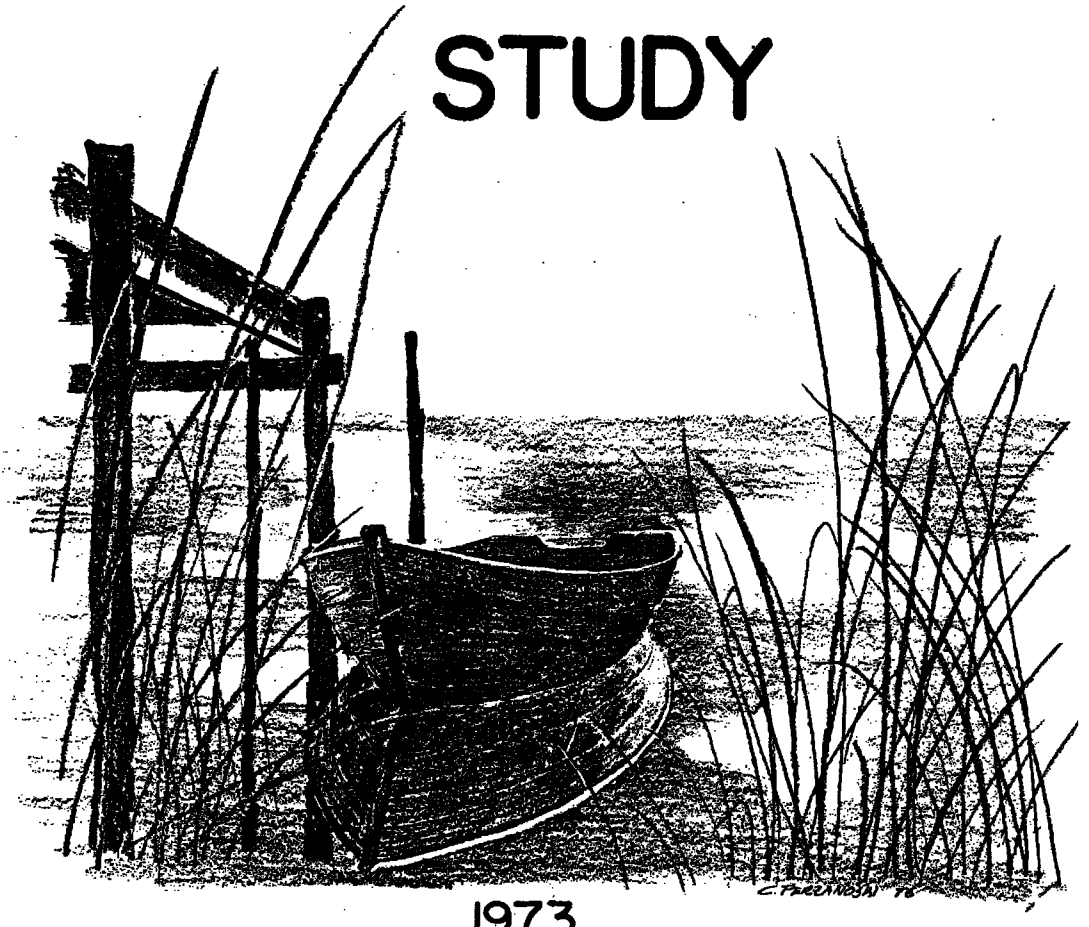
IPSWICH RIVER STUDY



1973

part a

massachusetts water resources commission

DIVISION OF WATER POLLUTION CONTROL

thomas c. mcmahon, director

IPSWICH RIVER

1973

WATER QUALITY SURVEY DATA

PREPARED BY
WATER QUALITY SECTION
DIVISION OF WATER POLLUTION CONTROL
MASSACHUSETTS WATER RESOURCES COMMISSION

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Alfred C. Holland
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IPSWICH RIVER

1973 SURVEY

FOREWORD

This report includes 1973 water quality data pertaining to the Ipswich River located in Northeastern Massachusetts. The survey was conducted by Massachusetts Water Resources Commission, Division of Water Pollution Control.

The present report is a continuum of an extensive survey of the river conducted in 1968 by the Division of Water Pollution Control. Those data were published in July 1970 by Water Resources Commission, Division of Water Pollution Control (see Ipswich River Study 1968, Parts A and B).

During the weeks of June 4 - 8 and August 13 - 17, 1973, samples were collected from 15 stations on the Ipswich four times daily. Samples were collected for dissolved oxygen on three consecutive days. Composite samples were collected on Tuesday and Thursday of the above mentioned weeks for general water quality. Concurrently a photosynthesis study (light and dark bottle method) was undertaken at three river locations.

All analyses involving dissolved oxygen were analyzed at the field laboratory located at Bradley Palmer State Park, Topsfield, Mass. All other samples were conveyed to Lawrence Experiment Station of the Massachusetts Department of Public Health for analysis. All analyses were performed according to procedures of A. P. H. A.'s "Standard Methods for Examination of Water and Wastewater" (13 edition 1971, New York). Data were compiled and placed in tabular form by personnel of the Massachusetts Division of Water Pollution Control.

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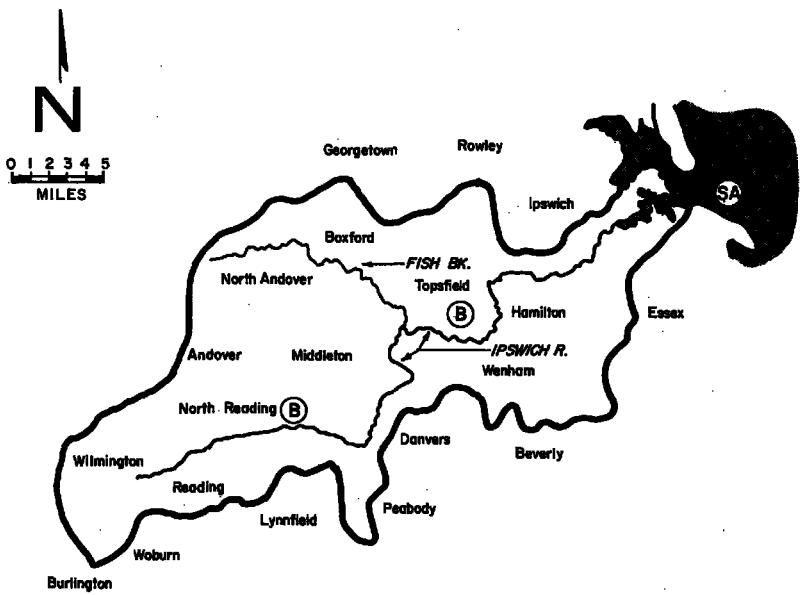
IPSWICH RIVER BASIN CLASSIFICATION

BOUNDARY	PRESENT USE	ANTICIPATED FUTURE USE	PRESENT CONDITION	CLASSIFICATION
The Ipswich River from its source to tidal water	Water Supply with treatment Bathing Fish & Wildlife propagation Fishing Canoeing	Same	B	B
Spring Pond, Peabody, Salem and Lynn Santaug Lake, Lynnfield	Water Supply	Water Supply	A	A
Middleton Pond Swan Pond Emerson Brook, Danvers	Water Supply	Water Supply	A	A
Bull Brook Reservoir, Ipswich	Water Supply	Water Supply	A	A
Other streams in the Ipswich River Basin area	--	--	--	B



IPSWICH RIVER BASIN

CLASSIFICATION MAP

FIGURE 1

DESCRIPTION OF IPSWICH RIVER BASIN

TOPOGRAPHY

The Ipswich River flows in a generally Northeasterly direction from its source in Wilmington to its mouth in Ipswich. The river is 35 miles in length and drains an area of 155 square miles.

The Ipswich River Basin contains portions of 18 towns. Three towns - Middleton, Topsfield, North Reading lie completely in the basin as do major portions of Boxford, Hamilton, North Andover, Reading, Wenham and Wilmington. Approximately half of Ipswich lies in the basin, but it includes the majority of the town's population and industry. Lesser portions of Andover, Beverly, Burlington, Danvers, Lynnfield and Peabody and small corners of Rowley and Woburn are within the basin limits.

Major tributaries are Martin's Brook, Boston Brook, Fish Brook and Mile River.

POPULATION

For the most part, these towns were rural prior to World War II. Since that time, they have all experienced rapid population growth due to their proximities to industry along Route 128. Of the 18 towns, 14 are within the study area of the Boston Area Metropolitan Planning Council (Andover, Boxford, North Andover and Rowley are located outside this area). It is expected that this rapid growth will continue in the smaller towns, but that cities such as Beverly and Peabody will taper off in their growth. The population which was 65,620 in 1965 will grow to over 100,000 people by the year 2000.

FLOW

The average discharge at the South Middleton gage is 69 cfs. The average discharge at the Ipswich gage is 198 cfs. During the two survey periods, June 4-8 mean daily flow was 206.6 cfs at the Ipswich gage and 46 cfs at South Middleton. August 13-17 mean daily was 55.5 cfs at Ipswich and 17.2 cfs at South Middleton. The 7-day minimum flow with 10-year frequency is 0.347 cfs at South Middleton and 1.842 cfs at Ipswich.

WATER SUPPLY

Beverly, Lynn, Peabody and Salem divert water from the Ipswich River to reservoirs for water supply. In addition, twelve other towns have water supplies within the basin. Gloucester and Rockport will probably have to take water from the basin due to lack of fresh water sources.

SOURCES OF POLLUTION

The only significant pollution is the Berry Rehabilitation Center on Martin's Brook in North Reading.

TABLE 1

IPSWICH RIVER 1973 SURVEY

LOCATION OF SAMPLING STATIONS

STATION NUMBER	LOCATION	RIVER MILE
I01	Wildwood Street, Wilmington	31.8
I02	Woburn Street, Wilmington	
I03	Chestnut Street, North Reading	28.9
I04	East Street, North Reading	27.9
I05	B.B. Chemical above dam, Middleton	24.8
I06	Route 114, Middleton	22.3
I07	Route 62, Middleton	20.3
I08	Peabody Street, Middleton	19.0
I09	Rowley Bridge Road, Topsfield	16.5
I10	Salem Street, Topsfield	15.4
I11	Rt. 97 above Salem Beverly diversion	14.3
I12	Hamilton Street, Topsfield	9.5
I13	Willowdale Dam, Topsfield	8.9
I14	Sylvania Dam, Ipswich	3.8
I15	Green Street, (Tidal) Ipswich	3.6

IPSWICH RIVER BASIN

LOCATION OF SAMPLING STATIONS

1973 SURVEY

FIGURE 2

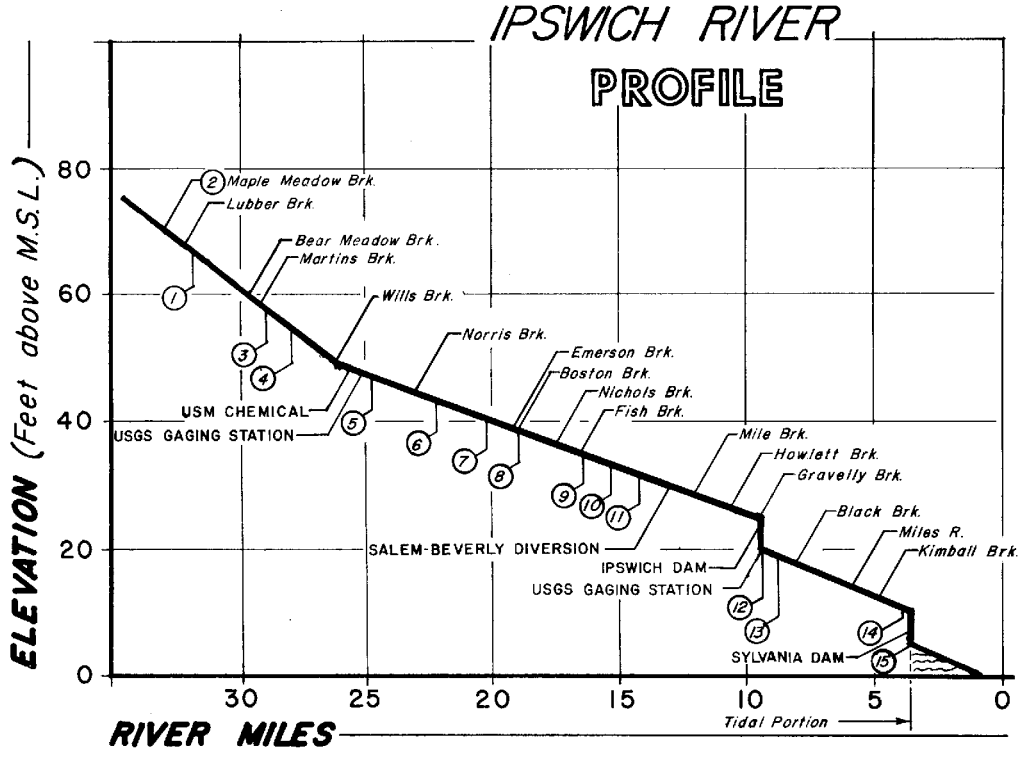

IPSWICH RIVER
PROFILE
ELEVATION (Feet above M.S.L.)
80
60
40
20
0
30
25
20
15
10
5
0
RIVER MILES
Tidal Portion
1
2 Maple Meadow Brk.
Lubber Brk.
Bear Meadow Brk.
Martins Brk.
3
4
Wills Brk.
USM CHEMICAL
USGS GAGING STATION
5
Norris Brk.
6
7
8
Emerson Brk.
Boston Brk.
Nichols Brk.
Fish Brk.
9
10
11
SALEM-BEVERLY DIVERSION
Mile Brk.
Howlett Brk.
Gravelly Brk.
Black Brk.
Miles R.
Kimball Brk.
IPSWICH DAM
USGS GAGING STATION
12
13
SYLVANIA DAM
14
15

