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EPA

Environmental Impact Statement

Final

MDC Proposed Sludge Management Plan, Metropolitan District Commission, Boston, MA.

Part B Volume I

FINAL ENVIRONMENTAL IMPACT STATEMENT

MDC Proposed Sludge Management Plan,
Metropolitan District Commission, Boston, Massachusetts

Lead Agency:	U.S. Environmental Protection Agency Region I JFK Federal Building Boston, Massachusetts 02203
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Abstract:

This Final Environmental Impact Statement (EIS) evaluates a sludge management plan proposed by the Metropolitan District Commission (MDC) and examines other alternative systems; in an attempt to ensure the most environmentally sound and cost effective sludge management plan for the handling and disposal of primary sludge for the MDC system. Although the proposed project would involve 75% federal funding; the ultimate responsibility for implementing the selected sludge management plan lies with the MDC. The various alternatives analyzed and their environmental impacts are discussed in the EIS, and the selected alternative(s) identified.

No Administrative Action will be taken on this project until 30
Federal Register.

VOLUME I

FINAL

ENVIRONMENTAL IMPACT STATEMENT

MDC PROPOSED SLUDGE MANAGEMENT PLAN, METROPOLITAN DISTRICT COMMISSION, BOSTON, MASSACHUSETTS

Prepared For

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June 8, 1979

TABLE OF CONTENTS

VOLUME I

LIST OF FIGURES

LIST OF TABLES

INTRODUCTION

As a result of the dialogue, enforcement conferences, and agreements that took place between 1968 and 1972, there developed a mutual acknowledgement between MDC, EPA (FWPCA), and the Massachusetts Division of Water Pollution Control that there was a significant water quality problem in Boston Harbor resulting from the current sludge disposal practices. In compliance with those agreements, MDC retained Havens and Emerson Ltd. of Cleveland, Ohio, to prepare a detailed engineering analysis of three alternative sludge handling and disposal techniques. In August, 1973, Havens and Emerson presented to the MDC the "Proposed Sludge Management Plan" for Boston Harbor.

Construction of the incinerators and attendant systems proposed in the Sludge Management Plan are eligible for Federal funding. Therefore, MDC was required to prepare an environmental assessment statement stating the anticipated environmental impacts that would result from the proposed project. At that hearing several statements were submitted by Massachusetts state legislators which actively opposed the concepts put forward by the proposed plan.

Region I issued a Notice of Intent in accordance with the National Environmental Policy Act of 1969, and Executive Order 11514 of March 5, 1970, entitled "Protection and Enhancement of Environmental Quality." All Federal agencies are required to prepare an Environmental Impact Statement (EIS) in connection with their proposals for major Federal actions having a significant impact on the quality of the human environment. EPA, Region I, Boston, Massachusetts, is the "Responsible Federal Agency" required by NEPA to prepare the EIS for the proposed sludge management plan. This EIS has been prepared pursuant to NEPA and Executive Order 11514 and in accordance with the guidance and regulations set forth in both the Council on Environmental Quality (CEQ) guidelines of August 1, 1973, and the Environmental Protection Agency (EPA) Final Regulations for Preparation of Environmental Impact Statements (40 FR 72, April 14, 1975). (Appendix AA contains a reproduction of the April 14 regulations.)

This EIS has been prepared on the Proposed Sludge Management Plan, as submitted to EPA by the Metropolitan District Commission, and is based on currently available data and information. The purpose of the EIS is to evaluate not only the system proposed by the MDC, but also to expand the scope of the investigation of feasible alternatives.

During preparation of the Final EIS, significant changes in the framework of regulations for air quality, water quality and solid waste classification and disposal occurred. Because of these changes, several additional alternatives for ultimate ash disposal were developed, and several earlier alternatives, focusing on land application or ocean disposal, were eliminated.

This Final EIS follows the format of the Draft EIS. To assist the reader in identifying new or changed information we have provided the following aids:

- New information added since the Draft EIS was printed is identified by a black line in the right margin.

- Information which as changed because of changes in Federal Legislation, policy, regulations or guidelines is screened and appears as lighter type. This information should be read in conjunction with the Executive Summary to fully understand the effect of these changes.

SECTION I

DESCRIPTION OF THE APPLICANT'S PROPOSED ACTION

The following section of the environmental impact statement contains information concerning existing sewage treatment facilities, as well as a description of the proposed sludge disposal plan for the Metropolitan District Commission (MDC). The discussion locates the study area, and defines the goals and objectives of the proposed project. This section includes a description of the existing Deer Island and Nut Island wastewater treatment plants, as well as their current operating characteristics. The following discussion also presents a history of the planning which has preceded and given rise to this impact statement. And, finally, the plan for sludge disposal as proposed by the applicant, MDC, is presented in detail. Information developed in this section will be incorporated into a detailed analysis (environment, energy, monetary costs) of not only the proposed action, but also an evaluation of feasible alternatives to the applicant's proposed project.

I. DESCRIPTION OF THE APPLICANT'S PROPOSED ACTION

A. Background

1. Location and Identification of the Study Area

The area limits discussed below have been selected in order to properly locate not only the area of the proposed project, but those areas immediately or potentially affected by alternatives to the project. For this EIS, the area limits of interest are as follows:

a. New England Region: Figure I-1 locates the Boston metropolitan area in relation to the major rivers of New England and the Northeast. The proposed project would be located on Deer Island in Boston Harbor. The Boston Harbor area is situated in the Massachusetts Coastal Drainage Area, and this drainage area is under the jurisdiction of the New England River Basin Commission (NERBC). New England is also defined as the area of responsibility for Region I of the U. S. Environmental Protection Agency, preparer of this EIS.

b. Commonwealth of Massachusetts: Figure I-2 is a general location map for the Commonwealth of Massachusetts, its counties and principal cities. The site of the proposed action is also located on this map.

While the proposed project would potentially affect only the Boston metropolitan area, one of the major alternatives to that action would encompass the State. Therefore, for some aspects of this EIS, the State as a whole may be considered as being the study area. However, due to the size of the Commonwealth, the portions of the study which are concerned with the entire State will by necessity be limited to general discussions, as compared to the detailed development associated with more restricted geographical areas.

c. Boston Harbor: Figure I-3 indicates the specific location of the proposed action in relation to the Boston Harbor area. Under the proposed project, it is the Harbor area which would be most significantly affected. The water and bottom sediment quality of Boston Harbor, as well as the future air quality of the Boston Air Quality Control Region, are the primary reasons why this EIS has been generated. Portions of the EIS which deal with this specific locale will receive detailed site-specific evaluations, since here we will be dealing with a reasonably confined geographical area.

The Boston Metropolitan Planning Council (MAPC) and the NERBC are the principal regional agencies having jurisdiction over the project area.

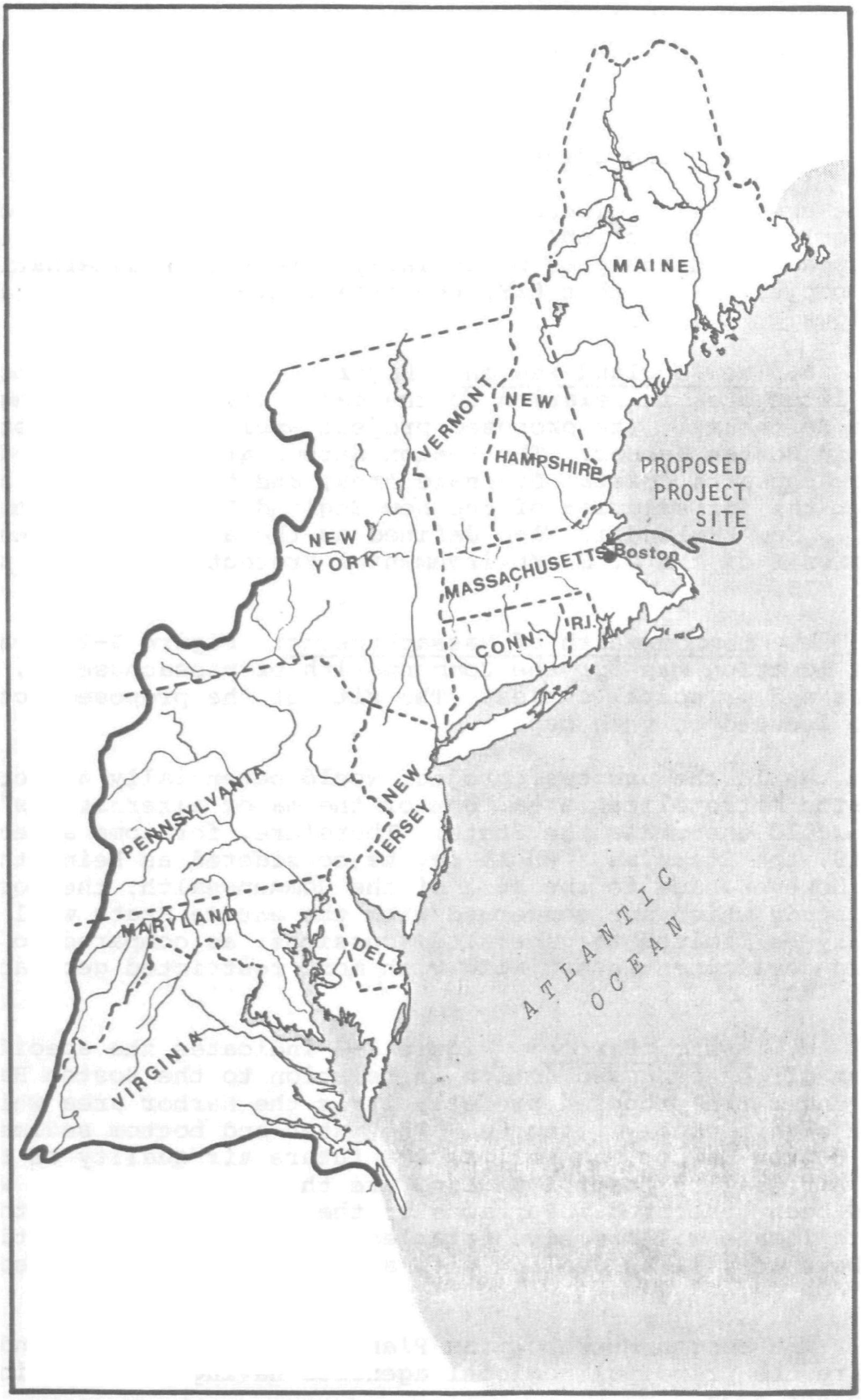


FIGURE I-1. NEW ENGLAND & THE NORTHEAST; GENERAL LOCATION MAP

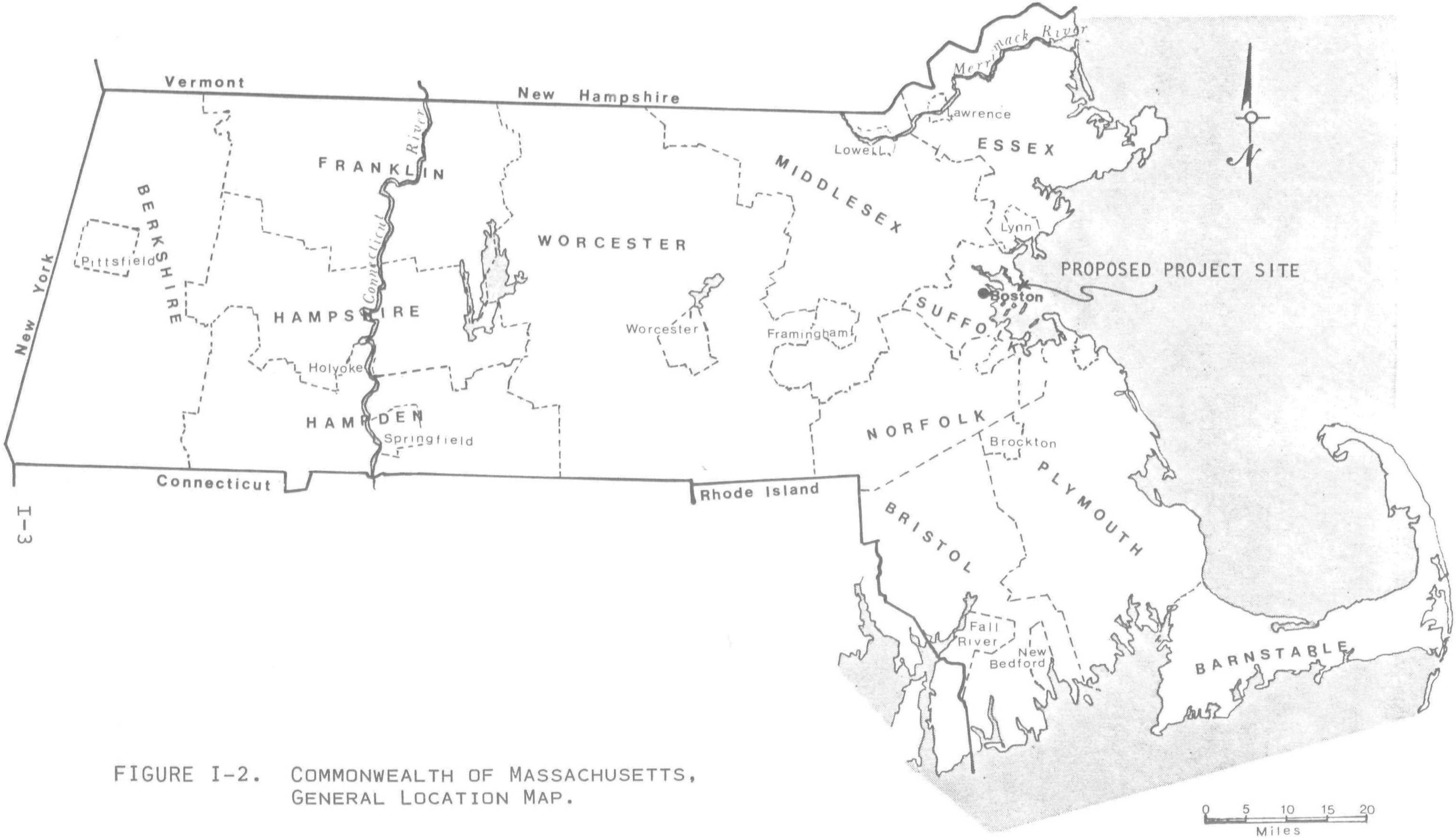


FIGURE I-2. COMMONWEALTH OF MASSACHUSETTS, GENERAL LOCATION MAP.

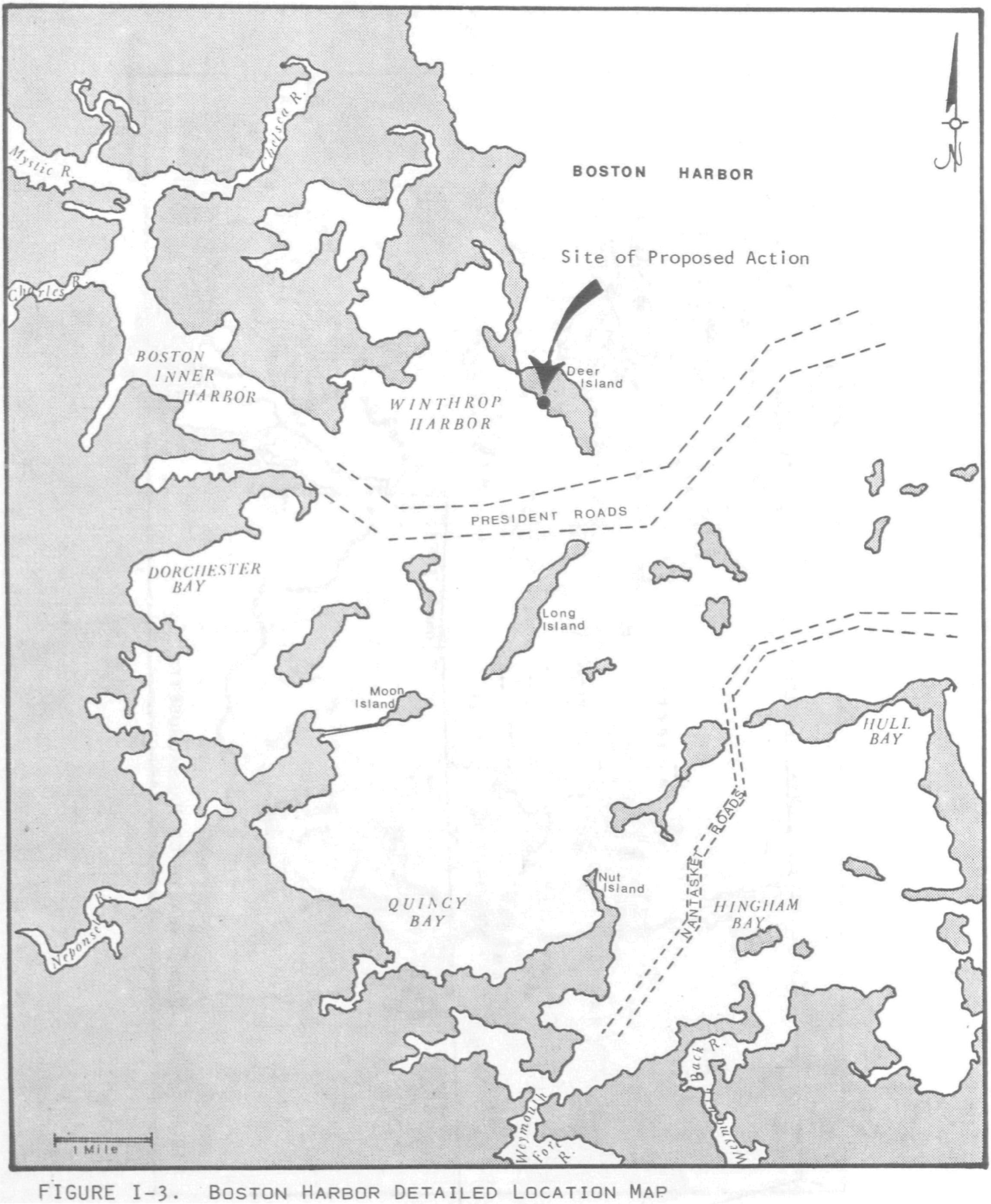


FIGURE I-3. BOSTON HARBOR DETAILED LOCATION MAP

2. Existing Wastewater Treatment Facilities

a. Metropolitan District Commission Sewerage Service Area: The Metropolitan District Commission (MDC) has a service area of 409 square miles, and is made up of 43 member communities. Forty-two of the MDC communities presently receive sewerage services. Figure I-4 identifies the MDC member communities and the sewerage service area.

The Sewerage Division of the MDC owns and operates two major wastewater treatment plants (WWTP), the Deer Island and Nut Island facilities. In fiscal year 1977, these two plants received a combined average daily wastewater flow of approximately 440 mgd (million gallons per day).

Both of these treatment facilities provide primary treatment, sludge digestion, and disinfection of the treated effluent. The effluent is discharged through submerged outfalls to Boston Harbor, and the digested sludge is discharged to the Harbor at the President Roads channel during ebb tide (see Figure I-5). The digested sludge is carried to the discharge points as a slurry, using the chlorinated primary effluent as the carrier. The outflowing ebb tide is then used to carry 80% of the sludge to sea.

b. Deer Island Operations: The island of Deer Island has approximately 210 acres, and contains a Suffolk County House of Correction, the Deer Island Wastewater Treatment Plant, and an inactive military installation at its tip (Ft. Edwards) (see Figure I-5). Deer Island is within the corporate boundaries of the City of Boston. The Deer Island treatment facility has been in operation since June, 1968, and it serves 26 communities, including northern and western portions of Boston proper. The total area served by this plant is 168 square miles, and in 1976 the contributing population was 1,339,940.

Seven MDC pumping stations are located throughout the service area, three of them being the headworks at Columbus Park (So. Boston), Ward Street (Roxbury) and Chelsea Creek (Chelsea). These three major pumping stations are connected to the Deer Island WWTP by two deep rock tunnels, 300 feet below Boston Harbor. The tunnels are a significant engineering achievement, since the tunnel to the Chelsea Creek headworks is 4 miles long, while the one to the Columbus Park and Ward Street facilities is 7 miles long (see Figure I-5). Preliminary screening and grit removal is performed at the headworks.

Figure I-6 indicates the overall transport and treatment system for Deer Island. The Deer Island WWTP is a complex primary treatment plant, relying very heavily on sophisticated control mechanisms to control the rate of pumping from the deep rock tunnels. The design flow of the facility is 343 mgd.

FIGURE I-4. METROPOLITAN DISTRICT COMMISSION: MEMBER COMMUNITIES & SEWERAGE SERVICE AREA

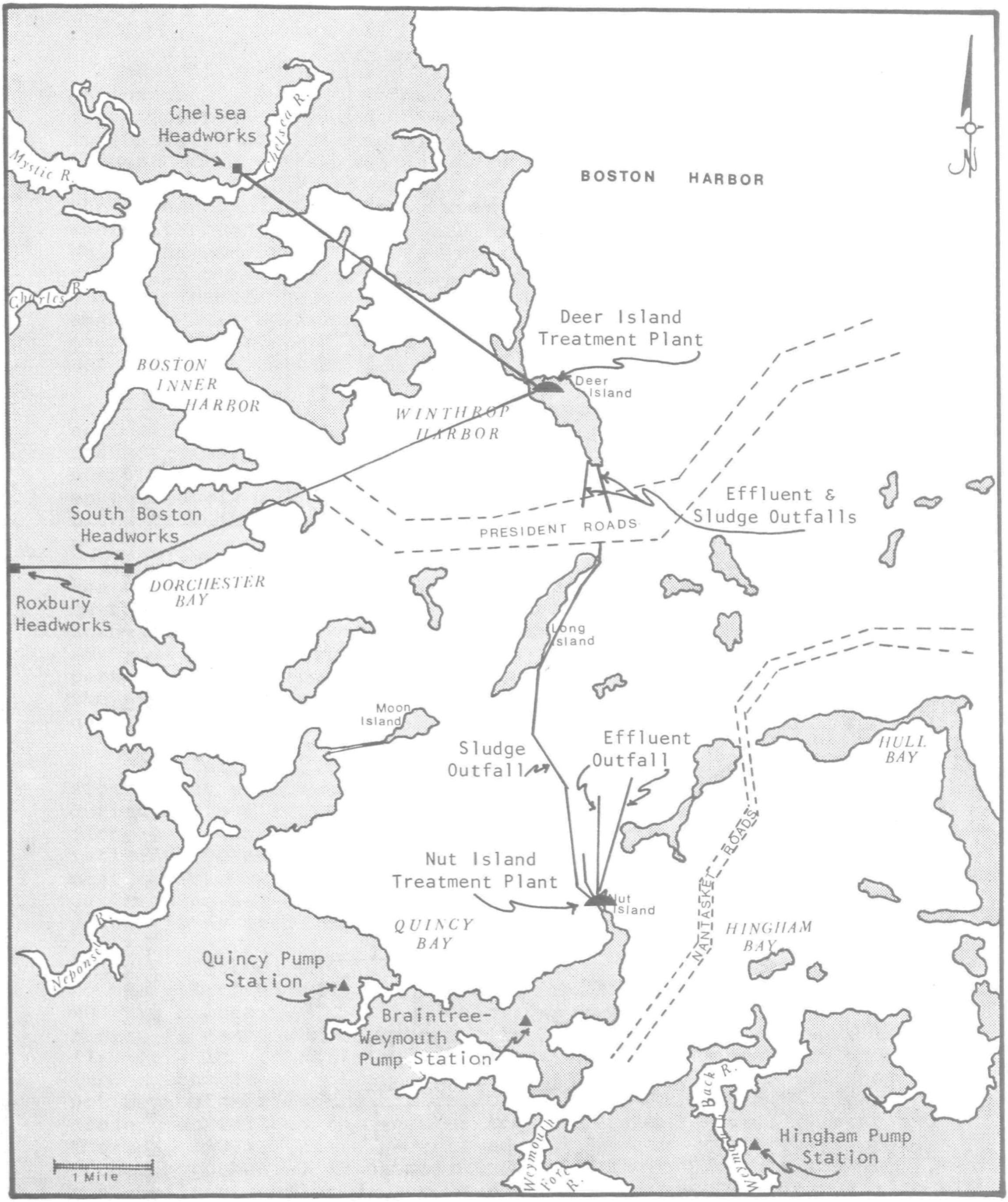


FIGURE I-5. EXISTING MDC SEWERAGE FACILITIES

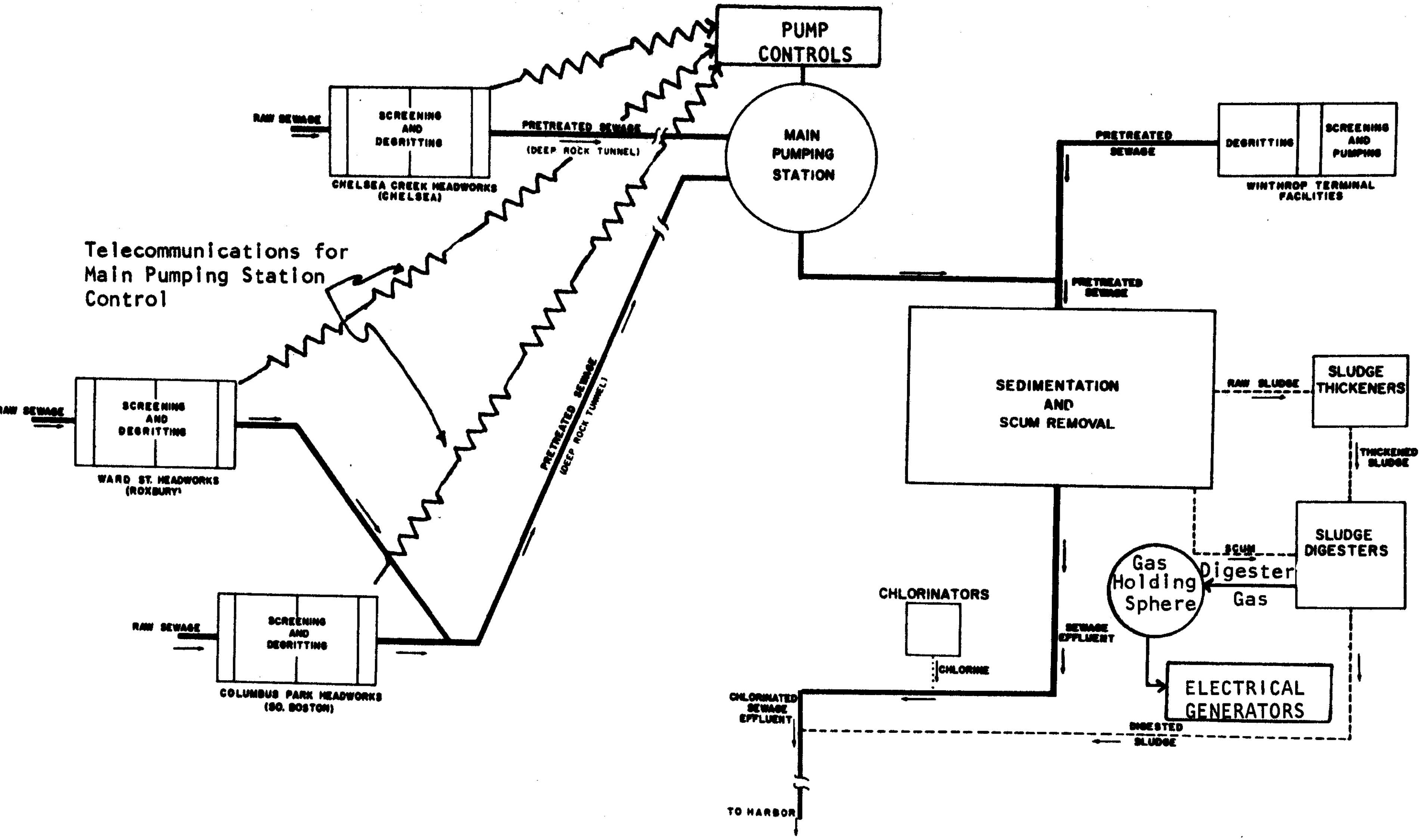


FIGURE I-6. SCHEMATIC OF UNIT PROCESSES, DEER ISLAND TREATMENT PLANT
(Source: Annual Report, Metropolitan District Commission, Sewerage Division)

After the solids have settled in the sedimentation basins they are first thickened, and then digested in three fixed cover anaerobic digesters. Lime is added in the thickening tanks to aid in this process, as well as to aid digestion. A fourth digester serves as a storage tank to allow controlled discharges of digested solids. The gas which is generated in the digesters is used to generate all of the WWTP's electrical energy through combustion in five 998 hp. diesel generators. While the nine radial diesel engines which are used to lift sewage into the plant were designed to operate either on fuel oil or digester gas, operational experience has shown that these engines can only run well on diesel fuel. Therefore, the maximum energy recovery that could be realized by the existing system is not possible because of equipment limitations.

The digested solids are disposed of by discharging to the sea. In present practice, the digested sludge is mixed with chlorinated primary effluent, and discharged for four hours at the beginning of each ebb tide. Of the total solids load discharged, approximately 20% is returned to the harbor area with the next flood tide (Hydroscience, 1971).

Table I-1 presents some of the major operating data for the Deer Island WWTP for five consecutive fiscal years (1973-1977). In the past, the raw wastewater was significantly diluted by substantial quantities of seawater intrusion. MDC personnel attribute its source to defective tide gates; the tide gates are an integral part of the combined sewer network which feeds Deer Island. During the past five years, the MDC has had an active program of tide gate repair.

Initially (through FY 1975) that repair program had a significant effect upon plant capacity and performance. However, during FY 1976 and FY 1977, sea water infiltration has apparently increased such that influent chloride levels have again risen, influent BOD and suspended solids have dipped, and primary treatment efficiency as a whole has dropped. Although digester performance has not dipped as significantly in the recent two years, it is still below the high performance year of 1975.

In the past there has been some difference of opinion as to the relative impact of the high chlorides on digester performance. MDC has maintained that the chlorides have been the predominant factor in causing the historically low rates for gas production (7-9 ft.^{3} lb. volatile solids destroyed). But Havens and Emerson (MDC's consultant) have suggested that the digester efficiency has not been significantly affected by high chlorides, but is more closely correlated to digester temperature and mixing (Havens and Emerson, 1973). While we will not attempt to conclusively prove either hypothesis, it should be noted on Table I-1 that the year that influent choloride levels showed their greatest drop (1974-1975) was the year that gas production had its most significant increase.

TABLE I-1

SUMMARY OF DEER ISLAND TREATMENT PLANT OPERATIONS

[Sources: MDC Sewerage Division Annual Reports]

Operational Parameters	July 1972-June 1973	July 1973-June 1974	July 1974-June 1975	July 1975-June 1976	July 1976-June 1977
Design Capacity (Average Daily Flow)	343 mgd	343 mgd	343 mgd	343 mgd	343 mgd
Actual Average Daily Flow	343 mgd	299 mgd	292 mgd	329 mgd	312 mgd
Operating Capacity	100%	87%	85%	96%	91%
Primary Treatment					
BOD_5, Influent	135 ppm	132 ppm	162 ppm	136 ppm	148 ppm
BOD_5, Effluent	95 ppm	88 ppm	107 ppm	95 ppm	102 ppm
BOD_5, Removal Efficiency	30%	33%	34%	30%	31%
Suspended Solids, Influent	131 ppm	129 ppm	165 ppm	135 ppm	154 ppm
Suspended Solids, Effluent	69 ppm	56 ppm	68 ppm	74 ppm	77 ppm
Suspended Solids, Removal Efficiency	47%	56%	59%	45%	50%
Chloride, Influent	2800 ppm	2600 ppm	1600 ppm	1822 ppm	1803 ppm
Sludge Digestion					
Lbs.Total Solids to Digesters (Dry Wt)	69.0×10^6	69.9×10^6	63.0×10^6	62.5×10^6	56.9×10^6
Lbs.Total Solids Discharged (Dry Wt)	39.3×10^6*	39.1×10^6*	34.1×10^6*	36.3×10^6	33.0×10^6
Total Solids Reduction	43%	44%	46%	42%	42%
Lbs.Volatile Solids to Digesters (Dry Wt)	48.6×10^6	49.9×10^6	46.4×10^6	44.2×10^6	40.9×10^6
Lbs.Volatile Solids Discharged (Dry Wt)	18.5×10^6*	19.0×10^6*	17.0×10^6*	17.2×10^6	16.0×10^6
Volatile Solids Reduction	62%	62%	63%	61%	61%
Digester Gas Production					
Total Gas Production, Cu. Ft.	219×10^6	219×10^6	324×10^6	250×10^6	229×10^6
Cu.Ft. Gas/Lb. Solids Destroyed	7.9	7.9	11.1	9.6	9.7

* Derived value based on reported loadings and percent reductions

c. Nut Island Operations: Nut Island is a 17 acre appendage at the tip of Houghs Neck (see Figure I-5), and is within the corporate jurisdiction of Quincy. The Nut Island facility has been in operation since 1952, and it serves 21 communities, including portions of southern and western Boston. The design capacity of this treatment plant is 112 mgd. The total area served by this plant is 238 square miles, and in 1977 the contributing population was 658,600. The Nut Island treatment plant is served by seven pumping stations, but none of them are of the magnitude of the headworks for Deer Island. Also, the pipeline routes to Nut Island are all via land corridors.

This plant is similar to Deer Island in that it is a primary treatment plant. While Nut Island is significantly older than Deer Island, it has been periodically upgraded in its equipment and operations. Figure I-7 is a schematic representation of the unit processes for the Nut Island WWTP.

In addition to the prechlorination and grit removal (which are also used at Deer Island) the raw sewage is pre-aerated for approximately 20 minutes. Then the wastewater passes through sedimentation tanks where the solids are settled out. The primary effluent is chlorinated before discharge.

The primary solids are not thickened at Nut Island prior to their anaerobic digestion. However, in a manner similar to Deer Island, the digested sludge is disposed of by discharging with chlorinated effluent during the four hour period beginning with each ebb tide. Since the greatest amount of dispersion can be realized by discharge in the area of President Roads, the Nut Island sludge is pumped across Boston Harbor approximately 4.2 miles to the northern tip of Long Island. Here the sludge enters President Roads just a few yards south of the discharge point from the Deer Island WWTP.

Even though the primary solids are not thickened prior to digestion, digester performance at Nut Island is significantly better than Deer Island. While Nut Island processes approximately 1/3 of the entire wastewater flow for the MDC service area, it generates nearly 1/2 of the entire digester gas for the two MDC treatment plants. Apparently because of (a) longer detention time (24 days Nut Island vs. 15 days for Deer Island), and (b) because of significantly lower chloride concentrations, Nut Island is able to produce 3-4 times more recoverable energy per million gallons of influent wastewater (Havens and Emerson, 1973) in the form of gas than Deer Island. Table I-2 presents this and other pertinent operating data for fiscal years 1973-1977.

This abundance of digester gas allows Nut Island to be totally energy independent. Since the pumps at the facility are electrical, there are no fuel compatibility problems. And the digester gases also power the Rootes-type blowers for the pre-aeration tanks. In addition, there is sufficient gas to operate

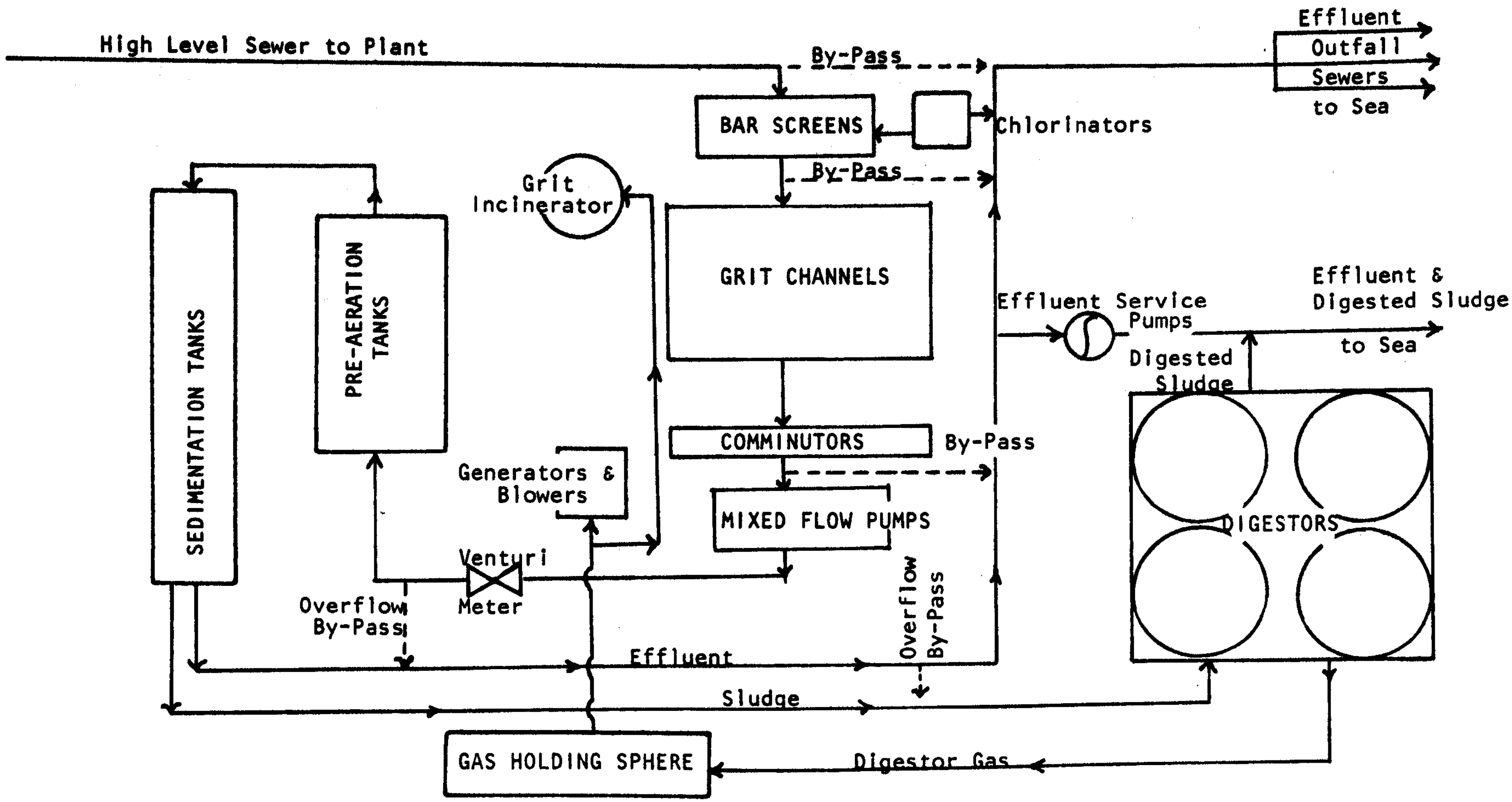


FIGURE I-7. SCHEMATIC OF UNIT PROCESSES, NUT ISLAND TREATMENT PLANT.
[Source: Metropolitan District Commission, Sewerage Division]

TABLE I-2

SUMMARY OF NUT ISLAND TREATMENT PLANT OPERATIONS

[Sources: MDC Sewerage Division Annual Reports]

Operational Parameters	July 1972-June 1973	July 1973-June 1974	July 1974-June 1975	July 1975-June 1976	July 1976-June 1977
Design Capacity (Average Daily Flow)	112 mgd	112 mgd	112 mgd	112 mgd	112 mgd
Actual Average Daily Flow	144 mgd	139 mgd	138 mgd	123 mgd	128 mgd
Operating Capacity	129%	124%	123%	110%	114%
Primary Treatment					
BOD_5, Influent	126 ppm	124 ppm	151 ppm	147 ppm	150 ppm
BOD_5, Effluent	95 ppm	88 ppm	119 ppm	122 ppm	120 ppm
BOD_5, Removal Efficiency	25%	29%	21%	17%	20%
Suspended Solids, Influent	218 ppm	250 ppm	200 ppm	209 ppm	199 ppm
Suspended Solids, Effluent	121 ppm	114 ppm	103 ppm	113 ppm	109 ppm
Suspended Solids, Removal Efficiency	45%	59%	49%	46%	45%
Sludge Digestion					
Lbs.Total Solids to Digesters (Dry Wt)	46.3×10^6	45.5×10^6	43.3×10^6	33.1×10^6	36.7×10^6
Lbs.Total Solids Discharged (Dry Wt)	24.1×10^6*	24.1×10^6*	21.7×10^6*	16.5×10^6	19.1×10^6
Total Solids Reduction	48%	47%	50%	50%	48%
Lbs.Volatile Solids to Digesters (Dry Wt)	36.2×10^6	35.5×10^6	34.2×10^6	26.2×10^6	28.9×10^6
Lbs.Volatile Solids Discharged (Dry Wt)	14.4×10^6*	14.2×10^6*	12.7×10^6*	9.7×10^6	11.3×10^6
Volatile Solids Reduction	61%	60%	63%	63%	61%
Digester Gas Production					
Total Gas Production, Cu. Ft.	319×10^6	285×10^6	299×10^6	225×10^6	233×10^6
Cu.Ft. Gas/Lb. Solids Destroyed	14.5	13.4	13.7	13.6	13.2

* Derived value based on reported loadings and percent reductions

the Nichols three-hearth multiple hearth incinerator which is used to burn screenings and grit. Ash from the incinerator is presently discharged to President Roads along with the digested sludge.

Nut Island has recently put into operation a Water-grate (brand) of grease incinerator. The large amounts of grease that accumulate at the Nut Island plant are a particularly bothersome operational problem.

As can be seen from Table I-2, the Nut Island facility has consistenly been hydraulically overloaded in recent years. Although the degree of overloading has been slowly dropping, the removal efficiencies for BOD and suspended solids has been somewhat variable, and have not shown a consistent improvement.

B. Purpose of the Proposed Project

1. Chronology of Administrative and Planning Activities

In order that this EIS may be put into the perspective of sludge management planning for Boston Harbor, a brief history and chronology of related activities will be presented first. This history is outlined schematically in Figure I-8.

The current planning for the disposal of sewage sludge generated in the Metropolitan Boston area had its genesis in May, 1968. At that time, the Federal Water Pollution Control Administration convened an enforcement conference to discuss with the Commonwealth of Massachusetts the adverse economic and public health impacts that wastewater was having on the shellfishing areas of Boston Harbor. In addition, the conference addressed the total impacts on the water quality of Boston Harbor.

Approximately one year later, in April, 1969, the enforcement proceeding was reconvened, and is referred to as the Second Enforcement Conference. This conference was called to discuss the progress made on the recommendations that were put forth in the First Conference. But most importantly, it made the following recommendations:

a) that a "consulting firm be retained" to evaluate the tidal and current patterns and the dispersion characteristics of Boston Harbor, particularly as it effects the Deer Island and Nut Island treatment plants. Evaluation would include....the determination of mixing zones and recommendations for sludge disposal and chlorination practices.

b) "Provide an evaluation and recommendation as to the most practical and economical solution to the....effects of tributary streams and combined sewer overflows."

In implementing the first recommendation, the Massachusetts Division of Water Pollution Control (DWPC) retained the firm of Hydroscience, Inc., to describe the hydrographic conditions of Boston Harbor. That hydrographic model reached the following conclusion: "that the present practice of discharging sludge for the first three hours of ebbing tide results in the deposition of approximately 15 to 20 percent of the sewage sludge solids in the portion of the harbor west of Deer Island."

The results of the Hydroscience model prompted the DWPC and the Metropolitan District Commission (MDC), operator of the Deer and Nut Island facilities, to sign a Memorandum of Agreement on October 1, 1971. This memorandum, supported by the EPA, stated that the MDC would:

> 1) "Study alternative methods for the disposal of sludge from the Nut Island and Deer Island Treatment Plants and file a report on alternative methods with the Secretary of Environmental Affairs and the Division on or before April 1, 1972;
>
> 2) "Prepare a preliminary engineering report indicated by the results of the above study for submission to the Secretary of Environmental Affairs and the Division by April 1, 1973..."

The Memorandum of Agreement was signed one week prior to the Third Enforcement Conference, which convened on October 7, 1971. At that third conference, representatives of the DWPC stated "that the sludge disposal practices at these facilities (Deer and Nut Islands) are not suitable to meet water quality standards," those standards being class "SB."* And that "alternate methods of sludge disposal by the MDC are required to increase the overall efficiency of the treatment plants..." The DWPC presented to the conferees a list of proposed recommendations which were essentially incorporated as the recommendations of the Third Conference. Those that dealt with the sludge management problems stated that:

> The MDC should complete a study of the alternative methods for the disposal of sludge from its Nut Island and Deer Island treatment plants by April 1, 1972; and a specific solution chosen and construction implementation schedule to be prepared by July 1, 1972.

As a result of both the Memorandum of Agreement and the Third Enforcement Conference, the MDC established a Boston Harbor Pollution Task Force. In April, 1972, the Task Force presented its recommendations; their original mandate was to screen on a preliminary basis all possible sludge management schemes; and to come up with those alternatives which it considered feasible for detailed engineering and environmental analysis. The Task Force recommended that three major sludge handling and disposal methodologies be evaluated in detail:

*Class SB requires salt water capable of fishing and contact recreation, such as swimming.

1) wet air oxidation,
2) land application, and
3) incineration.

Just prior to the completion of the Task Force report, the MDC, DWPC, and the EPA were preparing a tripartite agreement which essentially set up a detailed implementation schedule for wastewater management in the Eastern Massachusetts Metropolitan Area. Two major courses of action were set in motion as the result of this Three Party Agreement (finally signed in July, 1972): First, the Eastern Massachusetts Metropolitan Area (EMMA) Study for the long-range management of wastewater in Eastern Massachusetts was initiated; and second, the final steps in the early planning for the sludge management problem were completed.

In the fall of 1976, EPA contracted with Greeley and Hansen Engineers to prepare for the Region an environmental impact statement that assesses the technical environmental and institutional feasibility of the EMMA recommendations for secondary treatment. The completion of the MDC Secondary EIS is now scheduled for the summer of 1978. This EIS will make recommendations for the location and type of wastewater treatment and sludge disposal facilities necessary to meet the minimum secondary treatment requirements of PL92-500.

In August, 1973, MDC's consultant, Havens and Emerson, Inc. of Cleveland, Ohio, completed the Proposed Sludge Management Plan for the MDC. The completion of this plan satisfied the requirements of the Three Party Agreement, and was the logical follow-on to the Task Force recommendations. Havens and Emerson was mandated by MDC to investigate the three alternative sludge handling and disposal techniques recommended by the Task Force.

In its most essential form, the sludge management plan proposed by MDC consisted of the following:

> Digested sludge from Nut Island would be pumped across the Harbor to Deer Island. There it would be combined with the digested sludge at Deer Island, and burned in several multiple hearth incinerators.

Since MDC was intending to apply for Federal funding on this project, it was required to prepare an environmental assessment stating the anticipated environmental impacts that would result from the proposed project. The environmental assessment statement was completed in April, 1975, and the required public hearing was held in May, 1975.

Partly as a result of that hearing, and partly because of prior knowledge of the public controversy that was rising around the proposed plan, the Environmental Protection Agency issued a "notice of intent" whereby it gave public notice that a formal environmental impact statement would be prepared in accordance with the National Environmental Policy Act of 1969, and 40 CFR Part 6 (April 14, 1975 Federal Register).

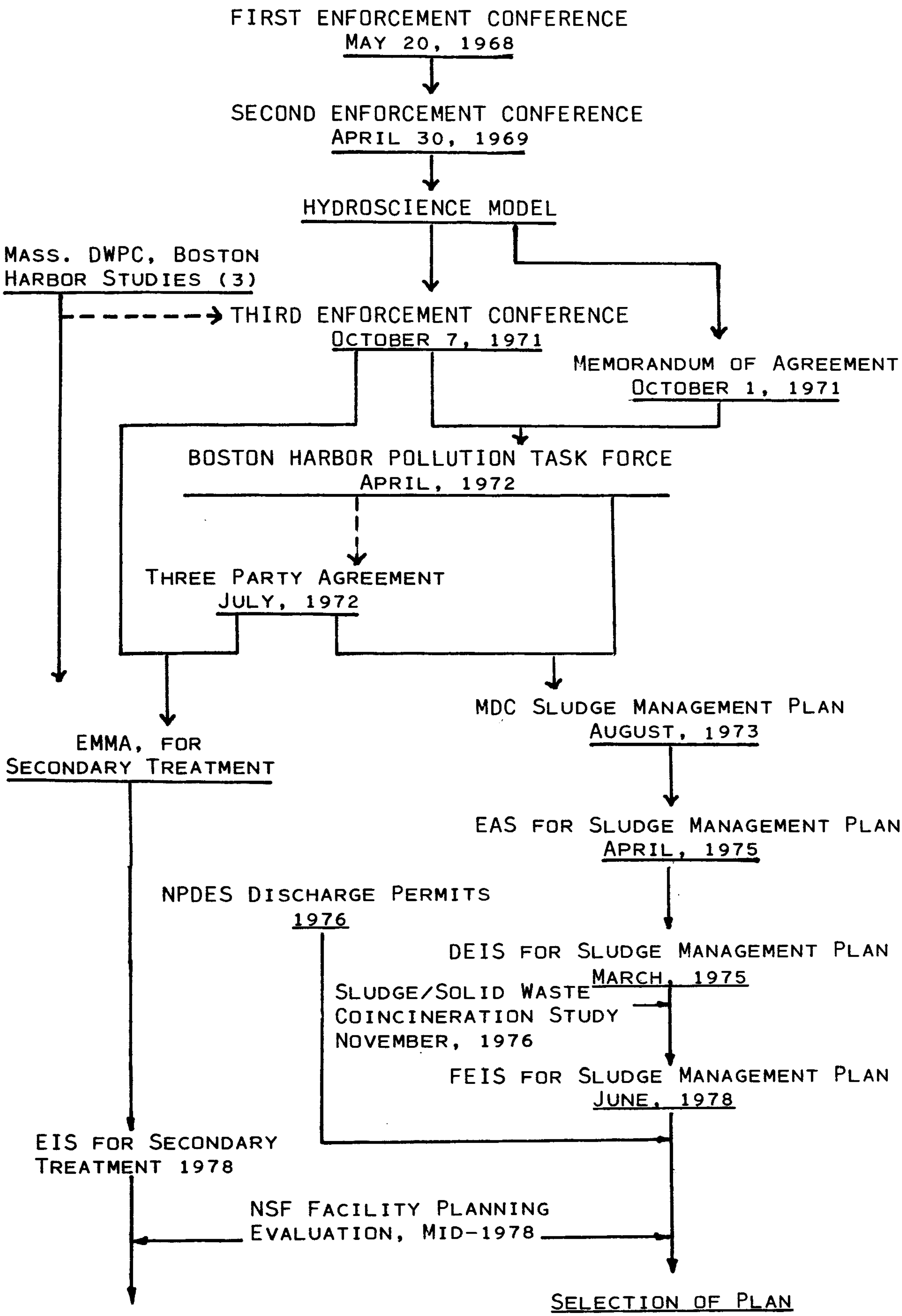


FIGURE I-8. CHRONOLOGY OF THE PLANNING FOR SLUDGE MANAGEMENT IN BOSTON HARBOR

In June, 1975, EPA Region I contracted with EcolSciences, inc. to assist the Region in preparing the Environmental Impact Statement. Their responsibility was to investigate in detail the following four major alternatives for the handling and disposal of primary sludge, and to determine the most environmentally acceptable and cost effective method of treating sludge by one of the following four methods:

1) sludge incineration,
2) land application,
3) ocean disposal
4) no action.

