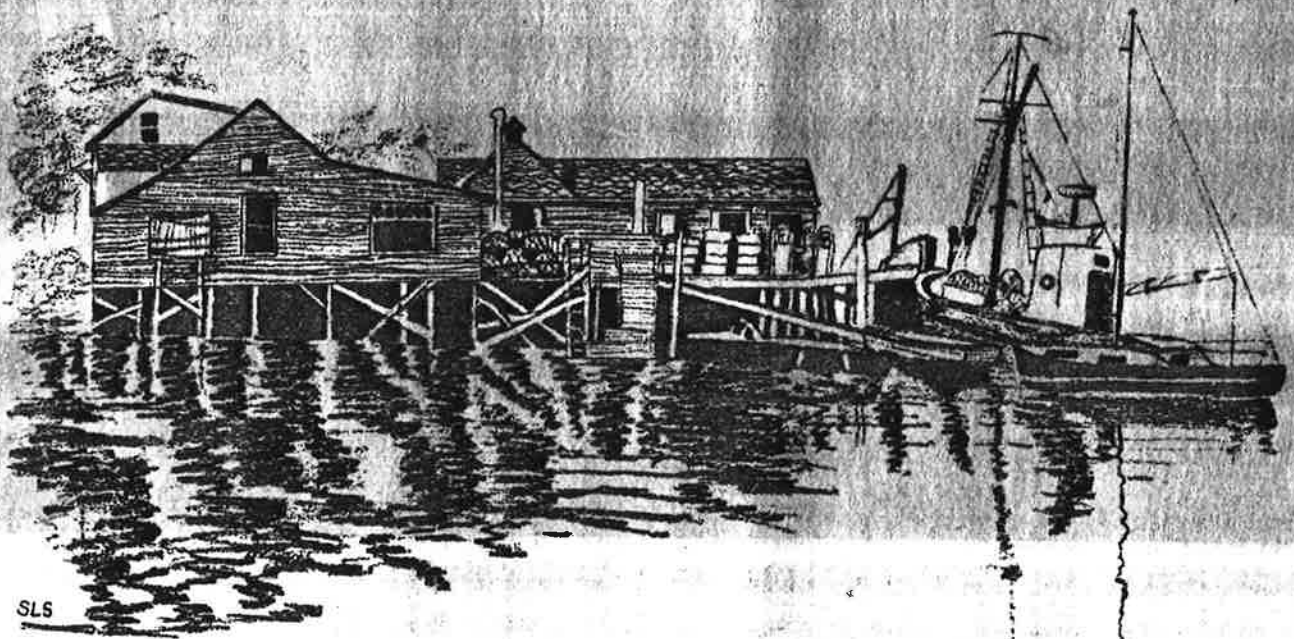


93-A-2

SALEM SOUND 1983 WATER QUALITY SURVEY



Massachusetts Department of Environmental Quality Engineering

ON of WATER POLLUTION CONTROL

Thomas C. McMahon, Director

MR
333.912M3
836
1983

c.1

93-A-2

SALEM SOUND
1983
WATER QUALITY SURVEY

MASSACHUSETTS DEPARTMENT OF ENVIRONMENTAL QUALITY ENGINEERING
DIVISION OF WATER POLLUTION CONTROL
TECHNICAL SERVICES BRANCH

WESTBOROUGH, MASSACHUSETTS
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FOREWORD

This report is a compilation of the results of water quality surveys conducted on the waters of Salem Sound on 20-21 July and 19-20 September 1983 by the Technical Services Branch of the Massachusetts Division of Water Pollution Control. Effluent sampling results at the South Essex Sewerage District (SESD) WWTP and New England Power generating station are also included in this report. It should be noted that the composite samples from SESD include the sludge discharge on the out-going tide, as well as the primary effluent.

Samples during the July survey were collected throughout Salem Sound, Manchester and Marblehead Harbors. Stations 1-18 are locations chosen by the SESD staff for their monitoring program. The Marblehead Harbor stations were originally sampled by the Division in 1978. During the September survey, only the Salem Sound stations were sampled. At each station, dissolved oxygen samples were collected at various depths and chemical, metals and bacteriological samples were collected at one meter below the surface.

The dissolved oxygen samples were fixed in the field and were analyzed at the Technical Services Branch in Westborough using the modified Winkler method. Temperature was measured in situ. Chemical, bacteriological and metals analyses were performed at the Department's Lawrence Experiment Station according to procedures outlined in APHA-AWWA's Standard Methods for the Examination of Water and Wastewater and approved by the U.S. Environmental Protection Agency.

All inquiries concerning the information contained in this report should be addressed to personnel at the Division's Technical Services Branch. The address is:

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TABLE OF CONTENTS

<u>ITEM</u>	<u>PAGE</u>
FOREWORD	2
LIST OF TABLES	4
LIST OF FIGURES	5
TIDAL INFORMATION	33
ASSESSMENT OF WATER POLLUTION	34

LIST OF TABLES

<u>TABLE</u>	<u>TITLE</u>	<u>PAGE</u>
1	Location of Sampling Stations	6
2	Depth-Temperature-Dissolved Oxygen Data	9
3	Secchi Disk Depth Data	16
4	Chloride Data	17
5	Specific Conductance Data	18
6	pH Data	19
7	Suspended Solids Data	20
8	Total Kjeldahl-Nitrogen Data	21
9	Ammonia-Nitrogen Data	22
10	Total Phosphorus Data	23
11	Total Coliform Bacteria Data	24
12	Fecal Coliform Bacteria Data	25
13	Metals Data - 20 July 1983	26
14	Metals Data - 21 July 1983	27
15	Metals Data - 19 September 1983	28
16	Metals Data - 20 September 1983	29
17	South Essex Sewerage District WWTP Discharge Data	30
18	New England Power - Salem Station Discharge Data	31
19	Sediment Metals Data	32
20	Tidal Information	33

LIST OF FIGURES

<u>FIGURE</u>	<u>TITLE</u>	<u>PAGE</u>
1	Salem Sound - Location of Sampling Stations	7
2	Manchester Harbor - Location of Sampling Stations	8
3	Marblehead Harbor - Location of Sampling Stations	8

TABLE 1
1983 SALEM SOUND SURVEY
LOCATION OF SAMPLING STATIONS

<u>STATION</u>	<u>LOCATION</u>	<u>BUOY</u>
SB01	Marblehead Channel	Light B21
SB02	Salem Sound	Light R16
SB03	Salem Sound, off Mingo Beach	N14
SB04	Salem Sound, off John Ledge	Light R12
SB05	Cat Island Channel	Light B3
SB07	Marblehead Channel	C1
SB08	Salem Sound	C7
SB09	Salem Sound, between SB08 and SB10	--
SB10	Salem Sound, just north of Little Haste	--
SB11	Salem Sound, east of Hardy Shoal	N8
SB16	Salem Sound, off Haste Shoal	Light B15
SB17	Salem Sound, east of SB16	Light B13
SB18	Beverly Harbor, near Monument Bar	C9
SB19	Beverly Harbor, east of double bridge	--
SB20	Bass River	N6
SB21	Danvers River, off Kernwood Park	--
SB22	Salem Harbor, near power plant jetty	--
SB23	Salem Harbor, off Long Point	--
MB01	Marblehead Harbor, at mouth	--
MB02	Marblehead Harbor, near Boder Rocks	--
MB03	Marblehead Harbor, opposite condominiums	--
MB04	Marblehead Harbor, opposite yacht club near causeway	--
MC01	Manchester Harbor, at mouth	C5
MC02	Manchester Harbor, off Tucks Point	--
MC03	Manchester Harbor, south of railroad bridge	--

