QUALITY OF WATER

INTRODUCTION

Surface water, where in a more or less natural condition, as in small headwaters draining sparsely populated areas around the southern margins of the Charles River basin, is generally of very good quality. Dissolved-solids concentration is low, ranging from 30 to 75 mg/l (milligrams per litre).

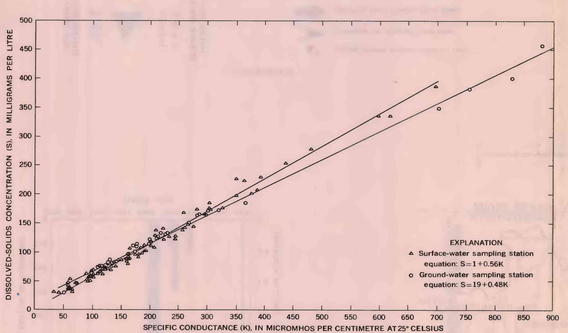
Water draining from headwater swamps tends to have a low pH, to be slightly corrosive, and to be too colored for public supply.

Dissolved-solids concentration generally increases downstream in the basin, owing to contributions of soluble substances from developed areas. Effluent from sewage-treatment plants contributes large amounts of dissolved substances, notable chloride, nitrate, and phosphate. Runoff from roads, streets, and urbanized surfaces contributes much dissolved material, notably dissolved deicing salts applied in winter, to surface-water bodies. Other sources of dissolved solids are wastes from some industries and water draining from landfill areas.

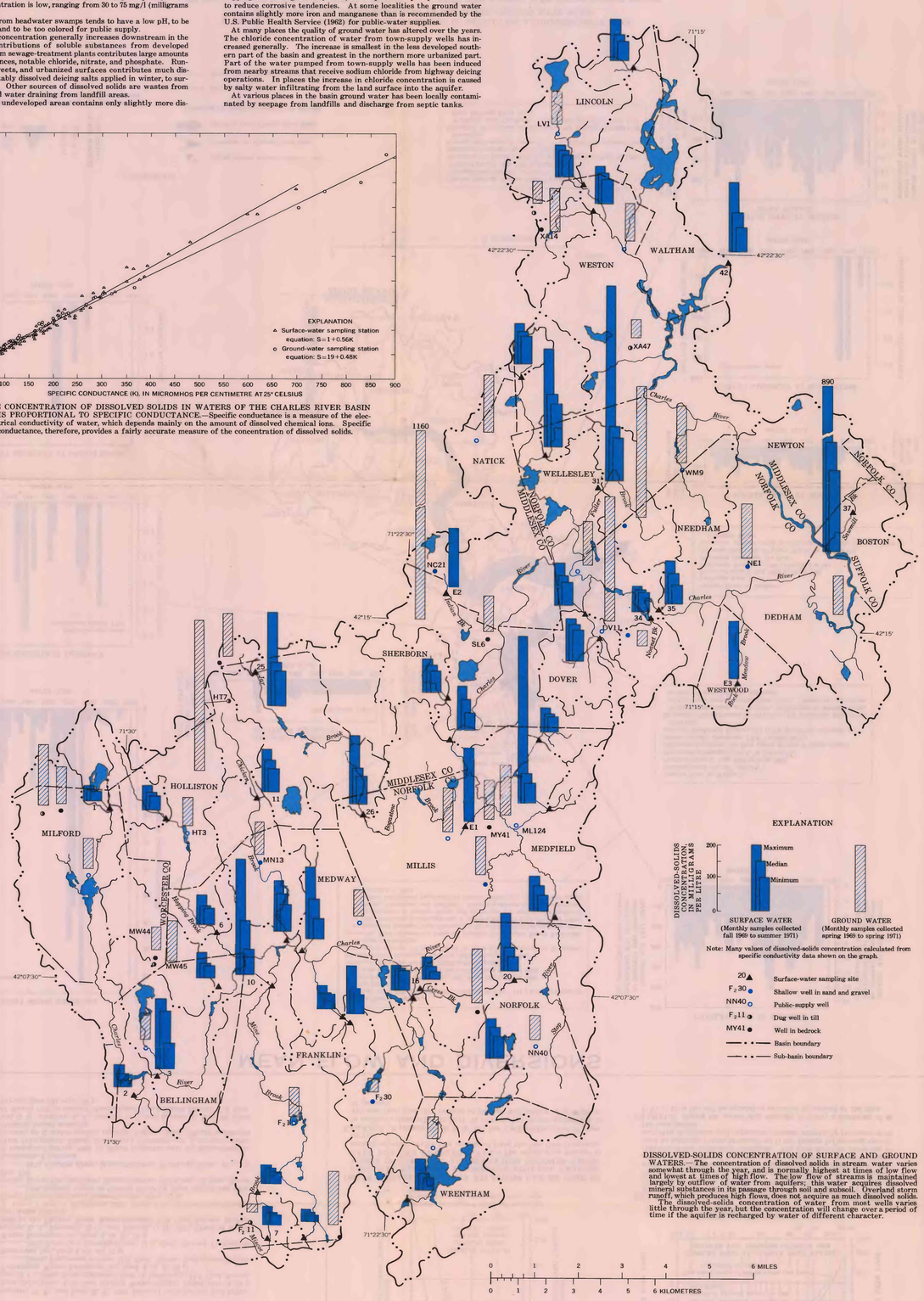
Ground water in undeveloped areas contains only slightly more dissolved solids than surface water in similar areas. The ground water tends to have a low pH, averaging 6.2 in water from town-supply wells tapping sand and gravel aquifers, and in places may require treatment to reduce corrosive tendencies. At some localities the ground water contains slightly more iron and manganese than is recommended by the U.S. Public Health Service (1962) for public-water supplies.

