Assignment Regulations require that the disposal area be at least four feet above groundwater. At a site that has a shallower groundwater table, the disposal facility can be engineered so that there is at least 4 feet between the lower-most liner and the high level of groundwater.

As indicated above, any new disposal facility used or built would be lined to keep any leachate from the dredged material from coming into contact with groundwater. For unlined landfills, additional testing of sediments would be needed to determine if UDM leachate poses a threat to groundwater. Groundwater sampling via monitoring wells and laboratory analysis of the groundwater samples would be conducted to confirm that leaks into groundwater have not occurred.

Sites SLM-06, EBR-02, and WEY-13 have shallow depth to groundwater (< 4ft.) and, therefore, risk of groundwater contamination at these sites would be greatest (The two quarry sites, SLM-06 and WEY-13 are excavated pits and, therefore, are actually *below* the groundwater table).

Surface Water and Wetlands

While disposal of dredged material into freshwater wetlands is not absolutely prohibited, it would be difficult to obtain a permit for such an activity. For this reason, candidate upland disposal sites that are wholly or in large part covered with wetlands were eliminated from further consideration. However, sites that contain a minimal amount of wetlands were not, because disposal site design could avoid impacts to the wetlands. However, sites that do not contain any nearby wetlands would obviously be preferred over sites that are adjacent to wetlands.

Wetlands were identified through the use of U.S.G.S. Topographic Maps and the National Wetlands Inventory (NWI) mapping developed by the U.S. Fish and Wildlife Service. The NWI maps only identify and described relatively large wetlands (>5 acres), so other, smaller wetlands and vernal pools may be present at these sites. A site-specific field delineation would be required to define the regulatory limits of these wetlands.

All the potential disposal sites either contain or abut wetlands. The entire western perimeter of the BFI Landfill in East Bridgewater (EBR-02) is a shrub/scrub and forested wetland. The Ipswich River runs through the Middleton Colony Parcel (MDL-06). The southwest quadrant of the Brockton Landfill (BRK-02) contains a forested shrub/scrub wetland. The remaining eight sites either have small, isolated wetlands on site or have wetlands near the property borders.

Site Accessibility

Many of the potential upland disposal sites are existing active or inactive landfills or quarries and, therefore, access to the sites has been improved over the years to accept trucks carrying solid waste or raw materials. Three of the inactive landfills (SAG-05, BRK-02, EBR-02) are accessed by residential roads, which is less preferred over sites that are accessed by roads that are engineered for industrial use (e.g. wide lanes, shoulders, multiple lane, gentle curve radii and sufficient lines of sight).

In terms of distance from Gloucester Harbor, SLM-06 is closest, while WOB-11, PEA-01, MDL-06 and SAG-05 are all within 20 miles. The remainder of the sites are beyond 20 miles, with WSM-01 the farthest away (48 mi).

Physical Area of Impact

The estimated footprint of UDM disposal at the potential disposal sites (Table 4-5) was estimated based on the existing topography of the land and engineering criteria established in the Commonwealth's Solid Waste Management Regulations. To receive 300,000 cy of UDM, disposal footprints for sites PLY-11/12, MDL-06, BRK-02, WOB-11, SAG-05 and PEA-01 would need to be 10 acres or less. Site EBR-02 would have the largest disposal footprint (48 ac). The quarry sites, SLM-06 and WEY-13, have expected disposal footprints of 18 and 14 acres, respectively. However, because they are pits, these footprints could be lessened depending on final engineering.

Duration of Potential, Adverse Impacts

Long term adverse impacts would be greatest at the new disposal sites. Sites MDL-06 and PLY-11/12 are both undeveloped parcels and would have the potential for the longest adverse impacts.

Present Habitat Types

Sites within or near productive, diverse, and undisturbed habitats are least preferred over sites with habitats that have been disturbed. Sites within existing or inactive landfills or quarries have undergone habitat disturbance already and, therefore, are preferred over sites such as MDL-06 and PLY-11/12, which are relatively undisturbed and undeveloped parcels of land.

To keep threatened and endangered species from being affected by the disposal of dredged material, sites containing their habitats failed the exclusionary screening. The Bardon Trimount Quarry (SLM-06) is the only site containing rare or endangered species habitat that was not eliminated, because the species of concern is located in the northern perimeter of the site, removed (400 feet) from the disposal area itself. The habitat covers approximately 5% of the entire property.

Of the remaining 10 sites, only one, PLY-11/12 has a rare, threatened or endangered species habitat, nearby. This habitat is located 0.25 miles away.

Existing Terrain (suitability for diking)

A disposal site for UDM can be engineered for practically any site conditions. However sites that are level or sites with existing topography that could easily contain dredged material (e.g. quarries, borrow pits) are preferred. As such, the quarry sites, SLM-06 and PLY-11/12, would be most effective in containing the dredged material because of the minimal need for dike/embankment creation. The existing landfills contain moderate to steep slopes, so additional side slope stabilization would need to be engineered. Of the two undeveloped sites (MDL-06 and PLY-11/12) the PLY-11/12 site contains slopes in excess of 8%.

Flood Plains

Five of the 11 potential disposal sites are wholly or partially within the 100-year flood plain. These are PLA-02, WEY-13, BRK-02, MDL-06, and EBR-02. All others are outside of the 100 and 500-year flood plain.

Agricultural Use

Two of the sites, BRK-02 and MDL-06 contain prime agricultural soils. All others do not contain prime agricultural soils, although PLA-02 and EBR-02 are within 500 feet of prime agricultural soils.

Adjacent Land Use

Sites in industrial or commercial areas are preferred over those in residential, agricultural, or recreational areas. Eight of the 11 sites are near residential, agricultural or recreational areas. Sites WOB-11, PEA-01 and SLM-06 are within industrial or commercial areas.

Portions of BRK-02, EBR-02, and SLM-06 are listed as Protected and Recreational Open Space, according to MassGIS. The first two sites were recently active landfills, so it is likely that the wilderness areas have already been impacted. At SLM-06, it is the area of the quarry that is listed as wilderness area, although the site is zoned as industrial, and large scale quarry activities have been going on for some time. Several other sites have undeveloped regions of the property where there may be potential for recreational activities such as hunting or fishing. These sites include PLY-11/12 and SAG-05.

Several sites abut protected and recreational lands. FRV-02 and WSM-01 are both active landfills situated next to state forests. MDL-06 abuts protected open space. These areas could potentially be negatively affected by disposal activities.

Facility Foundation Conditions

All sites have good foundation conditions for accepting UDM , except the Woburn Landfill (WOB-11), which has moderate foundation conditions. However, these conditions are not insurmountable with proper engineering.

Odors / Dust / Noise

Disposal sites that are close to residential, recreational, and tourist areas could be negatively affected by the odor, dust and noise created from a UDM disposal operation. Similar to the Land Use criteria discussion above, sites WOB-11, PEA-01 and SLM-06 would be preferred over the other eight sites because they are located in commercial or industrial areas.

Local, Regional, State Plans

Sites that, according to local, regional and state plans, are planned for continued use as disposal areas are preferred over sites that are not planned for use as disposal areas. Therefore, sites that are active landfills or quarries would be preferred over inactive sites or undeveloped land.

Ability to Obtain Permits

Because active landfills are currently operating with permits to dispose of certain materials (solid waste, ash), these sites would likely be the easiest for which to obtain the necessary state and local approvals (permits). It would be more difficult to obtain permits for inactive landfills because these sites were likely closed for environmental reasons. Undeveloped sites (raw land) such as MDL-06 and PLY-11/12 would likely be the most difficult to permit because of the stringent state and local regulations and policies for landfill siting. The ability to obtain a permit for a quarry sites (e.g. SLM-06 and WEY-13) is unknown, because the use of abandoned quarries for disposal of UDM has not occurred in Massachusetts. One of the key permitting issues is groundwater contamination because the UDM would be placed below the groundwater table, thereby potentially introducing contaminants to the groundwater.

Cost

Costs for disposal of UDM at the potential upland disposal sites would vary depending on the intended use of the material. For example, the cost for disposal of UDM that would be used as grading/shaping material for landfill closure purposes would be less than if the UDM were placed as a monofill at a landfill or raw parcel of land. There would be significant engineering measures needed for a monofill, similar to those used for construction of a solid waste landfill.

The landfills in Table 4-6 were contacted to determine their status, willingness to accept UDM, and the estimated cost for disposal. The cost for disposal of UDM as grading/shaping material will vary from site to site, but in general would be about $60/cy (excluding dredging). This cost encompasses dewatering ($20), hauling ($15), and tipping fees ($25) at the landfill. The lower cost for disposal as grading/shaping material versus solid fill is due to the fact that grading/shaping material is a *commodity* that is necessary for daily landfill activity or closure whereas disposal of large quantities of UDM uses up valuable landfill space that is reserved for solid waste.

Disposal of UDM at a landfill or undeveloped parcel would be much higher because of the many engineering, monitoring and permitting requirements (see cost breakdown in Appendix C) associated with the creation of a new landfill or landfill cell. These costs range from $117 to $683 per cubic yard (Table 4-5) . The least expensive is SLM-06 ($117/cy) and the most expensive is PEA-01 ($683/cy). The construction of a new facility is generally more expensive than using an active landfill, due to the extra costs required to site, permit, build, monitor, and close the landfill (see Appendix C for itemized costs). Economies of scale also make building a facility at a small site, with minimal capacity, cost more on a unit cost level than a larger facility. This is in part because the same siting and permitting process is required for all sites. Berm height also becomes more economical with larger volumes, therefore, disposal of larger volumes results in a lower unit cost.

Historic and Archaeological Resources

There are no disposal sites that contain archaeological sites, but there is one site that is listed as historical. The active quarry itself at SLM-06 is listed as an historic site. If the site is used as a disposal site, the quarry would be at least partially filled.

PLA-02 and WSM-01 both have archaeological sites abutting their properties. WEY-13 abuts a historic site. All of these abutting historic and archaeological resources have likely already been impacted by the active or recent disposal and quarry activities at these potential disposal sites.

4.7.5 The Preferred Upland Disposal Sites

Upland disposal sites with respect to the discretionary criteria have been evaluated. As a result of the upland disposal site analysis, it has been determined that none of the 11 potential upland disposal sites would be considered preferred alternatives for disposal of UDM from Gloucester Harbor. Although some of the 11 sites have greater merit than others, none of the sites, either alone or in combination, satisfy the goals of the DMMP. There are several environmental, logistical, and cost constraints that make upland disposal an infeasible alternative. Among them are:

1. There is no dewatering site available for the temporary stockpiling and dewatering of UDM. A dewatering site is a mandatory element of the upland disposal process.

2. The cost for disposal of large quantities of UDM at landfills is relatively high - about 7-10 times the cost of traditional open water disposal and about three times the cost of CAD disposal. The $117/cy cost assumes that all 330,000 cy of UDM would be disposed of at once, or at least within a reasonable time frame, so the unit cost for disposal of smaller, isolated projects could be even higher. For example, if a marina owner were to perform 10,000 cy of maintenance dredging (which is typical of dredging projects in Gloucester) and dispose of the material at an upland site (assuming a dewatering site is available), the total cost of the project would be at least $1.1 million. This capital outlay is beyond the financial capacity of most facilities in the Harbor.

   It appears that disposal of small quantities of UDM at landfills that require grading/shaping material would be viable, but only if a dewatering site is available. The cost of this type of disposal is comparable to CAD disposal, but the lack of a suitable dewatering site makes this infeasible at this time.

3. Massachusetts DEP regulations and policies for handling of dredged material, and landfill siting, engineering, and operations are very restrictive. The likelihood for obtaining a permit to site a new landfill, or activate a closed landfill is low and even if a site were to become permitted, it would take 5-7 years to achieve all the necessary approvals. While a large-scale facility sited on that schedule could potentially accommodate the outyear dredging projects, the 5-7 year permitting schedule does not accommodate the 0-5 year dredging need.

   DEP is severely restricting the period of time that inactive unlined landfills can be in operation for providing placement of grading and shaping material used for proper capping and closure. The typical timeframe for this is 2 years, which essentially renders the use of these sites unacceptable for the Gloucester DMMP.

5.0 AFFECTED ENVIRONMENT

This section of the DEIR describes the environmental and human resource characteristics of the preferred aquatic disposal sites. Documentation of existing conditions provides a baseline against which the impacts of the four preferred aquatic disposal alternatives, described in Section 4, can be analyzed. Impacts will be discussed further in Section 6. The preferred disposal sites are:

1. G-Cell-1: A portion of the northern corner of G3-ATC and a portion of the adjacent southwest corner of G2-OD.
2. G-Cell-2: A portion of the western corner of G3-ATC and adjacent areas.
3. G-Cell-3: A portion of the southern corner of G3-ATC and adjacent areas
4. G-Cell-4: A portion of the northeastern corner of G3-ATC and a portion of the adjacent southeastern corner of G2-OD.

In this section, the environmental and human aspects of these sites are characterized and their surroundings are described.

5.1 Location and Hydrography

Gloucester Harbor is located on the north shore of the Massachusetts coast and borders the communities of Rockport to the east, and Manchester-By-The-Sea and Essex to the west (Figure 5-1). It is approximately 30 miles north of Boston and 25 miles south of Portsmouth, NH. Gloucester Harbor is a coastal embayment with a mean tidal range of 8.7 feet or 2.65 meters (NVAI, 1996). There are no significant freshwater inflows to the harbor. However, the Annisquam River, a tidal stream fed by fresh water tributaries, drains into the Western Harbor area of the Gloucester Outer Harbor. The Outer Harbor mouth lies at an imaginary line which extends from Mussel Point, east to the Dogbar Breakwater at Eastern Point (Figure 5-2). Gloucester Harbor has various smaller coves and embayments between rocky headlands around its perimeter. Beginning from the mouth of the Harbor on the western shore and proceeding in a clockwise direction, the following distinct regions of the harbor are delineated: Old House cove lies between Mussel Point and Dolliver Neck. To the north, Freshwater Cove lies between Dolliver Neck and the rocky headland of Stage Head. Continuing northeasterly, the Western Harbor embayment lies between Stage Head to the west and Fort Point to the east. At this location, the Annisquam River bisects the Western Harbor. Proceeding southeasterly from Fort Point, the mouth of Gloucester Inner Harbor lies between Fort Point and Rocky Neck. Southeast of Rocky Neck lies Wonson's Cove on the eastern side of Gloucester Harbor. Proceeding southerly to the Eastern Point Breakwater, lies first the Southeast Harbor, then the headlands of Black Bess point, and finally Lighthouse Cove. Ten Pound Island, another major geographical feature of the Harbor, lies within the Gloucester Harbor just outside the mouth of the Inner Harbor. In addition, numerous submerged or partially submerged rocks, reefs and ledges lie around the perimeter of the Outer Harbor.

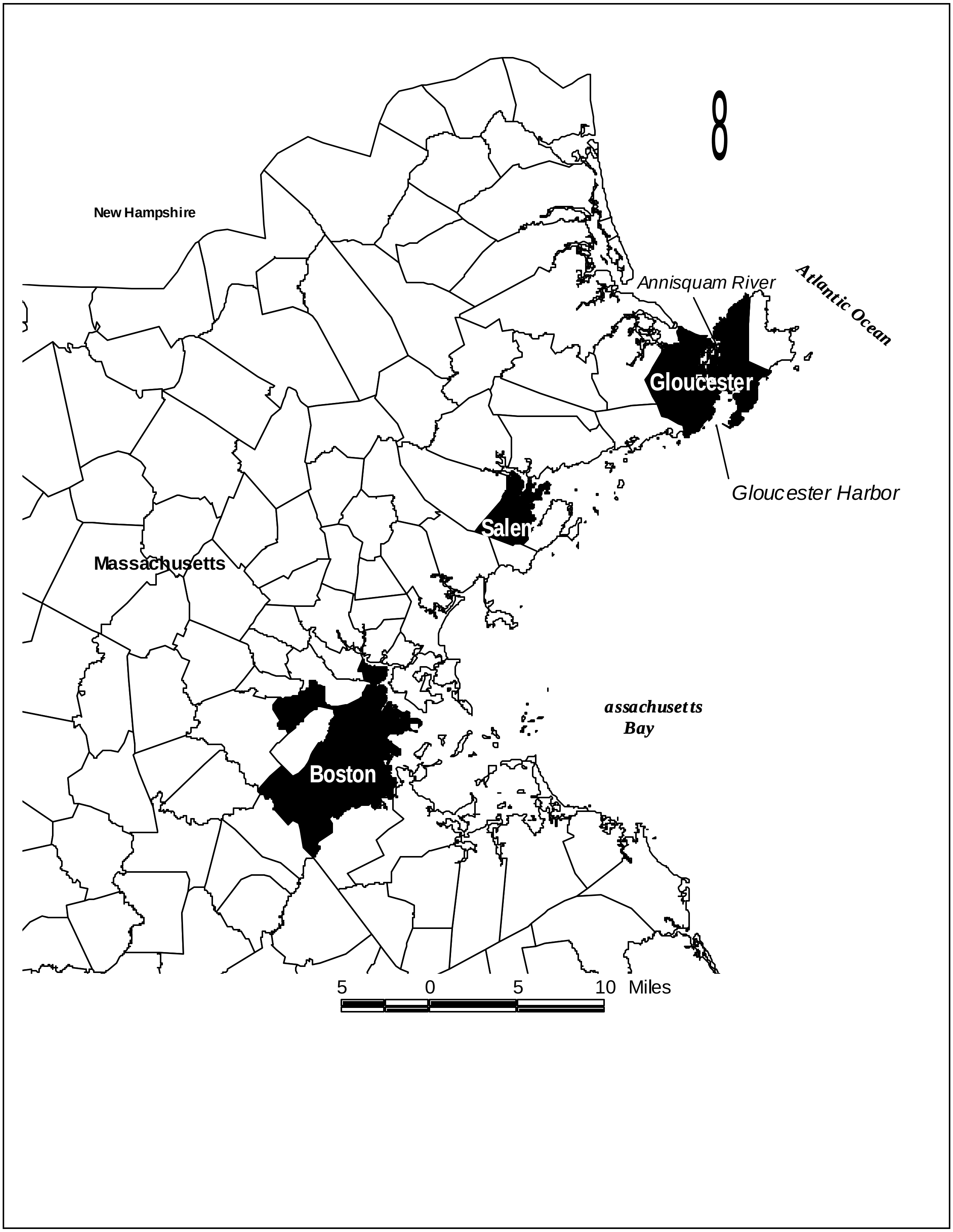


Figure 5-1: Location of Gloucester Harbor

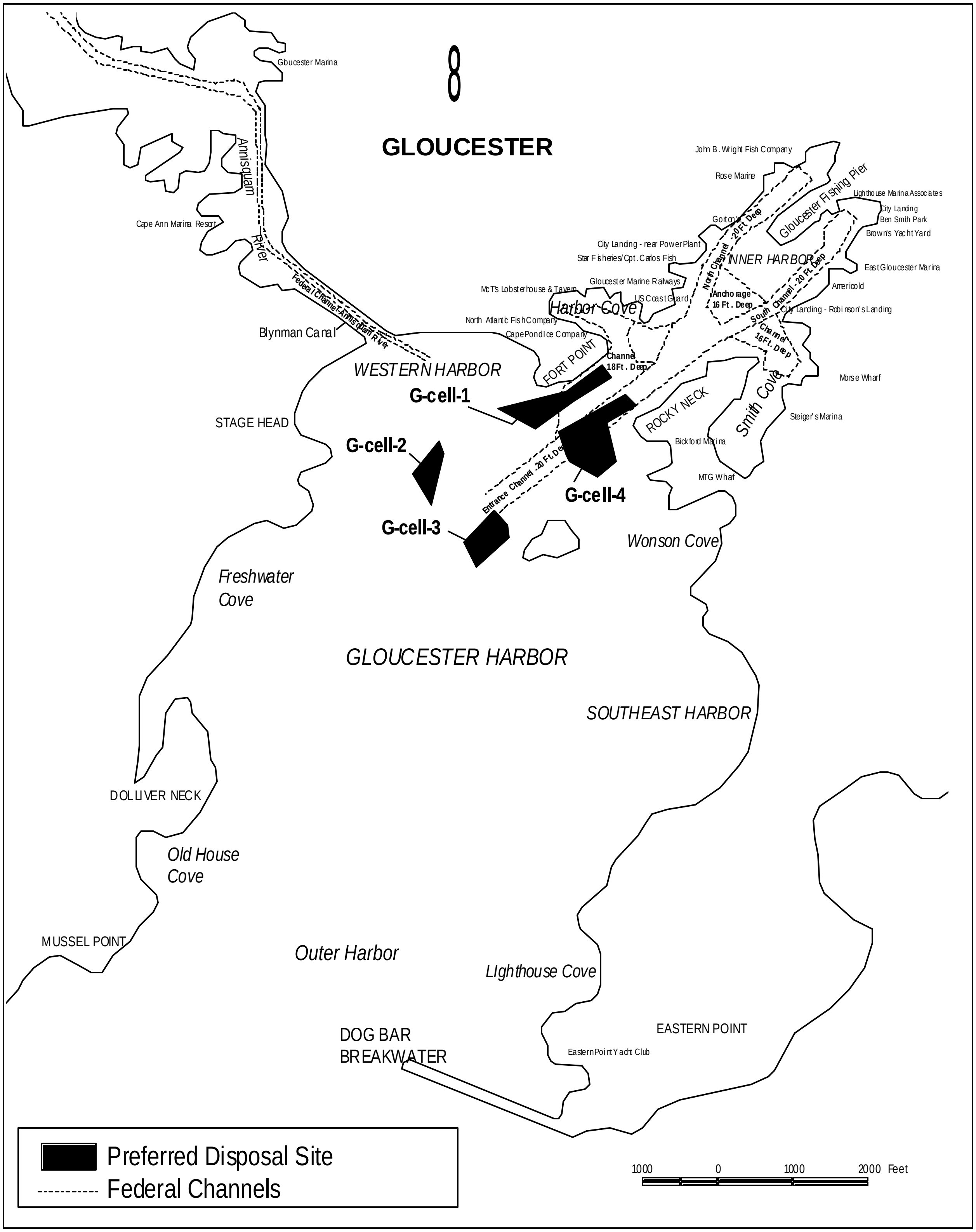


Figure 5-2. Federal Channels in Gloucester Harbor

Smaller coves also lie within the Gloucester Inner Harbor. Harbor Cove is located on the western side of the Inner Harbor. Harbor Cove accommodates numerous marinas and docking facilities for commercial fishing and recreational boats. Smith Cove is located on the south eastern side of the Inner Harbor.

The Blynman Canal provides navigational access to the Annisquam River via the Western Harbor. The channel is authorized to a depth of 8 feet (2.4 meters). Authorized depth refers to the channel depth (mean low water) that is needed to accommodate the drafts of vessels that use the channel. The USACE is responsible for maintaining channels at the authorized depth so long as economic justification can be established. Five other channels provide access to and within the Inner Harbor: the Main or Entrance Channel, the North Channel and South Channels, Harbor Cove Channel and Smith Cove Channel.

The main federal navigation channel leading into Gloucester Inner Harbor (the Entrance Channel) is authorized to a depth of 20 feet (6.1 meters). It terminates at the Inner Harbor Anchorage Area, which has an authorized depth of 16 feet (4.9 meters). Here the channel forks into the North and South Channels relative to the State Fish Pier. North of the entrance channel lies Harbor cove and its entrance channel and anchorage areas. The Harbor Cove channel has an authorized depth of 18 feet (5.5 meters); the adjacent anchorage area 15 feet (4.6 meters). Both the north and south channels of the Inner Harbor have an authorized depth of 20 feet (6.1 meters). Smith Cove channel has an authorized depth of 16 feet or 4.9 meters (ACOE, 1992). Figure 5-2 depicts the location of the navigation channels in the harbor.
The harbor contains several marinas, a significant recreational fleet, harborside historical attractions, and various commercial fishing fleets and fish processing/cold storage facilities (Figure 5-2).

5.2 Regulatory Environment

Disposal of dredged material and UDM in the aquatic environment of Gloucester Harbor falls under the jurisdiction of several federal and state environmental programs. The principal federal jurisdiction is Sections 401 and 404 of the CWA, which regulates the disposal of dredged material and UDM in open water landward of the baseline of the territorial sea. Because the candidate aquatic disposal sites are landward of the territorial sea baseline, they are not regulated by Section 103 of the Marine Protection, Research and Sanctuaries Act of 1972 (MPRSA) (a.k.a. Ocean Dumping Act).

The Section 401 Water Quality Certification program is administered by the DEP. A Water Quality Certificate must be issued for the disposal of dredged material and UDM within the limits of state waters, which extend from the shoreline seaward for three miles, or to the territorial sea baseline.

Other state regulatory programs include the Public Waterfront Act (Chapter 91 of the Massachusetts General Laws or MGL) and the Wetlands Protection Act, which govern dredged material and UDM disposal activities in the aquatic environment.

5.3 Marine Resource Characterization

Existing information pertinent to Gloucester Harbor was collected and reviewed to characterize general sedimentary environments in the vicinity of Gloucester Harbor. Recent fisheries information collected during the Salem Sound Resource Assessment, by the DMF, and surveys for this project, was used in the characterization of existing fisheries and habitat resources of the region. Natural resources mapping prepared by the DEP (eelgrass) and data provided by the Massachusetts Geographic Information System (MassGIS) office (wetland resources) were also used.

Site-specific field studies were performed at each of the candidate sites to collect Sediment Profile Images (SPI) using the REMOTS® camera system (Rhoads and Germano, 1982;1986). These sediment-profile images provide valuable site-specific information on sediment types and biological activity.

Sediments to be dredged from within the channnel were tested in 1997 to determine their suitability for unconfined aquatic disposal. The physical and chemical characteristics of the sediments at aquatic disposal sites were also determined.

A subbottom profile survey was conducted to determine the depth to bedrock in Gloucester Harbor. This information was needed to estimate the potential capacity of the proposed CAD sites in the Harbor.

5.3.1 Sediments and Water Quality

Data regarding sediments (physical characterization, transport and circulation, and sediment quality was obtained from various regional and site specific studies including the following:

- Habitat characterization of the DMMP Candidate Aquatic Disposal Sites report to MACZM (Maguire Group, 1999);
- An engineering assessment report for the Americold and Gorton's wharves (NVAI, 1996)
- The early benthic phase lobster report (Normandeau, 1999)

Water quality and water quality classification information was obtained from the following sources:

- Massachusetts Division of Marine Fisheries Designated Shellfish Growing Areas (MADMF, 1999)
- A Massachusetts Division of Marine Fisheries report on the marine resources of the Beverly-Salem Harbor (Jerome et al, 1967),
- A Massachusetts Division of Marine Fisheries report on the effects of the addition of a fourth generating unit at the Salem Harbor Electric Generating Station on the Marine Ecosystem of Salem Harbor (Anderson et al, 1975).
- An estuarine eutrophication survey conducted by the National Oceanic and Atmospheric Administration (NOAA, 1997).
- The DMMP, Phase I (Maguire Group, 1997).
- Other literature (Riley, 1967),(Hiscock, 1986),(Knebel, 1996).

5.3.1.1 Physical Characterization of Existing Sediments

Fine-grained unconsolidated sediments were found throughout the Gloucester G-cell sites and within Gloucester Harbor in general. This type of sediment suggests a low-energy, depositional environment which is typical of protected coastal embayments with limited freshwater inflow and a moderate tidal influence. Tests on composite grain samples taken from the upper two feet (0.6 meters) of sediment revealed that sediment from within and near the G-Cell sites were predominantly within the silt to clay grain size range (Maguire Group 1997).

Sediment-profile image data proximal to the G-Cell sites provided further insight into the sediment character. The majority of Gloucester Inner Harbor sites showed relatively high RPD values, indicating adequate sediment aeration, due to the effects of tidal flushing, and via bioturbation by Stage III benthic invertebrate organisms (subsurface deposit-feeders). REMOTS® images depicted fine-grained unconsolidated sediments with benthic invertebrate community successional designations of Stage I on III. RPD depths ranging from 4.39 to 7.95 cm were characteristic of the G-Cell sites. These successional designations and RPD values are indicative of low to mid energy regimes and thus net depositional environments. Lower RPD values and a Stage I designation are normally indicative of high-disturbance/degradation regimes in which the disturbance/degradation results in impact to habitat integrity. Distinguishing biological features, such as juvenile and adult lobster burrows, were also observed by divers on the seafloor surface during assessments conducted along transects oriented across the harbor (NAI 1999).

All images obtained in the vicinity of the G-Cell Sites had Organism-Sediment Index (OSI) values of +11 or greater, suggesting good or healthy overall benthic habitat quality. The OSI is a metric which defines overall benthic habitat quality by reflecting the depth of the apparent redox layer, successional stage of infauna, the presence/absence of methane gas in the sediment, and the presence/absence of reduced (i.e. anaerobic) sediment at the sediment-water interface. The high values determined for these sampling stations in or proximal to the G-Cell sites reflect the widespread presence of Stage I and bioturbating Stage III organisms coupled with relatively deep apparent RPD depths (Maguire Group 1999). A more detailed discussion of habitat conditions is presented in Section 5.2.3.2.

5.3.1.2 Sediment Transport/Circulation in the Vicinity of Disposal Sites

The circulation of water in coastal embayments such as Gloucester Harbor is influenced by a complex combination of forces produced by basin morphology, tidal fluctuations, wind, and density gradients. Although general information about present circulation conditions within these harbors has been collected (see below), no data exist describing the actual sediment transport and circulation patterns in Gloucester Harbor, particularly within the G-Cell sites and proximity. Factors affecting potential sediment transport at this site is dependent on disposal site design.

Detailed site-specific information is required to project the fate of UDM placed at this location. At present, understanding of the magnitude and seasonal/spatial components of these physical forces is insufficient to quantify the long-term stability of UDM at the preferred disposal sites. Detailed, *in situ* measurements of tides, circulation, and patterns of sediment resuspension will be evaluated at the preferred disposal site. This includes deployment of a tide gauge; current meters to provide a vertical profile of flows, bottom shear stress, and wave height; and an OBS (optical backscatter) meter to determine the relationship between wave heights, water currents, and sediment resuspension.

Nevertheless, the general sediment transport and circulation conditions within the vicinity of the G-Cell sites can be assessed using the existing available information to quantitatively determine the suitability of the proposed sites (refer to section 6.1.2). Circulation patterns within Gloucester Harbor are primarily driven by meteorological events and mixed semi-diurnal tidal currents. Mean tidal amplitude within the harbor is approximately 8.7 ft (NVAI, 1996).

Meteorological forcing and storm-driven events may have a strong influence on sediment resuspension in the region. In Massachusetts Bay, sediment resuspension is most prominent during the late fall through early spring when large waves from the northeast, north, and northwest are generated by storms. During spring and summer, winds are typically from the southwest and west, waves are smaller and weaker, and resuspension is less likely (Knebel et al. 1996). However, Gloucester Harbor is oriented to the southwest which makes it less susceptible to the more erosive storms and waves originating from the northeast throughout the winter. Data collected from NOAA's National Weather Service, Beverly Station, indicate that wind from the N and NE (300-360E) primarily occurs in winter and fall (Figure 5-3). Average winds are highest during these seasons (Figure 5-4) as is the frequency and duration of gusting winds from the NE (Figure 5-5). Relatively long expanses of open water with nearby depths off-shore are conducive for the development of large waves from winds out of the north and northeast. Due to Gloucester's orientation to the southwest, the harbor escapes much of the high energy storm driven winter waves of the region which come from the northeast.

<u>5.3.1.3</u> <u>Water Quality Classifications</u>

DEP has established Water Quality Classifications for the Commonwealth's surface waters, as listed below. The Gloucester cell sites are located within an area designated as SB (Figure 5-6). Class SB waters are designated as a habitat for fish, other aquatic life and wildlife and for primary and secondary contact recreation. The state's goals for Class SB water is to provide suitable water quality to sustain shellfish harvesting with depuration (Restricted Shellfish Areas), and to maintain consistently good aesthetic value.

The preferred aquatic disposal sites are proximal to SA waters. SA waters are designated as an excellent habitat for fish, other aquatic life and wildlife and for primary and secondary contact recreation. In approved areas they shall be suitable for shellfish harvesting without depuration (Open Shellfish Areas). The waters off Cape Ann within the Rockport town boundary and extending out to the 3 mile state boundary are designated as Class SA waters. North of Gloucester Harbor, SA waters lie within the upper reaches of the Annisquam River and Ipswich Bay.

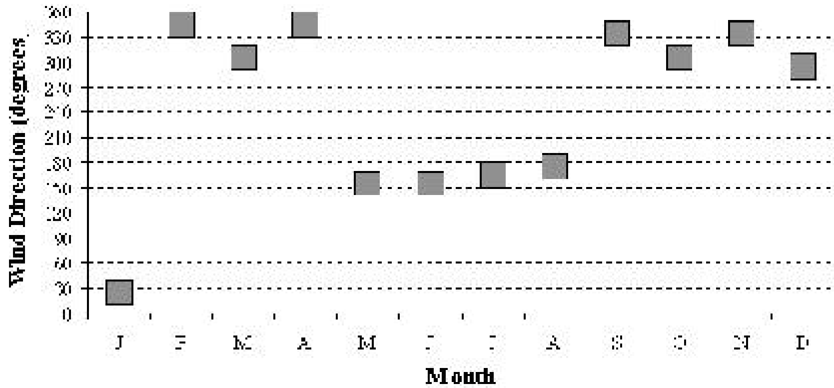


Figure 5-3: Prevailing Wind Direction by Month (1998) Recorded at Beverly Airport

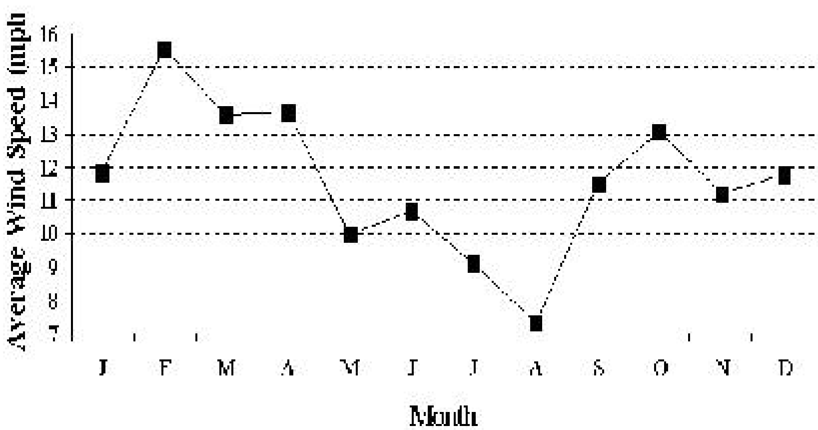


Figure 5-4: Average Wind Speed by Month (1998) Recorded at Beverly Airport

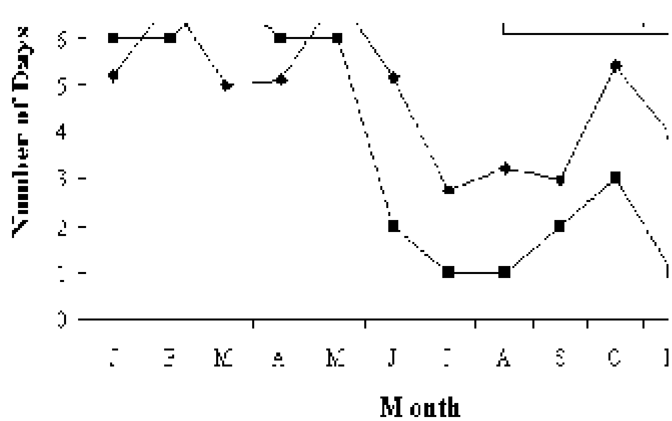


Figure 5-5: Number of Days/ Wind Speed by Month (1998) for Wind Gusts from the NE Recorded at Beverly Airport

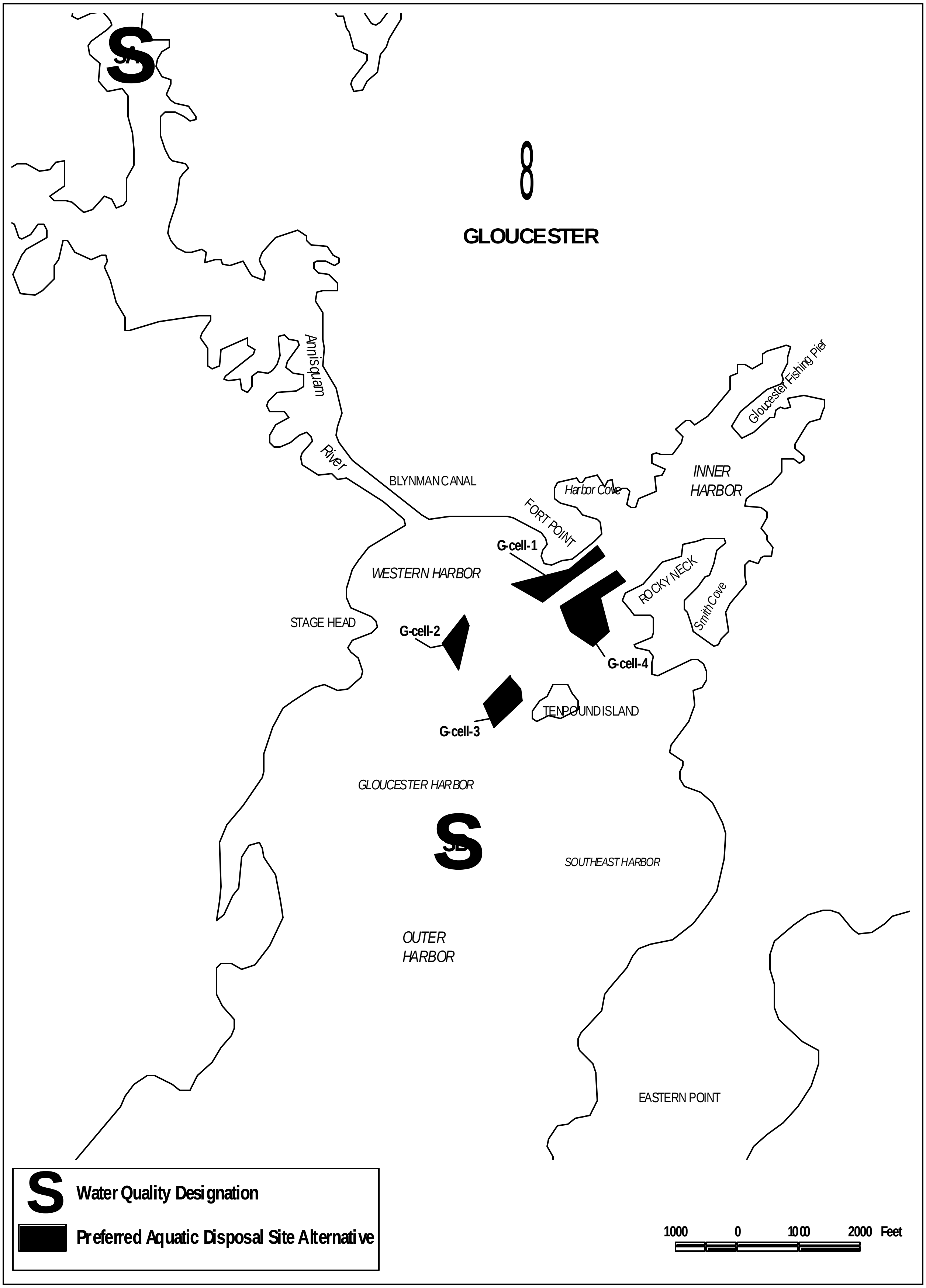


Figure 5-6. Water Quality Classifications of Gloucester Harbor and Annisquam River

In addition to the classification system for surface waters, the Commonwealth has also denoted specific subcategories of use assigned to water segments that may effect the application of criteria or specific antidegradation provisions of 314 CMR 4.05. Those restrictions pertinent to the siting of a disposal site for UDM from Gloucester Harbor include:

Shellfishing – open shellfishing areas are designated as "(O)" and restricted shellfishing areas are designated as "(R)." These waters are subject to more stringent regulation in accordance with the rules and regulations of the DMF pursuant to M.G.L. c. 130 § 75. These include applicable criteria of the National Shellfishing Sanitation Program. Shellfish Growing Area Designations by the DMF indicate that all of Gloucester Harbor, and its associated embayments and coves, and an area extending 3 miles into the ocean off Gloucester are currently classed as prohibited areas for fishing (MADMF 1999).

CSO – These waters are identified as impacted by the discharge of combined sewer overflows in the classification tables in 314 CMR 4.06(3). Overflow events may be allowed by the permitting authority without variance or partial use designation. Gloucester Harbor is designated a CSO area.

Water Quality - Historically, waters of Gloucester Harbor were utilized for the disposal of raw industrial and domestic sewage, as is typical of many tidal bays and estuaries in Massachusetts. Pollution and the subsequent reduction in water quality have been a contributing factor to the disappearance of important commercial and recreational finfish species, as well as the closure or restriction of harvesting from shellfish beds (Jerome et al. 1967). Currently, the sewage outfall lies well outside of Gloucester Harbor.

Water quality measurements have been taken in several north shore locations including Salem and Gloucester Harbors. Gloucester data from NAI (1999), USACE (1985), and Anderson et al. (1975) are summarized herein. Basic water column chemistry data (temperature, salinity, dissolved oxygen, turbidity) from the Salem Sound Resource Assessment Study (SSRAS) was reviewed as part of this study and the data collected from other north shore harbor locations corroborates the data collected by the aforementioned authors in Gloucester. The SSRAS was used to portray expected phytoplankton conditions in Gloucester. Even though the SSRAS stations were not located in Gloucester Harbor proper, the similarities in oceanography, latitude, and water depth at other stations in the north shore region are representative of Gloucester Harbor.

Generally, as one moves from oceanic water areas landward toward and into enclosed coastal waters, one can expect greater turbidity, wider temperature ranges, higher nutrient concentrations and more variable salinity (Hiscock, 1986). In Gloucester Harbor, water temperature, salinity and dissolved oxygen (DO) were collected during lobster and finfish sampling efforts (seining and trawling) from June 1998 through May 1999 (NAI, 1999) (refer to Sections 5.2.3.5 - lobsters, and 5.2.4 finfish, sections). During this study, water quality sampling conducted at each seine and trawl sample stations revealed that monthly mean water temperature followed a predictable seasonal pattern. Water temperatures were generally highest in September (seine: 17.4 ^{o} C; trawl: 15.3^{o}C) and lowest in March (seine: 3.2 ^{o} C; trawl: 2.8^{o}C). Salinity did not vary appreciably during the months sampled. In the seine, monthly mean salinity ranged from 29.1 ppt at one seine station (GS1) in May, to 32.1 ppt at other seining stations (GS2 and GS3) in January.

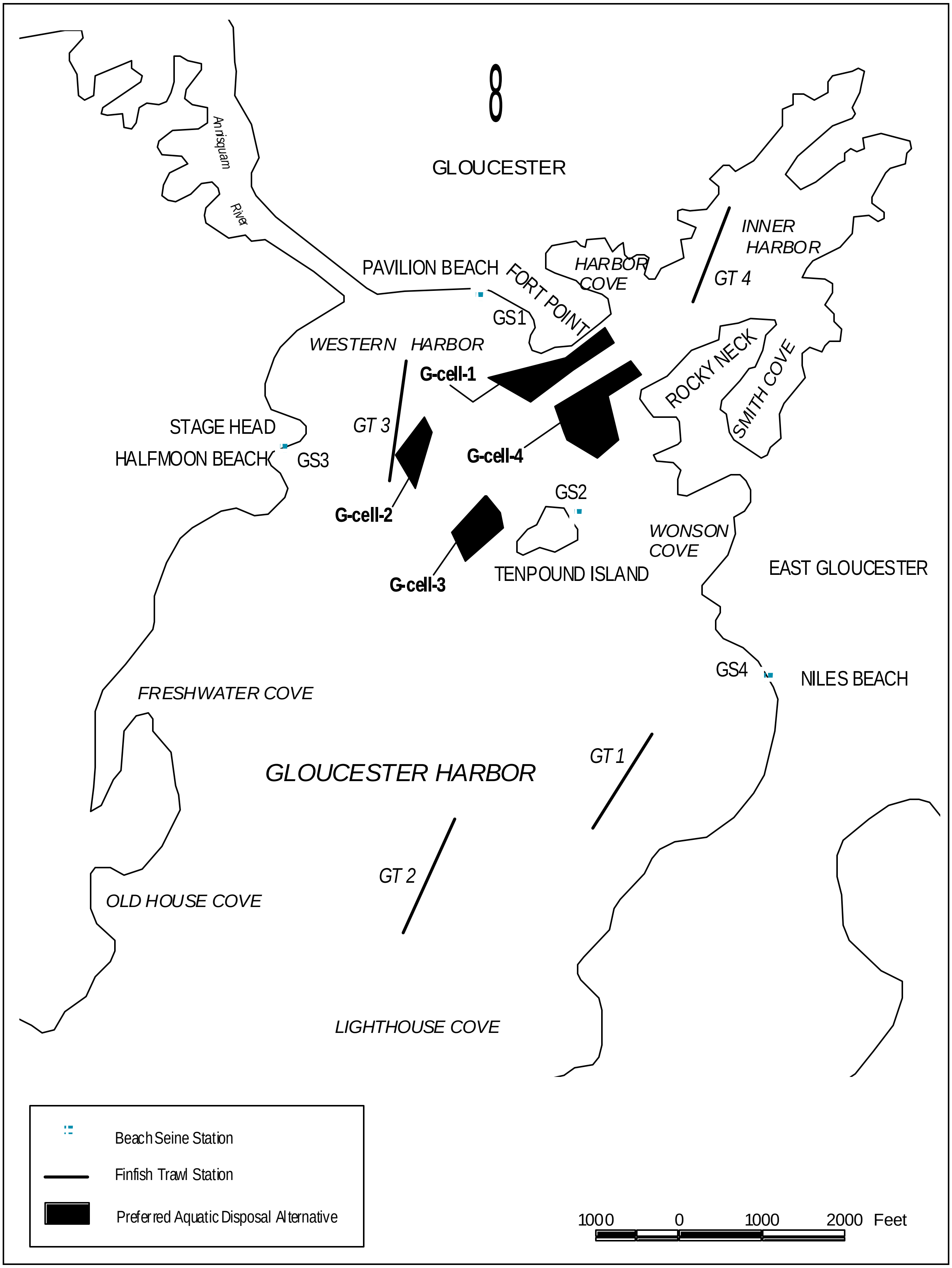


Figure 5-7. Beach Seine, Finfish Stations and Water Quality Monitoring Stations.

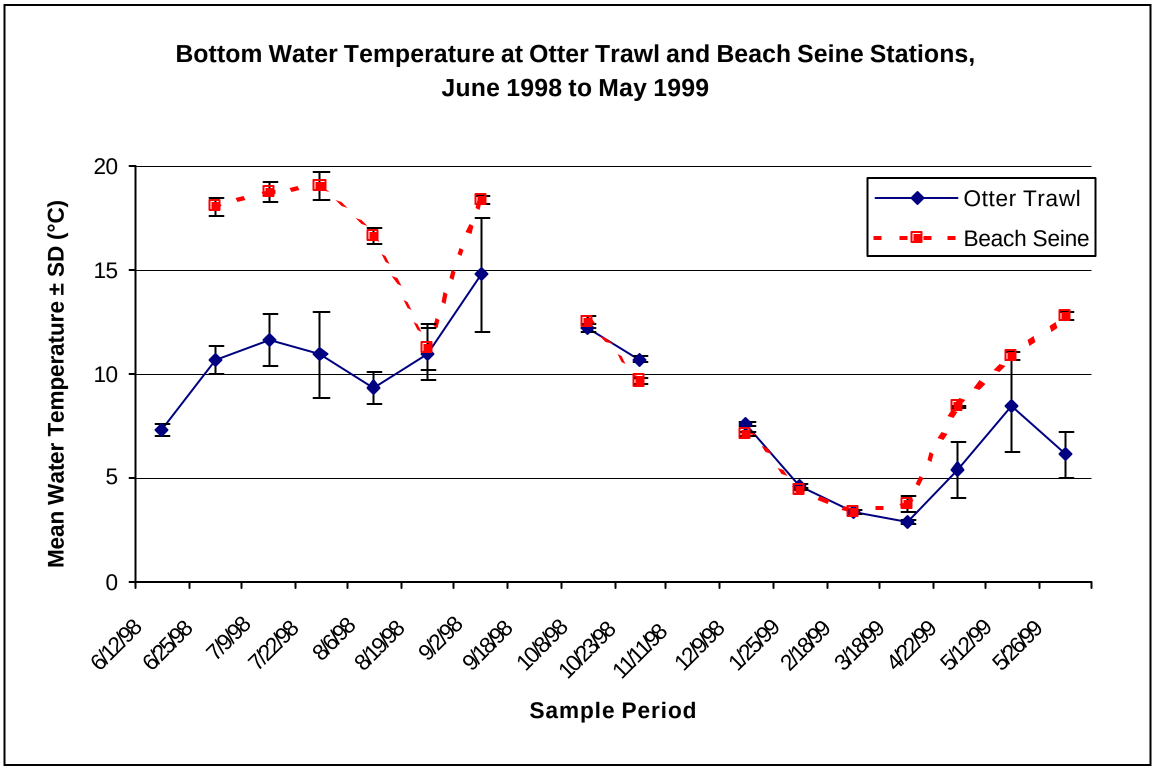


Figure 5-8: Bottom water temperature of otter trawl and beach seine stations in Gloucester Harbor, June 1998 to May 1999 (NAI 1999).

Monthly mean salinity in the trawl ranged from 30.4 ppt at one location (GT3) to 32.9 ppt at another (GT1) in May. These salinity values are very similar to average oceanic salinity and reflect the limited freshwater input and strong tidal influence in Gloucester Harbor. Monthly mean dissolved oxygen was never lower than 8.8 mg/l in the seine samples (GS3 in October) and 9.8 mg/l in the trawl samples (GT4 in May). These levels of DO were near saturation during the months collected and were not limiting to fish distribution.

The USACE measured salinity within Smith Cove at ‒25 parts per thousand (‰) at the surface and ‒28 ‰ at a depth of >1 meter below the surface (ACOE, 1985).

The SSRAS found that turbidities were highest within or proximal to the major drainages entering Salem Sound such as the Upper and Lower Danvers River during May through June. This is attributed to freshwater inflow, since suspended sediments are typically highest during spring, due to seasonal increases in precipitation and resultant runoff. Similar patterns are expected for the Annisquam River and western portion of Gloucester Harbor. Exceptionally high turbidities can also be expected form suspended sediment in areas relatively exposed to tidal or storm induced wave energy.

Anderson et al. (1975) reported that a seasonal variation in phytoplankton production, as estimated by chlorophyll *a* concentration, was evident within Salem Harbor. In Gloucester Harbor, seasonal patterns and bloom conditions similar to those reported for other estuaries within the same ecoregion (i.e.: boreal temperate climates) are expected. High temporal and spatial variability in chlorophyll concentration is characteristic of shallow near shore embayments, caused by fluctuations in riverine inflow, wind-driven turbulence, or patchy nutrient distribution. The first and largest bloom typically occurs in late winter to early spring with the warming of surface waters and the introduction of nutrients from freshwater inflow. Chlorophyll *a* concentration ranged from 0.69 to 29.08 mg/m^3 over the course of the Salem Sound study (July 1973-December 1974), and algal concentrations were estimated to be moderate (from 5 to 20 mg/m^3; NOAA 1997). NOAA's (1997) Estuarine Eutrophication Survey estimated that nuisance algal blooms typically do not have an impact on biological resources in the region.

5.3.1.4 Sediment Quality

Sources of potential contamination within Gloucester Harbor were evaluated during the Due Diligence review. As part of the Due Diligence review, a database search of existing local, state, and federal environmental files for reported releases of regulated substances (e.g. oil, hazardous chemicals) was conducted (Maguire Group, 1997). The results of this review revealed five reported hazardous or other regulated materials release incidents for Gloucester Harbor, however, details regarding the identity, quantity and exact location of release were seldom recorded in the incident reports. Available details regarding these releases (as recorded on the incident reports) are provided in Table 5-1.

