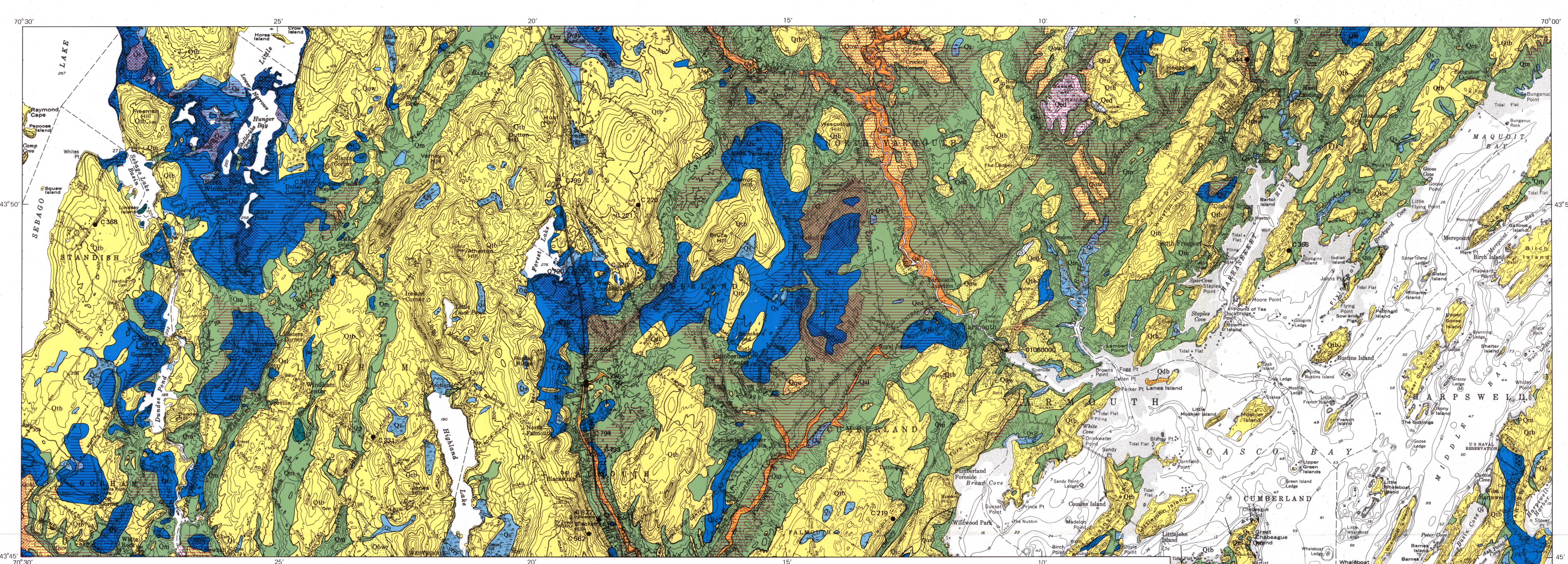

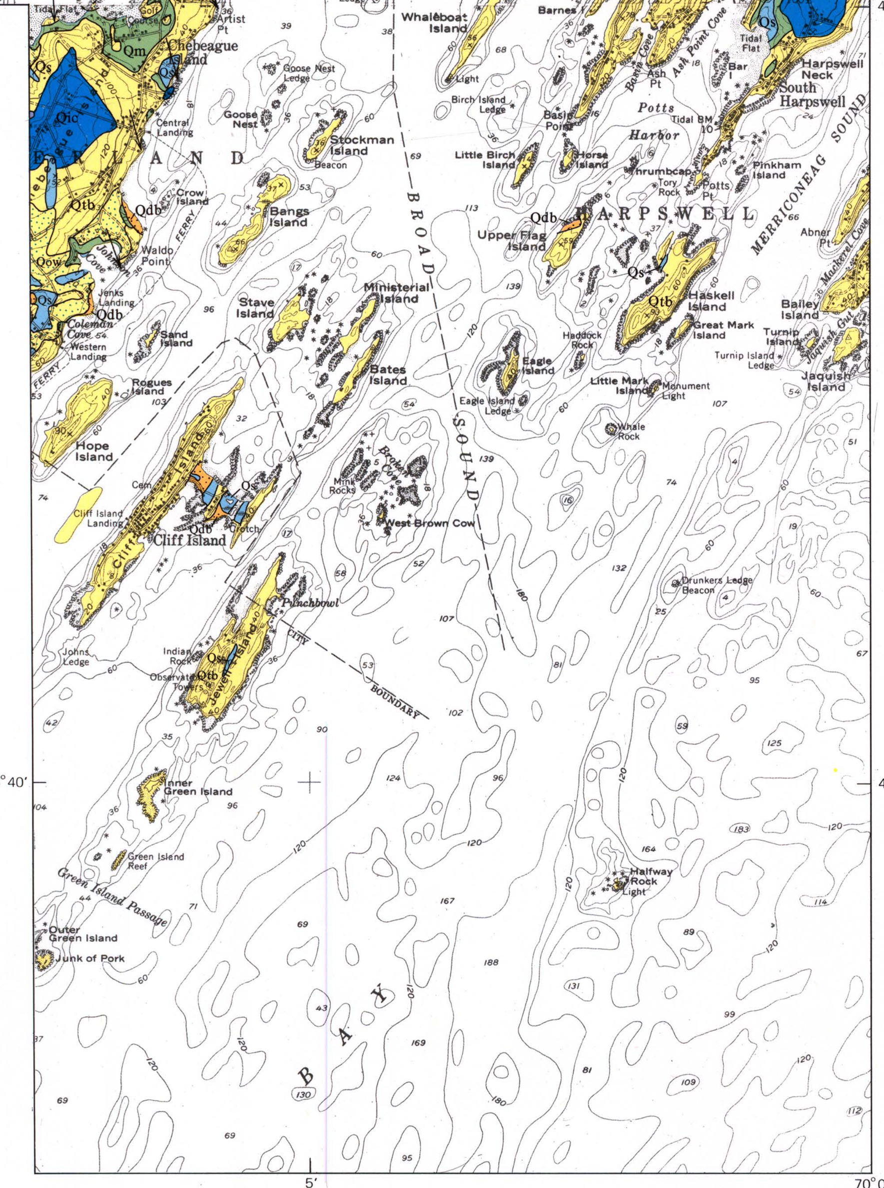

Base from U.S. Geological Survey
Freeport, 1957; Gray, 1957,
and Casco Bay, 1957

SCALE 1:62 500

CONTOUR INTERVAL 20 FEET
DATUM IS MEAN SEA LEVEL
DEPTH CURVES AND SOUNDINGS IN FEET—DATUM IS MEAN LOW WATER
SHORELINE SHOWN REPRESENTS THE APPROXIMATE LINE OF MEAN HIGH WATER
THE MEAN RANGE OF TIDE IS APPROXIMATELY 9 FEET

FIGURE 2.—SURFICIAL GEOLOGIC MAP AND GROUND-WATER FAVORABILITY MAP

INTRODUCTION

This report is one of a series describing the geologic and hydrologic conditions governing the occurrence of ground water in Maine. It is a product of the cooperative program of water-resources investigations between the U.S. Geological Survey and the State of Maine Public Utilities Commission (see fig. 1).