At many places the quality of ground water has altered over the years. The chloride concentration of water from town-supply wells has increased generally. The increase is smallest in the less developed southern part of the basin and greatest in the northern more urbanized part. Part of the water pumped from town-supply wells has been induced from nearby streams that receive sodium chloride from highway deicing operations. In places the increase in chloride concentration is caused by salty water infiltrating from the land surface into the aquifer.

At various places in the basin ground water has been locally contaminated by seepage from landfills and discharge from septic tanks.



THE CONCENTRATION OF DISSOLVED SOLIDS IN WATERS OF THE CHARLES RIVER BASIN IS PROPORTIONAL TO SPECIFIC CONDUCTANCE.—Specific conductance is a measure of the electrical conductivity of water, which depends mainly on the amount of dissolved chemical ions. Specific conductance, therefore, provides a fairly accurate measure of the concentration of dissolved solids.

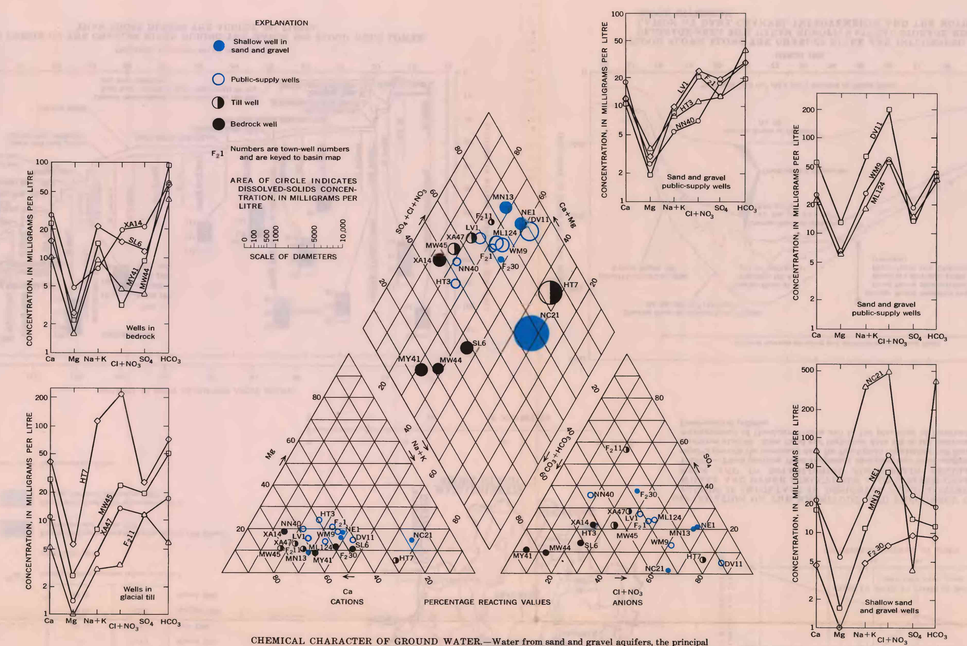


Note: Many values of dissolved-solids concentration calculated from specific conductivity data shown on the graph.