The formal Draft EIS was published in March, 1976.

Subsequent to the publication of the Draft EIS, EPA Region I and MDC cosponsored a study (conducted by Stone and Webster, Inc.) which investigated the feasibility of incinerating MDC wastewater sludges with solid waste from the City of Boston. The conclusions of that analysis were:

coincineration of sludge and waste was technically and environmentally feasible,

coincineration was not economically feasible when compared to separate treatment because of treatment costs,

the conditions necessary for economically feasible coincineration were:

having solid waste and sewage treatment at the same locale,

having one agency responsible for solid waste and wastewater management,

having a proximate market for steam generated by the coincinerating; and

having federal grants available for solid waste disposal similar to the water pollution control grant program.

In addition to the studies previously listed that have been directed towards the resolution of the sludge management problems per se, the National Science Foundation initiated a special study in mid-1976 to review and assess the EPA facility planning process in the Boston metropolitan area. Boston was selected as an example situation, and is the east coast equivalent of a similar study conducted by NSF for Sacramento, California. The results of that investigation will not be complete until mid- or late-1978. While this review may have some impact on EPA's facilities planning program at the national level, it is not expected to materially affect the Boston Sludge Management Plan per se.

Since the Draft MDC Secondary EIS is presently underway, and the implementation schedule for secondary treatment at the MDC facilities may yet be modified, it was felt that the disposal of primary sludge (through the near future) represented the most concrete set of operating conditions which could be projected, and still address the main issue.

2. Goals and Objectives

The purpose of the proposed project is to improve the quality of the tidal waters in Boston Harbor, and to satisfy the goals and objectives of the Federal Water Pollution Control Act Amendments of 1972 (PL 92-500). Provisions of PL 92-500 (Section 101) require the elimination of pollutant discharges into navigable waters by 1985 and the development and implementation of waste treatment management process by each state. National interim water quality goals (to be attained by 1983) propose the attainment of water quality which provides for "the protection and propagation of fish, shellfish and wildlife and provide for recreation in and on the water..."

PL 92-500 does specify minimum treatment technology. The Amendments have two target dates for providing this technology. By June, 1977, all municipal sewage treatment plants must provide a minimum of secondary treatment or its equivalent. "Secondary treatment is generally considered to encompass the various biological processes used to treat organic wastes still present after primary treatment." For implementation purposes it is also defined in terms of a minimum level of effluent quality attainable by these processes as reflected by BOD_5, suspended solids, fecal coliform bacteria, and pH. The maximum values for these constituents in secondary treated effluent are (40 CFR, Part 133, Subpart D):

BOD_5:	arithmetic mean for a period of 30 consecutive days not to exceed 30 mg/l
	arithmetic mean for a period of 7 consecutive days not to exceed 45 mg/l
Suspended Solids:	arithmetic mean for a period of 30 consecutive days not to exceed 30 mg/l
	arithmetic mean for a period of 7 consecutive days not to exceed 45 mg/l

Fecal Coliform Bacteria:	geometic mean for a period of 30 consecutive days not to exceed 200 per 100 ml

July 1, 1983 is the second target date given in PL 92-500. By that time municipal waste treatment plants will be required to provide "best practicable waste treatment technology" (BPWTT). For receiving waters which will not be degraded below the classification set for them, i. e., Classes A, B, C, SA, SB and SC by secondary treatment and discharge, BPWTT requirements will usually be met by secondary treatment processes. Such receiving waters are termed "effluent-limited." Treatment beyond secondary treatment may be required for sewage treatment plants on effluent-limited areas where the effluent will contribute nutrients or toxic materials in concentrations high enough to interfere with proposed uses of the water. For waters which will not be adequately protected by secondary treatment, additional treatment process or alternative disposal techniques will be required under BPWTT. Such waters are termed "water-quality-limited." In October, 1975 EPA proposed a series of criteria to identify what constitutes BPWTT (Office of Water Program Operations, 1975). The proposed criteria address the three waste management techniques mentioned in PL 92-500, e.g., land application, treatment and discharge to surface waters, and reuse.

State water quality standards vary according to the category of use for the surface waters involved. Class A waters are suitable for drinking water use without further treatment except simple disinfection. Class B waters are fit for swimming and fishing, and Class C waters can be used for fishing, but not swimming. By these definitions, only Class A or Class B waters would meet the 1983 national goals. The saltwater counterparts for the above classifications (SA, SB, SC) have similar levels of usage, except SA quality waters allow shellfishing to occur. (See Appendix B for definitions of water quality classes.)

In the case of Boston Harbor, the Massachusetts Division of Water Pollution Control, the Metropolitan District Commission, and the U. S. Environmental Protection Agency are jointly involved in translating the national goals into the local objective of significantly increasing the quality of Boston Harbor to meet its existing classification especially in the area of providing safe shellfishing areas. This latter objective was the initial stated reason for convening the enforcement conferences which have led to the present level of planning.

The Clean Water Act of 1977 (PS 95-217) contains several provisions which are germane to MDC's and EPA's wastewater and sludge management planning. Specific provisions have been made to allow upwards of $15 million to be spent for the construction of a new Sulfolk County correctional facility, since the present prison occupies a portion of Deer Island that might be used for a secondary treatment plant.

Section 301 of the Clean Water Act provides for communities that can show that existing deep marine discharges require less than secondary treatment, a case-by-case waiver procedure that must be requested by September 24, 1978. MDC made the requisite filing on September 18, 1978.

Section 301 also provides for extensions of the July 1, 1977 municipal secondary treatment deadline on a case-by-case basis provided that the municipality applies for that extension within 180 days from December 27, 1977. The maximum extension of that deadline would be up to July 1, 1983.

As of the time that this Final Environmental Impact Statement (FEIS) is being prepared, the MDC has not applied either for an extension of the secondary treatment guideline nor the waiver for secondary treatment itself.

The Resource Conservation and Recovery Act of 1976 (PL 94-580, RCRA) among other provision, classifies sludge from waste treatment plants as a solid waste. Regulations published in the Federal Register on February 6, 1978 set forth guidelines for the disposal of sludges (or their ashes) in sanitary or hazardous waste landfills, or for land application. This law and its regulations have had significant impacts on the ultimate disposal options available for the MDC generated sludges. The ramifications of RCRA sludge disposal planning will be examined and utilized in greater detail in Section III.

On December 27, 1976, EPA published in the Federal Register a series of regulations which are referred to as the "Interpretive Ruling." Specifically, the Interpretive Ruling governs the analysis of new sources of air pollutants, and whether or not such new sources need to be compensated for by concomittant reductions within the same air shed. In addition, Ammendments to the Clean Air Act were passed (as PL 95-95) in August, 1977.

Among other provisions, the 1977 Clean Air Act Amendments pertains to the Prevention of Significant Deterioration (PSD) in air quality maintenance areas, and that determinations of best available control technology be performed on a case-by-case basis. In addition, PL 95-95 increased the number of air pollutants covered by the Clean Air Act and redefined a major source as either one of the designated 28-sources having the potential to emit 100 tons per year, or any other source having the potential to emit 250 tons per year, of any one of the pollutants regulated under the act. Therefore, since the publication of the Boston Sludge Draft EIS oxides of nitrogen and hydrocarbon have been added to the list of regulated air pollutants that are to be addressed in the Final EIS. The results of this revised analysis are presented in Section IV.

The Commonwealth and the MDC have fully acknowledged that the sludge which is presently discharged to the Harbor must be disposed of in a more environmentally sound manner. In MDC's view, since sludge will be generated by both primary and secondary treatment processes, any sludge disposal program should be capable of handling both types, and that the decisions on how to handle that sludge is an integral part of the treatment requirements.

Our present objective is to determine what is the most cost effective and environmentally sound manner for disposing of the primary sludges which are generated at the existing MDC waste-water treatment facilities, both now and into the immediate future (1985). Such a course of action will remove approximately 80% of the sludge BOD load and an even larger portion of the sediment load now imposed on Boston Harbor by the digested sludge, while at the same time allowing discussions and planning to proceed. This planning will eventually satisfy the local objectives and the national goals as stated in PL 92-500 in a manner that satisfies all pertinent federal environmental regulations.

C. Applicant's Proposed Project

1. General Description

In fulfillment of the objectives for removing sludge from Boston Harbor, the Metropolitan District Commission retained the firm of Havens and Emerson (Cleveland, Ohio) to investigate three sludge handling and disposal alternatives (wet air oxidation, land application, and incineration). The results of that investigation were presented to the MDC in 1973 as a two phase plan. Phase I would incinerate the sludge generated at the existing primary facilities through the year 1985, at which time secondary treatment facilities would be completed. With the advent of secondary treatment and its resultant sludge, the project would move into Phase II, which would accommodate primary and secondary sludge volumes through the year 1995.

The Phase I plan is presented below, and the total project plan is presented in Appendix C. The following sections are verbatim extractions from the Havens and Emerson "A Plan for Sludge Management," 1973.

The recommended Phase I project plan is presented as the initial phase of plant expansion to provide sludge management facilities for the immediate needs in meeting the 1976 EPA requirements, and as a transition phase between current conditions and the reoommended 1995 plans. The Phase I Plan is based upon primary treatment only at both plants, but with expansion of primary facilities at both plants to handle flows expected through the year 1985. The recommended plan (Phase II) includes converting anaerobic digestion tanks to sludge storage tanks because the expansion of anaerobic digestion facilities did not prove economical. During Phase I, however, it is beneficial to continue use of the anaerobic digestion facilities and to extend this use period to approximate the "useful life" of the major portion of mechanical equipment associated with this process. The Phase I Project Plan is shown schematically on Figure I-9.

Nut Island: Phase I at Nut Island involves continuation of the use of anaerobic digestion. Approximately 90 percent of all raw sludge will go to digestion with the remainder by-passing digestion for direct transfer to Deer Island. Under these conditions the Nut Island digestion tanks will provide approximately 24 days detention at average 1985 conditions. Favorable gas production should continue at Nut Island and the generation of electric power from digester gas should continue. It is estimated that sufficient electrical energy will be provided to continue to supply the total Nut Island power requirements for primary treatment to the period 1980-1985.

A new sludge pumping facility will be provided to transfer sludge to Deer Island. These pumps will be high head, centrifugal, non-clog pumps. Two pumps will be provided with one serving as stand-by. The existing sludge disposal line will be extended to Deer Island and a new parallel sludge force main will be provided. All sludge will go through a grinder before pumping to Deer Island to reduce force main maintenance problems. Daily pumping will average about six hours at 1985 conditions. Following pumping of sludge, sewage or supernatant would be pumped to purge the sludge line to prevent sludge sedimentation and to keep the pipe walls clean. Alternate use of the parallel force mains is suggested to keep facilities at peak efficiency.

Deer Island: Phase I incorporates use of the existing sludge facilities, and addition of a new sludge disposal building. Although the recommended ultimate plan does not include thickening of raw primary sludge, it is recommended that the existing gravity thickeners at Deer Island continue in service to handle raw sludge during the Phase I program.

Anaerobic digestion will be continued until secondary treatment is added, but no additions would be made to the digestion system. Approximately 90 percent of the thickened primary solids will go to anaerobic digestion. Digester gas will be captured and utilized for generation of electrical energy using existing generation equipment.

The total sludge output from Deer Island and Nut Island will be blended and taken to the sludge disposal building. The sludge will be chemically conditioned, vacuum filtered, and incinerated in multiple hearth incinerators. The total incineration load will include filter cake, grit and screenings, and skimmings.

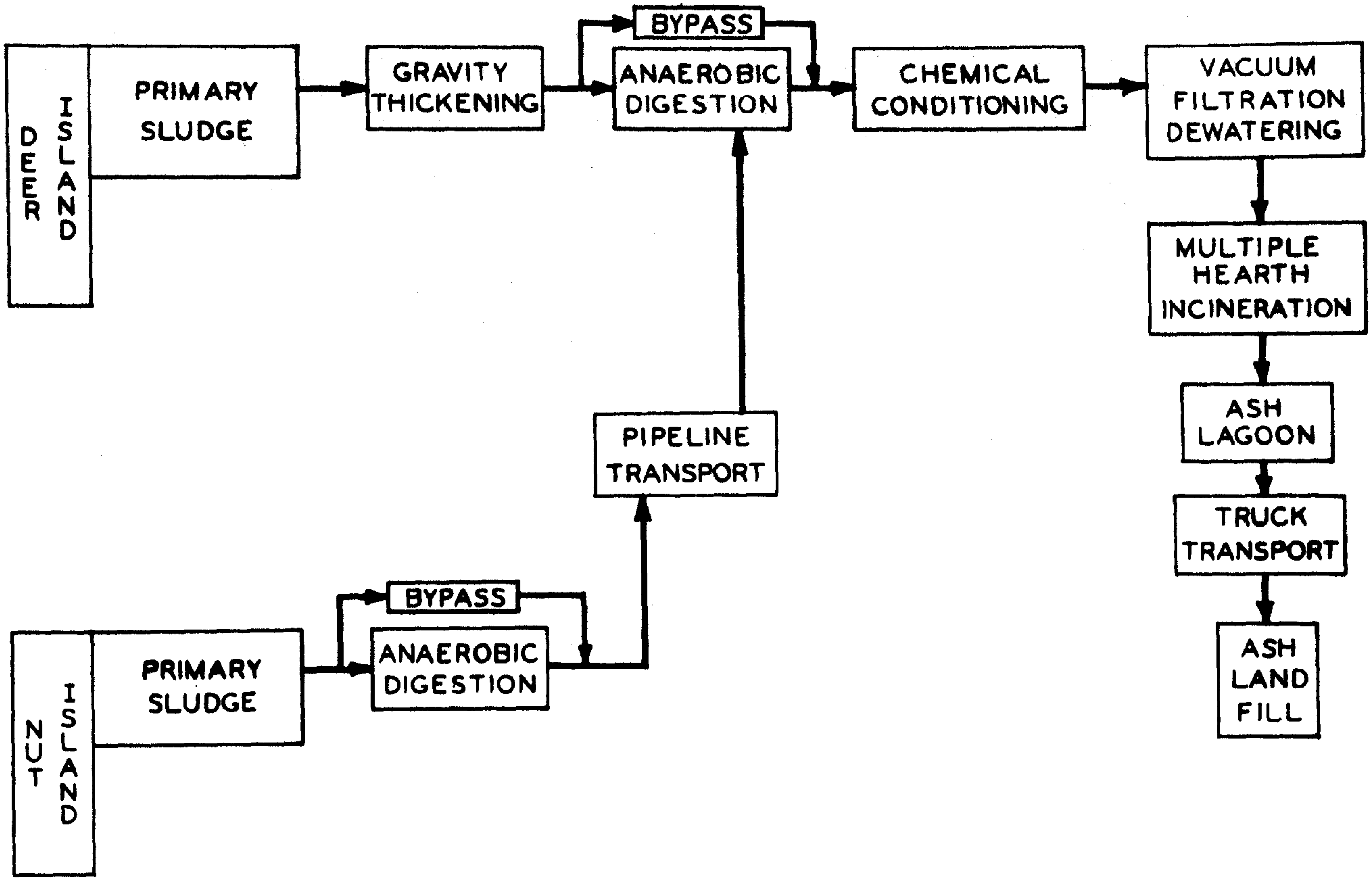


FIGURE I-9. WASTE SLUDGE MANAGEMENT SCHEMATIC: RECOMMENDED PHASE I PROJECT PLAN (1985) (Source: Havens & Emerson 1973)

Grit and screenings from the remote sites (MDC beaches) will be trucked to the sludge disposal building at Deer Island for disposal by incineration. A receiving station will house grinding equipment and storage hoppers. The material will be elevated and discharged into the incinerators. Grinding of the screenings will facilitate the conveying and feeding to the incinerator. This plan is based upon grinding all screenings at the sludge disposal building; however, should there be a problem of keeping grit and screenings separated during transit to Deer Island, grinding facilities could be located at the source. Deer Island skimmings will be transferred to the sludge disposal building, concentrated and introduced into the incinerators for disposal. Grit, screenings, and skimmings at the Nut Island plant will be incinerated as currently practiced. An enlarged Nut Island grit, screenings and skimmings disposal capability is proposed with the expansion of primary and secondary treatment processes.

The Phase I Plan at Deer Island will include waste heat recovery from the incinerator exhaust gases, and the generation of electric power from this energy source. The existing dual fuel engine generators will continue operation utilizing digester gas. Outside electric power supply should be provided to supplement on-site generated power, and for stand-by service for the turbo-generator set.

The construction of ash lagoons will be deferred until a later date. During Phase I, incinerator ash would be pumped to the western edge of the plant site. The ash will provide about 30,000 cubic yards of fill per year.

2. Basic Design Criteria - Phase I

The basic design criteria for the Phase I program is listed below. Loadings are for average conditions unless otherwise noted.

NUT ISLAND

1. Anaerobic Digestion (Existing)	
No. and Size	4 @ 110' diam. x 30' SWD
Detention	24 days
2. Sludge Pumping to Deer Island	
No. and Size	2 @ 1000 gpm
Average Daily Flow	270,000 gpd (190 gpm)

DEER ISLAND

3.	Gravity Thickeners (Existing)	
	No. and Size	4 @ 55' diam.
	Solids Loading	27 lbs./sf/d
4.	Anaerobic Digestion (Existing)	
	No. and Size	4 @ 108' diam. x 30' SWD
	Detention	24 days
5.	Vacuum Filters	
	No. and Size	6 @ 750 sf
	Filter Yield, Avg.Day (3 units)	4.4 lbs./sf/hr
	Max.Day (4 units)	4.0 lbs./sf/hr
6.	Incinerators	
	No. and Size	3 @ 25'-9" diam. x 9 hearths
	Rated Capacity, each	410 wet tons/day
	Loading Rate, Avg.Day (2 units)	7.2 lbs./sf/hr
	Max.Day (2 units)	10.2 lbs./sf/hr
7.	Turbine Generators	
	No. and Size	1 @ 3400 KW

3. Estimates of Cost - Phase I

Table I-3 summarizes capital costs for Phase I. These costs are based on current (1973) price levels. The electrification of the raw sewage pumps have been included in Phase I and this cost includes an estimated salvage value of $180,000 for the nine dual fuel engines.

Table I-4 presents the total annual cost for Phase I. The credit for recovered energy accounts for electric power generated from digester gas and waste heat recovery.

TABLE I-3

CAPITAL COSTS

PHASE I

[Source: Havens and Emerson, 1973]

NUT ISLAND	
Sludge Pump Station and Pipelines to Deer Island	$ 4,852,800
DEER ISLAND	
Electrification of Raw Sewage Pumps (1)	$ 1,920,000
Vacuum Filters and Incinerators	12,009,600
Power Generation Station	2,435,000
Miscellaneous Facilities (2)	798,500
Total for Deer Island	$17,253,100
TOTAL PROJECT COST (Rounded)	$22,016,000

(1) After allowance for $180,000 salvage value for 9 engines.

(2) Includes service water facilities, gravity thickener odor control, tunnels, and yardwork.

TABLE I-4

TOTAL ANNUAL COSTS

PHASE I
(1985)

[Source: Havens and Emerson, 1973]

Total Capital Cost	$22,016,000
Amortized Capital Cost[1]	1,446,500
Annual Operation and Maintenance Costs:	
Fuel and Power	$ 329,000
Chemical Costs	273,200
Maintenance	146,000
Manpower	1,120,000
Total Operation and Maintenance	$ 1,868,200
TOTAL	$ 3,414,700
Credit for Recovered Energy	$ - 318,000
TOTAL ANNUAL COST	$ 2,996,700

[1] Power generation facilities - 5% at 25 years, other facilities 5% at 30 years.

SECTION II

ENVIRONMENTAL SETTING

This section describes the present environmental setting of the two major study areas; i.e., the Commonwealth of Massachusetts, and the Boston Metropolitan Area. In those sections where the entire State of Massachusetts is discussed, general characteristics are described whenever possible; and when the Boston Metropolitan Area is of concern, the level of description becomes much more detailed. The environmental setting is described in the following subsections:

Topography
Geology
Soils
Hydrology
Ecology
Crops
Environmentally Sensitive Areas
Air Quality
Noise
Public Health
Historical and Archeological Sites
Energy Resources
Transportation
Aesthetics
Population and Socioeconomic Character
Land Use and Planning

Information developed in this Section will be incorporated into the analysis of the proposed project's environmental impact, and into the analysis of the feasible alternatives to the proposed plan.

II. ENVIRONMENTAL SETTING

A. Topography

The Commonwealth of Massachusetts contains a varied landscape due in part to the glacial ice sheets which have altered the original character of the land. These glaciers moved in from the north, carrying rocks and soil which modified the mountains and rivers. During this retreat, they left a cover of debris which has resulted in the rugged character of the land.

The State can be divided into several physiographic regions. The coastal lowlands extend from Narragansett Bay on the south, to New Hampshire near the Merrimack River on the north. The area encompasses the eastern portion of Massachusetts. The entire coastline appears to have been submerged early in the geologic age of Massachusetts and later uplifted to develop the rocky coast. The northeastern section of the coast has many outcroppings of rock because the bedrock is close to the surface. The southeastern section is much smoother, having long beaches and fewer outcroppings. The Cape Cod peninsula reflects this feature, having long stretches of grassland and sand dunes.

The interior of the Commonwealth contains two large valleys. The Berkshire Valley is enclosed by the Berkshire plateau and the Taconic Mountains, and the Connecticut River Valley is enclosed by the Berkshire plateau and the uplands of Worcester County. The uplands on both sides of the Connecticut River join to the north of the Valley to form the central uplands of northern New England.

The Taconic Range on the State's western border is an extension of the Green Mountains of Vermont. The highest point in Massachusetts, Mt. Greylock at 3,491 feet, is located in this range. The elevations in the southern part of the range are considerably lower.

The entire State is located within the New England Physiographic Province. Elevations along the coast range from sea level to 100 feet. In the uplands of Worcester County they reach as high as 1,000 feet and in the Berkshires, the elevations reach 2,000 feet (Mass. Dept. Comm. and Devel., 1970).

The State has several major and minor river basins which are illustrated in Figure II-7.

B. Geology

1. Continental

Since the geology of an area is best described in terms of its historical development, Table II-1 summarizes the geologic time periods which are discussed below. The eastern section is

TABLE II-1

GEOLOGIC TIME SCALE

[Source: National Park Service, 1970; Hunt, 1967

Era	Period	Geomorphic Occurrences	Approx. No. of Million Years
Cenozoic	Quartenary Recent Pleistocene	Soil and Alluvium Glaciation and Drift Deposits	0-1
	Tertiary	Uplift and Erosion Cycles	1-60
	Cretaceous	Peneplain formation, burying previous peneplain	60-130
Mesozoic	Jurassic	Erosion cycles; peneplain formation	130-155
	Triassic	Diabase intrusians, extensive faulting; volcanic activity	155-185
	Permian	Appalachian Revolution	185-210
	Carboniferous	Coal-forming forests formed	
	Pennsylvanian	Coal-forming forests	
	Mississippian	Coal-forming forests	210-265
Paleozoic			
	Devonian	Shickshock disturbance, upland formed	265-320
	Silurian	Inland sea	320-360
	Ordovician	Inland sea; volcanic activity	440-520
	Precambrian	Assorted Gneiss, Granites, Gabbro, Schists	520--

composed of metamorphosed and non-metamorphosed rocks believed to be of the Paleozoic Age. The metamorphic rocks along much of the coast contain granitic intrusions and intrusions of other rock types. These areas rise above the sedimentary rock regions which form basins such as the partially submerged basin of Boston Harbor.

Further west, the State is composed of metamorphosed rocks which form the uplands of Worcester County, extending to the Connecticut River Valley. The Valley is composed of sedimentary rocks with Triassic formations that are faulted to the east.

Rising to the west of the Connecticut River Valley are the Precambrian formations of the Berkshire plateau and Hoosac Mountains. These decline to the west where the Berkshire Valley is situated, composed of metamorphosed rock. Enclosing this valley on the western border of the State are the Taconic Mountains which are Cambrian formations.

The Coastal Plain formations surrounding Massachusetts and all of the New England Province are mostly submerged. The outstretched peninsula of Cape Cod and the islands of Nantucket and Martha's Vineyard are the only portions of the Coastal Plain in Massachusetts which are above sea level.

The New England Physiographic Province was greatly modified by Pleistocene glaciation. The structural geology of the area is consequently hidden by the resultant glacial deposits. In the Boston Harbor area, the glacier was responsible for the formation of drumlins or glacial hills, the most famous of which is Bunker Hill. The most recent glacier is also responsible for the formation of the abundant lakes in the New England region. These were formed by the damming of preglacial valleys or by the pitting of the terrain resulting in kettle holes.

The deposition of till in the valleys, which has resulted from glacial movement, made the valleys shallower in many areas. In some cases, the valleys contain fill as thick as 200 feet. These glacial effects have changed the appearance of the Massachusetts landscape, masking the true geology (Hunt, 1967).

The bedrock types found in the Commonwealth of Massachusetts are given in Appendix D (Emerson, 1916).

2. Massachusetts Bay

If it is assumed that the 100 meter depth contour divides the peripheral and central portions of the Gulf of Maine, then the Gulf consists of a bottle-necked basin connected to the open sea by two narrow channels, the most southern channel being shallower than 100 m (see Figure II-1). The Eastern Channel passes between Georges and Browns Banks and the Northern Channel passes between Browns Bank and the Coast Bank. North of the basin rim, the deepest water (>200 m) takes the form of a "Y", with the two arms extending westward and northeastward. More than 10,000 square miles of the Gulf of Maine are deeper than 200 meters, which has numerous, isolated deep holes (Bigelow, 1926A). The southwestern portion of the Gulf is known as Massachusetts Bay. It is bounded on the north by Cape Ann, on the west by the eastern coast of Massachusetts (centered on Boston) and on the south by Cape Cod Bay and Cape Cod (Bumpus, 1974).

The western portion of the Gulf of Maine, adjacent to Massachusetts Bay, includes the Wilkinson and Murray Basins, which have maximum depths of nearly 300 m, and several smaller basins (Rowe, Polloni, and Haedrich, 1975). Both fluvial and glacial erosion have shaped these basins (Rowe, Polloni, and Haedrich, 1975), and if sea levels were again lowered considerably, many rocky ridges and hills would rise above the floor of the basins (Shepard, 1963).

Recent sediments transported into the Gulf by rivers are gradually burying this glacial topography. Both the Wilkinson and Murray Basins are now nearly flat-bottomed, with fine silt-clay sediments 20-25 m thick (Rowe, Polloni, and Haedrich, 1975; Emery, 1966). The large basins also contain gravel and stone (Shepard, 1963). The general distribution and origins of these sediment types for the entire Gulf are shown in Figures II-2 and II-3. In general, the deep basins are characterized by silt-clay sediments, the marginal banks are primarily sand, and the north-eastern Gulf has extensive gravel areas.

Massachusetts Bay's chief topographic feature is a submarine ridge which rises to within 20 meters of the sea surface on the east side of the bay between Cape Ann and Cape Cod (Stellwagen Bank). This ridge blocks free exchange of water at depth with the Gulf of Maine. The basin is deepest to the west of the Bank, 80 m or more, and gradually rises toward the coast. East of Boston and Plymouth the bottom is hummocky and rough. It is generally smooth in Stellwagen Basin, Cape Cod Bay, and on Stellwagen Bank (Bumpus, 1974). In the Boston area, a gravel bottom occurs along the coast and is succeeded seaward by silt-clay sediments in deeper areas, while Stellwagen Bank is primarily sand (Shepard, 1963).

C. Soils and Sediment

1. Soils

Soils in Massachusetts are primarily derived from glacial material. They can be grouped into two general texture categories: coarse-grained and fine-grained (Eastern Mass. Metro. Area Study, 1975).

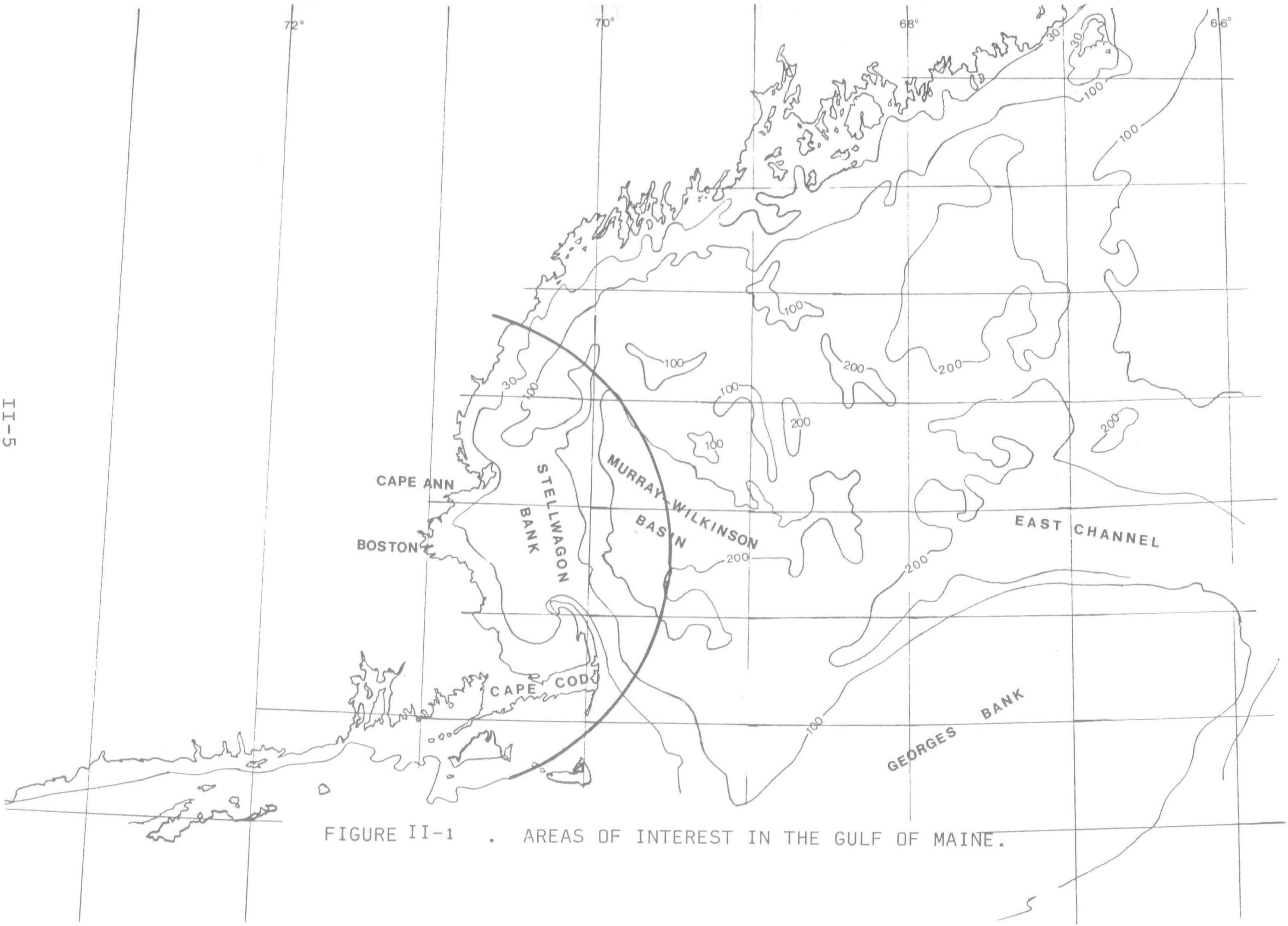


FIGURE II-1 . AREAS OF INTEREST IN THE GULF OF MAINE.

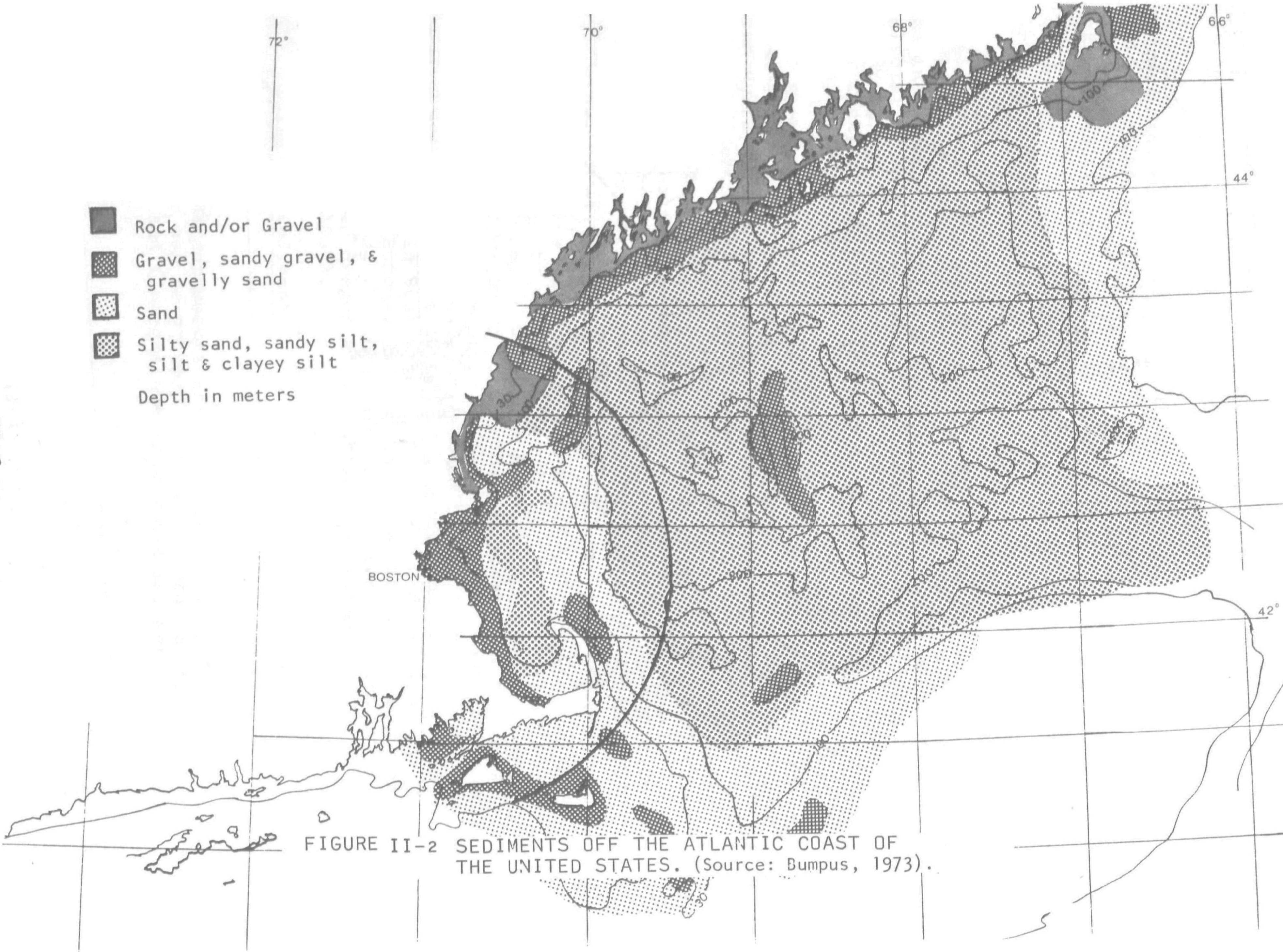


FIGURE II-2 SEDIMENTS OFF THE ATLANTIC COAST OF THE UNITED STATES. (Source: Bumpus, 1973).

FIGURE II-3 . SEDIMENTS OFF THE ATLANTIC COAST OF THE UNITED STATES CALSSIFIED BY CONTRIBUTING AGENT & AGE. (Source: Emery, 1966.)

The EMMA report based its soil data on U. S. Geological Survey Bulletins; U. S. Geological Survey Quadrangle Reports; U. S. Department of Agriculture soil survey publications; The Geography and Geology of the Region Including Cape Cod, the Elizabeth Islands, Nantucket, Martha's Vineyard, No Man's Land and Block Island by J. B. Woodworth and E. Wigglesworth (1934); and the report on the Preliminary Surficial Geology of the Natick Quadrangle by A. E. Nelson (1972).

Coarse-grained soils are subdivided according to the derivation of the parent material. Stratified sediments consisting of mostly sand and gravel were formed from ice contact features, while marine beaches and windblown dunes resulted in sandy soils with very little gravel or clay content. Silty and sandy soils containing minor proportions of clay and gravel were formed from alluvium and river terraces. Soils derived from glacial till are generally clayey or silty sands and gravels (EMMA, 1975).

Fine-grained and/or organic soils are subdivided into: silty and clayey sands from glacial lake bottoms; fine-grained marine deposits; and salt- and freshwater organic soils (EMMA, 1975).

The permeabilities of these soils range from less than 0.2 inches/hour to greater than 6.3 inches/hour, with the median value ranging from 2.0 to 6.3 inches/hour. This is probably due to the large proportion of sandy soils and the low proportion of the clay fraction found in each soil. The clay fraction ranges between 0 and 41.5% in representative soils, with 7% being a median value (U.S.D.A., 1969; Baker, 1975).

This low clay fraction affects the cation exchange capacity (CEC) of the soils. The clay that is available has a high CEC value, resulting in a range of 4.9 to 29.7 meq/100 grams of soil. This is based on the inorganic portion and may be increased slightly by the organic matter in the soil. The CEC in the top layer of soil, from 0 to about 10 inches deep, has a much higher CEC than the lower layers. Table II-2 indicates the soil fractions and the CEC value.

The soil pH ranges from acidic (3.8) to neutral (7.0). The range for different soil series is commonly pH 4.5 to pH 5.5. In order to make these soils suitable from crop production liming is often necessary.

The soils most favorable for crops in Massachusetts are generally loams; primarily fine sandy and silt loams. They are characterized by a high permeability rate, low rock content, little erosion potential and being nearly level. Most of the soils have a low natural fertility, requiring fertilization in order to produce a satisfactory crop (USDA, 1969). Soil series well suited for corn and hay production include: Agawan, Bernardston, Enfield, Essex, Hadley, Merrimac, Shelburne, and Warwick (USDA, 1967, 1969).

TABLE II-2

CHARACTERISTICS OF REPRESENTATIVE SOIL SERIES

[Source: J. H. Baker, 1975; USDA, 1967]

Series	Percent Sand	Percent Silt	Percent Clay	Percent Organic Matter	CEC meq/100g
Agawan	36.7	59.8	3.5	11.2	17.0
Blandford	44.2	49.9	5.9	7.9	12.0
Charlton	39.4	49.4	11.2	5.5	12.5
Coloma	49.3	45.5	5.2	12.0	18.8
Dover	68.2	28.6	3.2	5.0	16.9
Dover	57.3	40.4	2.3	11.3	17.5
Gloucester	62.5	36.2	1.3	5.5	8.7
Gloucester	52.3	40.2	7.5	10.2	14.1
Gloucester	71.1	24.0	4.9	----	11.7
Gloucester	65.3	20.0	14.7	----	20.0
Hadley	55.7	40.4	3.9	1.5	4.9
Hinckley	61.3	34.7	4.0	2.6	5.7
Hinckley	57.4	39.5	3.1	2.5	7.6
Hollis	36.1	53.2	10.7	7.2	13.0
Lenox	42.0	48.9	9.1	4.7	6.8
Marlow	49.8	38.1	12.1	----	26.9
Merrimac	64.6	31.8	3.6	5.0	8.0
Orono	2.8	59.0	38.2	4.9	17.0
Orono	1.5	57.0	41.5	5.6	21.8
Pittsfield	61.2	31.6	7.2	5.6	6.8
Stockbridge	26.3	58.3	15.4	5.2	8.1
Stockbridge	28.1	53.6	18.3	5.0	10.3
Sudbury	75.5	20.5	4.0	----	7.7
Westminster	50.1	38.0	11.9	----	29.7
Woodbridge	57.0	36.4	6.6	7.9	11.3
Worthington	50.7	44.8	4.5	5.8	10.9

Table II-3 indicates metal concentrations typically found in Massachusetts farm soils.

TABLE II-3

METAL CONCENTRATIONS IN THE SOILS OF MASSACHUSETTS FARMS

[Source: J. H. Baker, 1975; samples from 25 dairy farms throughout Mass.]

	Metal (μg/gram soil)			
	Iron	Manganese	Zinc	Copper
Average concentration	18.3	6.6	2.9	3.4
Range of concentration	13-28	0.8-16	1-6	2-7

These metals are micronutrients and are necessary for proper growth in plants. Copper (Cu) and zinc (Zn) are components of enzymes in plants, as are manganese (Mn) and iron (Fe). Manganese and iron are involved in chlorophyll synthesis, and zinc and copper are apparently necessary for production of growth promoting substances. Although necessary for plant growth in minute quantities, toxicity can occur when excess metals are present.

2. Boston Harbor Bottom Sediments

The bottom of Boston Harbor is covered by a layer of highly organic sediments which are deposited by the continuous settling of suspended materials. The high organic input to the bottom sediments has resulted in anaerobic conditions over much of the harbor bottom (New England Aquarium, 1972). In sheltered bays and around islands in the harbor, the bottom sediments consist of gray-to-black muck over light brown-to-gray clay. The Inner Harbor has a black oozy bottom with high concentrations of petrochemicals and trace metals (NEA, 1975).

In the Outer Harbor, trace metal levels are generally lower than those found in the sediments in the Inner Harbor (NEA, 1972). Localized areas of relatively high trace metals are found in the sediments of the President Roads areas which is the most likely deposition area for suspended solids from the Inner Harbor and sewage sludge effluent from the Deer Island sewage treatment plant (NEA, 1972). In the Outer Harbor, the highest trace metal concentrations are generally found at the surface of the sediments and decrease with depth.

D. Hydrology

According to the Regional Administrator's 1975 Annual Report on Environmental Quality in New England, nearly 50% of the total miles assessed in the Massachusetts Coastal Basin were not in compliance with Class B water quality standards (U.S. EPA, 1975E).

Class B waters are fit for swimming and fishing, and meet the maximum criteria for compliance with the 1983 national goal of "...water quality which provides for the protection and propogation of fish, shellfish, and wildlife, and provides for recreation in and on the water."

The condition in the Connecticut River Basin is much more severe, where of 1,057 miles assessed in the basin, 73% do not meet the Class B surface water standards. The Annual Report summarizes the condition of the Merrimack and Connecticut Rivers in Massachusetts by saying that they "...still receive untreated wastes from large urban municipalities."

Other New England river drainage basins that are within the Commonwealth of Massachusetts (in whole or in part), and their degree of non-compliance with the Class B standards are as follows:

River Basin	Percent of Assessed Miles in Non-Compliance
Merrimack	61
Housatonic	55
Upper Hudson (Hoosic)	72
Mystic River (below lake)	100

Table II-4 summarizes the water quality of the surface waters of Massachusetts in 1974, as represented by the major water areas in the Commonwealth.

Within the Boston Metropolitan Area, EPA recognizes three major water areas: Boston Harbor, the Charles River, and the Neponset River. The Charles River is sufficiently degraded such that the 1983 goal of Class B waters will not be met. The majority of the Charles' problems stem from combined sewer overflows, resulting in oxygen depletion, health hazards, and adverse aesthetic impacts. The Neponset River will probably meet the 1983 goal because its quality problems are related to nonpoint source pollution.

While the two major rivers discharging to Boston Harbor have moderate to severe problems, the significant water quality problems of the Harbor itself are aesthetic in nature. Figure II-4 presents the existing water quality classifications for Boston Harbor. And it is estimated that the Harbor will meet the 1983 goals for Class SB waters. The Regional Administrator's Annual Report states that "The urban harbors of Massachusetts, including Boston Harbor, are significantly affected by numerous sources of pollution, resulting in complex water quality problems."

1. Freshwater

a. Water Budget: Assuming a steady-state condition, the water budget for an area can be described as follows:

Precipitation - Runoff = Evapotranspiration

TABLE II-4

SUMMARY OF WATER QUALITY
STATE OF MASSACHUSETTS

[Source: Regional Administrator's Annual Report, 1975]

Major Water Areas	Water Quality Problems	Source of Problems	Will Area Meet 1983 Goals?
Assabet River	2,3,6	M, NPS	NO
Blackstone River	1,3,5	M, CS	NO
Charles River	3,4,5	CS	NO
Chicopee River	2,3	Flow regulation, M	YES
Concord River	2,3,4	M, Little elev. change Low velocity	NO
Connecticut River	2,4,5	M, CS, flow regulation	YES
Deerfield River	4, temperature	M, thermal disch.	YES
Farmington River	N/A	N/A	YES
Housatonic River	2,4	M	YES
Merrimack River	1,2,3,4	CS, M & I	YES
Millers River	3,5	M, I (paper)	NO
Nashua River	2,3,4,5,6	CS, M & I regulation	NO
Neponset River	4	NPS	YES
Taunton River	2,3,4,5	M & I	NO
Westfield River	3,4	I	YES
Boston Harbor	5	CS	YES

Water Quality Problems:

1. Toxics 2. Eutrophication Potential 3. Oxygen Depletion 4. Health Hazard 5. Aesthetics 6. Low Stream Flow

N/A = Not Applicable M = Municipal discharge I = Industrial discharge D = Domestic
CS = Combined Sewers NPS = Non-point Source

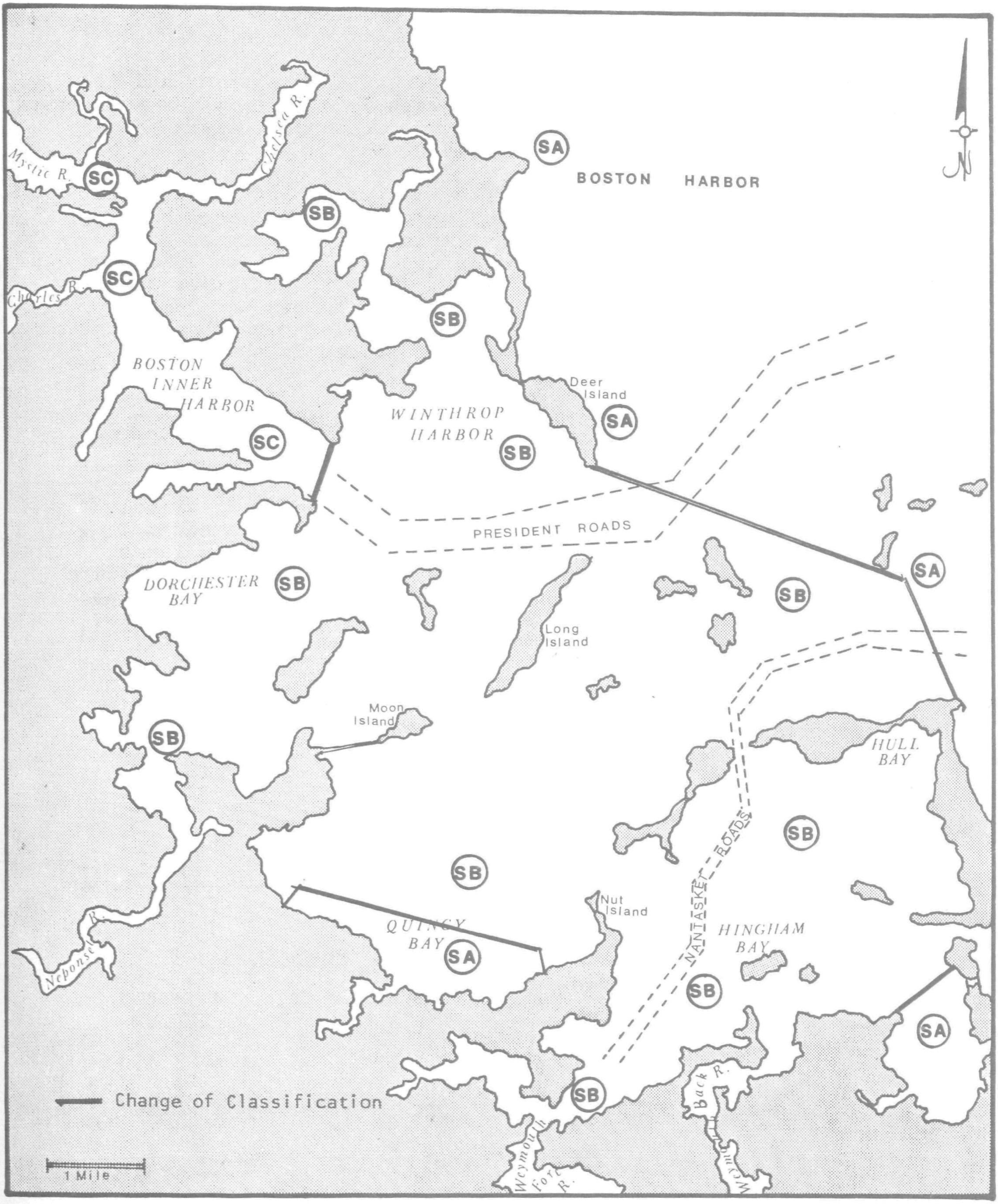


FIGURE II-4 BOSTON HARBOR WATER QUALITY CLASSIFICATIONS

Runoff includes both surface runoff into streams and other water bodies, and water infiltration into groundwater aquifers. Evapotranspiration includes evaporation from surface areas and transpiration from plants and animals.

Figure II-5 shows the mean annual precipitation for the Commonwealth of Massachusetts, and Figure II-6 indicates the average annual runoff. With average annual precipitation ranging from 42 to 50 inches, and the runoff ranging from 20 to 30 inches a year, the evapotranspiration ranges from 20 to 30 inches annually, with the median value being approximately 22 inches per year. Table II-5 shows the water balance for ten major river basins in Massachusetts. Included in these runoff values is that portion which seeps into the groundwater aquifers.

b. Water Quality: Surface water quality in Massachusetts ranges from basically uncontaminated to severely polluted (Frimpter, 1973). Figure II-7 shows representative surface water quality sampling sites for the Commonwealth, and nitrogen and phosphorus concentrations for these sites are given in Table II-6. Since nitrate concentration in rainwater is about 0.2 ppm, ammonia concentration is 0.5 ppm and phosphorus concentration in lakes averages 0.011 ppm (Reid, 1961), the values in Table II-6 indicate that the surface waters in general have a fairly normal nutrient content. Table II-7 indicates analysis of three rivers, showing a tendency toward hard water, with pH's ranging from slightly acidic to very alkaline.

