INTRODUCTION

This report provides information on the availability of ground water in an area of about 700 mi^2 (1,810 km^2) in western Massachusetts that is drained to the Connecticut River by streams of medium to small size. The areas drained to the Connecticut River by the Millers, Deerfield, Westfield, and Chicopee Rivers have been or will be described in separate reports. Information on streamflow and chemical quality of water in this area is presented in a separate, companion hydrologic atlas (HA-562).

This investigation was made by the U.S. Geological Survey in cooperation with the Massachusetts Water Resources Commission. It is one of a series of studies intended to cover all the river basins of the State.

Information on water wells essential to this report was provided by town officials, consulting engineering firms, and well-drilling firms. The Massachusetts Department of Public Health furnished information on public water supplies.

Most of the area is lowland of slight relief, but hilly terrain lies in the bordering uplands to the east and west where streams have their headwaters. The lowest altitude is about 40 ft (12 m) where the Connecticut River flows southward into Connecticut. Some hills in the bordering uplands reach altitudes of approximately 1,500 ft (460 m).

The lowland, consisting of flood plains and alluvial terraces, several miles wide near the Massachusetts-Connecticut boundary, becomes narrower to the north and is only a few times wider than the river at Northfield near the boundary with New Hampshire and Vermont. The lowland conforms fairly closely to a belt of rocks of Triassic age that are less resistant to erosion than the older rocks that form the bordering uplands. There are, however, many hills in the lowland area formed by resistant parts of the Triassic formations; Mount Toby owes its existence to a thick conglomerate and the Mount Holyoke Range to lava flows or trap rock.

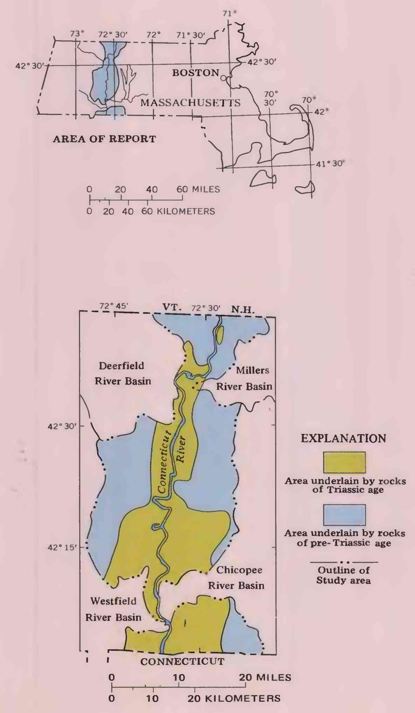


FIGURE 1. — LOCATION MAP.

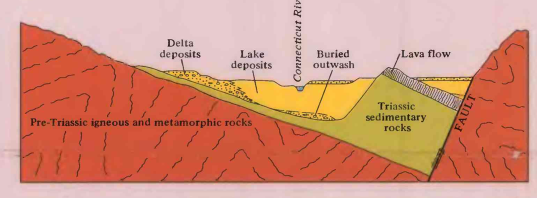


FIGURE 2. — GENERALIZED SECTION SHOWING GEOLOGIC CONDITIONS.

GEOLOGIC FRAMEWORK

The character and distribution of the geologic formations exerts major control over the occurrence of ground water, and, for this reason, a brief overview of the geology is offered.

The oldest formations of the area, mostly cropping out in the upland areas, are consolidated metamorphic rocks of pre-Triassic age, mainly gneiss and schist, with minor amounts of granite, slate, and marble.

In Triassic time, thousands of feet of reddish sandstone, conglomerate, and shale and some lava flows accumulated in a north-trending trough bounded on the east by a major fault. Owing to continued sinking of the valley block along the fault, the Triassic formations generally incline toward the east.

The present lowland is the result of erosion which occurred long before the glacial period and cut more deeply into the Triassic formations than the harder metamorphic and igneous rocks which were left standing at higher levels to form the bordering uplands.