FIGURE 3

TABLE 2

DISSOLVED OXYGEN (mg/l) - TIME - TEMPERATURE (^{o}F)

1973 IPSWICH RIVER SURVEY

	6/4/73		6/5/73				6/6/73	
STATION	RUN 1	RUN 2	RUN 3	RUN 4	RUN 5	RUN 6	RUN 7	RUN 8
I1	*1730	2230	0410	0955	1620	2222	0410	1013
	**65.0	68.0	63.0	66.0	65.0	58.0	60.0	60.0
	*** 6.3	3.3	2.3	4.5	6.9	2.9	3.2	3.6
I2	1745	2240	0420	1003	1630	2230	0416	1018
	66.0	67.0	62.0	67.0	65.0	62.0	61.0	60.0
	3.9	3.0	2.7	3.9	3.9	2.7	3.0	3.7
I3	1800	2245	0428	1013	1640	2245	0426	1030
	66.0	68.0	62.0	66.0	64.0	63.0	63.0	62.0
	3.9	3.2	3.2	3.2	3.7	3.4	3.2	3.5
I4	1810	2250	0435	1020	1647	2255	0433	1035
	66.0	68.0	63.0	66.0	64.0	63.0	63.0	62.0
	5.6	4.3	4.1	4.4	4.5	4.3	4.2	4.5
I5	1820	2308	0445	1025	1700	2305	0444	1044
	65.0	58.0	63.0	67.0	64.0	63.0	64.0	64.0
	5.0	4.9	4.7	4.3	4.7	4.7	4.8	4.7
I6	1835	2315	0455	1037	1710	2320	0505	1106
	66.0	66.0	64.0	65.0	64.0	63.0	62.0	62.0
	5.9	3.8	3.4	5.0	5.2	4.3	4.2	4.9
I7	1845	2320	0505	1045	1720	2330	0515	1117
	67.0	67.0	64.0	66.0	64.0	63.0	62.0	61.0
	5.7	5.4	4.3	5.0	5.4	5.1	4.3	4.3

* Time
** Temperature
*** Dissolved Oxygen

TABLE 2

DISSOLVED OXYGEN (mg/l) - TIME - TEMPERATURE (^{o}F)

1973 IPSWICH RIVER SURVEY

	6/6/73		6/7/73				6/8/73	
STATION	RUN9	RUN10	RUN11	RUN12	RUN13	RUN14	RUN15	RUN16
I1	*1635	2210	0413	1027	1615	2245	0434	1027
	**66.0	64.0	63.0	66.0	70.0	69.0	66.0	69.0
	*** 6.9	3.8	2.6	5.0	6.2	2.8	1.4	4.1
I2	1640	2223	0423	1035	1625	2259	0440	1033
	68.0	65.0	63.0	68.0	72.0	70.0	66.0	67.0
	5.1	3.0	2.9	4.2	4.2	2.3	2.8	3.1
I3	1652	2233	0438	1045	1635	2300	0451	1043
	65.0	64.0	64.0	66.0	69.0	69.0	67.0	69.0
	6.8	3.7	3.1	3.5	3.6	3.3	3.3	3.0
I4	1700	2240	0440	1052	1645	2306	0457	1049
	66.0	64.0	64.0	67.0	70.0	69.0	67.0	69.0
	4.8	4.7	4.1	5.3	5.0	4.7	3.8	3.8
I5	1707	2250	0450	1101	1700	2326	0505	1157
	66.0	65.0	65.0	68.0	68.0	69.0	68.0	71.0
	4.6	5.0	5.1	5.3	5.3	5.8	5.0	4.5
I6	1720	2300	0509	1120	1705	2330	0516	1108
	67.0	64.0	64.0	68.0	70.0	69.0	68.0	69.0
	6.7	5.0	4.1	5.3	5.7	4.2	4.0	4.3
I7	1728	2312	0518	1630	1715	2340	0522	1116
	67.0	65.0	64.0	68.0	70.0	69.0	68.0	70.0
	5.8	5.9	4.7	5.8	5.7	5.5	4.8	4.5

* Time
** Temperature
*** Dissolved Oxygen

TABLE 2 CONTINUED

	6/4/73		6/5/73				6/6/73	
STATION	RUN 1	RUN 2	RUN 3	RUN 4	RUN 5	RUN 6	RUN 7	RUN 8
I8	1850	2325	0510	1054	1730	2340	0523	1123
	68.0	66.0	65.0	67.0	64.0	62.0	63.0	62.0
	5.6	5.5	5.4	5.2	5.5	6.2	5.6	5.1
I9	1900	2335	0518	1105	1740	2350	0532	1131
	66.0	62.0	65.0	65.0	64.0	63.0	62.0	62.0
	5.9	5.6	5.6	6.1	5.8	6.3	6.3	6.0
I10	1905	2340	0525	1110	1750	2400	0537	1135
	67.0	66.0	65.0	67.0	64.0	63.0	62.0	62.0
	5.6	6.2	5.9	6.1	6.5	6.0	6.5	6.4
I11	1915	2350	0532	1127	1755	0010	0544	1145
	66.0	65.0	65.0	65.0	64.0	63.0	62.0	62.0
	5.9	---	5.7	6.3	6.0	6.0	6.5	5.5
I12	1930	2400	0542	1137	1810	0020	0552	1157
	67.0	66.0	66.0	66.0	64.0	64.0	62.0	62.0
	4.7	3.9	3.9	3.3	4.3	3.2	3.8	3.7
I13	1935	0016	0547	1147	1815	0030	0557	1202
	67.0	65.0	66.0	66.0	63.0	63.0	63.0	63.0
	5.0	4.9	3.7	3.7	4.5	4.1	3.8	3.4
I14	2000	0040	0600	1200	1840	0050	0607	1219
	66.0	66.0	66.0	65.0	64.0	64.0	64.0	62.0
	6.4	6.4	6.7	6.8	6.1	6.7	7.0	5.6
I15	2005	0025	0607	1205	1830	0040	0616	1226
	67.0	66.0	66.0	66.0	63.0	63.0	64.0	63.0
	8.2	7.4	7.3	8.2	7.4	7.9	7.7	5.2

TABLE 2 CONTINUED

	6/6/73		6/7/73				6/8/73	
STATION	RUN 9	RUN 10	RUN 11	RUN 12	RUN 13	RUN 14	RUN 15	RUN 16
I8	1735	2320	0527	1138	1720	2345	0528	1123
	66.0	65.0	64.0	67.0	70.0	69.0	68.0	70.0
	6.0	6.0	5.7	6.6	5.9	5.8	5.6	5.1
I9	1745	2330	0540	1150	1735	2355	0534	1132
	64.0	64.0	64.0	66.0	69.0	69.0	68.0	69.0
	6.3	5.6	6.3	6.5	6.3	6.2	5.6	5.5
I10	1750	2340	0545	1155	1740	0005	0535	1137
	64.0	64.0	65.0	66.0	69.0	69.0	68.0	69.0
	6.5	5.6	6.5	6.5	6.2	5.5	5.9	5.5
I11	1758	2345	0552	1203	1750	0010	0545	1143
	64.0	64.0	64.0	66.0	69.0	68.0	68.0	69.0
	6.3	6.5	5.9	6.3	6.2	6.2	5.9	5.3
I12	1808	0003	0602	1214	1845	0050	0552	1151
	66.0	65.0	65.0	68.0	70.0	69.0	67.0	69.0
	4.9	4.7	2.9	3.5	4.8	3.8	1.8	2.3
I13	1815	2355	0608	1220	1800	0025	0601	1156
	65.0	66.0	65.0	67.0	70.0	----	68.0	70.0
	5.0	5.3	3.7	4.1	4.7	4.7	3.6	2.8
I14	1830	0020	0620	1230	1825	0040	0612	1206
	65.0	64.0	65.0	67.0	69.0	69.0	68.0	70.0
	5.3	6.7	5.5	7.0	6.9	6.3	6.2	5.8
I15	1825	0015	0629	1238	1815	0032	0618	1212
	65.0	64.0	65.0	68.0	69.0	69.0	68.0	71.0
	7.8	7.9	6.8	7.8	7.7	7.7	6.2	7.1

TABLE 3

DISSOLVED OXYGEN (mg/l) - TIME - TEMPERATURE (^{o}F)

1973 IPSWICH RIVER SURVEY

	8/14/73				8/15/73				8/16/73			
STATION	RUN 1	RUN 2	RUN 3	RUN 4	RUN 5	RUN 6	RUN 7	RUN 8	RUN 9	RUN 10	RUN 11	RUN 12
I1	* 0400	1005	1606	2200	0405	1000	1610	2230	0400	1015	1630	2250
	** 68.0	69.0	68.0	65.0	68.0	67.0	65.0	63.0	65.0	64.0	67.0	66.0
	*** .8	1.2	1.2	1.0	.9	1.5	2.5	1.4	1.1	1.6	1.7	1.6
I2	0410	1010	1612	2205	0410	1005	1615	2235	0410	1020	1635	2259
	68.0	70.0	68.0	65.0	68.0	67.0	64.0	67.0	65.0	66.0	68.0	66.0
	1.1	1.9	1.9	1.2	1.5	2.1	2.2	1.5	1.1	1.7	2.3	1.4
I3	0420	1020	1620	2215	0415	1012	1620	2245	0415	1030	1645	2307
	70.0	71.0	68.0	68.0	70.0	68.0	65.0	68.0	66.0	67.0	66.0	65.0
	2.4	4.1	4.9	3.8	2.9	3.0	3.3	3.2	2.9	3.2	3.0	3.1
I4	0425	1030	1626	2220	0420	1017	1627	2250	0425	1038	1650	2314
	70.0	72.0	71.0	68.0	70.0	68.0	65.0	67.0	66.0	66.0	68.0	65.0
	2.9	5.0	4.7	4.0	3.1	3.8	4.7	4.5	3.9	3.9	4.0	3.8
I5	0440	1035	1635	2230	0430	1025	1635	2300	0435	1045	1655	2326
	72.0	74.0	72.0	71.0	72.0	69.0	66.0	70.0	68.0	68.0	66.0	63.0
	2.6	2.2	2.9	3.0	3.0	2.7	6.2	3.8	3.5	3.9	3.8	7.1
I6	0455	1050	1645	2235	0435	1035	1641	2305	0445	1050	1705	2334
	71.0	72.0	72.0	69.0	70.0	69.0	65.0	64.0	66.0	67.0	68.0	66.0
	2.3	2.5	3.6	3.8	3.3	3.7	4.4	3.7	3.2	4.2	4.1	3.6
I7	0505	1056	1650	2245	0445	1055	1647	2312	0455	1100	1710	2344
	71.0	72.0	72.0	69.0	71.0	69.0	65.0	64.0	67.0	68.0	70.0	66.0
	2.7	3.4	3.8	3.0	3.1	3.8	5.1	4.1	4.1	4.5	4.6	4.4

