ENVIRONMENTAL ASSESSMENT REPORT

ON

MAINTENANCE DREDGING AT

FALMOUTH INNER HARBOR

FALMOUTH, MASSACHUSETTS

New England Division
U. S. Army Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02154

April 1976

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1. Project Description

The Town of Falmouth, in Barnstable County, Massachusetts is at the southwestern "elbow" of Cape Cod. It is an agglomeration of separate and distinct communities -- Woods Hole, West Falmouth, North Falmouth, East Falmouth, Waquoit, Falmouth Center, etc. -- all united under one municipal government.

Falmouth's traditions are intertwined with the early maritime history of New England. The community continues, as it always has, to look seaward, though an appreciable amount of the town's total area is some distance from the sea.

The town fronts on two bodies of saltwater -- Vineyard Sound, an arm of Nantucket Sound to the south, and Buzzards Bay to the west. Harbors of various sizes indent the town's coastline. The most active harbors, however, are those at West Falmouth, Woods Hole, and Falmouth Center. It is from the last two harbors that commercial ferry service to "the islands" (Martha's Vineyard, Nantucket, and the Elizabeth Islands) originates.

The project area to be specifically discussed in this report is the harbor at Falmouth Center -- the so-called "Inner Harbor." (See Figure 1). The Inner Harbor, a narrow embayment about 0.7 miles long which must be periodically dredged, contains a Town Wharf, a Town Marina (with mooring slips), several commercial boatyards, ferry dock for the ferry "Island Queen," and an anchorage for numerous pleasure boats during the summer months. The harbor is to the east of the town's business center and is accessible from roads running parallel to and just behind the various marine installations on both sides.

a. Definition of the Project.

The maintenance dredging project entails dredging of that part of the Inner Harbor which has, since it was last dredged (1963), developed shoals diminishing the depth at mean low water (MLW) to less than the authorized 10 feet.

(See July 1974 Condition Survey - Figure 2).

As earlier stated the harbor is approximately 0.7 miles long; the project width varies - from a minimum of 100 feet at the entrance to almost 450 feet at the center of the Harbor, narrowing again to about 140 feet at the innermost end. Shoals have developed at the harbor entrance - especially adjacent to the east jetty where water depths are now less than 6 feet (at MLW) and in the vicinity of the Town Wharf where depths are less than 8 feet (at MLW). Slightly more than two-thirds of the Harbor's length (i.e. innermost part) needs little or no dredging at the present time.

It is estimated that as much as 24,000 cubic yards of shoal material must be dredged to restore the harbor to its authorized dimensions. The critically shoaled areas cover an area of about 4 acres.

The harbor's entrance is protected by two jetties at either side of the entrance channel - the western jetty extending about 200 feet oceanward with a beacon on the end of it, and the eastern jetty about half of that length and anchored to a shoreline that is already somewhat recessed from the shoreline on the opposite side of the channel.

The other area of shoaling occurs where the Harbor widens from the narrow dimensions of the entrance to the maximum width at the "waist" of the harbor. Here a "Venturi effect" - i.e., a diminished velocity - may cause tidal currents to decelerate with the result that sediments in suspension as well as in traction are deposited and a shoal is created.

Dredging will be accomplished by clamshell dredge. The dredged material will be transported by scows to the ocean disposal site recommended by the Commonwealth of Massachusetts' Department of Environmental Quality Engineering. (See letter from Commissioner Standley in Appendix.) That recommended site is located in Buzzards Bay, just west of West Falmouth, and is 500 yards in diameter with its center located at 41°36'00" N and 70°41'00" W (see Figure 3).

CORPS OF ENGINEERS U. S. ARMY

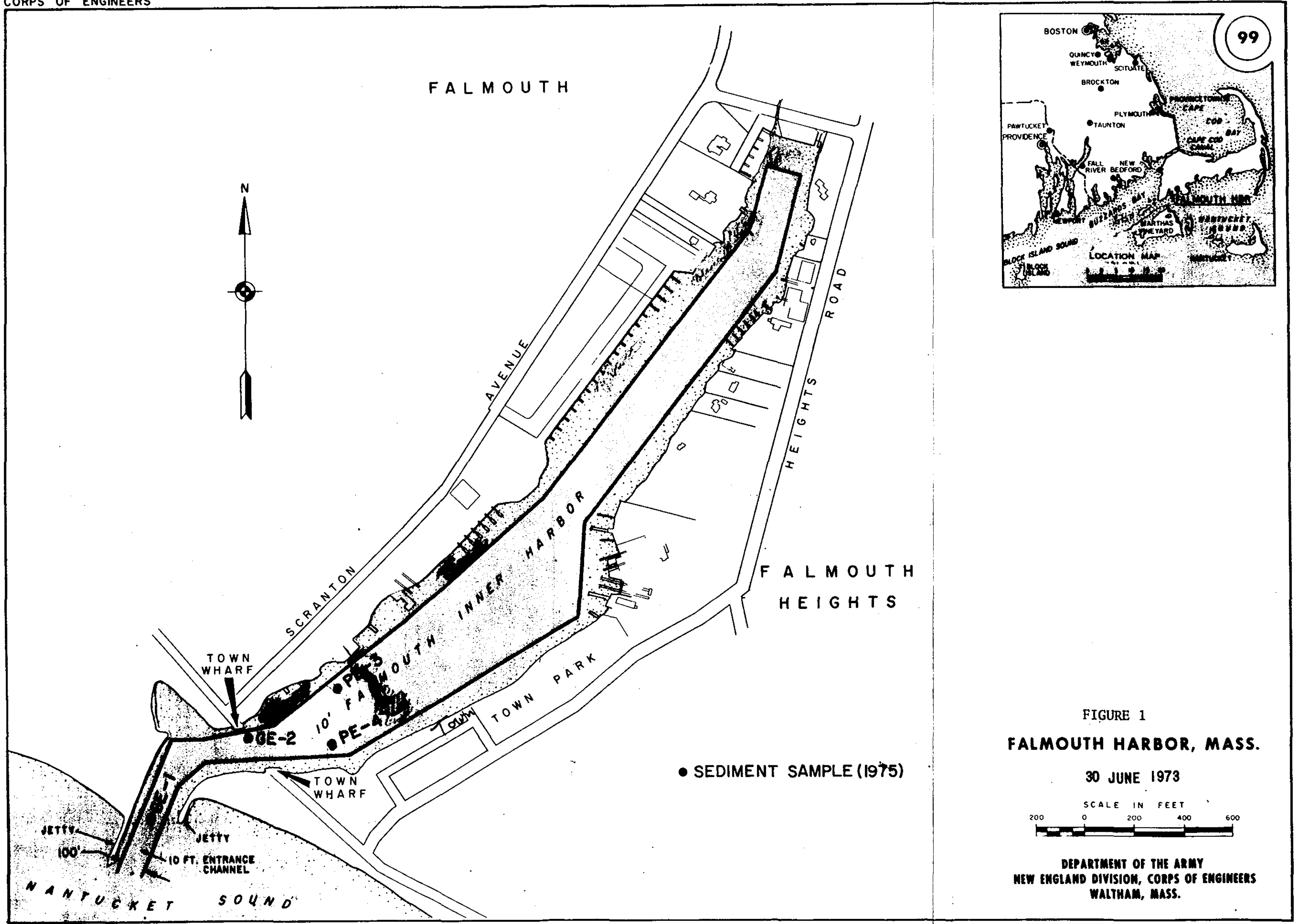

FIGURE 1

FALMOUTH HARBOR, MASS.

30 JUNE 1973

SCALE IN FEET
200 0 200 400 600

DEPARTMENT OF THE ARMY
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WALTHAM, MASS.

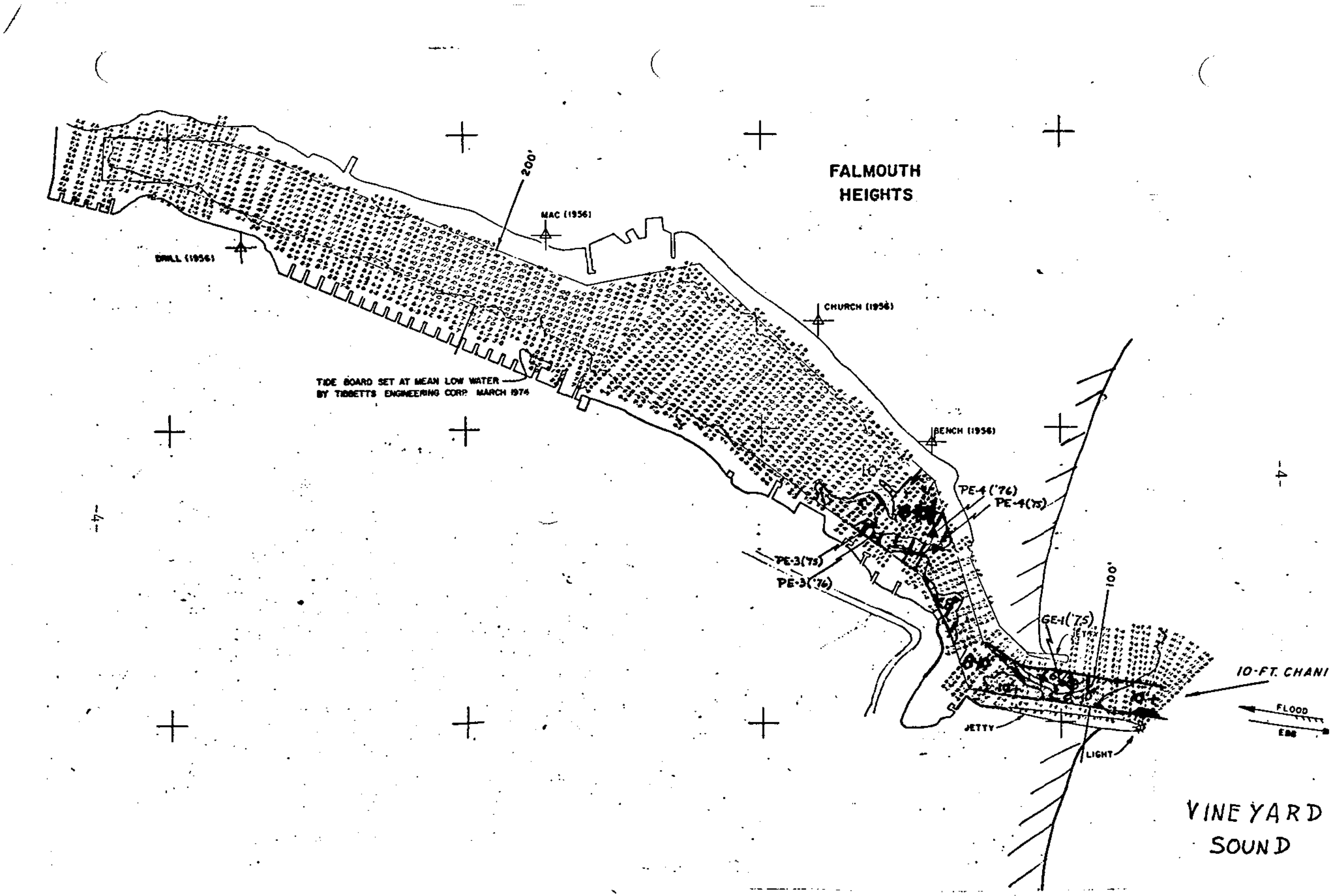

Figure 2: The Inner Harbor at Falmouth Mass.
Showing: Condition Survey, July, 1974, with shoaled areas colored; Locations of 1975 and 1976 Sediment Samples.

The contractor will be required to dump at a temporary buoy set at the center of the site. This point dropping will concentrate the material and decrease the chances of area dispersal of the finer grain size fraction. The inlet sand about 6,000 cubic yards will be dredged and deposited last in an attempt to cap the more organic material characterizing the inner harbor dredge area.

b. Previous Dredging History

Before 1900 the area which now includes the Inner Harbor was a herring-run pond, similar to other indented estuaries and ponds along the nearby coast.[1] A bridge then spanned the inlet to the pond. In about 1900 the decision was made to create a harbor at the site. The bridge was removed, the entrance to the ocean was shifted 250 feet to the west, jetties were built to protect the entrance, and the newly created harbor was dredged.

The Corps accepted maintenance of this project in June 1948. The project as now defined was completed in May 1957.

In 1963 the harbor was dredged again - and that was the most recent dredging. At that time about 8,400 cubic yards of sediments were removed from the entrance channel. As in 1957 the dredged materials were disposed of on the beach just below the bluffs of Falmouth Heights, a site about 1000 feet east of the harbor entrance.

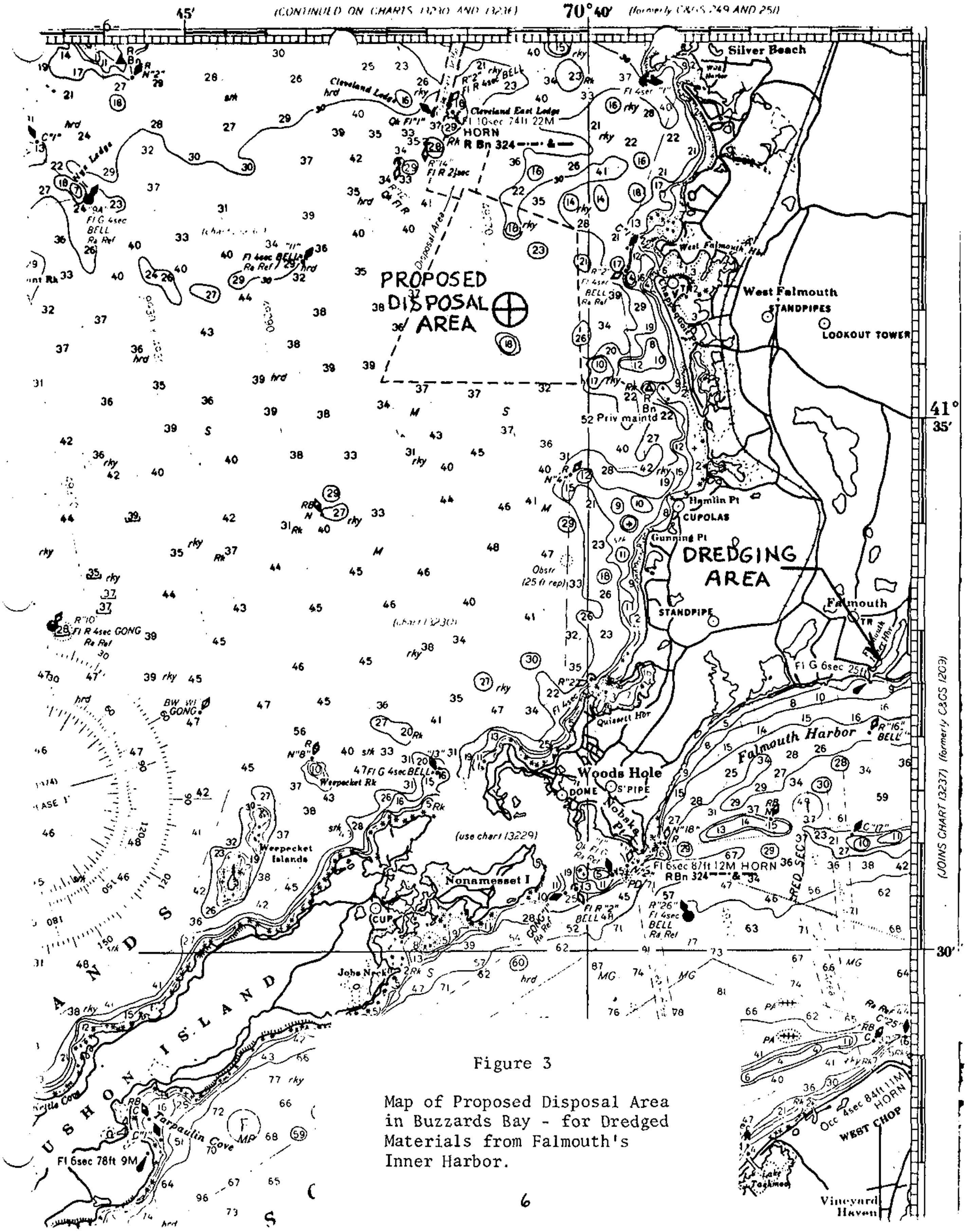

Figure 3

Map of Proposed Disposal Area in Buzzards Bay - for Dredged Materials from Falmouth's Inner Harbor.