Table 5-1: Reported Releases of Hazardous and Other Regulated Materials within Gloucester Harbor and Annisquam River from 1990 to 1997.

State or Federal Incident ID #	Location as Reported	Report Date	Material	Quantity	Units
N90-1341	Smith Cove	8/13/90	Diesel Fuel	101-250	Gallons
N92-1428	Annisquam River @ Squam Rock Road	10/30/92	other	1-10	Drums
N93-1235	International Seafood Pier	9/14/93	Petroleum	Unknown	Unknown
3-0011013	Gloucester Harbor	5/17/94	Oil	Unknown	Unknown
N93-1045	Harbor Cove	8/4/93	Diesel Fuel	Unknown	Gallons

The shoreline of Gloucester Harbor is a dense mix of residential, commercial and industrial land uses (Maguire Group Inc., 1997). There are nine (9) facilities permitted to discharge wastewater under the National Pollutant Discharge Elimination System (NPDES) within the Gloucester Harbor area. All but one are classified as minor discharge facilities. The remaining site, the Gloucester Water Pollution Control Facility, is classified as a major source of discharge and is located along the Annisquam River (Figure 5-9), however, discharge is well outside of the harbor. Existing and historical combined sewer outfalls have likely contributed pollutants to the Inner Harbor.

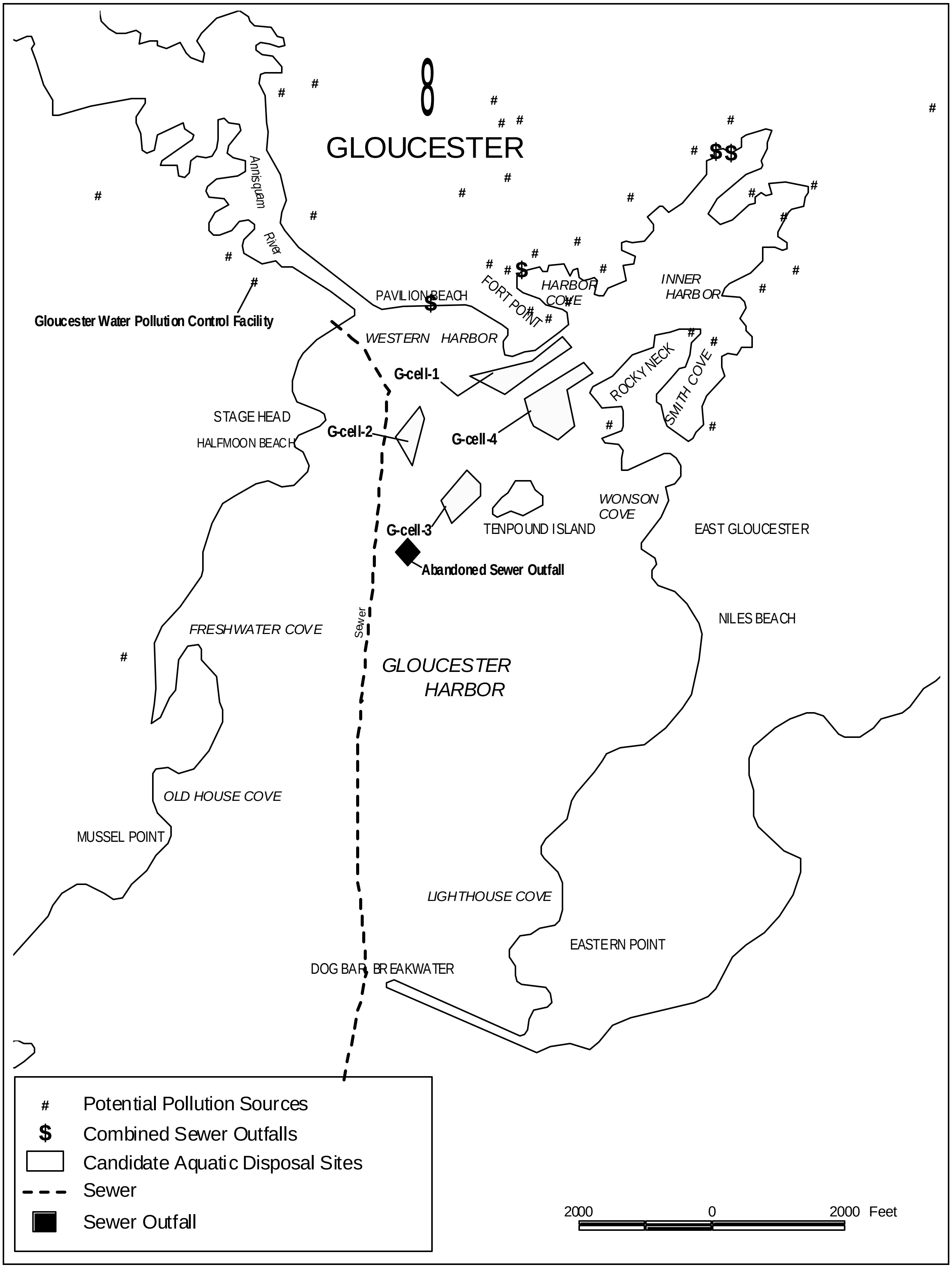


Figure 5-9. Potential Pollution Sources in Gloucester Harbor and Annisquam River

Sediment quality testing conducted in Gloucester Inner Harbor Federal Channel in 1997, confirmed the presence of total copper, total lead, and total PAHs in excess of Massachusetts Bay Disposal Site Reference Criteria. These results were anticipated due to the proximity of adjacent waterfront pollution sources, and the historic sediment contamination in this area (Maguire Group 1997). The following specific chemical concentration ranges were measured: lead 86 ppm; copper 62 ppm; and total PAH 12,372 ppb compared to reference values of 66.3, 31.7, and 2,996 respectively.

Potential sources of pollutants remain in the harbor watershed, due to the number of high risk industry within the commercially developed areas surrounding the harbor. For instance, the known 50 state hazardous waste sites within the Gloucester Harbor waterfront have been responsible for the release of PCBs, petroleum hydrocarbons, volatile organic compounds, and heavy metals to the soil, surfacewater, groundwater, and sediment media around the harbor. These sites include numerous gasoline filling stations, automotive service stations, fuel companies; autobody repair shops, and various industrial facilities.

Table 5-2: Selected Surficial Sediment Chemistry Results from Sampling within Annisquam River Channel and Gloucester Inner Harbor Federal Channel.

PARAMETER	UNITS	Annisquam River	Federal Channel	MBDS Reference
% Fines(silt/clay)	%	8%	85%	88%
Metals				
Arsenic	ppm	0.965	12	28.7
Cadmium	ppm	0.17	0.98	2.74
Chromium	ppm	0.13	35	152
Copper	ppm	9.71	**62**	31.7
Mercury	ppm	0.053	0.24	0.277
Nickel	ppm	4	16.7	40.5
Lead	ppm	19.3	**86**	66.3
Zinc	ppm	55.6	127.8	146
Other Parameters				
Total PAHS	ppb	2,670	**12,372**	2,996
Total PCB Congeners	ppb	38	113	ng

ng = no guideline

numbers in **bold** are above MBDS reference

5.3.2 Benthos

5.3.2.1 General

The term benthos refers to the community of organisms living in or on top of the sediments. For the purposes of this report, the term does not include finfish, although some finfish may live on the bottom (e.g. winter flounder). Benthic organisms include those valued for human consumption such as lobsters, clams, mussels, as well as many non-commercial species such as segmented worms, other bivalves, and various crabs.

The benthos of Gloucester Harbor is discussed in four categories. First, the overall benthic habitat is described based on a REMOTS® survey (Maguire, 1999) done in 1998, for this project. Second, the benthic invertebrate population is described, although limited information exists on the non-commercial benthos in Gloucester Harbor. Third, the commercially and recreationally harvestable mollusks are discussed based on surveys conducted primarily by DMF (e.g.: the Salem Sound Resource Assessment). Finally, the lobster habitat of Gloucester Harbor as a whole is evaluated based upon a recent early benthic phase lobster (EBP) survey (NAI, 1999), historic DMF studies, and DMMP-specific lobster sea-sampling.

Information regarding benthic invertebrates and benthic invertebrate habitat include the following sources:

- Habitat Characterization of the DMMP Candidate Aquatic Disposal Sites (Maguire Group, 1999)
- Early Benthic Phase Lobster Survey for Gloucester Harbor (NAI, 1999),
- DMF mapping of shellfish resources in Gloucester Harbor (DMF, 1999),
- A study of the marine resources of the Annisquam River-Gloucester Harbor Coastal System (Jerome, et al, 1969)
- other available literature (Robbins and Yentsch, 1973), (USACE, 1975), (Gosner, 1978), (NAI, 1987).

5.3.2.2 Benthic Habitat Conditions

In an effort to gain some general information on benthic habitat conditions at the candidate aquatic disposal sites Valente, et. al., (1999) conducted REMOTS® sediment-profile imaging surveys. The REMOTS® system uses a specialized camera to photograph a vertical cross-section of the sub-bottom to a depth of 15 to 20 cm. Data obtained from the photographs include sediment type, presence of macrofauna, presence of methane bubbles, and depth of oxidized sediments. The depth of oxidized sediments is apparent in the photographs as the boundary between colored surface sediment and underlying gray to black sediment, called the apparent redox potential discontinuity (RPD). The depth of the RPD is increased by the presence of bioturbating macrofauna. The foregoing parameters can be used to determine habitat type and infaunal successional stages, and to calculate an Organism-Sediment Index (OSI), an indicator of habitat quality of soft-bottom benthic environments. OSI values of less than 0 indicate degraded habitat quality, values of from 0 to +6 reflect intermediate quality, and values greater than +6 are indicative of good quality or healthy benthic habitats. During REMOTS® sampling, various sampling locations were chosen within the three former proposed aquatic disposal sites (i.e. G1-CDF, G2-OD, and G3-ATC). Delineation of the Preferred Aquatic Disposal G-Cell sites was conducted after REMOTS® sampling was conducted. Therefore, each Preferred Aquatic Disposal Site (e.g.: G-Cell-1, etc) may not have a site specific REMOTS® sampling station within its boundary. Station 77 of the REMOTS®

sampling is located within G-Cell-1. REMOTS® sampling Station 74 is located within G-Cell-3. No REMOTS® sampling stations lie within G-Cells 2 or 4. However station 75 is proximal to G-Cell-2, while Stations 73 and 78 lie just outside of southwestern and northeastern limits, respectively, of G-Cell-4.

The results of the REMOTS® imaging obtained at each sampling station within or proximal to the Preferred Alternative Aquatic Disposal (G-Cell) Sites are presented in Table 5-3. The images indicate that the site is characterized by unconsolidated, fine-grained sediment having a grain size major mode of >4 phi (i.e., silt-clay). This resulted in the habitat type being classified as "unconsolidated soft bottom, very soft mud" (UN.SF) in both images. The predominance of fine-grained sediment, and the location of the site in the relatively calm waters at the mouth of the Inner Harbor, support the supposition that this is a depositional sedimentary environment. The penetration depth of the camera prism was between 11.05 cm (GL77) and 18.44 cm (GL78) below the sediment surface. These are intermediate to deep penetration depths which reflect the soft nature of the substrate.

Table 5-3. The results of the REMOTS® imaging obtained at sampling stations within or proximal to the Preferred Alternative Aquatic Disposal Sites

Preferred Aquatic Disposal Site	Former Cell Designation	REMOTS® Station No.	Benthic Invertebrate Successional Stage	Median Grain Size	Mean RPD (cm)	OSI	Habitat Type
G-Cell-1	Portions of G2-OD & G3-ATC	GL77	Stage I on III	>4 f	7.95	11	UNSF
G-Cell-2	Portion of G3-ATC	Proximal to GL75	Stage I on III	>4 f	6.5	11	UNSF
G-Cell-3	Portion of G3-ATC	GL74	Stage I on III	>4 f	4.56	11	UNSF
G-Cell-4	Portions of G2-OD & G3-ATC	GL 73	Stage I on III	>4 f	7.95	13	UNSF
		GL78	Stage III	>4 f	4.39	11	UNSF

Key: RPD: Redox Potential Discontinuity (Refer to Text for Definition)

OSI: Organism-Sediment Index (Refer to Text for Definition)

UNSF: Unconsolidated Bottom Substrate: Very soft Mud

The mean depth RPD depth ranged from 4.56 cm at GL74 to 8.72 cm at GL75. These are relatively deep RPD values indicative of good sediment aeration. The change in optical reflectance (i.e., color contrast) between the light-colored, aerobic surface sediment and the underlying dark, anoxic sediment is very distinct in each image (Figures 5-11a-d). The black color of the underlying sediment suggests a high inventory of sulfides and high sediment oxygen demand, possibly related to elevated levels of organic loading within the Inner Harbor.

The well-established RPD depths are indicative of good bottom oxygen supply at the time of the survey in November 1998. It is unknown whether reduced near-bottom oxygen levels are experienced in or proximal to the Inner Harbor as a result of water column stratification during warmer months. Such seasonal near-bottom hypoxia would be expected to result in shallower RPD depths during the late summer and early fall months.

The REMOTS® infaunal successional stage was consistently determined to be Stage I on III in images obtained from each REMOTS® sampling station within or proximal to the G-Cell sites. The evidence of Stage III in the image from the sampling stations is the presence of feeding voids visible in the images (Figure 5-10a). In these images, the Stage I designation is due to the presence of small, opportunistic, tubicolous polychaetes at the sediment surface. Both Stage I and Stage III organisms can co-exist and are known to exploit the fine-grained, organic-rich, soft mud which characterizes the site. The presence of larger-bodied, Stage III infauna helps to explain the relatively well-developed RPD depths at these sites (compared to RPD values of <2 at the northern limits of the Inner Harbor). The feeding and burrowing activities of Stage III deposit feeders (bioturbation) result in increased sediment aeration and hence deeper RPD depths.

The REMOTS® Organism-Sediment Index (OSI), an overall measure of benthic habitat quality, was calculated to be +11 at all stations but GL78 which is the northernmost sampling station within the Inner Harbor Channel. The relatively high OSI values at the site reflect both the well-developed RPD depths and the apparent presence of a mixture of Stage I and Stage III taxa. Overall, the REMOTS® images suggest that stations within or proximal to the G-Cell sites represent relatively healthy soft-bottom habitat (Figure 5-10b).

Figure 5-10a: Sediment Profile Image from Station 74b (G-cell-3) showing a silt-clay sediment type. This is an example of unconsolidated soft-bottom, soft mud habitat (UN.SF). The RPD depth, marked by the change in color between light-colored surface sediments and dark anoxic sediments, is distinct and relatively deep in this image (6.11 cm). A few small polychaete tubes at the sediment surface result in a successional designation of Stage I.

Figure 5-10b: Sediment Profile Image from Station 75b (proximity of G-cell-2) showing a silt-clay sediment type. This is an example of unconsolidated soft-bottom, soft mud habitat (UN.SF). The RPD depth is distinct and deep in this image (8.72 cm). Polychaete tubes at the sediment surface and infaunal feeding voids and burrows provide evidence for a successional designation of Stage I on III.

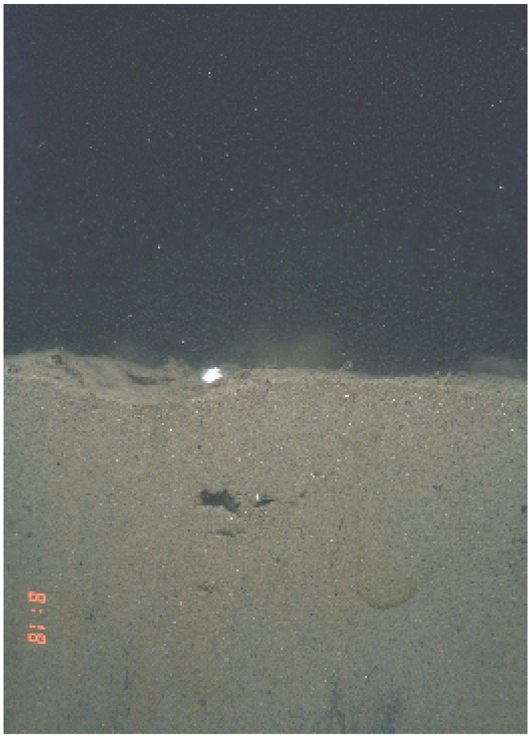


Figure 5-10c: Sediment Profile Image from Station 77b (G-cell-1) showing a silt-clay sediment type. This is an example of unconsolidated soft-bottom, silty habitat (UN.SI). The RPD depth is deep in this image (8.16 cm). A biogenic surface is evident and includes a shell fragment. Polychaete tubes at the sediment surface and an infaunal feeding void and burrow provide evidence for a successional designation of Stage I on III.

Figure 5-10d: Sediment Profile Image from Station 78b (G-cell-4) showing a silt-clay sediment type. This is an example of unconsolidated soft-bottom, soft mud habitat (UN.SF). The RPD depth in this image is (4.39 cm). Evidence of bioturbation is apparent as darker deeper sediment appears to have been deposited at the sediment surface. Feeding voids at depth are indicative of Stage III succession.

5.3.2.3 Benthic Invertebrates

The benthic invertebrate fauna of the Massachusetts coast north of Cape Cod are characteristic of the boreal biogeographical region (Acadian Province), which has colder temperatures and less summer warming, and therefore a smaller annual temperature range, than waters south of Cape Cod. Waters from Cape Cod south to Cape Hatteras, North Carolina lie within the Virginia Province of the American Atlantic Temperature Region. Many boreal species reach the southern limit of their range at Cape Cod, and it is there that many temperate species reach their northern range limit (Gosner, 1978).

Comprehensive benthic invertebrate sampling was not done, *per se*, at any of the candidate disposal sites. However, previous studies in the region (Jerome *et al*. 1967, ACOE 1975, NAI 1987) contain some information on the abundance and type of benthos in Salem Harbor. Other studies provide information on distinct areas of Gloucester Harbor (NVAI 1996, USACE 1986). Still other ancillary information was generated during other studies conducted for this project. For instance, REMOTS® sampling, conducted within Gloucester and Salem Harbors as part of this project, revealed general habitat conditions within or proximal to various disposal sites within the ZSF, including the vicinity of the preferred G-Cell sites. The REMOTS® sampling survey did not identify or quantify the species of benthic fauna in Gloucester, rather, it provided evidence on the ecological roles of the present species, so that conclusions on community structure could be made (Refer to Section 5.3.2.2 - Benthic Habitat Conditions). Site specific benthic invertebrate sampling will be conducted within the preferred G-Cell sites and this information will be included in the FEIR.

Based on information obtained from Mass GIS databases and information collected from ancillary studies for this project (e.g: habitat characterization via REMOTS® sediment profile imaging, early benthic phase lobster survey, etc.), various economically important benthic invertebrate species are expected to occur extensively within Gloucester Harbor and, therefore, warrant attention for potential environmental impacts associated with UDM disposal in Gloucester Harbor (Table 5-4).

Table 5-4. Important Invertebrate Species of Economic Importance Warranting Attention in Gloucester Harbor from UDM Disposal Impacts

COMMON NAME	***SCIENTIFIC NAME***
American lobster	*Homarus americanus*
Rock crab	*Cancer irroratus*
Blue mussel	*Mytilus edulis*
Soft-shelled Clam	*Mya arenaria*

The results of previous benthic invertebrate studies conducted in nearby Salem Harbor indicate that duck clams (*Macoma balthica*), blue mussels (*Mytilus edulis*), clam worms (*Nereis virens*), various amphipods, and the bivalve, *Nucula delphinodonta*, are dominant benthic invertebrates within Salem Harbor. The periwinkle, *Littorina littorea,* was found to be a dominant intertidal gastropod. A similar community is expected within Gloucester Harbor since the two harbors lie within the same faunal region (boreal zone) and since they share similar geomorphology in many areas (e.g.: fine-grained sediments overlying bedrock substrate, areas of cobble beach and rocky headlands, etc.). However, the Gloucester Inner Harbor is expected to be relatively less diverse (i.e. lower species richness and lower evenness) compared to the Outer Harbor due to the presence of hypoxic conditions which result in azoic areas within some portions of the Inner Harbor.

5.3.2.4 Commercially and Recreationally Harvestable Mollusks

DMF Mapping of Gloucester Harbor Shellfish

According to results presented in the 1994 Annual Report of the Gloucester 301(h) Monitoring Program, the benthic invertebrate community off the mouth of Gloucester Harbor was significantly more diverse than areas sampled within the harbor which was done in earlier studies. Likewise, the report of the Ocean Quahog Research and Demonstration Project (DMF,1977), concluded that the Gloucester Harbor area and vicinity would not support a commercial quahog fishery. All of Gloucester Harbor waters north of the breakwater are closed to shellfishing (DMF, 1999). However existing shellfish beds may still provide seed for cleaner areas, or could become fishable areas if pollutant concentrations were to be reduced in the future.

Various shellfish habitat and nursery areas of Gloucester Harbor and vicinity have been delineated on a map by DMF fisheries biologists and the Gloucester Shellfish Constable (Figure 5-11). It is important to note that these are merely general estimates of areas that have been anectdotally reported as supported shellfish. Shellfish sampling, identification and mapping was not performed as part of the DMMP. The areas depicted in Figure 5-11 support blue mussels (*Mytilus edulis*), and soft shell clams. Blue mussels are found on the benthic substrate just offshore of Pavillion Beach within the Western Harbor, and on rocky shores at several locations around the Main Harbor area, including the rocky coast areas of Mussel Point, Dolliver Neck, Stage Head,

Rocky Neck, and around Lighthouse Cove. Ocean quahogs lie in an extensive area outside the Main Harbor, approximately 3,070 feet (935.7 meters) southeast of Eastern Point. The shallow intertidal flats of Freshwater Cove (landward of Dolliver Neck), Wonson Cove, and Lighthouse Cove contain extensive soft shell clam beds and habitat. The two shellfish species identified from literature review as potentially supporting a future fishery within Gloucester Harbor include blue mussel and softshell clam.

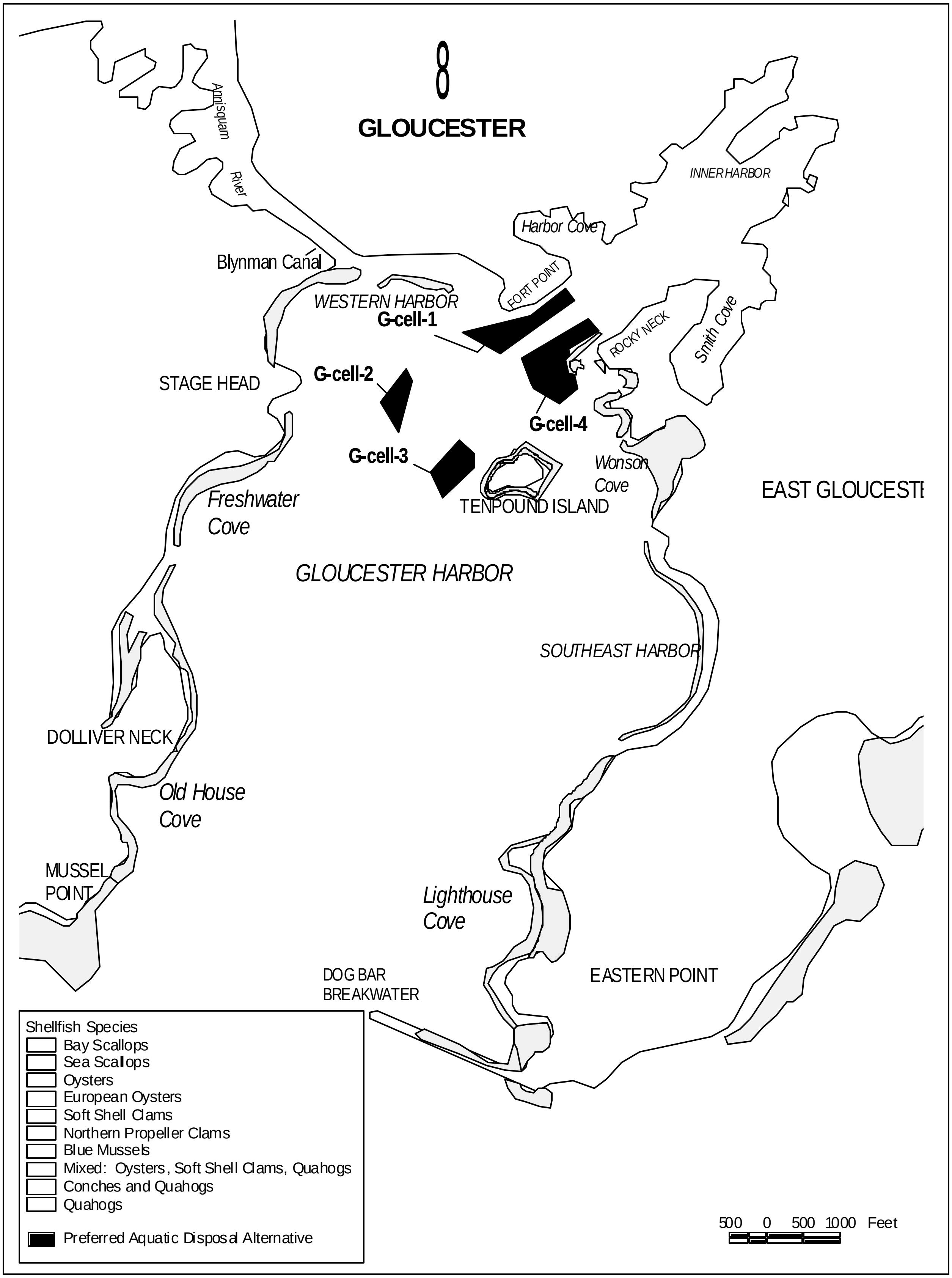


Figure 5-11: Shellfish Resources in the Vicinity of the Preferred Disposal Sites

Other Surveys

Cancer crabs were frequently encountered while transect sampling for early benthic phase lobsters within the main harbor and at the mouth of the Inner Harbor. The two most common species of *Cancer* crabs frequently encountered in the nearshore waters of Cape Ann include the Common Rock Crab, *Cancer irroratus* and the Jonah Crab, *Cancer borealis* (Robbins and Yentsch, 1973).

The results of the REMOTS® sampling did not identify benthic invertebrates to species level but did identify the successional stage of the benthic community. Within the area of the G-Cell sites, REMOTS® sampling stations consistently revealed Stage I marine polychaete concentrations atop sediment bearing characteristic markings of Stage III benthic infaunal invertebrates (refer to Section 5.3.2.2). Certain marine bivalves are part of the Stage III successional community.

5.2.3.5 Lobsters

Both the whole Cape Ann area (including Gloucester Harbor) and the Beverly-Salem area were cited by Jerome *et al*. (1967, 1969) as areas which were very productive and extensively fished for lobsters and very productive. However, specific locations within these areas were cited as being especially productive for lobsters. The DMF has conducted a commercial lobster trap sampling program since 1981, breaking down statistics by six areas in Massachusetts, including Cape Ann (which includes Gloucester) and Beverly-Salem (Estrella and Glenn 1998). The catch per unit effort (per trap per 3-day set) for marketable lobster was 1.11 at Cape Ann and 0.419 in Beverly-Salem in 1997, compared to 0.776 for the state as a whole. Marketable lobsters include all those of 82.6 mm carapace length (CL) or greater and without eggs. The statistics indicate that there is heavy fishing pressure for lobsters in the Beverly-Salem area, probably more than elsewhere in the state. One index of fishing pressure is the percent of the legal catch composed of new recruits, i.e. lobster which reached legal size during their most recent molt. Beverly-Salem leads the six state areas in this statistic, with 96 percent, compared to 88 percent for Cape Ann and 86 percent for the state as a whole, indicating that very few lobsters escape being trapped as soon as they reach legal size. Other indicators of fishing pressure in which Beverly-Salem leads the state are instantaneous fishing mortality, which is the proportion of all deaths that are attributable to fishing, and the exploitation rate, the fraction of the population removed by fishing. Cape Ann is close to or just above the state average in these statistics.

The lobster resources within Gloucester Harbor were sampled by monitoring the catch of a commercial fisherman over the course of one fishing season (NAI, 1999). Lobster trawls consisting of 5 to 20 baited traps were set in Gloucester Harbor (Figure 5-12). Approximately 150 traps were set in each sampling event. One trawl was set in the inner Gloucester Harbor and the remaining trawls were set in the outer harbor during each sampling event. Lobster were measured by carapace length (CL) to the nearest millimeter (mm). Observations of sex, reproductive condition, molt condition, presence or absence of claws, sub-legal (less than or equal to 82 mm)or legal (83 mm or greater) sizing and any pathology present. Trap set period was for three days.

The Inner Harbor CTH_3 was relatively consistent from June through September, and then decreased in October through November and was again low in May. Both legal and sublegal-size lobsters followed the same general month pattern as total CTH_3 (Figure 5-13).

Lobsters caught in the trawl samples, at all sampling stations (GT1 through GT4), were highest in September (Figure 5-14). The numbers then decreased rapidly in October and November. No lobsters were caught in December through March, and CPUE began to increase in April and May. Each of the four trawl stations showed similar patterns of monthly abundance, with catch per haul relatively high in June through November, low catches from December through March, and slight increases in April and May.

In general, Inner Gloucester Harbor area is twice as productive as the Outer Harbor area, primarily due to the high catches of legal-size lobsters in the Inner Harbor. Annual CTH_3 of sublegal lobsters was identical in the Inner and Outer Harbors. The presence of high numbers of legal-size lobster may be due, in part, to the fact that lobstering is not allowed there. The area from approximately Fort Point/Rock Neck inward is closed to lobstering (Figure 5-12).

Early Benthic Phase (EBP) Lobsters

Data and information on EBP lobsters, defined as those with a carapace length (CL) of from 5 to 40 mm, were collected in November 1999 by SCUBA divers swimming along transects within potential disposal site areas. The main objective of the survey was to investigate soft sediments (silt, mud, etc.) for the presence of EBP lobsters, which are highly shelter dependent and may indicate areas of settlement habitat. Additional information was noted, such as number and diameter of burrows, substrate type, and species present (NAI, 1999).

Figure 5-12 shows the survey transects for the EBP survey. Transects 15, 18, 19 were within the footprint of G-Cell sites 1 and 4. Transects 22-27 and Transect 23-28 were within the footprint of G-Cell sites 2 and 3 as a result of transect sampling. No EBP lobsters or EBP lobster habitat were found within the sample area. However during sampling efforts for EBP, evidence was noted which suggests the Inner Harbor and Outer Harbor are suitable for juvenile and adult lobsters. For example at Transect 15, 79 out of 219 burrows (36%) found along a 400m transect were occupied by juvenile or adult lobsters. Urchins and *Cancer* crabs were also noted along this transect. Abandoned (ghost) lobster traps, a gill net, and other debris were also noted along T-15. At T-18, 41 out of 54 (76%) burrows encountered along a 350m transect length were found to be occupied by juvenile or adult lobsters. Hermit crabs and *Cancer* crabs were also noted along the transect, as were ghost traps. At T-19, 54 out of 88 (61%) of the burrows encountered along a 350m transect were found to be occupied by juvenile or adult lobsters. Green and *Cancer* crabs were also noted as were a seastar and a cunner. At T-22-27, 41 out of 101 (40%) of the burrows encountered along a 550m transect were found to be occupied by juvenile or adult lobsters. Green and *Cancer* crabs were also noted. At T-23-28, 45 out of 137 (33%) of the burrows encountered along a 500m transect were found to be occupied by juvenile or adult lobsters. Green and *Cancer* crabs were also noted. This was the only transect in which mussels (probably the inedible horse mussel, *Modiolus modiolus*) and kelp (*Laminaria* sp.) were noted.

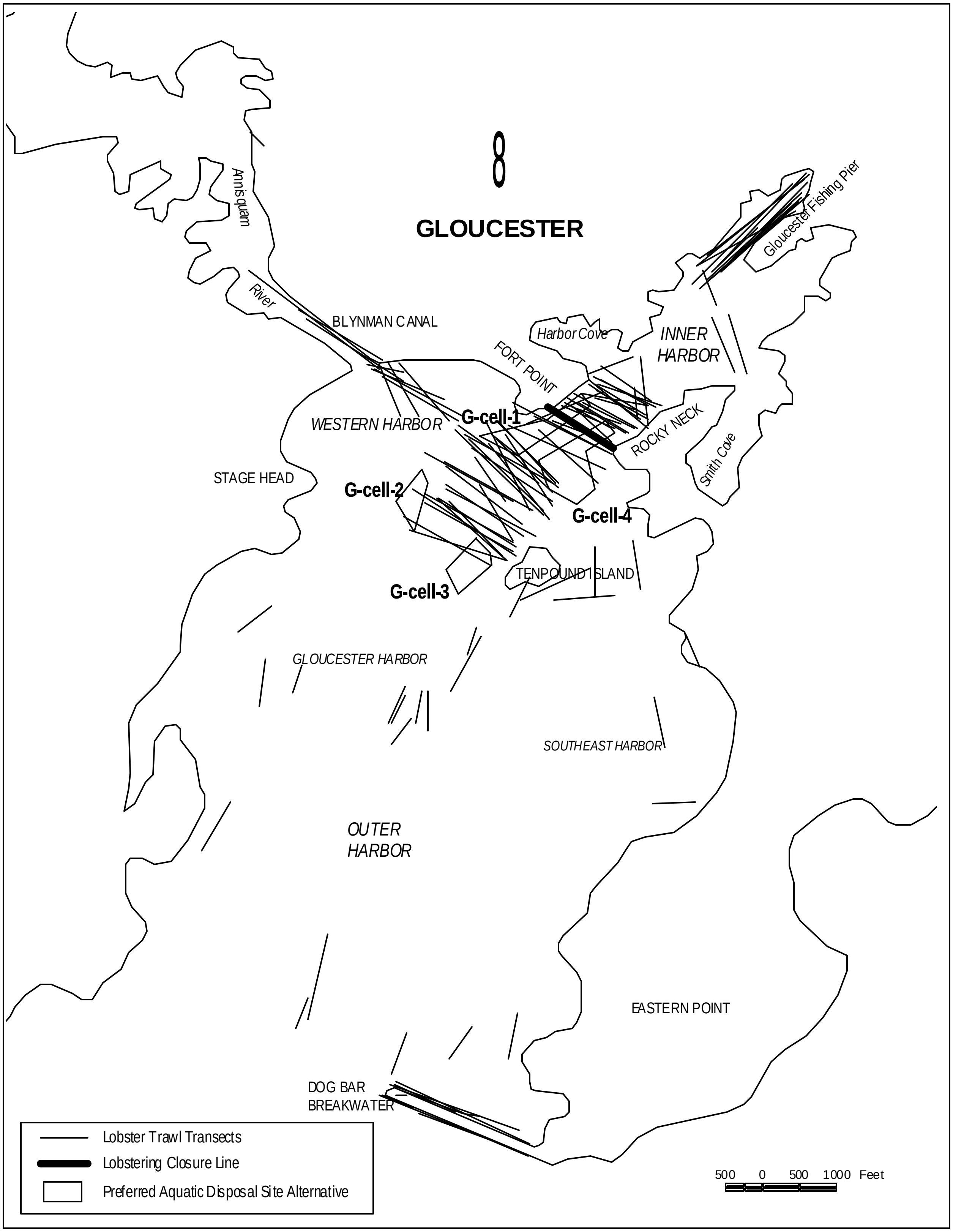


Figure 5-12: Lobster Trawl Transects in Gloucester Harbor, 1998-1999. (NAI, 1999)

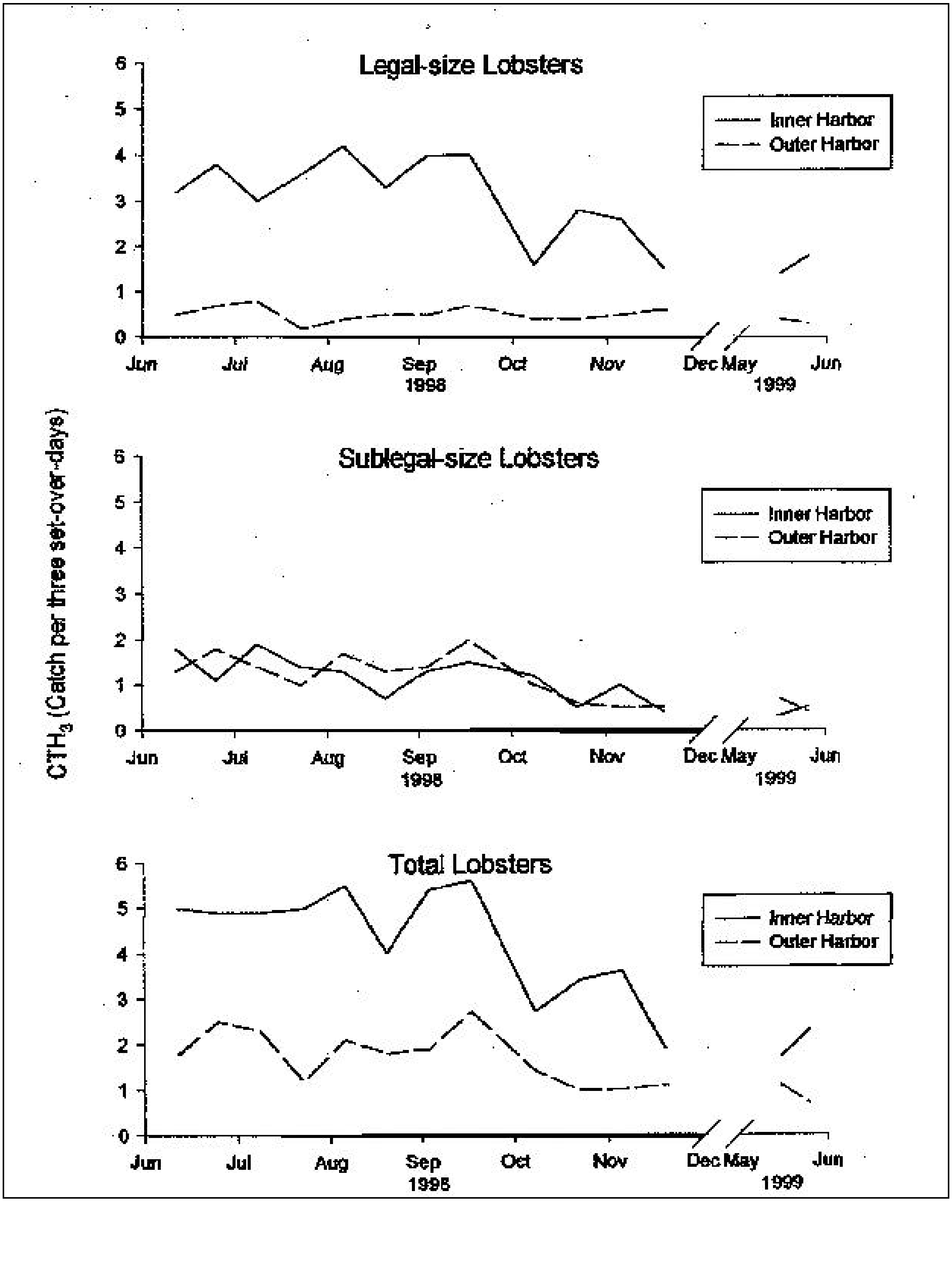


Figure 5-13: Catch per Three Set-Over-Days (CTH_3) for Lobsters in Inner and Outer Gloucester Harbor from Lobster Sea Sampling, June Through November 1998 and May 1999.
(Normandeau, 1999)

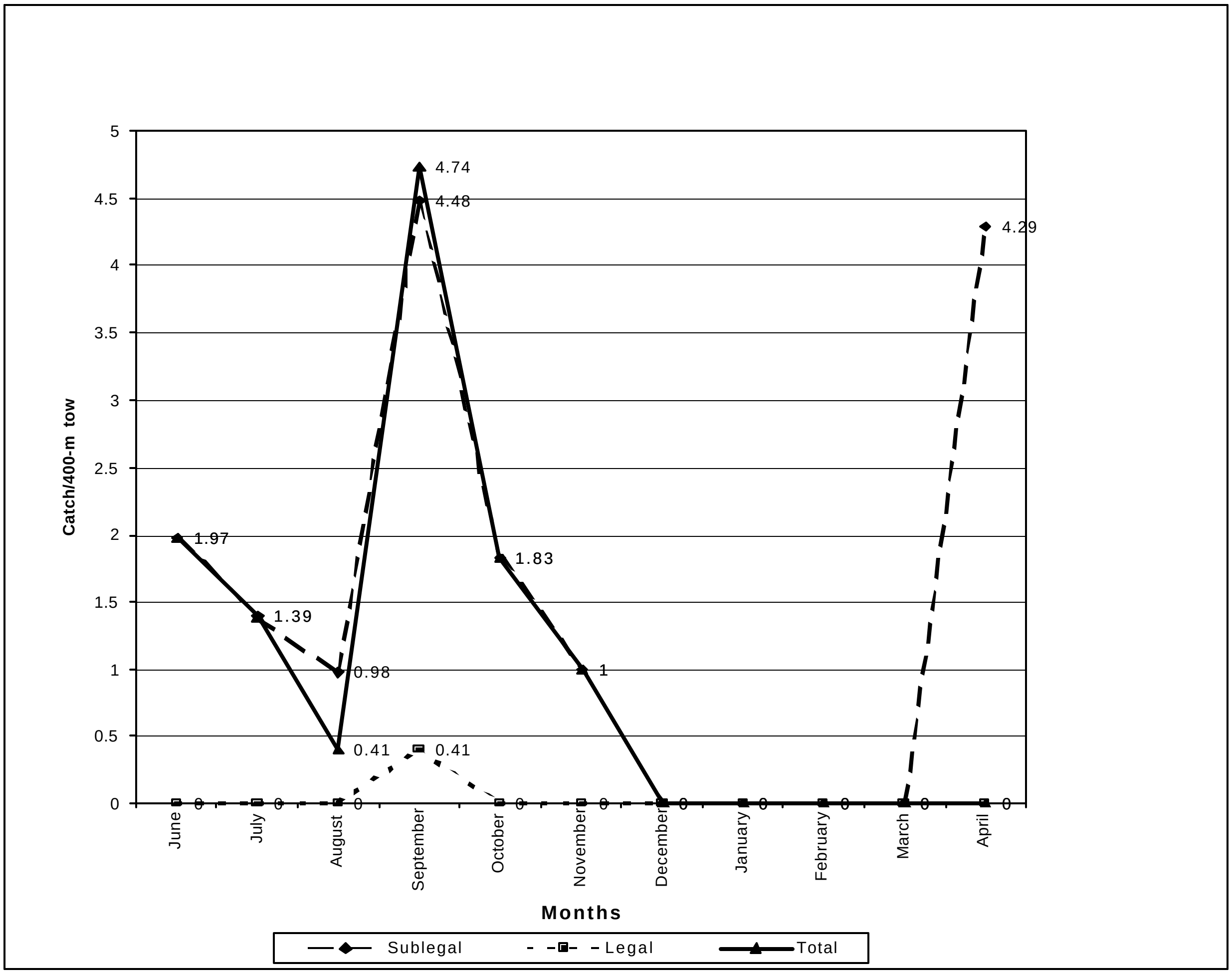


Figure 5-14: Catch Per Unit Effort of American Lobster in Gloucester from Otter Trawl Sampling, June 1998 Through May 1999 (Normandeau, 1999)

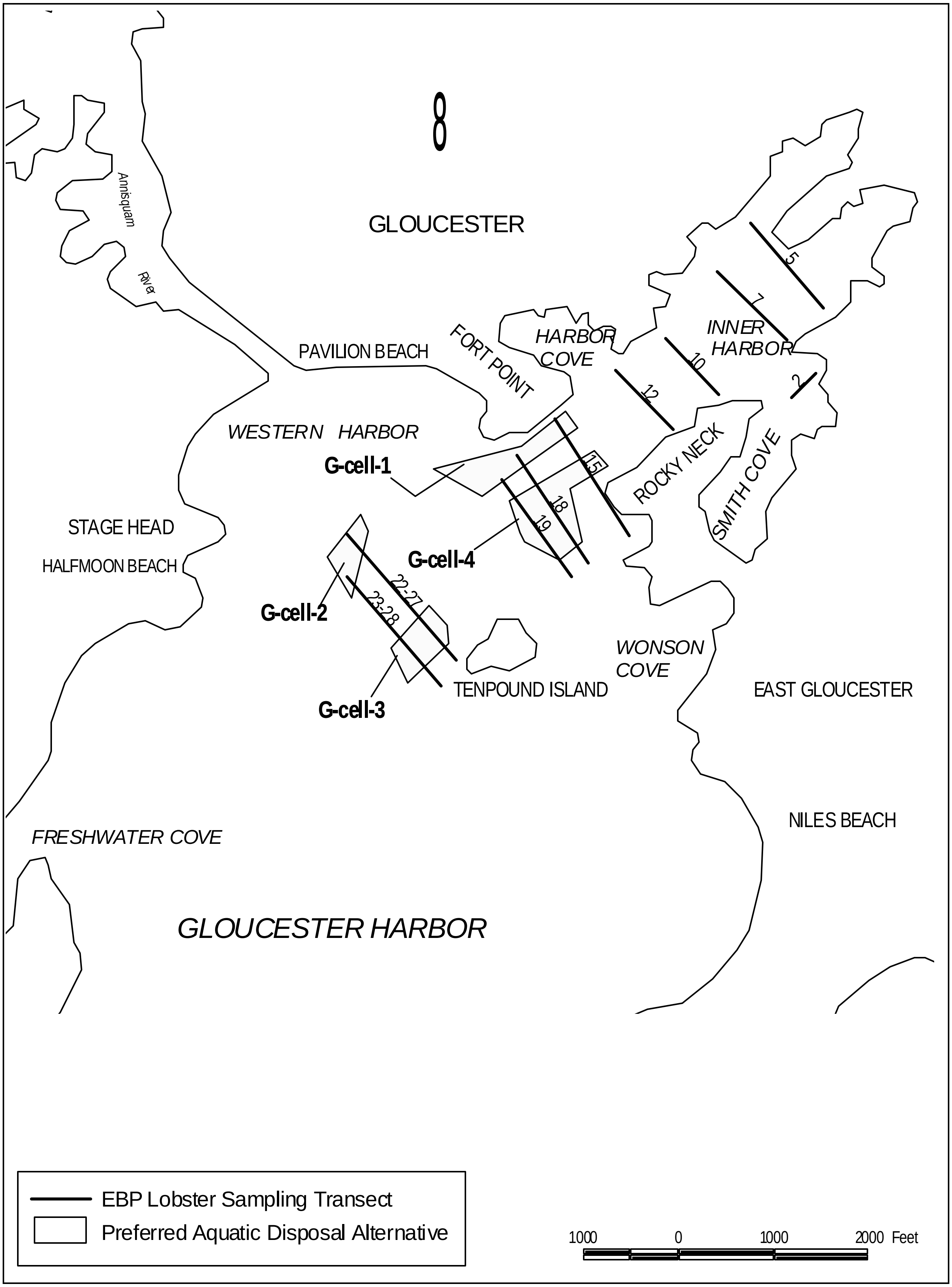


Figure 5-15: EBP Transects and Gloucester Sites (Normandeau, 1999)

Results of the transect sampling for early benthic phase lobster revealed that surficial sediments along transects across the channel and vicinity were primarily composed of soft silt / mud. Since no EBP were found within the inner harbor and northeastern portions of the Gloucester Main Harbor, these areas may not provide suitable habitat for early benthic phase lobsters. However, these areas of Gloucester Harbor appear to provide sufficient habitat to support juvenile and adult lobsters as well as other forms of benthic invertebrates. Transect T-15 had the highest relative index of lobster abundance (i.e. the greatest number of lobsters / linear meter).

5.3.3 Finfish

Because of the mobility of fish, the characterization of fish species within a specific area, such as the G-Cell sites is difficult. However, several studies give insight into the types, patterns, and behavior of the dominant fish species in the North Shore region and Gloucester Harbor, in particular. This information, coupled with what is known about environmental conditions at the G-Cell sites (e.g. substrate type, water quality, water depth), allows for a reasonable characterization of finfish at and near the preferred aquatic disposal sites.

This Section discusses the following aspects of finfish activity in the North Shore Region and Gloucester Harbor:

C Essential Fish Habitat (EFH) Listings for Gloucester Harbor;
C Summary of Gloucester Harbor boat trawl and beach seine survey data (June 1998 - May 1999)
• Summary of Salem Sound Resource Assessment trawl survey by depth strata ;
C Evaluation of nursery potential by site;
C Fish spawning potential;
• Diadromous fish activity; and,
C Commercial and recreational fishing.

Table 5-5 lists the common and scientific names of the fish species discussed in the ensuing sections.

5.3.3.1 Regional Finfish Data (Salem Sound to Cape Ann)

As with the invertebrate fauna, the marine fish of Gloucester are part of the boreal biogeographical region, characterized by colder temperatures and less summer warming, and therefore a smaller annual temperature range, than waters south of Cape Cod (the temperate region). Many northern species of fish reach the southern limit of their range at Cape Cod, and many southern species reach their northern range limit there as well.

The most extensive historic data on fishery resources in the north shore region are from the study conducted by DMF in 1965, which reported on a combination of otter trawls and beach seines in the waters of Beverly, Salem, Danvers, Manchester, and Marblehead. Thirty-one species of finfish were found in the Beverly-Salem area. Several of the sampling stations in the 1965 survey were replicated as part of the SSRAS (Figure 5-16).

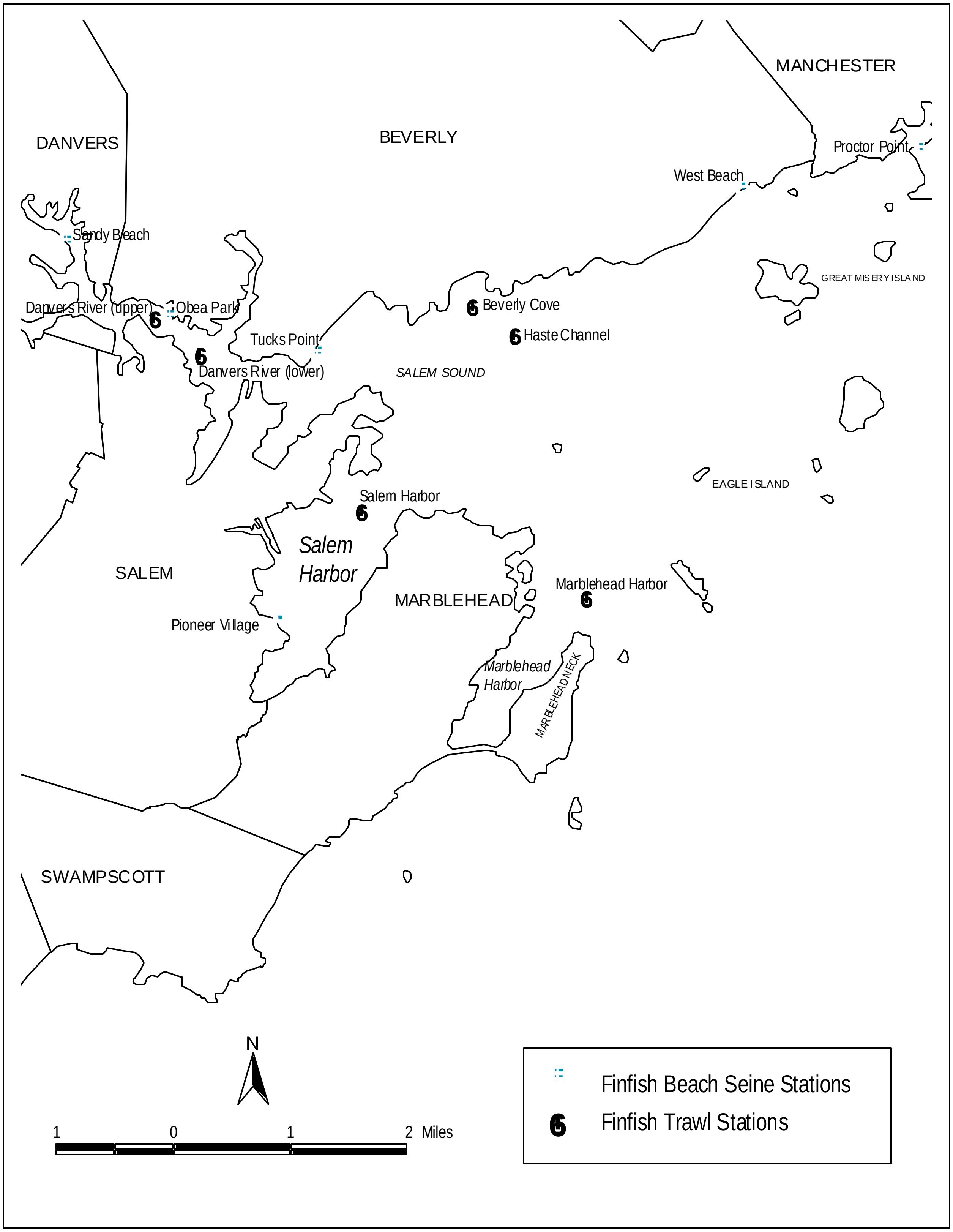


Figure 5-16: Beach Seine and Trawl Surveys in Beverly-Salem Area during January to December, 1997 (Chase, in prep.)