* Time
** Temperature
*** Dissolved Oxygen

TABLE 3 CONTINUED

	8/14/73				8/15/73				8/16/73			
STATION	RUN 1	RUN 2	RUN 3	RUN 4	RUN 5	RUN 6	RUN 7	RUN 8	RUN 9	RUN 10	RUN 11	RUN 12
I8	0515	1105	1656	2250	0450	1100	1655	2315	0500	1105	1715	2355
	71.0	72.0	72.0	69.0	71.0	69.0	65.0	64.0	66.0	67.0	69.0	66.0
	4.7	4.4	4.7	4.8	4.7	4.8	5.3	5.2	5.0	5.1	5.3	5.5
I9	0525	1115	1703	2255	0455	1107	1700	2325	0510	----	1722	0015
	70.0	71.0	71.0	68.0	70.0	68.0	64.0	64.0	68.0	----	68.0	65.0
	5.3	5.5	5.6	5.6	5.7	6.2	6.4	6.6	6.0	----	6.2	6.1
I10	0530	1120	1710	2300	0500	1111	1703	2330	0515	1120	1725	0030
	71.0	72.0	71.0	68.0	70.0	68.0	65.0	64.0	67.0	68.0	68.0	63.0
	5.3	5.3	5.5	5.6	5.3	5.8	6.4	6.1	5.9	6.0	6.4	6.3
I11	0540	1130	1715	2306	0510	1117	1710	2335	0520	1125	1732	0100
	71.0	72.0	71.0	68.0	70.0	69.0	65.0	64.0	67.0	67,0	67.0	66.0
	5.1	4.9	5.5	5.6	5.0	5.5	5.9	6.0	5.7	6.0	6.1	6.3
I12	0550	1140	1750	2340	0515	1125	1745	0005	0530	1130	1810	0134
	71.0	72.0	69.0	69.0	71.0	70.0	66.0	64.0	67.0	68.0	68.0	65.0
	4.0	3.6	3.9	3.6	4.0	4.0	4.4	4.5	4.1	4.4	5.8	4.8
I13	0555	1150	1725	2315	0520	1130	1717	2345	0535	1145	1745	0111
	65.0	74.0	74.0	69.0	71.0	70.0	66.0	64.0	68.0	69.0	69.0	66.0
	7.6	3.2	3.7	3.5	3.5	3.9	4.3	4.2	4.0	4.3	4.0	5.0
I14	0605	1245	1738	2330	0525	1133	1735	2357	0545	----	1800	0125
	74.0	74.0	74.0	69.0	71.0	70.0	66.0	64.0	68.0	----	69.0	63.0
	5.1	4.8	4.4	4.8	4.8	6.2	5.7	5.6	5.5	----	5.9	5.4
I15	0615	1204	1735	2325	0530	1140	1730	2355	0550	1200	1755	0120
	72.0	73.0	73.0	68.0	70.0	70.0	66.0	64.0	67.0	68.0	69.0	66.0
	4.2	7.0	6.0	5.7	5.7	6.6	6.4	6.7	6.1	6.5	6.7	5.6

TABLE 4

IPSWICH RIVER 1973 SURVEY

SUMMARY OF DISSOLVED OXYGEN DATA (mg/l)

	June 4 - 8, 1973			August 14 - 16, 1973		
STATION	MAX	MIN	AVG	MAX	MIN	AVG
I01	6.9	1.4	4.1	2.5	.8	1.4
I02	5.1	2.7	3.4	2.3	1.1	1.6
I03	3.9	3.1	3.6	4.9	2.4	3.3
I04	5.6	4.1	4.6	5.0	2.9	4.0
I05	5.8	4.3	4.9	3.9	2.2	3.3
I06	6.7	3.4	4.8	4.4	2.3	3.5
I07	5.9	4.3	5.2	5.1	2.7	3.9
I08	6.2	5.1	5.7	5.5	4.4	5.0
I09	6.3	5.6	6.0	6.6	5.3	5.9
I10	6.5	5.6	6.1	6.4	5.3	5.8
I11	6.5	5.7	6.1	6.3	4.9	5.6
I12	4.9	1.8	3.6	5.8	3.6	4.3
I13	5.3	3.7	4.3	5.0	3.2	4.0
I14	7.0	5.3	6.4	6.2	4.4	5.3
I15	8.2	5.2	7.4	7.0	4.2	6.1

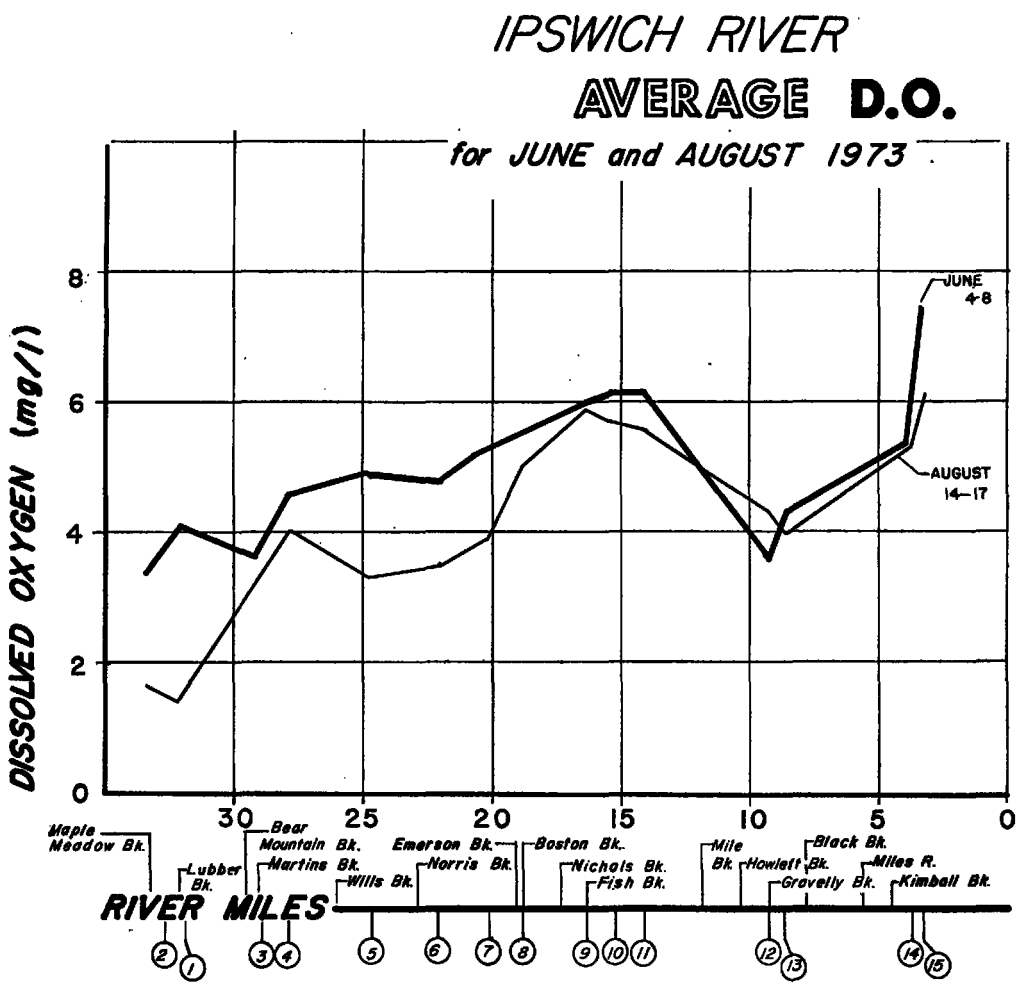

IPSWICH RIVER
AVERAGE D.O.
for JUNE and AUGUST 1973
DISSOLVED OXYGEN (mg/l)
0
2
4
6
8
JUNE 4-8
AUGUST 14-17
30
25
20
15
10
5
0
RIVER MILES
Maple Meadow Bk.
Lubber Bk.
Bear Mountain Bk.
Martins Bk.
Wills Bk.
Emerson Bk.
Norris Bk.
Boston Bk.
Nichols Bk.
Fish Bk.
Mile Bk.
Howlett Bk.
Gravelly Bk.
Black Bk.
Miles R.
Kimball Bk.
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15

FIGURE 4

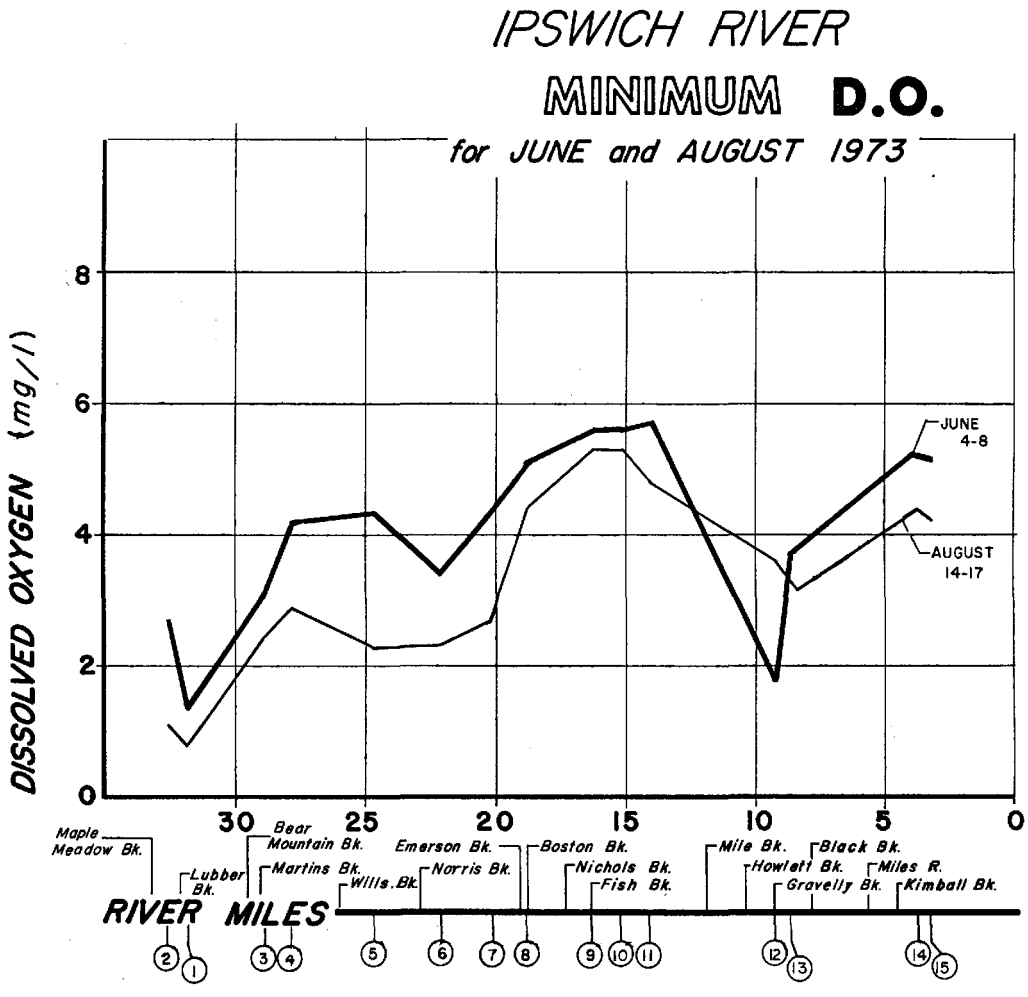

IPSWICH RIVER
MINIMUM D.O.
for JUNE and AUGUST 1973
DISSOLVED OXYGEN (mg/l)
0
2
4
6
8
JUNE 4-8
AUGUST 14-17
30
25
20
15
10
5
0
Maple Meadow Bk.
Lubber Bk.
Bear Mountain Bk.
Martins Bk.
Wills Bk.
Emerson Bk.
Norris Bk.
Boston Bk.
Nichols Bk.
Fish Bk.
Mile Bk.
Howlett Bk.
Black Bk.
Gravelly Bk.
Miles R.
Kimball Bk.
RIVER MILES
2
1
3
4
5
6
7
8
9
10
11
12
13
14
15

FIGURE 5

TABLE 5

IPSWICH RIVER 1973 SURVEY

SUMMARY OF TEMPERATURE DATA (^{o}F)

	June 4 - 8, 1973			August 14 - 17, 1973		
STATION	MAX	MIN	AVG	MAX	MIN	AVG
I01	70.0	63.0	62.0	69.0	63.0	66.0
I02	72.0	60.0	66.0	70.0	64.0	67.0
I03	69.0	62.0	65.0	71.0	65.0	68.0
I04	70.0	62.0	66.0	72.0	65.0	68.0
I05	69.0	62.0	66.0	74.0	63.0	65.0
I06	70.0	62.0	61.0	72.0	64.0	68.0
I07	70.0	61.0	66.0	72.0	64.0	69.0
I08	70.0	62.0	66.0	72.0	64.0	68.0
I09	69.0	62.0	65.0	71.0	64.0	68.0
I10	69.0	62.0	65.0	72.0	63.0	68.0
I11	69.0	62.0	65.0	72.0	64.0	68.0
I12	70.0	62.0	66.0	72.0	64.0	68.0
I13	70.0	62.0	65.0	74.0	64.0	69.0
I14	69.0	63.0	66.0	74.0	64.0	69.0
I15	69.0	63.0	66.0	73.0	64.0	69.0

TABLE 6

IPSWICH RIVER 1973 SURVEY

SUMMARY OF BIOCHEMICAL OXYGEN DEMAND DATA (mg/l)

STATION	6/5/73	6/7/73	AVG	8/14/73	8/16/73	AVG
I01	2.0	2.0	2.0	2.8	2.4	2.6
I02	1.6	1.9	1.8	6.0	2.2	4.1
I03	1.5	1.8	1.7	2.2	2.0	2.1
I04	1.6	2.0	1.8	1.6	2.4	2.0
I05	2.7	2.7	2.7	2.0	2.2	2.1
I06	2.0	2.6	2.3	0.4	2.0	1.2
I07	0.6	2.6	1.6	0.8	1.6	1.2
I08	2.1	2.1	2.1	1.6	1.8	1.7
I09	1.5	2.7	2.1	1.2	1.8	1.5
I10	1.8	2.8	2.3	0.6	1.2	.9
I11	1.5	3.0	2.3	3.6	1.4	2.5
I12	2.1	2.9	2.5	1.0	2.0	1.5
I13	1.9	2.1	2.0	1.0	1.2	1.1
I14	1.8	2.9	2.4	0.6	1.0	.8
I15	1.7	2.2	2.0	1.8	2.0	1.9