Table II-8 gives metal concentration at two sampling sites for two different time intervals. The site locations for this table are shown on Figure II-7.

TABLE II-8

METAL CONCENTRATIONS

[Source: Water Resources Data, USGS, 1973 and 1975; FWPCA, 1968; USEPA, 1975G]

Site # and Stream Name	Cd (μg/l)	Cr (μg/l)	Cu (μg/l)	Fe (μg/l)	Pb (μg/l)	Ni	Zn
11 A (Sippican)	<42	72	12	--	9	4	<180
B	2	190	<3	--	10	5	20
19 A (Mill Brook)	<20	<10	16	120	30	2	56
B	<5	<10	15	76	14	2	53
Public: Health Limits	0.01	0.05	100	30	0.05	--	1500

TABLE II-5

WATER BUDGET FOR MASSACHUSETTS

[Source: USGS Water Resource Atlases]

Basin	Avg. Annual Precipitation (Inches)	Avg. Annual Runoff (Inches)	Avg. Annual Evapotranspiration (Inches)
Millers River	43	22	20
Housatonic River	48	24	24
Deerfield River	44.8	21.4	23.8
Weweantic River	46	24	22
Weir to Jones River	43	22	21
Neponset River	43.7	22.0	21.7
Weymouth River	45.2	26.0	19.2
Hoosic River	43.6	22.0	21.6
Assabet River	44	20.7	23.3
Taunton River	44	24	20

TABLE II-6

NUTRIENT CONCENTRATION FOR SELECTED SAMPLING SITES

[Source: Water Resources Data, USGS, 1973 and 1975.]

Site No. & Stream Name	Dissolved Nitrate (mg/l)	Dissolved Ammonia (mg/l)	Total Kjeldahl Nitrogen (mg/l)	Total Phosphorus
1 (Merrimack)	2.6	.17	-	.26
2 (Shawsheet)	.19	.15	-	0.02
3 A (Merrimack)	.1	-	1.4	.18
B	2.7	-	1.4	.1
C	2.2	.00	-	.18
D	.3	.03	.77	.07
4 (Shawsheen)	.89	.16	-	0.06
5 A (Charles R)	1.0	.12	-	.39
6 (Neponset)	2.5	-	.013	-
7 A (Furnace Brk)	.6	.16	-	-
B	.3	.19	-	-
8 (North R)	.04	.16	-	-
9 (Neponset)	1.1	.67	-	-
10 A (Jones R)	.2	1.3	-	-
B	0.0	.11	-	-
11 (Sippican)	.16	.13	.35	.06
12 A (Slocums)	1.6	.05	.48	.06
B	.18	.14	.16	.02
13 (Palmer)	.2	.12	-	-
14 (Branch of Tenmile R)	.4	.12	-	-
15 (Blackstone)	-	17.0	-	22.0
16 (Browns Brk)	0	.02	-	0.0
17 (Quinsigamond)	-	9.0	-	20
18 (N. Nashua)	.5	.39	-	.27
19 A (Mill Brk)	.5	.11	.9	.12
B	.1	.07	.48	.03
20 A (Conn. R.)	.26	.01	.37	.02
B	.30	.04	.22	.02
21 A (Conn. R.)	.03	.10	-	.06
B (Westfield R)	.15	.05	-	.05
22 Housatonic	-	4.0	-	30.0
23 A (Green R)	0.0	.04	.80	.27
B (Hoosic R)	2.3	.02	1.1	.42

TABLE II-7

WATER ANALYSIS FROM SELECTED STREAM BASINS

[Source: Norvitch, et. al. 1968; Williams, et. al. 1973; Hansen, et. al. 1973]

	Hoosic River		Taunton River		Housatonic River	
	Min.	Max.	Min.	Max.	Min.	Max.
Nitrate (mg/l)	1	10	---	---	0	20
Nitrite (mg/l)	.1	1.2	---	---	---	---
Total N (mg/l)	1.3	3.2	---	---	---	---
P (mg/l)	.8	3.5	---	---	---	---
SO_4 (mg/l)	12	25	5.3	61	0	29
Cl (mg/l)	7	16	4	130	.8	28
Fe (mg/l)	.1	1.1	0	.7	0	1.2
$CaCo_3$ (mg/l)	30	125	13	116	20	302
Mn (mg/l)	.1	.3	0	2.2	0	.46
Ca (mg/l)	12	35	4	29	6.4	85
Na (mg/l)	5	24	4.2	42	.7	9.5
Mg (mg/l)	3	11	1	14	.9	36
K (mg/l)	2	4	.2	4.8	.1	4.4
D.O. (mg/l)	1	10	---	---	---	---
Fecal Coliforms (thousand/ml)	3	30	---	---	---	---
Total Coliforms (thousand/ml)	6	100	---	---	---	---
Dissolved Solids (mg/l)	60	220	39	268	29	308
pH	6.6	9	5.6	8.6	6.6	9

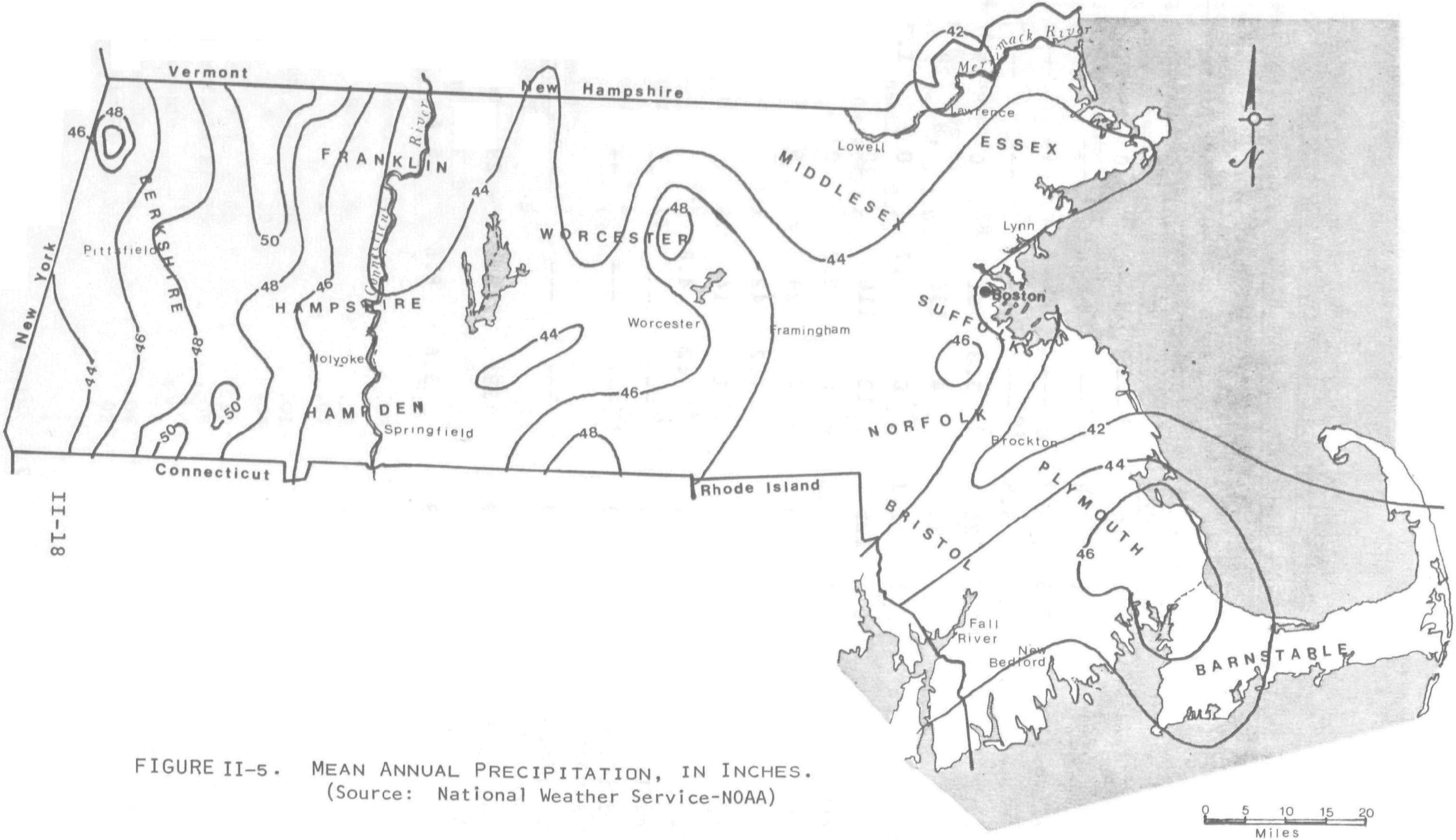


FIGURE II-5. MEAN ANNUAL PRECIPITATION, IN INCHES.
(Source: National Weather Service-NOAA)

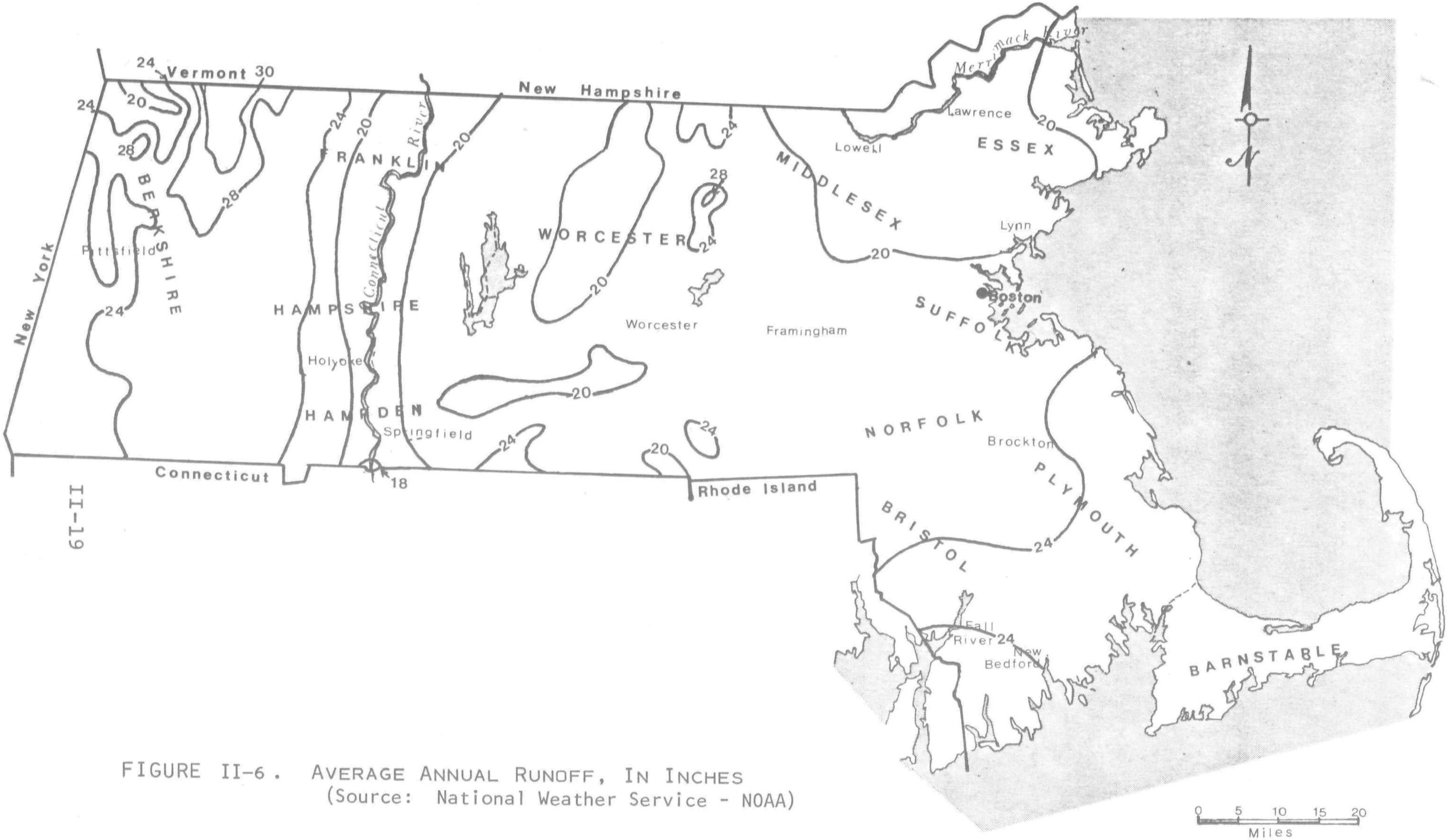


FIGURE II-6. AVERAGE ANNUAL RUNOFF, IN INCHES
(Source: National Weather Service - NOAA)

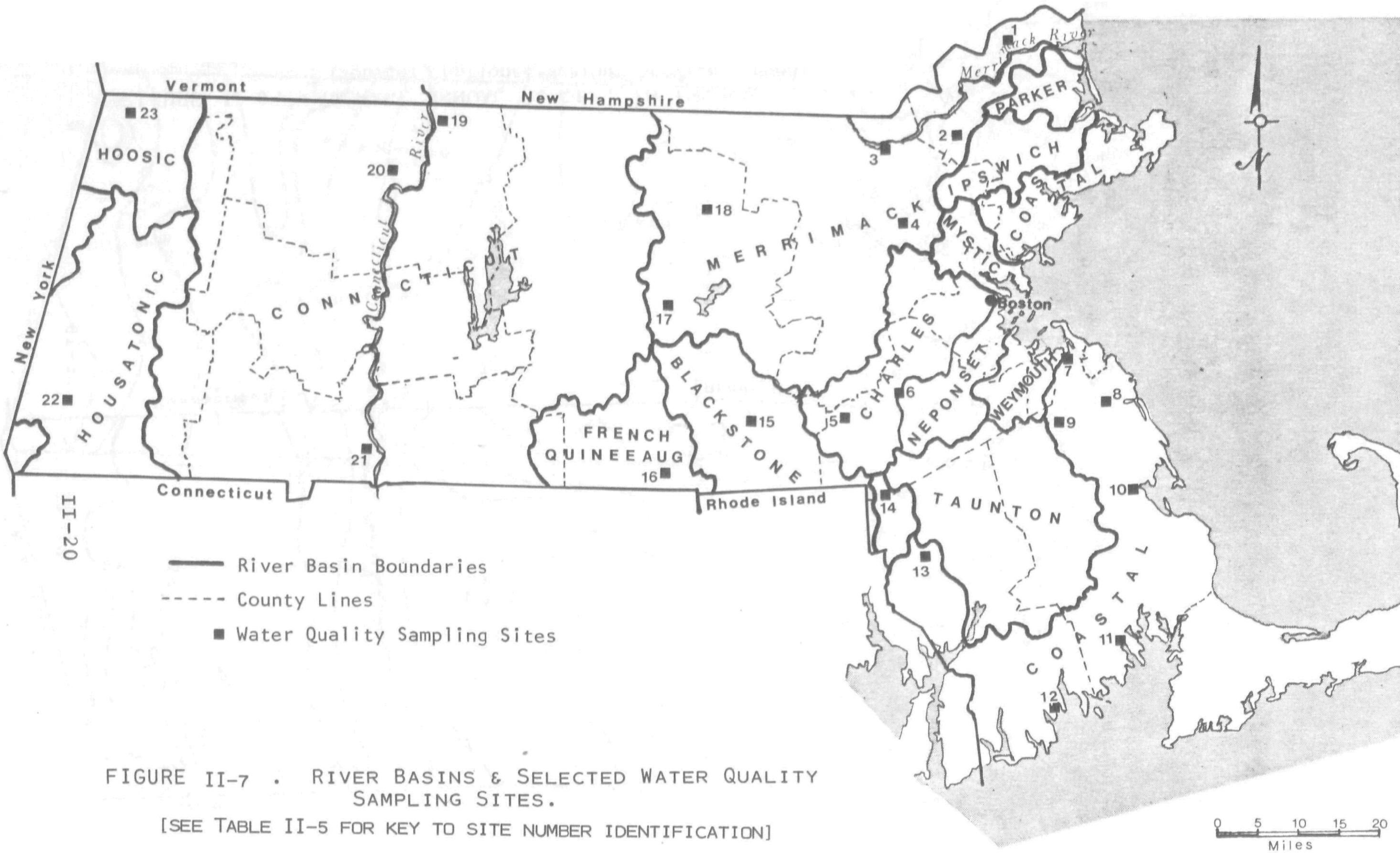


FIGURE II-7 . RIVER BASINS & SELECTED WATER QUALITY SAMPLING SITES.

[SEE TABLE II-5 FOR KEY TO SITE NUMBER IDENTIFICATION]

Compared with the Public Health Limits, cadmium, chromium, iron and lead are found in higher concentrations than are acceptable for human consumption. Nickel does not presently have a limiting value established (USEPA, 1975G).

Groundwater supplies generally have water of an acceptable quality. Although bedrock aquifers presently produce water of sufficient quantity and quality, aquifers of sand and gravel are the predominant water source. The water taken from the sand aquifers often is acidic and corrosive to metal pipes. Iron, manganese and high color levels are often present, especially from aquifers situated near swamps (Frimpter, 1973).

2. Marine Waters - Boston Harbor

a. Hydrodynamics: Boston Harbor is a shallow well-flushed embayment generally without stratified flow (Hydroscience, 1973). Average depth ranges from 10-50 feet at mean low tide and much of the Harbor is less than 15 feet deep (USDI, 1969). River flow into the Harbor is relatively weak and tidal currents are the dominant force in water movement (NEA, unpublished). The larger sources of freshwater inflow into the Harbor include the Mystic, Charles, Neponset and Weymouth-Fore Rivers and wastewater discharges from the Nut Island and Deer Island sewage treatment plants. Average freshwater inflow ranges from 50 cubic feet per second (cfs) in the late summer to around 1300 cfs in March, while average tidal flow is one million cfs (NEA, unpublished).

Figures II-8 and II-9 depict the major currents which flow in Boston Harbor during maximum ebb and maximum flow. Current velocities are generally less than 50 cm/sec (Folger, 1972). Tidal currents indicate major routes along which nutrients, trace elements, pollution and organisms are distributed.

Two major circulation cells dominate water movement in the Harbor. In the northern portion of the Harbor, Dorchester Bay, Boston Inner Harbor and Winthrop Harbor make up one cell. This cell is fed by major tidal flow through the President Roads and by the Charles, Neponset and Mystic Rivers. The second cell, in the southern portion of the Harbor, is made up of Quincy Bay and Hingham Bay. Tidal flow through Nantasket Roads and minor river flow from the Weir, Weymouth-Fore and Weymouth-Back Rivers are the primary sources of flow. Quincy Bay is shallow and lacks deep water passage, which results in poor tidal flushing (NEA, unpublished). A small amount of exchange takes place between these cells between Moon Island and Long Island.

b. Water Quality: A number of studies have been undertaken to monitor the water quality of Boston Harbor. In addition, many studies have attempted to determine the source of pollutants in the Harbor and to determine the relationships of these sources to observed water quality. Two major modeling efforts have been undertaken to describe the relationships between the hydrodynamics

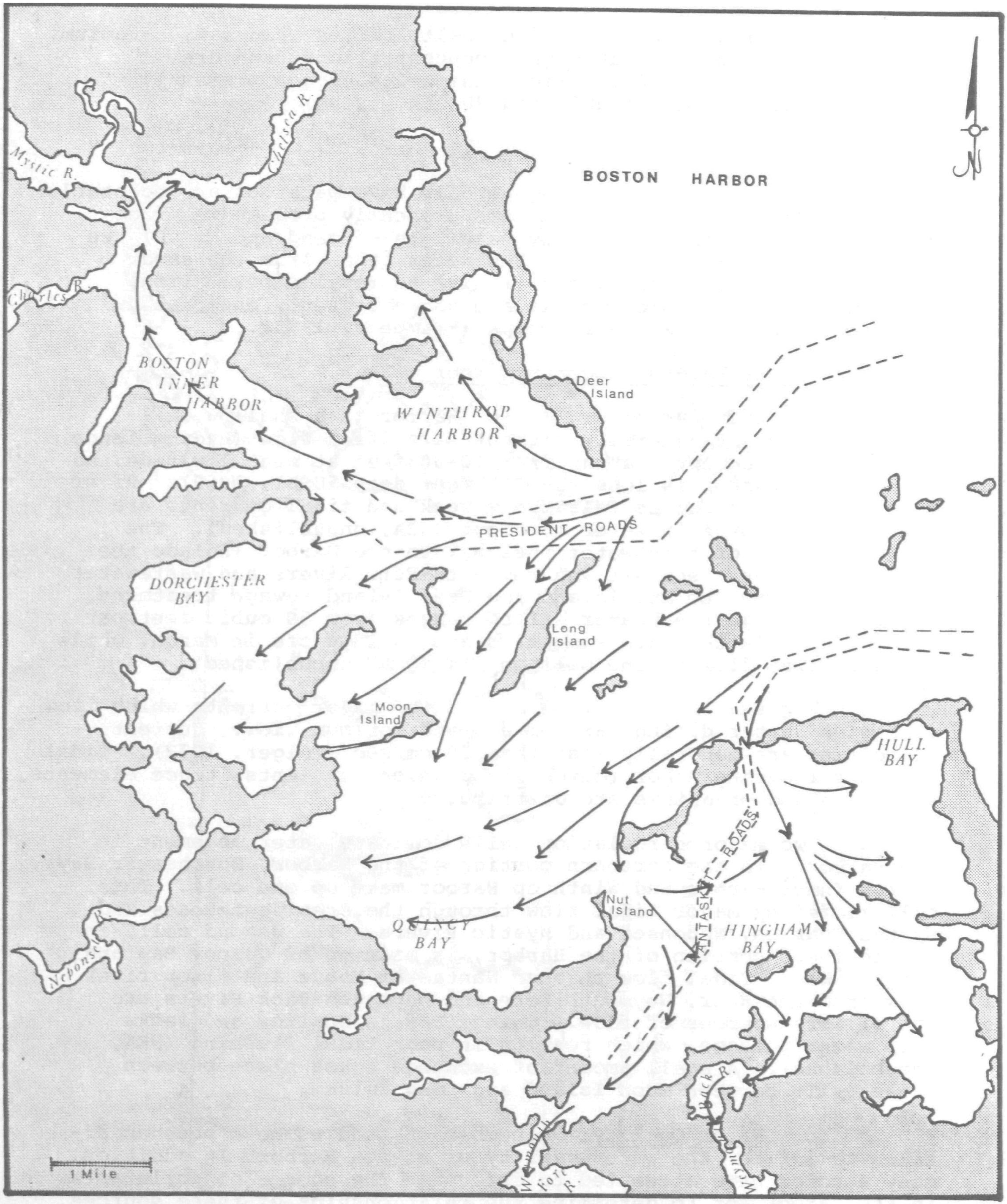


FIGURE II-8. CURRENT DIRECTIONS-MAXIMUM FLOOD
(Source: Hydroscience, 1973)

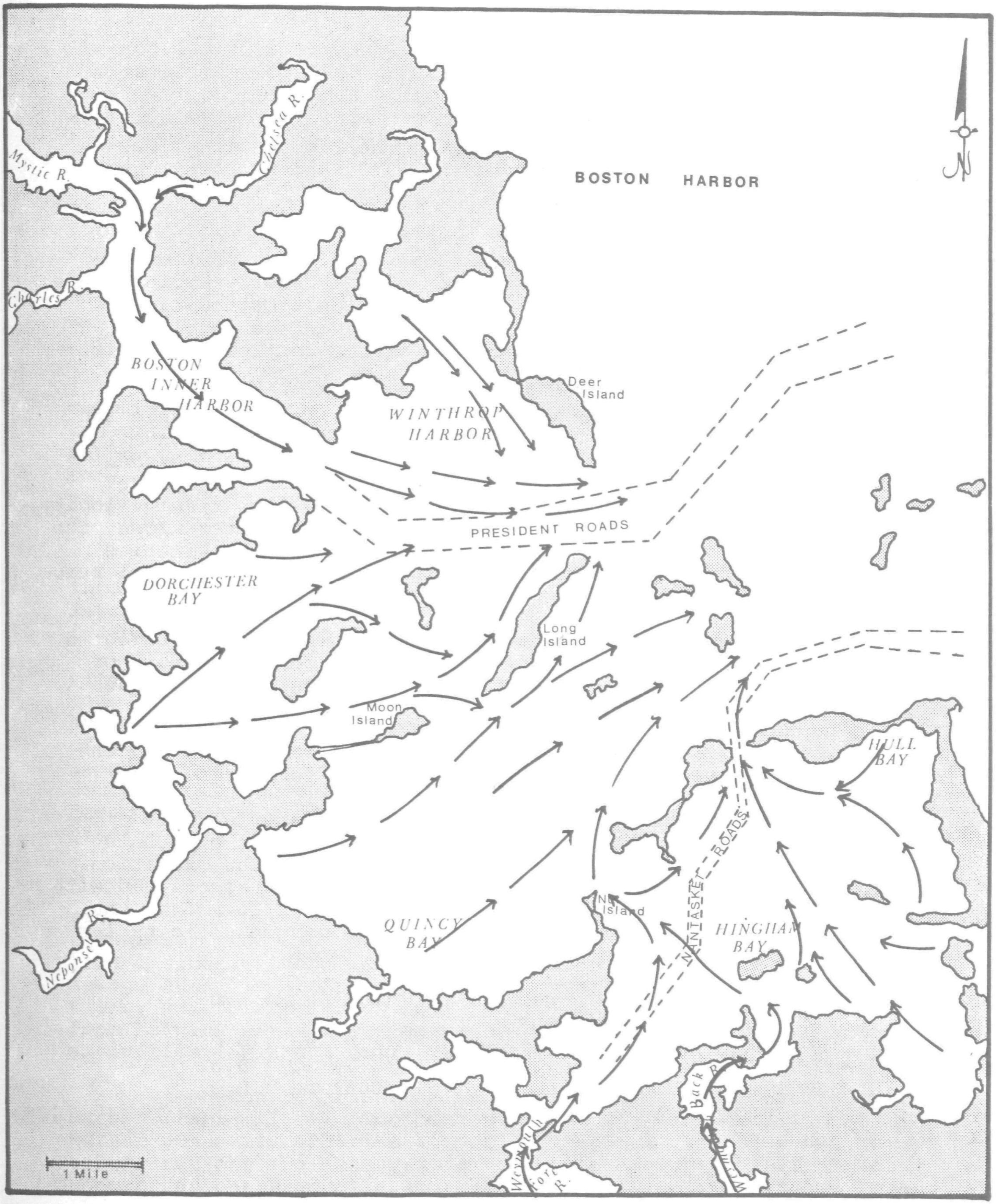


FIGURE II-9. CURRENT DIRECTIONS-MAXIMUM EBB
(Source: Hydroscience, 1973)

and pollution inputs for Boston Harbor. The Biodyne model was prepared by the New England Aquarium in 1970, and Hydroscience began its modeling efforts in 1969.

In July, 1971, Hydroscience, Inc. presented to the Massachusetts Water Resources Commission its final report on the "Development of Water Quality Model of Boston Harbor" (Hydroscience, 1971). The purpose of the study was to develop a mathematical model for the water quality of Boston Harbor, and to develop a methodology to evaluate the effects of various control procedures on water quality.

The variables which were considered in that analysis and were also used to verify the model were: the concentration of coliform organisms, biochemical oxygen demand, dissolved oxygen, digested sludge solids nutrients, and phytoplankton. The model subsequently considered the dispersive effects of the tidal velocity, the mixing associated with the freshwater and wastewater flows, the direct sources from treatment plant effluents, and the kinetics associated with the various physical, chemical, and biological reactions.

Actual bacterial counts were used to verify the projected areas of highest coliform counts. The highest concentrations of coliform bacteria in Boston Harbor occur in the area of President Roads, mid-way between the sludge discharge points for Deer and Nut Island WWTP's. Coliform counts in the first cell of the Outer Harbor consistently exceeded SB coliform standards, and the area seaward of Deer Island exceeds the SA coliform standards.

The major sources of oxygen demanding material are carbonaceous and nitrogenous components of wastewater effluents and digested sludge from the treatment facilities, the oxidation of benthic organic material, and the organic matter associated with the discharges to the Inner Harbor, including overflows from the combined sewer system. The maximum dissolved oxygen deficits for the various BOD inputs were determined as follows:

- Digested sewage sludge (0.2) mg/l D.O.
- Effluent from treatment plants (1.0) mg/l D.O.
- Inner Harbor source (0.7) mg/l D.O.
- Benthal demand (0.8) mg/l D.O.

The model analysis indicated that the sewage treatment plants cause the same order of D.O. deficit as the assumed benthal demands and sources from the Inner Harbor, but that the estimated combined effect does not violate the standards on a steady state basis.

The computed summer dissolved oxygen concentrations exceed 6-5 mg/l everywhere in the Outer Harbor, with an average exceeding 7.0 mg/l; and the D.O. levels exceed 5.0 mg/l in the Inner Harbor, all calculated on a steady-state basis. Therefore, concentrations of D.O. in the Outer Harbor are in conformance with water quality standards. However, while the D.O. in the Inner Harbor conforms to the time averaged standard of 5 mg/l, oxygen levels in that area violate the minimum value specified in the water quality standards, of 3 mg/l.

The most significant finding of the Hydroscience work revolved around the distribution of digested sludge solids. The proportion of discharged solids that eventually settle in Boston Harbor, west of Deer Island, was estimated to be 15%-20% of the total mass of settleable solids discharged. The bulk of the remaining 80% is probably deposited in an area 8-12 miles eastward of Deer Island.

In 1970, the New England Aquarium Corporation entered into an agreement with the Massachusetts Department of Natural Resources to undertake a comprehensive inventory of water quality in Boston Harbor, to develop a data bank and data storage retrieval system for handling water quality data in the Harbor and to accomplish preliminary development of an environmental/biological model of the Harbor which would predict the effects of environmental fluctuation on the Harbor biota (NEA, 1973B). The results of the three-part NEA study include analyses which are helpful in describing the water quality of Boston Harbor. The information contained in these reports is extensively used in the following description of water quality in Boston Harbor. Earlier reports and studies done by other individuals and organizations are also used.

Boston Harbor has received legal discharges of wastewater since 1880 (White, 1972). In addition to the sludge and treated wastewater from the MDC sewerage system, other sources of pollution include: industrial wastes, combined sewer overflows and sewage outfalls, tributary streams, wastes from Federal installations, watercraft wastes, oil pollution and debris and refuse from barging activities, garbage and refuse disposal and shore activities (MWRC and USDI, 1969)

Boston Inner Harbor is more polluted than Boston Outer Harbor (Table II-9). The concentration of pollutants in the Harbor generally exhibits a spatial gradient. Highest pollutant concentrations are measured in the Inner Harbor and pollutant concentrations gradually decrease with increasing distance from the Inner Harbor. Significant localized discharges may produce areas of high pollutant concentration.

TABLE II-9

NEW ENGLAND AQUARIUM DATA SET 1970-1972

[Source: NEA, 1973]

	MINIMUM-MAXIMUM VALUES	
Physical Parameters	Inner Harbor	Outer Harbor
T° C.	0-21	0-22
Salinity, ppt	4-32	21-34
Chemical		
D.O., ppm	2.41-11.49	6.02-14.0
Nitrogen mg/l		
Ammonia - N	0.01-1.10	0.01-1.02
Nitrate - N	.002-1.24	.001-.570
Organic - N	----	----
Phosphorus mg/l		
Total ,	0.05-1.02	.024-1.33
Ortho	.007-.924	.010-1.17
Biological		
Bacterial MPN/100 ml (coliform)	0-96,000	0-10,000

Boston Harbor is a moderately productive embayment as indicated by organic carbon productivity calculated by energy simulation (NEA, 1973A). Minimum average productivity is estimated at 20 K cal/m^2/day while a highly eutrophied embayment would be 7 to 10 times more productive (NEA, 1973A). The Harbor is nitrogen limited during most of the year. During the spring it may also be partially phosphate limited. According to NEA (1973A) inorganic nitrogen loadings to Boston Harbor from combined overflows during storms may be equal to or greater than that contributed by average daily sewage flows. Although turnover rates for nitrogen and algae have been estimated, the paucity of information about food-chain relationships in Boston Harbor precludes description of nutrient recycling processes in the Harbor (NEA, 1973A). Boston Inner Harbor is more highly eutrophied than Boston Outer Harbor (NEA, 1973A). The high nutrient levels are attributed to the untreated sewage load being carried by the Charles, Mystic and Chelsea Rivers (NEA, 1973B).

Coliform counts vary widely throughout the Harbor. The highest counts recorded by the NEA survey were encountered at the Charles River Dam Station where they exceeded 96,000 organisms per 100 ml (1973B). The median values for the Inner Harbor range from 46-200 per 100 ml while the median values for the Inner Harbor and tidal river mouths ranged from 360 to 2404 per 100 ml.

Data collected during the Boston Harbor Survey in 1972 (MWRC-DWPC, 1973) also indicate that coliform counts are significantly higher in the Inner Harbor as compared to the Outer Harbor. Most of the samples for the Inner Harbor (approximately 75 were taken) were significantly greater than 1000 organisms per 100 ml. This level of coliform contamination precludes swimming and bathing in these waters according to Massachusetts salt water standards (Appendix B-1). More than half of the coliform counts measured during the Boston Harbor survey exceeded 230 per 100/ml, and almost half exceeded 1000 per 100 ml.

Lowest dissolved oxygen levels are generally encountered at the river mouths which is probably due to their high chemical and biological oxygen demand (NEA, 1973B). The Outer Harbor is generally well-mixed with respect to dissolved oxygen and dissolved oxygen levels are relatively high (NEA, 1973B). Dissolved oxygen levels measured by NEA ranged from 2.41 to 11.49 ppm in the river mouth - Inner Harbor Complex, and from 6.02 - 14.0 ppm in the Outer Harbor.

Salinity in Boston Harbor is generally lowest along the shore and increases towards the Outer Harbor. The exception is Quincy Bay where slightly higher salinities are observed compared to what would be expected given the salinities of other bay areas in the Harbor (MWRC and FWPCA, 1969). Salinities range from 4-32 parts per thousand (ppt) in the Inner Harbor-river mouth complex and from 21-34 ppt in the Outer Harbor (NEA, 1973B). The entire Harbor generally has a wide range of salinity turning to uniform salinity at the Harbor mouth (NEA, 1973B). Freshwater flows into the Harbor are relatively small and dams on some of the rivers bar salt water intrusion, further reducing the area of variable salinity zones (NEA, 1973B).

Trace metal concentrations were monitored during the 1972 NEA study. Data for Boston Harbor waters are contained in Table II-10. The high values found for trace metals in the Harbor are thought to reflect the influence of industrial discharges (NEA, 1972). The high values for the Inner Harbor reflect river inputs, commercial activity and combined sewer outfalls. The highest average concentrations of zinc, copper and lead were measured in the Inner Harbor. Concentrations of nickel and cadmium were highest in the President Roads area of the Outer Harbor, while highest average concentrations for chromium were measured in Dorchester Bay. The residence time for trace metals in the Harbor waters is short. Trace metals are absorbed on the surfaces of the abundant suspended solids, taken up by micro-organisms, or coprecipitated (NEA, 1972). Trace metals were also monitored during diurnal studies. The observed periodicity of trace metal concentrations provides evidence that sludge which contains trace metals is returned by the tides landward from the point of discharge (NEA, 1972).

3. Marine Waters - Massachusetts Bay

The portion of the Atlantic Ocean which might be significantly affected by a project alternate (ocean dumping), is the Gulf of Maine and the associated nearshore areas of the open ocean. The Gulf of Maine is defined by the coast of Nova Scotia and the Bay of Fundy to the north and east, the New England Coast to the north and west, and Cape Cod to the southwest. There is a wide connection with the open Atlantic Ocean to the southeast.

As a natural province, it is delineated much more clearly below the sea surface than the shallow recession of its shoreline would suggest. The southern boundary is marked by a sill penetrated only by three narrow passages. This sill is identified by the locations of Georges Bank, Browns Bank, and Seal Island Bank (Bigelow, 1927A). The discussion which follows provides background information for the entire area. A general map showing the principle locations discussed in the text was Figure II-1.

TABLE II-10

AVERAGE TRACE METAL CONCENTRATIONS
MEASURED IN BOSTON HARBOR WATERS
DURING 1972 - SOLUBLE AND PARTICULATE PHASES (ppb)
[Source: NEA, 1972]

Sample Locations	Number of Samples	Zn	Cu	Pb	Ni	Cr	Cd
Inner Harbor	8						
Soluble		40.2	5.0	5.4	7.8	1.0	0.42
Particulate		3.7	1.8	6.4	1.6	1.8	ND
Average		22.0	3.4	5.9	4.7	1.4	
President Roads	5						
Soluble		11.6	5.2	2.0	8.2	0.5	0.46
Particulate		7.5	1.6	3.5	1.9	3.2	ND
Average		9.6	3.4	2.8	5.1	1.85	
Dorchester Bay	7						
Soluble		11.2	2.6	2.0	4.7	0.3	0.24
Particulate		1.7	0.8	2.4	1.8	4.5	ND
Average		6.5	1.7	2.2	3.3	2.4	
Thompson-Long Island Area	6						
Soluble		9.0	2.2	1.9	6.8	0.5	0.20
Particulate		1.8	1.5	1.7	1.3	1.3	ND
Average		5.4	1.9	1.8	4.1	0.9	
Average for Ocean Water*		5.0	0.9	0.03	6.6	0.2	0.11

Source: Turekian in NEA, 1972.

ND = Not determined.
* = coastal waters generally higher

a. Hydrodynamics: According to Graham (1970) there were 23 previous publications concerned with circulation features in the Gulf of Maine. The largest contribution to our knowledge of the physical oceanography of the Gulf is the study by Bigelow (1926A), who provided the first definitive analysis of current patterns in the area. Bumpus and Lauzier(1964) have compiled an atlas of surface currents on the east coast of the United States, based on drift bottle returns. Bottom currents have been poorly investigated, although general patterns from the Middle Atlantic Bight (Bumpus, 1965) and Massachusetts Bay (Bumpus, 1974) are suggestive of conditions in the Gulf of Maine. Graham (1970) does provide some seabed drifter data for the Western Gulf.

The land area tributary to the Gulf includes slightly more than 61,000 square miles in Massachusetts, New Hampshire, Maine, New Brunswick, Quebec and Nova Scotia. There are nine principal rivers which enter the Gulf, draining nearly 90 percent of the watershed, but no large rivers empty into the Gulf south of Cape Ann. The principal river is the St. John, with a drainage basin of 26,000 square miles.

The Gulf is a region of extremely strong tidal currents, which are the most obvious hydrodynamic feature, especially in near-shore areas (Bigelow, 1926B). There is also a definite surface ciruclation pattern for the Gulf.

The following summary of seasonal surface circulation patterns for the Gulf is taken from Bumpus and Lauzier (1964) and Bigelow (1926A). (Appendix E gives graphical representation of the current patterns discussed here.)

In the winter, surface circulation in the Gulf is characterized by inflow around Cape Sable into the Bay of Fundy, a southerly flow along the western side which continues past Cape Cod, with irregular eddies located between the two. A divergence area exists north of Georges Bank by February.

In the spring the Gulf of Maine eddy develops rapidly, stimulated by spring river discharge. By the end of May one large cyclonic gyre encompasses the whole Gulf of Maine. There are inputs to this gyre across the Scotian Shelf and Browns Bank. Drift may or may not enter the Bay of Fundy and Cape Cod Bay. The eddy begins to slow down in June, gradually dissipating over the summer. Autumn and winter circulation is characterized by a breakdown of the southern side of the gyre, which becomes a drift across Georges Bank.

There is limited direct information on bottom currents in the Gulf of Maine. Rowe, Polloni and Haedrich (in press) cite a lack of strong tidal mixing in the area. Graham (1970) reported on some seabed drifter data for the western Gulf. He found that there was a shoreward movement, including drifts into bays and estuaries, as well as movement along the coast. Bottom movement generally resembled surface patterns. Movements along the coast were usually from east to west, and in the west, drifters moved offshore and southward past Cape Ann. The movement of bottom water onto shore was in compensation for the removal of less saline water at the surface. This type of coastal upwelling has been noted in other areas of the east coast (Bumpus, 1965). The residual drift averaged 0.09 to 0.54 km per day.

Current patterns in Massachusetts Bay are summarized by Bumpus (1964). Tidal currents flood westward into Massachusetts Bay, and ebb northeastward to eastward. The maximum velocity over Stellwagen Bank increases from about 0.2 nautical miles per hour (kts) at the northern end to over 1 kt at the southern end. Tidal currents in the deep basin west of Stellwagen Bank (0.5-0.5 kt) are lower than those over the bank (0.6-0.9 kt) or inshore off Marblehead (0.8 kts). Residual drift patterns, both surface and bottom, have been estimated by drift bottle and seabed drifter data. Massachusetts Bay lies on the western side of the cyclonic Gulf of Maine eddy. This provides a southward flow across the mouth of Massachusetts Bay, with maximum rates occurring in April and May. This results in surface drifts east of Stellwagen Bank towards the south at 1-5 nautical miles per day (nmpd). To the west of Stellwagen Bank the drift follows the coastline, flowing southward past Boston Harbor, around Cape Cod Bay and northeastward past Race Point. These flows are also in the range of 1-5 nmpd. Bottom drifts are an order of magnitude lower. Generally these drifts have a shoreward component.

b. Water Quality:

Nutrients: As is the case with most coastal areas of the United States, the literature on water quality in the Gulf of Maine is scattered. Several early researchers, Rakestraw (1932, 1933, 1936), Redfield, Smith and Ketchum (1937), and Redfield and Keyes (1938) did pioneering studies on oceanic nitrogen and phosphorus cycles in the Gulf of Maine. Recent work is less abundant, although Vaccaro (1963) has provided data on nutrient levels.

Open water areas of the Gulf of Maine appear typical of coastal oceanic regions. Inorganic phosphorus levels and nitrate levels are highest in the winter, followed by a rapid depletion during spring phytoplankton blooms. Ammonia values are highest during the summer months. Seasonality of both nitrogen and phosphorus is a well documented phenomenon in the ocean (Harvey, 1966; and Davies, 1971).

The seasonal nitrate cycle for the Gulf of Maine has been summarized by Raymont (1963), on the basis of the early data. Nitrate-nitrogen values ranging from 0.100 to 0.200 mg/l were reported for the winter maximum, but after the spring phytoplankton blooms values were decreased to less than 0.005 mg/l at the surface.

In deep water (below 100m) there were relatively large amounts of nitrate throughout the year, exceeding 0.140 mg/l, as nitrate. Below 150 m even higher amounts (>0.200 mg N/l) were present.

Data on ammonia in the Gulf is provided by Vaccaro (1963) for August and January, 1962. During August only trace amounts of nitrate occurred in the photic zone, while ammonia was the major source of available nitrogen. Redfield and Keyes (1938) have reported ammonia values as high as 0.050 mg N/l.

Phosphate data from Bigelow, Lillick & Sears (1940) indicated a winter maximum concentration of 0.030 to 0.035 mg PO_4-P/l, while even during summer nearly 0.010 mg/l remained in surface layers over most the Gulf, although local depletion was noted. Redfield, Smith and Ketchum (1937) also found high phosphate values in the Gulf. Their data for the upper 60 m gives an average surface concentration of 0.018 mg PO_4-P/l (May), while deep water values remain from 0.038 to 0.050 mg/l.

Data for other phosphorus fractions is also available. The following summary of the early data is taken from Raymont (1963). Most dissolved ogranic phosphorus occurs in summer and autumn (up to .016 mg P/l in the summer). Mineralization results in a great reduction during the winter (90% of total phosphorus is inorganic during the winter). Particulate phosphorus values are also highest during the summer, reflecting the synthesis of organic material.

Dissolved Oxygen: No evidence of low oxygen values in any region of the Gulf of Maine has been found. There appears to be data available on oxygen levels throughout the Gulf, but it is in widely scattered documents. There is no indication that there has ever been an attempt to compile and compare the available information. In general, the area can be expected to show oxygen levels at or near saturation during most of the year since the basin is not thermally stratified except during the summer, and no stagnant basins are known to exist.

Temperature and Salinity: A great deal of information on temperature and salinity distributions in the Gulf of Maine is available. A detailed discussion of this data is not relevant, but the salient features are summarized below, based on summaries in Bigelow (1927), Bumpus (1974) and Sherman (1966B). Both parameters vary seasonally and in response to water circulation patterns.

Temperature shows significant seasonal variation. Coldest temperatures occur in February (0° to 3°C). By March vernal warming has begun. It proceeds most rapidly in the southwest portions of the Gulf, since it is opposed by the Nova Scotian current flowing past Cape Sable into the Gulf. By May or June thermal stratification becomes significant. The deep basins of the Gulf maintain their low temperatures throughout the summer. Maximum surface temperatures in the summer occur offshore in the western portion of the Gulf (10-20°C) and inshore in the eastern portion (10-15°C). Autumnal cooling commences in September, and by November fall overturn is in progress.

Salinity in the open waters of Gulf of Maine is highest in offshore areas, with the maximum values occurring in bottom waters. There is generally a distinct vertical salinity gradient throughout the Gulf. Summer salinities throughout the Gulf generally range from 27 to 35 parts per thousand. Inshore waters in the vicinity of river discharges vary considerably, according to discharge, but the effect is generally quite localized. Lowest values in the Gulf occur in the spring, during maximum runoff. Overall, the Gulf exhibits slightly lower salinities than the adjacent ocean, particularly the Gulf Stream.

E. Ecology

1. Terrestrial and Wetlands Ecology

Massachusetts lies in the eastern deciduous forest biome, and it contains several major subdivisions. The oak-chestnut association and the hemlock-northern hardwood association are the two major subdivisions, with boreal forest found in the higher elevations in the State. Perhaps more prevalent than the major associations is the so-called transitional forest, which is an ecotone, or gradation, between the oak-chestnut and hickory-northern hardwood associations (National Park Service, 1970). These forest types are characteristic of areas of abundant moisture, and moderate to cool temperatures.

The oak-chestnut association was originally characterized by various oak species and the American chestnut. American chestnut is no longer a dominant species since the Chestnut Blight has decimated its population. Root sprouts may still be found in the forest, but the fungus invades before the tree gains significant size. Presently the association is dominated by white oak, black oak, red oak, pin oak, shagbark hickory, mockernut hickory and butternut hickory (NPS, 1970).

The hemlock-northern hardwood association is found on cooler sites than the oak-chestnut association. In Massachusetts this association is found in the western section, in a slightly higher elevation than the oak-chestnut, but lower than the boreal. The hemlock-northern hardwood association is characterized by sugar maple, beech, hemlock, yellow birch and paper birch species (NPS, 1970).

The boreal forest is a remnant of forests found in this area during glaciation. Primarily found above 2300 feet at this latitude, balsam fir, black, red and white spruces are the dominant species, with paper and yellow birches, mountain maple and mountain ash also present (NPS, 1970). A provisional list of species for each association is given in Appendix F. These lists include those species that are characteristic of the association. They are not complete inventories and may include species that are not found throughout any given association in Massachusetts.

Since plant associations do not form definite borders, but grade into each other, a transitional forest is formed. This gradation, or ecotone, forms a large part of the Massachusetts forests. In the transitional forest, species of the major associations will be found, with the concentration of typical species of the northern hardwood trees being greater near that association, with a few oak-chestnut association trees scattered among them. Approximately halfway between the associations the concentration of characteristic species should be equal between the associations. This gradation also exists between the boreal forest and the next association.

There are several wetland types found in Massachusetts, with vegetation that differs significantly from the upland types and from each other. (Appendix F also contains provisional floral listings for wetland vegetation.) The northern bog, the most diverse type, occupies sites that are wet, strongly acid and cold. Typically the bog forms outward from the edge of a body of water. Progressing from open water to the peat mat that eventually forms along the shore, the vegetation is characterized by tolerance of acid conditions. The northern bog is regarded by ecologists as a remnant of the boreal forest that has become uniquely adapted to these conditions.

Other wetlands found in Massachusetts include the shrub swamp, floodplain forests, coast white cedar bogs, pine barrens and salt marshes (NPS, 1970; SENE, 1974). Floodplain forests generally are composed of species from the major associations that are the most moisture tolerant. Scrub swamps contain a vegetational type that remains in a dwarf condition due to the adverse moisture and nutrient conditions. Coast white cedar bogs and pine barrens are common along the Atlantic coast, although the species vary depending on the major vegetational type and the local climate. Both types are common on the sandy substrate found in association with the ocean.

Salt marshes can be separated into salt meadows, containing primarily grasses and herbs, and salt marshes, which also contain woody vegetation. Although the dominant vegetation differs, the same species may be found in both types and they are characterized by a high tolerance of salt (SENE, 1974).

The vegetation found along the coast is quite different from the inland forests. Dunes of sand are first stabilized by perennial grasses or herbs that have long filamentous roots and often propogate by runners. Included in the group are dunegrass *(Ammophila breviligulata)*, sea rocket *(Cakile eduntula)* and wormwood *(Artemisia* sp.). As the dunes stop moving, and the organic matter increases, beach heather *(Hudsonia tomentosa)*, Virginia creeper *(Parthenocissus quinquefolia)*, seaside goldenrod *(Solidago sempervirens)* and other plants become established, further stabilizing the sand and providing habitats for more animals. Species that become adapted to beach habitats are salt-tolerant and need a minimum amount of water.

The wide range of habitats in Massachusetts has resulted in a large number of wildlife species residing in the State or being transients. Appendix G contains provisional lists of mammals, birds, reptiles, amphibians and freshwater and anadromous fish that have a range that includes Massachusetts.

The Commonwealth of Massachusetts has designated species of plants and animals to be endangered in the State. This list includes those species recognized by the Federal government as being endangered. Lists of plants, birds, mammals, reptiles, amphibians and fishes on the endangered list are given in Appendix H (Isgur, 1973). These include those species that are endangered, rare, or are of unknown status.

2. Deer Island Beaches

Since a portion of the proposed project would directly affect a portion of the tidal area of Deer Island and the Outer Harbor (on the western side of the island), a field survey of the potentially affected site was undertaken. The intertidal zone of Deer Island in the vicinity of the MDC wastewater treatment plant is characterized by a mixture of coarse sand, cobble, large boulders used for rip rap, and stone bulkheads. The ocean side represents a high energy environment while the bay side is relatively protected. Intertidal slopes appear gradual, except in areas where bulkheading has been installed, and on the tip of the island where cliffs and bulkheads are prevalent. The bay side of the island, from the shore opposite the WWTP Administration Building to the vicinity of the Water Process Building, is characterized by a stone beach with or without stone bulkheading. Stones of very large size (2-3' in diameter) were often observed. In those areas where a bulkhead is present a stone beach occurs in front.

