DEPARTMENT OF THE INTERIOR
UNITED STATES GEOLOGICAL SURVEY

PREPARED IN COOPERATION WITH THE
COMMONWEALTH OF MASSACHUSETTS
WATER RESOURCES COMMISSION

HYDROLOGIC INVESTIGATIONS
ATLAS HA-507 (SHEET 1 OF 2)

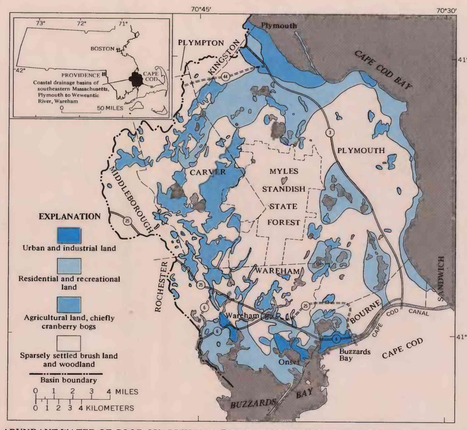
SUMMARY

The eastern two-thirds of the area is underlain by one of the largest aquifers in Massachusetts. Sand and gravel from 40 to more than 160 feet thick is expected to yield more than 300 gpm (gallons per minute) per well. The average annual recharge to the aquifer is conservatively estimated at 120 mgd (million gallons per day), which is equal to discharge from the aquifer to streams, directly to the sea, and to the atmosphere by ground-water evapotranspiration. The amount of water that can be withdrawn for man's use depends on the plan of development, whether the water is to be exported or returned to the basin, and many ecologic and economic considerations, such as willingness to accept diminished streamflow, lowered pond levels, and encroachment of salt water into the coastal fringe of the aquifer. Storage within the aquifer is estimated at 540 billion gallons. Depletion of storage can be made up by diversion of high streamflow to artificial recharge basins or wells in the sandy surficial deposits around proposed pumping centers. About 24 mgd of surface water and ground water is pumped, and 22 mgd is returned to streams or to the ground through on-site disposal systems. In the western and southwestern parts of the area, limited saturated thickness and low hydraulic conductivity of unconsolidated deposits may make it necessary to utilize the bedrock aquifer, which yields an average of 8 to 10 gpm per well.

Average streamflow from the area is about 250 cfs (cubic feet per second). The unconsolidated deposits of relatively high hydraulic conductivity, characteristic of the aquifer in the eastern part of the area, allow rapid infiltration of precipitation, large storage capacity, and gradual discharge of ground water to the streams. Therefore, surface runoff is low, and ground-water runoff is high. Streams draining the thin, unconsolidated deposits of relatively low hydraulic conductivity in the western and southwestern part of the area have higher surface runoff and lower ground-water runoff than those draining the aquifer.

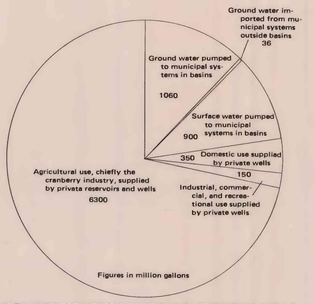
Ground water and surface water is generally soft and low in dissolved mineral content and is within the limits recommended by U.S. Public Health Service (1962) for drinking water, except for locally excessive iron, manganese, and color. The water is slightly acid and locally corrosive to metal. Dissolved solids exceeding 500 mg/l (milligrams per liter) occur in the tidal reach of streams and in ground water beneath tidal marshes, beaches, artificial fill, and areas adjacent to tidal reaches of streams.