These reports are intended to provide information for the use of those engaged in water- or land-resources planning or development, and particularly for those wishing to develop water supplies large enough for public, industrial, or commercial use. The magnitude of yields that might be obtained from properly located and constructed wells is indicated by the map showing surficial geology and ground-water favorability (fig. 2). This map gives a generalized interpretation of observed geologic and hydrologic data; it provides a basis for guiding detailed exploration for ground water but does not eliminate the need for such exploration.

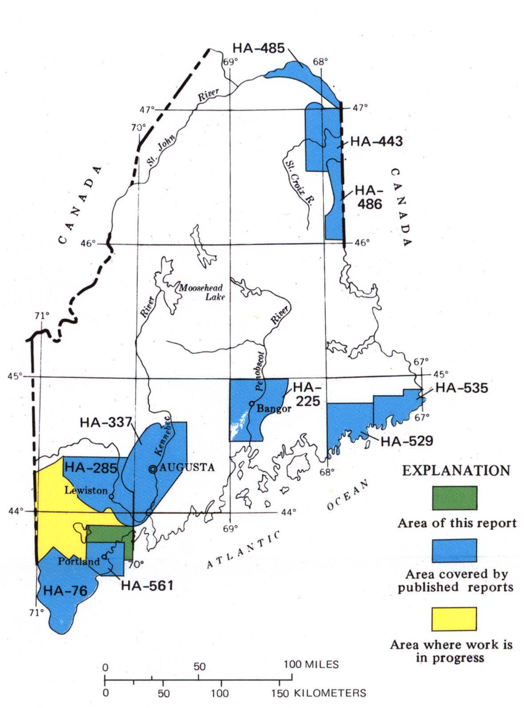

FIGURE 1.—INDEX MAP SHOWING AREAS OF GROUND-WATER INVESTIGATIONS

The character and water-bearing properties of the various aquifers are described and the relationships of the formations are shown in a geologic section along part of the Maine Turnpike (fig. 3).