DISSOLVED-SOLIDS CONCENTRATION OF SURFACE AND GROUND WATERS.—The concentration of dissolved solids in stream water varies somewhat through the year, and is normally highest at times of low flow and lowest at times of high flow. The low flow of streams is maintained largely by outflow of water from aquifers; this water acquires dissolved mineral substances in its passage through soil and subsoil. Overland storm runoff, which produces high flows, does not acquire as much dissolved solids.

The dissolved-solids concentration of water from most wells varies little through the year, but the concentration will change over a period of time if the aquifer is recharged by water of different character.

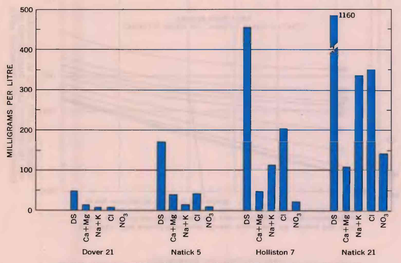
GROUND WATER



CHEMICAL CHARACTER OF GROUND WATER.—Water from sand and gravel aquifers, the principal aquifers, is similar chemically throughout the basin. The principal differences are in the concentration of dissolved solids, which ranges from 40 to 380 mg/l, and in proportion of chloride. With increase in dissolved solids, the proportion of chloride also increases. A concentration of more than about 100 mg/l of dissolved solids indicates that the water receives waste from urban runoff.

Water from bedrock in most places has a lower proportion of chloride and a higher proportion of bicarbonate than water from sand and gravel.

Water from glacial till usually contains a slightly higher proportion of calcium than that from sand and gravel.



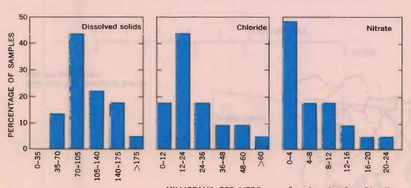
HIGH CONCENTRATIONS OF DISSOLVED SOLIDS IN GROUND WATER NORMALLY INDICATE THE PRESENCE OF WASTES.—Water from well DVW21 contains about 50 mg/l dissolved solids. The well is in a rural area, is 28 feet (8.5 m) deep, and taps a sand and gravel aquifer recharged by local precipitation.

Water from public-supply well NCW5, 58 feet (17.7 m) deep and tapping a sand and gravel aquifer, is of good quality. However, the concentration of dissolved solids and of principal dissolved constituents indicates that the stream from which some of the well water is induced contains urban wastes.

Well HTW7 is dug 26 feet (7.9 m) deep in glacial till in a rural area. The high concentration of dissolved substances in the well water suggests contamination, presumably from domestic wastes.

Well NCW21 is 6 feet (1.8 m) deep in permeable sand and gravel at the edge of a spreading town waste-disposal and landfill area. Water from well NCW21 contains 25 times more dissolved solids, 87 times more chloride, and 1,400 times more nitrate than water from well DVW21.

Well		Water-bearing material	Depth (ft)	Depth (m)	Dissolved solids (mg/l)	Date sample collected
Franklin	$F_2$1	Sand and gravel	57	17.4	76	28 May 1969
Holliston	HT3	Sand and gravel	85	25.9	83	28 May 1969
Norfolk	NN40	Sand and gravel	40	12.2	73	4 June 1969
Medfield	ML124	Sand and gravel	88	26.8	150	5 June 1969
Dover	DV11	Sand and gravel	—	—	380	4 June 1969
Wellesley	WM9	Sand and gravel	53	18.1	173	27 May 1969
Lincoln	LV1	Sand and gravel	46	14.0	100	27 May 1969
Natick	NC21	Sand and gravel	6	1.83	1160	22 Sept. 1970
Medway	MN13	Sand and gravel	16	4.88	99	12 June 1970
Needham	NE1	Sand and gravel	24	7.32	164	2 May 1971
Franklin	$F_2$30	Sand and gravel	27	8.23	40	3 May 1971
Holliston	HT7	Till	26	7.93	456	12 June 1970
Franklin	$F_2$11	Till	21	6.40	30	15 June 1970
Milford	MW45	Till	23	7.02	125	3 May 1971
Weston	XA47	Till	29	8.84	58	2 May 1971
Milford	MW44	Bedrock	200	61.0	66	3 May 1971
Millis	MY41	Bedrock	490	149	115	15 June 1970
Weston	XA14	Bedrock	700	214	128	10 June 1970
Sherborn	SL6	Bedrock	300	91.5	110	12 June 1970



