ENVIRONMENTAL ASSESSMENT REPORT

ON

MAINTENANCE DREDGING AT

DUXBURY HARBOR

DUXBURY, MASSACHUSETTS

Submitted to:

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

Attn: Gilbert L. Chase, Contract Representative

Submitted by:

Curran Associates, Inc.
Engineers and Planners
182 Main Street
Northampton, Massachusetts 01060

March 1976

TABLE OF CONTENTS

Page

LIST OF ILLUSTRATIONS

1. Project Description

(a) General Description of Project Location. The Town of Duxbury, in the north of Plymouth County (Massachusetts), traces its lineage back to the days of the Mayflower and the Pilgrims, the first of whom set foot on a memorable rock just a few miles to the south of Duxbury. The town -- and its neighbors -- continues to extoll marine traditions and to emphasize a seaward orientation. In addition, the Town has strong ties to the Boston metropolitan area, 30 miles to the north, an area to which many of its inhabitants daily commute.

Duxbury is a town well cared for. To both its residents and visitors the aspect of the town reflects a veneration of its graceful past, and especially those architectural and aesthetic values which are associated with an era of individualism and surplus resources.

Duxbury Harbor is located on the west side of Duxbury Bay (see Figure 1 and 2A) The bay is about three miles long, with an average width of two miles. It forms the northerly arm of a large sheltered area separated from Massachusetts Bay on the east by a narrow strip of land, Duxbury Beach, which trends generally north and south. On the southeast, Duxbury Bay is partially separated from Plymouth Bay by a point of land called "Saquish Head" which extends southwesterly from the southern end of Duxbury Beach. Duxbury Bay has within it many tidal flats, exposed at low water, through which run narrow anastamosing channels.

The entrance to Duxbury Harbor is through a deep channel about three miles long which extends westerly across the northern side of Plymouth Bay then northerly about 2,200 yards to a point just west of Clarks Island. This northerly trending natural channel, known as "the Cowyard", is about 200 yards wide and 20 to 40 feet deep. To the west of Clarks Island the channel branches. The western branch has a deep natural channel for about 1.5 miles, with depths ranging from 19 to 29 feet; the natural channel is intersected by the dredged channel at this point. Thence the dredged channel continues northwesterly to the town of Duxbury.

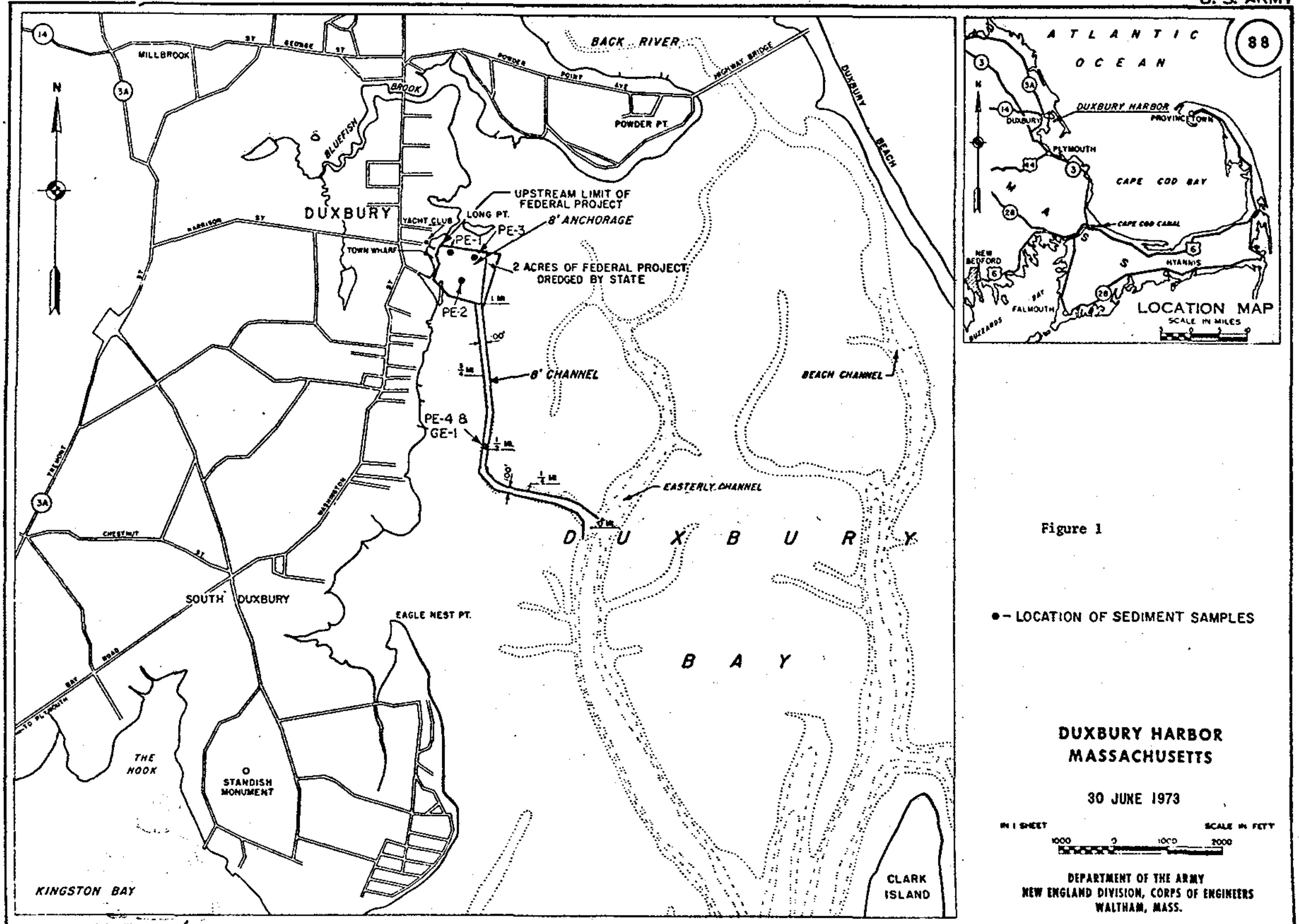
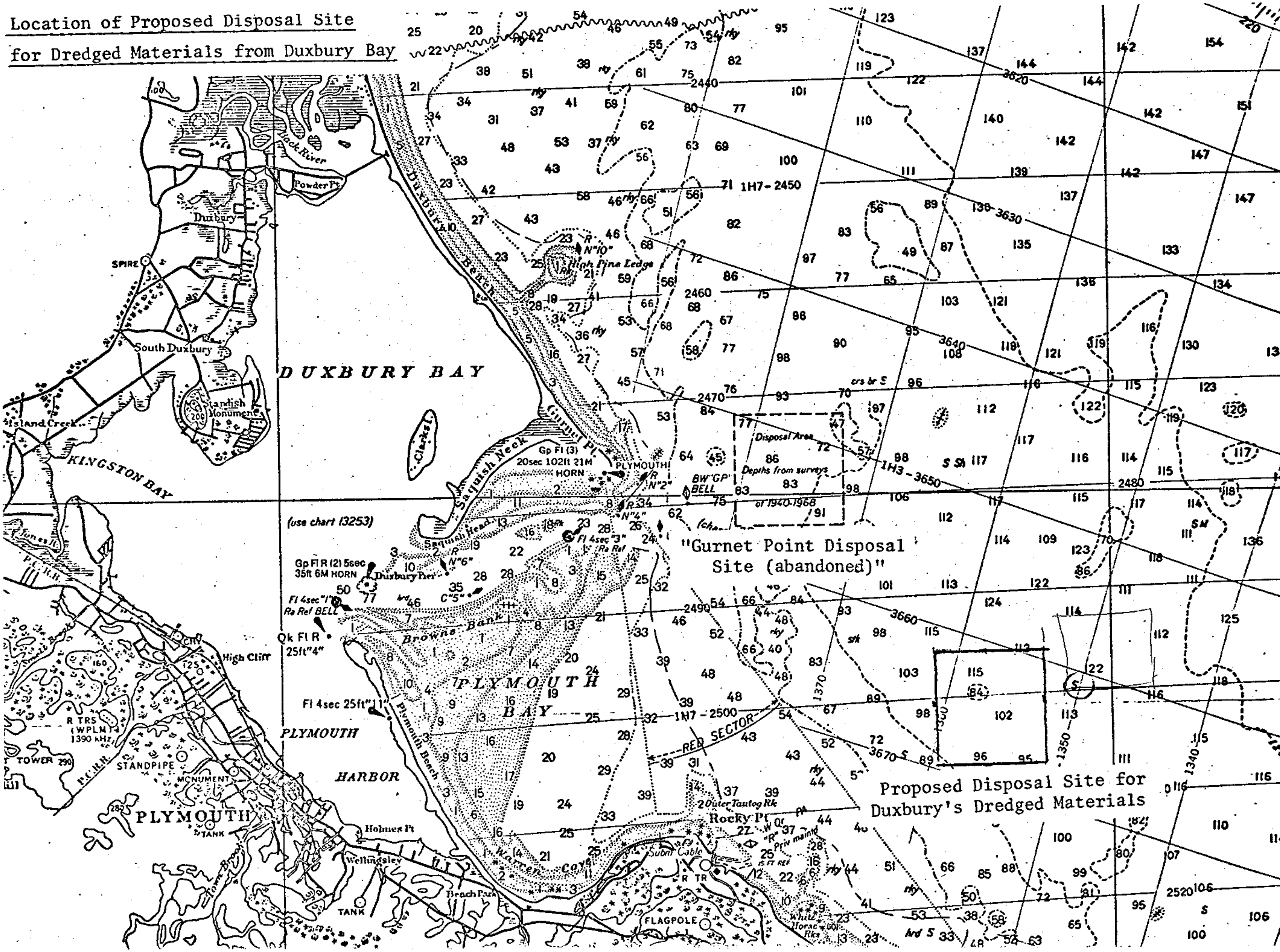

BACK RIVER
DUXBURY BEACH
HIGHWAY BRIDGE
POWDER POINT AVE
POWDER PT.
MILLBROOK
ST GEORGE ST
BLUEFISH
BROOK
DUXBURY
YACHT CLUB
LONG PT.
TOWN WHARF
UPSTREAM LIMIT OF FEDERAL PROJECT
8' ANCHORAGE
PE-1
PE-3
PE-2
2 ACRES OF FEDERAL PROJECT DREDGED BY STATE
8' CHANNEL
PE-4 & GE-1
BEACH CHANNEL
EASTERLY CHANNEL
D U X B U R Y
B A Y
HARRISON ST
TREMONT ST
WASHINGTON ST
CHESTNUT ST
SOUTH DUXBURY
BAY ROAD
TO PLYMOUTH
EAGLE NEST PT.
THE NOOK
STANDISH MONUMENT
KINGSTON BAY
CLARK ISLAND
ATLANTIC OCEAN
88
DUXBURY HARBOR
DUXBURY
PROVINCETOWN
PLYMOUTH
CAPE COD BAY
CAPE COD CANAL
NEW BEDFORD
FALMOUTH
HYANNIS
BUZZARDS BAY
MASS
LOCATION MAP
SCALE IN MILES
● - LOCATION OF SEDIMENT SAMPLES
DUXBURY HARBOR
MASSACHUSETTS
30 JUNE 1973
SCALE IN FEET
1000 0 1000 2000
DEPARTMENT OF THE ARMY
NEW ENGLAND DIVISION, CORPS OF ENGINEERS
WALTHAM, MASS.

Figure 1

Location of Proposed Disposal Site for Dredged Materials from Duxbury Bay



The dredged harbor at Duxbury is well protected from the north and west, and at low tide the flats in Duxbury Bay afford some protection from the south and east. Ice often closes this harbor from about January to March.

Duxbury's shoreline embraces the saltwater of Duxbury Bay and also the northern portion of Kingston Bay. These two bays, together with Plymouth Bay (to the south), are component parts of the same indentation in the extensive coastline of Massachusetts Bay. That indentation occurs about at the point where the waters of Massachusetts Bay merge indistinctly with those of Cape Cod Bay to the south.

Duxbury Bay is nearly due west of and across Cape Cod Bay from Provincetown, the town at the extreme tip of Cape Cod. It -- Duxbury Bay -- is protected on its eastern (ocean-side) margin by a narrow L-shaped barrier beach, the longest part of which fronts on the open sea and is called "Duxbury Beach."* At the southern end of Duxbury Beach is Gurnet Point, from which point the barrier beach trends at nearly a right angle and to a point of land called "Saquish Head." That last-named promontory point is on the opposite side of the main channel to the open ocean from the City of Plymouth.

(b) Existing Federal Navigation Project. The existing project was adapted on 2 March, 1945 and provides for a channel eight feet deep, 100 feet wide and an anchorage basin eight feet deep covering an area of about 21 acres. The dredged channel is an L-shaped one extending nearly due south from the Basin for more than one-half mile and then easterly for almost one-third of a mile until it intersects the natural channel referred to as the "Eastern Channel" of Duxbury Bay (see Figures 1 and 2).

The 21-acre basin is nearly square and unprotected by jetties or breakwaters. It is located in normally quiet waters to the south of the small estuary formed by the entrance of Bluefish River into the Bay. The Basin is, in effect,

---

*The Town of Duxbury has jurisdiction only over that part of the long barrier beach (nearly five miles in length) which extends northward beginning at a point about 4500 feet northwest of Gurnet Point.