This report covers an area of about 210 square miles (544 km²) in Cumberland County. Included are parts or all of the following cities or towns: Brunswick, Cumberland, Falmouth, Freeport, Gorham, Gray, Harpswell, North Yarmouth, Pownal, Standish, Westbrook, Windham, and Yarmouth.

The water needs for part of the area are provided by public supplies: the Portland Water District, which utilizes Sebago Lake and wells at Cumberland and North Windham; the Yarmouth Water District, which obtains its supply from wells; the Freeport Water Company, which uses wells, Burr Pond, and Frost Gully Brook; and the South Freeport Water District, which uses wells. However, most of the area is served by private supplies. This report can be used as a guide for locating and developing ground-water supplies for all uses.

The fieldwork on which this report is based was done largely during the 1974 field season. During the course of the fieldwork, the surficial geology was mapped, chemical analyses of 12 samples of ground water were made, and information on about 400 water wells and test holes was obtained.

RELATION OF CLIMATE TO AVAILABILITY OF WATER

All fresh ground water available for use in the Windham-Freeport area is derived from precipitation that falls locally or within the drainage basins of streams flowing into the area.

Correlations of precipitation, ground-water level, and streamflow are shown in figures 4 and 5. Water-level fluctuations are shown for well Y1 at Cornish, about 25 mi (40 km) west of the center of the project area, because it is the only observation well representative of water-table conditions in the southwestern Maine area for which a long-term record of water levels is available. Precipitation data are for the National Weather Service station at Hiram, which is a few miles from Cornish. Streamflow data are for the Royal River at Yarmouth, close to the center of the area covered by this report.

Precipitation at Hiram during the 1944–74 water years, the period for which ground-water levels are available, averaged 46.23 in. (1,174 mm). During the 1950–74 water years, the period for which streamflow information has been collected, precipitation averaged 47.00 in. (1,194 mm). Precipitation has ranged from a low of 29.24 in. (743 mm) for the 1965 water year to a high of 64.74 in. (1,644 mm) for the 1954 water year. Runoff of the Royal River at Yarmouth during the 1950–74 period has ranged from a low of 12.65 in. (321 mm) for the 1965 water year to a high of 40.56 in. (1,030 mm) for the 1952 water year and has averaged 25.72 in. (653 mm). As much as 40 percent of the runoff may be derived from ground water (Hayes, 1966, p. 22).

The difference between precipitation and runoff, which averages about 20 in. (508 mm) per year, is evaporated or transpired.

Years of above-average precipitation are normally years of above-average ground-water levels and streamflow. No long-term trend in precipitation, ground-water levels, or streamflow is indicated by the record.

Precipitation at Hiram during the 1950–74 water years was fairly evenly distributed on a monthly basis, although the greatest amount fell in November. The average for November was 5.12 in. (130 mm), and averages for the other months were generally from 3.5 to 4 in. (89 to 102 mm). The largest monthly amount received was 11.51 in. (292 mm) in March of 1953 and the lowest was 0.48 in. (12 mm) in May of 1965 (fig. 5). Ground-water levels generally are at seasonal lows near the end of the growing season during September as the result of high evapotranspiration rates during the summer. When the growing season ends, evapotranspiration rates decline, rainfall normally increases slightly, ground-water levels rise, and streamflow increases. Ground-water levels usually decline during January and February when much precipitation may be stored as snow and ice, and ground-water recharge may be inhibited by frozen ground. When temperatures rise in the spring, accumulated snow melts, and streamflow and ground-water levels rise. Ground-water levels and runoff normally reach peaks at the end of April. They decline from then until the end of the growing season, when they again begin to rise.