FREQUENCY OF VARIOUS CONCENTRATIONS OF DISSOLVED SOLIDS, CHLORIDE, AND NITRATE IN WATER FROM THE SAND AND GRAVEL AQUIFER.

TABLE 4.— CONCENTRATION OF IRON AND MANGANESE, IN MILLIGRAMS PER LITRE, FOR SELECTED WELLS

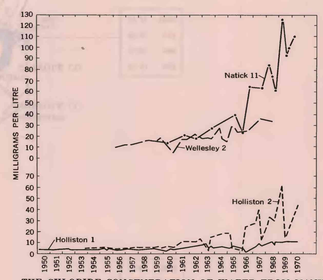
Type of well	Number		Iron	Manganese	pH
Bedrock	8	maximum	0.11	0.16*	8.4
		minimum	0.00	0.00	5.4
		mean	0.07	0.00	6.8
Dug well in till	6	maximum	0.32	0.06	6.8
		minimum	0.00	0.00	5.6
		mean	0.08	0.01	6.2
Dug well in sand	8	maximum	0.09	0.00	6.0
		minimum	0.00	0.00	5.4
		mean	0.04	0.00	5.6
Public supply	17	maximum	2.50*	0.65*	6.5
		minimum	0.00	0.00	6.0
		mean	0.12	0.07	6.2

*Not included in the mean

TABLE 5.—MAXIMUM LIMITS OF MINERALS AND TRACE ELEMENTS RECOMMENDED BY U.S. PUBLIC HEALTH SERVICE FOR PUBLIC WATER SUPPLIES[1]

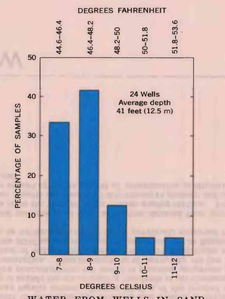
Mineral	Concentration in milligrams per litre	Trace element	Concentration in milligrams per litre
Iron (Fe)	0.3	Chromium (Cr^{6}) hexavalent	50
Manganese (Mn)	0.05	Arsenic (As)	50
Nitrate (NO_3)	45	Lead (Pb)	50
Sulfate (SO_4)	250	Copper (Cu)	1000
Chloride (Cl)	250	Zinc (Zn)	5000
Dissolved solids	500		

[1]U.S. Public Health Service (1962)



THE CHLORIDE CONCENTRATION OF WATER FROM MANY TOWN WELLS HAS INCREASED DURING THE PAST 20 YEARS.—The increase in chloride concentration of water from town wells in the past 20 years ranges from a few milligrams per litre to more than 200 mg/l. Much of the water pumped from these wells is induced from nearby streams or ponds, which, in turn, have been receiving more chloride in recent years, notably from highway deicing salts.

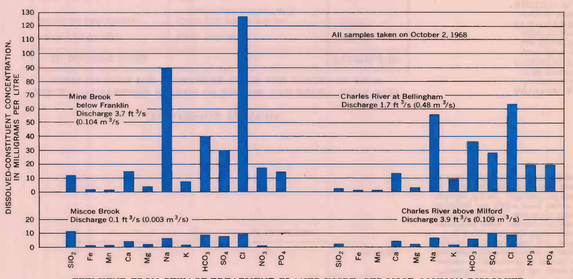
Much of the yield of well Holliston 1 is derived from a nearby pond, which receives runoff from an area of low population density; the chloride concentration of its waters has increased only about 8 mg/l in the 20 years. In contrast, much of the yield of well Natick 11 is derived from Morse Pond, which receives runoff from an area of higher population density with numerous streets and highways; the chloride concentration of its water has increased more than 100 mg/l in only 12 years.



