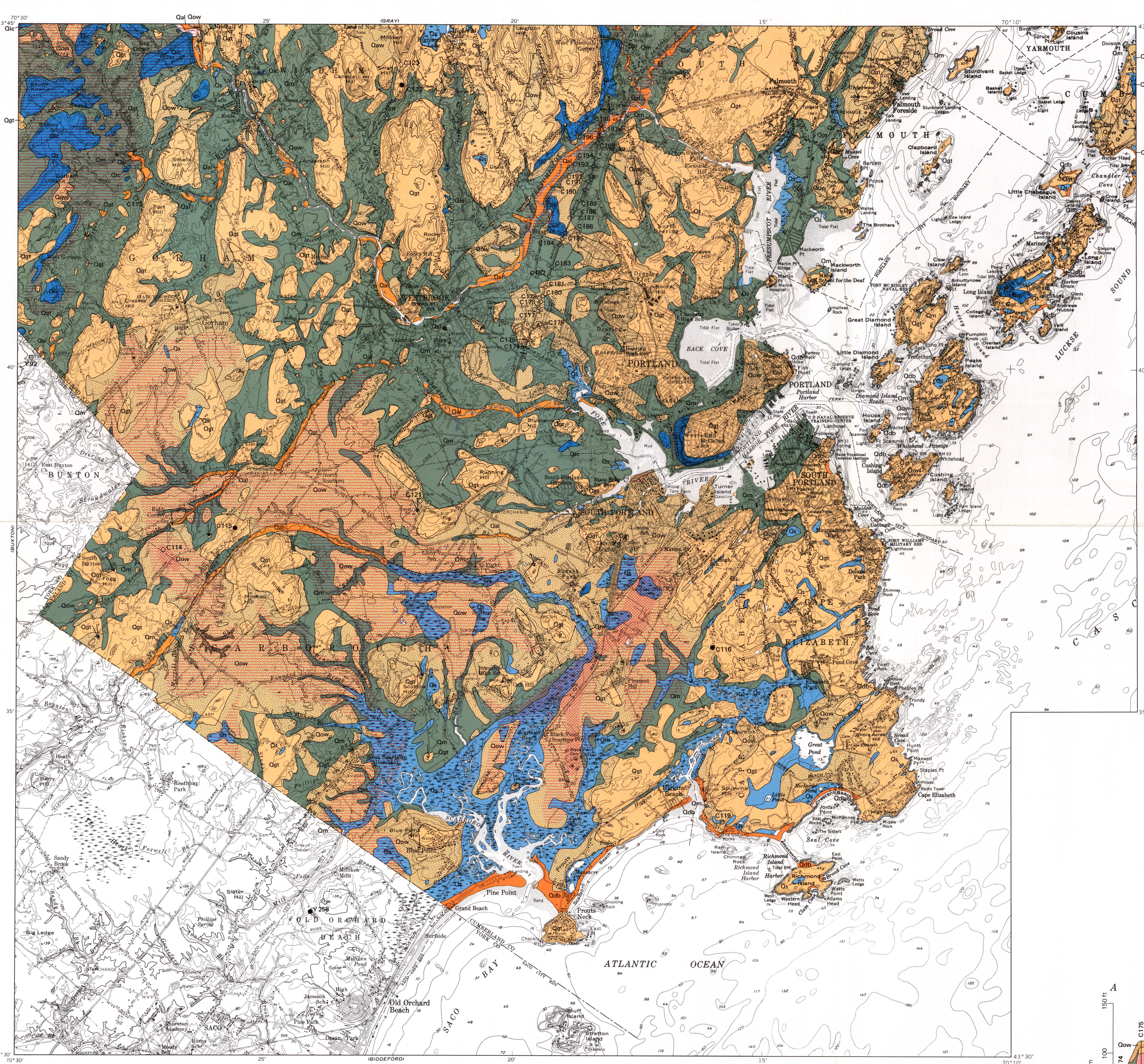


Base from U.S. Geological Survey
Portland and Casco Bay, 1957

APPROXIMATE MEAN DECLINATION, 1976

SCALE 1:62 500

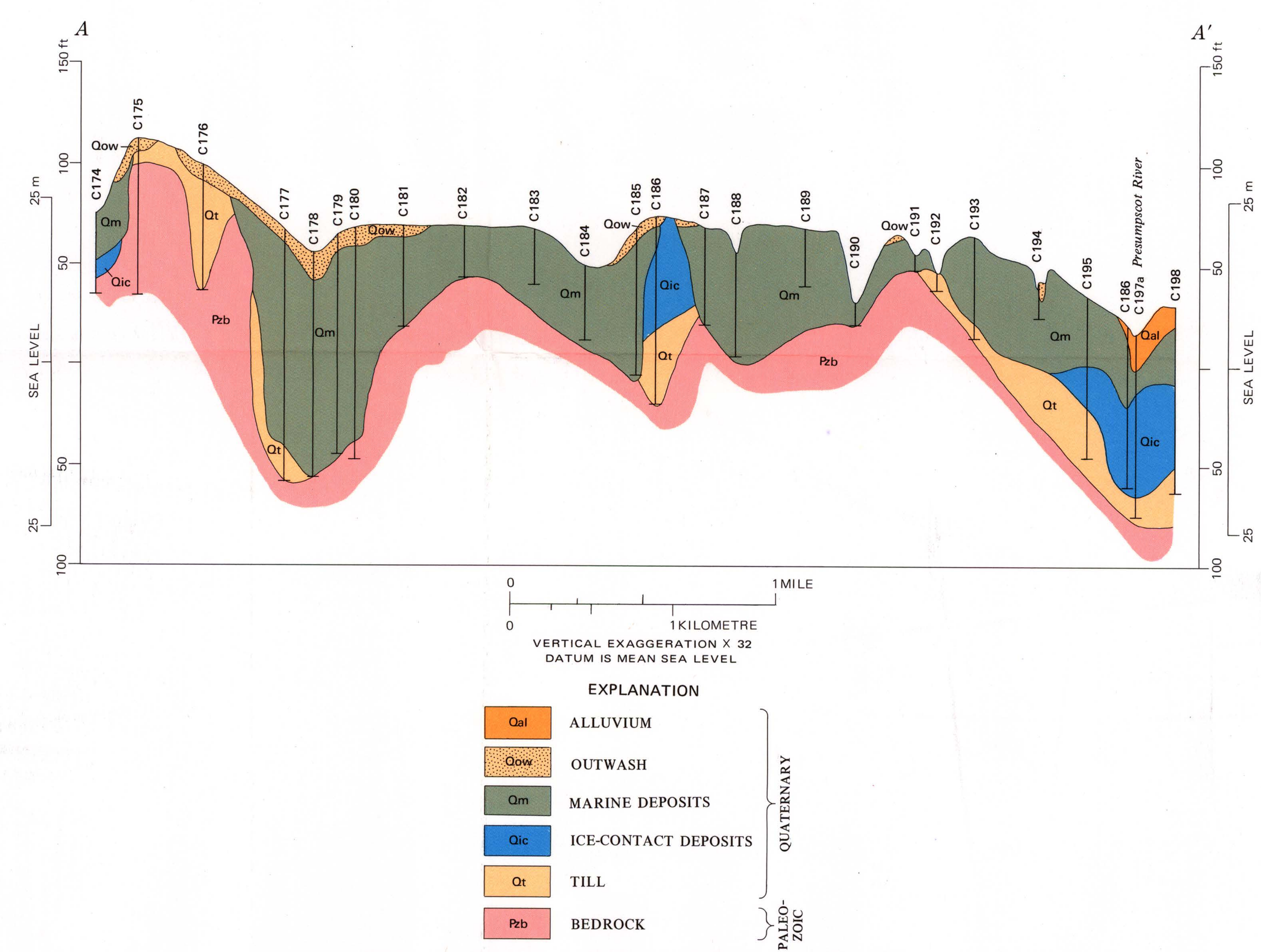
CONTOUR INTERVAL 20 FEET
DATUM IS MEAN SEA LEVEL
DEPTH CURVES AND SOUNDINGS IN FEET—DATUM IS MEAN LOW WATER
SHORELINE SHOWN REPRESENTS THE APPROXIMATE LINE OF MEAN HIGH WATER
THE MEAN RANGE OF TIDE IS APPROXIMATELY 8.9 FEET