INTRODUCTION

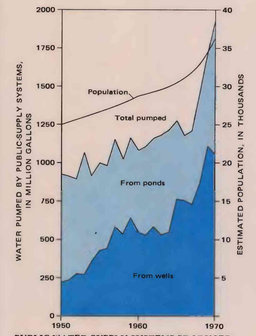


ABUNDANT WATER OF GOOD QUALITY IS ONE OF THE MOST IMPORTANT RESOURCES OF THE COASTAL BASINS, LOCATED WITHIN 55 MILES OF BOSTON AND PROVIDENCE ALONG EXPRESSWAYS LEADING TO CAPE COD. – *Other physical features favorable for development are: extensive deposits of sand and gravel for use as borrow; excellent percolation for on-site disposal systems; large tracts of level land; general lack of flooding; favorable sites for sanitary landfill; good foundations; and ease of leveling and clearing. The principal settlements are on Cape Cod Bay at Plymouth and along the shore of Buzzards Bay at Buzzards Bay, Onset, and Wareham. Recreational and residential areas have been developed to take advantage of the many miles of ocean shoreline and lake frontage. Inland, much of the land is devoted to cultivation of cranberries; the remainder is largely brushland and woodland. This report, based on field investigations in 1969-71, describes the availability and quality of ground water and surface water to meet needs anticipated from continued development and to aid in planning for the future of the region.*

WATER USE

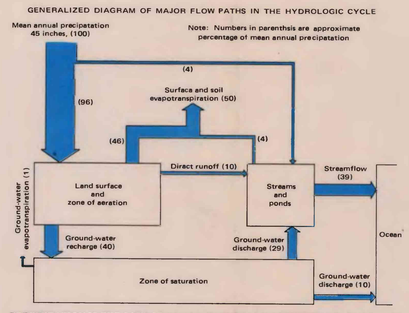


WATER USED FOR AGRICULTURE WAS 72 PERCENT OF THE 8.8 BILLION GALLONS PUMPED IN 1970. – *Of the total water pumped, 8.2 billion gallons was returned to the ground, discharged to streams, evaporated, and transpired; 0.6 billion gallons was discharged to the sea by sewage systems.*

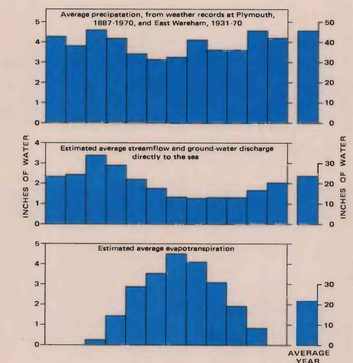


PUBLIC WATER-SUPPLY SYSTEMS PRODUCED 100 PERCENT MORE WATER IN 1970 THAN IN 1950, BUT POPULATION INCREASED ONLY 50 PERCENT. – *Increased per capita use of water, rapid expansion of water mains, and a larger percentage of year-round residents explain the increased demand. The additional demand has been met entirely from wells finished in sand and gravel of the major aquifer that extends from Plymouth into Bourne and Wareham.*

