Attachment A
Off-Shore Discharge Tunnel Outfall
NPDES Permit No. MA0103284
Boston, MA

Discharge Serial Number	Discharge Location	Receiving Water
TO1	Between latitude 42^{o}23'03.2", longitude 70^{o}48'13.5" and latitude 42^{o}23'19.6", longitude 70^{o}46'48.4"	Massachusetts Bay

Attachment B
Combined Sewer Overflow Discharge Outfalls
NPDES Permit No. MA0103284
Boston, MA

Discharge Serial Number*	Discharge Name (By Location)	Receiving Water
003	Cambridge Park Drive Overflow	Alewife Brook
201	Cottage Farm Chlorination and Detention Station	Charles River
203	Prison Point CSO Treatment Facility	Inner Harbor
205	Somerville Marginal CSO Pretreatment Facility	Mystic River
010	Brookline St. Overflow	Charles River
018	Gloucester St. Overflow	Charles River
019	Exeter St. Overflow	Charles River
020	Berkely St. Overflow	Charles River
021	Mt. Vernon St. Overflow	Charles River
022	Cambridge St. Overflow	Charles River
023	Fens Gatehouse Overflow	Charles River
205A	Somerville Marginal/ Fellsway by Wellington Bridge	Mystic River
207	Constitution Beach	Boston Harbor
209	Fox Point via BOS088/089	Dorchester Bay
211	Commercial Point via BOS090	Dorchester Bay

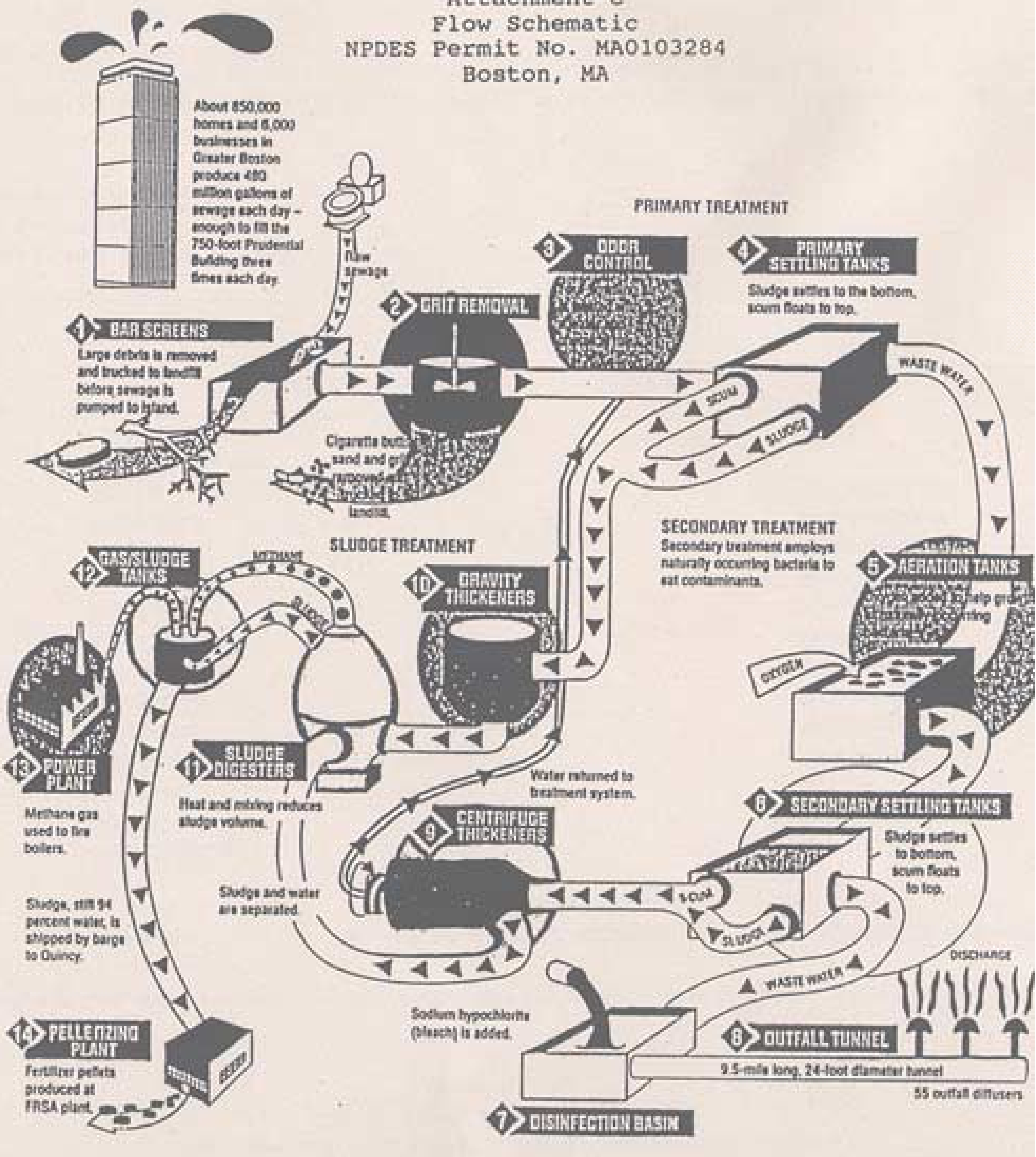
The CSO outfall 205A is used by the MWRA and the City of Somerville. The MWRA's designated sampling point for outfalls 205 and 205A shall be at the following location:

(1) Somerville Marginal (205) and Sommerville/Fellsway (205A) - 42" 23' 0.608" N Latitude and 71" 05' 0.062" Longitude

The CSO outfalls 211 and 209 are used by the MWRA and the Boston Water and Sewer Commission. The MWRA's designated sampling points shall be at the following locations:

(1) Commercial Point (211) - 42" 17' 0.862" N Latitude and 71" 03' 0.240" Longitude
(2) Fox Point (209) - 42" 18' 0.278" N Latitude and 71" 03' 0.261" W Longitude

Attachment C
Flow Schematic
NPDES Permit No. MA0103284
Boston, MA



(*Graphic reprinted courtesy of the Boston Globe*)

Attachment D
Communities within the MWRA Conveyance System
NPDES Permit No. MA0103284
Boston, MA

The following 60 communities are served by the MWRA water and/or wastewater conveyance systems:

1. Water:

Peabody*
Lynn**
Lynnfield
Saugus
Weston
Marlborough*
Southborough
Northborough*
Worcester***
Chicopee
Clinton
Leominster*
Nahant
Wilbraham
Swampscott
South Hadley Fire District #1
Marblehead

2. Sewer:

Wilmington
Burlington
Dedham
Natick
Ashland
Westwood
Walpole
Stoughton
Randolph
Braintree
Holbrook
Weymouth
North District of Hingham
Reading

3. Water, Sewer and/or Combined Storm Water:

Boston
Cambridge*
Chelsea
Somerville

4. Water and Sewer:

Stoneham	Needham*
Woburn*	Norwood
Winchester*	Bedford*
Lexington	Canton*
Waltham	Winthrop
Arlington	Quincy
Belmont	Milton
Medford	Newton
Malden	Watertown
Everett	Framingham
Revere	Melrose
Wellesley*	Brookline
Wakefield*	

* - is partially supplied water by MWRA.
** - water supplied to GE only.
*** - MWRA is emergency back-up water supply.

Wastewater, and combined (i.e., sewage and storm water) wastewater, are transported through 230 miles of MWRA pipes to the treatment system at Deer Island in Boston, MA. The MWRA provides water and/or sewer services to 60 communities.

Attachment E

Marine Acute Toxicity Test Procedure and Protocol

I. GENERAL REQUIREMENTS

The permittee shall conduct acceptable acute toxicity tests in accordance with the appropriate test protocols described below:

- **Mysid Shrimp (Mysidopsis bahia) definitive 48 hour test.**
- **Inland Silverside (Menidia beryllina) definitive 48 hour test.**

Acute toxicity data shall be reported as outlined in Section VIII.

II. METHODS

Methods to follow are those recommended by EPA in:
Weber, C.I. et al. Methods for Measuring the Acute Toxicity of Effluents to Freshwater and Marine Organisms, Fourth Edition. Environmental Monitoring Systems Laboratory, U.S. Environmental Protection Agency, Cincinnati, OH. August 1993, EPA/600/4-90/027F.

Any exceptions are stated herein.

III. SAMPLE COLLECTION

A discharge sample shall be collected. Aliquots shall be split from the sample, containerized and preserved (as per 40 CFR Part 136) for the chemical and physical analyses. The remaining sample shall be dechlorinated (if detected) in the laboratory using sodium thiosulfate for subsequent toxicity testing. (Note that EPA approved test methods require that samples collected for metals analyses be preserved immediately after collection.) Grab samples must be used for pH, temperature, and total residual oxidants (as per 40 CFR Part 122.21).

Standard Methods for the Examination of Water and Wastewater describes dechlorination of samples (APHA, 1992). Dechlorination can be achieved using a ratio of 6.7 mg/L anhydrous sodium thiosulfate to reduce 1.0 mg/L chlorine. A thiosulfate control (maximum amount of thiosulfate in lab control or receiving water) should also be run.

All samples held overnight shall be refrigerated at 4^{o}C.

IV. DILUTION WATER

A grab sample of dilution water used for acute toxicity testing shall be collected at a point away from the discharge which is free from toxicity or other sources of contamination. Avoid collecting near areas of obvious road or agricultural runoff, storm sewers or other point source discharges. An additional control (0% effluent) of a standard laboratory water of known quality shall also be tested.

If the receiving water diluent is found to be, or suspected to be toxic or unreliable, an alternate standard dilution water of known quality with a conductivity, salinity, total suspended solids, and pH similar to that of the receiving water may be substituted **AFTER RECEIVING WRITTEN APPROVAL FROM THE PERMIT ISSUING AGENCY(S)**. Written requests for use of an alternative dilution water should be mailed with supporting documentation to the following address:

Director
Office of Ecosystem Protection
U.S. Environmental Protection Agency-New England

JFK Federal Building (CAA)
Boston, MA 02203

It may prove beneficial to have the proposed dilution water source screened for suitability prior to toxicity testing. EPA strongly urges that screening be done prior to set up of a full definitive toxicity test any time there is question about the dilution water's ability to support acceptable performance as outlined in the 'test acceptability' section of the protocol.

V. TEST CONDITIONS AND TEST ACCEPTABILITY CRITERIA

EPA New England requires tests be performed using four replicates of each control and effluent concentration because the non-parametric statistical tests cannot be used with data from fewer replicates. The following tables summarize the accepted Mysid and Menidia toxicity test conditions and test acceptability criteria:

EPA NEW ENGLAND RECOMMENDED EFFLUENT TOXICITY TEST CONDITIONS FOR THE MYSID, MYSIDOPSIS BAHIA 48 HOUR TEST[1]

1. Test type	Static, non-renewal
2. Salinity	25ppt ± 10 percent for all dilutions by adding dry ocean salts
3. Temperature (°C)	20°C ± 1°C or 25°C ± 1°C
4. Light quality	Ambient laboratory illumination
5. Photoperiod	16 hour light, 8 hour dark
6. Test chamber size	250 ml
7. Test solution volume	200 ml
8. Age of test organisms	1-5 days
9. No. Mysids per test chamber	10
10. No. of replicate test chambers per treatment	4
11. Total no. Mysids per test concentration	40
12. Feeding regime	Light feeding using concentrated Artemia nauplii while holding prior to initiating the test
13. Aeration[2]	None
14. Dilution water	Natural seawater, or deionized water mixed with artificial sea salts
15. Dilution factor	≥ 0.5
16. Number of dilutions[3]	5 plus a control. An additional dilution at the permitted effluent concentration (% effluent) is required if it is not included in the dilution series.
17. Effect measured	Mortality - no movement of body appendages on gentle prodding

18. Test acceptability	90% or greater survival of test organisms in control solution
19. Sampling requirements	For on-site tests, samples are used within 24 hours of the time that they are removed from the sampling device. For off-site tests, samples must be first used within 36 hours of collection.
20. Sample volume required	Minimum 1 liter for effluents and 2 liters for receiving waters

Footnotes:

1. Adapted from EPA/600/4-90/027F.

2. If dissolved oxygen falls below 4.0 mg/L, aerate at rate of less than 100 bubbles/min. Routine D.O. checks are recommended.

3. When receiving water is used for dilution, an additional control made up of standard laboratory dilution water (0% effluent) is required.

EPA NEW ENGLAND RECOMMENDED TOXICITY TEST CONDITIONS FOR THE INLAND SILVERSIDE, MENIDIA BERYLLINA 48 HOUR TEST[1]

1. Test Type	Static, non-renewal
2. Salinity	25 ppt ± 2 ppt by adding dry ocean salts
3. Temperature	20°C ± 1°C or 25°C ± 1°C
4. Light Quality	Ambient laboratory illumination
5. Photoperiod	16 hr light, 8 hr dark
6. Size of test vessel	250 mL (minimum)
7. Volume of test solution	200 mL/replicate (minimum)
8. Age of fish	9-14 days; 24 hr age range
9. No. fish per chamber	10 (not to exceed loading limits)
10. No. of replicate test vessels per treatment	4
11. total no. organisms per concentration	40
12. Feeding regime	Light feeding using concentrated Artemia nauplii while holding prior to initiating the test
13. Aeration[2]	None
14. Dilution water	Natural seawater, or deionized water mixed with artificial sea salts.

15. Dilution factor	$\geq$ 0.5
16. Number of dilutions[3]	5 plus a control. An additional dilution at the permitted concentration (% effluent) is required if it is not included in the dilution series.
17. Effect measured	Mortality-no movement on gentle prodding.
18. Test acceptability	90% or greater survival of test organisms in control solution.
19. Sampling requirements	For on-site tests, samples must be used within 24 hours of the time they are removed from the sampling device. Off-site test samples must be used within 36 hours of collection.
20. Sample volume required	Minimum 1 liter for effluents and 2 liters for receiving waters.

____

Footnotes:

1. Adapted from EPA/600/4-90/027F.

2. If dissolved oxygen falls below 4.0 mg/L, aerate at rate of less than 100 bubbles/min. Routine D.O. checks recommended.

3. When receiving water is used for dilution, an additional control made up of standard laboratory dilution water (0% effluent) is required.

VI. CHEMICAL ANALYSIS

At the beginning of the static acute test, pH, specific conductance, salinity, total residual oxidants, and temperature must be measured at the beginning and end of each 24 hour period in each dilution and in the controls. The following chemical analyses shall be performed for each sampling event.

Parameter	Effluent	Diluent	Minimum Quantification Level (mg/L)
pH	x	x	---
Specific Conductance	x	x	---
Salinity	x	x	PT(o/oo)
Total Residual Oxidants[*1]	x	x	0.05
Total Solids and Suspended Solids	x	x	---
Ammonia	x	x	0.1
Total Organic Carbon	x	x	0.5
Total Metals			
Cd	x		0.001
Cr	x		0.005

Pb	x	x	0.005
Cu	x	x	0.0025
Zn	x	x	0.0025
Ni	x	x	0.004
Al	x	x	0.02

Superscript:

*1 Total Residual Oxidants

Either of the following methods from the 18th Edition of the APHA Standard Methods for the Examination of Water and Wastewater must be used for these analyses:

-Method 4500-Cl E Low Level Amperometric Titration (the preferred method);
-Method 4500-CL G DPD Photometric Method.

or use USEPA Manual of Methods Analysis of Water or Wastes, Method 330.5.

VII. TOXICITY TEST DATA ANALYSIS

LC50 Median Lethal Concentration

An estimate of the concentration of effluent or toxicant that is lethal to 50% of the test organisms during the time prescribed by the test method.

Methods of Estimation:

- Probit Method
- Spearman-Karber
- Trimmed Spearman-Karber
- Graphical

See flow chart in Figure 6 on page 77 of EPA 600/4-90/027F for appropriate method to use on a given data set.

No Observed Acute Effect Level (NOAEL)

See flow chart in Figure 13 on page 94 of EPA 600/4-90/027F.

VIII. TOXICITY TEST REPORTING

The following must be reported:

- Description of sample collection procedures, site description;
- Names of individuals collecting and transporting samples, times and dates of sample collection and analysis on chain-of-custody; and

- General description of tests: age of test organisms, origin, dates and results of standard toxicant tests; light and temperature regime; other information on test conditions if different than procedures recommended. Reference toxicity test data must be included.

- Raw data and bench sheets.

- All chemical/physical data generated. (Include minimum detection levels and minimum quantification levels.)

- Provide a description of dechlorination procedures (as applicable).

- Any other observations or test conditions affecting test outcome.

- Statistical tests used to calculate endpoints.

Attachment F
Marine Chronic Toxicity Test Procedure and Protocol

I. GENERAL REQUIREMENTS

The permittee shall conduct acceptable silverside chronic (and modified acute) and sea urchin chronic toxicity tests in accordance with the appropriate test protocols described below:

- **Inland Silverside (Menidia beryllina) Larval Growth and Survival Test.**

- **Sea Urchin (Arbacia punctulata) 1 Hour Fertilization Test.**

Chronic and acute toxicity data shall be reported as outlined in Section VIII. The chronic Menidia test can be used to calculate an LC50 at the end of 48 hours of exposure when both an acute (LC50) and a chronic (C-NOEC) test is specified in the permit.

II. METHODS

Methods to follow are those recommended by EPA in:

Klemm, D.J. et al. Short Term Methods for Estimating the Chronic Toxicity of Effluents and Receiving Waters To Marine and Estuarine Organisms, Second Edition. Environmental Monitoring Systems Laboratory, U.S. Environmental Protection Agency, July 1994, EPA/600/4-91/003.

Any exceptions are stated herein.

III. SAMPLE COLLECTION

For each sampling event involving the Menidia beryllina, three discharge samples shall be collected. Fresh samples are necessary for Days 1, 3, and 5 (see Section V. for holding times). A single sample is necessary for the Arbacia punctulata test. The sample shall be analyzed chemically (see Section VI). The initial sample (Day 1) is used to start the tests, and for test solution renewal on Day 2. The second sample is collected for use at the start of Day 3, and for renewal on Day 4. The third sample is used on Days 5, 6, and 7. The initial (Day 1) sample will be analyzed chemically (see Section VI). Day 3 and 5 renewal samples will be held until test completion. If either the Day 3 or 5 renewal sample is of sufficient potency to cause lethality to 50 percent or more test organisms in any of the dilutions for either species, then a chemical analysis shall be performed on the appropriate sample(s) as well.

Aliquots shall be split from the sample, containerized and preserved (as per 40 CFR Part 136) for the chemical and physical analyses. The remaining sample shall be dechlorinated (if detected) in the laboratory using sodium thiosulfate for subsequent toxicity testing. (Note that EPA approved test methods require that samples collected for metals analyses be preserved immediately after collection.) Grab samples must be used for pH, temperature, and total residual oxidants (as per 40 CFR Part 122.21).

Standard Methods for the Examination of Water and Wastewater describes dechlorination of samples (APHA, 1992). Dechlorination can be achieved using a ratio of 6.7 mg/L anhydrous sodium thiosulfate to reduce 1 mg/L chlorine. A thiosulfate control (maximum amount of thiosulfate in lab control or receiving water) should also be run.

All samples held overnight shall be refrigerated at 4°C.

IV. DILUTION WATER

Grab samples of receiving water used for chronic toxicity testing shall be collected from one or several distances away from the discharge. It may be necessary to test receiving water at several distances in a separate chronic test to determine the extent of the zone of toxicity. Avoid collecting near areas of obvious road or agricultural runoff, storm sewers or other point source discharges. An additional control (0% effluent) of a standard laboratory water of known quality shall also be tested.

If the receiving water diluent is found to be, or suspected to be toxic or unreliable, an alternate standard dilution water of known quality with a conductivity, salinity, total suspended solids, organic carbon, and pH similar to that of the receiving water may be substituted **AFTER RECEIVING WRITTEN APPROVAL FROM THE PERMIT ISSUING AGENCY(S)**. Written requests for use of an alternative dilution water should be mailed with supporting documentation to the following address:

Director
Office of Ecosystem Protection
U. S. Environmental Protection Agency-New England
JFK Federal Building (CAA)
Boston, MA 02203

It may prove beneficial to the permittee to have the proposed dilution water source screened for suitability prior to toxicity testing. EPA strongly urges that screening be done prior to set up of a full definitive toxicity test any time there is question about the dilution water's ability to support acceptable performance as outlined in the 'test acceptability' section of the protocol.

V. TEST CONDITIONS AND TEST ACCEPTABILITY CRITERIA

EPA New England requires that tests be performed using four replicates of each control and effluent concentration because the on-parametric statistical tests cannot be used with data from fewer replicates. Also, if a reference toxicant test was being performed concurrently with an effluent or receiving water test and fails, both tests must be repeated.

The following tables summarize the accepted Menidia and Arbacia toxicity test conditions and test acceptability criteria:

EPA NEW ENGLAND RECOMMENDED TEST CONDITIONS FOR THE SEA URCHIN, ARBACIA PUNCTULATA, FERTILIZATION TEST[1]

1. Test type	Static, non-renewal
2. Salinity	30 o/oo ± 2 o/oo by adding dry ocean salts
3. Temperature	20 ± 1°C
4. Light quality	Ambient laboratory light during test preparation
5. Light intensity	10-20 uE/m²/s, or 50-100 ft-c (Ambient Laboratory Levels)
6. Test vessel size	Disposal (glass) liquid scintillation vials (20 ml capacity), presoaked in control water
7. Test solution volume	5 ml
8. Number of sea urchins	Pooled sperm from four males and pooled eggs from four females are used per test
9. Number of egg and sperm cells per chamber	About 2000 eggs and 5,000,000 sperm cells per vial

10. Number of replicate chambers per treatment	4
11. Dilution water	Uncontaminated source of natural seawater or deionized water mixed with artificial sea salts
12. Dilution factor	Approximately 0.5
13. Test duration	1 hour and 20 minutes
14. Effects measured	Fertilization of sea urchin eggs
15. Number of treatments per test[2]	5 and a control. An additional dilution at the permitted effluent concentration (% effluent) is required.
16. Acceptability of test	Minimum of 70% fertilization in controls. Effluent concentrations exhibiting greater than 70% fertilization, flagged as statistically significantly different from the controls, will not be considered statistically different from the controls for NOEC reporting.
17. Sampling requirements	For on-site tests, samples are to be used within 24 hours of the time that they are removed from the sampling device. For off-site tests, samples must be first used within 36 hours of collection.
18. Sample volume required	Minimum 1 liter

____

Footnotes:

1. Adapted from EPA/600/4-91/003, July 1994.

2. When receiving water is used for dilution, an additional control made up of standard laboratory dilution water (0% effluent) is required.

EPA NEW ENGLAND RECOMMENDED TEST CONDITIONS FOR THE INLAND SILVERSIDE, MENIDIA BERYLLINA, GROWTH AND SURVIVAL TEST[1]

____

1.	Test type	Static, renewal
2.	Salinity	5 o/oo to 32 o/oo ± 2 o/oo by adding artificial sea salts
3.	Temperature	25 ± 1°C
4.	Light quality	Ambient laboratory light
5.	Light intensity	10-20 uE/m^2/s, or 50-100 ft-C (Ambient Laboratory Levels)
6.	Photoperiod	16 hr light, 8 hr darkness

7.	Test vessel size	600 - 1000 mL beakers or equivalent (glass test chambers should be used)
8.	Test solution volume	500-750 mL/replicate loading and DO restrictions must be met
9.	Renewal of test solutions	Daily using most recently collected sample.
10.	Age of test organisms	Seven to eleven days post hatch; 24 hr range in age.
11.	Larvae/test chamber	15 (minimum of 10)
12.	Number of replicate chambers	4 per treatment
13.	Source of food	Newly hatched and rinsed Artemia nauplii less than 24 hr old
14.	Feeding regime	Feed once a day 0.10 g wet wt Artemia nauplii per replicate on days 0-2; feed 0.15 g wet wt Artemia nauplii per replicate on days 3-6
15.	Cleaning	Siphon daily, immediately before test solution renewal and feeding
16.	Aeration[2]	None
17.	Dilution water	Uncontaminated source of natural seawater; or deionized water mixed with artificial sea salts.
18.	Effluent concentrations[3]	5 and a control. An additional dilution at the permitted effluent concentration (% effluent) is required.
19.	Dilution factor	$\geq$ 0.5
20.	Test duration	7 days
21.	Effects measured	Survival and growth (weight)
22.	Acceptability of test	The average survival of control larvae is a minimum of 80%, and the average dry wt of unpreserved control larvae is a minimum of 0.5 mg, or the average dry wt of preserved control larvae is a minimum of 0.43 mg if preserved not more than 7 days in 4% formalin or 70% ethanol.
23.	Sampling requirements	For on-site tests, samples are collected daily and used within 24 hours of the time they are removed from the sampling device. For off-site tests, samples must be first used within 36 hours of collection.
24.	Sample Volume Required	Minimum of 6 liters/day.

Footnotes:

[1] Adapted from EPA/600/4-91/003, July 1994.

[2] If dissolved oxygen (D.O.) falls below 4.0 mg/L, aerate all chambers at a rate of less than 100 bubbles/min. Routine D.O. checks are recommended.

[3] When receiving water is used for dilution, an additional control made up of standard laboratory dilution water (0% effluent) is required.

VI. CHEMICAL ANALYSIS

As part of each daily renewal of the Menidia test, pH, dissolved oxygen, specific conductance, total residual oxidants, and temperature must be measured at the beginning and end of each 24 hour period in each dilution and in the controls. It must also be done at the start of the Arbacia test. The following chemical analyses shall be performed for each sampling event.

Parameter	Effluent	Diluent	Minimum Quantification Level(mg/L)
pH	x	x	---
Specific Conductance	x	x	---
Salinity	x	x	PPT(o/oo)
Total Residual Oxidants[*1]	x	x	0.05
Total Solids and Suspended Solids	x	x	---
Ammonia	x	x	0.1
Total Organic Carbon	x	x	0.5
Total Metals			
Cd	x		0.001
Cr	x		0.005
Pb	x	x	0.005
Cu	x	x	0.0025
Zn	x	x	0.0025
Ni	x	x	0.004
Al	x	x	0.02

Superscripts:

[*1] Total Residual Oxidants
Either of the following methods from the 18th Edition of the APHA (1992) Standard Methods for the Examination of Water and Wastewater must be used for these analyses:

-Method 4500-CL E the Amperometric Titration Method (the preferred method);
-Method 4500-CL G the DPD Photometric Method.

or use USEPA Manual of Methods Analysis of Water or Wastes, Method 330.5.