2. Environmental Setting Without the Project

a. Climate and Tidal Regime.

The south coast of Cape Cod in the vicinity of Falmouth has a maritime climate typical of southern New England. Average daily temperatures in July range between 62 and 80°F and in January the mean daily temperature ranges from 24° to 40°F. The average frost-free growing season lasts for about 190 days each year.

Precipitation averages 42 inches per year and includes less than 30 inches of snowfall. Snow (of 1 inch or more) covers the ground about 35 days per year.

The winds are generally westerly - from the northwest during the winter and from the southwest during the summer. Infrequently there are storms which have their origin in the tropics and travel northward up the Atlantic coastline imperiling coastal communities.

Tidal measurements taken at Nobska Point (at Woods Hole) and at Falmouth Heights (just east of the Inner Harbor) show mean high water levels which are 1.5 feet and 1.3 feet, respectively, above the mean low water mark.

b. Geologic and Topographic Setting.

Like the rest of Cape Cod the area around Falmouth is mantled with glacial deposits which obscure and modify whatever influences on land forms are traceable to the underlying igneous bedrock. The thickness of the unconsolidated sediments mantling the surface are estimated to be about 300 feet[2] in the Falmouth area.

The exposed and unconsolidated Pleistocene (i.e., glacial) deposits exhibit a marked facies change in Falmouth. The western half of the town, which fronts on Buzzards Bay, is covered with glacial till, an unsorted, unstratified mixture of clay, silt, sand, and gravel. The topography in this area is irregular - characterized by rounded hills, hummocks, and depressions. The eastern part of town, by contrast, has at the surface glacial outwash materials and ice-contact deposits. These outwash sediments surround the area in which the Inner Harbor is situated - and also extend eastward along the whole south shore of the Cape, and they are characterized by silts, sands and gravels which exhibit a fair degree of sorting and stratification. The outwash area is referred to by Pleistocene geologists as the "Mashpee pitted plain." The topography of this region is only gently rolling - much more nearly level and less irregular than the land in the western part of town and dotted with kettle holes which are now small ponds. The northeast-trending boundary between these two types of glacial deposits represents a recessional moraine (Buzzards Bay moraine) dating from the last stage of Pleistocene glaciation. Within this moraine, extending from Woods Hole to Sandwich, are some of the most productive sand and gravel quarries on the Cape.

It is significant that the physiography of the Falmouth area - indeed of much of the Middle Atlantic coastline - is traceable to eustatic changes in sea level which have occurred since the Pleistocene glacial epoch. The indented estuaries, salt ponds, and marshes along the coast are relicts of a south-flowing Pleistocene drainage system established 15,000± years ago when sea level was 300 feet or more lower than it is today. When the ice melted the sea transgressed the area now termed "the continental shelf." As sea level rose barrier beaches were created, and these shore-paralleling beaches, in turn, were shoved landward "plugging" the entrances to many of the drowned valleys and changing them into marshes and ponds. These ponded saltwater areas, for this reason, have restricted drainage outlets. The Inner Harbor, like many other indentations of the southern New England coastline, owes its morphology to these geological processes which occurred during and after the period of Pleistocene glaciation.

c. General Physical Statistics of Falmouth.

The total area of the Township is 48.8 square miles, of which 43.7 is land (exclusive of ponds, harbors, and tidal flowage).[3]

The generalized ocean shoreline fronting on Vineyard Sound, Woods Hole Passage, and Buzzards Bay measures 25.5 miles. Total shoreline, however, on all tidal waters, is 67.9 miles. Of this area 9.25 miles of tidewater shoreline is suitable for bathing and 2.26 miles is town-owned beach.

d. <u>Vegetative Cover and Wildlife.</u>

The Falmouth area falls within the "Coastal Plain" physiographic province. Forest cover is characterized as the yellow pine-hardwood association, also a distinction of the sandy coastal areas of eastern Long Island and southern New Jersey. The pine species are usually of the pitch and shortleaf varieties, whereas the native (exclusive of ornamentals) hardwoods are mostly oaks, with some poplar and maples.

Open spaces (i.e., fields and pastures) are to be found mostly in the eastern half of town where the topographic relief is least.

The wildlife found within the town include: deer, raccoons, woodchuck, skunks, red fox, opossum, cottontail rabbits, red and gray squirrels. The habitat for all of these species is scattered throughout the inland portions of the township.

Inland birds include those usually associated with this portion of New England, not excluding such predatory species as owls and hawks. Wild turkey populations may soon be established as a result of recent transplanting efforts undertaken by the Commonwealth. Blue and snow geese have been propogated by the town Conservation Officer, as have also a population of mute swans. Canvasback and Redhead ducks are common residents of the saltwater ponds between Falmouth Center and Woods Hole. The above-named species are, however, protected from hunters.

In addition there is a burgeoning population of Canada geese which frequent the area's ponds seasonally. Pheasants and quail are annually stocked in the area's woodlands and fields by the Commonwealth, especially just before and during the hunting season.

Freshwater fish are stocked by the State in some of the inland ponds, as well as the rivers draining them. The stocked species include brook, rainbow, and brown trout. Sea-run brown (Salar) trout are to be found in the south-flowing rivers which drain the eastern part of town and flow into the bays and estuaries of Vineyard Sound to the east of the Harbor.

Along the shore and in adjacent saltmarshes are the habitats for numbers of seabirds. These species include a variety of sea ducks (among the most numerous: surf scoter, eider, goldeneye and mergenser), as well as cormorants, terns, gulls, loons and grebes.[4] A sanctuary attractive to many of these species is located a mile or so west of the harbor at the town's Salt Pond Sanctuary. Along the ocean frontage, as contrasted with the salt ponds, the wading birds predominate. Migratory and transient species (shearwaters, dowitchers, sanderlings, etc.) augment those numbers of birds which are seasonal residents of the area.

e. Water Resources.

The town of Falmouth is supplied by groundwater and surface water from the Long Pond area a mile north of the Inner Harbor. Because the reserves are sufficient to meet anticipated demand for several decades it is unlikely that additional sources will soon be sought.

The disposition of wastewater, however, is a current problem and the cause of considerable discussion in the town. At the present time, Falmouth does not have municipal wastewater collecting facilities, except at Woods Hole where 0.3 mgd of raw sewage is discharged into Great Harbor. Recent studies have proposed alternative solutions to the increasingly serious problem of wastewater disposal.[5] In essence, these alternatives are two in number: (1) construction of a treatment plant with a deep ocean outfall, and (2) land treatment coupled with inland groundwater recharge. No decision has yet been reached[6] on which alternative--or combination of alternatives--is both politically acceptable and economically feasible.

The implication of the town's decision on wastewater management alternatives is relevant to the dredging project only insofar as both projects (i.e., dredging and wastewater treatment) have potential and reinforcing (or compounding) impacts on water quality in the Falmouth Harbor area.*

The water quality classification of Falmouth Inner Harbor is "SB", meaning that these waters are suitable for water-contact activities but are not suitable for shellfish which are intended for human consumption. (Quahoags, however, are harvested from the harbor by the Town Warden and transplanted into another nearby water body - Great Pond - where, after depuration, they are expected to be acceptable for human consumption two years after transplanting.) The specific water quality standard not met by the waters of the Inner Harbor--and this has been true for a number of years--has been the coliform standard. Total coliform bacteria per 100 ml sample must not exceed, in an approved shellfish area, a median value of 70, nor can more than 100 percent of the sample ordinarily exceed 230 during any monthly sampling period.[7] Falmouth Harbor's coliform count, through failing to meet the above standards, does not exceed 700 per 100 ml, and therefore is within the limits of water classifiable as "SB". Sources of the measured pollution (i.e., coliform bacteria) in this instance are thought to be both underground septic systems on land adjacent to the Harbor and the waste discharged by boats concentrated in the harbor during the summer. (Waterfowl may also contribute to the problem.) Rules were proposed a few years ago by the Commonwealth requiring "tight tanks" on all watercraft, but these proposed standards were, before adoption, superseded by federal regulations requiring instead the maceration and chlorination of wastes. The federal water quality regulations which are applicable to watercraft have proven, up to this time, to be difficult to enforce.

There are no known drains emptying into the harbor save one swamp drain (or culvert) at the northernmost end of the harbor which sometimes carries runoff from the Morse Pond area. Some surface sources of pollution may contribute to this drain, but the impact on water quality is not believed to be serious.[8]

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*It should be noted in passing that the Woods Hole Oceanographic Institute has for years been experimenting, under federal subsidy, with the use of secondary treatment wastewater in the propagation of shellfish. Aside from the problem of climatic changes and their effect upon aquaculture the most troublesome problem in experiments of this type seems to be the removal of bacterial and viral contaminants from the wastewater.

In addition to the coliform count in the harbor, there is serious concern about mercury levels--especially in the bodies of shellfish where concentrations exceeded 0.5 ppm. (At Quisset Harbor, north of Woods Hole, the source of mercury has been traced to boat paint and when its use was discontinued the mercury levels decreased appreciably. That area is still closed to shellfish harvest.[9]) However, and as was mentioned just above, the town, with the collaboration of the Commonwealth's Division of Marine Fisheries and the Division of Environmental Health, has demonstrated that removal of immature quahoags to an unpolluted environment enables these shellfish to gradually reduce tissue levels of mercury concentrations.

f. Existing Land and Water Uses.

Falmouth, like other towns on the Cape, is sensitive to the pressures of urbanization. It is one of the five towns in the "Cape and Islands Planning Area" (as defined by the New England River Basins Commission[10]) which is under "high" to "medium-high" development pressures.

The town government has recently attempted to control residential development within those areas which it defined as "agricultural districts." A proposed town article to accomplish this, however, was disapproved by the Commonwealth. Nonetheless, suggested and restrictive amendments to existing zoning regulations which would satisfy the Commonwealth's legal authorities are still being discussed in town councils.

Falmouth's Conservation Commission has also addressed the need for restrictive regulations on land and water uses--this by incorporating conservation easements in land titles and by outright acquisition of acreage.

But in the vicinity of the Inner Harbor, there have been no recent nor relevant policy decisions by town councils, or boards, which could be construed as pertinent to the proposed maintenance dredging project. It should be added, however, that the town has for a number of years considered the adoption of a "Master Plan." Several proposals by consultants have been considered by the Planning Board, but no positive or substantive action on these proposals has yet transpired. It should also be noted that the town, as was earlier mentioned, is considering improved and town-wide wastewater treatment alternatives. The implication of sewering the area around the harbor are pertinent to water quality standards. But the proposed location of treatment plant and possible ocean outfalls is considerably to the south and west of the center of Falmouth.

The land which surrounds the Inner Harbor on three sides is nearly completely developed and devoted principally to marine activities. At least four boatyards are located at the harbor's edge. A motel and restaurant also occupy harborside acreage. The Town Wharf and town-owned slips are on the west side of the harbor. Adjacent to the town's mooring slips is a 4-acre town park (Marine Park).

At the head of the harbor is a publicly-owned parcel of land which contains a small, surfaced, boat-launching ramp for public use.

Near the entrance to the harbor, on the east side and just north of the harborside Falmouth Yacht Club, is the town-owned Deacon Park. This is a narrow strip of recreational open space about 1150 feet long (approximately 1 acre). A favorite summer occupation for visitors to this area is the feeding of ducks long accustomed to the hospitality shown them at this park.

At the harbor entrance, just northeast of the East Jetty is a public parking area which fronts on both Vineyard Sound and the bulkhead bordering the harbor entrance.

The town owns a considerable length (1650 feet long) of Vineyard Sound beach stretching eastward from the first groin east of the harbor. This is called the Falmouth Heights Beach. To the west of this public beach is a short stretch of privately owned beach (Tides Motel), and to the east of the public beach is another short (250 feet) stretch of beach (opposite a public playground) associated with "The Casino," a privately-owned recreational attraction for persons womewhat older than the youngsters who frequent the nearby playground. The publicly-owned Falmouth Heights Beach is the locale where all dredged materials from the harbor have heretofore been placed.

On the eastern side of the Casino, the town owns or controls, with but one interruption, all of the beach as far east as Little Pond--including a stretch on the east side of the entrance to the Pond. From that point eastward all of Vineyard Sound Beach is privately owned until one reaches Menauhant Beach, the barrier beach in front of Bournes Pond (2-1/2 miles east of the harbor entrance).

On the west side of the harbor entrance and fronting on Vineyard Sound, all land is privately owned (a distance of about 2000 feet) until one reaches the foot of Shore Street--and the beginning of Surf Drive. Stretching westward for several thousand feet from this point is Falmouth Beach, a public beach which extends in front of Salt Pond.

The public beaches just described are prime recreational resources in the region and receive intensive use during the summer months.

Water uses in the harbor are mostly those associated with recreational boating activity. Occasionally, there is some swimming in the Harbor, but the congestion of boats and resultant pollution discourages most of such activity.

Commercial boating also has its place in the harbor. Ferry service to Martha's Vineyard (Oak Bluffs) is provided by the "Island Queen" which sails from a pier on the east side of the harbor during the summer season (May through October). Five or six charter boats operate out of the harbor seasonally. And several commercial fishermen make routine calls to the Town Wharf throughout the year, though only one such boat spends any appreciable time docked in the harbor.

g. Marine Facilities.