HYDROLOGIC CYCLE

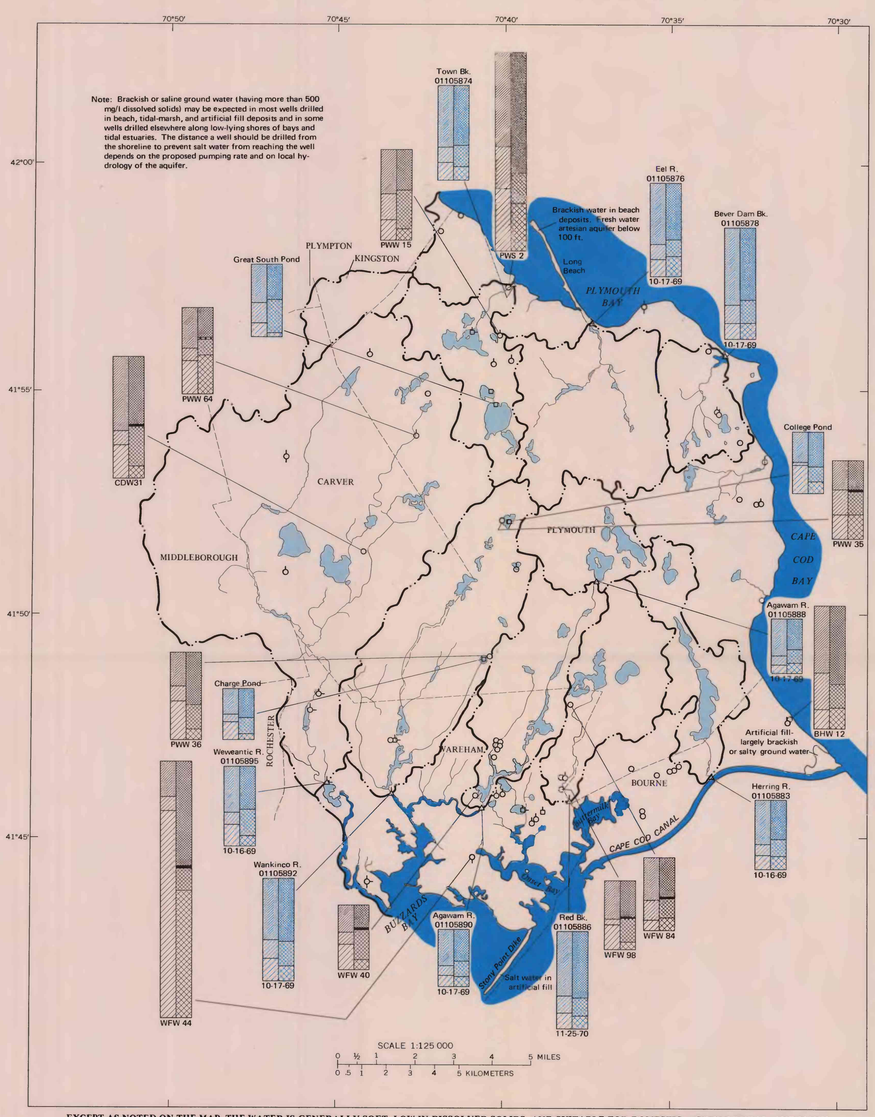


PRECIPITATION IS THE SOURCE OF ALL NATURALLY OCCURRING FRESH WATER IN THE AREA. – *About half the precipitation is evaporated or transpired. About 10 percent enters the streams and ponds as surface runoff, and about 40 percent percolates downward to the water table.*



SIMILAR AMOUNTS OF PRECIPITATION THROUGHOUT THE YEAR PRODUCE HIGH STREAMFLOW AND GROUND-WATER DISCHARGE DIRECTLY TO THE SEA DURING THE NONGROWING SEASON (AUTUMN AND WINTER) AND LOW STREAMFLOW AND GROUND-WATER DISCHARGE DIRECTLY TO THE SEA DURING THE GROWING SEASON (SPRING AND SUMMER), WHEN EVAPOTRANSPIRATION IS HIGH.

QUALITY OF WATER



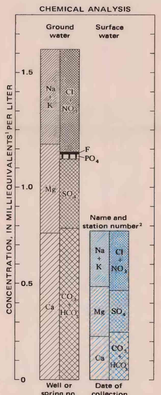
EXPLANATION

Limits for iron, manganese, and color are those recommended by U.S. Public Health Service (1962) for drinking water. Hardness of 60 mg/l used by the U.S. Geological Survey is the boundary between soft and moderately hard water. Combination of two or ticks on symbols indicates that the water falls within two or more categories, described below

Wells, springs	Streams	Ponds
Concentration of iron 0.3 mg/l or less; manganese 0.05 mg/l or less; color 15 units or less; and hardness 60 mg/l or less		
Concentration of iron more than 0.3 mg/l and (or) concentration of manganese more than 0.05 mg/l in at least 20 percent of analyses available for study		
Color exceeds 15 units		
Hardness, as $CaCO_3$, exceeds 60 mg/l		
Water reported to have objectionable odor or taste		

Sea water and mixed fresh and salt water of tidal reaches of streams that has concentration of dissolved solids greater than 500 mg/l at high tide when streamflow is low

Basin and subbasin boundary

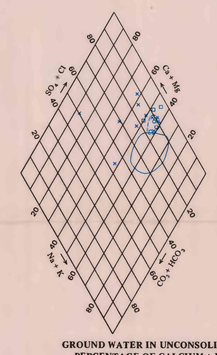


Analyses of water from wells BHW-12, PWW-15 WFW-98, and Great South Pond by Lawrence Laboratory, Massachusetts Department of Public Health

[1] To convert milliequivalents per liter to milligrams per liter, multiply milliequivalents per liter by the combining weight of the appropriate ions (Hem, 1970, p. 82-83)