VII. TOXICITY TEST DATA ANALYSIS

LC50 Median Lethal Concentration (Determined at 48 Hours)

Methods of Estimation:

- Probit Method
- Spearman-Karber
- Trimmed Spearman-Karber

- Graphical

See flow chart on page 56 of EPA/600/4-91/003 for appropriate point estimation method to use on a given data set.

Chronic No Observed Effect Concentration (C-NOEC)

Methods of Estimation:

- Dunnett's Procedure
- Bonferroni's T-Test
- Steel's Many-One Rank Test
- Wilcoxin Rank Sum Test

Reference flow charts on pages 191, 192, and 321 of EPA/600/4-91/003 for the appropriate method to use on a given data set.

In the case of two tested concentrations causing adverse effects but an intermediate concentration not causing a statistically significant effect, report the C-NOEC as the lowest concentration where there is no observable effect. The definition of NOEC in the EPA Technical Support Document only applies to linear dose-response data.

VIII. TOXICITY TEST REPORTING

A report of results will include the following:

- Description of sample collection procedures, site description;
- Names of individuals collecting and transporting samples, times and dates of sample collection and analysis on chain-of-custody; and
- General description of tests: age of test organisms, origin, dates and results of standard toxicant tests; light and temperature regime; other information on test conditions if different than procedures recommended. Reference toxicant test data should be included.
- All chemical/physical data generated. (Include minimum detection levels and minimum quantification levels.)
- Raw data and bench sheets.
- Provide a description of dechlorination procedures (as applicable).
- Any other observations or test conditions affecting test outcome.

Attachment G
Industrial Pretreatment Program Annual Report
NPDES Permit No. MA0103284
Boston, MA

The information described below shall be included in the pretreatment program annual reports:

1. An updated list of all industrial users by category, as set forth in 40 CFR 403.8(f)(2)(i), indicating compliance or noncompliance with the following:

   i. Baseline monitoring reporting requirements for newly promulgated industries,
   ii. Compliance status reporting requirements for newly promulgated industries,
   iii. Periodic (semi-annual) monitoring reporting requirements,
   iv. Categorical standards, and
   v. Local limits;

2. A summary of compliance and enforcement activities during the preceding year, including the number of

   i. Significant industrial users inspected by POTW (include inspection dates for each industrial user),
   ii. Significant industrial users sampled by POTW (include sampling dates for each industrial user),
   iii. Compliance schedules issued (include list of subject users),
   iv. Written notices of violations issued (include list of subject users),
   v. Administrative orders issued (include list of subject users),
   vi. Criminal or civil suits filed (include list of subject users) and,
   vii. Penalties obtained (include list of subject users and penalty amounts);

3. A list of significantly violating industries required to be published in a local newspaper in accordance with 40 CFR 403.8(f)(2)(vii);

4. A narrative description of program effectiveness and present and proposed changes to the program, such as funding, staffing, ordinances, regulations, rules and/or statutory authority;

5. A summary of all pollutant analytical results for influent, effluent, sludge and any toxicity or bioassay data from the wastewater treatment facility. The summary shall include a comparison of influent sampling results versus threshold inhibitory concentrations for the MWRA wastewater treatment system and effluent sampling results versus water quality standards. Such a comparison shall be based on the sampling program described in the paragraph below or any similar sampling program described in this Permit.

   At a minimum, annual sampling and analysis of the influent and effluent of the MWRA's Wastewater Plant shall be conducted for the following pollutants:

   a.) Total Cadmium
   b.) Total Chromium
   c.) Total Copper
   d.) Total Lead
   e.) Total Mercury
   f.) Total Nickel
   g.) Total Silver
   h.) Total Zinc
   i.) Total Cyanide
   j.) Total Arsenic

   The sampling program shall consist of one 24-hour flow-proportioned composite and at least one grab sample that is representative of the flows received by the POTW. The composite shall consist of hourly flow-proportioned grab samples taken over a 24-hour period if the sample is collected manually or shall consist of a minimum of 48 samples collected at 30 minute intervals if an automated sampler is used. Cyanide shall be taken as a grab sample during the same period as the composite sample. Sampling and preservation shall be consistent with 40 CFR Part 136.

6. A detailed description of all interference and pass-through that occurred during the past year;

7. A thorough description of all investigations into interference and pass-through during the past year;

8. A description of monitoring, sewer inspections and evaluations which were done during the past year to detect interference and pass-through, specifying parameters and frequencies;

9. A description of actions being taken to reduce the incidence of significant violations by significant industrial users; and,

10. The date of the latest adoption of local limits and an indication as to whether or not the Authority is under a State or Federal compliance schedule that includes steps to be taken to revise local limits.

11. Information on any new introduction of pollutants into MWRA's sewer system from a user which would be subject to section 301 or 306 of the Clean Water Act if it were directly discharging those pollutants and on any substantial change in the volume or character of pollutants being introduced into MWRA's sewer system by a user. For purposes of this paragraph, adequate notice shall include information on the quality and quantity of effluent introduced into MWRA's sewer system and any anticipated impact of the change on the quantity or quality of effluent to be discharged from MWRA's treatment plant.

Attachment H
Total Residual Chlorine
Discharge Limit Calculation
NPDES Permit No. MA0103284
Boston, MA

Water Quality Limitation Equation:
$C_L = C_a + [(C_c - C_a)/(1/S_n + 1/S_b - 1/(S_n)(S_b)]$

Given:
C_L = water quality limitation
C_a = maximum ambient data sample
C_c = marine water quality criterion
C_{c1} = 13 ug/l = Acute
C_{c2} = 7.5 ug/l = Chronic
S_n = flux-average nearfield dilution
S_b = farfield background build-up dilution
Q_{e1} = Maximum Daily Flow = 990 MGD
Q_{e2} = Average Monthly Flow = 690 MGD
I_d = Initial Dilution
I_{d1} = 62.0:1 ratio, at 990 MGD, 1 part effluent to 62 parts receiving water
I_{d2} = 69.1:1 ratio, at 690 MGD, 1 part effluent to 69.1 parts receiving water
S_n = Flux-Average Nearfield Dilution
S_{n1} = (62.0 x 1.15) = 71.3:1, at 990 MGD
S_{n2} = (69.1 x 1.15) = 79.5:1, at 690 MGD
(Note: 1.15 = flux-average correction value for this diffuser outfall.)
S_b = Farfield Background Build-up Dilution for a conservative toxic pollutant
S_{b1} = 150:1, acute
S_{b2} = 256:1, chronic
= 364:1, human health

Sample Calculation:
$C_L = C_a + [(C_c - C_a)/(1/S_n + 1/S_b - 1/(S_n)(S_b)]$

Acute:
$C_L = 0 + [(13 -0)/(1/71.3 + 1/150 - 1/(71.3)(150)]$
$C_L = [(13)/(0.014025)+(0.006666)-(0.000093502)]$
C_L = 631 ug/l = 0.631 mg/l

Chronic:
$C_L = 0 + [(7.5 - 0)/(1/79.5 + 1/256 - 1/(79.5)(256)]$
$C_L = [(7.5)/(0.012578)+(0.0039062)-(0.000049135)]$
C_L = 456 ug/l = 0.456 mg/l

Therefore, the total residual chlorine limits for the tunnel outfall are: (1) maximum daily limit = 631 ug/l, and (2) average monthly limit = 456 ug/l

Footnotes:

1. Effluent limits for daily maximum total residual chlorine are based on the chronic values defined in the EPA Quality Criteria for Water, 1986 (Gold Book) as adopted into the State Water Quality Standards, multiplied by the available receiving water dilution.

2. Under Section 301(b)(1)(C) of the CWA, discharges are subject to effluent limitations based on Water

Quality Standards. The Massachusetts Surface Water Quality Standards include the requirements for the regulation and control of toxic constituents and also require that EPA criteria established, pursuant to Section 304(a) of the CWA, shall be used unless a site specific criteria is established. The state will limit or prohibit discharges of pollutants to surface waters to assure that surface water quality standards of the receiving waters are protected and maintained or attained.

Attachment I
Sludge Applier's Responsibilities

These conditions do not apply to material meeting conditions at 13 e and f of the permit. The person who applies bulk sewage sludge shall comply with the following requirements:

General Requirements:

1. Bulk sewage sludge shall not be applied to the land except in accordance with 40 C.F.R. Part 503 Subpart B.

2. Bulk sewage sludge shall not be applied if any of the cumulative pollutant loading rates in Paragraph 13. g. vii. have been reached on the site.

3. The person who applies the bulk sewage sludge shall obtain notice and necessary information to comply with the requirements of 40 C.F.R. Part 503 Subpart B.

4. The person who applies the bulk sewage sludge shall obtain the following information:

a. Prior to application of bulk sewage sludge, the person who proposes to apply the bulk sewage shall contact the permitting authority for the state in which the bulk sewage sludge will be applied to determine whether bulk sewage sludge subject to the cumulative pollutant loading rates in § 503.13(b)(2) has been applied to the site since July 20, 1993.

b. If bulk sewage sludge subject to the cumulative pollutant loading rates has not been applied to the site, the cumulative amount for each pollutant listed in Paragraph 13. g. vii. may be applied.

c. If bulk sewage sludge subject to the cumulative pollutant loading rates has been applied to the site since July 20, 1993, and the cumulative amount of each pollutant applied to the site since that date is known, the cumulative amount of each pollutant applied to the site shall be used to determine the additional amount of each pollutant that can be applied to the site such that the loading rates in Paragraph 13. g. vii. are not exceeded.

d. If bulk sewage sludge subject to the cumulative pollutant loading rates has been applied to the site since July 20, 1993, and the cumulative amount of each pollutant applied to the site since that date is not known, an additional amount of any pollutant may not be applied to the site.

5. The person who applies the bulk sewage sludge shall provide the owner or lease holder of the land on which the bulk sewage sludge is applied notice and necessary information to comply with the requirements of 40 C.F.R. Part 503 Subpart B.

6. The person who applies the bulk sewage sludge shall provide written notice, prior to the initial application of the bulk sewage sludge, to the permitting authority for the State in which the bulk sewage sludge will be applied. The notice shall include:

a. The location, by either street address or latitude and longitude, of the land application site.

b. The name, address, telephone number, and National Pollutant Discharge Elimination System permit number (if appropriate) of the person who will apply the bulk sewage sludge.

Management Practices:

l. The person who applies the bulk sewage sludge to the land shall comply with the following management practices:

a. The bulk sewage sludge shall not be applied to the land if it is likely to adversely affect a threatened or endangered species listed under section 4 of the Endangered Species Act, or its designated habitat.

b. The bulk sewage sludge shall not be applied to agricultural land, forest land, a public contact site or a land reclamation site that is frozen, snow-covered, or flooded so that the bulk sewage sludge enters a wetland or other water of the United States as defined in 40 C.F.R. § 122.2, except as provided in a permit issued pursuant to section 402 or 404 of the Clean Water Act.

c. Bulk sewage sludge shall not be applied to agricultural land, forest land, a public contact site, or a land reclamation site that is less than 10 meters (33 feet) from waters of the United States, as defined in 40 C.F.R. § 122.2.

d. The whole sludge application rate shall be applied at an agronomic rate designed to (i) provide the amount of nitrogen needed by the crop or vegetation grown on the land; and (ii) minimize the amount of nitrogen that passes below the root zone for the crop or vegetation grown of the land into the groundwater.

Site Restrictions:

When Class B pathogen requirements are met, the person who applies the bulk sewage sludge shall insure that the following site restrictions are met for each site on which the bulk sewage sludge is applied:

1. Food crops with harvested parts that touch the sewage sludge/soil mixture and are not totally above the land surface shall not be harvested for 14 months after application of sewage sludge.

2. Food crops with harvested parts below the surface of the land shall not be harvested for 20 months after application of sewage sludge when the sewage sludge remains on the land surface for four months or longer prior to incorporation into the soil.

3. Food crops with harvested parts below the surface of the land shall not be harvested for 38 months after application of sewage sludge when the sewage sludge remains on the land surface for less than four months prior to incorporation into the soil.

4. Food crops, feed crops, and fiber crops shall not be harvested for 30 days after application of sewage sludge.

5. Animals shall not be allowed to graze on the land for 30 days after application of sewage sludge.

6. Turf grown on land where sewage sludge is applied shall not be harvested for one year after application of the sewage sludge when the harvested turf is placed on either land with a high potential for public exposure or a lawn.

7. Public access to land with a high potential for public exposure shall be restricted for one year after application of sewage sludge.

8. Public access to land with a low potential for public exposure shall be restricted for 30 days after application of sewage sludge.

Record keeping requirements:

1. The person who applies the bulk sewage sludge subject to the cumulative loading rate shall develop and retain the following information indefinitely:

a. The location, by either street address of latitude and longitude, of each site on which bulk sewage sludge is applied.

b. The number of hectares in each site on which bulk sewage sludge is applied.

c. The date and time bulk sewage sludge is applied to each site.

d. The cumulative amount of each pollutant listed in Paragraph 4a in the bulk sewage sludge applied to each site, including the amount in Paragraph 4 of the General Requirements portion of this section. (in kilograms)

e. The amount of sewage sludge applied to each site (in metric tons).

f. The following certification statement:

"I certify, under penalty of law, that the requirements to obtain information in § 503.12(e)(2) have been met for each site on which bulk sewage sludge is applied. This determination has been made under my direction and supervision in accordance with the system designed to ensure that qualified personnel properly gather and evaluate the information used to determine that the requirements to obtain information have been met. I am aware that there are significant penalties for false certification including fine and imprisonment."

g. A description of how the requirements to obtain the information in Paragraph 4 (i through iv) [of this attachment] are met.

2. When 90 percent or more of any of the cumulative pollutant loading rates are reached, the person who applies the bulk sewage sludge shall report the information in Paragraphs 1 a through d of the Record keeping Requirements of this attachment annually on February 19. Reports shall be submitted to EPA at the address in the Monitoring and Reporting section of this permit.

3. The person who applies the bulk sewage sludge shall develop and maintain the following information for five years:

a. The following certification statement:

"I certify, under penalty of law, that the management practices in § 503.14 have been met for each site on which bulk sewage sludge is applied. This determination has been made under my direction and supervision in accordance with the system designed to ensure that qualified personnel properly gather and evaluate the information used to determine that the management practices have been met. I am aware that there are significant penalties for false certification including the possibility of fine and imprisonment."

b. A description of how the management practices in the Management Practices Paragraph of this attachment are met for each site.

c. When Class B pathogen requirements are met, the following certification statement:

"I certify, under penalty of law, that the site restrictions in § 503.32(b)(5), and have been met for each site on which bulk sewage sludge is applied. This determination has been made under my direction and supervision in accordance with the system designed to ensure that qualified personnel properly gather and evaluate the information used to determine that the management practices and site restrictions have been met. I am aware that there are significant penalties for false certification including the possibility of fine and imprisonment."

g. A description of how the site restrictions in the Site Restrictions Paragraphs of this attachment are met for each site.

Attachment J
Pathogens
(40 CFR § 503.32)

Class A - Alternative 1 (503.32(a)(3))

(i) Either the density of fecal coliform in the sewage sludge shall be less than 1000 Most Probable Number per gram of total solids (dry weight basis), or the density of Salmonella sp. bacteria in the sewage sludge shall be less than three Most Probable Number per four grams of total solids (dry weight basis) at the time the sewage sludge is used or disposed; at the time the sewage sludge is prepared for sale or give away in a bag or other container for application to the land; or at the time the sewage sludge or material derived from sewage sludge is prepared to meet the requirements in §503.10(b), §503.10(c), §503.10(e), or §503.10(f).

(ii) The temperature of the sewage sludge that is used or disposed shall be maintained at a specific value for a period of time.

(A) When the percent solids of the sewage sludge is seven percent or higher, the temperature of the sewage sludge shall be 50 degrees Celsius or higher; the time period shall be 20 minutes or longer; and the temperature and time period shall be determined using equation (3), except when small particles of sewage sludge are heated by either warmed gases or an immiscible liquid.

$$D = \frac{131,700,000}{10^{0.1400t}} \qquad (3)$$

Where,

D = time in days.
t = temperature in degrees Celsius.

(B) When the percent solids of the sewage sludge is seven percent or higher and small particles of sewage sludge are heated by either warmed gases or an immiscible liquid, the temperature of the sewage sludge shall be 50 degrees Celsius or higher; the time period shall be 15 seconds or longer; and the temperature and time period shall be determined using equation (3).

(C) When the percent solids of the sewage sludge is less than seven percent and the time period is at least 15 seconds, but less than 30 minutes, the temperature and time period shall be determined using equation (3).

(D) When the percent solids of the sewage sludge is less than seven percent; the temperature of the sewage sludge is 50 degrees Celsius or higher; and the time period is 30 minutes or longer, the temperature and time period shall be determined using equation (4).

$$D = \frac{50,070,000}{10^{0.1400t}} \qquad (4)$$

Where,

D = time in days.
t = temperature in degrees Celsius.

Class A - Alternative 2 (503.32(a)(4))

(i) Either the density of fecal coliform in the sewage sludge shall be less than 1000 Most Probable Number per gram of total solids (dry weight basis), or the density of Salmonella sp. bacteria in the sewage sludge shall be less than three Most Probable Number per four grams of total solids (dry weight basis) at the time the sewage sludge is used or disposed; at the time the sewage sludge is prepared for sale or give away in a bag or other container for application to the land; or at the time the sewage sludge or material derived from sewage sludge is prepared to meet the requirements in §503.10(b), §503.10(c), §503.10(e), or §503.10(f).

(ii)(A) The pH of the sewage sludge that is used or disposed shall be raised to above 12 and shall remain above 12 for 72 hours.

(B) The temperature of the sewage sludge shall be above 52 degrees Celsius for 12 hours or longer during the period that the pH of the sewage sludge is above 12.

(C) At the end of the 72 hour period during which the pH of the sewage sludge is above 12, the sewage sludge shall be air dried to achieve a percent solids in the sewage sludge greater than 50 percent.

Class A - Alternative 3 (503.32(a)(5))

(i) Either the density of fecal coliform in the sewage sludge shall be less than 1000 Most Probable Number per gram of total solids (dry weight basis), or the density of Salmonella sp. bacteria in sewage sludge shall be less than three Most Probable Number per four grams of total solids (dry weight basis) at the time the sewage sludge is used or disposed; at the time the sewage sludge is prepared for sale or give away in a bag or other container for application to the land; or at the time the sewage sludge or material derived from sewage sludge is prepared to meet the requirements in §503.10(b), §503.10(c), §503.10(e), or §503.10(f).

(ii)(A) The sewage sludge shall be analyzed prior to pathogen treatment to determine whether the sewage sludge contains enteric viruses.

(B) When the density of enteric viruses in the sewage sludge prior to pathogen treatment is less than one Plaque-forming Unit per four grams of total solids (dry weight basis), the sewage sludge is Class A with respect to enteric viruses until the next monitoring episode for the sewage sludge.

(C) When the density of enteric viruses in the sewage sludge prior to pathogen treatment is equal to or greater than one Plaque-forming Unit per four grams of total solids (dry weight basis), the sewage sludge is Class A with respect to enteric viruses when the density of enteric viruses in the sewage sludge after pathogen treatment is less than one Plaque-forming Unit per four grams of total solids (dry weight basis) and when the values or ranges of values for the operating parameters for the pathogen treatment process that produces the sewage sludge that meets the enteric virus density requirement are documented.

(D) After the enteric virus reduction in (ii)(C) of this subsection is demonstrated for the pathogen treatment process, the sewage sludge continues to be Class A with respect to enteric viruses when the values for the pathogen treatment process operating parameters are consistent with the values or ranges of values documented in (ii)(C) of this subsection.

(iii)(A) The sewage sludge shall be analyzed prior to pathogen treatment to determine whether the sewage sludge contains viable helminth ova.

(B) When the density of viable helminth ova in the sewage sludge prior to pathogen treatment is less than one per four grams of total solids (dry weight basis), the sewage sludge is Class A with respect to viable helminth ova until the next monitoring episode for the sewage sludge.

(C) When the density of viable helminth ova in the sewage sludge prior to pathogen treatment is equal to or greater than one per four grams of total solids (dry weight basis), the sewage sludge is Class A with respect to viable helminth ova when the density of viable helminth ova in the sewage sludge after pathogen treatment is less than one per four grams of total solids (dry weight basis) and when the values or ranges of values for the operating parameters for the pathogen treatment process that produces the sewage sludge that meets the viable helminth ova density requirement are documented.

(D) After the viable helminth ova reduction in (iii)(C) of this subsection is demonstrated for the pathogen treatment process, the sewage sludge continues to be Class A with respect to viable helminth ova when the values for the pathogen treatment process operating parameters are consistent with the values or ranges of values documented in (iii)(C) of this subsection.

Class A - Alternative 4 (503.32(a)(6))

(i) Either the density of fecal coliform in the sewage sludge shall be less than 1000 Most Probable Number per gram of total solids (dry weight basis), or the density of Salmonella sp. bacteria in the sewage sludge shall be less than three Most Probable Number per four grams of total solids (dry weight basis) at the time the sewage sludge is used or disposed; at the time the sewage sludge is prepared for sale or give away in a bag or other container for application to the land; or at the time the sewage sludge or material derived from sewage sludge is prepared to meet the requirements in §503.10(b), §503.10(c), §503.10(e), or §503.10(f).

(ii) The density of enteric viruses in the sewage sludge shall be less than one Plaque-forming Unit per four grams of total solids (dry weight basis) at the time the sewage sludge is used or disposed; at the time the sewage sludge is prepared for sale or give away in a bag or other container for application to the land; or at the time the sewage sludge or material derived from sewage sludge is prepared to meet the requirements in §503.10(b), §503.10(c), §503.10(e), or §503.10(f), unless otherwise specified by the permitting authority.

(iii) The density of viable helminth ova in the sewage sludge shall be less than one per four grams of total solids (dry weight basis) at the time the sewage sludge is used or disposed; at the time the sewage sludge is prepared for sale or give away in a bag or other container for application to the land; or at the time the sewage sludge or material derived from sewage sludge is prepared to meet the requirements in §503.10(b), §503.10(c), §503.10(e), or §503.10(f), unless otherwise specified by the permitting authority.

Class A - Alternative 5 (503.32(a)(8))

(i) Either the density of fecal coliform in the sewage sludge shall be less than 1000 Most Probable Number per gram of total solids (dry weight basis), or the density of Salmonella, sp. bacteria in the sewage sludge shall be less than three Most Probable Number per four grams of total solids (dry weight basis) at the time the sewage sludge is used or disposed; at the time the sewage sludge is prepared for sale or give away in a bag or other container for application to the land; or at the time the sewage sludge or material derived from sewage sludge is prepared to meet the requirements in §503.10(b), §503.10(c), §503.10(e), or §503.10(f).

(ii) Sewage sludge that is used or disposed shall be treated in one of the Processes to Further Reduce Pathogens described in Appendix B.

Class A - Alternative 6 (503.32(a)(8)

(i) Either the density of fecal coliform in the sewage sludge shall be less than 1000 Most Probable Number per gram of total solids (dry weight basis), or the density of Salmonella, sp. bacteria in the sewage sludge shall be less than three Most Probable Number per four grams of total solids (dry weight basis) at the time the sewage sludge is used or disposed; at the time the sewage sludge is prepared for sale or give away in a bag or other container for application to the land; or at the time the sewage sludge or material derived from sewage sludge is prepared to meet the requirements in §503.10(b), §503.10(c), §503.10(e), or §503.10(f).

(ii) Sewage sludge that is used or disposed shall be treated in a process that is equivalent to a Process to Further Reduce Pathogens, as determined by the permitting authority.

Class B - Alternative 1 (503.32(b)(2))

(i) Seven samples of the sewage sludge shall be collected at the time the sewage sludge is used or disposed.

(ii) The geometric mean of the density of fecal coliform in the samples collected in (2)(i) of this subsection shall be less than either 2,000,000 Most Probable Number per gram of total solids (dry weight basis) or 2,000,000 Colony Forming Units per gram of total solids (dry weight basis).

Class B - Alternative 2 (503.32(b)(3))

Sewage sludge that is used or disposed shall be treated in one of the Processes to Significantly Reduce Pathogens described in Appendix B.

Class B - Alternative 3 (503.32(b)(4))

Sewage sludge that is used or disposed shall be treated in a process that is equivalent to a Process to Significantly Reduce Pathogens, as determined by the permitting authority.

Attachment K
Vector Attraction Reduction

Alternative 1 - (503.33(b)(1))

The mass of volatile solids in the sewage sludge shall be reduced by a minimum of 38 percent.

Alternative 2 - (503.33(b)(2))

When the 38 percent volatile solids reduction requirement in §503.33(b)(1) cannot be met for an anaerobically digested sewage sludge, vector attraction reduction can be demonstrated by digesting a portion of the previously digested sewage sludge anaerobically in the laboratory in a bench-scale unit for 40 additional days at a temperature between 30 and 37 degrees Celsius. When at the end of the 40 days, the volatile solids in the sewage sludge at the beginning of that period is reduced by less than 17 percent, vector attraction reduction is achieved.

Alternative 3 - (503.33(b)(3))

When the 38 percent volatile solids reduction requirement in §503.33(b)(1) cannot be met for an aerobically digested sewage sludge, vector attraction reduction can be demonstrated by digesting a portion of the previously digested sewage sludge that has a percent solids of two percent or less aerobically in the laboratory in a bench-scale unit for 30 additional days at 20 degrees Celsius. When at the end of the 30 days, the volatile solids in the sewage sludge at the beginning of that period is reduced by less than 15 percent, vector attraction reduction is achieved.

Alternative 4 - (503.33(b)(4)

The specific oxygen uptake rate (SOUR) for sewage sludge treated in an aerobic process shall be equal to or less than 1.5 milligrams of oxygen per hour per gram of total solids (dry weight basis) at a temperature of 20 degrees Celsius.

Alternative 5 - (503.33(b)(5))

Sewage sludge shall be treated in an aerobic process for 14 days or longer. During that time, the temperature of the sewage sludge shall be higher than 40 degrees Celsius and the average temperature of the sewage sludge shall be higher than 45 degrees Celsius.

Alternative 6 - (503.33(b)(6))

The pH of sewage sludge shall be raised to 12 or higher by alkali addition and, without the addition of more alkali, shall remain at 12 or higher for two hours and then at 11.5 or higher for an additional 22 hours.

Alternative 7 - (503.33(b)(7))

The percent solids of sewage sludge that does not contain unstabilized solids generated in a primary wastewater treatment process shall be equal to or greater than 75 percent based on the moisture content and total solids prior to mixing with other materials.

Alternative 8 - (503.33(b)(8))

The percent solids of sewage sludge that contains unstabilized solids generated in a primary wastewater treatment process shall be equal to or greater than 90 percent based on the moisture content and total solids prior to mixing with other materials.

Alternative 9 - (503.33(b)(9))

(a) Sewage sludge shall be injected below the surface of the land.