2
6
21

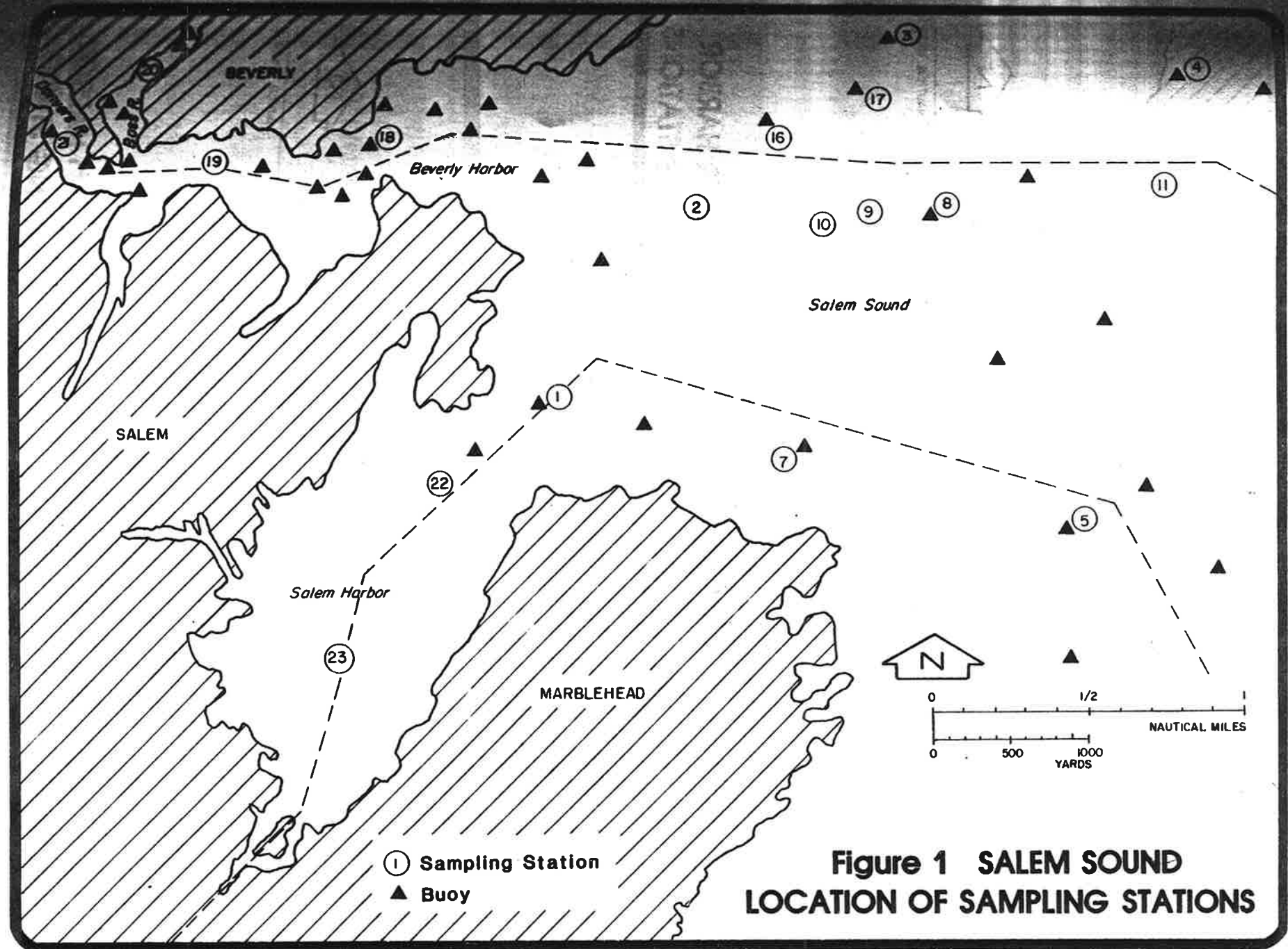


**Figure 1 SALEM SOUND
LOCATION OF SAMPLING STATIONS**

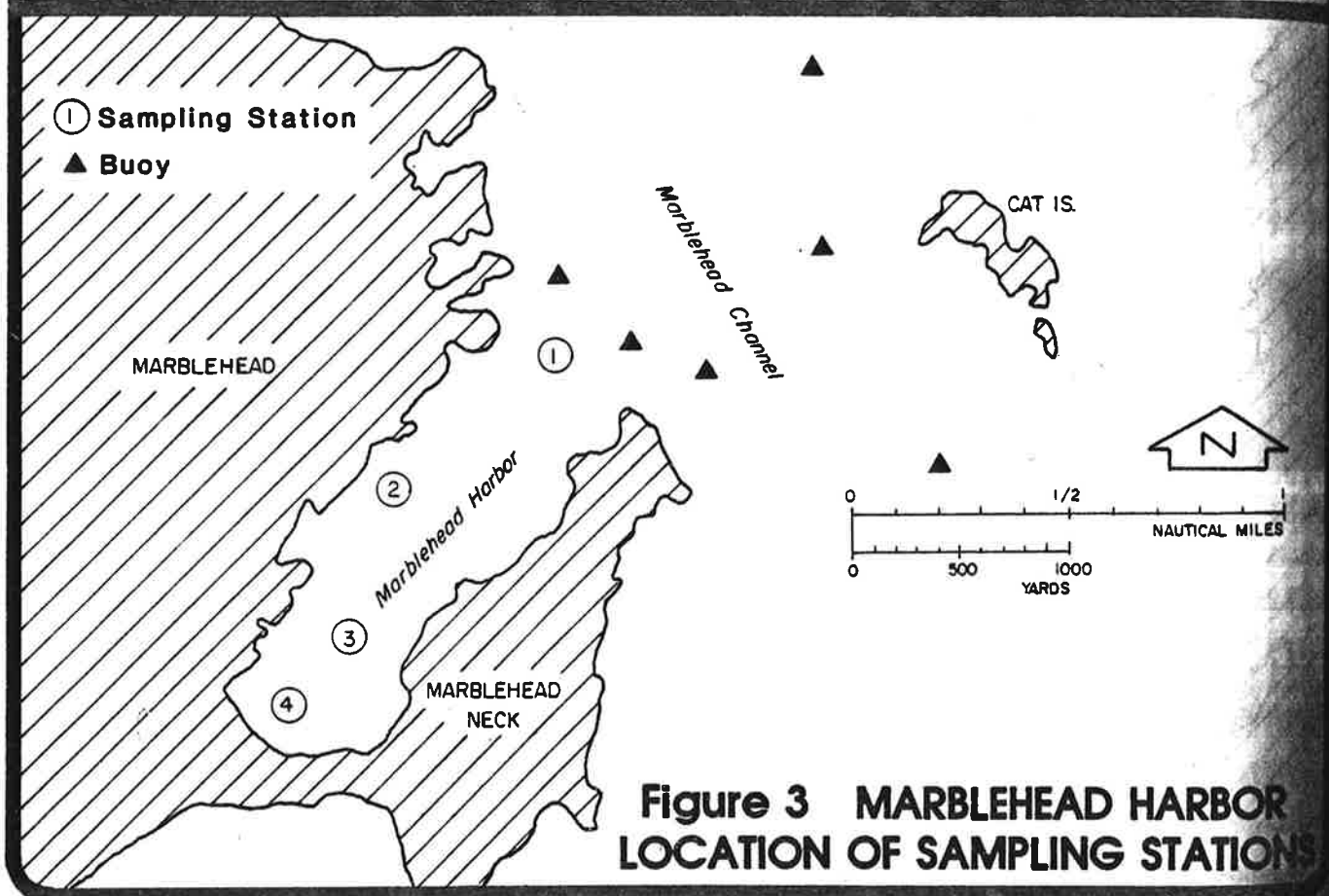
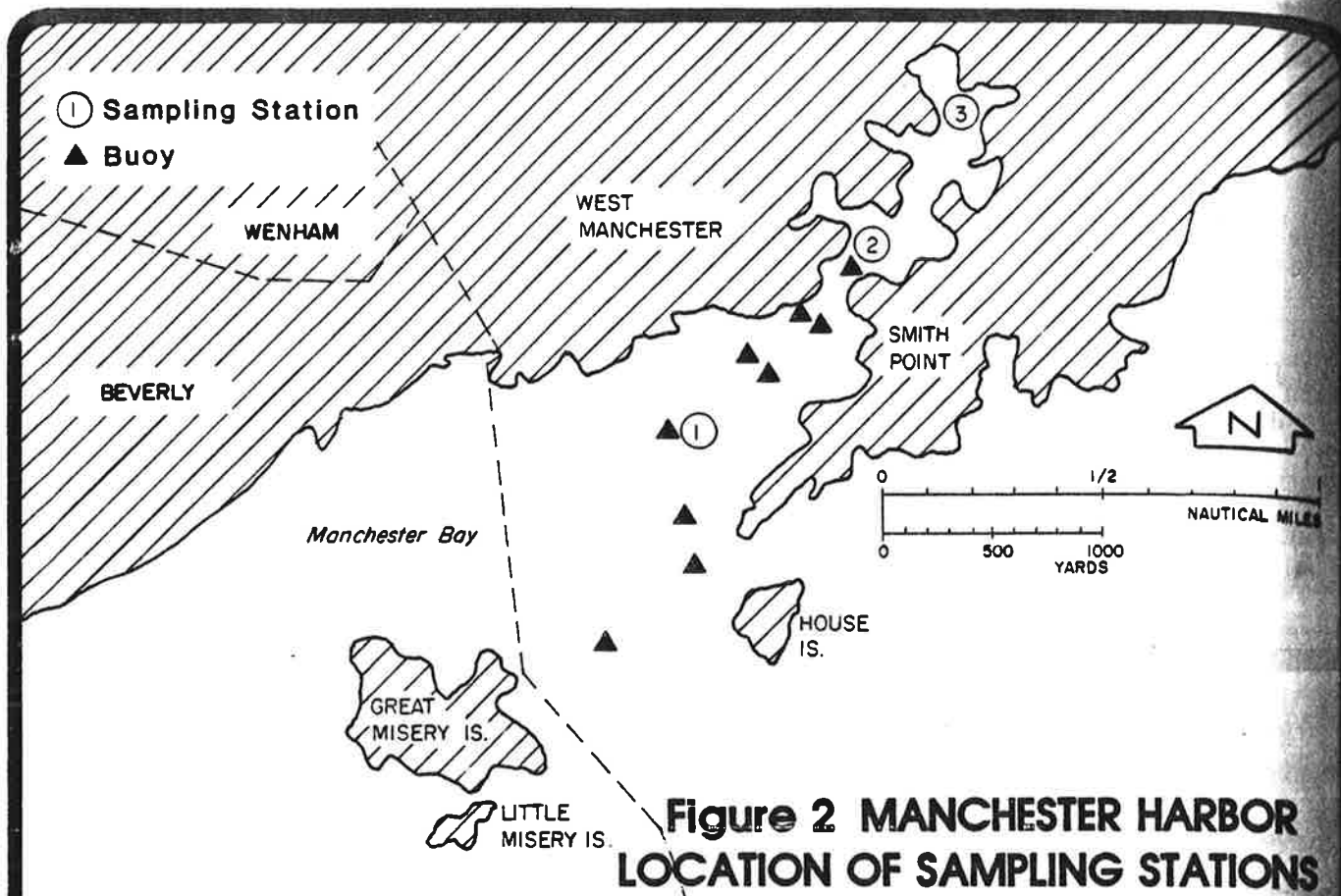


TABLE 2

1983 SALEM SOUND SURVEY

DEPTH-TIME-TEMPERATURE-DISSOLVED OXYGEN DATA

STATION		7/20	7/21	9/19	9/20
SB01	*	1	1	1	1
	**	1430	1445	1141	1159
	†	72	74	66	67
	††	9.7	10.1	8.3	8.5
		7	8.5	9.5	10
		1455	1445	1141	1200
		60	62	63	62
		7.9	8.4	5.7	6.5
SB02		1	1	1	1
		1145	1110	1318	1028
		68	71	65	67
		11.1	9.7	9.0	7.6
		9	6	5.5	6
		1150	1110	1320	1035
		59	66	65	64
		7.8	9.9	8.1	7.2
SB03		--	12	11	12
		--	1110	1318	1033
		--	57	65	62
		--	6.5	7.7	6.5
		1	1	1	1
		1214	1135	1039	1052
		68	71	65	66
		11.4	11.2	8.9	9.1
		--	5.5	--	6
		--	1135	--	1059
		--	65	--	62
		--	10.2	--	7.6
		10	11.3	12	12
		1215	1135	1039	1058
		58	59	63	60
		8.0	8.1	7.5	7.0

* Depth in meters

** Time in hours-minutes

† Temperature in °F

†† Dissolved Oxygen in mg/l

TABLE 2 (CONTINUED)