There is no evidence of marsh vegetation, nor do fine silts or sands occur intertidally. The ocean beaches in the vicinity of the WWTP are characterized by coarse grey sand (not extensive), cobble, and stone bulkheads fronted by large boulder rip rap leading to a stone beach. However, no marsh areas or marsh vegetation was observed. These areas are best classified as rocky beaches (high energy on the seaward side)

The flora and fauna of the area will reflect the substrate range and should consist of a mixture of organisms found on rocky shores, on loose stone beaches, and on sand beaches. Rocky shores (e.g., cliffs or bulkheads) are characterized by a mixture of attached algae and animals which are adapted to periodic exposure to air and to extreme fluctuations in temperature, salinity and insolation. The most obvious members of this community are barnacles, mussels and various attached algae. Periodically exposed pools in such areas support a distinctly different community of greater diversity. Loose rocks provide another type of habitat and grade into sandy types of shore. Since sand is generally also present there tends to be a lower zone on rocks (which are too large to be shifted by wave action) where attached organisms are absent because of wave/sand abrasion. On smaller rocks suitability for attachment of organisms depends on the frequency at which they are moved by wave action. Rocks that have a circulation of water under them tend to develop a special fauna on their undersides, but generally do not receive sufficient light to support algal growth. In this type of environment wave action is of prime importance (Moore, 1958). In sandy areas few organisms permanently inhabit the surface, but a variety of animals and plants exist within the sand. These range in size from microscopic interstitial organisms to burrowing crabs. Sand grain size and wave action are determining factors in such an area.

3. Boston Harbor Biota

The biota inhabiting Boston Harbor are generally stenohaline marine organisms rather than estuarine types (MWRC, 1969). (Stenohaline indicates that the species are only tolerant of a narrow salinity range.)

The phytoplankton population of Boston Harbor is dominated by diatom species (NEA, 1975). Although the Harbor is on the average only moderately productive, bloom conditions occur in some areas during the spring and fall. Excessive phytoplankton populations appear to be correlated with high ammonia nitrogen and phosphate concentrations (NEA, 1975). During the winter the algal pool turns over at seven-day intervals, while during the summer a peak turnover of 1.5 days is reached (NEA, 1975). During a 1967 study, phytoplankton populations were found to exceed 1,000 organisms per one milliliter in more than half of the Harbor. This level is indicative of bloom conditions. In the same study, excess growths of attached algae, particularly *Ulva* (sea lettuce) were noted in the vicinity of Winthrop Harbor (NEA, 1975).

Appendix I lists the dominant phytoplankton species found in the Boston Harbor-Massachusetts Bay area. *Chaetoceros* sp. and *Nitzschia* sp. were the dominant species observed during the 1968 survey of the Harbor (MWRC, 1969), along with *Ceratium* sp., *Peridinium* sp., *Dinophysis* sp., *Gonyaulax* sp., and *Tintinnopsis* sp. The generally sandy or muddy bottom of Boston Harbor precludes attachment of macroscopic algae. They are found in rocky intertidal areas and other areas with firm substratum throughout the bay. Appendix I also contains a checklist of algae identified in Dorchester Bay.

Anaerobic conditions in the bottom sediments over most of the Harbor have resulted in a reduced number of benthic species compared to what would be expected (NEA, 1975). Some pollution tolerant species exhibit increased densities. The pollution tolerant polychaete worm *(Polydora ligni)* predominates throughout the Harbor sediments, except in the inner reaches of Winthrop Bay where the polychaete *(Capitella capitata)* is dominant (NEA, 1975). Polychaete worm populations occur at a density greater than 200 per square foot, a level indicative of excessive enrichment (USDI, 1969). These organisms are absent only in places where currents and/or shallow depths prevent deposition of sludge (NEA, 1975). In areas of the Outer Harbor where bottom material is scoured by tidal action leaving mostly rocky sand and gravel, the free swimming polychaete *(Phyllodoce groenlandica)* and the fringed worm *(Cirratulus grandis)* are dominant benthic organisms. In the sandy shallow bottom adjacent to Long Island, softshell clams *(Mya arenaria)* are found at a density of 80 bushels per acre (Bridges, 1976). Appendix I contains a list of benthic organisms identified during the 1968 survey of Boston Harbor (USDI-MWRC, 1969).

The most abundant finfish species include winter flounder, Atlantic tomcod, American eel, fourspine stickleback, mimmichog and rainbow smelt. A composite checklist of fish species identified by the Massachusetts Division of Marine Fisheries during surveys of Quincy, Hingham and Dorchester Bays is contained in Appendix I. Good sportfishing opportunities are found within the Harbor. Major commerical fisheries for finfish and the American lobster *(Homarus americanus)* operate outside the limits of Boston Harbor.

Rowe, Polloni and Rowe (1972) have surveyed the benthic fauna of the lower Mystic River, which may be considered typical of the rivers entering Boston Harbor. They found low dissolved oxygen, high inorganic nutrient levels, and high coliform bacteria counts. An oily residue on the water and sediments and the smell of hydrogen sulfide in the sediments were further evidence of pollutional loading in the river. Salinities were high (29.5 to 32 parts per thousand).

Rowe, et. al. (1972) identified a total of 33 benthic species from 60 grab samples. The most abundant species was *Capitella capitata*. Diversity increased in a downstream direction, indicating an upstream source for the pollutional loading. In addition, the numerical abundance of *C. capitata* decreased downstream.

4. Massachusetts Bay Biota

In general, coastal areas are highly productive environments, much more so than the open ocean. This is related in part to the shallow depth in such areas, and in part to the influence of the adjacent coast. The range of seasonal variation for many habitat factors is greater in shallow water than in deep ocean areas. For example, increased turbulence due to wave action on the bottom may occur, and thus benthic organisms will play a large role in the community. Proximity to land results in lower salinity, increased sediment loads, nutrient enrichment, and a greater ratio of larvae to adults in the zooplankton. This is due to the large fraction of benthic organisms which have transitory planktonic stages (Moore, 1958). An example of the economic importance of coastal areas is the fact that most of the world's commercial fishes (finfish, shellfish and crustaceans) occur in shallow coastal seas.

In coastal seas, most primary production is due to microscopic planktonic algae, rather than benthic plants, because benthic plants are restricted to depths of approximately 60 meters or less (in those regions which have a suitable substrate). Phytoplankton populations in temperate coastal areas are typically dominated by diatoms with the second most abundant group being dinoflagellates. Cyanophyceae (blue-green algae) and chlorophyceae (green algae) are generally minor components of the temperature plankton, but may assume local significance. Whatever group is involved, their real importance is that they represent the first link in the food chain, since they are capable of converting inorganic substrates to organic substances. Appendix J summarizes the more important phytoplankton genera found in the Gulf of Maine.

Phytoplankton species in the area exhibit spatial and seasonal fluctuations in abundance (Lillick, 1940; Raymont, 1963). Winter populations are generally small, and are a mixture of a small number of diatoms and dinoflagellates. The spring diatom bloom is due mainly to *Thalassiosira* followed by *Chaetoceros*. Summer populations are generally considerably lower and consist of a mixture of species dominated by dinoflagellates and coccolithophores. A late summer bloom of diatoms frequently occurs (esp. *Rhizosolenia)*. Different areas of the Gulf show considerable variation in species composition.

While a wide variety of organisms occur in the zooplankton, the dominant groups are crustaceans, meroplanktonic (temporary) larvae of benthic organisms, chaetognaths, protozoans and coelenterates. Of these, crustaceans are by far the most significant. Crustaceans are, in turn, dominated by one group, the copepods. Copepods are abundant in all the oceans, both in coastal and open-ocean areas and constitute a very significant link in the marine food chain. Appendix J lists the planktonic copepod genera which do or could occur in the Gulf of Maine. Other significant zooplanktoners are also listed in Appendix J.

Zooplankton populations in the Gulf of Maine have been intensively studied by a variety of authors, notably Sherman (1965, 1966, 1968), Riley and Bumpus (1946), Redfield (1941), Fish and Johnson (1937), Fish (1936A, B, C) and Bigelow (1926A). The open waters of the Gulf are inhabited by an oceanic copepod assemblage dominated by the calanoid *Calanus finnarchicus* Bigelow, 1926A). Several other genera are associated with it, and occur mainly during spring and early summer. Redfield (1941) has shown that the general anticlockwise eddy, which completes one circulation of the Gulf in approximately three months, is largely responsible for changes in distribution and abundance of calanoids.

The Gulf of Maine supports a rich zooplankton population. The total zooplankton is minimal in February to March, but by April the spring bloom, dominated by *C. finnarchicus,* is underway. In the summer there is a general decrease in abundance but much greater diversity. The late spring and summer are periods of maximum abundance of meroplanktonic (temporary) larvae of benthic animals. There is a second, smaller zooplankton bloom in the fall, followed by a rapid decline to winter levels (Raymont, 1963). The Gulf Stream, which interacts with the Gulf of Maine at its southern end, transports warmer water species into the Gulf of Maine periodically, and limits the distribution of the cold-water *Calanus* community (Raymont, 1963).

The benthic invertebrate populations of the Gulf of Maine are highly variable. Local conditions, food, substrate types, and physical conditions, cause population densities to vary greatly. The benthic fauna of the "Western" basin (Murray/Wilkinson) has been evaluated by Rowe, et. al., (in press). This study involved 41 quantitative infaunal samples and 19 visual transacts from the Deep Submergence Research Vessel (DSRV) ALVIN. The bottom sediments were a silt/clay mixture.

Infaunal abundances averaged 4000 individuals/m^2, which was felt to be relatively low for a continental margin area. Eighty-seven benthic species were collected, with four polychaetes, *Paramphinome jeffreysii, Heteromastus filiformis, Ancistrosyllis groenlandica,* and *Ophelina abranchiata,* making up more than 50% of the individuals in all but one infaunal sample. Approximately 90% of all specimens belonged to 16 species,including 14 polychaetes. Mollusks, arthropods, echinoderms, some ascidians, coelenterates and ectoprocts represented less than 10% of the individuals. The infaunal data was supplemented by direct observations of benthic species using the DSRV ALVIN. The most consistently abundant species were the commercially important shrimp, *Pandalus* sp., the ophiuroids (brittle stars) *Ophiura sarsi* and *O. robusta*, the anemone, *Bolocera tuediae* and a hake, *Phycis* sp. Less frequent observations were made of another hake, *Vrophycis* sp., wolf eels, *Lycenchelys verrilli*, and two flounder species. This data is not as quantitative as the infaunal samples.

Haynes and Wigley (1969) and Wigley (1960) have reported on the abundance of four species of pandalid shrimp in the Gulf of Maine. Three species are abundant in the Central Gulf. *Pandalus borealis* is the most extensively studied (Haynes and Wigley, 1969). It is most abundant in moderate depths, and less abundant in the very deep areas of the Gulf. It occurs on fine grained, high organic sediments.

Other studies of benthic invertebrates not directly related to this project, are summarized by Rowe, et. al. (1975). Appendix J contains a list of those species which might be expected to occur in the Gulf of Maine. The species identified by Rowe, et. al. (1975) are marked by an asterisk.

The higher trophic levels of the Gulf are dominated by fishes, squid, marine mammals and sea birds. The fish species found in the Gulf of Maine are listed in Appendix J. The Gulf supports an extremely rich fish fauna and many are commercially valuable (see below). Sea birds are not of commercial value but are important ecologically. The species expected to be common in the Gulf are listed in Appendix J. Many marine food chains terminate with sea birds, particularly gulls, terns and skimmers. Marine mammals in the area are poorly studied, but a list of those species which might be present is given in Appendix J.

Extensive commercial fisheries are present in the Gulf of Maine region. There are important commercial species of ground fish, pelagic fish, and crustaceans in the area. Fitz (1965) has summarized the data on abundance and distribution for ground fish common in the area. Appendix K is a list of these species, with a summary statement as to their occurrence. Data on all commercial fisheries in the area is available from the Northeast Fisheries Center, Woods Hole (NMFS, 1975A, B). Appendix K also contains a summary of the U.S. fishlandings of all species from five areas of the Gulf likely to be affected by an ocean disposal alternative to the proposed project. All of the areas east of Boston Harbor are important commercial fishery areas. The coastal areas north of Cape Ann plus Massachusetts Bay produce the largest tonnages and are particularly important fishery areas for Cod, Winter Flounder, Grey Sole, Yellowtail Flounder, American Dab, Haddock, White Hake, Herring, Mackerel, Menhaden, Whiting, Rock Crab, Lobster, Shrimp and Soft Clams. The fishery area which overlies the Murray-Wilkinson Basin supports a significant fishery for Redfish. Cod, Yellowtail Flounder, Haddock, Silver Hake, and Sea Scallop are important species commercially in the area immediately east of Cape Cod, plus the Georges Bank area (which is further east).

F. Crops

Tables II-11 and II-12 summarize the crops produced in Massachusetts, the number of farms in selected counties and the number of acres in each crop category.

As is shown in Table II-11, the number of acres in cropland increased by almost 1% between 1973 and 1974. Both silage corn and sweet corn acreage increased by about 2.5% between 1973 and 1974 (USDA, 1975A). Silage corn, hay and cranberries are the major crops, occupying 89% of the harvested acreage and having

48% of the production value. Apples and tobacco, with a minor harvested acreage, have 31% of the crop value.

Table II-12 shows that the average acreage of farms in Massachusetts is generally less than 150 acres, with only 0.7% of the farms in the industrial counties having areas greater than 1000 acres (USDC, 1975)

Fertilizer consumption in the Commonwealth of Massachusetts increased by 1% between 1973 and 1974, i.e. in direct proportion to the increase in farmland. Consumption of mixed fertilizer, which contains two or more primary plant nutrients, was 61,540 tons in 1974. Fifteen thousand, eight hundred tons of primary nutrients (containing nitrogen, P_2O_5, and K_2O) were applied by direct application, while an additional 23 tons of secondary nutrients were directly applied (CRB, 1975). The average nutrient concentration of mixed fertilizers consumed in Massachusetts is: 11.92% Nitrogen, 10.17% available P_2O_5 and 9.92% potash. The most common grade of N-P fertilizer used is 13-39 (13% N, 39% P), with 552 tons being applied. The second most common grade of N-P fertilizer was 18-46, with 358 tons being applied (USDA, 1975B).

G. Environmentally Sensitive Areas

The Environmental Protection Agency has designated certain areas or situations as being environmentally sensitive to developmental pressures or disturbances (U.S. EPA, 1974G). Definitions of these areas and their relationships to Massachusetts are given below.

1. Surface Waters

Surface waters include lakes, ponds, streams, coastal waters, and other open bodies of water. These areas react rapidly to changing conditions and, once damaged, are slow to recover, therefore they require special attention (Kastarlak, 1970). Five percent of the surface area of the Commonwealth is composed of lakes, reservoirs and ponds which are 40 acres or more in size and an additional 1,102 square miles of streams, estuaries and coastal waters.

2. Marshland, Wetlands and Estuaries

Because swamps, bogs, freshwater and saltwater marshes are included in this category, it is very important for commercial benefits as well as wildlife habitat. Many commercial fish and shellfish species depend on estuaries or marshes for at least part of their lifespan. Managed bogs also provide habitats for cranberry bushes, which are farmed in the coastal plain of Massachusetts. Water and nutrient balances are readily upset by developmental or population activity in areas surrounding wetlands.

TABLE II-11

1974 MASS CROP SUMMARY

[Source: U. S. Department of Agriculture, 1975A]

Crops	Harvested Acres	Change from 1973 Acres	Yield/Acre	Production (Thousands)	Value of Production (Thousand dollars)
Corn (Silage)	35,000	+1,000	15.5 Tons	543	9,747
Hay	112,000	0	2.15 Tons	241	12,773
Potatoes	4,000	+ 300	200 CWT	800	2,800
Tobacco	1,460	- 50	1,649 lb.	2,408	11,719
Maple Syrup	----	----	----	25	280
Apples	----	----	----	2,167	11,011
Peaches	----	----	----	63	540
Cranberries	10,900	0	85.8 Bbl.	935	12,716
Asparagus	470	- 30	19 CWT	9	349
Cabbage	930	+ 150	274 CWT	255	1,286
Carrots	260	+ 10	230 CWT	60	450
Lettuce	370	+ 20	135 CWT	50	540
Peppers	540	+ 10	70 CWT	38	581
Snap Beans	700	- 20	33 CWT	23	478
Strawberries	280	+ 30	51 CWT	14	647
Sweet Corn	8,200	+ 200	62 CWT	508	4,521
Tomatoes	700	- 30	175 CWT	123	2,030
Totals	175,810 Acres	+1,590 Acres			72,468

TABLE II-12

FARM SUMMARY OF SELECTED COUNTIES FOR 1974

[Source: U. S. Department of Commerce, 1975]

	Franklin	Hampshire	Middlesex	Norfolk	Plymouth	Worcester
Number of Farms	404	495	504	172	532	816
Average Size (Acres)	180	131	85	70	145	160
Pasture Acres	6,771	8,269	2,668	875	3,081	13,492
Field Corn Acres	5,310	5,872	1,775	297	3,097	7,802
Hay Acres	13,238	11,736	10,106	2,326	4,615	29,234
Other Cropland Acres (Total)	4,601	7,785	7,771	1,215	10,858	2,001
Woodland Acres	34,166	23,586	14,404	5,214	34,305	51,471
All Other Lands	8,823	7,643	6,250	2,038	21,448	22,837
Percent County in Farms	16.1	19.2	8.1	4.7	18.5	13.5
Farms of (#)						
220-259 Acres	28	24	12	3	16	48
260-499 Acres	65	57	19	7	25	104
500-999 Acres	24	13	11	2	17	26
1000-1999 Acres	-	2	2	1	4	4
2000 Acres and Over	-	-	-	-	4	2

3. Floodplains or Flood-Retention Areas

Floodplains act as energy relief systems during floods. After leaving the river channel, floodwaters spread over the land surface, and are subsequently slowed by obstacles such as trees and other plants. In addition, water standing or running over a floodplain percolates into the ground more readily than it would through the channel bottom. Floodplains also provide habitats for a great diversity of wildlife. Development of these areas may result in increased flood damage, a decreased animal diversity and a decreased surface water quality. Special considerations are necessary to maintain this environment.

4. Groundwater Recharge Areas

Development on groundwater recharge areas results in less water reaching the aquifer layers, and possible contamination of the watertable. This in turn affects surface water quantity and quality. Certain portions of Massachusetts, such as heavily developed Cape Cod, are almost entirely groundwater recharge area.

5. Steeply Sloping Lands

Steeply sloping lands are generally defined as lands with a slope greater than 15%. These areas are easily eroded when their ground cover is removed, which results in increased sediment loads in nearby streams, which in turn affects the streams' ecology. Slope erosion also leads to a general degradation of the wildlife habitat in that area. Steep slopes are scattered throughout the State, although the mountainous western section of Massachusetts has a greater predominance.

6. Forests and Woodlands

Besides containing the habitats of numerous animal species, forests and woodlands are important in climate modification. They divert and reduce the force of winds, they reflect sunlight which results in cooler areas, and they reduce the rate of radiational cooling at night by reflecting heat back to the earth. They may be used for recreational purposes, they are aesthetically pleasing, and are a significant economic resource.

7. Prime Agricultural Lands

Prime agricultural lands are generally considered to be areas where soil is found that has characteristics best suited for crop production. Some of these characteristics are also well-suited for development. Massachusetts has been experiencing a decrease in farms, partially due to population pressures which have caused increased housing development.

8. Habitats of Rare and Endangered Species

Lists of rare and endangered species of plants and animals are given in Appendix A. Their habitats include oceans, beaches, estuaries, bogs, marshes, meadows and forests. Based on the Massachusetts list of endangered plants and animals (Isgur, 1973), species on the Federal endangered lists are noted.

9. Public Outdoor Recreation Areas

Ranging from wilderness parks to golf courses, this category includes any area set aside for public recreational activity.

10. Sensitive Geologic Areas

Primarily designed to safeguard areas of fossil concentrations; unusual geologic formations such as caves are also included.

11. Archeological and Historic Sites

The protection of possible archeological and historic sites is provided for (as well as presently accepted or recognized sites) by Federal law under the Historic Preservation Act, the Archaeological Preservation Act, and several State statutes.

H. Existing Ambient Air Quality

There are six principal air pollutants identified by the U. S. Environmental Protection Agency for which ambient air quality standards have been established under the 1970 Clean Air Act. These principal pollutants are: particulates, sulfur oxides (SO_x, measured as sulfur dioxide, SO_2), hydrocarbons (HC), nitrogen dioxide (NO_2), carbon monoxide (CO), and photochemical oxidants (O_x). The National and Massachusetts primary ambient air quality standards (relating to the protection of public health) and secondary ambient air quality standards (relating to protection of general welfare) for these pollutants are summarized in Table II-13. For carbon monoxide, photochemical oxidants, and nitrogen dioxide, primary and secondary standards are the same, while for sulfur oxides and particulate matter, the secondary standards are somewhat more stringent than the primary standard. As shown, the National and Massachusetts standards are identical for all pollutants of concern. These standards may not be exceeded more than once a year (except for those which are defined as an Annual Average). The hydrocarbon figure is considered a "guideline" rather than a specific standard, since the health effects of non-methane hydrocarbons are indirect. Specifically, the health impacts of non-methane hydrocarbons result from combining HC and NO_2 in the presence of sunlight to form irritating photochemical oxidants.

The baseline ambient air quality used in this study is derived from an analysis of the 1974 calendar year monitoring data for the Boston Metropolitan area (U.S. EPA, 1975E). Since the

TABLE II-13

Massachusetts and Federal Ambient Air Quality Standards

CONTAMINANT	AVERAGING TIME	TYPE OF AVERAGE	AVERAGE CONCENTRATION PRIMARY STANDARD µg/M^3	PRIMARY STANDARD ppm	SECONDARY STANDARD µg/M^3	SECONDARY STANDARD ppm
Sulfur Oxides (SO_2)	Year	Arithmetic Mean	80	0.03		
	Day	Maximum a	365	0.14		
	3 Hour	Maximum a	None	None	1,300	0.5
Total Suspended Particulates (TSP)	Year	Geometric Mean	75	--	60b	--
	Day	Maximum a	260	--	150	--
Carbon Monoxide (CO)	8 Hours	Maximum a	10 (mg/M^3)	9	10 (mg/M^3)	9
	1 Hour	Maximum a	40 (mg/M^3)	35	40 (mg/M^3)	35
Photochemical Oxidants (O_3)	1 Hour	Maximum a	160	0.08	160	0.08
Hydrocarbons (Non-Methane)	3 Hours	Maximum a, b Between 6 & 9 A.M.	160	0.24	160	0.24
Nitrogen Dioxide (NO_2)	Year	Arithmetic Mean	100	0.05	100	0.05

a) Federal standards other than annual average may be exceeded once per year.

b) A guide to be used in assessing implementation plans to achieve the 24-hour standard.

µg/M^3 = Micrograms per cubic meter.

ppm = Parts per million.

mg/M^3 = Milligrams per cubic meter.

ambient air quality can best be defined in terms of how closely the monitored data meets the ambient air quality standards, the most significant fact is the number of times the standards were exceeded. There are a number of air quality monitoring stations located throughout the Boston Intrastate Air Quality Control Region (AQCR). Table II-14 lists the monitoring stations at which the air quality standards were exceeded and the number of violations which occurred at each location during the period January-December, 1974. The maximum air pollutant concentrations measured at each site are given in Table II-15.

The following sections describe the baseline concentration for all pollutants except hydrocarbons. (Hydrocarbons are not monitored in the Boston region because the photochemical oxidant concentration can generally be used as the guideline for ambient hydrocarbons concentration.)

1. <u>Total Suspended Particulates</u>

A comparison of the 1974 total suspended particulate concentrations with the standards indicates that the primary standard of 260 micrograms per cubic meter was never exceeded in the Boston region during the year. The secondary 24-hour standard of 150 micrograms per cubic meter was exceeded only once at one single location, i.e., Kenmore Square in Boston. At this same location, the annual average particulate concentration was reported at 84 micrograms per cubic meter, which is 9 micrograms per cubic meter higher than the standard (75 micrograms per cubic meter).

Suspended particulates are generated from a number of sources such as power plants, industrial processes, home heating, etc. The ambient levels vary with the location situations and meteorological conditions.

2. <u>Sulfur Oxides (Sulfur Dioxide)</u>

Annual 24-hour primary and secondary, and 3-hour secondary standards have been established for sulfur oxides. The 1974 monitored data shows that none of these standards were exceeded in the Boston AQCR. Among the sampling sites in the metropolitan area, the maximum 24-hour sulfur dioxide concentrations ranged from 233 micrograms per cubic meter, measured at Cambridge, to 107 micrograms per cubic meter at Quincy and Waltham. The high at Cambridge is approximately 64 percent of the 24-hour standard of 365 micrograms per cubic meter. In general, the sulfur dioxide concentrations were well below the standards for the Boston AQCR in 1974.

TABLE II-14

Violations of National Ambient Air Quality Standards
Boston Air Quality Control Region 1974

POLLUTANT	STANDARD	MEASUREMENT LOCATION	NO. OF VIOLATIONS
Total Suspended Particulates	24-Hour Primary 260 μg/M^3	---	0
	24-Hour Secondary 150 μg/M^3	Boston-Kenmore	1
		Medford-Wellington	1
	Annual Average Primary 75 μg/M^3 Secondary 60 μg/M^3	Boston-Kenmore Cambridge-Sci.Pk. Waltham-Main St.	1 1 1
Carbon Monoxide	1-Hour Primary and Secondary 40 mg/M^3	East Boston	1
	8-Hour Primary and Secondary 10 mg/M^3	East Boston	39
		Boston-Kenmore	114
		Medford	28
		Waltham	13
Sulfur Oxides (sulfur dioxide)	24-Hour Primary 365 μg/M^3	---	0
	Annual Primary 80 μg/M^3	---	0
	3-Hour Secondary 1,300 μg/M^3	---	0
Nitrogen Dioxide	Annual Primary and Secondary 100	Kenmore Boston	1
Photochemical Oxidant	1-Hour Primary and Secondary 160 μg/M^3	Boston-Kenmore	24
		Cambridge-Sci.Pk.	60
		Quincy	221
		Waltham	77

The analysis of 1974 Hydrocarbon monitoring data is not available.

TABLE II-15

Maximum Concentrations of the Monitored 1974 Ambient Air Quality Data In Boston Air Quality Control Region

POLLUTANT

LOCATION	Particulates $\mu g/m^3$		Carbon Monoxide mg/m^3		Sulfur Dioxide $\mu g/m^3$ (Continuous)		Sulfur Dioxide $\mu g/m^3$ (Bubbler)		Nitrogen Dioxide $\mu g/m^3$	Photochemical Oxidants $\mu g/m^3$
Averaging Time	24-Hour	Annual	1-Hour	8-Hour	24-Hour	Annual	24-Hour	Annual	Annual	1-Hour
Standards	P260 S150	P75 S60	40	10	365	80	365	80	100	160
Boston (JFK Bldg.)	108	47	-	-	-	-	136	26	79	-
Boston (Kenmore)	200	84	27.4	18.2	189	47	150	34	128	267
Boston (Fire station)	119	59	-	-	-	-	84	10	71	-
East Boston (central sq)	112	-	-	-	-	-	66	-	-	-
Boston (Callahan Tunnel)	-	-	63.8	18.2	-	-	-	-	-	-
Brookline (High School)	840	38	-	-	-	-	105	16	55	-
Cambridge (Harvard Herb)	111	-	-	-	-	-	86	16	68	-
Cambridge (Science Pk)	257	62	31.9	16.4	233	-	126	21	83	255
Lynn (City Hall)	107	41	-	-	-	-	100	13	55	-
Marblehead (Jr. H.S.)	109	36	-	-	-	-	121	13	41	-
Medford (Fire headqrtrs)	198	43	-	-	-	-	94	18	73	-
Medford (Wellington Cir)	212	55	29.6	24	160	35	144	37	100	392
Quincy (JFK Health Ctr)	147	-	-	-	-	-	144	-	-	-
Quincy (Fore River)	157	56	18.2	15.6	107	22	136	29	73	367
Revere (Garfield Jr.HS)	116	46	-	-	-	-	144	24	68	-
Waltham (U. of Mass)	86	32	-	-	-	-	68	-	-	-
Waltham (Moody & Main)	185	70	30.8	9.2	107	31	97	18	71	314
Woburn	103	39	-	-	-	-	152	16	55	-

$\mu g/M^3$ = Micrograms per cubic meter.

mg/M^3 = Milligrams per cubic meter.

\- : Data are not available

3. Carbon Monoxide

A comparison of the 1974 carbon monoxide concentrations with the standards showns that the 1-hour carbon monoxide standard of 40 milligrams per cubic meter (35 ppm) was exceeded only once in the region, which is permissible. However, the 8-hour standard of 10 milligrams per cubic meter (9 ppm) was exceeded on several occasions (see Table II-14). Exhaust from motor vehicles is the principal source of carbon monoxide, and high concentrations generally occur in localized areas.

In order to alleviate this problem in the Boston AQCR, several measures are being implemented. The Federal Motor Vehicle Control Program, designed to eliminate exhaust emissions at the source, will be important to controlling all motor vehicle pollutants; however, the dates for meeting the exhaust control requirements are presently being reviewed by the Congress.

In addition, under the Clean Air Act requirements, a Transportation Control Plan (GCA, 1972) to reduce motor vehicle pollutants has been promulgated and is presently being implemented in the Boston Intrastate AQCR. It is expected that the region will not attain the CO standard by the target year 1977, and a series of strategies including carpooling plans and control of tunnels and other high density traffic centers is being implemented.

4. Nitrogen Dioxide

Two methods are used to measure nitrogen dioxide concentrations in the region: continuous monitoring and gas bubblers. For most sampling sites, the data indicates that nitrogen dioxide was below the ambient air quality standard in 1974. Only one sampling site, Kenmore Square Station, showed in annual nitrogen dioxide concentration higher than the standard of 100 micrograms per cubic meter. The measured concentration at Wellington Circle at Medford was right at the standard.

5. Photochemical Oxidants

As shown in Tables II-14 and II-15, the 1-hour photochemical oxidant primary standard of 160 micrograms per cubic meter (0.08 ppm) was repeatedly exceeded at many sampling stations in the Boston Intrastate Region; the total number of violations was 382 in 1974. Although photochemical oxidant is a regional problem, the characteristics of the violations vary by location. For example, the greatest frequency of violations occurred at the sampling station in Quincy, where the standard was exceeded 221 times duirng 1974. In addition, the maximum 1-hour photochemical oxidant reading was 392 micrograms per cubic meter (0.183 ppm) measured at Wellington Circle in Medford.

Photochemical oxidants are formed in the atmosphere by the reaction of intense sunlight on nitrogen dioxide in the presence of non-methane hydrocarbons. The alleviation of the photochemical oxidant problem will depend on the reduction of the regional emissions of hydrocarbons and nitrogen dioxide. Since the primary source of these pollutants is motor vehicles, the Transportation Control Plan is designed to accomplish a reduction of 60 percent in hydrocarbons and will be required to reach the standard by 1977.

I. Existing Ambient Noise

The objective of this section is twofold. First, quantitative measures of existing noise levels are presented to serve as a basis for comparison between existing conditions and established noise level guidelines, as well as to serve as a benchmark by which induced increments in potential noise levels can be evaluated. Second, detailed descriptions of the socio-physical characteristics of potential impact areas will be presented in order to identify particularly sensitive receptor sites/areas.

The ambient noise levels presented below have been extracted from existing data sources, and as such are subject to a number of limitations, particularly the choice of monitoring sites, as well as the currency of the data. Additionally, in some cases no ambient data was available. In these instances ambient figures were developed from noise levels associated with typical land uses. In this context, ambient levels presented should not be interpreted as exact, but rather as approximate values. Figure II-10 is a graphical representation of relative noise levels for different types of urban-suburban-rural environments.

Table II-16 illustrates the equivalent 24 hour sound level ($L_{eq}(24)$) for sites within the vicinity of the five potential impact areas (Charlestown, Plainville, East Boston, Quincy and Winthrop) and for the generalized rural sites. (As will be indicated later, in Section III, Plainville has been chosen as a potential landfill site.) The urban areas have ambient levels in the 69 dB to 74 dB range, while the rural areas and Plainville were estimated to have sound levels about 10 decibels lower. It should be noted as a point of comparison that the Federal Environmental Protection Agency has established guidelines including limits of equivalent 24 hour sound levels. Specifically, $L_{eq}(24)$ sound levels greater than 70 dBA are interpreted to degrade public health. This guideline is exceeded in the section of Charlestown considered, and possibly exceeded in Winthrop and East Boston. Background noise levels in these areas are greatly influenced by the proximity of Logan Airport. In addition, a day-night noise level (Ldn) of 55 dBA(Ldn) has been indicated as a minimum standard for protection of public health from the standpoint of sleep interference, even though approximately 50% of the national population presently experiences higher levels (USEPA, 1974I).

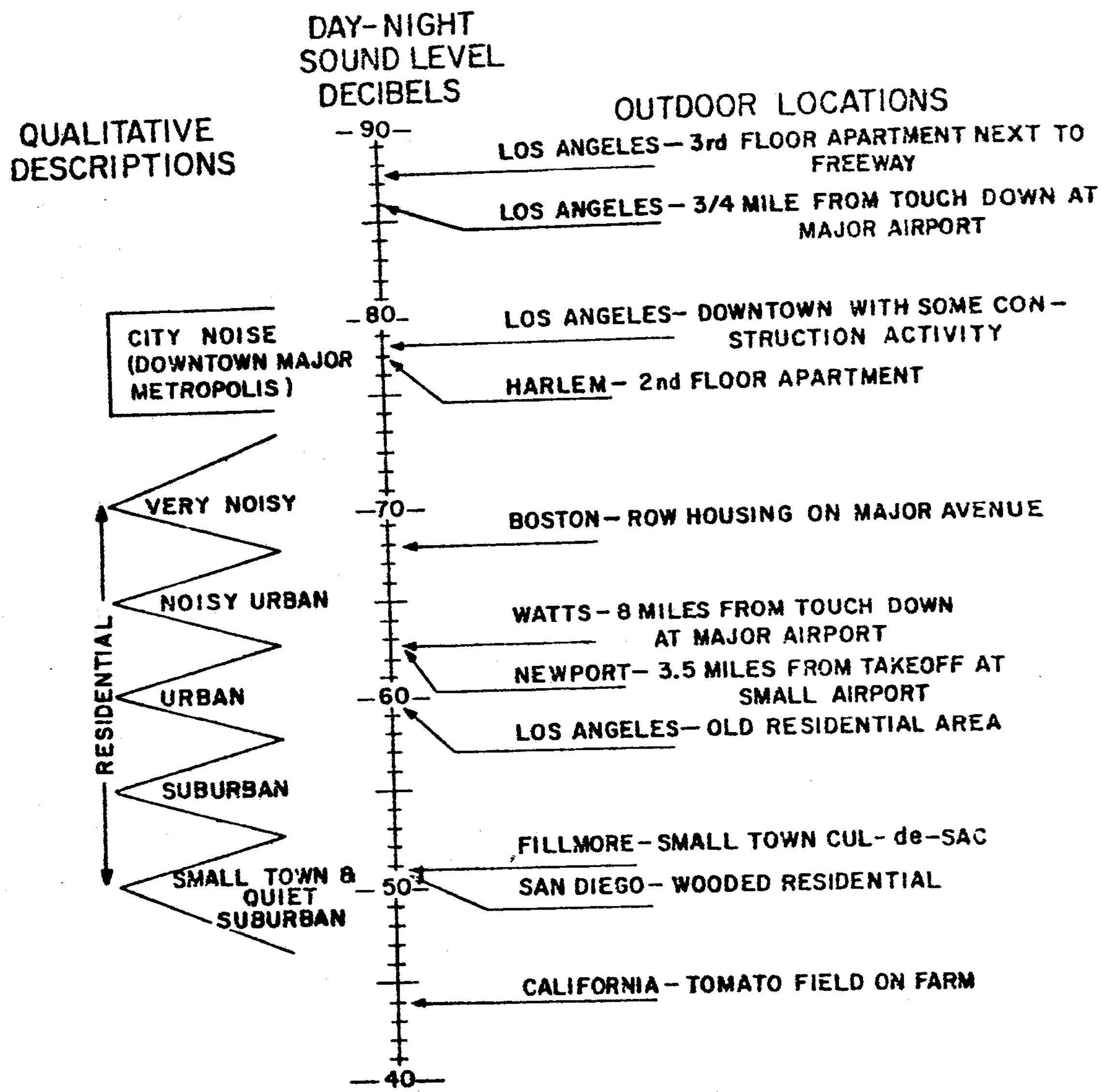


FIGURE II-10: OUTDOOR DAY-NIGHT SOUND LEVEL IN dB (RE 20 MICROPASCALS) AT VARIOUS LOCATIONS

[SOURCE: U. S. EPA, 1974G]

TABLE II-16

AMBIENT NOISE LEVELS

Location	Equivalent 24 hour Sound Level $L_{eq}(24)$
Charlestown: Henley Street between Main Street and Warren[1]	74 dB
East Boston: Bennington Street between Putnam Street and Prescott Street[2]	69 dB
Plainville*	60 dB
Quincy: Bayview Street between Edison Street and Thompson Street[2]	69 dB
Rural Sites*	60 dB
Winthrop*	70 dB

---

* Levels developed from typical land uses.

1 Source: City of Boston Air and Noise Pollution Control Commission, Boston Noise Survey, 1975. Site Number 28-42.

2 Source: Bolt Beranek and Newman, Inc., Community Noise Measurements in Los Angeles, Detroit and Boston, June 1971. Site numbers 11 and 23. $L_{eq}(24)$ level developed from L_{10} and L_{50} levels and adjusted to 1975.

J. Public Health

The potential for water borne disease occurrence in the Boston Harbor vicinity is related to three major sources of contamination:

- combined sewer overflows,
- primary effluent discharges from Deer and Nut Islands,
- sludge discharges from Deer and Nut Islands.

Of these three, the combined sewer overflow problem is regarded as the major area of concern (Metro. Area Planning Council, 1972 and EPA, 1971B). These combined sewer overflows originate from sections of Boston, Cambridge, Chelsea, Somerville and Brookline which are served by combined sewer systems. During normal conditions, sewage is conveyed via these sewers to the respective treatment facilities. However, during storm events, combined sewers overflow and discharge untreated sewage into the Harbor and its tributaries at approximately 125 outlets, 75 of which are from the City of Boston sewer system. Many of these combined sewers discharge wastes into the Harbor during low tide in dry weather because of defective tide gates at the outlets. Unlike the treatment plant effluents, these discharges are not chlorinated.

Associated with these conditions, studies by the EPA (EPA, 1971B) and the Nut Island treatment plant chemist have identified a correlation between coliform counts at the MDC bathing beaches in the Harbor and rainfall or tides. Tenean Beach was found to have particularly high coliform counts following rainfall, and all of the beaches were found to have higher coliform counts during low tides.

The MDC has adopted a tidegate repair program for correction of these problems. This program is now approximately 90% complete (EMMA, 1975), and the maintenance for the rehabilitated tide gates will be a responsibility ot the City. On June 30, 1977, the NPDES permit conditions allowing the discharge of combined sewer overflows during rainfall will expire, at which point the MDC must regulate these discharges. Since the program for repair was adopted, some improvement in the coliform counts at the beaches has been found (U.S. EPA, 1971B). For example, since 1968, there have been only three cases of gastroenteritis in the Boston area which were suspected to have resulted from water pollution (Hoke, 1975).

Air pollution resulting from industrial and municipal stack discharges and automotive emissions is also of concern in urban areas. Although there are no studies directly correlating air quality with respiratory disease in Boston, air quality standards

TABLE II-17

[Source: Hoke, 1975]

RESPIRATORY AILMENTS IN THE BOSTON HARBOR VICINITY

	Number of Cases			
	1971	1972	1973	Avg.
Bronchitis, Emphysema, Asthma				
Hull	1	3	1	2
Quincy	10	14	13	12
Boston	98	79	100	92
Cambridge	18	15	21	18
Somerville	18	14	14	15
Chelsea	8	5	4	6
Everett	6	7	10	8
Winthrop	1	* 1	0	1
Revere	7	3	3	4
Nahant	0	0	0	0
Total	167	141	166	158
Flu and Pneumonia				
Hull	4	5	3	4
Quincy	45	36	40	40
Boston	464	540	467	490
Cambridge	50	71	64	62
Somerville	56	52	53	54
Chelsea	18	21	13	17
Everett	16	11	13	13
Winthrop	7	* 8	9	8
Revere	24	19	11	18
Nahant	0	2	3	2
Total	684	765	676	708

* Data not given, assumed average

are based on public health criteria. Table II-17 lists the number of cases of respiratory ailments in the Boston Harbor vicinity in the years 1971-1973. These types of conditions in turn may be adversely affected by poor air quality.

In addition to the general population, two special populations can be considered sensitive receptors: the Long Island Chronic Disease Hospital and the Deer Island Confinement Facility.

The Long Island Chronic Disease Hospital, located on Long Island (southwest of Deer Island), has an average population of 445, of which 345 are hospitalized and 100 are residents. The average age of these inmates is 64 years of age or older. The Administrator has stated that statistics of age are more indicative of respiratory sensitivity than are data on specific respiratory diseases (LICDH, 1976).

The Deer Island Confinement Facility, operated by Suffolk County, is to be relocated. This relocation will be funded by a special grant incorporated in the Water Pollution Control Act Amendments of 1977.

K. Historic Places

Metropolitan Boston and the Commonwealth of Massachusetts are intimately entwined in the colonial heritage and early history of the United States. The Massachusetts Bay was the location of one of the first colonies in America, and the City of Boston was the cultural and commercial center of the northern colonies. The Boston Harbor has long been a major international shipping port; as early as 1660 it was the center of merchant shipping between the colonies and England. In addition, the Harbor has been a strategic military stronghold and the center of the New England fishing industry (MAPC, 1972).

The Commonwealth contains a large number of historic places recognized by the National Register and Massachusetts Historical Commission. Most historic sites are located in the eastern portion of Massachusetts as landmarks in urban areas of Boston or in the cities and towns in the vicinity. However, a large number are located in relatively rural areas in the western and middle sections of the state.

In all alternatives for sludge disposal, these sites must be considered. Any potential disturbance or other detrimental effect of an alternative on an historic place must be avoided to prevent the loss of irreplaceable segments of the American heritage.

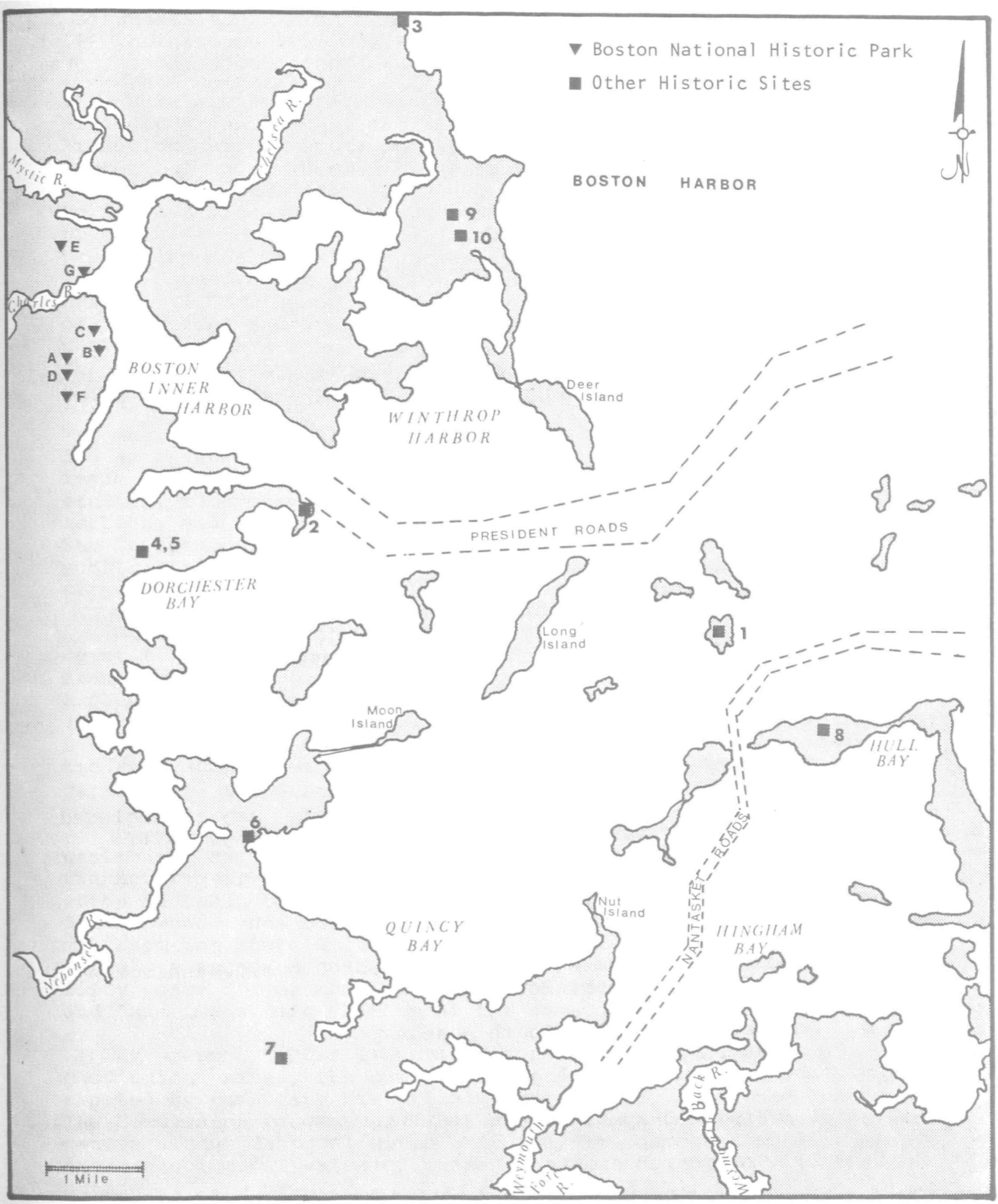


FIGURE II-11 LOCATION OF HISTORIC SITES IN VICINITY OF BOSTON HARBOR.
[Refer to Text for Description]

Figure II-12 indicates the location of historic places in the Boston Harbor vicinity that may be affected by various alternate sludge disposal methods (Massachusetts Historical Commission, 1975). They are described further in Appendix L. The numbers and letters given below are keyed to Figure II-11.

1. Fort Warren, Boston
2. Fort Independence, Boston
3. Slade Spice Mill, Revere
4. Fort Revere, Telegraph Hill
5. Telegraph Hill
6. Moswetuset Hummock, Quincy
7. Adams National Historic Site, Quincy
8. Hull Village, Hull
9. House, Winthrop
10. Deane Winthrop House, Winthrop

Sites that are to be included in the Boston National Historical Park are also indicated on Figure II-12, and are denoted by triangles.

A. Fanueil Hall, Dock Square, Boston

B. Paul Revere House, 9 North Square, Boston

C. Old North Church, 193 Salem Street, Boston

D. Old State House, Washington and State Streets, Boston

E. Bunker Hill Monument, Breeds Hill, Boston

F. Old South Meeting House, Mild and Washington Streets, Boston

G. Charlestown Navy Yard

In addition to the above, the following sites may be included in the National Historical Park at a later day (Gurney, 1975):

A. Boston Common, Boston

B. Dillaway Thomas House, Roxbury

C. Thomas Crease House (Old Corner Book Store), Washington and School Streets, Boston

D. Dorchester Heights, South Boston

E. The following burial grounds:

   1. King's Chapel, Boston

   2. Granary, Boston

   3. Copp's Hill, Boston

L. Archeology

There are two statutes relating to the preservation of significant archeological and historical resources: the National Archeological Preservation Act of 1974, and the Commonwealth Historical and Archeological Resources Preservation Act of 1973. Executive Order 11593 and the National Environmental Policy Act also encourage the identification and protection of cultural resources. The State's Act provided a system for preserving historical resources during the ongoing development of the Commonwealth. The Act established the Massachusetts Historical Commission which is responsible for the regulation of historical and archeological matters within the State. The Chairman of this Commission was charged with the responsibility to appoint a State Archeologist who will advise the State Secretary on archeological matters.

The State Archeologist will also be responsible for maintaining an inventory of historical and archeological sites and specimens, publishing information obtained during surveys and field studies, recommending sites for historical or archeological protection, and issuing permits for archeological investigations. The Commission is responsible for recommending reservation of public lands from sale on which archeological or historical sites or specimens are located or suspected to exist.

Under the Act, the Commission may request the State Archeologist to examine specific sites for recommendations on their archeological significance. Sites which are believed to be of archeological significance may be designated by the Commission as archeological landmarks, and the Commission may establish standards for the management of these sites. Field investigations on such sites must be authorized by the issuance of a permit from the State Archeologist.

During construction or excavation on any lands of the Commonwealth, if any historical or archeological specimen is encountered the Act requires that the State Archeologist be notified, and that steps be taken to preserve the specimen. Field inspections on State-owned lands must be performed under the authority of a permit from the State Archeologist. For the purpose of the Act, a "site" is accepted to be any location which is one hundred and fifty years old or more and may have archological significance, and "specimens" are objects of the same nature.

At present, there is no map identifying the location of archeological sites, the number of which has been tentatively anticipated by the State Historical Commission to be in the thousands. The Commission recommended that during the investigation of alternative sludge disposal sites that they be contacted to determine the archeological value of these sites in accordance with the Act.

The archeology of Boston has been described in "An Introduction to Archeology in the Greater Boston Area" (Dincauze, 1974). Despite extensive urbanization, the area has retained significant potential for research. In an area within a 30-mile radius of Harvard University, it was estimated that only half of all existing prehistoric sites have been recorded, totaling 199. Of these, 151 sites were sufficiently studied to allow mapping, and 42 of these were determined to have remaining potential for research. Dincauze has estimated that 80%-90% of all partially existing sites in the area have been mapped. The survey generally determined that the Boston area has been continuously occupied for approximately 9000 years.

M. Transportation

1. Highway System

a. Commonwealth: The Commonwealth of Massachusetts in 1966 contained 27,401 miles of municipal and rural roads. Of the 18,888 miles of rural roads in Massachusetts, the State controls 10,921 miles, local governments control 7,804, and the Federal government controls 163 miles (Mass. DCD, 1970). The State also contains significant segments of the interstate highway system, including I-95, I-93, I-495, I-91, and the Massachusetts Turnpike (I-90).

In the eastern part of the State, the major highways either radiate from Boston or are concentric around the city. The major arteries radiating outward from the city are I-95, I-93, U. S. 3, Rte. 2, I-90, Rte. 24, and Rte. 3 (counter clockwise from north to south). Two major concentric rings are formed by Rte. 128, approximately 10 miles from center city, and I-495, approximately 35 miles from center city.