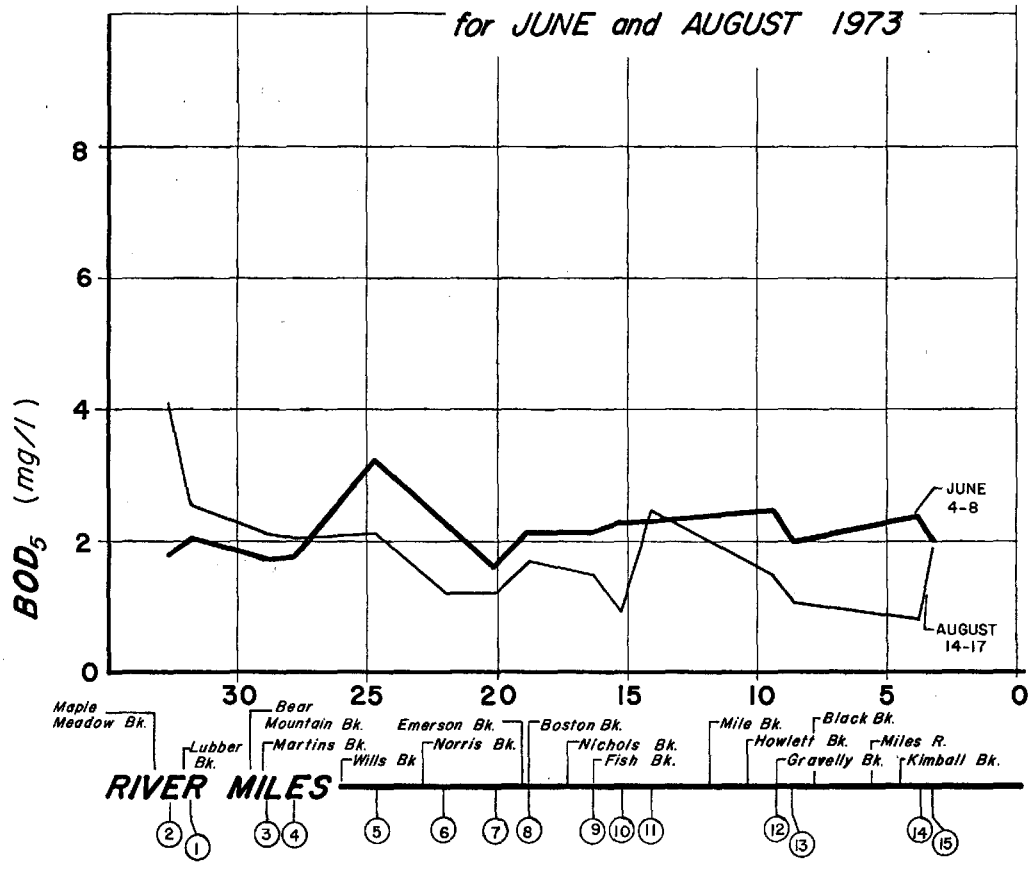

IPSWICH RIVER
AVERAGE 5 DAY BOD
for JUNE and AUGUST 1973
BOD5 (mg/l)
8
6
4
2
0
JUNE 4-8
AUGUST 14-17
30
25
20
15
10
5
0
Maple Meadow Bk.
Lubber Bk.
Bear Mountain Bk.
Martins Bk.
Wills Bk
Emerson Bk.
Norris Bk.
Boston Bk.
Nichols Bk.
Fish Bk.
Mile Bk.
Howlett Bk.
Black Bk.
Gravelly Bk.
Miles R.
Kimball Bk.
RIVER MILES
2
1
3
4
5
6
7
8
9
10
11
12
13
14
15

FIGURE 6

TABLE 7

IPSWICH RIVER 1973 SURVEY

SUMMARY AMMONIA - NITROGEN DATA (mg/l)

STATION	6/5/73	6/7/73	AVG	8/14/73	8/16/73	AVG
I01	0.06	0.10	0.08	0.45	0.28	0.37
I02	0.11	0.14	0.13	0.18	0.15	0.17
I03	0.04	0.07	0.06	0.18	0.28	0.23
I04	0.04	0.07	0.06	0.18	0.18	0.18
I05	0.05	0.06	0.06	0.13	0.09	0.11
I06	0.05	0.09	0.07	0.13	0.07	0.10
I07	0.05	0.09	0.07	0.12	0.07	0.10
I08	0.04	0.08	0.06	0.09	0.05	0.07
I09	0.04	0.06	0.05	0.10	0.06	0.08
I10	0.04	0.09	0.07	0.10	0.05	0.08
I11	0.04	0.07	0.06	0.12	0.06	0.09
I12	0.00	0.01	0.01	0.16	0.12	0.14
I13	0.00	0.01	0.01	0.16	0.12	0.14
I14	0.01	0.02	0.02	0.12	0.08	0.10
I15	0.03	0.02	0.03	0.18	0.12	0.15

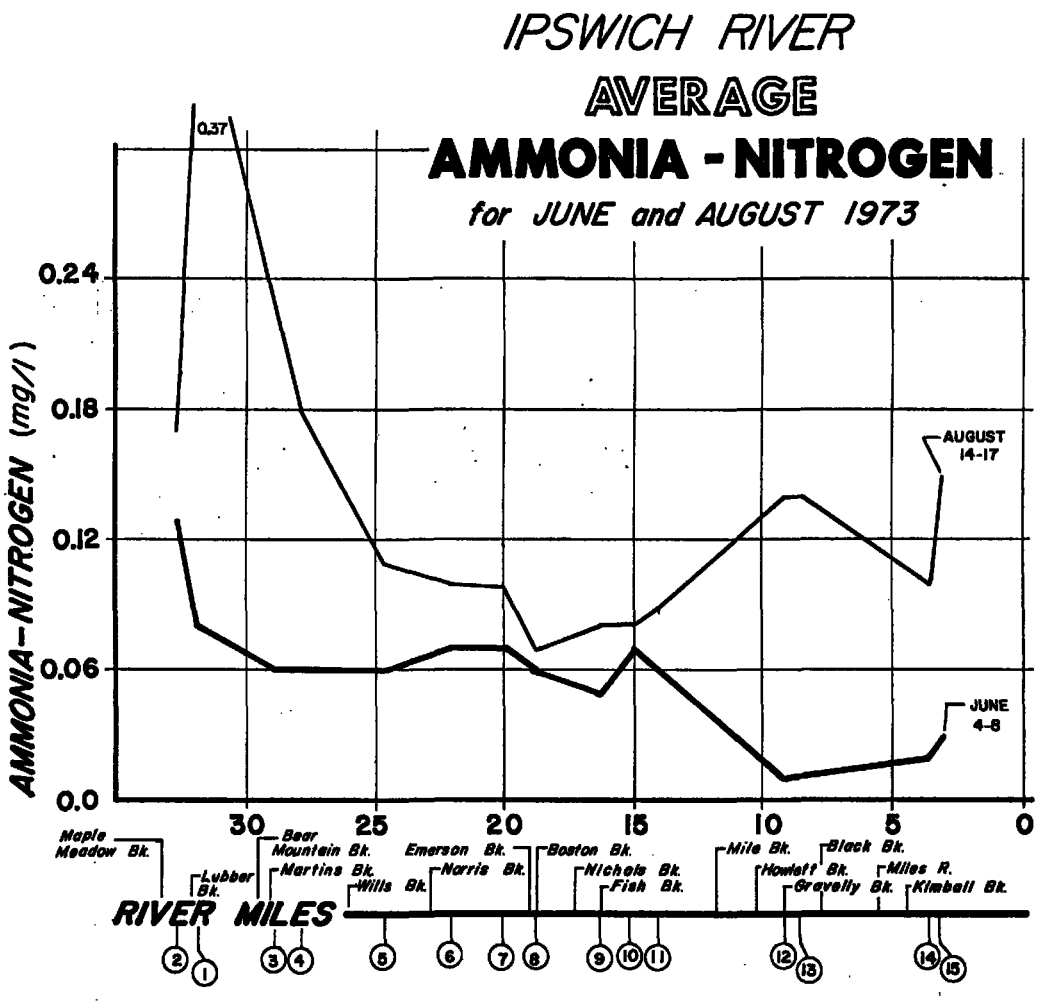

IPSWICH RIVER
AVERAGE
AMMONIA - NITROGEN
for JUNE and AUGUST 1973
AMMONIA-NITROGEN (mg/l)
0.37
0.24
0.18
0.12
0.06
0.0
AUGUST 14-17
JUNE 4-8
30
25
20
15
10
5
0
Maple Meadow Bk.
Lubber Bk.
Bear Mountain Bk.
Martins Bk.
Wills Bk.
Emerson Bk.
Norris Bk.
Boston Bk.
Nichols Bk.
Fish Bk.
Mile Bk.
Howlett Bk.
Black Bk.
Gravelly Bk.
Miles R.
Kimball Bk.
RIVER MILES
2
1
3
4
5
6
7
8
9
10
11
12
13
14
15

FIGURE 7

TABLE 8

IPSWICH RIVER 1973 SURVEY

SUMMARY OF NITRATE - NITROGEN DATA (mg/l)

STATION	6/5/73	6/7/73	AVG	8/14/73	8/16/73	AVG
I01	0.2	0.3	0.3	0.2	0.1	0.2
I02	0.2	0.3	0.3	0.3	0.2	0.3
I03	0.0	0.1	0.1	0.2	0.3	0.3
I04	0.1	0.1	0.1	0.3	0.3	0.3
I05	0.1	0.1	0.1	0.3	0.4	0.4
I06	0.2	0.2	0.2	0.6	0.4	0.5
I07	0.1	0.3	0.2	0.5	0.4	0.5
I08	0.1	0.2	0.2	0.4	0.5	0.5
I09	0.1	0.2	0.2	0.4	0.4	0.4
I10	0.1	0.2	0.2	0.4	0.5	0.5
I11	0.1	0.2	0.2	0.4	0.5	0.5
I12	0.0	0.0	0.0	0.4	0.4	0.4
I13	0.0	0.0	0.0	0.5	0.4	0.5
I14	0.1	0.1	0.1	0.4	0.4	0.4
I15	0.2	0.1	0.2	0.2	0.3	0.3

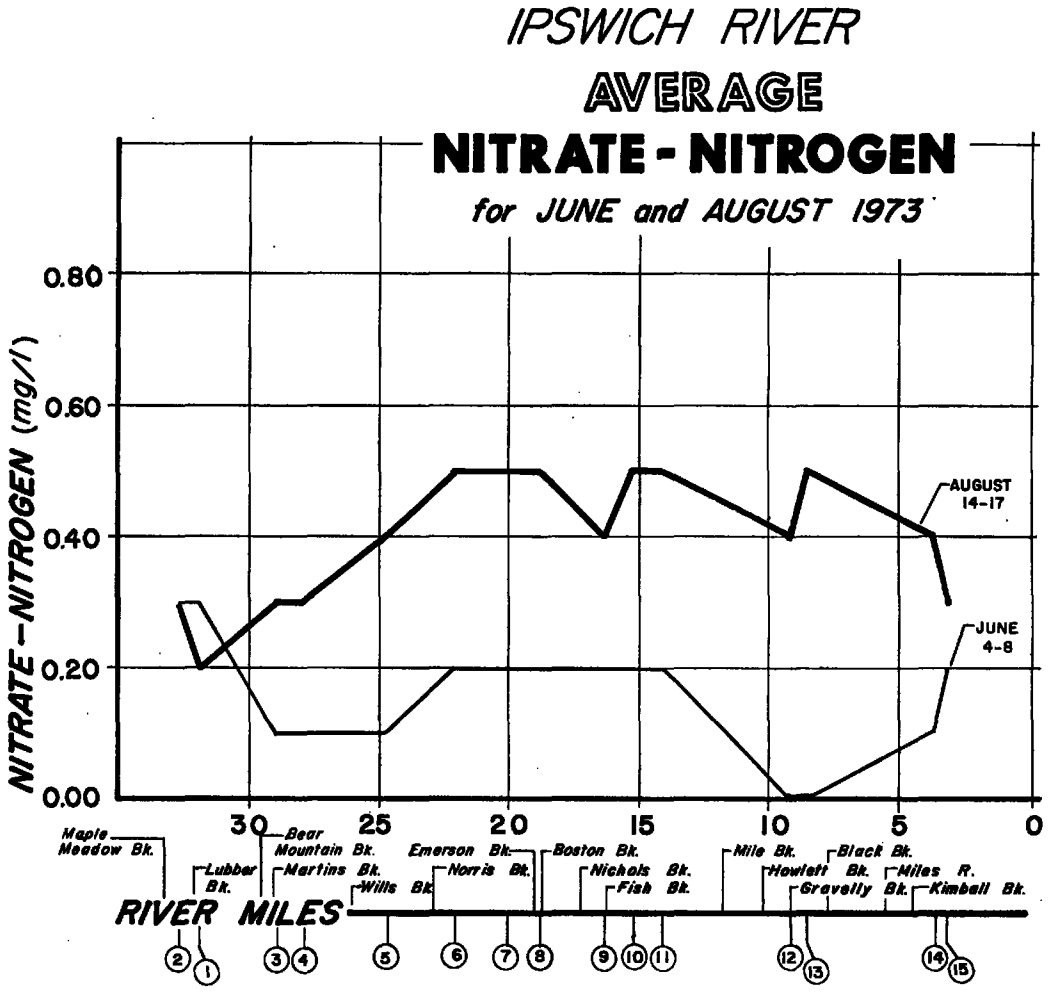

IPSWICH RIVER
AVERAGE
NITRATE - NITROGEN
for JUNE and AUGUST 1973
NITRATE-NITROGEN (mg/l)
0.80
0.60
0.40
0.20
0.00
AUGUST 14-17
JUNE 4-8
30
25
20
15
10
5
0
RIVER MILES
Maple Meadow Bk.
Lubber Bk.
Bear Mountain Bk.
Martins Bk.
Wills Bk.
Emerson Bk.
Norris Bk.
Boston Bk.
Nichols Bk.
Fish Bk.
Mile Bk.
Howlett Bk.
Gravelly Bk.
Black Bk.
Miles R.
Kimball Bk.
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15