Geology mapped in 1973, 75

E X P L A N A T I O N

System	Series	Geologic unit	Thickness (feet)	Character and occurrence	Water-bearing properties
QUATERNARY	Holocene	Qdb Coastal dune and beach deposits	0–25[1]	Sand and gravel of coastal beaches and associated deposits of windblown sand adjacent to the beaches. Most prominent in Scarborough.	Beach deposits 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. Very few wells obtain water from these deposits.
		Qal Alluvium	0–20[2]	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 tidalmarsh deposits	0–25[2]	Peat and organic muck and some interbedded silt, clay, and sand in low-lying and 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.
	Pleistocene	Qow Outwash	0–100[3]	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 outwash was deposited in a terrestrial environment and some in a marine environment. Some of this material was included in the marine Presumpscot Formation by A. L. Bloom, 1959, p. 55–58.	Yields small to moderate quantities of water to wells. Largest reported yield is 100 gal/min. Yield depends on saturated thickness, extent, and grain size of deposits. Throughout much of the area the deposits are too thin to be a source of water for more than domestic supplies. 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	0–200[2]	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 deposits of earlier stratified drift, till, or bedrock. Deposits form the major part of the Presumpscot Formation of Bloom (1959, p. 55–58).	Marine deposits are not a significant aquifer. Below a certain level, they are saturated but because of low permeability release water very slowly. Yield small amounts of water to a few dug wells, probably from sandy zones. Water may contain excessive iron (well C113), or may be cloudy because of clay particles.
		Qic Ice-contact deposits	0–100[3]	Well to poorly stratified deposits of sand, gravel, and cobbles, with some silt and boulders. Landforms include kames or kame fields, and kame terraces. Ice-contact deposits are not widespread in this area.	Many of the areas of outcrop are small and topographically high, and because of the high permeability of the deposits, contain only a few feet of water-saturated sand and gravel. Marine clay commonly covers the lower parts of ice-contact deposits and in the deeper valleys may completely mantle ice-contact deposits and, thus, may confine water under artesian pressure. Presumably moderate supplies of ground water would be available to wells drilled in such areas. The water is normally of good quality.
ORDOVICIAN TO QUATERNARY	Pre-Pleistocene and Pleistocene	Till Qgt Bedrock Till and bedrock	0–110[3] (Till)	Till and bedrock are mapped together, but on the geologic section 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. Till covers the bedrock in the upland areas with a mantle of varying thickness. It may also occur beneath younger deposits in the valleys. Bedrock formations consist largely of metamorphic rocks (primarily schist, gneiss, phyllite, and quartzite), with lesser areas of intrusive igneous rocks (chiefly granite, granodiorite, and quartz monzonite, with some diorite and gabbro).	Till is the source of water to numerous dug wells. Till transmits water slowly, and the yield of wells in till is small once water stored within the casing is pumped out. Dug wells 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 reached 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 encountered water containing excessive concentrations of iron, and some wells near the seashore have encountered 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 value estimated
2 Maximum value from test boring
3 Maximum value from well record



GEOLOGIC SECTION ALONG PART OF THE MAINE TURNPIKE

INTRODUCTION

The investigation upon which this report is based is part of a program of water-resources investigations in Maine made by the United States Geological Survey in cooperation with the State of Maine Public Utilities Commission. Most of the field work was done during the 1973 field season. During this period the surficial geology was mapped, chemical analyses of 10 samples of ground water were made, and information on about 350 water wells and test holes was obtained. These data provide the basis for the map.