As earlier mentioned, four boatyards are to be found within the Harbor, offering such facilities as an 85-foot marine railway, several lifts and cranes (up to 100 tons), and a variety of specialty repair shops.

There are four or five charter boats operating out of the harbor. However, the "Island Queen" ferry to Martha's Vineyard, with its support facilities located on the east side of the harbor, is the principal commercial transport facility in the area. Estimates are that this ferry generates $650,000 per year in direct revenue from freight and passenger service.

Mooring slips exist at both public and private piers and docks around the harborside. The town-owned slips at Marine Park will accommodate 60 boats. Privately owned slips elsewhere in the harbor will accommodate an additional 180 boats. And anchorages and mooring elsewhere in the harbor may increase the resident boat capacity of the harbor by 150, bringing to approximately 500 the number of boats (mostly recreational) based at the harbor.

The Falmouth Yacht Club, in the southeastern portion of the Harbor, is one of the focal points of recreational boating activity.

The Corps has estimated the following intensities of Harbor use during 1974:

Commercial traffic:

Draft range		Vessel trips	Carrying:
7-8'		950	120,298 passengers
6-7'		825	197 tons
others		255	130 tons
	Totals:	2,030 trips	120,298 passengers and 327 tons

Recreational traffic:

Draft range		Vessel trips
5-6'		2,500
4-5'		6,200
others		10,000
	Total:	18,700 trips

h. Socioeconomic Data.

Falmouth's population in 1970 was 15,942. The median age was 30.8 years as contrasted with a state-wide median age of 29.0 years. The median income of resident families in Falmouth in 1969 was $9,881. This figure compares with a state-wide family median income of $10,835.

The principal occupations of the more than six thousand employed persons (1970) in Falmouth is concentrated (i.e., more than 50 percent total) in professional, clerical, and craftsmen categories. The largest single private employer on the Cape is the Woods Hole Oceanographic Institute, located in the southwestern part of town.

In 1970, there were 9,619 housing units in Falmouth of which 6,176 were year-round units. Those units which were vacant and/or for sale had a median asking price of $24,300 (1970). Units which were (1970) renter-occupied had a median rent of $106 per month.

The town report of 1974 estimated that town water was supplied to 18,000 persons during the "off-season" of 1974 and that the number of water customers increased to 51,000 during the summer--an increase of more than 280% for the summer season.

i. Fishery Resources.

The fishery resources of the region since the colonial era have attracted some of the energies of Falmouth residents. The principal harbor in town from which fishermen depart for regional fishing grounds--Vineyard and Nantucket Sounds, Buzzards Bay, and the open Atlantic--is Great Harbor at Woods Hole. Inner Harbor, the proposed project site in Falmouth, is of only minor importance to the fishing industry. It is of passing historical significance that the Lighthouse Board, a predecessor of today's Coast Guard, had its beginnings in Woods Hole. And the first marine fisheries laboratory (now the U. S. Marine Fisheries Laboratory) was also established at Woods Hole (1871). A few years later, a private institute--the Marine Biological Laboratory--was also established nearby. And in 1930, the Woods Hole Oceanographic Institute was founded--making the Woods Hole section of Falmouth an international center for marine and oceanographic studies.

Whaling was one of the principal industries of the residents of such nearby places as New Bedford, Nantucket and Martha's Vineyard during the 1600's, 1700's, and until the Civil War. Falmouth residents too participated in this industry. Large fortunes were made by the most industrious and successful of these adventurous men. But the reason for this prosperity, the whales, in time became less numerous and other fishing ports became competitive, as whalers had to seek their quarry in more distant waters. And the rise of the petroleum industry introduced a competitive product to the world's economy which meant the end of New England whaling.

The nearby waters of Nantucket, Vineyard and Rhode Island Sound are characterized by seasonal changes in water temperature. Winter flounder, windowpane flounder, tautog, cunner, tomcod, and smelt are year-round residents. Cod, pollock, and several kinds of hake, however, are cold-water species and only in the winter may they be found closer inshore than is their custom during the warmer months. Surface waters begin to warm in the spring and the cod and other species move offshore to colder and deeper waters. As the waters continue to warm fluke, summer flounder, scup, black sea bass, bluefish, striped bass and weakfish move into the area to spend the summer (until October).

The many estuaries of the area, as well as the saltwater ponds open to the sea, are breeding grounds and nurseries for a variety of resident species (winter flounder and tomcod, and such forage species as killifish and silversides). Anadromous species (alewife and blueback herring) pass through these shallow marine zones during spawning runs. Shellfish, too, find the estuaries, bays, and ponds hospitable habitats because of the abundance of nutrients to be found there.

1) Finfish. The shifting shallow shoals of Nantucket Sound (south and east of Nantucket Island) are one of the area's attractive fishing grounds. The shallow shoals of Vineyard Sound are generally less attractive, but have, in teh past, yielded numerous black sea bass. Buzzards Bay, the body of water between the western Cape and its archipelago (the Elizabeth Islands) and the mainland of Massachusetts and Rhode Island, is a prolific striped bass fishery--individual specimens of up to 84 lbs. have been recorded. But in the estuaries and along the coast, "school" bass (i.e., striped bass of less than 10 lbs.) are the most common. Bluefish rank with stripers as a popular and prolific species--both inshore and, from May into October, offshore.

Tautog are caught off rocky bottom around wrecks, habitats not uncommon in

Buzzards Bay. Cunner--nicknamed "bait-stealers"--are a nuisance fish to the sport fishermen in some of the same areas where tautog and striped bass abound.

Winter flounder (blackback), a ubiquitous fish, are found in salt ponds, bays, and the open ocean. White perch are also found in these habitats, but especially in estuaries and river mouths. Scup, a visiting summer species, are frequently found at the western end of Martha's Vineyard and off the Rhode Island coast in Buzzards Bay.

Groundfish (cod and hake) are present offshore the year round. Some cod, in fact, which move inshore late in the year, are caught by surf-casters while fishing for stripers.

Migratory fish with pelagic habits, such as mackerel, tuna, and swordfish, are taken in the area--but usually some distance from shore.

Eels, the only catadromous species of the area, pass through the estuarine zones of the region on their way to a lengthy stay in freshwater, or on their way, as adults, to the Saragossa Area of the South Atlantic to spawn. They are caught by hook and line from April through November and through the ice with spears during the winter. Fishing grounds for eels are in all waters--marine, brackish, and fresh waters.

Landings of finfish in the town of Falmouth recorded in recent years are shown in Table I. It is presumed that most of these catch statistics were recorded at Woods Hole for, as was earlier mentioned, the Inner Harbor at Falmouth is a much less prominent fishing port than is Great Harbor at Woods Hole.

The Inner Harbor itself does not support an active or productive finfishery. Small numbers of herring routinely invade the harbor seeking entrance to the drainage pipe at the upper end of the harbor which connects with inland fresh water bodies. (Other south-draining rivers in the Falmouth area receive herring and alewife runs of some importance.) Only an occasional child or languorous fisherman drops a line in the harbor's waters. The same is generally true of waters immediately adjacent to the harbor's entrance in Vineyard Sound. As was

TABLE 1

FINFISH AND SHELLFISH SPECIES HARVESTED AND SOLD*

Waters fished (w/in 3 mile limit):	Wauquoit Bay		Vineyard Sound		Buzzards Bay		Popponesset Bay		Nantucket Sound	
Species Landed in Falmouth:	1973	1974	1973	1974	1973	1974	1973	1974	1973	1974
Common eel	700 / 385		7500 / 4500	9500 / 4270						
White Perch (sea perch)	1500 / 525			1600 / 480						
Bluefish				16,000 / 25,000						
Striped bass				65,000 / 27,900						
Shellfish: (pounds of meat / value)										
Quahoags & hard clams:										
public areas	40,600 / 40,872	19,800 / 36,000		25,300 / 46,000		4400 / 6000	10,494 / 12,383			
private areas	150,000 / 171,000	165,000 / 225,000								
Oysters	6200 / 22,058	1300 / 3400								
Soft-shell clams		1560 / 2400								
Bay scallops		5400 / 16,200	2460 / 5289	2600 / 4000	1230 / 2590					
Conch (channeled whelk)										69,300 / 27,720
Horseshoe crabs										9250 / 1480

Source: National Marine Fisheries Service, 1976, Gloucester, Massachusetts

(*Figures show = pounds/value)

earlier implied, the greatest quantity of finfish resources in the area are located some distance from the developed shorelines of Falmouth.

2). Shellfish. The Inner Harbor, like other indentations along the nearby Vineyard Sound coastline, has attracted a shellfish population comprised of several species. The area, for reasons earlier mentioned under "Water Resources," remains closed to shellfish harvest (except as permitted to the Falmouth Shellfish Warden by the Commonwealth's Department of Public Health).

Within the harbor are both quahoags (Mercenaria mercenaria) and soft-shelled steamer clams (Mya arenaria). Because the former are considered to be a more valuable resource than the latter they have been harvested in the harbor by the Warden in recent years and relocated for depuration and as breeding stock in salt ponds to the east of Inner Harbor (e.g., Great Pond and, in the future, Green Pond). The harvest of soft-shell clams might be feasible in the future but, as yet, no resources have been allocated for their inclusion in the depuration experiment. No bay scallops are found within the harbor--presumably because of their high mobility and low tolerance for pollution levels found in the harbor.

During 1974, a total of 1,174 bushels[11] of contaminated quahoags were dug from the sediments of the harbor by the Shellfish Warden and transplanted in (or "relayed" to) unpolluted areas. All specimens were presumed to be contaminated not only by bacterial pollution in the waters of the harbor but by organic up-take of mercury (in greater amounts than 0.5 ppm in the flesh of these hard clams). But depuration of the relocated individuals and the propagation of spat has occurred (during the intervening year and a half since the initiation of the project) and all parties concerned today express satisfaction with the relaying project.[12] Harvest of quahoags now living in the transplant areas is expected soon.

Elsewhere in the Falmouth area shellfish harvests of quahoags, soft-shelled clams and bay scallops have annually been substantial. Most harvests have occurred in the estuaries and ponds indenting the coastline of the town.

Table II shows shellfish statistics compiled for all of Barnstable County, which

TABLE II: SHELLFISH SPECIES HARVESTED AND SOLD*

	Equipment 1973	Equipment 1974	Quahoags 1973	Quahoags 1974	Soft-shell clams 1973	Soft-shell clams 1974	Oysters 1973	Oysters 1974	Bay Scallops 1973	Bay Scallops 1974	Razor Clams 1973	Razor Clams 1974	Sea Clams 1973	Sea Clams 1974	Mussels 1973	Mussels 1974	Conch 1973	Conch 1974
MASSACHUSETTS TOTAL																		
Total Fishermen:	683	763																
Rakes	400	413	20,660/300,818	18,052/249,150	763/12,990	872/15,334	188/2,984	304/5,065	886/13,800	423/3,815	180/500		42/190	15/100	—	154/312	—	—
Draggers	771	898	3,986/40,313	3,624/30,352	28/798	199/2,040	119/1,665	—	19,881/248,944	27,000/315,412	—	—	1,296/4,984	—	—	2,701/8,110	—	300/300
Forks	183	176	1,088/15,138	113/1,574	10,205/152,763	10,271/160,748	35/450	21/275	1/15	10/60	50/600	—	—	—	20/60	200/1,200	—	—
Tongs	85	62	4,459/50,784	2,395/28,261	1,148/16,935	15/195	139/1,827	30/305	176/2,605	124/1,958	—	—	8/25	—	—	—	—	—
Nets	3	2	30/450	—	—	—	—	—	14/1,203	65/695	—	—	—	—	—	—	—	—
Jets	3	2	—	—	30/490	8/180	—	—	10/150	—	—	—	—	—	—	—	—	—
Divers	3	8	86/862	159/1,600	50/750	200/3,000	—	—	—	47/362	—	—	—	—	—	—	—	—
Hand	3	1	12/100	30/300	38/900	—	—	—	—	—	—	—	—	—	—	—	—	—
BARNSTABLE COUNTY																		
Fishermen:	339	381																
Rakes	325	299	16,537/241,691	14,401/193,812	486/8,440	401/6,223	132/12,448	275/3,930	557/9,065	423/3,875	180/500	—	42/190	15/100	—	150/300	—	—
Draggers	331	30	2,708/25,855	2,267/18,500	6/72	100/1,300	99/1,465	—	8,205/93,095	11,130/131,928	—	—	—	—	—	—	—	300/300
Forks	19	32	23/200	95/1,370	163/2,746	251/4,211	35/450	17/255	1/15	10/60	50/600	—	—	—	—	1/10	—	—
Tongs	35	22	1,515/23,853	799/15,018	68/1,321	5/75	75/1,218	25/260	131/2,015	124/1,958	—	—	—	—	—	—	—	—
Nets	3	2	—	15/220	—	—	—	—	14/203	65/690	—	—	—	—	—	—	—	—
Divers	-	3	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—	—
Hand	1	-	—	—	38/900	—	—	—	—	—	—	—	—	—	—	—	—	—
Boats:																		
Inboard	33	20																
Outboard	235	207																
Other	13	6																

*Figures show: bushels / value ($)

Source: National Marine Fisheries Service 1976, Gloucester, Massachusetts includes all of Cape Cod and for the State. Presumably the figures which follow, for Falmouth alone, are included in Table II. The figures in Table II are presented so that some concept of the regional context for shellfishing effort can be appreciated.

1974 harvest figures[13] for Falmouth's shellfish beds are shown below (excluding Inner Harbor):

Area	Soft-shell Clams	Quahoags	Bay Scallops
Waquoit Bay	135	2,448	1,500
Eel Pond	185	565	393
Bourne's Pond	65	79	
Green Pond	210	3,200	2
Great Pond	759	1,075	15
Little Pond	85	12	2
Little Harbor, Woods Hole	2	450	3
Great Harbor, Woods Hole	28	285	
Sippewissett Area	52	95	
West Falmouth Harbor			4
Rand's Canal	7	36	
Fiddler's Cove	10	50	
Megansett Harbor	15	25	1
TOTALS:	1,552 bu.	8,320 bu.	1,900 bu.

The 1974 "commercial" and "family" shellfish harvests in Falmouth were:

	Soft-shell Clams	Quahoags	Bay Scallops
Commercial			
Bushels Harvested	320	4,500	900
Value	$7,680	$90,000	$27,000
Family			
Bushels Harvested	1,233	3,820	1,000
Value	$29,592	$76,400	$60,000

During 1974 the following numbers of shellfish permits were issued:

Family: Resident, - 65 yrs.	Family: Resident, + 65 yrs.	Family: Nonresident	Commercial
2,125	300	250	85

No significant numbers of eastern oysters are now being harvested in Falmouth, but the Shellfish Warden has initiated transplants of mature and larval spat oysters in a number of areas (especially on the Buzzards Bay side of town) in anticipation of a future oyster fishery.

In addition to natural reproduction of shellfish substantial efforts have been expended in Falmouth (especially by the Warden) to augment the native populations with laboratory-raised and artifically-cultured specimens.