(b) No significant amount of the sewage sludge shall be present on the land surface within one hour after the sewage sludge is injected.

Alternative 10 - (503.33(b)(10))

Sewage sludge applied to the land surface or placed on a surface disposal site shall be incorporated into the soil within six hours after application to or placement on the land.

Alternative 11 - (503.33(b)(11))

Sewage sludge placed on an active sewage sludge unit shall be covered with soil or other material at the end of each operating day.

Attachment L
Sampling and Analysis

(a) Sampling: Representative samples of sewage sludge that is applied to the land, placed on a surface disposal site, or fired in a sewage sludge incinerator shall be collected and analyzed.

(b) Analytical methods: The following methods shall be used to analyze samples of sewage sludge.

(1) Enteric viruses
ASTM Designation: D 4994-89, "Standard Practice for Recovery of Viruses From Wastewater Sludges", 1992 Annual Book of ASTM Standards: Section 11-Water and Environmental Technology, ASTM, 1916 Race Street, Philadelphia, PA 19103-1187.

(2) Fecal coliform
Part 9221 E or Part 9222D., "Standard Methods for the Examination of Water and Wastewater", 18th Edition, 1992, American Public Health Association, 1015 15th Street, NW., Washington, DC 20005

(3) Helminth ova
Yanko, W.A., "Occurrence of Pathogens in Distribution and Marketing Municipal Sludges", EPA 600/1-87-014, 1987. National Technical Information Service, 5285 Port Royal Road, Springfield, Virginia 22161 (PB 88-154273/AS).

(4) Inorganic pollutants
"Test Methods for Evaluating Solid Waste, Physical/Chemical Methods", EPA Publication SW-846, Second Edition (1982) with Updates I (April 1984) and II (April 1985) and Third Edition (November 1986) with Revision I (December 1987). Second Edition and Updates I and II are available for the National Technical Information Service, 5285 Port Royal Road, Springfield, Virginia 22161 (PB-87-120-291). Third Edition and Revision I are available from Superintendent of Documents, Government Printing Office, 941 North Capital Street, NE., Washington, DC 20002 (Document Number 955-001-00000-1).

(5) Salmonella sp. bacteria
Part 9260 D., "Standard Methods for the Examination of Water and Wastewater", 18th Edition, 1992, American Public Health Association, 1015 15th Street, NW., Washington, DC 20005; or

Kenner, B.A. and H.P. Clark, "Detection and enumeration of Salmonella and Pseudomonas aeruginosa", Journal of the Water Pollution Control Federation, Vol.46, no 9, September 1974, pp. 2163-2171. Water Environment Federation, 601 Wythe Street, Alexandria, Virginia 22314

(6) Specific oxygen uptake rate
Part 2710 B., "Standard Methods for the Examination of Water and Wastewater", 18th Edition, 1992, American Public Health Association, 1015 15th Street, NW, Washington, DC 20005

(7) Total, fixed and volatile solids
Part 2540 G., "Standard Methods for the Examination of Water and Wastewater", 18th Edition, 1992, American Public Health Association, 1015 15th Street, NW, Washington, DC 20005

(c) Percent volatile solids reduction: Shall be calculated using procedures in "Environmental Regulations and Technology - Control of Pathogens and Vectors in Sewage Sludge", Appendix C, EPA 625/R-92/013, December 1992, U.S. Environmental Protection Agency, Office of Research and Development, Washington, DC 20460

Attachment M
Nine Minimum Controls
Documentation and Implementation Guidance

The following guidance is for communities preparing documentation to demonstrate adequate implementation of the nine minimum technology based control measures for combined sewer overflows. For further information see *Combined Sewer Overflows: Guidance for Nine Minimum Controls (EPA MAY 1995)(EPA 832-B-95-003)*.

EPA has made a Best Professional Judgement (BPJ) determination that adequate implementation of technology based requirements, Best Practicable Control Technology Currently Available (BPT), Best Conventional Pollutant Control Technology (BCT) to control and abate conventional pollutants, and Best Available Technology Economically Achievable (BAT) to control and abate non-conventional and toxic pollutants, must include implementation of the nine minimum controls.

Documentation Requirements

Documentation should provide sufficient information to demonstrate:

- that alternatives were considered for each of the nine minimum control measures.

- the reasoning for the alternatives that were selected.

- that the selected alternatives have been implemented.

- that the permittee has developed a schedule for actions that have been selected but not yet fully implemented.

Nine Minimum Controls (NMC)

The following is a summary of specific information which must be included in the documentation of each of the NMCs.

1. **Proper operation and regular maintenance programs for the sewer system and combined sewer overflow points.**

    a. An organizational chart showing the staff responsible for operation and maintenance (O&M) of the combined sewer system. Document that organization and staffing levels are adequate.

    b. The funding allocated for O&M of the combined sewer system. Document that funding is adequate.

    c. A list of facilities and structures that are critical to the performance of the combined sewer system, including all regulators, tide gates, pumping stations, and sections of sewer lines which are prone to sedimentation or obstruction. Include an inspection plan which identifies the locations, frequency, procedures, documentation, and reporting of periodic and emergency inspections and maintenance. Document that these facilities are adequately operated and maintained.

    d. A summary of safety training and equipment provided to inspection and maintenance personnel. For instance, workers entering sewers must be trained and equipped for confined space entry. Document that training listed is adequate.

    e. A summary of technical training and maintenance equipment provided to inspection and maintenance personnel. Document that training and equipment are adequate to maintain the facilities identified in item 1.c. above.

2. Maximum Use of the Collection System for Storage

a. Collection system inspection: This should focus on the identification of maintenance or design deficiencies that restrict the use of otherwise available system capacity. This evaluation should document that inadequate regulators, piping bottlenecks, and pumping deficiencies have been identified and corrected, or scheduled for correction. Where increased inspection and/or maintenance is proposed, this shall be reflected in the inspection plan required in item 1.c.

b. Tide gate maintenance and repair: Tide gates prevent significant volumes of water from entering the conveyance system, thereby freeing up system storage capacity during wet weather periods. Where appropriate, document that tide gate maintenance and repair procedures are adequate.

c. Adjustment of regulator settings: Adjustment of regulating devices can increase in-system storage of CSO flows and maximize transport to the POTW. Care should be taken to ensure that the regulator adjustment will not result in unacceptable surcharging of the system. Document that regulators have been adjusted to optimum settings. The method by which the community determined the optimum regulator setting (e.g. modeling, trial and error) shall be included in the documentation.

d. Removal of obstructions to flow: Document that accumulations of debris which may cause flow restrictions are identified, and debris is removed routinely. Documentation shall include a summary of the locations where sediment is removed, the number of times each year the sediment is removed and the total quantity of material removed each year.

3. Review and Modification of the Industrial Pretreatment Program to assure CSO impacts are minimized.

a. Review legal authority: Review the community's legal authority (i.e. pretreatment program, sewer use ordinance) to regulate non domestic discharges to its collection system. Identify those activities for which the community has or can obtain legal authority to address CSO induced water quality violations. For example, does the community have legal authority to require non domestic dischargers to store wastewater discharges during precipitation events or can the community require non domestic dischargers to implement runoff controls?

b. Inventory non domestic dischargers: Identify those non domestic discharges that may, through quantity of flow or pollutant concentration or loadings, contribute to CSO induced water quality violations,

c. Assess the significance of identified dischargers to CSO control issues: Assess whether the identified non domestic sources cause or contribute to CSO induced water quality standards by using monitoring, dilution calculations or other reasonable methods.

d. Evaluate and propose feasible modifications: Identify, evaluate, and propose site-specific modifications to the pretreatment program which would address the non domestic dischargers identified as significant. Modifications which shall be considered include;

Volume-related controls: Document that detaining wastewater flows (sanitary, industrial, and/or storm water) within the industrial facility until they can be safely discharged to the POTW for treatment was considered and implemented where reasonable.

Pollutant Load-related controls: Document that reduction of concentrations of pollutants that enter the collection system during storm periods was considered and implemented where reasonable. Methods to be considered for reducing pollutant concentrations from stormwater runoff controls include structural and non-structural controls such as covering material storage areas, reducing impervious area, detention structures, and good housekeeping.

4. Maximization of flow to the POTW for treatment

It is recognized that most of the actions recommended for maximization of the collection system for storage will also serve to maximize flow to the POTW. In addition to optimizing those controls to maximize flow to the POTW, the following specific controls should be evaluated and implemented where possible;

a. Use of off-line or unused POTW capacity for storage of wet weather flows.

b. Use of excess primary treatment for treatment of wet weather flows. If the use of excess primary capacity will result in violations of the community's NPDES permit limits, the community shall get approval of the proposed bypass from the permitting authority prior to implementation.

5. Prohibition of CSO discharges during dry weather

a. Document that the community's monitoring and inspections are adequate to detect and correct dry weather overflows (DWOs) in a timely manner.

b. Document that DWOs due to inadequate sewer system capacity have been eliminated. If elimination is scheduled but not yet completed, the documentation shall include the schedule.

c. Document that DWOs due to clogging of pipes and regulators or due to other maintenance problems have been eliminated to the maximum extent practicable. Increased inspection and maintenance of problem areas must be considered as well as modification or replacement of existing structures.

6. Control of Solid and Floatable Material in CSO Discharges

Document that low cost control measures have been implemented which reduce solids and floatables discharged from CSOs to the maximum extent practicable. Alternatives which shall be considered include;

a. baffles in regulators or overflow structures.

b. trash racks in CSO discharge structures.

c. static screens in CSO discharge structures.

d. catch basin modifications.

e. end of pipe nets.

f. outfall booms (on surface of receiving water)

7. Pollution prevention programs that focus on contaminant reduction activities.

a. Prevention: through public education or increased awareness. For example, a water conservation outreach effort could result in less dry weather sanitary flow to the POTW and an increase in the volume of wet weather flows that can be treated at the POTW.

b. Control of disposal: through the use of garbage receptacles, more efficient garbage collection, or again, through public education.

c. Anti-litter campaigns: Campaigns through public outreach and public service announcements can be employed to educate the public about the effects of littering, overfertilizing, pouring used motor oil down catch basins, etc.

d. Illegal dumping: Programs such as law enforcement and public education can be used as controls for illegal dumping of litter, tires, and other materials into water bodies or onto the ground. Free disposal of these products at centrally located municipal dump sites can also reduce the occurrence of illegal dumping.

e. Street cleaning

f. Hazardous waste collection days: Communities are encouraged to schedule one or two days a year where household hazardous wastes can be brought to a common collection area for collection and environmentally safe disposal.

8. Public notification to ensure that the public receives adequate notification of CSO occurrences and CSO impacts.

The objective of this control element is to ensure that the public receives adequate notification of CSO impacts on pertinent water use areas. Of particular concern are beach and recreational areas that are affected by pollutant discharges in CSOs.

Where applicable, the permittee shall provide users of these types of areas with a reasonable opportunity to inform themselves of the existence of potential health risks associated with the use of the water body (bodies). The minimum control level, found in Section C.2.f. of the permit is posting of CSO discharge points.

9. Monitoring to effectively characterize CSO impacts and the efficacy of CSO controls.

As stated in the permit,in Section C.2.f. the minmum requirement is quantification and recording at the outfall. If possible, the permittee shall initiate monitoring, measuring and/or inspection activities above and beyond the minimum control levels specified in the permit. The purpose of these additional monitoring and/or inspection events is to better characterize quality of the CSOs and their impacts on all receiving waters. Examples of such events include CSO monitoring or receiving water monitoring for pollutants of particular concern.

Massachusetts Water Resources Authority effluent outfall monitoring plan:

Phase II post-discharge monitoring

Massachusetts Water Resources Authority
Charlestown Navy Yard
100 First Avenue
Boston, MA 02129
(617) 242-6000

December 1997

Environmental Quality Department
ms-044

citation:

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The Massachusetts Executive Office of Environmental Affairs organized an Outfall Monitoring Task force to provide advice, guidance, and oversight for monitoring of the MWRA effluent outfall in Massachusetts Bay. The membership (as of May 1997) of the Task Force is:

Members from State Agencies (Alternate members are shown in parentheses):

Department of Environmental Protection	Russ Isaac
Division of Marine Fisheries	Leigh Bridges, (Jack Schwartz)
Mass. Coastal Zone Management	Peg Brady, (Chris Krahforst)

Members from Federal Agencies:

National Marine Fisheries Service	Sal Testaverde
US Geological Survey	Rich Signell
US Army Corps of Engineers	Tom Fredette
Environmental Protection Agency	Matt Liebman, (Janet Labonte) (Dave Tomey)

Members from regions:

Boston	
Wastewater Advisory Committee	Susan Redlich
Save the Harbor/Save the Bay	Jodi Sugennan
Northshore	
Safer Water in Massachusetts	Polly Bradley
Cape Cod	
Center for Coastal Studies	Russ DeConti
Cape Cod Commission	Julie Early, (Susan Nickerson)

Members from the scientific community:

Robert Buchsbaum, Don Cheney, John Farrington, Gene Gallagher, Jonathan Garber, Diane Gould, Norbert Jaworski, Joe Montoya, Judy Pederson, Jerry Schubel [chair]

Non-voting participants:

MWRA staff: Mike Connor, Ken Keay, Mike Mickelson
MWRA consultants: Jim Blake, Steve Cibik, Don Galya

Drafts of this document were prepared by Windsor Sung and Carlton Hunt.

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1.0 INTRODUCTION

The Massachusetts Water Resources Authority (MWRA) is responsible for the construction and operation of a new sewage effluent outfall from the Deer Island Wastewater Treatment Plant. The new outfall will be located in Massachusetts Bay approximately 15 km from the Deer Island Plant in a water depth of 32 m (Figure 1-1). Improved effluent treatment, cessation of sludge discharge (accomplished in December of 1991), and moving the wastewater discharge from within the confines of Boston Harbor are expected to result in a significant improvement in water and sediment quality within the Harbor area without causing harm to the environment of Massachusetts and Cape Cod Bays (EPA 1988). Operation of the new outfall, originally scheduled for July 1995, has been delayed until 1998 (Table 1-1).

The MWRA is required to monitor for environmental impacts of the new outfall. The new outfall will be regulated through a permit issued by the U.S. Environmental Protection Agency and the Massachusetts Department of Environmental Protection under the National Pollutant Discharge Elimination System (NPDES). The EPA Supplemental Environmental Impact Statement (SEIS) (EPA 1988) requires monitoring for compliance with that NPDES permit, for assessing impact of the discharge beyond that which was identified in the SEIS as acceptable, and for collecting data useful for outfall management considerations. An amendment to the 1986 court order requiring the MWRA to upgrade their treatment facilities and effluent discharge outfall expanded on the data needs for outfall management (MWRA 1990). Included in this agreement was MWRA's commitment to implement "long term biological and chemical monitoring to describe existing conditions and evaluate the impacts of the treatment facility discharge." The information gained through these studies was to provide the fundamental understanding of the variability and ecological functioning of the Massachusetts Bay system.

Under the monitoring approach developed and adopted by MWRA and the Outfall Monitoring Task Force (OMTF) established by the Massachusetts Executive Office of Environmental Affairs (EOEA) to oversee the monitoring program, areas of concern (public, scientific, and regulatory) were identified following guidance for coastal monitoring included in NRC (1990). Using this information, a draft Phase I baseline monitoring plan was developed (MWRA 1991), reviewed, and accepted by EOEA with revisions (Pederson 1992). This plan described and discussed the ecological and other potential responses (perturbations) that were of concern (Table 1-2) and the field and laboratory studies that were necessary to acquire data to address these concerns. Details of the field and analytical program conducted under Phase I are described in a series of Combined Work/Quality Assurance Project Plans (Butler et al. 1995, Bowen et al. 1997, Blake and Hilbig 1995, Mitchell et al. 1995) with subsequent program revisions as data became available and in response to other recommendations (Hunt and Steinhauer 1994a,b; Hunt et al. 1994, McCarthy et al. 1996a,b,c).

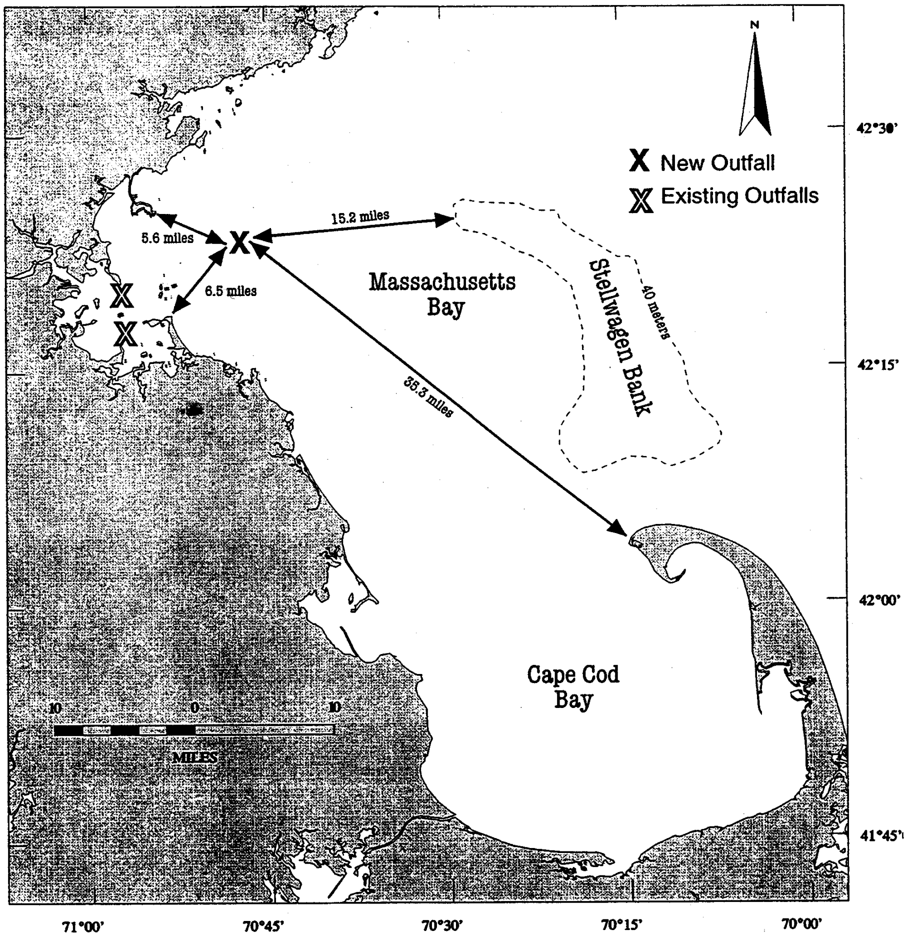

FIGURE 1-1
Distances of the new outfall from selected sensitive areas in Massachusetts and Cape Cod Bays. The exisiting outfalls are near Deer Island and the more southerly Nut Island. The new outfall is 9.5 miles from Deer Island.

TABLE 1-1

Schedule of Treatment Upgrades and Monitoring

Year	Operation
1991	The Phase I Outfall Monitoring Plan formulated the monitoring hypotheses to be tested. Sludge discharge into Boston Harbor ceased in December.
1992	Baseline monitoring initiated.
1995	New primary treatment facility on Deer Island became operational in January. Draft Contingency Plan developed.
1997	MWRA revised the Contingency Plan (2/97) in response to comments. Draft NPDES permit for relocated discharge will be presented for comment. South systems flows may be sent to Deer Island via the completed (10/97) inter-island tunnel.
1997 to 1999	Secondary treatment batteries will become operational on Deer Island in phases. (7/97 for battery A, 12/97 for battery B, 12/99 for Battery C; each battery is 160 MGD).
1998	When the outfall is relocated (scheduled for 10/98), the monitoring program changes in name from Phase I (baseline) to Phase II (post-discharge), though there is consistency in the monitoring effort.
2001	Review first 3 years of post-discharge monitoring results to evaluate the impacts of the outfall relocation, the level of monitoring effort, and the appropriateness of monitoring hypotheses and Contingency Plan provisions.

TABLE 1-2

Summary of Trigger Parameters

Monitoring Area	Trigger Parameter
Effluent	Total Suspended Solids
	Biochemical Oxygen Demand
	Pathogenic Indicator Bacteria
	Nitrogen Loading
	Toxic Metals and Organic Chemicals
	Toxicity Testing
	Floatable
	Oil and Grease
	Plant Compliance with Permit Limits
Water Column	Dissolved Oxygen Concentration
	Dissolved Oxygen Respiration Rate
	Chlorophyll
	Nuisance and Noxious Algae
	Zooplankton
	Diffuser Mixing
Benthos	Benthic Community Structure
	Sediment Oxygen
	Sediment Toxic Metal and Organic Chemicals
Fish and Shellfish	Mercury and PCBs in Flounder, Lobster, and Mussels
	Lead in Mussels
	Lipophilic Toxic Contamination
	Liver Disease in Flounder

The original discharge into Massachusetts Bay was planned for 1995. This is now projected for October of 1998. This has allowed collection of 6 years of baseline data, from 1992 to 1998, rather than the original 3 years required.

This report is the Post-Discharge Monitoring Plan (hereafter just referred to as the Monitoring Plan) for 1999 to 2001. The major emphasis is on the vicinity of the future outfall, with additional effort in Cape Cod and Massachusetts Bay. Improvements in Boston Harbor are also monitored by the MWRA but will not be covered in this report due to the difference in monitoring objectives. This Monitoring Plan describes the proposed monitoring effort and is complemented by two companion documents: the Outfall Monitoring Overview (e.g. Galya et al. 1996) describes the results of studies implemented under the Monitoring Plan, and the Contingency Plan (MWRA 1997) describes the response to exceedances of monitoring hypotheses. The Contingency Plan (MWRA 1997) lists thresholds (Caution and Warning Levels) which were developed to protect the environment and public health. The Contingency Plan also describes the various management actions that MWRA will undertake when thresholds are exceeded. Examples of management actions include additional monitoring, development of response plans and performance of engineering feasibility studies. The Contingency Plan provides more detailed discussion of the potential management actions.

1.1 Objectives for Post-Discharge Monitoring

The primary objectives of the Monitoring Plan are:

Objective 1: Test for compliance with NPDES permit requirements

Objective 2: Test whether the impact of the discharge on the environment is within the bounds projected by the SEIS

Objective 3: Test whether change within the system exceeds the Contingency Plan thresholds.

The MWRA effluent outfall will be regulated through a NPDES permit. It has to monitor regularly to test for compliance with the permit requirements. For example, the permit win specify allowable limits of carbonaceous Biochemical Oxygen Demand (cBOD) and Total Suspended Solids (TSS) in the effluent based on expected performance. Monitoring for these parameters allows MWRA to check for treatment performance, pinpoint areas of concern and correct for problems if they exist. MWRA win submit Monthly Discharge Monitoring Reports (DMR) and report exceedance of permit limits if they occur.

The EPA SEIS (with concurrent opinion from the National Marine Fisheries Service, NMFS) determined that there would not be significant water quality or biological impacts associated with the outfall. The Monitoring Plan tests for various water quality, sedimentary and biological parameters to ensure that impacts from the discharge is within the bounds projected by the SEIS.

The Contingency Plan was first recommended by the NMFS. It specifies numerical or qualitative thresholds which can suggest that effluent quality and/or environmental conditions may be changing or might be likely to change in the future. In the event that one of these thresholds is exceeded, the Contingency Plan sets into motion a process to confirm the threshold exceedance, to determine the causes and significance of the exceedance, and, if the suggested changes are attributable to the effluent outfall, to identify the response that will be taken to return the trigger parameter to a level which is at or below the relevant threshold. There is some overlap of Objective 3 with Objectives 1 and 2. The NPDES permit requirements are now a subset of Contingency Plan thresholds.

The Massachusetts Executive Office of Environmental Affairs (EOEA) and the U.S. EPA established the outfall monitoring task force (OMTF) to oversee and make recommendations on the Monitoring Plan, as well as to provide guidance in interpretation and evaluation of collected data. The task force is comprised of members from the scientific community as well as from state agencies (Department of Environmental Protection; Division of Marine Fisheries; Massachusetts Coastal Zone Management), federal agencies (National Marine Fisheries Service, U.S. Army Corps of Engineers, U.S. Environmental Protection Agency), and regional representatives (Boston Wastewater Advisory Committee; Save the Harbor/Save the Bay; Safer Water in Massachusetts; Cape Cod Commission; Center for Coastal Studies). MWRA and their consultants are non-voting participants. The current chairperson of the OMTF is Dr. Jerry Schubel, president of the New England Aquarium.

1.2 Components of the Monitoring Plan

The Monitoring Plan is organized around the general subject headings of effluent, water column, benthic, as well as fish and shellfish monitoring. Each of these subjects will be discussed in more detail in subsequent sections and is organized as follows:

- Overview of current baseline studies and important findings
- Contingency Plan trigger parameters and threshold levels
- Post-discharge Monitoring Plan components
- Data evaluation and comparison to thresholds

It should be noted that the effort described in the Monitoring Plan is more comprehensive than that necessary to just address the Contingency Plan thresholds. This is because there is extensive interaction among water quality and ecological parameters and natural variability in a complex environmental system such as Massachusetts Bay. The additional information collected is necessary in order to gain a more complete understanding of the system, and provide data that will be used to explain any changes in the system, and whether MWRA' s discharge contributed to the change.

The Post-Discharge Phase II monitoring will require rapid evaluation of data in relation to the trigger parameters. Biological and chemical data related to the thresholds will be examined individually ahead of the data report schedules. MWRA will require early notification from the laboratories when Caution and Warning Levels are exceeded.

1.3 Contingency Plan Thresholds

The ideal Monitoring Plan requires (1) a determination of what changes are significant and (2) establishment of an appropriate sampling and analysis plan. The issue lies with the relationship (or non relationship) between biological importance and the statistical significance of a given result. Parkhurst (1985) stated that "deciding on the degree of biological importance requires subjective scientific judgement, which some workers would rather not face." The Contingency Plan thresholds are based on expected permit limits, observations from the baseline monitoring, national water quality criteria and state standards, and in some cases, best professional judgement. A formal analysis of risk to the environment or human health if a trigger parameter is exceeded has not been performed.

The baseline monitoring has shown fairly large variations in the parameters being measured, as is expected in complex environmental systems. The statistical power of detecting change has been treated at various times by Hunt and Baptiste (1993) for fish and shellfish, Coats (1995) for sediment chemistry, and Hunt et al (1995) for water column. In general, detectable change can be as low as 10 to 20% for dissolved oxygen; 50 to 100% for fish and shellfish parameters, as well as some sediment chemicals; 100 to 200% for chlorophyll and dissolved inorganic nitrogen. The proposed Monitoring Plan should provide a high probability (80%) of detecting statistically significant change. Many of the Contingency Plan thresholds are greater than current baseline conditions (e.g. mercury levels in fish) such that statistically significant changes would be detected long before the threshold is approached.