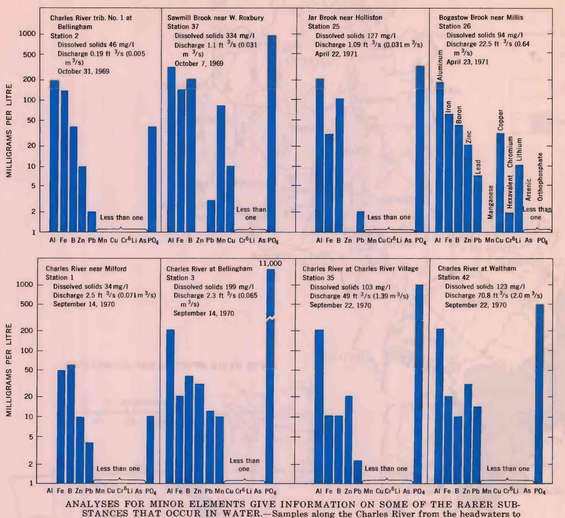
WATER FROM WELLS IN SAND AND GRAVEL IS NORMALLY COOLER THAN 10°C (50°F).

SURFACE WATER

	Station	Dissolved solids (Mg/l)	Discharge (ft³/s)	Discharge (m³/s)	Date sample collected
1	Charles River near Milford	36	3.90	.019	2 Oct 68
2	Charles R. trib. no. 1 at Bellingham	46	.19	.005	31 Oct 69
3	Charles River at Bellingham	230	1.70	.048	2 Oct 68
6	Hopping Brook near Medway	70	1.30	.036	31 Oct 69
7	Miscoe Brook near Franklin	54	.35	.010	8 Oct 69
10	Mine Brook near Franklin	253	5.60	.157	31 Oct 69
11	Chicken Brook at Holliston	106	.55	.015	30 Oct 69
18	Cress Brook near Millis	68	.84	.024	7 Oct 69
20	Stop River tributary at Norfolk	77	.31	.009	7 Oct 69
26	Bogastow Brook near Millis	107	2.80	.078	30 Oct 69
31	Fuller Brook at Wellesley	175	1.40	.039	7 Oct 69
42	Charles River at Waltham	126	29.0	.812	1 Oct 68
E1	Charles R. trib. no. 2 at Millis near sewage-treatment plant	224	.87	.024	2 Oct 70
E2	Indian Brook at Sherborn near Natick dump	175	.40	.011	5 Oct 70
E3	Rock Meadow Brook at Westwood near housing development	171	.27	.008	5 Oct 70



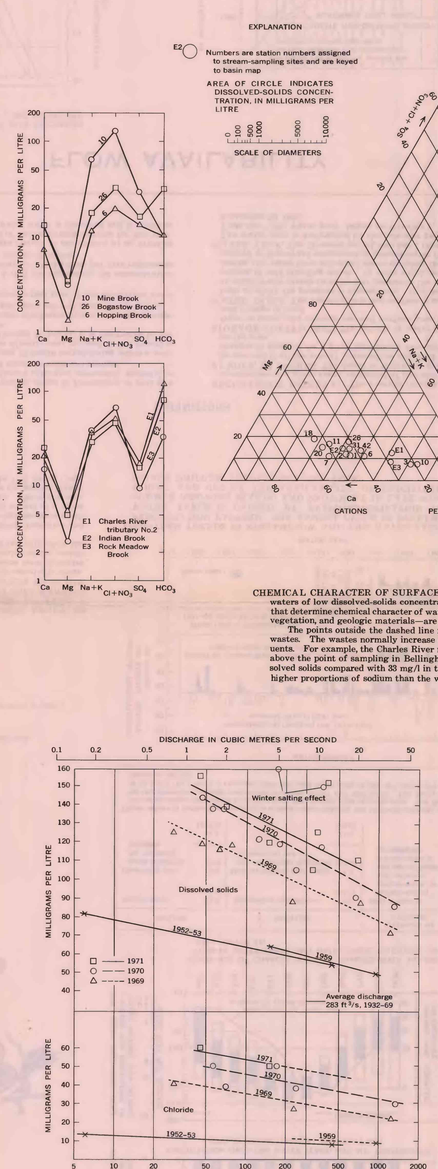
EFFLUENT FROM SEWAGE-TREATMENT PLANTS INCREASES MOST COMMON DISSOLVED SUBSTANCES IN STREAM WATER, ESPECIALLY NITRATE AND PHOSPHATE.—Comparison of water from two streams below outfalls of sewage-treatment plants, Mine Brook below Franklin and the Charles River at Bellingham, with water from their headwaters, Miscoe Brook and the Charles River above Milford, shows that many of the dissolved constituents increased markedly.