During the glacial period, ice advanced southward over this region several times and rounded off hills and scoured the valleys deeper in some places. The ice spread a sheet of till over bedrock. Till, sometimes called hardpan, is an unsorted and unconsolidated mixture of rock fragments that range in size from large boulders down to particles of clay. The till is as thick as 200 ft (60 m) at a few places in the lowland but much thinner in most places, and on uplands it is generally no more than a few feet (a meter) thick.

As the last glacier gradually melted away to the north, streams of meltwater spread sand and gravel here and there along the margins of the ice and in channels between the ice and hills then laid bare. Lake-bed deposits of silt, clay, and fine sand occur beneath most of the lowlands and reach a thickness of 200 ft (60 m) in places. These deposits accumulated in glacial Lake Hitchcock, formed behind a dam of glacial deposits across the Connecticut River in Connecticut. The lake spread northward as the ice melted and the fine-grained lake deposits overlap and bury sand and gravel deposited previously.

As the glacial ice melted out of the drainage basin of the Connecticut River, the natural dam in Connecticut was breached and Lake Hitchcock drained. The river meandered and cut into the lake deposits, producing the present wide terraces and flood plain. A layer of recent river sand, with some small gravel, as much as 30 ft (9 m) thick, lies on parts of the lower terraces and the flood plain.

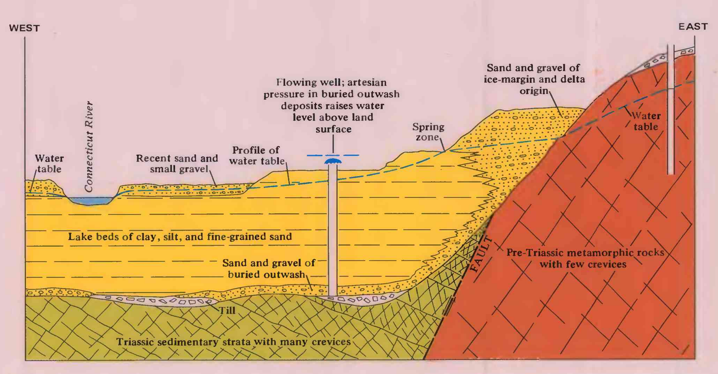


FIGURE 3. — GENERALIZED SECTION SHOWING AQUIFERS AND OCCURRENCE OF GROUND WATER.

AQUIFERS

Consolidated rocks

Pre-Triassic rocks

The metamorphic rocks are the only aquifer through most of the upland areas. These rocks have no primary porosity but yield water from fractures, and wells normally yield up to 10 gal/min (0.6 l/s). Well yields are generally greater at sites where recharge is available from nearby streams or overlying water-saturated stratified deposits. Water from this aquifer normally has low concentrations of dissolved solids and is of good chemical quality for domestic use.

Triassic rocks

Triassic rocks yield water from fractures that are more numerous than in the pre-Triassic aquifer, and wells may yield 10–100 gal/min (0.6–6 l/s). Where Triassic rocks lie under cover of water-saturated stratified deposits that provide recharge, well yields of more than 50 gal/min (3 l/s) are common, and a maximum yield of 700 gal/min (42 l/s) has been reported.

Water from the Triassic rocks is normally more mineralized than water from other aquifers in the study area and, in places, is unsatisfactory for domestic use because of hardness and high concentration of sulfate.

Unconsolidated deposits of Pleistocene age

Sand and gravel that occurs at many places beneath fine-grained lake deposits and is here termed "buried outwash" is the principal aquifer of the study area and sustains most of the municipal supply wells. Exceptionally, the buried outwash is 50 ft (15 m) thick, or even more, but it is generally much thinner. Wells in the Longmeadow well field yield 1,000 gal/min (63 l/s) where this aquifer is only 11 ft (3.4 m) thick, Some wells and borings, however, pass from fine-grained lake beds directly into till or bedrock, and the extent of the buried outwash aquifer cannot be accurately mapped from the subsurface data now available.

Delta deposits of sand and gravel, found mainly along the margins of the lowland, provide enough water for municipal supplies where the water-saturated zone is not less than about 20 ft (6 m) thick and near a stream that will provide recharge.