2.0 EFFLUENT MONITORING

The major purpose of effluent monitoring is to test for compliance with NPDES permit limits. The NPDES permit limits for priority pollutants are expressed as concentrations in effluent; these are based on national water quality criteria, ambient conditions, and the projected outfall dilution. The actual outfall dilution will be tested under water column studies. Effluent monitoring will also provide accurate mass loads of various contaminants such that the fate, transport and risk of these contaminants in Massachusetts Bays can be better assessed, if necessary.

2.1 Overview of Phase I Baseline Studies

MWRA currently monitors the effluent from Deer Island and Nut Island treatment plants as well as the effluent from Combined Sewer Overflow (CSO) treatment facilities. Parameters are measured on a daily, weekly or monthly basis (e.g. BOD and TSS are monitored daily; nutrients are monitored weekly; priority pollutants are monitored monthly). MWRA 's Toxics Reduction And Control (TRAC) department is charged with the pre-treatment source reduction program and has conducted studies on the source of toxic contaminants into the system. In addition, MWRA has undertaken a fairly detailed effluent characterization study (DECS) starting from June of 1993, which has the following highlights:

- Two-24 hour composite effluent samples were collected per month, on two of the three days of the routine NPDES permit sample collection.
- Samples were analyzed for trace metals, PAHS, PCBs and pesticides using methods modified to achieve significantly lower detection levels than NPDES methods.
- The same nutrients measured in the water column program were characterized in the effluent. These include dissolved inorganic nitrogen compounds (ammonium, nitrite, nitrate), total dissolved nitrogen and particulate organic nitrogen, dissolved phosphate, total dissolved and particulate organic phosphorus, urea, dissolved silicate and biogenic silica, dissolved and particulate organic carbon.
- Special studies of removal efficiencies for the above analytes were performed at the MWRA pilot secondary treatment plant from 1993 to 1995.
- Special study of potential sewage tracers in effluent were evaluated, including linear alkyl benzenes (LAB), *Clostridium perfringens* spores and stable isotope ratios of sulfur and nitrogen.

Important Findings

Effluent monitoring has demonstrated that, in general, improvements made at the MWRA system during the last few years have resulted in substantial improvements in wastewater effluent quality .The 1996 daily average concentration of BODS in Deer Island wastewater was 73 mg/l, with a range from 33 to 129 mg/l. The 1996 monthly average concentration of TSS in Deer Island wastewater was S2 mg/l, with a range of 24 to 133 mg/l. However, secondary treatment should lower both the BODS and TSS to below 30 mg/l in undiluted effluent. Typically, the carbonaceous BOD is less than BODS.

The total nitrogen load being discharged by MWRA in 1996 was estimated to be 12,692 tons, which slightly exceeded the Contingency Plan Caution Level. Figure 2-1 shows the total nitrogen load discharged from MWRA for the time period of 1990 to 1996.

The monitoring program demonstrated that substantial reductions have occurred in the loading of toxic contaminants. The pilot treatment studies demonstrated the efficacy for secondary treatment to further decrease the concentration of many toxic contaminants. MWRA anticipates that an approximately 100-fold dilution of the effluent will occur within a few tens to hundreds of meters of the future diffuser. This dilution will ensure that there is minimal risk to aquatic life.

The results of these effluent characterization studies have shown the importance of using proper laboratory analysis techniques with low detection limits. Toxic contaminant loads have been much better quantified, leading to the conclusion that earlier load estimates were too high.

2.2 Contingency Plan Trigger Parameters and Threshold Levels

Based on the results of these Phase I monitoring results, MWRA (1997) revised the Contingency Plan and linked potential management decisions to critical parameters. Trigger parameters and threshold levels applicable to the effluent are summarized in Table 2-1.

Many of the trigger parameters (such as TSS, cBOD) are based on U.S. EPA guidelines for secondary treatment and expected NPDES permit limits. However, the total nitrogen loading levels are based on the original 1988 SEIS determination, NOAA (1988) and the loadings that were assumed in the Massachusetts Bays Eutrophication Model (Hydroqual and Normandeau 1995). The Caution Level was derived as 90% of the Warning Level and rounded to 12,500. The threshold for floatables is based on best professional judgment. The threshold for plant performance is based on standards established by EPA and the Association of Metropolitan Sewerage Agencies to define preferred and acceptable operational achievement practices.

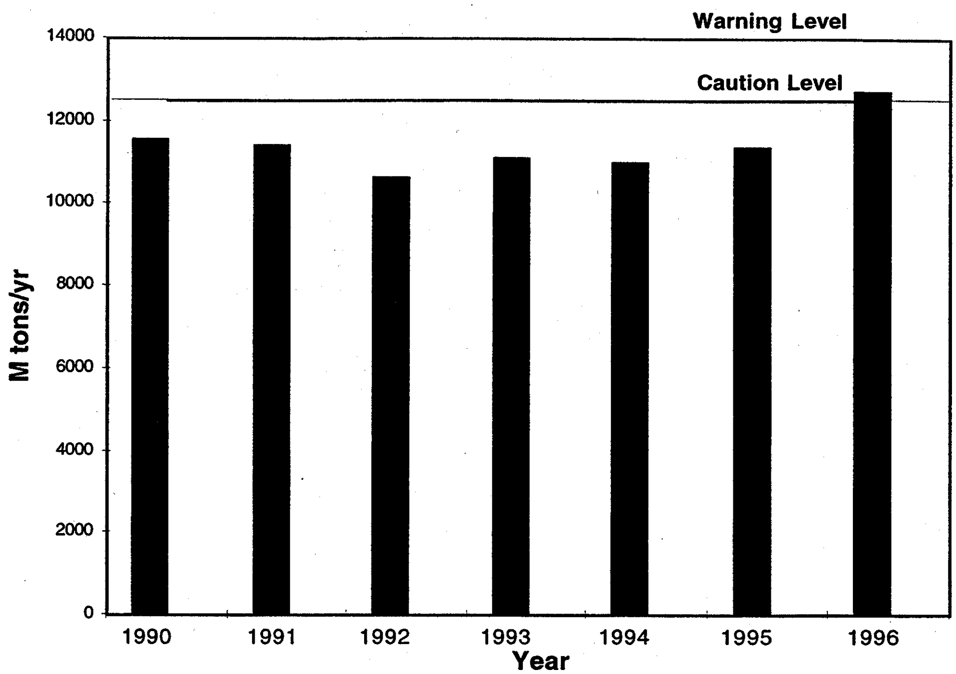

FIGURE 2-1
Total nitrogen load discharged from the Deer Island and Nut Island treatment plants from 1990-1996.

TABLE 2-1

Trigger Parameters for Effluent

Parameter	Rationale for Trigger Parameters	Caution Level	Warning Level
Total nitrogen	- Potential for eutrophication based on water quality modeling and SEIS	12,500 mtons/yr	14,000 mtons/yr
Toxics	- Levels developed to meet water quality criteria and NPDES permit limits		NPDES permit limits
Effluent Toxicity	- Direct measure of effluent toxicity - Based on expected NPDES Permit limits		Acute: LC50<50% for shrimp; chronic: NOEC for fish growth and sea urchin fertilization <1.5% effluent concentration at edge of mixing zone.
Carbonaceous BOD (cBOD)	- Provides measure of organic loading - Expected secondary treatment performance		40 mg/l weekly 25 mg/l monthly
Fecal coliform	- Surrogate for pathogens - Based on Massachusetts Water Quality Standards		14,000 fecal coliforms/100 ml daily at point of dechlorination
Total suspended solids (TSS)	- Provides measure of solids loading - Expected NPDES permit limit		45 mg/l weekly 30 mg/l monthly
Floatables	- Aesthetic issue and may cause harm to marine life - Expected removal		5 gal/day in final collection device
Oil and grease of petroleum origin	- Aesthetic issue - Expected NPDES permit limits		15 mg/l weekly
Plant performance	- Expected plant performance	More than 5 violations of permit requirements per year	Operating in violation of the permit requirements more than 5% of the time over a year

2.3 Phase II Monitoring Plan

The major purpose for Phase II post-discharge monitoring of wastewater effluent is to test for compliance with NPDES permit limits and other effluent thresholds, and to support evaluation of ambient monitoring data. The type of measurements, analytical methodology, sampling frequency and location planned for Phase II monitoring are described below.

Nutrients

Total Kjeldahl nitrogen, ammonia, nitrate, nitrite, total phosphorus and phosphate - weekly composite.

Toxic contaminants

Metals

Low-detection-limit analysis of heavy metals of concern: silver, cadmium, copper, chromium, mercury , lead, molybdenum, nickel, and zinc (The analyses incidentally yield data on arsenic, selenium, thallium, boron, beryllium, iron, and antimony) -weekly composite.

Organics

Low-detection-limit analysis of 17 persistent chlorinated pesticides, an extended list of PAHS, and 20 PCB congeners - weekly composite.
VOA (volatile organics) - bimonthly (every 2 months) grab.
ABN (acid-base-neutrals) - bimonthly composite.

Toxicity: Bioassay toxicity tests - quarterly composite.

Other: Total residual chlorine - 3 grabs/day. Cyanide - bimonthly grab**.**

Organic material

cBOD (carbonaceous biochemical oxygen demand) - daily composite.

Human pathogens

Pathogen indicators (total and fecal coliforms) -3 grabs/day.

Solids

TSS (total suspended solids) - daily composite.

Settleable solids - daily grab.

Floatables

Total petroleum hydrocarbons (oil and grease of petroleum origin) - weekly grab.
Floatables - weekly composite.

Other data:

pH - daily grab.
alkalinity - weekly composite.
LABs (linear alkyl benzenes) measured with PAHs above

Special Studies

The detailed effluent characterization study (DECS) carried out by MWRA using methods modified to achieve significantly lower detection levels than traditional methods has shown the inadequacy of traditional NPDES laboratory analysis methodologies. This is particularly true for trace metals and PCBS. The OMTF has recommended in 1996 to cutting back to roughly quarterly sampling on the low detection level based on the extensive results from 1994 and 1995. The MWRA Deer Island Laboratory is preparing to perform these low detection level measurements to supplement regular NPDES monitoring.

Pilot treatment study will be considered for continuation to compare the performance of the secondary batteries as they come on line. Detailed nutrient characterization and the measurement of potential sewage tracers, such as LAB and isotopes of sulfur and nitrogen will be re-evaluated with respect to the establishment of a clear framework on how such data would actually be used to address management concerns and aid in the decision process. These will be dropped in future monitoring programs if they fail to provide useful information for addressing management concerns.

The use of fecal and total coliform bacteria as indicators for human pathogens will be evaluated and the use of viral indicators will be explored as special studies.

2.4 Data Evaluation and Comparison to Thresholds

The Phase II Monitoring Program will provide the information to address all of the effluent thresholds and more. In particular, total nitrogen loadings will be available on a monthly basis (with no more than one to two month's lag time) and projected for the year. Effluent toxicity data and priority pollutant concentrations will be available in a similar time frame (with perhaps longer lag times for some parameters depending on sample holding time requirements, and the sample turnaround time within the laboratory). Daily evaluation of plant performance is achieved by comparing measured parameters versus expected performance.

The MWRA treatment plant is transitioning from primary treatment (new primary treatment plant came on line in 1995) to secondary treatment (first battery to come on line in 1997) in phases, with full secondary treatment by 1999. Thus, the effluent will be a blend of primary and secondary treated wastewaters until 1999. Measured concentrations of various effluent parameters will be compared to the pilot treatment plant study results. Large discrepancies between predicted and observed removal efficiencies will be resolved.

Data Analysis

Comparison of effluent monitoring results to threshold limits requires the calculation of weekly and monthly average values for several parameters. For conventional parameters, calculating the average concentration of a particular parameter is straightforward; the arithmetic mean is determined. However, when dealing with metals, pesticides, and organics, where very frequently the analytical results were below the method detection level, certain assumptions have to be made. The adoption of low detection limit methodologies will help overcome this weakness. Geometric means will be used in lieu of arithmetic means if it can be shown that the parameter follows a lognormal distribution. Time-average concentrations are flow-weighted in the case of priority pollutants (metals, cyanide, pesticides/PCBs, and organic compounds).

In addition, the flow through the wastewater treatment plant is not homogeneous. MWRA will evaluate the representativeness of different sampling locations.

Data Reporting

MWRA plans to issue quarterly wastewater performance reports, with information relevant to the Contingency Plan, effluent quality, wastewater flow, treatment plant operations and maintenance as well as residuals processing. This ensures that pertinent information will be available to the various stakeholders, including the public, in a timely manner.

3.0 WATER COLUMN MONITORING

Potential water column issues due to the relocation of the outfall are associated with effects of the effluent organic material, nutrients, and toxic contaminants. Of these, changes in the nutrient balance in Massachusetts and Cape Cod Bays have the most potential for significant effects on the health of marine life in the Bay.

Organic material occurs naturally in water bodies and may also be introduced by wastewater effluents. Decomposition of organic material consumes dissolved oxygen (DO). Nutrients are necessary for the growth of all plants, aquatic and terrestrial. There is concern that the nutrients provided by the MWRA effluent (in particular nitrogen) could promote excessive algal blooms, (e.g. Kelly 1993). The excess algae could lead to conditions of low dissolved oxygen (DO) where sensitive organisms may suffocate.

Adding effluent to the marine environment could change the relative levels of different nutrients so that undesirable algae dominate or are present along with useful algae. The undesirable algae could have impacts on the marine food web and ecology or human health.

The toxic contaminants discharged by the MWRA effluent are projected to be at extremely low concentrations. The impacts will probably not be seen directly in the water column but may be observed in sediments and bioaccumulate through fish and shellfish. This will be discussed in Sections 4 and 5.

3.1 Overview of Phase I Baseline Studies

Bigelow Laboratory for Ocean Sciences conducted a series of six surveys in 1989-1990 to collect a suite of environmental data from Massachusetts Bay. Hydrographic measurements (temperature, salinity) were taken along with nutrients (dissolved nitrate, nitrite, ammonium, silicate and phosphate), dissolved oxygen, chlorophyll-a, and particulate organic carbon (POC) and nitrogen (PON). In addition, primary production was measured, as well as phytoplankton community structure and zooplankton volume.

Water column monitoring was expanded in 1992, focussing on a nearfield area, a 120 square kilometer area (an area roughly the size of Boston Harbor) centered on the future outfall. The nearfield area included 21 stations and was sampled 14 to 16 times per year from 1992 to 1994. This expanded monitoring also included 25 to 31 farfield stations covering Massachusetts and Cape Cod Bays and Boston Harbor. These farfield stations were sampled six times per year from 1992 to 1994.

For 1995-97 the water column monitoring design was slightly modified following review to include 17 nearfield stations sampled 17 times per year. The farfield monitoring includes 26 stations sampled 6 times per year. *In situ* hydrographic parameters are measured at each station and samples are collected for analysis of dissolved inorganic nutrients. At a subset of the stations, samples are collected for analysis of dissolved organic carbon, nitrogen, and phosphorus; particulate carbon, nitrogen, and phosphorus; total suspended solids; and chlorophyll-a (filtered samples) and phaeopigments and identification and enumeration of phytoplankton and zooplankton. ^{14}C primary production has been measured in both the nearfield and the farfield, with current emphasis on two nearfield stations and one farfield station adjacent to Deer Island. Water column respiration has been measured at the productivity stations and at one offshore station.

Important Findings

Water column monitoring has shown Massachusetts Bay to be a complex and highly variable system. Much of what occurs in the system is controlled by its seasonal physical characteristics. Massachusetts Bay undergoes an annual progression from a vertically mixed water mass during late fall to spring, to a strongly stratified system in summer (during June to October). While mild stratification may occur in the spring due to freshwater inputs to the system, temperature is primarily responsible for the summer stratification.

Water column nutrient concentrations reach annual maxima in the winter. As light increases during late winter (February-March), a strong seasonal phytoplankton bloom typically develops which occasionally depletes nutrients throughout the water column. This late winter bloom may be followed by a second event in late April, particularly if the first bloom is not strong and sufficient nutrients remain. The baseline data indicate that nitrogen is typically the limiting nutrient in the system.

As the seasonal thermocline sets up, a strong density barrier is formed which prevents vertical mixing, and dissolved nutrient concentrations in the surface layer diminish due to phytoplankton uptake. The depth of the thermocline typically is at 15 to 20 meters in the nearfield (about half way to the sea floor). Periodic upwelling and mixing events, which occur during the stratified period, release nutrients from below the pycnocline into the surface waters, enhancing summertime phytoplankton productivity. As the surface layer begins to cool and sink in the fall, the water column mixes and nutrients trapped in the bottom layer are released to the surface. This nutrient release typically produces a fall phytoplankton bloom that can exceed the spring event in terms of chlorophyll biomass and productivity.

The thermocline also creates a barrier to oxygen diffusion from the atmosphere. As a result, dissolved oxygen (DO) concentrations in the bottom water typically decline throughout the stratified period. The relative magnitude of the DO depression is dependent upon several factors:

- initial DO concentration at the onset of stratification;
- bottom water temperature;
- duration of stratification;
- availability (and quality) of carbon substrate to fuel respiration; and
- the occurrence of periodic perturbations (mixing, horizontal advection) to the water column which may resupply oxygen to bottom waters.

The rate of DO decline during the stratified period has been relatively uniform throughout the baseline monitoring years, however, two baseline years (1994 and 1995) had significantly lower minimum DO concentrations. These two years both had higher bottom water temperatures as well as lower initial concentrations, and appeared to have been subjected to a lesser degree of periodic alteration of stratification.

The conceptual models, which have evolved from the synthesis of baseline data, have supported the development and refinement of threshold parameters to be used for post-relocation evaluations. These are discussed in the following section.

3.2 Contingency Plan Trigger Parameters and Threshold Levels

Based on the results of the Phase I baseline studies, MWRA (1997) revised the Contingency Plan and linked potential management decisions to critical parameters. The levels applicable to the water column are summarized in Table 3-1. These are discussed further below. Seasons are defined for the table as follows: spring, January to April; summer, May to August and fall, September to December.

Dissolved Oxygen Concentration and Saturation

Aquatic animals are sensitive to the concentration of DO in the water column. Low levels of DO can have negative impacts on marine life. Because of the importance of DO, the state has set a water quality standard that DO should not fall below 6 mg/l and 75% of saturation in Massachusetts bay. MWRA is using these standards as the basis for Caution and Warning Levels for bottom waters in the nearfield and Stellwagen Basin. During the five year baseline period (1992 to 1996), the DO saturation Caution or Warning level have been violated on several occasions (four times in the nearfield, five times in Stellwagen). The applicability of the current DO threshold levels should be re-evaluated.

Dissolved Oxygen Depletion Rate

The average baseline DO depletion rate measured from 1992 to 1996 is about -0.026 mg/l/day. A 1.5-fold increase in the DO depletion rate would trigger exceedance of a Caution Level. An increase could be related to increased respiration of discharged organic matter or of algae stimulated by discharged nutrients, or to decreased ventilation of bottom waters.

TABLE 3-1

Trigger Parameters for Water Column

Parameter	Rationale for Threshold Level	Caution Level	Warning Level
Dissolved oxygen in bottom waters of nearfield and Stellwagen basin (ppm or saturation level)	• Measures potential for hypoxia, or low DO impacts • Level based on Massachusetts Water Quality Standards	Monthly mean < 6.5 mg/l or 80% of saturation for any one month during stratification (June - Oct.)	Monthly mean < 6 mg/l or 75% of saturation for any one month during stratification (June - Oct.)
Oxygen depletion rate in nearfield bottom (mg/L/day)	• Measures short-term and long-term rate of DO depletion and potential for future hypoxia • Level based on prediction in SEIS for the potential for hypoxia	Monthly depletion rate > 1.5X baseline during stratification (June - October), -0.040 mg/L/day	Monthly depletion rate > 2X baseline during stratification (June - October), -0.053 mg/L/day
Chlorophyll in nearfield (μg/L)	• Measures the algal biomass and provides indication of eutrophication state • Level based on appreciable change from baseline conditions	Annual mean > 1.5X baseline, 2.80 μg/L Seasonal mean concenteration exceeds 95th percentile of baseline distribution. Spring: 2.71 μg/L Summer: 2.27 μg/L Fall: 4.44 μg/L	Annual mean > 2X baseline, 3.74 μg/L
Paralytic shellfish poisoning in farfield	• Measures the impact of undesirable algae	New incidence	None
Nuisance algae in nearfield (cells/L)	• Measures and evaluates increases in undesirable algae concentration • Level based on change from baseline conditions	*Alexandrium tamarense* season mean population densities exceeds 95th percentile of baseline mean. Spring: 2.34 cells/L Summer: 26.1 cells/L Fall: 7.57 cells/L	None

TABLE 3-1 (Cont'd)

Trigger Parameters for Water Column

Parameter	Rationale for Threshold Level	Caution Level	Warning Level
Zooplankton assemblage in nearfield region	• Measures potential change in zooplankton community structure • Level based on qualitative indications	Nearfield assemblage shifts from a transitional community towards an inshore community (*Acartia, Eurytemora, Centropages hamatus*) with fewer representatives from an offshore community (*Calanus, Pseudocalanus, Centropages typicus, Oithona*)	
Initial dilution	• Measures the performance of the actual outfall • Level based on comparison between design and actual dilution		Less than that set by NPDES permit

Chlorophyll

Adding effluent to the marine environment could change the amounts of nutrients or the relative levels of different nutrients so that excessive or prolonged algal blooms could occur. Chlorophyll is the most common measure of algal biomass. Since baseline concentrations of chlorophyll-a average about 2-3 ~g/l, the Caution and Warming Levels were set at 3 to 4 ~g/l based on peer review comments to the OMTF . The levels are well below the chlorophyll-a level of 20 g/l which is mentioned as a eutrophication threshold in the National Oceanographic and Atmospheric Administration' s Estuarine Eutrophication survey (NOAA 1997). In addition to annual means, seasonal thresholds for chlorophyll were developed to better reflect the seasonal nature of algal blooms. All the discrete sampling depth samples of the nearfield from each season are averaged to produce a seasonal mean for that year. The seasonal means for the baseline period were assumed to follow a normal distribution such that the 95th percentile is directly related to the mean and standard deviation of the baseline seasonal means. Actual 95th percentile values are summarized in Table 3-1.

Nuisance and Noxious Algae

Nuisance and noxious algae occur naturally in Massachusetts and Cape Cod Bays annually albeit in small numbers. The 1996 Peer Review Workshop recommended the use of paralytic shellfish poisoning (PSP) at shellfish beds to set red tide caution levels.

The nuisance algae thresholds were developed from the baseline conditions. The Caution Levels were set as the 95th percentile of seasonal mean concentrations of the three target species of *Alexandrium tamarense, Nitzchia pungens and Phaeocystis pouchetii.*

Zooplankton

Zooplankton community composition in inshore regions of Massachusetts Bay differs from that in offshore regions. The nearfield region represents a transition between the two communities. The zooplankton species in inshore communities require the high concentration of nutrients found in Boston Harbor for rnaximal growth and reproduction. One concern is that changes in nutrient concentrations resulting from outfall relocation could result in changes in the nearfield zooplankton community.

Dilution

Since all evaluations of toxic impacts depend on concentration after initial mixing, the MWRA will measure the actual dilution of effluent by seawater around the new outfall to test predictions of effluent dilution.

3.3 Phase II Monitoring Plan

Because the post-discharge monitoring results will be compared to pre-discharge results, it is important that the methods used to collect the data are comparable and consistent. Thus the Phase II monitoring plan is similar to the Phase I monitoring plan. The monitoring includes 17 surveys per year focussed on the nearfield area (see Figures 3-1 for station locations) and 6 surveys per year covering the farfield area with stations in Massachusetts and Cape Cod Bays and Boston Harbor (see Figure 3-2). Each station has a designated set of analyses performed on samples collected at various depths (see Tables 3-2 and 3-3 for nearfield and farfield station designations and Table 3-4 for definition of analysis groups). Stations F23, NO4 and N18 are actually D+P+R stations, but historically displayed as D+P stations in Figure 3-1 for convenience of representation. Further details are provided below.

3.3.1 Nearfield

Water Quality and Hydrography

Measurement: Dissolved ammonium, nitrate, nitrite, phosphate, and silicate; *in situ* temperature, salinity, dissolved oxygen, chlorophyll fluorescence, transmissometry , irradiance, depth of sensors, and altitude of sensors above seafloor .

Location: Discrete samples for nutrients at 21 stations (Figure 3-1) along rectangular cruise tracks at five depths: one surface sample, two rnid-depth samples that span the pycnocline when it exists, one rnid-depth sample at the chlorophyll maxima, and one bottom sample. Continuous vertical profiles of hydrographic measurements will be taken from surface to within 5 m of the bottom at each station.

Frequency: Seventeen surveys per year during weeks number 6, 9, 12, 14, 17, 20, 25, 27, 30, 32, 34, 36, 39, 41, 44, 48, and 51.

Biology and Productivity

Measurement: Dissolved organic carbon, nitrogen, and phosphorus; particulate carbon, nitrogen, and phosphorus; total suspended solids; discrete chlorophyll-a (filtered samples) along with phaeopigments; dissolved oxygen; in situ relative fluorescence.

Location: Discrete samples at 7 stations (type A or D in Figure 3-1) at 2 to 5 depths (depending on the parameter) as presented in Tables 3-2 and 3-4.

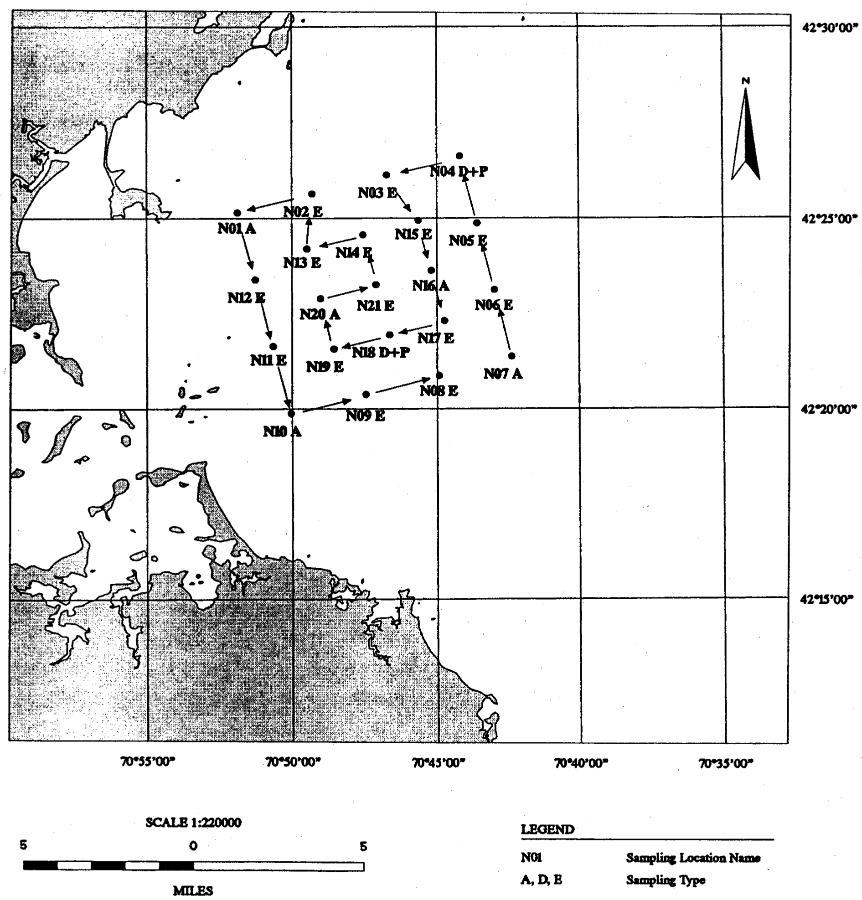

FIGURE 3-1
Nearfield Stations.
Arrows Denote Potential Survey Track.