[2] Station number is that used to identify gaging stations and low-flow partial-record stations in national network of hydrologic-data collection sites of U.S. Geological Survey (1970-72)

EXCEPT AS NOTED ON THE MAP, THE WATER IS GENERALLY SOFT, LOW IN DISSOLVED SOLIDS, AND SUITABLE FOR DOMESTIC, AGRICULTURAL, AND MANY INDUSTRIAL USES. – *However, the water of many streams and wells exceeds the recommended limits of the U.S. Public Health Service (1962) for iron, manganese, and color in drinking water. The water is acid to slightly acid and may require treatment to correct pH for certain uses. Locally the water is corrosive to metal.*



EXPLANATION

Area within which all uncontaminated samples from eight stream sampling stations plot; data points not shown

Area within which samples from Weweantic River (01105895) plot

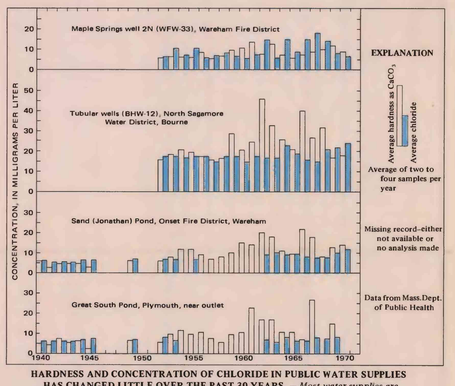
Data points

Water from wells and springs in unconsolidated deposits, chiefly sand and gravel

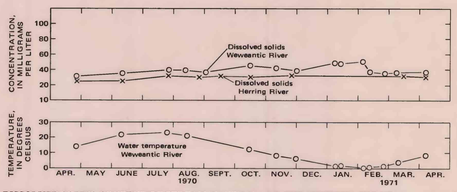
Water from ponds that have neither inlet nor outlet

Water from Weweantic River (01105895)

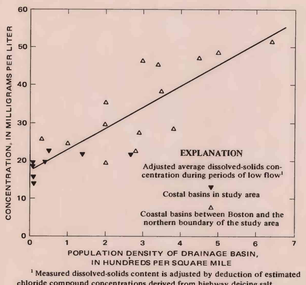
GROUND WATER IN UNCONSOLIDATED DEPOSITS HAS A HIGHER PERCENTAGE OF CALCIUM + MAGNESIUM AND LOWER SODIUM + POTASSIUM THAN MOST STREAMS.



HARDNESS AND CONCENTRATION OF CHLORIDE IN PUBLIC WATER SUPPLIES HAS CHANGED LITTLE OVER THE PAST 30 YEARS. – *Most water supplies are remote from sources of contamination, such as that caused by winter salting of highways for ice and snow removal.*

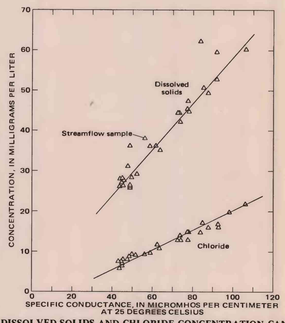


DISSOLVED-SOLIDS CONTENT OF STREAM WATER IS LOW THROUGHOUT THE YEAR. – *The U.S. Public Health Service (1962) recommended limit for dissolved solids in drinking water is 500 milligrams per liter.*



[1] Measured dissolved-solids content is adjusted by deduction of estimated chloride compound concentrations derived from highway deicing salt.