The layer of sand and small gravel present at the surface of parts of the flood plain and lower terraces yields 5–50 gal/min (0.3–3 l/s) to shallow wells or well points. Fields of wells in this aquifer can supply enough water for municipal supply, as in South Deerfield, or for irrigation.

The coarser grained recent alluvium along valleys in the uplands is thick enough in places to provide yields up to 50 gal/min (3 l/s) to wells located near streams.

The unstratified till was formerly used as a source of water to many large-diameter wells dug for domestic supplies. The till generally has low permeability and, in most places, will not yield enough water for a modern home. Wells drilled into bedrock aquifers have supplanted most of the old wells dug in till.

Water from the unconsolidated materials is generally of good chemical quality, though in the vicinity of extensive swampy areas objectionable amounts of iron may be present.

Water unconfined in bedrock or in unconsolidated deposits occurs under water-table conditions; that is, the water level in wells represents the top of the zone where all openings are saturated with water. Water occurring beneath the fine-grained lake deposits, in bedrock, or in sand and gravel is confined and, at many places, is under sufficient artesian pressure to flow from wells at land surface.

TABLE 1. — CONVERSION FACTORS OF ENGLISH AND METRIC UNITS, WITH ABBREVIATIONS.

To convert from	To	Multiply by
Inches(in.)	Millimeters(mm)	25.4
Feet(ft)	Meters(m)	0.3048
Miles(mi)	Kilometers(km)	1.609
Square miles(mi^2)	Square kilometers(km^2)	2.59
Gallons(gal)	Liters(l)	3.785
Gallons per minute(gal/min)	Liters per second(l/s)	0.0631
Million gallons per day(Mgal/d)	Cubic meters per second (m^3/s)	0.04381
Million gallons per day(Mgal/d)	Cubic meters per day (m^3/d)	3785.0
Gallons per acre(gal/acre)	Cubic meters per hectare (m^3/ha)	0.09354
Gallons per minute per foot of drawdown[(gal/min)/ft]	Liters per second per meter [(l/s)/m]	0.207

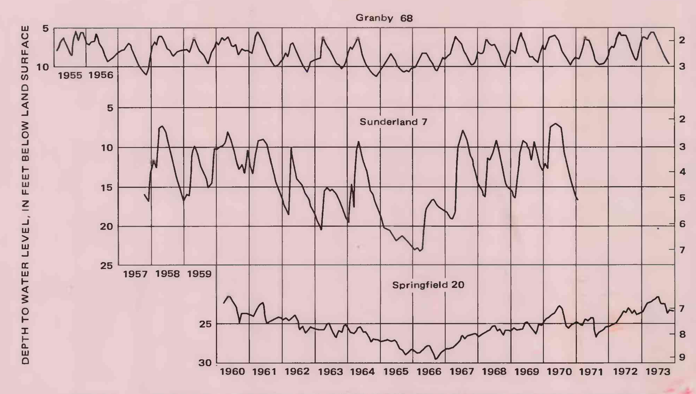


FIGURE 4. — HYDROGRAPHS SHOWING REPRESENTATIVE WATER-LEVEL FLUCTUATIONS.

SOURCES OF WATER

Precipitation is the main source of recharge to the aquifers. The water table rises each year during the cool months from late autumn until late spring, when recharge exceeds discharge. Precipitation is available for recharge in this part of the year, when evaporation and use of water by plants are at a minimum. The water table declines during the warm months, when evaporation and plants consume most of the precipitation and recharge is much less than discharge.

Aquifers serve as regulating reservoirs because the water that accumulates in the cool months is discharged gradually to streams in the warm season of the year. Seepage of water from aquifers provides most of the water of streamflow during summer and early autumn. Water levels in the well Sunderland 7 fluctuate about 7.5 ft (2.3 m) per year. The aquifer in the vicinity of this well stores about 18 in. (460 mm) more water in spring than in autumn, assuming 20 percent storage space in the sand and gravel. The annual change in amount of water stored in the aquifer near this well is about 470,000 gallons per acre (4,400 cubic meters per hectare).