Table 5-5. Common and Scientific Names of Fish Species Discussed in this DEIR

Common Name	Scientific Name
Atlantic silverside	*Menidia menidia*
Atlantic menhaden	*Brevoortia tyrannus*
Atlantic herring	*Clupea harengus*
Winter flounder	*Pseudopleuronectes americanus*
Mummichog	*Fundulus heteroclitus*
Winter flounder	*Pseudopleuronectes americanus*
Skate spp.	*Raja* spp.
Atlantic cod	*Gadus morhua*
Cunner	*Tautogolabrus adspersus*
Windowpane	*Scophthalmus aquosus*
Blueback herring	*Alosa aestivalis*
Lumpfish	*Cyclopterus lumpus*
Pollock	*Pollachius virens*
Rock gunnel	*Pholis gunnellus*
Atlantic mackerel	*Scomber scombrus*
Striped bass	*Morone saxatilis*
Tautog	*Tautoga onitis*
Haddock	*Melanogrammus aeglefinus*
Yellow-tailed flounder	*Limanda ferruginea*
American plaice	*Hippoglossoides platessoides*
Silver hake	*Merluccius bilinearis*
Monk fish	*Lophius americanus*
White hake	*Urophycis regia*
American sand lance	*Ammodytes americanus*
Longhorn sculpin	*Myoxocephalus octodecemspinosus*
Ocean pout	*Marcozoarves americanus*
Northern pipefish	*Syngnathus fuscus*
Northern puffer	*Sphoeroides maculatus*
Grubby	*Myoxocephalus aenaeus*
Bluefish	*Pomatomus saltatrix*

The fish species sampled in 1997, are typical of nearshore environments north of Cape Cod. The most common species sampled by Jerome et al. in 1965 were also common in 1997. For example, the first, second and third ranking species in 1965, (mummichog - *Fundulus heteroclitus*, silverside - *Menidia sp.*, and Atlantic herring - *Clupea harengus*), ranked fifth, first, and third in 1997. A notable difference in the species found between the two years is that menhaden (*Brevoortia tyrannus*), the second most abundant species seined in 1997, was not caught at all in the seine in 1965. Differences in the total species list and in some relative abundances between the two studies maybe due to a result of the patchy distribution typical of many marine fish. This illustrates the limitations of seine sampling. For example, over 96 percent of the menhaden sampled were seined from two stations on a single date in September. At Tucks Point, all but two of the 4,249 individuals sampled were from a September sampling date. It is possible that if that single date had been missed, menhaden would have been regarded as scarce in Salem Sound in 1997, rather that as the second most abundant shore species. The two stations at which the greatest numbers of fish were caught in the seine were Tucks Point at the mouth of the Danvers River in Beverly, and Sandy Beach on the Porter River. These stations were dominated by menhaden and silverside, respectively, although other species were also caught. The lowest numbers of fish throughout the 1997, survey were collected at West Beach, the only station exposed to the open ocean and therefore exposed to greater wave action than the others. In 1965 at West Beach, no fish at all were seined in 8 of the 12 months in which sampling took place, and if it were not for a single haul in May of 236 Atlantic herring, West Beach would have been the least productive station in 1997, as well. The station with the lowest seine catch in 1965 was Tucks Point, which was the most productive in 1997. The station with the highest seine catch in 1965 was Proctor Point, due mainly to a large number of mummichogs on a single date. These results further illustrate the variable nature of seine sampling. Although seine catches may be largely influenced by single catches of single species; the seine data is a good indication of the seasonality of fish abundance.

The most consistent result noted was the low numbers from the West Beach sampling station, which indicated that high-energy beaches have relatively few nearshore fishes, or the seine is inefficient at collecting nearshore fishes. In the trawl samples, 34 species were caught, with the most abundant species being winter flounder, followed by skates (*Raja* spp.), Atlantic cod (*Gadus Morhua*), and cunner (*Tautogolabrus adspersus*). Table 5-6 indicates the most common species sampled in the trawls, comprising over 76 percent of individuals caught.

The most noticeable differences between the samples taken in 1965, and those taken in 1997, are the decrease in dominance by winter flounder, from 84 percent of individuals sampled in 1965, to 32 percent in 1997, and the appearance of large numbers of skates in the samples, which had been a very minor part of the catch (only eight individuals all year) in 1965. Also, yellowtail flounder had been the third most common species at the deeper stations in 1965, but was represented by only two individuals in 1997. Haddock, fourth most common in 1965, was absent in 1997. Skate have become a more common part of the local demersal fish fauna in recent years, and this is reflected in the 1997 samples.

Table 5-6: Five Most Abundant Fish Species Collected (Total No.) in Nearby Salem Sound Beach Seine Survey, 1997 (Massachusetts Division of Marine Fisheries unpublished data).

Common Name	ScientificName	Obea Park	Pioneer Village	Proctor Point	Sandy Beach	Tucks Point	West Beach	All Stations
Atlantic silverside	*Menidia menidia*	2,201	2,449	718	4,438	218	232	10,256
Atlantic menhaden	*Brevoortia tyrannus*	7	95	1,397	6	4,249	--	5,754
Atlantic herring	*Clupea harengus*	1	--	--	390	1,708	49	2,148
winter flounder	*Pseudopleuronectes americanus*	20	40	45	264	526	33	928
mummichog	*Fundulus heteroclitus*	80	61	15	238	2	--	396
all other species								345

Table 5-7: Five Most Abundant Species Collected (Total No.) in Salem Sound Trawl Survey (Massachusetts Division of Marine Fisheries unpublished data)

Common name	Scientific name	Beverly Cove	Danvers River	Haste Channel	Marblehead Harbor	Salem Harbor	All Stations
winter flounder	*Pleuronectes americanus*	68	197	256	98	451	1070
skate spp.	*Raja* spp.	65	59	181	45	293	643
Atlantic cod	*Gadus morhua*	32	15	112	71	123	353
cunner	*Tautogolabrus adspersus*	240	34	19	22	25	340
windowpane	*Scophthalmus aquosus*	7	--	73	4	70	154
Total of 29 other species							792

Note: values in table are numbers of individuals

5.3.3.2 Gloucester Finfish Data

Essential Fish Habitat (EFH)

Under the Magnuson-Stevens Fishery Conservation and Management Act, a.k.a. the Sustainable Fisheries Act (SFA), an EFH is broadly defined as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity". All of Gloucester Harbor is within a designated EFH for 30 species listed in the SFA.

Diadromous Fish Activity

Four species (alewife, American shad, blueback herring, rainbow smelt) of diadromous fishes inhabit the north shore area, although it is not known if any diadromous fish runs occur within Gloucester Harbor. Diadromous fish are those that, at any particular life stage, regularly move between freshwater and saltwater, spending part of their life cycle in each environment. Blueback herring were found during the months of June and July within Gloucester Harbor during a recent beach seine sampling survey conducted in the harbor for finfish (NAI, 1999). Many fish within the sample contained individuals that were between 55 and 92 mm long, which are considered to be young of the year (YOY) (Mullen et al, 1986). This suggests that blueback herring may run the Annisquam River and its tributaries.

Summary of Seine and Trawl Surveys

Seine and trawl sampling was conducted for fisheries and lobsters, consistent with previous studies (i.e. Jerome et. al., 1969), in Gloucester Harbor from June 1998 through May 1999 in support of proposed dredging activities. The purpose of the sampling was to provide data that can be used to evaluate the effects of dredging and aquatic disposal on fisheries resources. All sample locations were recorded by differential GPS (Global Positioning System). Fish sampling occurred twice per month at four nearshore locations and four deeper water locations , within Gloucester Harbor. This sampling was conducted June through October 1998 and in May 1999, while once per month in November 1998 through April 1999.

For each seine and trawl sample, all fish were identified to species, counted and measured for total length to the nearest mm, and biomass in grams. Exceptionally large catches were estimated through volumetric sub-sampling, in which a minimum of twenty fish were measured. Ages of the fish were estimated based on their lengths. Descriptive statistics (mean, range and percent composition) were used to characterize trawl and seine stations. Temporal and spatial features of the juvenile fish community are described for Gloucester Harbor.

The locations of each Seine and Trawl station are depicted in Figure 5-17. The sampling protocol and results for each sampling method are described in their respective sub-sections below.

Seine Survey

Nearshore sampling locations consisted of a 50-foot seine with a 3/16 delta mesh, positioned parallel to shore in approximately 1 m of water and then directly hauled to shore covering a rectangular area. The resources were calculated as a Catch Per Unit Effort (CPUE) based on the number of fish per haul.

Seine catches in Gloucester harbor were dominated by large catches of a few species. On several sampling dates no fishes were caught. The most numerous fish captured by the seine was Atlantic Silversides (*Menidia menidia*), accounting for 43 % of the total catch at all seine sampling locations. Winter flounder comprised 8%, lumpfish (*Cyclopterus lumpus*), blueback herring, and mummichog all comprised of 6 % of the fishes captured in nearshore Gloucester Harbor (Table 5-8).

Four nearshore sampling stations, identified as GS1 through GS4, were regularly sampled in Gloucester Harbor seine survey. Sampling station GS1 was located at Pavillion Beach, GS2 at the northeast side of Ten Pound Island, GS3 near Halfmoon Beach and GS4 at Niles Beach (Figure 5-14).

CPUE of Atlantic silversides generally rose throughout the summer to a peak in abundance in September and October (Figure 5-18), primarily due to an increase in the capture of Atlantic silversides, mostly Young of Year (YOY, annual fry) fish. The lowest CPUE was observed from November through March and began to increase thereafter. Winter flounder, which ranked second in CPUE, was highest in September. Most of the captured comprised of YOY fish (less than 100 mm). Sampling events in January through April decreased to zero, due to the fish moving to deeper water. Lumpfish ranked third in overall CPUE and were primarily captured during one sampling event (September 2) when large amounts of debris was observed in the haul. Based on the captured fish length, most of the sample was comprised of YOY fish. Blueback herring were recorded at sample stations GS2 and GS3 in June and July. Largely the sample contained fish that were between 55 and 92 mm long, considered to be YOY (Mullen et al, 1986). Mummichog were present in August, October and November, primarily at sampling station GS3 at lengths less than 60 mm. Other fish observed in the sample catches were windowpane, Atlantic menhaden, northern pipefish (*Syngnathus fuscus*), northern puffer (*Sphoeroides maculatus*) and grubby (*Myoxocephalus aenaeus*). Seine sampling revealed that fish species total abundance and diversity was generally greatest in the late summer and early fall months.

Trawl Surveys

Deeper water sampling was conducted with a 30-foot trawl made of 2-inch stretch mesh in the body and 1-inch stretch mesh in the cod end with a 1/4-inch liner. Each trawl was towed for approximately 400 m. When a 400 m tow length was not achieved, the length and catch was standardized by the following mathematical equation.

$CPUE_{s,t} = (CATCH_{s,t}/TOW_t)\ 400$

where,

$CPUE_{s,t}$ = Catch per unit effort for species S in Sample T

$CATCH_{s,t}$ = Catch of species S in sample T

TOW_t = Tow length in m of sample T

The trawl catches characterized the fish community of depths from 18 to 36 feet, within Gloucester Harbor. Trawl sampling locations are identified as GT1 through GT4 as shown in Figure 5-14. Sampling location GT1 was located in Southeast Harbor at a depth of 30 to 36 feet (9 to 11 meters). Station GT2 was located in the outer Gloucester Harbor at a depth of 29-35 feet (8.8 to 10.7 meters). Sampling station GT3 was located at the entrance to Blynman Canal at depths ranging from 18 to 25 feet (5.5 to 7.6 meters). Lastly, sampling station GT4 was located in the Inner Harbor near the entrance to the North Channel at depths between 25 and 28 feet (7.6 to 8.5 meters).

Catches were numerically dominated by winter flounder representing 27 % of CPUE, skates (*Rajaformes*), 20 %, Atlantic cod 12%, and both red hake and rock gunnel (*Pholis gunnellus*) 7 %. The skate species were grouped into one category due to the difficulty in field identification. Skates ranked first in biomass.

Monthly CPUE was relatively consistent from June through November, and then decreased during December through February as water temperatures decreased and the fish moved to deeper water (Figure 5-19). On average monthly CPUE began to increase in March and reached the highest levels in April and May. Winter flounder and Atlantic cod contributed to the high CPUE in April and high catches of cod and skates resulted in the high CPUE in May. The fifth most abundant fish captured in Gloucester Harbor, rock gunnel, was observed in every month except August and January.

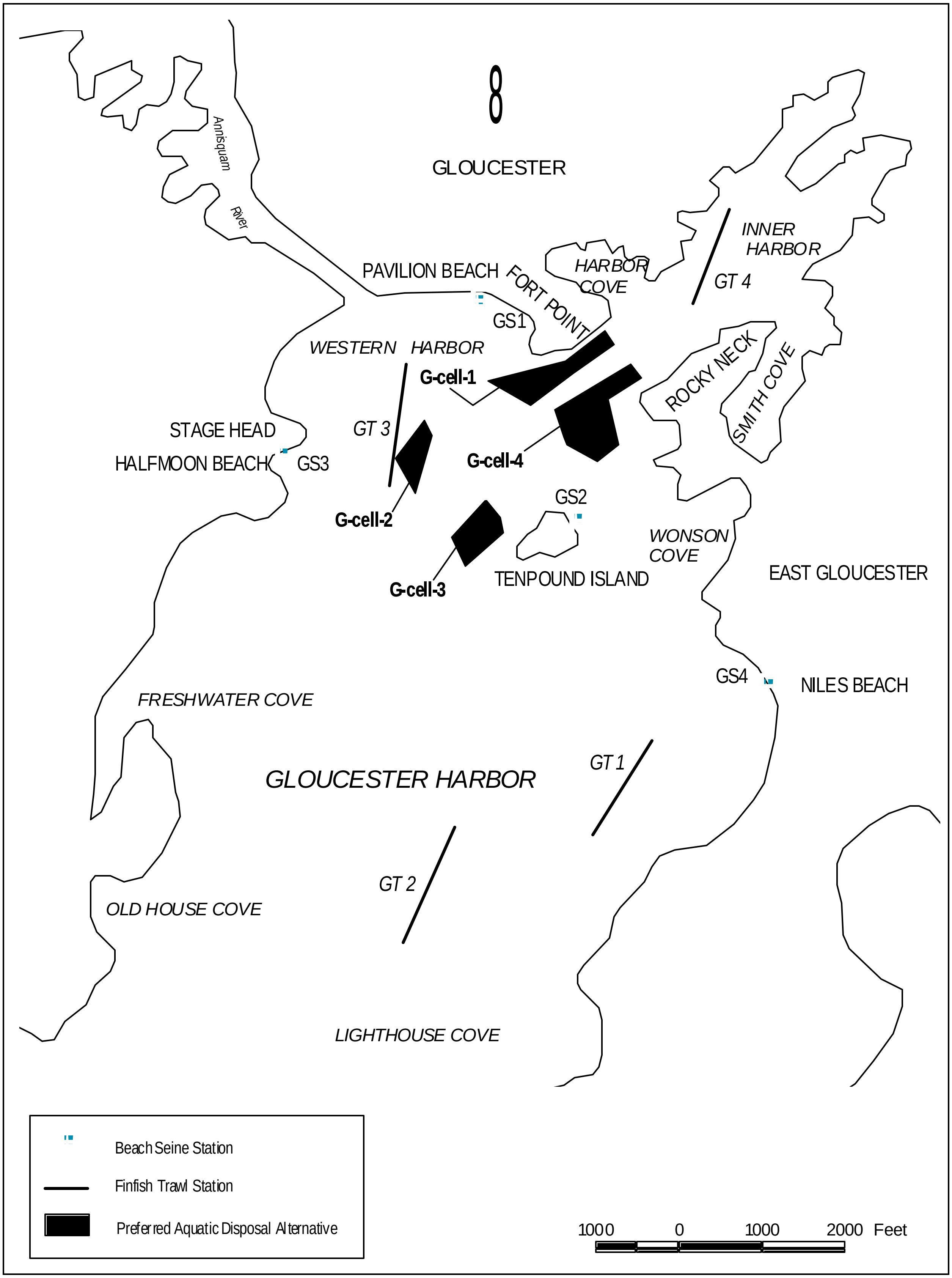


Figure 5-17: Beach Seine and Trawl Station Locations in Gloucester Harbor (Normandeau, 1999)

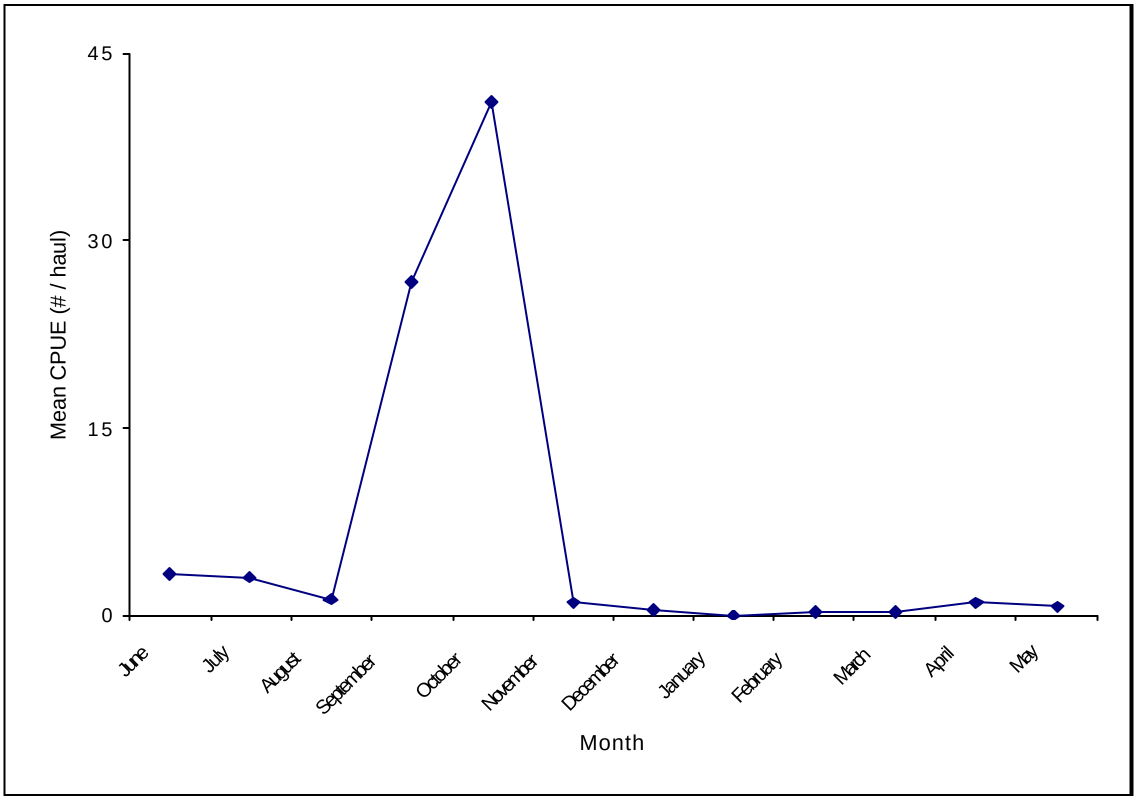


Figure 5-18: Total mean catch per unit effort (CPUE= #/haul) for Gloucester Harbor beach seine stations, June 1998 to May 1999 (Normandeau, 1999).

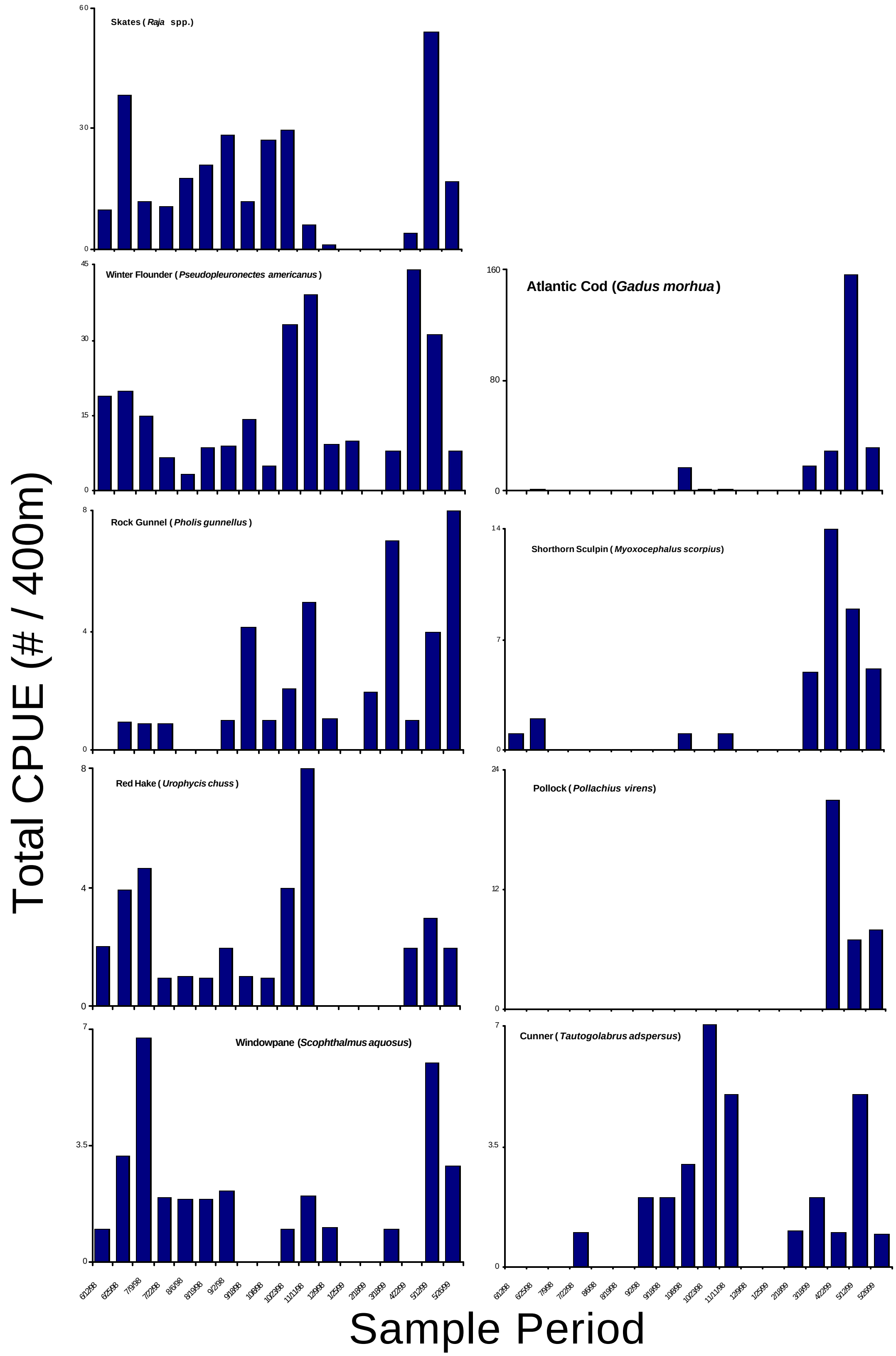


Figure 5-19: Total catch per unit effort (CPUE - #/400m) for all Gloucester Harbor otter trawl stations combined of selected fish species, June 1998 to May 1999 (Normandeau, 1999)

Note: *Different CPUE scales*

Table 5-8. Percent of fish caught in seine samples taken in Gloucester Harbor from June 1998 through May 1999 (geometric mean catch per trawl).

Species	Station GS1 %	Station GS2 %	Station GS3 %	Station GS4 %	All Stations Combined (GS1-4) %
Atlantic Silverside	56	15	36	56	43
Blueback herring	N	17	7	N	6
Lumpfish	N	N	12	N	6
Mummichog	6	N	8	N	6
Winter flounder	9	N	9	N	8
Northern pipefish	6	12	N	9	0
Windowpane flounder	11	N	N	N	0
Cunner	N	12	N	N	0
Grubby	N	15	N	14	0
Other species	11	30	28	6	31
Total	99	101	100	100	100

Notes: N = negligible. Some totals do not equal 100% because of rounding
Source: Normandeau, 1999

Table 5-9. Percent of fish caught in trawl samples taken in Gloucester Harbor from June 1998 through May 1999.

Species	Station GT1 %	Station GT2 %	Station GT3 %	Station GT4 %
Atlantic Cod	9	16	12	11
Pollock	8	N	N	N
Skate sp.	19	11	27	16
Rock gunnel	14	N	N	N
Winter flounder	24	28	24	29
Cunner	N	10	N	N
Shorthorn sculpin	N	8	N	9
Windowpane flounder	N	N	7	N
Red hake	N	N	9	N
Rainbow smelt	N	N	N	8
Other species	26	27	20	29
Total	100	100	99	100

Notes: N = negligible. Some totals do not equal 100% because of rounding
Source: Normandeau, 1999

Nursery Potential

Utilizing the information from the EBP lobster survey (SCUBA observations), DMMP Seine and Trawl Surveys, REMOTS® survey, and other literature, the potential value for the Preferred Aquatic Disposal Sites as a nursery for finfish and large invertebrates was assessed. UDM disposal is more likely to affect sensitive larval and juvenile stages of fish and invertebrates, so the protection of areas with high nursery potential is important. Nursery potential is estimated using the following empirical formula (Wilbur, 1999):

HABITAT COMPLEXITY + JUVENILE PRESENCE = NURSERY POTENTIAL (HIGH, MODERATE, LOW)

Habitat complexity (1-12) is highest where there is variation in substrate conditions and greatest vertical structure. Juvenile presence (yes/no) is the dominant commercial, recreational and non-target organism collected in substantial numbers or apparent in similar habitat.

All Gloucester Harbor candidate aquatic disposal sites were determined to have moderate to high nursery potential for juvenile fish, namely Atlantic cod, pollock (*Pollachius virens*), and winter flounder. Therefore, the G-Cell sites will also have moderate to high potential for juvenile fish since the G-Cell sites are subsets of the three original candidate aquatic disposal sites within the Inner Harbor. Recent beach seine and open water trawl sampling conducted within Gloucester Harbor (NAI, 1999) revealed winter flounder to be one of the most abundant fish within the harbor in the fall. Most of the winter flounder captured during this recent sampling effort were noted to be young of the year juvenile fish. This suggests that the harbor provides important nursery habitat for this species. Semi-annual inshore trawl surveys from 1978 to 1999 revealed that many eastern Massachusetts coastal embayments are used by juvenile Atlantic cod as settlement and nursery areas. Juvenile cod are brought to these coastal embayments due to prevailing southwestward-flowing coastal currents and off-shore prevailing easterly summer winds which, combined, carry eggs and larvae shoreward (Pierce, 2000).

Spawning Potential

Spawning periods for the most common fish and invertebrates within a given area are commonly used as a model for assessing overall marine fish spawning potential for that area. In fact, dredging is often limited to the times of year of decreased spawning, which is typically winter to spring. Many local surveys have identified important habitat associations (sand and cobble, eelgrass) that appear to be essential for the reproduction and development of fishes and invertebrates. Spawning potential within and proximal to the G-Cell Sites is estimated as “MODERATE” because the sediment there is uniformly soft silt, with little variation and no eelgrass beds are present. The Inner Harbor and proximity is a depositional environment, hence the predominance of soft silt in the surficial sediment.

Based on habitat associations and regional distribution of spawning activity, several species may find suitable environmental conditions for spawning within ports, estuaries and/or open water. Within nearby Salem Harbor, Salem Sound and Massachusetts Bay, there are at least eleven common fish species that spawn. They are: American sand lance (*Ammodytes americanus*), Atlantic cod, cunner, longhorn sculpin (*Myoxocephalus Octodecemspinosus*), northern pipefish, ocean pout (*Macrozoarves americanus),* red hake, silversides, tautog, windowpane flounder and winter flounder. Gloucester is expected to have a similar community assemblage of spawning fish species, especially winter flounder, since young of the year juveniles were found to dominate catches per unit effort in a recent fall sampling effort (NAI, 1999).

The seasonality of spawning for the dominant fish and invertebrates is an important factor in planning UDM disposal. For instance, dredging and disposal restrictions are imposed by DEP for north shore harbors to protect the spawning activities of the dominant species within that region of Massachusetts coastal waters (see DMF memo in Appendix B). Spawning for most of these organisms occurs in the spring, summer and early fall. As such, dredging has historically been limited to the late fall and winter season to protect spawning activities. The imposition of seasonal restrictions avoids impacts to sensitive eggs and larvae within the water column (pelagic) and on the seafloor (demersal).

Recreational and Commercial Fishing

A series of meetings with local fishermen, both commercial and recreational, were held to discuss the regional fisheries resources of the Gloucester area. At these meetings, they were asked to map the major recreational finfishing, commercial finfishing, and commercial lobstering areas and to denote which months specific species were sought and harvested. Any area with suitable access to the waterfront is a likely recreational area. However, the areas identified for this section were reported to have particular local significance, importance, or popularity.

Recreational Fishing

There is an extensive recreational fishery based in Gloucester Harbor and vicinity (Sartwell, 1997). Striped bass, bluefish, mackerel, tautog and winter flounder are among the principal species sought by recreational fishermen from both nearshore locations and via private boat. The best areas for flounder, reported by Gloucester fisherman and accessible by boat, occur off Niles Beach in the Southeast Harbor and off Doliver Neck on the western side of the Harbor. Local fisherman report that flounder were formerly more abundant, and that it is believed by most local fisherman that the flounder population may have been reduced over the years by overfishing, pollution, or a combination of factors. However, in recent years, with cleanup of the harbor and catch limits, the flounder are recovering (Koutrakis 1997). The other common recreational finfish species can be found in most areas of Gloucester Harbor and vicinity. However, there are certain areas that these species are most frequently fished (Figure 5-20). Some of these areas are fished because of easy boat or land-side access (e.g. Ten Pound Island and the State Pier, respectively), while others are fished because environmental conditions favor aggregation of the species. In either case, recreational fishing is prevalent along Pavillion Beach, Niles Beach, Cressy Beach and the Stage Fort Park area, and from the Dog Bar Breakwater. In contrast to nearshore locations, deep water areas may not be as commonly fished recreationally, not because there are no fish present, but because of greater travel distance from shore. Tautog remain close to submerged structures such as rocks, reefs and ledges. Therefore, they are also not caught in trawls in open water. Table 5-10 lists some of the principal recreationally fished species in the Gloucester Harbor area with notes on habitat from Bigelow and Schroeder (1953). The reported or expected locations of the various recreational fish in Gloucester Harbor are also presented in Table 5-10.

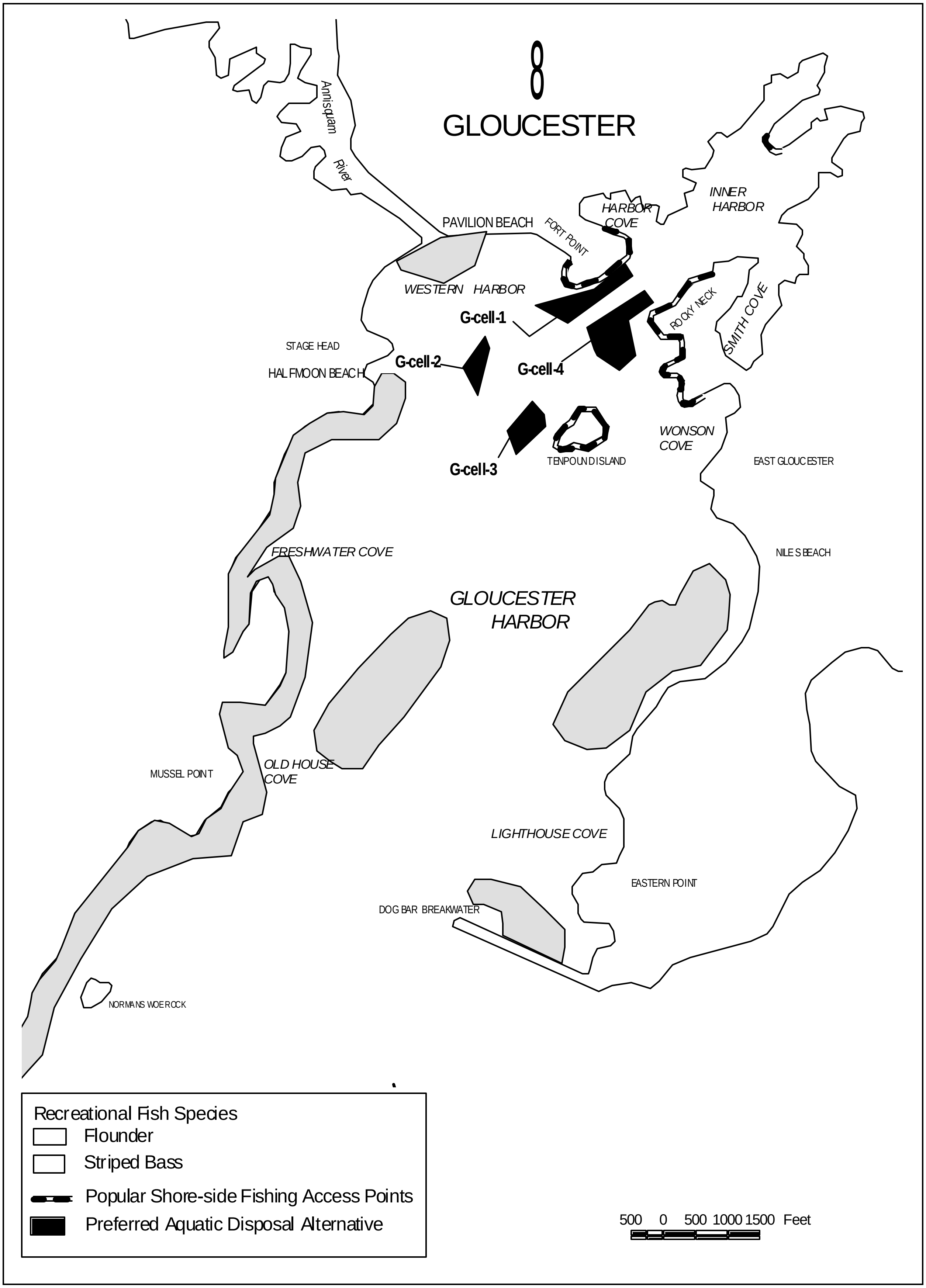


Figure 5-20: Recreational Fishing Areas in Gloucester Harbor.

Table 5-10: Important recreational fish species, their habitat, and principal locations in the Gloucester Harbor area.

Species[1]	**Habitat**[1]	**Where common in Gloucester**
Winter flounder	muddy sand, cleaner sand, eelgrass beds	off Dolliver Neck; Southeast Harbor
Atlantic Cod	rocks and pebbles, gravel, sand, shells	not specified.
Atlantic mackerel	pelagic, schooling	throughout the harbor
Bluefish	pelagic, schooling	throughout the harbor
Striped bass	islands, rocks, sandy beaches	Freshwater cove, Mouth of Annisquam River
Tautog	ledges, rocks, piers	Dog Bar Breakwater, Harbor Ledges (e.g. Round Rock Shoal, Ten Pound Island Ledge, Prairie ledge).

[1] Source: Koutrakis 1997

[2] Source: Bigelow and Schroeder

Commercial Fishing

Commercial gill net fishing and lobstering is practiced outside Gloucester Harbor and in Salem Sound and more distant off-shore areas such as George's Bank. Since the G-Cell sites lie within Gloucester Harbor, all of the G-Cell aquatic disposal sites are within areas closed to mobile gear fishing (e.g. trawls, seines, dredges). Most of the commercial fishing effort is at depths of 60 feet or greater. Groundfish, particularly winter flounder, are the majority catch from January to June. From June to August dogfish move inshore and some fishermen remove their gill net gear in favor of lobster gear. As shown in Figure 4-38 (Sasnowski, et. al., 1998), coastal gillnetting (Area 1) is practiced in the winter months while commercial fishing in Area 2 is most prevalent from April to July. Deep water gillnetting (Area 3) occurs from January to August. Gloucester Harbor is more important to commercial fishing as a landing port. Fish landings for Gloucester, MA in comparison to Massachusetts statewide landings are provided in Table 5-11. Approximately half of all the haddock and silver hake landed in Massachusetts came into Gloucester Harbor in 1999. Seventy-eight percent of all white hake landed in Massachusetts came into Gloucester Harbor. Gloucester harbor also had significant percentages of other species landed in Massachusetts in 1999 such as American Plaice (41.5%) and Witch Flounder (37.0%). The majority of landings come from offshore fishing grounds.

Table 5-11. Fish Landings (lbs) for Gloucester Harbor and Massachusetts Statewide from May-December, 1999 (x1000)

Fish Species	Pounds Landed in Gloucester	Pounds Landed in Massachusetts (Statewide - All Ports Combined)	% of State Total Landed in Gloucester
Cod	2,320	11,721	19.8
Haddock	1,651	3,533	46.7
Yellow-tailed Flounder	592	4,915	12.0
White Hake	1,204	1,539	78.0
American Plaice	998	2,402	41.5
Winter Flounder	256	6,426	4.0
Witch Flounder	590	1,590	37.0
Window Pane	2	65	3.1
Silver Hake	2,065	3,996	51.7
Monk Fish	2,220	15,990	15.1

Source: NMFS (1999)

Lobstering within Gloucester Harbor (Figure 4-39) occurs primarily from April to September, which is outside of the DEP-designated dredging/disposal window, but may continue until December. Deeper waters (Areas 2, 3 and beyond) are more commonly fished from late spring/summer to early/mid winter.

Because of their mobility and natural changes in environmental conditions from season to season and year to year, the location of good lobster grounds can vary at any time. However, the anecdotal information given above does indicate some general differences in lobstering between in-shore and off-shore areas. Lobstering is practiced in deeper waters nearly year-round including fall and winter months when dredging and disposal would occur. Coastal lobstering is most intensive from April to August, but does continue at lower levels until December.

5.3.4 Coastal Wetlands, Submerged Aquatic Vegetation and Intertidal Flats

The following subsections discuss coastal wetlands, submerged aquatic vegetation and intertidal flats, their presence within and near the preferred disposal sites, their ecological importance, and their regulatory status under the Massachusetts Wetlands Protection and and Federal Clean Water Act.

5.3.4.1 Coastal Wetlands

The Massachusetts Wetland Protection Act, 310 CMR 10.21 through 10.37, regulates coastal wetlands including numerous submerged and intertidal resource areas. Salt marshes are areas with the most stringent protection under the Act (See Section 7.1.3). In addition, the following resources are regulated under the Act: Land Under Ocean; Coastal Beaches; Coastal Dunes; Barrier Beaches; Coastal Banks; Rocky Intertidal Shores; Salt Marshes; Land Under Salt Ponds; Land Containing Shellfish; Banks of or Land Under the Ocean, Ponds, Streams, Rivers, Lakes or Creeeks that Underlie Anadramous/Catadramous Fish Runs; and, Estimated Habitats of Rare Wildlife (for coastal wetlands).

The Wetland Protection Act regulations define a salt marsh as "a coastal wetland that extends up to the high tide line, that is, the highest spring tide of the year, and is characterized by plants that are well adapted to or prefer living in, saline soils. Typically dominant plants within salt marshes are salt meadow cord grass (*Spartina patens*) and/or salt marsh cord grass (*Spartina alterniflora*) ".

Salt marshes are also protected under federal law because they are wetlands; one of the "special aquatic sites" designated in the Section 404(b)(1) Guidelines for Specification of Disposal Sites for Dredged or Fill Material (40 CFR 230, Subpart E). The regulations describe possible impacts on these sites from dredged disposal, and the applicant for a dredging permit must demonstrate compliance with guidelines for avoiding adverse impacts to these areas before a permit can be issued. (See Section 7.2.5.3).

Massachusetts DEP Environmental Sensitivity Index mapping depicts salt marshes proximal to Gloucester Harbor along the Annisquam River and within limited areas of the south end of Freshwater Cove (west of Dolliver Neck) (Figure 5-21). These areas lie outside the footprint of the G-Cell sites.

5.3.4.2 Submerged Aquatic Vegetation

Vegetated shallows (a.k.a. submerged aquatic vegetation) are regulated by DEP as "Land Under Ocean", and are also Special Aquatic Sites protected by the federal 404(b)(1) guidelines, where they are defined as "permanently inundated areas that under normal circumstances support communities of rooted aquatic vegetation". In marine settings north of Cape Cod, eelgrass (*Zostera marina*) beds are the most common form of SAV. Eelgrass beds increase species diversity and productivity by providing substrate shelter and food for a variety of marine fish and invertebrates (Levington, 1982). They also stabilize marine sediments (reduce erosion and resuspension within the water column) by reducing wave energy. The formation of Eelgrass beds are also the first step in saltmarsh succession (Gosner, 1978).

Eelgrass beds in Gloucester Harbor were mapped by the DEP in 1997 from aerial photographs (Costello, 1997) (Figure 5-21). These resource areas are also depicted on draft Massachusetts DEP Environmental Sensitivity Index mapping of Gloucester Harbor (NOAA, 1998). Submerged aquatic vegetation (eelgrass beds) of Gloucester Harbor occur within areas of the many harbor embayments. Specifically, eelgrass beds are known to exist within the western and central regions of the Western Harbor, throughout the Southeast Harbor, the north and south sides of Black Bess Point, and within Lighthouse Cove. The nearest eelgrass bed to any of the G-Cell sites is the Western Harbor bed which lies approximately 740 feet (225 meters) northwest of G-Cell-1.

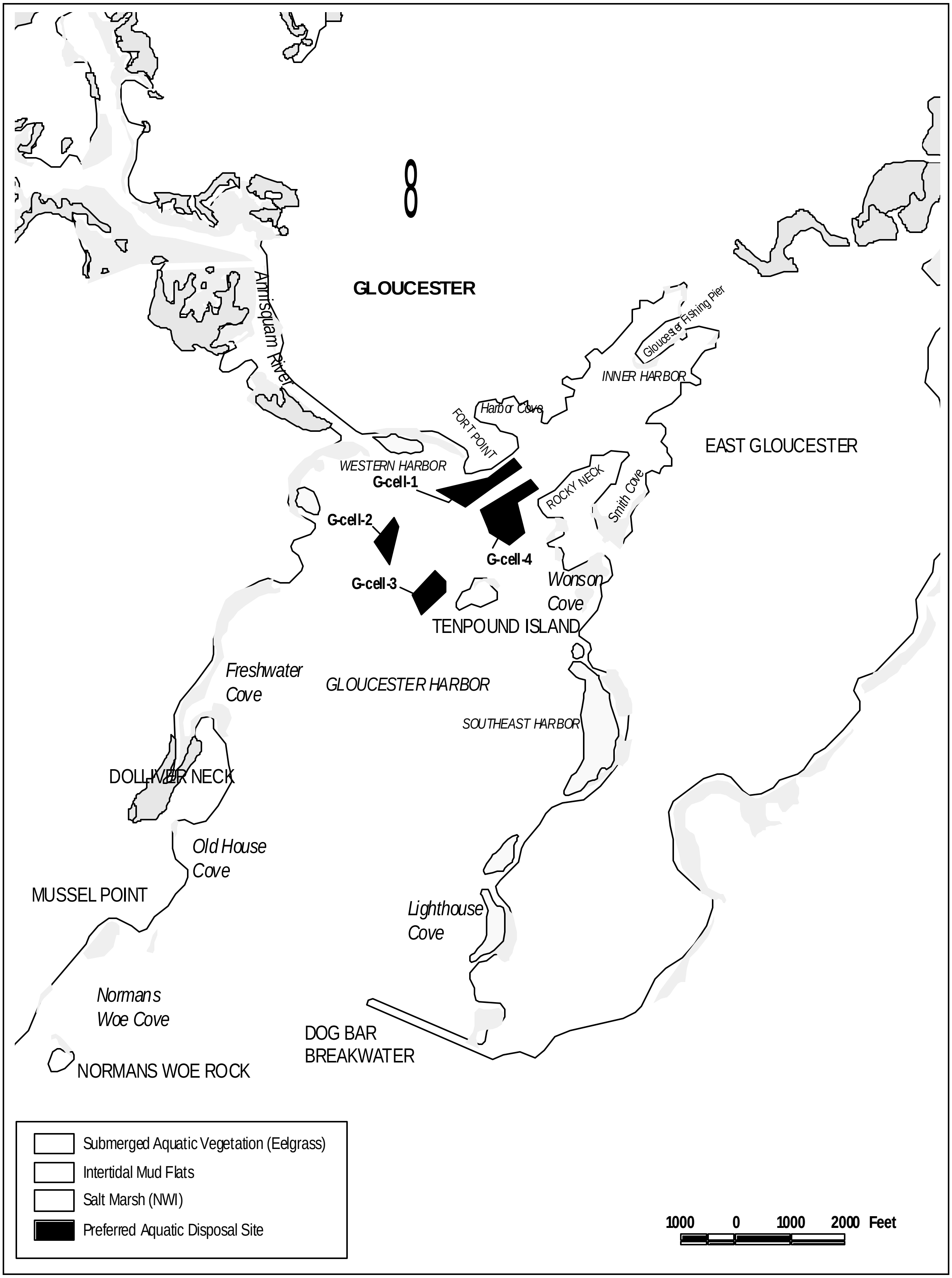


Figure 5-21:. SAV, Intertidal Mud Flats, and Salt Marsh in the Vicinity of the Preferred Disposal Sites.

5.3.4.3 Intertidal Habitats

The only areas other than wetlands and vegetated shallows, which are specifically protected under the 404(b)(1) guidelines and found in the Gloucester coastal area, are mud flats. These are defined as follows in the federal guidelines:

> *"Mud flats are broad flat areas along the sea coast and along coastal rivers to the head of tidal influence and in inland lakes, ponds, and riverine systems. Wind and wave action may resuspend bottom sediments. Coastal mud flats are exposed at extremely low tides and inundated at high tides with the water table at or near the surface of the substrate. The substrate of mud flats contains organic material and particles smaller in size than sand. They are either unvegetated or vegetated only by algal mats."*

This definition differs from the state's definition of tidal flats principally in that mud flats are composed only of fine-grained material, whereas tidal flats may also include intertidal sand bars. Mud flats contain biota such as clams and marine polychaete worms, and may provide foraging and nursery areas for fish and foraging habitat for shorebirds.

Tidal flats (either mud flats or sand bars) generally occur along the Annisquam River and within the many embayment areas of Gloucester Harbor such as Freshwater Cove, Western Harbor, Wonson Cove, Southeast Harbor, and Lighthouse Cove. Smith Cove, within Gloucester Inner Harbor, has an extensive tidal mud flat at its southern end. The Rocky Neck Peninsula separates this mud flat from the G-Cell site areas. Available mapping for Gloucester Harbor (NOAA, 1998) depict the nearest tidal flats to lie within 420 feet (128 meters) east of G-Cell-4 within a small embayment on the west side of Rocky Neck, and within 460 feet (140 meters) north of G-Cell-1 offshore of Pavillion Beach. Figure 5-18 depicts other tidal flats within the harbor in relation to the G-Cell sites.

5.3.5 Wildlife

The coastal waters off Gloucester and within Gloucester are inhabited by wintering waterfowl. Seabirds and shorebirds also frequent the various coastal habitats within and proximal to Gloucester Harbor. The areas within the harbor and immediately offshore are not known to support any significant concentrations of marine mammals or reptiles. All wildlife in the area is mobile and will avoid any areas of disturbance.

5.3.5.1 Avian Habitats

In the Gloucester area, beaches and tidal flats exist mainly in the protected embayment areas of the main Harbor, and along the Upper Annisquam River area. The G-cell sites are not located in an eelgrass, intertidal flat or salt marsh habitat, therefore, they are not within potential shorebird breeding or foraging habitat. Nevertheless, the eelgrass and intertidal flat areas proximal to the G-Cell sites (Figure 5-18) are habitat for diving ducks, shorebirds, and seabirds. A general discussion of the waterfowl, shorebird, and seabird habitats of Gloucester Harbor is presented below.

Waterfowl

Diving ducks (Family Anatidae, Subfamily Anatinae, Tribes Aythyini and Mergini) can be found within Cape Ann embayments, including Gloucester Harbor at any time of year, however most species are typically absent from June to July (Forster, 1994). Species richness and total abundance is greatest by late November when many farther north breeding sea ducks have arrived in the waters of eastern Massachusetts as winter residents. The total abundance may fluctuate throughout late fall to mid-winter months with the arrival and departure of somewhat transient loose flocks and individuals. Species richness and total abundance usually increases once again in late winter to early spring as the wintering waterfowl begin to stage for their flights to northern breeding grounds (Leahy, 1994).

The abundance of wintering waterfowl during diurnal cycles is usually greatest in nearshore (littoral) waters during mid to high-tide. During low tide, many of the deeper-diving species such as the seaducks and mergansers (Tribe Mergini) move out to deeper, off-shore waters (Leahy, 1994). The various species of diving ducks found within Gloucester Harbor include representatives of the herbivore (e.g. Redhead, *Aythya americana*), piscivore (e.g. Red-breasted Merganser, *Mergus serrator*), and molluscivore (e.g. Common Eider, *Somateria mollissima*) feeding guilds. Surface feeding ducks (Tribe Anatini) may also be found wintering within Gloucester Harbor, foraging in littoral waters for aquatic vegetation and invertebrates (e.g. Black Duck, *Anas rubripes;* American Widgeon, *Anas americana*, etc.).

Other waterfowl to be expected within Gloucester Harbor other than ducks include the loons (Family Gaviidae), grebes (Family Podicipedidae) and cormorants (Family Phalacrocoracidae). In the Cape Ann region, including Gloucester Harbor, loons and grebes are mainly absent as summer residents, but tend to be rare to locally common winter residents (Viet and Petersen, 1993). The species of loons (e.g. Common - *Gavia immer* and Red-throated - *G. stellata*) and grebes (e.g. Horned *Podiceps auritus* and Red-necked *Podiceps grisegena*) reported by Forster (1994) to winter in coastal eastern Massachusetts embayments (including Gloucester Harbor) feed mainly on fish by diving in open waters (Terres, 1980).

Of the cormorants, Double-crested Cormorants (*Phalacrocorax auritus*) are most abundant during the summer months, while Great Cormorants (*Phalacrocorax carbo*) appear in the harbor in winter months. However, either may be expected to be present at all times of the year as is reported for Nahant Bay, located to the south of Gloucester Harbor (Rines and Stymeist, 1994). Nearshore (littoral) and off-shore waters are used for feeding. Both species of cormorant feed primarily on fish (such as sculpins, haddock, cod, flounders, and herrings) but crustaceans such as spider crabs and shrimp may also be consumed (Terres, 1980). Food is caught by diving in open water areas. However, the harbor's reefs and rocky promontories are used by these species for roosting and sunning.