In the central and western parts of the State, two major east-west corridors exist. Rte. 2 passes from Boston through Leominster and Greenfield to North Adams along the northern portion of the State. The Massachusetts Turnpike passes from Boston through Worcester and Springfield to Albany, N. Y., along the southern part of the State. Interconnecting these highways between Springfield and Greenfield is I-91 which is a major north-south artery from Connecticut to Vermont/New Hampshire. In addition to these major highways are many local highways throughout the State providing access to smaller towns.

b. Winthrop - Deer Island: Winthrop is an older densely populated residential community, which has a population of 20,181 (1970 census) in an area of 1.56 square miles. Winthrop is bordered by Boston and Revere to the north and the Massachusetts Bay on all other sides. It is a peninsula, connected by two access routes leading into Revere and Boston. Saratoga Street-Main Street is the sole access facility from Boston Proper while Winthrop Parkway-Revere Street provides the only access into Revere. Both access facilities are designated as State Route 145.

A designated truck route through the town to Deer Island follows Saratoga Street into Winthrop Proper via Main Street. It then proceeds along Pleasant Street (Route 145)/ Washington Avenue to Shirley Street, which eventually forms Shirley Avenue and Tafts Avenue. Tafts Avenue then provides the sole access onto Deer Island.

c. Quincy - Nut Island: Quincy is one of the largest cities within the Boston Metropolitan Area. It is located southeast of Boston, with the primary connecting roadway facility being the Southeast Expressway. The population of Quincy is approximately 90,000.

Land use within the City is widely mixed. The Central Business District serves a major regional shopping area and commercial district for many of the surrounding communities. Many scattered areas have been developed with manufacturing and other industrial uses. The General Dynamics Fore River Shipyard is one of the biggest employers within the City.

The Red Line Rapid Transit System was recently completed to Quincy Center. The Quincy Center terminal has developed to be a major focal point in the area with the constructed garage serving both commuter needs and Quincy business needs.

The Neponset Bridge, recently reconstructed, is one of the principal roadways servicing Quincy. It provides the only connection between the City of Quincy and the City of Boston. State Route designation 3A is given to the Neponset Bridge and Hancock Street through Quincy.

2. Rail Services

The Commonwealth of Massachusetts is served primarily by two railroad companies. The Penn Central Railroad predominantly serves the southern half of both the Commonwealth and the Boston area, and the Boston & Maine Railroad serves the northern half. Some overlapping of service occurs in the Springfield and Lowell areas. In addition to these major lines, several smaller companies maintain short segments within the Commonwealth. These are:

- Providence & Worcester Railroad
- Grafton & Upton Railroad
- Central Vermont Railroad
- Fore River Railroad

Figure II-12 illustrates the rail network in the Commonwealth. Because Boston is the major center of industry and commerce in the New England area, a considerable network of rail lines radiates from the city in all directions on either of the two major services. The network has relatively dense coverage within approximately 40 miles of the city. Beyond this radius, the network begins to thin out, serving only the cities and larger towns in the central and western portions of the State.

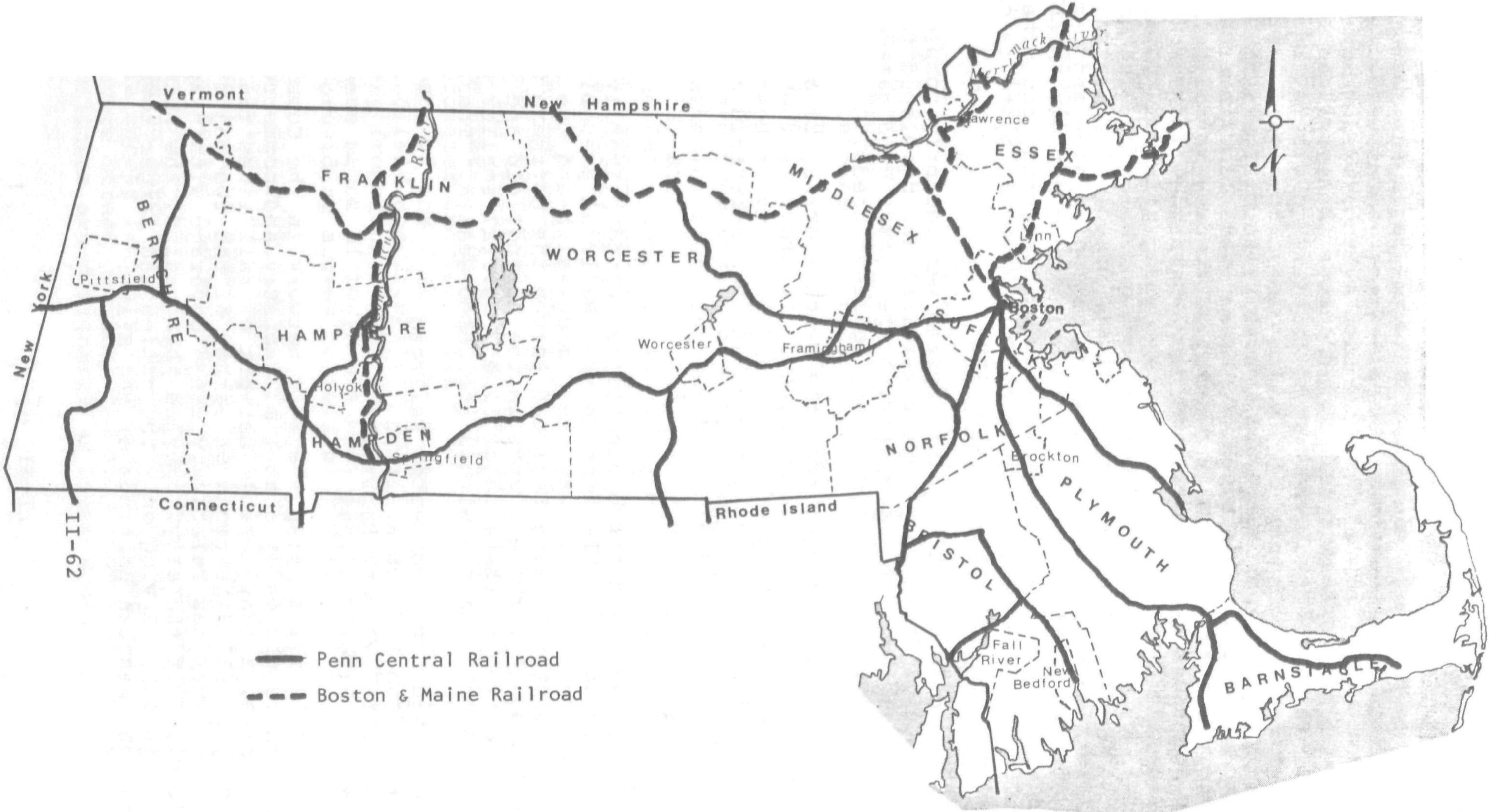


FIGURE II-12 . MAJOR RAILROAD ROUTES IN THE COMMONWEALTH OF MASSACHUSETTS

0 5 10 15 20
Miles

Because of this extensive network, it is possible to consider rail transportation as an alternative method for transporting sludge, provided that the site of land application is within access of a rail service. Other factors must be considered in this alternative, however, such as interchanges, monetary costs, availability of adequate land for disposal, and availability of service on the lines, among others. These factors will be incorporated into the land disposal alternative and weighed against the other transportation alternatives.

3. Shipping

The Port of Boston has historically provided a means of access by sea for the New England area. Boston has a well protected deep water harbor which is eight miles from the open sea, and one day closer to Europe than other eastern ports.

The Massachusetts Port Authority (Massport) is the agency responsible for revitalization of the port beginning in 1956, after an overall post-World War II decline. Massport is the major authority of the harbor, maintaining the only full service container port in New England, at Mystic Terminal, on the Mystic River.

In 1974, the tonnage of container cargo exported from Massport locations amounted to 275,000 short tons (Massport, 1974).

Access to the port from Boston and the harbor area is provided by both rail and truck traffic.

4. Air Travel

Access to Boston by air is provided at the Boston-Logan International Airport. The airport provides service for cargo transport as well as passenger and mail services. In 1974, the airport handled 347,321,000 pounds of cargo of which 266,159,000 pounds were domestic in nature (Massport, 1974).

The airport is in close proximity to center city and the harbor vicinity by rapid rail mass transit and highway.

N. Energy Resources

Electrical power in the Boston area is supplied by two companies. The Boston Edison service area includes the City of Boston and the western and northern regions around the harbor, while Massachusetts Electric serves the southern part of the harbor including Quincy.

The Deer Island treatment plant is located within the Boston Edison service area. At present it does not purchase energy from the company, because the methane generated by sludge digestion is used to produce the needed electricity. However, in the event that it becomes necessary for the plant to purchase additional electrical energy, it will most likely obtain it from Boston Edison.

Boston Edison maintains four oil, one gas and one nuclear generating plant, and purchases additional electricity to provide a peak capability (1974) of 2,954,000 KW and a net system output of 11,170,085,000 kilowatt hours. Of this 10,297,761,000 kilowatt hours were sold to customers in 1974 (Boston Edison, 1974).

If the Deer Island treatment plant were to purchase primary power from Boston Edison, it would be billed under rate G-3, the general service rate for industrial use at a single location. Table II-18 details the charges for the G-3 rate. The range for fuel adjustment is $.01586 to $.025399 per KWH for 1977 and 1978.

The Nut Island treatment plant is located within the Massachusetts Electric Company service area. At present, it, too, does not purchase electrical energy because its digesters produce sufficient gas to make the facility totally energy independent. However, in the case that it were to require outside power, the plant would purchase electricity from Massachusetts Electric. Massachusetts Electric is a member of the New England Electric System which operates (jointly or solely) five fossil fuel, four diesel or gas, thirteen hydroelectric, and eight nuclear plants in the States of Connecticut, Rhode Island, Massachusetts, Vermont, New Hampshire, and Maine (NE Electric, 1974).

The Nut Island treatment plant would be billed either under general rates G-22 or C-22, or under the optional large-power rate H. These rates are given in Table II-19.

O. Aesthetics

The Boston area and the Commonwealth of Massachusetts are important areas of tourism and local attraction. In the eastern section of the State are the sites of early colonies, revolutionary museums, battlefields and historic buildings and forts. Recreational areas include the seashore of Cape Cod, Nantucket and Martha's Vineyard, and the rugged coastline north of Boston. Boston, as the largest city in New England, is also an important art and cultural center.

The central and western portions of the Commonwealth offer recreational opportunities for year-round tourism including hiking, fishing, swimming, canoeing, and skiing, as well as other outdoor activities. The many rivers and streams in these regions associated with the highlands of the Taconic Mountains and the Berkshire Valley add to the picturesque quality of the State. Massachusetts presents a wide variety of landscapes in a relatively small land mass.

TABLE II-18

BOSTON EDISON SERVICE RATE, G-3

(Source: Boston Edison, 1978)

Demand charge (per month):

July-October	November-June	
$530.00	$530.00	0-150 Kilowatts (KW);
3.65	2.80	per KW for next 650 KW;
3.50	2.65	per KW for next 2200 KW;
3.35	2.50	per KW for the excess.

Energy charge (per Kilowatt hour per month):

$.019	for first 50 hours use of demand;
.015	for next 100 hours use;
.0095	for next 150 hours use;
.0080	for excess over 300 hours;
plus .0040	surcharge, July through October.

TABLE II-19

MASSACHUSETTS ELECTRIC COMPANY SERVICE RATES

[Source: New England Electrical System, 1974]

Rate: G-22

Demand Charge:

$20.00	first 0-5 kilowatts (KW)
2.15	per KW next 5 KW
1.80	per KW next 15 KW
1.65	per KW next 75 KW
1.50	per KW excess of 100 KW

Energy Charge (per Kilowatt hour per month):

.03517	first 500 kilowatt hours (KWH)
.02757	next 500 KWH
.02477	next 4,000 KWH
.02217	next 5,000 KWH
.02117	next 40,000 KWH
.01917	next 50,000 KWH
.01787	excess of 100,000 KWH
.01687	excess of 200 H.U. per KW of demand per month
.01587	excess of 300 H.U. per KW of demand per month
.01287	excess of 400 H.U. per KW of demand per month

Rate: C-22

Monthly Charge as Adjusted (per month):

$1.92	0-20 kilowatt hours (KWH)
.06287	per KWH next 80 KWH
.05687	per KWH next 200 KWH
.04577	per KWH next 1700 KWH
.03387	per KWH excess of 2000 KWH

Rate: Optional Large-Power Rate H

Demand Charge:

$700.00	first 500 kilowatts (KW) or less
1.30	per KW excess of 500 KW of demand.

Energy Charge (per kilowatt hour per month):

$.02317	first 50,000 KWH
.02017	next 50,000 KWH
.01707	excess of 100,000 KWH
.01597	excess of 200 H.U. per KW of demand per month
.01137	excess of 300 H.U. per KW of demand per month
.01037	excess of 400 H.U. per KW of demand per month
.00987	excess of 500 H.U. per KW of demand per month

The State has become increasingly aware of these attractions, as well as the need for expanded recreational facilities in the urban areas. As a result, the Office of Environmental Affairs has been purchasing large acreages of land for Commonwealth forests, parks and other reserves. Much of Cape Cod is already a part of the National Seashore reserved by the Federal government, and most of the historic sites are protected by the National Historic Preservation Act. The Metropolitan Area Planning Council has recommended a program for the reclamation and maintenance of the Harbor Islands as areas of recreation and environmental preservation within easy access of the Boston community.

Tourism is a valuable part of the Massachusetts economy. In 1966, 106,000 persons were employed full time in the recreational and tourism sector, constituting 5% of the total work force. Overnight travel expenditures amounted to over $900 million for the State, resulting in approximately 1.5% of the total employee compensation. Ultimately, however, the tourist income from outside visitors results in a lower amount of money than that removed from the State by Massachusetts residents who recreate in other States (Mass DCD, 1970).

The region which includes the counties of Middlesex, Norfolk, and Suffolk (Boston area) has the highest ranking for tourism both on the basis of event and site attractions. This region also has the highest ranking based on seasonal activity attractions, and the largest number of sites of national significance in the State. In addition, the second largest category of tourist activity in the region (after historical interests) is fishing (Mass DCD, 1970).

Boston is by far the single most significant tourist area in the region, and in the State. It is rated as having 316 site attractions out of 3,854 in the State (8%), and 200 event attractions out of 798 in the State (25%). In the region, Quincy is also highly rated as a tourist attraction area (Mass DCD, 1970).

P. Population and Socioeconomic Character

Population and socioeconomic character, as considered in this study, are developed at two levels. First, the MDC communities will be discussed because of the impact of their growth on treatment plant loading. Second, similar data for the Commonwealth of Massachusetts will be developed because of the interest in land application and its impact on agriculture and forestry.

1. Population

a. Service Areas: Population data were developed by Havens and Emerson (1973) for the Metropolitan District Commission service area in order to project the total waste loading expected at the Deer and Nut Island facilities. These projected populations are shown in Table II-20. For purposes of comparison, the total service area populations can be compared with OBERS data presented in the Southeast New England Study (SENE, 1975). These population totals are presented in Table II-21.

Although the 1990 OBERS (Office of Business Economics) projection used by SENE for total population is slightly lower than the rough projection developed by Havens and Emerson, the OBERS estimate is only 5.7% less than the estimate used in design. The compound annual growth rate indicated by Havens and Emerson data is 0.78% per year in the period 1970 to 1990, while the OBERS compound growth rate is 0.54% per year. The growth rates for the Boston Metropolitan Region (not the MDC Region), and for this region plus the Ipswich North Shore and South Shore regions are shown in Table II-22.

With this variation between,(1) the regional planning agencies, (2) SENE, and (3) the MDC, perhaps the only common denominator is a low rate of growth, with actual population loss expected in the core cities, with slow growth in the inner suburbs, and somewhat more rapid growth in the outer suburbs. None of the rates of growth presented are radically high, although the growth rate used in the Havens and Emerson study is the highest of the group. Therefore, the sizing of the proposed (or alternate) facilities for 1985 allows a certain cushion for either over-projection (which allows for expansions) or under-projections (which means earlier expansions).

Since the goal of the project is to improve sludge processing, an over-estimation of capacity would only extend the useful lifetime of the equipment, and would not induce secondary growth. (This concept will be more fully explored in Section IV). Therefore, we conclude that the waste loadings (and needed capacity) projected by MDC's consultant are reasonable, although conservative.

b. Operational Areas: For the municipalities which will be more affected by construction and/or operation of any facilities, Winthrop and Quincy, population projections are shown in Table II-23 along with "environmental holding capacities." These environmental holding capacities are developed based on the present zoning and environmentally sensitive areas such as steep slopes and wetlands. The 1990 projections in both cases are in excess of the holding capacity, but 2020 estimate for Quincy converges toward this capacity, while the Winthrop population continues to exceed its capacity.

TABLE II - 20

PROJECTED POPULATIONS - MDC SERVICE AREA
[Source: Havens and Emerson, 1973]

	1970	1980	1985	1990
Total Population				
Deer Island	1,420,000	1,510,000	1,530,000	1,580,000
Nut Island	790,000	920,000	960,000	1,000,000
Total	2,210,000	2,430,000	2,490,000	2,580,000
Serviced Population				
Deer Island	1,330,000	1,430,000	1,460,000	1,520,000
Nut Island	620,000	770,000	820,000	890,000
Total	1,950,000	2,200,000	2,280,000	2,410,000

TABLE II-21

POPULATION PROJECTIONS FROM SENE REPORT
(MDC Sewered Municipalities)
[Source: SENE, 1975 (OBERS projections)]

County	1970	1990	2020
Middlesex	960,243	1,070,771	1,159,430
Norfolk	469,395	614,561	690,355
Plymouth	18,845	27,132	38,346
Suffolk	735,190	727,131	710,816
Total	2,191,828	2,439,595	2,560,600

Source: SENE Report Basic Data (OBERS projections)

TABLE II-22

COMPOUND ANNUAL GROWTH RATES FROM SENE REPORT
[Source: SENE Study Summary, 1975]

	Regional Planning Agencies	Office of State Planning	OBERS
Boston Metropolitan Region	0.48	0.29	0.43
BMR plus Ipswich and South Shore Regions	0.86	0.59	0.82

TABLE II-23

POPULATION PROJECTIONS FOR QUINCY AND WINTHROP
[Source: OBERS Projections and land use analysis, SENE, 1975]

	1970	1990	2020	Holding Capacity
Quincy	87,966	93,677	91,760	91,806
Winthrop	20,335	21,376	22,042	20,432

The projections by OBERS show a statewide growth rate from 1970 through 1990 of 0.94 percent per year compounded over that period, with a 1970 population of 5,699,000 and a 1990 population projection of 6,875,500. This growth would tend to put developmental pressure on certain areas which are currently agricultural, and which may be included in a scheme for land application.

2. Social and Economic Data

The principal areas of interest in terms of social and economic data for this study are the population currently farming, which would interact with any land application alternative, and employment in the metals finishing, electronics and other industries which would be affected by more stringent controls on wastewater pretreatment for heavy metals removal. Based on OBERS data, the personal income from agricultural activity within the Commonwealth of Massachusetts is expected to rise marginally in the period 1970-1990 (from $\$103.4 \times 10^6$ to $\$112.8 \times 10^6$). The rate of growth of manufacture of electrical machinery and supplies, on the other hand, is expected to be very high, from $\$759.4 \times 10^6$ to $\$1,119 \times 10^6$ in 1990, a compound annual growth rate of 1.96 percent, much in excess of population growth. Focusing on the statewide farm population from the 1969 Census of Agriculture, the average age of farm operators was 52.9 years, and the average farm size was 124.5 acres, indicating that small farms predominate. In fact, only 26 farms of more than 1,000 total acres were reported in the 1969 Census of Agriculture.

3. Economic Characteristics of Farm Operators

In the Commonwealth of Massachusetts, many farm operators supplement their farming income with off-farm labor. These operators are separately identified in the Agricultural Census of 1969 as both "farms with part-time operation" and "farm operators reporting days of work off farm." These characteristics are shown in Table II-24 for the major agricultural counties in the Commonwealth. As the table shows, over half of all farm operators work off the farm at least one day per year. Assuming that those operators having greater than 200 days per year of off-farm employment are actually employed full-time in another job, 929 operators or 16.7% of all farm operators are deriving a significant portion of their income from part-time work (less than 199 days per year).

Q. Land Use and Planning

1. Massachusetts: Existing Land Use

The existing land use in the Commonwealth of Massachusetts was compared between the early 50's and early 70's by the University of Massachusetts Remote Sensing Project. The study measured land use by acreage for each county in the State, with the objective

TABLE II-24

FARM OPERATIONS - PART TIME AND FULL TIME

[Source: USDA, Census of Agriculture, 1969]

		Characterized as "Part Time"		Farm Operators Reporting Off-Farm Work					
County	Number of Farms	Number	Percentage	1-49 Days	50-99 Days	100-199 Days	200+ Days	Total	Percentage of Total Operators
Berkshire	380	95	25.0%	23	13	20	127	183	48.2%
Bristol	625	112	17.9%	22	19	47	173	261	41.8%
Dukes*	20	6	30.0%	--	1	6	3	10	50.0%
Essex	407	82	20.1%	35	12	25	137	209	51.4%
Franklin	550	136	24.7%	42	18	55	185	300	54.5%
Hampden	367	73	19.9%	26	11	23	110	170	46.3%
Hampshire	664	135	20.3%	59	36	56	213	364	54.8%
Middlesex	617	102	16.5%	31	8	39	184	262	42.5%
Norfolk	233	56	24.0%	9	2	14	84	109	46.8%
Plymouth	721	177	24.5%	31	41	55	315	442	61.3%
Suffolk*	10	---	----	--	--	--	---	5	50.0%
Worcester	986	233	23.6%	50	18	89	333	490	49.7%
TOTAL	5,550	1,201	21.6%	328	178	423	1,861	2,790	50.3%
Percentage				5.9%	3.2%	7.6%	33.5%	50.3%	

* Not included in totals.

of identifying land use changes over the 20-year period. The project was intended to aid in the prediction of future changes in land use by the analysis of past trends. While the study encompassed all of the counties in the State, information has been compiled (at present) for 11 counties of the 14 counties. The remaining reports (Hampden, Hampshire and Berkshire) have not been completed for public use as yet.

Table II-25 lists the acreages by county for six categories of land use: Forest Land, Agriculture or Open Land, Wet Land, Mining or Waste Disposal Land, Urban Land, and Outdoor Recreation. Table II-26 lists the percentage for each category in each county. In general, the Commonwealth contains large areas of forest, approximately 2,317,883 acres or 60% of the 11 county total. The State total would be considerably higher if the remaining 3 counties were added, and the State percentage would undoubtedly be greater because of the rural nature of most of these three counties.

Urban usage is dependent upon the location of the county. The largest urban percentage is in the East, Suffolk County (Boston area) and the surrounding counties of Norfolk, Essex, and Middlesex.

Agricultural usage in 9 of the counties is relatively uniform (between 8% and 15%), the exceptions being Suffolk (3%) and Nantucket (40%). Wet Lands throughout the 11 counties ranged between 4% and 17%, and the lowest usage categories were Recreation (generally 2%) and Mining and Waste Disposal (1%).

During the 20-year period, changes in land usage in the 11 counties resulted in a net increase in Urban Land of 300,349 acres with an accompanying loss of 90,667 acres of Forest Land and 278,226 acres of Agricultural and Open Land (see Table II-27). Agricultural Land was prevalent throughout 10 of the 11 counties, while gain in Urban Land occurred in all. Forest Land decreased in acreage in most eastern counties, but increased in the central ones.

2. <u>Massachusetts' Planning Objectives</u>

The Commonwealth of Massachusetts contains a number of planning agencies representing planning regions throughout the State. The approximate areas of responsibility covered by these regional agencies is illustrated in Figure II-13.

In general, the objectives of these planning agencies are to provide for adequate economic development, while maintaining sufficient open lands for recreation and conservation.

Planning agencies in the western part of the State are concerned with the conservation of open spaces which are presently used as farm lands and forest areas. Growth in these regions is anticipated along existing major and minor access roads radiating from and interconnecting the cities and towns. Urban development

TABLE II-25

1971 LAND USE, COMMONWEALTH OF MASSACHUSETTS (acres)
[Source: University of Massachusetts, Remote Sensing, 1975]

County	Forest	Agriculture or Open	Wet Land	Mining or Disposal	Urban	Recreation	Total
Nantucket	12,190	12,730	2,417	160	2,361	1,631	31,489
Dukes	48,745	9,991	7,670	140	3,550	1,359	71,445
Barnstable	153,742	22,754	47,234	1,659	48,692	6,226	280,307
Plymouth	266,515	49,910	42,213	3,570	72,663	5,369	440,240
Bristol	210,287	56,134	28,011	4,098	64,556	5,312	368,398
Norfolk	135,744	25,053	14,313	3,550	77,775	4,624	261,059
Suffolk	2,443	1,263	3,056	335	28,685	2,376	38,158
Essex	155,863	41,174	46,944	3,027	81,926	7,089	336,023
Middlesex	280,275	58,821	32,781	5,116	155,371	8,200	540,564
Worcester	693,209	134,998	62,365	5,951	106,133	6,494	1,009,150
Franklin	358,870	68,598	19,040	1,055	16,832	1,060	465,455
Hampshire*	---	---	---	---	---	---	---
Hampden*	---	---	---	---	---	---	---
Berkshire*	---	---	---	---	---	---	---
Overall	2,317,883	481,426	306,044	28,651	658,544	49,740	3,842,188
Percent	60	12	8	1	17	2	100

* Results were not available.

TABLE II-26

PERCENT OF LAND USE, COUNTY TOTALS
[Source: University of Massachusetts Remote Sensing, 1975]

County	Forest	Agriculture	Wet Land	Mining	Urban	Recreation	Total
Nantucket	39	40	8	0	8	5	100
Dukes	68	14	11	0	5	2	100
Barnstable	55	8	17	1	17	2	100
Pylmouth	60	12	10	1	16	1	100
Bristol	57	15	8	1	18	1	100
Norfolk	52	10	5	1	30	2	100
Suffolk	7	3	8	1	75	6	100
Essex	47	12	14	1	24	2	100
Middlesex	52	11	6	1	29	1	100
Worcester	69	13	6	1	10	1	100
Franklin	77	15	4	0	4	0	100
Hampshire	--	--	--	--	--	--	--
Hampden	--	--	--	--	--	--	--
Berkshire	--	--	--	--	--	--	--
Average	53	14	9	1	21	2	100

*Results were not available.

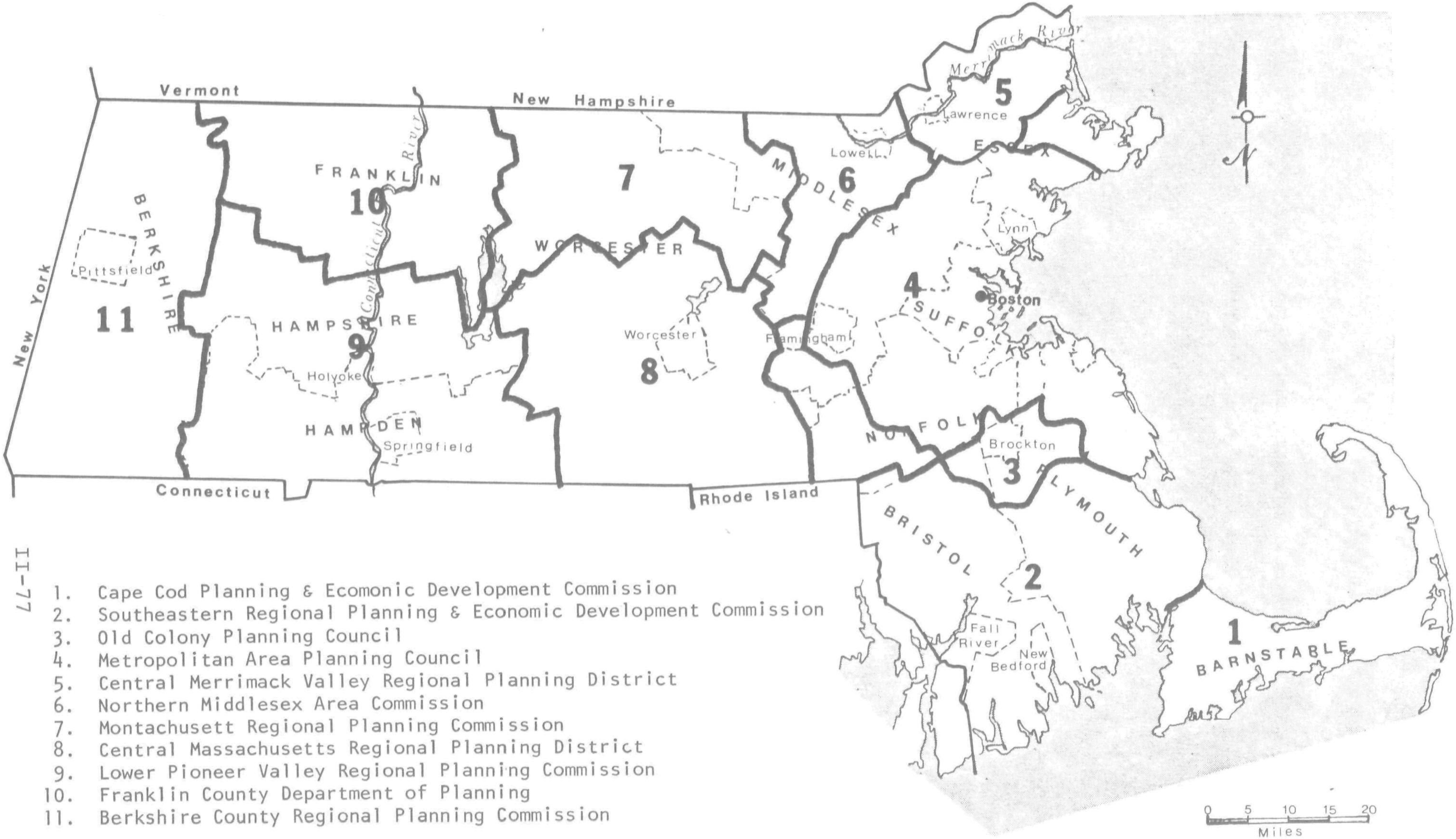
TABLE II-27

INCREASE/(DECREASE) IN LAND USE BY COUNTY
EARLY 50'S VERSUS EARLY 70'S (acres)
[Source: University of Massachusetts Remote Sensing, 1975]

County	Forest	Agriculture	Wet Land	Mining**	Urban	Recreation**
Nantucket	(7,915)	4,628	283	160	1,213	1,631
Dukes	219	(4,901)	1,348	130	1,845	1,359
Barnstable	(20,153)	(19,503)	2,169	1,659	29,602	6,226
Plymouth	(31,636)	(22,241)	2,578	3,570	42,360	5,369
Bristol	(16,098)	(17,567)	2,001	4,098	22,254	5,312
Norfolk	(18,250)	(13,743)	(4,035)	3,550	27,854	4,624
Suffolk	(179)	(340)	(144)	335	2,048	2,376
Essex	(10,665)	(33,190)	(120)	3,027	33,859	7,089
Middlesex	(16,723)	(62,225)	(4,624)	5,116	70,256	8,200
Worcester	20,711	(85,366)	(5,841)	5,951	58,051	6,494
Franklin	10,022	(23,778)	634	1,055	11,007	1,060
Hampshire*	----	----	---	----	----	----
Hampden*	----	----	---	----	----	----
Berkshire*	----	----	---	----	----	----
Net Change	(90,667)	(278,226)	(5,751)	28,651	300,349	49,740

* Results were not available.

** These categories were not included in the 1950's study, therefore the increase is not due to a strict change in usage.



1. Cape Cod Planning & Ecomonic Development Commission
2. Southeastern Regional Planning & Economic Development Commission
3. Old Colony Planning Council
4. Metropolitan Area Planning Council
5. Central Merrimack Valley Regional Planning District
6. Northern Middlesex Area Commission
7. Montachusett Regional Planning Commission
8. Central Massachusetts Regional Planning District
9. Lower Pioneer Valley Regional Planning Commission
10. Franklin County Department of Planning
11. Berkshire County Regional Planning Commission

FIGURE II-13. MASSACHUSETTS PLANNING REGIONS.

will continue to occur around the major cities and towns in the central and western regions such as Worcester, Springfield and Pittsfield. In all of these regions, plans provide for the improvement of essential services (transportation, water supply, sewer systems) during growth, and the attraction of industries to provide employment as necessary for the well-being of the population.

In the northeast, planning agencies are concerned with these same considerations, as well as certain unique problems. In particular, the regions are concerned with their proximity to the Boston Metropolitan Area, and the maintenance of local identities in the face of Boston's outward expansion. Planning in these areas must address the relationship of these regions to the Boston Metropolis, and provide for a balanced development, while maintaining local identities.

The eastern and southeastern regions, including the City of Boston, and the corridor of population between Boston and Providence, are those which must critically address the problems of metropolitan expansion and inner city decline. In 1968, the New England River Basins Commission recognized the Southeastern New England (SENE) Water and Related Land Resources Study region as one of the highest priority areas for Commonwealth and Federal resource planning. Included in the area are all of Rhode Island and parts of Connecticut and Massachusetts, an area encompassing approximately 50% of the total New England population.

The SENE study area in Massachusetts is composed of the Blackstone, Charles, Mystic, Ipswich, and Parker River Basins, plus all drainage basins east of these (see Figure II-14). This region is a transition zone between the dense urban areas of Boston and Providence, and the small towns and rural areas of much of New England. The pressures of growth, as in most metropolitan areas, are considerable. The goal of the SENE study was to provide for directing growth to areas with a net result in economically and environmentally acceptable consequences.

Suggestions included in the draft SENE study include the following:

- Guiding growth to protect critical environmental areas while providing for economic development.

- Developing adequate water supply to meet future water needs of a growing populous.

- Improving water quality to achieve fishable and swimmable waters by 1983 where possible.

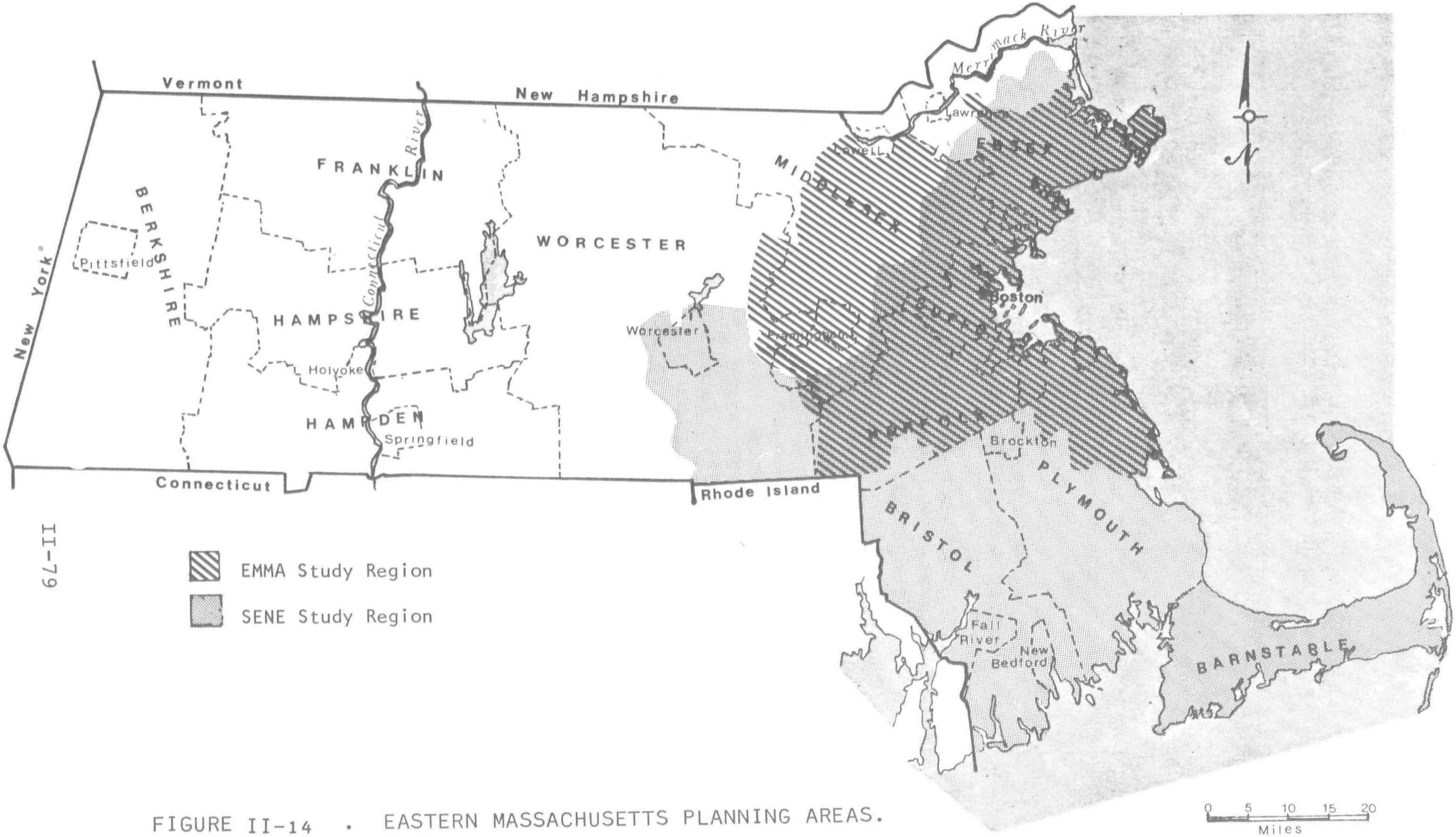


FIGURE II-14 . EASTERN MASSACHUSETTS PLANNING AREAS.

- Expanding outdoor recreation to provide adequate facilities and natural areas for the growing population.
- Marine management to develop and maintain marine resources.
- Controlling flooding and erosion to reduce dangers to the population and resources.
- Providing for the location of unwelcome facilities (power plants, solid waste disposal, sewage treatment plants) in the most environmentally and economically acceptable areas.

Generally, these major objectives have been embraced by the planning agencies located within the SENE region.

A related study, the Boston Harbor-Eastern Massachusetts Metropolitan Area Wastewater Management Study (EMMA) was initiated as a joint effort by the Metropolitan District Commission, the U. S. Army Corps of Engineers, the Commonwealth, Federal and regional agencies. The objective of the study is the development of a comprehensive wastewater management plan for the Eastern Massachusetts area. The direct goal of EMMA is to determine the ultimate size of the Boston Metropolitan Sewer District, and to provide guidelines and recommendations for the best method to implement the BPWTT goals of PL 92-500. The EMMA study region is also illustrated in Figure II-15. The geographical relationship of the SENE and EMMA planning areas can be compared in Figure II-15. The EMMA planning area contains 109 communities and a total population of greater than 3 million people, all within a 30 mile radius of Boston that encompasses 1760 square miles.

3. Boston Area - Existing Land Use

In 1972, the Dartmouth College Project in Remote Sensing studied the existing land use in the Boston area through the use of high altitude photographs of the region. The study area included 3250 square kilometers (approximately 1275 square miles) extending from Hamilton to Groton in the North, Groton to Hopedale in the West, and Hopedale to Hanover in the South (refer to Figure II-15). This area included the City of Boston and its entire metropolitan area.

The Dartmouth project identified and listed parcels of land as small as 10 acres according to 13 classifications of usage. Table II-28 illustrates the breakdown of land usage in the Dartmouth study area by total square kilometers, approximately 42% is forest land, 30% is residential, and 10% is "unimproved" land (that which has been scarred or stripped by man), with the remaining 18% consisting of the other classifications. Less than 1% of this is agricultural land.

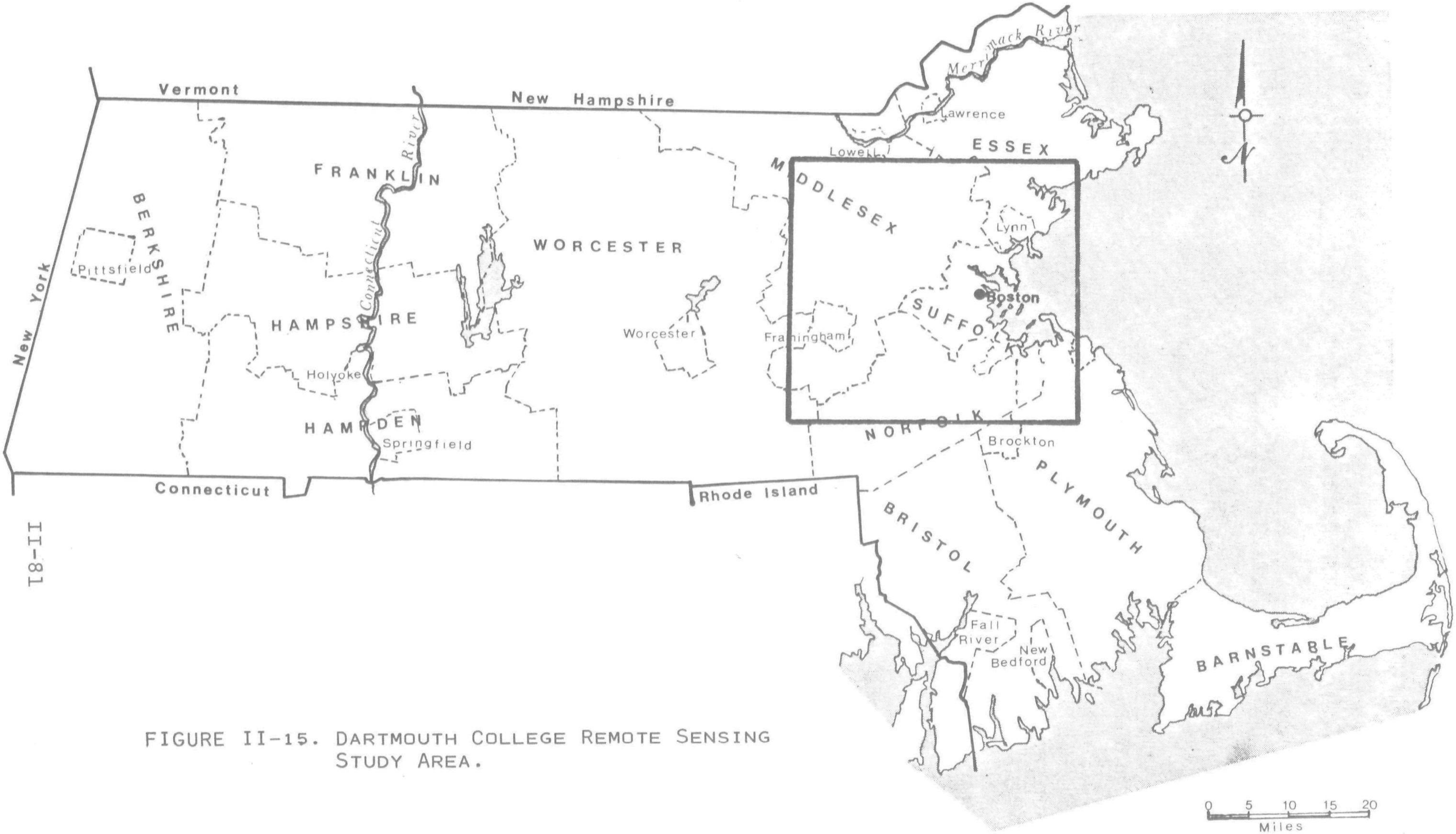


FIGURE II-15. DARTMOUTH COLLEGE REMOTE SENSING STUDY AREA.

TABLE II-28

LAND USE IN BOSTON AND VICINITY (1972)

[Source: Dartmouth College Project in Remote Sensing, 1972]

Land Use	Square Kilometers	Percent
Forest	1365.4	42.0
Water	82.8	2.6
Unimproved	315.4	9.7
Residential	958.3	29.5
Multifamily	136.4	4.2
Commercial	62.3	1.9
Industrial	72.4	2.2
Extractive	26.7	0.8
Transport	44.0	1.4
Institutional	95.2	2.9
Agriculture	28.5	0.9
Orchards	4.5	0.1
Urban/Open	58.8	1.8
Total	3250.7	100.0

In the two years between 1970 and 1972, the project identified a change in usage of approximately 16 square kilometers. The single major portion of this change (4 square kilometers or 25%) resulted from the conversion of forest land to residential usage. In general, the largest combined changes resulted from a loss of forest land to other uses (9 square kilometers), while the remaining changes were distributed among the other categories. And during this period, the growth rate in the area was less than 1% per year, reflecting the slow economic condition in the Country at the time.

4. Boston Area Planning Objectives

The Boston Metropolitan Planning Area is an integral part of the Southeastern New England (SENE) Water and Related Land Resources Study. The objectives of the study are to make recommendations for action on the part of all governmental levels and private interests to provide a balanced use and conservation of the region's resources. In the Boston Metropolitan area, the study has identified four items of a critical nature: Growth, Water Quality, Water Supply, and Outdoor Recreation.

In the first category, the draft study recommends that growth be guided to protect critical environmental areas such as salt marshes, wetlands, and historical sites. These areas are to be conserved by various means such as existing or enacted legislation, zoning regulations, or purchase by the public. Other critical areas (floodplains, prime agricultural land, and proposed reservoir site) are to be protected and restricted in use through the use of public purchases, ordinances, tax incentives, etc. Growth in areas limited in septic disposal capacity or on steep slopes (greater than 15%) is to be discouraged or carefully managed by the municipalities concerned. And finally, growth is to be encouraged (but restricted where necessary) in areas where essential public services (water, sewer, transportation) are already in existence. In general, growth is to be carefully managed and restricted by all possible means to locations which will benefit the planning area both economically and environmentally.

The water quality problems in the Boston area are significant in the three river basins and the harbor. The Mystic River suffers from combined (storm/sanitary) sewers which overflow during rainfall, from urban runoff and petroleum tank farm spillage. The river is Class D below Mystic Lakes. The Charles River is Class C and D below Milford, suffering from untreated or inadequately treated municipal and industrial discharges in the upper reaches, leachate from poorly located municipal dumps, and urban runoff. The Neponset River is Class C for most of its urban reach. Problems result from inadequate treatment of domestic wastes, urban runoff, and combined sewer overflows. And finally, the Boston Harbor, which is Class SC for most of its extent, suffers from combined sewers, oil pollution, debris and refuse, vessel pollution, and primary treated effluent and sludge discharges from the Deer Island and Nut Island wastewater treatment plants. These classifications are indicative of existing conditions.

The plans for improving water quality include those measures already adopted by the Massachusetts Office of Environmental Affairs, as well as controlling urban runoff, treating storm water drainage, studying alternative waste management techniques in surrounding communities, examining landfill leachate conditions, and providing water craft waste pump-out facilities.

The MDC, as the major water supplier in the area, is presently experiencing demands from member communities for increased water supply. To provide for future water reserves and to meet growing requirements, the MDC is in the process of developing two additional water supply projects. The Northeastern United States Water Supply Study (NEWS) by the Army Corps of Engineers also recommended that the MDC divert water from the Connecticut River at Northfield Mountain and Millers River Basin. The SENE study also recommends that these projects be completed, viz. that the Northfield project be done immediately, and the Millers River plan implemented by the late 1980's. Furthermore, SENE concurs in the MDC recommendation for further measures on the part of both the MDC and the local municipalities to promote water conservation, protect groundwater sources, and develop alternative water districts where possible.

The SENE study recommends that improved recreational facilities be provided in the Boston Harbor area. Beach management and improvement of access to recreational areas are key recommendations of the study. In a similar vein, the Metropolitan Area Planning Council (MAPC) prepared the Boston Harbor Islands Comprehensive Plan in 1972. The MAPC plan recommended that the Harbor Islands be properly developed as areas of environmental conservation and public recreation within ready access of the Boston Metropolitan Area. The plan encompassed all of the islands with the objective of recognizing the unique character of each and emphasizing the attributes of each, whether it be environmental, historical, or recreational.

The MAPC Harbor Islands Plan recommended that a ferry system be provided for frequent and inexpensive access to the islands. It also recommended that the future uses of the islands be limited to facilities which enhance the location of the islands, and that recreational areas and utilities be removed from important natural areas to avoid adverse impacts. The plan recognized the need for various water-related recreational activities, as well as historical and natural preservation, and provided for a wide range of facilities for these requirements. Emphasis on water-borne transportation would be made to minimize local traffic impacts on shoreline areas.

MAPC has taken the position that SENE will form the backbone of its inventory of existing and future land uses. MAPC is just beginning to develop an overall future land-use plan, and they have indicated that SENE recommendations will be implemented wherever possible (SENE, 1975).

The draft SENE study has also made recommendations for additional recreational facilities for the Boston area, including improvement and expansion of inner-city recreational areas. Access to public recreation for the inner-city populous was identified as a necessity for improved relations in these communities.

Other recommendations of the SENE study provide for improved port development and waterfront planning to develop a regionwide harbor strategy. Included in these recommendations were the improvement of fishery management, restricting offshore mining and excavation, and a general rehabilitation of waterfront structures. SENE also proposed a floodplain management program for the Neponset watershed, as well as improved floodplain management in all communities subject to potential flooding.

The critical thrust behind all of these recommendations is the recognition of existing problems and deficiencies in resource conservation and to provide for a careful, sensible program for improving these conditions while maintaining a balanced growth. In accordance with these recommendations is the need for an improved water quality in the harbor area and better recreational and environmental management.

SECTION III

DEVELOPMENT OF SLUDGE PROCESS AND DISPOSAL OPTIONS

This section of the statement presents the alternatives to be further analyzed in Section IV, and presents the detailed process development for these final alternatives. The sequence of presentation is:

- Development of Alternatives
- Description of Feasible Alternatives
- Screening for Compliance with Federal Legislation
- Hazardous and Non-hazardous Wastes
- Process Streams and Inputs for Construction and Operation

This section, in conjunction with Section II, will then be used as a basis for analyzing impacts of each alternative.

III. DEVELOPMENT OF SLUDGE PROCESS AND DISPOSAL ALTERNATIVES

In developing this impact statement, the starting point was the work of Havens and Emerson, Ltd., consulting engineers for the Metropolitan District Commission, *viz.,* A Plan for Sludge Management (1973) and Environmental Assessment Statement for a Plan for Sludge Management (1974). The general conclusion of these two documents was that incineration with on-site ash disposal was the best system for disposal of MDC sludge. It is the task of this Environmental Impact Statement to not only review this finding, but also to analyze three alternatives previously rejected, *viz.,* land application, ocean disposal, and no-action. This section will develop the possible technical approaches for each of the three major action alternatives: (a) incineration; (b) land application; and (c) ocean disposal. After the processes are selected for feasible alternatives in each category, the demands of each alternative for energy, labor, land and money will be calculated.

A. Development of the Alternatives

Detailed alternatives for sludge management were developed as follows:

- Unit processes were screened for applicability;
- Suitable unit processes were grouped into treatment trains;
- The best groupings of unit processes were selected;
- Conceptual design was then done for each alternative.