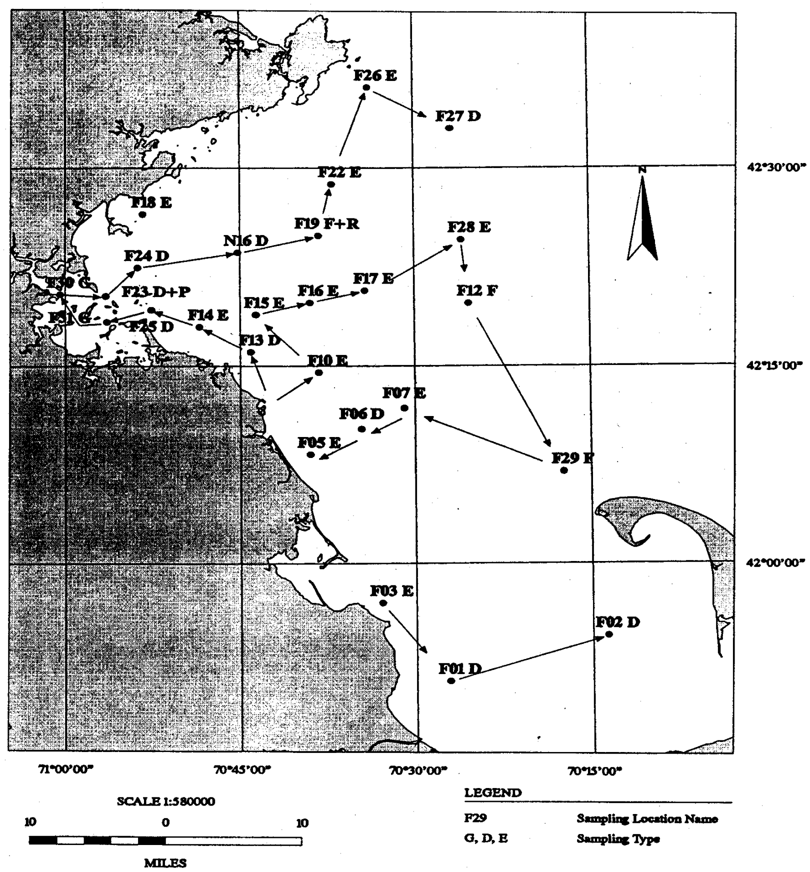

FIGURE 3-2
Farfield Stations.
Arrows Denote Potential Survey Track.

TABLE 3-2

Analysis Group for Each Station and Depth, Nearfield Survey

Station Name	N01	N02	N03	N04	N05	N06	N07	N08	N09	N10	N11	N12	N13	N14	N15	N16	N17	N18	N19	N20	N21
Station Type	A	E	E	D+P+R	E	E	A	E	E	A	E	E	E	E	E	A	E	D+P+R	E	A	E
Nearfield Stations																					
Surface	G3	G8	G8	G1 + P + R	G8	G8	G3	G8	G8	G3	G8	G8	G8	G8	G8	G3	G8	G1 + P + R	G8	G3	G8
Mid-surface	G5	G8	G8	G5 + P	G8	G8	G5	G8	G8	G5	G8	G8	G8	G8	G8	G5	G8	G5 + P	G8	G5	G8
Middle	G3	G8	G8	G2 + P + R	G8	G8	G3	G8	G8	G3	G8	G8	G8	G8	G8	G3	G8	G2 + P + R	G8	G3	G8
Mid-bottom	G5	G8	G8	G5 + P	G8	G8	G5	G8	G8	G5	G8	G8	G8	G8	G8	G5	G8	G5 + P	G8	G5	G8
Bottom	G3	G8	G8	G3 + P + R	G8	G8	G3	G8	G8	G3	G8	G8	G8	G8	G8	G3	G8	G3 + P + R	G8	G3	G8

TABLE 3-3

Analysis Group for Each Station and Depth, Farfield Survey

Station Name	F01	F02	F03	F05	F06	F07	F10	F12	F13	F14	F15	F16	F17	F18	F19	F22	F23	F24	F25	F26
Station Type	D	D	E	E	D	E	E	F	D	E	E	E	E	E	F+R	E	D+P+R	D	D	E
Farfield Stations																				
Surface	G1	G1	G8	G8	G1	G8	G8	G7	G1	G8	G8	G8	G8	G8	G7+R	G8	G1+P+R	G1	G1	G8
Mid-surface	G5	G5	G8	G8	G5	G8	G8	G7	G5	G8	G8	G8	G8	G8	G7	G8	G5+P	G5	G5	G8
Mid-depth	G2	G2	G8	G8	G2	G8	G8	G7	G2	G8	G8	G8	G8	G8	G7+R	G8	G2+P+R	G2	G2	G8
Mid-bottom	G5	G5	G8	G8	G5	G8	G8	G7	G5	G8	G8	G8	G8	G8	G7	G8	G5+P	G5	G5	G8
Bottom	G3	G3	G8	G8	G3	G8	G8	G7	G3	G8	G8	G8	G8	G8	G7+R	G8	G3+P+R	G3	G3	G8

Station Name	F27	F28	F29	F30	F31	N16
Station Type	D	E	F	G	G	D
Surface	G1	G8	G7	G1	G1	G1
Mid-surface	G5	G8	G7	G0	G0	G5
Mid-depth	G2	G8	G7	G2	G2	G2
Mid-bottom	G5	G8	G7	G0	G0	G5
Bottom	G3	G8	G7	G3	G3	G3

TABLE 3- 4

Chemical and Biological Analysis Performed in Each Analysis Group

Analysis	Analysis Group											
	G0	G1	G2	G3	G4	G5	G6	G7	G8	G9	P	R
Dissolved Inorganic Nutrients		X	X	X	X	X	X	X	X			
Dissolved Organic Carbon		X	X	X								
Total Dissolved N & P		X	X	X								
Particulate C & N		X	X	X								
Particulate P		X	X	X								
Biogenic Silica		X	X	X								
Chlorophyll & Phaeopigments		X	X	X	X	X	X			X		
Total Suspended Solids		X	X	X	X					X		
Dissolved Oxygen		X	X	X	X	X		X		X		
Urea		X	X									
All Phytoplankton		X	X									
Screened Phytoplankton		X	X									
Zooplankton		X										
Areal Productivity											X	
Respiration												X

Frequency: Seventeen surveys per year during weeks number 6, 9, 12, 14, 17, 20, 25, 27, 30, 32, 34, 36, 39, 41, 44, 48, and 51.

Measurement: Phytoplankton and zooplankton identification and enumeration, urea, ^{14}C primary productivity, and respiration.

Location: Discrete samples at 2 stations (type D Figure 3-1) at two depths for phytoplankton and urea (surface and mid-depth), zooplankton by net tow. Primary productivity and respiration measurements at stations N04 and N18.

Frequency: Seventeen surveys per year during weeks number 6,9, 12, 14, 17, 20,25, 27, 30, 32, 34, 36, 39,41,44,48, and 51.

Dilution

The dilution performance of the outfall will be evaluated and compared with design and model results. Revised dilution ratios will be used to update the NPDES permit and allow for better fate and transport evaluation of contaminants of concern.

Measurement: Continuous monitoring of sewage tracers such as salinity and dye (rhodamine WT added to the effluent for the survey). Hydrographic measurements to establish the current and density stratification field. The details of these measurements remain to be developed along with the workplan.

Location: Rectangular tracks in a twenty five square km area centered on the middle of the future outfa1l.

Frequency: Four surveys after the outfall becomes operational spread out over the year to represent various seasons. Measurements will be carried out in a time frame to cover typical tidal variations.

3.3.2 Farfield

Data is collected from far-field stations to establish reference conditions and to determine if a region-wide trend is occurring.

Water Quality and Hydrography

Measurement: Dissolved ammonium, nitrate, nitrite, phosphate, and silicate; *in situ* temperature, salinity, dissolved oxygen, chlorophyll fluorescence, transmissometry, irradiance, depth of sensors, and altitude of sensors above seafloor.

Location: Discrete samples for nutrients at 26 stations (Figure 3-2) at five depths: one surface sample, two mid-depth samples that span the pycnocline when it exists, one mid-depth sample at the chlorophyll maxima, and one bottom sample (three depths at the shallower harbor stations). Continuous vertical profiles of

hydrographic measurements will be taken from surface to within 5 m of the bottom at each station.

Frequency: Six surveys per year during weeks number 6, 9, 14, 25, 34, and 41.

Biology and Productivity

Measurement: Dissolved organic carbon, nitrogen, and phosphorus; particulate carbon, nitrogen, and phosphorus; total suspended solids; discrete chlorophyll-a (filtered samples) along with phaeopigments; dissolved oxygen.

Location: Discrete samples at 11 stations (type G or D in Figure 3-2) at 3 to 5 depths (depending on the parameter) as presented in Tables 3-3 and 3-4.

Frequency: Six surveys per year during weeks number 6, 9, 14, 25, 34, and 41.

Measurement: Phytoplankton and zooplankton identification and enumeration, urea, ^{14}C primary productivity, and respiration.

Location: Discrete samples at 9 stations (type D, Figure 3-2) at two depths for phytoplankton and urea (surface and mid-depth), zooplankton by net tow. Primary productivity measurements at station F23 (Figure 3-2). Respiration measurements at stations FI9 and F23.

Frequency: Six surveys per year during weeks number 6, 9, 14, 25, 34, and 41.

Paralytic shellfish poisoning

The monitoring of PSP in shellfish beds is managed by Massachusetts Department of Public Health.

3.3.3 Special Studies

Water Circulation, Particle Fate and Plume Tracking

An understanding of how the effluent would be transported away from the outfall area after initial dilution is necessary for an assessment of the risk associated with various contaminants dissolved in the effluent. An understanding of how particles would be transported, coagulate and settle is also important because many toxic contaminants tend to be sorbed on the particulate phase. The MWRA has entered into an cooperative agreement with the U.S. Geological Survey (USGS) since 1991 to perform some of these studies. The USGS maintains a moored array near the future outfall site for continuous monitoring of currents, conductivity (salinity), temperature, fluorescence (chlorophyll), and transmittance (turbidity). In addition, a sediment trap is employed at the mooring. Additional moorings could be employed, along with the use of drogues and drifters to ascertain long term average transport and sedimentation patterns. At a minimum the current USGS mooring at the outfall site will be maintained.

Plume tracking surveys are performed to determine the location and chemical and biological characteristics of the effluent discharge plume leaving the outfall and mixing with ambient waters. Physical characteristics will also be monitored. Continuous sensor measurements of salinity (conductivity), temperature, DO, chlorophyll (fluorescence), TSS (via optical beam transmittance) and perhaps acoustic techniques will be performed along with discrete water sample measurements (for calibration).

Remote Sensing

Remote sensing via satellite imagery offers the opportunity to evaluate spatial variations in the system, and to provide information on changes within the system which occur between monitoring surveys. Parameters which are available from satellite imagery include sea surface temperature and chlorophyll (e.g. Ocean Color and Temperature Scanner, OCTS). This imagery is available in processed form off the Internet; the monitoring program will access this imagery and use it in the synthesis of water column monitoring results.

Primary productivity, Benthic nutrient flux, denitrification and oxygen demand

The relation between nutrient level, chlorophyll-a and primary production, as well as its impact on dissolved oxygen, are an important concern. Alternate methods for measuring primary productivity more efficiently are being explored.

An understanding of benthic nutrient flux is necessary for calculating a mass balance of nutrients, especially for nitrogen. The bottom water depletion of dissolved oxygen is due to both water borne oxygen demands (cBOD, respiration and decay of planktonic material) and sediment bound oxygen demand. A knowledge of both is necessary to understand the DO depletion rate. This is discussed in the Benthic Monitoring Section.

Modeling

It has been recommended that the Bays Eutrophication Model (BEM) should be used to see whether DO conditions in 1992 to 1995 could be reproduced, and to be used for assessing future conditions. The original framework was ambitious in its design, with the ultimate goal to establish detailed cause and effect relations between nutrients, plankton growth and the subsequent impact on dissolved oxygen. The ability of such models for making predictions should be realistically assessed and re-evaluated, in particular whether deterministic models are applicable to complex environmental systems.

Shoreline Pathogen Monitoring

It was recommended that shellfish bed monitoring for pathogens be integrated into the overall monitoring program (in conjunction with the Division of Marine Fisheries). This recommendation is under development.

3.4 Data Evaluation and Comparison to Thresholds

Post-discharge monitoring of the water column is similar to the baseline monitoring. The suite of measurements will provide all the necessary information for threshold comparisons (chlorophyll, DO, phytoplankton and zooplankton). Other measurements are made which serve as supporting information for interpreting the threshold parameters. Furthermore, the sampling provides data suitable for input to the Bays Eutrophication Model.

<u>Dissolved Oxygen Concentration and Saturation</u>

The concentration of dissolved oxygen is bottom waters of individual samples in the nearfield and Stellwagen basin has on occasion gone below the threshold values of 6 mg/l and 75% saturation during the baseline monitoring period. The factors that determine minimum DO are 1) the initial DO concentration before it starts to decline; 2) water temperature; 3) the total time of decline and; 4) the occurrence of mixing events. These items are closely linked to the onset stratification and the tinting of the fall overturn. Violation of the DO threshold during the baseline period indicates that low DO excursions of bottom waters in Massachusetts Bay occur naturally. This issue will require consideration during evaluation of post-discharge DO data.

Dissolved Oxvgen Depletion Rate

The DO depletion rate in bottom waters of the Nearfield and in Stellwagen Basin are of special concern. The numerous DO measurements over time will allow for calculations of the DO depletion rate, which will then be compared to the threshold levels. Standard linear regression of DO concentration versus time will be performed with collection data to calculate the DO depletion rate. This will be compared directly with the mean DO depletion rate measured in the baseline period (with the appropriate multipliers, e.g. 1.5 x for Caution Level).

Chlorophyll

Chlorophyll concentrations will be available from the nearfield and farfield surveys. These chlorophyll measurements will be aggregated by time and space to provide suitable values for comparison to the threshold levels. For example, mean seasonal chlorophyll concentrations in surface waters in the nearfield will be calculated and compared to the 95th percentile of the seasonal average concentration from the baseline period. Annual average chlorophyll from ship surveys in the nearfield area will also be calculated and compared to the threshold values. Additional measurements of chlorophyll are available from satellite imagery and from an instrument deployed on the long term USGS Mooring near the future outfall site.

Nuisance and Noxious Algae

Water samples are collected for identification and enumeration of phytoplankton. Special attention will be given to the three target species *Alexandrium tamarense, Nitzchia pungens and Phaeocystis pouchetii.* The Caution Level relates to the 95th percentile of the seasonal mean concentrations.

Zooplankton

The phytoplankton net tows described above will also provide samples for zooplankton identification and enumeration. These cell data will allow for a characterization of the community structure in both the nearfield and the farfield. This will be used to determine whether the nearfield region is becoming more like the inshore region rather its present status of being a transition between inshore and offshore regions.

Dilution

The special dilution studies will provide the information necessary for calculating the actual outfall dilution and comparison against designed dilutions. This information could be used along with effluent monitoring information for permit evaluation. The available effluent loading information can be used along with the measured dilution and plume tracking studies to further evaluate the long-term fate and transport of various parameters of concern (e.g. nutrients).

Data Reporting

MWRA will develop a reporting schedule with the objective to expedite communication of threshold parameter results. For the water column monitoring, these include chlorophyll, oxygen, and nuisance phytoplankton species. Both chlorophyll and oxygen are monitored by *in situ* sensors which are post-calibrated using analytical results from discrete samples. The expedited reporting for these parameters will be:

- 1 week turnaround time (TAT) after each survey for a tabular summary of preliminary sensor un-calibrated results (e.g. Temperature, Salinity, DO, fluorescence, etc), to be accompanied by any supporting information regarding sensor offset, drift, or maintenance activity (membrane change) which may affect relative sensor output;

- 3 week TAT for a tabular summary of DO and chlorophyll analytical results to confirm preliminary sensor results, which will coincide with submittal of the survey report:

- two months (following last survey of each period) for periodic data reports, which are submitted five times per year.

MWRA will also require expedited reporting for nuisance phytoplankton taxa. Since the seasonal occurrences of the three taxa which have been identified as nuisance species *(Phaeocystis pouchetii, Alexandrium tamarense, and Pseudo-nitzschia multiseries)* vary widely, and together encompass almost the entire annual monitoring period, this reporting will be performed on a routine basis for each survey.

To achieve the objective of nuisance phytoplankton reporting, an extra screened phytoplankton sample will be collected at nearfield station N18 during each of the 17 nearfield surveys. This sample will be collected at the chlorophyll maxiinum depth. This approach will provide the best representation of the potential presence of nuisance taxa in the photic zone.

The extra screened sample will be qualitatively examined immediately upon receipt by the plankton subcontractor. The subcontractor will determine whether the nuisance taxa are present in the sample and estimate their density .In addition, the subcontractor will identify the dominant form of other taxa present. These results will be communicated with the plankton task manager, and, in the event that nuisance species are encountered, forward the results to the MWRA Water Column Task Manager. The results will also be included with the survey summary provided within one week of the survey's completion. Complete reporting of quantitative taxonomic analyses will be submitted within two months (following the last survey of each period) in the periodic plankton reports submitted five times per year.

4.0 BENTHIC MONITORING

One of the primary concerns with wastewater discharge into marine environments is organic enrichment of the seafloor, resulting in poorly oxygenated muds supporting impoverished communities of opportunistic colonizers which are pollution tolerant. Another concern is the build-up of toxic contaminants in the sediments that can be bioaccumulated by benthic organisms and eventually fish and shellfish that are commercially important. These concerns are justified in terms of sludge discharge (such as Boston Harbor prior to 1992 or the New York Bight) or primary treated effluent discharge (such as Los Angeles Hyperion plant prior to upgrade to secondary treatment) where particle loads are still relatively high. Effective dilution of the new outfall in Massachusetts Bay will help ensure only minor impact on the benthos within a relatively narrow zone around the diffuser.

4.1 Overview of Phase I Baseline Studies

The Benthic Monitoring Program was initiated in 1992 to focus on soft sediments near the site of the new outfal1 (the nearfield) with its line of 55 diffusers as well as selected sentinel stations in various parts of Massachusetts Bay and Cape Cod Bay (the farfield). It initially included 10 special stations at farfield locations sampled for biology in May 1992 as part of a USGS/MWRA survey, 20 stations in the nearfield sampled in August 1992, and 12 stations in the farfield also sampled in August 1992. However, achieving a good monitoring design for the nearfield area has been difficult due to the heterogeneity of habitats and paucity of muddy sites, and the sampling protocol was modified several times to find the best approach. Regardless of these changes, the baseline program should permit a full assessment of natural processes in the nearfield prior to the initiation of sewage disposal operations in 1998. Based upon the data through 1994, the nearfield was redefined for benthic monitoring as a 2-krn area around the outfall in which changes are most likely to occur once the outfall goes on line. The remainder of the original nearfield, and some of the nearshore farfield stations, have .since been termed midfield (see Table 4-1). Stations FF10, FF12 and FF13 are now midfield stations, but their designations have not been changed. See Figures 4-1, 4-2 for the location of these stations.

Twice since 1992, the spatial array of stations sampled with grab samples was integrated with the sediment profile camera to allow mapping of physical and biological patterns in Massachusetts Bay.

Important Findings

In Western Massachusetts Bay, including the vicinity of the future effluent outfall, relic glacial topography and infrequent physical disturbances control sediment deposition in the near and midfield. This sedimentary regime results in a complex mosaic of sediment types in the mid- and nearfield, with small

TABLE 4-1

Revised Station Grouping after Coats (1995)

Station Grouping	Distance from Outfall	Stations
nearfield (diffuser-induced changes are expected)	0-2 km	NF13, NF14, NF15, NF17, NF18, NRF19, NF23, NF24
midfield (diffuser-induced changes are less likely)	2-8 km	MF2, MF4, MF5, MF7, MF8, MF9, MF10, MF12, MF16, MF20, MF21, MF22, FF10, FF12, FF13
farfield (diffuser-induced changes are highly unlikely)	>8 km	FF1A, FF4, FF5, FF6, FF7, FF9, FF11, FF14
The original grouping by Coats for the midfield was 2-7 km from the outfall, this has been modified to 2-8 km in this plan.		

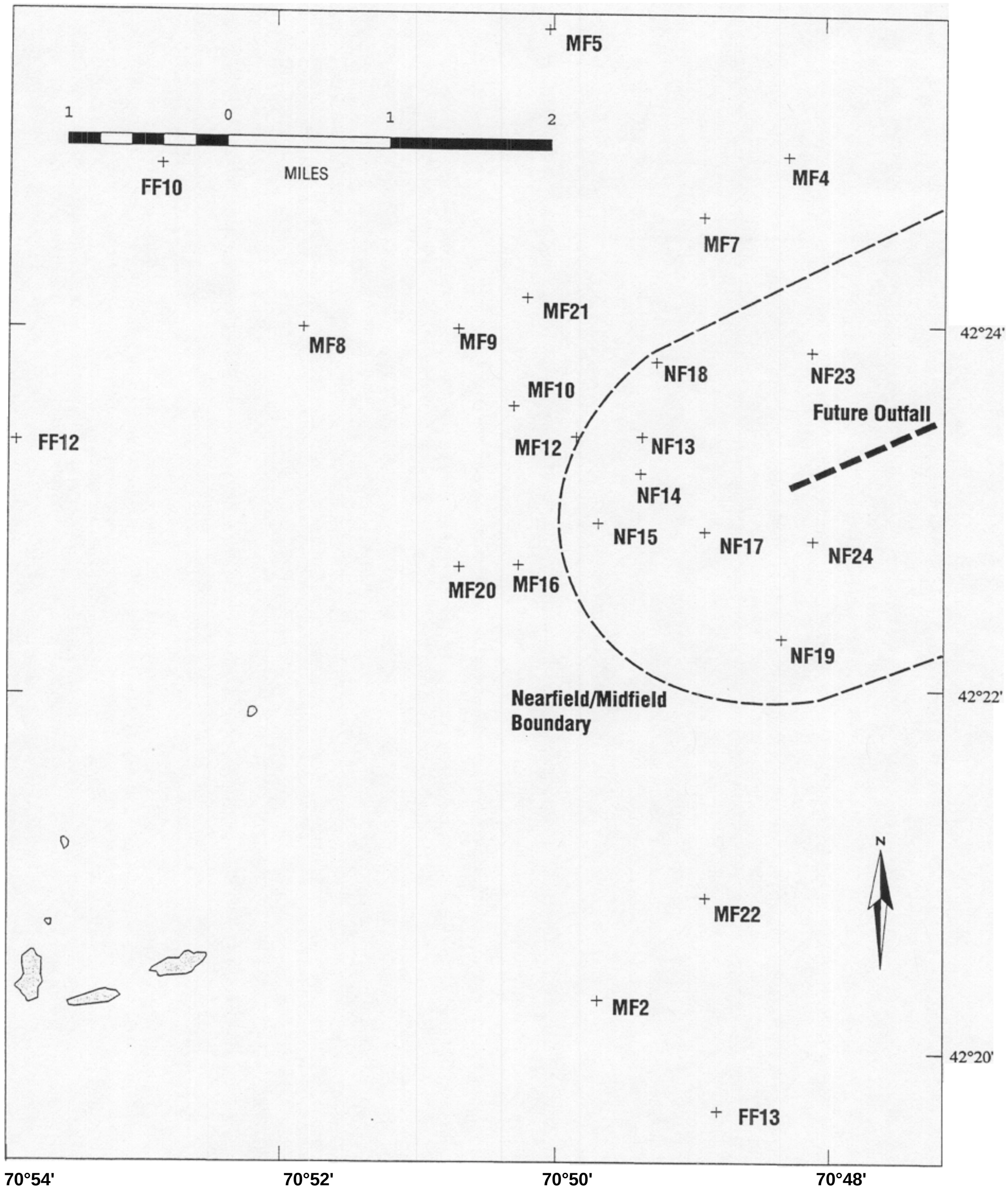

FIGURE 4-1

Nearfield and Midfield Soft Bottom Stations.