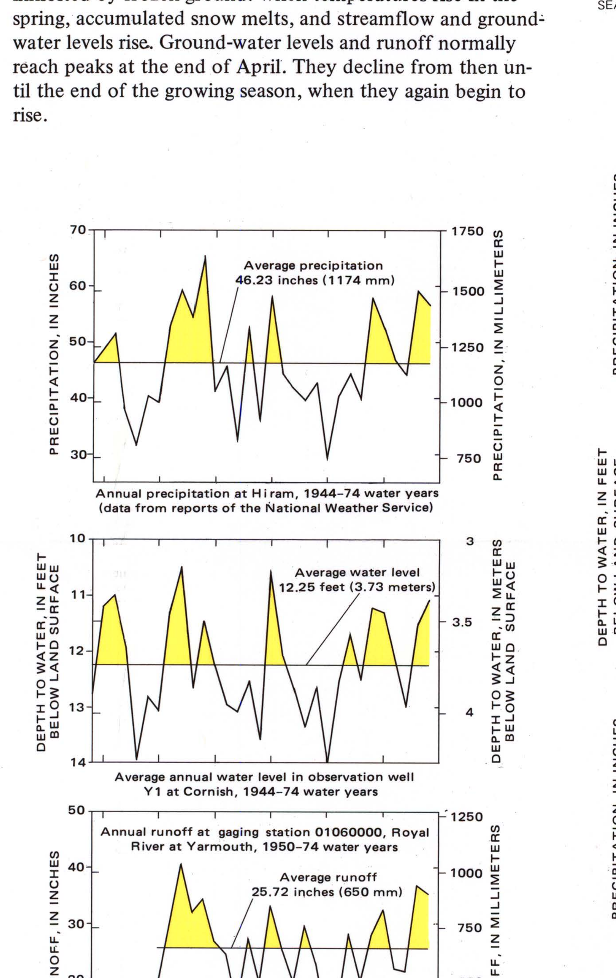

FIGURE 4.—GRAPHS SHOWING CORRELATION OF ANNUAL PRECIPITATION, GROUND-WATER LEVEL, AND RUNOFF

WATER IN UNCONSOLIDATED DEPOSITS

The outcrop areas of the unconsolidated deposits are shown on the geologic map (fig. 2) and their character, occurrence, and water-bearing properties are described in the table of geologic units. The areas most favorable for developing water supplies from these formations are indicated by patterns on the map (fig. 2). The largest yield reported for a well in unconsolidated deposits is 1,200 gal/min (gallons per minute) or 75.7 l/s (liters per second). More details on ground water in unconsolidated deposits are given in the explanations for the geologic units and favorability patterns.

WATER IN BEDROCK

The depths of 282 bedrock wells range from 24 to 1,205 ft (7 to 367 m). The average depth is 194 ft (59 m) and the median depth is 154 ft (47 m). About 99 percent of the wells are deeper than 50 ft (15 m); 20 percent are deeper than 250 ft (76 m); about 13 percent are between 251 ft and 400 ft (76 and 122 m); and about 7 percent are deeper than 400 ft (fig. 6). Almost none of the wells were drilled for commercial or industrial purposes, so the well depths generally reflect the depth necessary to drill for supplies adequate for single-family domestic use.

The yields of 271 bedrock wells range from 0 to 150 gal/min (0 to 9.5 l/s). The average yield is 12 gal/min (0.76 l/s), and the median yield is 5 gal/min (0.32 l/s). About 68 percent of the wells have yields exceeding 2.5 gal/min (0.16 l/s), and about 15 percent of the wells have yields exceeding 20 gal/min (1.3 l/s). The following table indicates the number of wells in each of several depth ranges with minimum, maximum, average, and median yields. Yields of 1 gal/min (0.06 l/s) or less are reported for all depth ranges except 0 to 50 ft (0 to 15 m). Of the total number of wells yielding 20 gal/min (1.3 l/s) or more, about a third are in the 51 to 100 ft (15 to 30 m) depth range (fig. 7).

Only 1 of the 18 wells deeper than 400 ft (122 m) has a yield of 20 gal/min (1.3 l/s), and none yields more than 20 gal/min (1.3 l/s). The deepest well, 1,205 ft (367 m) in depth, has a reported yield of only 1 gal/min (0.06 l/s).