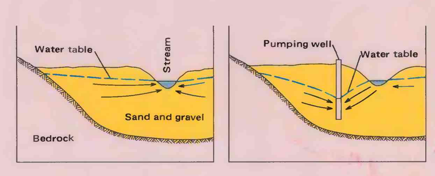
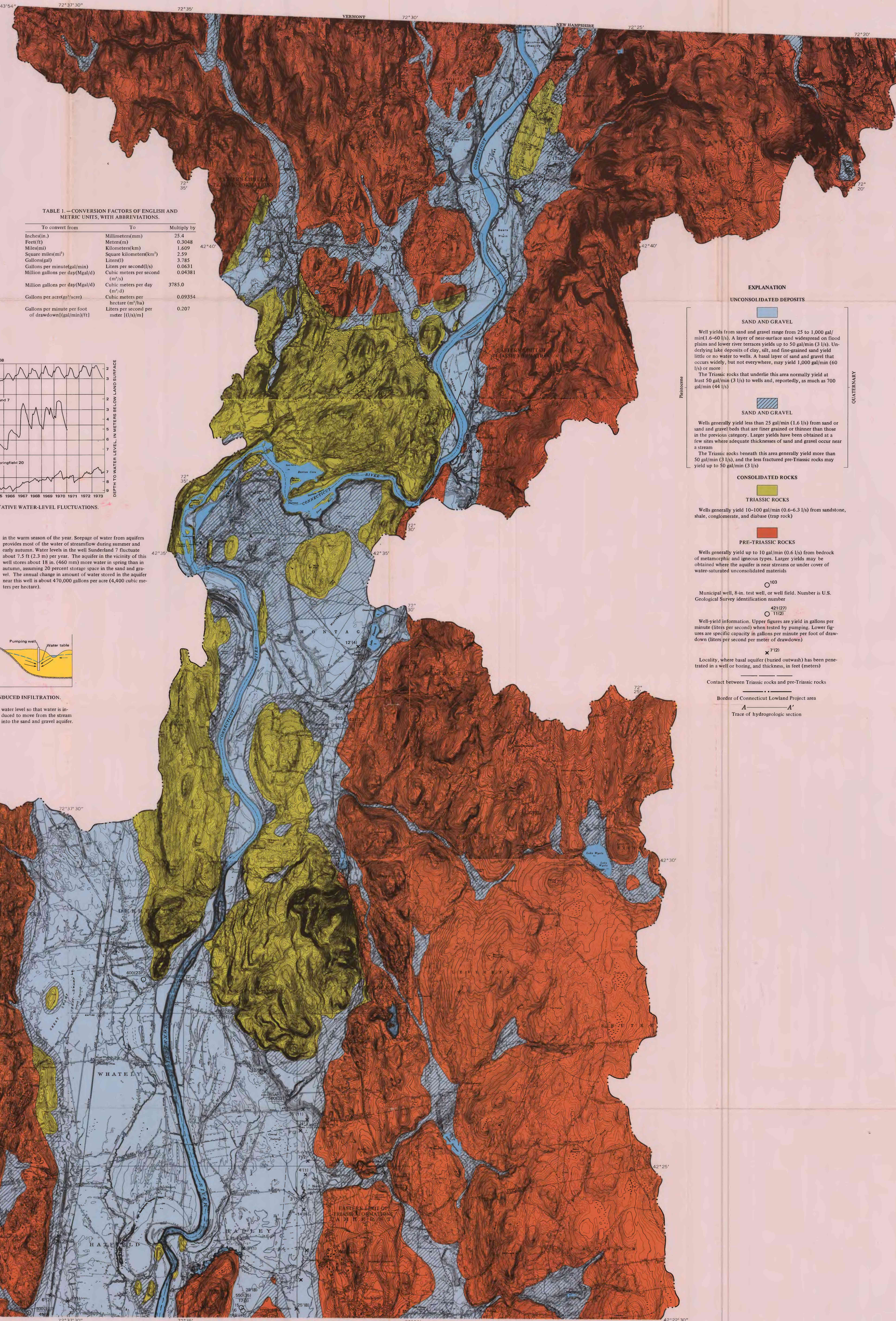


FIGURE 5. — RECHARGE BY INDUCED INFILTRATION.

