PREPARED IN COOPERATION WITH THE
NEW YORK STATE DEPARTMENT OF CONSERVATION
DIVISION OF WATER RESOURCES

OCCURRENCE AND AVAILABILITY OF GROUND WATER

Present (1966) ground-water use in the Genesee River basin averages about 12 mgd (million gallons per day). Full economic development could cause at least several times this rate.

The three major categories of unconsolidated deposits in the basin are sand and gravel, clay and silt, and till. The combined thickness of these deposits (depth to bedrock) is greatest in lowland areas and least in the uplands.

Stratified sand and gravel deposits usually occur in the valleys of the Genesee River and many of its larger tributaries. Some of the sand and gravel aquifers are close to the land surface under water-table conditions; others are confined beneath fine-grained deposits of clay and silt and contain water under artesian conditions. Wells drilled in these aquifers may yield as much as 500 gpm (gallons per minute).

The fine-grained stratified deposits of clay, silt, and very fine sand that occur in the valleys are usually confining beds rather than aquifers, and the yield of a single well tapping these deposits is not likely to be adequate for more than domestic supply.

Till is an unsorted mixture of fine- and coarse-grained materials that mantles most upland areas. A well in till will seldom yield enough water for more than one house. Till is usually a few feet to several tens of feet in thickness.

In the larger valleys, the unconsolidated deposits may be as much as several hundred feet thick. Most of these deposits are the fine-grained materials, and are often interbedded in the sand and gravel.

Estimates of maximum continuous yields from water-table aquifers in the valleys were based on the following assumptions:

a. No water is, or will be, diverted out of the valley upstream from the reach for which the estimate is made.
b. Specific yield of the deposits averages about 0.2 or 20 percent.
c. Maximum allowable drawdown equals one-half the saturated thickness of the aquifer.
d. Diameter of each pumping well is 1 foot.
e. Spacing of wells is 1,000 feet apart along center of valley.
f. No recharge for 200 days (June to mid-December for example), and complete refilling of aquifer during remaining 165 days of the year.
g. Permeability of streambeds in the valleys is 40 gpd per sq ft (gallons per day per square foot).

Aquifer yields from stream infiltration are controlled by the rate of streamflow (flow at 90-percent duration was arbitrarily selected as the low limit for infiltration) and by the permeability of the streambed.

As these assumptions indicate, the aquifer yield is obtained entirely from ground-water storage and stream infiltration during the summer and autumn, when little or no recharge from precipitation takes place. Recharge from precipitation occurs chiefly during winter and spring thaws and spring rains.