FIGURE 8

TABLE 9

IPSWICH RIVER 1973 SURVEY

SUMMARY OF TOTAL PHOSPHORUS AS P (mg/1)

STATION	6/5/73	6/7/73	AVG	8/14/73	8/16/73	AVG
I01	0.08	0.09	0.09	0.16	0.11	0.14
I02	0.08	0.10	0.09	0.11	0.07	0.09
I03	0.08	0.10	0.09	0.17	0.04	0.11
I04	0.09	0.09	0.09	0.09	0.09	0.09
I05	0.08	0.08	0.08	0.09	0.08	0.09
I06	0.08	0.09	0.09	0.09	0.08	0.09
I07	0.07	0.10	0.09	0.06	0.08	0.07
I08	0.06	0.07	0.07	0.06	0.07	0.07
I09	0.07	0.07	0.07	0.05	0.05	0.05
I10	0.06	0.08	0.07	0.05	0.05	0.05
I11	0.07	0.07	0.07	0.05	0.05	0.05
I12	0.06	0.06	0.06	0.05	0.05	0.05
I13	0.05	0.05	0.05	0.05	0.05	0.05
I14	0.05	0.05	0.05	0.06	0.05	0.06
I15	0.07	0.06	0.07	0.05	0.05	0.05

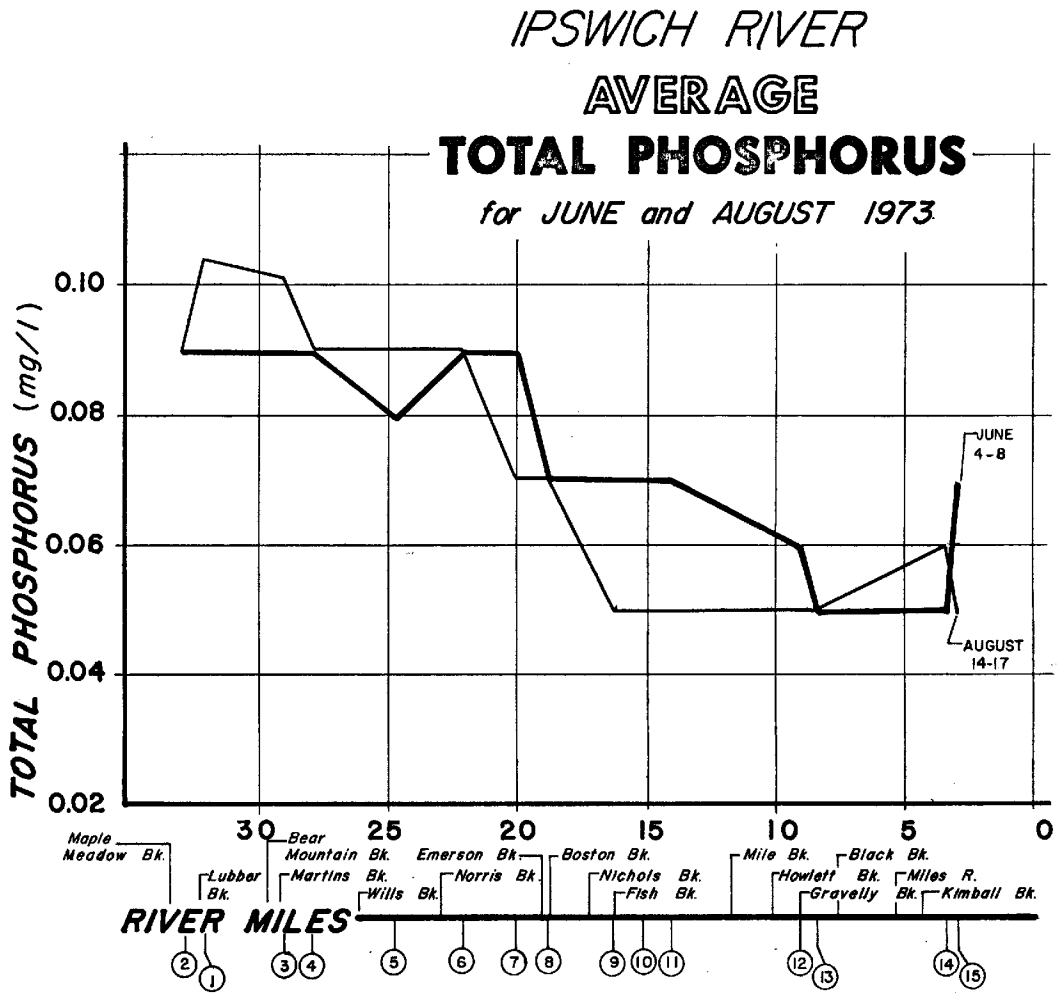

IPSWICH RIVER
AVERAGE
TOTAL PHOSPHORUS
for JUNE and AUGUST 1973
TOTAL PHOSPHORUS (mg/l)
0.10
0.08
0.06
0.04
0.02
JUNE 4-8
AUGUST 14-17
30
25
20
15
10
5
0
RIVER MILES
Maple Meadow Bk.
Lubber Bk.
Bear Mountain Bk.
Martins Bk.
Wills Bk.
Emerson Bk.
Norris Bk.
Boston Bk.
Nichols Bk.
Fish Bk.
Mile Bk.
Howlett Bk.
Gravelly Bk.
Black Bk.
Miles R.
Kimball Bk.
1
2
3
4
5
6
7
8
9
10
11
12
13
14
15

FIGURE 9

TABLE 10

IPSWICH RIVER 1973 SURVEY

SUMMARY TOTAL ALKALINITY DATA (mg/l)

STATION	6/5/73	6/7/73	AVG	8/14/73	8/16/73	AVG
I01	33	35	34	35	51	43
I02	20	20	20	18	24	21
I03	22	19	20.5	61	27	44
I04	22	22	22	28	27	27.5
I05	22	25	23.5	28	29	28.5
I06	22	25	23.5	31	42	36.5
I07	28	25	26.5	32	41	36.5
I08	24	25	24.5	33	33	33
I09	24	23	23.5	36	33	34.5
I10	23	22	22.5	39	34	36.5
I11	23	24	23.5	37	32	34.5
I12	22	24	23	38	36	37
I13	24	23	23.5	38	35	36.5
I14	27	23	25	35	36	35.5
I15	26	23	24.5	48	48	48

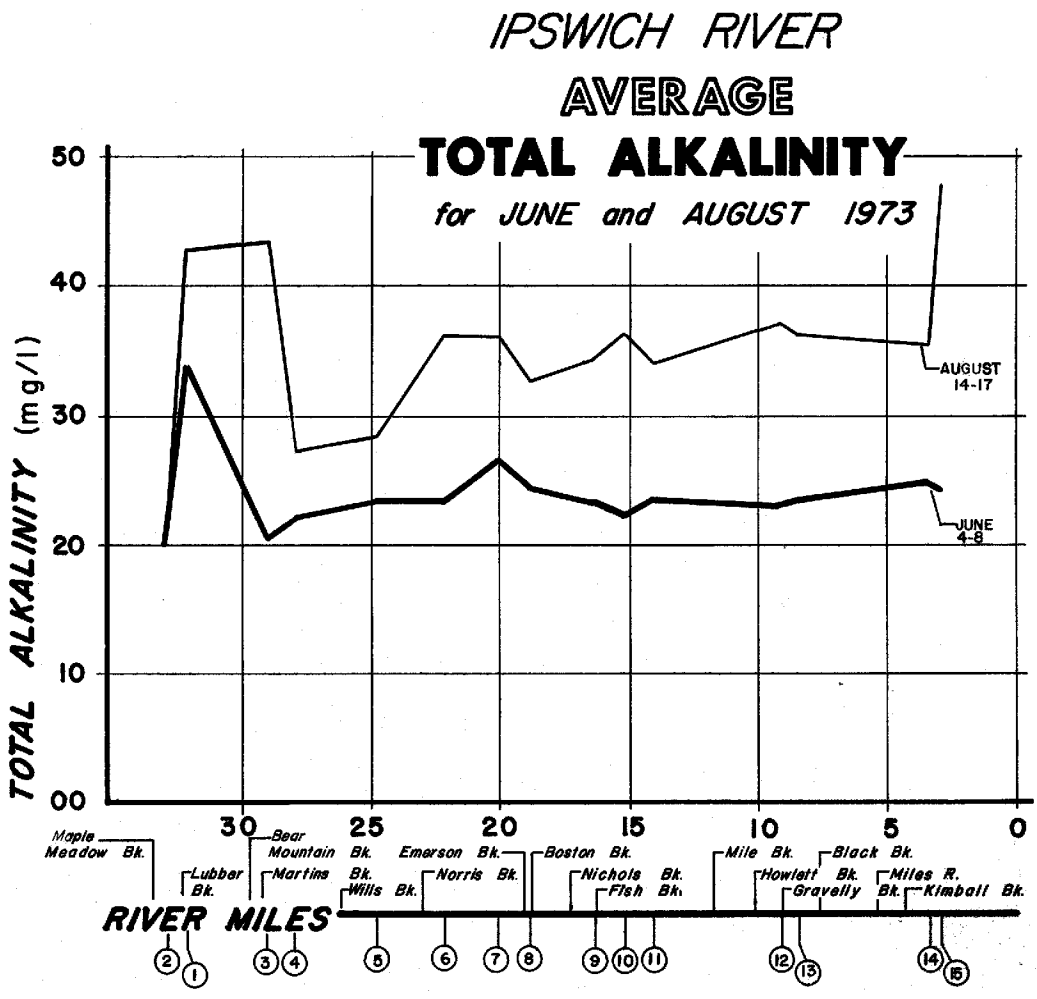

IPSWICH RIVER
AVERAGE
TOTAL ALKALINITY
for JUNE and AUGUST 1973
TOTAL ALKALINITY (mg/l)
50
40
30
20
10
00
AUGUST 14-17
JUNE 4-8
30
25
20
15
10
5
0
RIVER MILES
Maple Meadow Bk.
Lubber Bk.
Bear Mountain Bk.
Martins Bk.
Wills Bk.
Emerson Bk.
Norris Bk.
Boston Bk.
Nichols Bk.
Fish Bk.
Mile Bk.
Howlett Bk.
Gravelly Bk.
Black Bk.
Miles R.
Kimball Bk.
2
1
3
4
5
6
7
8
9
10
11
12
13
14
15

FIGURE 10

TABLE 11

IPSWICH RIVER 1973 SURVEY

SUMMARY OF pH DATA

STATION	6/5/73	6/7/73	8/14/73	8/16/73
I01	7.2	7.2	6.8	6.7
I02	7.1	6.7	6.6	6.9
I03	7.2	6.6	6.6	7.3
I04	7.1	6.8	6.6	7.0
I05	7.2	6.9	6.8	6.9
I06	7.2	6.9	6.9	7.2
I07	7.0	6.9	6.8	7.1
I08	7.4	7.1	6.9	7.3
I09	7.3	7.6	6.8	7.3
I10	7.3	7.2	7.0	7.2
I11	5.7	7.1	7.0	7.7
I12	6.2	7.1	6.9	7.6
I13	6.4	7.1	6.7	7.5
I14	6.4	7.2	6.7	7.2
I15	6.3	7.2	7.2	7.7

TABLE 12

IPSWICH RIVER 1973 SURVEY

SUMMARY SUSPENDED SOLIDS DATA (mg/l)