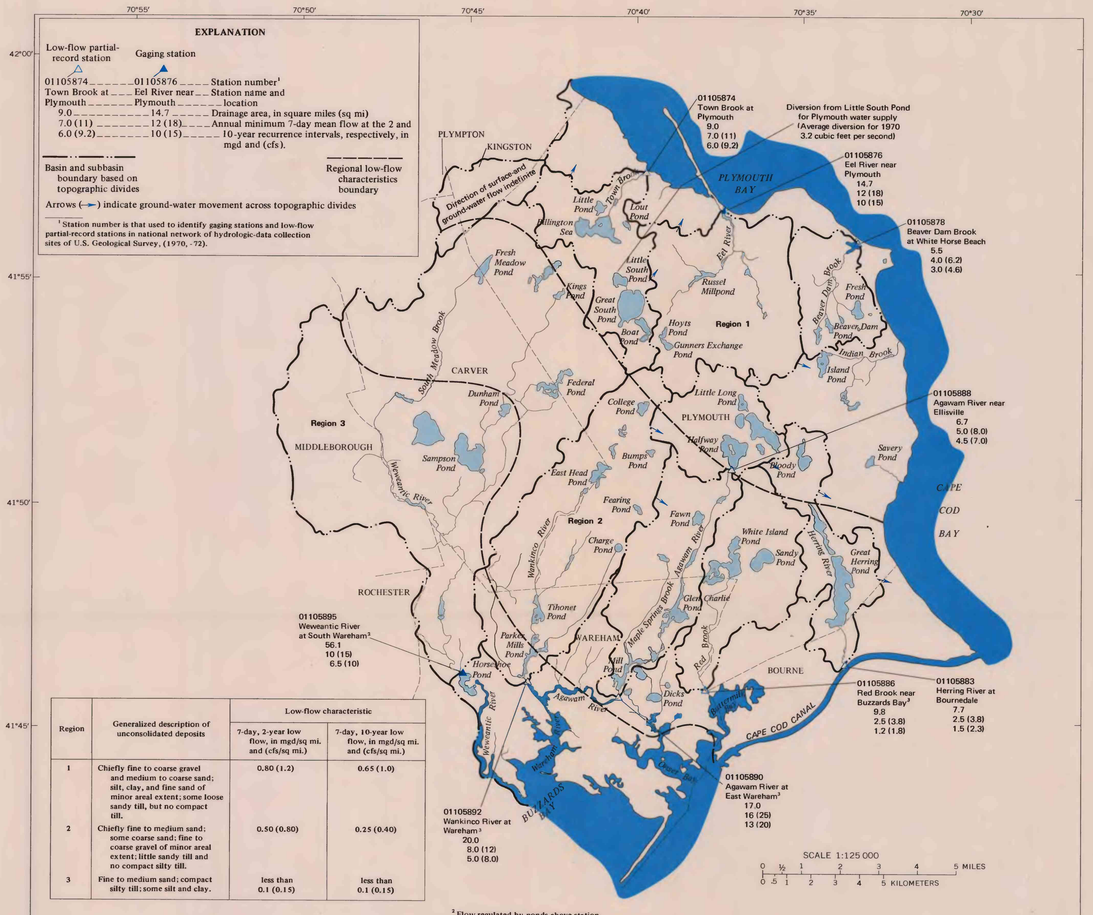
THE CHEMICAL QUALITY OF STREAMFLOW IS RELATED TO THE POPULATION DENSITY OF THE DRAINAGE BASIN



DISSOLVED-SOLIDS AND CHLORIDE CONCENTRATION CAN BE ESTIMATED FROM SPECIFIC CONDUCTANCE MEASUREMENTS

SURFACE WATER

LOW FLOW

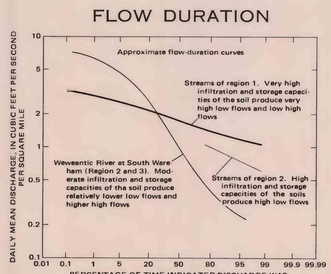


Region	Generalized description of unconsolidated deposits	Low-flow characteristic: 7-day, 2-year low flow, in mgd/sq mi. and (cfs/sq mi.)	Low-flow characteristic: 7-day, 10-year low flow, in mgd/sq mi. and (cfs/sq mi.)
1	Chiefly fine to coarse gravel and medium to coarse sand; silt, clay, and fine sand of minor areal extent; some loose sandy till, but no compact till.	0.80 (1.2)	0.65 (1.0)
2	Chiefly fine to medium sand; some coarse sand; fine to coarse gravel of minor areal extent; little sandy till and no compact silty till.	0.50 (0.80)	0.25 (0.40)
3	Fine to medium sand; compact silty till; some silt and clay.	less than 0.1 (0.15)	less than 0.1 (0.15)

[2] Flow regulated by ponds above station.
[3] Some regulation by operation of cranberry bogs above station.