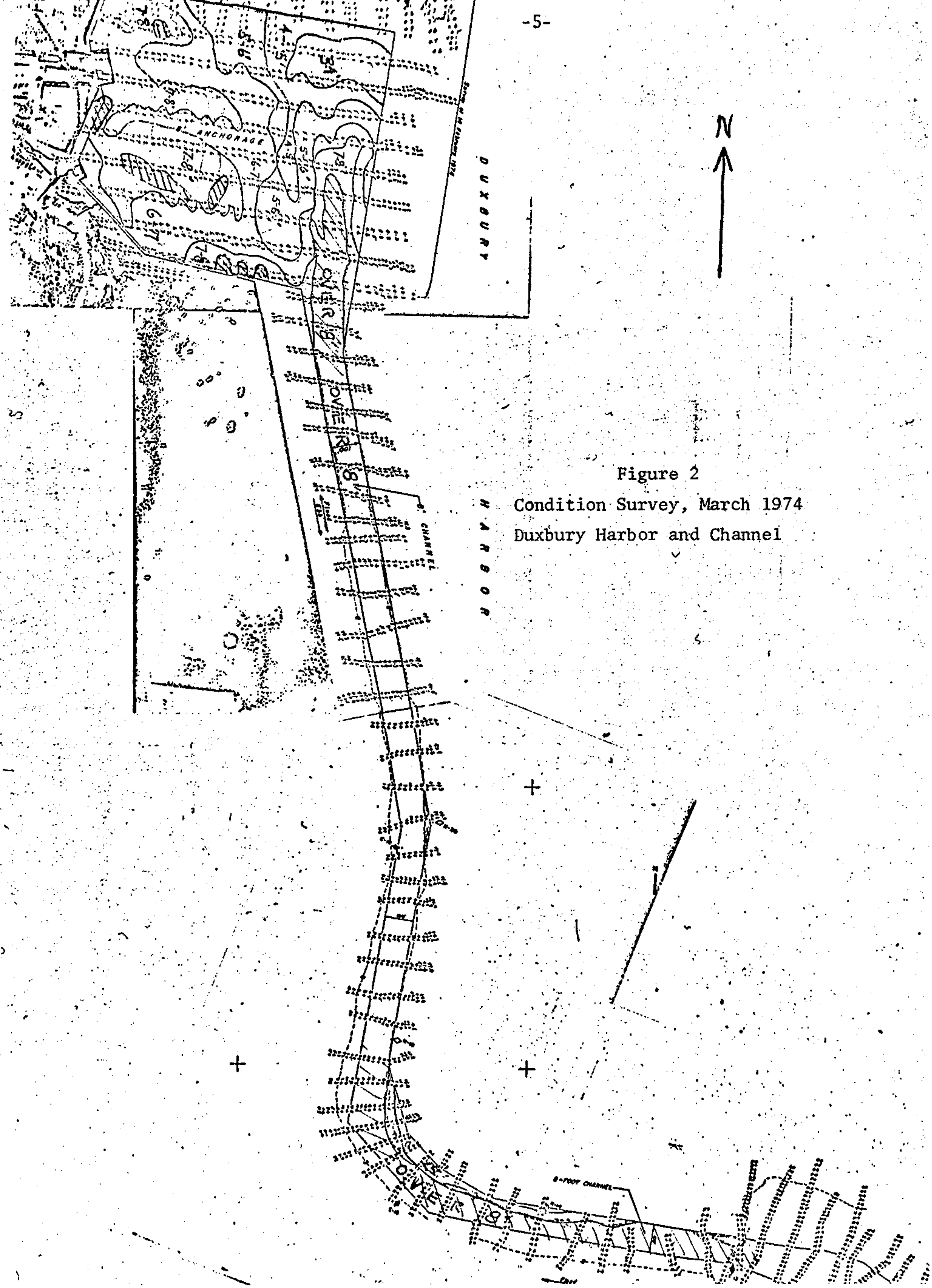


Figure 2
Condition Survey, March 1974
Duxbury Harbor and Channel

gouged out of the tidal flats which rim the western (landward) side of Duxbury Bay.

(c) Proposed Dredging Action. The maintenance project entails dredging improvements to both the 21-acre anchorage basin, at the northwest edge of Duxbury Bay, and an artificial mile-long channel connecting that basin with a natural channel on the western side of the Bay. Shoaling by tidal currents has reduced the depths of both the Basin and Channel to less than authorized dimensions. This is especially true of almost all of the Basin and also of the inside curve of the L-shaped portion of the Channel (see Figure 2.)

Both the anchorage basin and the Channel are to be dredged to a depth of 8 feet below mean low water. This will entail the removal of an estimated 110,000 cubic yards of material. The sediments to be dredged are classified as predominantly black organic silt with some sand. Dredging will be accomplished with a clamshell or bucket dredge.

(d) Proposed Disposal Plans. Local interests are obligated to provide land sites for the disposal of dredged materials from maintenance projects. But as a result of both discussions with Duxbury officials and field investigations the availability of such sites has been discounted. Ocean disposal has therefore been elected, with the understanding that the Town must defray the differential increase in the cost of ocean disposal over land disposal.

Relevant background information relating to the proposed disposal is presented in the following paragraphs.

The waters of Massachusetts Bay, Cape Cod Bay, Buzzards Bay, and Nantucket and Vineyard Sounds are now protected under statutes adopted by the Commonwealth of Massachusetts and termed "ocean sanctuary acts".

The adoption of these statutes came as a result of encouragement offered to coastal states by the U.S. Environmental Protection Agency "to establish dump sites for [both] clean and polluted spoil". The Massachusetts Department of Natural Resources made a preliminary evaluation of offshore dredged materials disposal sites within waters of the Commonwealth resulting in the following disposal policy and definition of disposal sites (in letter dated 21 February 1974):

a. All proposed dredging projects shall first have exhausted all possibilities for on-land disposal of spoil material before offshore dumping is considered.

b. All offshore dumping must be point source disposal with a buoy marking the approved site.

c. No polluted spoil material (as defined by EPA and the Massachusetts Division of Water Pollution Control) shall be disposed of within any ocean sanctuary as defined by Massachusetts General Laws Ch. 132A ss. 13-16.

d. Sidecast dredging of clean spoil material will be permitted in selected areas.

e. All future projects will be evaluated individually and this accompanying list of sites will in no way represent the Commonwealth's approval of a project disposal site beforehand.

Recommended disposal sites for clean dredge spoil material include:

I. North Shore - beach disposal on Plum Island is recommended whenever possible to replenish eroded and storm damaged areas. Where not possible, an area located at 42° 46' N-70° 46' W shall be utilized for disposal of clean spoil only. The recommended site shall not exceed one nautical mile in diameter.

II. Massachusetts Bay

1. The "Foul Area" shall be utilized for polluted spoil material.

2. Clean spoil material shall be dumped in an area one nautical mile in diameter centered at 42° 21' 14" N-70° 40' 12" W.

III. Cape Cod Bay - an area one nautical mile in diameter centered at 41° 49' N-70° 25' W shall be used for the disposal of clean spoil only.

IV. Nantucket Sound

1. The existing site off Great Point centered at 41° 26'N-70° 01'W shall be used for clean spoil only. The dumping area shall not exceed one nautical mile in diameter.

2. The existing Cross Rip Shoal area, centered at 41° 26'N-70° 22'W, and not to exceed one nautical mile in diameter shall be used for the disposal of clean spoil only.

V. Buzzards Bay

1. A portion of the existing dumping ground off West Falmouth, centered at 41° 36' N-70° 41' W shall be used for the disposal of clean spoil only. This area shall not exceed one nautical mile in diameter.

VI. An area south of Browns Ledge in Rhode Island Sound approximately on a line extending the Massachusetts and Rhode Island border in about 20 fathoms is recommended for further study by EPA and the Corps of Engineers to determine the feasibility of utilizing this area for the disposal of polluted dredge spoil material.

Based on elutriate tests recently concluded the Commonwealth has determined that the dredged materials may be classified as "unpolluted" and may be disposed of at so-called "clean" disposal areas. In a letter from the Department of Environmental Quality Engineering, dated 5 March 1976 (see Appendix), it was recommended that disposal of the dredged materials from the Duxbury project take place in an area centered at 41° 58' N and 70° 31.5' W. The maximum water depth at the center of this designated area is approximately 102 feet. The site is a new disposal area, about 4 nautical miles southeast of Gurnet Point and about 2.5 nautical miles north-northwest of Manomet Point. The new site is also about 2.5 nautical miles southeast of the historic "Gurnet Point disposal area" (see Figure 2A).

The recommendation by the Department of Environmental Quality Engineering has the approval of the Commonwealth's Division of Marine Fisheries.

(e) Previous Dredging History. The existing project, as earlier noted, was adopted in 1945 and completed in 1960. In 1965 the Basin was extended by the Commonwealth of Massachusetts when an additional two acres were dredged on its eastern side.

When the dredging was accomplished in 1960 the dredged material was conveyed hydraulically by pipeline to a land disposal site about 750 yards east of the Basin on the north side of Harrison Street. There dredged material was impounded behind walls installed for that purpose on a marshland -- a site draining into the Bluefish River.

In 1968 the project was dredged again. This time dredged materials were transported by scow to a disposal site in the ocean about one and one-half nautical miles due east of Gurnet Point. (See Figure 2A for location of this now abandoned disposal site.)

Both of the above-mentioned dredging and disposal operations occurred prior to the enactment of the stringent state and federal environmental laws now in force. Had such statutory regulations then been in force, it is likely that they would have prevented disposal of the dredged materials at either of the sites (marshland or ocean) then selected.

2. Environmental Setting Without the Project

a. Climate and Tidal Regime. The coastal area of which Duxbury is a part has daily temperatures which, in the summer, average near 70° F and in the winter average about 30°--though there are approximately 3 days per year during the winter when the temperature may get below zero. About 180 days per year constitute the average frost-free growing season.

Precipitation during the average year is about 46 inches, a figure which includes nearly 25 inches of annual snowfall.

Winds are generally from the west, or more particularly, from the northwest during the winter and from the southwest during the summer. "Nor'easters" are infrequent but constitute serious hazard to the coastal communities, as do the infrequent but serious tropical storms which sometimes travel up the Atlantic seaboard from the south.

Tidal measurements taken at Gurnet Point show a mean high water (MHW) level of 9.2 feet, as measured from a datum of mean low water (MLW).

Total surface area of the bay at MHW is approximately six times the saltmarsh area. The percent of tidal exchange in composite Duxbury-Plymouth Bay is 66.1 percent, reflecting the change in water volume from MHW to MLW.[1]

b. Geologic and Topographic Setting. Duxbury, like the region north and south of this town, is underlain by granodiorite, an igneous rock of uncertain but ancient age. Little of this bedrock is exposed because the area is thickly mantled with more recent and glacially-derived sediments. These glacial sediments are, for the most part, coarse-grained and but poorly stratified. They were transported into the area by streams running off the glacial ice, or by the glacial ice itself. Some landforms representative, or characteristic, of glacial action are to be observed in the area, but these are not remarkable.

In addition to the coarse-grained materials there are also some areas of fine-grained and mostly organic deposits associated with estuaries, tidal marshes, and mud flats. These sediments rim much of the mainland and extend inland into the Bluefish and Back Rivers drainage basins. And the final category of sediments is the coastal dune deposits which make up most of the Duxbury Beach area.

The undulating land of Plymouth County has within its confines a physiographic boundary separating the land characterized as "coastal plain" (to the south) from that referred to as "uplands"; all of Duxbury is just barely within the uplands region. With the exception of Captain's Hill (in Myles Standish State Park and on that peninsula which juts out from the mainland to separate Duxbury Bay from Kingston Bay) most of the land within a mile of the coastline in Duxbury is below 100 feet in elevation.

e. Vegetative Cover and Wildlife. The northwest part of town is moderately well drained and covered with stands of white pine and oak. To the south of that, the area is less well drained and swamp maples are dominant.[2]

Natural open areas on the mainland are relatively scarce, except in tidal marsh areas. Some small areas, however, are cultivated, and a few cranberry bogs exist.

In the tidal marshes and coastal beach areas the principal wildlife are native and migrating waterfowl and muskrat. At the upper extremity of tidal influences, where salt-tolerant vegetation exists, are the nesting areas for native wildfowl and the burrows of mammals.

Where swamp maples and oaks dominate--and scattered residences are to be found in such areas--the principal wildlife are cottontail rabbit and ruffed grouse. But to the north where forests of oak and white pine become more numerous the above-named species are joined by deer, varying hare, some aquatic mammals (muskrat and beaver), and waterfowl.

The estuaries and tidal flats of the Duxbury region are an important regional shorebird habitat, especially for those birds which migrate in the late summer fron the Arctic all the way to South America and the Caribbean.[3] Statistics gathered by observers of these migration habits suggest that the Duxbury-Plymouth area is among the most important stop-overs, or resting places for birds which sometimes fly more than 2000 miles nonstop from their nesting grounds to their winter homes. Migrating species which have been noted in the area from year to year (especially from July through October) include: black-bellied plover, short-billed dowitcher, ruddy turnstones, red knots, sanderlings, and semi-palpated sandpipers.

The feeding grounds of these birds include a rather wide variety of tidal flats where food of a corresponding diversity may be found. Sandy flats, mud flats, and other types of shore habitat are common feeding grounds for different--and sometimes the same--group or species (e.g. different age or social groups of the same species). Ruddy turnstones, for example, show a preference for the bayshore side of Duxbury Beach because that shoreline is littered with fist-sized rocks, beneath which are found organisms of special appeal to that species. Other habitats--such as beaches--are utilized as resting grounds. Marshlands, though not directly used by these birds, undoubtedly have special importance as the base of food chains ultimately utilized by these birds.

Food items for shorebirds specifically identified include small mussels, small crustaceans, the spat of mollusks, large and small polychaete worms, and small sand shrimp--all common invertebrates of the Duxbury region.

In addition to the migratory species which utilize the Duxbury region as a stop-over point during migratory flights, there are seabirds which are longer-term residents of the area. These include five species of waders (including herons), great black-back gulls, herring gulls, and least terns. The latter species nests on Duxbury Beach and, although not an endangered species, its life style is being monitored carefully by ornithologists wherever the bird occurs. The other species utilize principally the habitat of Clarks Island (located in Plymouth just across the Duxbury line in the southeast corner of Duxbury Bay), especially the eastern half of that island.[4]

Breeding season for the resident sea birds is from March to August.

d. Water Resources. The South Shore area in and around Duxbury has few major drainage basins. Among the small streams emptying into Duxbury Bay are those estuarine waterways which drain southward from Duxbury Marsh (to the north of Powder Point) and are collectively termed "Back River." These waters enter the Bay under the timbered Powder Point Bridge which now serves only foot traffic.

To the south of Powder Point, where that promontory is joined to the mainland, the Bluefish River enters the Bay. No other freshwater streams of any significance flow into the Bay from within the Town of Duxbury.

The water quality classification of the Bay, as well as the open ocean waters of Massachusetts Bay to the east (i.e. within jurisdictional limits of the Town of Duxbury), are designated as "SA', suitable for any water contact sports and for harvesting shellfish.

Duxbury's drinking water is obtained from four town-owned wells. No serious deficiencies in this supply are anticipated in the near future.