This report is one of a series describing the geologic and hydrologic conditions governing the occurrence of ground water in Maine. (See index map figure 1). These reports are intended to provide information for the use of those doing resource planning and those wishing to develop ground-water supplies, particularly 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. This map gives a generalized interpretation of observed geologic and hydrologic data; it provides a basis for directing detailed exploration for ground water but does not eliminate the need for such exploration.

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

This report covers an area of about 240 square miles (622 km^2) in Cumberland County. Included are part or all of the following cities or towns: Portland (including Casco Bay Islands), South Portland, Westbrook, Cape Elizabeth, Cumberland (including part of Great Chebeague Island), Falmouth, Gorham, Scarborough, and Windham.

Water supply for much of the area is provided by the Portland Water District from its major source, Sebago Lake. However, there are numerous rural areas not served by the Water District. This report will be of special value in such areas or in other areas where for economic or other reasons private water supplies are desired.

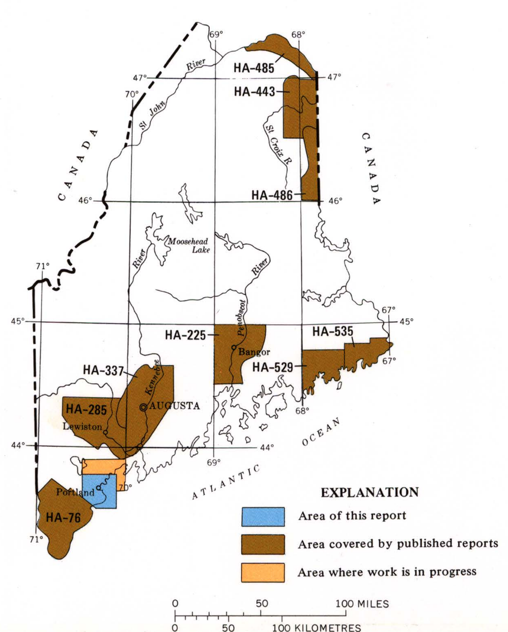


Figure 1. – *Index map showing areas of ground-water investigations*

RELATION OF CLIMATE TO AVAILABILITY OF WATER

All fresh ground water in the Portland area is derived from precipitation that has fallen locally or within the drainage basins of streams flowing into the area.

Correlations of precipitation, ground-water level, and streamflow are shown in the following graphs (figures 2 and 3). Water-level fluctuations in Well Y1 at Cornish, which is more than 25 miles (40 km) northwest of the center of the project area, are shown because this well is the only observation well in the southwestern Maine area for which a long-term record of water levels is available. Precipitation at the National Weather Service station at Hiram, which is a few miles from Cornish, is given. (During the period of record, weather measurements have been made in at least three separate sites in Hiram; the site in 1975 is at East Hiram.) Streamflow data are for the Royal River at Yarmouth, which is about 5 miles (8 km) northeast of the study area. Streamflow correlations with data for the Saco River at Cornish or the Ossipee River at Cornish stations were not made because the flow of these streams is regulated by changes in storage in upstream lakes.

Precipitation at Hiram during the 1944–74 water years averaged 46.23 inches (1174 mm) and during the 1950–74 water years averaged 47.00 inches (1194 mm). Precipitation ranged from a low of 29.24 inches (743 mm) for the 1965 water year to a high of 64.74 inches (1644 mm) for the 1954 water year. Runoff of the Royal River at Yarmouth during the 1950–74 period ranged from a low of 12.65 inches (321 mm) for the 1965 water year to a high of 40.56 inches (1030 mm) for the 1952 water year and averaged 25.72 inches (653 mm). Perhaps as much as 40 percent of the runoff was ground water derived from precipitation that percolated to the water table and gradually moved to streams (Hayes, 1966, p. 22).