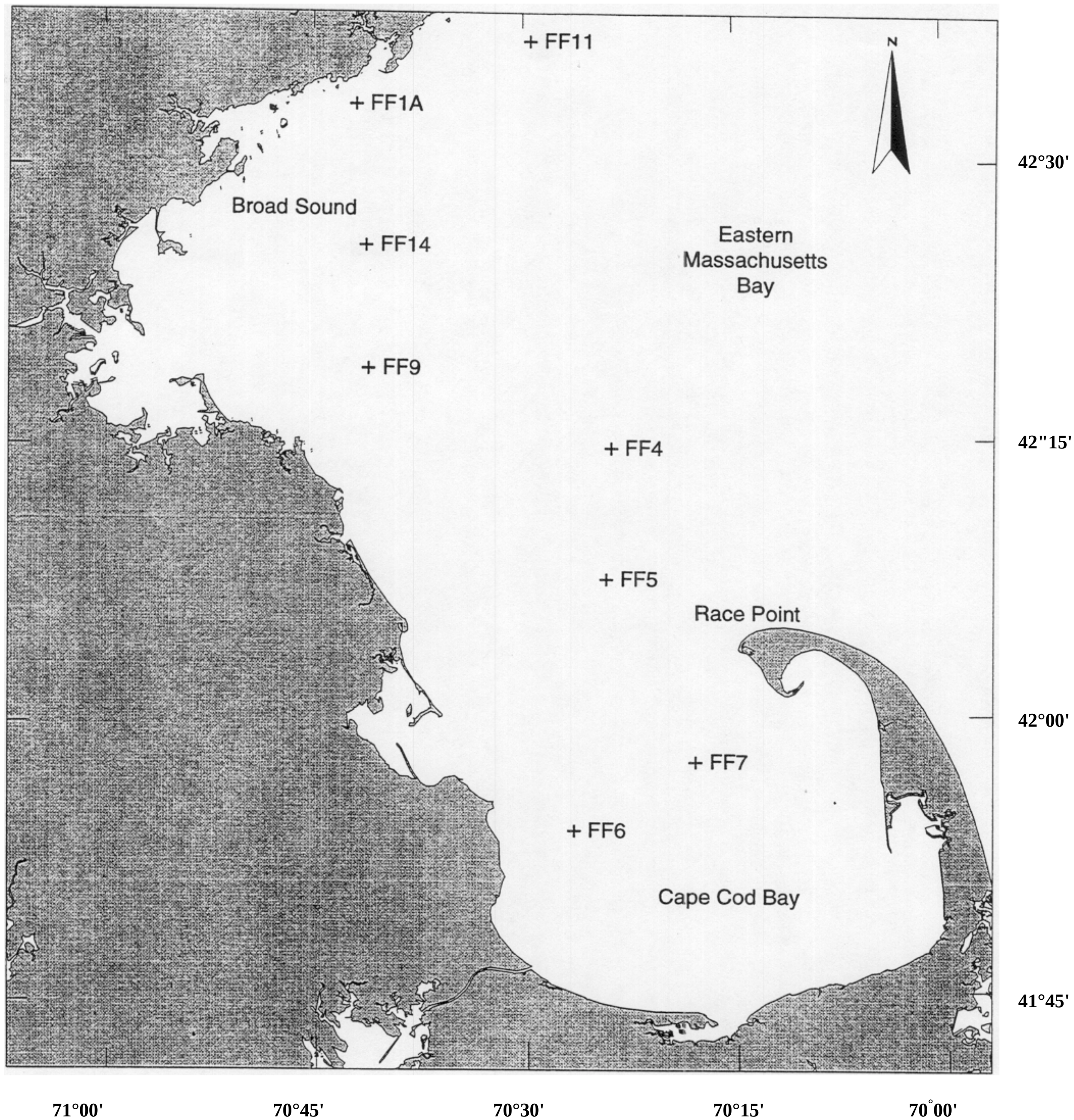

FIGURE **4-2**
Station Locations for Grab Samples, Farfield.

patches, about 100 to 1,000 m in diameter, of muddy depositional sediments interspersed with sandier patches and separated by expanses of erosional gravels, cobbles, and boulder-strewn submerged drumlins.

The presence of layered sediments, such as sand over mud, as well as changes in surficial grain size at some sites between years, has suggested active, storm-induced sediment transport.

The structure of the benthic communities in the near- and midfield is largely determined by sediment grain size. These structures have been observed in the area since inception of this program, with slight changes reflecting the shifting of sediments. Benthic community structure in the farfield is mostly influenced by water depth and also by location (Massachusetts Bay versus Cape Cod Bay). Species diversity and species composition have been varying over time, and likely have been a reflection of natural events such as larval settlement. The dominant benthic species at the future outfall site in 1995 was also abundant in 1987, but not in 1992 through 1994.

In 1994 and again in 1995, serni-quantitative video surveys were conducted in the hard-bottom areas adjacent to the new outfall to complement the soft-bottom studies. These two surveys have shown that location on the drumlins, depth. substratum type, and habitat relief all appear to playa role in determining the structure of benthic communities inhabiting hard-bottom areas in the vicinity of the future outfall. Benthic communities inhabiting drumlin tops are dominated by red algae, whereas the drumlin flanks and topographic lows are characterized by encrusting or attached fauna.

In 1995, organic contaminant concentrations in sediments were generally low and did not exceed any of the thresholds. Nearfield mean metal concentrations for all trace metals were below the ER-M sediment criteria. Mercury concentrations were relatively high at two individual stations, with the one at NF24 (1.69 ~g/g) exceeding the ER-M value of 0.71 ~g/g.

4.2 Contingency Plan Trigger Parameters and Threshold Levels

Based on the results of the Phase I Baseline Monitoring results, MWRA (1997) revised the Contingency Plan and linked potential management decisions to critical parameters. The levels applicable to the benthic environment are summarized in Table 4-2.

TABLE 4-2

Trigger Parameters for the Benthic Environment

Parameter	Rationale for Threshold Parameters	Caution Level	Warning Level
Redox potential discontinuity in nearfield sediments	- Measures decrease in oxygen content in sediment environment	RPD depth declines by half. The threshold value is under development, average is about 3.5 cm in 1995	
Toxic contaminants in nearfield sediments	- Measures potential for toxic effects on benthic marine life - Thresholds based on national sediment quality criteria	90% of EPA sediment criteria where available. 90% of NOAA ER-M or PEL, whichever is lower for a given contaminant	
Community structure (diversity, species composition, and species abundance) in outfall midfield area	- Provides measure of benthic community health	Species diversity, composition, and relative abundance patterns measured in the mid-field appreciably depart from those measured during the baseline monitoring period, after factoring out the effect of storms on sediment texture. Specific diversity threshold values are being developed.	
Species composition in the midfield (2-8 km from outfall): appearance of opportunistic species not encountered during baseline monitoring	- indicates changes in sedimentary environment	25% shift of community toward opportunists	50% shift of community toward opportunist's

4.3 Phase II Monitoring Plan

Soft-bottom benthos in the nearfield and farfield

Measurements: Benthic species composition and abundance as retained on 0.3 mrn sieves; chemical constituents including PAHS, LABS, PCBS, pesticides, metals, TOC; sediment grain size; *Clostridium perfringens* spore counts in the 0 to 2 cm depth fraction; and sediment profile images for measurement of RPD depth, and other physical and biological parameters.

Replication: In order to permit statistical comparisons between stations and years,. replication has been built into the sampling design. For the benthic biology samples, three replicate 0.04 m2 grab samples are collected at each of the farfield stations, nearfield stations NF17 and NF24 and midfield stations MF12, FF10, FF12, and FF13. The mix of replicated and non-replicated samples in the nearfield and midfield brings the total number of samples to 12 and 23 in each of these areas, respectively. According to Coats (1995), these 12 replicates can be treated as independent observations to provide sufficient statistical power to detect smaller scale changes in benthic parameters (e.g., 8% change in the Shannon-Wiener index, H' in the pooled midfield stations).

Location: Eight stations in the nearfield and 15 stations in the midfield. Eight stations in the farfield.

Frequency: One sampling per year (August) for all parameters. The OMTF has indicated that the measurement frequency for contaminants should be revisited after approximately two years of discharge monitoring data are available, and that a long-term sediment contaminant sampling frequency on the order of every 3-5 years should then be appropriate except organic and metal constituents which are to be sampled at 2-3 year intervals depending upon recommendation of the OMTF.

Special study of hard-bottom benthos in the nearfield

Measurements: Benthic hard-bottom species composition as determined by 35-mm photography and video analysis; topography and sediment cover.

Location: Eight transects along drumlins and other topographic features in the vicinity of the outfall to a distance of 2 mi (=3.2 km) north and south. See Figure 4-3 for suggested transect locations.

Frequency: One sampling per year (June to August timeframe).

Special studies on benthic nutrient flux

Benthic flux measurements have provided important information on bounds of the sediment denitrification rate, as well as the contribution of sediment oxygen demand to overall bottom water DO depletion rates.

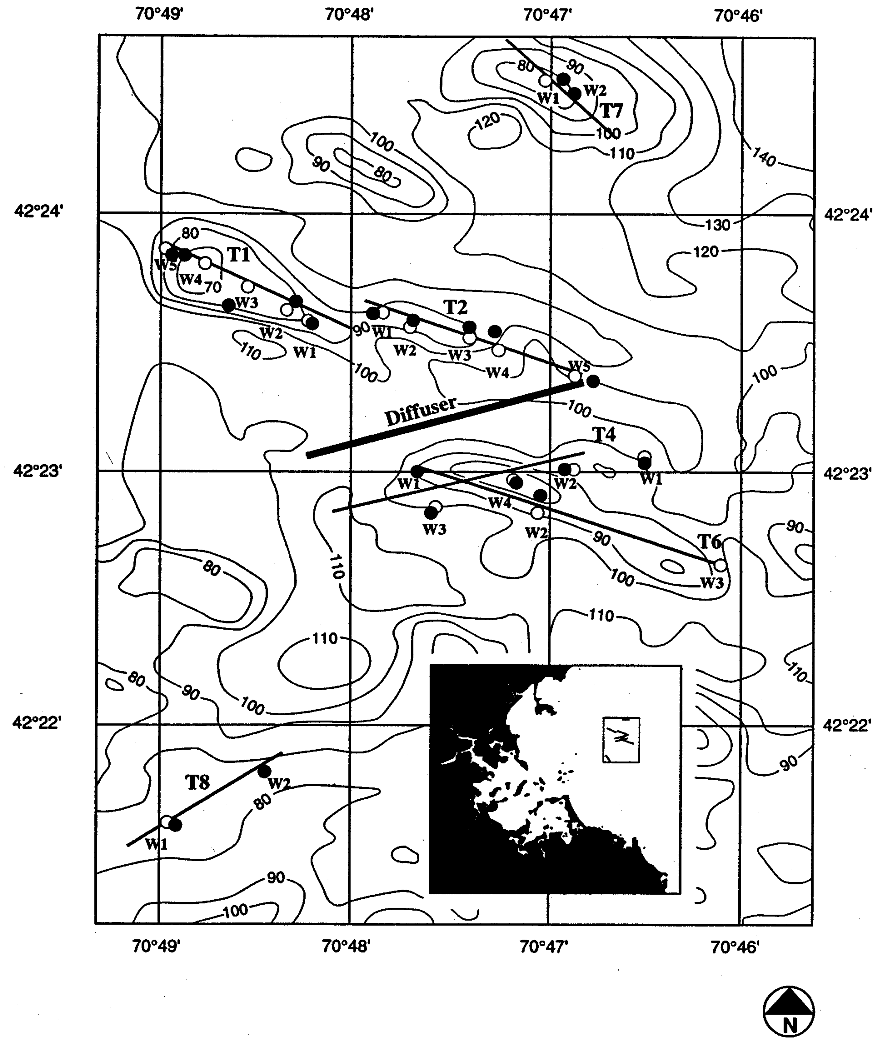

FIGURE 4-3
Transect locations for nearfield hard-bottom video survey.
Open circles are 1995 stations; filled circles are 1996 stations.

Measurements: Temperature, salinity and DO of the bottom water at each station when surveyed. Two cores per station will be incubated and measured for ammonia, nitrate & nitrite, urea, phosphate, silica and DO in the overlying water of those two cores per station every 2-8 hours. Total carbon dioxide will be measured at the beginning and end of the incubation. In addition, undisturbed sediment cores will be obtained from each station and measured for profiles of porewater ammonia, nitrate & nitrite, urea, phosphate, silicate, dissolved sulfides, pH, alkalinity and redox potential in at least 10 depths per station. Surficial sediments from each station will also be analyzed for total organic carbon, total nitrogen and grain size.

Location: See Figure 4-4 for location of benthic flux sampling locations.

Frequency: Four surveys each year during March, May, July, August and October.

Special studies on sediment transport

In addition, the USGS maintains an active research program to study the transport of sediments in Massachusetts Bay.

4.4 Data Evaluation and Comparison to Thresholds

Coats (1995) developed a complex multivariate approach to test for change in the nearfield benthic communities. He also demonstrated that pooling of replicated and non replicated contaminant data within the nearfield and midfield provides sufficient statistical power to detect any increases in contaminant concentration well before concentrations of concern are reached. However, some caution needs to be exercised because there may be a bias in pooling multiple samples from one site with non-replicated samples that are more widely distributed among sediment types.

The multivariate analysis developed by Coats (1995) for detecting change in nearfield and midfield benthic communities from baseline variation shows promise as a sensitive indicator of change in species diversity and composition, but suffers from shortcomings that limit its application as a rapid response threshold. First, it is theoretically quite complicated, and is fully interpretable only to specialists in numerical ecology. Second, before the requisite analyses can be run, extensive checks must be carried out to ensure full comparability between a year's species identifications and the baseline data set. Occasional changes in the understanding of individual groups of organisms can lead to what were formerly thought to be 2 species lumped into a single group, or to the reverse situation, with a single taxon split into 2 new species. Multivariate analyses similar to those developed by Coats (1995) are particularly sensitive to the effects of this kind of change. Reconciling the implications of such changes to a multi-year data set can often required weeks, as appropriate taxonomic authorities must sometimes be consulted.

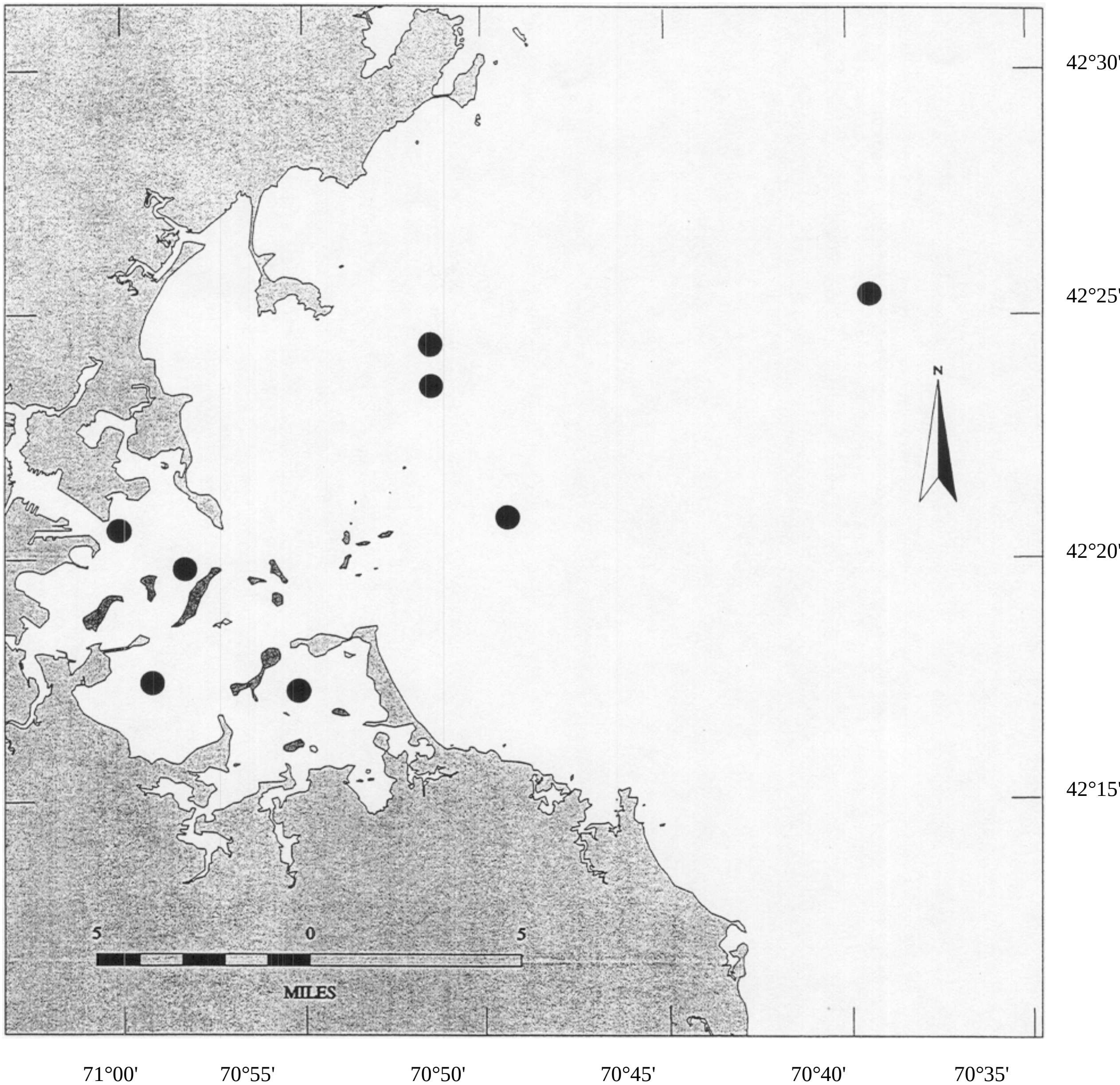

FIGURE 4-4
Benthic Nutrient Flux Sampling Locations.

Taken together, these shortcomings suggest that multivariate analyses similar to or derived from that of Coats (1995) are best used as confirmatory and/or interpretive analyses, with initial threshold testing carried out using parameters more readily understood by non-specialists, and less sensitive to minor changes in species identifications.

Soft-bottom Benthos/Benthic Diversity

A suite of parameters was developed by ecologists in the past 50 years to summarize patterns of species richness, species diversity, abundance, and dominance. However, to date none have shown broad applicability as stand-alone indicators of change in sediment communities. Investigations to refine rapid response trigger parameters for threshold testing are ongoing, and revisions to the parameters described below will be submitted for OM1F review in early Spring 1998.

Data generated by these analyses will be compared with the baseline results to ensure that no appreciable impact has occurred. In the case of the soft-bottom benthos, the nearfield has been divided into a nearfield that is within 2 km of the discharge and a midfield that extends outside of the 2 km discharge radius to a distance of 8 km. An additional three farfield stations (each with three replicates) are also located in the midfield area.

Water quality model predictions of organic carbon deposition to the seafloor (Hydroqual and Normandeau, 1995) suggest that some faunal changes are likely within 2 km of the outfall, but not in the midfield. Therefore, while changes in near-field stations will be monitored, trigger levels apply to the midfield stations outside the 2-km boundary.

Currently, the most promising diversity parameter for threshold testing appears to be species diversity calculated with the Hurlbert rarefaction method at a sample size of 100 individuals. Ongoing threshold development efforts include deriving related measures of species evenness. Other diversity metrics, for example, the Shannon Wiener information function (H') and Pielou's evenness (J'*)* will continue to be calculated, but will probably not be primary thresholds.

Measures of species diversity cannot stand alone as indicators of community change, as the identities of the species present plays no role in their calculation. In other words, identical diversities might be calculated from 2 samples that share no species. Since changes in the types of species found in sediments (known as a community's composition) are frequent responses to pollution, diversity thresholds need to be coupled with a community composition threshold.

The establishment of trigger parameters for changes in species composition is difficult because there could be a range of natural changes possible depending upon the degree of perturbation on the community.

Caution levels might include the appearance of species in dominance lists that were not previously encountered at those stations or groups of stations. Warning levels might include the total dominance of these species coupled with a corresponding decrease in species diversity .For example, the common estuarine polychaete *Polydora cornuta* is a common indicator species in Boston Harbor, yet is rare in Massachusetts Bay. The appearance of *P. cornuta* at a midfield station might be interpreted as a shift to a stressed community because the species is normally found in situations where the RPD is shallow, species diversity is low, and organic loading is high. Likewise, the appearance of dense assemblage of amphipods, such as now occur in Boston Harbor, might be indicative of an altered sedimentary regime. Any such changes in faunal composition will need to be closely compared with the species diversity and sedimentary data in order to explain and understand the processes that have led to change. Suggested Caution (20%) and Warning (50%) Levels are presented in Table 4-2.

The hard-bottom study was established by OM1F as a supplemental study, not intended to duplicate the intensity (and ultimately the sensitivity) of the soft-bottom monitoring. Therefore, no thresholds have been established for this component. The hard-bottom program will focus on interpreting effects of the discharge within the outfall nearfield. Monitoring results (consisting of video and 35-mm slides) in the different habitat types will be compared against the baseline results. The video tapes will be viewed to provide information on the uniformity of the environment. Large, clearly identifiable organisms will be enumerated. Slides will be projected and analyzed for sea-floor characteristics and organisms. Most recognizable taxa will be recorded, counted and normalized to mean number of individuals per slide. Data from each waypoint will be pooled and examined by hierarchical classification. This consists of a pairwise comparison of the species composition of all waypoints using the percent similarity coefficient. Changes in species composition and increased sediment drape on the rocks may be evidence of impact. See Figure 4-3 for the location of the hard-bottom survey transects.

Toxic Chemicals in **Sediments**

The very low contaminant concentrations found in secondary effluent means that loading of contaminants from the future discharge will be small compared to the amounts already present in the environment (Mitchell, et al., 1997). Therefore, sediment-bound contaminant concentrations are not expected to change over short time scales (months to a year) as a result of the discharge, although moderate short-term fluctuations have been documented associated with major storm events (Bothner, et al., 1993). Nonetheless, concerns over short-term build-up of contaminants were sufficient for the OMTF to determine that during the first 2 to 3 years after discharge begin, all nearfield, midfield, and farfield stations should be sampled annually, and that a small, 3 to 4 station 2-year special study focussing on even shorter time scales (every 4 months) be designed to supplement the annual sampling and the USGS sediment transport study.

The OMTF has indicated that the measurement frequency for contaminants should be revisited after approximately two years of discharge monitoring data are available, and that a long-term sediment contaminant sampling frequency on the order of every 3 to 5 years should then be appropriate.

An OMTF subcommittee that evaluated the sediment contaminant program in April 1997 recommended that previously suggested contaminant thresholds (see, for example, MWRA, 1995) be modified as follows: Where EP A has recommended draft sediment quality criteria, a Caution threshold will be established at 90% of that level. Where criteria are not available, Caution Levels will be established for individual compounds at either 90% of the Effects Range-Medium Levels published in Long et al., (1995) or at the Probable Effects Levels established in MacDonald (1993). The subcommittee recommended that no Warning Level thresholds be established at this time.

The subcommittee recommended against the addition of sediment toxicity bioassays to the routine monitoring, however suggesting that such measurements may be useful supplementary measurements if contaminant thresholds are reached. A recent study in the area demonstrated no clear link between contaminant concentrations, measurements of sediment toxicity , and the apparent health of the benthic communities sampled (Hyland and Costa, 1995).

Sediment Profile Image Analysis/RPD Depth

Sediment profile image analysis will provide an accurate estimate of the apparent depth of the redox potential discontinuity level (RPD) in sediments. The SPI camera also provides detail of surface benthic boundary features, sediment layering, grain size, methane, and various biological parameters including bioturbation and presence/absence of tube mats. An organism/sediment index can be generated, that when coupled with dissolved oxygen and *Clostridium pe1fringens* data can estimate the relative health of the seabed. A reduction in the depth of the RPD is an indication that water column dissolved oxygen is decreasing. Shallow RPDs will result in hydrogen sulfide production and possibly methane production. Deep RPDs are indicative of healthy conditions. The 1995 RPD by sediment profile image studies showed a range of 1.8 cm to greater than 6.2 cm, with a mean value of 3.5 cm.

In a monitoring program where short-term results may be crucial for identifying problems with sediment quality, the SPI camera offers the possibility of rapid data return. If necessary, the 35mm slides can be examined with a "quick-look" method that can be used to provide evidence of Caution Levels within 24 hours of sampling.

5.0 FISH AND SHELLFISH MONITORING

MWRA has continued to conduct a biomonitoring program for fish and shellfish, which supports evaluation of the future effluent outfall in Massachusetts Bay. The goal of the biomonitoring program is to obtain baseline data that may be used to assess the potential environmental impact (i.e., protection of human health and biological resources) of the effluent discharge on Massachusetts Bay, and to evaluate the facility's compliance with threshold values.

The specific objective of the fish and shellfish monitoring program to date has been to define the baseline condition of three indicator species: winter flounder (*Pleuronectes americanus*), Northern lobster (*Homarus americanus),* and blue mussel (*Mytilus edulis).* These three indicator species are used to evaluate environmental impacts to: bottom-dwelling fish (winter flounder); surface-dwelling macroinvertebrates (lobster); and water-column filter-feeder (blue mussel). Body burdens of certain pesticides (DDT , aldrin/dieldrin, chlordane, heptachlor, etc.), PCBS, lead, and mercury were compared to FDA Action limits and monitoring program warning limits to evaluate potential risk or trends. Finally, the results were evaluated for their ability to answer the underlying monitoring hypotheses.

5.1 Overview of Phase I Baseline Studies

Earlier bioaccumulation studies by MWRA have utilized blue mussels and analyzed for PAHS, selected pesticides, PCBS, lead, copper and zinc. The current baseline fish and shellfish monitoring program added more metals, mercury in particular (see Table 5-1). As shown on Figure 5-1, specimens were collected from sites in Boston Harbor (Deer Island Plats, off *Discovery*), Massachusetts Bay (Future Outfall Site, Nantasket Beach, Broad Sound), and Eastern Cape Cod Bay. Baseline conditions were characterized in terms of biological parameters (length, weight, biological condition); the presence/absence of disease (both internal and external); and concentrations of organic and inorganic compounds in various tissues. These tissues included: for the winter flounder -liver and filet; for the northern lobster -hepatopancreas and tail meat; and for the blue mussel -soft tissue. The monitored parameters were examined for spatial trends between stations and interannual variations from previous monitoring data. Since the mussels are incubated *in situ* in caged arrays, the predeployment mussels serve as experimental controls. Table 5-1 summarizes the chemical analyses performed for fish and shellfish.

Gross deformities, parasites or visually apparent diseases are noted for both collected flounder and lobster. In addition, histological measurements in flounders are used (in particular, liver lesions) as a measure of their general health, which in turn reflect on the ecological status of their general environs.

TABLE 5-1

Chemistry Analyses for Fish and Shellfish Monitoring

Organism	Number (Type of Samples)	Parameters
Flounder	9 or 15 composites (fillet)*	Mercury PCB Chlorinated pesticides Lipids
Flounder	9 or 15 composites (liver)*	Trace metals PCB PAH Chlorinated pesticides Lipids
Lobster	9 composites (meat)	Mercury PCB Chlorinated pesticides Lipids
Lobster	9 composites (hepatopancreas)	Trace metals PCB PAH Chlorinated pesticides Lipids
Mussel	20 composites (soft meat)	Mercury Lead PCB PAH Chlorinated pesticides Lipids

1 = Chemical analyses of flounder and lobster meat are conducted on three composite samples per stations. Composites are comprised of the pooled biological material from 5 individual specimens. For flounder, three monitoring stations were occupied in 1995 and 1997, by inclusion of the Nantasket Beach and Broad Sound five were occupied in 1996 (yielding 15 samples)

2 = Chemical analyses of mussel tissue is conducted on five composite samples per station (at 3 monitoring stations + 1 predeployment station). Composite are comprised of the pooled biological material from 10 individual specimen.