Under natural conditions, ground water moves through the sand and gravel to the stream. Pumping a well lowers ground-water level so that water is induced to move from the stream into the sand and gravel aquifer.

Base from U.S. Geological Survey 1:24,000 quadrangles

FIGURE 6. — MAP SHOWING AVAILABILITY OF GROUND WATER IN THE NORTHERN HALF OF THE CONNECTICUT RIVER LOWLANDS.

EXPLANATION

UNCONSOLIDATED DEPOSITS

Pleistocene — QUATERNARY

SAND AND GRAVEL

Well yields from sand and gravel range from 25 to 1,000 gal/min(1.6–60 l/s). A layer of near-surface sand widespread on flood plains and lower river terraces yields up to 50 gal/min (3 l/s). Underlying lake deposits of clay, silt, and fine-grained sand yield little or no water to wells. A basal layer of sand and gravel that occurs widely, but not everywhere, may yield 1,000 gal/min (60 l/s) or more

The Triassic rocks that underlie this area normally yield at least 50 gal/min (3 l/s) to wells and, reportedly, as much as 700 gal/min (44 l/s)

SAND AND GRAVEL

Wells generally yield less than 25 gal/min (1.6 l/s) from sand or sand and gravel beds that are finer grained or thinner than those in the previous category. Larger yields have been obtained at a few sites where adequate thicknesses of sand and gravel occur near a stream

The Triassic rocks beneath this area generally yield more than 50 gal/min (3 l/s), and the less fractured pre-Triassic rocks may yield up to 50 gal/min (3 l/s)

CONSOLIDATED ROCKS

TRIASSIC ROCKS

Wells generally yield 10–100 gal/min (0.6–6.3 l/s) from sandstone, shale, conglomerate, and diabase (trap rock)

PRE-TRIASSIC ROCKS

Wells generally yield up to 10 gal/min (0.6 l/s) from bedrock of metamorphic and igneous types. Larger yields may be obtained where the aquifer is near streams or under cover of water-saturated unconsolidated materials

○103

Municipal well, 8-in. test well, or well field. Number is U.S. Geological Survey identification number

○ 421(27) / 11(2)

Well-yield information. Upper figures are yield in gallons per minute (liters per second) when tested by pumping. Lower figures are specific capacity in gallons per minute per foot of drawdown (liters per second per meter of drawdown)

× 7'(2)

Locality, where basal aquifer (buried outwash) has been penetrated in a well or boring, and thickness, in feet (meters)

Contact between Triassic rocks and pre-Triassic rocks

Border of Connecticut Lowland Project area

A——A'

Trace of hydrogeologic section

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NOTE: Under the cooperative program between the Massachusetts Department of Public Works and the U.S. Geological Survey, maps showing geology of surficial unconsolidated deposits and bedrock have been published in the Geologic Quadrangle Map series for a majority of the 7 1/2-minute quadrangles in this region of Massachusetts. Information on the quadrangles mapped and method of ordering these maps may be obtained by writing to the U.S. Geological Survey, Reston, Va. 22092.

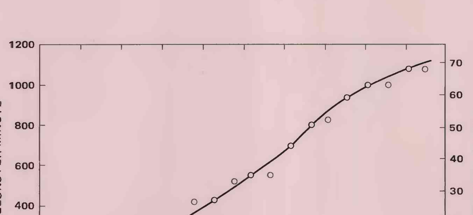

FIGURE 7. — DISTRIBUTION OF YIELDS OF MUNICIPAL WELLS TAPPING SAND AND GRAVEL.

YIELDS OF MUNICIPAL WELLS

Sustained yields of wells in the buried outwash, the principal aquifer of the study area, range from 120 to 1,200 gal/min (7.6 to 76 l/s). Half the yields are greater than 520 gal/min(33 l/s).