The SENE Report[14] identified Wauquoit Bay in Falmouth (and the Town of Mashpee) as an ideal shellfish aquaculture site. However, no aquacultural enterprises (save for that conducted by the Shellfish Warden under town auspices) yet exist in estuarine environments within the town.

3) Lobsters. Though the statistical records of the National Marine Fisheries (see Table 1) show no landings of lobsters in Falmouth, it is known that fishing for this most valuable of all of the Commonwealth's fishery resources does occur in Falmouth waters. Lobster pots are set in rocky areas in the Woods Hole area and off the Elizabeth Islands, as well as off the Buzzards Bay shoreline of Falmouth. (Barnstable County's chief lobster fishing ports, however, are Sandwich and Chatham.)

j. Benthic Investigations. As far as is known, no investigations or surveys of benthic organisms in the Inner Harbor (aside from shellfish harvests with hand rakes) have been made. The sediments of the harbor (as defined by the sediment samples taken in anticipation of the proposed maintenance dredging) range from fine sand near the harbor entrance (GE-1 on Figure 1) to black organic silt (PE-3 and 4, on Figure 1).

A reconnaissance diving survey was conducted by the Corps in the harbor during 1975. It confirmed that in the harbor's bottom sediments there is a distinct interface between (1) relatively clean, ocean-derived sand and (2) silt (and finer material) with an admixture of organic material. This interface, or boundary, is presumed to "outcrop" in a line stretching across the harbor a short distance inland from the town wharf and to dip oceanward from the "outcrop line." Definition of the spatial and other relationships of the sediments at depth, however, awaits more detailed and deeper coring and sampling than has yet been undertaken. When better understood, the mechanics of sediment transport into the low energy environment of the harbor will permit more accurate estimates of--and distinctions between--the volumes of clean sand and the fine-grained material with which organic material is inextricably mixed.

From a quahoag's point of view, the harbor's sediments are a hospitable environment. Quahoags and soft-shelled clams are found throughout the harbor (i.e., in the middle as well as along the edges) for about two-thirds of the harbor's length (excluding the entrance portion). Their habits--for example: burrowing depth, rate of growth, etc.,-- are no different in the harbor than in less polluted waters.[15] In an ecological sense, these filter-feeders seem to be successfully filling their appropriate niches in the harbor's ecosystem.

k. Historical and Archeological Features. No features appearing on the National Register of Historic Places are present in the town of Falmouth. Portions of the town, to the west of the harbor and closer to its center, have been declared "historic districts" by the Commonwealth. These areas would not be affected by the proposed dredging.

3. Relationship of the Proposed Action to Water and Related Land Use Plans

The land area surrounding Falmouth's Inner Harbor is already well developed. Questions on developmental changes in the Harbor area are frequently the concern of the town's active Planning Board and the resultant policy seems to favor a minimum of change in land uses in the Harbor area. Approval for a proposed multiple dwelling complex on the east side of the Harbor, for example, was withheld recently.[16] The proposed dredging of the Harbor, however, is strongly supported by the present town administration because of its importance in maintaining those established harborside enterprises and facilities which are important to the town's economic well being.

A current and unresolved question (earlier addressed in this report) is that of municipal wastewater collection and treatment. This issue impinges seriously upon such matters as land use policies, residential density, water quality, etc. There is concern within the town about water quality parameters measured in the Harbor. And there is also recognition that the absence of sewer facilities in the Harbor area exacerbates these water quality problems, though there is some question about the proportional assignment of cause for water quality degradation to boating activity in the Harbor and/or infiltration from septic systems.

The town is proud and protective of both its marine and its land-based resources. Land acquisition for conservation purposes is stressed, as is the provision for public beach facilities. The town now controls 2.26 miles of beach frontage and 2.39 additional miles of ocean frontage.[17]

The proposed dredging action has at least historic relevance to the town's policy of beach preservation. As has already been mentioned, the two earlier dredging operations of the Harbor (in 1957 and 1963) resulted in the dredged materials being placed on the Falmouth Heights Beach (just east of the Harbor entrance). Though there may have been some objections to these actions voiced then, there is now near unanimity in endorsing these earlier actions. The reasons given for endorsement are that the dredged materials supplemented and replenished that stretch of beach east of the Harbor which, in the memory of many residents, had been eroding.

Similarly, the Public Works Department of the town has suggested[18] that disposal of dredged materials on the ocean side of Surf Drive (beginning 2000 feet west of the Harbor entrance and extending westward from that point) would serve to lessen the impact of storm damage to that exposed roadway. On the average of once each year--usually in the winter--high tides and storm-driven waves inundate that roadway with sand and debris which require removal and expenditures by the town.

Thus it seems that the disposition of dredged materials on the beach is actively solicited by at least some of the town's citizens. There are, it should be added, persons opposed to such action because of the uncertain consequences of dispersing the dredged materials along a much-used section of beach, but such opposition is only volunteered as an opinion when the issue is raised for discussion.

The possibility of allowing the Harbor, over the years, to shoal and become unusable by those boats drawing an appreciable amount of water is probably unthinkable to most of the town's residents. Admittedly, other and alternative harbors are available within the town (Woods Hole and Quissit, for example). But the intensity and importance of enterprises and facilities now located at Inner Harbor precludes, for most residents, the option of phasing out or de-emphasizing that center of recreational boating. The proposed dredging action therefore is supported by those interests in town who find it consistent with present land use policies adopted by the town.

The town is affiliated with the Cape Cod Planning and Economic Development Commission and, of course, is within the jurisdictional province of the Barnstable County Commission. Recent and productive efforts have been made by these two regional agencies to familiarize the residents of Falmouth with current regional plans and options on such matters as a Cape-wide groundwater inventory, regional transit authority, areawide wastewater management planning, solid waste management, and those other State-sponsored programs relevant to the Cape Cod region. The proposed dredging action of Falmouth's Inner Harbor appears not to be in conflict with any of these regional activities.

One additional public and institutional entity which conceivably might have an interest in the status of the Inner Harbor facilities is the Woods Hole, Martha's Vineyard and Nantucket Steamship Authority. That Authority is a public body, licensed as a common carrier, to provide year-round daily service to the three towns named. The port facility in Falmouth which is used by the Authority is not at the Inner Harbor but in Woods Hole Harbor. The service provided by the Authority is, however, competitive with that provided seasonally by the privately-owned ferry operating out of the Inner Harbor (by Island Commuter Corp.) plying the route to and from Oak Bluffs (Martha's Vineyard). Cessation of service by this Oak Bluff ferry, if Falmouth Harbor could no longer accommodate ships of that draft (about 7 feet) would have an uncertain (positive or negative) but direct impact upon the public Authority. That Authority, it has been observed, continually struggles with fiscal problems seeking to avoid additional tax assessments on the three towns served. And were the closing of Falmouth Harbor to occur and the resultant economic impact on the Authority to be a negative one, there would be ramifying implications.

The New England River Basins Commission has recently completed a study (SENE Report)[19] of water and related land uses in southeastern New England. Among the recommendations made by this study was one specifically addressed to salt water fishing and recreational boating--namely, the "maintenance, or dredging of up to ten recreational boating channels" in the Cape Cod area.

Falmouth presently has, in all of its harbors:

	865	slips
	1310	moorings
Total:	2175	boat accommodations

This total, incidentally, exceeds those of any other town on the Cape.

The SENE report recommends[20] the increase of boating facilities in Falmouth to include two marinas with:

	120	slips
	30	moorings
Total:	150	additional boat accommodations.

The report specifies the recommendation that the harbor at West Falmouth (among others) should be dredged in order to implement the recommended expansion of recreational boating facilities in the Cape Cod area.

The implication of this recommendation is that existing recreational boating facilities--such as those at the Inner Harbor--should be maintained in order to accommodate expanding demand.

The Commonwealth in recent years (1970 and later) has passed four separate "Ocean Sanctuary Acts" (under General Laws, Chapter 132A), defining and restricting those practices and activities which may take place within specified marine waters under the Commonwealth's jurisdiction.

The dredging of Falmouth Harbor, inasmuch as it is to take place below the mean low water line, is within the "Cape and Island Ocean Sanctuary" (defined in Section 15; 1971 c. 742; and 1974 c.822, sec. 2). However, the Act does state that it is:

> ...not intended to prohibit...channel and shore protection projects...deemed to be of public necessity and convenience affected by municipalities, governmental districts and the federal government, contingent upon required approval wherever applicable by the U. S. Army Corps of Engineers, the Division of Water Pollution Control, the Department of Public Works, and the Department of Natural Resources, or other improvements approved by appropriate federal and state agencies.

Therefore proscriptions and limitations embodied in the Act do not seem to contravene or conflict with the actions proposed--most especially as the specifics of the Act pertain to dredging activity.

Two alternative disposal sites (at Cross Rip Shoals in Nantucket Sound, or off West Falmouth in Buzzards Bay) are both within the Cape and Island Ocean Sanctuary. Both of these disposal sites, however, have been specifically and recently defined by the Commonwealth as open water disposal sites suitable for "clean spoil" only. The "Foul Area" disposal site, east of Boston in Massachusetts Bay, by contrast, is the only site designated by the Commonwealth for disposal of "polluted" dredged materials.[21]

4. Probable Impact of Proposed Actions on the Environment

a. Impacts of Dredging and Disposal - An Overview

The proposed operation involves two distinct phases: dredging in the Inner Harbor and channel and disposal of the dredged material at an ocean site. The dredging operation itself will have physical and chemical effects upon the biota of the harbor. Associated with the dredging there will be an increase in suspended and dissolved solids which will increase turbidity and decrease light penetration. This decreased light penetration will have an inhibitory effect upon photosynthesizing plants in the areas effected. A reduction in productivity due to decreased light penetration in the dredged area may, however, be offset by increased nutrient concentrations (most notably forms of nitrogen and phosphorus) which, in turn, may stimulate primary production. The extent of the turbidity increase may be fairly short term and will depend upon the prevailing currents and tides at the time of dredging. Nutrient increases, on the other hand, may be longer lasting.

The dredging operations will result in alterations to the benthic macroinvertebrate communities in and around the dredged area. The most obvious effect will be that of the dredge itself which will result in destruction and/or relocation of a portion, largely the nonmobile portion, of the benthic community. A secondary effect will be caused by smothering of elements of the benthic macroinvertebrate community by the sediment plume. The extent of this plume which will be composed of the fine fraction of the sediments, will depend on the quantity of spoil and the prevailing tide and wind activity. The duration of this effect on the benthic biota will depend upon the duration of the operations and the presence of recolonizing organisms. The dredging operation will have different effects on the harbor's fish populations. Those species which can relocate will do so and damage will occur to the less mobile species. The most severe damage will be to the eggs and larvae of fish species, both planktonic and demersal types. This damage will be caused by smothering and may cause large scale mortalities of immature stages.

Dredging operations may resuspend material having a high biochemical oxygen demand (BOD) as well as materials which may contain concentrations of toxic elements. This increased BOD may result in oxygen depletion in areas surrounding the operation. The resulting low oxygen levels may be sufficient to produce stress in portions of the animal community. The concentrations of toxic elements released may be sufficient to have lethal or sublethal effects on the biota. Sublethal effects affect reproduction or feeding behavior and may result in major population losses. The actual impact and effects of the BOD and toxic element increases depends on the dilution of sediment plumes caused by tidal and wave action.

The impacts of dredged material disposal will be much similar to those discussed for the dredging operation. A major concern regarding the selection of any spoil disposal site should be to ensure that the material dumped is similar, at least physically, to the type of bottom sediment already present. Attention to this concern will help to ensure that a community similar to that already established will re-establish after the dumping operation has ceased, and reduce the possibility of major long-term alterations to the biota of the dump site. If this concern is not met the newly deposited sediment may be slow to be recolonized, as there may be insufficient recruitment populations in the immediate area of a type adaptable to the new substrate.

b. Sediment Studies of the Area to be Dredged

Sediment samples of Falmouth's Inner Harbor were taken in June 1975 and subsequently analyzed (see Table III). One sample site was in the entrance channel and the others were not far from the Town Wharf (see Figure 1). Additional samples were taken in February 1976 for the express purpose of making elutriate tests, the results of which are shown in Tables V.a and V.b.

Physical descriptions of the 1975 samples are as follows:

GE-1: Fine sand (SP)
GE-2: Sea weeds and grass
PE-3: Dark gray to black organic silt with traces of fine sand and gravel, and with marine odor (OH to OL)
PE-4: Black organic silt with trace of fine sand, and marine odor (OH)

Table III.
Chemical Analyses (Dried) of Sediment Samples
Falmouth Inner Harbor (September 1975)

Sample Site & Depth	Parameters (ppm)											
	Volatile Solids (EPA)	COD	TKN	Oil & Grease	Hg	Pb	Zn	Cd	Cr	Cu	Ni	Vn
GE-1 surface	15,600	2,410	160	60	0.0	7.3	9.7	.5	9.8	2.4	4.9	9.8
GE-2 surface	(No clastic sediments retrieved)				—							
PE-3 0.0 - 0.25	220,000	211,000	8310	2700	4.64	140.	194.	4.5	86.	173.	54.	85.
1.0 - 1.17	103,000	---	---	---	5.77	140.	129.	2.2	51.	73.	56.	95.
PE-4 0.0 - 0.17	182,000	172,000	5570	1490	2.60	73.	124.	2.9	58.	73.	36.	58.
1.0 - 1.17	175,200	---	---	---	3.09	55.	133	4.7	47.	86.	39.	95.
EPA - Specified Critical Limits (1973)	---	---	---	---	.75	---	---	0.6	---	---	---	---
Mass. DWPC Criteria	60,000	50,000	1000.	1500.	1.0	50.	50.					

The physical nature of samples from the interior of the Inner Harbor (i.e., their silt grain size), as differentiated from the samples at the entrance channel, confirms that the area is one with restricted boundary conditions, and an environment in which the energy for sediment transport from the principal sediment source, i.e., the sea, is derived from tidal currents and wind-whipped waves. No appreciable freshwater inflow to the harbor exists. The sampling station in the channel, GE-1 (see Figure 1), is the only station with an appreciable fine-sand fraction. The high percentages of organic constituents in the Inner Harbor samples are an additional indication of the restricted movement of sediments within the sampled area. These organic components are not winnowed by current action and therefore not relayed out of the area to any extent. Instead, they appear to be accumulating within the harbor as they derive from the abundant nutrients contributed by: wastes from boats in the harbor, leakages from nearby septic systems, and the aquatic life (vegetative and animal) which has become established in the harbor.

Bulk chemical analyses of the 1975 samples have been reviewed by Commonwealth authorities (see November 21, 1975, letter from Thomas C. McMahon, Director of Massachusetts Division of Water Pollution Control (MDWPC) in Appendix).

