

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:

- 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

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.

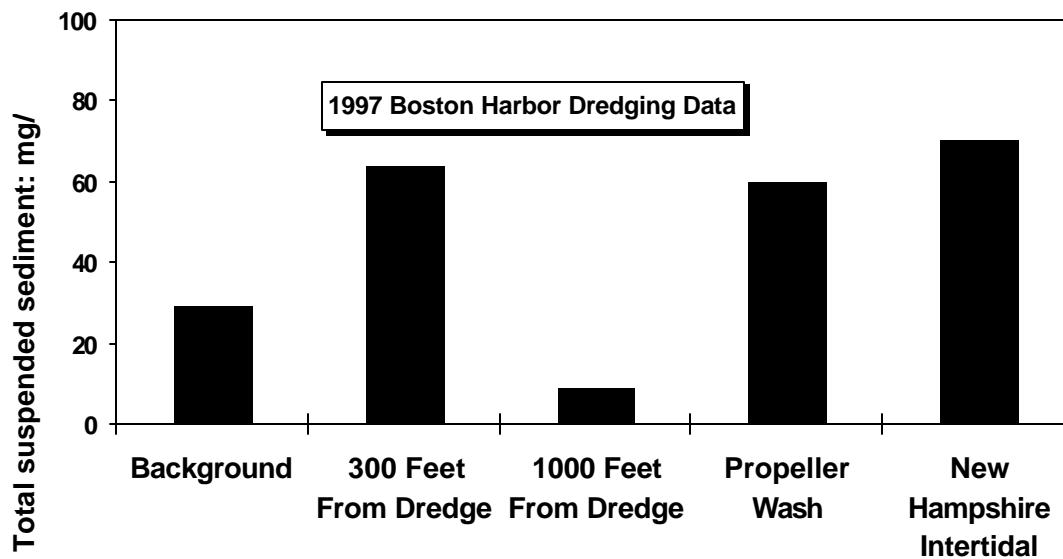


Figure 6-1: Total suspended sediment measurements from Boston Harbor dredging operations.

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 capping 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.