STATION	7/20	7/21	9/10	9/20
SB04	1	1	1	1
	1220	1145	1049	1102
	70	71	64	66
	11.1	10.7	8.6	9.1
	7.5	7	7.5	8
	1220	1145	1051	1108
	60	60	63	61
	10.3	10.7	8.1	7.7
	15	14	15	16.5
	1225	1145	1049	1105
	55	58	61	57
	8.0	7.7	7.9	7.2
SB05	1	1	1	1
	1345	1325	1115	1122
	70	72	65	67
	11.8	11.8	9.1	9.0
	7.5	8.5	8.5	8
	1345	1325	1123	1125
	61	62	63	61
	9.7	9.5	7.8	6.9
	15	17	17	16
	1350	1325	1125	1125
	54	55	61	58
	8.6	8.7	5.6	7.0
SB07	1	1	1	1
	1445	1435	1137	1137
	72	70	65	68
	10.8	11.8	8.4	8.9
	5	6	7	7
	1450	1435	1137	1135
	60	62	63	61
	10.9	8.5	7.3	7.0
SB08	1	1	1	1
	1520	1525	1251	1237
	70	72	66	66
	10.7	11.2	7.9	9.1
	5.5	6	6	6.5
	1520	1525	1259	1240
	63	63	65	62
	10.2	9.1	8.2	7.4

TABLE 2 (CONTINUED)

STATION	7/20	7/21	9/19	9/20
SB08 (continued)	11	12	12	13
	1525	1325	1256	1240
	54	57	63	58
	10.9	6.5	4.2	4.8
SB09	1	1	1	1
	1530	1530	1300	1244
	67	72	65	67
	10.8	11.6	8.7	7.8
	5.5	--	--	5
	1535	--	--	1247
	59	--	--	63
	8.7	--	--	8.0
	--	9	10	10
	--	1530	1300	1247
	--	60	64	60
	--	8.3	6.3	5.6
SB10	1	1	1	1
	1540	1540	1311	1252
	70	72	65	68
	11.3	12.0	9.1	8.3
	5	5	6	8
	1545	1540	1311	1255
	62	67	65	62
	10.7	10.1	7.0	6.1
SB11	1	1	1	1
	1340	1310	1100	1110
	70	72	65	67
	11.4	10.6	8.9	9.4
	6.5	--	8	7.5
	1330	--	1105	1115
	61	--	63	61
	10.2	--	8.0	8.0
	13	14	16	15
	1340	1310	1100	1115
	54	58	60	56
	7.7	7.5	6.8	6.5
SB16	1	--	1	1
	1156	--	1030	1037
	70	--	65	66
	10.6	--	8.9	8.2

TABLE 2 (CONTINUED)

STATION	7/20	7/21	9/19	9/20
SB16 (continued)	6	6.5	--	6.5
	1155	1115	--	1045
	63	66	--	62
	10.2	8.4	--	7.1
	11.5	13	12.5	13
	1200	1115	1030	1040
	59	58	63	57
	8.2	6.3	7.7	6.7
	1	1	1	1
	1210	1130	1035	1045
	70	70	65	66
	11.6	10.5	9.3	9.0
	10	6	--	6
	1210	1130	--	1053
SB17	57	65	--	62
	8.3	--	--	7.7
	--	12	11	12
	--	1130	1035	1050
	--	58	63	58
	--	6.8	7.3	6.6
	1	1	1	1
	1130	1050	1015	1019
	65	70	65	67
	10.0	9.4	8.1	7.6
	9.5	9.5	9.5	9
	1140	1050	1015	1022
	59	60	64	63
	9.6	9.0	7.2	7.0
SB18	1	1	1	1
	1125	1040	1006	1006
	66	67	65	66
	11.2	7.4	8.2	7.1
	6	7.5	6.5	7.5
	1130	1040	1006	1010
	66	65	64	64
	9.9	7.5	7.4	7.3
	1	1	1	1
	1115	1030	0952	0958
	72	72	65	68
	10.9	8.3	6.9	6.2
	1	1	1	1
	1115	1030	0952	0958
	72	72	65	68
	10.9	8.3	6.9	6.2
SB19	1	1	1	1
	1115	1030	0952	0958
	72	72	65	68
	10.9	8.3	6.9	6.2
	1	1	1	1
	1115	1030	0952	0958
	72	72	65	68
	10.9	8.3	6.9	6.2
	1	1	1	1
	1115	1030	0952	0958
	72	72	65	68
	10.9	8.3	6.9	6.2
	1	1	1	1
	1115	1030	0952	0958
	72	72	65	68
	10.9	8.3	6.9	6.2
SB20	1	1	1	1
	1115	1030	0952	0958
	72	72	65	68
	10.9	8.3	6.9	6.2
	1	1	1	1
	1115	1030	0952	0958
	72	72	65	68
	10.9	8.3	6.9	6.2
	1	1	1	1
	1115	1030	0952	0958
	72	72	65	68
	10.9	8.3	6.9	6.2
	1	1	1	1
	1115	1030	0952	0958
	72	72	65	68
	10.9	8.3	6.9	6.2

TABLE 2 (CONTINUED)

STATION	7/20	7/21	9/19	9/20
SB20 (continued)	3.5	2	2.5	3.5
	1120	1030	0952	0953
	67	70	65	65
	11.2	10.7	6.8	6.7
SB21	1	1	1	1
	1100	1015	0941	0943
	70	70	65	68
	9.6	9.5	7.0	6.6
	4	7	4.5	2
	1100	1015	0941	0945
	67	67	65	65
	10.5	8.8	7.2	6.7
SB22	1	1	1	1
	1500	1450	1153	1206
	72	72	69	69
	10.0	9.1	8.2	8.7
	6	4.5	7	5.5
	1500	1450	1153	1210
	60	69	64	64
	7.8	10.2	6.8	6.7
	--	--	--	11
	--	--	--	1210
	--	--	--	63
	--	--	--	6.4
SB23	1	1	1	1
	1505	1500	1234	1220
	72	70	68	71
	9.4	10.7	9.2	8.5
	--	--	2.1	2.5
	--	--	1234	1223
	--	--	66	67
	--	--	7.2	8.4
MB01	1	1	--	--
	1355	1340	--	--
	71	70	--	--
	11.2	12.0	--	--
	--	5.5	--	--
	--	1340	--	--
	--	67	--	--
	--	10.5	--	--

TABLE 2 (CONTINUED)

STATION	7/20	7/21	9/19	9/20
MB01 (continued)	9	11	--	--
	1400	1340	--	--
	57	58	--	--
	9.2	8.7	--	--
MB02	1	1	--	--
	1405	1355	--	--
	72	71	--	--
	10.2	10.3	--	--
	7	9	--	--
	1410	1355	--	--
	59	59	--	--
	8.8	--	--	--
MB03	1	1	--	--
	1415	1400	--	--
	70	72	--	--
	10.3	11.4	--	--
	6	7	--	--
	1415	1400	--	--
	69	62	--	--
	9.8	8.6	--	--
MB04	1	1	--	--
	1320	1410	--	--
	67	71	--	--
	10.9	--	--	--
	3.5	3.5	--	--
	1430	1410	--	--
	65	66	--	--
	11.2	6.2	--	--
MC01	1	1	--	--
	1230	1200	--	--
	71	70	--	--
	10.4	9.1	--	--
	4.5	6	--	--
	1235	1200	--	--
	62	66	--	--
	11.4	9.2	--	--
MC02	1	1	--	--
	1310	1215	--	--
	72	71	--	--
	11.3	10.5	--	--