Analyses of these samples appears in Table III, along with those applicable criteria (1) established by EPA[23] and (2) selected by MDWPC.[24]

Two samples (PE-3 and PE-4) "Violated one or more of the numerical criteria established by EPA," according to MDWPC, and therefore could be labeled "polluted", rather than "clean". And so it was that the Commonwealth initially ruled that Falmouth sediments must be deposited at the Boston Foul Area, 80 miles away. The volatile solids and chemical oxygen demand values shown in the tests are high. These values indicate that a considerable amount of organic matter is present in the surface sediments. Oil and grease concentrations, an indicator of the volume of motorized activity in the harbor, is high, but excessive only in one of the samples. Mercury is excessive in two of the three locations analyzed and in greater concentrations in the Falmouth samples than in any other New England locality where maintenance dredging has recently occurred. Preliminary comparisons show that the average mercury value in sediments at Falmouth is almost 12 times greater than the highest value from all other Federal projects sampled to date in the Cape Cod area.[25] High mercury levels at Quisset Harbor, on the Buzzards Bay side of Falmouth, were reportedly traced to marine paint which had been much used by boats in that harbor. Cadmium too exceeds the EPA permissible limit.

It is not possible to generalize from the few analyses available (in Table III) that levels of concentration of any chemical fraction are correlatable with depth of sample. Nor is it appropriate to draw conclusions from the results of these bulk chemical analyses about the availability of the heavy metals to marine organisms.[26] Impacts of concentrations of these metals on species making up a food chain requires, among other things, definition of the physical-chemical state of a contaminant in situ and its availability for up-take by different species--in short, more than measurements of its mere presence in the environment.

Elutriate ("shake") tests were performed in February, 1976, by the Corps at the request of the Massachusetts Department of Environmental Quality Engineering. These tests were requested so that additional information would be available to aid in the determination of "acceptability" of the dredged sediments at a Commonwealth-designated "clean spoil" disposal site.

Elutriation tests of dredged samples are an alternative or additional (to bulk chemical analysis) technique for determining the acceptability of dredged materials at a specified ocean disposal site. The procedure (as specified by the EPA)[27] is to mix one volume of the proposed dredged sediments with four volumes of water from the selected disposal site and shake the two ingredients together for thirty minutes. The criterion for acceptability of the sediment (at the proposed ocean disposal site) is that the elutrient must not exceed 1.5 times the chemical analysis of the "dumping ground water."

Elutriation tests have recently been conducted for sediments from the two

TABLE V.a

NEW ENGLAND DIVISION, CORPS OF ENGINEERS, U. S. ARMY
REPORT OF NEW ENGLAND DIVISION, MATERIALS TESTING LABORATORY
WATER AND SEDIMENT TESTING
Falmouth Harbor, Mass. and Cleveland Ledge Disposal Area
February 1976

Sample identification and field and laboratory data pertinent to the samples tested are as follows:

Pertinent Data	West Falmouth Dumping Ground Water	Dredge Site Water		Bottom Sediment Samples	
Laboratory Serial No.	100-227-1	100-227-2	100-227-3	100-227-4, 5	100-227-6,7
Exploration No.	EW-1-76	EW-2-76	EW-3-76	PE-3-76	PE-4-76
Sample No.	-	-	-	T_1-T_2	T_1-T_2
Sample Depth, Ft.	Near bottom	Near bottom	Near bottom	0.0-2.7	0.0-2.15
Coordinate Locations:					
North	-	199,630	199,420	199,630	199,420
East	-	844,640	844,590	844,640	844,640
Sounding, Ft.	37.0	8.7	7.8	8.7	7.8
Reduced Sounding, Ft(MLW)	-35.7	-8.4	-7.3	-8.4	-7.3
Date-Hour Sampled	6041-1050	6041-1400	6041-1455	6041-1400	6041-1455
Weather	1	1	1	1	1
Sea State	5	2	2	2	2
Secchi Discs					
Black	8.1	3.3	2.8	3.3	3.3
White	8.9	3.9	3.3	3.9	3.9
Visual Classification:	Sea Water	Sea Water	Sea Water	T_1 0.0-1.3' Black organic Silt(OH) w/marine odor 1.3' to 2.7' Dark grey organic clay (OH) w/ marine odor T_2 0.0-2.0' Black organic silt (OH) w/marine odor	T_1 0.0-1.85' Black organic Silt (OH) w/trace of fin sand, small amount of algae and marine odor T_2 0.0-2.15' Same as above

TABLE V.b

NEW ENGLAND DIVISION, CORPS OF ENGINEERS, U.S. ARMY

REPORT OF NEW ENGLAND DIVISION, MATERIALS TESTING LABORATORY

WATER AND SEDIMENT TESTING

Falmouth Harbor, Mass. and Cleveland Ledge Disposal Area
February 1976

Results of tests performed on (1) the standard elutrient resulting from the "shake test" using 1 part bottom sediment from various sampling locations with 4 parts water from the sampling location, (2) the virgin water from the dumping ground and the virgin water from the sampling location are as follows:

	A	B		C				D
	West Falmouth Dumping Ground Water	Dredge Site Water		Standard Elutrient designation and depths of sediment used in shake test (1)				EPA's Allowable Limits (1.5 times "A")
				PE-3		PE-4		
Test Property (2)(3)	EW-1	EW-2	EW-3	0-2"	12-14"	0-2"	12-14"	
Nitrite (N), mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Nitrate (N), mg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Sulfate (SO4), mg/l	2,475	2,500	2,700	2,500	2,150	2,350	2,100	3,712
Freon Soluble, mg/l	0.0	0.0	0.0	0.2	0.0	0.2	0.8	----
Phosphorus (P)								
Ortho, mg/l	0.025	0.013	0.017	0.015	0.255	0.010	0.330	0.037
Total, mg/l	0.027	0.020	0.030	0.043	0.310	0.055	0.430	0.040
Mercury (Hg), ug/l	0.4	0.6	1.2	0.75	1.7	0.75	2.3	0.6
Lead (Pb), ug/l	2.	4.	2.	4.	3.	3.	3.	3.
Zinc (Zn), ug/l	14.0	12.3	15.0	21.5	9.5	19.0	7.5	21.0
Arsenic (As) ug/l	10.	9.	4.	4.	4.	4.	4.	15.0
Cadmium (Cd), ug/l	0.7	1.0	1.0	1.5	2.0	1.3	1.0	1.05
Chromium (Cr), ug/l	<4.	<4.	<4.	<4.	<4.	<4.	<4.	<6.
Copper (Cu), ug/l	23.	6.	6.	4.	8.	10.	13.	34.5
Nickel (Ni), ug/l	1.5	2.5	3.0	5.0	3.0	5.0	2.5	2.25
Vanadium (V), ug/l	<7.	<7.	<7.	<7.	<13.	<7.	20.	<10.5
	----see (2) above----			--------see (1) above--------				

Note: Underlined values in Column C exceed EPA criteria.

1976 sampling sites in the Harbor (see Figure 2 for locations); the results appear in Table V b. The allowable limits for sediment samples elutriated with water from a proposed disposal site--in this case, the state-approved site off the West Falmouth shore-- were exceeded by a majority of the test results (see underlined value in Column "C" in Table V b. Specifically, those parameters exceeded are shown below.

TABLE VI: Criteria Exceeded by Elutriate Test Results at Two Sampling Locations in Falmouth's Inner Harbor

Parameter	Criterion Exceeded by Samples from Station
Freon Soluble	PE-3, PE-4 (3 out of 4 samples)
Phosphorus	
Ortho	PE-3, PE-4 (2 out of 4 samples)
Total	PE-3, PE-4 (4 out of 4 samples)
Mercury	PE-3, PE-4 (4 out of 4 samples)
Lead	PE-3 (1 out of 2 samples)
Zinc	PE-3 (1 out of 2 samples)
Cadmium	PE-3, PE-4 (4 out of 4 samples)
Nickel	PE-3, PE-4 (4 out of 4 samples)
Vanadium	PE-3, PE-4 (2 out of 4 samples)

The elutriate test is considered by many to be superior to the bulk chemical analysis technique because it comes closer to replicating the chemical availability of elements in the sediment. But its limitations are those imposed by differences between laboratory and actual field conditions. The test results, in other words, may be highly dependent upon test conditions. Variations in test conditions, for example, which may influence test results are: solid-liquid phase ratios of constituents, time of contact (e.g. different parameters have differently timed release patterns), filtration or centrifuge procedures, etc.

The results of the elutriate tests are shown in Table V.b. With these results in hand the Massachusetts Department of Environmental Quality Engineering determined (see March 5, 1976, letter from Commissioner Standley in Appendix) that the sediments to be dredged from Falmouth Harbor could be "classified as unpolluted and could therefore be disposed of in so-called "clean" areas."

Cadmium has long been considered a toxic element, especially in the marine environment. It has also been recognized as a common constituent of normal sea water--at concentrations of about 0.1 mg/1.[28] Its susceptibility to concentration by marine organisms, especially mollusks, and the markedly acute and chronic effects caused by formation of organic compounds in a variety of organisms identifies the metal as a critical environmental component. Its presence or synergistic action with other metals, especially copper and/or zinc, increases its toxicity. The National Academy of Sciences has suggested[29] that "minimal risk of deleterious effects" from cadmium exist when, in the presence of Zn and Cu concentrations of 1 mg/l or more (Falmouth Harbor's samples are .021 mg/l or less) cadmium levels are less than .02 ug/l; Falmouth's maximum cadmium concentrations are 2.0 ug/l.

Other National Academy of Science recommendations (regarding toxic metal concentrations) are:

	Hazardous	Minimal Risk	Falmouth
Nickel	0.1 mg/1	.002 mg/1	.005 mg/1
Zinc	0.1 mg/1	.020 mg/1	.0215 mg/1
Lead	0.05 mg/1	.010 mg/1	.004 mg/1

Mercury concentrations in the marine environment have been of special ecological concern and have been carefully monitored since the 1960's when lethal levels of mercury in fish caused multiple deaths in Japan and scares around the rest of the world. Mercury enters the marine environment in a number of ways--through the combustion of petroleum, as wastes from industrial processes (especially plastics manufacturing), etc. But perhaps the principle source of mercury at Falmouth's Inner Harbor, as was found at Falmouth's Quisset Harbor, was from anti-fouling paint used on boat bottoms. Such paint was popular with those owners of recreational boats who could afford a rather expensive marine paint, and for this reason traces of it might be more prevalent in the sediments of recreational boating harbors than in commercial harbors.

Because of the proclivity for concentration of mercury by organisms at various levels of aquatic food chains there is the potential of increasing hazard to the carnivores and predators which include these organisms as substantial parts of their diets. Though sublethal amounts are known to be chronic and tolerable to a variety of organisms threshold limits of mercury derived from specific compounds have been exceeded in a number of instances causing deformities, retardation, and/or death.

The mercury concentrations at the Inner Harbor as measured by both bulk analysis and elutriate test, as was earlier mentioned, are high.

Not enough is now known about the changes in chemical parameters of waters resulting from either dredging or dredged material disposal. A number of studies, however, have shown that the concentrations of materials in sediments did not influence the effect of dredged material on water quality.[30] Increases in pH and dissolved oxygen, for example, will inhibit increases in trace metal concentrations. Another physical-chemical process caused by dredging is the oxidation of iron, which is in a reduced form in the dredged sediments, and its subsequent precipitation in an oxidized state with the ferric precipitate carrying other metals to the bottom by sorption and/or entrapment.

c. Sediment Studies at Commonwealth-Designated Sites

There have been no sediment studies conducted at any of the Commonwealth-designated disposal areas located in the waters adjacent to Cape Cod. The West Falmouth dumping ground (at 41°36'N and 70°41' W) has been used for many years for disposal of sediments dredged from the west entrance to the Cape Cod Canal and presumably the area is covered with dredged material. The West Falmouth site is about 3000 yards west of the shoreline in waters ranging in depth from about 18 to 36 feet.

The Cross Rip Shoals area (41°27'N and 70°22' W) has never been used by the Corps and therefore would constitute a "new" disposal site if it were to be used.[31] The area, centered at the coordinates given above, is one mile in diameter as defined by the Commonwealth. It is probable that field investigations of the site will be required before federal agencies (EPA and the Corps) will accede to its use as a disposal site for a federal project. Furthermore, an area close to the Cross Rip site has been designated part of another federal channel project, so there is the possibility of project conflicts if Cross Rip were to be a disposal site for Falmouth's dredged materials.

d. Effects of Dredging on the Inner Harbor

The biota identified within the Inner Harbor include quahoags and soft-shelled clams, and it is these species--especially the former--which constitute the principle resource of the area. The value of these particular shellfish, as has earlier been mentioned, is their utility as spawners of gametes which, in turn, become marketable specimens when reared in the "relay" location to which the adults have been transferred.

Removal. The most direct biological impact of dredging is the physical removal of infaunal and benthic organisms. But studies[33] have shown that a fairly rapid repopulation by both infaunal and epifaunal organisms usually occurs after dredging. Certainly, such would be the case if only a small portion of this habitat was to be disturbed (as is indicated by the shoaling shown on the 1974 Condition Survey - Figure 2). Furthermore, the Harbor habitat has continued to be productive of quahoags despite earlier dredging.

Quahoags prefer mud which contains minor amounts of sand, shell, and small rocks;[34] they do less well in sediments of pure mud. Planktonic stages for the species last 10 to 12 days following mid-summer spawning, after which the larvae settle upon whatever substrate exists below them. Juvenile clams will later move only limited distances in search of suitable sediments in which to bury themselves. Growth of the individuals varies considerably (as much as threefold) from one environment to another, depending upon sediment type, food abundance, and temperatures. Growth is fastest during the warm months and also during the clams' early years. Their food is primarily phytoplankton (especially diatoms).

Apparently, the Inner Harbor is a hospitable environment for the quahoags. They can tolerate high levels of pollution and have the ability to live under low oxygen conditions.[35] They are found evenly distributed throughout the inner two-thirds of the Harbor; their density approximate 150 bushels to the acre (or more).[36] Though the sediment of the Inner Harbor is fine-grained, it apparently is not a handicap to the filtering apparatus of the clams and no deterrent to growth.

Turbidity. Another impact of dredging is the increase of turbidity occasioned by operation of the clamshell . This impact is of serious concern only to the larval stages of quahoags. Soft-shelled clams, too, have been shown [37] to be equally able to withstand the effects of turbidity. (The soft-shelled clam population in the Harbor, as was earlier mentioned, though considerable, does not have an appreciable value placed on it by the community because of the abundance of these shellfish in other waters in Falmouth where supplies for public and private harvests seem to meet current demands.)

Toxic Heavy Metals. Estuarine sediments, like those of the Inner Harbor are usually fine-grained and highly organic. Both the physical nature of the sediments and the restricted environment results in the accumulation of those heavy metals which find their way into the environment. Trace amounts of these metals are transported from the water column to sediments in one or more ways: by chemical exchange, adsorption on detrital organic and inorganic particulate matter, concentration by plankton, and ionic precipitation.