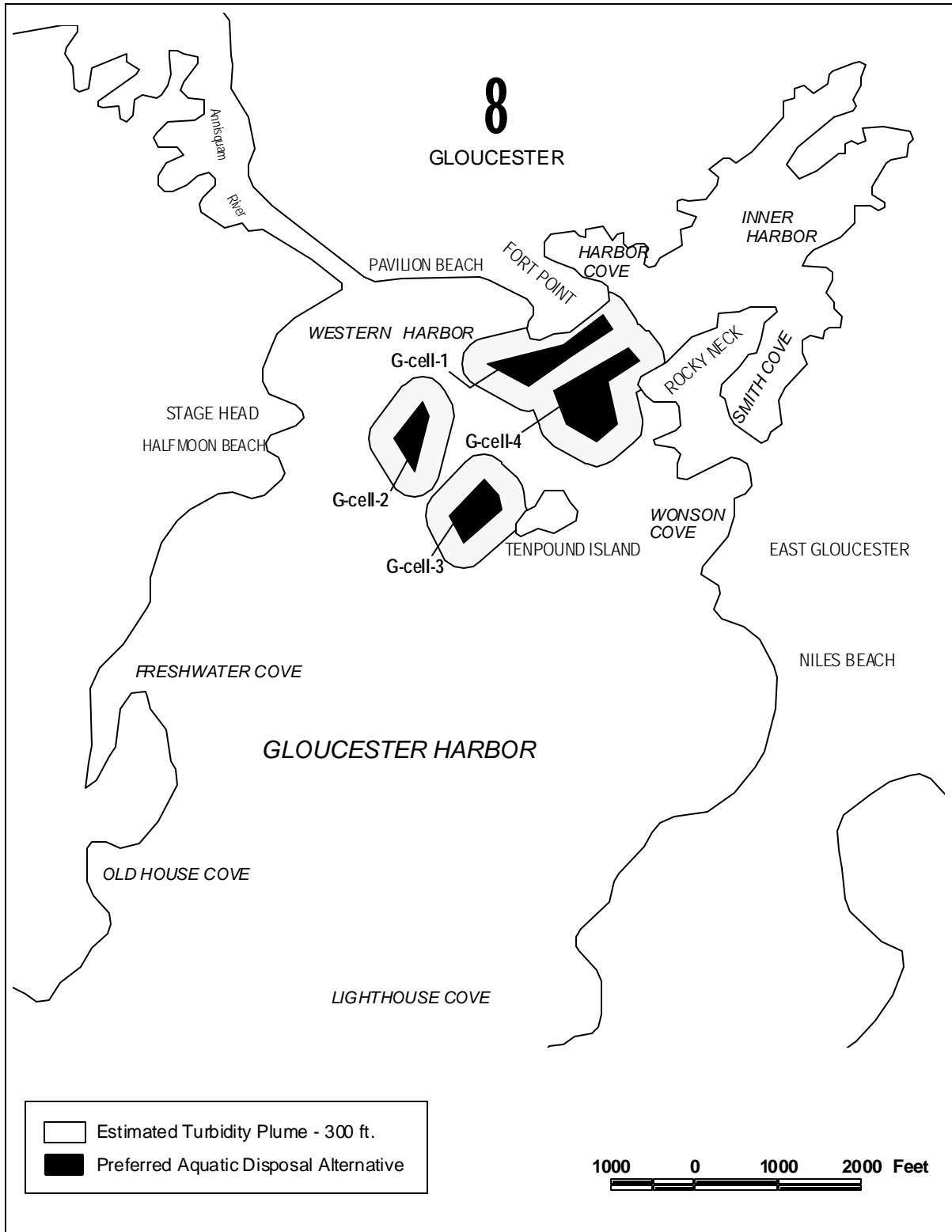


Figure 6-2: Estimated turbidity plume from dredging and disposal at the G-Cell sites.

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. 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 occurring 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 disturbance 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 substrate 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 (Berrill 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.

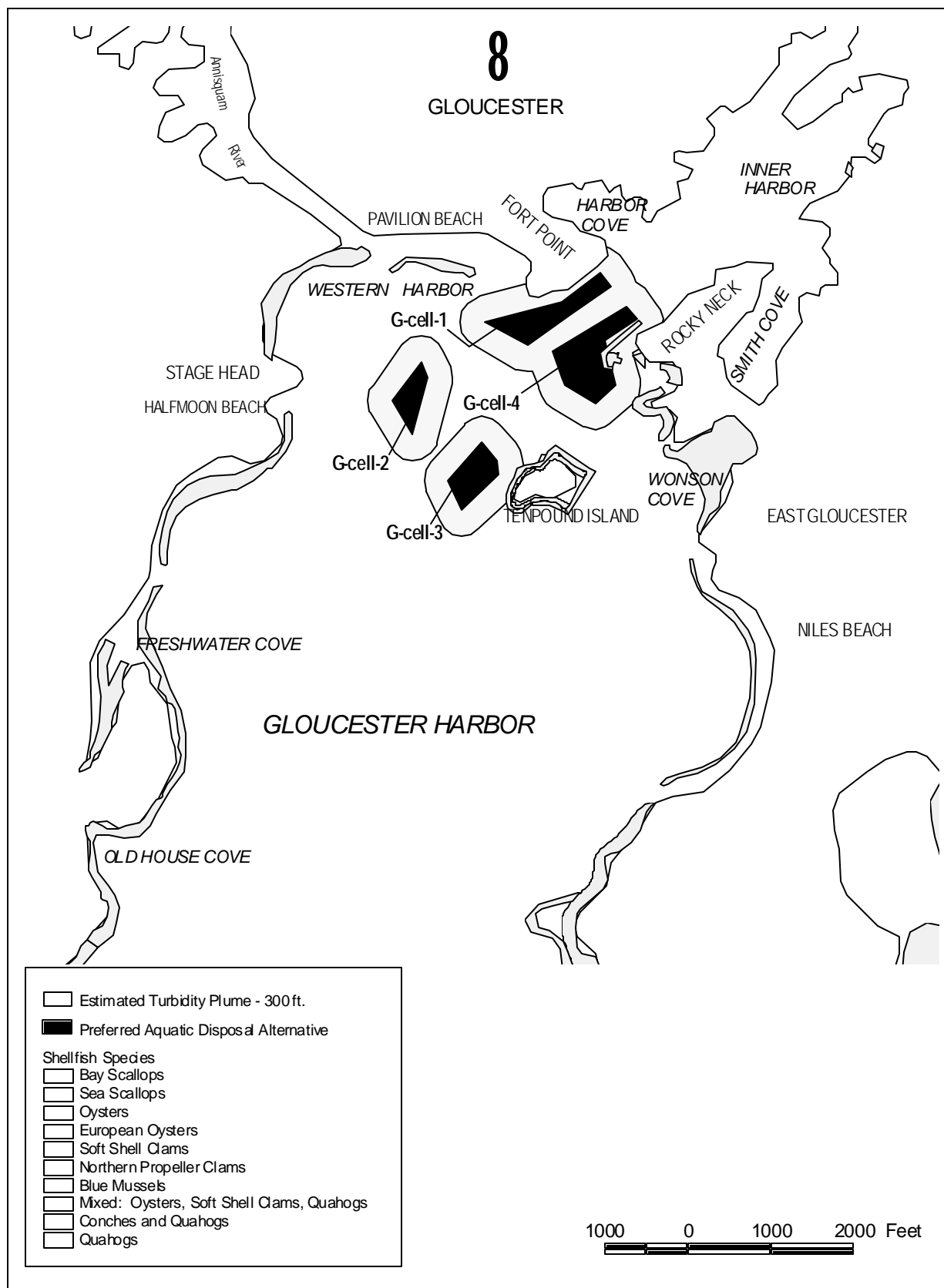


Figure 6-3: Estimated turbidity plume and shellfish resources. (Source: Gloucester Shellfish Constable).