TABLE 2 (CONTINUED)

STATION	7/20	7/21	9/19	9/20
MC02 (continued)	3	4	--	--
	1315	1215	--	--
	69	69	--	--
	11.8	13.0	--	--
MC03	1	1	--	--
	1245	1230	--	--
	73	73	--	--
	10.5	9.9	--	--
	3	4	--	--
	1250	1230	--	--
	69	--	--	--
	13.1	9.7	--	--

TABLE 3
1983 SALEM SOUND SURVEY
SECCHI DISK DEPTH DATA (m)

STATION	7/20	7/21	9/19	9/20
SB01	2.4	1.7	2.4	2.8
SB02	2.0	1.3	2.4	3.0
SB03	2.0	2.0	2.8	2.8
SB04	2.0	2.1	4.1	2.4
SB05	2.0	2.0	2.2	2.8
SB07	2.8	1.6	3.0	2.2
SB08	1.8	1.2	0.8	0.8
SB09	1.8	*	0.6	0.6
SB10	1.8	1.2	2.2	2.6
SB11	1.6	1.8	2.6	2.2
SB16	2.0	2.0	2.3	2.4
SB17	2.0	2.0	2.3	2.8
SB18	2.2	1.2	2.6	3.4
SB19	2.2	1.6	2.2	3.6
SB20	1.6	1.3	2.5	2.8
SB21	2.2	--	2.6	2.4
SB22	2.2	1.6	2.4	2.4
SB23	2.0	--	1.0	2.4
MB01	2.2	1.4	--	--
MB02	2.8	1.8	--	--
MB03	2.6	2.0	--	--
MB04	2.8	2.0	--	--
MC01	3.0	3.0	--	--
MC02	2.8	2.2	--	--
MC03	2.6	2.0	--	--

* too windy to measure Secchi depth

TABLE 4
1983 SALEM SOUND SURVEY
CHLORIDE DATA (mg/l)

STATION	7/20	7/21	9/19	9/20
SB01	13,800	6,250	18,700	18,125
SB02	14,400	17,500	18,300	17,500
SB03	13,800	15,000	18,000	17,500
SB04	6,900	13,800	19,000	17,500
SB05	19,400	13,800	19,000	17,500
SB07	18,100	11,900	19,000	17,500
SB08	19,400	14,400	18,700	16,875
SB09	15,600	16,900	18,700	16,875
SB10	13,800	16,900	18,500	17,500
SB11	13,100	15,600	20,000	17,500
SB16	18,100	14,400	20,000	17,500
SB17	13,800	14,400	20,000	17,500
SB18	18,100	11,250	20,000	17,500
SB19	16,200	16,250	18,500	17,500
SB20	15,100	15,000	17,500	17,500
SB21	18,100	15,000	18,500	17,500
SB22	15,000	13,800	18,700	16,875
SB23	8,800	16,200	18,700	17,500
MB01	14,400	16,200	--	--
MB02	12,500	14,400	--	--
MB03	15,600	6,200	--	--
MB04	16,200	3,125	--	--
MC01	18,100	4,400	--	--
MC02	8,100	6,900	--	--
MC03	10,000	3,800	--	--

TABLE 5
1983 SALEM SOUND SURVEY
SPECIFIC CONDUCTANCE DATA (umhos/cm)

STATION	7/20	7/21	9/19	9/20
SB01	38,000	36,000	40,000	40,000
SB02	36,000	37,000	40,000	40,000
SB03	38,000	38,000	40,000	40,000
SB04	34,000	36,000	40,000	40,000
SB05	37,000	35,000	40,000	40,000
SB07	38,000	35,000	40,000	40,000
SB08	33,000	38,000	40,000	39,000
SB09	33,000	38,000	40,000	40,000
SB10	32,000	35,000	40,000	40,000
SB11	35,000	36,000	40,000	40,000
SB16	32,000	34,000	40,000	40,000
SB17	34,000	36,000	40,000	40,000
SB18	35,000	37,000	40,000	40,000
SB19	34,000	36,000	40,000	40,000
SB20	33,000	35,000	40,000	40,000
SB21	35,000	35,000	40,000	40,000
SB22	37,000	37,000	40,000	40,000
SB23	37,000	34,000	40,000	--
MB01	37,000	35,000	--	--
MB02	36,000	36,000	--	--
MB03	38,000	35,000	--	--
MB04	36,000	34,000	--	--
MC01	34,000	36,000	--	--
MC02	36,000	37,000	--	--
MC03	36,000	35,000	--	--

TABLE 6
1983 SALEM SOUND SURVEY
pH DATA (Standard Units)

STATION	7/20	7/21	9/19	9/20
SB01	8.3	8.4	8.6	8.6
SB02	8.3	8.5	8.6	8.5
SB03	8.3	8.4	8.6	8.6
SB04	8.2	8.5	8.6	8.6
SB05	8.3	8.5	8.6	8.6
SB07	8.3	8.5	8.6	8.6
SB08	8.2	8.5	8.6	8.7
SB09	8.2	8.6	8.6	8.7
SB10	8.3	8.5	8.6	8.6
SB11	8.1	8.4	8.6	8.7
SB16	8.2	8.5	8.6	8.6
SB17	8.3	8.5	8.6	8.6
SB18	8.2	8.4	8.5	8.4
SB19	8.2	7.5	8.5	8.5
SB20	8.2	8.3	8.4	8.5
SB21	8.2	8.5	8.4	8.4
SB22	8.2	8.4	8.5	8.6
SB23	8.1	8.4	8.6	8.6
MB01	8.3	8.4	--	--
MB02	8.3	8.5	--	--
MB03	8.3	8.4	--	--
MB04	8.3	8.4	--	--
MC01	8.2	8.3	--	--
MC02	8.2	8.4	--	--
MC03	8.2	8.4	--	--

TABLE 7
1983 SALEM SOUND SURVEY
SUSPENDED SOLIDS DATA (mg/l)

STATION	7/20	7/21	9/19	9/20
SB01	22	18	16	34
SB02	21	44	11	16
SB03	31	40	33	22
SB04	26	19	23	20
SB05	21	31	18	36
SB07	19	20	29	18
SB08	41	24	19	42
SB09	35	27	32	54
SB10	21	36	22	32
SB11	41	33	14	22
SB16	18	33	16	35
SB17	24	22	10	24
SB18	37	29	10	27
SB19	19	21	5.5	22
SB20	21	17	26	32
SB21	27	16	14	20
SB22	19	26	22	35
SB23	24	52	26	20
MB01	22	28	--	--
MB02	21	19	--	--
MB03	29	32	--	--
MB04	23	31	--	--
MC01	32	24	--	--
MC02	18	45	--	--
MC03	99	18	--	--

TABLE 8
1983 SALEM SOUND SURVEY
TOTAL KJELDAHL-NITROGEN DATA (mg/l.)