There is no public sewerage in Duxbury--all buildings having their own cesspools or septic tanks. And here, too, the existing system seems adequate for foreseeable needs. The Town Board of Health is concerned, however, with site suitability for new septic systems and with the redesign of systems for homes that have been recently converted to year-round use. Decisions about treatment of sewage from schools and planned developments have been serious matters of discussion within the town.

To date there have been no closures of shellfish beds or recreational swimming areas within Duxbury Bay--or in the waters under the jurisdiction of the Town--for reasons of excessive pollution. (An only exception to this record has been those occasions within recent years when there were incursions of "the red tide" [caused by population explosions of planktonic dinoflagellates] at numerous points along the New England Coast.) In Kingston, the town to the south of Duxbury, there have been, however, concerns about the water quality parameters in the Jones River, but these have relevance only to the receiving waters of Kingston Bay and they have no appreciable impact upon the quality of water at the dredging project in Duxbury Bay. In passing, it should be mentioned that large areas of tidal flats in Plymouth Bay, between the Jones River (Kingston) and the Eel River (Plymouth) have been contaminated at different times and shellfish harvest, for example, from these areas has often been prohibited.

e. <u>Existing Land and Water Uses</u>. Duxbury has been grouped with those towns in the South Shore region which are under what has been called "high development pressure".[5] This pressure stems from in-migration of people to those towns south of Boston where suburban niches are still available and attractive. During 1974 the Town received five applications for "planned developments." In 1975 a new community for 165 elderly citizens was opened.

Land within Duxbury includes a high percentage of "conservation land" upon which the Town has placed development restrictions. These areas include principally: the Bluefish River basin, and the High Pines marsh (on the bay side of Duxbury Beach), and Kingston Bay marshes. Also included are the wetlands of the Back River area, Duxbury Beach and Saquish Neck beaches and various patches of ecologically fragile shoreline less than a mile in several directions from the Standish Monument on Captains Hill.

The Duxbury Beach area - one of the region's most popular attractions - has until recently been privately owned by stockholders of an "association." Title to this beach area is now vested in a public trust - the Duxbury Beach Reservation Trust. Management is controlled by elected trustees; public access is permitted (with some provisions), and concessionaires are restricted. Considerable effort has been expended by both private and public entities to protect this valuable recreational asset. Much of this effort has been directed toward inhibiting erosion by wind and sea, and management policies for the Beach continue to reinforce the various protectionist measures (snow fences, beach grass, etc) now installed.

The Town is also cognizant of the need for land management policies in areas of: landscape quality, groundwater recharge, and wildlife habitat. Conservation restrictions on lands thus characterized occur throughout the Town's area.

Urbanized sections are generally scattered throughout the Town and interspersed with open areas. Concentration of residences and shops are mostly alongside the network of secondary roads which serve the town. Very few multiple dwelling units exist.

Land use acreages (as of 1968) are as follows:[6]

Cropland:	500
Pasture:	150
Residential:	700
Commercial:	330
Public Institutions:	1000
Forests:	9200
Water:	1410
Total	16,320

A state park surrounds the Standish Monument on Captains Hill. A Coast Guard station is located at Gurnet Point - just inside the confines of Plymouth and outside those of Duxbury.

Water uses, in the marine environment, are principally recreational--and therefore seasonal. Swimming is very popular on the ocean side of Duxbury Beach and during a fine summer weekend thousands of persons are attracted to this extensive five-mile long beach. The use of vehicles to the south of a parking lot at the end of Powder Point Bridge, is, however, restricted, resulting in more intensive use of that part of the beach, and the adjacent waters, from the vicinity of the parking lot northward. Access to the Beach by vehicle has for several years--ever since the Powder Point Bridge was closed to vehicular traffic--been solely via the Town of Marshfield (north of Duxbury). Boating, fishing, and swimming are popular activities within the Bay. Fishing is for both finfish and shellfish, and is from boats as well as numerous spots along the shoreline.

f. Marine Facilities. Duxbury Bay has but one principal center of marine facilities, and that is clustered around the Town Wharf adjacent to the Basin. There, where as many as 320 boats[7] may be moored from May to October, there is a boatyard with a marine railway, a portable hoist, and repair facilities. Charter boats are also available. Adjacent to the Basin there is an all-tide, surfaced, launching ramp which attracts as many as 400 trailer-carried boats per week from cities and towns some distance from Duxbury.

There are no marina slips, or berths at the Duxbury anchorage.

At Howlands Landing, on the south side of Captains Hill (Standish Monument), another launching ramp (unsurfaced) is maintained. Construction of a pier and small boat basin is proposed for this area. A few moorings exist just offshore from this landing.

Deep water moorings for visitors are available at the southern entrance to the dredged channel, one mile south of the Basin. A few additional moorings are also used in the natural channel just south of Powder Point Bridge.

An uncounted number of small skiffs, rowboats, sailboats, and outboard motorboats are seasonally moored offshore around the Bay in areas which become tidal flats during low tide.

Duxbury Bay, unlike Plymouth Harbor, is not ice-free during the winter.

g. Socioeconomic Data. Duxbury's population in 1970 was 7,636. The median age was 29.2 years, as contrasted with a state-wide median age of 29.0 years.

The median and mean incomes of families in Duxbury in 1969 was $13,523 and $16,166. These compare with statewide figures of $8,170 and $9,137 for other urbanized areas of the same size.

In 1970 there were 2521 housing units in Duxbury, of which 2429 were year-round units. Those which were vacant and/or for sale had a median asking price of $32,700. Renter-occupied housing was rented at a median monthly rental (in 1970) of $184.

Duxbury is principally a residential and resort town. No industrial base of any appreciable significance exists within the town.

h. Fishery Resources. The fishery resources of the region have, since the colonial era, attracted the energies of Duxbury residents as well as those of neighboring towns (principally Plymouth). These resources were those to be found in water close at hand as well as those as distant as Georges Bank and other prolific fishing grounds in the North Atlantic. Competition with foreign fleets and economies, as well as technological changes in the fishing industry (e.g. development of trawlers), have resulted in changing the importance once accorded fishing activity in this area.

1) Shellfish. Duxbury Bay today supports a healthy shellfish population. Of principal importance are the quahoags, which were first transplanted into the area in the early 1900's,[8] and the soft shell clams which are native to the area. The largest reported harvest of quahoags was 7,290 bushels in 1933; only a few hundred bushels are now harvested annually in Duxbury. Soft shell clam production was 77,950 bushels in Duxbury during 1936 but is now only a few hundred bushels per year. Razor clams too have been harvested in significant numbers (a maximum of nearly 5000 bushels in 1937). Mussels are also found in the Bay. Scallops and oysters have not yet been successfully established in the Bay, though there is some current planning for oyster transplants in the near future.[9]

Duxbury's shellfish beds are shown on Figure 3.

The areal extent of the various soft shell clam beds is:[10]

Standish Flat	59.6 acres
Bluefish River	14.9 acres
Long Point	29.4 acres

In addition there are productive quahoag beds on the south and east shores of Powder Point and also just across the Bay from Powder Point. (See Figure 3)

Recent reports from the Duxbury Shellfish Constable on harvest figures are as follows:

	1971[11]	1974[12]
Quahoags	735 bu.	300 bu.
Mussels	2250 bu.	-
Soft shell clams	225 bu.	300 bu.
Sea Clams	150 bu.	-
Razor clams	-	25 bu.
Oysters	7 bu.	-
Licenses issued	1715	2300

A Duxbury ordinance prohibits dredging for shellfish anywhere within the Town's jurisdiction.

In addition to the shellfish an important adjunct to the area's fishery are those worms which are used as bait; these are the sand worms and blood worms found on intertidal flats. They have a ready market in the area and provide important income for some person. Irish moss is also harvested from the rocks around the Bay; it is sold to processors for its carrageen content, which is used in pharmaceuticals, bakeries, textile products and dairy products.

2) Finfish. Species of finfish caught in the composite Duxbury-Plymouth Bay in 1971 numbered 28.[13] Because of the morphometry of the bay, its tidal

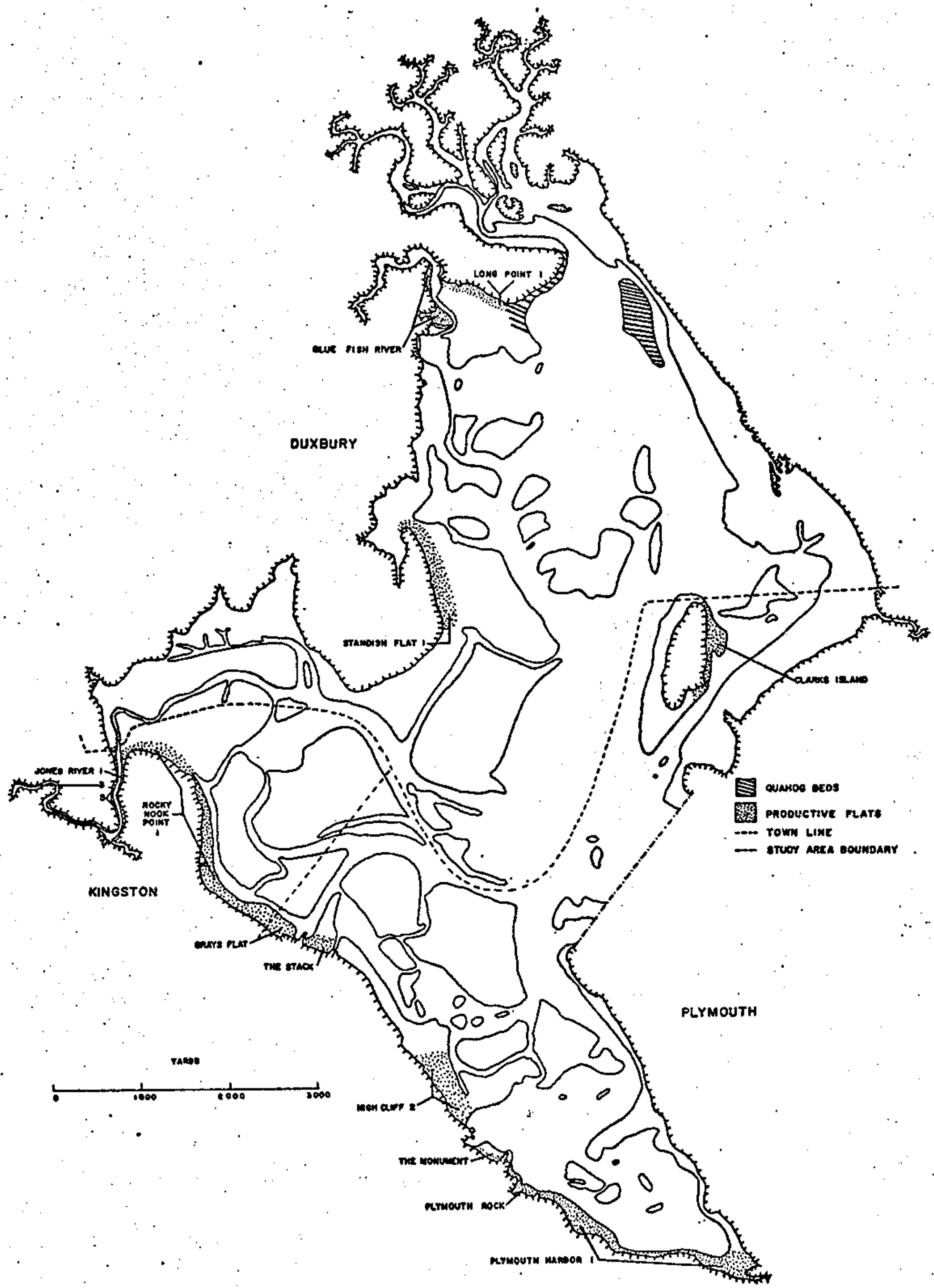


FIGURE 3

Location of the productive soft shell clam flats in Plymouth, Kingston and Duxbury Bay, 1971.

From: "A Study of the Marine Resources of Plymouth, Kingston and Duxbury Bay,"- Mono.#17, Division of Marine Res., Commonwealth of Mass., 1974.

characteristics and seasonal migrations, the species populations, as measured at any one spot, are ever-changing within the Bay. (See Table I.)

Finfish may be characterized as permanent residents, anadromous species, or migratory species.

Permanent residents of the waters of the composite bay include (in decreasing rank of numbers observed) the following(see Table I):

- -Atlantic silversides
- -mummichog
- -winter flounder
- -Atlantic tomcod
- -sticklebacks
- -smooth flounder

Anadromous species found within the bay and tributary streams are but three in number:

- -alewife
- -rainbow smelt
- -blueback herring

Migratory species are not found within the interior portions of the larger bay with any degree of regularity - save for modest numbers of bluefish. Striped bass are to be found most often in open waters, as are juvenile pollock and mackerel which move through the area. Groundfish, (hakes, haddock, cunner (sea perch), tautog, and Atlantic Cod) occasionally venture into the bay from their normal open-ocean habitat and are caught. In general, it can be said that the permanent and anadromous residents of the bay are those species (euryhaline) which can tolerate a wide range of salinities - from less than 10% to more than 30%, whereas the other species avoid and are less tolerant of changes in this quality of their environment. Numbers of sculpin, sea ravens, and grubby--all carnivores and scavengers and classified as "trash fish"--spend much of the year in the bay.

Table I

Numerical Rank of All Finfish Species from Plymouth, Kingston and Duxbury Bay, 1971.

Species	Shore Stations	120-ft Haul Seine Stations	30-ft Shrimp Trawl Stations	Totals
1. Atlantic silverside	21,513	1,486	51	23,050
2. Mummichog	810	2,396	11	3,217
3. alewife	783	300	108	1,191
4. winter flounder		51	819	870
5. Atlantic herring	656	145	2	803
6. rainbow smelt	2	6	213	221
7. Atlantic tomcod	1		161	162
8. threespine stickleback	16	7	103	126
9. northern pipefish		5	40	45
10. fourspine stickleback	1	12	21	34
11. bluefish	18	13		31
12. striped killifish	27	3		30
white hake			30	30
13. red hake			28	28
14. American eel			19	19
15. cunner			13	13
16. silver hake			8	8
17. longhorn sculpin			5	5
grubby			5	5
18. sea raven			4	4
white perch		3	1	4
19. Atlantic cod			2	2
Atlantic needlefish	2			2
20. bay anchovy			1	1
blueback herring	1			1
lumpfish			1	1
smooth flounder			1	1
tautog			1	1
Totals	23,830	4,427	1,648	29,905

From: A Study of the Marine Resources of Plymouth, Kingston, and Duxbury Bay, by H. R. Iwanowicz, R. D. Anderson and B. A. Ketschke, Mass. Division of Marine Fisheries, June 1974.