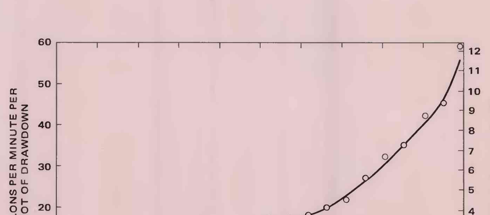

FIGURE 8. — DISTRIBUTION OF SPECIFIC CAPACITIES FOR MUNICIPAL WELLS TAPPING SAND AND GRAVEL.

SPECIFIC CAPACITIES OF MUNICIPAL WELLS

Wells pumping water from the buried outwash have specific capacities that range from 2 to 59 gallons per minute per foot of drawdown (0.4 - 12 liters per second per meter of drawdown). Half the wells have specific capacities of more than 16 (gal/min)/ft[(3 l/s)/m].

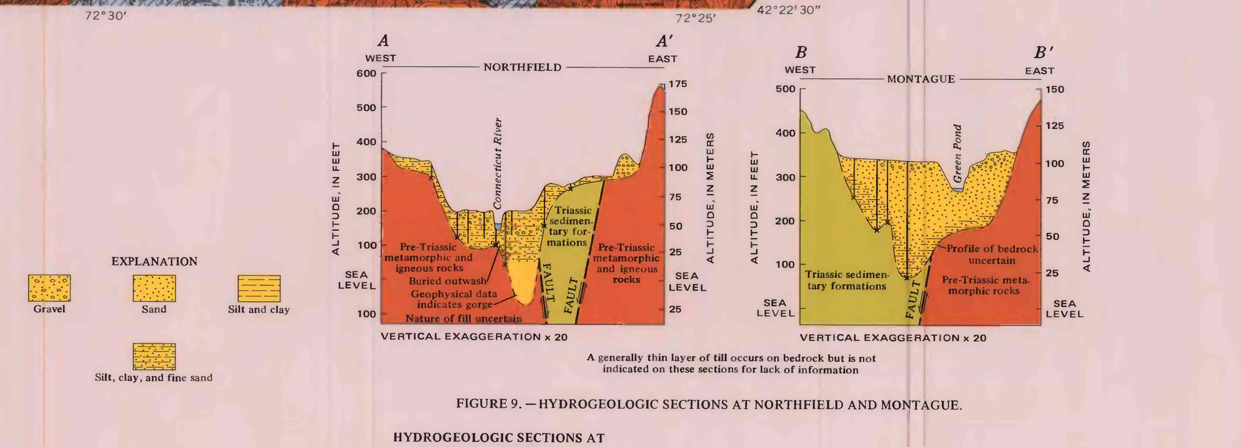

FIGURE 9. — HYDROGEOLOGIC SECTIONS AT NORTHFIELD AND MONTAGUE.

HYDROGEOLOGIC SECTIONS AT NORTHFIELD AND MONTAGUE

In the northern part of the area, at Northfield (section A–A') and at Montague (section B–B'), the lowland is underlain by unconsolidated deposits which partly fill a narrow trench in the Triassic and pre-Triassic bedrock.

The principal aquifer is the buried outwash, which has been penetrated by wells at some places but not at others. Water can also be obtained from shallow sand and gravel where a sufficient thickness of these materials lies within the zone of saturation.

Water can be obtained from the bedrock of Triassic and pre-Triassic age, beneath the unconsolidated deposits. Experience indicates that the Triassic rocks will generally yield 50 gal/min (3 l/s) or more, the pre-Triassic rocks considerably less.

SCALE 1:48 000

1 ½ 0 1 2 3 MILES

1 .5 0 1 2 3 4 5 KILOMETERS

CONTOUR INTERVAL 10 FEET
DATUM IS MEAN SEA LEVEL

Interior—Geological Survey, Reston, Va.—1977—W76267

MAP SHOWING AVAILABILITY OF GROUND WATER IN THE CONNECTICUT RIVER LOWLANDS, MASSACHUSETTS NORTH HALF

By
Eugene H. Walker and William W. Caswell

1977

For sale by Branch of Distribution, U.S. Geological Survey, 1200 South Eads Street, Arlington, VA 22202