STATION	7/20	7/21	9/19	9/20
SB01	1.2	1.4	1.2	1.1
SB02	1.1	1.8	1.2	1.1
SB03	1.2	1.3	1.5	1.2
SB04	1.4	1.3	1.1	1.1
SB05	1.1	1.2	1.7	1.2
SB07	1.0	1.3	1.1	1.2
SB08	1.3	1.6	2.7	1.8
SB09	1.4	1.4	2.0	2.4
SB10	1.2	1.6	1.3	1.2
SB11	1.7	1.4	1.0	0.87
SB16	1.3	1.4	1.0	1.1
SB17	1.3	1.2	1.1	0.81
SB18	1.2	1.5	1.3	0.89
SB19	1.2	1.6	1.0	1.1
SB20	1.1	1.4	1.3	2.4
SB21	1.1	1.5	1.2	1.2
SB22	0.89	1.5	1.3	1.6
SB23	1.1	1.7	1.3	1.4
MB01	1.1	2.6	--	--
MB02	1.2	1.6	--	--
MB03	1.1	1.4	--	--
MB04	1.2	1.5	--	--
MC01	1.1	1.9	--	--
MC02	1.2	1.3	--	--
MC03	1.3	1.0	--	--

TABLE 9
1983 SALEM SOUND SURVEY
AMMONIA-NITROGEN DATA (mg/l)

STATION	7/20	7/21	9/19	9/20
SB01	0.07	0.00	0.06	0.10
SB02	0.09	0.00	0.06	0.10
SB03	0.10	0.00	0.10	0.06
SB04	0.15	0.01	0.05	0.04
SB05	0.59	0.14	0.03	0.06
SB07	0.09	0.10	0.03	0.40
SB08	0.27	0.01	0.52	0.48
SB09	0.28	0.18	0.65	0.71
SB10	0.02	0.01	0.05	0.21
SB11	0.03	0.01	0.20	0.19
SB16	0.07	0.00	0.06	0.23
SB17	0.09	0.00	0.06	0.04
SB18	0.06	0.25	0.09	0.11
SB19	0.03	0.09	0.08	0.10
SB20	0.05	0.01	0.13	0.04
SB21	0.04	0.00	0.10	0.14
SB22	0.04	0.03	0.07	0.03
SB23	0.63	0.01	0.04	0.03
MB01	0.53	0.13	--	--
MB02	0.06	0.09	--	--
MB03	0.16	0.08	--	--
MB04	0.04	0.09	--	--
MC01	0.04	0.12	--	--
MC02	0.06	0.11	--	--
MC03	0.13	0.09	--	--

TABLE 10
1983 SALEM SOUND SURVEY
TOTAL PHOSPHORUS DATA (mg/l)

STATION	7/20	7/21	9/19	9/20
SB01	0.09	0.13	0.12	0.13
SB02	0.09	0.13	0.10	0.10
SB03	0.11	0.10	0.09	0.09
SB04	0.10	0.17	0.08	0.12
SB05	0.09	0.11	0.12	0.10
SB07	0.10	0.13	0.13	0.17
SB08	0.12	0.14	0.63	0.61
SB09	0.12	0.13	0.67	0.89
SB10	0.10	0.11	0.12	0.17
SB11	0.13	0.11	0.12	0.15
SB16	0.10	0.10	0.11	0.32
SB17	0.11	0.08	0.11	0.15
SB18	0.10	0.25	0.11	0.18
SB19	0.10	0.09	0.11	0.15
SB20	0.12	0.01	0.12	0.14
SB21	0.10	0.00	0.11	0.17
SB22	0.09	0.03	0.12	0.20
SB23	0.10	0.01	0.18	0.13
MB01	0.10	0.13	--	--
MB02	0.08	0.09	--	--
MB03	0.09	0.08	--	--
MB04	0.09	0.09	--	--
MC01	0.09	0.12	--	--
MC02	0.09	0.11	--	--
MC03	0.10	0.09	--	--

TABLE 11
1983 SALEM SOUND SURVEY
TOTAL COLIFORM BACTERIA DATA (#/100m¹)

STATION	7/20	7/21	9/19	9/20
SB01	10	8000	100	80
SB02	20	500	1300	20
SB03	80	260	600	5
SB04	10	600	1400	10
SB05	20	280	60	120
SB07	10	3000	20	280
SB08	75,000	--	160,000	85,000
SB09	20,000	200	170,000	70,000
SB10	60	800	400	20
SB11	10	10	1700	58,000
SB16	1600	--	1600	150,000
SB17	200	10	400	40
SB18	80	240	100	80
SB19	60	800	340	300
SB20	200	1200	680	1000
SB21	120	200	360	220
SB22	40	20	20	80
SB23	10	3000	10	40
MB01	10	20	--	--
MB02	20	320	--	--
MB03	40	10	--	--
MB04	10	100	--	--
MC01	20	5	--	--
MC02	10	120	--	--
MC03	30	5	--	--

TABLE 12
1983 SALEM SOUND SURVEY
FECAL COLIFORM BACTERIA DATA (#/100 ml)

STATION	7/20	7/21	9/19	9/20
SB01	<5	20	5	<5
SB02	<5	10	100	<5
SB03	<5	<5	50	<5
SB04	<5	10	130	<5
SB05	<5	<5	<5	<5
SB07	<5	20	<5	<5
SB08	300	--	30,000	6000
SB09	2100	20	18,000	5500
SB10	40	40	10	5
SB11	<5	<5	120	1000
SB16	--	250	150	4000
SB17	70	<5	30	<5
SB18	10	<5	<5	<5
SB19	5	<5	30	10
SB20	80	300	50	150
SB21	10	<5	30	30
SB22	<5	<5	<5	<5
SB23	<5	<5	<5	<5
MB01	<5	<5	--	--
MB02	<5	<5	--	--
MB03	<5	<5	--	--
MB04	<5	<5	--	--
MC01	<5	<5	--	--
MC02	<5	<5	--	--
MC03	<5	<5	--	--

TABLE 13
1983 SALEM SOUND SURVEY
METALS DATA (mg/l) - 20 JULY 1983

	<u>SB05</u>	<u>SB09</u>	<u>SB19</u>	<u>SB22</u>
Aluminum	0.20	0.33	0.10	0.13
Arsenic	0.000	0.000	0.000	0.000
Cadmium	0.04	0.05	0.04	0.04
Chromium (Total)	0.03	0.04	0.04	0.03
Copper	0.10	0.05	0.05	0.05
Lead	0.27	0.27	0.27	0.27
Nickel	0.26	0.26	0.22	0.24
Mercury	0.0003	0.0002	0.0006	0.0000
Silver	0.04	0.03	0.04	0.04
Tin	<0.50	<0.50	<0.50	<0.50
Zinc	0.00	0.00	0.00	0.01