Shorebirds

Shorebirds are also expected to frequent Gloucester Harbor. Numerous species of shorebirds such as the plovers (Family Charadriidae), and sandpipers (Family Scolopacidae) can be expected to frequent the intertidal flats of Gloucester Harbor throughout the seasons. Typically, species richness and abundance of shorebirds is generally greatest on exposed mudflats and sandy beaches at low tide during autumn migration (late summer to early fall) with peak occurrences for various species

varying throughout this time period (Forster, 1994). Although many species of shorebirds frequent mudflat habitat for feeding, some prefer pebbly or cobbly beaches (e.g. Ruddy Turnstone, *Arenaria interpres*) and others prefer rocky coast (i.e. Purple Sandpiper, *Calidris maritima*). However, as many as 15 species of shorebirds have been reported (many routinely) from the rocky ledges of nearby Halibut Point in Rockport (Leahy, 1994).

Shorebirds feed mainly on marine polycheates, amphipods, and even mollusks (Terres, 1980) on tidal flats, intertidal rocks, and shallow subtidal bottoms (Levinton, 1982). These food sources tend to be more easily accessible to the birds during low tides, therefore diurnal cycles of abundance and species richness will be greatest during low tides. Sandpipers and plovers feed on surface-dwelling invertebrates such as amphipods and marine worms by gleaning from the surface or turning over stones. Larger shorebirds, such as dowitchers, whimbrels and willets, probe the soft substrata using their long bills (Levinton, 1982).

5.3.5.2 Marine Mammals

Marine mammals found in the waters in and around Stellwagen Bank located approximately 4.5 to 5 miles east southeast of Gloucester, include thirteen species of cetaceans (whales and porpoises), and two species of seals (NOAA, 1993)(Table 5-12). Although five of the whale species are endangered, some, especially the large and conspicuous humpback (*Megaptera novaeangliae*) and fin whales (*Balaenoptera physalus*), have become locally common enough to support a whale-watching industry. As of the end of 1998, this industry produced revenues of $20,000,000 per year and brings 860,000 people annually to Stellwagen Bank to view whales (Boston *Globe*, January 11, 1999). Most of these species may be expected to be found occasionally in the ocean waters closer to Gloucester, but rarely, if ever, within the harbors. An exception to this is the harbor seal *(Phoca vitulina*), which from late September to late May is commonly seen resting on sheltered and undisturbed rocky ledges in harbors, bays and estuaries from Maine, south to Plymouth, Massachusetts and occasionally beyond.

Table 5-12. Marine mammals found in the waters over and around Stellwagen Bank (NOAA, 1993)

Common Name	Scientific Name	Remarks
Humpback whale	*Megaptera novaeangliae*	March-November, offshore, near bank
Northern right whale	*Eubalaena glacialis*	Late winter - July
Fin whale	*Balaenoptera physalus*	Peak April - October, offshore
Sei whale	*Balaenoptera borealis*	Very rare
Blue whale	*Balaenoptera musculus*	Very rare
Minke whale	*Balaenoptera acutorostrata*	Peak spring - late summer/early fall
Pilot whale	*Globicephala* spp.	(2 species)
Killer whale	*Orcinus orca*	Peak mid-July through September
White-sided dolphin	*Lagenorhynchus acutus*	Common all year
White-beaked dolphin	*Lagenorhynchus albirostris*	Rare, April - November
Harbor porpoise	*Phocaena phocaena*	Peak in spring
Bottlenose dolphin	*Tursiops truncatus*	Late summer/fall, offshore
Common dolphin	*Delphinus delphis*	Occasional, fall/winter, offshore
Harbor seal	*Phoca vitulina*	Common, nearshore
Gray seal	*Halichoerus grypus*	Abundant in Canada, rare in Massachusetts

5.3.5.3 Reptiles

The only marine reptiles found in the project region are sea turtles. Although four species of sea turtles have been recorded in the Gulf of Maine, only two, the leatherback (*Dermochelys coriacea*) and the Atlantic ridley (*Lepidochelys kempi*), are seen with any regularity (Payne 1991). The leatherback, the largest living reptile, may grow to 11 feet (3.3 meters) in length and weigh up to 1900 pounds. Leatherbacks breed in Central and South America and are most frequently sighted off Massachusetts from June through September.

The Atlantic or Kemp's ridley is the most commonly reported turtle from Cape Cod Bay (Payne, 1991), but most of the sightings are of stranded juveniles. Individuals of this warm-water species breed in Mexico, drift or swim north as juveniles, and become trapped in Cape Cod Bay as temperatures fall, where they are killed by the cold. They are not an important part of the fauna near Gloucester. The other two species of turtles reported for the area, loggerhead (*Caretta caretta*) and green turtles (*Chelonia mydas*), are very rarely found north of Cape Cod. Sightings of these two species north of Cape Cod are usually wandering juveniles that do not survive the winter (Weiss, 1995).

5.3.5.4 Endangered Species

The Massachusetts Natural Heritage Atlas does not indicate any estimated habitat of state-listed Endangered, Threatened or Special Concern species in or adjacent to the marine waters of the Gloucester area with the exception of Tinkers Island located approximately 10.5 miles to the southwest of Gloucester Harbor. It does not indicate any priority sites of rare species habitats or exemplary natural communities in this area.

Of the marine mammals and reptiles reported on in Section 5.1.6.2, five whales and two turtles are federally listed as endangered. These include the humpback whale, fin whale, sei whale, blue whale, northern right whale, leatherback turtle and the Atlantic or Kemp's ridley turtle. These species, if they attain enough numbers to have centers of concentration at all, are found mainly at Stellwagen Bank off the northern tip of Cape Cod or at Jeffrey's Ledge north of Cape Ann.

5.3.6 Historical and Archaeological Resources

5.3.6.1 General

The Port of Gloucester is rich in colonial maritime history. First visited by Samuel de Champlain in 1603, it was soon settled by colonists from Plymouth and became established as a commercial fishing port in 1632. It is the oldest commercial fishing port in the nation. Gloucester history is preserved in several museums and exhibits in the region including, the Essex Shipbuilding Museum, the Cape Ann Historical Museum, and the Sargent House Museum, among others. In addition, Rocky Neck Avenue in East Gloucester has been designated the oldest working artist colony in America by the Smithsonian Institution. Because of Gloucester's maritime historical significance, a reconnaissance survey of the potential shipwrecks and aboriginal (Native American) sites in the Harbor was conducted.

As requested by the Massachusetts Board of Underwater Archaeological Resources, a reconnaissance survey was conducted to identify the potential for historical (shipwrecks) and archaeological (aboriginal) sites for the Gloucester DMMP. The full survey report in included in Appendix I.

5.3.6.2 Historical Shipwrecks

To determine significance for each shipwreck the Department of the Interior's definition of eligibility for the National Register of Historic Places (i.e. generally sites over fifty years old) was used as guidance. However, most of the shipwrecks were over one hundred years old. Because the recording of shipwrecks was not done in a thorough and programmed manner in the 19th and early 20th century, the information for any particular site might be inaccurate. However, the approximate number of significant shipwreck sites in the Gloucester study area is accurate enough to allow the determination that pre-dredging/disposal planning is recommended.

The survey-level historical research located a total of 349 shipwrecks in the Gloucester aquatic ZSF, including vessels listed as lost "off" Salem, Marblehead, Beverly, Manchester, or Gloucester. Eliminating those vessels known to be outside of any of the candidate disposal sites, we are left with 5 shipwreck sites known to be within in, or close to, the original aquatic disposal candidate sites and

317 at some unknown spot in the ZSF. Of the latter two groups, 302 would fit the Department of the Interior's eligibility for the National Register of Historic Places (Reiss, 1998).

Located wrecks are shown in Figure 5-22. There are no known shipwrecks near the preferred aquatic disposal sites. The closest mapped wrecks to the G-cell sites are the Nina T (ca. 1990), and the Chester Poling (ca. 1977) located outside of Gloucester Harbor approximately 1,000 feet (305 meters) and 1,100 feet (335.3 meters) southeast of Dog Bar Breakwater.

In addition to those vessels found in the historical records, we must assume many others were lost in the study area and not recorded. Before radios and radar, vessels were surely lost with all hands on the numerous ledges in the area during storms and fogs. Others could only record them as missing at sea, whether they had just left the harbor, were returning after a long voyage, or were blown in while trying to sail past the shore. No one would know what happened to them. They would include small and large fishing boats, coasters, and transoceanic merchant men and warships.

Besides those vessels lost while underway, a number would have been lost at their moorings or abandoned in shallow water, such as the abandoned 1800s fishing vessel seen at low tide on the western shore of Manchester Harbor and the 1690s Hart's Cove shallop in Newcastle, New Hampshire. Some of the shipwrecks would have been salvaged shortly after wrecking or more recently.

Since we know so little of the early vessels, onboard fishing processes, or life aboard the early merchant vessels, the remains of any historic ship or boat would be archaeologically and historically significant on a local, regional, and national level.

Historic shipwreck sites are known to exist in the study area and are relatively easy to detect. The number of vessel losses found in this study is smaller than the total losses that would be located with a complete study, but the results found are indicative of a large number of probable shipwreck sites within or proximal to the Harbor. The lack of complete recorded evidence is typical for any locality along the New England shore. Until recently the loss of a vessel, even with the loss of life, was not considered newsworthy enough for the ubiquitous 4-page weekly newspaper in the 1700s and 1800s. State and federal government compilations of vessel losses, which are incomplete, date only from the very late 1800s. In addition, the parameters of this study only included some primary research with mostly the inspection of secondary compilations of data from the primary sources. The data located in this study indicate that there is a probability of encountering the remains of an historic vessel in or near the G-Cell sites, although because this area was dredged for the creation of the Federal Channel, the remains of a shipwreck may have already been removed, wholly or in part.

Field surveys of the G-Cell sites and vicinity will be conducted to ascertain if any shipwrecks or shipwreck debris is present. See Appendix I for more information on potential future studies.

5.3.6.3 Archaeological Sites

Prehistoric Indians (Native Americans) used the shore as a summer dwelling area to get away from the heat and insects of the interior and to collect the bountiful food offered by the sea. Regionally, Indians were known to collect many types of shellfish which were smoked, dried, stored and traded for winter food. They used small dugout and bark canoes for fishing and hunting mammals, and for transportation along the shore and to nearby islands.

In most areas of New England, seasonal Indian dwelling sites are typically found near a beach and a fresh water source with a southeast exposure to the sea. In addition, shell middens, created by Indians processing bivalves, are often found in similar areas without the need of running fresh water (Bourque, 1980, IV-45-49 & Riess, 1989, 12). Since the last ice age, the net sea level change has placed the coastline of 6,000 BP under approximately 25 feet (7.62 meters) of water in the Cape Ann area (Bourque, 1980, IV-229). For example, some of the islands now close to shore near Gloucester would have been small hills connected to the mainland by low strips of land as recently as 2,000 years ago. If they were close to a beach, which might have been part of the connecting strips, they would have been prime areas for prehistoric residential use.

Since little is known of the prehistoric Indians of the study area, any remains, whether a village, fish processing site, or sunken canoe, would be of great importance. However, previous sub-bottom profiling data indicate that the area has an irregular bedrock surface which is typically covered by 0-30 feet (0 to 9.1 meters) of glacially deposited medium sand and some organic and clay sediment.

Remains of any sites would be extremely hard to locate under the sediment in the survey area. Remote sensing surveys will generally not indicate a prehistoric site in this type of topography. Locating prehistoric Indian sites would require archaeological trenching of each proposed impact area. Spot inspection by archaeological divers, while investigating remote sensing targets of possible historic remains, would be useful, but probably not productive.

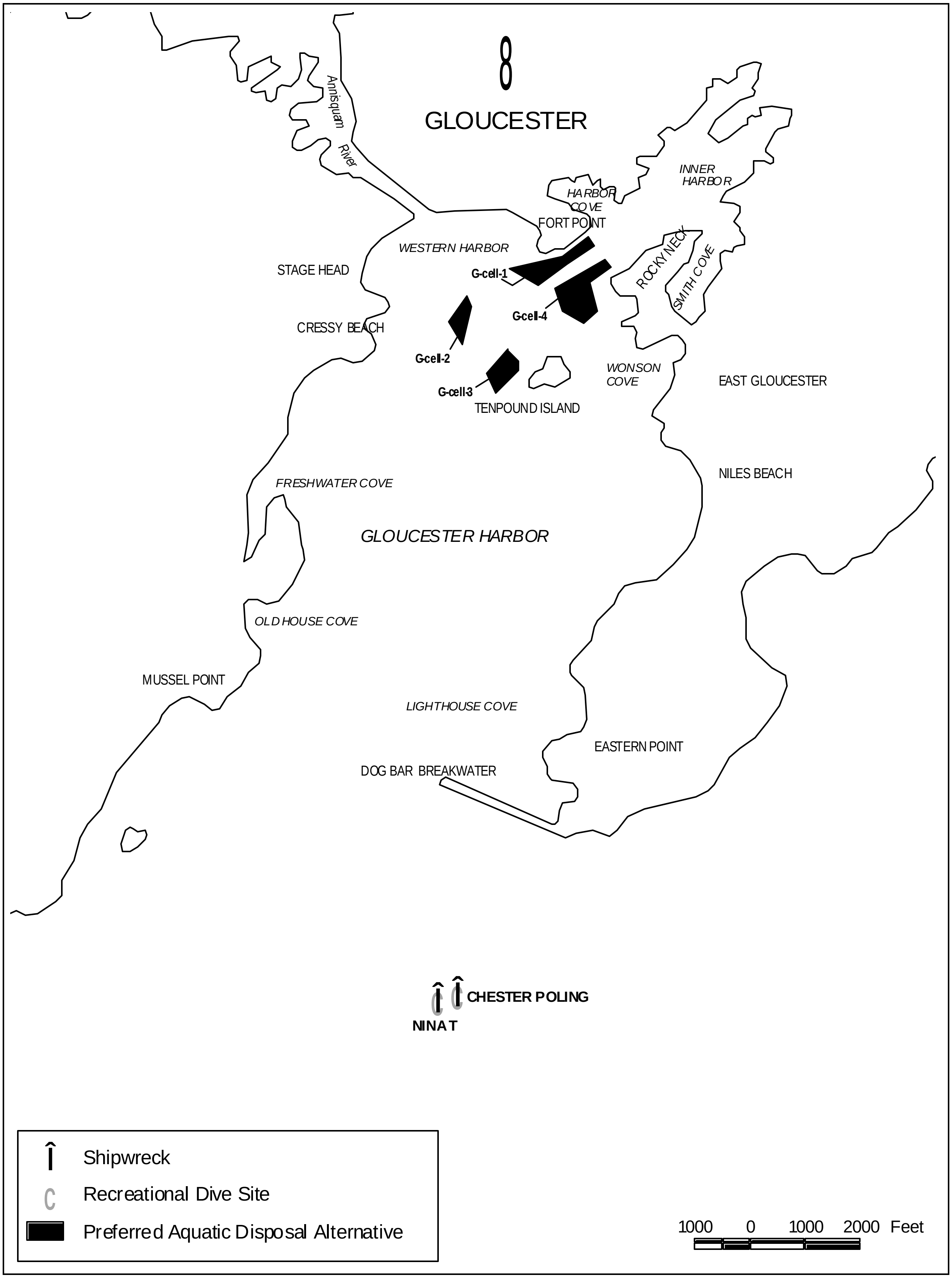


Figure 5-22: Known Shipwreck Locations in Gloucester Harbor.

5.3.7 Navigation and Shipping

Gloucester Harbor is the oldest fishing port in the nation, and the second largest commercial fishing port in New England (second only to New Bedford). The Gloucester Main Harbor is deep enough along the main navigation channel, and does not require maintenance dredging. However access to the commercial areas of the port within the Inner Harbor is provided through the dredged federal navigation channel (Figure 5-2) which has an authorized navigational depth of 20 feet (6.1 meters). Maintenance of the dredged federal navigation channel in Gloucester Harbor is required to support the Harbor's role as a commercial fishing port. With further expansion of the port and waterfront facilities, the need for additional commercial deep water berthing in the harbor exists. In many areas of the Harbor, there is insufficient water depth to accommodate large commercial vessels at some of the existing harborside facilities.

Recreational vessel traffic also plays a large role in Gloucester Harbor. The harbor contains approximately 16 marinas or boat yards, approximately three yacht clubs and three dockside restaurants. There is a significant recreational boating fleet, with numerous moorings distributed within three mooring basins. Gloucester Harbor is a significant recreational boating destination, due to the large number of historical and cultural attractions of the town, largely located adjacent to or within close proximity to the Inner Harbor.

The entrance to Gloucester Harbor lies west of Round Rock Shoal and The Dog Bar Breakwater. Entrance to the Inner Harbor is via the main Federal Channel which begins at a point just southwest of an imaginary line from Fort Point to Rocky Neck. The entrance channel maintains an average depth to MLW of 15.5 feet (4.7 meters) across an approximate width of 300 feet (91.4 meters) and along its approximate 3900 foot (1188 meter) length.

At the northeastern end of their entrance channel, the channel splits into north and south channels, which are separated by first, an anchorage area, then rock shoals, and finally by the State fish pier. The North Channel maintains a depth of 17 feet (5.2 meters) MLW and an average width of 200 feet (61 meters) for an approximate length of 2,350 feet (716 meters) long. The South Channel maintains a depth of 18 feet (5.5 meters) MLW and an average width of 200 feet (61 meters) for an approximate length of 2,300 feet (701 meters) long. The anchorage at the intersection of the North and South Channels has an approximate depth of 16 feet (4.9 meters). The two major embayments of the Inner Harbor, Harbor Cove to the northwest and East Gloucester Harbor to the southeast (at the entrance to Smith Cove) have an average depth of approximately 15 feet (4.6 meters) and 13 feet (4 meters), respectively.

The Blynman Canal provides navigable access along the Annisquam River. It is accessed from the Western Harbor area of the Gloucester Main Harbor. The Blynman Canal provides access for recreational and fishing vessels to the Annisquam River. The Blynman Canal has a navigation depth of 6.7 feet (2 meters) from the entrance at the Western Harbor, north to the B & M Railroad Bridge. This segment of the canal has a mean width of 30 feet (9.1 meters). From the B & M Railroad Bridge, north to Bouy No. 21, the canal has an average depth of 4.7 feet (1.4 meters) MLLW and average width of 50 feet (15.2 meters) (NOAA, 1992).

5.3.8 Land Use

Land use along Gloucester Harbor in the vicinity of the preferred aquatic disposal sites, is a mixture of undeveloped, residential, commercial and industrial usage (Figure 5-2). G-Cell-1 lies adjacent to the western and southwestern sides of Fort Point. The western waterfront of Fort Point is developed with commercial facilities including Fuji Food, Parisi Seafood, and Cape Pond Ice. However, further landward, across Fort Point Avenue, lie residential areas. Residential and recreational land use areas also lie along the southeastern end of Fort Point. G-Cell-2 lies within an open water area of the Gloucester Main Harbor. The nearest land use is a public park (Stage Fort Park) located approximately 1155 feet (352 meters) to the west. G-Cell-3 lies proximal to Ten Pound Island which is mostly undeveloped. G-Cell-4 lies adjacent to residential land use areas of Rocky Neck approximately 200 feet (61 meters) to the south.

5.3.9 Air Quality and Noise

5.3.9.1 Air Quality

Background air quality in Gloucester Harbor has been estimated using monitoring data reported by the DEP to the USEPA Aerometric Information Retrieval System (AIRS). Although the DEP does not operate any air pollution monitors within the Town of Gloucester, data collected at other DEP monitors in Essex County during the three-year period of 1996-1998 were used to determine existing air quality of the region. The location of air quality monitoring stations within Essex County varies according to the parameter being measured and the year of data collection, and includes sites in Lawrence, Lynn, Newbury, Peabody, and Haverhill. This is a conservative approach, as the air quality in Gloucester is likely to be as good or better than that which exists near the monitoring sites. In particular, Gloucester is located farther from major industrial sources of air pollution than Lawrence or Lynn, with the PG&E Generating Station power plant in Salem being an exception. However Gloucester is upwind of Salem under the prevailing northwesterly wind. The Gloucester area also has significantly fewer mobile sources of air pollution, since its population density is less than that of either Lawrence or Lynn.

The USEPA mandates monitoring of the following six criteria air pollutants: nitrogen dioxide (NO_2), particulate matter with diameters less than or equal to 10 microns (PM_{10}), sulfur dioxide (SO_2), ozone (O_3), carbon monoxide (CO), and lead. Ambient Air Quality Standards (AAQS) have been established for each of these pollutants to protect the public health and welfare, with a margin of safety. PM_{10}, O_3, and NO_2 emissions are those associated with operation of heavy equipment used in UDM disposal operations. Ozone is not a pollutant emitted by heavy equipment, but is formed in the atmosphere when "precursor" elements and compounds such as nitric oxides, hydrocarbons (e.g. from unburned fossil fuels) and oxygen are combined in the presence of sunlight.

A geographic area that meets or exceeds an AAQS is called an attainment area for that air pollutant standard. An area that does not meet an air standard is called a non-attainment area for that standard. The entire state of Massachusetts is in attainment of all criteria air pollutant standards except for ozone, for which it is classified as in serious non-attainment. A summary of existing air quality data for Essex county is as follows:

Nitrogen Dioxide (NO_2): For the period of 1996-1998, no violations were recorded at either the Lynn or Newbury, MA monitoring locations. The 1998 annual arithmetic mean for the Newbury monitor was 0.006 ppm, which is only 11% of the standard. The 1998 annual arithmetic mean for the Lynn monitor was 0.014 ppm, or only 26% of the standard.

Particulate Matter 10-Microns (PM_{10}): Between 1996 and 1998, there were no violations of the PM_{10} air quality standards, which are (1) an annual arithmetic mean of 50 g/m^3, and (2) a 24-hour value of 150 g/m^3. The Lawrence monitor station readings had an annual arithmetic mean of 15 g/m^3, which was 30% of the standard.

Sulphur Dioxide (SO_2): The SO_2 monitoring site located closest to Gloucester is in Peabody, although no 1998 data was available from this site. SO_2 data was also collected from 1996-1998 at Essex County monitoring sites in Haverhill and Lawrence. The SO_2 standards are (1) 0.50 ppm (3-hour average, (2) 0.14 ppm (24-hour average), and (3) 0.03 ppm (annual mean). There were no violations of SO_2 standards in Essex county during 1996-1998. The 1997 annual mean in Peabody was 0.004 ppm, which is 1.3% of the standard. Similarly low measurements were recorded in Haverhill and Lawrence.

Ozone (O_3): During 1996-1998, O_3 was monitored in Essex County at sites in Newbury, Lawrence and Lynn. The air quality standard for O_3 is 0.12 ppm (one-hour standard). At Lynn, the maximum value recorded in 1998 was 121 ppm, which is 101% of the standard. The new 8-hour standard (0.085 ppm) is calculated as a three-year average of the annual fourth-highest daily maximum 8-hour O_3 concentration. From 1995-1997, Lynn had an 8-hour value of 0.089 ppm (105% of standard), and Newbury had a value of 0.084 ppm (99% of standard). Statewide, Massachusetts continues to be in non-attainment of the O_3 standard.

Carbon Monoxide (CO): Among the nine CO monitoring sites in Massachusetts, the sites closest to Gloucester are located in Lowell and Boston. Both of these urban locations can be expected to have higher ambient levels of CO due to higher population density and greater CO emissions from mobile sources. The CO standards are 35 ppm (1-hour average) and 9 ppm (8-hour average). During 1998 and 1997, there were no violations of the CO standards in Massachusetts. In Lowell, the maximum 1-hour value in 1998 was 6.0 ppm (17% of standard) and the maximum 8-hour value was 4.1 ppm (46% of standard). In Boston, the maximum 1-hour value in 1998 was 6.7 ppm (19% of standard) and the maximum 8-hour value was 6.6 ppm (73% of standard). In 1996, one violation of the 8-hour standard was recorded in Lowell (10.5 ppm).

Lead (Pb): Although lead is a criteria air pollutant, monitoring for lead was not conducted in 1997 because concentrations in Massachusetts have been minimal in recent years. The most recent available data for Essex County was recorded at monitoring sites in Newbury, Haverhill and Lynn during 1994-1995. The standard for lead is 1.5 $\mu g/m^3$ (quarterly mean). At all locations in Essex County, no value exceeded 0.01$\mu g/m^3$, which is less than 1% of the standard.

Overall, the existing air quality in the Gloucester area is good and is in compliance with all state and federal air quality standards except for ozone. Statewide non-attainment for the ozone standard requires that Massachusetts continue to make progress on implementing a State Implementation Plan (SIP) for attaining the standard.

5.3.9.2 Noise

Gloucester Harbor is a heavily commercialized port, and as such nearshore areas in Gloucester exhibit noise levels typical of commercial environments. Industrial noises, such as that associated with operation of a seafood processing plant or traffic noise from shipping and commerce, all contribute to the existing noise environment. Recreational areas, such as Stage Fort Park at the west end of the Gloucester Main Harbor, and residential areas, such as the Rocky Neck area, are generally quieter.

In the vicinity of the navigation channel and G-Cell sites, noise levels are typical of a mixed land use environment, quiet at some times, noisy at others. Most of the existing noise is generated from existing vessel traffic in the channel.

5.3.10 Recreational Resources

Recreational resources in Gloucester Harbor are abundant, and reflect a wide range of passive and recreational activities. Predominant among the recreational uses of the harbor are boating and sailing, swimming, and fishing. The harbor, as viewed from various locations around the perimeter, is often painted by artists from Rocky Neck.

There are sixteen recreational marinas or boat yards and approximately three yacht clubs located in Gloucester Harbor. In addition, numerous single point moorings are located within three major mooring basins. In addition, at least three dockside restaurants are located within Gloucester Harbor.

Recreational fishing is a significant activity, with winter flounder, cod, mackerel, bluefish, and striped bass the most important recreational species. Section 5.3.3.2 provides a more complete description of recreational fishing in Gloucester Harbor.

Public parks abutting Gloucester Harbor include Stage Fort Park at the western end of the harbor, (the site of the nation's first commercial fishing stage), which provides public beach access and picnic areas. Smaller municipal parks are located along the waterfront on the western side of Fort Point, and in East Gloucester. These small municipal parks generally contain neighborhood playgrounds.

5.3.11 Economic Environment

Gloucester, founded in 1623, was among the first commercial seaports in colonial America. Gloucester Harbor's natural attributes as a natural harbor refuge of the Commonwealth provided economic opportunity for the Town of Gloucester. Early economic activity in Gloucester Harbor centered upon fishing and timber interests (Riess, 1998). Cod, mackerel and haddock were fished off-shore stored in salt on the fishing vessels and processed on stages in the harbor. Gloucester Harbor was critical to the development of colonial Massachusetts and remained important throughout the colonial period. Trade duties collected from economic activity in Gloucester harbor fueled our emerging nation's economy and funded our fledgling independence. The local and regional economy grew around the fishing industry as Gloucester became the preferred port of call for off-shore fishing vessels. Gloucester rose to international prominence in the mid-nineteenth century as various factors led to continued expansion of the port. Railroads connected the harbor to farther potential fresh fish markets. With the onset of powered shipping, Gloucester lost its distinction as the preferred port of call for fresh fish in preference to Boston. This forced the fish processing industry within the harbor to change from fresh fish to first canned fish, then frozen fish by the 1940's. Gloucester remains an important fishing port in New England today (Riess, 1998). It is the second largest commercial fishing port in New England, second only to New Bedford. The Harbor contains numerous dealers, processors, and cold storage facilities associated with the industry.

While the review of regional economic data for Essex County, indicates a small percentage of marine related industries in Essex County, less than one percent of total employment (US Census Bureau, 1997), marine-related industry in Gloucester is actually substantial. By applying the percentage of Gloucester residents living and working in Gloucester, 58% (US Census Bureau, 1990), to the 1998 Labor Force, 16,017, adjusted for the 1998 Unemployment Rate, 5.3% (Massachusetts Department of Revenue, 2000) the City's percentage of resident jobs attributable to the Harbor is over 33%, when seasonal jobs are included.

The *Gloucester Harbor Plan* identifies the seafood industries and cultural and visitor activities as specific economic sectors directly related to the Harbor. Seafood industries are estimated to generate $700,000,000 and support 2,500 jobs. While the cultural and visitor sectors are estimated to account for $20,000,000 of the local economy while providing 430 permanent jobs and over 800 seasonal job opportunities (Gloucester, 1999). Table 5-13 shows the approximate number of jobs and estimated dollars generated for the seafood industries and cultural and visitor sectors as estimated in the Harbor Plan.

Table 5-13: Gloucester Harbor Economic Data - Employment

	Approximate # of Jobs	**Estimated $ Generated**
Seafood Industries	2,500	$700,000,000
Cultural and Visitor Activities	430 (+800 seasonal)	$20,000,000
Totals	2,930 (+800 seasonal)	$720,000,000

Source: Gloucester Harbor Plan, 1999

To quantify the total value in dollars of other maritime commercial activities, data for imports and exports were reviewed. Total imports for 1999, in Gloucester Harbor were valued at $17,219,968, representing a 28% increase over import values from 1998. Even with a decrease in total export weight between 1998, and 1999, export values for Gloucester Harbor in 1999, corresponding with an increase of 48% over 1998, exhibiting a total value of $5,727,637. The composite increase in total imports and exports is over 28% between 1998, and 1999, for a total value of $22,947,605 in 1999 (US Maritime Administration, 2000). Table 5-14 illustrates total weights and total values of imports and exports for 1998, and 1999.

Table 5-14: Imports and Export for Gloucester Harbor, 1998, and 1999

Year	Total Weight (Kilograms)	Total Weight (Short Tons)	Total Value (US Dollars)
Imports			
1999	5,170,237	5,700	$17,219,968
1998	3,908,220	4,309	$13,531,629
Exports			
1999	771,644	851	$5,727,637
1998	901,309	994	$2,940,354
Total Imports and Exports			
1999	5,941,881	6,551	$22,947,605
1998	4,809,529	5,303	$16,471,983

Source: US Maritime Administration, 2000

6.0 ENVIRONMENTAL CONSEQUENCES OF THE PREFERRED ALTERNATIVE

A detailed evaluation of the environmental and human resource impacts and benefits associated with the implementation of the preferred aquatic alternative was undertaken, and is presented in this section. The four G-Cell Sites (G-Cell-1, G-Cell-2, G-Cell-3, and G-Cell-4) collectively, comprise the preferred alternative aquatic disposal option for the Gloucester Harbor DMMP DEIR. Where impacts or benefits associated with the disposal of UDM is common to all four G-Cell sites, they are referred to as the G-Cell sites collectively. Where impacts or benefits associated with the disposal of UDM varies among the four G-Cell sites, the impact or benefit associated with each specific G-Cell site is discussed. In addition, at the end of each subsection (e.g. 6.1 Sediments and Water Quality), a summary of the impacts that would occur/not occur as a result of the no-action alternative are presented.

Discussed herein are the potential impacts to the resources within and near the preferred disposal sites. It is important to note that impacts could occur at several stages in the dredging and disposal process and, therefore, are evaluated as such in the ensuing sections. First, there are potential impacts associated with the creation of the CAD cells themselves, i.e. the excavation of sediment needed to create the cells. Once the cells are created, then the impact of dredged material disposal into the cells is considered. Finally, the capping of the UDM with a sandy sediment, which would level the harbor bottom to its pre-existing depth, is evaluated. This final step is seen as the long-term effect of disposal, i.e. the effect of the presence of a patch of clean, sandy substrate in a harbor predominantly composed of soft silt and mud.

As discussed Section 9 of this DEIR, the planned operation and management of the disposal site will have a bearing on the temporal and spatial aspects of impact. Currently, it is envisioned that each of the four disposal cells would be open for one dredging season within a five year window. The dredging window, as specified by DMF and DEP, is usually from late fall to spring and is designed to avoid the sensitive life stages of important fish and shellfish species. Therefore, excavation of the cells, placement of the UDM within the cells, and capping of the cells would likely occur within a period of less than 6 months. This period would be the time when *temporary* impacts would occur. After the cap is placed atop the UDM, then the potential impacts would be considered *long term*.

The expected impacts of the project were evaluated based upon the following: site-specific information gathered during the DMMP process; previous studies of Gloucester Harbor and the north shore region; studies done at other New England ports (e.g. Boston Harbor) and disposal sites, and laboratory studies of the effects of dredging and related activities. It is recognized that additional site-specific information is needed to complete the MEPA process and subsequent federal and state permitting. The following site-specific efforts will be undertaken in support of continuing the MEPA and/or permitting processes:

- Geotechnical borings to confirm depth to bedrock and determine side slope stability;
- Macrobenthic sampling and identification
- Current meter measurements and basic water column chemistry
- Dredging and disposal event modeling and hydrodynamic analysis
- Underwater archaeological surveys
- Physical and chemical analysis of G-cell surficial sediments

6.1 Sediments and Water Quality

6.1.1 Existing Sediments

Dredging and UDM disposal is intrinsically a high disturbance process with respect to existing sediments. The primary potential repercussions of UDM disposal on existing sediments include the mortality of resident benthic organisms and the alteration of the existing sediment composition at the disposal site. The long-term sediment character is dependent upon the grain size of the final sediments at the surface cap relative to the pre-existing sediments. The expected type of sediment at the surface of the cells is discussed further in this section.

The final character of the sediments overlying the CAD cells will be dependent upon the construction of the disposal cells. CAD cells are typically capped with a coarse-grained material (sand) because coarser grained sediment provides better resistance against resuspension and stronger armoring capabilities. Because the existing sediment at the G-Cell sites is fine-grained, capping will alter the existing sediment type for a period of time. There is insufficient information to accurately predict the long term nature of the surficial sediments of the proposed disposal site, however, rough estimates of shoaling rates in the federal channel areas of Gloucester Harbor indicate that sedimentation occurs slowly, perhaps on the order of 0.25 in/year. This sedimentation rate is based upon the average amount of sediment accumulated in the harbor channels as derived from a comparison of historical bathymetric surveys (USACE, 1996). The specific shoaling rate of the G-Cell sites is not known at this time, but will be evaluated as part of the Final EIR.

Sedimentation rates will be increased if the final topography of the CAD cells is recessed below the existing bottom. Active sedimentation will likely fill the cell so that the surface sediments may eventually reflect the composition of the fine-grained sediment naturally deposited in the area. For example, CAD cells have been constructed at the bottom of the existing dredged navigation channel in the Mystic River (Boston Harbor) in the past few years. Consolidation of the sediments in the CAD cells resulted in a recessed topography that resulted in faster sedimentation at the top of the cells as compared to the surrounding area (USACE, 1999). At the surface of a coarse-grained cap, it is unlikely that species that prefer unconsolidated fine-grained sediments will recolonize as quickly or thoroughly. Thus some change in species composition could result through capping with sand. Nonetheless, sand-capped mounds in other projects have been recolonized successfully (SAIC, 1998) albeit by different species of organisms than those that had inhabited the previous fine-grained sediment.

Data collected from the G-Cell sites suggests that significant improvement to the present bottom habitat as a result of UDM disposal is unlikely. For instance, the sediment profile sample stations within the G-Cell sites showed high RPD values (>4 cm), suggesting good sediment aeration through tidal flushing, bioturbation by Stage III organisms (subsurface deposit-feeders), or a combination of these two factors. The mean Organism Sediment Index (OSI) was +11 or greater at the sampling stations within or proximal to the G-Cell sites, suggesting good or healthy overall benthic habitat quality.

After capping, the surficial sediments will be exposed to prop wash from vessels utilizing the channel and other areas. The presence of sand will reduce the potential for erosion from prop wash. Existing sediments are fine grained silts which have higher erodability than sand. A study is currently being conducted in Boston Harbor to determine the potential effects of prop wash on the integrity of CAD cell surficial sediments (cap). Results from this study will be applied to the design and management of the CAD cells.

6.1.2 Sediment Transport/Circulation in the Vicinity of the Disposal Sites

The circulation of water in coastal embayments such as Gloucester Harbor is influenced by a complex combination of forces produced by tidal fluctuations, wind, and density gradients. Factors such as wave height, geomorphology, and water-column stratification influence harbor current velocities, localized circulation patterns, and sediment transport. These factors are of particular concern in the siting and management of UDM disposal, since they will influence the long-term integrity of the cap material and the ability to isolate the contaminated sediments from the aquatic environment. The following discussion of potential impacts to sediment transport conditions from UDM disposal is based on analysis of historical hydrodynamic data collected from Gloucester Harbor (see Section 5.3). A more accurate and complete understanding and prediction of impacts will be possible once site-specific circulation field studies of tidal currents and waves have been conducted as part of the Final EIR.

Hydrodynamic data collected within Gloucester Harbor, albeit limited, suggests that the areas in the vicinity of the preferred disposal sites are low energy, depositional areas. In depositional areas, fine-grained sediments accumulate and tend to be stable for long periods of time. Disposal sites located in these areas should effectively contain UDM in properly designed facilities. In contrast, boulders, rock outcrops, and coarse-grained sediments are typically detected in erosional or non-depositional areas. Erosional forces, due to a combined action of tidal currents and waves, may transport sediment away from disposal sites. Ensuring the confinement of sediments over time is difficult in turbulent environments, therefore locating disposal sites in low energy containment areas is of primary importance.

Given the level of information available, it is difficult to assess the potential impact of storm-induced circulation patterns within Gloucester Harbor. Sites located in shallower regions may be more exposed to the effects of current scouring than those located at greater water depth which are relatively protected from meteorological conditions and surface wave-action. If storm-induced erosion does occur, the effects appear to be temporary as the sediment data from the G-Cell Sites suggests a long-term depositional environment. In addition, the placement of a sand cap will reduce the potential for sediment resuspension over the CAD cells. Sites located in protected coastal embayments are less likely to be exposed to significant storm-induced conditions because of the protection provided by surrounding land masses. Those areas sheltered within the harbor, such as the G-Cell sites, are more protected than sites farther offshore.

The Gloucester Harbor sites are most exposed to waves from Massachusetts Bay from the southwest. As a result, they may be most exposed during summer storms originating from the south since data collected from NOAA's National Weather Service, Beverly Station, indicates that prevailing winds from the S to SSW occur mostly during summer. Above average wind speed and gusting winds from the NE, conditions most likely to contribute to sediment resuspension, are highest during winter and fall. The orientation of Gloucester Harbor protects it from these northeasterly wind and wave events.

Water column depth at the disposal sites may play an important role in determining localized current velocities. Bottom currents experience increasing friction as they approach the sediment boundary layer. Given this phenomena, in-channel CAD/OD sites located at greater depth will be exposed to lower current velocities and less potential sediment resuspension forces than ATC sites at shallower depths. Coarser grained material also has the effect of greater frictional and gravitational forces holding the grains on the seabed. Thus a greater critical shear stress would be required to resuspend coarse-grain cap material than fine-grained silty sediments.

Hydrodynamic conditions may also be influenced by the construction of the containment cell created to dispose of UDM. In the case of Boston Harbor, an overdredged channel site was created which was moderately recessed from the surrounding channel sediments. The effect of this recessed pit was reduced water column mixing with surrounding waters, and active sedimentation within the pits (USACE, 1999). Navigational channels often experience some degree of reduced mixing via stratification due to temperature or salinity gradients. Bottom sediments within navigational channels can experience hypoxic or anoxic dissolved oxygen (DO) conditions due to the reduced vertical mixing and higher BOD from the accumulation of organic material. Reduced circulation may be beneficial from the standpoint of cap integrity (if required) since resuspension is less likely, but by the same effect, this localized condition may also contribute to reduced water quality (see next section). Over the long term, the final topography of the disposal cells will equilibrate with the surrounding area, therefore no long term effects on the hydrodynamics of the Gloucester Harbor system.

6.1.3 Water Quality

From prior overdredging projects, evidence suggests the impact to water quality from UDM disposal is short-term (USACE, 1996). These impacts typically include a localized decrease in DO, pH, light penetration, and increase in TSS and contaminant concentrations. Conditions typically return to ambient conditions within hours to days, depending on the amount and composition of the disposed material. For example, at the New London Disposal Site (NLDS), DO levels have been shown to return to predisposal concentrations from 15 minutes to 2 hours after disposal (U.S. Navy, 1979). NOAA (1977) reported that the DO content in the bottom waters at the NLDS dropped to about 48 percent of saturation and returned to ambient 84 percent within 40 minutes. However, surface and middle waters were hardly affected, therefore, it is likely that short-term negative impacts on water quality, particularly DO, would be greatest at the bottom of the water column. Even the short-term depletion of DO in the bottom water column should not significantly impact marine organisms. Lee et al. (1977) reported that the greatest drop in DO in a Galveston, Texas disposal project was 1.7 mg/l, but at no time did the level drop below 5.0 mg/l, which is the concentration at which many marine organisms become stressed.

Total suspended solids may increase dramatically due to the entrainment of fine material in the water column. A plume typically forms whereby material may be advected short distances from the disposal site. A reduction in DO is typical as common constituents of sediments are oxidized and organic material is metabolized by microbial activity at the sediment-water interface. High suspended solid concentrations have the effect of attenuating ambient light.

Water quality was extensively monitored in the Boston Harbor project during both dredging and disposal (ENSR, 1997). Monitoring results collected from the Boston Harbor project showed that the suspended sediment plume was limited to an area within 300 feet of the dredging and disposal activity (Figure 6-1).

No increases in TSS were measured at the reference area 1000 feet from the dredge, although short-term spikes were noted during passage of larger working vessels - tugboats, tankers and bulk carriers. There were no apparent differences in DO between the monitoring stations and the reference areas. All of the contaminants measured were below chronic aquatic toxicity levels except for mercury, which was measured at above chronic but below acute aquatic toxicity values during a limited number of monitoring events. Bioassay data also suggested no difference in impacts between the area dredged and a reference area based on the observed toxicity to the test organisms..

The final results from Phase 1 of the Boston Harbor project showed that the project met the Water Quality Certification compliance standards during the operations, and data collected during Phase 2 of the monitoring has suggested similar results (Steve Wolfe, personal communication).
There has been no dredging/disposal water quality monitoring in Gloucester Harbor. In addition, there is currently insufficient oceanographic data to predict water TSS effects, so the evidence from Boston Harbor (Figure 6-1) monitoring was used to estimate short-term impacts to water quality and aquatic resources in Gloucester Harbor. Figure 6-2 illustrates the predicted 300 foot area of turbidity as applied to the G-Cell preferred aquatic disposal site. Additional study, including oceanographic field studies to support water quality monitoring, will be done at a later date. Results of these studies will be presented in the FEIR.

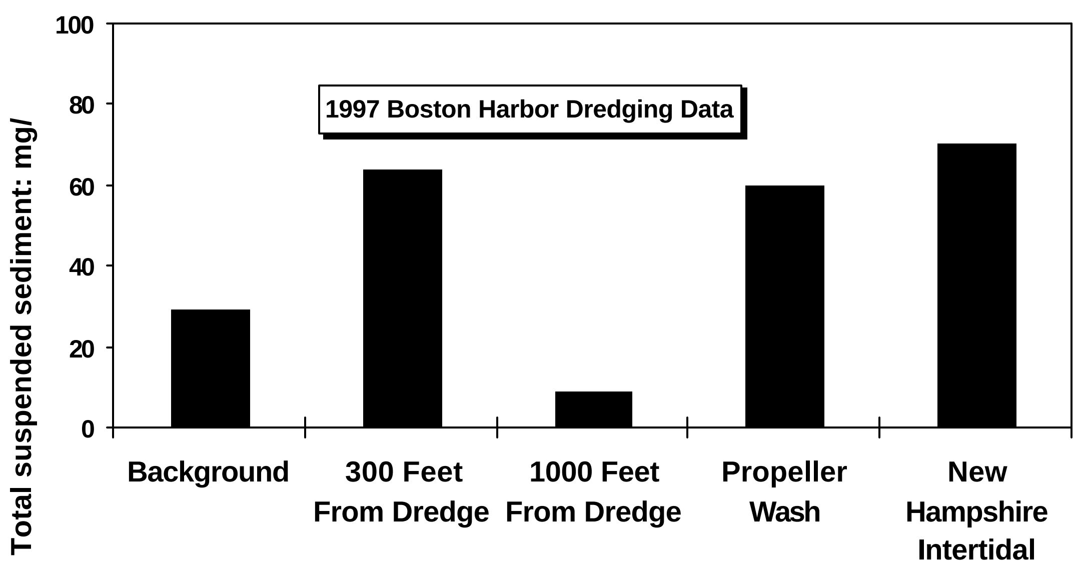


Figure 6-1: Total suspended sediment measurements from Boston Harbor dredging operations.

A concern, relative to long-term impacts to water quality, was raised during the Boston Harbor dredging project. To ensure acceptable water quality, successful capping needs to be employed. Successful capping, defined as the placement of a discreet layer of three feet of sand over the entire surface of the cell, proved more difficult than anticipated. Most of the CAD cell was covered with a highly variable thickness of sand, while the southern end had little or no cap material (USACE, 1999). Initial modelling suggested that tidal currents would influence the positioning of disposal barges. However, it was discovered during the monitoring that the dredged material dumped from the barges fell directly to the bottom (USACE, 1999). This accounted for the minimal cap material at the southern end of the cell.

In addition, density differences between the sand and the fluidized UDM may have resulted in a mixing of sand and UDM. This mixing phenomena was mitigated during Phase 2 of the project by allowing more time for UDM consolidation. Sediment that slumped from weakened cell walls may have contributed some of the fine grained/coarse grained mixture. Other construction measures, as recommended in USACE (1999), were employed during Phase 2. The result was a successful capping of UDM that satisfied DEP's water quality concerns (see MDEP June 13, 2000 letter to USACE in Appendix B).

The experiences of Boston Harbor will be applied to Gloucester Harbor to ensure that a successful ccapping operation is conducted and short and long-term adverse water quality impacts area avoided or minimized.

6.1.4 No Action

If the G-Cell sites and vicinity were not to be used as a disposal site, existing water quality and sediment transport conditions at and near the site would remain unchanged. Further information on the existing water quality conditions at the site will be collected and included in the FEIR.

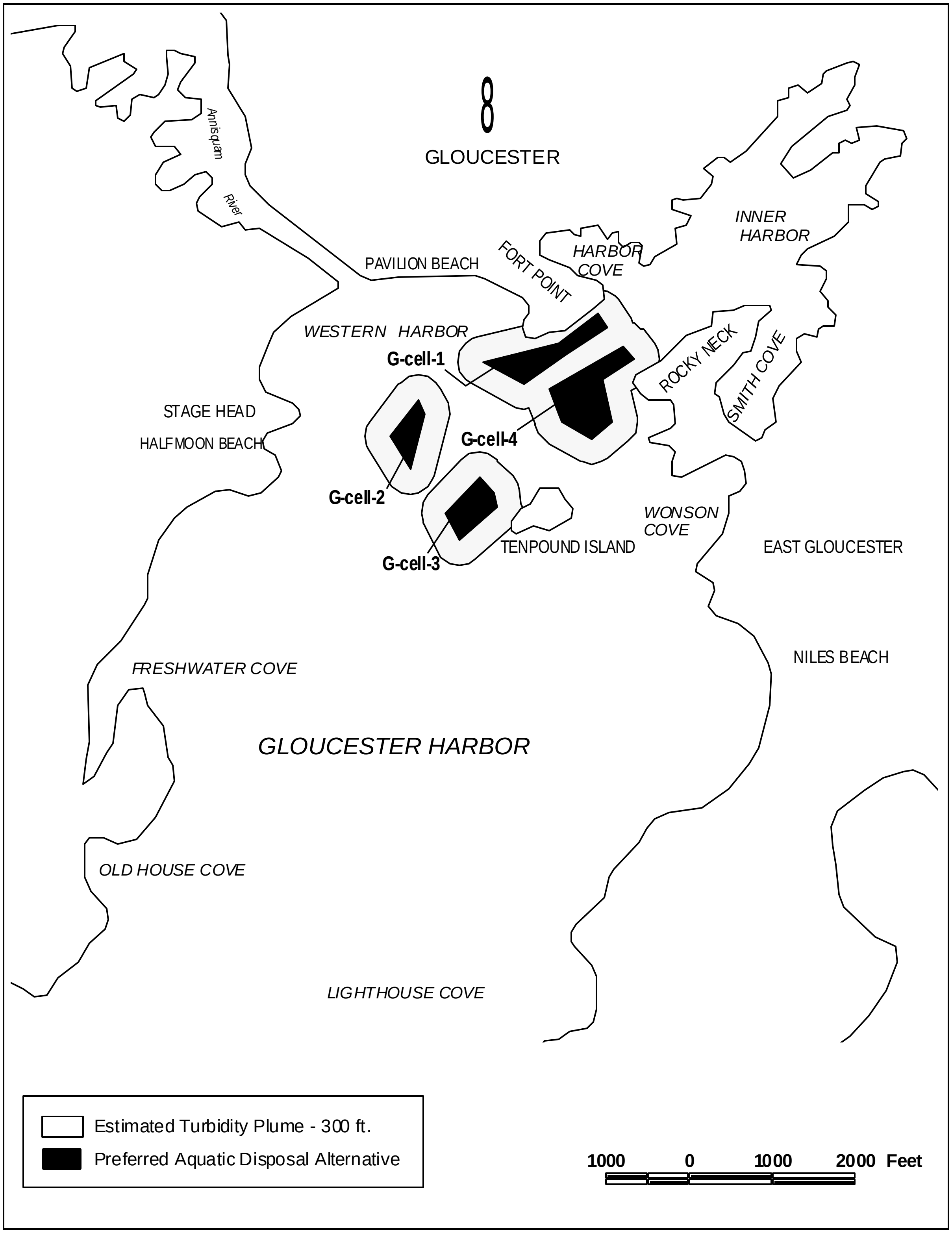


Figure 6-2: Estimated turbidity plume from dredging and disposal at the G-Cell sites.

6.2 Benthos

6.2.1 Benthic Invertebrates

Direct impacts to benthic organisms will occur as a result of cell excavation, disposal of UDM and placement of capping material. All these events are expected to result in temporary and reversible impacts to the benthos at the G-Cell sites. Excavation of the CAD cells will result in the mortality of the organisms residing on the bottom. Many of the larger, more mobile benthos such as lobsters and crabs will be able to flee the disturbed area. Following cell excavation, colonization of the substrate along the cell walls and bottom is expected via larval recruitment and emigration of benthos from the surrounding area (Santos and Simon, 1980), however, the rate of recolonization is difficult to estimate because little effort has been made to study the recolonization of subaqueous pits. Such a study may not be useful because the pit would soon be filled in with dredged material, so the "interim" benthic recolonization is a very short-term, relatively insignificant event.significance. Nevertheless, it is reasonable to assume that some recolonization would occur. The type and abundance of benthos would depend on many factors including physical substrate conditions, water temperature, dissolved oxygen content and salinity.

As UDM is placed within the excavated cells, impacts will occur to the benthos. Some organisms will be buried and unable to survive, while burrowing specialists will likely survive. Vertical migration of benthic invertebrates, particularly crustaceans, polychaetes and molluscs, following burial has been demonstrated by Maurer et al., (1982) and Nichols et al. (1978). These studies showed that burrowing organisms can survive repeated burial events by vertically migrated to the sediment surface. Survival rates depended primarily on burial depth. For example, in the Nichols et al. (1978) study, organisms were able to burrow upwards through 28 cm (11 in). It is reasonable to assume that repeated burial will weaken some organisms, resulting in direct or indirect (easier predation) mortality.

Both the excavation and disposal events are likely to result in adverse impacts to benthic organisms due to constant perturbation of the substrate for continuous dredged material disposal discharges. However, as discussed below, these impacts will be temporary. The long term effect of having CAD cells in Gloucester Harbor on the benthos is more important. These long term effects are discussed below.

There will be a change in substrate conditions as a result of the placement of the sand cap atop the UDM. As suggested by the Boston Harbor CAD cell project, the cap will consist of primarily sand, however some silt may be introduced into the cap from slumping of the cell walls and/or from active sedimentation occuring within the harbor (USACE, 1999). The result will be a primarily coarse grained substrate with a small fraction of silt/clay.

The specific nature of the benthic recovery process will largely depend on the timing of the disposal operation, local habitat characteristics and which species exist in the surrounding areas to form source populations for recolonization. Typically, the first forms to arrive to a recently disturbed area are "opportunistic" (Stage I) species such as *Streblospio benedicti, Polydora ligni* and *Capitella sp*. Total macrobenthic densities during the initial stages of recolonization will likely be high and species diversity will be low (Grassle and Grassle, 1974: McCall, 1977; Kaplan et al., 1975; Jones, 1986; Zajac and Whitlatch, 1982). This situation may actually act to enhance the food supply of bottom feeding species (e.g. winter flounder) (Rhoads et al., 1978).