Disturbance of the sediments during both dredging and disposal may in some circumstances cause release of metals to the water column and thus make them available to organisms. The body of knowledge concerning the complex physical, chemical and biological processes which control sediment - water interactions is, however, insufficient to accurately predict the fate of heavy metals in dredged materials.

Uptake of heavy metals by acquatic organisms has deleterious effects on individual organisms classified as either toxic or sublethal. Both of these effects may lead to stresses on populations. Heavy metals act to produce enzyme structure alterations in the organism which, in turn, affect a range of biochemical reactions within the organism and, in critical concentrations, lead to death. Sublethal effects are more subtle and may be reflected in abnormalities in the second generation, or in failure to reproduce. A third concern regarding toxic metals is magnification along a food chain. This magnification is important inasmuch as organisms at the base of a food chain, e.g., phytoplankton, may be tolerant to low metals levels, but when these levels are concentrated the animals further along the food chain (in some cases ultimately man) may have a toxic reaction. There appears to be a wide variation in the abilities of organisms to concentrate heavy metals. Young and Barber,[38] in discussions of heavy metal toxicities to phytoplankton, mention this selective and differential rate of uptake at the species level.

Pringle, et al.,[39] working on trace metal accumulation by estuarine mollusks, found that they appear to concentrate metals at different rates and at certain tissue levels depending upon the environmental concentration of the particular metal, the temperature, the time of exposure, the species concerned, and the physiological activity of the animal itself. Rates and levels of concentrations under experimental conditions were in decreasing order as follows: soft-shelled clam (Mya arenaria), American Eastern oyster (Crassostrea virginica), and the northern quahoag (Mercenaria mercenaria). Depletion rates were in the same order and depend upon biochemical turnover within the animal.

Evidence of concentration of heavy metals through a food chain was investigated by Hardisty et al.,[40] working with flounders (Platichthyes flesus) off the coast of England. They found that when this diet was principally crustaceans containing a fairly high metal level, the flounder developed a high level of the same metal.

Some temporary depletion of dissolved oxygen may be caused by the exposure of the anaerobic sediments which, in the two interior samples of the Inner Harbor, have an average (and high) volatile solid content of 170,000 mg/kg. This demand for oxygen may be accompanied and offset by release of nutrients in a form available for marine organisms. The degree and direction (positive or negative) of this impact cannot be precisely determined with the data at hand.

In summary, the adverse effects are principally those resulting from physical removal of organisms and the possible release of heavy metals. Degradation of water quality from trace metal increases, on the other hand, has not always been found to be a concommittant of dredging.

Mitigation Consideration for Dredging Operations. The issues of scheduling and timing of dredging operations is important to the reduction of adverse impacts.

It is generally recommended that dredging should not take place in shellfish beds during spawning and spat-setting. These periods for both quahoags and soft-shelled clams are during the mid-summer months. Autumn and early winter dredging would have less ecological effect on these species than would dredging in other seasons. Reduced water tempature in the fall and early winter would also lessen the biochemical impacts resulting from changes in water quality parameters.

Recreational use of the Harbor would also be less inconvenienced if dredges and scows were active in the Harbor after the summer recreational boating seasons.

e. Environmental Effects of Dredged Materials Disposal at Commonwealth-Designated Sites

Very little site-specific information is available from the Commonwealth-designated disposal sites, and therefore it is not possible to address in any detail the environmental effects of dredged materials disposal. Data needed from the West Falmouth and other designated disposal sites in the Cape region, includes current measurements, profiles, biological dredge sampling results, and physical-chemical analyses of bottom sediments. Analyses of current dynamics and the ecological interactions of benthic organisms could be made with the aid of such data thus making possible better appraisals of potential impacts.

It is appropriate here to digress briefly to discuss the general problem of sediment disposal. There have been numerous investigations of impacts stemming from disposal of dredged materials. In addition to those concentrating on biological impacts, there have been a variety of sedimentological studies.[41] These studies have been both site-specific and theoretical.

Studies have shown that fluid mechanics and sediment transport are complex inter-related phenomena affecting the behavior of dumped or dispersed sediments, with individual case conditions adding an additional category of variables. Complications are introduced by variations in: finite sediment volumes, settling velocity characteristics, current conditions, the presense of a seasonal thermocline, sediment organic content, salinity, temperature, susceptibility to flocculation, conditions favoring suspended-sediment density currents, etc. Moreover, almost all of the factors that affect the fate of dredged materials are time-varying, or stochastic, in nature. Most theoretical and predictive investigations, on the other hand, are deterministic and apply only to the short time period under which a given set of conditions apply.

Because of the interrelatedness of factors influencing the dispersion of dredged sediment techniques employing integrated systems analysis are recognized as ideal. Modelling--both hydrologic and mathematical--is one approach often used to supplement field investigations undertaken under a variety of conditions. In the instance of the project under discussion here, however, and as has earlier been noted, there is a paucity of information on any of the pertinent factors which bear on the environmental effects of dredged materials disposal at the designated sites.

Impacts stemming from disposal operations are, in general, similar in kind to those occurring during dredging--that is, they are both short-term and long-term. In addition, the long-term effects may be cumulative at the disposal site as a result of continued and periodic disposal operations at the site from more than one dredging project.

Short-term impacts are not only similar in kind but in degree to those anticipated at the dredging site. Effects from degraded water quality, the burial or smothering of benthic organisms, and the subtle effects and influences upon species propagation resulting from ingestion of contaminants--these are the principal short-term effects. Longer-term effects to the marine ecosystem are more likely to be chronic and involve food-chain magnification of toxicants, regional changes in species diversity and other influences on population dynamics.

Water samples from the West Falmouth disposal site have been collected and analyzed (see Table V-b, Column A). These sample analyses, when compared with those from the Inner Harbor (Table V-b, Column B) show that there is very little difference (in the parameters analyzed) between the waters at the two sites.

In general, the Buzzards Bay area (which includes the proposed disposal site near West Falmouth) has bottom sediments characterized by diversity of sediment type, i.e., sediment types range from rocks to muds. The tidal currents there are weak and variable. They tend to flow northeasterly or southwesterly, parallel to the axis of Buzzards Bay, at velocities rarely exceeding 0.4 knots/hour.[43] As earlier mentioned depths of water there vary from about 18 to 36 feet.

The existence of on-going disposal operations at the West Falmouth site suggests that conflicts with other activities -- recreational and commercial boating and fishing -- have already been minimized (by buoy markers and the general word-of-mouth sharing of information to stay clear of the area).

Nantucket Sound (which includes the Cross Rip Shoals area) is characterized by sandy bottoms with shifting shoals. Currents at Cross Rip Shoals are, as the name implies, influenced by currents trending nearly at right angles to each other. One system flows ESE or WNW, depending on ebb or flood conditions, and the other system, flowing through Muskeget Channel between Nantucket and Martha's Vineyard, trends nearly northerly or southerly (also dependent on the tidal phase). Tidal velocities measure up to 1.3 knots/ hour (=1.3 nautical miles/hour) in the nearby area.[42] The resultant movement of surface waters in the area, however, probably approximate a rotary motion and therefore fine suspended material in the dredged sediments dumped in the area would probably oscillate in suspension within the region for some time before eventual dispersion occurred. The existence of a seasonal thermocline in these waters, however, resulting in a distinction between bottom currents and surface (tidal) currents, would complicate the dispersal patterns. Depths in the Cross Rip disposal site vary from 40 to 70 feet deep -- as deep as anywhere between Martha's Vineyard and the mainland.

5. Probable Adverse Environmental Impacts Which Cannot Be Avoided

Maintenance dredging of the Inner Harbor will result in the removal/destruction of a portion of the shellfish population near the outer (seaward) end of the Harbor. Indirect impacts on organisms remaining in the Harbor will also result from dredging operations. More particularly, these impacts will be caused by increased siltation and changes in water chemistry occasioned by resuspension of sediments. In turn, these changes will produce stresses of uncertain magnitude on resident shellfish populations. Bottom habitat in the dredged areas will be less than optimal for larval attachment should the dredging occur during, or shortly after, spat fall. Concentrations of toxic metals in the overlying water column, as the result of dredging, will depend upon the physical state of these components in the sediments--and at present, not enough is known about their physical-chemical characteristics to predict impacts.

Impacts of earlier dredging at the project site have neither been recorded nor apparent.

Disposal of dredged materials at the proposed disposal site will result in the burial of some resident organisms close to the site. Species and population diversity and stability will be interrupted or modified at the disposal site so as to favor those species with greater tolerance for a substrate which is both foreign to the area and temporarily unstable. Benthic and demersal species which have commercial significance (e.g. flounder and lobsters) will undoubtedly temporarily avoid the disposal site for that period during which dumping operations take place.

At the disposal site there will occur some diffusion and dispersion of the contaminants contained in the dredged materials. The dispersion of these contaminants could, over the long-term, contribute incrementally to cumulative and increased concentrations of the most persistent and nondegradable of these substances in the ocean system.

6. Alternatives to the Proposed Action

The alternatives that can be considered at the Falmouth project site are principally those of a "dredge-or-no-dredge" situation. Inasmuch as the shoaling occurs periodically across the narrow channel entrance restricting the exit and entrance of boats to the Harbor, and limiting thereby its utility to the majority of boats now using the Harbor, there is little likelihood of reducing the scale or scope of maintenance dredging operations.

Options or alternatives to implementing the proposed project are therefore principally those relating to the selection of a disposal site. However, in light of the "state-of-the-art" of environmental evaluations and the specifications and criteria for "clean" spoil now endorsed by the federal and state agencies, the selection of a disposal site is mostly dependent upon judgments about the "pollutedness" of the dredged materials made by these agencies.

Two kinds of alternative disposal sites are considered in this section. The first is disposal on Falmouth beaches, and the second is disposal at a proposed regional site in Rhode Island Sound, Brown's Ledge, about eight miles southwest of Cuttyhunk Island, Massachusetts.

Two beach locations on Vineyard Sound are considered as possible disposal sites. They are:

(1) the Falmouth Heights beach, just east of the Harbor entrance and
(2) the Falmouth Beach (so-called), oceanward from Surf Avenue on the west side of the urbanized section of Falmouth.

Falmouth Heights Beach. The Falmouth Heights Beach has served as the only disposal site for dredged materials removed to date from the Inner Harbor.

Adoption of this alternative would present no difficulties to the parties of interest (especially town, state and federal agencies) were all of the sediments to be dredged from the Harbor homogeneous winnowed sand. And it is likely that a significant percentage of the sediments to be dredged from the Harbor entrance is indeed homogeneous sands as is found in sample GE-1 (see Fig. 1).

But it is also true that an appreciable and major volume cf dredged materials is organic silt with associated contaminants which, if deposited at the beach and ocean interface, would not only be incompatible with the existing substrate but dispersed in the marine environment and add thereby an increment of environmentally objectionable material.

No data is presently available to make the volumetric distinction between these two kinds of sediment. Nor have any provisions been suggested for differentiated disposal methods of that portion of the Harbor's sediments which apparently qualify as "clean" sand and that portion of the sediment volume which is "polluted." If this distinction were made--in effect dividing the volume of dredged materials into that portion acceptable, on environmental grounds, for deposition on the beach and that portion which would contribute an increment of contaminants to the marine and intertidal environment--two purposes would be served. The sediment volumes on the beach could be augmented and nourished by compatible materials and the "polluted" materials could be disposed of at another site with minimal environmental impact.

Should the dredged materials be differentiated on the basis of volumes compatible and incompatible to beach replenishment two dredging techniques would likely need to be employed. The sandy portion could be removed by hydraulic dredge and the silt and clay portion by clamshell dredge and scow. Employment of two separate and different engineering and dredging techniques would greatly increase the cost of operation.

It should be noted that longshore currents off shore from Falmouth Beach result in a net easterly sediment transport.[45] This means that beach materials entering the Inner Harbor are, in general, derived from east of the harbor entrance.* Their introduction thereafter to the Harbor is affected principally by tidal currents, wave action, and storms. Dredged sediments deposited at Falmouth Heights, therefore, can be expected to move mostly easterly and away from the Harbor entrance.

*Since the rip-rapping of Nobaska Point (near Woods Hole) in 1957, or thereabouts, the erosion of this promontory has appreciably decreased, as has the sediment supplied to longshore currents trending towards Falmouth and Falmouth Heights beaches.

Falmouth Beach. The consideration of disposal of dredged sediments on the Falmouth Beach, to the west of the Harbor, is subject to some of the same suggested provisions for differentiation and caveats just mentioned. Advantages to disposing of "clean" sandy spoil on this beach, in addition to accomplishing beach replenishment, are those associated with protection of--or mitigation of damage to--Surf Drive. Falmouth's Department of Public Works, on the average of once a year, is required to clean up and repair Surf Drive after storm-driven waves have inundated the area. The most recent storm was in January 1976 when a 7-foot tide closed the road temporarily and storm-derived debris had to be removed before the road could be reopened.[46] Additional and dredged material deposited on the beach, it is suggested, would widen the buffer zone between the normal high tide level and the roadway thus lessening the impact of storms on that narrow coastal strip.

But there are disadvantages to this alternative disposal site. The Salt Pond Sanctuary is just inland from Surf Drive and Falmouth Beach. Those occasional storms which inundate Surf Drive also transfer materials from the waters of Vineyard Sound across the barrier beach and into this wildlife sanctuary. Should there be any contaminants associated with the littoral zone--because they were contained in dredged materials that had been deposited there--this would place an unnecessary stress on waterfowl populations which frequent the Santuary and forage there for food. The ingestion of lead shotgun pellets by ducks, for example, has elsewhere been identified by wildlife biologists as a hazard associated with a number of waterfowl habitats. Contaminants more subtle and dispersed than shotgun pellets which are introduced and incorporated in various levels of the food chain of the Sanctuary environment are considered by some biologists to be potentially adverse environmental impacts.[47]

The existing easterly sediment transport patterns, as early described, would mean that disposal of dredged materials on Falmouth Beach would increase the likelihood of those same materials being reintroduced to the Harbor. Existing groins on the beach, however, would slow the transport of that fraction of the sediment moved by saltation and traction.

Aesthetic (sight and smell) impacts of beach disposal have been considered. However, after the earlier Harbor dredgings and subsequent disposal of materials at Falmouth Heights, this potentially adverse impact was a relatively short-term one, lasting only two or three months before the beach situation became stabilized. Hydrogen sulfide released from the exposed dredged materials reportedly was responsible for temporary discoloration of some house paints.[48] Timing of the disposal to minimize conflicts with recreational use of the beaches is an important additional consideration.

Brown's Ledge Disposal Site. The Brown's Ledge site is now being assessed by the Corps in the course of an environmental impact study, and its designation as a disposal site acceptable to state and federal agencies cannot be be assumed. Therefore, because the exercise of this option must be delayed pending appraisal and acceptance of the studies now underway, an unacceptable constraint may be imposed upon the project's schedule.