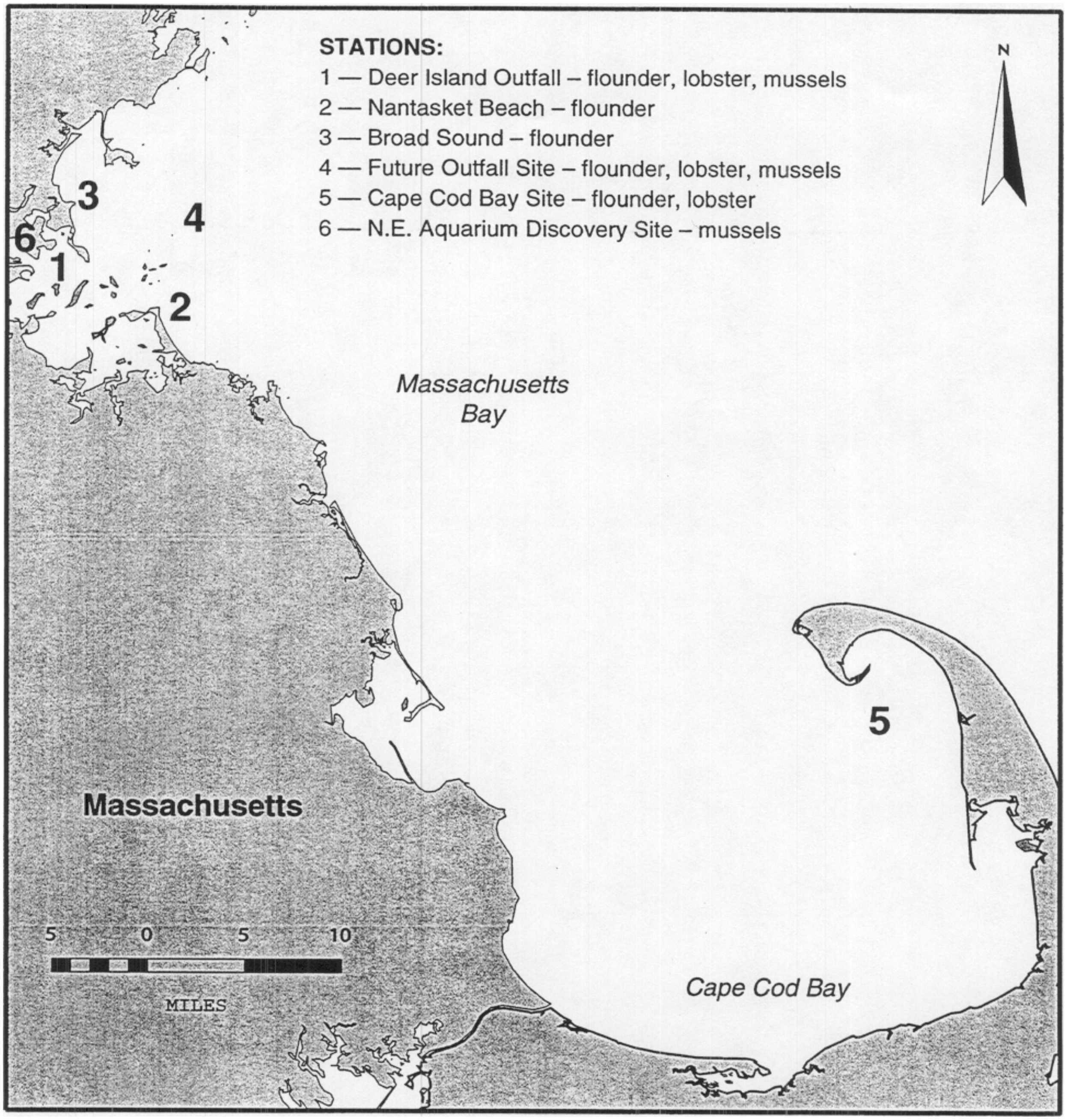

FIGURE 5-1
Sampling Stations for Winter Flounder, Lobster and Mussels during 1996.

Important Findings

The baseline fish and shellfish monitoring program has shown that contaminant concentrations are generally higher in flounder from Boston Harbor than from the future outfall site. Contaminant concentrations at the future outfall site are generally higher than similar measurements from a site in Cape Cod Bay. However, the highest 1995 mercury concentrations were present in flounder from the future outfall site. The 1995 data indicated significantly increased concentrations of DDT and PCBs over values from previous years. Liver lesions are present in flounder from all sites though the frequency of lesions has been decreasing from year to year. In lobster, the highest organic contaminant concentrations in 1995 were present at the future outfall site. Metal concentrations in lobster were lowest in Cape Cod Bay and similar at other sites, except for mercury which was highest at the future outfall site. Fish and shellfish contaminant concentrations have been consistently well below levels that might cause any concern because of human consumption.

The 1995 findings are consistent with results from earlier baseline years, which reported elevated levels of some toxic contaminants in the lobster hepatopancreas (commonly referred to as the "tomalley"). This finding has been observed in coastal Massachusetts waters for some time and was the basis for a Massachusetts Department of Public Health advisory on the consumption of tomalley issued in 1988.

5.2 Contingency Plan Trigger Parameters and Threshold Levels

Based on results from the baseline studies, MWRA (1997) revised the Contingency Plan and linked potential management decisions to the critical parameters. The trigger parameters and threshold levels applicable to Fish and Shellfish are summarized in Table 5-2. The threshold values for edible tissue body burdens are more conservative than federal Food and Drug Administration (FDA) limits based on human health risk.

5.3 Phase II Monitoring Plan

The Phase II Post-discharge Monitoring Plan will be consistent with monitoring conducted during Phase I Baseline Studies. The basic premises remain the same -that of protection of human health for fish and shellfish consumption and maintenance of the ecological health of the benthic communities. The details of the Phase n Monitoring Plan are considered below. See Figure 5-1 for the location of the sampling stations.

TABLE 5-2

Trigger Parameters for Fish and Shellfish

Parameter	Rationale for Threshold Levels	Caution Level	Warning Level
Mercury in fish and shellfish tissue near outfall	- Human health FDA limit	0.5 µg/g wet weight	0.8 µg/g wet weight
Total PCB in fish and shellfish tissue near outfall	- Human health FDA limit	1 µg/g wet weight	1.6 µg/g wet weight
Lead in mussel near outfall	- Human health FDA limit	2 µg/g wet weight	3 µg/g wet weight
Lipid normalized toxics in fish tissue near outfall	- Indicator for ecological and human health	2X baseline	
Liver disease incidence in flounder	- Indicator for ecological health	Greater than average harbor prevalence from 1991 to 1997	

Flounder and lobster

Measurements: PCB, pesticides, mercury and lipids in flounder fillet, and lobster meat. PCB, PAH, trace metals, pesticides, and lipids for flounder liver, and lobster hepatopancreas. Histological analysis for flounder liver. Animal size, mass, and dry/lipid weight will also be recorded.

Location: For flounder, Deer Island flats, Future Outfall Site and East Cape Cod Bay, Nantasket Beach and Broad Sound Sites sampled every year for histology with the Nantasket Beach and Broad Sound fish being analyzed for chemical constituents every other year. For lobster, the Deer Island flats, Future Otufall Site and East Cape Core Bay Sites are sampled every year.

Frequency: Once a year during April for flounder and July-August for lobster. Biological material from fifteen specimens from each station are pooled to form three composite samples of 5 individuals each for chemical analysis. Fifty histological sections to be made per station for flounder liver.

Mussels

Measurements: PAH, PCB, pesticides, mercury and lead.

Location: Outside the mixing zone near the Future Outfall Site, In-Harbor reference site (Discovery Site).

Frequency: Caged mussels in replicate arrays (with > 50 mussels each) deployed at mid-depth or below the pycnocline. Deployment will be for 60 days during June through August. Biological material from 50 mussels from a station as pooled to form five composite sample (10 specimens per sample) for chemical analyses.

Special Studies

Currently there are no special studies to be conducted for Fish and Shellfish Monitoring under the Phase n Monitoring Plan. Such studies will be considered on a case-by-case basis, such as in the event that threshold values are repeatedly exceeded.

5.4 Data Evaluation and Comparison to Threshold Values

Data evaluation and comparison to threshold values are conducted for two types of trigger parameters. The first is based on comparison of contaminant levels to risk-based Caution and Warning Levels (Section 5.4. I) and the second is based on relative increases in indicator parameter (Section 5.4.2). A summary of the data sources and comparison for evaluation of the trigger parameters is contained in Table 5-3.

TABLE 5-3

Data Sources and Comparison for
Trigger Parameter Threshold Values

Parameter	Data Source	Comparison
A. Contaminants in Fish and Shellfish		
1. Mercury in fish and shellfish meat near future outfall site	Data:	Wet weight mercury concentration of composite flounder fillet or lobster tail/claw meat from future outfall site.
	Reported In:	MWRA Annual Fish and Shellfish Report.
	Comparison:	• Mean tissue concentration vs. Caution Level and/or Warning Level
2. Total PCB in fish and shellfish meat near future outfall site	Data:	Wet weight total PCB concentration of composite flounder fillet or lobster tail/claw meat from future outfall site.
	Reported In:	MWRA Annual Fish and Shellfish Report.
	Comparison:	• Mean tissue concentration vs. Caution Level and/or Warning Level
3. Lead in mussel near future outfall site	Data:	Wet weight lead concentration of caged mussels from future outfall site.
	Reported In:	MWRA Annual Fish and Shellfish Report.
	Comparison:	• Mean tissue concentration vs. Caution Level and/or Warning Level

TABLE 5-3 (Cont'd)

Data Sources and Comparison for Trigger Parameter Threshold Values

Parameter	Data Source	Comparison
B. Ecological Health Parameter		
4. Lipid-normalized toxics in fish and shellfish tissue near future outfall site	Data:	Lipid-normalized PAHs, PCBs/pesticides, and mercury in founder liver and lobster hepatopancreas from future outfall site
	Reported In:	MWRA Annual Fish and Shellfish Report
	Comparison:	• Mean tissue concentration vs. mean "baseline" concentration
5. Liver disease incidence in flounder	Data:	Prevalence of centrotubular hydropic vacuolation (CHV) in founder liver at future outfall site.
	Reported In:	MWRA Annual Fish and Shellfish Report.
	Comparison:	• Mean prevalence of CHV vs. 1991-1997 baseline conditions in harbor.

5.4.1 Contaminant Concentrations in Fish and Shellfish

The thresholds for fish and shellfish include the Caution Level and Warning Level for mercury and PCBs in fish and lobster edible tissue and for lead in mussels. Exceedance of the Caution Level by the mean of composite samples collected near the outfall should be noted but no further action would probably be required, unless an increasing trend appeared to be developing. Exceedance of the Warning Level by the mean of the composite samples could lead to further analysis such as revalidating lab results or running additional replicate analyses (if tissue is available). Further elaboration of contingency plans for repeated exceedances of the Caution Level or Warning Level have yet to be established. However, based on current trends (described in Section 2.1), there is no reason to anticipate that environmental conditions will change following diversion to cause an exceedance of the Caution Level or Warning Level for the monitored species.

5.4.2 Ecological Health Indicators

In addition to the parameters which are used to evaluate potential human health risk, there are parameters which are used as indicators of overall fish -and shellfish community health (Ecological Indicator Parameters). Unlike the contaminant threshold parameters discussed in Section 5.4.1, these thresholds are triggered by relative rapid increase in parameter. These thresholds include a relative increase (i.e., 2X the baseline level) of lipid-normalized toxics in the fish and shellfish edible tissues or the incidence of liver lesion in flounder liver. The use of the relative increase criterion provides a pragmatic trigger for investigating a rapid increase in the amount of tissue burdens or histopathological lesions. While the increase, in itself, may not result in an adverse impact to the fish or shellfish communities, it does provide a measurable indication of potential deterioration in water or sediment quality that may need further investigation. It should be recognized, however. that these trigger parameters have indirect application to human health concerns as well.

Application of a statistical comparison or evaluation of these Ecological Indicator Parameters in Phase II may require further discussion as to what constitutes "baseline' conditions (i.e., does this only apply to years 1991-1997?). For example, it has not been determined whether the mean, maximum, or range of values best constitutes the baseline. Summation and analysis of the current baseline data (i.e., 1991-96 data sets) for the individual monitoring parameters has indicated that a significant increase is detectable to a level below the Caution Level. A simple metric of statistical change (a one-tested T-test at 5% significance) can be used to indicate significant change at levels below an exceedance of the Caution Level. This potentially allows refinement of the monitoring program in the following year, if necessary, to modify or increase monitoring effort for that parameter. In addition, some type of trend analysis (i.e., multivariate analysis) with comparison of the temporal and spatial results will potentially be useful.

Comparison of the histopathology results is straight forward due to the large sample size (50 per station). In this case, a comparison of the mean prevalence of hepatocellular hydropic vacuolation to the mean and standard deviation of the "baseline" years could be used to evaluate whether the year's results is significantly higher (e.g., one-tailed t-test or nonparametric equivalent).

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NOAA. 1988. **Strategic Assessment of near coastal waters, Northeast case study. Susceptibility and status of Northeast estuaries to nutrient discharges.** National Oceanic and Atmospheric Administration, Rockville, MD.

NOAA. **1997. NOAA's Estuarine Eutrophication Survey. Volume 3: North Atlantic region.** Silver Spring, MD: Office of Ocean Resources Conservation and Assessment. 45p.

NRC. 1990. **Managing Troubled Waters: The Role of Marine Monitoring.** National Research Council. National Academy Press, Washington, DC. 125pp.

Parkhurst, D.F. 1985. **Interpreting failure to reject null hypothesis.** Bull. Ecol. Soc. 66:301-302.

Pederson, J. 1992. Letters to Susan F. Tierney and Julie Belaga recommending approval of monitoring plan, dated March 9, 1992. Also letter from Susan Tiemey to Douglas MacDonald urging support of monitoring plan, dated March 19, 1992.

Attachment O
Contingency Plan

(Note: Please contact bmcarthy@mwra.state.ma.us to obtain copies.)

Attachment P
Pollution Prevention

1. Pollution prevention fact sheet examples:

(1) DO NOT deposit used motor oil on the ground or down a drain. INSTEAD, bring your used oil back to where it was purchased. (A seller must accept used oil of up to 2 gallons a day, free of charge, from a customer with a receipt of purchase under the MA Used Oil Return Law, MA General Law Chapter 21, Section 52A.);

(2) RECYCLE used anti-freeze: some car service stations have a recycling service for this;

(3) CALL hotline phone numbers for pollution prevention information and ideas:

(1.) USEPA Pollution Prevention Information Clearinghouse - 800/424-9346 - for information and answers to questions about reducing or eliminating discharges and/or emissions to the environment through source reduction and environmentally sound recycling;

(2.) USEPA National Pesticides Telecommunications Network Hotline - 800/858-7378 - for information on pesticide-related health, toxicity, and minor cleanup to physicians, veterinarians, fire departments, government agencies, and the general public;

(3.) USEPA Unleaded Fuel Hotline - 800/631-2700 in MA;

(4.) MADEP Used Oil Hotline - 617/556-1022 - for information on available collection locations;

(5.) MA Office of Technical Assistance - 617/727-3260, extension 696 - for information on alternate household cleaners;

(4) USE environmentally safe household cleaners. (Follow the recipes from this fact sheet, or call the MA Office of Technical Assistance at 617/727-3260 extension 696 for more information on sources. For your own safety, do not create your own recipes);

(1.) For a good surface cleaner - add vinegar + salt;
(2.) general cleaner - 1 quart warm water + 4 tablespoons baking powder;
(3.) deodorizer/surface cleaner - damp sponge + baking soda;
(4.) carpet cleaner - sweep the carpet to make the nap stand up, cover with a layer of baking soda, wait 15 minutes or more, vacuum;
(5.) oven cleaner - sprinkle salt on a spill while the oven is still warm, rinse with off with a cloth + warm water;
(6.) drain cleaner - mechanical means, such as a plunger or plumbers snake found at hardware stores;
(7.) toilet bowl cleaner - sprinkle baking soda, then drizzle with vinegar and scour with a toilet brush;
(8.) glass cleaner - use equal parts of water + white vinegar and dry with a soft cloth;
(9.) gold - clean with toothpaste;
(10.) silver - clean with toothpaste, or let stand in sour milk over night and rinse with a cold water
and polish dry with a soft cloth;
(11.) stainless steel - clean with baking soda and a scouring pad. Rub stainless steel sinks with
olive oil or club soda to remove streaks; and,

(12.) grease stains on fabric - apply a paste of cornstarch + water, let dry and rub off. Or, scrub spot with toothpaste.

2. Examples of how to involve established organizations with the implementation of pollution prevention public awareness programs, within the MWRA treatment system:

(1.) Work with the boy scouts to establish a badge that would require boy scouts to personally handout fact sheets, with adult supervision, to neighbors and explain and encourage pollution prevention ideas to the visited person. The badge could be called the "environmental community outreach and education badge";

(2.) Work with the girl scouts to establish a badge using the idea described above;

(3.) Work with school boards to establish an environmental education curriculum; and,

(4.) Establish an "MWRA Stenciling Day" and request volunteer assistance to stencil street drains with an environmental awareness message. Advertise this volunteer activity in the newspaper, television, or radio.

Attachment Q
Marine Acute Toxicity Test Procedure and Protocol

I. GENERAL REQUIREMENTS

The permittee shall conduct acceptable acute toxicity tests in accordance with the appropriate test protocols described below:

- **Mysid Shrimp (Mysidopsis bahia) definitive 24 hour test.**

- **Inland Silverside (Menidia beryllina) definitive 24 hour test.**

Acute toxicity data shall be reported as outlined in Section VIII.

II. METHODS

Methods to follow are those recommended by EPA in:
Weber, C.I. et al. Methods for Measuring the Acute Toxicity of Effluents to Freshwater and Marine Organisms, Fourth Edition. Environmental Monitoring Systems Laboratory, U.S. Environmental Protection Agency, Cincinnati, OH. August 1993, EPA/600/4-90/027F.

Any exceptions are stated herein.

III. SAMPLE COLLECTION

A discharge sample shall be collected. Aliquots shall be split from the sample, containerized and preserved (as per 40 CFR Part 136) for the chemical and physical analyses. The remaining sample shall be dechlorinated (if detected) in the laboratory using sodium thiosulfate for subsequent toxicity testing. (Note that EPA approved test methods require that samples collected for metals analyses be preserved immediately after collection.) Grab samples must be used for pH, temperature, and total residual oxidants (as per 40 CFR Part 122.21).

Standard Methods for the Examination of Water and Wastewater describes dechlorination of samples (APHA, 1992). Dechlorination can be achieved using a ratio of 6.7 mg/L anhydrous sodium thiosulfate to reduce 1.0 mg/L chlorine. A thiosulfate control (maximum amount of thiosulfate in lab control or receiving water) should also be run.

All samples held overnight shall be refrigerated at 4^{o}C.

IV. DILUTION WATER

A grab sample of dilution water used for acute toxicity testing shall be collected at a point away from the discharge which is free from toxicity or other sources of contamination. Avoid collecting near areas of obvious road or agricultural runoff, storm sewers or other point source discharges. An additional control (0% effluent) of a standard laboratory water of known quality shall also be tested.

If the receiving water diluent is found to be, or suspected to be toxic or unreliable, an alternate standard dilution water of known quality with a conductivity, salinity, total suspended solids, and pH similar to that of the receiving water may be substituted **AFTER RECEIVING WRITTEN APPROVAL FROM THE PERMIT ISSUING AGENCY(S)**. Written requests for use of an alternative dilution water should be mailed with supporting documentation to the following address:

Director
Office of Ecosystem Protection
U.S. Environmental Protection Agency-New England

JFK Federal Building (CAA)
Boston, MA 02203

It may prove beneficial to have the proposed dilution water source screened for suitability prior to toxicity testing. EPA strongly urges that screening be done prior to set up of a full definitive toxicity test any time there is question about the dilution water's ability to support acceptable performance as outlined in the 'test acceptability' section of the protocol.

V. TEST CONDITIONS AND TEST ACCEPTABILITY CRITERIA

EPA New England requires tests be performed using four replicates of each control and effluent concentration because the non-parametric statistical tests cannot be used with data from fewer replicates. The following tables summarize the accepted *Mysid* and *Menidia* toxicity test conditions and test acceptability criteria:

EPA NEW ENGLAND RECOMMENDED EFFLUENT TOXICITY TEST CONDITIONS FOR THE MYSID, *MYSIDOPSIS BAHIA* 24 HOUR TEST[1]

1. Test type	Static, non-renewal
2. Salinity	25ppt ± 10 percent for all dilutions by adding dry ocean salts
3. Temperature (°C)	20°C ± 1°C or 25°C ± 1°C
4. Light quality	Ambient laboratory illumination
5. Photoperiod	16 hour light, 8 hour dark
6. Test chamber size	250 ml
7. Test solution volume	200 ml
8. Age of test organisms	1-5 days
9. No. Mysids per test chamber	10
10. No. of replicate test chambers per treatment	4
11. Total no. Mysids per test concentration	40
12. Feeding regime	Light feeding using concentrated *Artemia* nauplii while holding prior to initiating the test
13. Aeration2	None
14. Dilution water	Natural seawater, or deionized water mixed with artificial sea salts
15. Dilution factor	≥ 0.5
16. Number of dilutions[3]	5 plus a control. An additional dilution at the permitted effluent concentration (% effluent) is required if it is not included in the dilution series.
17. Effect measured	Mortality - no movement of body appendages on gentle prodding
18. Test acceptability	90% or greater survival of test organisms in control solution

19. Sampling requirements	For on-site tests, samples are used within 24 hours of the time that they are removed from the sampling device. For off-site tests, samples must be first used within 36 hours of collection.
20. Sample volume required	Minimum 1 liter for effluents and 2 liters for receiving waters

____

Footnotes:

1. Adapted from EPA/600/4-90/027F.

2. If dissolved oxygen falls below 4.0 mg/L, aerate at rate of less than 100 bubbles/min. Routine D.O. checks are recommended.

3. When receiving water is used for dilution, an additional control made up of standard laboratory dilution water (0% effluent) is required.

EPA NEW ENGLAND RECOMMENDED TOXICITY TEST CONDITIONS FOR THE INLAND SILVERSIDE, MENIDIA BERYLLINA 24 HOUR TEST[1]

____

1.	Test Type	Static, non-renewal
2.	Salinity	25 ppt $\pm$ 2 ppt by adding dry ocean salts
3.	Temperature	$20^{o}C \pm 1^{o}C$ or $25^{o}C \pm 1^{o}C$
4.	Light Quality	Ambient laboratory illumination
5.	Photoperiod	16 hr light, 8 hr dark
6.	Size of test vessel	250 mL (minimum)
7.	Volume of test solution	200 mL/replicate (minimum)
8.	Age of fish	9-14 days; 24 hr age range
9.	No. fish per chamber	10 (not to exceed loading limits)
10.	No. of replicate test vessels per treatment	4
11.	total no. organisms per concentration	40
12.	Feeding regime	Light feeding using concentrated Artemia nauplii while holding prior to initiating the test
13.	Aeration[2]	None
14.	Dilution water	Natural seawater, or deionized water mixed with artificial sea salts.
15.	Dilution factor	$\geq$ 0.5
16.	Number of dilutions[3]	5 plus a control. An additional dilution at the permitted concentration (% effluent) is required if it is not included in the dilution series.

17. Effect measured | Mortality-no movement on gentle prodding.

18. Test acceptability | 90% or greater survival of test organisms in control solution

19. Sampling requirements | For on-site tests, samples must be used within 24 hours of the time they are removed from the sampling device. Off-site test samples must be used within 36 hours of collection.

20. Sample volume required | Minimum 1 liter for effluents and 2 liters for receiving waters.

Footnotes:

1. Adapted from EPA/600/4-90/027F.

2. If dissolved oxygen falls below 4.0 mg/L, aerate at rate of less than 100 bubbles/min. Routine D.O. checks recommended.

3. When receiving water is used for dilution, an additional control made up of standard laboratory dilution water (0% effluent) is required.

VI. CHEMICAL ANALYSIS

At the beginning of the static acute test, pH, specific conductance, salinity, total residual oxidants, and temperature must be measured at the beginning and end of each 24 hour period in each dilution and in the controls. The following chemical analyses shall be performed for each sampling event.

Parameter	Effluent	Diluent	Minimum Quantification Level (mg/L)
pH	x	x	---
Specific Conductance	x	x	---
Salinity	x	x	PT(o/oo)
Total Residual Oxidants[*1]	x	x	0.05
Total Solids and Suspended Solids	x	x	---
Ammonia	x	x	0.1
Total Organic Carbon	x	x	0.5
Total Metals			
Cd	x		0.001
Cr	x		0.005
Pb	x	x	0.005
Cu	x	x	0.0025

Zn	x	x	0.0025
Ni	x	x	0.004
A1	x	x	0.02

Superscript:

*1 Total Residual Oxidants

Either of the following methods from the 18th Edition of the APHA Standard Methods for the Examination of Water and Wastewater must be used for these analyses:

-Method 4500-Cl E Low Level Amperometric Titration (the preferred method);
-Method 4500-CL G DPD Photometric Method.

or use USEPA Manual of Methods Analysis of Water or Wastes, Method 330.5.

VII. TOXICITY TEST DATA ANALYSIS

LC50 Median Lethal Concentration

An estimate of the concentration of effluent or toxicant that is lethal to 50% of the test organisms during the time prescribed by the test method.

Methods of Estimation:

- Probit Method
- Spearman-Karber
- Trimmed Spearman-Karber
- Graphical

See flow chart in Figure 6 on page 77 of EPA 600/4-90/027F for appropriate method to use on a given data set.

No Observed Acute Effect Level (NOAEL)

See flow chart in Figure 13 on page 94 of EPA 600/4-90/027F.

VIII. TOXICITY TEST REPORTING

The following must be reported:

- Description of sample collection procedures, site description;
- Names of individuals collecting and transporting samples, times and dates of sample collection and analysis on chain-of-custody; and
- General description of tests: age of test organisms, origin, dates and results of standard toxicant tests; light and temperature regime; other information on test conditions if different than procedures recommended. Reference toxicity test data must be included.
- Raw data and bench sheets.
- All chemical/physical data generated. (Include minimum detection levels and minimum quantification

levels.)

- Provide a description of dechlorination procedures (as applicable).
- Any other observations or test conditions affecting test outcome.
- Statistical tests used to calculate endpoints.

Attachment R
Fresh Water Acute Toxicity Test Procedure and Protocol

- Daphnids (Ceriodaphnia dubia) definitive 24 hour acute test.
- Fathead Minnow (Pimephales promelas) definitive 24 hour acute test.

I. GENERAL REQUIREMENTS

The permittee shall conduct acceptable toxicity tests in accordance with the appropriate test protocols described below. The permittee must collect discharge samples and perform the toxicity tests that are required by Part I of the NPDES permit. Acute toxicity test data shall be reported as outlined in Section IX.