Two important pieces of information are needed to better predict the benthic impact at the G-Cell sites. First, the benthos, type and abundance needs to be assessed. This will be done at a later date and the results will be included in the Final EIR. Also, the chemical nature of the existing substrate should be characterized to compare existing conditions with post-cap conditions. The sediment profile survey (Maguire Group Inc., 1999) did determine that overall benthic habitat quality is high, suggesting that contaminant concentrations of the sediments are relatively low. However, it is sometimes difficult to establish a correlation between chemical concentrations and overall benthic habitat conditions as evidenced by good benthic habitat quality at candidate site S6-CAD, which has relatively high concentrations of inorganic and organic contaminants (Maguire Group Inc., 1999).

The only benthic invertebrate data which are site-specific to G-Cell sites were obtained by the REMOTS® sediment-penetrating camera, and the discussion of environmental consequences to benthic organisms is therefore based mainly on this information, however, other studies of disposal sites in the northeastern United States have been reviewed.

The only REMOTS® stations within the preferred alternative G-Cell sites in Gloucester are G-77 (within G-Cell-1) and G74 (within G-Cell-3). The OSI (See Section 5.1.3.2) for these G-Cell sites indicates good overall benthic habitat quality. The OSI values at stations 77 and 74 are +11, indicative of good habitat quality. Other stations proximal to the G-Cell sites had similar values (+11 to +13). However, impact within the G-Cell sites will not be significant for the harbor or region as a whole, and rapid recolonization of the cleaner surface sediments of the cap is expected (Rhoads et al., 1978; Rhoads et. al., undated).

Sand capping may alter benthic conditions, therefore favoring other types of organisms. At the Central Long Island Sound Disposal Site (CLISDS), Rhoads et al. (undated) observed that a sand cap, with trace silt, was colonized by the same organisms (polychaetes and bivalves primarily) as a nearby site that consisted of a silt cap, suggesting that larval recruitment and emigration from surrounding areas was the major factor in recolonization. This implies that the colonization of the sand cap at the G-Cell sites, will consist of organisms that live in the surrounding area. However, over the long term, species diversity and abundance may be skewed towards those organisms that prefer sandier habitat. Such a situation may increase diversity to the overall Gloucester Harbor ecosystem, which is dominated by a soft silt and mud substrate.

6.2.2 Commercially and Recreationally Harvestable Mollusks

The G-Cell sites do not contain any known commercially or recreationally active shellfish beds, although the nearby rocky intertidal zones of Ten Pound Island and Rocky Neck may be inhabited by blue mussels. These shellfish are not commercially harvested. In fact, all Gloucester Harbor waters north of the Dog Bar Breakwater are closed to commercial shellfishing. Figure 6-3 was developed based upon discussions with the local Shellfish Constable in which general areas of known shellfish habitat were mapped. Additional field sampling would be needed to confirm the presence/absence of these resources within and near the proposed disposal sites. Recreationally harvested shellfish such as soft shell clams and mussels are generally found in the more shallow, near-shore locations. With the exception of small areas of blue mussel and soft shell clam near the southwest shores of Ten Pound Island and Rocky Neck, most major areas of shellfish are found outside of the G-Cell footprints and beyond the expected 300 foot area of temporary impact (Figure 6-3). G-Cell-1 is 955 feet from rocky intertidal zones inhabited by blue mussels. Likewise, G-Cell-2 is 1,482 feet from rocky intertidal zones inhabited by blue mussel. G-Cell-3 lies 300 feet from blue mussel habitat. The footprint of G-Cell-4 overlaps approximately 33,628 square feet of shellfish habitat (soft shell clam and blue mussel). Within G-Cell-4, there will be a temporary loss of shellfish habitat. Given that recolonization of disposal mounds is influenced, at least in part, by the benthos of the surrounding area and the larvae in the water column (Maurer et al., 1982a,b; Rhoads et al., 1978), soft shell clams are expected to recolonize the area. If blue mussels are indeed present within G-Cell-4 (further sampling needed for verification), then the lack of hard substrate (rock, gravel) would preclude them from recolonizing in appreciable numbers. The recolonization rate, however, is expected to occur in stages (Stages I, II, III) and higher trophic level benthos such as clams and mussels are typically part of the Stage II, II/III assemblage (Rhoads et al., 1978). Stage I organisms will recolonize first, followed by succession to Stage II and Stage III. Under normal conditions, it has been hypothesized that the time-span of full recovery from distrubance should be on the order of the life spans of the dominant species of the benthic community (McCall and Tevesz, 1983). Assuming that soft shell clam and blue mussel are the dominant species (this must be verified by sampling), then one would predict the recovery process to be 2-5 years. Monitoring will be needed to track the progress of recovery.

6.2.3 Lobsters

The survey of early benthic phase (EBP) and juvenile lobsters in Gloucester in November 1998 bisected the G-Cell sites and vicinity (Figure 5-10). The channel and adjacent G-Cell sites did not contain newly-settled lobsters. Some juveniles of 31 to 60 mm carapace length were found, but these are considered capable of movement toward suitable cover in the event of disturbance of their habitat. The lack of EBP lobster indicate the area in and near the proposed CAD cells are not settlement habitat for lobster.

A portion of G-Cell Sites 1 and 4 lie within the Inner Harbor. The Inner Harbor was found to have a high density of marketable lobster (NAI, 1999). Adult and juvenile lobsters were found at every transect (Figure 5-13). The catch per three day trap set value was determined to be 2.9; compared to the outer harbor value of 0.5 or harbor wide of 0.9. However, adult lobsters will likely be able to either avoid the dredging and disposal activities or, if buried during disposal, able to vertically migrate to the sediment surface, as will other strong burrowers [(Maurer et al., 1982b (laboratory study); Nichols et al., 1978 (in-situ SCUBA observations)]. Although the soft silt/mud subsrate conditions which dominate the harbor are not preferred habitat for lobster (Hudon, 1987; Wahle and Steneck, 1991), the results of the most recent sampling (NAI, 1999) indicate that adult and juvenile lobster density is relatively high. This may be due to several factors including the fact that lobstering is not allowed in the inner harbor. Dense lobster habitation, however, can occur in muddy substrates (Berril and Stewart, 1973; Berrill, 1974; Botero and Atema, 1982). Because of the abundance of lobster in the immediate area, emigration of lobsters from outside the disturbed area is expected. Such movement has been recorded at disposal sites in New England, including the NLDS[NOAA 1975 (*in-situ* observation)]. Larval recolonization of the sand-capped CAD cell would likely be another means of lobster community regeneration (Santos and Simon, 1980).

MCZM will continue to coordinate with DMF to address potential impacts to lobster habitat. Monitoring of lobster recovery may be required and, if habitat loss is documented, mitigation may be required.

6.2.4 No Action

If there is no action, sediments will remain in their present condition. The nature of the benthos would not be expected to change in any predictable way.

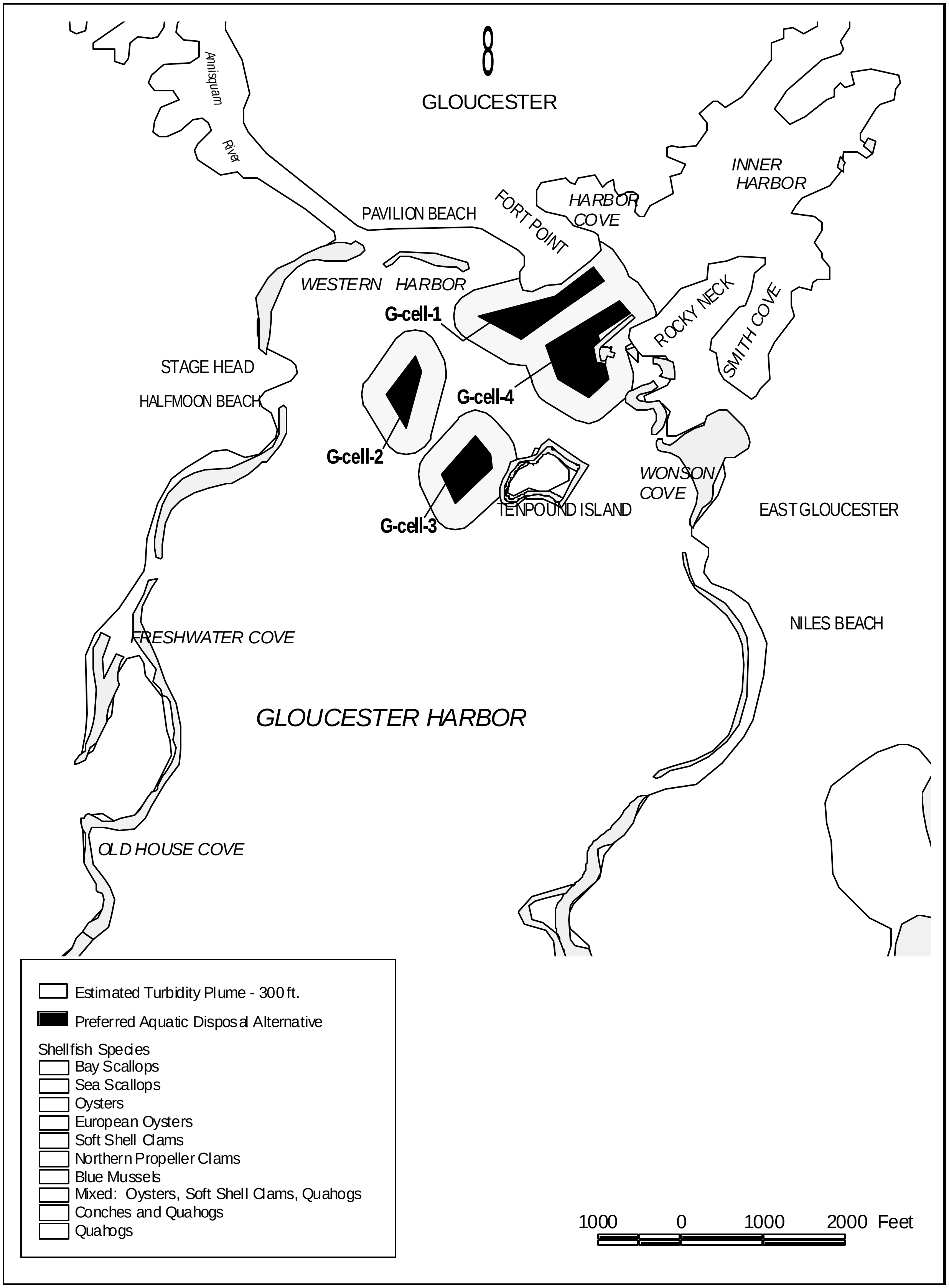


Figure 6-3: Estimated turbidity plume and shellfish resources. (Source: Gloucester Shellfish Constable).

6.3 Finfish

Dredge disposal will have an impact mainly on those activities and life stages of fishes which are dependent on the bottom. Little to no impact will occur to pelagic fishes, since they are very mobile and can readily avoid the temporary areas of turbidity in the water column . Also, many fish popular with sport fishermen, such as cod, striped bass, and tautog are found mainly near shoal, rocky areas and ledges, rather than in the relatively featureless and muddy channel and adjacent-to-channel areas proposed for dredge disposal (Koutrakis, 1997). Therefore, disposal should have little if any impact on these species. Flounder, one of the most important fishery species in the area, are bottom spawners with demersal eggs and, although they have pelagic larvae, live on the bottom for most of their life cycle. They spawn during February and March in the Massachusetts Bay region, and the eggs hatch in about 15 to 18 days (Bigelow and Schroeder, 1953). There could be an adverse impact on spawning and egg development from dredge disposal unless disposal is restricted during this time, which is typically February through May.

Little is known about the specific fishery resources at each G-Cell site. However the fishery of the Harbor, in general, has been characterized from various studies (Jerome, et. al., 1967; Normandeau Associates, Inc., 1999). As described in Sections 4.8 and 5.2 , the value of the G-Cell sites and vicinity as a spawning and nursery area is rated as moderate to high for winter flounder, pollock, and Atlantic cod. Bigelow and Schroeder (1953) report that winter flounder are most often caught on muddy sand, but may be found on a variety of bottom types. They spawn on sandy bottom, therefore, the presence of a sandy bottom at the CAD cell sites may increase spawning activity of winter flounder..

The sediments at the G-Cell sites lack the heterogeneity that is the preferred habitat for bottom-dwelling fish, however, if the site is capped with sand or a mixture of sand and silt, then the area may be become more attractive for fish spawning and nursery activities. Over time, silt will accumulate over time and the substrate will revert back to its original condition.

Short term impacts to fish at the G-Cell sites would occur during excavation of the CAD cells and disposal of UDM. Fish are capable of fleeing the area during these events and would then return to the area once these activities cease. G-Cell sites have been identified as suitable habitat for juvenile Atlantic cod, pollock, winter flounder, short horn sculpin, and rock gunnel. The egg, embryonic, and larval stages of winter flounder (and most other fish) are most susceptible to mortality and injury (Bannister et al., 1974; May, 1974; McGurk, 1986; Black et al., 1988; Blaxter, 1969, 1974; Chambers et al., 1988). These impacts are unavoidable, but short term in nature (minutes or hours).

6.3.1 No Action

If there is no action, fisheries will remain as at present, with the exception of changes not related to dredge or disposal of UDM, such as those caused by natural cycles or over-fishing. Although some relative abundances of fish species may have changed, the basic species richness has remained relatively unchanged during the past 30 years.

6.4 Wetlands

6.4.1 Coastal Wetlands

As reported in Section 5.2.5.1, there are no Federally designated coastal wetlands or salt marshes within the vicinity of the G-Cell sites, therefore there will be no effect on these resources in the harbor. The limited salt marshes, at the southern end of Freshwater Cove and along the Annisquam River, are beyond the influence of dredging and disposal (approximately 300 ft.), and therefore would not be affected (Figure 6-4).

However the entire area within the footprint of the G-Cell sites lie within state regulated wetlands. These areas are classified as "Land Under Ocean" according to the DEP wetland regulations. The G-Cell-1 site lies within 100 feet of state regulated "Rocky Intertidal Shore" jurisdictional wetland. The nearest state jurisdictional wetland to the G-Cell-2 site is "Coastal Bank Bluff or Sea Cliff" located approximately 1,220 feet to the west. "Rocky Intertidal Shore" state jurisdictional wetlands lie within 521 feet east of G-Cell-3 and G-Cell-4 lies within 471 feet west of "Coastal Bank Bluff or Sea Cliff" wetlands.

Land containing shellfish is also a resource protected under the Massachussets Wetlands Protection Act. Shellfish impacts are discussed in Section 6.2.2.

6.4.2 Submerged Aquatic Vegetation

Submerged aquatic vegetation (SAV), equivalent to eelgrass beds in this area, are not located within the G-Cell sites. The nearest recorded eelgrass beds are located in the Western Harbor. One such area lies approximately 740 feet northwest of G-Cell-1. Another lies approximately 1,155 feet northwest of G-Cell-2 (Figure 6-4). These beds lie beyond the expected 300 foot turbidity zone. One of the many functions and values of eelgrass beds is that they tend to filter suspended sediments from the water column by reducing current and wave energy. The impact of dredging and disposal, depends on many environmental conditions including current speed and direction, tides, UDM disposal volume, sediment water content, and other factors. These factors will be included in modeling efforts to be completed and included in the FEIR. At that time, a better estimate of the impact (if any) to these eelgrass areas will be made.

6.4.3 Intertidal Habitats

The nearest intertidal mud flats to the G-Cell sites are approximately 460 feet north of G-Cell-1 and 420 feet southeast of G-Cell-4. Both mud flats lie beyond the expected influence of dredging and disposal.

6.4.4 No Action

If there is no action, the nature of the bottom will not change beyond long-term natural effects such as siltation which is estimated at 31 cy/ac/yr within the main channel (USACE, 1995). There will be no effect on salt marshes, submerged aquatic vegetation or intertidal mud flat.

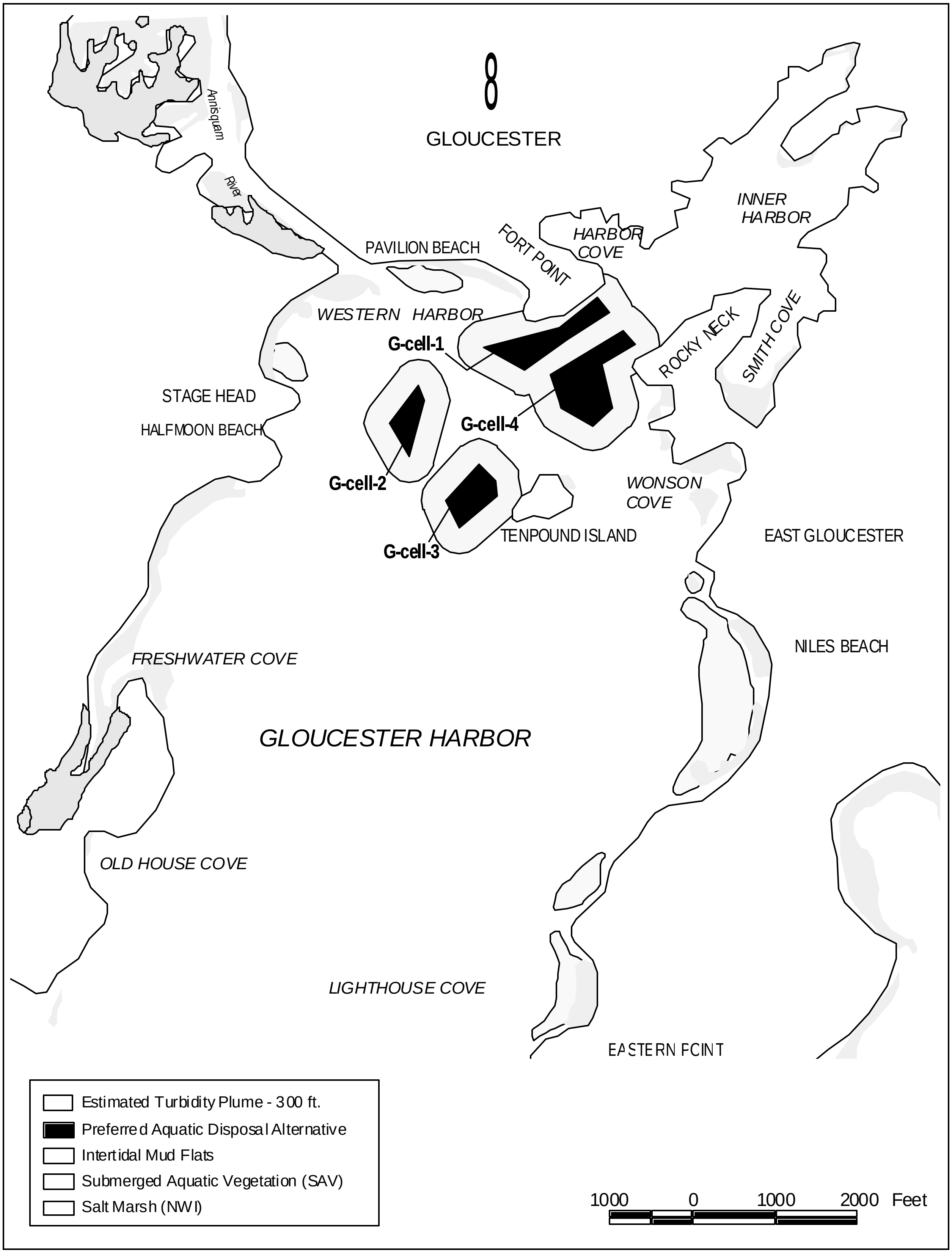


Figure 6-4: Estimated turbidity plume and submerged aquatic vegetation, salt marsh and intertidal mud flats.

6.5 Wildlife

6.5.1 Avifauna

Tidal flats are important shorebird feeding habitat. Since no tidal flats are located in close proximity to the preferred alternative disposal sites, impacts to shorebird habitat from suspended sediments or covering of feeding areas via siltation will be negligible. No loss of breeding habitat will occur from either dredging or disposal of UDM.

Depending on the species, seabirds such as gulls and terns forage in a variety of marine habitats such as the open water surface, along beaches, on tidal flats, within salt marshes, or within a combination of these habitats. Certain species are well adapted to human activity and may forage in urban environments. No loss of seabird foraging or breeding habitat will occur during dredging. However, dredging of marine sediments may cause temporary suspension of benthic invertebrate macrofauna in the upper water column. Here the invertebrates may be eaten by gulls or terns. Benthic invertebrate macrofauna may also be gleaned by gulls from excavated sediment temporarily stored on scows.

The various species of waterfowl (loons, grebes, ducks, etc.) that frequent Gloucester Harbor reach their greatest concentrations in winter. They tend to congregate in areas of abundant food supply proximal to shellfish beds, and areas where marine fish congregate such as rocks, ledges and reefs. The dredging and disposal of marine sediment will either avoid these areas (shellfish beds) or will have minimal impact to these areas (submerged structure). Fish concentrations will avoid the temporary disturbances to the water columns during dredging and disposal of marine sediments. Therefore loss of waterfowl foraging habitat is expected to be negligible. No loss of waterfowl breeding habitat will occur since all dredging and disposal will occur in open water areas.

6.5.2 Marine Mammals

As discussed in Section 5.3.5.2, the marine mammals of the region, with the exception of the harbor seal, are unlikely to be found in the vicinity of the G-Cell sites and therefore should not be affected by dredging and disposal activities. Furthermore, the sheltered and undisturbed rocky ledges preferred by harbor seals will not be impacted by disposal operations. In addition, seals are very mobile and easily able to avoid the limited area of the harbor impacted by disposal. The fish on which they feed will tend to be most abundant near the rocks and ledges where sport fishing is most productive, rather than at the muddy bottom of the preferred disposal site.

6.5.3 Reptiles

Sea turtles, the only marine reptiles of the area, are not an important part of the fauna in the Gloucester area and are rarely seen in the harbor. Any effect on the water column from dredge disposal will not extend to the open ocean where these animals live, therefore none of the preferred alternative disposal scenarios will affect marine reptiles.

6.5.4 Endangered Species

As discussed in Section 5.3.5.4, five whales and two turtles, federally listed as endangered, occur in the ocean off Gloucester. These species are not known to occur within Gloucester Harbor, or close enough to be affected by any indirect impacts of the project, such as turbidity or release of contaminants. Therefore, the project will have no impact on any endangered or threatened species.

6.5.5 No Action

If there is no action, the wildlife resources of the area, including endangered species, would not be affected.

6.6 Historic and Archaeological Resources

The G-cell sites would be constructed entirely under water in Gloucester Harbor. This fact, combined with the distance to the nearest significant land-based historic resource, Stage Fort Park to the west and Rocky Neck Artist colony to the southeast, will result in no impacts to shore-side historic resources in Gloucester.

However, there is potential for impacts to yet undiscovered underwater historical and archaeological resources, as discussed below.

6.6.1 Historical Shipwrecks

The nearest known shipwrecks, the Chester Poling and the Nina T (Figure 5-20), are outside of Gloucester Harbor and, therefore, outside the footprints and associated zone of influence of the G-Cell sites. However, the historical record of shipwrecks in Gloucester Harbor is not complete, therefore, there is potential for historic shipwrecks anywhere in Gloucester Harbor, including the G-Cell sites. Because the Inner Harbor and anchorage areas have been previously dredged, the likelihood of encountering the remains of shipwrecks during future dredging, is lessened. Nevertheless, a field survey has been proposed to determine if there are shipwreck remains at the G-Cell sites. Refer to Appendix I for details.

6.6.2 Archaeological Resources

Gloucester Harbor has a long maritime history and the harbor is considered to be an area of archaeological sensitivity. The preferred aquatic disposal site is not located in the vicinity of any known archaeological resource in Gloucester Harbor, although there is limited information on Native American sites within or proximal to the Harbor. Because of this paucity of information, and the fact that the G-Cell sites are near-shore and may have once been above sea level, there is a possibility of previous Native American activity in the area.

Previous sub-bottom profiling data indicate that the area has an irregular bedrock which is typically covered by 0-30 feet of glacially deposited medium sand and some organic and clay sediment. Remains of any sites would be extremely hard to locate under the sediment in the survey area. Remote sensing surveys will generally not indicate a prehistoric site in this type of topography. Locating prehistoric Native American sites would require archaeological trenching of each proposed impact area.

6.6.3 No Action

If the preferred aquatic disposal site in Gloucester Harbor is not constructed, there would be no further disturbance of the site and therefore no impacts to extant underwater historic or archaeological resources. Any shipwrecks or colonial or aboriginal artifacts, if present at the site, would not be discovered, recovered, recorded, or preserved.

6.7 Navigation and Shipping

As detailed in Section 5.2.8, existing commercial navigation in the harbor is largely divided into three primary categories, traffic related to commercial fishing and fish processing industry, other maritime vessels and recreational boats. Construction and use of The G-Cell Sites will pose minimal impacts to existing navigation and shipping in the Harbor, provided disposal activities are managed and coordinated closely with the Harbormaster. Issuance of navigational advisories will help place infrequent maritime harbor visitors on notice of disposal activities. Additionally, because disposal will only take place for one season during each planning horizon, opportunity for adequate public notice to frequent harbor users is provided.

Construction of the CAD cells adjacent to channel has the benefit of avoiding interference with container ships as they enter the Inner Harbor area and dock at the cold storage facilities. Many of these ships are deep draft when fully loaded, and enter the harbor during higher tide conditions to ensure adequate navigation depths. Therefore CAD cell excavation, dredging or material disposal activities during the high tide periods when container barges are active in the area could interfere with safe navigation of these vessels. This could be mitigated by placement of buoys around the work area and notifications to mariners through Coast Guard advisories. As noted above, close coordination with Harbormaster will be essential to maintaining the smooth flow of vessel traffic within the Harbor.

The nature of the construction of the disposal cells will not result in any reduction of navigable depth in Gloucester Harbor. The three foot thick sand caps proposed for all of the disposal cells of the preferred alternative sites will maintain existing bottom depths and not protrude into the water column any higher than existing conditions. After the completion of disposal of activities for each planning horizon, navigational and shipping conditions in the vicinity of the disposal cells will return to preexisting conditions.

In the late 1980s the USACE conducted a feasibility study for the proposed deepening of the federal channel from 20 feet to 26 feet (mlw). The study resulted in a negative cost-benefit ratio (i.e. the benefits of the deepening did not outweigh the need for deeper water). However, if economic conditions change, future deepening may resurface as a desire of the City. The presence of CAD cells that lie within the federal navigation channel should not prevent future deepening. G-Cell-4 would be located partially within the federal channel. The authorized depth of the channel is 20 feet (mlw), but existing depths are greater, ranging from 24-26 feet (mlw). As proposed, the CAD cell would be filled and graded back to its original depth (24-26 feet mlw).

6.7.1 No Action

If the preferred aquatic disposal site in Gloucester Harbor is not constructed and UDM from dredging projects in the harbor is not able to be disposed cost-effectively, maintenance and planned improvement dredging projects may not be undertaken. Historical rates of sediment accumulation will continue and navigation channels, anchorage areas, turning basins, marine terminals, marinas and boat ramps in the harbor would gradually silt in. Navigation would become increasingly difficult in the harbor.

6.8 Land Use

There would be no direct or indirect permanent impacts to land use in Gloucester Harbor as a result of construction or UDM disposal activities at the preferred aquatic disposal site. The G-Cell Sites are an aquatic site, constructed entirely under water and therefore not visible from near shore areas.

Shoreline land use in the vicinity of the G-Cell sites is a mixture of residential and commercial (Figure 5-2). Dredging and disposal, would involve the use of heavy machinery such as cranes and barges, therefore, residential areas may bear temporary noise impacts during a typical 8-hour working day.

Although there are nearby recreational areas (e.g. municipal parks and various marinas), these are most active in the warm-weather months when dredging and disposal would cease. Therefore, the activities at these sites would not be negatively affected.

Indirect impacts from the construction of the G-Cell Sites are expected to be positive. The presence of a cost-effective solution to disposal of UDM from harbor dredging projects will help to maintain the economic viability of the existing marine facilities and associated recreational and commercial land uses along the Gloucester Harbor shoreline.

Construction of the preferred aquatic disposal site in Gloucester Harbor is consistent with the stated goals of the Gloucester Harbor Plan. The presence of the proposed disposal site will encourage the anticipated public and private dredging projects in the harbor to be undertaken and will provide a cost-effective, local disposal option for the UDM from those dredging projects. The Gloucester Harbor Plan encourages the finding a solution for the disposal of UDM associated with the public and private dredging projects identified in the Harbor Plan.

6.8.1 No Action

If the preferred aquatic disposal site is not constructed, the existing industrial land use in the vicinity of the disposal site will likely remain unchanged for the foreseeable future. Over the long term, if planned private and public dredging projects in Gloucester Harbor are not undertaken due to the lack of a cost-effective disposal option for UDM, then water-side land use patterns along the Gloucester shorefront may change (e.g. industrial/commercial land use may decline due to reduced access to shipping ports). Access to recreational boat slips may also decrease.

6.9 Air Quality / Noise

6.9.1 Air Quality

Air quality impacts from the construction of the CAD cells and UDM disposal activities at the preferred aquatic disposal site in Gloucester Harbor are expected to be minor, and temporary in nature. Impacts will result from the operation of heavy construction equipment, such as dredges and tugboat engines, and from the potential release of volatile organic compounds and the escape of odors from temporary storage of UDM on barges.

During construction, operation of the clamshell dredge will result in emissions from the diesel engine of the dredge. Among the chemicals emitted will be NO_x and VOCs, two EPA Priority Pollutants that are precursor of ozone. Emissions of these pollutants would be minimized through the use of proper emission controls on the diesel engine, the use of equipment that complies with emission standards, and by the temporary nature of the activity. All dredging equipment will be equipped with proper air pollution control equipment and mufflers as required by DEP regulations.
A study done by the U.S. Navy (1995) estimated the total emissions of VOC and NO_x from a 1.1 million cy dredging and disposal project that was completed within one dredging season (approximately 4 months). It was forecast that 0.9 tons of VOC and 6 tons of NO_x would be emitted from the various construction equipment (barges, tugs, cranes). Similar emissions would result from the dredging and disposal in Gloucester, but these emissions would be distributed over a 20-year period.

To construct the proposed aquatic disposal site, silts from the harbor bottom must be dredged and temporarily stored on barges or on land until this material is disposed of in the CAD cell. This material is assumed to be unsuitable for unconfined ocean disposal. The construction process for the CAD cell is illustrated in Figure 4-1. Depending on the location of the temporary stockpile and the length of time it is necessary to stockpile the material, minor air quality impacts may result. Other factors that determine the degree of air quality and odor impacts include temperature (colder temperatures slow bacteria growth on dredge material and lessen odor impacts), wind direction, and proximity of residential areas.

Odors, occurring primarily as a result of the anaerobic decomposition of organic materials in the dredged sediments, may pose objectionable impacts. This can be controlled, if necessary, with the mixing of lime (which neutralizes odors) into the UDM.

Volatilization of organic compounds in the UDM may occur if the temporary stockpiling occurs over a period of time sufficient to result in the drying of the UDM. A covering of water over the UDM prevents the volatilization of organic compounds in the UDM. Overall, volatilization is not expected to be a concern as the duration of the temporary stockpiling activities is expected to be minimal, preventing the complete drying of the UDM stockpiles.

6.9.2 Noise

CAD cell construction and UDM disposal activities will result in temporary and localized minor noise impacts at the preferred aquatic disposal site nearby waterfront locations such as Fort Point and Rocky Neck. Given the mixture of abutting industrial and residential land use, this potential impact is considered relatively minor since local residents are somewhat accustomed to sounds of harbor commerce. Residential areas along Rocky Neck may be more sensitive to noise since this area is an artist colony and relies on tourism for economic sustenance. The use of construction and dredging equipment that is properly equipped with mufflers, and by conducting CAD cell construction and UDM disposal activities during daytime hours, these impacts will be reduced or minimized.

6.9.3 No Action

If the preferred aquatic disposal site is not constructed in Gloucester Harbor, there will be no additional temporary air quality, odor and noise impacts in the vicinity of the disposal site.

6.10 Recreational Resources

The nearest shoreline recreational areas include Pavilion Beach to the north, Fort Point Park to the west, and marina/mooring areas of Rocky Neck to the southeast (Figure 5-12). Construction of the G-Cell Sites in Gloucester Harbor will not directly impact these recreational resources. Indirect impacts may include temporarily increases in noise. CAD construction and UDM disposal would occur in late fall and winter months, thus avoiding the peak seasons for recreational activity.

Minor impacts to both recreational boaters and recreational fisheries resources may result during the construction of the CAD cell and the UDM disposal operations. Recreational boaters are numerous in Gloucester Harbor, and the boaters would have to avoid the dredge and dump scows during activities at the proposed disposal site. Also, a portion of G-Cell-4 lies within an area that is used for recreational boat moorings. The specific plan to minimize impacts to the mooring areas will be addressed in the CAD Management Plan, which will continue to evolve in the FEIR and subsequent permitting phases of the DMMP. Moorings would have to be removed during CAD cell construction and UDM disposal.

Although the proposed disposal site is not located within an area known to be favored as a destination by recreational fisherman, some of the sub-cells are adjacent to submerged topographic features such as rocks, ledges and reefs. These features tend to be inhabited by recreational fish species which are attracted to the features for cover. For instance, G-Cell-1 lies proximal to Babson Ledge, G-Cell-3 to Mayflower ledge, and G-Cell-4 to Black Rock Reef. The presence of the dredge equipment and dump scows for dredging and disposal of UDM in the vicinity may temporarily drive fish may avoid the area. The temporary duration of these activities and the presence of other nearby recreational fishing areas in the harbor will minimize these impacts.

6.10.1 No Action

If the preferred aquatic disposal site in Gloucester Harbor is not constructed, there will be no direct impacts to recreational resources in the harbor. However, over time, the lack of a cost-effective disposal site for the disposal of unsuitable dredge material from dredging projects in the harbor may result in the loss of moorings at harbor mooring areas and slips at local marinas or access to public boat ramps, impacting recreational boaters in the area.

6.11 Economic Environment

Implementation of the preferred aquatic disposal alternative for Gloucester Harbor is projected to cost between approximately $14.2 and $15.1 million (2000 dollars) over the twenty-year planning horizon. A detailed cost estimate for the preferred alternative is included at the end of Appendix C - Estimated CAD Cell Construction Costs.

As Gloucester Harbor enters the next century, economic development activity for the Harbor is expected to center seafood industries and tourism and recreational activities. In addition to viewing many examples of the early period and post-colonial architecture of Gloucester and visiting key tourist destinations including the Hammond Castle, Beauport Museum, the Schooner *Adventure*, and the Cape Ann Historical Museum. Tourists are also drawn to the Harbor's historic art colony at Rocky Neck, and to waterfront areas to board chartered vessels for deep sea fishing and whale-watching. The above attractions draw thousands of visitors to Gloucester on an annual basis. Another significant contributor to the economy of the harbor comes from recreational boating activities.

The *Gloucester Harbor Plan* projects that implementation of the all the improvements noted will result in an estimated total increase of 385 jobs, 150 additional seafood industry jobs and 235 new cultural and visitor activity jobs. The estimated increase in dollars associated with Plan improvements is estimated at an additional $30,000,000 for the seafood industries and $9,385,000 for cultural and visitor activities sectors for a total boost of $39,385,000 into Gloucester's economy (Gloucester Harbor Plan Committee, 1999). Table 6-1 highlights projected economic impacts associated with fully implementing the recommendations of the *Gloucester Harbor Plan.*

Table 6-1: Projected Harbor Economic Impacts - Harbor Plan Scenario

	Approximate # of Jobs	Estimated $ Generated
Estimated Financial Benefit over Existing Conditions		
Seafood Industries	150	$30,000,000
Cultural and Visitor Activities	235	$9,385,000
Totals	385	$39,385,000
Estimated Resulting Total Economic Benefit		
Seafood Industries	2650	$730,000,000
Cultural and Visitor Activities	665	$29,385,000
Totals	3315	$759,385,000

Source: Gloucester Harbor Plan, 1999

In addition to the economic benefits and effects discussed above, the *Gloucester Harbor Plan* also projects additional benefits of fully implementing the Plan including $3,770,000 of payroll and $450,000 in annual tax revenue associated with the newly created cultural and visitor activities sector, which alone, would achieve a five to seven year pay back period of the $13.4M Plan implementation costs. The added jobs to the seafood industries is estimated to generate an annual payroll of $4,000,000 (Gloucester, 1999). The Harbor Plan demonstrates the potential economic benefits to the City of implementing its recommendations, including identified dredging projects. The technical assistance provided by MCZM in developing a cost-effective, environmentally sound disposal option for UDM associated with identified dredging projects will aid in the preservation of maritime activities in the port and help achieve the economic development goals of the City of Gloucester and the Commonwealth.

6.11.1 No Action

If a disposal option for UDM is not identified, dredging projects essential to maintaining the fishing and maritime industries in Gloucester Harbor could be significantly delayed with negative economic impacts upon the City. No action would limit the City's ability to implement the Harbor Plan's vision of maintaining a "working harbor" and compromise the fishing and maritime industries ability to remain competitive, and in Gloucester.

7.0 COMPLIANCE WITH REGULATORY STANDARDS AND REQUIREMENTS

This section includes a description of the primary regulations associated with the implementation of the preferred alternative aquatic disposal sites. Compliance with state standards and regulation, and federal standards and regulations for aquatic disposal are discussed as they relate to the preferred alternative.

7.1 Compliance with State Standards/Regulations - Aquatic Disposal

7.1.1 Wetlands Protection Act and Regulations (310 CMR 10.00)

The preferred alternative for Gloucester Harbor is a combination of aquatic disposal sites, G-Cell-1, G-Cell-2, G-Cell-3 and G-Cell-4, which are located in resource areas protected by the Massachusetts Wetlands Protection Act (WPA), specifically Land Under the Ocean (LUO) and Designated Port Areas (DPAs). The WPA is administered on the local level by the Conservation Commission, which implements the Massachusetts Wetlands Regulations at 310 CMR 10.00. A Notice of Intent (NOI) application to the Gloucester Conservation Commission will be required for disposal activities. An Order of Conditions (OOC) will be need to be issued by the Conservation Commission to permit the work. In addition, the City of Gloucester also has a local wetlands ordinance (see Section 7.3).

7.1.1.1 Designated Port Areas

The main federal channel into Gloucester Harbor, in which portions proposed preferred alternative sites G-Cell-1 and G-Cell-4 are located, is included within the Harbor's Designated Port Area. The Wetlands Regulations at 310 CMR 10.26 state that LUO in DPAs is likely to be significant to marine fisheries, storm damage prevention and flood control. LUO in DPAs often serves to provide support for coastal engineering structures such as seawalls and bulkheads, which have replaced natural protection for upland areas from storm damage and flooding. Projects affecting LUO in DPAs should not result in alteration of wave and current patterns so as to affect the stability of such structures.

Construction of the aquatic preferred alternative is not expected to result in adverse effects on marine fisheries caused by changes in water circulation. The bottom elevation at the disposal sites following construction of the disposal site, disposal activities and final placement of capping materials, will not be higher than the existing bottom elevation, and will likely be slightly recessed compared to existing bottom elevations. The effect of this recessed pit is expected to be reduced water column mixing with surrounding waters, and active sedimentation within the pit. In addition, the location of the CAD sites within the main navigation channel will also minimize localized changes in water circulation. Navigational channels often experience some degree of reduced mixing via stratification due to temperature or salinity gradients.

Water column depth at the disposal sites may play an important role in determining localized current velocities. Current velocities typically behave in a logarithmic relationship with water column depth. Therefore, currents further from the surface experience increasing frictional retardation, particularly as currents approach the sediment boundary layer. Given this phenomena, the preferred

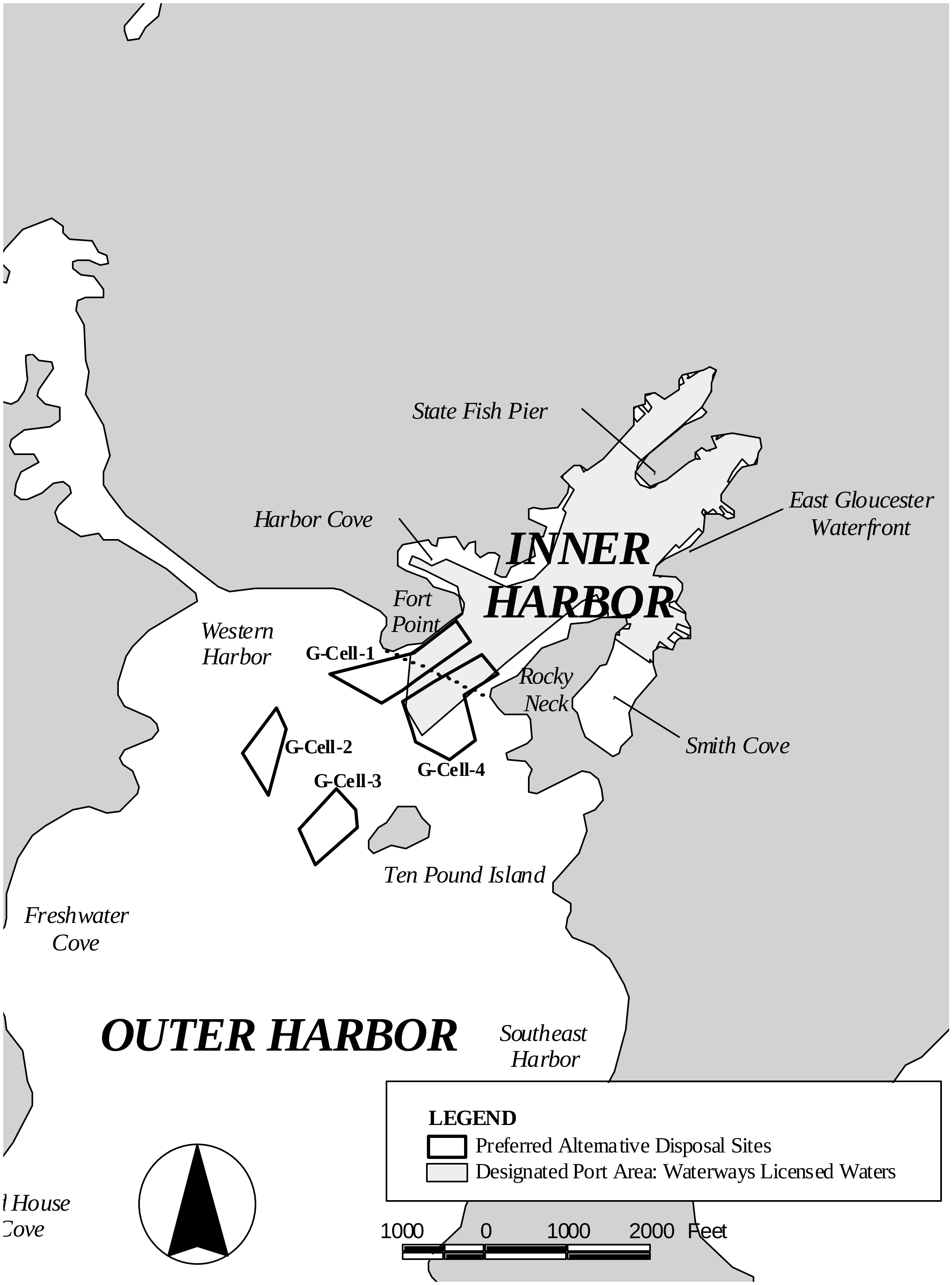


Figure 7-1: Relationship of Preferred Disposal Alternatives with DPA

alternative sites will be exposed to smaller current velocities and less potential sediment resuspension forces than sites at shallower depths. Coarser grained cohesive material also has the effect of greater frictional and gravitational forces holding the grains on the seabed. Thus a greater critical shear stress would be required to resuspend coarse grain cap material than fine grain silty sediments.

Reduced circulation may be beneficial from the standpoint of cap integrity since resuspension is less likely, but by the same effect this localized condition may also contribute to reduced water quality. Typically, the impact to water quality from dredged material disposal is short-term. These impacts typically include localized degradation in dissolved oxygen (DO), total suspended solids (TSS), pH, light penetration, and contaminant concentrations. Conditions typically return to ambient conditions within hours to days, depending on the amount, composition, and frequency of the disposed material. Total suspended solids may increase dramatically due to the entrainment of fine material in the water column. A plume typically forms whereby material may be advected short distances from the disposal site. A reduction in DO is typical as common constituents of sediments are oxidized and organic material is metabolized by microbial activity at the sediment-water interface. High suspended solid concentrations have the effect of attenuating ambient light, thereby reducing penetration. Finally, contaminants sorbed to sediment particles may be dissolved by the aquatic environment through physical disturbance of the material as the sediment stream is released from the scow. Modeling of dredged material disposal events will be performed for the FEIR to more conclusively determine short term local water quality impacts.

The preferred alternative sites have been located so as to provide a sufficient distance to the nearest coastal engineering structure. No impact on the stability of the harbor bottom that would affect the support of the nearby coastal engineering structures is expected, and therefore no adverse effect on any structure's ability to serve a storm damage prevention or flood control functions in the area.

7.1.1.2 Land Under the Ocean

Land Under the Ocean (LUO) is defined as "*... land extending from the mean low water line seaward to the boundary of a municipality's jurisdiction and includes land under estuaries*", within the Wetlands Regulations at 310 CMR 10.25(2). LUO is significant to the protection of marine fisheries and projects which affect LUO shall not cause adverse effects by altering the bottom topography so as to increase storm damage or erosion of coastal beaches, banks, dunes, of marshes. They must, among other things, also have no adverse effects on marine fisheries or wildlife habitat caused by alterations in water circulation, destruction of eelgrass beds, alterations in the distribution of sediment grain size, changes in water quality, or alterations of shallow submerged lands with high densities of polychaetes, mollusks, or macrophytic algae.

As described above, the aquatic preferred alternative sites are expected to have no adverse effect on marine fisheries caused by localized alterations in water circulation, sediment grain size or changes in water quality. The sites are not located in or adjacent to existing eelgrass beds.

Any impacts to benthic organisms at the disposal sites will be temporary and reversible. Immediately after disposal, the sites will be devoid of benthic populations, because the benthos will have been removed by overdredging or buried under disposed sediments.. The existing Organism-Sediment Index at the sites range from 9 (G-Cell-3 and G-Cell-4) to 11 (G-Cell-1 and G-Cell-2), all are greater than +6, indicative of a healthy benthic environment. However, most benthic species are capable of rapid dispersal and colonization by means of planktonic larvae, and will quickly recolonize disturbed areas. The post-disposal benthic populations at the preferred alternative sites may be healthier and more diverse than those existing at present, since contaminated sediments at this in-harbor location will have been removed or buried and the new populations will be growing in the cleaner surface sediments.

7.1.1.3 Land Containing Shellfish

Land Containing Shellfish (LCS) is defined as *"... land under the ocean, tidal flats, rocky intertidal shores, slat marshes or land under salt ponds when any such land contains shellfish"*, within the Wetlands Regulations at 310 CMR 10.34(2). LCS is found to be significant to the protection of marine fisheries, when such areas have been identified and mapped by the local conservation commission or by DEP in consultation with DMF. Documentation required for this designation includes recording the density of shellfish, size of the area and the historical and current importance of the area to commercial and recreational fishing.

The preferred alternative disposal sites are not located within areas that have been designated as areas of Land Containing Shellfish as specified in the Wetlands Protection Act and Regulations. As described above, the preferred alternative disposal sites are not expected to have an adverse effect on marine fisheries caused by localized alterations in water circulation, alterations in relief elevation, sediment grain size or changes in water quality.

7.1.2 Water Quality Certification (314 CMR 9.00)

The federal Clean Water Act gives states the authority to review projects that must obtain federal licenses or permits and result in a discharge to state waters, and requires a 401 Water Quality Certification to ensure that the project complies with state water quality standards and other appropriate requirements of state law. As a project which will require disposal of more than 5,000 cubic yards of dredged material, the DMMP will require a major dredge project certification (BRP WW 07) from the Department of Environmental Protection, Division of Wetlands and Waterways. The application will require a description of the proposed activity, detailed plan view and section, sediment analysis, and description of the characteristics of the proposed disposal site. The DEP may then put conditions on the dredging and disposal process designed to ensure compliance with water quality standards.

Per the provisions of 314 CMR 9.06(1), no discharge of dredged material will be allowed if there is a practicable alternative to the proposed discharge which would have less adverse impact on the aquatic environment than the proposed discharge. As documented in this DEIR, the proposed preferred alternative aquatic disposal sites in Gloucester Harbor are the least environmentally damaging practicable alternative for the aquatic disposal of UDM from the dredging projects in the Harbor.

Per the requirements of 314 CMR 9.06(2), the proposed discharge of dredged material will not be permitted unless the "appropriate and practical steps" are taken to minimize potential adverse impacts to land under water. The discharge of UDM and subsequent capping of the material at the aquatic preferred alternative disposal sites in Gloucester Harbor will result in the cleanup and capping of contaminated sediments at the site, and will result in a cleaner harbor bottom.

Per the requirements of 314 CMR 9.06(3), no discharge of dredged material will be allowed in Outstanding Resource Waters. The Proposed Preferred Alternative aquatic disposal sites in Gloucester Harbor are not located in Outstanding Resource Waters, as the water quality classification of Harbor is Class SB, due to the presence of combined sewer overflows in the harbor (314 CMR 4.06, Table 28).

As specified in 314 CMR 9.06(4), no discharge of dredged material to vernal pools, Outstanding Resource Waters within 400-feet of a drinking water supply reservoir and other areas designated in 314 CMR 4.06(1)(d), is allowed. The preferred alternative disposal sites in Gloucester Harbor are not located within any of those areas.

Finally, no discharge of dredged material will be allowed, per the provisions of 314 CMR 9.06(7), where the discharge meets the criteria for evaluation as specified above, but would result in "substantial adverse impacts" to the physical, chemical or biological integrity of surface waters of the Commonwealth. As described in this DEIR, disposal of UDM at the preferred alternative disposal sites in Gloucester Harbor will not result in substantial adverse impacts to surface waters in the Harbor.

7.1.3 MGL Chapter 91 (Public Waterfront Act) and Waterways Regulations (310 CMR 9.00)

Dredging activities to create a subaqueous disposal site for UDM, involving the subaqueous placement of unconsolidated material below the mean low water mark, requires a waterways permit, under the provisions of the Waterways Regulations at 310 CMR 9.05(2). Regulatory requirements for a Waterways permit are less stringent than those for a Waterways License, required for activities involving fill or structures in tidelands. Dredging activities for purposes such as navigation channels, boat basins, and other water-dependent purposes, and the subaqueous placement of unconsolidated material from those dredging projects below the mean low water mark, are considered a water-dependent project, under the provisions of 310 CMR 9.12(2)(a).

Waterways permits are issued only if certain requirements specified in the Waterways Regulations at 310 CMR 9.31 to 9.40 are met. Section 9.31 states that no permit shall be issued unless the project serves a "proper public purpose which provides greater public benefit than detriment to the rights of the public" in tidelands. As a water-dependent use project, the construction and use of the proposed preferred sites in Gloucester Harbor are presumed to meet this standard.

Because the proposed alternative sites require a Waterways permit, the provisions of 310 CMR 9.32, Categorical Restrictions on Fill and Structures, do not apply. As required under section 9.33, Environmental Protection Standards, construction and use of the proposed aquatic sites will comply with the applicable environmental regulatory programs of the Commonwealth, including: MEPA; the Wetlands Protection Act; the Massachusetts Clean Waters Act (MGL c. 21, s. 26-53 and the regulations for Water Quality Certifications, 314 CMR 9.00); Marine Fisheries Laws (MGL Chapter 130); and the Underwater Archaeological Resources Act (MGL c. 91 and c. 6, s. 179-180 and 310 CMR 22.00).