Killifish, mummichog, stickleback, and silversides are found in shallow waters; the latter species are also often found among the intertidal saltmarsh grasses. These species provide much of the abundant food for the larger predator fish in the Bay. Their numbers are greatest during the summer months. Winter flounder too are found throughout much of the year in shallow waters - especially those areas with muddy bottoms. Their spawning season is from January through April. Most of the other fish are found in deeper waters, moving from place to place during tidal cycles.

Anadromous species (alewives, rainbow smelt, and blueback herring) enter those small rivers located mostly at the south side of Kingston and Plymouth bays. The only stream in Duxbury which is reported as having spawning runs (especially for alewives) of any magnitude is Island Creek (in the southwest corner of the Town), a tributary to Kingston Bay. Spawning for all of these species occurs in the spring of the year; juveniles return to the sea in the fall.

3) Lobsters. A significant lobster fishery exists within easy access of fishermen from the Duxbury-Plymouth region. The great majority of pots, however, are set outside the bay entrance (i.e. east of a line drawn from Saquish Head to Plymouth Beach).

Lobster fishermen are characterized as: commercial, or "regular" fishermen - those paying $100 for a permit to fish all year with as many pots as they want to use; seasonal or "casual" fishermen, who may fish from June 15 to September 15 with 25 or less pots; and family or "other" types of fishermen, who may not sell their catch and must limit their efforts to the use of 10 pots of less.

It is probable that most lobsters harvested in Duxbury-Plymouth Bay are those caught by family fishermen and that this figure is only a very small percentage of the total lobster landings. Most of these family fishermen set their pots during the warm weather months. Plymouth County's lobster landings in 1973 totalled 649,000 lbs.[14] a figure ranking second to Essex County--among the Massachusetts counties.

Though lobsters have been characterized as preferring a hard-bottom seafloor habitat it is nonetheless true that at certain seasons resident (as opposed to migratory) lobsters seem to seek out soft-bottom areas. The Duxbury-Plymouth bay area is characterized by a "soft" bottom.[15]

Among those places where lobster pots have been spotted in Duxbury Bay from time to time are areas in the vicinity of Clarks Island and off the Standish Shores coastline.[16]

<u>Trends of the Fishing Industry</u>. Statisticians monitoring the fishing industry in the Duxbury area are constrained by elements of industry competition and privileged information from specifically identifying in their published reports either individual fishermen or their home ports. Therefore trends of this industry at any single locality, such as Duxbury, are difficult to obtain. Statistics showing county-wide trends over a span of years are the best that are presently available.

Shellfish and finfish landings at Plymouth County ports are shown in Tables II, III, and IV.

The local Shellfish Constable's report, because of the manpower limitations of that office, are only approximate insofar as harvest figures are concerned. Similar qualifications can be made for the reports from other sources

j. <u>Intertidal Benthic Organisms</u>. Duxbury Bay is a shallow bay, approximately 45% of which may be considered intertidal. An additional amount of acreage (about 35% of the Bay) is covered with water one to six feet deep.

Table V shows a list of epi-benthic organisms sampled by the William Clapp Laboratory from various places in Duxbury Bay. Table VI contains a more extensive listing of both epi- and infaunal species which were obtained by hand.

Epi-benthic organisms on the above list are fewer than might be expected

Table II

FINFISH AND SHELLFISH SPECIES - LANDED IN PLYMOUTH COUNTY FROM VARIOUS FISHING GROUNDS — 1973 and 1974

WATERS FISHED (w/in 3 mi. limit):	CAPE COD BAY ①		WAREHAM RIVER		BUZZARDS BAY		ATLANTIC OCEAN ①		NORTH RIVER ①		MATTAPOISETT RIVER		HINGHAM BAY ①		DUXBURY-PLYMOUTH BAY ①	
SPECIES LANDED IN PLYMOUTH CO.	73	74	73	74	73	74	73	74	73	74	73	74	73	74	73	74
Alewives				1500/300								3500/675				
Bluefish		19000/2660			65000/16250	5600/2410		400/480								
Black-back (winter) Flounder					600/125											
Lemon sole (flounder)							2400/900									
Cod		27500/9416														
Mackerel					3500/420											
Scup (porgie)					100/27											
Striped bass		70000/28700			255200/89320	100000/ 43250										
Swordfish (sea)							155000/ 299450	29500/ 35400								
White Perch						850/298										
Catfish							6100/1990									
Flounder (fluke)							200/100									
Yellowtail flounder		4000/1200														
Haddock							1000/646									
Tuna							50000/ 20000									
Wolffish							2000/531									
Crabs							14300/ 1600									
Lobster**							921075/ 1347528	721800/ 1184130								
Sea Mussels																
Oysters			800/2080	3250/9000												
Hard Clams (private)					21800/ 30520											
" " (public)					100000/ 142000	20680/ 45600	500/510		26500/ 29150							
Mussels								53000/ 11130	10000/ 3000	21200/ 6360	400/480					
Bay Scallops																
Soft Clams							3960/3900			15314/ 23560			5000/5[illegible]5[illegible]			
Blood Worms (44=1 lb.)							400/620									
Sand Worms (40=1 lb.)							500/750	4000/5200							1200/1800	
Conch						2700/1400										
Eels						12000/5760				4000/1800						

* Figures shown: pounds/value (dollars)
** Approx. 70% of lobsters taken in pots
① Cape Cod Bay and North

(Data from National Marine Fisheries service)

TABLE III SPELLFISH SPECIES HARVESTED AND SOLD* - 1973 AND1974 - MASSACHUSETTS TOTALS

MASSACHUSETTS TOTALS	FQUIPMENT 1973	1974	QUAHOAGS 1973	1974	SOFT-SHELLED CLAMS 1973	1974	OYSTERS 1973	1974
Total Fishermen:	683	763						
Rakes	400	413	20660/300818	18052/249150	763/12990	872/15334	188/2984	304/5065
Draggers	771	898	3986/40313	3624/30352	28/798	199/2040	119/1665	----
Forks	183	176	1088/15138	113/1574	10205/152763	10271/160748	35/450	21/275
Tongs	85	62	4459/50784	2395/28261	1148/16935	15/195	139/1827	30/305
Nets	3	2	30/450	----	----	----	----	----
Jets	3	2	----	----	30/490	8/180	----	----
Divers	3	8	86/862	159/1600	50/750	200/3000	----	----
Hand	3	1	12/100	30/300	38/900	----	----	----

MASSACHUSETTS TOTALS	BAY SCALLOPS 1973	1974	RAZOR CLAMS 1973	1974	SEA CLAMS 1973	1974	MUSSELS 1973	1974	CONCHES 1973	1974
Total Fishermen:										
Rakes	886/13800	423/3815	180/500	---	42/190	15/100	----	154/312	---	----
Draggers	19881/248944	27000/315412	----	---	1296/4984	----	----	2701/8110	---	300/300
Forks	1/15	10/60	50/600	---	----	----	20/60	200/1200	---	----
Tongs	176/2605	124/1958	----	---	8/25	----	----	----	---	----
Nets	14/1203	65/695	----	---	----	----	----	----	---	----
Jets	10/150	----	----	---	----	----	----	----	---	----
Divers	----	47/362	----	---	----	----	----	----	---	----
Hand	----	----	----	---	----	----	----	----	---	----

* Figures show: bushels / $ value

(Data from Natl. Marine Fisheries Service)

TABLE IV

SHELLFISH SPECIES HARVESTED AND SOLD*

1973 and 1974

PLYMOUTH COUNTY

PLYMOUTH COUNTY	Equipment Used 1973	Equipment Used 1974
Total Fishermen	32	--
Boats: Inboard	4	0
Outboard	18	15
Other	0	2

	Equipment Used 1973	Equipment Used 1974	QUAHOAGS 1973	QUAHOAGS 1974	SOFT-SHELLED CLAMS 1973	SOFT-SHELLED CLAMS 1974	OYSTERS 1973	OYSTERS 1974	BAY SCALLOPS 1973	BAY SCALLOPS 1974	MUSSELS 1973	MUSSELS 1974
Rakes	14	8 →	272/4429	241/4480	59/1005	----	9/66	28/420	1/15	----	----	4/12
Draggers	15	12 →	----	----	----	----	20/100	----	7/92	----	----	----
Forks	15	12 →	----	----	859/14547	625/12166	----	----	----	----	---	2700/8100
Tongs	5	1 →	309/2960	----	38/500	----	----	----	----	----	----	200/1200
Divers	1	0 →	----	----	----	----	----	----	----	----	----	----

* Figures show bushels/value

(Data from National Marine Fisheries Service)

BETWEEN APRIL AND OCTOBER, 1969
from Wm. Clapp Laboratories
Duxbury, Mass.

Table V

Phylum: Coelentera

Sertularia pumila

Phylum: Arthropoda

Subclass: Malacostraca

Order: Mysidacea

Mysis mixta

Order: Cumacea

Diastylis species

Order: Isopoda

Chiridotea nigrescens

Idotea baltica

Order: Amphipoda

Gammarus gammarus

Aeginella longicornis

Order: Decapoda

Cancer maenas

Crangon septemspinosus

Pagurus longicarpus

Pagurus pollicaris

Phylum: Mollusca

Class: Pelecypoda

Gemma gemma

Mya arenaria

Mytilus edulis

Saxicava arctica

A LIST OF ORGANISMS TAKEN DURING SUBSTRATA SAMPLING IN DUXBURY BAY

BETWEEN APRIL AND OCTOBER, 1969

from Wm. Clapp Laborotories
Duxbury, Mass.

Table VI

Phylum: Platyhelminthes

Phylum: Nemertea

Phylum: Sipunculoidea

Golfingia gouldi

Phylum: Annelida

Class: Polychaeta

Amphitrite affinis

Amphitrite ornata

Clymenella torquata

Glycera dibranchiata

Lepidametria commensalis

Maldanopsis elongata

Nephtys bucera

Nephtys incisa

Nereis virens

Phyllodoce species

Scoloplos species

Phylum: Arthropoda

Subclass: Malacostraca

Order: Amphipoda

Order: Decapoda

Crangon septemspinosus

Order: Isopoda

Chiridotea species

Cyathura polita

Edotea triloba

Idotea baltica

Table VI (continued)

Class: Gastropoda

Subclass: Prosobranchia

Acmaea testudinalis

Bittium alternatum

Columbella avara

Crepidula convexa

Hydrobia species

Lacuna vincta

Littorina litorea

Lunatia heros

Margarites helicina

Nassarius obsoletus

Polinices duplicata

Subclass: Opisthobranchia

Coryphella rufibranchialis

Elysia chlorotica

Phylum: Echinoderma

Class: Asteroidea

Asterias forbesi

Asterias vulgaris

Class: Ophiuroidea

Amphipholis squamata

Ophiura robusta

Class: Echinoidea

Echinarachnius parma

Strongylocentrotus drobachiensis

Phylum: Prosopygia

Subphylum: Bryozoa

Phylum: Chordata

Class: Ascidiacea

<u>Boltenia ovifera</u>

<u>Bostrichobranchus pilularis</u>

<u>Molgula arenata</u>

<u>Table VI</u> (continued)

because their niche is such a small part of the total and diverse total substratum habitat in Duxbury Bay. Both the sand and muddy substrate are well-populated with polychaetes, each species adapted to preferred environments. The same is true of pelecypods (Mya, Mytilus, and Mercenaria). The feeding types (filter, ditritus/scavenger, and carnivorous) were all represented among the species found, illustrative of a well-balanced aquatic environment.

k. Historical and Archaeological Features. No features appearing on the National Register of Historic Places are present in the town of Duxbury. Neither are there listings of any Duxbury sites* with the Massachusetts Historical Commission which would in any way be affected by the proposed action.

*Buildings proposed for listing include the King Caesar House--on Powder Point, the Unitarian Church and the John Alden House--both inland from the Bay.

3. Relationship of the Proposed Action to Land Use Plans

The land area fronting on Duxbury Bay is already well developed. Policy questions relating to land use are, moreover, continually the concern of an active Town Planning Board. The proposed dreging action, it is felt by most town officials, can be adequately addressed by existing ordinances and policies; moreover, it is strongly supported by the town's present administration. No adverse impact upon either land or water uses by proposed dredging is now apparent to town officials.

The Town of Duxbury is proud of its stewardship of the Bay's resources and those associated with the marine environs. When the Commonwealth of Massachusetts passed Chapter 768 (amending the earlier Chapter 130) of the General Laws--laws intended to protect the Commonwealth's wetlands--the town was quick to endorse them. In 1971 the town passed its own wetlands protection by-laws in order to reinforce this particular element of conservation effort. Within the town, 3,025 acres of saltmarsh fall within the purview of these state and town statutes. (Total acreage of the town, incidentally, is 15,564 acres.)

The eventual closing of the anchorage basin and channel--both dependent on periodic maintenance dredging--would have an appreciable effect upon the town. Such closing would occur in a few years if the sediments which are moved by tide and current action within the Bay were allowed to accumulate in the areas now being dredged.* Because the town has established both a tradition and a reputation for accommodating ships that draw as much as 8 feet, the denial of access to such ships would have appreciable consequences on recreational activities, real estate values, marine service industries, fish retailers and the like. The resultant changes in land use patterns would be opposed by a number of interests now established in the town. The proposed dredging action, therefore, is supported by those interests who find it consistent with present land use policies.

---

*An example of the rate of sedimentation can be appreciated (Figure 2, especially in the northeast corner) when one remembers that the project area was last dredged in 1968 to a depth of 8 feet.

Though the town is within the South Coast Basin, its regional affiliation is with the Metropolitan Area Planning Council, centered in Boston. This Council's land use plans do not appear to have any degree of conflict with the proposed dredging project.

Duxbury falls within the South Shore Planning Area, as that area is defined by the New England River Basins Commission.[5] Detailed recommendations from NERBC's study which apply specifically to Duxbury were aimed at: (1) improving public recreational facilities at Duxbury's beaches, and (2) adoption of fore-and-aft mooring practices in the Basin so as to increase the numbers of boats which that anchorage could accommodate. The latter recommendation appears to be consonant with the proposed action, nor is the first recommendation antithetical to the action.