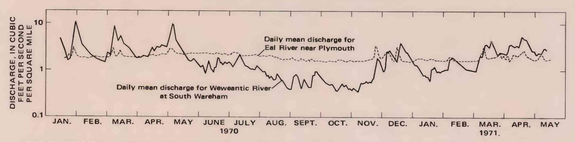
LOW-FLOW CHARACTERISTICS ARE COMMONLY USED TO DESCRIBE THE POTENTIAL OF A STREAM FOR WASTE DISPOSAL, MUNICIPAL OR INDUSTRIAL WATER SUPPLIES, IRRIGATION, AND FISH HABITAT. – *Topographic divides enclose basins within which direct surface runoff normally drains by gravity to streams. However, the area contributing to streamflow may be more or less than indicated by topographic divides because ground water is known to cross topographic basin divides in some areas, which are indicated on the map by arrows showing direction of flow. Low flows at ungaged sites on streams not significantly affected by regulation can be approximated by applying data from the table of regional low-flow characteristics to the drainage area of the desired site. Greater accuracy at a specific site will require base-flow measurements or a continuous record of discharge.*

FLOW DURATION



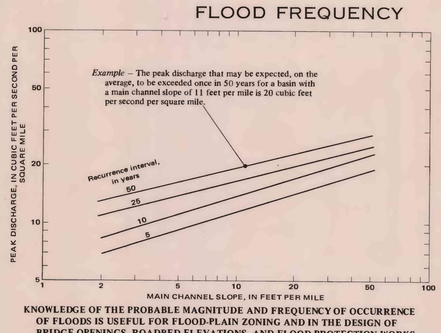
DIFFERENCES IN HYDRAULIC CONDUCTIVITY AND THICKNESS OF UNCONSOLIDATED MATERIAL UNDERLYING REGIONS 1, 2, AND 3 (LOW-FLOW MAP) CAUSE DISTINCT DIFFERENCES IN MAGNITUDE AND DURATION OF LOW FLOWS IN STREAMS IN THE THREE REGIONS. – *The curves are estimated by correlation with Taunton River at State Farm, near Bridgewater, 1930-70.*

FLOW VARIABILITY



THE DAILY MEAN DISCHARGE IN THE EEL RIVER IS UNIFORM IN CONTRAST TO THE WEWEANTIC RIVER. – *The differences in daily mean discharge reflect differences in hydraulic characteristics in the two drainage basins. The unconsolidated deposits of relatively high hydraulic conductivity underlying much of the Eel River basin allow rapid infiltration of precipitation, abundant storage, and gradual discharge of ground water to the stream, so that the flow is evenly distributed throughout the year. The high surface runoff and low ground-water runoff in the Weweantic River reflect the relatively low hydraulic conductivity of the unconsolidated deposits of much of the western part of the area.*

FLOOD FREQUENCY



KNOWLEDGE OF THE PROBABLE MAGNITUDE AND FREQUENCY OF OCCURRENCE OF FLOODS IS USEFUL FOR FLOOD-PLAIN ZONING AND IN THE DESIGN OF BRIDGE OPENINGS, ROADBED ELEVATIONS, AND FLOOD-PROTECTION WORKS. – *Estimates of the magnitude of peak flows for a given recurrence interval can be made from the above graph. With the exception of flood damage in the Buzzards Bay area from hurricanes in 1938, 1944, and 1954, floods have generally caused little damage.*

DEFINITIONS

Main channel slope is the difference in altitude at points 10 and 85 percent of the distance along the channel from the site to the drainage divide, divided by the distance along the channel between the points.

Recurrence interval is the average interval of time within which the given flood will be equaled or exceeded once.

LIMITATIONS

Does not apply to streams with drainage area less than 8 square miles or area of lakes and ponds greater than 5 percent of the drainage area.

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WATER RESOURCES OF THE COASTAL DRAINAGE BASINS OF SOUTHEASTERN MASSACHUSETTS, PLYMOUTH TO WEWEANTIC RIVER, WAREHAM

By

John R. Williams and Gary D. Tasker

1974

For sale by U.S. Geological Survey, price $1.25 per set