The water equivalent to the difference between precipitation and runoff, which averages about 20 inches (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 trends in precipitation, ground-water levels, or streamflow are indicated by the record.

Precipitation at Hiram during the 1950–74 water years is fairly evenly distributed monthly. November, with 5.12 inches (130 mm) normally receives the largest amount, and averages for the other months are generally from 3.5 to 4 inches (89 to 102 mm). The largest amount received was 11.51 inches (292 mm) in March of 1953 and the lowest was 0.48 inches (12 mm) in May of 1965 (fig. 3). Ground-water levels generally reach seasonal low levels near the end of the growing season, during September, as the cumulative result of little or no ground-water recharge because of high evapotranspiration rates during the summer. When the growing season ends, evapotranspiration rates decline, rainfall normally increases slightly, ground-water levels rise, and stream-flow increases. Ground-water levels usually decline during January and February, when much precipitation may be stored as snow and ice, and the ground may be frozen-inhibiting ground-water recharge. When temperatures begin to rise in the spring, accumulated snow begins to melt, a greater proportion of precipitation occurs as rain, and streamflow and ground-water levels rise. Peak ground-water levels and runoff are normally reached at the end of April. They then decline until the end of the growing season, when they again begin to rise.

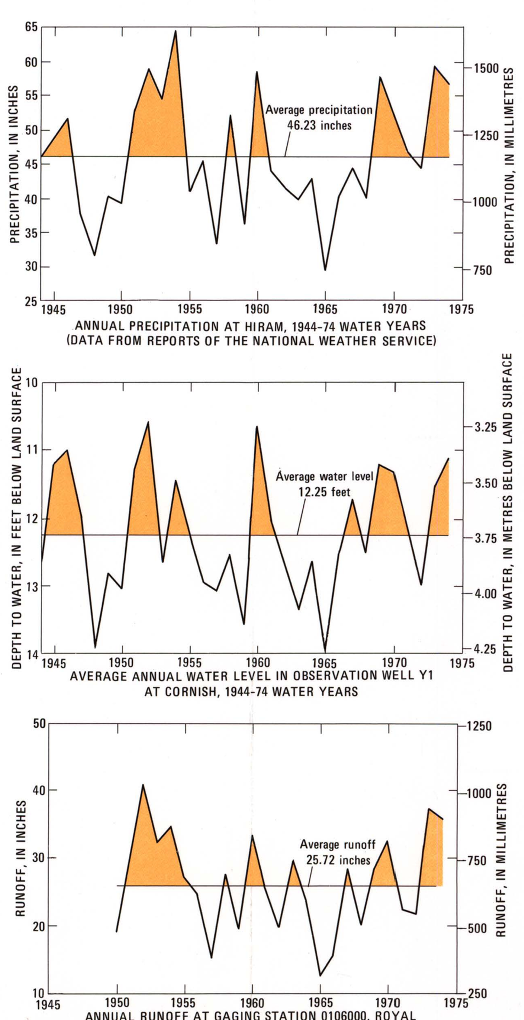


Figure 2. – *Graphs showing correlation of annual precipitation, ground-water level, and runoff*