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 Duxbury project's proposed dredging, inasmuch as it is to take place below the mean low water line and to the south of Brant Rock in Marshfield (a point defining the jurisdictional limits of the relevant Act), does fall within the Cape Cod Bay Ocean Sanctuary (defined in Section 14, 1971 c.742; 1974 c.822 sec. 1). However, the Act does state that it is:

> not intended to prohibit...channel and shore 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 relate to dredging activity. The proposed disposal site is also within the jurisdictional limits of the "ocean sanctuaries" defined by the Commonwealth but the determination that the sediments to be dredged are <u>not</u> polluted allows for disposal of this material.

A recent report prepared for the Massachusetts Coastal Zone Management Office[17] contains recommendations for: improved liaison between state and federal agencies in the selection of disposal sites, establishment of improved environmental criteria, assessments of project priorities, etc. The proposed dredging action at Duxbury, though not in conflict with these recommendations, comes at a time when many of the state agencies have not yet achieved the recommended degree of inter-action and coordination on matters relating to dredging called for in this report.

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 Basin 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 Bay. Associated with the dredging there will be an increase in suspended and dissolved solids which will increase turbidity and decrease light penetrations. 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 various 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 will depend upon 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 disposal site should be to ensure that the material dumped is similar, at least physically, to the type of bottom sediment already present. This would ensure that a community similar to that already established would re-establish after the dumping operation had ceased, thus ensuring no 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.

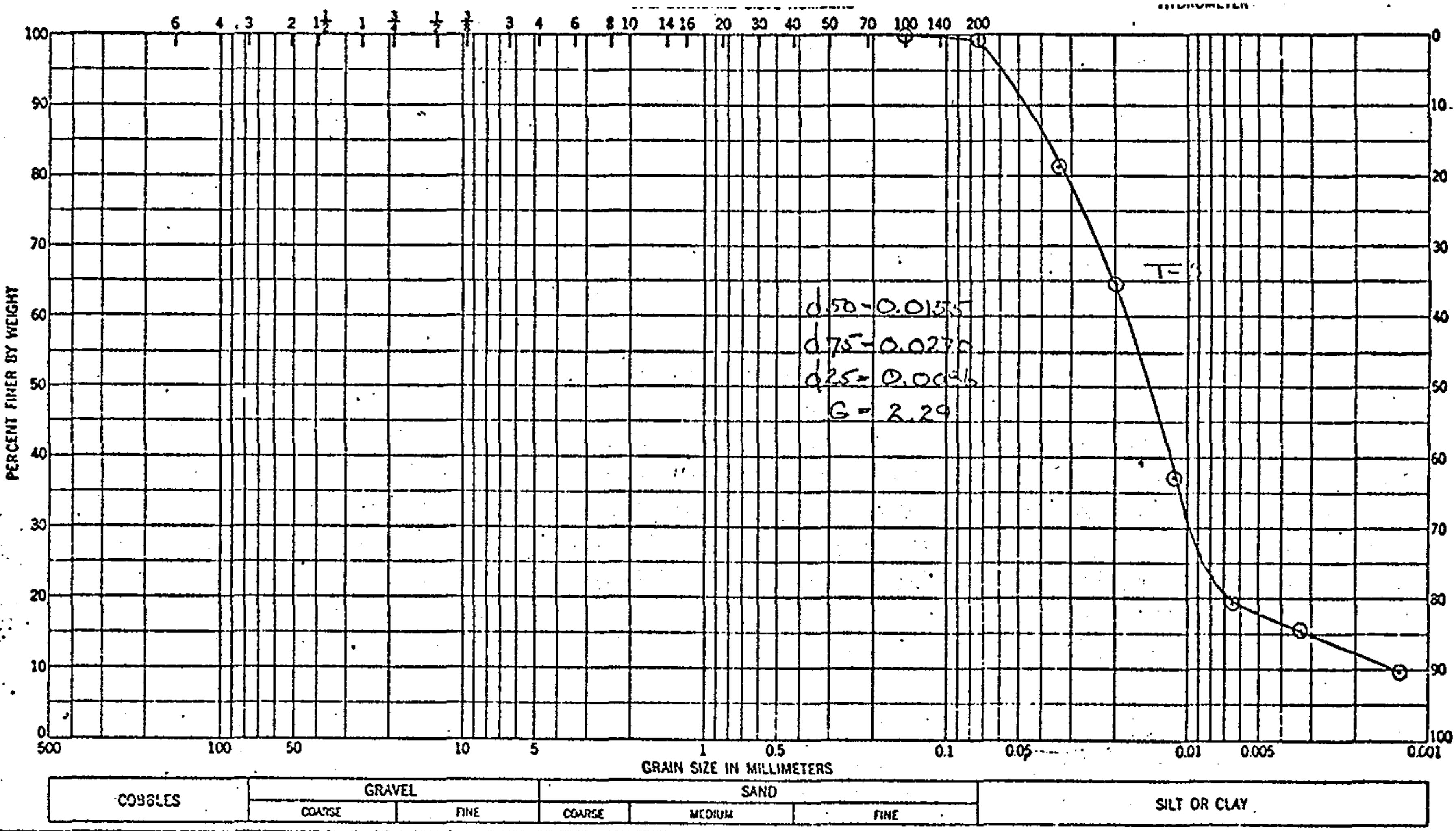
b. Sediment Studies of the Area to Be Dredged

Four locations within the project were sampled in March 1975. Three samples were within the Basin and one in the connecting channel south of the Basin. (See Figure 1.)

The three Basin samples were all classified as organic silts; the channel sample, however, was an organic silty fine sand. (Gradation curves and sieve analysis of the samples are shown in Figures, 4, 5, and 6.)

The physical nature of the samples from both the Basin and channel area confirms that the area is one with rather restricted boundary conditions and an environment in which the predominant energy for sediment transport is derived from tidal currents and occasional wind-whipped waves. Freshwater currents from the mainland emptying into the Bay are not strong, though they do maintain natural channels coursing along both sides of Duxbury Bay, and Bluefish River does

Figure 4



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
T-3	0.0'-2.0'	Organic SILT (OH)		99	59	40
				(71)*	(58)	(13)
		* Test performed on oven-dried soil				

Project DUXBURY HARBOR

Area MASS

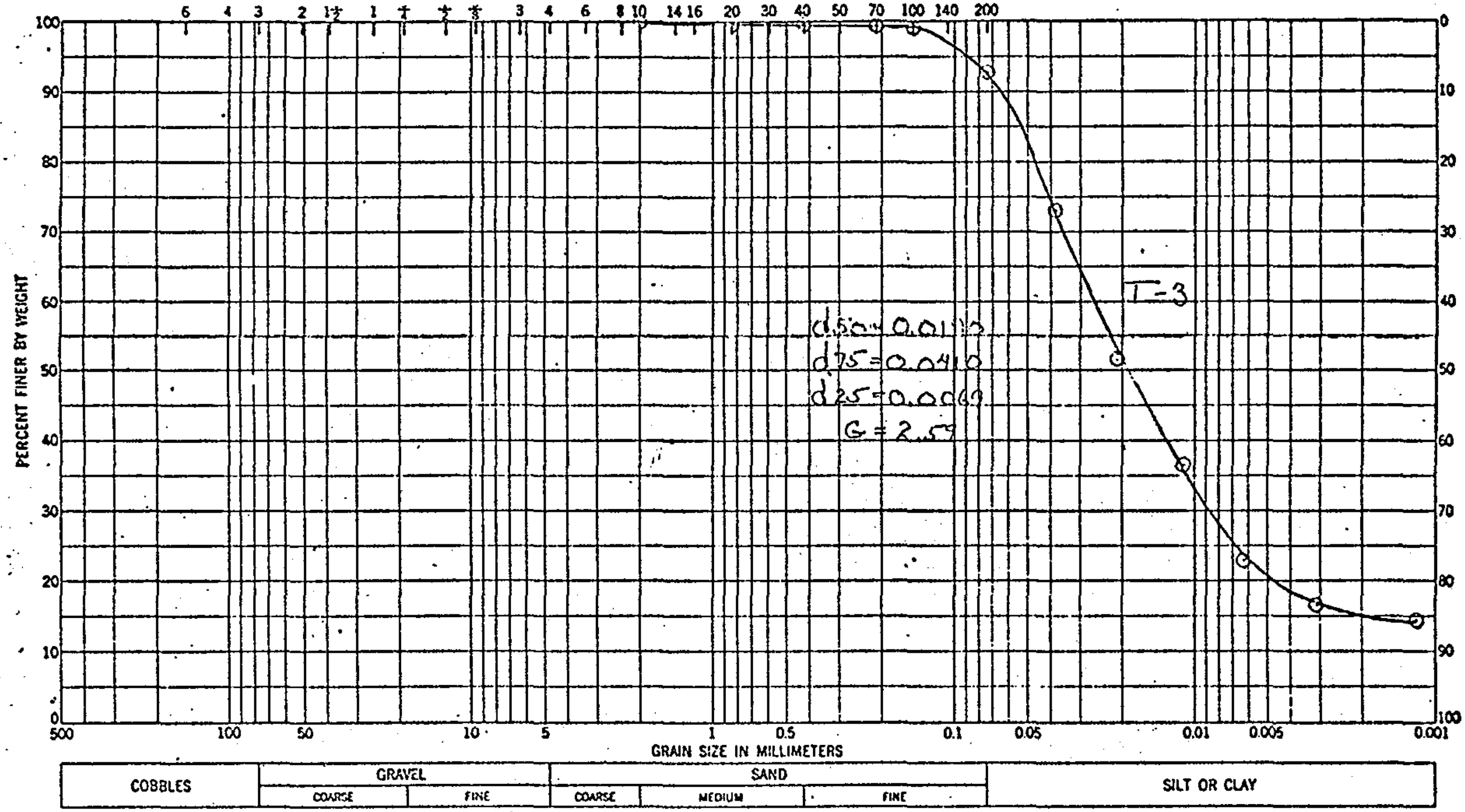
Boring No. PE-1

Date JULY 1975

GRADATION CURVES

ENG FORM 1 MAY 63 2087

Figure 5



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
T-3	0.0 → 1.7'	ORGANIC SILT (OH)		79	38	41

Project: DUXBURY HARBOR

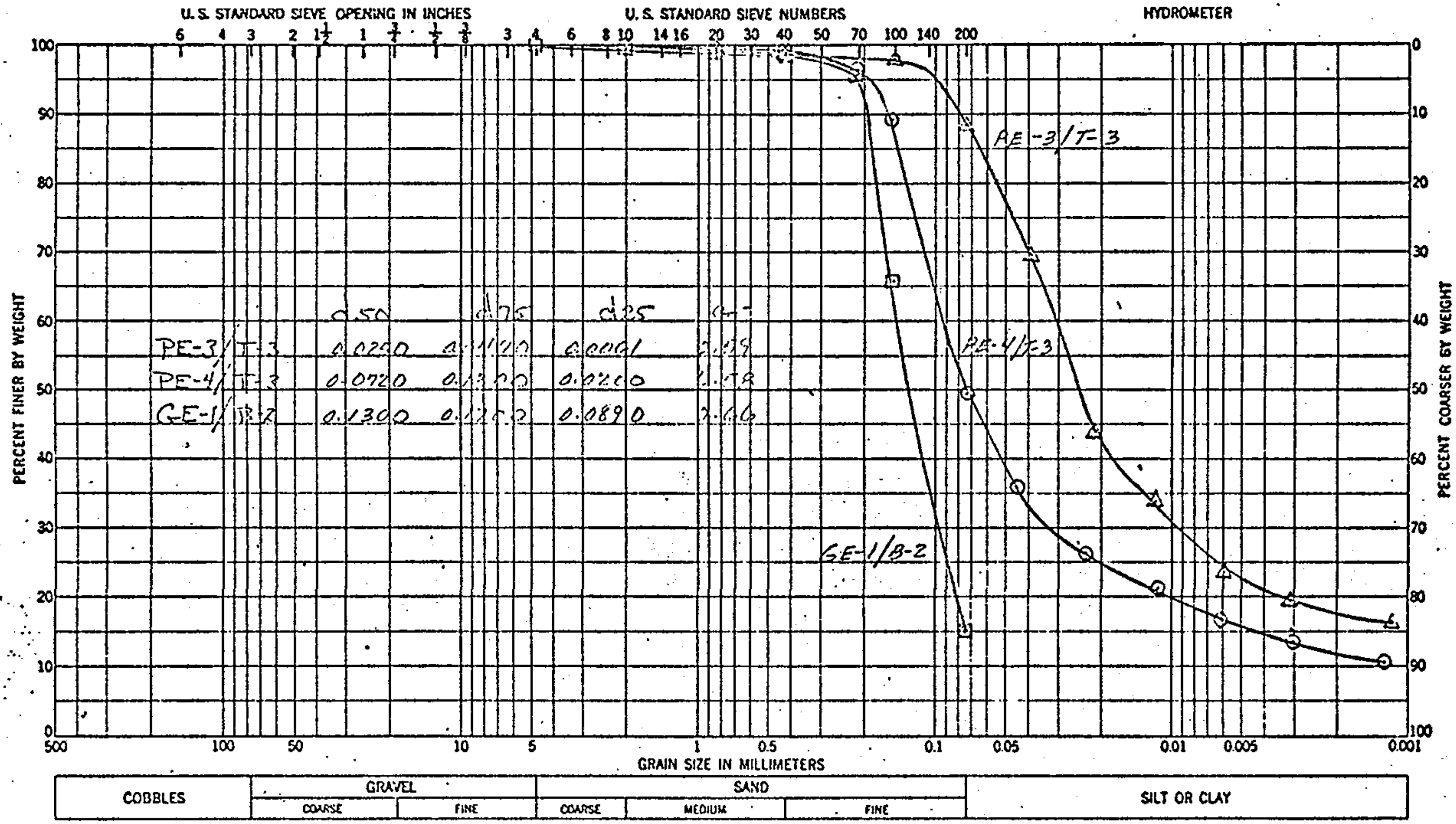
Area: MASS

Boring No. PE-2

Date: JULY 1975

GRADATION CURVES

ENG FORM 1 MAY 63 2087



Sample No.	Elev or Depth	Classification	Nat w %	LL	PL	PI
PE-3/T-3	0.0' TO 1.9'	FINE SANDY ORGANIC SILT (OH)		73	38	35
PE-4/T-3	0.0' TO 1.0'	ORGANIC SILTY FINE SAND (SM)		46	32	14
GE-1/B-2	SURFACE	SILTY FINE SAND (SM)		NP	NP	NP

Project DUXBURY HARBOR

Area MASS

Boring No. PE-3/PE-4/GE-1

Date JULY 1975

GRADATION CURVES

ENG FORM 1 MAY 63 2087

contribute land-derived sediments from that river's drainage basin north of the anchorage. The sampling station closest to the Bay entrance, PE-4 (see Figure 6), is the only station where an appreciable fine-sand fraction is to be found. The organic constituents in all of the sediment samples are an additional indication of the rather restricted movement of sediment within the sample area; the implication is that decomposed detritus from marshlands and intertidal flats is a principal additive to the Bay's sediment. Bulk chemical analyses of the samples appear in Table VII.