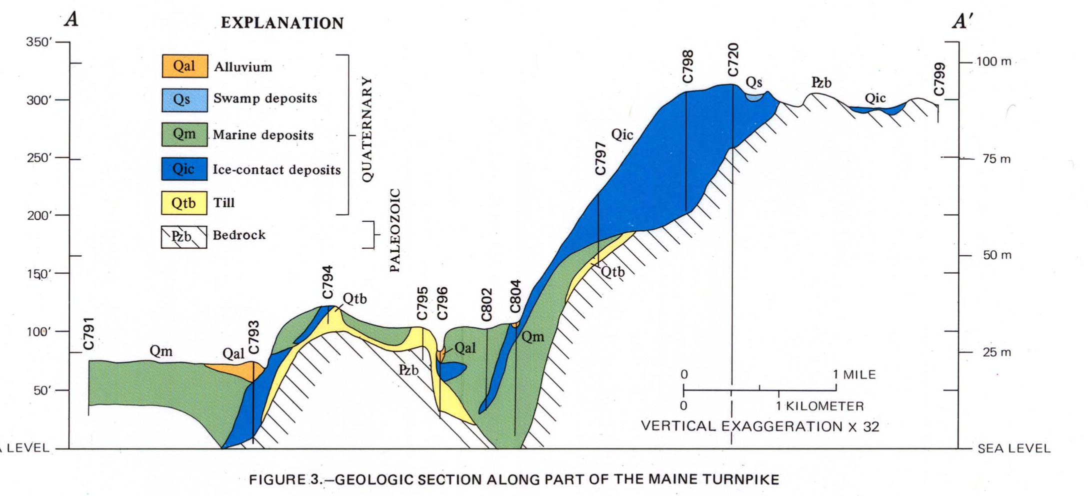

FIGURE 3.—GEOLOGIC SECTION ALONG PART OF THE MAINE TURNPIKE

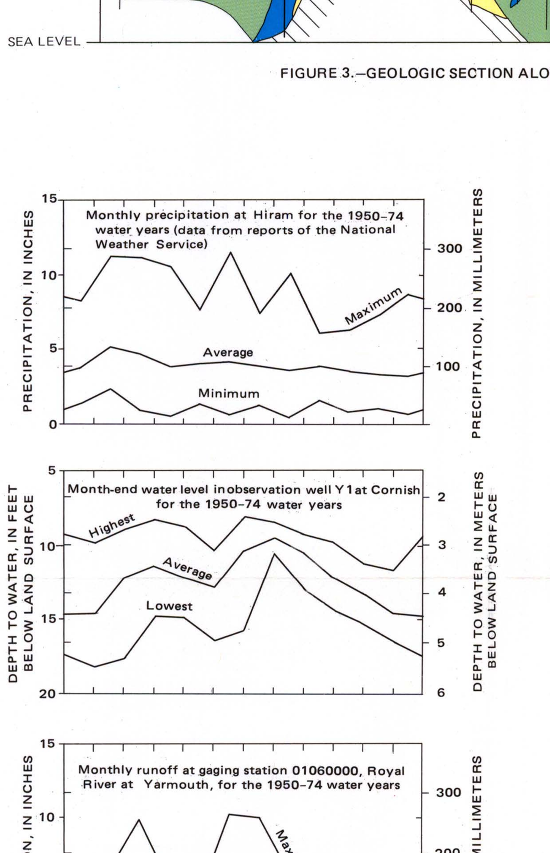

FIGURE 5.—GRAPHS SHOWING CORRELATION OF MONTHLY PRECIPITATION, MONTH-END GROUND-WATER LEVELS, AND MONTHLY RUNOFF

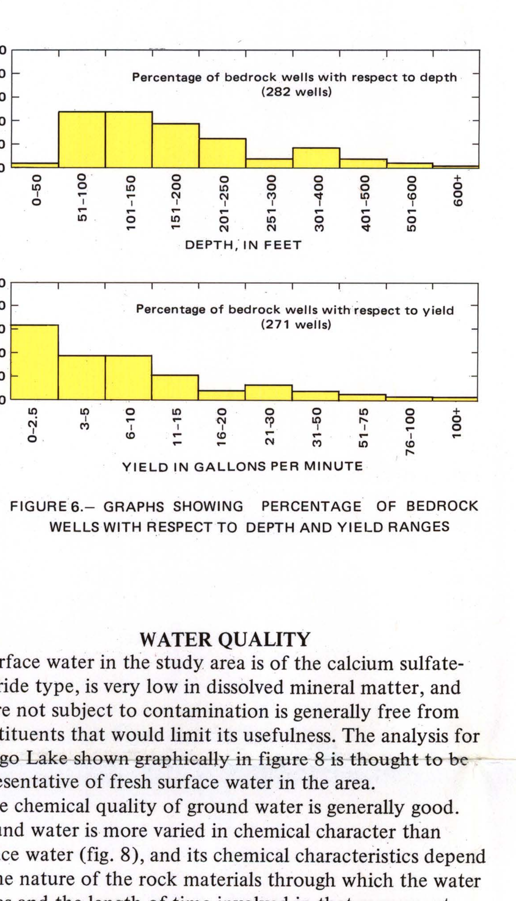

FIGURE 6.—GRAPHS SHOWING PERCENTAGE OF BEDROCK WELLS WITH RESPECT TO DEPTH AND YIELD RANGES

WATER QUALITY

Surface water in the study area is of the calcium sulfate-chloride type, is very low in dissolved mineral matter, and where not subject to contamination is generally free from constituents that would limit its usefulness. The analysis for Sebago Lake shown graphically in figure 8 is thought to be representative of fresh surface water in the area.

The chemical quality of ground water is generally good. Ground water is more varied in chemical character than surface water (fig. 8), and its chemical characteristics depend on the nature of the rock materials through which the water moves and the length of time involved in that movement. Water in the bedrock is normally more highly mineralized and harder than water in the unconsolidated deposits. Water from bedrock ranges from soft to very hard and generally has a pH of about 7. In 5 of 7 samples collected, the water was soft. Two of these samples were from unusually deep wells, well C 562, which is 1,205 ft (367 m) deep, and well C 822, which is 1,078 ft (329 m) deep. Water from these wells was atypical of water from bedrock wells in the area. In addition to being extremely soft (hardness of 6 and 17 mg/l), the water was of the sodium–bicarbonate