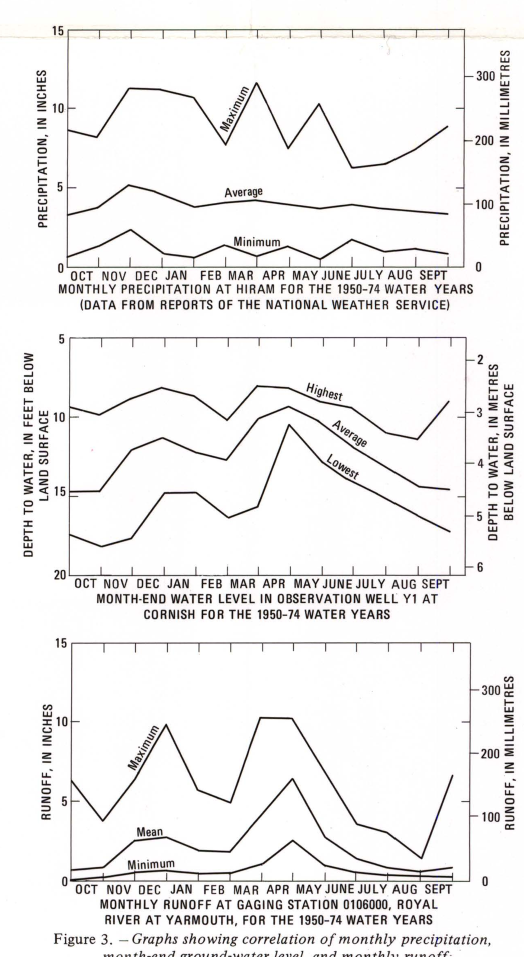


Figure 3. – *Graphs showing correlation of monthly precipitation, month-end ground-water level, and monthly runoff*

WATER IN UNCONSOLIDATED DEPOSITS

The outcrop areas of the unconsolidated deposits are shown on the geologic map, 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 overlay patterns on the map. The largest reported yield from a well in unconsolidated deposits is 100 gal/min (gallons per minute) or 6.3 l/s (litres per second). Properly located and constructed wells may in some areas obtain as much as 500 gal/min (31.5 l/s) from outwash or ice-contact deposits. More details on ground-water in unconsolidated deposits are given in the explanations for the geologic units and the favorability patterns.

WATER IN BEDROCK

The depth of 212 bedrock wells ranges from 40 to 1,205 feet (12 to 376 m). The average depth is 177 feet (54 m), and the median is 145 feet (44 m). Less than 2 percent of the wells are 50 feet (15 m) or less in depth; about 85 percent are 250 feet (76 m) or less; about 8 percent are between 251 and 400 feet (76 and 122 m); and about 6 percent are deeper than 400 feet (122 m). (See fig. 4.) Some of the wells were drilled to obtain supplies for industrial or commercial uses, but well depths generally reflect the depth necessary to drill for supplies adequate for domestic use.

The table below indicates the number of wells in several depth ranges with minimum, maximum, average, and median yields. Yields range from 0 to 150 gal/min (0 to 9.5 l/s). The average yield is 11 gal/min (0.69 l/s) and the median yield is 5 gal/min (0.32 l/s). Yields of 1 gal/min (0.06 l/s) or less are reported from all depth ranges except 0 to 50 and 51 to 100 feet (0 to 15.2 and 15.5 to 30.5 m). The deepest reported well, 1,205 feet (367 m), has a yield of only 1 gal/min (0.06 l/s). About 16 percent of the wells, or 1 well in 6, has a yield of 20 gal/min (1.3 l/s) or more (figure 4), and yields of this magnitude are obtained from wells in each depth range except the less-than-50-foot (15.2 m) and the greater-than-600-foot (183 m) ranges (figure 5). The largest percentage of wells yielding 20 gal/min (1.3 l/s) or more is in the 151-to-200-foot (46-to-61-m) range. The largest reported yield, 150 gal/min (9.5 l/s) is from a well 202 feet (62 m) deep.

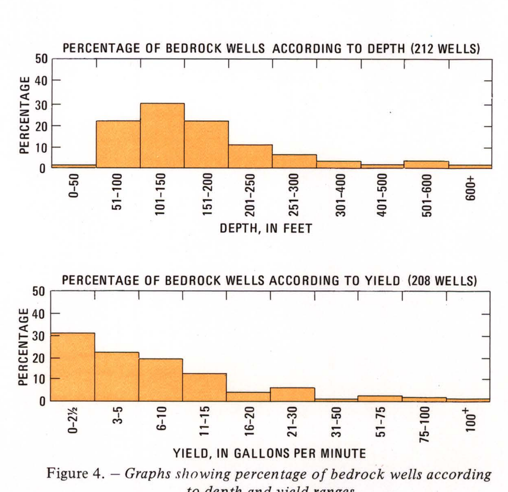


Figure 4. – *Graphs showing percentage of bedrock wells according to depth and yield ranges*