It should be mentioned, in addition, that a new suite of sediment samples from the Bay has recently been taken under the auspices of the Town of Duxbury for a comparison check with the Corps' test results. Analyses of these samples is expected to be available in mid-February 1976.

Results of bulk chemical analyses of the samples have been reviewed by the Massachusetts Division of Water Pollution Control (DWPC). (See letter in Appendix dated November 21, 1975 signed by Thomas C. McMahon, Director). It is the opinion of the DWPC that all samples (with the exception of sample "B-2") "violated one or more of the numerical criteria established by EPA [U.S. Environmental Protection Agency]".

A lack of bureaucratic unanimity, however, seems to exist insofar as application of specific criteria for "polluted" or "unpolluted" dredged materials is concerned. A published list of criteria in the Federal Register (40 CFR Sec. 227.1 et seq.), dated October 15, 1973, specifies limits for only mercury and cadmium (.75 and .6 mg/kg, respectively). In the same regulations, trace contaminants of arsenic, lead, copper, zinc, selenium, vanadium, beryllium, chromium, and nickel are considered "materials...requiring special care" (Sec. 227.31). But the Commonwealth of Massachusetts (i.e., DWPC) has adhered to an earlier specification (1971?) of EPA-endorsed critical criteria. That earlier list of critical limits (currently[18] recognized by the DWPC) are shown as follows:

Table VII

Chemical Analyses (Dried) of Sediment Samples
Duxbury Harbor and Channel (March 1975)

	Parameters (ppm)											
Sample Site & Depth	Volatile Solids (EPA)	COD	TKN	Oil & Grease	Hq	Pb	Zn	Cd	Cr	Cu	Ni	Vn
PE-1												
0.0 - 0.25	100,300	100,400	4300	2740	.39	87.	95.	5.8	102.	66.	73.	124.
1.1 - 1.17	86,300	---	---	---	.27	75.	100.	3.5	115.	45.	50.	85.
PE-2												
0.0 - .17	56,300	63,300	2300	1260	.15	39.	154.	3.4	60.	39.	43.	47.
1.0 - 1.17	91,000	---	---	---	1.50	77.	91.	3.2	105.	41.	45.	100.
PE-3												
0.0 - 0.17	88,800	100,200	4140	2160	0.0	74.	74.	4.3	74.	43.	31.	105.
1.0 - 1.17	81,700	---	---	---	0.0	84.	98.	3.4	98.	54.	49.	84.
PE-4												
0.0 - 0.17	57,200	63,500	2250	730	0.0	78.	73.	3.1	89.	47.	52.	115.
0.83 - 1.0	60,000	---	---	---	0.0	50.	46.	2.9	38.	29.	21.	46.
GE-1 (or B-2) Surface	15,800	13,800	560	640	0.0	17.	29.	1.7	17.	40.	14.	14.
EPA - Specified Critical Limits (1973)	---	---	---	---	.75	---	---	0.6	---	---	---	---

Parameters (in ppm)

Volatile Solids:	60,000.
COD	50,000.
TKN	1,000.
Oil and Grease	1,500.
Mercury	1.0
Lead	50.
Zinc	50.

It is with respect to the above listing of critical limits that the earlier referenced letter from Director McMahon (November 1975) found the Duxbury samples to be in "violation" of pollution limits.

A comparison of the bulk analysis of Duxbury sediments with those from some other dredging projects in New England is presented in Table VIII. The sample chosen (i.e. PE-1) from Duxbury's anchorage basin for comparison with others in Table VIII is found to be, in most instances, within the high range of the parameters measured. Levels of mercury in the Duxbury sample, it should be noted however, are within acceptable EPA limits.

Informal appeal was made to the November 1975 MWPC ruling (letter from McMahon in Appendix) and subsequently the Corps agreed to conduct elutriation ("shake") tests to determine the acceptability of these sediments at a Commonwealth designated "clean spoil" disposal site.

Elutriation tests of samples of sediments to be dredged 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) 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. An earlier (1973) criterion for acceptability of the sediment as "unpolluted" was that the elutrient must not exceed 1.5 times the chemical analysis of the "dumping ground water."

Table VIII

Comparisons of Various Parameters of Bottom Sediments at Several New England Dredging Sites

Sites (with sample number, if known)	Parameters (in p.p.m.)							
	Volatile Solids (EPA)	C.O.D.	T.K.N.	Oil & Grease	Hg	Pb	Zn	Cd
Providence River*	64,200	112,400	3,490	6,310	0.58	168.5	321.9	--
New London Harbor*	29,400	42,000	820	720	0.098	26.0	57.9	--
Point Judith*	8,800	10,010	632.5	125	0.32	17.5	25.8	4.2
Falmouth Harbor** (PE-4)	182,000	172,000	5,570	1,490	2.60	73.0	124.0	2.9
Cape Porpoise, ME*** (PE-1)	57,600	84,200	2,890	1,210	0.67	67.0	79.0	2.4
Duxbury Harbor**** (PE-1)	100,300	100,400	4,300	2,740	0.39	87.0	95.0	5.8
EPA Specified Critical Limites (1973)					0.75	--	--	0.6

*Data obtained from "Announcement of Public Meeting on Navigation Improvements in Point Judith Harbor & Pond on 29 Jan. 1976", issued by U. S. Army Corps of Engineers, NED, Dec. 1975.

**Data obtained from Corps of Engineers, Project CHA 83, Sept. 1975

*** " " " " " " Project CHA 94

**** " " " " " "

Elutriation tests have recently been completed for sediments from six 1976 sampling sites in the Harbor. Sample locations for elutriated samples PE-1 and PE-2 were approximately the same as for the bulk chemical samples (see Figure 1). Samples PE-3, 4, 5, and 6 were, respectively 50 feet north, south, east and west of the site for PE-1 shown on Figure 1. The results of the elutriate test appear in Table IX. EPA's 1973 limits for sediment samples elutriated with water from an open ocean disposal site were exceeded by a majority of the test results. Specifically, those parameters exceeded by 1973 criteria are shown in Table X.

Table X

EPA's 1973* Criteria Exceeded by Elutriate Test Results at Sampling Locations in Duxbury Harbor

Parameter	1973 Criterion Exceeded by Std Elutrient from the following:											
	EW Sites:						PE Sites:					
	2	3	4	5	6	7	1	2	3	4	5	6
Nitrate							X					
Freon soluble						X	X		X	X	X	
Phosphorus - Ortho							X	X	X	X	X	X
Phosphorus - Total							X	X	X	X	X	X
Mercury	X		X	X	X	X	X	X	X	X	X	X
Lead				X			X	X	X	X	X	X
Arsenic			X		X		X		X	X	X	X
Cadmium							X		X		X	
Copper							X					
Nickel			X	X	X	X	X		X	X	X	X
Vanadium									X	X	X	X

* Reference: Sec. 227.61 (c), Federal Register (Oct. 15, 1973), Vol. 38 No. 198, Pt. II, "Ocean Dumping". (Superceded by Sept. 5, 1975 "Rules and Regulations")

It should be noted that the 1973 criteria established by EPA (see Table X and footnoted reference accompanying it) were revised in September 1975 (40 CRF 230.4 - 1) to permit greater latitude in determination of those contaminants "deemed critical." Therefore the data presented in Tables IX and X are to be

Table IX
WATER AND SEDIMENT TEST RESULTS
Duxbury Harbor and Disposal Area, Mass.
February, 1976

Test Property	Dumping Ground Water	Dredge Site Water						Standard Elutrient Results from Samples(at specified depths)												EPA's 1973 Limits (1.5 x DG Water)
		EW-2	EW-3	EW-4	EW-5	EW-6	EW-7	PE-1		PE-2		PE-3		PE-4		PE-5		PE-6		
								0-2"	12-14"	0-2"	12-14"	0-2"	12-14"	0-2"	12-14"	0-2"	12-14"	0-2"	12-14"	
Nitrite (mg/1)	<0.01	<.01	<0.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	<.01	.015
Nitrate "	0.16	.16	0.10	.10	<.10	.11	<.10	0.31	<.10	<.10	<.10	<.10	<.10	<.10	<.10	0.11	<.10	<.10	<.10	.24
Sulfate "	2,900	2,500	2,400	2,400	2,375	2,300	2,400	2,350	2,300	2,650	2,400	2,050	2,200	1,900	2,000	1,950	2,000	2,000	1,950	4,350
Freon soluble "	0.0	0.0	0.0	0.0	0.0	0.0	1.8	1.8	0.0	0.0	0.0	0.9	1.8	0.9	0.0	1.8	2.1	0.0	0.0	0.0
Phosph. Ortho "	0.030	0.01	<0.01	<0.01	<0.01	<0.01	<.01	0.77	0.17	0.10	0.073	0.180	0.310	0.50	0.925	0.475	0.642	0.390	0.850	0.045
Phosph. Total "	0.043	0.035	0.027	0.025	0.015	0.017	0.020	1.40	0.265	0.215	0.110	0.240	0.940	0.60	0.960	0.550	0.775	0.560	1.00	0.064
Mercury (ug/1)	0.1	2.5	0.0	.75	0.75	0.9	0.4	0.6	0.0	0.6	0.0	0.0	0.5	0.5	0.9	0.9	0.75	1.2	1.2	0.15
Lead "	4.	6.	2.	2.	7.	5.	4.	40	6.	8.	6.	7.	7.	7.	2.	14.	5.	7.	7.	6.
Zinc "	12.5	17.5	7.5	7.0	11.5	14.0	9.5	12.5	13.0	17.5	13.0	9.0	6.5	11.5	3.5	7.5	3.5	8.5	10.5	18.7
Arsenic "	0	0	0	4.	0	9.	0	6.	6.	0	0	10.	20.	14.	31.	43.	19.	29.	17.	0
Cadmium "	1.0	1.0	1.0	<0.5	0.5	1.0	<0.5	6.5	1.5	1.5	1.5	3.5	1.0	1.5	0.5	4.0	0.5	1.5	1.0	1.5
Chromium "	<5.	<5.	<5.	<.4	<4	<4.	<4.	<5.	<5.	<5.	<5.	<4.	<4.	<4.	<4.	<4.	<4.	<4.	<4.	<7.5
Copper "	11.0	13.5	10.0	11.0	8.5	7.5	5.0	18.0	6.5	6.5	6.5	8.5	5.0	5.0	4.0	16.5	8.5	14.0	11.0	16.5
Nickel "	1.	1.	1.	2.	4.	2.	2.	6.	1.	1.	1.	2.	4.	4.	4.	2.	4.	2.	4.	1.5
Vanadium "	<5.	<5.	<5.	<5.	<5.	<5.	<5.	<5.	5.	<5.	<5.	<5.	10.	5.	20.	10.	20.	<5.	20.	< 7.5

Notes: 1. All tests performed by NED laboratory personnel in accordance with accepted EPA procedures.

2. Reference is made to section 230.4 - 1 of Federal Register (dated Sept. 5, 1975), Vol. 40, No. 173, Pt. II, EPA, "Discharge of Dredged or Fill Materials - Navigable Waters"

considered as guides and not absolute criteria for persons evaluating the elutriate results.

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.

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/l. 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[43] that "minimal risk of deleterious effects" from cadmium exists when, in the presence of Zn and Cu concentrations of 1 mg/l or more (Duxbury's samples are .018 mg/l or less) cadmium levels are less than .02 ug/l; Duxbury's maximum cadmium concentration is 6.5 ug/l.

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

	Hazardous	Minimal Risk	Duxbury
Nickel	0.1 mg/l	.002 mg/l	.006 mg/l
Zinc	0.1 mg/l	.020 mg/l	.0175 mg/l
Lead	0.05 mg/l	.010 mg/l	.040 mg/l (1 sample) .014 mg/l (1 sample)

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 Duxbury Harbor is from anti-fouling paint used on boat bottoms. Such paint was until recently, 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 by some organisms at the lower end of food chains for concentrating mercury there is increasing hazard to the carnivores and predators which include and ingest 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.

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.[44] 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 the Proposed Disposal Site

Until the determination was recently made that the Duxbury sediments could be disposed of at the specified site southeast of Gurnet Point an anticipated disposal site was many miles north of Duxbury at the Boston Foul Area (see earlier referenced letter in Appendix from Director McMahon of the Massachusetts DWPC). The center of the Foul Area is located at 42° 25'N and 70° 35' W. That site has been used for years as a disposal site for containerized contaminants, ammunition, explosives, and similar polluted material. The area, as its name implies, is one in which fishermen may "foul" their trawling or dredging equipment. Depths at the site vary from 280 to 304 feet. A survey of the site in August 1973[19] showed the bottom to be littered with containers and fine sediment. Polychaetes and nematodes characterized the infauna, while numerous shrimp and an occasional starfish characterized the benthic epifauna.

The Foul Area site is one designated to receive those materials which are suitable for ocean disposal, but, at the same time, too grossly polluted for disposal in designated areas where only minimal impacts may be tolerated. The Boston Foul Area at this time is the only site designated by the Commonwealth as suitable for disposal of "polluted" materials.

The newly designated disposal site (see page 6 under "Project Definition - Proposed Disposal Plans") is located about four nautical miles southeast of Gurnet Point (see Figure 2A). At this time there have been no specific or detailed determinations made of the nature of the seafloor sediments or current conditions at this site. Therefore no pertinent data exists with which to effectively gauge or predict environmental impacts of the proposed action.

d. Effects of Dredging Operations on the Marine and Estuarine Biota of Duxbury Bay

The interactions within estuaries are complex--involving geological, hydraulic, biological, and chemical factors, as well as socioeconomic effects. Those most easily identified may be classified as "acute," whereas others less well quantified or perceived may be characterized as "chronic" impacts. Much of the discussion which follows is relevant to those impacts considered to be acute.