TABLE 14
1983 SALEM SOUND SURVEY
METALS DATA (mg/l) - 21 JULY 1983

	<u>SB05</u>	<u>SB09</u>	<u>SB19</u>	<u>SB22</u>
Aluminum	0.17	0.13	0.13	0.13
Arsenic	0.012	0.011	0.000	0.000
Cadmium	0.04	0.04	0.04	0.04
Chromium (Total)	0.04	0.04	0.02	0.03
Copper	0.06	0.05	0.06	0.13
Lead	0.26	0.37	0.27	0.27
Nickel	0.24	0.22	0.23	0.25
Mercury	0.0000	0.0001	0.0000	0.0001
Silver	0.03	0.03	0.03	0.03
Tin	<0.50	<0.50	<0.50	<0.50
Zinc	0.00	0.00	0.01	0.01

TABLE 15
1983 SALEM SOUND SURVEY
METALS DATA (mg/l) - 19 SEPTEMBER 1983

	<u>SB05</u>	<u>SB09</u>	<u>SB19</u>	<u>SB22</u>
Aluminum	1.0	0.85	0.62	0.77
Arsenic	0.470	0.530	0.480	0.560
Cadmium	0.01	0.01	0.00	0.02
Chromium (Total)	0.03	0.07	0.05	0.03
Chromium (hexavalent)	0.00	0.00	0.00	0.00
Lead	0.18	0.18	0.22	0.22
Nickel	0.20	0.22	0.21	0.23
Silver	0.03	0.03	0.03	0.03

TABLE 16
1983 SALEM SOUND SURVEY
METALS DATA (mg/l) - 20 SEPTEMBER 1983

	SB05	SB09	SB19
Aluminum	0.92	0.92	0.92
Arsenic	0.550	0.520	0.560
Cadmium	0.02	0.01	0.01
Chromium (Total)	0.03	0.10	0.03
Chromium (hexavalent)	0.00	0.00	0.00
Lead	0.23	0.24	0.24
Nickel	0.20	0.18	0.22
Silver	0.03	0.03	0.03

TABLE 17
1983 SALEM SOUND SURVEY
SOUTH ESSEX SEWERAGE DISTRICT WASTEWATER TREATMENT PLANT DISCHARGE DATA

PARAMETER*	7/21	7/21-22	9/19-20	9/20-21
Chemical Oxygen Demand	--	--	226	841
Biochemical Oxygen Demand ₅	228	291	120	270
pH (Standard Units)	7.6	7.3	7.5	8.3
Alkalinity (as CaCO ₃)	207	193	190	300
Suspended Solids	94	280	235	410
Settleable Solids (ml/l)	2.5	3.8	3.0	8.0
Total Solids	1900	2800	3250	3000
Total Kjeldahl-Nitrogen	56	155	32	72
Ammonia-Nitrogen	22	35	22	29
Nitrate-Nitrogen	0.1	0.0	0.0	0.0
Total Phosphorus	4.8	11	16	11
Aluminum	0.60	1.2	1.3	2.7
Arsenic	0.000	0.000	0.032	0.065
Cadmium	0.00	0.01	0.01	0.02
Chromium (Total)	1.0	2.1	0.47	2.9
Copper	0.00	0.11	--	--
Mercury	0.0004	0.0005	--	--
Nickel	--	--	0.04	0.16
Lead	0.03	0.12	0.10	0.20
Silver	0.00	0.01	0.00	0.00
Tin	<0.50	<0.50	--	--
Zinc	0.08	0.20	--	--
Total Coliform (#/100 ml)	2.4X10 ⁶	--	4.3X10 ⁶	430,000
Fecal Coliform (#/100 ml)	2.4X10 ⁶	--	2.4X10 ⁶	240,000
Flow (MGD)	18.5	19.2	17.3	18.7

*in mg/l unless stated otherwise

TABLE 18
1983 SALEM SOUND SURVEY
NEW ENGLAND POWER-SALEM STATION DISCHARGE DATA
10 AUGUST 1983

<u>PARAMETER*</u>	<u>INTAKE</u>	<u>OUTFALL 001</u>	<u>OUTFALL 006</u>
pH (Standard Units)	--	8.1	8.6
Suspended Solids	--	27	31
Oil & Grease	--	0.2	0.0
Turbidity (NTU)	--	--	2.3
Temperature (°F)	64	81	--
Copper	--	--	0.03
Iron	--	--	0.45
Nickel	--	--	0.17
Zinc	--	--	0.06
Chlorine Residual	--	<0.2	--
Flow (MGD)	--	1656	--

*in mg/l unless stated otherwise

TABLE 19
1983 SALEM SOUND SURVEY
SEDIMENT METALS DATA (mg/kg)*

<u>PARAMETER</u>	<u>SB05</u>	<u>SB09</u>	<u>SB22</u>
Aluminum	2000	3680	11,200
Arsenic	0.00	4.0	2.2
Cadmium	0.40	6.4	2.0
Chromium (Total)	76	1000	140
Chromium (Hexavalent)	0.00	0.00	0.00
Lead	13	108	22
Nickel	3.6	13	26
Silver	0.00	1.2	0.40

*samples collected on 19 September 1983

TABLE 20
1983 SALEM SOUND SURVEY
TIDAL INFORMATION

<u>DATE</u>	<u>HIGH TIDE*</u>	<u>LOW TIDE*</u>
7/20	0837	1437
7/21	0935	1541
9/19	1020	1619
9/20	1101	1701

*time in hours-minutes

THE ASSESSMENT OF WATER POLLUTION

A workable definition of the term "water pollution" is difficult to formulate simply because pollution problems are extremely variable and site-specific. The word "pollute" literally means to "render impure"; however, a more acceptable definition of pollution must take factors into account such as the chemical, physical, and biological characteristics of natural water, the intended use of a receiving water, and an understanding of the nature and fate of a given pollutant after its introduction into a body of water. Regardless of how we choose to define it, water pollution involves the addition of certain characteristics to a water body which may render that water unfit for its intended utilization. Some of the more common forms of water pollution include: oxygen demanding organic wastes and sewage derivatives; man-made organic compounds such as pesticides, some industrial wastes, and inorganic toxic compounds; infectious disease producing agents; nutrients and sediments from land runoff; radioactive substances; oil and grease; and thermal discharges. In some instances, the combined effects of two or more contaminants are further enhanced by their interaction. These synergistic effects may result from a chemical reaction in the receiving water which yields a product more toxic than the reactants. For example, the discharge of an acid into a water containing a high concentration of cyanide ions would produce hydrogen cyanide, an acid that is toxic to both aquatic organisms and man. In short, whether discharged from residences, institutions, or industries, each form of pollution has a characteristic effect on the water into which it is introduced. The receiving water may become unsightly, malodorous, and/or a hazard to public health, and consequently its uses may be severely limited.