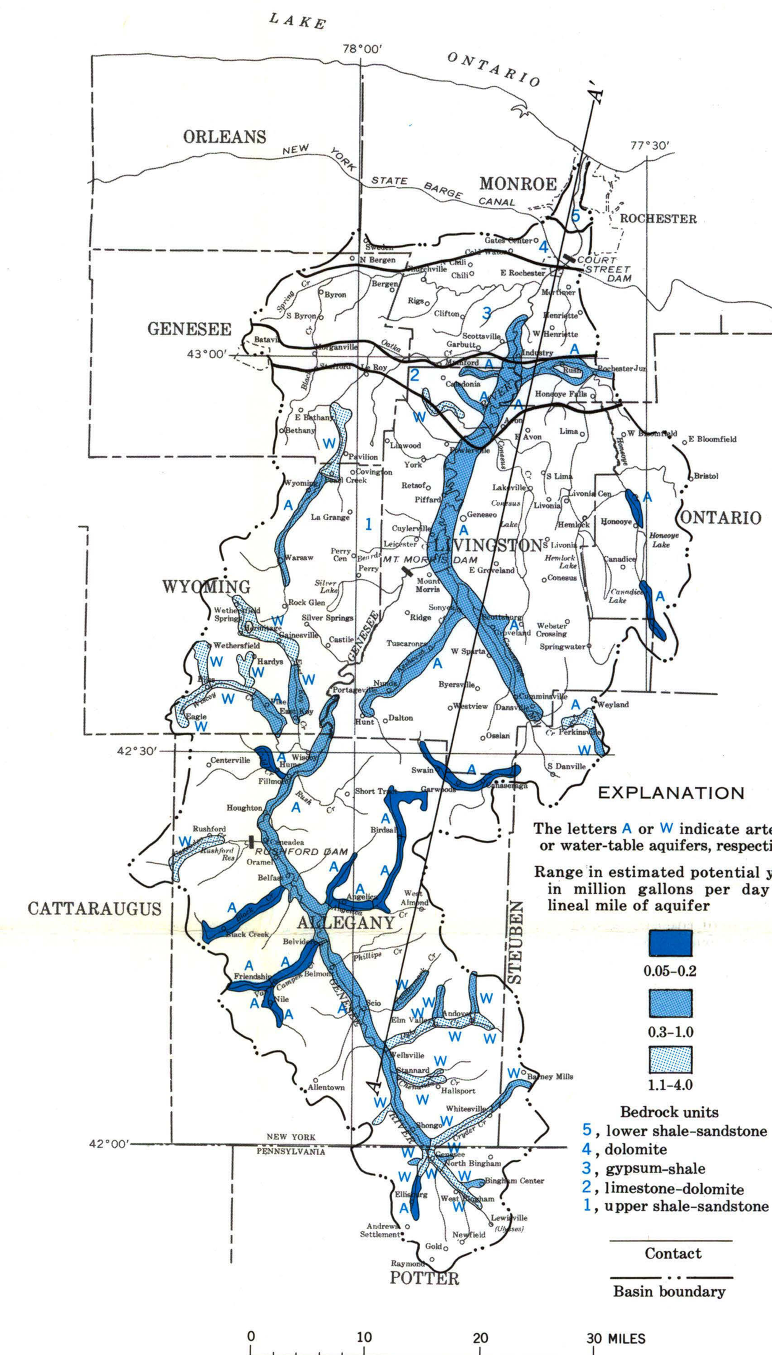
All the estimates are only first approximations because the thickness, areal extent, and continuity of each aquifer are not yet adequately defined.

Yields from the artesian aquifers were estimated by assumptions and computations based on the work of La Sala (written commun.) and others. The three principal assumptions are that:

a. The recharge to valley deposits of sand and gravel through confining beds of silt and clay would be about 0.3 mgd per square mile of silt and clay deposits if a constant gradient were maintained by pumping from the sand and gravel, and if the deposits of silt and clay contained a fully saturated zone of water above the sand and gravel.
b. The recharge to confined sand and gravel deposits through surficial ice-contact deposits (if any) would be at an average rate of 0.3 mgd per square mile of ice-contact deposits and upland areas draining into the ice-contact deposits.
c. The recharge to valley deposits of sand and gravel through till and bedrock on the adjacent uplands would be 0.01 mgd per square mile of upland area.

These estimates show yields from the various water-table and artesian sand and gravel aquifers ranging from 0.2 to 18 mgd, with the total estimated yield (from the 53 aquifers analyzed) of about 200 mgd.

Bedrock in the Genesee River basin consists of layers of shale, limestone, dolomite, and sandstone. The beds have a southward dip averaging between 30 and 60 feet per mile. The bedrock is covered in most places by unconsolidated deposits (till, clay, sand, and gravel) that range in thickness from 5 to 80 feet. Greater thicknesses, some several hundred feet, cover the bedrock in some of the larger valleys, such as that of Canaseraga Creek northwest of Dansville and that of the Genesee River between Wellsville and Portageville and between Mt. Morris and Avon. Wells are seldom drilled through these thicker overlying materials because larger yields and better quality water are usually obtainable from beds of sand and gravel in the unconsolidated deposits. In the rest of the basin, where bedrock is nearer the surface, the depth of most bedrock wells ranges from 30 to 300 feet. Drilling to greater depths usually is not warranted, both because of the decreasing likelihood of water-bearing openings and the increasing likelihood of obtaining water of undesirable chemical quality. The typical occurrence of water in bedrock in the basin is within very thin interconnected openings, such as along bedding planes and joints. Yields to wells penetrating such systems of water-filled openings in bedrock are seldom greater than 30 gpm, and yields of less than 5 gpm are common. Only where the fracture openings occur in partly soluble rocks such as limestone, dolomite, and gypsum-bearing shale (found near the land surface in the northern part of the basin) is there much likelihood of yields greater than 100 gpm.