The most direct biological impact of dredging is the physical removal of benthic organisms, most especially infaunal. Several studies[20] have shown, however, that a fairly rapid repopulation of the dredged area by both infaunal and epifannal organisms most often occurs. The situation at Duxbury is presumed not to be atypical of the areas in the referenced studies.

Dredging may have the result of altering circulation patterns within an estuary. These may induce temperature and/or salinity changes which, in turn, adversely affects species composition in the area. In the case of Duxbury, however, observations of such changes in biological activity which may have been caused by earlier dredging (1960 and later) do not appear to have been recorded.

It was reported (in an informal 1969 study of Duxbury Bay by William Clapp Laboratories) that the release of free sulphides to the overlying waters and air in the tidal flats is a normal occurrence during the warm summer months. The implication of this observation was that hydrogen sulfide gas, which is toxic to several infaunal, epifaunal and other benthic organisms -- as well as to fish, could be responsible for a seasonal decrease in populations in some areas. Eggs and juvenile stages of aquatic organisms are more sensitive to such sulfides than are adults.[21]

These facts have relevance to the proposed Duxbury dredging to the extent that the disturbance of the substrate may release sulfur compounds, present in the substrate, for anaerobic digestion. The oxidation of such compounds--contrasted with anaerobic reduction--will not directly produce toxic compounds.

Uptake of heavy metals by aquatic organisms are an additional potential impact which may occur as a result of dredging. There are two primary deleterious effects of heavy metals at the level of individual organisms. These are: toxic and sublethal effects, both of which 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.[22] 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[23] in disucssions of heavy metal toxicities to phytoplankton, mention this selective and differential rate of uptake at the species level.

Pringle, et al.,[24] working on trace metal accumulation by estuarine mollusks, found that mollusks 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-shell 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.

Research at the Millstone nuclear site on Long Island Sound has shown that mussels (Mytilus edulis) are great concentrators of nickel[25] with the result that a multiplying effect for nickel can occur in such environments as Duxbury Bay where mussels flourish. Evidence of concentration of heavy metals through a food chain was investigated by Hardisty, et al.,[26] working with flounders (Platichthyes flesus) off the coast of England. They found that where the diet was principally crustaceans with a fairly high metal level, the flounder developed a high level of the same metal.

Turbidity effects on benthic macroinvertebrates are principally caused by the burying of animals by sediment deposition. Increased turbidity may result from both dredging and disposal operations. Stringer[27] demonstrated that quahoags are resistant to siltation showing no distress after having two inches of sediment deposited during 24 hours. They simply moved their siphon to the new sediment surface when the material settled. According to Glude,[28] soft shell clams can also withstand rapid increased of turbidity on a temporary basis.

Flemer,[29] working on estuarine sites for a disposal of dredged materials in Chesapeake Bay, reported no gross effects from disposal of fine materials (e.g., from dredge-induced turbidity plumes) on the microscopic plants and animals in the water nor on eggs and larvae of fish. Sissinwine and Saila[30] did not find a relationship between a decline in the Rhode Island Floating Trap Fishery and ocean dumping in Rhode Island Sound.

The above turbidity studies seem to imply that, although the eggs and larvae of fish are most susceptible to physical damage, the extent of the effect from dredging is generally not so widespread that it affects entire fish populations.

One of the contaminants found in high concentrations in the sediments of Duxbury Bay was "oil and grease" (Table VII). While it generally agreed that the presence of oil residues in sediment is undesirable, essentially no information is available on the relationship between such residues and degradation of water quality.[31] Research has shown, furthermore, that Spartina grasses--of the sort found in the saltmarshes of Back River in Duxbury--may yield as much as 2 percent fats and oils.[32] Little is know of how this naturally-produced product of the estuarine ecosystem moves through the environment. Nor is it known if the chemical analyses of sediments, using hexane solvent, makes a distinction between naturally produced oils and those refined oils which are an expected result of motorized activity in and around a bay.

The persistence of oil from accidental spills and the resultant degradation of environmental values has been studied in considerable detail.[33] Oil of this sort can be dissolved and concentrated within fatty tissues and passed along food chains.

Therefore, one can conclude that, on the basis of what is now known about the conditions within Duxbury Bay, the acute effects of removal of dredged material upon the biota of Duxbury Bay cannot be precisely defined. Even less well known are the chronic effects which are more subtle and which can only be identified after the results of more long-term research has been accumulated.

As a footnote to all of the above, it should be remembered that dredging of at least the same magnitude has earlier occurred in the Bay. Measures of changes in productivity over a span of years, which might serve as a basis of impact evaluation are not available.

e. Environmental Effects of Dredged Materials Disposal at the Proposed Disposal Site

As was earlier mentioned ("Probable Impacts - Sediment Studies," page 48), the disposal site to the southeast of Gurnet Point has not yet been investigated in sufficient detail to enable the prediction of environmental effects of dredged materials disposal. Data needed for a complete assessment of impacts includes: current measurements, seafloor profiles, biological dredge sampling results, and physical-chemical analyses of bottom sediments. Analyses of current dynamics and the ecological interactions of benthic, demersal, and pelagic organisms then could be made and potential impacts could be more accurately appraised.

It is appropriate here to digress briefly to discuss the general problems 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.[45] 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 presence 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 the set of conditions existing at the time of investigation apply.

Because of the interrelatedness of factors influencing the dispersion of dredged sediment those 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 proposed site.

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 involved food-chain magnification of toxicants, regional changes in species diversity and other influences on population dynamics.

Within the area of the proposed disposal site the bottom is believed to be characterized by variable sediment types, ranging from sand to mud, with at least one local rocky prominence rising 15-20 feet above the seafloor. Bottom-dwelling fish may include cod, haddock, hake, tautog and cunner; pelagic species will include pollock and striped bass.

The existence of a seasonal thermocline in these waters would imply a distinction between surface tidal and bottom current movements which, in turn, would influence dispersion patterns of materials dumped at the site.

5. Probable Adverse Environmental Effects Which Cannot Be Avoided

The dredging operation, as contrasted with disposal operations, will result in destruction and/or removal of a portion of the benthic fauna and habitat in the immediate vicinity of the operation.

Increased concentrations of suspended solids will also result from dredging operations. This will have a deleterious effect on planktonic production during the length of time that dredging occurs. To the extent (unknown) which primary production is a limiting factor in shellfish (especially soft-shell clams and quahoags) and finfish production (especially winter flounder) this is an adverse impact. But inasmuch as the dredging is limited in areal extent and also somewhat removed from areas identified as productive fisheries, this impact is not considered to be a major one.

The impact of release to the water column and thence to aquatic organisms of undesirable--or even toxic--materials is unknown. Impacts of earlier dredging of the project, however, have not identified to any degree or significance the adverse impacts resulting from resuspension of contaminated sediments.

6. Alternatives to the Proposed Action

There are two categories of alternatives to the proposed action. The first involves political-economic changes in the definition of both project scope and funding. The second involves the consideration of alternative disposal sites.

Consideration of alternatives to the project as presently defined is prompted by the possibility of adverse findings and/or rulings on implementation of the project. Such rulings could have an economic and/or environmental basis.

(a) Political-Economic Alternatives for Redefining the Scope of the Project

The alternatives in this category are all considered in the light of the assumption that the material to be dredged is polluted and therefore must be disposed of at the Boston Foul Area. It has been estimated that the town of Duxbury would have to defray most of the $400,000 additional (in excess of Corps' project budget) cost[34] of barging the dredged materials to the Boston Foul Area. This possibility suggests the consideration of three options:

(1) reduce the scope of the project so as to diminish the volume of dredged materials,

(2) apply to the Commonwealth for financial aid for "public works" under Chapter 91 provisions of the General Laws, or

(3) abandon the project.

Each of these options will be addressed in turn.

(1) Reduction in scope of the project would, in effect, entail the reduction in size of the anchorage basin. Because the mile-long channel to the Basin now requires but little dredging (only at the right-angle elbow turn), and because the channel is essential to provide access to the established center of marine activities for the town (at the Basin), it is impractical to consider reduction of channel dredging. The condition survey of March 1974 (see Figure 2)

shows that approximately 90 percent of the anchorage Basin has depths less than the authorized 8 feet, and approximately 40 percent of the Basin has depths less than 6 feet. The northeast corner of the Basin appears to be that part in which shoals develop first and/or more rapidly--perhaps due to sedimentation influenced by the outflow from the Bluefish River to the north of the Basin.

Abandonment of a portion of the Basin--for example, that 40 percent which is from 3 to 6 feet deep at this time (i.e., as of the March 1974 conditions survey)--would mean that only about 30 percent of the volume of dredged material now scheduled for dredging would have to be moved. An approximate correlation of this reduced scope with the earlier mentioned estimated cost (while ignoring fixed costs of equipment mobilization) indicates that an expenditure of about $120,000 would temporarily maintain 60 percent of the Basin at the authorized 8-foot depth.

A reduction in the size of the Basin would necessarily have an impact--most especially upon the boat-oriented residents and businesses who have committed themselves to ownership and servicing of the larger boats. Already it is reported[35] that at least three boats have permanently transferred their registry from Duxbury to other harbors--presumably because of their inability to use the shoaled Basin in its present condition. On the other hand, a case could be made for defraying dredging costs with a proportional and increased assessment of those residents whose deeper draft boats require, for their continued safe use of the Basin, that the depth be maintained at 8 feet. But even though the traffic in the channel and Basin is almost 100 percent recreational, there are commercial interests whose livelihood is now dependent on the established recreational activity and so the economic impact of an anchorage reduced in size would be felt by a wide variety of interests.

(2) Application to the Commonwealth for financial aid in underwriting the cost of channel-dredging is another option of the Town. There does not appear to be a precedent for state aid in projects of this sort. The likelihood of assent by the Commonwealth to an application for state funds (under Chapter 91 provisions) cannot be accurately gauged, but the present climate of fiscal austerity at the state level certainly increases the odds against this possibility.

(3) The last option--that of abandoning the project--even now has a minority of supporters within the town. The adoption of this alternative, however, would have relatively rapid and serious consequences for the town. Revenues from personal property taxes levied against the boats now registered in Duxbury would decline. Businesses catering to the larger, more expensive boats would be eclipsed. And some summer residents would doubtless move to areas where their boats could be better accommodated. The list of ramifying impacts is extensive.

Doubtless the economic costs of electing such an alternative would be offset by some environmental gains. Boating activity would decrease but environmental quality and productivity would increase--at least to the extent that boating (and other supporting activities, such as dredging) has a degrading effect upon the area's natural resources.

The question is essentially a political and economic one. The "tradeoffs" can best be calculated by those whose interests are affected.

(b) Alternative Disposal Sites

The critical question which all parties of interest to this project (town, Commonwealth and federal agencies, as well as individual residents of Duxbury) want to resolve is: "Is, or is not, the material which is to be dredged considered polluted and therefore degrading to the environment where it will be dumped?" Alternatives to be discussed in the following section are those which are undergirded by the assumption that the critical question can be resolved in such a manner that will satisfy all existing environmental criteria, regulations, and statutes designed to minimize adverse environmental impacts of dredged materials disposal.

Several alternative disposal sites are considered. They are:

(1) the bayshore area (western side) of Duxbury Beach,

(2) the disposal area off Gurnet Point (and last used for Duxbury dredged materials disposal in 1968), and

(3) the disposal area in Cape Cod Bay (about 4 nautical miles northeast of Sandwich) which has been designated by the Commonwealth as a "clean spoil" disposal area.

(4) the Boston Foul Area (located approximately 25 air line miles northeast of Duxbury) which has been designated by the Commonwealth as a "polluted spoil" disposal area.

1) The only land disposal site within the town of Duxbury which appears now to be available is that located on the bayshore side of Duxbury Beach. This land is held by a chartered public trust, the Duxbury Beach Reservation Trust.

The possibility of disposal of dredged materials at this site has at least one principal advantage over other alternatives. Dredging and transport of the material to the disposal site could be accomplished hydraulically. This would make possible the emplacement of natural reinforcing materials in areas along this barrier beach which are now susceptible to wind and storm-wave erosion. The beach, in effect, would be widened on the bayshore side making that fragile strip of land less susceptible to erosion by storms traveling over the reach of water from the south and west. Continual effort is now being expended to reduce or retard the forces of erosion now acting on this stretch of land.

Secondly, the land disposal site has been made available to the town for dredged materials disposal by the directors of the Trust.[36] And in the absence of another site for dredged materials disposal, the advantage of site availability is significant.

And lastly, there is the likelihood that dredge spoil from maintenance dredging operations which are anticipated in future years could also be accommodated when there is a need to expand the potential bayshore disposal site.

There are, however, some unresolved issues. The emplacement of dredged material on the bayshore beach, in an area that is only occasionally a high-energy environment, presupposes that some containment of impounding devices would have to be constructed. The cost of construction of dikes (earthern or sheet-piling) would greatly increase the disposal cost. Moreover, the retaining dikes would have to be wide enough to insure stability and they would, therefore, have to extend some distance into waters of the Bay. Both aesthetic concerns and environmental conflicts (with shorebirds and quahoags, for example) are problems which must be addressed in such an event.

On the question of design of the containment areas, there are a number of complexities. The sluicing of the fluids produced by dewatering of the dredged material raises not only sluice-design questions but problems of effluent quality (especially turbidity) within the Bay. Both the definition of adequate foundation conditions and the selection of appropriate construction materials and techniques are critical insofar as stability of the impounded areas is concerned.

Though there have been a number of Corps projects involving the successful construction and emplacement of dredged materials behind impoundments which extend across the existing shoreline, there are no such installations in New England. The risk inherent in such a first venture in the region must be counted as a disadvantage.

Some unresolved environmental questions are associated with this alternative. It is likely, considering the organic content of the sediments, that increased phytoplankton productivity (with resultant rise in biological oxygen demand) will result from the availability of nutrients now "locked into" the sediments to be dredged. But, on the other hand, there is also the possibility that additional nutrients may instead serve to increase the productivity of the Bay's ecosystem with all of its inter-related food webs.