type and had a pH of 8.5 to 9.1. Fluoride concentration in water from well C 562 was 4.9 mg/l and from C 822 was 3.8 mg/l, as compared to a concentration of only about 0.1 mg/l for water from most bedrock wells in the area. Water from well C 822 has a hydrogen sulfide odor and taste.

Water from unconsolidated deposits is of the calcium bicarbonate type and is characteristically soft and low in dissolved mineral matter. Two samples contained iron in excess of the U.S. Public Health Service (1962) recommended limit of 0.3 mg/l for drinking water. The pH of water from unconsolidated deposits is normally slightly less than 7.

Water from well C 344 in outwash is more highly mineralized than water from most of the bedrock wells sampled. This well is in the valley of a small brook downstream from Interstate Highway 95, is near a populated area, and is close to an area of marine deposits. The mineralization may be caused by salt used to deice the highway, urban runoff, effluent from septic systems in the populated area, or from saline water or minerals contained in the marine deposits.

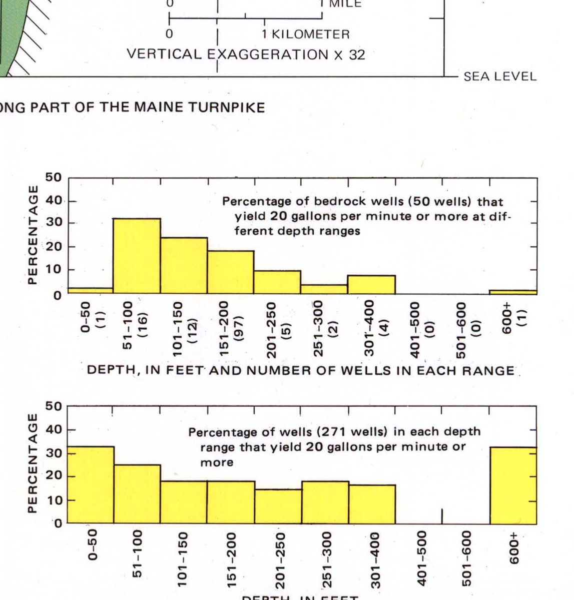

FIGURE 7.—GRAPHS SHOWING PERCENTAGE OF BEDROCK WELLS YIELDING 20 GAL/MIN (1.3 L/S) OR MORE AT DIFFERENT DEPTH RANGES

CONVERSION FACTORS

The following table may be used to convert English units to International System of units (SI)

Multiply English units	By	To obtain SI units
inches (in.)	0.0254	meters (m)
feet (ft)	.3048	meters (m)
miles (mi)	1.609	kilometers (km)
square miles (mi²)	2.590	square kilometers (km²)
gallons per minute (gal/min)	.06309	liters per second (l/s)