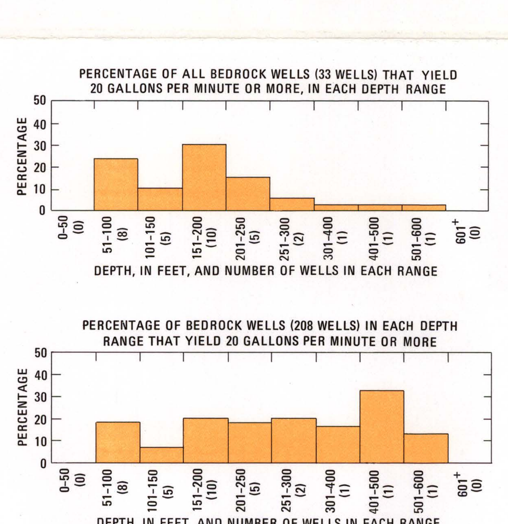


Figure 5. – *Graphs showing percentage of bedrock wells yielding 20 gal/min (1.3 l/s) or more, in relation to well depth*

YIELD OF WELLS ACCORDING TO DEPTH RANGE

Depth (feet)	Number of Wells	Yield (gallons per minute) Minimum	Maximum	Average	Median
0–50	2	10	12	11	11
51–100	43	2	100	14	10
101–150	61	0	30	7	5
151–200	47	1	120	14	6
201–250	27	0	150	14	3
251–300	10	.5	30	7	3
301–400	6	.8	40	8	2
401–500	3	1	20	8	4
501–600	7	.5	60	15	12
600+	2	1	3	2	2
TOTAL	208	-----	-----	-----	----

EXPLANATION

FAVORABILITY AREAS

More than 50 gallons per minute

Areas most favorable for developing water supplies of 50 gal/min (3.2 l/s) or more from individual wells. Water-bearing materials are stratified sand and gravel deposits of glaciofluvial or glaciomarine origin, particularly ice-contact deposits and outwash. In some areas the water-bearing beds are overlain by marine deposits. The greatest potential yields are where coarse-grained saturated deposits are thick and are in hydraulic contact with a body of surface water as a source of induced recharge. The maximum reported yield from a well in the area is 100 gal/min (6.3 l/s), but it is possible that as much as 500 gal/min (31.5 l/s) may be available in some areas from properly located and developed wells.

10 to 50 gallons per minute

Areas favorable for developing water supplies of 10 to 50 gal/min (0.6 to 3.2 l/s) from individual wells. Water-bearing materials are stratified sand and gravel deposits of glaciofluvial or glaciomarine origin and include outwash and ice-contact deposits where the saturated section is thin, deposits are relatively fine-grained, or where induced recharge is not possible

NOTE

Areas where most wells will yield less than 10 gal/min (0.6 l/s) are shown without the colored overprint for the areas mentioned above. Aquifers may include any of the formations described in the map explanation. About 35 percent of the wells drilled in bedrock yield 10 gal/min (0.6 l/s) or more and about 16 percent have a yield of 20 gal/min (1.3 l/s) or more. As explained elsewhere, it is not feasible to delineate the map areas where bedrock wells within certain yield ranges can be expected.

Contact

Direction of glacial striations
Point of arrow indicates location of striation

Well in unconsolidated deposits

Well in bedrock

Test hole

WATER QUALITY

Surface water is of the calcium sulfate-chloride type, is very low in dissolved mineral matter, and is apparently free from constituents that would limit its usefulness for most purposes. The analyses shown graphically in the illustration (fig. 6) are for the Saco River and Sebago Lake, both of which are outside the area of this report.