The question of increased turbidity of sluiced effluent and release of contaminants needs also to be considered if dredged materials are moved to a "storage" site. Hydraulic dredging, too, induces more turbidity at the dredging site than does the proposed clamshell dredging. It is not known, for example, what the nature of the bond is between dredged material particles and pollutants, nor how easily released during disposal or storage operations are the more toxic elements and their compounds. Odorous compounds may also present a problem in the area.

A precedent, however, does exist for this alternative. As was earlier noted, the sediments first dredged from the Basin, when the Corps accepted the project for maintenance dredging (1960), were disposed of on land (east of the Town Wharf and north of Harrison Street). Though the project was looked upon with some misgiving initially,[37] few residents of the town who now recall the event have any regrets that the decision was made. (That area is now classified as a wetland and dredged materials may not legally be disposed of there.)

2) A disposal area located off Gurnet Point, with the center of the mile-square area at a point 3333 yards due east of Gurnet Point Light, was once used as a disposal site. In fact, in 1968, dredged materials from Duxbury Basin were disposed of at that site. The depth of water varies from 70 to 90 feet. The principal advantage of this site is its easy accessibility by barge (or scow) loaded with dredged materials from the Duxbury site.

The site has been closed by the Commonwealth (subsequent to its use as a disposal site in 1968). Commercial fishing activity now occurs in that area.

The site is approximately 2.8 nautical miles northwest of the proposed site and about two miles closer to the site of proposed dredging operations at Duxbury.

Environmental conditions at the site are not well known. It has been generally accepted that in order to minimize the effects of disposal materials on the bottom community at thedisposal site "like" materials should be placed upon "like" material. This practice would minimize ecological disruption caused by widescale changes in community structure at most sites. Unfortunately, no site-specific data on the existing bottom sediments at this alternative disposal site are available. Bottom-dwelling fish species are, generally speaking, correlatable with the kind of bottom habitat found in an area. Cod, for example, are found over rocky bottom, flounder over smooth hard bottom, and hake over muddy bottom. Other species (pelagic types), such as mackerel and bluefish, are independent of bottom types. There is evidence that the site is close to areas which are used by both commercial and sport fishermen in varying degrees. Cod, flounder, hake, and bluefish are caught off the Gurnet Point area. Disposal of fine material at sites close to commercial fishing grounds may have a deleterious effect upon benthic and demersal species causing burial and/or relocation, and on finfish who may show a district avoidance reaction if there is a major plume or suspended material produced. In addition to the effect upon adult and/or juvenile fish, a potential impact to larvae and eggs needs to be appraised; this is minimized by timing disposal operations so as not to conflict with those species spawning in the area.

Waters from the Gurnet Point area have recently been collected for the purpose of evaluating a site nearby as a disposal area (see Figure 2A). These waters, together with sediment samples from Duxbury Basin, have been elutriated so as to better detect the release of chemical contaminants if the sediments were to be disposed of in ocean waters nearby. The tests were conducted in late February 1976 and the results are given in Table IX.

It is appropriate to repeat here a comment about the interpretation of elutriate test results. Elutriation which produces an increase of 50 percent in the concentration of contaminants in waters from the proposed disposal site has previously been enough to disqualify that site from consideration as a disposal site for "unpolluted" sediments (40 CFR Sec. 227.61). More recent federal guidelines have been adopted, however, which permit greater latitude of interpretation of elutriate results (40 CFR Sec. 236 4-1,-2). The evaluation criteria now embrace consideration of time-concentration-toxicity relationships which are more specific for various chemical constituents and also more relevant to appraised conditions and resident organisms at the proposed site.

3) The Cape Cod Bay disposal site near Sandwich has been approved[39] as a disposal site for unpolluted dredge spoil. The site is a one-mile circle centered at 41° 49'N and 70° 25'W, and is northeast of Sandwich. Waters are more than 70 feet deep at the site.

This site has, for some time, received the dredged sediments from the northern portion of the Cape Cod Canal. Sediments dredged from Barnstable Harbor have also been dumped at the site.

Whereas both the historic Gurnet Point and the nearby and newly-proposed disposal site (Figure 2A) are approximately 5 to 8 airline nautical miles (respectively) from Duxbury Basin the Cape Cod Bay disposal site is about 19 miles distant. A handicap imposed on this alternative is, therefore, its distance from the proposed Duxbury project.

Utilization of this disposal site and nearby areas by fishermen is not reported to be heavy.[40] Trawlers, however, have been known to complain about the absence of buoys accurately defining the disposal site.[41] The area is closed to trawlers from May 1st to October 31st because of conflict with recreational boating. Some lobstering is carried on in the region, but it is not intensive, nor is it in conflict with disposal operations which have taken place.[41] Ocean quahoags (Arctica islandica) are harvested from nearby Cape Cod Bay areas. And surf clams (Spisula solidissima) are harvested from shallower waters, closer in shore -- especially in the Barnstable region.

If disposal took place during the autumn (e.g., October) there would be minimal conflict with both recreational boating and commercial trawling. Entrainment of eggs and larvae would also be low at this time. And because of earlier and continued dumping at the site, the impact upon benthic organisms from disposal of Duxbury materials would probably be minimal -- that is, if those sediments have "acceptable" concentrations of pollutants.

At both of the sites in the Gurnet Point area and at the Sandwich site, there is a paucity of data available on current strength and direction -- both net and instantaneous. Such data is relevant to the appraisal of those impacts on biota occasioned by sediment plumes of suspended solids during disposal operations. Neither is there detailed information about bottom sediment type at the disposal sites. (An important conference[42] on ocean disposal of dredged materials recommended that "like material" be deposited on "like material").

Additional research and documentation of ecological relationships is desirable at all of the disposal sites discussed in this report.

4) The Boston Foul Area, as an alternative site, would be considered and/or utilized only in the event the dredged sediments were classified as "polluted".

A discussion of this site appears in an earlier section (Section 2C) of this report.

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

The fundamental issue which must be addressed in a dredging project--or in other projects of the same general sort, such as the construction of a highway--is the "benefit and cost" relationship. The benefits to man, and the economy which supports him, must be balanced against the costs to the wide spectrum of natural systems which, in the long-term, form the basis for a productive environment and healthy ecosystem.

Certainly the resources of the basin, channel and a variety of supporting land-based facilities have long since been committed to the short-term uses of man. Implicit in these commitments is the continued use of these resources for an indeterminate time. That is not to say, however, that the scale and intensity of use may not be modified as time and events later dictate. The acceptance of certain adverse environmental impacts associated with the utilization of resources is almost axiomatic, but the minimization of these--especially the most chronic or less keenly perceived impacts, has only recently been addressed.

Minimization of those impacts associated with the dredging of the Duxbury Basin and channel may be achieved in several ways. The seasonal timing and frequency (now assumed to be every eight years) of dredging could be carefully and explicitly selected so as to cause the least impact upon estuarine and related biota. The scale and scope of the dredging could be reviewed periodically so as better to determine what environmental costs are incurred by maintaining the facility at specified dimensions. Selection of disposal sites for the dredged materials could be planned far enough in advance so that the pressures on decision-makers and budgetary constraints are alleviated.

The return to the predredging status of the Duxbury project area is not possible and therefore not an appropriate alternative--at least in the context of today's sociopolitical-economic system. It is essential, therefore, that if long-term productivity of the Bay and its environs is to be sustained while, at the same time, man-made systems are encouraged to function efficiently there needs to be continual effort to monitor all environmental systems and to better understand how those systems interact.

8. Irreversible or Irretrievable Commitments of Resources

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

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 various ocean sites along the Atlantic seaboard which have been monitored. Earlier dredging at Duxbury, it should be pointed out, has not caused any discernible and/or irreversible losses of resources. There is no lack of evidence, however, that 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.

There is less evidence at the various dredged materials disposal sites used to date 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 number of disposal sites in the Duxbury region have been utilized in the past. Moreover, a variety of agencies (local, state, and federal) have applied different criteria to disposal site evaluation. The result has been that commitments of resources cannot be accurately measured. Countering the trend toward case-by-case 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 Duxbury, 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 Duxbury Bay is that of the development of the land area surrounding the Bay. The town's waterfront is nearly completely developed. Periodic enhancement of the anchorage Basin and 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. Neither--as was earlier stated--does the commitment of such resources as may be involved in the actual dredging or spoil disposal imply any irreversibility.

9. Coordination

The proposed dredging project at the Town of Duxbury has been discussed (orally or in written communications) with those organizations, agencies, and persons listed below. As a result 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 Duxbury

Harbormaster and Shelfish Constable - Manuel Oliver
Selectmen's Office - Edmund Dondero, Chairman, Board of Selectmen
Paul Barber, Selectman
Mr. Puglia, Executive Assistant
Beach Reservation Trust - Bartlett Bradley, President
Thomas Herrick, Board Member
William Clapp Laboratories (of Battelle Institute) - Charles Willingham, Biologist

REFERENCES

1. Iwanowicz, H. Russell, et. al., A Study of Marine Resources of Plymouth, Kingston, and Duxbury Bays, Mono. Series #17, Mass. Div. of Marine Fisheries, June 1974.

2. Rodiek, Jon, and Warren Archey, A National Resources Inventory Atlas for Plymouth County, Series #21, Mass. Coop. Extension Service, Feb. 1973.

3. Harrington, Brian, "1974 Season Progress Report," Massachusetts Shorebird Studies, Manomet Bird Observatory, Manomet, Mass., June 1975.

4. Brian Harrington, biologist at Manomet Bird Observatory - personal communication.

5. New England River Basins Commission Staff, South Shore Planning Area Report, Vol. 3 of Part IV of Review Draft of "How to Guide Growth in Southeastern New England" (SENE Study), May 1975.

6. Rodiek, J., op. cit.

7. Manuel Oliver, Harbormaster of Duxbury - personal communication.

8. Iwanowicz, H. R. op. cit.

9. Manuel Oliver, Shellfish Constable of Duxbury - personal communication.

10. Iwanowicz, H. R., op. cit.

11. Iwanowicz, H. R., op. cit.

12. Annual Report of Town of Duxbury, 1974.

13. Iwanowicz, H. R., op. cit.

14. Beals, Richard, and John Phelan, 1973 Massachusetts Coastal Lobster Fishery Statistics, Mass. Div. of Mainr Fisheries.

15. James Fair, biologist at Mass. Div. of Marine Fisheries, Sandwich - personal communication.

16. Ibid.

17. Spencer, James, Review of Dredge and Spoil Disposal Practices in Massachusetts Mass. Coastal Zone Management Office, December 1975.

18. According to William Slagle, Mass. Div. of Water Pollution Control - personal communication.

19. Referred to in: "Final Environmental Statement: Weymouth-Fore and Town Rivers, Boston Harbor, Mass. -- Rock Removal," NED, Corps of Engineers, April 1974, p. 2-39.

20. Slotta, Larry S. and K. J. Williamson, "Estuarine Impact Related to Dredge Spoiling," in Proceedings of the Sixth Dredging Seminar, Jan.25, 1974, Texas A & M University, Sea Grant Report TAMU - S6-74-104, March 1974.

21. Environmental Studies Board, National Academy of Science and National Academy of Engineering, Water Qualtiy Criteria - 1972, EPA 1972, p. 256.

22. Reish, D. J. and R. Barnard, Pacific Naturalist, Vol. 1, 1960, pp. 1-8.

23. 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.

24. 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, pp. 455-75.

25. Charles Willingham, biologist at Clapp Laboratories, Duxbury - personal communication.

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

27. Stringer, L. D. "The Population Abundance and Effect of Sediment on the Hard Clam" in Hurricane Damage Control - Narragensett Bay and Vicinity - A Detailed Report on Fishery Resources, U. S. Dept. of Interior, Fish and Wildlife Soc., Boston, 1959, 271 pp.

28. Glude, J. B. "Survival of Soft-shell Clams (Mya arenaria) Buried at Various Depths" in Sea and Shorefish Resources Bulletin, Maine Dept. of S. and S. Res. Bull. #23, 26 pp.

29. Flemer, D. A., W. L. Dovel, H. T. Pfitzenmayer and D. E. Ritchie, "Biological Effects of Spoil Disposal in Chesapeake Bay" in Journal of the Sanitary Engineering Divison, ASCE Vol. 94, #SA4, 1968, pp. 683-706.

30. Sissenwine, M. P. and S. B. Saila, Rhode Island Sound Dredge Spoil Disposal and Trends in the Floating Trap Fishery, Marine Reprint #30, University of Rhode Island, 1975, 7pp.

31. Lee. G. F. and R. H. Plumb, Literature Review on Research Study for the Development of Dredged Material Disposal Criteria, Office of D.M.R., U.S. Army Engineers Waterways Experiment Station, June 1974, p. 9.

32. Blumer, M. and J. Sass, "Oil Pollution, Persistence and Degradation of Spilled Fuel Oil," in Science, No. 176, 1972, pp. 1257-58.

33. Charles Willingham, biologist at Clapp Laboratories, Duxbury - personal communication.

34. Mr. Puglia, Executive Assistant to Duxbury Board of Selectmen, made this approximation in a personal communication.

35. Owner of marine supplies store at end of Duxbury Town Wharf - personal communication.

36. Bartlett Bradley, President of Reservation Trust - personal communication.

37. Paul Barber, Selectman from Town of Duxbury - personal communication.

38. Gilbert Chase, NED, Corps of Engineers - personal communication.

39. Spencer, J., op. cit., p. 6.

40. Andrew Kolek, biologist at Mass. Div. of Marine Fisheries, Sandwich - personal communication.

41. James Fair, biologist at above MDMF station - personal communication.

42. Anonymous, Proceedings of Ocean Disposal Conference - Woods Hole, Mass., 1971.

43. Environmental Studies Board, Water Quality Criteria - 1972, Environmental Protection Agency, Washington, D.C., p. 245.

44. Lee, G.F. and R.H. Plumb, Literature Review on Research Study for the Development of Dredged Materials Disposal Criteria, Office of Dredged Material Research, U.S. Corps of Engineers, Vicksburg, Missippi, June 1974, p. 58.

45. Bosco, David R., Arnold H. Bourna, 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. Corps of Engineers, Vicksburg, Mississippi, February, 1975, 238 pp.

APPENDIX

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

E OF THE DIRECTOR
VISION OF WATER
LLUTION CONTROL

Rec'd. 9 Dec. 1975 Corps, Waltham

November 21, 1975

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
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