Yield of wells according to depth range

Depth (feet)	Number of wells	Yield (gallons per minute) Minimum	Minimum	Average	Median
0–50	3	5	25	13	8
51–100	63	0	75	15	10
101–150	67	.1	75	12	6
151–200	51	.1	115	13	4.5
201–250	34	.5	150	15	2
251–300	11	.5	100	16	4
301–400	24	.25	36	8.3	2.5
401–500	11	0	15	5.4	1
501–600	4	.5	1.5	1.4	.6
600+	3	1	20	10	1
All wells	271	0	150	12	5

EXPLANATION

FAVORABILITY AREAS

More than 50 gallons per minute

Areas favorable for the location of wells that will yield more than 50 gal/min (3.2 l/s). Water-bearing materials are ice-contact deposits and outwash. The largest yields are obtainable where the deposits are coarse grained, have a large saturated thickness, and are in hydraulic continuity with surface-water bodies as a source of induced recharge. As much as 1,200 gal/min (75.7 l/s) has been obtained from individual wells in the area.

10 to 50 gallons per minute

Areas favorable for location of wells that will yield 10 to 50 gal/min (0.63 to 3.2 l/s). Water-bearing formations are ice-contact deposits and outwash where the saturated thickness is small, the deposits are fine grained, or where induced recharge is not possible. In some of these areas surficial deposits consist of marine clay, and the presence of underlying beds of water-bearing sand and gravel is inferred or is known from test drilling.

NOTE

Areas where most wells will yield less than 10 gal/min (0.63 l/s) are shown without the colored overprint. Aquifers may include any of the formations described in the map explanation. About 30 percent of the wells drilled in bedrock obtain more than 10 gal/min (0.63 l/s), and about 15 percent have yields exceeding 20 gal/min (1.3 l/s).

Contact

Direction of glacial striations
Point of arrow indicates location of striation

C369
Well in unconsolidated deposits

C366
Well in bedrock

C797
Test hole

01060000
Gaging station

EXPLANATION

System	Series	Geologic unit	Thickness (feet)	Character and occurrence	Water-bearing properties
QUATERNARY	Holocene	Qdb Coastal dune and beach deposits	0–20[1]	Sand and gravel of coastal beaches and associated deposits of windblown sand adjacent to the beaches. Principal exposures are on islands in Casco Bay.	Beach deposits generally contain salt water. Sand dunes may contain a few feet of fresh water overlying salt water, which would be available to dug or driven wells. No wells known to obtain water from these deposits in this area.
		Qal Alluvium	0–20[1]	Sand, silt, clay, and some gravel, of flood plains of some of the larger streams in the area. Subject to flooding.	Contains some available ground water, especially along streams draining outwash areas, but not used as an aquifer in this area.
		Qs Swamp and tidal marsh deposits	0–25[1]	Peat, and organic muck and some interbedded silt, clay, and sand in low-lying or poorly drained areas.	Not known to yield water to wells in the area. May release water to streams flowing through or issuing from the deposits in times of low flow or may store surface water during times of high flow.
		Qed Eolian sand deposits (exclusive of coastal dune sand)	0–40[2]	Fine to coarse sand in active drifting dunes of Desert of Maine in Freeport and Pownal. Also includes some vegetated, fixed dunes in same general area.	Supplies water to a few dug wells and springs.
	Pleistocene	Qow Outwash	0–75[1]	Stratified deposits of sand and gravel of outwash plains and glaciomarine deltas. Also includes some materials that were reworked by currents and waves and redeposited. Overlies and is interfingered with deposits of marine clay. Some of this material was included in the marine Presumpscot Formation by Bloom, 1960, p. 55–58.	Yields small to moderate quantities of water to wells. Largest reported yield is 100 gal/min (6.3 l/s). Yield depends on saturated thickness, extent, and grain size of deposits. Some springs occur in gullies where the contact of sand and the underlying marine clay is exposed. Water is of good quality.
		Qm Marine and estuarine deposits	0–150[3]	Dark-blue to gray silt, clay, and fine sand; tan where weathered. Contains layers of sand and gravel. Underlies most areas of outwash, crops out in many low areas and stream valleys, and overlies earlier deposits of till, stratified drift, or bedrock. Deposits form the major part of the Presumpscot Formation of Bloom (1960, p. 55–58).	Not a significant aquifer. Generally saturated, but because of low permeability releases water very slowly. Yields small amounts of water to a few dug wells, probably from sandy zones. Water may contain excessive iron or may be cloudy because of clay particles.
		Qic Ice-contact deposits	0–114[4]	Well- to poorly stratified deposits of sand, gravel, and cobbles, with some silt and boulders. Land forms include kames or kame fields, and kame terraces.	The source of the largest supplies of ground water in the area. The highest reported yield is 1,200 gal/min (75.7 l/s). Largest yields are in areas where the deposits are coarse grained, have a large saturated thickness, and are in hydraulic continuity with a body of surface water as a source of induced recharge. Marine clay commonly covers parts of ice-contact deposits and confines the water under artesian pressure. The water is normally of good chemical quality.
PRE-QUATERNARY OR QUATERNARY	Pre-Pleistocene or Pleistocene	Qtb Till or bedrock	0–100[1]	Till and bedrock are mapped together, but on the geologic section (fig. 3) the units are shown separately, based on data from selected wells. Till is an unsorted, unstratified mixture of clay, silt, sand, gravel, cobbles, and boulders. Till generally has a clay-rich matrix and is very compact, but in places it consists of sand and gravel resembling ice-contact deposits except for lack of stratification. In a few areas, particularly at Windham Center, the till occurs in low parallel ridges known as washboard moraines (Bloom, 1960, p. 28–32). Till, as a mantle of variable thickness, covers the bedrock in the upland areas. It may also occur beneath younger deposits in the valleys. Bedrock formations (Paleozoic) consist of metamorphic rocks (primarily schist, gneiss, phyllite, and quartzite) and intrusive igneous rocks (chiefly granite, granodiorite, and quartz monzonite, with some diorite and gabbro).	Till is the source of water for numerous dug wells. Till transmits water slowly, and the yield from wells in till is small once water stored within the casing is pumped out. Wells dug in till are likely to go dry during periods of low precipitation. The water is generally of good quality. Bedrock formations are dense and relatively impermeable and contain little water compared to their total volume. They contain recoverable water in secondary openings such as joints, fractures, bedding or cleavage planes, and solution openings. The water in bedrock is generally confined and will rise above the level at which it is encountered by the drill. Several wells for which information is available flowed at the land surface when drilled. The water is generally of good chemical quality, although some wells have produced water containing excessive concentrations of iron and manganese, and some wells near the seashore have produced brackish or salty water. Based on present knowledge it is impossible to predict accurately the depth at which water-bearing zones will be found and how much water will be available to wells.