STATION	6/5/73	6/7/73	AVG	8/14/73	8/16/73	AVG
I01	6	3	4.5	20	9	14.5
I02	7	3	5	10	35	27.5
I03	6	3	4.5	17	20	18.5
I04	8	2	5.0	5	7	6
I05	9	1	5	4	7	5.5
I06	6	2	4	7	6	6.5
I07	7	2	4.5	4	5	4.5
I08	9	1	5.0	3	1.0	2
I09	6	1	3.5	4	2	3
I10	5	0	2.5	3	2	2.5
I11	5	4	4.5	4	4	4
I12	9	2	5.5	2	3	2.5
I13	4	4	4	2	5	3.5
I14	6	3	4.5	1	1.0	1.0
I15	10	6	8	7	8	7.5

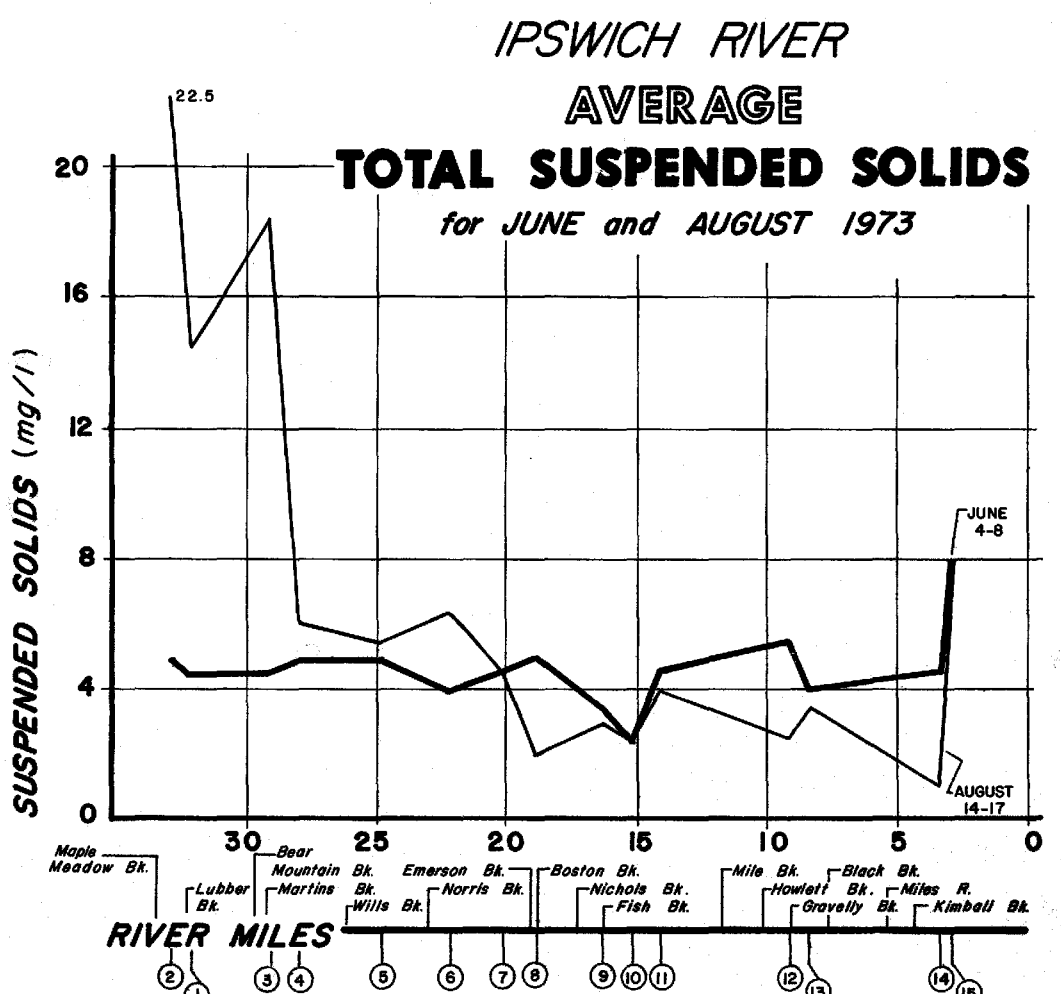

IPSWICH RIVER
AVERAGE
TOTAL SUSPENDED SOLIDS
for JUNE and AUGUST 1973
SUSPENDED SOLIDS (mg/l)
22.5
20
16
12
8
4
0
JUNE 4-8
AUGUST 14-17
30
25
20
15
10
5
0
RIVER MILES
Maple Meadow Bk.
Lubber Bk.
Bear Mountain Bk.
Martins Bk.
Wills Bk.
Emerson Bk.
Norris Bk.
Boston Bk.
Nichols Bk.
Fish Bk.
Mile Bk.
Howlett Bk.
Gravelly Bk.
Black Bk.
Miles R.
Kimball Bk.
2
1
3
4
5
6
7
8
9
10
11
12
13
14
15

FIGURE 11

TABLE 13

IPSWICH RIVER 1973 SURVEY

SUMMARY OF TOTAL COLIFORM DATA - COLIFORM/100ml

STATION	6/5/73	6/7/73	Geometric Mean	8/14/73	8/16/73	Geometric Mean
I01	2,200	1,500	1,800	2,500	3,500	3,000
I02	400	800	600	8,000	1,500	3,500
I03	1,600	500	900	4,800	1,000	2,200
I04	1,100	500	700	1,400	3,800	2,307
I05	900	600	700	4,000	2,500	3,200
I06	800	1,100	900	5,400	2,800	3,900
I07	1,700	800	1,200	9,000	4,500	6,400
I08	1,300	900	1,100	7,000	3,800	1,500
I09	1,900	2,700	2,300	5,500	2,700	3,900
I10	1,500	2,500	2,500	10,000	3,000	5,500
I11	3,000	2,300	2,600	3,500	4,500	4,000
I12	600	600	600	4,000	3,000	3,500
I13	1,100	400	700	6,300	5,600	6,000
I14	1,300	800	1,000	4,400	4,000	4,200
I15	700	1,400	900	13,000	30,000	19,748

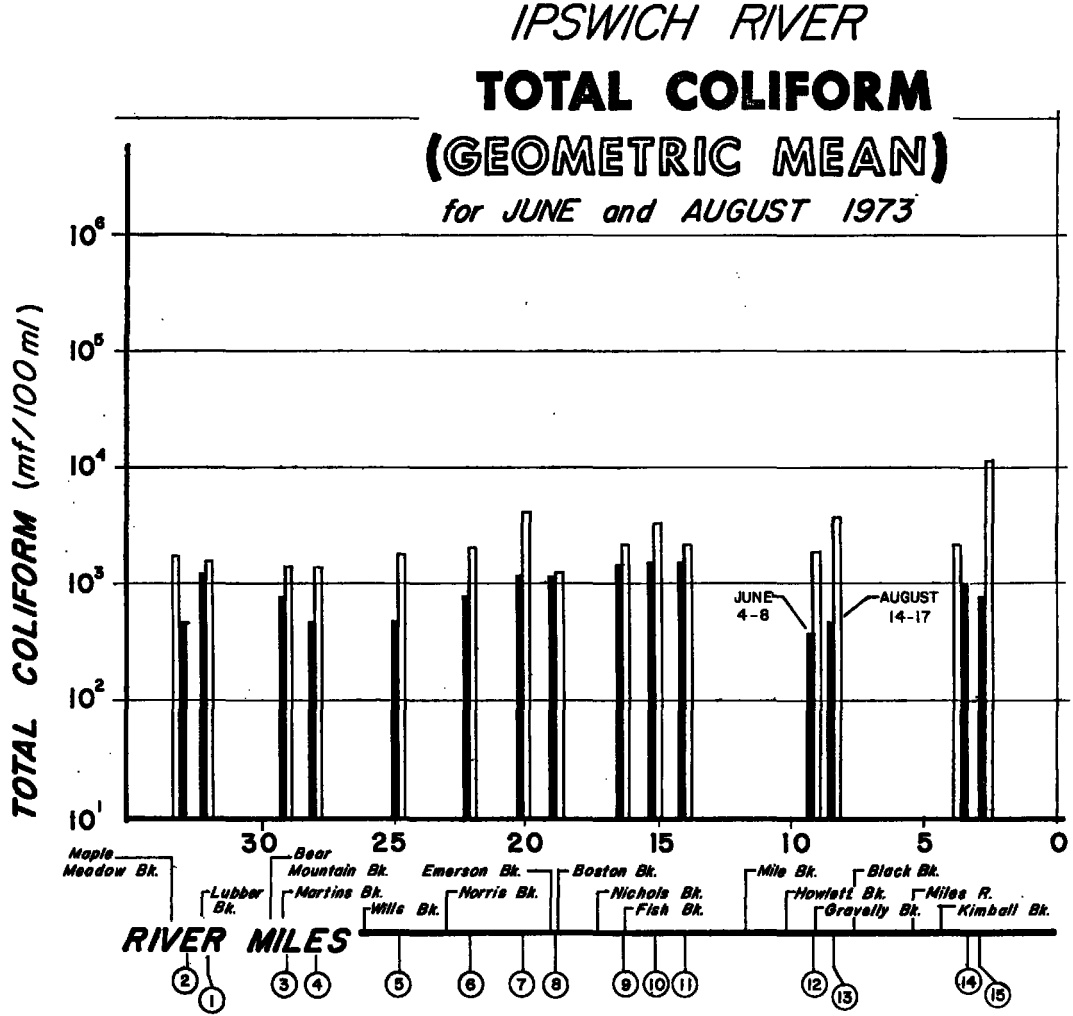

IPSWICH RIVER
TOTAL COLIFORM
(GEOMETRIC MEAN)
for JUNE and AUGUST 1973
TOTAL COLIFORM (mf/100 ml)
10^6
10^5
10^4
10^3
10^2
10^1
JUNE 4-8
AUGUST 14-17
30
25
20
15
10
5
0
Maple Meadow Bk.
Lubber Bk.
Bear Mountain Bk.
Martins Bk.
Mills Bk.
Emerson Bk.
Norris Bk.
Boston Bk.
Nichols Bk.
Fish Bk.
Mile Bk.
Howlett Bk.
Gravelly Bk.
Black Bk.
Miles R.
Kimball Bk.
RIVER MILES
2
1
3
4
5
6
7
8
9
10
11
12
13
14
15

FIGURE 12

TABLE 14

IPSWICH RIVER 1973 SURVEY

SUMMARY OF CHLOROPHYLL-A DATA (mg/l)

August 14, 1973

STATION	RIVER MILE	CONCENTRATION
I01	31.8	.001
I02	32.9	.017
I03	28.9	.005
I04	27.9	.001
I05	24.8	.004
I06	22.3	.001
I07	20.3	.000
I08	19.0	.001
I09	16.5	.000
I10	15.4	.000
I11	14.3	.000
I12	9.5	.000
I13	8.9	.000
I14	3.8	.001
I15	3.6	.001