The preferred alternative sites are not located on private tidelands or filled Commonwealth tidelands and do not need to be deemed in compliance with the Zoning Ordinance. The preferred alternative disposal sites for Gloucester Harbor conform to the provisions of Harbor Plan, in that the construction and use of the sites for the disposal of UDM from the dredging projects in Harbor supports the stated goals of the

Harbor Plan to encourage identified maintenance and improvement dredging projects. The provisions of 310 CMR 9.34, Conformance with Municipal Zoning and Harbor Plans, are met by construction and use of the site.

The provisions 310 CMR 9.35, Standards to Preserve Water-Related Public Rights, are applicable to the proposed alternative sites in the Harbor. Construction and use of the disposal sites will not interfere with existing navigation. Use of the sites will also not significantly interfere with the public rights of free passage over the water, nor will it interfere with access to any city landings, easements or any other form of public access to Gloucester Harbor. Use of the preferred alternative sites will not significantly interfere with the public rights of fishing and fowling, and being a subaqueous site, will not interfere with on-foot passage, swimming or boating across the site.

Section 9.36, Standards to Protect Water-Dependent Uses, also applies to a portion of the preferred alternative sites in Harbor. Construction and use of the preferred alternative will result in the preservation of the availability and suitability of tidelands in Gloucester Harbor which are reserved as locations for maritime industrial uses, such as the Americold and Gorton's facilities, and other water-dependent uses in the Harbor. The sites are located so that there will be no interference with private access to littoral property from Gloucester Harbor, or to approach the Harbor from the private property. Use of the disposal sites will not result in disruption to existing water-dependent uses in Harbor, nor will it displace any existing water-dependent uses. The preferred alternative does not include fill or structures for nonwater-dependent or water-dependent non-industrial uses which preempt any water-dependent industrial use within the Gloucester Harbor DPA.

The provisions of section 9.37, Engineering and Construction Standards, will be met through the development of a sound engineering design for the aquatic preferred alternative disposal site. Construction and use of the proposed aquatic sites will not interfere with the ability to perform future maintenance dredging of the federal channel. The preferred alternative disposal sites are neither a Recreational Boating Facility nor a Marina, Boatyard or Boat Ramp, therefore the provisions of 310 CMR 9.39 and 9.39 do not apply.

Finally, the provisions of Section 9.40, Standards for Dredging and Dredged Material Disposal, also apply to the proposed alternative disposal sites in Gloucester Harbor. As two of the sites are located partially within the Harbor DPA, the prohibition on dredging to a mean low water depth greater than 20 feet in 310 CMR 9.40(1)(a) does not apply. The project also serves a commercial navigation purpose of federal and state significance, allowing the maintenance dredging of the main federal channel. The sites have been located so as to avoid shellfish beds, significant fisheries resources, and submerged aquatic vegetation such as eelgrass beds. Dredging activities necessary to construct the disposal sites will comply with the operational requirements specified in section 9.40(3), in that the depth of the disposal sites will be that necessary to accommodate the anticipated volume of UDM from Gloucester Harbor, therefore accommodating the navigational dredging needs of the harbor users.

Operational procedures will be established for use of the aquatic disposal sites which will meet the intent of the requirements specified in section 9.40(4), Operational Requirements for Dredged Material Disposal and 9.40(5), Supervision of Dredging and Disposal Activity. Section 9 of this DEIR outlines the monitoring and management measures to be implemented to confirm compliance with permit standards and long-term sequestering of UDM for the preferred alternative sites.

7.1.4 Coastal Zone Management (301 CMR 21.00)

This project will be required to complete a federal consistency certification for review by MCZM, describing the project and demonstrating consistency with MCZM's program policies and management principles. The MCZM Program Plan establishes program policies which embody coastal policy for the Commonwealth of Massachusetts. Recognition of these statements as Massachusetts coastal policy is formalized in Memoranda of Understanding (MOU) between MCZM and state environmental agencies. Projects subject to federal consistency review must be consistent with MCZM program policies. MCZM enforces its program policies through existing Massachusetts statutes and their implementing regulations.

In addition, the federally-approved MCZM Program Plan lists management principles. These policy statements are not currently enforceable through existing state statutes and regulations. They are published as guidance to proponents of activities in the Coastal Zone, representing MCZM's preferred policy direction. Program policies cover issue areas such as Water Quality, Habitat, Protected Areas, Coastal Hazards, Port and Harbor Infrastructure, Public Access, Energy, Ocean Resources, and Growth Management. Construction and use of the proposed preferred alternative aquatic disposal sites within Gloucester Harbor involve the MCZM policies on Water Quality and Habitat.

7.1.4.1 Water Quality

Water Quality Policy #1 - Ensure that point-source discharges in or affecting the coastal zone are consistent with federally approved state effluent limitations and water quality standards.

Water Quality Policy #2 - Ensure that nonpoint pollution controls promote the attainment of state surface water quality standards in the coastal zone.

Water Quality Policy #3 - Ensure that activities in or affecting the coastal zone conform to applicable state and federal requirements governing subsurface waste discharges.

Conformance: Use of the aquatic preferred alternative disposal sites in Gloucester Harbor will not be inconsistent with the Water Quality Policies. Disposal of UDM at a subaqueous site is not considered to be a subsurface discharge of waste.

7.1.4.2 Habitat

Habitat Policy #1 - Protect coastal resource areas including salt marshes, shellfish beds, dunes, beaches, barrier beaches, salt ponds, eelgrass beds, and fresh water wetlands for their important role as natural habitats.

Habitat Policy #2 - Restore degraded or former wetland resources in coastal areas and ensure that activities in coastal areas do not further wetland degradation but instead take advantage of opportunities to engage in wetland restoration.

Conformance: The proposed preferred sites has been located in an area of Gloucester Harbor which avoids protected coastal resource areas, including subtidal resources such as shellfish beds and eelgrass beds. There are no nearby salt marshes, dunes, beaches or barrier beaches, salt ponds or freshwater wetlands which would be affected by use of the disposal sites.

7.2 Compliance with Federal Regulations/Standards - Aquatic Disposal

7.2.1 Clean Water Act Section 404(b)(1) Analysis

The Code of Federal Regulations at 40 CFR 230 specifies guidelines for implementing the policies of Section 404(b)(1) of the federal Clean Water Act. The guidelines apply to discharges of dredged or fill materials into navigable waters, and their purpose is to restore and maintain the chemical, physical, and biological integrity of waters of the United States. The guidelines are divided into Subparts A through I. Subpart A is a general discussion of the guidelines. Compliance with more specific requirements is discussed below.

7.2.1.1 Subpart B - Compliance with the Guidelines

(a) The discharge shall not be permitted is there is a practicable alternative which would have less adverse impact on the aquatic ecosystem, so long as the alternative does not have other significant adverse environmental consequences.

The Alternatives Analysis in Section 4 of this DEIR establishes that the preferred alternative is the least environmentally damaging of the alternatives considered.

(b) No discharge shall be permitted if it contributes to the violation of a state water quality standard, violates any applicable toxic effluent standard or prohibition under Section 307 of the Act, jeopardizes the continued existence of endangered or threatened species, or violates any requirement to protect any federally-designated marine sanctuary.

The proposed discharge shall not violate any of these requirements, as discussed in Section 6.1.2.3 (Water Quality) and Section 6.1.7 (Endangered or Threatened Species). The proposed discharge sites are more than two miles from the closest point of the nearest marine sanctuary, Stellwagen Bank, and will have no effect on it.

(c) No discharge shall be permitted which will cause or contribute to significant degradation of the waters of the United States. This discharge will not cause such degradation, as explained in discussions of the Subparts C through F.

(d) No discharge shall be permitted unless appropriate and practicable steps have been taken to minimize adverse impacts. Steps which will be taken to minimize these impacts are listed in the discussion of Subpart H.

7.2.1.2 Subpart C - Potential Impacts on Physical/Chemical Characteristics of the Aquatic Ecosystem

The discharge will not have a significant impact on physical and chemical characteristics of the ecosystem, as discussed in Section 6.2.1. Within this section, impacts on sediments are discussed in 6.2.1.1; impacts on suspended particulates/turbidity and water column impacts are in 6.2.1.3; and current patterns and water circulation in 6.2.1.2. The discharge will have no impact on normal water fluctuations, because the proposed disposal locations are in an open area where they will not interfere with tidal circulation. Since the discharge will not affect circulation and is not near an area where fresh and salt water mix, it will therefore not affect salinity gradients.

7.2.1.3 Subpart D - Potential Impacts on Biological Characteristics of the Aquatic Ecosystem

The disposal will have no impact on threatened and endangered species, as discussed in Section 6.2.6.4. There are no benthic endangered species in the area which could be covered or otherwise directly killed, and no habitat for these species occurs in any area influenced by the disposal.

The disposal will not permanently affect fish, crustaceans, mollusks, or other organisms in the aquatic food web. Any benthic organisms affected by disposal will be replaced by recolonizing organisms with aquatic larvae brought in by currents. The dredged material will be capped by clean sediments and therefore the recolonizing organisms will not be affected by toxins or heavy metals. Further discussion of impacts on aquatic organisms is contained in Sections 6.2.3. and 6.2.4.

Other wildlife such as mammals, birds, reptiles, and amphibians will not be affected by the disposal. The subsurface open water disposal will not affect their habitat, and any turbidity during disposal will be temporary. Wildlife impacts are further discussed in Section 6.2.6.

7.2.1.4 Subpart E - Potential Impacts on Special Aquatic Sites

Sanctuaries and refuges. The proposed disposal sites are in the outer harbor and are not in the vicinity of any designated sanctuaries or refuges.

Wetlands. The disposal sites, being in open water removed from shore in the outer harbor, will not affect any wetlands, as defined in these guidelines.

Mud flats. The proposed disposal sites are all subtidal and will not affect any intertidal mud flats.

Vegetated shallows. Although eelgrass beds do exist in Harbor, they are far enough away from the proposed disposal sites so that they will not be affected.

The other two special aquatic sites, coral reefs and riffle and pool complexes, are found only in tropical and subtropical seas and in freshwater streams, respectively, and are not a factor in this project area.

7.2.1.5 Subpart F - Potential Effects on Human Use Characteristics

As a subaqueous disposal site, this project will have no effect on municipal and private water supplies. The proposed disposal sites are not in an area of concentration or important migration or spawning areas for species important in recreational or commercial fisheries. Any impacts to the water column or substrate will be temporary and will have no effect on fisheries. Fishery impacts are further discussed in Sections 6.2.3 and 6.2.4.

Water-related recreation activities will not be affected by disposal. Even if disposal is conducted in the limited period of the year when recreational activities take place (which is not proposed), turbidity from disposal, the most probable impact, will be temporary and limited in scope.

The disposal of UDM at the proposed disposal sites will have no permanent aesthetic impacts because the subsurface disposal sites will not be visible. Temporary changes in appearance of the water will last no longer than the actual disposal operation.

There are no parks, national and historical monuments, national seashores, wilderness areas, research sites, and similar preserves which could be affected by disposal at the proposed sites.

7.2.1.6 Subpart G - Evaluation and Testing

Thorough testing of sediments proposed for dredging from Gloucester Harbor has been initiated and will be completed in accordance with all regulatory requirements. This includes physical and bulk chemistry testing, bioaccumulation tests, and evaluation of sediment transport and circulation in the vicinity of disposal sites. These results of the chemical and physical testing performed to date are presented in Sections 3.3.2, 4.8.2, 5.2.2, and 6.2.2 of this DEIR.

7.2.1.7 Subpart H - Actions to Minimize Adverse Effects

The following actions, among those listed in Subpart H of the Guidelines, will be taken to minimize averse effects from disposal:

- Confining the discharge to minimize smothering of organisms;
- Designing the discharge to avoid a disruption of periodic water inundation patterns;
- Disposal of dredged material in such a manner that physicochemical conditions are maintained and the potency and availability of pollutants are reduced;
- Selecting discharge methods and disposal sites where the potential for erosion, slumping, or leaching of materials into the surrounding aquatic ecosystem will be reduced;
- Capping in-place contaminated material with clean material or selectively discharging the most contaminated material first to be capped with the remaining material;

- Avoiding changes in water current or circulation patterns which would interfere with the movement of animals;
- Avoiding sites having unique habitat or other value, including habitat of threatened or endangered species;
- Timing discharge to avoid spawning or migration seasons and other biologically critical time periods;

7.2.2 Rivers and Harbors Act of 1899, Section 10

Section 10 of the Rivers and Harbors Act of 1899, authorizes the USACOE to regulate virtually all obstructions to navigation within navigable waters the United States. This section defines navigable waters as *"those waters of the United States that are subject to the ebb and flow of the tide shoreward to the mean high water mark and/or are presently used, or have been used in the past or may be susceptible to use to transport interstate or foreign commerce"*. Because all the dredging projects identified in Gloucester Harbor are located in navigable waters, they will require a Section 10 permit from the USACOE.

7.2.3 Marine Protection, Research and Sanctuaries Act (MPRSA)

The Marine Protection, Research and Sanctuaries Act (MPRSA) of 1972, also known as the Ocean Dumping Act, requires obtaining a permit for discharging some wastes (such as dredged material) and prohibits disposal of others (including radioactive wastes, chemical and biological warfare wastes). Three primary sections of the MPRSA apply to dredging projects:

(1) Section 102 - This section empowers the USEPA to establish the criteria for evaluating all dredged material for open ocean disposal. Section 102 also authorizes USEPA to designate ocean dredged material disposal sites such as MBDS.

(2) Section 103 - USACOE has the authority issue Section 103 permits, with concurrence from the USEPA, to dispose of dredged material in the open ocean. The permitting process includes public notice, public hearings, compliance with USEPA criteria, and the use of designated disposal sites, when possible.

(3) Section 104 - The USEPA and the USACOE have the authority to place conditions upon any aspect of ocean disposal operations to minimize negative environmental impacts. Typical conditions are imposed on the type and volume of dredged material, timing and location of disposal, and surveillance and monitoring of disposal activities.

The preferred alternative disposal sites for Gloucester Harbor will not require approval under the MPRSA. However, projects including the transportation and disposal of dredged material at MBDS will require testing and approval under the MPRSA.

7.2.4 Endangered Species Act - Section 7

The Endangered Species Act of 1973, protects federally listed and proposed threatened and endangered species. Section 7 of the Act requires the consultation with USFWS and NMFs and a opinion statement. This project is being coordinated with NMFS and the USFWS to determine whether any endangered or threatened species under their jurisdiction may be affected by use of the preferred alternative disposal sites in Harbor. To date, staff of NMFS and USFWS have participated in the review of the preliminary upland, aquatic and dewatering site screening processes and have indicated their concurrence with the results of the screening. As the final preferred alternative is selected in the FEIR, MCZM will continue to coordinate with both NMFS and USFWS staff in the Section 7 consultation process.

7.2.5 Magnuson-Stevens Fishery Conservation and Management Act (MSFCMA)

The MSFCMA authorizes the NMFS to establish Essential Fish Habitat (EFH) areas. The general purpose of the act is to conserve productive fisheries that provide recreational and commercial benefit. EFH is defined as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity" and all of Harbor is classified as EFH.

Under section 305(b) of the Act, coordination between federal agencies is required for any work proposed within an EFH. The intent and procedures of the Act are very similar to the Endangered Species Act (ESA). MCZM has been coordinating with NMFS and USFWS in accordance with Section 7 of the ESA as well as the MSFCMA. Correspondence is included in Appendix B.

7.3 Compliance with City Standards/Regulations - Aquatic Disposal

7.3.1 Gloucester General Wetlands Ordinance (Section 12-10)

To strengthen the City's ability to protect wetland resources area, Gloucester has adopted a local wetlands protection ordinance. The purpose of the City of Gloucester's General Wetlands Ordinance (Section 12-10) is to protect the City's wetland resources by controlling activities deemed to have a significant effect either individually or cumulatively upon the following interests relevant to the DMMP including: prevention of pollution, protection of land containing shellfish, protection of fisheries and erosion and sediment control. As the preferred alternative for Gloucester Harbor is a combination of aquatic disposal sites, G-Cell-1, G-Cell-2, G-Cell-3 and G-Cell-4, which are located in a resource area protected by General Wetlands Ordinance, specifically Land Under the Ocean (LUO). The General Wetlands Ordinance is administered the Gloucester Conservation Commission. A Notice of Intent (NOI) application to the Gloucester Conservation Commission will be required for proposed disposal activities. Also, a Wetlands Permit will be need to be issued by the Commission to permit the work.

8.0 CAD ENGINEERING AND CONSTRUCTION

This section describes the basis for conceptual engineering for CAD disposal of Gloucester Harbor UDM and a description of potential construction sequencing associated with the implementation of the aquatic preferred alternative, as identified in this DEIR. Included in the discussion of the construction measures are the steps necessary to minimize negative environmental impacts associated with the disposal of UDM in the marine environment.

8.1 Conceptual Engineering

In order to evaluate the practicability of the preferred alternative, conceptual engineering of potential CAD pit aquatic disposal cells needed to be conducted. Inherent in this exercise is a set of assumptions based upon the level of data collected. The results of this exercise are not intended to provide a specific final design. The results of the conceptual engineering exercise are for illustrative purposes only, final CAD cell designs and specifics will be developed in the FEIR based upon detailed site specific information.

8.1.1 Planning Horizon UDM Volumes

To evaluate the phasing of UDM disposal for Gloucester Harbor over the DMMP's twenty year planning horizon, the volume of UDM identified in the dredging inventory was apportioned, as reported by the facilities, to the five (years 0-5), ten (years 6-10), fifteen (years 11-15) or twenty (years 16-20) year planning horizons. A contingency of 20% was added to the total UDM volume of 330,840 c.y. identified in the dredging inventory and distributed to the various planning horizons to determine the capacity necessary to dispose of UDM associated with dredging projects on a phased basis. An assumption was made that the five-year and ten-year horizons', UDM dredging volumes were more certain than the fifteen and twenty-year horizons' volumes. The contingency volume was distributed as 1/6 and 1/6 of the total contingency to five and ten year planning horizons and 1/3 and 1/3 to fifteen and twenty year planning horizons. Table 8-1 shows the planning horizon UDM volume total volumes.

Table 8-1: Planning Horizon UDM Volumes

DMMP Planning Horizon (Years Covered)	5 Year (0-5)	10 Year (6-10)	15 Year (11-15)	20 Year (16-20)	
UDM Identified in Inventory (c.y.)	150,505	117,000	4,195	4,000	275,700
Contingency Totals (c.y.)	9,190	9,190	18,380	18,380	55,140
Planning Horizon UDM Totals (c.y.)	***159,695***	***126,190***	***22,575***	***22,380***	***330,840***

Note: Contingency total distributed 1/6 & 1/6 to 5 and 10 year horizons and 1/3 & 1/3 to 15 and 20 year horizons

8.1.2 Cell Capacity Calculation

In order to contrast the planning horizon UDM volumes requiring disposal with the preferred alternative disposal sites identified in Section 4.0, site capacity calculations were conducted to determine the extent of the predicted disposal volumes occupying the preferred alternative disposal sites. The footprints of the preferred alternative disposal sites identified through the site screening process for Gloucester were used to determine the areal extent of the Cell Footprint. Assuming a 3 to 1 side slope within the disposal cell, the area of the Cell Bottom was calculated. ArcView Geographic Information System (GIS) software was used to determine the areas of the Cell Footprints and Cell Bottoms.

To calculate the Total Capacity for the disposal cells, volumes were determined by using an average end area calculation method. The Cell Footprints and Cell Bottom areas were averaged and then multiplied by the cell depth. Accounting for potential variability in both surface and depth to bedrock contours and limitations of existing data, five feet were subtracted from the average depth to bedrock determined for each site. This assumption resulted in a conservative value for cell depth. For conceptual engineering and planning purposes, the maximum capacity values take into account the variability of seafloor elevations and depth to bedrock to the extent practicable based upon the level of data available for the sites. The maximum cell capacities were then adjusted further to accommodate a three (3) foot thick cap. The cap volume was calculated by multiplying the Cell Footprint Area by three (3) feet. To determine the UDM Capacity for each cell, the cap volume calculated was subtracted from the maximum capacity value for each cell.

Table 8-2: Cell Capacity Calculation

	G-Cell-1	**G-Cell-2**	**G-Cell-3**	**G-Cell-4**
Cell Footprint (sq. ft.)	526,949	247,146	325,113	673,759
Cell Bottom Area (sq. ft.)	349,115	164,500	238,969	517,039
Average Depth to Bedrock (ft.)	20.9	18.0	18.4	19.6
Cell Depth (ft.)	15.9	13.0	13.4	14.6
Total Capacity (cy)	257,952	99,100	139,976	321,956
Cap Volume (cy)	58,550	27,461	36,124	74,862
UDM Capacity (cy)	***199,402***	***71,639***	***103,852***	***247,094***

Assumption:
Cell Depth = Average depth to bedrock - 5 feet (accounting for potential variability of seafloor and depth to bedrock)

8.1.3 Disposal Cell Phasing Scenario

The final phase of the conceptual engineering exercise is the contrasting of calculated cell UDM capacities with planning horizon UDM volumes to develop a potential cell phasing scenario. To account for possible additional UDM, an assumption was made that the footprints of G-Cell-1 and G-Cell-4 were UDM (three feet thick). This additional UDM, was subtracted from the UDM Capacity volume calculated above to determine an Adjusted UDM Capacity. Table 8-3 shows the results of this adjustment.

Table 8-3: Capacity Adjustment for potential UDM in Cell Footprints

	G-Cell-1	**G-Cell-2**	**G-Cell-3**	**G-Cell-4**
UDM Capacity (cy)	199,402	71,639	103,852	247,094
UDM Footprint Adjustment (cy)	58,550	0	0	74,862
Adjusted UDM Capacity (cy)	**140,852**	**71,639**	**103,852**	**172,232**

Table 8-4: Planning Horizon Volumes Disposal Cells can Accommodate

Disposal Cell	**Planning Horizon**
G-Cell-1	10, 15 & 20
G-Cell-2	15 & 20
G-Cell-3	15 & 20
G-Cell-4	5, 10, 15 & 20

By contrasting ability of each disposal cell to accommodate planning horizon UDM volumes with the adjusted UDM capacities (Table 4), the following potential phasing sequence was developed:

- ***G-Cell-4*** - Five Year Planning Horizon
- ***G-Cell-1*** - Ten Year Planning Horizon
- ***G-Cell-3*** - Fifteen Year Planning Horizon
- ***G-Cell-2*** - Twenty Year Planning Horizon

The locations and configurations of the disposal area cells for the preferred alternative are shown on Figure 8-1. The graphic indicates the cell footprint, cell bottom and side slope contours. In addition, a cell profile corresponding with Table 8-2 is also included on Figure 8-1.

Please note that for each five year phase, the DMMP is proposing that each CAD disposal cell be open for UDM disposal for one dredging season within each five year phase. The five year duration of each phase is intended to provide ample notice of availability of a disposal facility, providing facilities an opportunity to secure the necessary permits and funding to conduct dredging projects. This planned opening of a disposal facility on a regular basis should also provide opportunities for coordinating various harbor projects.

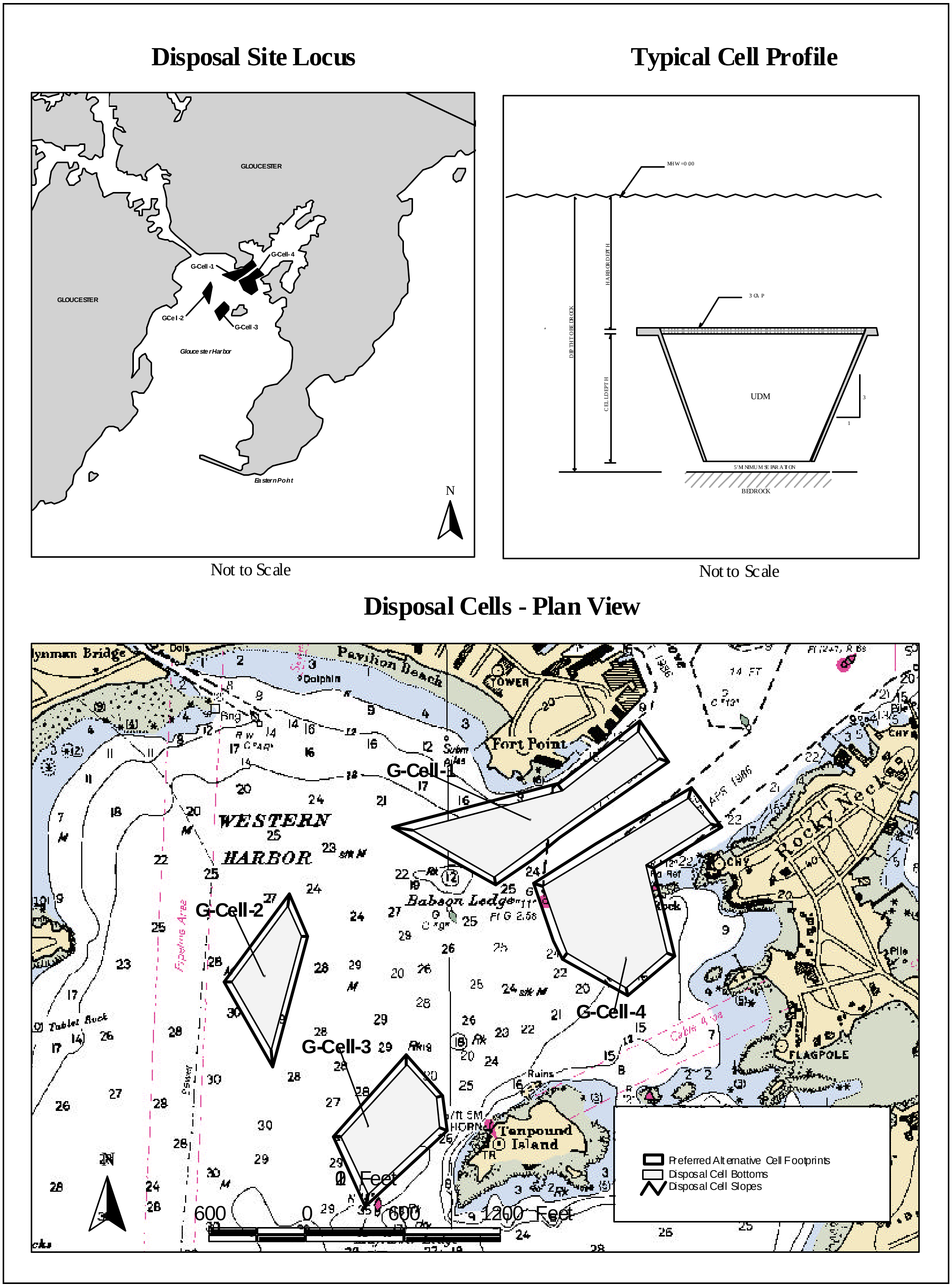


Figure 8-1: Conceptual engineering for Gloucester Harbor UDM disposal cells

8.1.4 Gloucester's Cell Phasing Preference

The results of the conceptual engineering exercise and the disposal cell phasing was presented to the City of Gloucester. The Dredging Subcommittee, see Appendix B, ranks the City's preference for use of the preferred alternative disposal cells as follows:

- ***G-Cell-4*** - Five Year Planning Horizon
- ***G-Cell-2*** - Ten Year Planning Horizon
- ***G-Cell-3*** - Fifteen Year Planning Horizon
- ***G-Cell-1*** - Twenty Year Planning Horizon

The proposed cell phasing scenario described above in Section 8.1.3, is based upon matching the projected volumes of UDM identified in the dredging inventory with the estimated cell capacities, based upon the current configurations. Both the DMMP's and the City's preference is to use G-Cell-4 to accommodate the UDM volume identified for the 5 year planning horizon, the planning horizon projection with the greatest level of confidence. As the DMMP moves into the 10, 15 and 20 year planning horizons, the level of confidence in the projections are less certain. The City's preferred approach will determine the design and location of the CAD cells as additional site specific data is developed and out-year disposal volumes are determined.

In the FEIR, detailed site specific data will be collected for the G-Cell sites. These data will be examined and revised cell capacities will be calculated based upon site-specific data and engineered designs. The results of the final design of the disposal cells will be determined by the City's cell phasing preference in developing the both the configuration of the final alternative disposal cell footprints and the phasing sequence proposed in the FEIR.

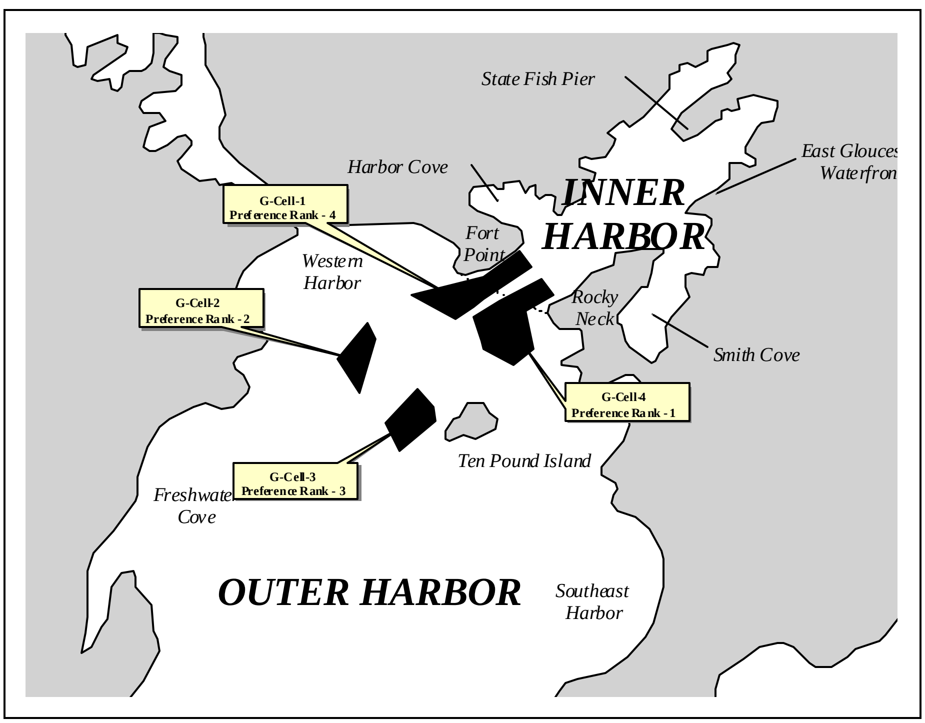


Figure 8-2: Disposal cell preferred ranking

8.2 CAD Cell Construction

8.2.1 Construction Sequencing

The general construction phasing proposed in this report is divided into four major steps: cell construction, UDM disposal, cell closure, and management. Prior to the commencement of dredging projects, the construction of the CAD disposal cell needs to be completed first. Dredging of the disposal cells will be completed during an environmentally favorable window to reduce the disturbance to marine life. Cell construction involves the following actions: conducting a pre-dredge survey, project mobilization, dredging the cell footprint, dredging to create cell capacity and final cell contouring. During this step, dredged material suitable for open ocean disposal would be taken to MBDS and UDM (if footprint material determined to be UDM) would be stockpiled for disposal in the cell being constructed.

To construct each cell, dredge limits and locations will be located by Geodetic Positioning System (GPS), which is a satellite positioning system, accurate to within a foot of the intended horizontal design limits. The dredge machinery will most likely be a large barge mounted crane with a clamshell bucket. Bucket size will likely be in excess of ten cubic yards. The material will be removed to the intended depth and side slopes. The Dredging contractor will also be compensated for an allowable over-dredge limit to ensure that the intended depths are achieved. The material is removed by a bucket and deposited within a transport barge called a scow. The scow will deliver the material to the Massachusetts Bay Disposal Site where it is positioned prior to dumping using GPS. A bottom dumping or split hull scow will most likely be used. These barges open from the bottom allowing the material to drop out through the water column to the seafloor below. This material is clean and will therefore not need to be capped.

Following the completion of the disposal cell, the dredging of UDM from the facilities in the Harbor will be completed by mechanical means, using siltation curtains to minimize turbidity impacts. After being dredged, the UDM will be placed on a dump scow and transported to the disposal cell, where the material will be deposited. If UDM from the footprint had been stockpiled, it would also be placed in the CAD disposal cell.

To close or "cap" the cell, clean material would be placed over the UDM to achieve a thickness of three (3) feet deep to sequester the UDM from the marine environment. By conducting a post capping survey, the need to perform final contouring or placement of additional cap material would be determined. The end result of the capping will be a surface that mimics the ambient seafloor elevations and pre-construction contours.

The final step in the cell construction process is management. To ensure long-term environmental protection, a CAD cell monitoring plan would be implemented. A proposed monitoring plan for consideration is described in Section 9.0. The CAD aquatic disposal cell construction management sequence is illustrated in Figure 8-3.

CELL CONSTRUCTION/MANAGEMENT SEQUENCE

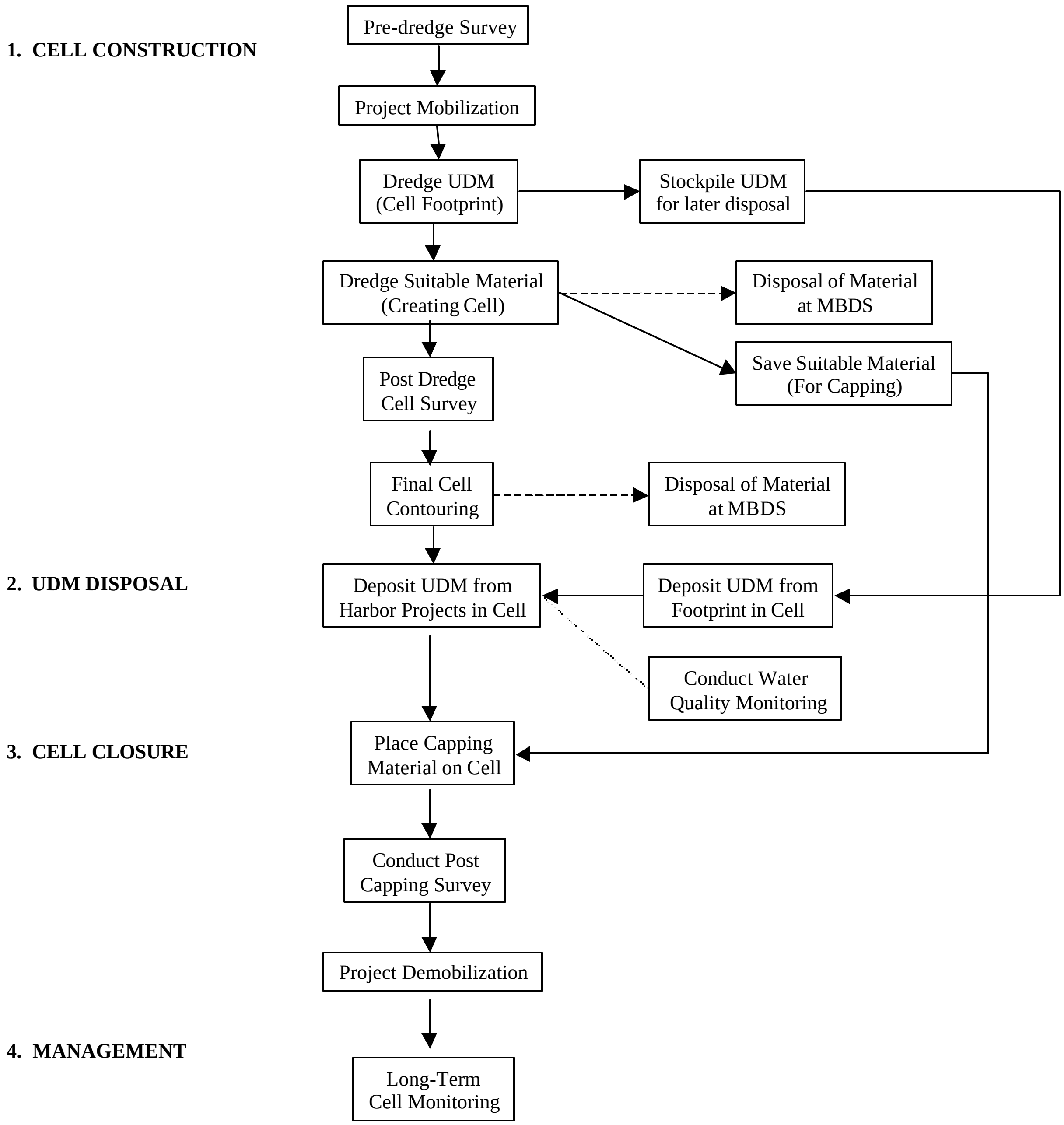


Figure 8-3: Aquatic disposal cell construction management sequence

8.3 CAD Cell Best Management Practices

MCZM is developing Best Management Practices (BMPs) for CAD of UDM in Gloucester Harbor based on the experiences and data from the Boston Harbor Navigation Improvement Project (BHNIP). The BMPs will be developed to be applicable as 1) stand alone guidelines, 2) the basis for new dredged material disposal regulations, and 3) the basis for site management recommendations in the DMMP FEIR. The BMPs will be developed to meet state and federal water quality criteria and standards under CWA s. 404, 314 CMR 9.00, other applicable regulations.

The BMPs will be designed to be effective regulatory tools, where 'effective' means:

- Appropriately protective of resources and uses;
- Cost-effective;
- Yield unambiguous results to the maximum extent practicable;
- Contribute directly to performance review (decision-making); and
- Applicable by non-specialist regulatory agency staff.

MCZM is also developing a model Water Quality Certificate (WQC) building upon the experiences of the BHNIP. This WQC will be applicable to future CAD projects for UDM. The WQC will include provisions for baseline monitoring and monitoring both during and post construction. Both the CAD BMPs and model WQC are being developed with input and participation of applicable state and federal agencies.

9.0 DRAFT DISPOSAL SITE MANAGEMENT PLAN

A disposal site management and monitoring plan ("management plan") will be developed by a Technical Advisory Committee (TAC) composed of local, state, and federal interests. The purpose of a management plan is to determine the specific actions and responsibilities necessary to ensure that disposal site use protects human and environmental health and resources. A management plan addresses where, when, and how a disposal site can be used, what kind of short and long-term monitoring will be required, and establishes who is responsible for every aspect of site use, management, and monitoring. The management plan will also determine what kind of material can be safely disposed of, and what testing may necessary to determine the nature of the material proposed for disposal.

MCZM anticipates that comments from the City on this DEIR will recommend the appropriate local membership for the TAC. For the recent dredging project in Boston Harbor, the management plan was developed by a TAC composed of a core group of City representatives, state and federal agencies, and environmental interest groups, and was open to any members of the public who wished to participate. This model may be appropriate for Gloucester.

It is important to note that (1) the final, approved management plan will be the basis for the local, state and federal permits required for use of the disposal sites; and (2) no final approval for any disposal sites will occur until a management plan is developed, presented for public comment in the Final EIR, and approved by the City and state and federal regulatory agencies.

9.1 AQUATIC SITE MONITORING

9.1.1 Monitoring Objectives

Evaluation of the environmental impacts of dredged material disposal in Gloucester Harbor is best addressed through the use of a tiered monitoring strategy. With the exception of a few aquatic dredged material disposal monitoring programs including New England (DAMOS), Washington (PSDDA), and New York, most have suffered from a lack of clearly defined objectives, testable hypotheses, careful sampling design, statistical rigor, and conclusive results. The tiered monitoring approach is based upon addressing key questions and/or formal hypotheses at a series of predetermined levels to ensure compliance with objectives and permitting requirements. The decision criteria are used to create a framework for defensible management decisions and eliminate the tendency for a "shotgun" approach to data collection.

The tiered monitoring approach is dependent on rapid data return and analysis to identify and respond effectively to any detected changes in physical, chemical, or biological condition within the disposal site. The monitoring program will incorporate data at multiple temporal and spatial scales and of various media (e.g., video, photographs, maps); it is critical that these data be quickly integrated into digital and written products. Utilization of state-of-the-art decision-making tools such as Geographic Information Systems (GIS) will facilitate the rapid dissemination of spatially-explicit information for decision-making by resource managers.

The Gloucester disposal site management/monitoring plan addresses both the engineering aspects of the disposal and capping operations and the environmental impacts of the project, through the following major objectives:

- Establish an environmental baseline prior to dredging and disposal of the dredged material,
- Establish acceptance guidelines for Water Quality Standards during dredging and disposal operations,
- Evaluate the short-term effects of disposal on benthic habitat quality and marine resources,
- Assess the engineering effectiveness and integrity of the CAD approach cap, and
- Evaluate the effectiveness of the confined disposal method and cap for preventing long-term impacts on biological resources.

Federal guidelines for laboratory testing of dredged material prior to its discharge in open water require that reference sediment be used as a basis for comparison. Reference sediment typically is collected in areas outside the influence of previous disposal operations at a dredged material disposal site, but near enough to the disposal site that the reference sediment is subjected to the same water quality and hydrodynamic influences. The laboratory test results for the proposed dredged material are compared to the reference sediment test results to evaluate the likelihood of adverse environmental impacts. Likewise, in environmental monitoring of dredged material disposal impacts in the field, results from reference areas are used in a comparative way to evaluate environmental impacts at the disposal site. Thus, use of reference sediment and/or reference areas is key to the evaluation of dredged material disposal impacts. The following information will provide the basis for the monitoring section of the management plan. These recommendations will be modified in response to public and agency comments, and to accommodate additional site-specific data yet to be collected.

9.1.2 Baseline Studies

Although the dredged material disposal siting process in Gloucester Harbor incorporated vast amounts of information about the physical and chemical properties of seawater and sediments at the proposed disposal sites, much of this information was either dated, spatially insufficient to provide site-specific details, or lacking temporal resolution. Collection of additional information prior to usage of the designated site is necessary before proceeding to dredging or disposal activities. The baseline study should include the collection of additional data to characterize existing (i.e., pre-disposal) conditions at the designated site, including current velocity, background suspended sediment concentration, and water quality. The measurement of several of the parameters will continue during dredging and disposal activities, but it is critical to characterize existing ambient conditions prior to the disturbance to provide a comparison with later measurements.

<u>9.1.2.1 Wave, Current, and Tidal Measurement</u>

Circulation patterns and sediment transport in Gloucester Harbor have not been well characterized due to the limited number of oceanographic studies. In order to develop an understanding of the physical processes influencing the stability of sediments at disposal sites, monitoring of current flow dynamics using instrument deployments is required. The major objective of monitoring activities will be to acquire site-specific data on waves, near-bottom tidal currents, and sediment resuspension within the disposal site. In addition, vertical current profile measurements are necessary as input variables into computer models (i.e., STFATE and LTFATE) to predict the fate of dredged material during disposal operations. The collected data will be used to evaluate and predict the potential for dredged material resuspension and transport under typical conditions, as well as during storm events. Measurement of critical site-specific data may also help determine the potential for sediment resuspension as a result of propeller wash from passing vessels, surface waves, and storm events.

The suggested approach is to deploy a bottom-mounted instrument array from a surface vessel, to be left in place on the seafloor at a selected location within the disposal site. The use acoustic Doppler current profilers (ADCP) for several days during a maximum tidal phase (spring tides) will provide needed information characterizing local hydrodynamic conditions at the disposal site. It is suggested that one of the ADCPs be upward-looking to provide a profile of current speed and direction in the overlying water column. A second ADCP could be used to measure tidal current speed and direction within one meter of the bottom. The equipment can be deployed with no surface buoy and an acoustically released retrieval mechanism to reduce potential fouling with lobster trawls or anchor lines, although there is a low probability of disturbance to the instruments since fishing activity within Gloucester Harbor is minimal.

Accurate measurement of tidal height is also necessary since it can be used as input to nearshore circulation and tidal current amplitude predictions. Presently all tidal measurements in Gloucester Harbor are based on predicted estimates from the Boston Harbor tidal gauge, the nearest permanent NOS/NOAA measurement station. More accurate tidal height measurements in Gloucester Harbor are possible by deploying high resolution pressure sensors at one or more locations to provide vertical control and record tidal height measurements over a 28-day cycle. This information could then be used to predict the tidal component of currents and be correlated to long-term current data gathered from vertical profiles or bottom-mounted current measurements.

9.1.2.2 Water Quality Monitoring

To provide an accurate assessment of water quality impacts as a result of dredged material disposal, a detailed characterization of baseline conditions at the disposal site should be undertaken using a monitoring plan that conducts sampling at multiple time scales. The greatest potential change to background water column conditions is likely to occur during periods of high suspended sediment loads immediately following barge disposal. It is recommended that monitoring of water quality conditions be conducted at the time of disposal using both shipboard and stationary sampling instruments.

The data collected at the disposal site will also need to be compared with data collected at one or more nearby reference sites to determine if any detected changes are a result of localized or regional patterns. Water quality measurements should include vertical profiling of total suspended solids, dissolved oxygen, salinity, and temperature. These variables provide sufficient information to gauge the presence of low dissolved oxygen levels (hypoxia or anoxia), the development of a thermocline, and/or localized disturbances that may influence water quality.

9.1.3 Water Quality Standards

The development of water quality standards prior to dredging and disposal actives will provide target baseline conditions, which are not to be exceeded during operations. Failure to meet these standards will trigger mitigation responses to ensure that water quality conditions and marine resources within Gloucester Harbor are not compromised. The following criteria are recommended:

> The boundary of the mixing zone for dredging and disposal of project sediments should be located 300 ft downcurrent from the operations. Both acute and chronic water quality criteria shall be met at the mixing zone boundary, with the acute criteria to be met at all times. 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 four day average concentration which should not be exceeded more than once every three years, except for the PCB chronic criterion which is a 24 hour limit of exposure.
>
> Exceedence of the water quality criteria shall be attributed to operations when the sample concentration down current from the project operations exceeds the particular standard and the sample concentration is 30% higher than the reference sample. Real-time measurements of DO should be used to measure compliance and failure to meet the standards when there is a statistical difference at a 95% confidence interval between the mean of the reference sample and the mean of the down-current sample. If the samples exceed the water quality standard and this effect is attributed to project operations than repeat samples should be analyzed for TSS and the parameter(s) of concern within 24 hours.
>
> If two consecutive water samples fail to meet chronic water quality criteria the project operants can take the following actions to limit such exceedences: implement pre-approved contingency plan or cease all activities until a suitable alternative is provided.
>
> If two consecutive water samples fail to meet acute water quality criteria than the following actions shall be implemented: work may continue if chronic bioassay tests are conducted within 24 hours or an approved mitigation effort is implemented.
>
> In the event that compliance with the water quality standards is not maintained, the following bioassay and bioaccumulation tests are recommended:
>
> Conduct bioassays to monitor disposal of dredged material. Collect water samples during first two days of monitoring, four to six hours after disposal 300 yards downcurrrent from the cell. Conduct two bioassay tests: sea urchin (*Arbacia punctulata*) fertilization and 7 day shrimp (*Mysidopsis bahia*) chronic endpoint studies to assess the biological effects of pollutants that may be present.
>
> Conduct a bioaccumulation study to assess the long-term impacts of contaminants on blue mussels (*Mytilus edulis*). Deploy caged mussels for at least 60 days at mid water column depth 300 yards from the disposal cell. Analyze mussel tissues for the metals arsenic, cadmium, lead, mercury, and organics (PCBs and PAHs).

9.1.4 Monitoring of Short-term Water Quality Impacts

The proposed tiered approach to monitoring dredged material disposal impacts in Gloucester Harbor has been summarized in a series of "decision tree" flow charts, which are presented and discussed in the following sections. Each flow chart is organized around a null hypothesis. Different "tiers" within the flow chart present a series of questions and "yes/no" decision points used to address this null hypothesis. Tier 1 generally represents the minimum or "routine" level of monitoring. If the monitoring at this level indicates an absence of adverse environmental impacts, then there typically is no need to take management action and proceed to higher levels (involving more extensive and costly monitoring). However, the decision tree is structured such that indications of adverse effects at lower levels will trigger management actions involving more thorough examination of the impacts at higher levels. The following sections refer to the decision tree flow chart shown in Figure 9-1, which is designed to test the following null hypothesis: "Dredging and disposal activities have no short-term impact on water quality."

9.1.4.1 Tier One: Acute and Chronic Water Quality Standards

Box 1.1: "Assess Water Quality in Mixing Zone"

The assessment of short-term (hours to days) water quality impacts from disposal activities will require standardized and frequent monitoring during disposal events. The Tier 1 monitoring activities shown in Figure 9-1 also are required to verify compliance to the water quality standards. There was an intensive water quality monitoring effort associated with the placement into CAD cells of material generated by the Boston Harbor dredging project. This experience showed that exceedances of water quality criteria during disposal operations were rare. The proposed plan for Gloucester Harbor, therefore, incorporates the water quality monitoring deemed necessary to verify compliance while avoiding unnecessary data collection. The following standards are recommended:

- The mixing zone for disposal of project sediments should be located 300 ft downcurrent from the activity.
- To ensure that water quality standards are maintained, samples should be taken within the downcurrent turbidity maximum; use of instrumentation capable of real-time display of the plume extent is recommended. Use of a transmissometer can provide a depth profile of light transmittance or turbidity values. This instrument provides the capability to generate turbidity contour plots showing the areal extent and concentration.
- Suspended solids should not exceed 25mg/l over background levels at 25 m from the operation when ambient levels are lower than 100 mg/l.
- Turbidity should not exceed ambient levels by more than 30% at 25m from the operation.
- Plume samples should be taken at 0.5 and 1.0 hours, and four and six hours after the disposal at a location 300 feet downcurrent from the cell. Samples should be obtained from within 3 feet of the harbor bottom and from the mid-water column. These samples can either be combined or depth integrated. The first set of samples will be used to determine if acute criteria are met and the second set to determine whether chronic criteria are met.

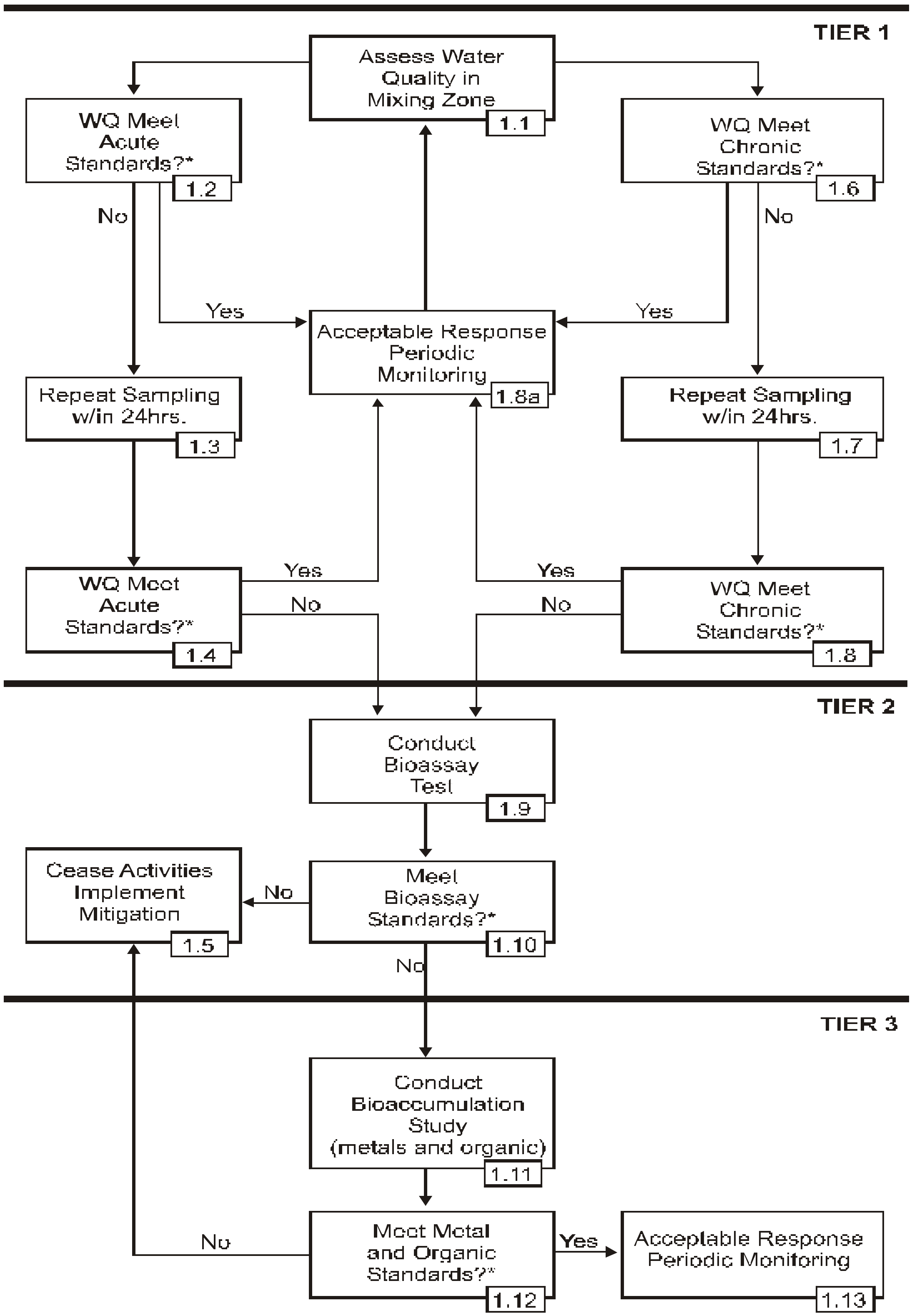


Figure 9-1: H_o1: Dredging or Disposal Activities have no Short-Term Impact on Water Quality.