Methods used for the assessment of water quality generally fall into three main categories: chemical, physical, and biological. Chemical analyses may include the determination of pH and alkalinity in addition to the concentrations of various ions, metals, and dissolved gases such as oxygen, carbon dioxide and hydrogen sulfide. Physical parameters often measured are temperature, color, turbidity, and flow characteristics. Biological methods may be categorized as either field surveys which are an attempt to ascertain the numbers and kinds of aquatic organisms associated with various water qualities, or laboratory studies in which bioassays are conducted to determine the levels of toxicity of different chemical parameters for a given test organism.

The parameters listed above are measured in most water quality surveys conducted by the Massachusetts Division of Water Pollution Control. Although no bioassay studies are done by the Division, the Biological Section conducts macroinvertebrate surveys on selected rivers and streams throughout the Commonwealth. In addition, microscopic examinations are conducted during most surveys to determine the abundance and kinds of algae and other microorganisms present in the water. Finally, bacterial samples are obtained and analyzed during each water quality survey.

Two types of samples are collected for chemical analysis. A grab sample is an instantaneous sample collected to indicate water quality conditions at a

particular time. Composite samples are collected over a period of time at specific intervals. This method gives a better indication of the overall water quality situation during the sampling period.

Oxygen Relationships

The dissolved oxygen (D.O.) in water refers to the uncombined oxygen held in solution and thereby made available to aquatic organisms for respiration. Sources of dissolved oxygen include atmospheric aeration and the direct addition of oxygen as the byproduct of chemical reduction reactions and algal photosynthesis. Whereas respiratory processes of aquatic organisms consume oxygen throughout the day and night, photosynthetic release of oxygen is restricted to the daylight hours. As a result, productive waters exhibit a characteristic diurnal variation in dissolved oxygen concentration. The solubility of oxygen (O_2) in water is primarily a function of water temperature and the atmospheric partial pressure of oxygen. Saturation levels at standard pressure (760 mm Hg) range from 14.6 mg/l O_2 at 0°C to 6.6 mg/l O_2 at 40°C.

Organic matter is introduced to a river or stream either as the result of natural phenomena, such as the deposition of leaves and other plant materials in autumn, or by the discharge of pollutants resulting from human related activities. Regardless of its origin, organic matter is gradually decomposed by bacteria which utilize the available dissolved oxygen in the water. Therefore, the ability of a stream segment to assimilate these organic materials, that is, its waste assimilative capacity, is dependent upon the amount of dissolved oxygen present in the water. In many instances, the assimilation of large amounts of organic wastes severely depletes the oxygen concentration in the water body rendering it unsuitable for the existence of aquatic organisms such as invertebrates and fish.

The biochemical oxygen demand (BOD) is a measure of the amount of oxygen required by bacteria to decompose a given amount of organic matter. This decomposition process occurs in two distinct steps each governed by a specific kind of bacteria. During the first step, or carbonaceous stage, carbon compounds are stabilized with a concurrent release of carbon dioxide. The second stage, nitrification, begins approximately seven days later and is the process by which nitrogenous substances are broken down to ammonia and ultimately to nitrate. The total combined oxygen demands of both stages is the ultimate BOD which may be exerted over a period of thirty days or more. Through recurrent use, the five day BOD (BOD_5) has been accepted as the standard test used in water quality analysis. While the BOD_5 of untreated sewage normally ranges from 150 to 300 mg/l, the BOD_5 of an unpolluted water rarely exceeds 2 mg/l.

Some types of organic wastes are not readily broken down by bacteria but can be decomposed by chemical processes. The chemical oxygen demand (COD) refers to the amount of oxygen required for the dichromate oxidation of a given amount of organic matter. Since some organic matter in any waste is not biodegradable, the COD is usually greater than the BOD.

Nutrients

Nutrients are substances that are essential to the growth or reproduction of organisms. In aquatic habitats algae and macrophytes rely on dissolved nitrogen and phosphorus compounds as nutrients and, as such, these substances are not harmful at low concentrations. Wastewater discharges often contain large amounts of carbon, nitrogen, and phosphorus containing compounds. Excessive nutrient loading of a water body increases plant production. As a result of this increased productivity, rapidly multiplying algal populations or "blooms" occur which may severely limit the potential use of the water. In many instances a high oxygen demand is exerted by the decomposing algae resulting from a sudden dieback.

Nitrogen compounds exist in water in a variety of forms. They may occur as cellular components, particulate matter, soluble organic substances or inorganic ions. These different forms and their interrelated chemical reactions are collectively known as the nitrogen cycle. Organic nitrogen in the form of protein, amino acid, or urea occurs in water containing organic wastes. Oxidation and reduction of these nitrogenous compounds are closely linked to the metabolic activity of many kinds of microorganisms. As described above, nitrification is tied to bacterial action, and is carried out by a fixed sequence of reactions through which ammonia, nitrite, and ultimately nitrate are produced. Therefore, the progress of decomposition of organic nitrogen can be determined by assessing the relative amounts of these compounds. Ammonia (NH_3) results from the initial decomposition of organic nitrogen and is always present in untreated sewage. It can also be formed by the reduction of nitrite. Ammonia exerts a high oxygen demand and is toxic to many aquatic organisms. Oxidation of ammonia yields nitrite (NO_2^-) which is quickly converted to nitrate (NO_3^-), the end product of the decomposition of nitrogenous matter. Nitrate is the form of nitrogen that is directly available to algae and other aquatic plants as a nutrient.

Phosphorus is present in water bodies in dissolved, colloidal, or particulate states and originates primarily from agricultural runoff and wastewaters containing detergents. It may exist as orthophosphate, polyphosphate, or in organic compounds. Although phosphorus occurs in natural waters in smaller amounts than nitrogen, it is an essential plant nutrient.

Coliform Bacteria

Fecal coliform bacteria are found in the intestinal tract of warm-blooded animals. Although not a serious health hazard by themselves, their presence in water is a good indication that sewage and associated pathogenic microorganisms may be present. Since coliforms can be detected by relatively simple test procedures they are used to indicate the extent of bacterial pollution from sewage and combined sewer overflows. Tests are usually conducted to determine the number of fecal and total coliforms present in water or wastewater. The number of total coliforms includes those of fecal origin and from non-fecal sources such as soil, grain, or decaying

of color. Severe color problems resulting from a pollution discharge are described qualitatively rather than numerically. Although color may not be harmful to aquatic life, it may render the water unacceptable for drinking purposes and for some types of industrial use.

Other Parameters

Depending upon specific river conditions, a water quality survey may include additional analyses such as those for oil and grease or heavy metal content. Grease in a wastewater consists of a mixture of fats, waxes, free fatty acids, calcium and magnesium soaps, mineral oils, and certain other nonfatty substances.

Heavy metals are toxic to aquatic organisms when present in sufficient quantities. They may also have an adverse effect on sewage and industrial wastewater treatment systems. Metals that are often monitored are cadmium, chromium, copper, iron, lead, manganese, nickel, and zinc.