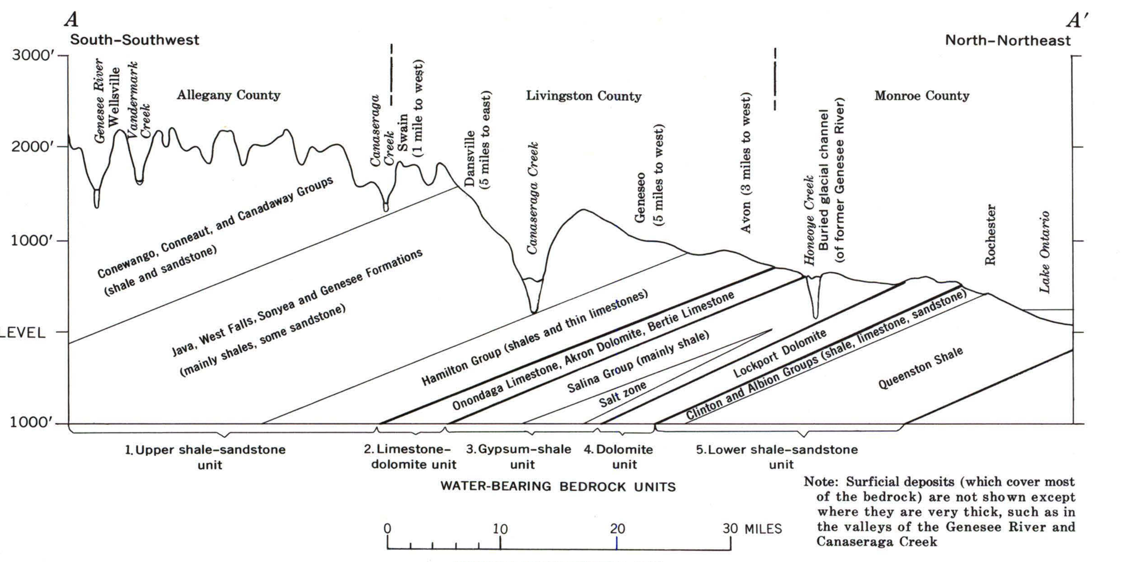


THE PRINCIPAL SOURCES OF GROUND WATER ARE UNCONSOLIDATED DEPOSITS OF SAND AND GRAVEL AND THE VARIOUS KINDS OF BEDROCK THAT UNDERLIE THE BASIN. OF THESE TWO TYPES OF AQUIFERS, THE SAND AND GRAVEL DEPOSITS YIELD MORE WATER.

Table 5.—*Summary of ground-water conditions in the Genesee River basin.*

Map key	Water-bearing unit	Age	Maximum thickness near top of unit (feet)	Yield of selected wells: Number of wells for which data on yields were obtained	Range in depth of wells (feet)	Median yield (gpm)	Range of yield based on middle 80 percent of wells (gpm)
	Unconsolidated deposits						
A	Coarse-grained stratified sand and gravel under artesian conditions (usually confined by fine-grained stratified clay and silt, which is sometimes overlain by thin alluvial deposits or other coarse materials; the coarse-grained sand and gravel is interfingered with lenses of clay and silt). Water occurs in pore spaces between grains.	Pleistocene (glacial epoch).	[1] 600	57	10-329	100	20-700.
W	Coarse-grained, stratified sand and gravel under water-table conditions (sometimes overlain by thin alluvial deposits; commonly the sand and gravel is interfingered with lenses of clay and silt). Water occurs in pore spaces between grains.						
	Clay or silt (fine-grained stratified deposits; sometimes includes fine-grained sand). Water occurs in pore spaces between grains.						Yields no more than a few gpm; sometimes no water at all.
	Till (unsorted mixture of fine- and coarse-grained materials). Water occurs in pore spaces between grains.						
	Bedrock						
1	Upper shale-sandstone (includes some thin limestones near northern limit). Water occurs along joints and bedding planes; possibly also in intergranular pore spaces in some sandstones.	Upper and Middle Devonian.	4,000–4,400	150	25-385	10	2-40.
2	Limestone-dolomite (includes dolomitic shale). Water occurs along joints and bedding planes; some openings have been widened by solution of carbonates.	Middle Devonian and Upper Silurian.	230	18	36-300	10	5-160.
3	Gypsum-shale (shale, gypsum-bearing shale, and dolomite; includes salt beds in central and southern parts of basin). Water occurs along joints and bedding planes; some openings have been widened by solution of gypsum.	Upper Silurian.	500	15	20-135	25	18-42.
4	Dolomite (includes some limestone). Water occurs along joints and bedding planes; some openings have been widened by solution of carbonates.	Middle Silurian.	200	18	25-173	85	10-190.
5	Lower shale-sandstone (predominantly shale; a few feet of limestone at top of unit). Water occurs along joints and bedding planes.	Middle and Lower Silurian and Upper Ordovician.	1,240	Few wells in this limited area.			Most yields probably no more than a few gallons per minute.