Furthermore, the cost of transporting the dredged materials to this relatively distant site, almost 18 nautical miles southwest of the harbor, will significantly increase the project costs.

Cost and logistical considerations of transporting by scow (or barge) any or all materials to an ocean disposal site are important ones. This is as true of the proposed transport to the West Falmouth (or Cross Rip Shoals) site as it is of the possible transport to Brown's Ledge. The size of scows to be used for such an operation are constrained by the project's dimensions. The Inner Harbor would not accommodate scows drawing more than 8 feet when loaded. Scows of this draft and available for this operation have a capacity of about 560 cubic yards.[49] If they were to be used to traverse stretches of open ocean where there might be rough water their capacity would be decreased by about half--in order to obtain, for the sake of safety, the 5 feet (more or less) of required freeboard. Diminished scow capacities would, of course, increase the cost of dredged materials transport by a corresponding amount.

7. Relationship Between Local Short Term Uses of Man's Environment and the Maintenance of Long Term Productivity

The phrase "short-term uses of man's environment" implies a sense of stewardship and responsibility by mankind for those natural environmental endowments and resources which are being exploited for social and economic benefits.

In the instance of the project herein discussed these resources are those associated with the Inner Harbor--its estuarine waters which are artificially maintained--mostly for recreational boating, as well as the community-wide benefits accruing from such activities, and the shellfish population (most especially quahoags) which are a renewable and productive resource of the Harbor area.

Balanced against the benefits to man, and the economy which supports him, are the "costs" assessable to those diverse elements of natural system which, in combination and over the long term, form the basis for a productive and healthy ecosystem. These systems must not only be functionally sustained and preserved but their net productivity must not be diminished to the extent that irretrievable and irreplaceable losses occur.

One of the elements of natural systems most severely impacted by society's utilization of the harbor is the quality of the estuarine waters. These waters are currently degraded by bacterial contamination stemming both from the leakage of nearby private septic systems and from wastes generated by boats in the harbor. This parameter of water quality, however, is reversible if remedial measures, some of which have already been proposed, are instituted.

Other water quality parameters (see Table V-b) compare favorably with those of open ocean sites.

The presence of contaminants within the Harbor--especially in the sediments--when left undisturbed apparently has no appreciable degrading environmental effects--save perhaps on the indigenous shellfish population and its utility as a food source. But because implementation of the project implies both disturbance of the sediments and relocation of the contaminants therein contained the question of environmental costs of such action is raised. Unfortunately no clear-cut answer to the impact of such action is now available. Certainly the knowledge of the presence of these contaminants can or will serve to reduce the rate of their accumulation, at least to the extent that their provenance can be determined.

An unusual example of maintaining long-term productivity of the Harbor's resources is the program of relaying the area's quahoags to a less polluted environment where depuration can occur. Recognition of the value and continued productivity potential of these clams--albeit in an environment which denies their immediate availability as a consumer item--has resulted in reclamation and the eventual intensive utilization of this stock resource.

The return to the predredging status of the Falmouth project area is not possible and therefore not an appropriate alternative--at least in the context of today's socio-political system. It is essential therefore that if long-term productivity of the Harbor and its environs is to be sustained while, at the same time, man-made systems and activities are encouraged to function efficiently there needs to be continuing effort to better understand how man's activities interact with natural systems and to minimize resultant conflicts.

8. Irreversible and/or Irretrievable Commitments of Resources

An irretrievable commitment of labor and capital is implicit in the acceptance years ago by the Corps of the maintenance dredging project at Falmouth.

Certain other irretrievable losses of resources will perforce occur as a result of removal of the benthic and other organisms at the dredging sites. But these losses, however irretrievable they are in the specific sense, should not be considered as irreversible in the systemic sense. Recolonization of the substrate and overlying water column at the dredging site has been shown to occur at those sites which have been more carefully monitored than has been the case at the Falmouth site. Earlier dredging at Falmouth, it should be pointed out, has not caused any discernible and/or irreversible losses of resources. There is no lack of scientific evidence, however, that the activity of periodic dredging does place stresses on ecosystems. But these stresses are, in most cases, countered by renewed and vigorous species competition for the available niches, with the result that recolonization occurs and faunal equilibrium is, in most cases, eventually reestablished. In summary, no evidence exists, either at Falmouth or at correlatable sites, that long-term productivity has been irreparably harmed by dredging within the Harbor.

There is less evidence at the disposal site earlier used at Falmouth that irreversible commitments of resources has--or has not--occurred. One of the reasons for this lack of knowledge has been the absence of an overall policy on dredged materials disposal. A variety of agencies (local, state, and federal) have applied different criteria to disposal site evaluation. The result has been that commitments of resources, as measured by local, state and federal entities, cannot be accureately summarized. Countering the trend toward case-bycase determination--or approximation--of impacts has been the recent mobilization of effort to coordinate research and environmental assessments so that the issue being addressed at Falmouth, for example, becomes the concern of institutions and organizations with regional perspectives and expertise. The selection and evaluation of regional disposal sites exemplifies this latest trend toward more objective evaluation of resource allocation.

Another example of commitment of resources already made at Falmouth is that of the development of the land area surrounding the Inner Harbor. The town's waterfront is nearly completely developed. Periodic enhancement of the Harbor and its channel, it is therefore felt, will not induce an appreciable commitment of additional resources--as for example in the development of additional or more intensive recreational facilities.

9. Coordination

The proposed dredging project at the town of Falmouth has been discussed (orally or in written communications) with those organizations, agencies, and persons listed below. As a reuslt of these interactions, there have been contributions of information to, and evaluations of, this report which provide a degree of comprehensiveness which could not otherwise have been achieved.

U.S. Government

Environmental Protection Agency, Boston, Mass.
National Marine Fisheries Service, Gloucester, Mass.
Fish and Wildlife Service, Concord, New Hampshire
Corps of Engineers (NED), Waltham, Mass.

Commonwealth of Massachusetts

Office of Environmental Affairs
- Division of Water Pollution Control, Boston
- Division of Marine Fisheries, Boston and Sandwich
- Division of Inland Waterways, Boston
- Coastal Zone Management Office, Boston

Town of Falmouth

Shellfish Warden - George Souza
Harbormaster - Henry Madden
Department of Public Works - Nathan Ellis, Superintendent
Conservation Officer - Matthew Souza
Planning Board - Charles A. White, Consultant
Waterways Committee - Emil Tietje, Chairman
Woods Hole Oceanographic Institute - Dean Bumpus, Oceanographer
Marine Biological Laboratory - Ivan Valiella, Biologist

References

1. Kemp, James M. and William S. Butcher, "Review of Geology, Hydrography, and Meteorology of Shoreline between Penzance Point and Falmouth Heights," Woods Hole Oceanographis Institute, August 1952.

2. Fessenden, Franklin W., John Ayers, and Steven L. Dean, A Summary of the Geology of Eastern Massachusetts, Corps of Engineers (NED), March 1975.

3. Town of Falmouth, Annual Reports of the Finances of the Town of Falmouth, 1974

4. Ivan Valiella, Marine Biological Laboratory, Woods Hole - personal communication.

5. Baur Engineering Company, "Cost Effectiveness Analysis: Land Treatment vs. Ocean Disposal, Town of Falmouth," Association for Preservation of Cape Cod, September 1975.

6. Nathan Ellis, Commissioner of Public Works, Town of Falmouth - personal communication.

7. Division of Water Pollution Control, Commonwealth of Massachusetts, "Rules and Regulations for the Establishment of Minimum Water Quality Standards and for the Protection of the Quality and Value of Water REsources," adopted May 2, 1974.

8. Emil Tietje, Chairman of Waterways Committee, Town of Falmouth - personal communication.

9. *Ibid*.

10. New England River Basins Commission, How to Guide Growth in Southeastern New England, Southeastern New England Water and Related Land Resources Study, (SENE), 'Cape Cod and Islands Planning Area Report," (review draft) Boston, MA, May 1975.

11. Town of Falmouth, op. cit. p. 226.

12. George Souza, Shellfish Warden, Town of Falmouth - personal communication.

13. Town of Falmouth, op. cit. p. 227.

14. New England River Basins Commission, op. cit., p. 7-12.

15. George Souza, Personal communication.

16. Charles A. White, consultant to the Planning Board, Town of Falmouth - personal communication.

17. Town of Falmouth, op. cit., p. 285.

18. Nathan Ellis - personal communication.

19. New England River Basins Commission, op. cit.

20. Ibid, p. 6-3.

21. James Spencer, Review of Dredge and Spoil Disposal Practices in Massachusetts, Mass. Coastal Zone Management Office, EOEA, Boston, December 1975, p. 7.

23. 40 CFR, Section 227, Published in Federal Register, Volume 38, No. 198, October 15, 1973.

24. According to William Slagle, Massachusetts Division of Water Pollution Control - personal communication.

25. Gilbert Chase, U.S. Corps of Engineers (NED) - personal communication.

26. Lee, G.F. and R.H. Plumb, Literature Review on Research Study for the Development of Dredged Material Disposal Criteria, Office of Dredged Material Research, U. S. Corps of Engineers, Vicksburg, Mississippi, June 1974, p. 6.

27. 40 CFR, op. cit., Section 227.61.

28. Environmental Studies Board, Water Qualtiy Criteria - 1972, Environmental Protection Agency, Washington, D.C., 1972, -. 245.

29. Ibid., p. 246.

30. Lee and Plumb, op. cit., p.. 58.

31. Gilbert Chase - personal communication.

32. Ibid.

33. Slotta, Larry S. and K. J. Williamson, "Estuarine Impact Related to Dredge Spoiling," in Proceedings of the Sixth Dredging Seminar, January 25, 1974, Texas A & M University, Sea Grant Report, TAMU, 56-74-104, March 1974.

34. Olsen, Stephen B. and David K. Stevenson, Commercial Marine Fish and Fisheries of Rhode Island, University of Rhode Island Marine Technical Report 34, Kingston, 1975, p. 98.

35. Saila, S. B. and S. D. Pratt, "Mid-Atlantic Bight Fisheries" in Coastal and Offshore Environmental Inventory - Cape Hatteras to Nantucket Shoals, University of Rhode Island Marine Publ. Series, Kingston, 1973, -. 6-34.

36. George Souza - personal communication.

37. Glude, J. B., "Survival of Soft-Shelled Clams Buried at Various Depths" in Sea and Shorefish Resources Bulletin, Maine Department of Sea and Shorefish Resources Bulletin #23, 26 pp.

38. Young, D. L. K. and R. T. Barber, "Effects of Waste Dumping in New York Bight on the Growth of Natural Populations of Phytoplankton" in Environmental Pollution, Vol. 5, 1973, pp. 237-252.

39. Pringle, B. H., D. E. Hissong, E. L. Katz, and S. T. Malawka, "Trace Metal Accumulations by Estuarine Mollusks" in Journal of the Sanitary Engineering Division, ASCE, Vol. 94, SA3, 1968, --. 455-75.

40. Hardisty, M. W., S. Kartar, and M. Sarnsbury, "Dietary Habits and Heavy Metal Concentrations in Fish from Severn Estuary and Bristol Channel" in Marine Pollution Bulletin, Vol. 6, #1, pp. 61-63.

41. Bosco, David R., Arnold H. Bouma, Wayne A. Dunlap, Assessment of the Factors Controlling the Long-Term Fate of Dredged Materials Deposited in Unconfined Subaqueous Areas, Contract Report D-74-8, U. S. Army Corps of Engineers, Vicksburg, Mississippi, February 1975, 238 pp.

42. National Oceanographic and Atmospheric Administration, Tidal Current Charts, Narragansett Bay to Nantucket Sound, 3rd edition.

43. Ibid.

45. Kemp and Butcher, op. cit, p. 11.

46. Nathan Ellis - personal communication.

47. Ivan Valiella - personal communication.

48. Henry Madden, Harbormaster, Town of Falmouth - personal communication.

49. A. Guptill, U. S. Corps of Engineers (NED), personal communication.

CONCLUSIONS

Based on my review of the information within this Environmental Assessment and in consideration of the general public need, I believe the project as described should proceed according to schedule. In my evaluation, the Assessment prepared in accordance with the National Environmental Policy Act of 1969 is an accurate document revealing that proper coordination with appropriate regulatory agencies has been conducted with subsequent minimization of environmental impacts insured based on the scheduling of the actual work and disposal site selection. The Assessment therefore precludes the need for preparation of a formal Environmental Impact Statement.

13 May 1976
(Date)

JOHN H. MASON
Colonel, Corps of Engineers
Division Engineer

APPENDIX

UNITED STATES ENVIRONMENTAL PROTECTION AGENCY
REGION I

J.F. KENNEDY FEDERAL BUILDING, BOSTON, MASSACHUSETTS 02203

April 23, 1976

Mr. V. L. Andreliunas
Chief, Operations Division
Department of the Army
New England Division, Corps of Engineers
424 Trapelo Road
Waltham, MA 02154

Dear Mr. Andreliunas:

This refers to letter dated 5 March 1976 from your office with respect to dredging of the Federal navigation project in Falmouth Harbor Massachusetts. Approximately 20,000 cubic yards of shoal material to be disposed of in Buzzards Bay.

We have reviewed the application and have no intention to deny or restrict this project.

Sincerely yours,

Edward J. Conley
Chief, Permits Branch

U.S. DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
Federal Building, 14 Elm Street
Gloucester, Massachusetts 01930

April 15, 1976

Col. John H. Mason
Division Engineer
Department of the Army
Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02154

Dear Colonel Mason:

We have reviewed Public Notice No. NEDOD-N, dated March 16 and March 17, 1976, relative to maintenance dredging projects for Falmouth and Duxbury Harbors, Massachusetts, respectively. The Corps of Engineers plan to dredge these habors by use of a clam shell dredge and to dispose of the spoil material in open-water at a predesignated site.

Data supplied by your letters of March 5 and March 8, 1976, relative to Falmouth and Duxbury Harbor sediments indicate that the spoil material for the proposed projects exceeds EPA ocean dumping criteria and are therefore considered polluted. Analysis of the data, relative to Falmouth Harbor sediments, indicates that concentration of total phosphorus, mercury, lead, cadmium, nickel, and vanadium exceed EPA ocean dumping criteria as do the concentrations of total phosphorus, mercury, lead, arsenic, cadmium, nickel, and vanadium for Duxbury Harbor sediments.

We do not anticipate any long-term environmental impacts associated with the dredging portion of these projects. However, the disposal areas chosen for these projects are in question. The site chosen for Falmouth Harbor dredge spoil is a disposal area for clean spoil only, while the site chosen for the Duxbury Harbor dredged material is in an area designated as an ocean sanctuary in Cape Cod Bay. According to Massachusetts General Law, Chapter 132A, Section 13-16, and Massachusetts Ocean Dumping policy, it is unlawful to dispose of polluted spoil in these waters.