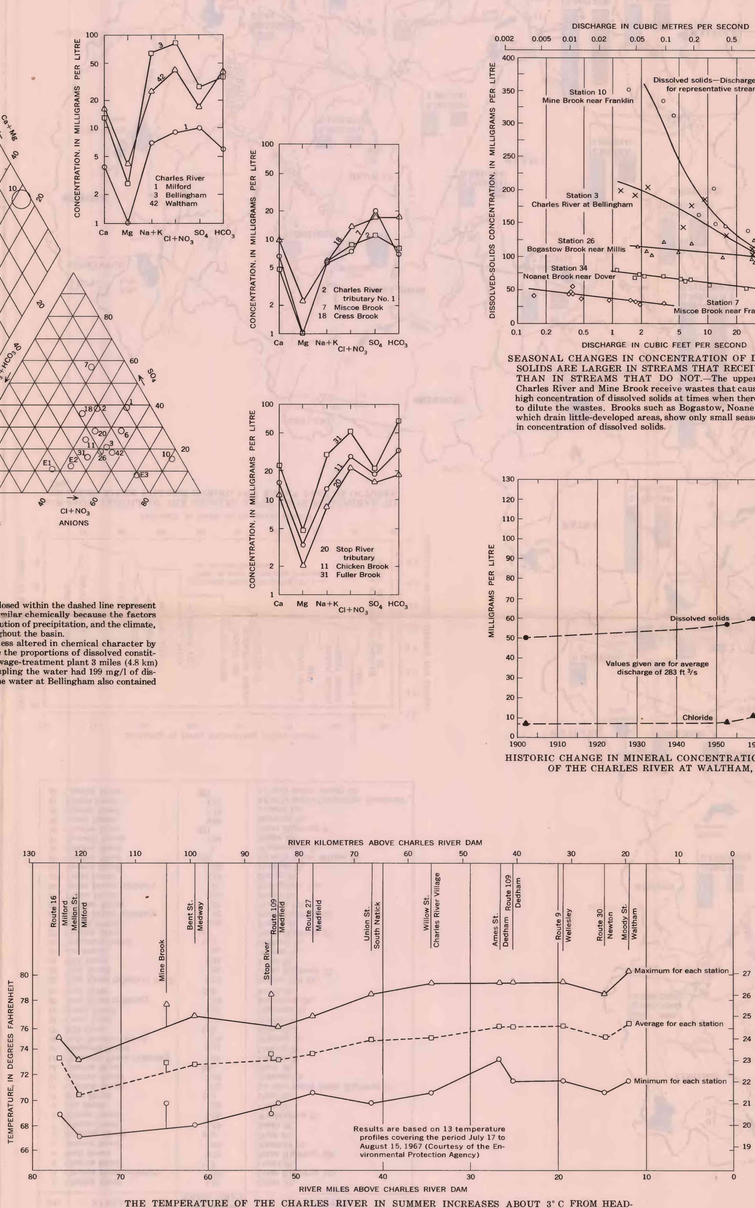
ANALYSES FOR MINOR ELEMENTS GIVE INFORMATION ON SOME OF THE RARER SUBSTANCES THAT OCCUR IN WATER.—Samples along the Charles River from the headwaters to Waltham show increases in zinc, lead, and phosphate.

Samples taken from the lower part of Bogastow Brook and from its headwater, Jar Brook, show the addition of zinc, lead, copper, chromium, and lithium.

The water from Sawmill Brook, which drains an urbanized area and a large dump, shows much more boron, lead, manganese, and copper than the water from a brook draining an undeveloped area in Bellingham.