These steps are presented in detail in Appendix EE (Volume II). The total range of alternatives developed are shown in Table III-1.

After development, all alternatives were screened for compliance with federal legislation and guidelines. Those alternatives satisfying federal requirements were then analyzed for capital and operating costs, and resource and energy use.

B. Description of Feasible Alternatives

Appendix EE presents the development of the feasible alternatives which are to be analyzed in greater detail. In this Appendix the feasible process trains are described, the best process trains for each disposal route are determined, and the locations of processing and disposal sites and transportation schemes are developed. Also, certain elements of the proposed MDC system are discussed in the Appendix, including the questions of autogenous operation and energy recovery from incineration.

The operational schemes for each of the alternatives are detailed below and in Table III-1. Anaerobic digestion is the first process step for each alternative.

- <u>Alternative 1</u>

Dewatering of chemically conditioned sludge at Deer Island, followed by incineration. Ash handling is to be dry, with ash transport to a terminal by barge, thence to an inland commercial landfill site by highway. Transport of sludge from Nut to Deer Island would be via 28,000 feet of parallel force mains, with 10,000 feet constructed across the harbor and 18,000 feet in the tidal flats along Long Island. This alternative is evaluated in detail in Section IV.

- <u>Alternative 2</u>

Dewatering and incineration with ash disposal on site in an enclosed, sealed fill area on the east (ocean) side of Deer Island. This alternative is the scheme proposed by the Metropolitan District Commission in 1973. While this alternative may not be viable based on Executive Orders 11988 and 11990 (discussed below), this alternative is evaluated in detail in Section IV.

- <u>Alternative 8</u>

Dewatering and incineration, with ash disposal via truck to a landfill on Deer Island. Alternative 8 is analyzed in detail in Section IV.

- <u>Alternative 9</u>

Dewatering and incineration, with transport of non-hazardous ash via barge to Spectacle Island for disposal as fill. Trucks or front-end loaders will carry the ash from the barges to the actual site.

- <u>Alternative 10</u>

Alternative 10 has the same operational scheme as Alternative 2. It differs in that this alternative deals with ash as a hazardous waste and with the cofferdam on the west (harbor)side of Deer Island. While this alternative may not be viable because of Executive Orders 11988 and 11990, but is analyzed in detail in Section IV.

TABLE III-1

DESCRIPTION OF THE ELEVEN BASIC SLUDGE HANDLING AND DISPOSAL ALTERNATIVES

	Alternative 1:	Dewatering, Incineration, and Off-site Ash Disposal
	Alternative 2:	Dewatering, Incineration, and On-site Ash Disposal
	Alternative 3:	Dewatering, Incineration, and Deep Ocean Disposal of Ash
	Alternative 4:	Dewatering and Deep Ocean Disposal of Dewatered Sludge
	Alternative 5:	Dewatering and Land Application on Private Farmlands
	Alternative 6:	Dewatering with 50% for Land Application on Private Farmlands and 50% Disposal in a Landfill
	Alternative 7:	No Action
	Alternative 8:	Dewatering, Incineration, Landfill at Deer Island
	Alternative 9:	Dewatering, Incineration, Landfill at Spectacle Island
*	Alternative 10:	Dewatering, Incineration, Landfill at Deer Island Harbor Fill
*	Alternative 11:	Dewatering, Incineration, Landfill at Deer Island

* Disposal of ash as a hazardous waste

- Alternative 11

Alternative 11 has the same operational scheme as Alternative 8. It differs in that this alternative deals with ash as a hazardous waste, requiring additional management considerations as outlined below.

C. Screening Alternatives for Compliance with Federal Legislation

All of the alternatives were reviewed with respect to recent federal legislation, resulting in the elimination of several alternatives. The recent federal legislation and regulations which affected the screening process include:

- The Resource Conservation and Recovery Act of 1976 (PL 94-580), including proposed Sections 1008 and 4004 published in the Federal Register on February 6, 1978, and unpublished drafts of other sections.

- Sections 405 d. and e. of the Clean Water Act (PL 95-217) requiring EPA to promulgate sludge management regulations and making them binding on federally funded projects.

- The Safe Drinking Water Act of 1974 (PL 93-523) requiring protection of groundwater supply.

- The Marine Sanctuaries Act (PL 92-532) affecting ocean disposal and the No-Action Alternative.

- Executive Orders 11988 and 11990, regarding floodplain and wetlands protection. These have been expanded to include surface waters. They require that, for federally funded or assisted projects, wetlands and floodplains be minimally impacted. Construction in these areas shall be avoided unless there is no practicable alternative and all practicable measures to avoid harm used.

In addition to reducing the range of alternatives, other federal regulations will directly affect the facilities and operations proposed under each of the remaining alternatives. Principal areas affected are:

- It is not recommended that putrescible wastes such as sludge, grit, screening or skimmings not be landfilled within a 3048 meter (10,000 foot) radius of Logan Airport because of bird hazard criteria in FAA Order 5200.00. Therefore, all such materials should be incinerated before using fills suggested under Alternatives 2, 8, 10 and 11.

- Leachate or disposal liquid must be recovered and treated for Alternatives 8 and 11 (hazardous wastes) because of the limitations imposed by PL 94-580 and PL 93-523. Unless the groundwater which would be affected by the disposal site, is classified as "unusable", this liquid must be returned to the plant for treatment. In addition, monitoring wells must be maintained and results of analyses reported to the Commonwealth of Massachusetts.

- Because Executive Orders 11988 and 11990 have recently been interpreted to include surface waters, Alternatives 2 and 10 may be untenable in the future. However, since since these alternatives constitute the applicant's proposed plan, they will be retained for further evaluation.

In summary, the results of various laws and federal regulations have been to reduce the possible range of alternatives, eliminating those with ocean disposal or with land application for final disposal. Feasible alternatives originally developed but not acceptable because of this legislation are:

- Alternative 3

Dewatering and incineration, with ash disposal via barge transport to the Murray-Wilkinson Basin, 70 NM east of Deer Island. Not viable because of the Marine Sanctuaries Act prohibiting ocean disposal of sewage sludge as discussed in Appendix O.

- Alternative 4

Dewatering of sludge with barging to the Murray-Wilkinson Basin. Not viable because of the Marine Sanctuaries Act prohibiting ocean disposal of sewage sludge as discussed in Appendix O.

- Alternative 5

Dewatering at Deer Island, followed by barge transport of sludge (in trailers) to a dedicated terminal, with truck transport to dispersed storage sites in the Connecticut River Valley and Bridgewater-Westport areas. During two months of the year, sludge would be applied to privately owned, cropped farmland with application site soil analysis for nitrogen species and heavy metals on an annual basis. Application would occur two months per year (60 days) at two dry tons per acre per application. Storage would be dedicated sites, with piles being covered to prevent contamination of runoff. The alternative of land application, which was analyzed in detail in the Draft EIS, was originally conceived to include application of sludge to food or food-chain crops. This does not agree with the concept given in Guidelines for Municipal Sludge Management (EPA, 1977) which directs application to non-food chain crops on publicly owned land. The use of food chain crops or privately owned land in the conceptual design was chosen for the following reasons:

- Resource recovery (recovery of nutrients);
- Agreement with the goals of the Massachusetts Department of Agriculture;
- Relative ease of implementation without exacerbating urban-rural tension.

The land application alternative was eliminated from consideration because of the uncertainty about sludge quality (see Hazardous Wastes, III-D), the amount of land necessary (over 11,000 acres), costs and energy use.

- Alternative 6

Dewatering at Deer Island, followed by barge transport of sludge (in trailers) to a dedicated terminal. Half of the sludge (high cadmium:zinc ratio) would be transported to the Plainville landfill site. The sludge acceptable for land application (50%) would be handled as in Alternative 5 above. This alternative was originally developed when cadmium to zinc ratio was a determinant in sludge acceptability. Not a viable alternative, as discussed above.

- Alternative 7

No Action, with continued digestion and discharge of digested sludge in the main effluent outfalls from the Deer Island and Nut Island wastewater treatment plants. Not viable as discussed in Appendix O.

D. Hazardous and Non-hazardous Wastes

The Resource Conservation and Recovery Act (RCRA) of 1976 (PL 94-580) required formulation of regulations defining hazardous wastes and the management and disposal criteria for such wastes. Draft regulations have been published detailing ultimate disposal of hazardous wastes and the environmental constraints on disposal facility siting. The regulations defining hazardous and non-hazardous wastes are in preparation. Wastes may be defined as hazardous based on the following criteria:

- Flammability
- Reactivity
- Corrosiveness
- Toxicity
- Mutagenic or Teratogenic Potential
- Bioaccumulation
- Infectiousness
- Radioactivity

Digested sludge and ash from the Nut Island and Deer Island plants were analyzed for metals content. Results of these analyses were suspect because of laboratory error. Based on comparison with sludge from other urbanized areas similar to the Greater Boston area, the sludge or ash from the proposed MDC facilities may or may not be hazardous, depending upon possible changes in criteria, changes in incoming waste with pretreatment, or changes in analytical methods. This uncertainty regarding the basic nature of the sludge or ash necessitates the consideration of alternatives under both situations.

If the material is hazardous as defined in RCRA regulations, the processing, transportation and disposal of such material will be controlled by federal regulation. If non-hazardous, management will be controlled by state regulations of the Commonwealth of Massachusetts. Under Section 404e of the Clean Water Act Amendments of 1977 (PL 95-217), disposal practices must be consistent with Sections 4004 and 1008 of RCRA.

If the sludge is hazardous, an incineration facility may have to meet the performance criteria for hazardous waste facilities. The requirements may place the burden of proof for acceptable emissions on the MDC. Table III-2 compares the potential differences in federal construction and operation criteria for incinerating hazardous and non-hazardous sewage sludge.

After incineration or other processing, the residues must undergo additional testing to determine whether they shall be considered hazardous or non-hazardous.

If the residue is disposed of as a hazardous waste, the previously described EPA regulations control land disposal. Table III-3 compares federal land disposal criteria for hazardous and non-hazardous wastes.

Given the uncertainty of classification of the MDC sludge and of ash resulting from incineration, the alternatives must address either potential situation. This can be done by creating an alternative capable of being adapted to either hazardous or non-hazardous waste or by creating alternatives for each potential category of waste. The second approach was chosen because of the fundamental differences in handling hazardous and non-hazardous wastes. The feasible alternatives and the type of wastes suitable for each potential situation are:

- Alternative 1: Incineration with inland fill of dry ash, for non-hazardous ash;
- Alternative 2: Incineration with dry ash disposal in a cofferdam type lagoon on the ocean side of Deer Island, for non-hazardous ash;
- Alternative 8: Incineration with dry ash disposal by landfill on Deer Island, for non-hazardous ash;
- Alternative 9: Incineration with transport of dry ash to Spectacle Island by barge for disposal as fill, for non-hazardous ash;
- Alternative 10: Same as Alternative 2 except that the cofferdam is located on west (or harbor) side of the island to facilitate recycling of leachate for treatment for hazardous ash;

TABLE III-2

PROPOSED FEDERAL REQUIREMENTS INCINERATION CRITERIA FOR HAZARDOUS AND NON-HAZARDOUS WASTE

Characteristic	Hazardous Feed	Non-hazardous Feed
Operation; Temperature & Residence Time	1,000°C and 2 sec.	667°C
Automatic Feed Cutoff Controlled by Temperature	Yes	No
Emissions Control:		
Emission of TSP $\leq$ 1.3 $\frac{lb}{ton}$	Yes	Yes
Opacity $\leq$ 20%	Yes	Yes
Removal of HCl	99%	No Standard
Retention of Scrubber Water	Yes	No
Sampling and Analysis:		
Startup; Trial Burn Required	Yes	No
Provision of Stack Sampling Point	Yes	No
Continuous Recording of CO, CO_2, O_2, Temperature	Yes	No

TABLE III-3

COMPARISON OF PROPOSED FEDERAL HAZARDOUS AND NON-HAZARDOUS WASTE MANAGEMENT CRITERIA

Characteristics	Disposal of Hazardous Wastes (Working Draft-RCRA Section 3004)	Disposal of Non-hazardous Wastes (Proposed Draft RCRA Section 4004) FR February 6, 1978
Environmentally Sensitive Areas:		
Wetlands, Floodplains, Critical Habitats	1. No NPDES Permits to be issued for disposal in wetlands, flood-plains, or critical habitats	1. NPDES Permit Required 2. If containment structure used, 404 Permit (PL 92-500) required
Surface Waters:	1. Requirements the same, plus diversion structures must be placed to divert the 24 hour 25 year storm away from active area	1. No adverse impact 2. NPDES Permit for point sources (e.g leachate treatment) 3. Control to prevent or minimize non-point sources
Air:	1. See Table III-1	1. See Table III-1
Controlling Agency:	1. U.S. EPA or 2. State Agency if authorized by EPA	1. State Solid Waste Agency (if NPDES required EPA or authorized State Water Agency)
Other Criteria:	1. Partial and Final Closure 2. Sampling and Analysis 3. Site Selection, Construction, Operation	1. Disease Vectors 2. Safety ● Explosive or Toxic Gases ● Fires ● Bird Hazards to Aircraft ● Access

TABLE III-3 CONT'D

COMPARISON OF PROPOSED FEDERAL HAZARDOUS AND NON-HAZARDOUS WASTE MANAGEMENT CRITERIA

Characteristics	Disposal of Hazardous Wastes (Working Draft-RCRA Section 3004)	Disposal of Non-hazardous Wastes (Proposed Draft RCRA Section 4004) FR February 6, 1978
Other Criteria	4. Financial Responsibility 5. Security 6. Emergency Procedures and Contingency 7. Training 8 Records and Reporting Plans	
Land Application or Spreading:	1. Wastes not made non-hazardous by Land Application 2. Incompatible Wastes 3. Site Selection including Soils Requirements 4. Site Preparation 5. Waste application and Incorporation 6. Monitoring 7. Growth of food chain crops 8. Closure	1. Sludge must be stablized before application 2. Facilities spreading solid wastes on land used for food chain crops must comply with all other criteria plus criteria on: a. Cadmium ● Annual addition ● Total addition ● Crops allowed ● Maintenance of pH

TABLE III-3 CONT'D

COMPARISON OF PROPOSED FEDERAL HAZARDOUS AND NON-HAZARDOUS WASTE MANAGEMENT CRITERIA

Characteristics	Disposal of Hazardous Wastes (Working Draft-RCRA Section 3004)	Disposal of Non-hazardous Wastes (Proposed Draft RCRA Section 4004) FR February 6, 1978
		b. Pathogens c. Pesticides and Persistent Organics d. Direct ingestion e. Other metals Note: Use of test plots and control plots may be substituted for a. and c. above.
Groundwater	Aquifer Use Designation by Regional Administrator 1. No discharge to groundwater 2. Strict monitoring requirements for zones of aeration and saturation 3. Landfill lines must be clay with permeability of 10^{-7} cm/sec on bottom ● 10' thick if onsite soils used ● 5' thich if offsite soils used ● Liner compatible with wastes 4. Strict closure and long term care required	Aquifer Use Designated by state 1. Leachate collected with artificial liner, removed, recirculated or treated, or; 2. Leachate migration controlled by natural hydrogeology, soil attenuation mechanisms or recovery and treatment 3. Infiltration prevented or minimized 4. Prediction and monitoring of leachate migration

TABLE III-3 CONT'D

COMPARISON OF PROPOSED FEDERAL HAZARDOUS AND NON-HAZARDOUS WASTE MANAGEMENT CRITERIA

Characteristics	Disposal of Hazardous Wastes (Working Draft-RCRA Section 3004)	Disposal of Non-hazardous Wastes (Proposed Draft RCRA Section 4004) FR February 6, 1978
	5. Bonding required	5. Acceptable and current contingency plan for corrective action if monitoring indicates contamination
Unusable Aquifer	Groundwater regulations do not apply to unusable aquifer	Groundwater beyond facility must meet quality specified by state.

- Alternative 11: Same as Alternative 8, except that this alternative deals with ash as a hazardous waste, requiring determination of usability of aquifers or lining of fill site.

Figure III-1 shows the approximate location of disposal facilities for each of these alternatives.

E. Process Streams and Inputs for Construction and Operation

In development of impacts, quantities and concentrations of waste streams and amounts of capital inputs, labor, energy and chemicals are necessary for quantitative development. The following sections summarize the material developed in detail in Appendix N. "Quality and Quantity Liquid and Solid Emissions", and Appendix T. "Process and Transportation Impacts of Labor, Materials, Energy, and Monetary Costs."

1. Quality and Quantity of Liquid and Solid Emissions

Data used in preparing the quantity and concentration of waste streams were developed by Havens and Emerson (1973), the Metropolitan District Commission (1973, 1974, 1975) and a sludge analysis that was done as part of this study. The quantities developed by Havens and Emerson for 1985 were reviewed. These quantities are somewhat conservative (overestimated) because:

- Population growth in the MDC service area is even lower than the low rates developed in 1970 and used by Havens and Emerson in 1973

- Per capita loading rates for solids, which were expected to increase between 1973 and 1995, may not occur because of the reduced economic prospects for the future.

- Upstream processes, primary settling and anaerobic digestion may not change as predicted. Efficiency of

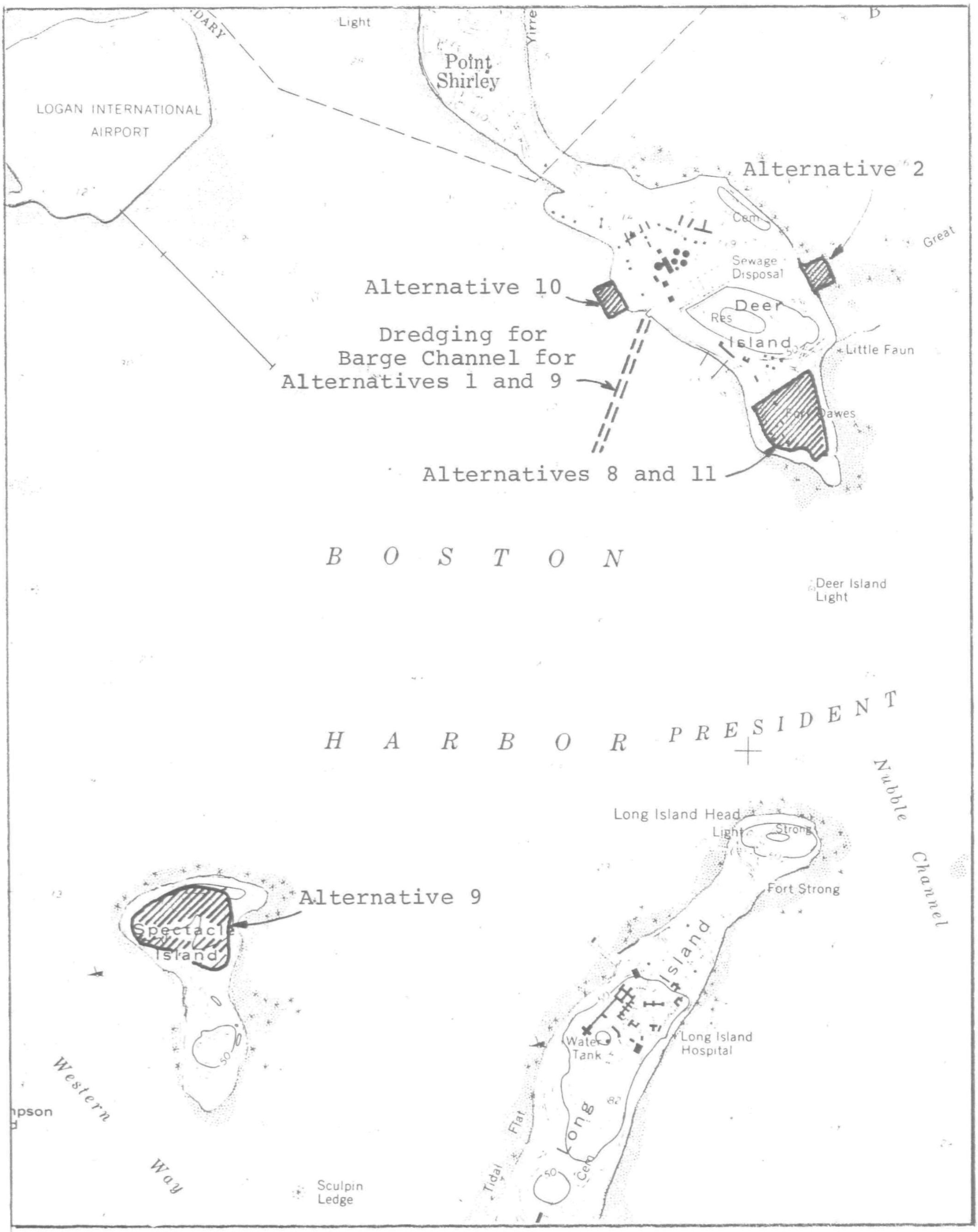


FIGURE III-1 : LOCATION OF ALTERNATIVE FILL SITES primary solids removal is expected to rise with expansion of primary settling facilities, which may not occur, and the anaerobic digesters may not be overloaded (which was expected to require bypassing of 10 percent of the primary solids at 1985 conditions).

While these considerations indicate conservative future projections, the inclusion of grit, screening and skimmings (which were not considered in Havens and Emerson's 1973 work) will increase the per capita loading. Accordingly, the quantities developed by Havens and Emerson (1973) will be used in further analysis of the six action alternatives. These quantities are shown in Table III-4.

Quality data from the major sources shown above (Havens and Emerson, MDC, study analysis) were compared. While analytical variations were found, especially in concentrations of heavy metals, the environmental impacts stemming from these metals show less variation than the long-term variations in the analyses. The question of pretreatment of industrial wastes was reviewed and compared with residential area metals loadings that have been found in other cities, and there appears little likelihood of significant improvement as the result of pretreatment. Quality and quantity of waste streams for the various alternatives are shown in Appendix N. These data were also developed from Havens and Emerson data, with modifications as necessary based on the analyses performed during this study.

2. Process and Transportation Inputs of Labor, Materials and Energy, and Cost

Inputs of labor, materials and energy for the six final action alternatives are developed in Appendix T. For analysis of project impact, these inputs must be known, including not only the process energy and dollar requirement, but also the number of employees and the number of vehicle miles and trips per day for transportation to disposal.

Once these are developed, the costs can be developed as shown in Tables III-5 and III-6. Process, transportation and disposal costs and inputs have been revised to 1978 conditions as shown in Appendix T.

TABLE III-4

PROCESS STREAM CHARACTERIZATION
PHASE I PROJECT
MAINTAINING ANAEROBIC DIGESTION AT DEER & NUT ISLAND PLANTS
WITH PRIMARY TREATMENT EXPANSION

[Source: Havens and Emerson, 1973]

Item	AVERAGE DAY					MAXIMUM DAY				
	DSS lb/dy x 10^3	VSS lb/dy x 10^3	%Vol	%Sol	mgd	DSS lb/dy x 10^3	VSS lb/dy x 10^3	%Vol	%Sol	mgd
Primary Solids										
Deer Island	257	179	70	5.0	0.62	450	313	70	4.5	1.20
Nut Island	189	145	77	5.4	0.42	312	239	77	5.0	0.75
Thickened Solids										
Deer Island	250	174	70	7.0	0.43	437	305	70	6.5	0.81
Nut Island			None					None		
Bypassed Solids										
Deer Island	25	17	68	7.0	0.04	43	30	70	6.5	0.08
Nut Island	19	15	79	5.4	0.04	32	25	78	5.0	0.08
Solids to Digester										
Deer Island	225	157	70	7.0	0.39	394	275	70	6.5	0.73
Nut Island	170	130	76	5.4	0.38	280	214	76	5.0	0.67
Solids after Digestion										
Deer Island	137	69	50	4.2	0.39	240	121	50	4.2	0.73
Nut Island	80	40	50	2.5	0.38	132	66	50	2.5	0.67
Solids to Filters										
Deer Island - Total	148	79	53	6.6	0.27	178	98	55	6.1	0.34
Raw	25	17	68	7.0	0.04	43	30	70	6.5	0.08
Digested	123	62	50	6.3	0.23	135	68	50	6.3	0.26
Nut Island - Total	91	51	56	4.0	0.27	111	65	59	4.0	0.33
Raw	19	15	79	5.4	0.04	32	25	78	5.0	0.08
Digested	72	36	50	3.8	0.23	79	40	50	3.8	0.25
Comb. Plants - Total	239	130	54	5.3	0.54	289	163	56	5.2	0.67
Raw	44	32	73	6.6	0.08	75	55	73	5.7	0.16
Digested	195	98	50	5.1	0.46	214	103	50	5.0	0.51
Filter Cake										
Total	255	129	50	30*	0.10*	312	162	52	30*	0.13*
Ash	126	--	--			150	--	--		

* Modified to be in accordance with projected heat balances

TABLE III-5

RESOURCES AND COSTS

ON-SITE PROCESSES

Capital Costs (1978) and Inputs

Inputs:	Labor	480 manyears	
	Concrete	2,000 CY	
	Steel	1,500 Tons	
Costs:	Dewatering & Incineration		$ 25,652,500
	Thermal Energy Recovery		4,213,600
	Total Cost		$ 29,866,100
	Annual Capital Cost		$ 2,737,500

Operating Resource Costs and Inputs

Inputs:	Labor	113,900 manhr/year	
	Electrical Energy	5.49×10^6 kwh/year	
	Fuel, Pilot & Auxiliary	147,800 gallons/year	
	Chemicals: CaO	3,250 tons/year	
	$FeCl_3$	1,170 tons/year	
Costs:	Labor		$ 779,100/year
	Electrical Energy		247,000/year
	Fuel		56,160/year
	Chemicals: CaO		130,000/year
	$FeCl_3$		140,400/year
	Maintenance: 2.5% of Dewatering & Incineration		641,300/year
	10% of Energy Recovery Equipment		148,500/year
	Annual O & M Costs		$ 2,142,460

Total Annual Costs	$ 4,879,960
Annual Credit for Electricity	$ 441,000
Net Annual Cost	$ 4,438,960
Net Annual On-Site Energy Production	54×10^9 BTU/year

TABLE III-6

RESOURCES AND COSTS

TRANSPORTATION AND ULTIMATE DISPOSAL

	ALTERNATIVE					
	1	2	8	9	10	11
Operating Resources						
Barge Link, Miles	6.3	-	-	5.5	-	-
Ton Mi/Year	1.45×10^6	-	-	1.27×10^5	-	-
BTU/Year	1.63×10^8	-	-	1.42×10^8	-	-
Annual Fuel Use, Gallons	1,160	-	-	1,000	-	-
Annual Labor, Hours	6,240	-	-	6,240	-	-
Truck Link, Miles	30	0.4	1.0	0.2	0.2	1.0
Ton Mi/Year	689,800	9,200	23,000	4,600	4,600	23,000
BTU/Year	1.39×10^9	1.84×10^7	4.6×10^7	9.2×10^6	9.2×10^6	4.6×10^7
Annual Fuel Use, Gallons	9,650	130	320	65	65	320
Annual Labor, Hours	10,400	6,240	6,240	6,240	6,240	6,240
Disposal Operation						
Tons/Year	23,000	23,000	23,000	23,000	23,000	23,000
Cubic Yards/Year	34,100	34,100	34,100	34,100	34,100	34,100
Area Reqd., 15' Depth, Acres	1.41	-	1.41	1.41	-	1.41
30' Depth, Acres	-	0.70	-	-	0.70	-
Labor	-	2,080	2,080	2,080	2,080	2,080
Capital Resources						
Barge Link						
Roll-on Facilities	2 @ $100,000	-	-	1 @ $100,000	-	-
Barge-Ferry	1 @ $300,000	-	-	1 @ $300,000	-	-
Truck Link						
Tractors	9 @ $ 35,000	2 @ $35,000	2 @ $35,000	4 @ $ 35,000	2 @ $ 35,000	2 @ $ 35,000
Trailers	19 @ $ 22,000	3 @ $22,000	3 @ $22,000	6 @ $ 22,000	3 @ $ 22,000	3 @ $ 22,000

TABLE III-6 CONT'D

RESOURCES AND COSTS

TRANSPORTATION AND ULTIMATE DISPOSAL

	ALTERNATIVE					
	1	2	8	9	10	11
Capital Resources (Cont'd.)						
Disposal Site Prep.						
Cofferdam	-	7ac @ $685,700	-	-	7 @ $685,700	-
Lining and Recycle	-	-	15 @ $39,000	15 @ $39,000	$22,000	15 @ $39,000
Monitoring Wells	-	-	2 @ $ 2,000	-	-	2 @ $ 2,000
Total Annual Operating Resources						
Fuel, Gallons/Year	10,720	130	320	1,065	65	320
Labor, Hours/Year	16,640	8,320	8,320	8,320	8,320	8,320
Land, Acre/Year	1.41	0.70	1.41	1.41	0.70	1.41
Equivalent Energy, BTU/Year	1.53×10^9	1.53×10^9	4.58×10^7	1.52×10^8	9.3×10^6	4.58×10^7
Total Annual Costs						
Capital Costs						
Barge	$300,000	-	-	$300,000	-	-
Roll-on Facilities	$200,000	-	-	$100,000	-	-
Tractors & Trailers *	$733,000	$136,000	$136,000	$272,000	$ 136,000	$136,000
Disposal Site Prep.	-	$4,800,000	$589,000	$595,000	$4,822,000	$589,000
Annual Capital Costs, 6-5/8%	$148,400	$459,000	$ 73,000	$ 90,770	$ 461,000	$ 73,000
Annual Operating Costs						
Fuel @ $0.38/gallon	$ 4,075	$ 50	$ 120	$ 405	$ 25	$ 120
Labor @ $6.84/hour	$113,820	$ 56,910	$ 56,910	$ 56,910	$ 56,910	$ 56,910
Transfer Fees, $/Year	$ 60,000	-	-	-	-	-
Landfill Fees, $/Year	$230,000	-	-	-	-	-
Maintenance	$103,300	$ 13,600	$ 13,600	$ 57,200	$ 13,600	$ 13,600
Total Operating Costs	$511,195	$ 70,560	$ 70,630	$114,515	$ 70,535	$ 70,630
Total Annual Costs, without Grant	$659,595	$529,560	$143,630	$205,285	$531,535	$143,630
with Grant	$574,825	$187,115	$ 90,690	$149,970	$187,620	$ 90,690

*Using 10-year equipment life for trucks and trailers.

TABLE III-6 CONT'D

RESOURCES AND COSTS

TRANSPORTATION AND ULTIMATE DISPOSAL

	ALTERNATIVE					
	1	2	8	9	10	11
Totals Including Dewatering, Incineration, and Energy Recovery						
Total Annual Costs Including Incinerator,						
without Grant	$5,089,555	$4,959,320	$4,573,420	$4,635,245	$4,961,495	$4,573,420
with Grant	2,960,660	2,572,950	2,476,525	2,535,805	2,573,455	2,476,525
Total Annual Net Energy Production, BTU x 10^9	52	54	54	54	54	54

SECTION IV

ENVIRONMENTAL IMPACTS OF FEASIBLE ALTERNATIVES

Section IV presents a summary matrix to indicate the environmental impacts associated with each alternative. A detailed analysis of the effects of each alternative will be made on the basis of sensitive receptors. Included in this section are the following subsections:

- Description of Analysis System
- Matrix of Environmental Impacts
- Description of Impacts according to Receptor:

  Soils
  Marine Water Quality
  Groundwater Quality
  Air Quality
  Biotic Communities
  Public Health and Noise
  Economics
  Energy
  Land Use
  Transportation
  Historical and Archeological Sites
  Aesthetics

With the evaluation of the environmental, monetary, and energetic impacts, it will then be possible (in Section V) to assess the magnitude of any trade-offs necessary to obtain an environmentally sound and cost effective solution to the sludge management question.

Upon completion of the receptor impact analysis, there will be presented a summarization of the major impacts for each alternative. Specifically, the significant environmental impacts will be highlighted, and brief statements on monetary and energy costs will be made.

IV. ENVIRONMENTAL IMPACTS OF FEASIBLE ALTERNATIVES

In the following section, the impacts of feasible alternatives developed for Final EIS will be evaluated on a comparative basis. In addition, portions of the analysis done for the Draft EIS concerning land application have been incorporated, with revisions, to reflect the interest expressed by public comment on the draft document. Please observe that while there is some discussion of land application of sludge or compost, these alternatives are infeasible at this time because of the requirements of Public Law 94-580, the Resource Conservation and Recovery Act.

A. Description of Analysis System

In preparing the impacts from the feasible alternatives, the descriptive matrix used for the Draft EIS was found to be inappropriate. Accordingly, a tabulation of common and differentiating impacts was prepared, with the following descriptive categories being used:

- Action: Short description of the action causing impact
- Type of Impact: Short term construction impacts or long term operational impacts
- Impact: Adverse, potentially adverse or beneficial
- Areal Extent: Either localized within a few kilometers of the site, regional pertaining to the surrounding counties, or national. While all impacts theoretically have universal implications, the detectability of impact is the basis of areal extent.

Table IV-1 describes impacts common to all feasible alternatives, and Tables IV-2 through IV-5 describe the differentiating impacts of the alternatives.

TABLE IV-1

IMPACTS COMMON TO ALL FEASIBLE ALTERNATIVES

Area of Impact	Action	Type of Impact	Assessment of Impact	Areal Extent
Soils	Construction of incinerator and storage facilities	Short term	Adverse	Localized in areas of construction
	Particulate fallout resulting from incinerator operation	Long term	Adverse	Localized, near incinerator
Marine sediments and water quality	Construction of force mains for sludge transport on the harbor bottom	Short term	Adverse	Localized in areas near the proposed pipelines
	Operation of sludge force mains (malfunction)	Potential short term	Potentially adverse	Localized to sediments and dispersed in water column near the point of rupture
	Elimination of sludge discharge	Long term	Beneficial	Regional
Economic	Increased annual cost due to implementation of the project	Long term	Adverse	Regional
	Generation of construction jobs through project implementation	Short term	Beneficial	Regional
	Operating labor increase through project implementation	Long term	a) Beneficial b) Adverse	a) Individual level b) Regional level

TABLE IV-1 (Cont'd.)

Area of Impact	Action	Type of Impact	Assessment of Impact	Areal Extent
Energy	Recovery of thermal energy (equivalent to 370,000 gallons diesel fuel)	Long term	Beneficial	Regional
Land use	Expansion of Deer Island facilities causing displacement of other land uses	Long term	Adverse	Local
Surface and groundwater quality & quantity	Ultimate disposal scheme (malfunction)	Potential short term or long term	Potentially adverse	Localized in area of final disposal site
Air quality	Incinerator operation	Long term	Adverse	Localized near incinerator
	Construction of incinerator and storage facilities	Short term	Adverse	Localized in areas of construction
Biotic communities	Construction of force mains for sludge transport on the harbor bottom	Short term	Adverse	Localized in areas near the proposed pipeline
	Operation of force mains (malfunction)	Potential short term	Potentially adverse	Localized in area near the point of rupture
	Elimination of sludge discharge	Long term	Beneficial	Regional marine biota

TABLE IV-1 (Cont'd.)

Area of Impact	Action	Type of Impact	Assessment of Impact	Areal Extent
Public health and noise	Construction of incinerator and storage facilities causing a noise level increase and a decrease in air quality	Primary short term	Adverse	Localized in areas of construction
	Incinerator emissions	Primary long term	Adverse	Localized near incinerator
	Elimination of sludge discharge	Primary long term	Beneficial	Boston Harbor area

TABLE IV-2

DIFFERENTIATING IMPACTS OF ALTERNATIVE 1

(Inland Fill)

Area of Impact	Action	Type of Impact	Assessment of Impact	Areal Extent
Soils	Increase in heavy metals concentration of landfill cover soil	Potential long term	Potentially Adverse	Landfill site
	Landfill operation, resulting in erosion and soil structure destruction	Potential long term	Potentially Adverse	Landfill site
Marine sediments and water quality	Dredging and construction for bargind	Short term	Potentially Adverse	Localized, near channel
Surface and Ground-water quality and quantity	Malfunction of leachate control at landfill	Potential short term	Potentially Adverse	Local, near fill site
Air quality	Emissions due to as transportation (fuel usage = 10,690 gal/yr)	Long term	Adverse	Localized, along truck routes

TABLE IV-2 (Cont'd)

Area of Impact	Action	Type of Impact	Assessment of Impact	Areal Extent
Biotic Communities	Heavy metal uptake by vegetation growing upon final landfill cover	Potential Long term	Potentially Adverse	Landfill site
	Loss of vegetation at landfill site	Short term	Adverse	Landfill site
Public Health and Noise	Noise and Emission from ash transportation.	Long term	Adverse	Sensitive reception near truck routes
	Malfunction of leachate control and contamination of useable aquifer or surface waters.	Potential Long term or Short term	Potentially Adverse	Localized near landfill site
Energy	Use of Fossil Fuels (158,520 gal/yr)	Long term	Adverse	Regional
Land Use	Use of additional landfill area causing displacement of the other uses	Long term	Adverse	Local
Transportation	Truck transport (10 trips/day) much of which is through residential neighborhood)	Long term	Adverse	Along truck routes
Historical and Archaeological	Use of landfill sites (No known historical and archaeological resources nearby)	Potentially Adverse	Potentially Adverse	Regional

TABLE IV-3

DIFFERENTIATING IMPACTS OF ALTERNATIVES 2 AND 10
(Cofferdam Fill)

Area of Impact	Action	Type of Impact	Assessment of Impact	Areal Extent
Marine sediments and water quality	Construction of cofferdam resulting in a habitat loss of 2.8 ha (7 ac)	Long term	Adverse	Localized, near Deer Island
Surface and ground-water quality and quantity	*Rupture of cofferdam (principanny for hazardous waste)	Potential short term; long term for hazardous waste	Potentially Adverse for hazardous waste	Localized, near Deer Island
Air Quality	Emissions due to ash transportation	Long term	Potentially Adverse	Localized, near Deer Island
Biotic Communities	Construction of cofferdam causing habitat loss.	Long term	Adverse	Localized, near Deer Island
	Rupture of cofferdam	Potential long term or short term	Potentially Adverse	Localized, near Deer Island
Public Health Noise	*Rupture of cofferdam	Potential long term or short term	Potentially Adverse	Localized, near Deer Island

TABLE IV-3 (Cont'd)

Area of Impact	Action	Type of Impact	of Impact	Areal Extent
	Noise generation during cofferdam construction (pile driver)	Short term	Potentially Adverse	Localized, near Deer Island
	Noise emissions from ash transport	Long term	Potentially Adverse	Deer Island
Energy	Use of fossil fuels (147,900 gal/yr)	Primary long term	Adverse	Regional
Land Use	Cofferdam site usage causing displacement of other uses.	Primary long term	Adverse	Local
Aesthetic	Cofferdam construction	Short term, Long term	Adverse	Localized, near Deer Island

*More significant impact when the alternative dealing with hazardous wastes is involved.

TABLE IV-4

DIFFERENTIATING IMPACTS OF ALTERNATIVES 8 AND 11
(Fill on Deer Island)

Area of Impact	Action	Type of Impact	of Impact	Areal Extent
Soils	Increase in heavy metals concentration of landfill cover soil	Potential Long term	Potentially Adverse	Landfill site
	Landfill operation resulting in erosion and soil structure destruction	Potential Long term	Potentially Adverse	Landfill site
Surface and ground-water quality and quantity	Malfunction of leachate control at landfill	Potential short term or long term	Potentially Adverse	Local near fill site
Air Quality	Emission due to ash transportation (Fuel usage 320 gal/yr)	Long term	Potentially Adverse	Localized, near Deer Island
Biotic Communities	Heavy metal uptake by vegetation growing upon final landfill cover	Potential Long term	Potentially Adverse	Landfill site
	Loss of vegetation at landfill site	Short term	Potentially Adverse	Landfill site

TABLE IV-4 (Cont'd)

Area of Impact	Action	Type of Impact	Assessment of Impact	Areal Extent
Public Health and Noise	Noise and emission from ash transportation	Long term	Potentially Adverse	Deer Island
	*Malfunction of leachate control at landfill	Potential short term or long term	Potentially Adverse	Localized, near Deer Island
Energy	Use of fossil fuels (Fuel usage = 147,900 gal/yr)	Long term	Adverse	Regional
Land Use	Use of landfill area causing displacement of landuse (Probable fill site is within Fort Dawes	Long term	Adverse	Local
Historical and Archeological	Use of Fort Dawses area as landfill site (possible historical resources)	Potential Adverse	Potentially Adverse	Regional
Aesthetic	Use of Fort Dawes as a landfill	Long term	Adverse	Local

TABLE IV-5

DIFFERENTIATING IMPACTS OF ALTERNATIVE 9

(Fill on Spectacle Island)

Area of Impact	Action	Type of Impact	Assessment of Impact	Areal Extent
Marine sediments and water quality	Dredging and construction for barging	Short term	Adverse	Localized, near channel
Surface and ground-water quality and quantity	Malfunction of leachate control at landfill	Potential short term or long term	Potentially Adverse	Localized, near Spectacle Island
Air Quality	Emissions due to ash transportation (Fuel usage = 1,065 gal/yr)	Long term	Potentially Adverse	Localized, near Spectacle Island
Biotic Communities	Heavy metal uptake by vegetation growing upon final landfill cover	Potential long term	Potentially Adverse	Spectacle Island
	Loss of vegetation at fill site	Short term	Potentially Adverse	Spectacle Island
Public Health and Noise	Noise and emissions from ash transporation	Long term	Potentially Adverse	Localized, near Spectacle Island
	Malfunction of leachate con-trol at landfill	Potential long term or short term	Potentially Adverse	Localized, near Spectacle Island

TABLE IV-5 (Cont'd)

Area of Impact	Action	Type of Impact	Assessment of Impact	Areal Extent
Energy	Use of fossil fuels Fuel usage = 148,865 gal/yr	Long term	Adverse	Regional
Land Use	Landfill site usage causing displacement of other land uses	Long term	Adverse	Local
Historical and Archeological Sites	Use of landfill site (Prehistoric sites are known to exist on Spectacle Island	Potential Long term	Potentially Adverse	Regional

B. Environmental Analysis of Differential Impacts

1. Soils

a. Adverse Impacts: Construction and operation of facilities and storage sites for the alternatives incorporating on-land fill of ash will have some adverse impacts, including:

- erosion from construction sites,
- soil structure destruction,
- erosion from site during operation, and
- particulate addition of heavy metals to soil.

Construction of storage sites and facilities for incinerator alternatives may result in a slight degree of erosion. This will be a short-term impact and can be mitigated by erosion control procedures (e.g., mulching at 2 tons/ac) and careful site selection.

The cover soil of the landfill for incinerator alternatives could show an increase in the heavy metal concentration, although this would be expected to be a negligible impact. Some soil structure destruction may occur from the mechanical removal and replacing of the soil layers. Erosion during operation of the landfill might have a moderate adverse impact on the soil, and could be reduced by using acceptable erosion controls.

Alternatives 2, 9 and 10 will have no soil impacts for the ultimate disposal section, being either an existing fill (Alternative 9) or in an artificial lagoon (Alternatives 2 and 10).

Incineration, common to all feasible alternatives, can create problems with decreasing pH of rainfall and, hence, soil leaching. The equivalent acid produced, neglecting photochemical conversion, is 177 kg sulfuric acid per day and 396 kg of nitric acid per day.

Incineration can also result in particulate fallout adding a small amount of heavy metals to the soil, resulting in a negligible adverse impact. However, particulate fallout would also increase the soil pH slightly, partially offsetting the pH reduction.

If land application were feasible, the potential adverse impacts include:

- increase in heavy metal concentrations,
- increase in sodium and chloride ions, and
- increased plant uptake of metals upon cessation of lime application.

The heavy metals, especially copper, zinc, nickel and cadmium, would increase in concentration in the soil. This is a potentially severe, long-term impact that would be controlled by the EPA guidelines limiting the amounts of sludge that may be applied (see Appendix R). Application of lime (used as a conditioning chemical in dewatering) to keep the soil pH near neutral results in less availability of the metals to leaching and plant uptake.

Sodium and chloride ions would also increase in the soil during land application. Sodium ions destroy the soil structure, resulting in reduced permeability. The amount of sodium that may be applied to the soil depends on the amount of calcium and magnesium that is available to inactivate the sodium effects. The chemical models for soil (Appendix R) discusses the sodium balance for the soils. However, chloride would not be expected to be a significant problem.

One major adverse effect would occur after sludge application ends. A high pH results in less heavy metals being available for crop uptake. If liming of the soil ends with the sludge application, a natural lowering of the soil pH may result in an increased availability of heavy metals. This could lead to metal toxicity of plants growing on these sites.

b. Beneficial Impacts: Operation of land application alternatives could result in some beneficial impacts on soils, such as:

- lime application to raise native pH,
- increased organic content, and
- increased organic nitrogen levels.

The amount of lime applied with the sludge would be similar to the amount applied on farms. Lime application with the sludge will result in about 0.5 tons per acre of calcium oxide, which is equivalent to 0.9 tons per acre of calcium carbonate. Present agricultural practices put 1.6 tons per acre of calcium carbonate on the land (U.S. Department of Commerce, 1972).

The organic content of the soil should increase from land application of sludge, benefically affecting the soil structure, the cation exchange capacity, and the water-holding capacity of the soil. This may be a major impact, and since organic breakdown is relatively slow, would be expected to have a long-term effect on the soil. The organic nitrogen level would also increase and subsequently be released during organic breakdown.

The combination of potential beneficial and adverse impacts on soil of the (infeasible) land application alternative would be, on balance, weighted toward the adverse. The benefits of lime organic material and nitrogen addition can be obtained without the accompanying heavy metals contribution of the sludge.

2. Marine Sediments and Water Quality

a. Adverse Impacts: Two of the alternatives (2 and 10) have potential adverse effects on the marine environment. While the cofferdam structures are intended to prevent release of ash to either the ocean or the harbor, extreme weather conditions could result in rupture of the cofferdam system. Release of ash is potentially an adverse long term impact.

The major adverse impact of Alternatives 2 and 10 is the loss of 2.8 ha (7 ac) marine bottom habitat. The habitat on the harbor side (Alternative 10) is a mud-flat environment, and the bottom sediments on the ocean side are a combination of rocky bottom and mudflats.

For Alternatives 1 and 9, dredging and construction for barging would be an adverse impact. The impact would be long term because of the need for channel maintenance.

b. Beneficial Impacts: Alternatives 1, 8, 9 and 11 will have beneficial impacts on marine sediments and water quality because no loss of area is connected with any of these disposal methods. Provided leachate treatment is practiced, no adverse effects will result from any in terms of ocean or harbor water quality.

3. Surface and Groundwater Quality and Quantity

a. Adverse Impacts: The preparation of landfill facilities in accordance with P.L. 94-580 (RCRA) will prevent adverse impacts of runoff and leachate on surface and groundwater quality by returning these flows to the treatment plant. If the ash is defined as a hazardous material based on metal extraction data, this recycling is required by RCRA. If the ash is nonhazardous, the recycle is optional but should be done to prevent potential adverse impact. Therefore, Alternatives 1 and 9 are less desirable, having less defined measures for leachate and runoff control. The daily volume of leachate and seawater displaced (2 and 10) for treatment will be about 10,000 gpd for Alternatives 1, 8, 9 and 11 and about 15,000 gpd for Alternatives 2 and 10.

Implementation of the (infeasible) land application alternatives would have potentially severe impacts on groundwater and surface water quality. In accordance with RCRA, land application would require underdraining and leachate treatment for the 4,671 ha (11,550 ac) used. With an annual infiltration of 234 mm (10") this would result in loss of 32,500 m^3/day

(8.6 mgd) from groundwater. Without leachate recovery, the quality impacts would be adverse because of possible excessive nitrogen loss to groundwater.

Comparing the feasible, incineration based alternatives, the greatest potential adverse impacts are from Alternatives 1 and 9 in terms of leachate control and from 2 and 10 in terms of potential cofferdam rupture.

b. Beneficial Impacts: All feasible alternatives will exert a beneficial impact on surface water quality by removing BOD, solids and metals from the water column. As shown in the Hydroscience Report (1971) 20% of the sludge discharged during ebb tide returns to Boston Harbor. Alternatives 1, 2, 8, 9, 10 and 11 will remove this load to the harbor.

4. Air Quality

a. Adverse Impacts: Impacts of the feasible alternatives are essentially identical (Appendix V) because they all include incineration. Based on the emission burden analysis, Alternative 1, having the greatest transport fuel use, will have a greater adverse impact on air quality by 4% for TSP and 2% for sulfur oxides. The carbon monoxide emissions are much greater (7.8 kg/day vs. less than 1 kg/day) but are still negligible in absolute terms. Because of additional controls required for hazardous waste incineration, Alternatives 8 and 10 should have reduced adverse impacts on air quality.

Air quality impact sources during construction include fugitive dust and fuel used in construction, and are similar for all feasible alternatives. Mitigating measures include:

- Watering of the dirt roads during construction
- Covering stockpiled soils
- Cleaning vehicles before they leave the site
- Cleaning dust or dirt off paved access roads
- Limiting truck speeds on unpaved surfaces
- Covering open-bodied trucks when they are in motion
- Timely scheduling to minimize the time and area exposure of denuded areas

- Appropriate maintenance of contruction vehicle and equipment

- Scheduling truck movements to minimize potential interference with local traffic

b. Beneficial Impacts: Comparing the incineration alternatives to the land application alternative, the CO emissions for land application transport are about ten times that of the incineration alternatives.

5. Biotic Communities

a. Adverse Impacts: Freshwater, marine, and terrestrial organisms (both animal and plant) may be adversely affected by the different alternatives. Impacts that may be involved include:

- heavy metal uptake by terrestrial and aquatic plants,
- primary consumer toxicity from feeding on contaminated plants,
- particulate fallout on plant species,
- effects of SO_2 on vegetation,
- vegetation effects from low pH rains,
- alteration of species diversity,
- habitat disruption during operation,
- smothering of benthic organisms, and
- benthic and pelagic disruption of Boston Harbor from pipeline construction and operation.

An adverse, long-term impact that could vary from minimal-to-severe is the heavy metal uptake by vegetation growing on the landfill upon conclusion of filling operations. This impact is dependent on plant type, depth of cover soil and the type of cover soil.

The incinerator alternatives may affect plant life by emissions. Sulfur dioxide, released from the incinerator in gaseous form, combines with moisture to form a dilute sulfuric acid which is harmful to plant life. This would result in a moderate adverse impact. Particulate fallout on plants may also have a moderate adverse impact. The dust could cause screening of sunlight, resulting in a slightly lower photosynthetic rate.

During operation of the landfill sites (Alternatives 1, 8, 11) additional vegetation would be cleared, possibly resulting in an increased erosion rate. The animal life would also be displaced during landfill operations. However, this would be expected to be a minimal adverse impact since the amount of surface area necessary would not be large, and the criteria for landfill site selection minimizes the possible impacts. Construction of incinerators would also have a minimal adverse impact on terrestrial ecology since its location would be at a presently disturbed site, and would require less than 0.5 hn (1 ac) of land.