We are aware of Commissioner Standley's letter of March 5, 1976, from the Department of Environmental Quality Engineering, to Mr. Andreliunas stating that the dredged material for these projects could be classified as unpolluted and therefore could be deposited at the two sites under consideration. However, it appears that the Department of Environmental Quality Engineering has ignored the EPA criteria for evaluating elutriate tests as well as the ocean sanctuary law and the ocean dumping policy established by the former Department of Natural Resources. In addition, the Department of Environmental Management, a very vital part of the state's environmental affairs, has not commented on the proposed projects. It is our belief that approval for the use of the proposal disposal sites should come from this department.

Therefore, because of the circumstances surrounding these projects and the polluted nature of the spoil, it is our conclusion that spoil material from both of these projects be disposed of in the foul area dumping ground, or, approval first be granted from all appropriate state agencies for the projects as proposed.

Further, in evaluating the elutriate tests, we like to bring your attention to the fact that the concentrations of various chemicals in the "dredge site water" is often higher than the concentrations of chemicals in "substrate sediments". For example, at Duxbury Harbor, sample site PE-3, the mercury level in the sediments is 0.0 at 0" to 2" and 0.5 at 12" to 14" but the dredge site water reading is 0.75. This is somewhat confusing and should be clarified since it implies the sediments do not concentrate elements in the water column.

Very truly yours,

for David P. Crestin

William G. Gordon
Regional Director

UNITED STATES
DEPARTMENT OF THE INTERIOR
FISH AND WILDLIFE SERVICE
Division of Ecological Services
P. O. Box 1518
55 Pleasant Street
Concord, New Hampshire 03301

April 15, 1976

Division Engineer
New England Division, Corps of Engineers
424 Trapelo Road
Waltham, Massachusetts 02154

Dear Sir:

Reference is made to Mr. Andreliunas' letter dated March 5, 1976, regarding the proposed maintenance dredging of Falmouth Harbor, Barnstable County, Massachusetts (NEDOD-N). This is the report of the Service and the Department of the Interior and is provided in accordance with provisions of the Fish and Wildlife Coordination Act (48 Stat. 401, as amended; 16 U.S.C. 661 et seq.).

This Service and the Department of the Interior do not object to the proposed maintenance dredging. However, in our opinion, use of the West Falmouth disposal area has raised several issues which, without resolution, preclude the use of that area.

First, it should be noted that, according to elutriate test results prepared by your agency, the Falmouth spoil apparently exceeds Environmental Protection Agency criteria for phosphorous, mercury, lead, cadmium, nickel and vanadium. As a result, placing this material within the West Falmouth disposal site would be contrary to the recommendations of former Massachusetts Department of Natural Resources Commissioner Brownell as stated in his letter to you dated February 21, 1974. Specifically, we refer to page 2, section B, item 1, which establishes a single polluted spoil disposal site in Massachusetts, the foul area off Boston Lightship. Also in that letter, Commissioner Brownell recommends that no polluted material (EPA criteria) be disposed of in any ocean sanctuary, as defined by Massachusetts General Laws, Ch. 132A, ss. 13-16. It is our understanding that the West Falmouth disposal site is located within the Cape and Islands Sanctuary.

This Service and the Department of the Interior support the concept of restricting disposal of polluted spoil materials. Furthermore, we believe that the Massachusetts Department of Natural Resources' recommendations regarding dredge spoil disposal should be implemented whenever possible.

AMERICAN REVOLUTION BICENTENNIAL 1776-1976

Therefore, in view of these considerations, we recommend that:

1. All work be conducted in accordance with former Department of Natural Resources Commissioner Brownell's letter to you dated February 21, 1974, unless otherwise approved by the Massachusetts Division of Marine Fisheries and all appropriate departments within the Massachusetts Executive Office of Environmental Affairs (formerly the Department of Natural Resources).

2. This Service shall be advised of the final plan of action approved by the Secretary of the Massachusetts Executive Office of Environmental Affairs.

3. This Service shall be provided the opportunity to comment on the final plan of action.

4. Prior to dumping, dredge spoil disposal sites, with the exception of the "foul area", shall be surveyed by your agency to determine presence and abundance of vertebrate and invertebrate species of biological and/or economic significance.

Please advise this office of any action taken on these recommendations.

Sincerely yours,

Melvin R. Evans

Melvin R. Evans
Field Supervisor, NEAO

9/20

82 Tadmuck Rd.
Westford, MA 01886
April 13, 1976

Army Corps of Engineers
424 Trapelo Rd.
Waltham, MA 02154

Dear Sir:

We are writing concerning the proposed dredging of Falmouth inner harbor, scheduled for September through December 1976. We question the change of proposed dumping from the Falmouth Heights shoreline to the dumping grounds in Buzzards Bay and wonder how this change can be made without an environmental impact study.

We have several concerns regarding the proposed dumping area:

1. the affect that 20,000 cubic yards of sand and silt will have on the fall fishing and scalloping in Buzzards Bay.

2. the affect the dumping will have on the lobster grounds adjacent to the dumping grounds.

3. the affect on the beaches and waters of Buzzards Bay. (Because of the strong currents in the upper bay, any debris dumped is very likely to end up on the beaches further up the bay.)

4. why this sand is not being put to better use, considering the damage done to the area beaches during the recent winter storms.

We would like to have a better explanation as to why the dumping location was changed and we urge that an environmental impact study be made.

Sincerely,

Mr. and Mrs. Richard A. Loring

cc: Mr. Burke Limeburner
Bourne Dept. of Natural Resources
MacArthur Blvd.
Buzzards Bay, MA 02532

The Commonwealth of Massachusetts
Water Resources Commission
Leverett Saltonstall Building, Government Center
100 Cambridge Street, Boston 02202

OFFICE OF THE DIRECTOR
DIVISION OF WATER POLLUTION CONTROL

Rec'd. 9 Dec. 1975 Corps, Waltham

November 21, 1975

RECEIVED
DEC 10 1975
CURRAN ASSOCIATES, INC.

John Wm. Leslie
Chief, Engineering Division
U. S. Army Engineers
424 Trapelo Road
Waltham, Massachusetts 02154

Re: Maintenance Dredging
Duxbury and Falmouth Harbors

Dear Mr. Leslie:

Reference is made to your letter of March 31, 1975 to Joseph H. Brown, former Commissioner of the Department of Natural Resources, relative to disposal of maintenance dredging spoil from navigation projects in Duxbury and Falmouth Harbors, Massachusetts, and the several meetings which have been held with representatives of the Corps and the various involved state agencies.

Analyses of the bottom sediment sample test results taken September 18, 1975 which were furnished this office were compared with EPA standards and criteria. EPA criteria included volatile solids, COD, oil and grease, Kjeldahl-nitrogen, mercury, lead and zinc. Judgement was used to determine whether or not trace metals were present at hazardous levels.

With the exception of Station B-2 in Duxbury Harbor and B-1 in Falmouth Harbor, all stations violated one or more of the numerical criteria established by EPA. Several stations clearly had hazardous levels of trace metals present.

On the basis of these analyses, it is our opinion that the disposal of the dredged spoil from these two harbors is permissible only in the so-called Boston Harbor "Foul Area" located at 42 degrees 25.5 minutes north and 70 degrees 34.5 minutes west.

If you have any questions, please do not hesitate to contact Mr. Slagle of my staff.

Very truly yours,

Thomas C. McMahon
Director

TCM/WAS/jl

cc: Vyto Andreliunas, Chief, Operations Division, Corp of Engineers, 424 Trapelo Road, Waltham, Massachusetts
Carl Hard, Engineering Division, Corp of Engineers, 424 Trapelo Road, Waltham, Massachusetts
Charles F. Kennedy, Director, Water Resources Division
Frank Grice, Director, Division of Marine Fisheries
Matthew Connaly, Director, Division of Coastal Zone Management

DAVID STANDLEY
COMMISSIONER

The Commonwealth of Massachusetts

Executive Office of Environmental Affairs

Department of Environmental Quality Engineering

100 Cambridge Street
Boston, Massachusetts 02202

March 5, 1976

Vyto Andreliunas, Chief
Operations Division
U. S. Army Corp of Engineers
424 Trapelo Road
Waltham, Massachusetts 02154

Re: Maintenance Dredging
Duxbury & Falmouth Harbors

Dear Mr. Andreliunas:

Reference is made to the many letters and meetings held between your agency and representatives of the Department of Environmental Quality Engineering relative to disposal of dredged material from the maintenance navigation projects in Duxbury and Falmouth Harbors. Preliminary estimates indicate that approximately 110,000 cubic yards would be dredged from the Duxbury project and 20,000 cubic yards from the Falmouth project. Both towns hope to be able to locate suitable on-shore disposal sites for the dredged material. However, it is my understanding that you require acceptable ocean dumping grounds in the event that the material proves to be unsuitable for beach replenishment.

This Department has reviewed the projects and the results of the elutriate tests taken in both the proposed dredge areas and suggested dumping grounds. It appears from these tests that the dredged material could be classified as unpolluted and could therefore be disposed of in so-called "clean" areas.

This agency, therefore, has no objection to the disposal, if necessary, of the dredged spoil from the Duxbury project in a disposal area centered at 41° 58' N, 70° 31.5' W. This agency likewise has no objection to the disposal of the dredged spoil from the Falmouth project in a disposal area centered at 41° 36' N, 70° 41' W. It should be noted that the location of the Duxbury disposal area is a new one not listed on former Commissioner Brownell's letter of February 21, 1974 but which has the approval of the Division of Marine Fisheries.

I trust that this letter permits the implementation of maintenance dredging for the Duxbury and Falmouth projects.

Very truly yours,

David Standley

David Standley
Commissioner

DS/WAS/jl

cc: John Wm. Leslie, Chief, Engineering Division, U. S. Army Corp of Engineers, 424 Trapelo Road, Waltham, Massachusetts 02154
Edward J. Conley, Chief, Permits Branch, Environmental Protection Agency, John F. Kennedy Building, Boston, Massachusetts
Matthew B. Connolly, Jr., Director, Coastal Zone Management
Frank Grice, Director, Division of Marine Fisheries
Thomas C. McMahon, Director, Division of Water Pollution Control
Charles F. Kennedy, Director, Division of Water Resources
John C. Hannon, Director, Division of Waterways
Joseph C. Iagallo, Acting Director, Division of Wetlands
Raymond Rodriguez, Director, Division of Planning
Bette Woode, Commissioner, Department of Environmental Management

JXD

NEW ENGLAND DIVISION, CORPS OF ENGINEERS, U. S. ARMY
REPORT OF NEW ENGLAND DIVISION, MATERIALS TESTING LABORATORY
WATER AND SEDIMENT TESTING
Falmouth Harbor, Mass. and Cleveland Ledge Disposal Area
February 1976

1. Sample identification and field and laboratory data pertinent to the samples tested are as follows:

Pertinent Data	Dumping Ground Water	Dredge Site Water		Bottom Sediment Samples	
Laboratory Serial No.	100-227-1	100-227-2	100-227-3	100-227-4, 5	100-227-6,7
Exploration No.	EW-1-76	EW-2-76	EW-3-76	PE-3-76	PE-4-76
Sample No.	-	-	-	T_1-T_2	T_1-T_2
Sample Depth, Ft.	Near bottom	Near bottom	Near bottom	0.0-2.7	0.0-2.15
Coordinate Locations:					
North	-	199,630	199,420	199,630	199,420
East	-	844,640	844,590	844,640	844,640
Sounding, Ft.	37.0	8.7	7.8	8.7	7.8
Reduced Sounding, Ft(MLW)	-35.7	-8.4	-7.3	-8.4	-7.3
Date-Hour Sampled	6041-1050	6041-1400	6041-1455	6041-1400	6041-1455
Weather	1	1	1	1	1
Sea State	5	2	2	2	2
Secchi Discs					
Black	8.1	3.3	2.8	3.3	3.3
White	8.9	3.9	3.3	3.9	3.9
Visual Classification:	Sea Water	Sea Water	Sea Water	T_1 0.0-1.3' Black organic Silt(OH) w/marine odor 1.3' to 2.7' Dark grey organic clay (OH) w/ marine odor T_2 0.0-2.0' Black organic silt (OH) w/marine odor	T_1 0.0-1.85' Black organic Silt (OH) w/trace of fine sand, small amount of algae and marine odor T_2 0.0-2.15' Same as above

NEW ENGLAND DIVISION, CORPS OF ENGINEERS, U. S. ARMY
REPORT OF NEW ENGLAND DIVISION, MATERIALS TESTING LABORATORY
WATER AND SEDIMENT TESTING
Falmouth Harbor, Mass. and Cleveland Ledge Disposal Area
February 1976

2. Results of tests performed on (1) the standard elutrient resulting from the "shake test" using 1 part bottom sediment from various sampling locations with 4 parts water from the sampling location, (2) the virgin water from the dumping ground and the virgin water from the sampling location are as follows:

Test Property (2)(3)	Dumping Ground Water (EW-1)	Dredge Site Water EW-2	Dredge Site Water EW-3	Standard Elutrient designation and depths of sediment used in shake test (1): PE-3 0-2"	PE-3 12-14"	PE-4 0-2"	PE-4 12-14"
Nitrite (N), mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Nitrate (N), mg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Sulfate (SO_4), mg/l	2,475	2,500	2,700	2,500	2,150	2,350	2,100
Freon Soluble, mg/l	0.0	0.0	0.0	0.2	0.0	0.2	0.8
Phosphorus (P)							
Ortho, mg/l	0.025	0.013	0.017	0.015	0.255	0.010	0.330
Total, mg/l	0.027	0.020	0.030	0.043	0.310	0.055	0.430
Mercury (Hg), ug/l	0.4	0.6	1.2	0.75	1.7	0.75	2.3
Lead (Pb), ug/l	2	4	2	4	3	3	3
Zinc (Zn), ug/l	14.0	12.3	15.0	21.5	9.5	19.0	7.5
Arsenic (As) ug/l	10	9	4	4	4	4	4
Cadmium (Cd), ug/l	0.7	1.0	1.0	1.5	2.0	1.3	1.0
Chromium (Cr), ug/l	<4	<4	<4	<4	<4	<4	<4
Copper (Cu), ug/l	23	6	6	4	8	10	13
Nickel (Ni), ug/l	1.5	2.5	3.0	5.0	3.0	5.0	2.5
Vanadium (V), ug/l	<7	<7	<7	<7	13	<7	20

(2) Elutriate Designations PE-3-76 etc. correspond to location of sediment sample with same Exploration Number shown on Sheet 1.

(3) All tests performed by NED Materials Testing Laboratory personnel in accordance with current accepted EPA procedures.

(3) Reference is made to Section 230.4-1 of Federal Register dated Friday, September 5, 1975, Volume 40, No. 173, Part II, EPA Discharge of Dredged or Fill Materials for navigable waters.