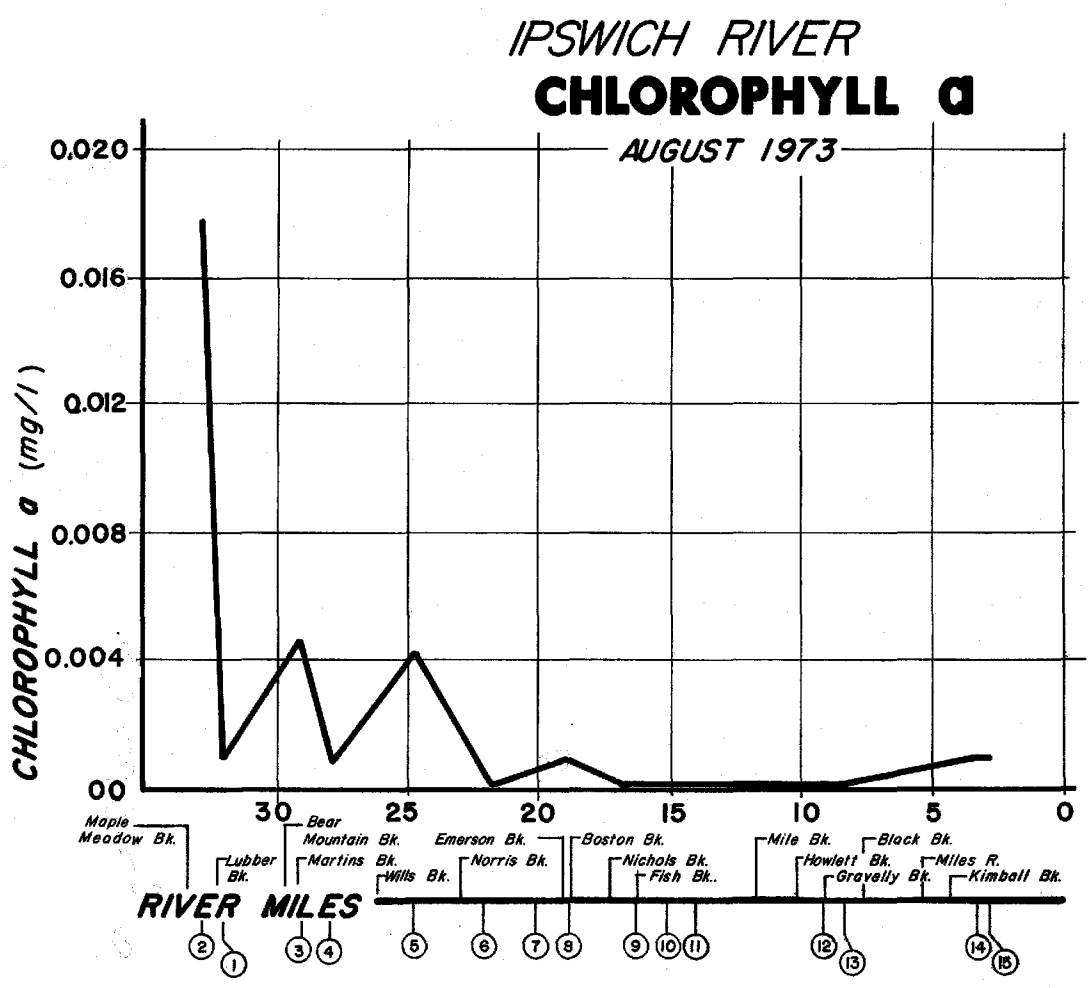

IPSWICH RIVER
CHLOROPHYLL a
AUGUST 1973
CHLOROPHYLL a (mg/l)
0.020
0.016
0.012
0.008
0.004
00
30
25
20
15
10
5
0
Maple Meadow Bk.
Lubber Bk.
Bear Mountain Bk.
Martins Bk.
Wills Bk.
Emerson Bk.
Norris Bk.
Boston Bk.
Nichols Bk.
Fish Bk.
Mile Bk.
Howlett Bk.
Gravelly Bk.
Block Bk.
Miles R.
Kimball Bk.
RIVER MILES
2
1
3
4
5
6
7
8
9
10
11
12
13
14
15

FIGURE 13

TABLE 15

IPSWICH RIVER 1973 SURVEY

SUMMARY OF BIOCHEMICAL OXYGEN DEMAND (mg/l)

STATION	DATE SAMPLED	B.O.D. 2 Day	5 Day	7 Day	14 Day	21 Day
I02	6/5/73	0.6	1.6	2.4	4.2	5.0
I07	6/5/73	0.0	0.6	0.8	2.0	3.2
I13	6/5/73	1.0	1.9	2.0	3.2	3.4
I03	8/14/73	0.6	3.6	6.0	7.4	8.6
I11	8/14/73	0.4	3.6	4.8	5.8	6.4

TABLE 16

IPSWICH RIVER SURVEY

MICROSCOPIC ANALYSES IN AREAL STANDARD UNITS/ml

JUNE 1973

ORGANISM	STATION														
	I01	I02	I03	I04	I05	I06	I07	I08	I09	I10	I11	I12	I13	I14	I15
ALGAE															
Bacillariophyceae (Diatoms)	100	160	65	60	55	50	25	45	40	30	35	60	390	---	35
Cyanophyceae (Blue-Green)	None														
Chlorophyceae (Green)	130	---	10	---	---	5	---	5	---	---	---	---	405	150	150
FUNGI	None														
PROTOZOA															
Mastigophora	15	15	---	10	10	---	5	45	---	---	5	---	---	---	---
Infusoria	None														
ROTIFERA	None														
AMORPHOUS MATTER	905	585	165	875	455	425	515	855	535	440	790	260	185	265	645
CRUSTACEA	None														

TABLE 17

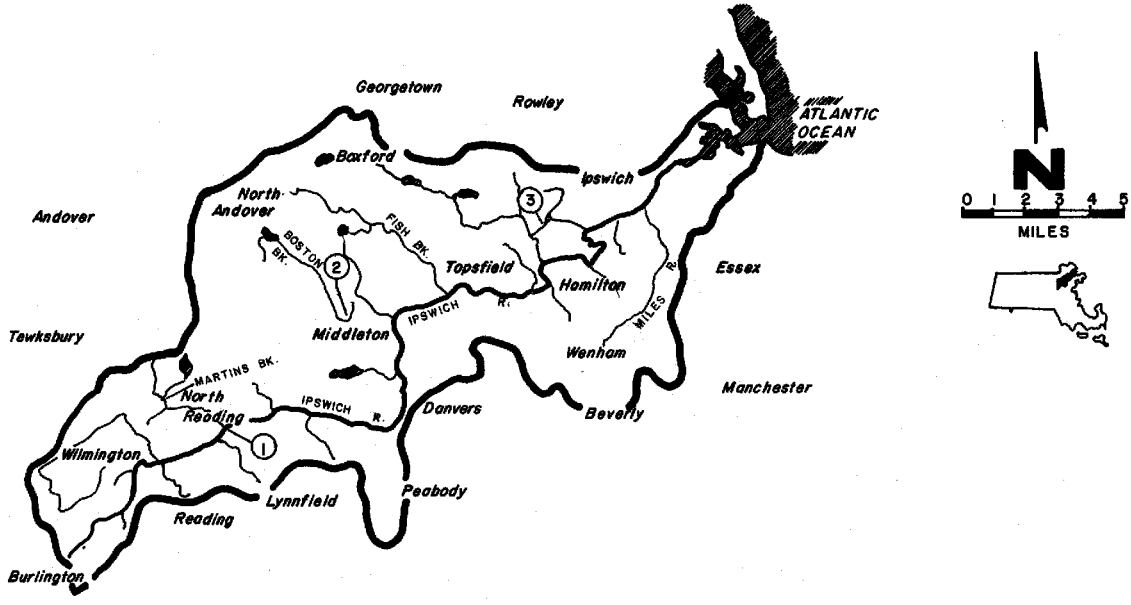
IPSWICH RIVER 1973 SURVEY

PHOTOSYNTHESIS STATIONS

STATION	LOCATION	RIVER MILE	BOTTOM DEPTH(ft.)	SECCHI DISK DEPTH(ft.)
I1P	Central Street North Reading	28.0	6	4
I2P	Peabody Street Middleton	19.0	4	2
I3B	Willowdale Dam	8.9	6	4

WEATHER INFORMATION

6/4	Partly cloudy, warm.
6/5	Heavy overcast all day, windy cooler.
6/6	Mostly cloudy, sun later afternoon, warm.
6/7	Bright sun all day, warm.
6/8	Sunny all day, hot.



IPSWICH RIVER BASIN

LOCATION OF PHOTOSYNTHESIS STATIONS

1973 SURVEY

FIGURE 14

TABLE 18A

IPSWICH RIVER - STATION IP 1
PHOTOSYNTHESIS DATA

JUNE 4 - JUNE 8, 1973

DEPTH	DATE	INITIAL	LIGHT	DARK
1'	6/4 - 6/5	* 1040	0525	0525
		** 64.0	64.0	64.0
		*** 3.4	3.2/3.4	3.4/3.6
	6/5 - 6/6	0520	0525	0525
		64.0	62.0	62.0
		7.6	8.3/8.4	8.3/8.4
	6/6 - 6/7	0540	0535	0535
		60.0	64.0	64.0
		4.0	3.7/4.2	3.9/---
	6/7 - 6/8	0535	0525	0525
		64.0	67.0	67.0
		4.0	3.8/4.0	4.1/4.1
3'	6/4 - 6/5	1035	0530	0530
		64.0	63.0	63.0
		3.6	3.4/3.7	3.4/3.6
	6/5 - 6/6	0535	0530	0530
		64.0	61.0	61.0
		8.0	8.4/8.5	8.5/8.7
	6/6 - 6/7	0535	0530	0530
		60.0	65.0	65.0
		3.8	3.9/4.0	3.5/4.1
	6/7 - 6/8	0530	0515	0515
		64.0	67.0	67.0
		4.2	3.7/3.9	3.9/4.1
5'	6/4 - 6/5	1030	0535	0535
		64.0	63.0	63.0
		4.6	3.5/3.6	3.7/3.8
	6/5 - 6/6	0540	0540	0540
		64.0	61.0	61.0
		8.4	8.6/8.7	8.5/8.8
	6/6 - 6/7	0525	0535	0535
		61.0	64.0	64.0
		4.0	3.7/4.0	3.5/3.7
	6/7 - 6/8	0525	0515	0515
		66.0	67.0	67.0
		4.1	4.1/4.4	4.3/4.5

* Time
** Temperature (^{o}F)
*** Dissolved Oxygen (mg/l)

TABLE 18B

IPSWICH RIVER - STATION IP 2

PHOTOSYNTHESIS DATA

JUNE 4 - JUNE 8, 1973

DEPTH	DATE	INITIAL	LIGHT	DARK
1'	6/4 - 6/5	0950	0630	0630
		63.0	65.0	65.0
		4.6	4.8/5.0	4.9/4.9
	6/5 - 6/6	0635	0630	0630
		66.0	60.0	60.0
		8.2	8.8/9.0	8.7/9.0
	6/6 - 6/7	0630	0620	0620
		60.0	64.0	64.0
		5.7	5.4/5.6	5.5/5.7
	6/7 - 6/8	0625	0600	0600
		----	----	----
		5.7	6.0/6.1	5.9/6.1
3'	6/4 - 6/5	0945	0630	0630
		63.0	64.0	64.0
		4.8	4.9/4.9	4.8/5.0
	6/5 - 6/6	0645	0625	0625
		65.0	60.0	60.0
		8.0	8.7/8.7	8.8/8.9
	6/6 - 6/7	0625	0625	0625
		60.0	64.0	64.0
		5.5	5.6/5.6	5.5/---
	6/7 - 6/8	0625	0600	0600
		63.0	66.0	66.0
		6.2	5.8/5.9	6.0/6.1

TABLE 18C

IPSWICH RIVER - STATION IP 3
PHOTOSYNTHESIS DATA

JUNE 4 - JUNE 8, 1973

DEPTH	DATE	INITIAL	LIGHT	DARK
1'	6/4 - 6/5	1150	0740	0740
		66.0	66.0	66.0
		3.0	3.0/3.1	3.4/3.8
	6/5 - 6/6	0800	0750	0750
		67.0	60.0	60.0
		7.2	7.5/7.6	7.4/7.9
	6/6 - 6/7	0745	0735	0735
		62.0	65.0	65.0
		3.4	3.2/3.4	2.7/2.8
	6/7 - 6/8	0745	0650	0650
		66.0	68.0	68.0
		3.5	3.3/3.4	3.6/3.6
3'	6/4 - 6/5	1150	0745	0745
		65.0	66.0	66.0
		3.1	3.2/3.3	3.2/3.3
	6/5 - 6/6	0750	0740	0740
		66.0	61.0	61.0
		7.4	7.6/7.9	7.7/8.0
	6/6 - 6/7	0740	0740	0740
		62.0	65.0	65.0
		3.3	2.8/3.0	2.8/2.9
	6/7 - 6/8	0745	0650	0650
		66.0	68.0	68.0
		4.0	3.1/3.5	3.5/3.6
5'	6/4 - 6/5	1150	0755	0755
		65.0	65.0	65.0
		3.2	3.0/3.2	2.3/3.2
	6/5 - 6/6	0755	0735	0735
		66.0	61.0	61.0
		7.5	7.7/7.9	7.7/8.3
	6/6 - 6/7	0735	0735	0735
		60.0	64.0	64.0
		3.2	2.8/3.5	2.9/3.2
	6/7 - 6/8	0745	0650	0650
		65.0	68.0	68.0
		3.5	3.6/3.6	0.1/0.1

TABLE 19

IPSWICH RIVER 1973 SURVEY

SUMMARY OF FLOW DATA

LOCATION	QUANTITY OF FLOW IN CU. FT./SEC.			
	Date	Q	Date	Q
B.B. Chemical Sewer Pipe	6/6	0.45	8/14	.007
B.B. Chemical Channel Inlet	6/6	1.89	8/14	5.28
Wills Brook near Lynn Pumping Station	6/6	1.45		
Unamed tributary draining Eisenhour Pond	6/7	1.70		
Bear Meadow Brook at Haverhill Street	6/6	2.84	8/14	No velocity
Ipswich River at Peabody Street	6/5	134.0		
Ipswich River below Lynn Pumping Station	6/6	44.8		
Ipswich River above Lynn Pumping Station	6/6	59.7		
Ipswich River at Central Street	6/6	55.5	8/14	20.2
Ipswich River at Central Street	6/7	49.9		
Ipswich River at Woburn Street	6/6	19.0	8/14	10.3
Ipswich River at Wildwood	6/6	7.81	8/14	5.76
Miles River at Main St., Ipswich	6/5	20.1	8/14	7.7
Miles River at Main St., Ipswich	6/7	21.5		
Howlett Brook at Ipswich River	6/4	20.7	8/14	5.52
Fish Brook at River Road	6/5	23.1	8/14	2.95
Boston Brook at Peabody Street	6/5	8.14	8/14	1.95
Boston Brook at Peabody Street	6/7	12.6		
Martins Brook at Park Street	6/6	22.7		
Martins Brook at Park Street	6/7	19.6	8/14	5.52
Lubber Brook at Concord Road	6/6	7.99		