With the on-site landfill of incinerator ash at Deer Island, a portion of the harbor would be filled. It is currently planned that the fill area will be located either on the harbor side of Deer Island (Alternative 10), near the Administration Building or the same area on the ocean side (Alternative 2), and will initially consist of 600 x 600 feet rectangle. This area would be sufficient for a period of 5-10 years. Intertidal communities lost by the fill will be replaced by similar ones on the face of the bulkhead within one season. This action does not represent a significant impact. However,in other areas of the nation uncontrolled fill operations have gradually eliminated large portions of valuable estuaries, and as discussed in Section III, the Executive Orders controlling wetlands and flood plains use have been construed to include surface waters, and therefore, permits would be required for such operations. Practically speaking, current EPA policy is to not grant such permits unless no alternatives exist (I. Leighton, 1978).

Construction and operation of a sludge pipeline leading from Nut Island to Deer Island, and extension of the current Nut Island discharge line to Deer Island will have several adverse impacts on Boston Harbor. Water quality will decrease in Boston Harbor during construction activity. Several parameters will be affected; however, all the impacts will be limited in extent and will exist only during the active construction phase. All are related to the resuspension of bottom sediments in the water column. Fine particulate material such as is common in Boston Harbor sediments will be easily resuspended by dredging activities. This material will decrease the transparency of the water column and change the quality of light reaching any given depth.

The sediments of Boston Harbor are known to contain large amounts of organic materials (PCB's) as well as heavy metals. Resuspension of such materials will result in increased levels of inorganic nutrients, toxic materials (including heavy metals), organic substances, bioaccumulatory substances such as pesticides, and suspended solids in the water column. At the same time, decomposition of the dissolved and suspended organic materials will cause a reduction in dissolved oxygen levels.

Dredging activities for pipeline construction will have a variety of effects on the flora and fauna of the Harbor. The presence of fine suspended solids in the water column will cause flocculation and deposition of phytoplankton. In addition, all primary production will be reduced due to decreased light levels. It is unlikely that nutrient levels are normally limiting in much of the bay, so a counteracting simulation due to increased nutrient levels is not expected. The fine particles will adversely affect organisms with fills by mechanical clogging. Motile creatures, such as fish, may avoid the plume, but organisms which are sessile or weak swimmers may be suffocated. Organisms which are filter feeders may also be adversely affected by mechanical clogging of their feeding apparatus. Larval organisms, both invertebrate and vertebrate, are particularly sensitive to these problems, and to minimize the effect dredging should be avoided the spring and summer months. The benthic community in the immediate path of the dredge will be largely eliminated, and additional organisms will be buried when the dredge spoil is returned to the Harbor. Spoil from the pipeline construction would be returned to the pipeline trench.

The area of the Harbor where the effects of dredging will be noticed is dependent upon the extent of the sediment plume resulting from dredge operation. For example: if the water depth equals 15 feet, the sediment is coarse silt (31 μ diameter), and the current speed is 1 ft/sec., a plume of between 0.5 and 1.0 miles would result. The density of the plume and the severity of the impact decreases with increasing distance from the operation dredge, but considerable areas of the bay may be affected, depending on conditions. Particle size is critical, since the settling velocities change exponentially with particle radius. In any case the problem ends almost immediately with cessation of dredge operation. While some localized damage could be significant, recovery should be completed within a two month period, which would mean that dredging in the spring and summer could be avoided. Given these circumstances the impacts of the pipeline construction are not considered to be significant.

Normal operation of the pipeline should not affect the Harbor, but malfunctions could produce adverse impacts. A leak in the pipe would contribute sludge to the sediments around the pipe, with the possibility of exchange with the water column. This is unlikely since the pipe is to be 8 feet under the bottom of the Harbor. More likely would be the slow buildup of contaminants contained in the sludge in the sediments near the pipe. This appears to be of minimal significance but should be monitored by some appropriate method of leak detection. A catastrophic rupture would release 40 tons of sludge into the sediment, assuming shutdown was immediate. It is essential that rapid switching between the two pipes be available to allow for rapid shutdown. Holding capacity on Nut Island would provide additional flexibility in case both pipes were involved. If shutdown could not be accomplished, there would be, in effect, a subsurface sludge discharge similar in scope to the existing Nut Island discharge. The probability of such an event occurring during the life of the project is considered to be minimal.

b. Beneficial Impacts: Several beneficial impacts to biotic communities may result from the various alternatives. There are:

- increased habitation for buffer zone species,
- alteration of species diversity,
- improved shellfishing conditions in the Harbor.

Terrestrial biota may experience a minimal beneficial impact from the increased amount of uncultivated or buffer zone land surrounding the landfill sites. This is expected to be minimal since presently there are buffer zones in many areas. Species diversity is often greater in a buffer-zone area since the vegetation is a gradation between two environments. Therefore, where buffer zones are created species diversity is expected to increase.

Improved water quality in Boston Harbor due to cessation of the present disposal method would result in improved conditions for shellfish. This would enable shellfishing in areas that are presently closed for this activity due to high pollution levels.

6. Public Health and Noise

a. Adverse Impacts: The adverse public health impacts that may be associated with the alternatives are:

- contamination of water supplies,
- occupational noise impacts,
- occupational accident impacts,
- occupational pathogen impacts,
- respiratory interference from lowered air quality
- residential pathogen impacts via aerosals, and
- introduction of toxic materials into food chains.

Noise: Noise-generating activities are inherent in the implementation of three alternatives associated with any sludge management plan. These noise-generating activities can be generally categorized as those stemming from the use and transport of construction equipment and those noises generated by the hauling of ash in 20-ton trucks moving through residential areas in Alternative 1. In all cases, the determination of nuisance, or harmful noise levels is dependent on the location of the receptor site in relation to the noise source.

Potential receptor site areas were identified through the use of a procedure based on specific criteria to identify potential receptor site areas. Appendix X presents in detail the methodology and results of this noise impact analysis. Those receptor sites are residential areas directly adjacent to transport routes which were designated either for the movement of construction equipment and personnel, or the movement of sludge laden trucks. Following such a procedure, potential receptor site areas were identified on Deer and Nut Island, and in neighborhoods in Winthrop, East Boston, Quincy, Charlestown, and Plainville.

Recall from Section I (Environmental Setting) that the 24-hour sound equivalent level [L_{eq} (24)], for sites within the vicinity of potential receptor site areas ranged from 69 db to 74 db in urban sections, (Charlestown, East Boston, Quincy and Winthrop) and about 10 to 15 db lower in rural and semi-rural areas like Plainville.

It was noted that the ambient noise levels in the urbanized areas of Boston either exceeded, or were barely below EPA recommended guidelines. The proximity of a major airport figured significantly in this condition. Further examination of sociophysical information for potential receptor areas indicated that Charlestown and Boston would be particularly sensitive and susceptible to noise impacts of the project.

The final determination of impact was designated by construction and operation phases. In this context, it was found that in the construction phase impacts for alternatives other than 2 and 10 would be limited to those on construction workers and treatment plant employees, while local residential areas would likely only be affected by the frequent disturbance generated by the coming and going of cement mixers, or other heavy trucks. Construction noise impacts are a function of total employment, vehicles, and types of equipment used. For Alternatives 2 and 10, placement of cofferdams by piledriver will result in noise peaks of 105 dB at 15 m (50 ft), as shown by Magrab (1975). For Alternatives 2 and 10, the distance to homes in Point Shirley is 1220 m (4000 ft) and 760 m (2500 ft) respectively. Under adverse conditions (high humidity and low temperature), sound dissipation of 20 dB/km may be expected. This in turn would mean impulse noise levels at Point Shirley of 80 dB for Alternative 2 and 90 dB for Alternative 10, not including the effect of other construction equipment.

It was found that operational impacts of transportation noise varied between urban and rural areas, as summarized in Table X-6. The impact of all alternatives was found to be negligible in urban areas. In rural areas, the relative noise impact is greater, but two considerations apply. The alternatives were established such that only day-time transportation was required, and applicable noise standards vary in rural areas. In residential areas, a day-night noise standard (L_{dn}) of 55 dBA (protecting general health and welfare) applies, and the noise equivalent standard (L_{eq}) of 70 dBA (preventing hearing damage) applies in non-residential areas. An equivalent noise level (L_{eq}) of greater than 60 dBA would also violate the L_{dn} standard of 55 dBA. Because the rural areas have relatively scattered residences, there will not be noise impacts in excess of standards in most areas.

In comparing the feasible incineration alternatives to the land application alternative, the impact of construction will be greater for incineration (more materials, equipment and workers) than for land application. Because of the much greater number of vehicles for transport, however, the noise impacts of operation would be much higher for land application.

Regarding operational noise exposure, the exposure of workers is limited by the Walsh-Healy Act which gives a combined noise-exposure standard. The occupational noise level with greatest impact is that of incineration, which may range from 82 to 97 dBA at 25 feet (USEPA, 1972), which would limit workers to three hours per day of direct exposure (Hovey, 1972).

Reduced air quality will result from implementing incineration alternatives. This reduction will leave air quality essentially unchanged from present levels in the Boston area. The present air quality being less than that required by Massachusetts and federal law may result in some adverse health effects. On the smaller scale, the proposed incineration facility is located in a "Clean Zone", and incineration will not result in contravention of standards for prevention of significant deterioration.

b. Beneficial Impacts: Discontinuation of harbor disposal of sludge may result in some improved beach conditions. This is beneficial for public health, as well as for recreational purposes. However, this impact should be negligible to minimal since it has been shown that the greatest amounts of beach bacterial contamination is a result of combined sewer overflows.

7. Economic Impacts

a. Adverse Impacts: The adverse economic impact of the feasible alternatives is the increased annual cost to residents of the MDC service area. Based on 1975 Fiscal Year MDC operating and capital budget costs of $17,637,000 and the estimated 1985 service area population of 2,280,000 (3.2 persons per household), the increased costs are, based on annual costs after grants:

Alternative	Incremented Cost to MDC	Incremented Annual Cost per Household
1	16.8%	$4.16
2	14.6%	$3.61
8	14.0%	$3.48
9	14.4%	$3.56
10	14.6%	$3.61
11	14.0%	$3.48

Based on the OBERs projections of $5900 per capita income in 1985, the differential and absolute impacts on each household are negligible.

For contrast, the original land application alternative, developed in detail in the Draft EIS with 1975 costs, would have increased the costs to MDC by 23.4% per year and would have had a cost per household of $5.79 per year.

b. Beneficial Impacts: The beneficial economic impact of all action alternatives is the generation of construction jobs with federal grant funds. The 480 man years of effort translates into about 120 jobs over a three year period. Operating labor increase for all alternatives is about 95 employees (98 for Alternative 1) assuming 1500 hours per employee per year. While this is beneficial on an individual level, it is adverse on a regional basis because these employees do not produce export goods.

8. Energy Impacts

a. Adverse Impacts: All of the feasible alternatives (1, 2, 8, 9, 10, 11) will require energy use for operation which must be drawn from existing fossil fuel sources. This fuel use is for startup and auxiliary fuel and for transport of ash to ultimate disposal. To offset this fossil fuel use, the inclusion of energy recovery will produce more total energy than will be consumed by the sludge management operation. Alternative 1 with inland ash disposal required about 2×10^9 BTU more per year than do the other alternatives. The imbalance in direct fossil fuel use is greater, with Alternative 1 requiring 158,520 gallons per year while the next Alternative (9) requires 148,865 gallons per year, or 6% less, and the remaining alternatives all require about 147,900 gallons per year, about 6.7% less than 1.

In contrast, the original land application alternative from the Draft EIS required direct energy imputs of 162×10^9 BTU per year, mostly in fossil fuels, and an indirect (chemical) energy input of 50×10^9 BTU per year. This energy use would have been partially offset by a maximum nutrient energy recovery of 51.1×10^9 BTU per year for a total net use of 161×10^9 BTU per year.

b. Beneficial Impacts: The most obvious beneficial impact of the feasible alternatives is the recovery of thermal energy in excess of that required for start operations. The total net recovery of $52\text{-}54 \times 10^9$ BTU per year is equivalent to 370,000 gallons of diesel fuel that will be saved annually by converting radial diesel pump engines to electric motors.

9. Land Use Impacts

a. Adverse Impacts: In most wastewater treatment plant projects, the issue of secondary impacts which are induced by the project (and are most significantly reflected in pressures on land use and land use planning)are not present with this project. There are some minor secondary land use impacts associated with some of the alternatives (to be discussed later in this section), but the very nature of the problem precludes significant, secondary impacts. Specifically, what has been proposed by MDC is not the creation of new or expanded wastewater treatment facilities, but a change in the method of processing the sludge generated at existing treatment plants. A simple test which can be applied to test the validity of this conclusion is to ask the question, "Will people move into the MDC sewage service area because their sludge can receive better treatment?" The answer is "No." Therefore, the bulk of the following evaluation centers around the primary impacts of the several alternatives on land uses.

Adverse land use impacts may result from:

- decreases in land values adjacent to ash disposal sites, and
- decreases in productive land area.

The expansion of facilities at the existing Deer Island treatment plant site will result in minimal adverse effects. Except for the "No-Action" alternative, the enlargement of facilities on Deer Island is part of all of the alternatives under examination. Although the facilities may eventually displace other existing uses on the island, location of these facilities at any other site would not be feasible.

b. Beneficial Impacts: No beneficial impacts differentiate the feasible alternatives. In comparison to land application, which would require use of 40 acres of storage land and 11,500 acres of application land, the total impact is beneficial. Although positive impacts on agriculture would result from land application designed and operated in accordance with the provisions of the Resource Conservation and Recovery Act, the loss of this area from agriculture in the event of problems would constitute a severe negative impact.

10. Transportation Impacts

a. Adverse Impacts: All feasible alternatives (1, 2, 8, 9, 10 and 11) will have adverse impact on traffic as discussed in Appendix Y. This impact, however, will be negligible. For purposes of differentiation, the impacts of 10 truck trips per day of Alternative 1 will be worse than the other feasible alternatives.

b. Beneficial Impacts: There are no differentiating beneficial impacts on traffic or transportation.

11. Historic and Archeological Impacts

a. Adverse Impacts: Alternatives 1, 8, 9 and 11 have potential adverse archeological impacts as follows:

Alternative 1: The fill sites proposed (Randolph, Amesbury and Plainville) have not been surveyed, but filling in existing sites should have no further adverse effect.

Alternatives 8, 11: Filling in the Ft. Dawes area of Deer Island may disrupt existing archeological resources. Before final fill location, an archeological survey should be conducted.

Alternative 9: Prehistoric sites are known to exist on Spectacle Island (Weslowski, 1978), as well as historic sites, and therefore, a detailed survey would be necessary before locating the fill.

Operation of the incineration alternatives may result in damage to historic sites from SO_2. This impact will be negligible, however, considering the amount of SO_2 that would be produced, the predominant wind direction and the location of sites within the effective flume distance.

b. Beneficial Impacts: No differentiating beneficial impacts will result from any of the feasible alternatives.

12. Aesthetic Impacts

Adverse aesthetic impacts may result from the alternatives. These include:

- visual impact from on-site facilities (Deer Island), although fill placement for Alternative 11 may screen the main facility from visual impact on other Boston Harbor islands;
- visual impact from off-site facilities;
- odor impacts from on-site facilities; and
- odor impacts from off-site facilities.

The impacts of construction and operation of the expanded facilities would be negligible or minimal concerning noise, appearance, and odor, and will be essentially identical to the other alternatives. The existing plant already produces odor, noise, and visual impacts, and while it is isolated from the main residential areas of Winthrop, there will be increases in the existing adverse effects upon the inmates of the Suffolk County prison. The addition of increased noise and odor will probably be in the range of minimal to moderate.

Alternatives 2 and 10 would have adverse aesthetic impacts on the harbor or ocean because of cofferdam construction. Alternatives 8 and 11 would have adverse impacts on use of Ft. Dawes as a recreational site, but because of the existence of the Deer Island plant, the present aesthetic quality may be limited.

SECTION V

SELECTION OF RECOMMENDED PROJECT

In this section, the alternatives developed in Section III are evaluated on the basis of the following criteria:

- Inputs of labor and energy
- Costs, gross and net
- Environmental impacts
- Implementation feasibility

After this evaluation the best action alternatives are selected and are then discussed in more detail in order to select the most desirable action plans. Descriptions of the Recommended Projects close this section.

V. SELECTION OF RECOMMENDED PROJECT

A. Summary Comparison and Selection of Best Action Alternates

In this section the action alternatives are compared in order to select the best method for processing and disposing of digested sludge from the Metropolitan District Commission service area. The selection process begins with a summarization of:

- Elimination of infeasible alternatives (from Section III)
- Process and disposal inputs of land, labor, energy and materials,
- Capital and annual costs with and without grants,
- Significant environmental impacts,
- Implementation and control problems.

After this summary of information pertinent to the selection process, the subsequent steps are:

- Step 1, elimination of the least desirable alternatives. The first selection step is to eliminate those action alternatives that are clearly inferior.
- Step 2, selection of the best action alternative, based on a further development of the criteria.

To reiterate, the six alternatives developed and evaluated require incineration of Deer and Nut Island sludges at Deer Island. The ultimate disposal alternatives for ash are:

- Alternative 1: Transport to an inland landfill site (non-hazardous wastes only)
- Alternative 2: Lagoon fill on the ocean side of Deer Island (non-hazardous waste only)
- Alternative 8: Inland landfill at Deer Island (non-hazardous waste)
- Alternative 9: Inland landfill at Spectacle Island (non-hazardous waste).

- Alternative 10: Lagoon fill on the harbor side of Deer Island (hazardous wastes)

- Alternative 11: Inland fill at Deer Island (hazardous wastes).

a. Elimination of Infeasible Alternatives: In Section III alternatives using land application or ocean disposal as the ultimate disposal method were eliminated for the following reasons:

- Ocean Disposal Alternatives (3, 4 and 7) were eliminated because of recent federal legislation forbidding ocean dumping of sewage sludge after December 31, 1981. See Appendix O and Section III E. for more detail.

- Land Application Alternatives (5 and 6) were eliminated for several reasons: present and future sludge quality, land area required, and the requirement for leachate control for hazardous waste disposal sites. In addition, as discussed in Section IV, certain impacts on transportation and cost would have been excessive.

b. Process and Disposal Inputs; Monetary Costs: Inputs of labor, energy, materials, land, and monetary costs for construction and operation of these alternatives are given in Appendix T, Section III and Section IV. Summaries of the required inputs are shown in Tables V-1 and V-2. In addition to labor, energy inputs, materials and land, Table V-1 also includes the energy recovered from digestor gas (which applies to all alternatives).

c. Environmental Impacts: Environmental impacts of the action alternatives are covered in detail in Section IV, and will not be reiterated in such detail. A summary of impacts by category is possible as shown in Table IV-1-5. It should be noted that none of the impacts are of such severity as to eliminate the alternative from further consideration. The elimination process shown originally in the Draft EIS has been largely superseded by federal law as described above and in Section III. With this increased influence of law, the possible range of alternatives has been correspondingly reduced, particularly since both sludge and ash are deemed hazardous because of potential heavy metal leaching.

d. Feasibility of Implementation: With respect to implementation, each alternative remaining has barriers to implementation (as might be expected in an urbanized area with many competing uses for resources such as land and water).

TABLE V-1

INPUT RESOURCE USE AND PRODUCTION *

	ALTERNATIVE					
	1	2	8	9	10	11
ON-SITE ANNUAL ENERGY USE						
Electrical	57.6×10^9	57.6×10^9	57.6×10^9	57.6×10^9	57.6×10^9	57.6×10^9
Fuel	21.1×10^9	21.1×10^9	21.1×10^9	21.1×10^9	21.1×10^9	21.1×10^9
Chemical	50×10^9	50×10^9	50×10^9	50×10^9	50×10^9	50×10^9
Total	128.7×10^9	128.7×10^9	128.7×10^9	128.7×10^9	128.7×10^9	128.7×10^9
ON-SITE ANNUAL ENERGY PRODUCTION						
Electrical	161×10^9	161×10^9	161×10^9	161×10^9	161×10^9	161×10^9
Fuel	650×10^9	650×10^9	650×10^9	650×10^9	650×10^9	650×10^9
Total	811×10^9	811×10^9	811×10^9	811×10^9	811×10^9	811×10^9
NET ON-SITE ENERGY PRODUCTION	682×10^9	682×10^9	682×10^9	682×10^9	682×10^9	682×10^9
NET ON-SITE ELECTRICAL ENERGY PRODUCTION	103×10^9	103×10^9	103×10^9	103×10^9	103×10^9	103×10^9
TRANSPORT & DISPOSAL ENERGY USE	1.53×10^9	9.3×10^6	4.58×10^7	1.52×10^8	9.3×10^6	4.58×10^7
NET ENERGY PRODUCTION						
Total	680×10^9	682×10^9	682×10^9	682×10^9	682×10^9	682×10^9
Equivalent Fuel Production (Gallons of #2 Diesel Fuel/Yr.)	4.76×10^6	4.77×10^6	4.77×10^6	4.77×10^6	4.77×10^6	4.77×10^6

* All units in BTU/year except where noted

TABLE V-2

COSTS OF ALTERNATIVES (1978 DOLLARS)

	ALTERNATIVE					
	1	2	8	9	10	11
Capital Costs						
Without Grant	$31,099,100	$34,802,100	$30,591,100	$31,163,100	$34,824,100	$30,591,100
With Grant	7,774,775	8,700,525	7,647,775	7,790,775	8,706,025	7,647,775
Annual Capital Costs						
Without Grant	2,885,900	3,196,500	2,810,500	2,832,850	3,198,500	2,810,500
With Grant	748,005	800,930	704,435	720,975	801,460	704,435
Annual Operating Costs	2,653,655	2,213,020	2,213,090	2,256,975	2,212,995	2,213,090
Credit for Electrical Energy	441,000	441,000	441,000	441,000	441,000	441,000
Total Annual Costs						
Without Grant	5,098,555	4,968,520	4,582,590	4,648,825	4,970,495	4,582,590
With Grant	2,960,660	2,572,950	2,476,525	2,536,950	2,573,455	2,476,525

The major barriers to implementation of each alternative are:

- Alternative 1: Although this is based on an existing fill site (e.g. Plainville), the possibility that the ash will remain hazardous cannot be ignored. The Plainville fill site is not approved for hazardous wastes. Also, to be cost effective, Alternative 1 requires access to roll-on-roll-off facilities not owned by MASSPORT. As an additional barrier, water-borne transport of hazardous materials will require a Coast Guard permit, so even if a hazardous waste fill is developed in eastern Massachusetts, this requirement will still exist.

- Alternatives 2 and 10: The principal implementation barrier to Alternative 2 is the use of coastal area for fill. The City of Boston Environmental Commission has authority over shoreline changes. The Corps of Engineers is on record as disapproving the ocean fill for ash disopsal.

- Alternatives 8 and 11: Use of the Fort Dawes area for fill of ash, either hazardous or non-hazardous, is complicated by the Boston Harbor Islands Master Plan, which includes use of Fort Dawes as a recreational site. This recreational use will be seriously compromised if Deer Island is used for a secondary treatment plant site, which will consume the greater part of the island, but the Master Plan still exists and approval for change would be necessary.

- Alternative 9: As with Alternative 1, Coast Guard approval would be required for transport of ash by barge to Spectacle Island. In addition, for hazardous ash, the leachate from the ash fill must be treated for metals removal (in Appendix T, treatment cost was included for this) and an NPDES permit would be necessary for discharge. The Spectacle Island site is presently a fill area for municipal refuse, and installation of leachate control would be difficult. Because of limitations on use of the harbor islands, the only landfill possible would be use of nonhazardous ash for surface contour regrading. The present plan for Spectacle Island requires use within five years for passive recreation. Therefore, use for fill would last for three years or less.

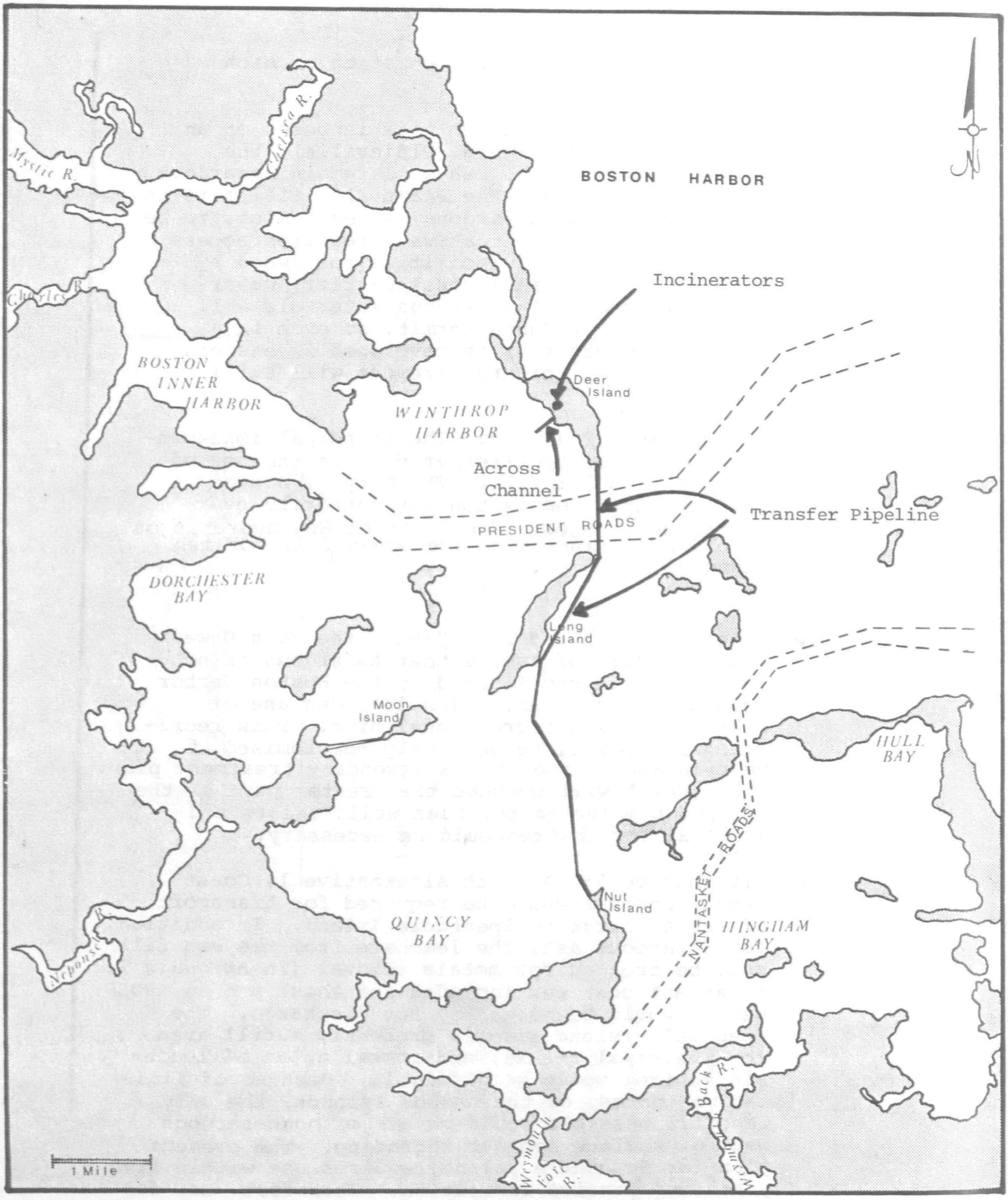


FIGURE V-1 APPROXIMATE LOCATIONS OF CONSTRUCTION AREAS FOR RECOMMENDED PROJECT

- Alternatives 10 and 11: Preparation of a fill for hazardous wastes will require obtaining a permit in accordance with draft provisions of the Resource Conservation and Recovery Act (P.L. 94-580), and monitoring of groundwater observation wells and collection and treatment of leachate must be done. Because the permit will require public hearing (I. Leighton, 1978), some delays may be experienced.

In summary, all feasible alternatives are subject to implementation difficulties but of these six alternatives, 8 and 11 will probably have the fewest implementation problems. Alternatives 2 and 10 have implementation difficulties which may be insurmountable, particularly in combination with the increased cost for cofferdam construction. Alternative 9 cannot be implemented unless the ash is considered nonhazardous.

In addition to the institutional considerations, there are three technical areas which enter into the evaluation of a system's implementability: simplicity of operation, system flexibility, and speed with which the system can be made operational. In considering the area of operational simplicity, the most complex alternative (Alternative 1) would have the greatest problems in terms of maintaining a smoothly running series of steps. In considering system flexibility, all feasible alternatives are similar. With respect to the time required for systems to become operational, all alternatives are the same because the limiting factor will be incinerator construction.

B. Selection of the Best Action Alternative

The selection process, at this point, must be principally based on implementation and relative impact. Alternatives 2 and 10, which include filling of ash in cofferdammed areas on either the ocean or harbor side of Deer Island, (which are elements of the Applicant's Proposed Action) can be eliminated for the following reasons:

- The Boston Environmental Commission, which has review authority over this action, would not accept this (Beal, 1975) if there were alternatives to this action.

- The Corps of Engineers would require a permit application and would not grant such a permit if there are alternatives to this action.

- The cofferdam construction makes these alternatives less cost effective than Alternatives 8, 9 and 11, with or without federal grants.

- The impact of harbor area loss makes Alternative 10 unacceptable, and the potential impact of cofferdam rupture makes both Alternatives 2 and 10 unacceptable.

The rationale behind this discussion is that there are other more cost effective alternatives to the use of cofferdam fill sites, and that if there are other satisfactory alternatives, the proposed plan should not be one with delays built in because of implementation problems.

Alternative 1, using inland fill at an existing fill site, can be eliminated for the following reasons:

- The ash analysis indicates that the ash is a hazardous material as defined by RCRA, and therefore the absence of landfills in eastern Massachusetts licensed for hazardous wastes precludes use of this alternative.

- Alternative 1 is the least cost effective alternative, with or without federal grants.

- The resource costs and transportation impacts are such that if other more cost effective alternatives are available this alternative should be eliminated.

Alternative 8, using an inland fill on Deer Island for nonhazardous wastes, can also be eliminated because of the known hazardous nature of the ash. The sole difference between Alternatives 8 and 11 is the recycle of leachate for treatment. This means that if the sludge ash should be nonhazardous (probably by a change in definition rather than by a change in sludge) there will be no reason not to proceed with Alternative 11.

Therefore, the Recommended Project Alternatives are the remaining two, Alternatives 9 and 11. These have about the same levels of implementation problems and of adverse impacts. While Alternative 11 is the most cost effective, its implementation could be blocked by legislative action and thus an alternative must be carried forward for this eventuality.

C. Detailed Description of Recommended Project Alternatives

The Recommended Project Alternatives are described as follows:

a. On-Site Processes Common to Both Alternatives: The on-site processes are: dewatering and incineration with recovery of heat for electricity generation. The dewatering process may be vacuum filtration or horizontal belt filtration depending on detailed studies in Step II. The incinerator will be a multiple hearth incinerator with a variable speed fan for intake air. The energy recovery facilities will include the boiler and a 4000 kw generator. The temperature difference through the boiler will be about 500°F. Quenching and ash removal from the incinerator will be either wet or dry, with dry quenching recommended to minimize the amount of leachate to be recycled. Air pollution control will be by a Venturi-type scrubber with a 42" H_2O pressure drop through the scrubber.

b. Transportation and Disposal: The transportation and ultimate disposal of ash will be by one of the following:

- Alternative 9: The nonhazardous ash will be transported in trailers to a barge-ferry for transport to Spectacle Island for disposal. At Spectacle Island, truck tractors will be employed to unload the trailers off the barge. The ash will be placed as necessary for reshaping contours.

- Alternative 11: The ash will be transported to the lower end of Deer Island (the Fort Dawes area) where it will be placed in a sealed fill. The leachate from the fill will be recycled to the plant for treatment. If the ash becomes nonhazardous then fill can also be placed as necessary for grading. In terms of long-term impact, but not costs, Alternative 11 then resembles Alternative 8.

SECTION VI

ENVIRONMENTAL EVALUATION OF THE RECOMMENDED PROJECT ALTERNATIVES

This section summarizes the beneficial and adverse impacts of the Recommended Project Alternatives, and the mitigating measures that can be taken to lessen the severity of unavoidable impacts. Section VI specifically addresses the following questions:

- What are the adverse impacts that cannot be avoided?
- What is the relationship between local short term use of the environment and maintenance and enhancement of long term productivity?
- What irreversible and irretrievable commitment of resources accompany the Recommended Project?

VI. ENVIRONMENTAL EVALUATION OF THE PROPOSED PROJECT ALTERNATIVES

In this section, the impacts of the Recommended Project Alternatives are summarized, along with suitable mitigating measures (if applicable), and the answers to the questions mandated by the National Environmental Policy Act of 1970 are given. The NEPA questions are:

- Adverse impacts that cannot be avoided.
- Relationship between local short term use of the environment and maintenance and enhancement of long term productivity.
- Irreversible and irretrievable commitment of resources to the recommended project.

A. Summary of Environmental Impacts and Mitigating Measures

The impacts of the recommended project and relevant mitigating measures are summarized in Tables VI-1 and VI-2. These tables are essentially checklists of impacts, with amplification in the following section on unavoidable adverse impacts. Additional information, i.e. type, assessment and areal extent of impact, can be found in Tables IV-1 to IV-5.

Regarding mitigating measures, it should be noted that the recommended plan was developed in such a way as to minimize adverse impacts detected in the early stages of evaluation. In going from the Draft EIS to the Final EIS, the principal level of evaluation involved plan selection to minimize adverse impacts of ultimate disposal.

B. Adverse Impacts That Cannot be Avoided

The principal adverse impacts that cannot be avoided are related to air quality. With the scrubber system to be used, little further mitigation can be expected. As discussed previously, because the proposed project alternatives do not include expansion of the service area, little secondary impact, either beneficial or adverse, is expected. The adverse impacts are identified in Table IV-1-5, and are summarized below.

- Soil quality and structure: Loss of soil through erosion during construction of facilities at Deer and Nut Island. Mulching can reduce this by approximately 90%.

TABLE VI-1

ALTERNATIVE 9 - SUMMARY OF IMPACTS

Area of Impact	Action	Mitigating Measure
Soils and topography	Construction of incinerator and storage facilities	Use of mulching at 2 tons per acre on cleared areas
	Particulate fallout resulting from incinerator operation	
	Beneficial impact of regrading soil cover	
Marine sediments and water quality	Construction of force mains for sludge transport on the harbor bottom	Rapid recovery of pipeline cut
	Operation of sludge force mains (malfunction)	Pressure sensor to detect rupture
	Elimination of sludge discharge	Beneficial impact
	Dredging and construction for barging	Rapid recovery of dredged area

TABLE VI-1 (Cont'd.)

Area of Impact	Action	Mitigating Measure
Land use	Expansion of Deer Island facilities causing displacement of other land uses	Provision in PL 95-217 for $15 million to build new correctional facility
Air quality	Incinerator operation	Maintenance of scrubber; use of lime for conditioning
	Construction of incinerator and storage facilities	Daily watering, mulching of cleared areas
	Emissions due to ash transportation (fuel usage = 1,065 gallons/year)	National vehicle emission control program
Biotic communities	Heavy metal uptake by vegetation growing upon final landfill cover	
	Loss of vegetation at fill site	Rapid revegetation
	Construction of force mains for sludge transport on the harbor bottom	Dredging during winter season
	Operation of force mains (malfunction)	Pressure sensor to detect rupture
	Elimination of sludge discharge	Beneficial impact

TABLE VI-1 (Cont'd.)

Area of Impact	Action	Mitigating Measure
Public health and noise	Noise and emissions from ash transportation	
	Construction of incinerator and storage facilities causing a noise level increase and a decrease in air quality	Daily watering, mulching of cleaned areas
	Incinerator emissions	Scrubber maintenance
	Elimination of sludge discharge	Beneficial impact
Economic	Increased annual cost due to implementation of the project	
	Generation of construction jobs through project implementation	
	Operating labor increase through project implementation	
Energy	Recovery of thermal energy (equivalent to 370,000 gallons diesel fuel)	Beneficial impact
	Use of fossil fuels (fuel usage = 148,865 gallons/year)	
Historical and archeaological sites	Use of landfill site (prehistoric sites are known to exist on Spectacle Island)	Archaeological survey

TABLE VI-2

ALTERNATIVE 11 SUMMARY OF IMPACTS

Area of Impact	Action	Mitigating Measures
Soils	Construction of incinerator and storage facilities	Use of mulching at 2 tons/acre on cleared areas
	Particulate fallout resulting from incinerator operation	
	Increase in heavy metals concentration of landfill cover soil	
	Landfill operation resulting in erosion and soil structure destruction	Rapid revegetation
Marine sediments and water quality	Construction of force mains for sludge transport on the harbor bottom	Rapid recovery of pipeline cut
	Operation of sludge force mains (malfunction)	Pressure sensor to detect rupture
	Elimination of sludge discharge	

TABLE VI-2 (Cont'd)

Area of Impact	Action	Mitigating Measures
Surface and groundwater quality and quantity	Malfunction of leachate con- control at landfill	Contingency Plan
Land Use	Expansion of Deer Island facilities causing displacement of other land uses	
	Use of landfill area causing dis- placement of landuse (Probably fill site is within Fort Dawes	
Air Quality	Incinerator operation (may be different for hazardous waste)	Maintenance for scrubber Use of lime for conditioning
	Construction of inciner- ator and storage facilities	Daily watering, mulching of cleared areas
	Emission due to ash trans- portation (Fuel usage 320 gal/yr)	National vehicle emission control program
Biotic Communities	Heavy metal uptake by vege- tation growing upon final landfill cover	
	Loss of vegetation at land- fill site	Rapid revegetation

TABLE VI-2 (Cont'd)

Area of Impact	Action	Mitigating Measures
	Construction of force mains for sludge transport on the harbor bottom	Dredging during winter season
	Operation of force mains (malfunction)	Pressure sensor to detect rupture
	Elimination of sludge discharge	Beneficial impact
Public Health and Noise	Noise and emission from ash transportation	
	*Malfunction of leachate control at landfill	Contingency plan
	Construction of incinerator and storage facilities causing a noise level increase and a decrease in air quality	Daily watering, mulching of cleared areas
	Incinerator emissions	Scrubber maintenance
	Elimination of sludge discharge	Beneficial impact

TABLE VI-2 (Cont'd)

Area of Impact	Action	Mitigating Measures
Economic	Increased annual cost due to implementation of the project	
	Generation of construction jobs through project implementation	
	Operating labor increase through project implementation	
Energy	Recovery of thermal energy (equivalent of 370,000 gallons diesel fuel)	Beneficial impact
Historical and Archeological	Use of Fort Dawes area as landfill site (possible historical resources)	Archeological Survey
Aesthetic	Use of Fort Dawes as a landfill	

- Ocean and Harbor sediments: Dredging for the pipeline and for the barge channel for the alternative of filling on Spectacle Island will cause unavoidable loss of habitat. This is a short term impact, and mitigation can be accomplished by proper timing of the dredging.

- Groundwater quality: Recycle of leachate from the fill site will reduce flow to groundwater by about 15,000 m^3/yr (4,000,000 gallons per year).

- Air quality impacts from incineration: The Deer Island treatment plant and proposed incinerator facilities are located in a Clean Zone, for which Class II requirements for prevention of significant deterioration exist. Based on air quality modeling as shown in Appendix V, none of the PSD criteria will be violated. The only violation shown will be the annual second highest daily total suspended particulate (TSP) concentration at a point 1.25 km from the stacks. This violation will probably not occur, because it is based on background TSP concentration data from Revere. The monitoring site location is more that 5 km from the incinerator site.

- Use of fossil fuels: The use of some fuel energy is unavoidable. In addition to transport use, some auxiliary fuel will be required for incinerator start-up and for auxiliary heat during its operation. The use of fossil fuels for startup pilot and auxiliary fuel can be mitigated by partial use of digester gas. The total energy use will be mitigated by energy recovery from the incincerator off gas.

- Increase in costs to MDC and MDC system users: The annual cost of the recommended project alternatives will increase the cost of operations to the MDC and will increase the cost of wastewater treatment to area residents. This increase in costs of about 14% over present levels will not seriously affect area residents (annual costs per household will rise by $3.48 to $3.56). This impact is mitigated by the 75% federal grant for construction.

- Aesthetic impacts of filling on Deer Island: If the alternative of filling on Deer Island is implemented, there will be a adverse impact on use of Fort Dawes as a recreational area. With the construction of secondary treatment facilities, however, the aesthetic value of Fort Dawes would be reduced in any case.

The adverse impacts are predicted based on 1985 conditions, but the variation in expected quantity of primary sludge between 1975 and 1995 is small, and none of the impacts should change in the project period. Similarly, the implementation of secondary treatment will necessitate additional investigation because capacity will possibly not exist for additional air emissions of the magnitude expected with incineration of secondary solids.

C. Relationship Between Local Short Term Use of the Environment and Maintenance and Enhancement of Long Term Productivity

The Recommended Project Alternatives involve a tradeoff between air quality and quality of the marine environment. By using incineration, with concomitant air quality reduction, the sludge quantity is reduced sufficiently to allow economical landfilling of the residue, thus destroying toxic organic materials and isolating heavy metals from the environment.

The loss of land through landfilling is not permanent, with reconstruction of the soil and biota being possible. In contrast with this, the loss of productive ocean habitat is not reversible under continued sludge dumping.

We recognize now that the Recommended Project Alternatives are not the only viable methods for sludge disposal that can be practiced now, or in the future. With the advent of secondary treatment, the quantities of sludge to be handled and disposed of become significantly larger than those amounts to be encountered by the recommended plan. Since the incinerators represent a reasonably inflexible solution for the project period, the temptation will be to allow that inflexibility to become institutionalized, thus automatically closing out future options. We also recognize that MDC's sludge handling and disposal methods may eventually consist of a variety of procedures and not just one approach. The investigation into the feasibility of land application has demonstrated that it is viable alternative for sludge disposal.

D. Irreversible and Irretrievable Commitment of Resources to the Recommended Project, Should it be Implemented

With the Recommended Project there are certain unavoidable commitments of labor, materials, energy and land, along with the commitment of air quality resources. The input resources for the project are given in Appendix T and are summarized in Section III. The use of air quality resources is unavoidable, irreversible and irretrievable, but not excessive in light of the expected future background conditions. In terms of energy, implementation of the project will result in a net production of electrical energy, and if digester gas can be used for auxiliary and startup fuel, the only fossil fuel use will be in transportation to ultimate disposal.

A major commitment will be continued use of Deer Island for primary treatment because of increased investment. However, the present and continued use of Deer Island as a waste treatment site is more properly the consequence of earlier and more fundamental decisions.

SECTION VII

COMMENTS TO THE DRAFT ENVIRONMENTAL IMPACT STATEMENT AND RESPONSES

VII. COMMENTS TO THE DRAFT ENVIRONMENTAL IMPACT STATEMENT AND RESPONSES

A. Introduction and Summary

The Environmental Protection Agency, Region I, held a public hearing on the Proposed Metropolitan District Commission Sludge Management Plan on April 6, 1976, Room 2003 of the John F. Kennedy Federal Building, Boston, Massachusetts. The hearing was attended by approximately three dozen people, of which twelve presented testimony for the record. The transcript of that hearing is available for review at the EPA offices. Subsequent to that hearing, the record was held open for approximately seven (7) weeks during which written comments were submitted to the Agency.

In order to minimize volume in the Final Environmental Impact Statement (FEIS), the comments and questions which have been raised are summarized here in Volume I, and are also available for review at the EPA offices. Since many of the comments from different sources were similar in nature, these equivalent questions have been categorized and singular responses have been prepared.

Table VII-1 summarizes the written comments which were received during the review period, as well as the comments made at the public hearing. The categories of questions listed at the top of the table are the same ones (and in the same order) which will be discussed in this section. The comments made during the public hearing are also answered within the same categories. The comments (which are summarized here) are identified by author.

B. Comments and Responses

1. Land Application

Comments: "I believe the model used...is inadequate and underestimates the amount of sludge which could be applied to the land...the model assumes negligible immobilization of inorganic nitrogen, which the (draft) report (p. 134, Vol. II) states occurs only when the C/N ratio exceeds 20 to 25...the ratio for the MDC sludge will probably exceed this ...allowing more sludge to be applied.

...N_2-fixation is assumed to be constant whether sludge is present or not, whereas the sludge will depress N_2-fixation again allowing more sludge to be applied. Further, loss of ammonia to the air by volatilization is likely." (Howarth)

TABLE VII-1 SUMMARY OF COMMENTS RECEIVED

1976 Date Rec'd	Comments Received From	Land Application Sites	Landfill Sites	Fertilizer Production	Ocean Disposal	Impacts on Harbor	Incineration Process	Coincineration	Air Quality	Pasteurization	Pretreatment of Sewage	Transportation of Sludge/Ash	Continued Studies	Resource Recovery	Energetics	Historical/ Archaeological	Matrix	Mistakes/ Missing Info.	Additional Topics
3/16	J.D. McDermott															✓		✓	
3/25	P.T. Anderson	✓	✓					✓		✓									
3/25	T.C. McMahon					✓	✓				✓							✓	
3/26	W. Folger											✓							
3/29	A.J. Screpetis	✓																	
3/30	E.R. Amadon															✓		✓	
3/31	R.T. Donaldson						✓		✓										Noise levels
4/ 1	J.R. Elwood		✓		✓													✓	Secondary treatment
4/ 5	W.M. Bulger			✓			✓	✓											
4/ 5	T.P. Callaghan				✓														
4/ 6	R.W. Howarth	✓	✓		✓		✓	✓		✓		✓			✓		✓	✓	Chemical modeling for sludge application.
4/ 6	D. Standley	✓	✓	✓				✓	✓		✓			✓					Pyrolysis
4/ 8	A. Weinburg		✓	✓								✓					✓		Pipeline from Nut to Deer Island.
4/ 9	M.B. Ullman		✓					✓											
4/14	M. Weiss	✓	✓	✓	✓	✓	✓	✓		✓		✓		✓	✓			✓	

TABLE VII-1 SUMMARY OF COMMENTS RECEIVED

1976 Date Rec'd	Comments Received From	Land Application Sites	Landfill Sites	Fertilizer Production	Ocean Disposal	Impacts on Harbor	Incineration Process	Coincineration	Air Quality	Pasteurization	Pretreatment of Sewage	Transportation of Sludge	Continued Studies	Resource Recovery	Energetics	Historical/ Archaeological	Matrix	Mistakes/ Missing Info.	Additional Topics
4/10	M.H. King	✓	✓		✓		✓		✓					✓	✓				Information program, state farming policy, treatment at origin.
4/23	K.E. Bigland	✓			✓										✓			✓	Separate disposal for Deer and Nut Island.
4/23	R.S. Babb	✓	✓			✓										✓	✓		
4/30	Boston Harbor Committee	✓						✓			✓	✓	✓	✓					Public education of use of sewage.
5/ 3	G.K. Briggs, Jr.												✓						
5/ 4	W.H. Holcombe				✓														
5/ 5	E.F. Murphy	✓					✓	✓			✓		✓						Secondary treatment, use of ash.
5/ 7	M. Kolb						✓	✓	✓	✓	✓	✓				✓	✓		
5/18	J.L. Ignazio				✓	✓													Permits necessary, construction impacts on harbor.
6/ 2	R.M. Doherty																		Comments from Council Representatives
Public Hearing 4/ 6	J. Thorton				✓														Removal of sewage origin.
	P. Harrington											✓							
	D. Duxbury		✓					✓						✓					
	J.E. Murphy																		Quality of water entering harbor.
	D. Fawcett								✓			✓							

Response: Based on the carbon and nitrogen content of the volatile solids shown in test samples, the C/N ratio of the Deer and Nut Islands sludges is 5 to 1, well under the level that would result in immobilization of inorganic nitrogen. It is undesirable to have a high C/N ratio, as the organic material would compete with the crop for the nitrogen.

Nitrogen fixation would only be repressed when there is abundant free soil nitrogen, i.e. shortly after sludge application. The model is based on gradual release of organic nitrogen. Fixation will occur (especially by nonsymbiotic organisms) with the organic levels that would be present. Volatilization would be significant if the sludge were left exposed to the air for an extended period to time. The land application systems require rapid incorporation of the sludge into the soil by plowing. This would result in negligible loss by volatilization. Volatilization loss is undesirable in those situations which consider the economic or energy benefits of nitrogen recovery.

Comments: [The draft document relies]"...on the filtering effect of soil to protect groundwater from toxic concentrations of the heavy metals...in this analysis of filtering effects in order to permit objective evaluation of the resultant impacts." (Babb)

"...the addition of organic sludge should greatly increase the cation exchange capacity (CEC) of the soil, so the model used again underestimates the amount of sludge which could be applied." (Howarth)

Response: The filtering ability of the soil varies tremendously depending upon the soil properties. In order to discuss this in any greater detail a detailed soil analysis of the sites is necessary.

Although the CEC would be raised by the organic matter (about 200 mg/100 gm), this increase is temporary. Upon discontinuance of sludge application, this organic material will breakdown, possibly releasing the metals. If soil liming ends with the sludge application, soil pH will drop and may lead to increased availability of metals to crops.

Comments: "...the model is inadequate...considerably more than 10 tons dry weight [sludge] could be added to each acre per year. 30 tons dry sludge/year have been added to agricultural lands with no problems." (Howarth)

Response: The amount of sludge that can be applied is dependent upon the nitrogen content as well as other factors. If the land is used for cultivating food chain crops, recent EPA restrictions (43 FR 25: 4942-4955) also apply. Appendix P describes systems that used 30 dry tons of sludge or more. Reports of these applications generally did not give metal concentrations in the sludge, nor did they monitor movement of metals in the soil.

Comment: "How much acreage is required for land application and buffer zones. What are acreage, size and locational requirements of storage facilities?" (Weiss)

Response: For Alternative 5 about 40 acres would be required for storage of dewatered sludge (Appendix T), and about 20 acres would be required for Alternative 6. Buffer areas required would be about 28 acres for a 40 acre site and 52 acres for 160 acres. Because the minimum site area would be 40 acres for application, buffer area would be a major component, but use of more isolated agricultural land could decrease buffer required.

Comment: "What would they do with the sludge during 7 months of November through May?" (Anderson)

Response: The sludge would be stored at dedicated sites for all but two months of the year. These sites would be situated near ultimate disposal areas.

Comment: "[Sludge Application Sites]... in Bridgewater are...generally wet and unsuitable, Lakeville locations [are] too close to public water supply." (Anderson)

Response: No specific site was chosen. Instead, areas that are presently used for agricultural purposes were identified. They may fit criteria for sludge disposal. On-site inspections would be necessary before arrangements could be made for application. The list and mapping in Section III were to show that there is sufficient farmland available within a reasonable distance of the treatment plants.