[1] Combined thickness of all types of glacial deposits found at a single place; thickness of sand and gravel rarely, if ever, exceeds 200 feet at a single place, and most commonly is only a few tens of feet in thickness.



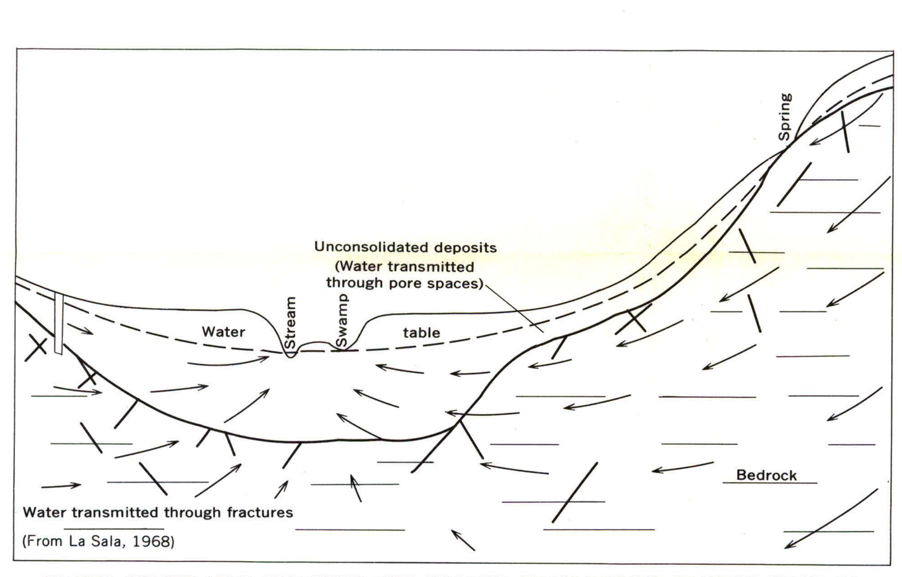
QUALITY OF WATER

The chemical quality of water in the Genesee River basin ranges from very good to poor. In places there is only a small quantity of dissolved minerals in the water (less than 100 mg/l (milligrams per liter), for example, in Canadice Lake). In contrast to this relatively low concentration of dissolved solids, the downstream parts of Black and Oatka Creeks and many wells in the northern part of the basin contain water which commonly has a dissolved-solids content of more than 500 mg/l, and sometimes of more than 1,000 mg/l. The dissolved-solids content of Lake Ontario at Rochester is about 200 mg/l, and that of the Genesee River at Rochester varies between 200 and 500 mg/l.

The most common chemical-quality problems in the river basin are a high hardness and an iron concentration that frequently exceeds 0.3 mg/l (capable of causing brownish stains). However, both these problems are among the easiest to solve by economical treatment methods, either at a municipal plant or with units installed in individual homes. Most of the water in the Genesee River basin is suitable for drinking after only a small amount of treatment, such as filtration and chlorination. Many ground-water supplies, especially those privately owned, receive no treatment.