II. TEST FREQUENCY AND SAMPLING REQUIREMENTS

See Part I of the NPDES permit for sampling location, sample type, test frequency, test species, and test date(s) requirements. Chain of Custody information should be provided for each sample tested.

An acute toxicity test sampling event is defined as a single discharge (composite or grab) sample.

III. METHODS

Methods should follow those recommended by EPA in:

Peltier, W., and Weber, C.I., 1985. Methods for Measuring the Acute Toxicity of Effluents to Freshwater, Third Edition. Office of Research and Development, Cincinnati, OH. EPA/600/4-90-027 Rev. 9/91 Section 6.1.).

Any exceptions are stated herein.

IV. SAMPLE COLLECTION

A discharge sample shall be collected. Aliquots shall be split from the sample, containerized and preserved (as per 40 CFR Part 136) for chemical and physical analyses required. The remaining sample shall be dechlorinated (if necessary) in the laboratory using sodium thiosulfate for subsequent toxicity testing. Grab samples must be used for pH, temperature, and total residual chlorine (as per 40 CFR Part 122.21).

The Methods for Aquatic Toxicity Identification Evaluations (Phase I) EPA/600/3-88/034, Section 8.7, provides detailed information regarding the use of sodium thiosulfate (i.e. dechlorination).

All samples held overnight shall be refrigerated at 4°C.

V. REGION I RECOMMENDED EFFLUENT TOXICITY TEST CONDITIONS FOR THE DAPHNIDS (Ceriodaphnia dubia and) 24 HOUR ACUTE TESTS[1]

____

1. Test type	Static, non-renewal
2. Temperature (°C)	25 ± 1°C
3. Light quality	Ambient laboratory illumination
4. Photoperiod	16 hour light, 8 hour dark
5. Test chamber size	Minimum 30 ml

6. Test solution volume	Minimum 25 ml
7. Age of test organisms	1-24 hours (neonates)
8. No. daphnids per test chamber	5
9. No. of replicate test chambers per treatment	4
10. Total no. daphnids per test concentration	20
11. Feeding regime	None
12. Aeration	None
13. Number of dilutions	1 plus a control.
14. Effect measured	Mortality - no movement of body or appendages on gentle prodding
15. Test acceptability	90% or greater survival of test organisms in control solution
16. Sampling requirements	For on-site tests, samples must be used within 24 hours of the time that they are removed from the sampling device. For off-site tests, samples must first be used within 24 hours of collection.
17. Sample volume required	Minimum 2 liters

Footnotes:

1. Adapted from EPA/600/4-85/013.
2. Standard prepared dilution water must have hardness requirements to generally reflect the characteristics of the receiving water.

VI. REGION I RECOMMENDED TEST CONDITIONS FOR THE FATHEAD MINNOW (Pimephales promelas) 24 HOUR ACUTE TEST[1]

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1. Test Type:	Static, non-renewal
2. Temperature (°C):	25 $\pm$ 1°C
3. Light quality:	Ambient laboratory illumination
4. Photoperiod:	16 hr light, 8 hr dark
5. Size of test vessels:	250-1000 ml
6. Volume of test solution:	Minimum 200ml/replicate
7. Age of fish:	1-14 days

8.	No. of fish per chamber:	10 (not to exceed loading limits)
9.	No. of replicate test vessels per treatment:	2
10.	Total no. organisms per concentration:	20
11.	Feeding regime:	None
12.	Aeration:	None, unless DO concentration falls below 40% of saturation, at which time gentle single-bubble aeration should be started at a rate of less than 100 bubbles/min. (Routine DO check recommended.)
13.	Number of dilutions:	1 plus a control.
14.	Effect measured:	Mortality-no movement on gentle prodding
15.	Test acceptability:	90% or greater survival of test organisms in control solution
16.	Sampling requirements:	For on-site tests, samples must be used within 24 hours of the time that they are removed from the sampling device. For off-site tests, samples must be first used within 48 hours of collection.
17.	Sample volume required:	Minimum 4 liters

____

Footnotes:

1. Adapted from EPA/600/4-85/013.
2. Standard dilution water must have hardness requirements to generally reflect characteristics of the receiving water.

VII. CHEMICAL ANALYSIS

The following chemical analyses shall be performed for each sampling event.

Parameter	Effluent	Diluent	Minimum Detection Limit (mg/L)
Hardness[*1]	x	x	0.5
Alkalinity	x	x	2.0
pH	x	x	---
Specific Conductance	x	x	---
Total Solids and Suspended Solids	x	x	---
Ammonia	x	x	0.1
Total Organic Carbon	x	x	0.5
Total Residual Chlorine (TRC)[*2]	x	x	0.02

Total Metals

Cd	x		0.005
Cr, Ni	x		0.05
Pb, Cu	x	x	0.005
Zn, Al	x	x	0.02
Mg, Ca	x	x	0.05

Superscripts:

*1 Method 314A (hardness by calculation) from APHA (1985) Standard Methods for the Examination of Water and Wastewater. 16th Edition.

*2 Total Residual Chlorine

Methods: either of the following methods the 16th edition of the APHA (1985) Standard Methods for the Examination of Water and Wastewater must be used for these analyses.

Method 408-C (Amperometric Titration Method)-the preferred method;
Method 408-D (Ferrous Titrimetric Method).

VIII. TOXICITY TEST REPORT

The following must be reported:

- Description of sample collection procedures, site description;
- Names of individuals collecting and transporting samples, times and dates of sample collection and analysis; and
- General description of tests: age of test organisms, origin, dates and results of standard toxicant tests; light and temperature regime; other information on test conditions if different than procedures recommended.

Toxicity test data shall include the following:

- Survival for each concentration and replication at time 24 hours.
- LC50 and 95% confidence limits shall be calculated using one of the following methods in order of preference Probit, Trimmed Spearman Karber, Moving Average Angle, or the graphical method. All printouts (along with the name of the program, the date, and the author(s)) and graphical displays must be submitted. When data is analyzed by hand, worksheets should be submitted.

  The Probit, Trimmed Spearman Karber, and Moving Average Angle methods of analyses can only be used when mortality of some of the test organisms are observed in at least two of the (% effluent) concentrations tested (i.e. partial mortality). If a test results in a 100% survival and 100% mortality in adjacent treatments ("all or nothing" effect), a LC50 may be estimated using the graphical method.
- All chemical/physical data generated (include detection limits).
- Raw data and bench sheets.
- Describe method of dechlorination where applicable.
- Any observations and test conditions which affected the outcome of testing.

IX. REPORTING

Signed copies of the toxicity testing reports shall be submitted as required by of Part I of the NPDES permit.

- July 1990 -

Attachment S
Sample Calculations

The MWRA's outfall dilution can be expressed using the following mathematical equation:

$C_l = C_a + [(C_c - C_a)/(1/S_n + 1/S_b - 1/(S_n)(S_b))]$

Given:

C_L = water quality limitation
= the level of a pollutant that is acceptable to meet water quality standards.

C_a = maximum ambient data sample
= level of a pollutant that is sampled from the water column, within fairly close distance to the outfall discharge area.

C_c = water quality criterion
= level set as the standard to meet without dilution.

S_n = nearfield initial dilution
= 70:1

S_b = background farfield dilution
= 150:1 (occurs at a 990 MGD flow rate);
= 256:1 (occurs at a 690 MGD flow rate); and
= 364:1 (occurs at the long-term average flow rate).

Assumptions Used to Determine the Mixing Zone - Dilution:

The most restrictive assumptions were used to determine the MWRA's initial dilution. The list of assumptions are as follows:

a. Flux-Average Nearfield Initial Dilution -

A stratified counterflow will occur whenever wastewater is discharged into an otherwise stagnant environment. To address this phenomenon, two sets of experiments were run: (1) long-duration experiments - to measure stability and temporal variability of the flow field, and (2) dye streaks within a tank - to measure induced-velocity and flux-average dilution. Both sets of experiments were performed under the most critical conditions: late summer stratification and zero current speed. EPA usually defines initial dilution as flux-average dilution. Flux-average dilution was measured directly by discharging a clear effluent and dropping dye crystals into an experimental tank, which formed vertical dye streaks. The deformation of the dye streaks was photographed and video-taped. Although the tests provide only a relatively crude estimate of the volume fluxes, the results imply that the flux-average dilution may only be 10-20% higher than the minimum. That is, the ratio of flux-average to minimum dilution is probably in the range of 1.1 - 1.2. Therefore, the estimated measured values for flux-average dilution are assumed as: 1.15 X the minimum initial dilution, for the draft permit. This value represents the average distribution of dilution over the plume's cross-sectional area.[1]

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[1] Roberts, P.J.W. and Snyder, W.H. "Hydraulic Model Study of the Boston Outfall. II: Environmental Performance," *Journal of Hydraulic Engineering*, Volume 119, No. 9 (September 1993), 944-1000.

b. Background Build-up Entrainment Assumptions -

(1) August - lowest flow month; most conservative month.
(2) 90th percentile - consistent with the Technical Support Document for Water Quality-based Toxics Control (TSD).
(3) 50th percentile - human health is a long term median;
(4) 50th percentile is a long term median flow event.
(5) loading of 1000 - this represents the amount of concentration of pollutant that is introduced into the tank study in order to determine the amount of pollutant that remains after diffusion; the amount itself is relative; the amount into the system divided by the amount out of the system is a ratio of the dilution available. The amount of pollutant out is relative to the flow distribution that you choose to use. EPA and the MADEP used the 90th percentile flow distribution for acute and chronic background farfield dilutions, and the 50th percentile for the human health background farfield dilution.

c. Acute = 150:1 background farfield dilution assumptions -

(1) hourly average flow during the month of August 1990
(2) 90th percentile flow distribution
(3) assumed loading = 1000
(4) concentration at 90th percentile = 6.7
(5) background dilution = 1000/6.7 = 150:1

d. Chronic = 256:1 background farfield dilution assumptions -

(1) 4-day running average flow during the month of August 1990
(2) 90th percentile flow distribution
(3) assumed loading = 1000
(4) concentration at 90th percentile = 3.9
(5) background dilution = 1000/3.9 = 256:1

e. Human Health = 364:1 background farfield dilution assumptions -

(1) 4-day running average flow during the month of August 1990
(2) 50th percentile flow distribution
(3) assumed loading = 1000
(4) concentration at 50th percentile = 2.75
(5) background dilution = 1000/2.75 = 364:1 (When determining limits for human health, nearfield dilution was not included.)

f. Ambient Background Assumptions -

Draft permit limits, and monitoring requirements, are based on incorporating the highest reported ambient water column sampling data that is collected within the closest distance to the outfall discharge area.

Sample Calculations:

$C_L = C_a + [(C_c - C_a)/(1/S_n + 1/S_b - 1/(S_n)(S_b))]$

Given:

C_L = water quality limitation
C_a = maximum ambient data sample

C_c = water quality criterion
S_n = nearfield initial dilution
S_b = background farfield dilution

a. Copper - CHRONIC Water Quality Limitation -

Given:

C_L = unknown (water quality limitation)
C_a = 0.4167 ug/l (maximum ambient data sample)
C_c = 2.9 ug/l (chronic water quality criterion)
S_n = 79.5 (flux-average nearfield dilution at 690 MGD flow rate)
S_b = 256 (farfield dilution, chronic)

$C_L = C_a + [(C_c - C_a)/(1/S_n + 1/S_b - 1/(S_n)(S_b))]$

C_L = 0.4167 + [(2.9 - 0.4167)/(1/79.5 + 1/256 - 1/(79.5)(256)]
C_L = 0.4167 + [(2.4833)/(0.01257 + 0.003906 - (0.000049135)]
C_L = 0.4167 + [(2.4833)/(0.01642)]
C_L = 0.4167 + [151.1]
C_L = <u>151.5 ug/l</u> = <u>chronic water quality limitation for copper</u>

b. Copper - ACUTE Water Quality Limitation -

Given:

C_L = unknown (acute water quality limitation)
C_a = 0.4167 ug/l (maximum ambient data sample)
C_c = 2.9 ug/l (acute water quality criterion)
S_n = 71.3 (nearfield flux-average dilution at 990 MGD flow rate)
S_b = 150 (farfield dilution, acute)

$C_L = C_a + [(C_c - C_a)/(1/S_n + 1/S_b - 1/(S_n)(S_b))]$

C_L = 0.4167 + [(2.9 - 0.4167)/(1/71.3 + 1/150 -1/(71.3)(150)]
C_L = 0.4167 + [(2.4833)/(0.014025 + 0.006666 - 0.0000935)]
C_L = 0.4167 + [(2.4833)/(0.0207854)]
C_L = 0.4167 + [119.47]
C_L = 119.88 = <u>120 ug/l</u> = <u>acute water quality limitation for copper</u>

c. Aldrin - Chronic HUMAN HEALTH Limitation -

Given:

C_L = unknown (chronic human health limitation)
C_a = 0.0000498 ug/l (maximum ambient data sample)
C_c = 0.00014 ug/l (chronic human health criterion)
S_n = not applicable (nearfield flux-average dilution)
S_b = 364 (farfield dilution, chronic human health)

$C_L = C_a + [(C_c - C_a)/(1/S_n + 1/S_b - 1/(S_n)(S_b))]$

C_L = 0.0000498 + [(0.00014 - 0.0000498/(1/1000000 + 1/364 -1/(1000000)(364))]

C_L = 0.000498 +[(0.0000902)/((0.000001 + 0.002747 - 0.000000003))]
C_L = 0.000498 + [(0.0000902)/(0.002747)]
C_L = 0.000498 + [0.032823]
C_L = 0.0328 ug/l = chronic human health limitation for aldrin

Attachment T (Reference Document)
Outfall Monitoring Science Advisory Panel
Charter:

The two entities responsible for administering the permit - the United States Environmental Protection Agency (EPA) and the Massachusetts Department of Environmental Protection (MADEP) - shall appoint a scientific and technical advisory panel to advise them on all scientific and technical matters related to the outfall and the impacts of the discharge on the receiving waters, both near-field and far-field. The Outfall Monitoring Science Advisory Panel is referred to hereafter as the OMSAP, or simply as the Panel.

The OMSAP shall be appointed by the New England Regional Administrator of EPA and the Commissioner of the Massachusetts Department of Environmental Protection. Membership shall be restricted to scientists and engineers who are recognized for their expertise within their fields, and for their knowledge of the coupled aquatic system: Boston Harbor-Massachusetts Bay-Cape Cod Bay-Gulf of Maine--that makes up the near-field and far-field receiving waters.

Because of the importance of framing scientific and technical issues in the context of those environmental values and uses important to society, the Regional Administrator and the Commissioner shall also appoint a standing committee advisory to the OMSAP. The committee shall be convened by the OMSAP and shall report to the OMSAP. Membership of the committee shall be drawn from environmental groups, non-governmental organizations, and academia.

Because of the importance of framing scientific and technical issues in the context of environmental regulations, the Regional Administrator and the Commissioner shall also appoint an inter-agency standing committee advisory to the OMSAP to ensure that the OMSAP recommendations have the benefit of information from the regulating community. The committee shall be convened by the OMSAP and shall report to the OMSAP. Membership of the committee shall be drawn from state and federal agencies.

Among the most important areas the OMSAP shall concentrate on are:

a. Review the results of the outfall monitoring program.

b. Advise EPA and the MADEP if and when there are National Pollutant Discharge Elimination System (NPDES) and contingency plan threshold exceedences, recommend any actions that may be needed to protect human and ecosystem health, and evaluate the appropriateness of threshold levels.

c. Review and provide recommendations for revision of the outfall monitoring program to ensure that it is capable of detecting changes at an early enough stage to allow action to prevent any unacceptable impacts of the discharge on public health or on the marine environment and its biota.

The OMSAP may form focus groups on an ad hoc basis whenever specific scientific and technical issues arise which require expanded breadth and depth of expertise than exists within the membership of the OMSAP. All focus groups shall be chaired by OMSAP members. Focus groups shall present their recommendations to the OMSAP and the OMSAP will forward them to the Commissioner and the Regional Administrator along with their recommendations for action.

All OMSAP meetings shall be open to the public. The OMSAP shall convene a public forum at least once a year to present findings, to explain their significance, and to hear and respond to concerns from the public.

MEMBERSHIP

a. The OMSAP shall consist of 11-13 members appointed jointly by EPA and the MADEP. Membership shall be drawn from, but not limited to, the following areas of expertise:

(1) fisheries
(2) phytoplankton
(3) zooplankton
(4) marine mammals
(5) biostatistics
(6) public health
(7) aquatic toxicology
(8) modeling
(9) benthic biology
(10) physical oceanography
(11) nutrient dynamics
(12) microbiology
(13) chemical oceanography

b. EPA and the MADEP shall appoint a standing committee advisory to the OMSAP, called the Public Interest Advisory Committee (PIAC), which will report to the OMSAP. The PIAC shall consist of no more than 11 members drawn from local non-governmental organizations, academia, and environmental groups. The committee will advise the OMSAP on values and uses of the local natural system important to society.

c. EPA and the MADEP shall appoint a standing committee advisory to the OMSAP, called the Inter-Agency Advisory Committee (IAAC), which will report to the OMSAP. The IAAC shall consist of no more than 11 members drawn from state and federal agencies. The committee will advise the OMSAP on environmental regulations.

d. Criteria for selection:

The initial members of the OMSAP are to be chosen from a list of candidates developed by a selection committee appointed by EPA and the MADEP. The selection committee will review the credentials of each nominee and their relevance to the issues of importance and make recommendations for appointments of members to staggered two or three year terms. Each member may be appointed for two consecutive terms. After two consecutive terms, members must leave the Panel, but may be re-appointed after one year off of the OMSAP. Members of the OMSAP may not be current or imminent contractors to the MWRA, nor may they be employees of any governmental agency in the chain of command. If a member accepts a contract with the MWRA, he/she must resign from the OMSAP.

Membership of the PIAC and the IAAC shall rotate among organizations. OMSAP membership eligibility may include agencies that are not responsible for making direct regulatory decisions. Members of OMSAP, PIAC and IAAC who do not attend meetings on a regular basis may be replaced by the EPA Regional Administrator and the Massachusetts Commissioner, if the Chair of the OMSAP recommends such action.

Attachment U
Total Residual Chlorine Limitation
Sample Calculation
for Combined Sewer Overflows (CSOs)
NPDES Permit No. MA0103284
Boston, MA

Given:
Dr = dilution ratio = (4 parts receiving water to 1 part effluent) = 4 : 1
Df = dilution factor = (dilution ratio plus one) = 5
A = acute water quality limitation (maximum hourly limit) = 0.1 mg/l
C = chronic water quality limitations (average of the samples taken during the discharge event) = 0.05 mg/l

Calculations:
1. Acute Limitation (A)

MA Water Quality Standard for total residual chlorine = salt water, 0.013 mg/l; fresh water, 0.019 mg/l.
Salt Water Limit = Water Quality Standard x dilution factor = (0.013 mg/l x 5) = 0.065 mg/l = 0.1 mg/l
Fresh Water Limit = Water Quality Standard x dilution factor = (0.019 mg/l x 5) = 0.095 mg/l = 0.1 mg/l
Therefore, the hourly maximum limitation for all CSOs listed under Part I.16.a. of the Permit = 0.1 mg/l

2. Chronic Limitation (C)

*Water Quality Limitation for total residual chlorine = 0.05 mg/l (salt and fresh water).
Salt Water Limit = Water Quality Standard x dilution factor = (0.05 mg/l x 5) = 0.25 mg/l.
Fresh Water Limit = Water Quality Standard x dilution factor = (0.05 mg/l x 5) = 0.25 mg/l.
Therefore, the average chronic limitation for all CSOs listed under Part I.16.a. of the Permit = 0.25 mg/l.\

*Based on a study called: *Acute Toxic Effects of Chlorinated Primary Sewage Effluent on Brook Trout and Brown Trout*, Manchester, Vermont, Batten Kill River, by Peter M. Nolan, U.S.E.P.A., Region I.

Attachment V
Agreement of NMFS, EPA, and MWRA
Concerning Implementation of Conservation Recommendations

Massachusetts Water Resources Authority (MWRA) is constructing an extended ocean outfall, which will discharge treated effluent from the MWRA's new Deer Island wastewater treatment plant. National Marine Fisheries Service (NMFS), Environmental Protection Agency (EPA), and MWRA agree, that since endangered and/or threatened marine species are present within the area which could potentially be affected by this discharge, the outfall falls within the class of projects which "may affect" protected species, within the meaning of the Endangered Species Act (ESA). Because the outfall falls within this "may affect" category, Section 7 of the ESA require that EPA consult with NMFS before issuing a discharge permit.

On September 8, 1993, that consultation concluded when NMFS issued its Biological Opinion. The Biological Opinion found that the MWRA outfall is not likely to jeopardize endangered or threatened species.

Along with the Biological Opinion, NMFS issued a number of "Conservation Recommendations". These recommendations, which suggest optional measures that may be taken to further protect endangered or threatened species, are designed to minimize any possibility of adverse effects on such species. The recommendations are discretionary and non-binding. See 40 C.F.R. § 402.14 (j).

After the Biological Opinion was issued, NMFS began a series of discussions with the EPA and MWRA concerning implementation of the conservation recommendations. The agencies have also received comments on the Conservation Recommendations from scientists both within and outside the agencies. These discussions and comments have helped clarify the intent and purpose of the conservation recommendations. It has become clear that some of the recommendations have been addressed by earlier work. In some cases, the agencies have identified more effective means of achieving NMFS' purpose than the methods proposed by the original recommendations.

NMFS, EPA, and MWRA are strongly committed to the protection of endangered and threatened species, and to continued to develop and implement practical methods of reducing threats to those species. The agencies have developed the attached plan for implementation of the Conservation Recommendations to reduce the potential for adverse effects on protected species.

NMFS, EPA, and MWRA also acknowledge that MWRA expects to propose a reduction in the number of batteries of secondary treatment to be constructed at Deer Island. At the time it makes its proposal, MWRA will address the potential impacts of any reduction in the number of batteries upon endangered and threatened species, and will provide the agencies with information relevant to whether MWRA's proposal would affect any of the assumptions upon which the Biological Opinion was based, including any change in the quantity or quality of effluent discharged from the ocean outfall. Upon receipt of any such MWRA proposal, NMFS and EPA will review it to determine what further action is required pursuant to the ESA.

This agreement is intended to reflect the mutual understanding of NMFS, EPA, and MWRA, and is not intended to create legal rights in any other party.

CONSERVATION RECOMMENDATIONS IMPLEMENTATION PLAN

Permit Actions

1. EPA will require chronic toxicity testing in its draft NPDES permit (EPA cannot make commitments on the content of the final permit before receiving public comments). MWRA agrees not to oppose such a requirement.

2. EPA's draft NPDES permit will include limits on priority pollutants, where such pollutants are or may be discharged at a level which has a reasonable potential to cause or contribute to any exceedance of a State

water quality standard.

3. MWRA will continue it efforts to reduce pollutant loadings to its treatment facilities through aggressive enforcement of its Industrial Pretreatment Program, and will continue to comply with the federal court order concerning pretreatment.

4. Implementation of the baseline monitoring program has been a requirement of the federal court order since June, 1992. NMFS, EPA, and MWRA agree that the court order is an appropriate mechanism for enforcement of the monitoring program.

5. By March, 1995, MWRA will develop a draft contingency plan that describes how treatment plant operations can be modified to respond to any problems indicated by monitoring. EPA and NMFS will review this framework, which will also be made available to the public. NMFS and/or EPA may recommend further work if it believes that MWRA's plans are not sufficiently detailed or are inadequate for any other reason. NMFS, EPA, and MWRA agree that the purpose of this planning effort is to reduce the time that would be needed to respond to any need for removal of nutrients and toxics at a future date.

<u>Modeling Actions</u>

1. The MWRA has released a draft report on the results of its three-dimensional dilution model for stratified conditions. EPA and NMFS are reviewing this report.

2. MWRA has reported to NMFS and EPA on updated projections of future wastewater loadings due to future development in the Boston area in its CSO System Master Plan in December, 1994.

<u>Monitoring Actions</u>

1. MWRA has reported to the Outfall Monitoring Task Force on the proportion of chemical contaminants in its effluent associated with particulate and dissolved states. The Task Force is now evaluating the information. In consultation with the Task Force, EPA, NMFS, and CZM will determine future monitoring needs.

2. Prior to commencement of the discharge, MWRA will review the status of USGS studies concerning transport, resuspension, and accumulation of particulates and toxic contaminants in Massachusetts Bay, and shall report on the results (or interim results, if the studies have not yet been completed) of those studies and their significance for outfall-related impacts. EPA and NMFS will review this report and make appropriate recommendations on further action or studies. If these studies are not complete by the time the discharge begins, MWRA shall continue to review the progress of the studies and shall periodically report on the significance of any new results for outfall-related impacts.

3. NMFS, EPA, and MWRA agree that plume tracking studies will be done as a special study under the existing monitoring plan. NMFS, EPA, and MWRA agree that studies defining density accumulation horizons may be useful for plume tracking, but that it is unnecessary to specify a particular technology at this point. MWRA agrees to coordinate its sampling with pilot hydroacoustic studies which may be proposed by NOAA for the summer of 1995 to compare with methods already being used to define water column density structure.

<u>Endangered Species Protection Actions</u>

1. EPA/NMFS will request that the Marine Mammal Working Group on Unusual Marine Mammal Mortalities identify any potential pathogens from sewage effluent that may serve as disease vectors for marine mammals. If any such pathogens are identified, MWRA will test for these pathogens in its effluent. Based on treatment effectiveness, MWRA, in consultation with appropriate elements of EPA (e.g. ORD), will

determine the potential for these pathogens to survive discharge into salt water. MWRA/EPA will report the results to NMFS.

2. Consistent with the existing recovery plans for the humpback and northern right whales, a recovery plan implementation team, comprised of federal and non-federal whale and other marine researchers, will review whale related research and monitoring activites in Massachusetts and Cape Cod Bays.

3. EPA and NMFS will continue their consultations regarding water quality criteria and standards, and will consult on cumulative impacts of ocean discharge and disposal as appropriate.

4. EPA and NMFS will continue their efforts concerning impacts of toxins on endangered marine mammals. For example, EPA's Narragansett Lab is conducting analyses of humpback whale body burdens and is considering spatial partitioning to develop sampling methods. The NMFS Northwest Fisheries Science Center is conducting analyses on North Atlantic cetacean tissues.

4/8/95 _________________________
Date Rolland A. Schmitten
Assistant Administrator for Fisheries
National Marine Fisheries Service
National Oceanic and Atmospheric Administration

4/12/95 _________________________
Date Patricia L. Meaney
Acting Regional Administrator
Environmental Protection Agency

3/27/95 _________________________
Date Douglas B. MacDonald
Executive Director
Massachusetts Water Resources Authority