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 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 Massachusetts 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.

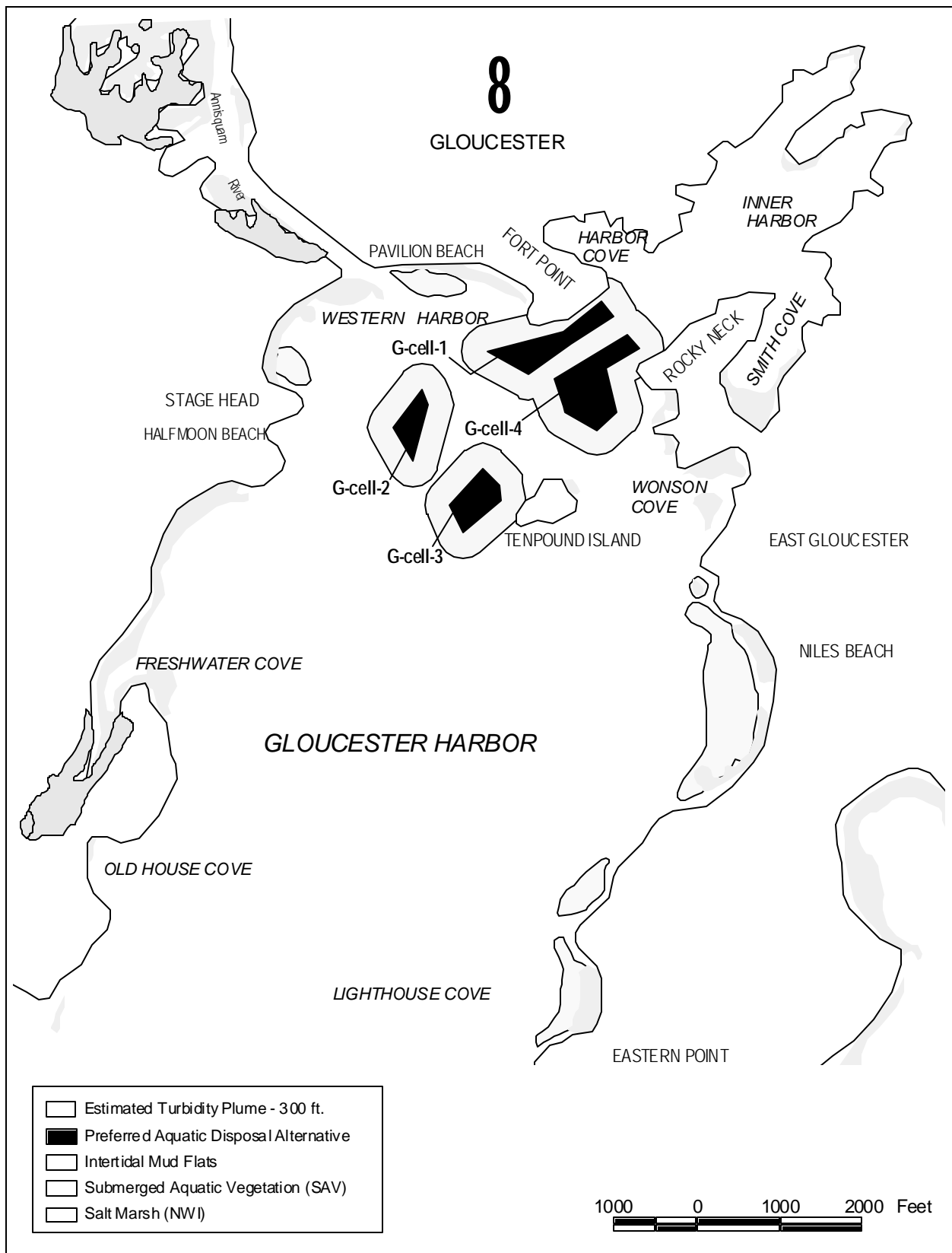


Figure 6-4: Estimated turbidity plume and submerged aquatic vegetation, salt marsh and intertidal mud flats.

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		
<i>Seafood Industries</i>	150	\$30,000,000
<i>Cultural and Visitor Activities</i>	235	\$9,385,000
Totals	385	\$39,385,000
Estimated Resulting Total Economic Benefit		
<i>Seafood Industries</i>	2650	\$730,000,000
<i>Cultural and Visitor Activities</i>	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.