- Acceptable locations for reference samples include a point 1000 ft upcurrent of the disposal cell, a point 300 ft downcurrent from the disposal cell prior to disposal, or some other pre-approved location.

- Water quality monitoring and analysis should be conducted during the first five days of disposal.

Box 1.2 and Box 1.6 "Water Quality Conditions meet Acute and Chronic Standards"
Acute criteria are defined as the one hour average concentration which should not be exceeded more than once every three years on average. Acute criteria should be met within the mixing zone at all times. 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 hr limit of exposure.

Box 1.3 and Box 1.7 "Repeat sampling within 24 hrs."
If samples fail to meet water quality standards, than repeat samples should be obtained within 24 hrs under similar conditions. The repeat samples should be analyzed for the parameter(s) of concern and TSS.

Box 1.4: "Water Quality Conditions meet Acute Standards"
If two consecutive water samples fail to meet the acute water quality criteria than either a pre-approved mitigation measure must be implemented or all disposal activities should cease within the effective area till further notice.

Box 1.8 : "Water Quality Conditions meet Chronic Standards"
If two consecutive water samples fail to meet chronic water quality criteria the following action should be implemented: work may continue if chronic biossay tests are conducted within 24 hours or mitigation controls are implemented.

9.1.4.2 Tier Two: Bioassay Testing

Box 1.9 "Conduct Bioassay Test"
Conduct sea urchin fertilization test and seven-day *Mysidopsis bathia* (shrimp) test according to EPA protocols for chronic endpoints. The results of the biological test should be considered as more significant than the water quality criteria in determining any operational mitigation measures to be required.

Box 1.10 "Meet Bioassay Standards"
Failure to meet Chronic bioassay standards will require all disposal activities to cease or implementing pre-approved mitigation controls.

9.1.4.3 Tier Three: Bioaccumulation Testing

Box 1.11 "Conduct Bioaccumulation Study"
Should continued concern over water quality impacts result from the first two tiers, conduct a bioaccumulation study for the contaminants of concern by deploying caged blue mussels (*Mytilus edulis*) at mid-water column depth within approximately 1000 ft of the disposal area for at least 60 days.

Box 1.12 "Meet Metal and Organic Standards"
Failure to meet bioaccumulation standards will require all disposal activities to cease or implementing pre-approved mitigation controls.

Box 1.13 "Acceptable Response, Periodic Monitoring"
Meeting the bioaccumulation standards will be considered an acceptable response. Disposal can continue with periodic water quality monitoring during events.

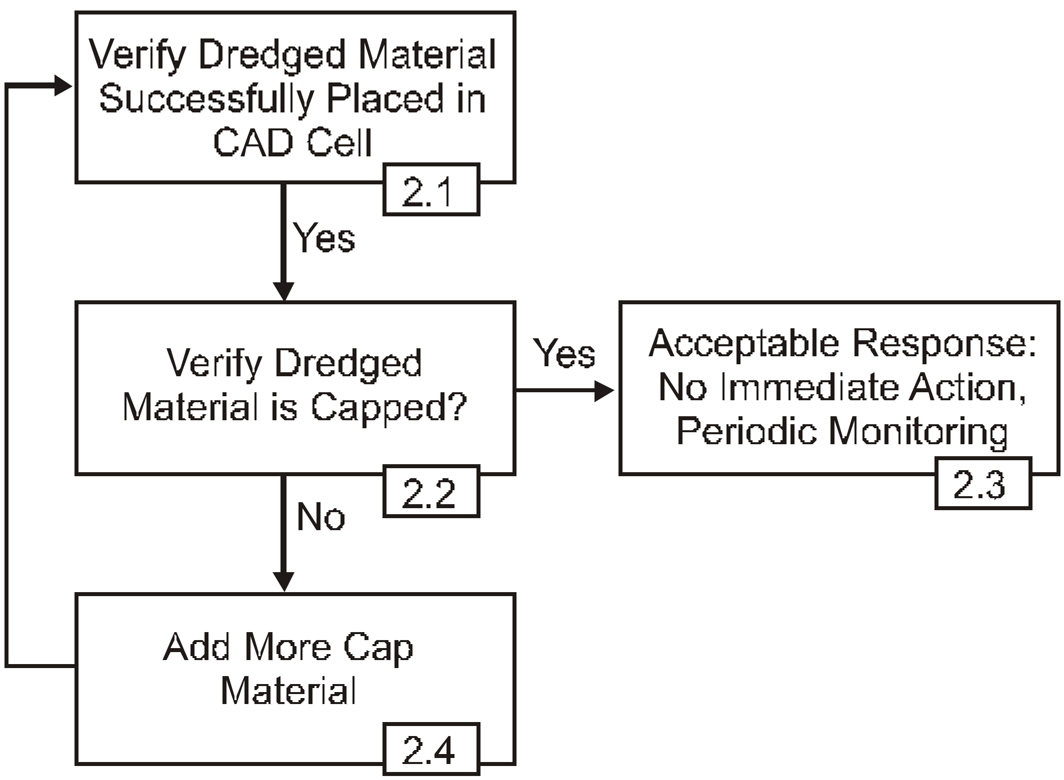


Figure 9-2: H_o2: Dredged material and cap material have been successfully placed according to design specifications.

9.1.5 Verify Successful Placement of Dredged Material and Cap Material

The following sections refer to the decision tree flow chart shown in Figure 9-2, which is designed to test the following null hypothesis: "Dredged material and cap material have been successfully placed according to design specifications."

9.1.5.1 Tier I: Operational Processes

Box 2.1 "Verify Dredged Material Successfully Placed"
Monitoring is required to verify that dredged material is placed accurately within a disposal site or CAD cell. The position of all vessels (e.g., barges, scows, dredges) used for placing material within a CAD cell must be controlled using a navigation system capable of achieving horizontal accuracy on the order of less than 10 m (e.g., differential GPS or microwave system). In addition, it is recommended that the position of all disposal vessels be recorded during loading at the dredging site, transit, and placement of the material at the disposal location using an automated "black box" surveillance system (e.g., ADISS system or equivalent). The combination of high-resolution navigation systems and automated surveillance of vessel position will help to ensure that material is placed accurately during the disposal operations.

Box 2.2 "Verify Placement of the Cap"
Similar to the dredged material placement operations, the position of all vessels (e.g., barges, scows, dredges) used for placing cap material within a CAD cell must be controlled using a navigation system capable of achieving horizontal accuracy on the order of less than 10 m (e.g., differential GPS or microwave system). Vessel position should be recorded using an automatic surveillance system. Following cap placement, physical monitoring is conducted to verify complete coverage of the dredged material. This evaluation typically involves conducting a high-resolution bathymetric survey in combination with sub-bottom profiling to verify depth of the cap material. Sediment cores might also be collected to measure cap thickness at individual points. A minimum average thickness of cap material should be specified (typically 1 meter), and the postcap monitoring should serve to verify whether or not this goal has been attained.

Box 2.4 "Add More Cap Material"
If the dredged material is insufficiently covered with capping material, further capping operations are necessary until the specified average cap thickness is achieved. Once the recapping has been completed, the disposal site should be re-surveyed to verify the cap thickness. If the cap thickness is found to be sufficient, no further operational monitoring is deemed necessary (Box 2.3).

9.1.6 Verify Isolation of Sediment Contaminants

The operational monitoring described above is used to verify successful placement of the cap according to design specifications. Additional monitoring is necessary to verify that the in-place cap is effective in isolating chemical contaminants known to occur at elevated levels in the underlying dredged material. The following sections refer to the decision tree flow chart shown in Figure 9-3, which is designed to test the following null hypothesis: "Capping has isolated sediment contaminants effectively."

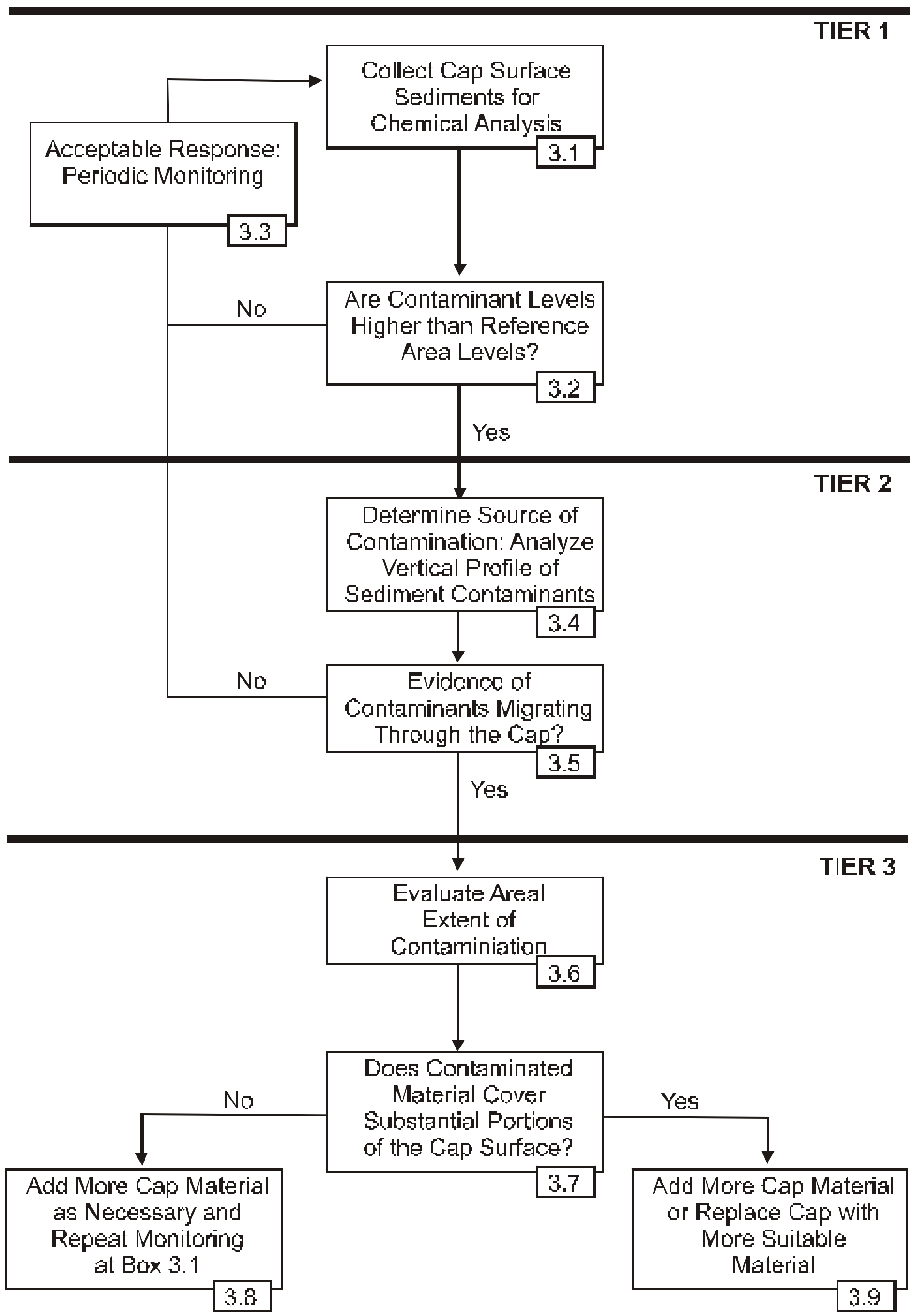


Figure 9-3: H_o3: Capping has Isolated Sediment Contaminants Effectively.

9.1.6.1 Tier I: Surface Sediment Chemical Analysis

Box 3.1 " Collect Surface Sediments for Chemical Analysis"
Sediments comprising the surface of the cap are collected using a grab sampler and analyzed for the chemical contaminants known to be present at elevated levels in the underlying dredged material. The chemical concentrations in the surface of the cap are compared to those found in nearby reference areas (Box 3.2). If the concentrations are not significantly higher than those in the reference areas, it is assumed that the cap is effectively isolating the contaminants. Chemical analysis of the surface sediments should occur at regular intervals to ensure continued effectiveness of the cap through time (Box 3.3). Significant elevations above reference values indicate possible migration of the chemicals through the cap. Such results would trigger Tier 2 monitoring involving further sampling to ascertain the source of the contamination.

9.1.6.2 Tier II: Vertical Sediment Chemical Profiling

Box 3.4 "Determine Source of Contamination: Analyze Vertical Profile of Sediment Contaminants"
If there are contaminants present in the surface sediments of the cap at significant elevations above reference area levels, it is likely that the contaminated material has not been from sufficiently contained below the cap. Sediment core samples should be collected; these cores should be long enough to encompass both the cap material and the underlying dredged material. Chemical analysis of the sediment at discrete intervals within each core can be used to evaluate whether there are any vertical concentration gradients serving to implicate the underlying dredged material as the contaminant source.

Box 3.5 "Evidence of Contaminants Present Above the Cap?"
If the cores indicate there is contaminated material at the surface of the cell that originated from below the cap, it is possible that the cap not functioning as designed. The extent of the cap failure should be investigated further under Tier 3.

9.1.6.3 Tier III: Evaluate Extent of Cap Failure

Box 3.6: "Evaluate Areal Extent of Contamination"
Using the methods to establish cap presence (Figure 9-2) along with the coring data from above, the areal extent of the contaminated sediments should be measured to establish the areas most in need of additional cap material. Results from this study may indicate whether new material has been deposited on the site, an errant disposal event occurred, or large-scale failure of the cap occurred.

Box 3.7 "Does Contaminated Material Cover Substantial Portions of the Cap"
If the survey data collected above indicates that contaminated material has migrated through the cap in substantial portions of the disposal site, mitigation efforts are considered necessary to prevent further bioavailability of contaminants.

Boxes 3.8 and 3.9 "Add More Cap Material or Replace Cap with more Suitable Material"
The existing cap will need to be enhanced, based upon the identified origin of the cap failure. For example, the cap may need to be enhanced with sediment having a coarser grain size, which is less prone to erosion

It may also be necessary to increase the thickness of the cap material to provide a more effective barrier and greater insurance against future cap failures.

9.1.7 Long-term Impact on Biological Resources

9.1.7.1 Tier I: Benthic Recolonization of the Placed Material

The following sections refer to the decision tree flow chart shown in Figure 9-4, which is designed to test the following null hypothesis: "Dredging or disposal activities have no long-term adverse impacts on biological resources." Tier 1 of the flowchart addresses potential impacts to benthic infauna, while Tiers 2 and 3 address impacts to fisheries (Figure 9-4).

Box 4.1 : Assess Population Density of Stage 1 Organisms”

Uncontaminated, fine-grained sediment (e.g., dredged material or cap material) placed on the seafloor represents a clean, open substrate suitable for colonization by both adult and larval benthic organisms. Extensive past experience has demonstrated that benthic organisms colonize soft bottoms following a predictable pattern or successional sequence. Typically, the new sediment is populated first by an assemblage of pioneering or opportunistic species. This "Stage I" assemblage is usually comprised of small, tube-dwelling marine worms (polychaetes) which thrive at the sediment surface within days to weeks of material placement. With time (weeks to months), other benthic organisms which live at and a few centimeters below the surface begin to appear. This transitional, "Stage II" community may be comprised of small, shallow-dwelling bivalves and amphipods. Ultimately (months to years), the successional sequence leads to a "climax" or "equilibrium" community dominated by larger-bodied organisms which live and feed at depth within the sediment. This "Stage III" community is typically comprised of organisms which orient themselves in a head-down position and feed by ingesting the fine-grained sediment; these "deposit feeders" extract the organic matter and eject their waste (sediment and feces) at the sediment surface.

The feeding and burrowing activities of benthic infauna act to mix and thus enhance aeration of the sediment through a process called bioturbation. A mature, healthy soft-bottom benthic community typically is comprised of a diverse mixture of both surface-dwelling, Stage I and Stage II organisms and larger-bodied, deeper-dwelling Stage III organisms.

Since Stage I organisms are expected to be the initial colonizers of a newly-placed deposit of dredged material or cap material, Box 4.1 of Figure 9-4 involves assessing the population density of these organisms following the completion of capping operations. The Stage I population densities can be assessed through traditional grab sampling followed by taxonomic analysis of the benthic community, or by using a sediment-profile camera to obtain a vertical cross-section image of the sediment surface and associated organisms.

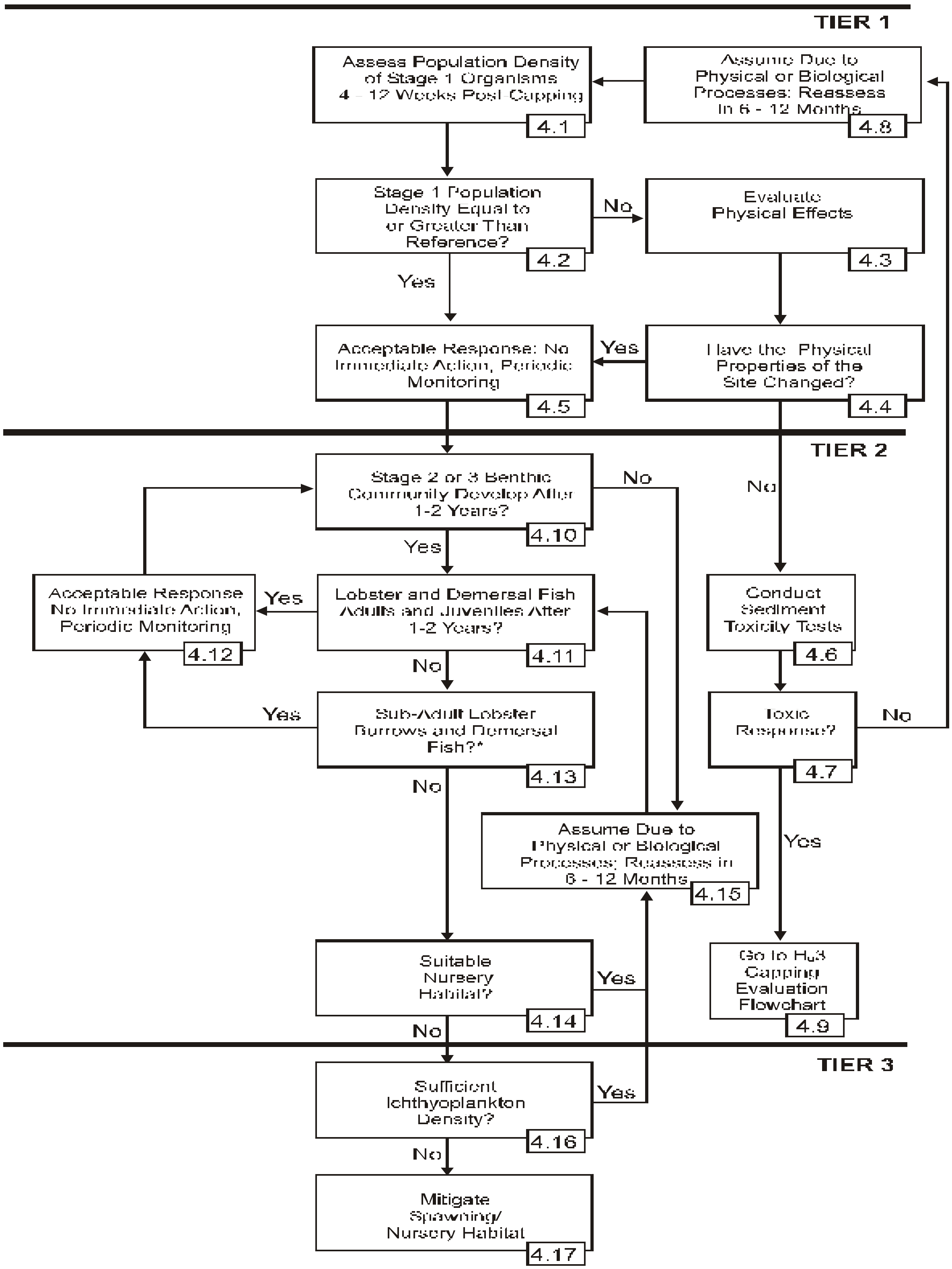


Figure 9-4: H_o4: Disposal/Capping Have No Long-Term Adverse Impacts on Biological Resources.

Box 4.2 "Stage 1 Population Density Equal to or Greater than Reference Area(s)"

The densities of surface-dwelling, Stage I polychaetes at the disposal site should be compared with densities at one or more reference stations located outside the designated boundaries of the disposal site. The selection of reference areas should include the following factors: similar sediment type as the disposal site cap, comparable water depths and water quality conditions, and a benthic and fisheries community structure similar to that at the disposal site prior to activities. Based on the standard benthic successional model for soft-bottom communities, it is expected that Stage 1 population densities at the disposal site will be equal to or higher than in the undisturbed reference areas within a few weeks of dredged material or cap material placement. If this condition is found, it indicates an acceptable response (Box 4.5). Monitoring at regular intervals (i.e., every 6 to 12 months) should continue to ascertain that the successional sequence proceeds to later, more advanced stages (see Tier 2).

Box 4.3 "Evaluate Physical Effects"

The detection of anomalous rates of colonization at the disposal site are typically attributed to physical or chemical properties of the dredged material or cap material.

Box 4.4 "Have the Physical Properties of the Site Changed?"

Sediment erosion and scour or differences in sediment material may cause anomalous recruitment patterns at the disposal site that may disrupt larval colonization.

Box 4.5 "Acceptable Response: No Immediate Action Necessary, Periodic Monitoring"

If the anomalous recolonization is due to a physical event, no immediate mitigation is warranted.

9.1.7.2 Tier II: Recovered Adult and Juvenile Marine Resources

Box 4.6 "Conduct Toxicity Tests"

If the anomalous recolonization pattern is not due to a physical event, testing of the sediment using the 10-day amphipod test is recommended to determine whether the anomaly is due to sediment toxicity (Box 4.7).

Box 4.8 "Assume Due to Physical or Biological Processes"

If the toxicity test shows an absence of sediment toxicity, the anomalous benthic results are most likely due to natural environmental conditions. The Stage I benthic recolonization status should be re-assessed in 6 to 12 months.

Box 4.9 " Go to $H_0$3 Disposal Evaluation Flowchart (Figure 9-3)"

If the toxicity test shows a toxic response, there may be a problem with the containment of the contaminated dredged material. The H_o3 (Effective Sediment Isolation) Flow Chart must be re-visited.

Box 4.10 "Stage 2 or 3 Benthic Community Develops after 1 Year"

As previously indicated, experience has shown that benthic succession on newly placed dredged material or cap material will result in the establishment of a more mature (i.e., Stage 2 or 3) benthic community within 1 to 2 years. Using either traditional grab sampling and taxonomic analysis or sediment-profile imaging, the benthic community can be compared to the reference area to evaluate longer-term recovery.

Box 4.11 "Lobster and Demersal Fish Adults and Juveniles after 1 Year"
Disposal activities are usually scheduled during winter and early-spring to avoid impacts to reproduction and recruitment dynamics of marine and invertebrate species. Establishment of a healthy, mature (i.e., Stage III) benthic community traditionally has been used as an indicator of acceptable recovery following dredged material or cap placement. Direct sampling of the fisheries at the disposal site also can be used to evaluate potential long-term impact. These data need to be collected over several seasons and analyzed with caution due to the temporally and spatially variable nature of fisheries data.

Box 4.12 "Acceptable Response: No Immediate Action, Periodic Monitoring"
The presence of both an advanced benthic community (Stages 2 and/or 3), as well as benthic fisheries (demersal fish and commercially valuable crustaceans like lobster) would suggest no long-term adverse impact from the disposal or cap placement activities.

Box 4.13 "Sub-adult Lobster Burrows and Juvenile Fish"
If the lobster and demersal fisheries data show a paucity of numbers, additional information on different life stages of these species can be collected.

Box 4.14 "Suitable Nursery Habitat"
The lack of juvenile fish might indicate that the habitat at the disposal site is no longer productive as a fisheries resource. This information would trigger more evaluation in Tier 3.

Box 4.15 "Assume Due to Physical or Biological Processes"
If the juvenile fish data indicate acceptable nursery habitat, the lack of both adult and juvenile fisheries at the site may be due to natural environmental processes, and additional data should be collected within a year, potentially during a different sampling season.

9.1.7.3 Tier III: Recovered Spawning and Nursery Habitat for Marine Resources

Box 4.16 "Sufficient Icthyoplankton Density"
An icthyoplankton survey would help to evaluate the suitability of the disposal site as an acceptable spawning and nursery habitat for benthic fisheries.

Box 4.17 "Mitigate Spawning/Nursery Habitat"
If all of the data collected indicate that the disposal site, as compared to reference, has been negatively impacted by the dredging and disposal operations, a mitigation plan should be implemented. The anomolous fisheries results may be indicating that the underlying contaminated dredged material has not been isolated effectively, and the site may need to be reassessed relative to the contaminant isolation flowchart (Figure 9-3).

9.1.8 Description of Monitoring Techniques

This section provides brief descriptions of various surveying and sampling techniques commonly used to address marine environmental monitoring objectives and explains how each can be utilized to address specific questions associated with the disposal of dredged material in coastal embayments.

9.1.8.1 Disposal Tracking

Verification of the location and timing of dredged material or cap placement is a critical component of monitoring efforts. One approach involves the use of an automated vessel tracking system. Available systems provide fully automated tracking of disposal scow positions and draft level information using highly accurate differential GPS and pressure sensors during the loading, transit, and disposal phases of dredging operations. The disposal tracking equipment consists of an electronic box, battery, and antennas that can be easily installed onto one or more disposal scows. The instrumentation records the trackline of the scow navigation path, position of the released dredged material based on changes in vertical measurement of the scows position, and uplinks the data via ARGOS satellite for easy retrieval. These data can then be automatically updated and displayed via the internet using a Geographic Information System. By recording the precise locations and timing of disposal positions when placing dredged and cap material, vessel tracking data can greatly increase the accuracy of cap material placement.

9.1.8.2 Sediment-Profile Imaging

Sediment-profile imaging is a benthic sampling technique in which a specialized camera is used to obtain vertical cross-section photographs (profiles) of the upper 15 to 20 cm of the seafloor. It is a reconnaissance survey technique used for rapid collection, interpretation and mapping of data on physical and biological seafloor characteristics; it has been employed in estuarine, coastal and deep-sea environments worldwide for almost 20 years. Measurements obtained from sediment-profile images are used to characterize sediment types, evaluate benthic habitat quality, map disturbance gradients, and follow ecosystem recovery after disturbance abatement. This technique was first introduced under the name REMOTS® (REmote Ecological Monitoring Of The Seafloor), a registered trademark of Science Applications International Corporation (SAIC). REMOTS® is a formal and standardized technique for sediment-profile imaging and analysis (Rhoads and Germano 1982; 1986). In generic terms, this sampling technique is called sediment-profile imaging (SPI) or sediment vertical profile imaging (SVPI).

The SPI hardware consists of a wedge-shaped optical prism having a camera (sensor) mounted horizontally above in a watertight housing. The prism is shaped like an inverted periscope, with a clear Plexiglas window and an internal mirror mounted at a 45^{o} angle to reflect the image in the window up to the camera. The entire assembly is lowered to the bottom using a standard winch mounted aboard the survey vessel. Upon contact with the bottom, the prism descends slowly into the seabed, cuts a vertical cross-section profile of the upper 15 to 20 cm of the seabed, and a photo is taken. The camera normally is raised and lowered multiple times at each sampling station to obtain replicate images. Because the photographed sediment is directly in contact with the prism window and light is provided by an internal strobe, turbidity of the ambient seawater is never a limiting factor. Typically, 100 to 200 images can be obtained in a single survey day (i.e., three replicate images obtained at roughly 30 to 70 stations).

In the laboratory, a suite of physical and biological parameters are measured directly from the film negatives using a video digitizer and computer image analysis system. The measured parameters include sediment grain-size major mode and range, prism penetration depth (a relative measure of sediment shear strength), boundary roughness as measured from small-scale topographic relief (e.g., ripples, fecal mounds), depth of the apparent redox potential discontinuity (RPD), surface mud clast number and diameter, thickness of dredged material or other depositional layers, linear density of tubicolous fauna at the sediment-water interface, depth and number of subsurface feeding void structures, and designation of infaunal successional stage. Complete image analysis, interpretation, mapping and reporting can be accomplished within 1 to 4 weeks, depending on the size of the survey.

Sediment-profile imaging has proven to be an effective tool for addressing the monitoring objectives of several dredged material disposal projects (SAIC 1998). The information on physical sediment characteristics and biological activity has been useful for assessing benthic habitat quality both prior to and following disposal and capping operations. Sediment-profile imaging has also facilitated monitoring of the recolonization of capped dredged material mounds by benthic organisms following cap placement. In addition, sediment-profile imaging can be used to detect and map depositional layers of disposed project material occurring on the mound apron in layers too thin to be detected using high-resolution bathymetric techniques. For example, information on the disposal mound "footprint" was used to ensure that dioxin-contaminated dredged material was covered with clean capping material and thus isolated from the overlying water column at the New York Mud Dump Site (SAIC 1998).

9.1.8.3 Subbottom Profiling

Subbottom seismic profiling is a standard technique for determining changes in acoustic impedance below the sediment-water interface. In a seismic profiling survey, the vessel is driven over the seafloor along consecutive lanes in a manner similar to that used for bathymetric surveys. Penetration of sound in sediment is both a function of system frequency and the impedance contrast between the water column and sediment. In general, sound penetrates further into fine-grained sediment because the impedance of silt and clay with a high water content is closer to that of the water column. Sediments having different geotechnical characteristics (i.e. bulk density) will have distinct acoustic impedance, and therefore sound will reflect from the boundary between layers of sediment having different densities. The digital information collected via subbottom sampling can be used to identify depth to bedrock, and therefore potential containment capacity of a CAD cell, and for verifying the thickness and distribution of cap material in a CAD cell or on the open seafloor.

9.1.8.4 Geotechnical and Chemical Analysis of Sediment Cores

Geotechnical surveys are generally performed as part of a dredged material monitoring program to obtain sediment core samples at stations located on and around the disposal site. Vibracorer systems (which employ a motor to "vibrate" the core into the sediment) are used for sediment core analysis because they are capable of obtaining long, relatively undisturbed cores from coarser-grained sand caps, while conventional gravity corers (which rely on weight alone to push into the sediment) are incapable of penetrating to the desired depths. The cores provided a vertical section of both the sand cap and the underlying, fine-grained dredged material at a single location. Visual observations and geotechnical analyses of these vertical sections enable assessments to be made of sand cap thickness and stability through time, while chemical analyses enable a determination of cap effectiveness in isolating underlying contaminants.

9.1.8.5 Macrobenthic Analysis

Although the overall response of benthic infaunal populations to disposal activities can be assessed using sediment-profile imaging, ground-truthing of the images and more detailed information about benthic community structure including dominant species, diversity, and population density and abundance is primarily obtained through traditional benthic sampling and taxonomic identification of invertebrates. Grab samples are typically collected and analysed when assessing soft bottom infaunal communities.

Laboratory analysis consists of sample transfer to alcohol, Rose Bengal staining, and sorting to major taxonomic groups (e.g,. crustaceans, polychaetes, mollusks, nemerteans). Following initial sorting procedures, each organism is counted and identified to the lowest practical taxon (typically to the species level) by taxonomic specialists. Taxonomic data can be loaded into a database and evaluated using a variety of statistical procedures (e.g., Analysis of Variance and multivariate techniques such as principal component analysis and clustering) to quantify the relative similarity of benthic infaunal populations among the stations sampled. Summary information derived for each station from macrobenthic analyses may include estimates of: 1) mean number of individuals; 2) total number of individuals; 3) total number of taxa; 4) species diversity; 5) dominance; 6) species richness; and 7) species evenness.

9.1.8.6 Fisheries Assessment

A number of organizations have conducted assessments of seasonal fisheries distribution, abundance, and species composition in coastal Massachusetts using a variety of techniques and gear types, including boat trawls, beach seining, and diver transects. Shellfish resources have been mapped by delineating information provided by Commonwealth resource managers, digitizing data shown in the Massachusetts Monograph series, and interpreting video transect data.

Despite these efforts, continued monitoring is necessary to further define the pre-disposal (i.e., baseline) abundance of marine resources, estimate the magnitude and rate of reuse by non-benthic species, and assess the success of mitigation efforts. Effort is necessary to elucidate the relationship between physical conditions (i.e. sediment type, flow conditions, water quality) and marine resources at proposed disposal sites, to estimate the potential long-term consequences of permanent disturbance to the habitat from dredged material and cap material placement. This objective is best met by more intense but continued use of methods which have been successful to date such as diver transects and lobster early benthic phase suction sampling. Sampling techniques such as visual observations, benthic grabs, patent tonging, or raking can also be used to better estimate the presence and density of ecologically important bivalve species at disposal sites. This information should then be transcribed to cartographic products to provide a spatially-explicit record of shellfish and their abundance.

Post-capping sampling efforts are best addressed using a mixture of collection techniques for targeting demersal and pelagic species. These include use of otter trawls for capturing lobster and demersal species and experimental gill nets to sample pelagic fish species of various sizes. In waters less then 20 m, i*n situ* observation using video or 35 mm photographic images from a drop camera may also be utilized to estimate lobster size-class distributions or burrow densities. Shellfish colonization plates can be deployed at strategic positions in the water column to assess recruitment and attachment of larval forms of bivalves like blue mussels or eastern oysters. Further information about impacts (positive and negative) to commercial and recreational activities can be obtained from on-site interviews with local fishermen, bait shops, and resource managers, as well as conducting visual assessment of any commercial fishing activity and/or lobster pot distributions. Continuous contact with lobstermen and local fishing clubs or organizations can aid in identifying timeframes and locations of greatest activity, as well as provide a review of any proposed dredging "windows" (i.e. months in which dredging and disposal should be limited due to the presence of spawning or nursery activity).

9.2 AQUATIC DISPOSAL MANAGEMENT OPTIONS

As part the DMMP process, management examples within the state and throughout the country were investigated including the Cape Cod Disposal Site, NY/NJ Port Authority, and Barnstable County Dredge Program, to serve as potential models to be applied. The two most relevant approaches are discussed below.

9.2.1 State Managed Site

At the conclusion of the MEPA process and the designation of the Preferred Alternative, the state would own the site as Commonwealth Tidelands. Massachusetts Department of Environmental Management (DEM) would manage the operation of the aquatic disposal site in Gloucester Harbor based upon a plan approved by MEPA and subject to recommendations of a technical advisory committee. This agency has a long history of managing state owned waterfront properties, such as state fish/cargo piers, and maintenance of waterways, including dredging state channels, harbors and berthing areas.

As the disposal site manager, DEM would officially obtain site designation by securing permits from DEP and USACE; announce the availability of the disposal site to public and private users; levy any fees for use; have legal authority to manage liability; oversee disposal activities; and monitor short and long term impacts and environmental conditions of the disposal site environs. DEM would also publish operating specifications to ensure that contractors meet disposal and capping specifications.

9.2.2 City Managed Site

To establish a City managed site, an application would be filed by the City to use the disposal site designated by the MEPA process. The City managed site would be subject to a MEPA approved management plan. The City would license the facility under Chapter 91, assuming all management responsibilities. The City would be responsible for permit compliance, legal agreements with contractors using the sites, establishing disposal rates long-term monitoring and remediation if necessary.

Under this option, an agency of the City of Gloucester or an existing or created semi-public authority would manage the disposal site. The agency would levy fees for use and manage liability much like that of a municipal landfill. The City would establish a revolving or enterprise fund to manage the long-term operation of the facility. Gloucester would be responsible for program implementation, operation, and monitoring.

9.3 SUMMARY

MCZM will develop, implement and monitor a detailed Disposal Site Management Plan for the final preferred alternative pursued in the FEIR. This plan will identify the site specific measures necessary to minimize potential negative impacts to the environment associated with implementing the final preferred alternative. The plan will include the monitoring measures discussed in this section. The plan will also establish the environmental baseline upon which performance of the site will be gauged. The Disposal Site Management Plan will also include triggers for appropriate actions to be taken if criteria are exceeded.

10.0 PROPOSED SECTION 61 FINDINGS

This section of the DEIR presents the Proposed Section 61 Findings for the Gloucester Harbor DMMP, as required under the Massachusetts Environmental Policy Act (MEPA) regulations at 301 CMR 11.12. Section 11.07 of the MEPA regulations require that the proposed Section 61 Findings be included in the DEIR for a project. As a state agency, MCZM is bound by the statutory requirement under MEPA to take all feasible measures to avoid or minimize damage to the environment. This section presents draft Section 61 Findings for the preferred alternative for Gloucester Harbor.

10.1 Aquatic Sites - G-Cell-1, G-Cell-2, G-Cell-3 and G-Cell-4

Potential environmental impacts associated with selection of the preferred alternative aquatic disposal sites in Gloucester Harbor (G-Cell-1, G-Cell-2, G-Cell-3 and G-Cell-4) include those associated with sediments and water quality, benthos, finfish, wetlands, wildlife, endangered species, navigation and shipping, land use, air quality and noise, historic and archaeological resources and recreation areas.

10.1.1 Sediments and Water Quality

Construction of disposal cells and dredged material disposal activities at the preferred alternative sites will lead to temporary impacts to the existing sedimentary environment at the site, including mortality of existing benthic organisms and the alteration of existing sediment composition. Analysis of sediment profile imaging data was gathered from the vicinity of the preferred aquatic disposal sites. This baseline data indicates that the existing benthic habitat quality exhibits characteristics indicative of minimal to moderate impact from existing harbor conditions. Existing benthic conditions include sediment aeration depths sufficient to support epifaunal and infaunal macro benthic organisms. The depth of aeration may be from adequate, tidal flushing, bioturbation by deposit feeding (Stage III) infauna, or a combination of both factors.

Placement of a final sand cap over the disposed dredged material will allow re-colonization to occur, although at a slow rate, as the organisms present at the site prefer finer grained sediments. Changes in species composition may result in the sand cap. As finer grained harbor sediments within the water column settle on the final sand cap over time, the benthic species composition at the site is likely to approach the composition of other nearby areas of the harbor.

The location of the proposed disposal sites within the upper reaches of the outer harbor minimizes potential storm-induced wave action impacts, minimizing the impacts to water quality from the resuspension of cap sediments. Also, the depth of the disposal sites, with a final cap elevations no higher than the ambient elevation, will also minimize any sediment resuspension at the site. Deeper, in-channel and near channel sites are exposed to smaller current velocities. The placement of coarse-grained sand as a final cap will also minimize sediment resuspension at the preferred alternative sites.

10.1.2 Benthos

Benthic resources include marine epifauna and infaunal invertebrates, and submerged aquatic vegetation. As described above, the community structure of benthic organisms is typically a function of sediment characteristics and water quality (Day, et. al., 1989). Dredging and disposal of sediment may impact benthic marine organisms by altering preferred microhabitat (i.e. sediment composition) or via interference with the organism's feeding type. Therefore, impacts to benthic epifauna and infaunal sessile invertebrates such as various bivalve mollusks and echinoderms are expected. The area of the disposal sites are closed to shellfishing, therefore there would be no impact to commercially or recreationally harvestable mollusks or shellfish. According to DMF mapping, blue mussels and soft-shell clams do inhabit a portion of G-Cell-4 (<1 acre. Over time (2-5 years), recolonization of these species is expected. Motile invertebrates such as various crustacea can avoid impact areas. However, they may have sedentary stages of their life cycle that could make them more susceptible to dredging and disposal of sediment. For instance, lobsters enter an early benthic phase of their life cycle following their planktonic larval stage. Surveys of the disposal site for early benthic phase lobsters was conducted, since lobstering is an important economic resource in Gloucester and the region. The study revealed that the disposal sites are not within suitable early benthic phase lobster habitat, since this developmental stage was not found during sampling. The other stages of the lobster's life cycle were found during EBP lobster sampling. However, juvenile and adult lobsters are highly mobile, and these forms are likely able to avoid dredging and disposal impacts. The timing of disposal cell construction and dredged material disposal after maintenance dredging of the area will limit the number of juvenile or adult lobsters impacted.

There were no eelgrass beds identified in the area of the proposed disposal site. Water depths are too deep to support the vegetation. The closest eelgrass beds to the G-Cell sites lie outside of the expected zone of influence caused by resuspension of harbor sediments during cell construction and dredged material disposal activities.

10.1.3 Finfish

Construction and disposal activities at the preferred alternative sites will have little impact on existing fisheries resources. Commercial fishing within the Inner Harbor is prohibited. Commercial lobstering is practiced at and near the G-Cell sites. Loss of lobstering ground would occur as the cells are excavated and filled. Lobster recolonization via emigration from surrounding areas is expected. Most of the important recreational sport fishing species in the harbor are neritic or pelagic and are able to easily avoid dredged cell construction and dredged material disposal activities. Many sport fish species, including cod, striped bass and tautog frequent areas proximal to submerged structures such as rocky ledges and reefs in the harbor, rather than the muddy and relatively featureless conditions at the disposal sites. However, winter flounder, an important recreational species in the area that frequents neritic waters, are bottom spawners. Larvae live as pelagic forms but return to estuaries to live as demersal adults. Timing of cell construction and dredged material disposal activities to avoid the spawning and egg development cycle of demersal fish will avoid impacts to these resources.

10.1.4 Wetlands

There would be no impacts to coastal wetlands or salt marsh. The entire area of the preferred disposal sites are sub-tidal, therefore, no coastal wetlands exist there. The sites are, however, classified as Land Under the Ocean within a DPA under the Massachusetts Wetlands Regulations at 310 CMR 10.26. Under the regulations, a project impacting Land Under the Ocean in a DPA must minimize adverse impacts to water circulation and water quality, including fluctuations in dissolved oxygen, temperature or turbidity, or the addition of pollutants. As discussed in the preceding section on water quality impacts, no adverse long term impacts to water quality are expected from construction and dredged material disposal activities at the site. Likewise, the impacts to water circulation are described in the preceding section. No adverse impacts are expected.

10.1.5 Wildlife

Wildlife impacts assessed included those to avifauna, marine mammals, and marine reptiles. No shorebird breeding or foraging habitat is located within the confines of the disposal site, since these areas are generally intertidal or supratidal areas. Prime shorebird habitat in Gloucester harbor lies outside of the UDM disposal zone of influence. However, Ten Pound island is a nesting area for birds (E. Hutchins, personal communication). The nature of the disturbance (sub-tidal) dictates that impacts to nesting habitat would not occur. Since finfish will leave the area to avoid dredging and disposal impacts, piscivorous waterfowl will also avoid the impact areas as they follow departing finfish concentrations. Molluscivorous waterfowl tend to congregate in areas with high mollusk density such as the vicinity of shellfish beds and reefs. Since shellfish beds do not lie within the disposal area or within the zone of UDM disposal influence, minimal impact to molluscivorous waterfowl is expected.

The various species of whales and other cetaceans found in the region, occur far offshore of Gloucester, rarely, if ever, entering harbor waters. Therefore, the only marine mammal species commonly found in Gloucester Harbor is the harbor seal, which frequents rocky ledges and shorefront areas, not the deep water and muddy bottom conditions of the disposal site. The harbor seal is also highly mobile, and quite able to avoid cell construction and dredged material disposal events. Therefore, no impacts to marine mammals are expected.

Marine reptiles in the region are represented by sea turtles. Two species of marine turtles that occur in the North Atlantic are not commonly found in Gloucester Harbor. They occur in the much deeper open ocean waters off Gloucester and the north Atlantic Ocean and rarely, if ever, enter Gloucester Harbor. The distance from the disposal site to the sea turtle habitat will preclude any impact to these species or their habitat from either cell construction or dredged material disposal activities.

10.1.6 Endangered Species

Although five whale and two sea turtle species listed by the USFWS occur in the ocean waters off of Gloucester, there is no indication that these species occur at the disposal sites within the harbor. Therefore, no impacts to endangered species habitat from cell construction and dredged material disposal activities will occur.

10.1.7 Navigation and Shipping

Gloucester Harbor has developed and prospered over the last three centuries as a vital center for Cape Ann fishing activity. The harvesting, processing and supporting industry to the fishing industry in Gloucester is directly linked to the ability of vessels to navigate within the Harbor in a safe fashion. Continued access to shore-side locations is an integral component of the Harbor Plan's vision of maintaining and expanding existing maritime, industrial and visitor harbor uses, to continue the Harbor as a working, productive port and economic asset for the City and Commonwealth. Disposal cell construction and dredged material disposal activities will be scheduled to avoid vessel movements, avoiding temporary impacts to existing navigation and shipping. The depth of the final cap elevation at the disposal sites with portions within the channel, will be below the existing authorized depth, and the portion of the cells outside of the navigation channel will be restored to ambient depths. Therefore, there will be no permanent impacts to existing navigation and shipping in Gloucester Harbor.

10.1.8 Land Use

The proposed disposal sites are entirely within subtidal waters, therefore there would be no direct impacts to existing shore front land use patterns surrounding Gloucester Harbor. Being located entirely under water, the disposal sites are not visible from land. Positive indirect impacts will result from the construction and use of the disposal site. The presence of the disposal sites will allow the cost effective disposal of UDM from Gloucester Harbor dredging projects, maintaining the economic viability of existing marine facilities and existing land use patterns along the Gloucester Harbor shoreline.

Construction and use of the proposed aquatic disposal sites are consistent with the stated goals of the Gloucester Harbor Plan. As noted on the preceding paragraph, the presence of the disposal sites will encourage the completion of the anticipated public and private dredging projects in Gloucester Harbor and provide a local disposal option for the UDM from those dredging projects. The Gloucester Harbor Plan also encourages the coordination with the DMMP to develop a suitable alternative for disposal of UDM.

10.1.9 Air Quality and Noise

Air quality and noise impacts from construction and use of the disposal site in Gloucester Harbor are expected to be temporary and minor in nature. Impacts will result from the heavy construction equipment used to construct the disposal site and to conduct dredged material disposal activities.

Air quality impacts will be minimized through the use of equipment that complies with emission standards applicable to equipment, use of proper emission controls, participation in DEP's Voluntary Diesel Retrofit Program(VDRP) and the temporary nature of the activity. Temporary stockpiling on or near land of dredged material may result in minor air quality and odor impacts to adjacent properties due to anaerobic decomposition of organic materials in the dredged sediment. These odors will be minimized with the use of lime as necessary. Volatilization of organic compounds in the stockpiled dredged material is not expected to occur because the short duration of stockpiling activities will not allow for complete drying of the dredged material.

Unavoidable noise impacts are also expected to be temporary, localized and minor. Also minimizing adverse noise impacts will be the use of properly mufflered construction and dredging equipment, the temporary duration of the noise-producing activities and limiting activity to daylight hours.

10.1.10 Historic and Archaeological Resources

The location of the proposed disposal site within the subtidal area of Gloucester Harbor avoids direct and indirect impacts to nearby land-based local-, state- and federal-listed historic sites and districts.

Gloucester Harbor has a long and rich maritime history and is an area of archaeological sensitivity. However, the portions of the proposed disposal sites located within the confines of the existing federal navigation channel, have been previously disturbed by past dredging activities that deepened the area. This deepening of the area has likely destroyed any underwater archaeological resources at the site. Therefore, no impacts to underwater archaeological resources are expected in these areas.

Portions of the preferred disposal sites are adjacent to the federal channel, in areas that have not been previously dredged. These areas have the potential to contain underwater shipwrecks, alhtough no known shipwrecks occur in this area. Nevertheless, detailed underwater archeological surveys will be conducted for all areas of the preferred alternative in the FEIR.

10.1.11 Recreation Areas

There would be no direct impacts to existing recreation areas from the construction or use of the proposed disposal sites. The site is entirely within subtidal waters, and the distance to the nearest recreational areas, Pavilion Beach and Fort Stage Park, functions to avoid direct impacts to the area. Disposal site construction and dredged material disposal activities may temporarily impact recreational fishing activities. This temporary impact is minimized by the presence of other recreational fishing areas in the harbor.

10.2 Implementation of Mitigation Measures and Proposed Mitigation Implementation Schedule

10.2.1 Aquatic Sites - G-Cell-1, G-Cell-2, G-Cell-3 and G-Cell-4

Prior to the commencement of dredging projects, the construction of the disposal cell needs to be completed. Dredging of the disposal cells will be completed during an environmentally favorable window to reduce the disturbance to marine life. Dredge limits and locations will be located by GPS Geodetic Positioning System, which is a satellite positioning system, accurate to within a foot of the intended horizontal design limits. The dredge machinery will most likely be a large barge mounted crane with a clamshell bucket. Bucket size will likely be in excess of ten cubic yards. The material will be removed to the intended depth and side slopes. The Dredging contractor will also be compensated for an allowable over-dredge limit to ensure that the intended depths are achieved. The material is removed by a bucket and deposited within a transport barge called a scow. The scow will deliver the material to MBDS where it is positioned prior to dumping using GPS. A bottom dumping or split hull scow will most likely be used. These barges open from the bottom allowing the material to drop out through the water column to the sea floor below. This material is clean and will therefore not need to be capped.

Following the completion of each disposal cell, the dredging of unsuitable material from the harbors will completed by mechanical means, using siltation curtains to minimize turbidity impacts. After being dredged, the UDM will be placed on a dump scow and transported to the disposal cell, where the material will be deposited.

The party responsible for the implementation of the required mitigation measures has not been identified to date. Potential entities include the Massachusetts Department of Environmental Management, the US Army Corps of Engineers, or the City of Gloucester operating through an existing or created public authority.

10.3 Draft Section 61 Finding

With the selection of the preferred alternative disposal sites for dredged material disposal from Gloucester Harbor, MCZM finds that, with implementation of the mitigation measures listed above, all feasible means have been taken to avoid or minimize damage to the environment.

11.0 RESPONSE TO COMMENTS

This section of the DEIR provides individual responses to the public and agency comments received on the Environmental Notification Form (ENF) for the Gloucester Harbor DMMP. In this section, each comment letter is addressed in a specific subsection, with individual comments listed, followed by a response to the comment. Letters are addressed in the order in which they are listed in the MEPA ENF Certificate of April 24, 1998.

Comments are presented in italicized text for ease in distinguishing between comments and responses. Where appropriate, the response may direct the commentator to the specific sections of the DEIR where the comments are answered. The Certificate of the Secretary of Environmental Affairs is included in the front matter of this report, the remaining comment letters are included in Appendix A.

11.1 Certificate of the Secretary of Environmental Affairs on the Environmental Notification Form

Comment: *Project Description, Purpose and Need - The EIR should contain a full description of the project that includes a description of the purpose and need for the DMMP in Gloucester Harbor.*

Response: A full description of the Gloucester DMMP is included in Section 1.0, Executive Summary. Purpose and Need for the project is addressed in Section 3.0.