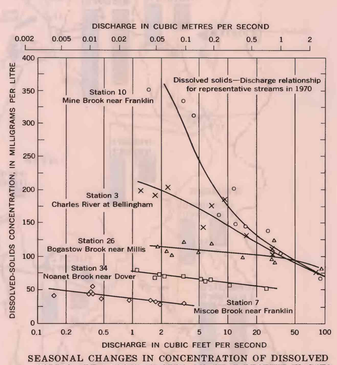


MINERAL CONCENTRATION OF THE CHARLES RIVER AT WALTHAM HAS INCREASED MARKEDLY DURING 1952–71.—In 1971 the concentration of dissolved solids at a given rate of discharge was about twice as high as it was in 1952. The concentration of chloride increased about five times during the same period.

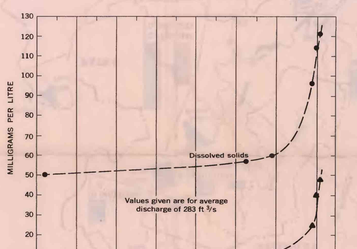


CHEMICAL CHARACTER OF SURFACE WATER.—The points enclosed within the dashed line represent waters of low dissolved-solids concentration. These waters are similar chemically because the factors that determine chemical character of water—the amount and distribution of precipitation, and the climate, vegetation, and geologic materials—are more or less similar throughout the basin.

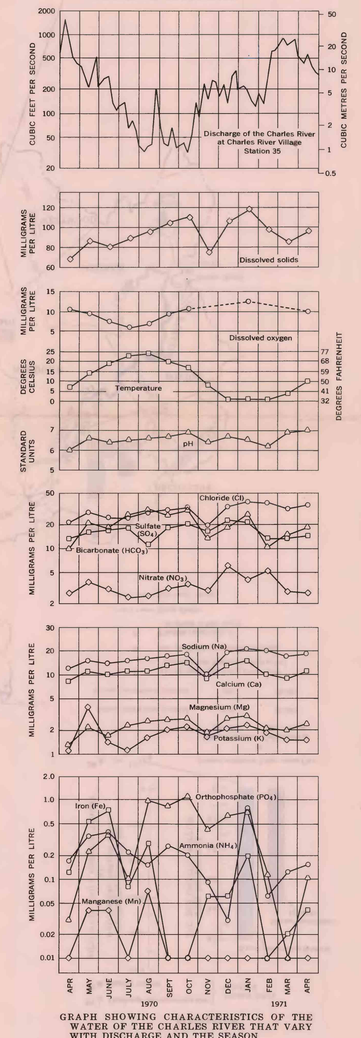
The points outside the dashed line represent waters more or less altered in chemical character by wastes. The wastes normally increase dissolved solids and change the proportions of dissolved constituents. For example, the Charles River receives effluent from a sewage-treatment plant 3 miles (4.8 km) above the point of sampling in Bellingham, and at the time of sampling the water had 199 mg/l of dissolved solids compared with 33 mg/l in the water above Milford. The water at Bellingham also contained higher proportions of sodium than the water above Milford.



SEASONAL CHANGES IN CONCENTRATION OF DISSOLVED SOLIDS ARE LARGER IN STREAMS THAT RECEIVE WASTES THAN IN STREAMS THAT DO NOT.—The upper part of the Charles River and Mine Brook receive wastes that cause abnormally high concentration of dissolved solids at times when there is least flow to dilute the wastes. Brooks such as Bogastow, Noanet, and Miscoe, which drain little-developed areas, show only small seasonal variation in concentration of dissolved solids.



HISTORIC CHANGE IN MINERAL CONCENTRATION OF WATER OF THE CHARLES RIVER AT WALTHAM, 1900–71.



GRAPH SHOWING CHARACTERISTICS OF THE WATER OF THE CHARLES RIVER THAT VARY WITH DISCHARGE AND THE SEASON.

Interior—Geological Survey, Reston, Va.—1976—W75108

WATER RESOURCES OF THE CHARLES RIVER BASIN, MASSACHUSETTS

By
E. H. Walker, S. W. Wandle, Jr., and W. W. Caswell

1976