The chemical quality of ground water is also generally good. Ground water is more variable in chemical character than surface water (fig. 6), and its chemical characteristics depend on the nature of the rock materials through which the water moves. Water from ice-contact and outwash deposits is characteristically low in dissolved mineral matter and is of the calcium bicarbonate type. Water from well C114, in outwash, contained less dissolved material than water from Sebago Lake. Water in bedrock is normally more highly mineralized than water from the unconsolidated deposits. It is moderately hard and in places may contain undesirable concentrations of iron and manganese. Excessive iron content was reported in water from bedrock wells in several areas, particularly in Cape Elizabeth and on Chebeague Island. Some wells near the seashore have reportedly yielded brackish or salty water.

One sample (well C113) was collected from a dug well in marine clay. Though the water was relatively low in mineral content, it contained iron in excess of the U.S. Public Health Service (1962) recommended limit for drinking water. A high dissolved organic carbon concentration was probably derived from organic matter in the clay. Wells in marine deposits sometimes yield water that remains cloudy (turbid) owing to the presence of suspended clay particles.

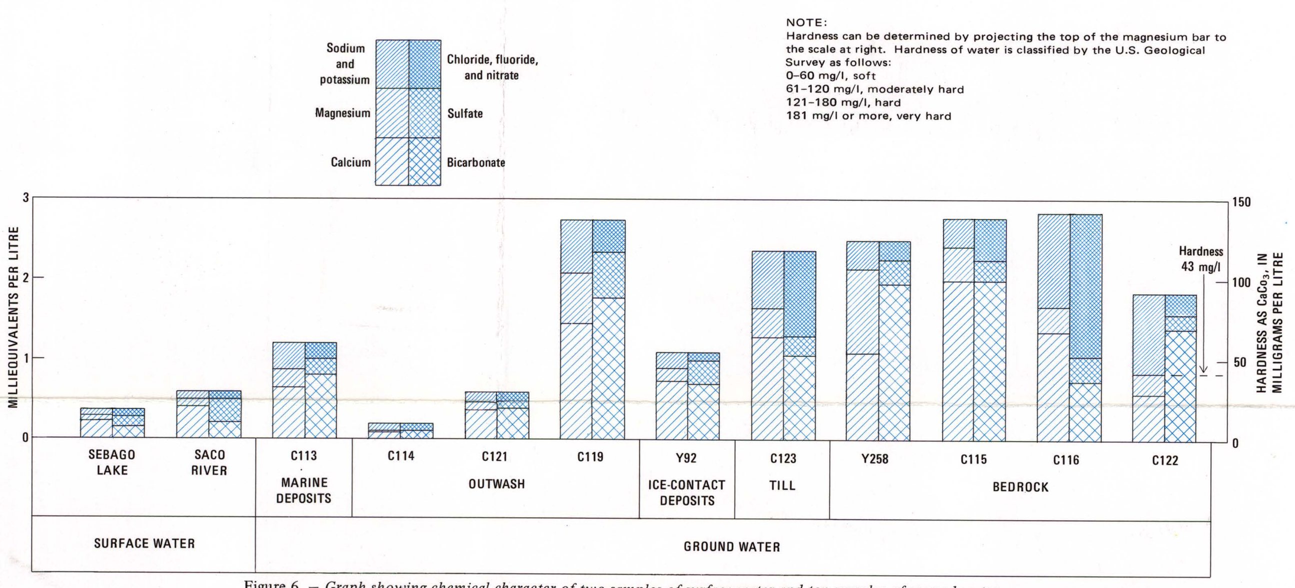


Figure 6. – *Graph showing chemical character of two samples of surface water and ten samples of ground water*

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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)	25.4	millimetres (mm)
feet (ft)	.3048	metres (m)
miles (mi)	1.609	kilometres (km)
square miles (mi^2)	2.590	square kilometres (km^2)
gallons per minute (gal/min)	.06309	litres per second (l/s)

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GROUND WATER FAVORABILITY AND SURFICIAL GEOLOGY OF THE PORTLAND AREA, MAINE

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Glenn C. Prescott, Jr.

1976

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