Most of the dissolved minerals in the water are there naturally rather than being caused by man. The minerals are dissolved from rocks and rock particles over and through which the water moves. Three main factors cause increase in the amounts of dissolved minerals in water: 1) a decrease in the rate of water movement and, therefore, an increase in time of contact between water and the adjacent rock materials; 2) the presence of acids, such as carbonic acid, in the water; and 3) the presence of certain rocks and minerals, such as limestone, gypsum, and salt, which are more readily soluble than other types of rocks and minerals, such as shale, sandstone, and silica.

These three factors more directly and more substantially affect ground water than surface water. However, during dry-weather periods, the water in streams is also affected significantly because the water sustaining the streamflow comes principally from the ground-water reservoirs (base flow).



WATER CIRCULATES THROUGH THE GROUND FROM POINTS OF HIGH HEAD TO POINTS OF LOW HEAD; THAT IS, IT MOVES FROM THE UPLANDS TO THE VALLEYS.

The path in which the water moves and the types of materials through which the water passes affect the chemical quality of the ground water from place to place.

Table 6.—*Representative chemical characteristics of ground water in the Genesee River basin.*

[Number of analyses given in parentheses after data. All data are in milligrams per liter]

Constituent	Upper shale-sandstone unit: Bedrock	Upper shale-sandstone unit: Overlying deposits	Limestone-dolomite unit: Bedrock	Limestone-dolomite unit: Overlying deposits	Gypsum-shale unit: Bedrock	Gypsum-shale unit: Overlying deposits	Dolomite unit: Bedrock
Silica (SiO_2)	8.6–12 (4)	5.0–13 (14)	6.7–7.8 (3)	7.4–8.9 (2)	7.4–8.9 (2)	8.5 (1)	12 (1)
Iron (Fe)	.06–1.2 (16)	.02–1.3 (37)	.1–.64 (8)	.02–.07 (6)	.04–.19 (11)	.03–.87 (21)	.02–.89 (12)
Calcium (Ca)	11–64 (12)	26–112 (36)	57–147 (10)	80–151 (7)	80–332 (12)	86–358 (20)	62–132 (12)
Magnesium (Mg)	3.8–18 (12)	6.6–36 (34)	17–52 (10)	24–53 (7)	39–75 (12)	34–68 (20)	20–42 (12)
Sodium (Na)	31–95 (4)	4.7–64 (13)	29–74 (3)	20–75 (2)	12–24 (2)	82 (1)	9.2 (1)
Potassium (K)	1.6–2.3 (4)	.9–2.5 (13)	2.5–4.0 (3)	2.2–3.1 (2)	2.7–2.8 (2)	4.3 (1)	3.4 (1)
Bicarbonate (HCO_3)	148–296 (14)	104–375 (37)	192–408 (11)	189–492 (11)	232–412 (15)	240–436 (24)	211–337 (12)
Sulfate (SO_4)	1.4–4.3 (23)	.6–56 (43)	44–180 (16)	11–991 (12)	63–1,150 (16)	82–938 (23)	56–187 (14)
Chloride (Cl)	7.6–180 (23)	3–110 (43)	3.2–99 (16)	5–129 (12)	5–97 (17)	6.2–159 (24)	3–29 (15)
Nitrate (NO_3)	0–1.2 (16)	0–12 (39)	.1–135 (10)	.2–60 (7)	.5–15 (12)	.4–150 (20)	.2–60 (12)
Dissolved solids [1]	160–517 (23)	82–365 (43)	315–748 (16)	350–1,600 (12)	509–2,000 (16)	429–1,590 (23)	328–542 (14)
Hardness as $CaCO_3$ (Ca,Mg)	54–336 (23)	160–463 (43)	242–548 (16)	314–1,012 (12)	376–1,540 (17)	349–1,226 (24)	264–502 (15)
pH	7.6–8.2 (22)	7.2–8.1 (44)	7.4–8.3 (11)	7.4–8.1 (10)	7.6–7.9 (7)	7.4–8.1 (6)	8.0–8.2 (5)

[1] Where a dissolved-solids determination was not made in the laboratory, the laboratory-determined specific conductance was used to estimate the dissolved-solids content. Number of analyses and estimates given in parentheses after data.