[1] Maximum known value
[2] Maximum value, from Caldwell, (1965, p. 97).
[3] Maximum value from well record.
[4] Maximum value from test boring.

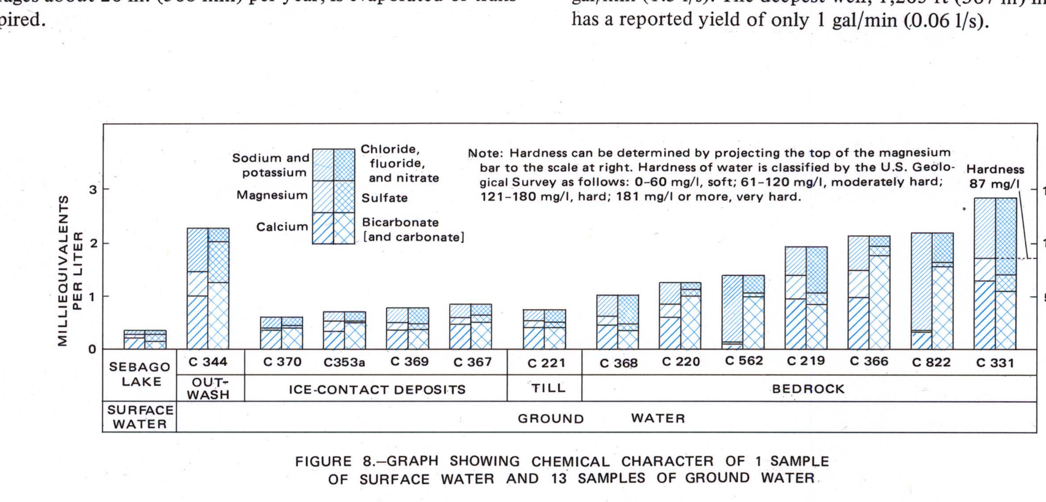

FIGURE 8.—GRAPH SHOWING CHEMICAL CHARACTER OF 1 SAMPLE OF SURFACE WATER AND 13 SAMPLES OF GROUND WATER

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GROUND-WATER FAVORABILITY AND SURFICIAL GEOLOGY OF THE WINDHAM-FREEPORT AREA, MAINE

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Glen C. Prescott Jr.

1977

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