Comment: "What assurance is there that private farmers would take the sludge over an extended period of time? (Weiss)

"[Will]...a reliable market exist for land application of sludge [if the trend of removal of land from cultivation continues]?" (Weiss)

"Problems associated with private ownership [of land application sites (i.e. to assure continued and uninterrupted use)] should be addressed." (Weiss)

"...in view of the results of the sludge marketing survey, it is doubtful that sufficient private owners could be found to accept sludge application." (Weiss)

Response: Presently there is a large amount of farmland in Massachusetts. Current patterns and planning should allow maintenance of at least sufficient amounts of land for the next 20 years. Long term contracts or agreements would provide a reasonable assurance that the necessary land would be available, while distribution and application of the sludge by MDC employees would provide the necessary control. This cost was included in the land application estimates. The market survey indicated that the sludge could not be sold competitively, but it did not rule out free distribution. While private ownership of land for sludge application and use of food chain crops for nutrient removal are discouraged by the EPA guidelines for municipal sludge management, the discussion in Section III indicates why these courses of action were assumed. The use of private farmland is because of Massachusetts policy on encouraging private agriculture.

Comment: "[Incineration represents a relatively inflexible solution for the project period.] To choose an admittedly inflexible method is unwise.... In terms of the other criteria of feasibility, incineration is perceived as the favored alternative by the writers.... This ... seems to derive from a general tendency to regard structural solutions are easier to implement than non-structural modes." (Kolb)

Response: In light of RCRA and the possible hazardous waste determination regarding MDC sludge and ash, incineration to reduce the volume and increase the manageability of this waste is warranted. Land application of the sludge may require leachate recycle, vast amounts of dedicated lands, and in addition the hazardous nature of the sludge eliminates application to food chain crops and subsequent nutrient recovery.

Comment: "...disagree with statement that the environmental impact of the land application alternative is greater than that for the incinerator alternatives." (Howarth)

Response: In light of the Resource Conservation and Recovery Act of 1976 (published since the draft EIS), the land application alternatives were eliminated because of the need for leachate recycle, the large land area required, the need to use dedicated sites for disposal, and the elimination of nutrient recovery through food chain crops.

Response: "On page IV-20 of the Draft Statement, it is stated that aquatic biota are more sensitive to heavy metal concentrations than are terrestrial biota, but no reference is given in support of this statement...." (Howarth)

Response: "Concentrations of trace elements in water considered to be toxic to aquatic organisms are, in many cases, less than those considered to be toxic to animals, man and higher plants." A. L. Page, 1974, Fate and Effects of Trace Elements in Sewage Sludge When Applied to Agricultural Lands. Prepared for the Office of Research and Development, U.S. EPA. Cincinnati, Ohio. EPA-670/2-74-005. P. 82.

Comment: "Recommendations of this nature [expanded analysis and pilot scale land application] are totally inappropriate in an EIS. They have no bearing on MDC's proposed project and presume to advocate land application as the future MDC plan." (Weiss)

Response: We disagree, this is why EIS's are prepared.

Comment: "...if we were to use the sludge for agricultural application, we could probably choose our crop species carefully so as to minimize the uptake for heavy metals." (Howarth)

Response: In light of RCRA, and the possible hazardous sludge, agricultural application of sludge has been eliminated. This comment is no longer applicable.

2. Landfill

Comments: "Landfill Sites - Inadequate description of site at Plainville." (Anderson)

"The draft statement should include at least a brief description of the Plainville facility and a comment on the reasoning behind the assertion of no impact." (Babb)

Response: Descriptions of the sites are found in Section III of the FEIS, and discussions of impact are found in Section IV and VI. Because the Plainville site is no longer available, and because landfill of sludge is not a part of any feasible alternatives, these comments may no longer apply.

Comments: "...whether the leaching collection system that has been built...was taken into account and whether there were any provisions in the plan for the acceptance of sludge..." (D. Duxbury, Hearing Transcript)

"The recommended plan could only result in improvement of water quality in Boston Harbor but could adversely affect water quality elsewhere in proper leachate control is not practiced." (Elwood)

"...groundwater quality may be affected by leaching of heavy metals and increases in chloride and sodium ion concentrations...on the other hand, the matrix...seems to imply no increase in concentrations...as a result of Alternatives 1 and 2..." (Babb)

"...measures to control drainage resulting from excessive storm-water runoff (at the landfill site) should be included." (Babb)

Response: RCRA defines acceptable leachate control systems and operations to prevent adverse impact of runoff and leachate on surface and groundwater quality. Impermeable liners (natural or artificial) must be employed to contain runoff and leachate; further, these flows must be returned to the treatment plant.

Comment: "Identified landfill site may not have the capacity necessary for length of project." (Anderson)

Response: Based on the projected quantity of ash and the existing use, the proposed sites will have the capacity for the ash produced by the primary system. The disposal of the wastes after construction of secondary facilities will be discussed in another study. It should be noted that landfill life was a major factor in ultimate plan selection.

Comment: "The report does not discuss the feasibility and long term risks of containing ash by means of polyethylene barrier (for on-site landfill)." (Weinburg)

For those alternatives requiring filling of hazardous ash, use of a natural impervious barrier would be required, and use of such barriers is incorporated in the FEIS in Section III and Appendix T.

Comment: "Sufficient information is not provided to substantiate the recommendation for ash disposal at the Plainville landfill rather than by filling adjacent to Deer Island." (Weiss)

Response: This is no longer the case. Ash disposal in a landfill on Deer or Spectacle Island is presently recommended, for reasons discussed in pp. V-7-9.

Comment: "...problems associated with on-site landfilling are downplayed in the discussion on pages IV-15 and IV-18 of Vol. I (DEIS). It is stated that the input of heavy metals to the harbor could be similar to what it is at present because of the scrubber-water recycle to the plant." (Howarth)

Response: The sections referenced state that significant impact to the harbor would occur if the landfill site is breached during a storm. Under design conditions little impact would occur. The statement about the scrubber water was to indicate that almost all the metals would be located in the ash; a small amount would be discharged to the harbor with the effluent under design conditions.

Comment: "A complete comparison of [inland and on-site] landfills should be given..." (Weiss)

Response: The detail necessary for comparison of alternatives is given (refer to Vol. I, section V).

Comment: "Also, lagooning of sludge at Deer Island and its removal every couple of years and disposal in landfill has not been evaluated)." (Weiss)

Response: Regardless of the intermediate step (i.e. temporary lagooning on-site) the ultimate point of disposal would have to be evaluated, whether transport was done on a regular or intermittent basis. On page III-11, the reasons are stated for elimination of landfilling of dewatered sludge.

...The lagooning of ash before final disposal implies use of a wet ash handling system. Because of the premium placed on availability of fill sites, and because of the potential need for leachate management, a dry ash ("dry quenching") handling system is assumed.

3. Fertilizer Production

Comment: "...Urban applications (of sludge) require more evaluation...such as land reclamation, beautification projects, park development, golf courses, regrading cemeteries, airport areas and highway mediam strips." (Standley)

Response: Urban applications of sludge were investigated by the separate market survey (Appendix Q). It was determined that demand at this time is not sufficient to dispose of more than half the total amount of sludge fertilizer. With the passage of RCRA, and the potentially hazardous nature of the sludge and ash, such application has been eliminated.

Comment: "...the DEIS...has assumed that the total [nutrient] value [for land application] can be viewed as a credit ..." (Weiss)

Response: As stated, the alternatives give nutrient cost and energy credit to that portion of the sludge which is used for fertilizer. In order to grow crops of sufficient quality and quantity to make a profit, farmers use some form of fertilizer. The efficiency of the sludge is not expected to be greater than commercial fertilizers. The basis of comparison is between fertilizer and no fertilizer. Again, land application is eliminated from further consideration.

Comment: "It is not clear...whether the market survey... took into consideration the possibility of using heat dried sludge as fertilizer or soil conditioner on MDC and other public lands..." (Weinburg)

Response: The market survey investigated this possibility and found it infeasible; (The complete marketing survey is available for review in the Region I, EPA offices; for further clarification please refer to Appendix Q in the DEIS.)

4. Ocean Disposal

Comments: "There did not appear to be an assessment of the biological impact of extension of a combined sludge outfall to vicinity of the Graves (an alternative originally proposed by MDC and evaluated hydrodynamically by Hydroscience, Inc.)." (Elwood)

"...construct a pipeline to consolidate the outfall from that Nut Island, ...and...Deer Island and bring them out to the deep water and start to get clean water in the harbor." (J. Murphy, in Hearing Transcript)

Response: Conditions that make the sludge unacceptable for harbor or near shore disposal also make it unacceptable for deep ocean disposal. These conditions include: heavy mentals, fisheries, toxic organics and noncompliance with EPA guidelines.

Comment: "...use of sewage effluent to increase the productivity of the caostal fisheries...." (Holcombe)

Response: The metal content and toxic organics that make the sludge unacceptable for harbor species also make it unacceptable for open ocean species.

Comment: "[Regarding ocean dumping]...heavy metals can form chelated complexes with organic compounds [which] are soluble in water and are fairly likely to be taken up by organisms." (Howarth)

Response: Ocean dumping of sludge for this reason, numerous other reasons and EPA mandate has been eliminated as a feasible alternative as discussed in Section III and Appendix O of the FEIS.

Comment: "...the Draft Statement indicates that sludge would probably settle fairly rapidly when released from a barge (pp. III-11 and III-13). It is not clear to me that this true. Further, it is possible that water and accompanying sludge could upwell (come to the surface) during storms, etc." (Howarth)

Response: The density of the dewatered sludge would cause it to settle fairly rapidly, although there would be some fractionation. The inert solids would settle first, the lighter solids would take longer.

Due to the currents found in the Gulf of Maine, it is possible that the sludge could upwell. A physical survey investigating prospective dumping sites could determine the potential of upwelling.

Comment: "Is discussion of phytoplankton and zooplankton in Gulf of Maine relevant to conditions in Boston Harbor and Mass Bay?" (Weiss)

Response: Massachusetts Bay is considered to be a part of the Gulf of Maine and contains some of the same species. A description of the phytoplankton and zooplankton was given as a background for the ocean dumping alternatives, as ocean dumping could have effects on the fisheries resource in both areas.

Comment: "Location should be given for metal contents for ocean waters (Table, Vol. I, p. II-29 DEIS)." (Weiss)

Response: These concentrations are averages from different samples in the four general locations. Exact locations were not given by the author, Turekian from NEPA, for each sample

5. Impacts on Harbor

Comment: "Alternatives 1 and 2 should be further evaluated...to determine more specific reasons for deciding on the recommended alternatives." (McMahon)

Response: Alternative 1 was selected over Alternative 2 (harbor fill) because no major environmental or economic benefits would have resulted from filling in of the Boston Harbor, a finite resource. Also, the potential adverse impacts from a rupture of the cofferdam are significant. An inland landfill does not pose the same hazard to biota and public health if a storm should remove part of the soil cover.

Comment: "[Regarding the environmental impact of the No Action Alternative] It has not been established that the discharge of digested sludge with chlorinated effluent on outgoing tides is responsible for either the banning of shellfishing or impairing any other recreational use of the Harbor. The source of this allegation is requested and concurrence from regulatory agencies." (Weiss)

Response: Shellfishing has been halted by the Massachusetts Board of Health due to the high levels of pollution in the harbor. The heavy metals are important in this ban, as well as coliforms levels. The discharge of effluent is a contributory factor. The original enforcement hearings (1968, 1969, 1970) called by the Commonwealth and the Federal Water Pollution Control Administration were held on the basis of protecting the shellfishing in Boston Harbor.

Comment: "...What is implied by 'bloom condition' (in Boston Harbor)?" (Weiss)

Response: A bloom condition is defined as being equal to or greater than 500 organisms per ml. The text showed a typographical error. The average during the 1967 survey was 1,000 organisms per one ml for the harbor. In the 1968 survey the harbor showed 750 organisms per ml, still indicating bloom conditions. [Source: Tom Gilbert, NEA, personal communication, 1976 (May)]

Comment: "The environmental impact of the no-action alternative were not equally assessed...." (Weiss)

Response: Conditions and impacts on the harbor resulting from existing operational conditions were assessed. A description of the present harbor species in relation to existing conditions was discussed in DEIS Vol. I, pp, II-36, II-37 (refer to Vol. I). sludge impacts on the biota, water column, and sediments would be similar or greater than for the ocean, as the harbor is very high production section of the ocean.

Comment: "The Final Environmental Impact Statement should present information showing the need for obtaining proper regulatory permits under Section 404 of the Federal Water Pollution Control Act of 1972 and under Section 10 of the 1899 River and Harbor Act." (Ignazio)

Response: This has been incorporated in Section III and IV of the Final EIS along with the scheduling to be expected for the application procedure.

Comment: "Site specific information should be presented for areas to be disturbed and significantly impacted...Information should include a description of the resources and impacts as concerns barging and piping sludge...along Long Island, [and] the areas of harbor bottom...." (Ignazio)

Response: The habitat to be traversed by the pipeline includes: beach habitat at Nut Island; soft bottom, with principal biota being polychaete worms, between Nut and Long Islands; shallow sandy bottom along Long Island, with a shoftshell clam population of approximately 80 bushels per acre (Bridges, 1976); soft bottom in the President Roads crossing, again with polychaete population; and beach habitat at Deer Island. The softshell clam population along Long Island cannot be harvested because of the harbor concentrations of bacteria (Bridges, 1976). The impact of dredging and pipeline construction would be to remove about 560 bushels of clams (with a 30 foot dredge width), and if the substrate is properly replaced, the clam population should replace itself in three to four years (Bridges, 1976).

6. Incinerator Processes

Comment: "In view of the 35.5% efficiency of the four installations surveyed...further information is necessary to support the claim that the proposed sludge incinerator would operate autogenously." (Murphy)

Response: In Appendix S, Table S-3 presents a tabulation of the incinerator heat balance. This balance indicates that autogenous operations under steady-state conditions will be achieved. In an independent calculation, R. A. Olexsey of the National Environmental Research Center, Cincinnati, determined that autogeny may be attained under steady-state operation (FEIS Vol. II, p. 168).

The efficiency value discussed in Appendix S is developed by dividing the fuel value of the sludge (and any auxiliary fuel) into the heat required to convert the sludge moisture content to steam at the design exit temperature. If the heat loss through the incinerator walls and to input air were included, a total heat balance would be the result rather than efficiency calculation.

Comment: "...the assumed exit gas temperature in the EIS...were lower than those of the H & E design criteria which reduce the exit gas volume for a given mas discharge." (Weiss)

Response: As described in FEIS Vol. II, pp. 22 and 195, the exit temperature was actually higher than design criteria, when operated under worst case conditions.

Comment: "...start-up cycle of once in 10 days is unrealistically frequent..." (Weiss)

Response: This is based on plant data from similarly sized plants that are presently operating (refer to Vol. II, pp. 157-170).

Comment: "...assumptions made in regard to the costs of operation of sludge incinerators generously assume perfect functioning of an unproved technology." (Kolb)

Response: Analysis of the proposed system and investigations of other systems indicate that the proposed modifications would result in autogeny. One hundred percent efficiency was not assumed (refer to Vol. II, p. 151). The FEIS has taken into account the possibility of day to day operational failure.

Comment: "...the ultimate fate of those materials collected in the scrubber water is not discussed." (Donaldson)

Response: The water is to be returned to the plant (refer to DEIS Vol. I, p. IV-18), where it will re-enter the process stream.

Comment: "...grit and screenings from beaches will be disposed of in the incinerators. Does this include driftwood, litter and refuse?" (Donaldson)

Response: According to Havens and Emerson's project design, beach debris would be incinerated.

Comment: "...heavy metals to the harbor could be similar to...present because of the scrubber-water recycle to the plant." (Howarth)

Response: The amount of heavy metals being returned to the harbor will be those that are in a soluble form and are carried in the effluent. The scrubber water is treated with the sewage, removing the insoluble portions with the sludge. At the pH expected at the treatment plant, soluble metals concentrations are significantly less than total metals.

Comment: "This incinerator is assumed to be completely autogenous, whereas the average incinerator in the U.S. requires 50 gallons of fuel/wet ton." (Howarth)

Response: Post start-up autogeny is provided for by a series of design modifications to the incinerator. The controls are more complete than previous designs. However, since heat cannot effectively be saved, overall operational autogeny is not assumed because of auxiliary fuel requirements during start-up. Although it is possible that the incinerators may not operate autogenously, the design modifications are expected to result in a higher efficiency (refer to FEIS Vol II, p. 169).

Comment: "The NSPS [New Source Performance Standard] for sludge incinerators has been in effect since June of 1973. No mention is made of emissions from similar source that are subject to NSPS and their actual experience as far as compliance with the standard." (Donaldson)

Response: Data used in developing the NSPS (U.S. EPA, 1975C, Supplement No. 5, for Compilation of Air Pollutant Emissions Factors, 2nd Edition show an average emission of 0.6 lbs/ton for an incinerator having less than one-half the scrubber pressure drop than that determined for the proposed system (18" H_2O vs. 42" H_2O). The pressure drop in the scrubber is one determinent of scrubber efficiency. A large pressure drop can be expected to give greater efficiency.

Comment: "The history of the preparation of a plan for sludge management...instills a measure or doubt as to the openness of the process... We are frankly disturbed at the reiteration of support for the construction of a system which Havens and Emerson are evidently uniquely equipped to build...." (Kolb)

Response: The decision to support incineration came only after a rigorous and open study of alternatives was completed. The study process included two public workshops, an independent sludge marketing study, and an independent co-incineration study. Should the State decide to support, both on a policy and a financial basis, a composting and compost distribution system, some of the need for incineration may be alleviated; however, some incineration capability will be required for at least the useful life of the proposed project.

Many consultants and contractors have the capability of designing and or building sludge incineration systems.

7. Coincineration

Comments: "...whether or not it is feasible to burn solid waste and the sludge together ...." (Duxbury, Hearing Transcript)

"Although the Sierra Club has serious reservations about the construction and operation of incinerators as part of a sludge management plan, nonetheless, we would be interested in an analysis of the various costs and benefits associated with the co-incineration of sewage sludge and municipal refuse." (Kolb)

"The opportunity to assist in solving the problem of refuse disposal and resource recovery through a facility burning a combination of sludge and resource merits serious evaluation. A combined incinerator might also be more energy efficient if the hoped for ability of a sludge-only incinerator to operate autogenously cannot be realized. Both the Department of Environmental Quality Engineering and the Bureau of Solid Waste Disposal should be consulted in evaluating this alternative." (Murphy)

"Conincineration - should be pursued." (Anderson)

"Under Alternative 1, the concept of co-incineration of primary sludge along with solid waste should be given...." (Boston Harbor Committee)

"As mentioned, opportunities for resource recovery should be more fully explored. Also, a detailed analysis of a system of co-incineration with the City of Boston should be undertaken. Only briefly mentioned in the draft EIS, co-incineration can provide a unified, cost-effective solution to two pressing problems - solid waste and sewage sludge." (Standley)

Response: Based on information prepared by Stone and Webster (1976) and other sources as shown in Appendix EE, coincineration was evaluated for a new facility in the City of Boston, for the existing RESCO system and for the West Suburban Project. Although coincineration may be more cost effective for the MDC, it was eliminated because of the costs and impacts of transport and because of implementation problems.

8. Air Quality

Comment: "...the EIS states that the maximum ground level concentration of emissions is predicted to occur at...1.25 kilometers...and that about 10 receptor sites are located within this area...[but] all receptor sites except one are actually located 2 to 3 kilometers from the plant, which indicates that the air pollution impact given...may be overstated..." (Weiss)

Response: The numbers for the air quality impacts are not overstated. The maximum concentration will not occur at a receptor site, but about 1.15 km downwind from the stacks. Due to improper editing the impression was mistakenly given that the maximum concentrations would occur at the indicated receptors sites (refer to Vol. II, Appendix V).

Comment: "Data collected at Point Shirley...shows substantially better ambient air quality than at Revere and is more realistic." (Weiss)

Response: Point Shirley does show better ambient air quality; however, there was only three months of sampling done in this area. This is not enough background data to use in modelling air impacts.

Comment: "The basis of mercury emission calculations is not clear, and seem to be higher than reasonable." (Weiss)

Response: The mercury emissions are based on sludge sample analysis and mercury removal efficiency for the scrubber description is given in Vol. II, p. 186.

Comment: "[This writer] criticizes the non-identification of the receptor points which were studied in the modelling." (Donaldson)

Response: The receptors are identified in FEIS Vol. II, Appendix V.

Comment: I fail to see that these impacts [particulate fallout adding negligible amounts of heavy metals and alkali material to soil] balance and consider the heavy metals a very serious problem." (Howarth)

Response: The areal concentrations of each that will be added to the soil of fallout from incineration are small compared to the areal concentration contributed by land application of sludge. The basis for this is discussed in more detail in DFEIS Vol. II, page 186.

Comment "TSP problems associated with the proposed incinerator may have been overstated for the following reasons... [the reasons stated deal with facets of the State Air Quality Maintenance Plan]." (Standley)

Response: This has been revised in the FEIS, as shown in Appendix V and Section IV and VI.

Comment: "The air pollution analyses apparently are computed on the assumption for the "worst case" that auxiliary fuel, plus afterburner fuel, plus the full rated tonnage of sludge are all being burned at startup." (Weiss)

Response: Air pollution analyses done for the FEIS include operation of two incinerators at full rated tonnage plus startup fuel for the worst case, as shown in Appendix V.

Comment: "It seems obvious that the maximum ambient air concentrations at [Point Shirley and Winthrop] must occur when...winds cannot bring the stack emissions toward these receptors...the two "worst conditions" cannot physically occur simultaneously". (Weiss)

Response: The 'worst case' as shown is qualified by two factors:

- The Larsen's Method used for determining the second maximum daily concentration is nondirectional, i.e. not dependent upon the direction of the wind; and

- during a three hour or 24 hour period of interest, the wind direction can change the area subject to impact.

Comment: "Although recognizing that incineration may exacerbate an already serious environmental condition, the writers of the draft document rationalize that, 'In comparing the projected air quality against the secondary standard it can be seen that while the particulate limits are exceeded, the emissions from this project did not cause the violation'. This seems a dubious defense of a project with potentially deleterious effects on public health." (Kolb)

Response: The MDC incinerators will be incorporated in the Air Quality Maintenance Plan for Boston. This will insure that the incinerator is considered in maintaining acceptable air quality. Other sources of particulates may be corrected before 1979 which would have a more immediate beneficial effect on air quality. These sampling sites which now show existing and projected particulates violation of secondary standards are relatively distant from the proposed incinerators.

Comment: "A further problem arises from the finding by the Massachusetts DPH of a perceptible increase in... particulate material from mid-1974 to the present. The projection, then, of the appropriate background level, appears... uncertain..." (Kolb)

Response: The data used in the projections in the DEIS was collected from April 1974 through March 1975, and appears to coincide well with the findings of the DPH. The FEIS incorporates 1977 data in the projection of appropriate background concentrations.

Comment: "In the event incineration is selected, the application of best available control technology should be seriously considered." (Murphy)

The decision to apply Best Available Control Technology is required because the proposed facility will be a major source as defined by the Clean Air Act Amendments of 1977.

Comment: "Are we correct in interpreting the SO_2 emission calculations that zero removal of SO_2 in the scrubber system. This same rate of removal was assumed for the fossil fuel used in start up and in afterburning if required.

Comment: "In at least one case a sludge-buring incinerator has been shut down because of fear that atmospheric lead from the plant was creating a public health hazard..." (Howarth)

Response: The incinerator alluded to, located at the Washington Suburban Sanitary Commission Piscataway treatment plant (Prince Georges County, Maryland) was closed. Stack sampling was then done, and stack emissions were found to be insufficient to create this background condition. The principal source of background lead concentrations was thought to be automotive in nature (M. Johnson, 1976). Personal Communication. Washington Suburban Sanitary Commission, Hyattsville.). Stack sampling data from the similar WSSC Parkway plant showed an emission rate of 0.33 grams Pb per ton dry solids (Battelle, 1976). If this rate occurred at the proposed MDC incinerator, the expected lead emission would be 41.8 grams per day.

9. Pasteurization

Comments: "The requirement for Pasteurization imposes a substantial energy cost on Alternatives 5 and 6. To weigh... with this...constraint is to bias the evaluation." (Kolb)

"Pasteurization - obviously all sludge applied on ground should be pasteurized due to public health (vector) problems." (Anderson)

Response: Land application alternatives have been determined infeasible in the FEIS, thus these comments are no longer applicable. The MDC, however, had been allowing operation of a pilot system to disinfect liquid sludge with high energy ionizing radiation. Should land application be feasible for other installations the use of this technology is favored over thermal disinfection because of the reduced energy costs.

10. Pretreatment

Comments: "In the long run, if land application is to work, some of the heavy metals will have to be removed - preferably through enforcement of sewer-use ordinances." (Howarth)

"The suitability of sludge for land application should be further explored in light of two future circumstances: (1) industrial pretreatment pursuant to PL 92-500, which could result in significant reduction in heavy metals concentrations...." (Murphy)

"Would better enforcement of sewer ordinances now reduce the metallic load enough to warrant re-evaluation of the hybrid study and Alternative 1?" (Boston Harbor Committee, League of Women Voters)

"Since the ash was found to be unacceptable for ocean disposal chiefly because of heavy metal concentrations, the EIS should consider the viability of removing the metals at the sources." (McMahon)

"The writers of the draft EIS seem to suggest that we design treatment trains according to the specifications of particular industrial wastes, such as heavy metals, rather than requiring the wastes to conform to the capabilities of the total treatment and disposal method as the law compels.

Admittedly, the presence of heavy metals constitutes a problem. However, the MDC is currently conducting an industrial survey which could serve as a first step in implementing the pretreatment mandate of PL 92-500. Whatever sludge disposal scheme is ultimately selected, the cessation of discharge of these toxic chemicals into the Metropolitan Sewerage System will be environmentally beneficial. For in each alternative, the heavy metals (whether settling in the sludge or remaining in the effluent) are released to some part of the environment." (Kolb)

Response: Pretreatment, as a means to reduce heavy metals, is effective only as much as these metals originate with point sources. This is discussed on page 103 (Appendix N,Vol. II. EPA is in total agreement with the goal of reducing and/or eliminating the point source introduction of toxic substances into the MDC sewerage system. However, the identification of these sources by MDC has just begun, and the program for their elimination will be a long term project. In the meantime, EPA feels that the timely elimination of a larger pollutant source (digested primary sludge) from Boston Harbor carries a higher priority. As indicated in the Draft EIS, EPA potentially sees incineration as only a portion of the total sludge management system for metropolitan Boston. In addition, EPA has recommended the improvement of data collection to establish the viability of land disposal at a future time, when the heavy metals content of the sludges will have been reduced.

11. Transportation of Sludge or Ash

Comments: "Under Alternative 1 the route from Mystic Terminal to Plainville is not identified, the availability and ownership of the barges is not clear. Are there terminal facilities on the southern Harbor coastline that would be closer to Plainville or could they be created?" (Weiss)

"...impact on air quality, traffic and noise generated by the trucks...in Charlestown." (Fawcett, Hearing Transcript)

"...MDC explored the possibility of barging to another spot rather than to Mystic Terminal?" (Fawcett, Hearing Transcript)

"We recommend investigation of sites other than Mystic Terminal to receive the ash..."

"The negative impact on Charlestown created by the selection of Mystic Terminal appears to have been given little importance in comparison with the assessment of the impact on Winthrop." (Boston Harbor Committee)

"...even one truck coming through Charlestown is bad news so I suggest that you leave Charlestown out of your plans." (Harrington, Hearing Transcript)

"...people are concerned that already air pollution standards have been exceeded in a bad way with the trucks coming from MASSPORT and probably will exceed with the MASSPORT expansion." (Fawcett, Hearing Transcript)

Response: The FEIS discusses proposed siting of roll-on/roll-off facilities at an unspecified site in the greater Boston Harbor area. It will not be owned by MASSPORT or located at Mystic Terminal. Alternative 1 is the only Alternative (FEIS) that includes transport over public streets during operation. Tea truck trips per day will not create a detectable impact in the area.

Comment: "Additional assessment should be made of the reliability, continuity and economy of transporting sludge by truck to 100 to 200 separate applications sites...." (Weiss)

Response: In the EIS, the number of vehicles for storage and transport was increased by 10% over those necessitated by volume for transport in order to account for such problems. Also, because application of sludge to land was eliminated because of other reasons, the impact of transport need not be evaluated.

Comments: "Was pipe transport of sludge considered? (Weiss)

"...farms...are in the Connecticut Valley and the Bridgewater-Westport area, a pipeline could be built to carry liquid sludge to either or both locations." (Howarth)

Response: Descriptions of pipeline transportation are given in Section III. If a pipeline were used, tank trucks would still be required to transport the liquid sludge from the pipeline to the farms. About four times the number of trucks would be necessary for the final distribution of liquid sludge as would be required for dewatered sludge transport. The construction of the pipeline would reduce system flexibility which is necessary when dealing with the metal concentrations in the slduge and with private farm owners. Storage facilities would also have to be greater for the liquid sludge than for the dewatered sludge. Given the distances to storage and application, and the system of application to private lands, pipeline transport would be more costly in terms of both energy and dollar costs.

Comment: "...rail transport to the site of application ...was not actively pursued...." (Kolb)

Response: This alternative was fully explored and was eliminated based on cost and feasibility information supplied by the major railroads serving the Boston metropolitan area and the Commonwealth (refer to Vol. I, Section III).

12. Continued Studies

Comment: "...the variations [in sludge constituents] in DEIS Vol. II, p. 94, suggest that adequate sampling [program] is important because there may be both day/night and seasonal fluctuations in heavy metals." (Murphy)

Response: The table presents both temporal variations in analysis by the Metropolitan District Commission and a comparative analysis between the MDC and JBF Laboratories. The JBF sampling effort was intended only to confirm MDC's prior sampling effort. Because of the 20 day residence time in digestion of sludge, day/night variations in quality would become non-existant. While seasonal fluctuations are shown, use of average quality data are sufficient for analysis at this level.

Comment: "Further, more complete knowledge of potential fluctuations in volatile solids would assist in determining variations in the heat value of the sludge." (Murphy)

Response: As Table N-4 indicates, the range of values for volatile solids is:

Deer Island	47.2% to 56.6%
Nut Island	51.6% to 60.3%

Within these ranges, variations can occur as a result of changes in loading, digester residence time, temperature and operation mode.

Comment: "How can land application be considered for the future...if, in fact, it cannot be recommended for existing volumes?" (Weiss)

Response: Because of air quality problems that may result from the increased volumes from secondary sludge, land application may be necessary. Also, the higher nutrient content of the secondary sludge may make land application more viable energetically; and the implementation of pretreatment requirements should reduce the existing high levels of heavy metals. Strickly speaking, volume is not the question. Rather, nutrient content and metals content are the key to the future viability of land application. RCRA guidelines must also be addressed and complied with.

Comment: "...the suggestion that EPA and the state further combine efforts to further evaluate land application as a means of sewage sludge disposal....[especially for Nut Island sludge]" (Standley)

Response: Perhaps the most significant questions remaining unanswered are the amount of heavy metals removable by industrial pretreatment, the impacts of heavy metals in the food chain, and the acceptability of farm operations of sludge as a substitute for inorganic fertilizer. The reason that Nut Island sludge with a portion of the sludge from Deer Island, approximately 18% more sludge can be made acceptable for land application based on the cadmium-to-zinc ratio. In the FEIS, data are presented which indicate that sludge from either plant cannot be applied to food chain crops.

Comments: "...[for land application] further studies, involving considerable time and expense, would be necessary." (Babb)

"The Boston Harbor Associates recognizes the need for on-going studies and tests....for solving the future sludge disposal problems of MDC."

Response: Pilot studies for land application were suggested in the DEIS and further monitoring of sludge is recommended (refer to Vol. I, pages V-12, VI-6, IV-56). Support for these recommendations is appreciated. The FEIS eliminates land application, however, due to the hazardous nature of the sludge and ash. Pilot studies for land application may be warranted if and when these residues can be rendered non-hazardous.

Comment: "...release of metals to the environment should be monitored, and the effects of these metals on natural systems and on human public health should be carefully watched."

Response: Monitoring was proposed in the DEIS. In the FEIS, monitoring for disposal sites is required as described in RCRA.

Comment: "They state that 'heavy metals are removed in the primary sludges.' One of EPA's arguments for secondary treatment at the MDC plants has been substantially greater metal removal." (Elwood)

Response: Table N-11 on page 104 of the DFEIS shows the source for estimates of heavy metal removal in primary treatment. Heavy metals are preferentially removed in any process which removes solids. In secondary treatment, heavy metals suspended in the fluid are also removed.

13. Resource Recovery

Comment: "The waste heat recovery system and its associated costs and benefits has not been eliminated by MDC." (Weiss)

Response: In the FEIS, the question of energy recovery was reevaluated based on 1978 costs of purchased power. With the costs brought forward to 1978 conditions, recovery of thermal energy for generation of electrical is sufficiently feasible to warrant incorporation into Step II planning.

Comment: "begin a compaign of public education to look upon sewage waste as a resource instead of an undesirable by-product of man." (Boston Harbor Committee)

Response: The Resource Recovery Act of 1976 and EPA policy promotes investigation of recycling of resources. However, sewage wastes are only a resource to the extent that recovery and reuse are less costly in terms of energy or dollars or ultimate environmental impact than is use of virgin materials.

Comment: "For the 400 lb. of volatile [solid] destroyed to be correct, the volatile destruction in digestion would be approximately 28%. From experience, the four year average at Deer Island was 57.8% volatile reduction." (Weiss)

Response: The MDC is correct is this. The proper amount of volatile solids destroyed is 178,000 lb/day. With the 10,000 BTU produced per pound of volatile solids destroyed, the average energy available would be 1,780 x 10^6 BTU/day. Because of the total energy design of the two plants, all of this energy would be available for power generation. The Final EIS has been changed to reflect this. It should be pointed out that this change affects all alternatives equally, and does not change the relative energy costs.

14. Energetics

Comment: "...in caluclating the energy expense of dewatering, 272 tons of 25% solids sludge per day is assumed... [this] greatly changes the energetic attractiveness of the land application alternatives." (Howarth)

Response: Because of awkward writing in the DEIS, the 272 tons was obtained using assumptions not included in the DEIS. In the FEIS energy costs are computed for dewatering 127.5 dry tons of sludge per day. The change in energy cost is caused by inclusion of indirect energy costs to produce chemicals such as lime and ferric chloride.

Comment: "To move liquid sludge by pipeline would require less energy than to move dewatered sludge.... These numbers come from page 115 of Vol. II and contradict the numbers shown on page III-22 of Vol. I." (Howarth)

Response: It is true that there is a contradiction. The figure for energy cost of truck transport on page 115 of Vol. II was increased by 50% to account for return of the container when empty.

Comment: "I see no reason why liquid sludge could not be transported to Bridgewater and then distributed to small farms in the area by truck." (Howarth)

Response: This distribution by truck would require about 50,000 BTU per mile per dry ton at 4% solids. Using 11,250 BTU per dry ton per mile for pipeline transport (4% solids), 414,000 BTU per dry ton for dewatering and 8,000 BTU per dry ton per mile for trucking 25% solids sludge, the local distribution distance at which the commentor's proposed system would become less energy efficient that the proposed system is 6.0 to 7.5 miles. This does not include the energy cost of constructing the pipeline itself, or storing the sludge, or of pasteurization.

Comment: "Page I-11 states that digester performance at Nut Island is better than that at Deer Island...could Deer Island detain longer and become more energy independent?" (Biglane)

Response: As stated, digester performance is better at Nut Island. Changes in the Deer Island collection system and treatment plant operating program could potentially increase digester capacity and performance as discussed in Section III. EPA recommends testing be performed on the Deer Island Treatment Plant, however, such as investigation is beyond the scope of this study.

15. Historical and Archaeological

Comment: "Please furnish additional data indicating:

Compliance with Section 106 of the National Historic Preservation Act of 1966 (89 Stat. 915);

Compliance with Executive Order 11593 of May 13, 1971 (16 U.S.C. 470)."

"...the Advisory Council recommends that the environmental statement contain evidence of contact with the appropriate State Historic Preservation Officer. A copy of her comments concerning the effects of the recommended project upon these resources should be included in the environmental statement." (McDermott)

Response: Appended is a copy of the latest National Register of Historic Places listing. The monthly supplements were also consulted and there were no registered historic sites within the construction area. Included in the comments section is a letter from Ms. Amadon, the Massachusetts State Historic Preservation Officer.

Comment: "If archaeological areas do underlie the farm, in what way will the use of dewatered sludge disrupt such potential areas?" (Kolb)

Response: The use of dewatered sludge would not disrupt archaeological sites if normal agricultural operations are used. The potential however, is great for disruption since a large area is involved and construction of buildings, drainage ditches, etc. at the farms may occur. As an archaeological survey is not required for this kind of construction, the potential exists for disruption of sites.

Comment: "There are other properties near Boston Harbor which have not been listed in the National Register, but which are historically significant...examples include the Boston Harbor Islands." (Amadon)

Response: Located in Appendix FF is a copy of the latest National Register of Historic Places listing for the Boston area.

Comment: "...written commentaries be secured from the State Historic Preservation Officer and such a qualified archeologist...." (Babb)

16. Matrix

While the matrix was intended to reflect the subjective assessment though process, it was interpreted as being the mechanism, or governor, of the selection process. Therefore, because of numerous misunderstandings of the semi-quantitative nature of the matrix, in the Final EIS the numerical rating system has been replaced with a non-numerical system. The reason for multiplication rather than addition is to prevent "negligible" impacts (rated at zero) from having a significance other than zero (e.g. (-) (1) (2) (0) = 0, whereas (-) (1+2+0) = -2, which is larger in magnitude than "0"). The comments to follow apply to the matrix utilized in the DEIS, which was not included in the FEIS.

Comment: "The text states in evaluation of impacts of land-oriented options that groundwater quality may be affected by leaching of heavy metals and increases in chloride and sodium ion concentrations (Vol. I, p. IV-21). On the other hand, the matrix on effects of sludge management (Vol. I, p. IV-4) seems to imply no increase in concentrations of these ions in groundwater as a result of Alternatives 1 and 2, both of which include landfill operations... Some explanation of the meaning is needed." (Babb)

Response: The land application system which was proposed should not result in significant leaching to groundwater levels; the chemical models for heavy metals, nitrogen and sodium were used to insure negligible impact. However, since the potential for some adverse impact still exists, it was described.

Comment: "Are secondary impacts really always twice as deleterious (or positive) in effect as are primary impacts? Further, what is the basis for rating long-term effects 2 whereas short-term impacts are rated one? ...not at all clear why the impacts in terms of degree (primary or secondary), duration (long or short term) and severity are multiplied rather than simply being added...." (Kolb)

Response: The matrix is simply a tool that was used to obtain an idea of how alternatives compare with each other environmentally. The numbers were not meant to be read as secondary impacts being twice as deleterious as primary. It is a rating system and is meant to give a degree of relative impact. The numbers were multiplied to avoid magnifying impacts with negative numbers.

Comment: Inconsistencies in alternative analysis: "...the reduced commercial fertilizer sales associated with the land application alternatives is called a negative impact, while ...the displacement of energy used in organic fertilizer production is assumed to be negligible." (Howarth)

Response: The decrease in fertilizer sales would affect local salesmen, while the decrease in production of fertilizer would be on a nationwide scale. The EIS is focused on regional impacts.

Comment: Inconsistency in alternative analysis: "...the land application of sludge is assumed to have a very adverse (-4) impact on archaeological areas,...but on page IV-54, such impact is said to be negligible...." (Howarth)

Response: This is identified as a potential impact due to the amount of land involved. The likelihood that an impact would occur is negligible, because an archaeological survey would be required prior to any construction. This should have been made clear in the Draft.

17. Corrections (Applicable to DEIS)

Comment: "Mystic River excluded in middle paragraph (Metropolitan Rivers)." (Weiss)

Response: Correction made.

Comment: "The data on metal concentrations (Table II-8) appear to be incorrectly reported as mg/l instead of μg/l." (Elwood)

Response: The standards and analytical results are for milligrams per liter.

Comment: "...groundwater component included in runoff values (Vol. I, p. II-14, par. 2), additional references should be cited." (Babb)

Response: The number of factors involved with groundwater seepage make predictions on a uniform statewide basis extremely difficult. The runoff data presented by NOAA is based primarily on precipitation and slope characteristics. In order to be more accurate the depth to bedrock, type of bedrock, soil type, slope of land, amount and intensity of each rainfall, groundcover, temperature and moisture content of the soil would have to be known. This information is difficult to obtain for a small area.

Comments: "P. II-14, third paragraph: Table II-5 should be II-6." (Weiss)

"P. 72 in Vol. II: Should 513 be 514?" (Weiss)

"...discrepancy in terms of projected background levels of particulates...." in reference to Vol. I, p. xiii and p. VI-6. (Kolb)

"P. II-1 in Vol. I: Both the figure number and figure showing major and minor river basins are not included."

"P. IV-26 (Vol. I) and P. 170 (Vol. II): 122 g Hg/day vs. 657 g Hg/day." (Howarth)

"P. II-59: The state law, Chapter 1155, is part of the Acts of 1973." (Amadon)

Response: Corrections made.

Comment: "Paragraph 2. The first sentence is fatuous at best. The MDC had embarked on the Northfield Project and Millers River studies prior to the Corps involvement. Further, both the MDC and the Corps were interested in water conservation before SENE's recommendation." (Weiss)

Response: EPA apologizes for the wording of the subject statement and acknowledges the leadership role played by MDC in the Northfield and Millers River areas. We also acknowledge that the MDC was involved in water conservation studies prior to the SENE recommendation. Page II-83 of the EIS has been corrected to eliminate this suggestion.

Comments: "Volume II does not contain the latest Massachusetts Water Quality Standards." (McMahon)

In reference to p. II-82, last paragraph. "This paragraph mixes up existing conditions and classifications." (Weiss)

"Fresh water standards are not the ones in effect now. Salt water standards appear to be the revised ones." (Weiss)

Response: The latest Water Quality Standards have been inserted in Volume II. Rephrasing has corrected the sense of page II-82.

Comment: "MAPC and NERBC are two very different types of regional agencies and it is misleading to lump them together without further explanation. What sort of jurisdiction do they have?" (Weiss)

Response: MAPC and NERBC were mentioned together to indicate that there is more than one planning agency involved in the MDC area of responsibility. The New England River Basin Commission (NERBC) has under its jurisdiction all of New England and the bordering parts of New York State. It is responsible for the coordination of federal, state, interstate, local and non-government plans for the development of water and related land resources in its area. The Metropolitan Area Planning Council (MAPC) contains the Weymouth, Neponset, Charles, Ipswich and Suasco River basins, as well as most of the north and south coastal drainage areas of Eastern Massachusetts.

18. Other Questions

Comment: "How was 80% [of the sludge BOD load] calculated? Should this figure be 100% of the primary sludge now discharged...?" (Weiss)

Response: The 80% value for BOD takes into account the effect of recycle streams being returned to the main plant.

Comment: (Table III-10) "Operation and Maintenance Costs - If the figure given is the first year O & M, it should be so stated." (Weiss)

Response: The operation and maintenance costs shown are those for 1985 conditions.

Comment: "The differential between 'with grant' and 'without grant' seems wrong given that MDC pays 10% under the former and 100% under the latter." (Weiss)

Response: The costs with the 75% federal grant were computed excluding vehicle replacement (average life of 10 years) and land costs from grant eligibility. Because grants are not to be considered in determining cost effectiveness, the 'with grant' line has been removed from the table.

Comment: "If heat recovery is to be omitted...capital and operation costs of the heat recovery system should be omitted." (Weiss)

Response: The capital and operation costs of the heat recovery system were omitted in the original calculations. Costs rose between the 1973 Havens and Emerson estimate and 1975 because of the increase in treatment plant construction costs in general, using the treatment plant cost index for the Boston area. For the FEIS, capital and operating costs of the heat recovery system were incorporated.

Comment: "We would like to see further investigation and study of Alternative 6...(because) according to some experts, figures given in support of this alternative...are inconsistent or in error." (Boston Harbor Committee)

Response: While certain errors brought to our attention by the commentors have been corrected, none of these corrections affect the overall comparison and selection of alternatives. In addition, consideration of RCRA eliminates any potential feasibility.

Comment: "We question why the EIS did not consider the alternative...of each plant treating their own sludge separately. (Biglane)

Response: This was not addressed on a detailed alternative basis because the transfer of Nut Island sludge to Deer Island would permit an 18% increase in sludge suitable (in the DEIS) for land application; and the limited land area available at Nut Island would necessitate filling in the harbor in order to accommodate enlarged sludge handling facilities.

Comment: "How much clean water can we expect will get into the harbor compared with what it is today?" (J. E. Murphy, Hearing Transcript)

Response: The average freshwater flow into Boston Harbor is 700 cfs (Hydroscience, 1971). The effluent from the treatment plants at design capacity (1985) will be an additional 830 cfs. With improved sludge management as well as industrial pretreatment, it is hoped Boston's future water quality will enable shellfishing and recreation to exist unharmed.

Comments: "...secondary treatment, which would generate secondary sludge which would be largely free of heavy metals. If secondary sludge were combined with primary sludge (particularly after industrial pretreatment), the resulting mixture would be low in heavy metals and hence more suitable for land application. Further consideration should also be given to alternative types of land application, e.g. state forests and other public lands." (Murphy)

"...sludge should be taken out by each city and town; that is, that each city and town should be required to maintain its own plant, its own facilities for taking the solids out." (Thorton, Hearing Transcript)

Response: Analysis of secondary treatment and of local treatment plants is beyond the scope of this study. They will be included in a report of the Eastern Massachusetts Metropolitan Area which is a joint MDC/U. S. Army Corps of Engineers project. In addition, Region I EPA is preparing a separate EIS which will address the issues inherent in the planning (or need for planning) for secondary treatment.

Comment: "Relationship of gastroenteritis cases to pollution is poor." (Weiss)

Response: This statement was from C. Hoke of the Communicable Disease Center in Atlanta, Georgia. It was based on their research.

Comment: In reference to p. II-83: "There are as yet no plans to control pollution from stormwater." (Weiss)

Response: The intent of the paragraph is to describe the planning objectives as well as those plans that are already in progress. Management of the pollutants contained in urban runoff is a planning objective.

Comment: "The final report should consider reuse of incinerator residue for commercial purposes, e.g. as an aggregate." (Murphy)

Response: In considering the use of ash for other purposes, certain objectives should be kept in mind. These objectives for reuse are:

- The use should isolate the ash from the biosphere. For this, the aggregate suggestion would be ideal.
- The use should not require a great amount of handling to prevent fugitive dust problems.

With these criteria, reuse as aggregate might be practiced, provided the mechanical quality of the ash is acceptable in accordance with ASTM Standard C330, Weight and Strength of Aggregate. For the ash to be acceptable, lime conditioning of the sludge prior to incineration would have to be replaced with polymer conditioning. The United States annual per capita Portland Cement use, 600 pounds per year (Klieger, 1976), is equivalent to about 1 cubic yard of concrete per year per capita. Because each cubic yard requires about 1,450 pounds of aggregate, sufficient concrete production in the Boston Metropolitan Area would exist to consume the entire MDC ash production (3.19×10^9 pounds aggregate required compared to 4.65×10^7 pounds of ash produced).

Comment: "...land application will create many more jobs...than the other alternatives...." (Howarth)

Response: Yes, the number of long-term jobs that would be created by a land application system is greater than would be created by other alternatives. However, the actual number of jobs is not that significant and most are of a part-time nature. In addition, the jobs created in government are not generally productive of regional export revenue and thus increase the regional tax burden more than they assist the individual. The creation of government jobs in fact increases the costs to the regional economy for Alternatives 5 and 6, because the increased cost of recovery over other alternatives is greater than the savings of equivalent inorganic, imported fertilizer.

19. Questions Raised by Members of the Massachusetts Assembly

a. Representative King:

Comments: "...the very brief discussion of the impacts of the incinerator on the air quality of the surrounding area is inadequate for such an important consideration."

"...the increase in heavy metals in the air is given limited discussion."

Response: The impacts from the five criteria air pollutants as well as metals were studied and modelled. The analysis was compared to the Air Quality Attainment and Maintenance Plan, the air quality standards, as well as all other regulations (see FEIS Vol. II, pp. 185-230). It is anticipated that the incinerator emissions will meet the New Source Performance Standards as well as the metal emission criteria. Although the TSP standard would be violated for the Boston area, the cause of this violation would be from sources other than the incinerator.

Comment: "...there is no information about the possible comparable problems of heavy metals in the ash that would still have to be disposed of after incineration."

Response: The possible problems from metals in ash that are landfilled are similar to the problems of metals in sludge that are land applied. (This was discussed in FEIS Vol. II, pp. 123-126.) Alternatives 8, 9, 10 and 11 have been added because of the Resource Conservation and Recovery Act constraints on metals control.

Comment: "The potential of using forest lands, where the toxicity and uptake of metals (assuming they were not removed) would be of less concern than crop or pasture land, was ruled out without adequate explanation."

Response: Although the metals would be less likely to affect the human food change, the native fauna would be affected, including those that have been identified as being endangered or threatened (refer to Appendix H). This impact could be as significant as if the sludge were applied to crop land.

In order to receive full credit for the nutrient value of the sludge, it must replace existing or future fertilizer use. As forests are not presently fertilized, this credit cannot be taken. This reduces its beneficial impact when compared to other land application systems.

Comment: "The discussion of the state's planning objectives takes no note of the recent policy statements on food and the Commonwealth's avowed goal of becoming more energy and food self-sufficient."

Response: Mention of the state's goal was given in DEIS Vol. I, p. IV-45.

Comment: "...the table on page IV-50 in Vol. I shows that no action would provide the greatest net recovery of energy."

Response: This is true. No additional treatment or transport is necessary, therefore no further energy is used.

Comment: "...it seems unlikely that the increase of land dedicated to this use (disposal of sludge) would 'force' small farmers out of production. In fact, it could help them."

Response: The dedicated land (i.e. owned and operated by MDC) would be purchased from farmers. This active soliciting of farmland would encourage farmers to sell their properties. As 4,300 acres would be needed every 10 years, this could be significant. However, we agree with Representative King that the act of applying sludge to a farmer's property would not force a small farmer out of production but assist him, and this is why the decision was made that MDC should not own and operate the sludge application sites.

b. Senator Bulger:

Comment: "I see no effort to undertake a study of the on-site conversion of the sludge to a usable fertilizer or other product and to dry ship it to the ultimate consumer site."

Response: This possibility was investigated in the market survey which is a separate report and is summarized in the EIS in Vol. II, Appendix Q. (It is also mentioned in DEIS Vol. I on pages V-29 and VI-11.) This marketing study is located in the Region I office and will be made available for review by Senator Bulger upon his request.

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