TABLE 19 CONTINUED

LOCATION	QUANTITY OF FLOW IN CU. FT./SEC.				
	6/4	6/5	6/6	6/7	6/8
Howlett Brook	20	20	19	19	18
Ipswich at Central Street	61	58	54	50	47
Martins Brook	24	22	21	19	18
Ipswich at Woburn Street	22	20	18	17	15
Fish Brook	26	24	22	20	19
Miles River	23	21	20	18	16
Ipswich at Wildwood	9	8	7	7	6
Ipswich at South Middleton	70	55	43	38	33
Ipswich at Ipswich	240	223	207	193	176
	8/13	8/14	8/15	8/16	8/17
Ipswich at South Middleton	7.2	13	28	32	18
Ipswich at Ipswich	53	48	44	63	75

TABLE 20

IPSWICH RIVER 1973 SURVEY

DAM REAERATION STUDY

DAM	RIVER MILE	June 6, 1973 TEMPERATURE	D.O.
South Middleton Dam	24.8		
Above dam		39°	9.5
Below dam		40°	11.4
Willowdale Dam	8.9		
Above dam		38°	9.2
Below dam		38°	10.3
Sylvania Dam	3.8		
Above dam		41°	10.6
Below dam		42°	13.9

MEASURES OF WATER POLLUTION

The term "water pollution" has acquired many connotations. Literally, the word pollute means "render impure;" thus, in this sense, any water containing matter other than its chemical constituent of two parts hydrogen to one part oxygen would be considered polluted. Such "pure" water, however, is never found in natural bodies; the ecological balance in a waterbody is dependent on the presence of other material. In this report, water pollution refers to a condition which is in contravention of the Water Quality Standards. Pollution degrades the physical, chemical, and bacterial quality of a waterbody and can make it unsightly, malodorous, and a health hazard, its uses sharply limited. Pollution occurs mainly through the discharge of wastes from homes and industries. The various types of pollution are: (1) oxygen-demanding, such as originates from domestic sewage and certain industrial wastes, (2) toxic materials as in some industrial wastes, (3) radioactive, (4) thermal, (5) bacterial, (6) oil, and (7) physical. Stormwater runoff from both urban and rural areas can also add pollutants to a waterbody.

The extent of pollution in a particular waterbody is determined by measuring certain chemical and biological constituents and properties. Chemical constituents, such as dissolved oxygen, phosphates, and metals, are generally measured in milligrams per liter (mg/l); since the unit weight of water is 1.0 grams per milliliter, milligrams per liter are roughly equivalent to parts per million for a solution which is mostly water.

Dissolved Oxygen (D.O.) refers to the uncombined oxygen in water which is available to aquatic life. Since this oxygen is consumed more rapidly in the decomposition of wastes, the D.O. gives an instantaneous picture of the condition of a waterbody. Time of day and temperature of the water are important in interpreting D.O. Levels. Temperature affects the amount of oxygen which water can contain. Time of day is related to the effects of algae. Algae consume oxygen through respiration throughout the day and night. During daylight hours, they add oxygen through photosynthesis. D.O. levels are therefore generally highest during the afternoon and lowest just before sunrise.

Biochemical Oxygen Demand (B.O.D.) measures the amount of oxygen required by bacteria to decompose organic matter. The B.O.D. is gradually exerted, consisting of two stages. In the first stage, carbonaceous matter is stabilized while nitrogenous substances are broken down in the second stage. The second stage (nitrification) usually begins after seven days. The ultimate, or total, B.O.D. from both stages may require an incubation period of 30 days or more. Through recurrent use, the 5 day B.O.D. has become the standard test used in water quality analysis.

Chemical Oxygen Demand (C.O.D.) refers to the amount of oxygen required to chemically oxidize waste material. Since some of the organic matter in a waste cannot be decomposed by microorganisms but can be broken down by chemical oxidation, the C.O.D. is generally greater than the B.O.D.

The C.O.D. is especially useful in analyzing a waste that contains a great deal of non-biodegradable matter.

Total Solids measures all solids in water including suspended and dissolved, organic and inorganic. They are measured by evaporating the water from a sample of known volume and weighing the residue remaining. The residue then can be ignited in a laboratory furnace to determine the organic portion. The loss on ignition is considered organic and the remaining residue, known as fixed solids, is considered to be inorganic.

Suspended Solids are those which can be removed by passing the water through a filter. The remaining solids are called dissolved solids. Suspended solids provide a good measure of the efficiency of a sewage treatment plant; primary treatment should remove about 50 percent of the suspended solids while secondary treatment should remove about 90 percent.

Coliform Bacteria are found in abundance in the intestinal tract of warm-blooded animals. They are not harmful in themselves, but their presence indicates that pathogenic bacteria also may be present. Since they can be detected by relatively simple test procedures, coliforms are used to indicate the extent of bacterial pollution from sewage. Bacterial tests usually measure the fecal coli and the total coli. Fecal coli make up about 90 percent of the coliforms discharged in fecal matter. Non-fecal coli may originate in soil, grain, or decaying vegetation.

pH measures the hydrogen ion concentration on an inverse logarithmic scale ranging from 0 to 14. pH values under 7 indicate more hydrogen ions and therefore more acidic solutions; pH values over 7 indicate less hydrogen ions and therefore more alkaline solutions. A pH of 7 indicates a neutral solution. Alkalinity is a quantitative measure of the alkaline materials present while acidity is a quantitative measure of acidic materials.

Nutrients are compounds which act as fertilizers for aquatic organisms. Small amounts are necessary to the ecological balance of a waterbody, but excessive amounts can upset the balance by causing excessive growths of algae and other aquatic plants. Sewage discharged to a waterbody usually contains large amounts of carbon, nitrogen, and phosphorus. The concentration of carbonaceous matter is reflected in the B.O.D. test. Additional tests are run to determine the concentrations of nitrogen and phosphorus.

Phosphorus appears in waterbodies in combined forms known as ortho- and poly- phosphates and organic phosphorus. The majority of the phosphorus contained in domestic sewage and industrial wastes comes from detergents. Additional phosphorus may enter a waterbody in agricultural runoff where fertilizers are used.

Nitrogen in the form of organic nitrogen decomposes into ammonia nitrogen, nitrite nitrogen and nitrate nitrogen. Since each decomposition reaction is dependent on the preceding one, the progress of decomposition can be determined in terms of the relative amounts of these four

forms of nitrogen.

Ammonia Nitrogen is present in sewage and is also generated from the decomposition of organic nitrogen. It can also be formed when nitrites and nitrates are reduced. Ammonia is particularly important since it has high oxygen and chemical demands and is also toxic to fish.

Nitrite Nitrogen is the oxidation product of ammonia. It has a fairly low oxygen demand and is rapidly converted to nitrate. The presence of nitrite nitrogen usually indicates that active decomposition is taking place.

Nitrate Nitrogen is important since it is the end product in the aerobic decomposition of nitrogenous matter. Nitrogen in this form is readily available to plants.

Turbidity is the measure of the clarity of a water sample. It is expressed in Jackson Standard Units which are related to the scattering and absorption of light by the water sample.

Color is determined by visual comparison of a sample with known concentrations of colored solutions and is expressed in standard units of color. Certain waste discharges may turn water to colors which cannot be defined by this method; in such cases, the color is expressed qualitatively rather than numerically.

Specific Conductance yeilds a measure of a water sample's capacity to convey an electric current. It is dependent on temperature and the concentration of ionized substances in the water. Distilled water exhibits specific conductance of 0.5 to 2.0 micromhos per centimeter while natural waters show values from 50 to 500 micromhos per centimeter.

The above parameters are measured in most water quality surveys. Other constituents such as metals or radioactivity are measured in areas where particular problems are known to exist. Microscopic examinations are conducted on most surveys to measure the amount of algae and other microorganisms present. Additional samples of the river bottom are usually collected in order to determine the types of deposits present. Decomposition of organic suspended matter which settles to the bottom will exert an oxygen demand on the water.

Two types of samples are collected for analysis: grab and composite. A grab sample is an instantaneous sample collected to show conditions at a particular time. Composite samples are collected over a period of time at specific intervals, giving a better picture of the overall water quality situation for the time covered.

Certain levels of the above parameters occur naturally in waterbodies. Since these levels vary among the different ponds, streams, and coastal waters, the following tables are presented for the sake of reference. Table A summarizes the numerical limits for certain parameters as specified by the Massachusetts Water Quality Standards. Table B lists levels found in unpolluted reaches of various Massachusetts waters.

TABLE B

SPECIFIED LEVELS OF CERTAIN PARAMETERS

MASSACHUSETTS WATER QUALITY STANDARDS

	Dissolved Oxygen	pH	Coliform Bacteria	Total Phosphate	Ammonia Nitrogen
Class A	Not less than 75% of saturation for 16 hours of any 24 hour period and never less than 5mg/l	As naturally occurs.	Not to exceed an average of 50 per 100 ml. for any monthly period.	No Standard (as naturally occurs).	No Standard (as naturally occurs)
Class B	Same as above	6.5-8.0	Not to exceed an average value of 1000 for any month nor 2400 in more than 20% of samples collected.	Not to exceed an average of 0.05 mg/l during any month.	Not to exceed an average of 0.5 mg/l as N during any month.
Class C	Not less than 5 mg/l during at least 16 hours of any 24 hour period and never less than 3.0.	6.0-8.5	None in concentrations that would impair usages assigned to this class.	Same as above.	Not to exceed an average of 1.0 mg/l as N during any month.
Class D	Not less than 2.0mg/l	6.0-9.0	Same as above.	No Standard.	No Standard.
Class SA	Not Less than 6.5mg/l	6.8-8.5	Not to exceed a median value of 70 and not more than 10% of samples over 230.	Not to exceed an average of 0.07 mg/l as P during any month.	Not to exceed an average of 0.2 mg/l as N during any month.
Class SB	Not less than 5.0mg/l	6.8-8.5	Not to exceed a median value of 700 and not more than 10% of samples over 2300	Same as above.	Same as above.
Class SC	Not less than 5 mg/l during at least 16 hours of any 24 hour period and never less than 3 mg/l.	6.5-8.5	None in concentrations that would impair any uses assigned to this class.	Same as above.	Not to exceed an average of 1.0 mg/l during any month.

TABLE C

SELECTED ANALYSES OF UNPOLLUTED WATERS

	Lake Quinsigamond Worcester	Swift River below Quabbin Reservoir	Parker River Byfield	Charles River Hopkinton
Dissolved Oxygen, mg/l	11.2-12.5	7.4-9.2	7.2-8.4	6.2-7.4
5-Day B.O.D., mg/l	0.8	1.8	1.9	0.7
Suspended Solids, mg/l	1.5	5	4	0
pH	6.7	6.5	7.6	6.4
Alkalinity, mg/l	18	8	37	8
Total Coliform per 100ml.	28	1300	300	170
Fecal Coliform per 100ml.	5	14	---	---
Color, Std. Units	28	25	68	35
Turbidity, Std. Units	2	4	2	2
Ammonia as N., mg/l	.04	0.10	0.04	0.0
Nitrate as N., mg/l	---	0.000	0.006	0.0
Nitrate as N., mg/l	---	0.0	0.1	0.0
Total Phosphate as P, mg/l	.04	.07	0.16	0.03

TABLE 21

IPSWICH RIVER NOVEMBER, 1972 SURVEY

TIME OF TRAVEL STUDY

REACH	RIVER MILE	REACH TIME	VELOCITY ft./sec.	CUM. HRS.
1. Martin's Brook	29.1	30 hrs., 43 min.	.2053	30 hrs., 43 min.
2. S. Middleton gage	24.8	14 hrs., 40 min.	.43	45 hrs., 23 min.
3. Boston Brook	19.0	27 hrs., 15 min.	.315	72 hrs., 38 min.
4. Fish Brook	16.5	5 hrs., 15 min.	.6984	77 hrs., 53 min.
5. Route 97	14.3	3 hrs., 50 min.	.8417	80 hrs., 50 min.
6. Ipswich gage	8.9	27 hrs., 5 min.	.2924	107 hrs., 55 min.
7. Tidal water	3.2	5 hrs., 5 min.	1.4426	113 hrs.

FLOW DATA

South Middleton gage	11/27	gage height 3.2'	cfs = 167
South Middleton gage	11/28	gage height 2.74'	cfs = 140
South Middleton gage	11/29	gage height 2.75'	cfs = 142
Ipswich gage	11/20	gage height 4.1'	cfs = 240
Ipswich gage	11/28	gage height 4.4'	cfs = 438
Ipswich gage	11/29	gage height 4.3'	cfs = 375