Comment: *Sediment Quality and Quantity - The EIR should contain an analysis of the quality and quantity of dredged material for DMMP dredging projects in Gloucester Harbor. It should summarize dredge sampling and testing programs and discuss conformance with DEP and Army Corps/EPA requirements, including physical, bulk chemistry and any required biological testing. The EIR should also identify low, medium and high volume dredge volume estimates in consultation with Gloucester Working Group and Harbor Plan Committee. For overdredge and adjacent to channel aquatic disposal alternatives, it should provide a summary of results of subsurface investigations.*

Response: Section 3.3 includes a complete discussion of the quality and quantity of the dredged material for the Gloucester DMMP. Please note that the DEIR analysis assumes conservative UDM volume estimates, roughly corresponding to the "high volume" dredging estimates included in the ENF. This approach has been taken to ensure that disposal site planning considers the maximum volume of UDM that may need to be disposed. Future chemical and biological, if required, analyses of individual dredging projects will pinpoint the capacity required for the final disposal sites or alternative treatment technology.

Comment: *Identification of Disposal Alternatives - The EIR should identify the full range of practicable disposal alternatives considered under DMMP Phase I, including:*

a. Alternative Technologies and Methodologies - Identify potential alternative technologies, and discuss operational requirements, regulatory feasibility, and characteristics of output and sidestream flows and associated environmental impacts. Based on these factors, identify potentially practicable technologies.

b. Upland Reuse/Disposal - Identify potential upland alternatives within the municipal boundaries of Gloucester, consistent with existing DEP regulations and policy. Also consider the use of brownfield sites consistent with DEP policy and the Massachusetts Contingency Plan.

c. Aquatic Disposal - Identify all potential aquatic disposal alternatives as defined under DMMP Phase I within the Gloucester Zone of Siting Feasibility, consistent with Army Corps operational policies and Clean Water Act, Section 404 provisions.

Response:

a. Alternative Technologies and Methodologies: Section 4.5 summarizes the Alternative Technologies and Methodologies analyzed for the DMMP.

b. Upland Reuse/Disposal: Section 4.7 summarizes the Upland Reuse and Disposal Alternatives analyzed for the Gloucester DMMP.

c. Aquatic Disposal: Section 4.8 summarizes the Aquatic Disposal Alternatives analyzed for the Gloucester DMMP.

Comment: *Screening of Disposal Alternatives - Perform a first order screen of disposal alternatives for impacts to natural resources, permitting feasibility, engineering characteristics, capacity, cost, logistics, and users conflicts, based on existing information. Screening criteria used in the analysis should be developed in consultation with local interests and state and federal resource agencies. Identify potentially practicable alternatives resulting from the screening.*

Response: Sections 2.0 and 4.4 of the DEIR describe the coordinated development of the DMMP screening criteria with local interests, state and federal regulatory agencies and the specifics of the DMMP screening process. Sections 4.5, 4.6, 4.7 and 4.8 of the DEIR provide a summary of the first order screen for each type of disposal alternative considered, including the identification of potentially practicable alternatives resulting from the screening.

Comment: *Fisheries Investigation and Monitoring - The proposed fisheries studies are intended to fill information voids relative to the present status of marine resources in specific areas so that the potential impacts from dredging and in-water disposal can be determined. These studies will complement other resource investigations either currently underway or recently completed by the Division of Marine Fisheries (DMF).*

The important marine fisheries resources in Gloucester Harbor are shellfish (soft shell clams), lobster, and finfish. Very little information is currently available on these resources in Gloucester Harbor.

Juvenile lobster and shellfish surveys shall be site specific, and shall be conducted at the areas identified within each study site, below, subject ot final direction from DMF and MCZM.

<u>Finfish</u> - Finfish will be sampled twice monthly at 3-4 stations from May through October and once monthly from November through April in Gloucester Harbor with a standard DMF 30' shrimp trawl.

Sampling stations will be selected based on historical sampling sites and the specific information required for the DMMP. In addition, haul seining will be conducted with a 50' bag seine at 2-3 stations twice monthly from May through October and once monthly from November through April. Sampling sites will be selected based on historical sampling and other information including site suitability for haul seining. Fish will be enumerated, total weights by species and important species length frequencies obtained.

<u>*Lobsters*</u> *- Juvenile lobsters (carapace length ,40 mm) will be surveyed in August in both the purposes dredge area and aquatic sites identified on DMMP project maps as ATC, CAD and the Fish Pier CDF. A diver operated suction device will be utilized to obtain quantitative information on juvenile lobsters. Twelve randomly placed 0.5 m^2 quadrats will be sampled in each site. Samples will be enumerated and compared to other similar investigations in state waters. It is noted that while this method of EBP lobster assessment is experimental, it is rapidly becoming the standard for evaluating juvenile lobster habitat.*

Lobster sea sampling is routinely conducted by the Division to obtain both biological and commercial harvest information. Although sea sampling is proposed specifically in Gloucester Harbor. Sea sampling is proposed specifically to obtain catch information within Gloucester harbor and, if possible, proposed dredge and in-water disposal sites. Catch ratio will be compared to other lobster producing areas in the state waters. Sea sampling will be conducted by monitoring the normal operations of one or two commercial lobster men within the harbor and specific areas collected for disposal.

Sampling will be conducted twice each month from May through November. Standardized information will be collected to calculate catch rates as well as biological information.

<u>*Shellfish*</u> *- The EIR should contain the results of a shellfish survey performed to locate and evaluate shellfish resources in the harbor. Shellfish resources should be plotted on a map of reasonable scale in the EIR.*

Response: Section 4.8 of the DEIR provides a detailed screening of aquatic disposal alternatives which include an assessment of benthic impacts in Section 4.8.3 and finfish impacts in Section 4.8.4. Section 6.1.3 provides a detailed assessment of impacts to benthic species, while Section 6.1.4 provides a detailed assessment of impacts to finfish for aquatic disposal alternatives. Additionally, DMMP research documents including; Fisheries Survey for Gloucester and Early Benthic Phase Lobster Survey for Gloucester Harbor are included in Appendix G.

Comment: *Characterize identified potentially practicable sites in terms of: engineering, physical, chemical, and meteorological characteristics; quantify natural resource impacts; identify permitting requirements; cost; capacity; and operational requirements, based on site specific conditions.*

Response: Sections 5.0 and 6.0 of this DEIR provides engineering, physical, chemical, and meteorological characteristics and quantification of natural resource impacts for potentially practicable site and the preferred alternative sites. Appendix F contains the Habitat Characterization study that served as the baseline for the analysis of the above sections.

Comment: *Identify, in consultation with Gloucester officials and other interested organizations and individuals, a preferred alternative(s)and/or methodology(s). Identify mitigation requirements and identify the parties responsible for implementation of mitigation measures.*

Response: The disposal site screening process has been closely coordinated with City of Gloucester and key harbor stakeholders, as described in Section 2.0 of this DEIR. The Draft Section 61 Findings, Sections 8.0 and 10.0, identify mitigation requirements specific to the aquatic preferred alternative sites.

Comment*: Disposal Site Management Plan*

The EIR should contain a draft disposal site management plan detailing measures to be taken to ensure protection of the public health and welfare and to properly manage the construction and operation of the preferred disposal alternative. It should also identify parties responsible for implementation of the plan.

Response: The Disposal Site Management plan, detailing measures to be taken to ensure protection of the public health and welfare and to properly manage the construction and operation of the preferred disposal alternative sites, is included as Section 9.0 of this DEIR. This section also identifies potential parties responsible for implementation of the DMMP.

Comment*: Draft Section 61 Findings*

The EIR should contain a draft Section 61 Finding for the preferred alternative. This finding should set out what mitigation is available to minimize or eliminate environmental impacts.

Response: Section 10.0 of this DEIR includes the Draft Section 61 Findings outlining mitigation available to minimize or eliminate environmental impacts.

Comment*: Federal permitting requirements*

The EIR should contain, as appropriate, the draft federal Endangered Species Act Section 7 consultation and draft Clean Water Act Section 404(b)(1) analysis.

Response: Section 7.2.1 includes a draft Clean Water Act Section 404(b)(1) analysis for the preferred aquatic disposal sites in Salem Harbor. As the preferred aquatic disposal sites are located outside of any federally-listed Endangered Species habitat areas, a draft ESA Section 7 consultation is not included in this DEIR. Consultation and coordination with the NMFS and the USFWS is continuing to determine the need for a formal Section 7 consultation process.

11.2 Department of Environmental Protection

Comment: *DEP experiences with CA/T materials (both excavate and dredged sediments) have demonstrated that even though there initially appeared to be a fairly large demand for these materials at public (or private) landfills, the reality was that very few landfills actually decided to use the materials. In addition, by 1999 most unlined landfills in Massachusetts will be capped, the exception being a category of historic landfill disposal sites, most of which have been unused for* *over 30 years, and the potential for placement of significant volumes of dredged sediments at any of these sites is questionable and severely limited at best. Nevertheless, the DMMP should fully assess any and all historic landfills and DEP will work with the consultant in this activity.*

The ENF specifically refers to [the] existing municipal solid waste landfill in ... Gloucester (40-acre site)... Relative to the 40-acre Gloucester Landfill, as indicated previously in this, correspondence, the City previously attempted to dispose of sediments at the site and was forced to cease the activity due to complaints of noxious odors. The site is currently implementing closure and capping activities which are expected to be completed in 1999, thereby making the site unavailable for sediment disposal.

Response: MCZM has worked in consultation with the DEP on the inclusion and assessment of historic landfills within 50 miles of Gloucester Harbor in screening of upland disposal sites. This analysis is described in detail in Section 4.8.

Comment: *The DMMP estimates a total volume of ... 727,200 cubic yards of dredged material unsuitable for unconfined ocean disposal for the port... of Gloucester ... DEP fully supports the conclusion in the Phase I DMMP that this large volume and physical/chemical quality of dredged material drives an informed alternatives analysis; one that must carefully review all possible mechanisms for both in-water and upland disposal/reuse.*

Response: This comment is acknowledged. The DMMP disposal site screening analysis involved a comprehensive analysis of all practicable alternative treatment technologies, upland and aquatic disposal options, including a detailed review of potential dewatering sites, a key mechanism to implementing upland and alternative treatment technology disposal options.

Comment: *<u>Upland Disposal/Reuse at Locations Subject to Jurisdiction of M.G.L. c, 21 and the Massachusetts Contingency Plan, 310 CMR 40.0000 et. sec.</u>*

“Despoiled Areas," “Brownfields”, and 21E Sites

The ENF states that, should an upland disposal/reuse alternative be selected, ... use of already despoiled areas, such as a "brownfield" site are preferable to pristine areas. Potentially contaminated areas of an otherwise suitable brownfield site will be identified via the Environmental Site Assessment Process under M.G.L. c. 21E and the Massachusetts Contingency Plan (310 CMR 40.0000) (Page 7, Section III. E. 3.).

Response: Since the preferred disposal alternative for Gloucester Harbor is in the marine environment, the proposed sites are not subject to provisions Chapter 21E and the MCP.

Comment: *DEP wishes to point out that it is inaccurate to conclude that "brownfields" are synonymous with "despoiled areas." Areas that could be considered brownfields include much of downtown Boston, the commercial/retail/industrial hubs of many Massachusetts cities, and many suburban and rural locations that have hosted and continue to support a variety of land uses and activities; e.g. manufacturing, research, medical facilities, retail establishments, etc.; and would likely not be appropriate for the disposal of dredged sediments.*

Response: The comment is acknowledged.

Comment: *In addition, the phrase " ... potentially contaminated areas of an otherwise suitable brownfield site ..." suggests the type of brownfields site that, in fact, ends up proving to be "clean." Such areas would not be appropriate for the disposal of dredged sediments.*

Response: The comment is acknowledged and the Gloucester Harbor DMMP DEIR does not include such a site as a preferred alternative.

Comment: *Neither c. 21E nor the MCP define the word "brownfields." C. 21E sites are those areas that become subject to the jurisdiction of c. 21E and the MCP because they are where releases[1] of oil or hazardous material have come to be located. DEP only allows contaminated media generated at a 21E site to go to locations or facilities that are permitted or otherwise approved by DEP.*

Response: The comment is acknowledged.

Comment: *DEP understands that, if upland disposal outside of site assigned facilities is necessary, it is preferable to consider locations that have already been subject to contamination over areas that may be described as "pristine." However, DEP currently has no statutory/regulatory authority over "despoiled areas" or "brownfields"as described in the ENF statement.*

Accordingly, DEP suggests that the discussion concerning the use of non-pristine locations be restyled to consider the locations over which DEP has such authority, specifically 21E sites.

Response: The comment is acknowledged. The intent of the ENF statement regarding "pristine" areas was to express a preference for a beneficial reuse approach to a contaminated (despoiled) site over a disposal approach on a pristine, undeveloped site. MCZM understands that "despoiled areas" and "brownfields" are not regulatory definitions.

Comment: *<u>Scope and Complexity of 21E Site Remediation</u>*

DEP, while concurring with limiting any upland alternatives analysis for the disposal/reuse of dredged sediments to non-pristine areas, has several concerns about focusing on 21E sites:

- *21E sites must be remediated to a condition of No Significant Risk[2]. This is, in many instances, a complicated process and, in some cases, a process that requires years of careful oversight and treatment to achieve; and*

Response: MCZM understands that a human health risk assessment will be required if an upland disposal

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[1] While 21E jurisdiction also encompasses threats of release of oil or hazardous material, these comments are limited to actual releases.

[2] A "Significant Risk" exists when a release of oil or hazardous material presents a hazard to health, safety, public welfare, or the environment if it were present even for a short time.

site subject to Chapter 21E and the MCP is selected as the preferred alternative disposal site for the Gloucester Harbor DMMP.

Comment:

(b) the awareness of the complexity of this process has precipitated DEP's ongoing development of guidelines for the use and management of dredged sediments and DEP is hopeful that it will have at least draft guidelines by November of this year [1998].

Response: MCZM concurs with the comment and is actively working with DEP to develop the draft guidelines.

Comment: *<u>Project Permitting</u>*

The ENF correctly indicates the various potential major DEP Permits that might be necessary to implement the construction and operation of dredged sediment reuse/disposal facilities. Depending on the alternative(s) finally chosen additional DEP permits (or technical reviews) may be required under the jurisdiction of c.111 s.150A and 310 CMR 16.000 and 19.000 (Solid Waste Review); c.21E/MCP at 310 CMR 40.000; 310 CMR 7.00 (Air Plans Review); and c.131, s.40 (Wetlands Protection Act) if a Superseding order or Variance is deemed to be necessary.

Response: MCZM acknowledges the comment.

Comment: *<u>Waterways Permitting</u>*

The projects will require a Chapter 91 dredge permit. If the Confined Disposal Facility (CDF)or the Tidal Habitat Creation option is chosen, a Chapter 91 license will be necessary. Chapter 91 licenses require the payment of Commonwealth tidelands occupation fees at $30/sq.yd. and tidewater displacement fees at $2.00/cu.yd. These costs may become quite prohibitive for large amounts of fill. Public agencies however are exempt from these licensing fees. So if one of these options is chosen, a public agency should be the permittee. A further requirement of the Waterways regulations at 310 CMR 9.32 (1)(b), is that within DPAs, a project shall be eligible for a license only if it is restricted to fill or structures for water-dependent-industrial use, provided that, in the case of proposed fill, neither pile-supported nor floating structures are a reasonable alternative. The EIR should address how this requirement will be met.

Response: The Gloucester Harbor DMMP has not identified a CDF or Tidal Habitat Creation option as a preferred alternative site. Therefore, the analysis requested to address the requirements of 310 CMR 9.32(1)(b) is not included in the DEIR.

Comment: *<u>Wetlands Permitting</u>*

There is not yet enough information on the Wetland Resource Areas likely to be impacted by these projects to determine what the requirements under the Wetlands regulations will be. For each of the alternatives under consideration, the EIR should address the following: which Wetlands Resource Areas will be impacted, the square footage of impact, whether the impact is temporary or *permanent, whether the project will require a variance, or whether it can be considered a Limited Project under the Wetlands Regulations*.

Response: Section 6.1.5 quantifies the amount and type of wetland resource areas, and the duration of the impact, for all wetland resources which are potentially impacted.

11.3 Board of Underwater Archaeological Resources

Comment: *The BUAR conducted a review of its files and secondary literature sources to identify known and potential submerged cultural resources. Research strongly suggests there exists the possibility for both prehistoric and historic cultural resources, now submerged, to be located within the vicinity of Gloucester Harbor and associated dredged disposal areas. This preliminary review revealed potential submerged cultural resource (e.g., shipwrecks) in the vicinity of the study area.*

Given the geomorphological evolution of Gloucester Harbor as a possible inundation feature (limited seaward exposure reducing erosional effects), there exists the strong possibility for the preservation of now submerged prehistoric cultural resources. A regional model for the southern Gulf of Maine suggests the expected site frequency for the study area would be low for all site types dating prior to 6000 BP, but would increase from low (habitation) to high (shell middens) for the period 6000 to 3000 BP. In the period from 3000 BP to Present, the expected site frequency increases to high for habitation, camp, and shell midden sites. During both periods, the size of these sites would be small. While this model does not provide sufficient resolution to specifically identify potential site locations at the scale of the study area, it points to the need to consider the occurrence of prehistoric sites.

A preliminary review of historic literature strongly suggests there exists some reasonable concern for possible site occurrence within the proposed dredging and disposal areas. In general, we must recognize Gloucester was a major early colonial port in the region and maintained commercial and fishing importance throughout the historic period, and thus maintained a high volume of vessel traffic along the Cape. Additionally, the numerous coves along the shore provided small safe harbors and quays to support vessel outfitting, fisheries and quarry activities. At the same time, we must recognize that Cape Ann, like Cape Cod, was a major natural landscape feature that contained numerous hazards to navigation, and thus became the site of several hundred shipwrecks. A variety of maritime related cultural resources, such as wharves/piers/quays, anchorages, careening sites, derelict and shipwreck vessels, might be anticipated to be located in the project area, either submerged or along the shore.

While the vast majority of known shipwrecks occurred along the eastern and southern shores of Cape Ann, a number of shipwrecks are known to have occurred in the vicinity of the project area. Secondary sources indicate that as many as 70 shipwrecks might be located in the vicinity of Gloucester Harbor. The loss of earlier and smaller coastal vessels and the purposeful abandonment of derelict vessels are generally not found in the documentary record. The level and diversity of maritime commercial, fishing, and recreational activities throughout the Cape Ann region may have resulted in the creation of a number of undocumented and anonymous underwater archaeological sites such as small craft, derelict vessels, or dump sites. These possible site types represent classes *of vessels where our knowledge is severely limited and, thus, are potentially historically and archaeologically important.*

Therefore, the BUAR takes this opportunity to express its concern that heretofore unknown cultural resources might be encountered during the course of work and hopes the project's sponsor will take steps to limit adverse affects and notify the BUAR, as well as other appropriate agencies, if historical or archaeological resources are encountered.

Response: This DEIR presents the results of an initial (Phase I) underwater archaeological investigation for Gloucester Harbor. We concur the waters of Gloucester Harbor, near the location of the preferred aquatic disposal alternative sites, are likely to contain several potentially significant archaeological sites. As noted above, MCZM will coordinate with both the BUAR to define the appropriate further investigations and identification of mitigation and avoidance measures as the DMMP site selection and disposal site design process proceeds.

11.4 Letter of Gloucester Harbor Plan Committee

Comment: *Sediment Quality and Quantity - Sediment sampling should include areas of Smith Cove previously proposed by the City for dredging.*

Response: The potential need for the dredging of Smith Cove has been brought to the attention of MCZM as potential project in our public participation process. However, because representative sediment data from the USACE is on file, new field work was determined to be unnecessary.

Comment: *Screening of Disposal Alternatives - Local consultation is a critical element, given the importance of offshore resources to local interests. The information to be used in the analysis should be locally reviewed.*

Response: The screening of disposal alternatives has been closely coordinated with the Gloucester Dredging Subcommittee. The development of screening criteria, natural resources information and results of the screening process have presented to the City at key DMMP milestones as outlined in Section 2.0.

Comment: *Fisheries Investigation and Monitoring - The existing information to be used in the screening analysis should be reviewed with local interests. The information shown in Attachment #3 does not include the entire ZSF, does not include other significant resources such as shellfish, and is incomplete with regard to some of the resources shown, e.g. recreational fishing is important throughout the area. It should be noted that there are important areas for shellfish in tidal flats along the Annisquam River. This consultation should be done before fisheries investigation sampling plans - to fill information gaps - are finalized. The actual sampling sites proposed for the finfish and the lobster investigations should be reviewed with local interests. The descriptions of the finfish and lobster surveys refer to locations in Gloucester Harbor. Does this include both inner and outer harbor areas? Will surveys be conducted in other areas of the ZSF?*

Response: Section 2.0 outlines the coordination with the Gloucester Dredging Subcommittee and DMF in developing the sampling plans and reviewing study results. Additionally, DMMP research documents including; *Fisheries Survey for Gloucester* and *Early Benthic Phase Lobster Survey for Gloucester Harbor* are included in Appendix G.

Comment: *Project Description - The description of the need for dredging, such as is presented in this section, should note the traditional importance of the existing channels and their maintenance, both in the Harbor and the Annisquam River, to the ongoing fishing activity and other marine activity which is of significance in this community.*

Response: Section 3.0 of the DEIR describes the dredging inventory conducted for the Gloucester Harbor DMMP and documents the need for dredging identified as it relates to the mission statement, goals and objectives of the Gloucester Harbor Plan.

Comment: *Upland Reuse and Disposal - This discussion includes reference to the Gloucester Landfill as a potential existing facility which could be considered as a disposal site. The City is in the process of closing this landfill. The status and timing of the closure should be investigated to determine whether this facility would be available as a disposal option.*

Response: Section 4.7, Upland Disposal Alternatives, included the Gloucester Landfill as a potential disposal alternative. However, this site did not emerge as a preferred alternative site.

Comment: *Natural Resources Map - The information shown on this map appears to significantly underestimate the areas with important natural resources and fisheries. Accurate and complete information is essential for meaningful analysis and screening of alternatives.*

Lobsters - The inner harbor as well as the entire Outer Harbor should be included in resource maps showing lobster areas. While the Inner Harbor is closed to lobster fishing, this area is known to be a habitat area for lobster.

Response: The DMMP team has worked closely with the subcommittee and local officials to develop a comprehensive natural resources assessment. See Sections 4.0, 5.0, 6.0 for a complete discussion. DMMP research conducted related to lobster areas included the Inner Harbor. The results of this research is described in Section 4.0 and Appendix G.

Lobster and Fin Fisheries - These fisheries occur throughout the entire area of the outer harbor.

Shellfish - The map of shellfish resources (included in an earlier draft of the ENF document) is missing. Information on shellfish resources should be included in the analysis and screening of potential disposal options.

Recreational Fishery - Recreation fishing is important throughout the Annisquam River, all of the Outer Harbor and all along the shoreline areas of Cape Ann.

Response: Additional mapping and analysis of lobster and fin fisheries, shellfish and recreational fishing has been incorporated into Sections 5.0 and 6.0 of this DEIR.

Confined Aquatic Disposal (CAD) Alternatives - The sites for CAD Alternatives shown as sites 3 and

4 on Attachment 1E include active fishing areas. Fishing activity should be included in the criteria for screening to eliminated sites form consideration. Accurate information, reviewed by local fishing industry representatives, should be used in this screening analysis.

In addition, currents and tidal flows should be analyzed in considering whether material placed in such locations will remain covered or in place over time. The EIR will need to demonstrate that contaminated material would not be uncovered or transported away form any proposed disposal location. In this regard, we have particular concerns with the locations shown as Sites 3 and 4 in Attachment 1-E.

Response: Sites 3 and 4 in Attachment 1-E of the ENF, did not emerge as preferred alternatives based upon the application of screening criteria, developed jointly with input from City, State and Federal entities, because of high resources values and erosional conditions present at both sites.

11.5 Letter of Anne Montague, Montague Associates

Comment: *Please note that, overall, I feel the 20 year plan must be based on more. Examples are:*

- *Innovative technologies and methods;*
- *Designing CDFs with beneficial uses in mind, with one benefit being that life of CDFs be extended far beyond 20 yrs;*
- *Cost analyses that depend on much fuller information;*
- *Better professional and public education, for better procedures of choice.*

Response: MCZM concurs with the sentiment of the comment. It is the intent of the DMMP to research and provide such information.

Comment: *The science and technology of managing sediments is rapidly changing as technologies and methods emerge for processing a) clean and b) contaminated sediments. Decision makers and the public need to know what is possible, in order to know how to manage and use sediments.*

From review of the DMMP and public meeting I have attended, my comments center on the inadequate consideration of processing sediments and of beneficial uses of processed sediments, which, in my view, result from a lack good understanding of alternatives. The use of sediments requires integration of technology, sediments, products, uses, sites, storage, and other factors. Thus, the following comments stress looking at the whole, as well as details, by cooperating with various initiatives for better short-term to permanent solutions.

Response: The DEIR reviews fourteen classes of individual treatment technologies for their efficacy and cost-effectiveness in treating UDM. The review is summarized in Section 4.5 of this document.

Comment: *A Paradigm Shift Is Occurring, Based on Emerging Breakthroughs a) in Technologies/Methods and in b) Beneficial Uses of Sediment, which outdates conventional planning and public comment fur dredging, scheduling, cost, and port and other development. Thus, the procedures should be up-dated to accommodate progress with both clean sediments and* *contaminated sediments made environmentally safe. Some examples of new information that must be evaluated are (see throughout for others):*

A. Beneficial Use Products (blocks, statues, flowable cementitious material [for fill, highway objects such as Jersey barriers. etc.), manufactured soils, artificial soils, capping materials, molded products (lampposts, flagstones), soil-erosion control blocks, roofing dies), and others.

B. Beneficial Use Sites. Wildlife habitat, wetlands (including for remediation), construction of shoreline land space (including for processing sediments), brownfields (including for processing sediments), anywhere that blocks, molded objects, soils, etc. can be used.

C. Cost comparisons are not meaningful without adequate studies of how sediment uses can a) saved [sic] money, b) help create unique, viable solutions to brownfields and industrial reuse sites, c) make products that can be sold, d) provide long-term planning of markets/uses and of remediation, c) create jobs, f) increase community pride and tourism from a beautiful communities that have been a first to reconstruct with sediments.

D. Matching sediments with products, site uses, and best technologies should be on-going. Extreme activity in finding processes and uses for sediment may help save money, resources, environment. Again, using sediments from CDFs to avoid their filling up, is one example.

E. It is usually necessary to know the specific use before finding the technology to meet a need. For example, stabilization and solidification for capping a brownfield may have different performance standards than SS technologies for landfill cover, building monoliths such as berms that might border CDFs or constructed wetlands.

F. Balancing/coordinating/integrating many factors emerges as a short-to-long term mission of dynamic problem-solving centered around people's fuller awareness and choices.

G. Open-Water Disposal of Uncontaminated Dredged Material Is A Waste of Valuable Natural Resources.

Response: The comment is acknowledged.

Comment: *III. Demonstrations of Processing Sediments into Safe Products, How Processes/Products Can Be Used Cost-effectively, and How To Do Good Cost Analyses Are Not Outlined.*

Slow but definitely emerging are:

A. Demonstrations of Contaminated Sediments Made Environmentally Safe. For many reasons *beyond product safety and viability, moneys for demonstrations have been slow, although many demonstrations are under way now. Some barriers to demonstrations are:*

1) *Brookhaven National Laboratory and others first concentrated on high-tech decontamination technologies that are expensive. Many policy makers had a wait-and-see attitude about these and are only now beginning to realize that a) other decontamination technologies are emerging at lower cost and b) low-tech processes that do not decontaminate per se but make useful product that is environmentally safe and ready to be demonstrated.*
2) *Prevailing attitudes of some stakeholders is that vendors with technologies should find their own funding for demonstrations, despite the fact that these processes a) are proving in scientific and bench scale ways, and b) are proving to make useful product with clean sediment. This is unfortunate and not in the American spirit of allowing ways to solve problems for the common good.*
3) *The private-sector is slow to invest till markets are proven, which is happening, but slowed by the above bottle necks.*
4) *Research on public acceptance bas been too slow. Those who might fund objective research are afraid that their present plans will be stopped with public involvement and education. However, based on my own and others' research (e.g., brownfields managers, sediment uses on the West coast) that the public should be involved early and the public wants to know: the alternatives, that contaminated raw material will require several classes of decisions for safety (e.g., monitoring), what environmental good can come of uses, what jobs can be created, what education can come from looking at the issues, what kinds of structures can be created, and what full costs are. By and large, the public wants to face the problem of contamination, not run from it or have it hidden. We have polluted, we need to decide how to take care of what we have created, as well as how to prevent it.*
5) *Products (e.g., soils, bricks, wetlands, capping) have not been made visible to the public. Talk is absolutely insufficient.*

B. Demonstrations of Clean Sediment Products.

1) *These are evolving, including commercialization of soils from sediment, bricks and blocks for homes, security walls, and various plans for statues and other beautification projects.*
2) *These are like1y to be shorter in permitting and public acceptance.*

C. Demonstrations of Cost Effectiveness.

Cost analyses are often case-by-case. Some issues are:

1) *Profit from different processes will differ. For example, transportable manufacturing plants for bricks used for specific environmental projects such as soil/riparian erosion control will have different cost analyses than permanent plants for making aggregates and these will differ for other solutions.*
2) *Markets may have to be developed.*

3) *Waste products (e.g., ash, fish gurry, glass) will have different savings, and some may bring a tipping fee to offset production cost.*
4) *The integration of many missions can offset costs. A few examples are:*

- *Creation of nature-friendly sites such as wildlife habitat, ecoeducation sites, wetlands, plant propagation walks).*
- *Job creation efforts such as with fishermen, HUD, youth.*
- *Port development with sediment-based products that will enhance port missions and reduce costs.*
- *Brownfields/Superfund redevelopment.*

These barriers to demonstration are not long-term. However, the DMMP is for 20 years, which means there is time to introduce processes, if plans are made now for their introduction

Response: Much of the comment is not directed at the Gloucester Harbor DMMP ENF and is acknowledged. As previously noted, the DMMP carries forward all fourteen technologies investigated as potential alternatives, which includes a periodic review, every five years by MCZM, of the efficacy of alternative treatment technologies. This information will be made available to individual dredging proponents.

Comment: *IV. Confined Disposal Facilities and Contained Aquatic Disposal design should be rethought.*

A) *CDFs should not be filled and then rebuilt. Sediment can be used from these CDFs to make them last much longer than 20 years. CDFs should:*
   a) *Contain all (uncontaminated and contaminated) material that is not used, to make it environmentally safe and useful later*
   b) *Be coordinated with beneficial uses (blocks, statues, flowable fill, soils, brown field capping and other uses, wetlands, wildlife habitat, construction of shoreline landspace. so that CDFs are neither overbuilt nor do they fill up, which will produce product and save CDF construction.*
   c) *Be coordinated with remediation (minimize contaminant migration), so that contaminants are rendered environmentally safe, and., if possible used in appropriate ways.*

A) *CADs should be reconsidered. Alternatives are suggested based on:*
   a) *Public distaste for putting contaminated sediment in an aquatic environment and not planning more than to cover it is accepted procedure; however, there have been few choices, and alternatives need to be openly considered to get to choices for determining accepted and preferred procedures.*
   b) *Possibly creating wetlands with new know-how that has good scientific evidence of passively remediating organics.*
   c) *Problems with monitoring CADs, which should be compared to evolving ways to monitor via constructed wetland and low-cost technologies to bind up contaminants.*

Response: A CDF alternative is not proposed as a preferred alternative for the Gloucester Harbor

DMMP. Our extensive research did not identify any current alternative treatment technology or suite of technologies that can address Gloucester Harbor UDM at the volumes proposed. 1) As discussed in Section 4.5, factors of cost, emissions, residuals, available space and public sentiment argue against a viable alternative technology-based approach to the immediate need for disposal or reuse of dredged material. As discussed above, MCZM will maintain alternative technologies as an "open" category, and will actively support the integration into service those feasible technologies that emerge in the future. 2) Wetland creation often involves significant permitting hurdles, as viable sites are often considered as valuable wetland resources in themselves, and "creating" wetlands often means converting one type of resource to another; and 3) the issue of monitoring CADs is ongoing and regulatory agencies and project proponents are learning from experiences in Boston Harbor. Section 9.0 of this DEIR outlines a comprehensive monitoring program that will be implemented if the CAD preferred alternative disposal sites identified in this DEIR are constructed.

Comment: *V. Inadequate Sequence: The sequence of schedules and selections is not in synchrony with full consideration of alternatives. For example:*

A) Sites: Finding the site where sediment can be used and assessing those needs are early steps in assessing if there are adequate technologies to deliver desired products and/or materials. Since little site assessment has been done, technologies and methods, by definition, have not been adequately considered. It is usually necessary to know the specific use before finding the technology to fit. For example, stabilization and solidification for capping a brownfield may have different performance standards than SS technology for landfill cover, building monoliths such as berm that might border CDFs or constructed wetlands,

B) Therefore, sufficient search for technology and methods has not. been done.

C) Selection and summation of alternative technologies (i.e., soil washing) was typical of what might have been done a year ago, while high-tech processes were being stressed.

Response: The ENF was not intended to provide a comprehensive summary of all research conducted on alternative treatment technologies and methodologies conducted for Phase I of the DMMP. This DEIR includes a more comprehensive summary of research conducted to date, including on the specific treatment technologies identified above. Section 4.5 of this DEIR describes the alternative treatment technologies reviewed and the results of the application of the DMMP screening criteria.

Comment: *VII. Along with Emerging Technologies/Methods and Uses of Sediment, Emerging Procedures of Assessment of Alternatives are Necessary. Full professional and public awareness of alternatives and public education will take additional effort.*

Some (not all) Other Problems Include:

a) Since areas to be dredged are not fully decided, dredged material and users/uses are hard to put together, which stack the cards against a realistic look at beneficial uses.

b) The type of dredging to be used is unclear and, likewise, impacts decisions about uses.

c) *Cost sharing for uses is unduly difficult to plan or assess without these and other questions answered.*

d) *Innovative and proven technologies have not been fully assessed, and numbers are not accurate for comparisons.*

Response: The dredging inventory conducted for the DMMP serves as the most reasonable (conservative) baseline assumption of dredging demand, taking into account the above unknown variables a twenty percent contingency has been added to the total UDM volume: see previous responses for comments regarding innovative technologies.

Comment: *VIII. Time for Introduction and Community Assessment of Alternative/Emerging Technologies and Methods is Too Short. In this period of advance where the education, testing, demonstration, cost/benefit analyses are emerging, means for up-to date, practical solutions should be fully allowed.*

Response: MCZM concurs that a means for identifying up-to-date practical solutions needs to be identified. Accordingly, MCZM has developed a process whereby the alternative treatment technology analysis will be updated and formally reviewed under MEPA every five years. As noted elsewhere, the DMMP process allows for the integration at any time, of practicable alternatives.

Comment: *IX. Can Sediment Uses Be Tied to Brownfields (Inside and Outside these Two Harbors) via Applications for Redevelopment and via Making Brownfields Processing Centers for Sediment? Interest is increasing in using sediments for brownfields, particularly along waterways, and moneys to do this should be planned.*

Response: As part of the review of alternative treatment technologies and methodologies, this DEIR included an assessment of the use of "brownfields" sites as potential sites for disposal and/or reuse of UDM. No such sites were identified as potential preferred alternative sites. In addition, DEP policy and the practical apsects of the regulations that govern the 21E process discourage the use of UDM as remediation material. See Appendix B for a discussion of the issue.

Comment: *X. Cost is a major factor; however, the DMMP does not adequately deal with cost, particularly over 20 years. Examples are inadequate cost analysis:*

- *of alternative, low-tech, low-cost technologies (short-term forward);*
- *of uses of clean and contaminated sediments (short-term forward);*
- *to fish breeding grounds (short-term);*
- *to make CDFs last longer by using sediment (long-term);*
- *of adequate public and professional education so that decisions, including from required public comment, is meaningful and industry can grow from sediment uses;*
- *of not just treatment but what the product will sell for or save (e.g., in brownfield development).*

Response: The DMMP does include a 20-year planning horizon, however, it deals with only <u>unsuitable</u> dredged materials, and not clean material, for which there are available practicable disposal and/or reuse options**.** Impacts to fish breeding grounds are an important screening factor in the identification of potential aquatic disposal sites, as documented in this DEIR (Section 4.8).

Comment: *XI. The public must be involved better and early (via research from many sources).*

Regarding contaminated sediments, the public often says it does not want to pass contamination on to the future. Though they do not yet trust beneficial uses of sediment made environmentally safe and know that choices will sometimes be difficult, they want to a) know that we are doing something more, b) know we are doing something, c) want to know what those somethings are, and e) want to be able to monitor what is done so that problems will be detected and dealt with.

Regarding clean sediments, the public is accepting products (e.g., manufactured soils in Toledo).

Again, the public and professionals want to a) see what can be done--to touch and smell and see product and b) understand and help plan uses.

Response: MCZM concurs with the comment.

Comment: *XII. Public Meetings and the Draft Left Questions and Issues. Examples are:*

1. Is there Time to introduce technologies/methods and uses?

Two messages seemed to be given, one by MEPA and the other by MCZM.

Message 1. MEPA: There is time for assessment of alternatives to CADs and CDFs.

Message 2. MCZM: Technologies have been adequately assessed, there will be no time for feasibility studies of others, permitting of alternative technologies and beneficial uses will be next to impossible.

2. If sampling and analysis of the sediments has not been done, how can alternative methods be considered? That is, CADs and CDFs require less sampling, since there is less concern over what is in the sediment when they are contained and confined.

The answer was unclear, and these issues emerge from lack of up-front sampling:

1) Sampling helps determine best alternative uses, but little has been done.

2) Alternative uses must be introduced quickly in order to be considered as part of the state and local plans, which are slated for the fall of this year.

3. Is it possible to get funds for demonstration of technologies/methods and uses?

One answer was to call the State after MCZM talked to them (Salem meeting). Another was that, although the State would decide, there was little room for demonstrations and other proof of viability of beneficial uses and technologies.

4. *What portion of the Seaport Bond moneys goes to each harbor and are the Harbors in danger of losing moneys if schedules are not met (e.g., If time is taken to consider alternatives)?*

5. A. *Why is prevention via point and non-point-source prevention and cleanup (e.g., tributaries into Salem Harbor) not part of the short- or long-term action plan?*

   B. *Why is the Annisquam [sic] River part of the Gloucester effort, while the tributaries to Salem are not?*

6. A. *Why is WRDA not an issue (MCZM stated in Salem meeting that it is not).*

   B. *Why does it apply or not apply to the five ports receiving Sea Port Bond Moneys?:*

It seems that WRDA's mandate to consider beneficial uses applies to both Harbors and the Annisquam.

7. *What per cent of Gloucester Harbor is federal channel?*

   Though USACE responsibility is probably not a key issue since all permitting for dredging must go through the USACE, it was not answered, and, instead, the question was asked to why one would want to know).

8. *If sites are found that would use large volumes of sediment, is it too late to use Boston sediments, assuming that uses can be found?*

9. *What rules apply and don't apply to five different ports - are they similar and different?*

10. *What will happen to the debris and how is this a different topic than sediment (asked in the context of landfill disposition).*

11. A. *Is the purpose of dredging these harbor for commerce, only? If it is for environmental cleanup, issues such as the tributaries into the Salem Harbor seems relevant.*

    B. *How do these and other purposes/goals interact with funding via other agencies for cleanup.*

(Discussion on this question was poor in Gloucester, and such lack of discussion appears to be leading to frustration from fisherman and others that in my view, is great enough to lead to the "no dredging" option),

12. *Why are secondary effects of dredging not discussed?*

(Question from USACE, Boston District led to this answer Salem meeting, April 7.)

13. *Will attendees be provided with the attendee list? (Was provided in Salem; was not answered in Gloucester).*

14. *Since Gloucester's sewage went into the harbor for many years and is now taken into the outer harbor, several questions arise:*

    A. *What is the breakdown of the 94% pollution that was named in the public meeting in Gloucester on April 9th. What percentage is from pathogens left from sewage, from metals, from hydrocarbons, from copper paint, from pesticides, etc. ?*

    B. *Does this pose different problems than in other ports (e. g. Salem), in terms of suspension of contaminants into fishing waters?*

    C. *Do fishermen not oppose pathogens in the waterway? What impact does this have on any aspect of the DMMP plan?*

    D. *Has a common solution to the sewage and the sediment, as a common effort been considered?*

15. *MCZM stated that all materials that could be blended into sediment were assessed.*

    A. *What is that list of blending materials that have been considered?*

    B. *What were the technologies/methods and uses assessed that led to the decision that the process of blending does not prove desirable?*

    C. *Were products assessed with tipping fees, to offset costs?*

16. *Manufacturing plants can be sea based (i.e., barge) or land based (i.e., stationary or transportable). Was the statement that manufacturing sediment-based product won't work based on a full assessment:*

    A. *Were more flexible (i.e. barge and transportable) systems considered, to offset the problem of factories needing large supplies of sediment on a regular, long-term basis?*

    B. *Did manufacturers give presentations based on the situation or was assessment made in the abstract?*

    C. *What is the list of alternative technologies that were assessed for beneficial use products?*

17. *Has there been effort to assess cost in light of local efforts that might offset expenses? A few examples are HUD (e.g., in Gloucester where HUD is an active issue), historic restoration, Brownfields, marinas?*

18. *Disposal and use are different actions. They should not be referred to as "disposal/use" but*

as Disposal and Use, as separate concepts. Representing disposal/use as one concept fails to recognize that sediments are becoming a valuable resource (i.e., raw material) and that products can be selected based on problem solution. Combining them shows the need to get rid of sediment, not the growing awareness that the emphasis should be on the needs of the user of sediment-based products and the sites where they are applied. An alternative to consider is to entirely change phrasing to "Placement and Use."

19. *Scheduling of major events was unclear to most attendees. Hand outs should have been available to show steps and what must be done by given dates.*

20. *What will be done with the sediments in the CDFs to make them safe?*

21. *It has been assumed that sediments must be used by the cities where the harbors are (i.e., Salem and Gloucester). This may not be the case, if:*

    a) *Sites are made attractive, profit making, safe, especially from sediment that can be engineered to perform better than conventional materials.*

    b) *Product is deemed safe and useful, perhaps starting with clean sediment.*

22. *Can what is learned in Salem and Gloucester about alternatives to CDFs and CADS be transferred to Fall River and New Bedford?*

23. *Can practices in Boston be altered, based on advances in the other four ports? How is that introduced?*

24. *What mechanisms exist for integrating many efforts, so that a) repletion of red-tape can be avoided, b) needs of individual ports can be honored while still benefitting from common efforts, c) many missions can be met, short-term to permanently.*

Response:

1. As discussed at the MEPA scoping meeting, the purpose of the EIR is to provide a comprehensive analysis of disposal and management alternatives.

2. As discussed at the MEPA scoping meeting, sediment testing is a necessary foundation for an assessment of potential alternatives. Sediment testing was performed under the terms of the MEPA scope and the results are presented in Section 3.3.3. of the DEIR.

3. The state actively supports alternative technologies that meet reasonable feasibility thresholds. The Massachusetts STEP (Strategic Envirotechnology Program), a collaborative effort between EOEA and the UMASS system provides analytical, permitting and marketing support for viable technologies.

4. Specific projects in ports and waterways throughout the Commonwealth are included in the Seaport Bond Bill, not just projects in the four ports of Salem, Gloucester, Fall River and New

Bedford. There are no strict schedules set in the bill, and bonding authorization for a project is no guarantee that monies will be allocated in the future.

5. MCZM has been very active in the development of coastal non-point pollution prevention programs throughout the Commonwealth. Prevention of non-point pollution is an important priority and is expected to make a significant contribution to a reduction in pollution to Massachusetts waterways in the future. The Annisquam River is included in the Gloucester DMMP because of the presence of the federal navigation channel in the river.

6. The Commonwealth has held extensive discussions with the USACE regarding the potential applicability of the federal Water Resources Development Act (WRDA) to the DMMP. WRDA provisions currently do not apply in Gloucester because it applies only to federally-funded projects. Potential improvements to Gloucester Harbor were determined by the USACE to lack the economic justification required for federal involvement.

7. Approximately 7% of Gloucester Harbor is federal channel.

8. Sediments from Boston Harbor are being accommodated within the confines of Boston Harbor. There are no plans to bring Boston Harbor sediments to any other disposal sites, including any sites located in Gloucester Harbor.

9. Boston is not considered a part of the DMMP study efforts. The DMMP is being developed for all subject ports under applicable local, state and federal policy regulation. State and federal regulations are by definition consistent among the ports; local regulations are by definition specific to the individual ports.

10. Debris (items such as large metal pieces, fishing tackle, and other material found in the harbors) will be separated by the dredging contractor, and be separately disposed of. This is common to dredging projects in urban waterways.

11. Maintenance and improvement dredging projects identified in Gloucester Harbor over the next twenty years are considered to be for the purpose of maintaining or improving commerce and recreational opportunity in the ports. MCZM is currently not aware of any harbor-wide marine sediment remediation proposals for Gloucester Harbor. Project-specific remediation activities (e.g. potential project at the Marine Railway facility) will be evaluated on a case-by-case basis under the terms of the disposal site management plan. MCZM is not aware of other agencies' funding for cleanup of Gloucester Harbor.

12. Discussion of secondary impacts resulting from identified dredging projects in Gloucester Harbor are included in Section 6.0, Secondary Impact Analysis.

13. The attendance list for the Gloucester Harbor ENF scoping meeting of April 9, 1998 is included in Appendix A, following the ENF.

14. The characteristics of the sediments tested is described in Section 3.3.3 of this DEIR. The suspension of contaminants in fishing waters will be mitigated as described in Sections 8.0, 9.0 and

10.0, any impacts incurred will be temporary and of short duration. The focus of the DMMP is to find an environmentally sound disposal location for UDM and does not directly deal with the reduction of pollution from point sources.

15. Blending materials identified by specific technology vendors, such as clean sands, cement and lime, were assessed. Blending (also considered as a form of solidification and stabilization) has been used in Massachusetts to treat unsuitable sediments prior to disposal. Tipping fees were not included unless specifically identified by technology vendors.

16. The type of systems assessed were identified by specific technology vendors and included mobile, transportable systems. No local reuse opportunities were identified by MCZM in the City of Gloucester. Also a direct solicitation of interest was mailed to all municipalities within 50 miles of Gloucester and resulted in no expressions of interest. A complete list of the technologies assessed in included in Appendix D.

17. As previously noted, use of brownfields sites was included in the assessment of upland alternatives summarized in this DEIR (Section 4.7). MCZM is not aware of local efforts such as those identified in the comment that may offset expenses for treating unsuitable dredged material.

18. MCZM does not consider disposal and use to be a single concept, but has rather assessed both disposal and reuse options in this DEIR.

19. The City of Gloucester has published notices of all presentations and working meetings with the Gloucester Dredging Subcommittee.

20. The Gloucester Harbor DMMP does not include a CDF site as a preferred alternative.

21. While MCZM does not disagree with the comment, the practical reality of gaining public acceptance for a regional site has proven to be extremely difficult in the past for other major infrastructure projects in Massachusetts. MCZM's experiences in Salem regarding this approach further underscores the difficulty in garnering support for a regional disposal option.

22. Developing the EIRs for the four ports on a relatively simultaneous schedule provides the opportunity to integrate the lessons learned in each of the harbors.

23. MCZM notes that advances in dredged material management developed by the Boston Harbor project will be applied to the DMMP planning and management approach.

24. The DMMP EIRs combines the state's regulatory requirements with the substance of the CWA's requirements (as recorded in the parallel Highway Methodology concurrence letters) in a single document. With the integration of the results of local coordination, the EIRs allow MCZM to accommodate local, state, and federal interests simultaneously.

Comment: XII. Professionals and the Public Showed Misperceptions in My Discussions with Them

1. Reasons professionals cited over last weeks for not using sediment in this region must be

reassessed. Some of these cited reasons and their answers are:

S Products can not be made from salt water sediments.

Ans: They can be.

S Supply is not consistent enough to warrant manufacturing,

Ans: This is overcomeable.

S There are no processing sites.

Ans: This is not convincing, since many a complete assessment of ways to Process (e.g. transportable. passively remediating wetlands, on brownfields), creation of processing locations via dredged material, and kinds of processing are not included in the DMMP, since they were likely not know at the time of the DMMP.

S Landfills are too far away or are already using Boston Harbor materials.

Ans: Landfills

a) are not likely a preferred alternative use,
b) were not informed well (public meeting in Gloucester) that debris is not sediment and problems of debris will be solved, and
c) might be generated for special uses (profit making) and know how in design will incorporate, the use of sediments.

S If technologies were good, investors would have invested.

Ans: Investors wait for markets to be clear, and this is happening. In addition, environmental technologies are not popular with investors.

S Markets are not developed.

Ans: True, but they can be, likely starting with clean sediment and going to contaminated sediments, but not necessarily. That the need to be is further evidence that more work is needed on the plan.

Sediment may be regulated as a waste in Massachusetts.

Ans: Clear evidence exists that Congress has deemed that sediment is not a waste and policy seems unformed in Massachusetts.

Response: As noted previously, the DMMP has comprehensively assessed the efficacy of alternative treatment technologies and methodologies for treating unsuitable sediments from Gloucester Harbor, considering the current market and regulatory environment. As previously noted, it is the intent of both MCZM and the DEP to promulgate revised dredging regulations in Massachusetts in the near future.

Comment: 2. Issues that the public did not seem to understand (beyond those above) were:
Why can't dredging be postponed till a) it is clear why dredging must be done, and b) alternatives are better assessed?

Why should the public accept that the state has done a complete assessment?

Why were questions not fully answered (i.e., why dredge, does WRDA play a role, what happens to the debris, etc.) or glibly responded to which stifled discussion?
Is there political payoff/Incentive? Are contracts already let for dredging and disposal? Will Ports lose money if they do not dump at sea and follow the recommended plan?

Why was the public not better informed for better involvement in public comment?

Response: Dredging is contingent on a full assessment of need and alternative disposal or management methodologies under MEPA. That process began with the filing of the ENF, continues with the publication of this DEIR and will conclude with the approval of the FEIR. The public will have the continuing opportunity to review and comment on the thoroughness of the EIR as it moves through the MEPA process.

Comment:
OUTSTANDING ISSUES, IN SUMMARY

Some leading issues (not to diminish those mentioned above).

Conventional assessment and implementation of "disposal/use" alternatives must respond to information which is so new that most professionals working with sediment need more comprehensive education.

Technologies and methods, mostly innovative, must be considered.

Integration of sediment technology/methods with uses calls for public involvement and cost assessments that is lacking in the current process. With sediment uses comes more public involvement in decision making, and old methods of public involvement are not adequate.

Sites that can use sediment products and products that can be sold must be found and involved very early.

Plans for ocean dumping are wasteful, plans for CADs and CDFs are not the safest alternative and should be rethought in order to balance them beneficial uses, full costs, environmental issues, with more public choice.

Time and money must be allowed to find out what is best to do, so all can do their best.

A change of mind-set is needed to allow for beat solutions,, to:

A. Prevent irreversible solutions that will be outdated quickly.
B. Select best alternatives, based on full public awareness.
C. Flexible planning that can include better ways as they emerge.

The science and technology of sediment management is quickly emerging. Some advances occurring in sediment use that should be incorporated into Harbor Plans are:

Lower cost, low-tech processes that yield useful practical products. Clean sediment products appear to be:

a) cost effective compared to conventional materials

b) yield products that can be engineered to do a better job than conventional materials, create jobs, beautify, and help in port development cost and pride.

Other advances emerging are:

a) Decontamination technologies at lower cost (ports and states are putting out RFPs for no more than $35 cy)
b) Indications of job creation.
c) Indications of profit from manufacturing.

Potential for interesting, aesthetic applications that are both structurally sound and environmentally safe.

Demonstrations are needed to expand the array of proven technologies and will continue to be necessary for specific sites, uses and sediments. These can be a plus for sponsoring organizations, because the public wants to know what will work and what will be safe.

Public understanding is not apparent. One-to-one interviews of citizens that offer questions that both give public education and get public opinion is needed in order to get dynamic public involvement that will lead to consensus and long-term cooperation.

Problems with CDFs as the end of the plans for the dredged material:

They put the problem off of what to do with contaminated materials off to the future;

They fill up, and new ones must be built, unless the sediments are extracted and used beneficially;

Response: See the responses to each of the summary comments, included previously in this subsection.

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