Note.—These data represent the "middle 80 percent" of the chemical results, omitting the highest and lowest 10 percent of the chemical concentrations; however, no data were omitted for constituents analyzed less than six times.

DEPENDING ON THE DOMINANT DISSOLVED CHEMICAL CONSTITUENT, GROUND WATER IN THE GENESEE RIVER BASIN FALLS INTO ONE OF THREE MAJOR CATEGORIES: SODIUM BICARBONATE TYPE, CALCIUM-MAGNESIUM BICARBONATE TYPE, OR SULFATE TYPE.

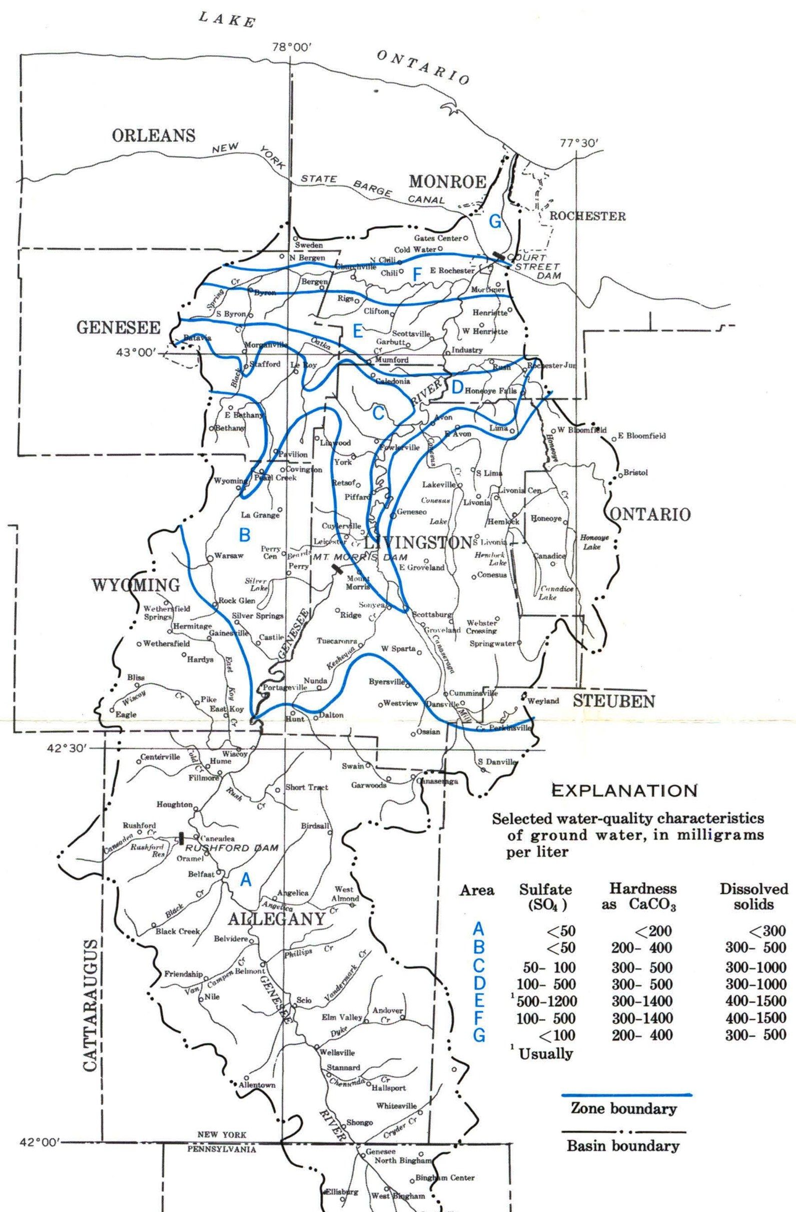
Water in the upper shale-sandstone unit is low in dissolved solids, hardness, and sulfate, and is primarily of the sodium bicarbonate type. This differs from the calcium bicarbonate type water found in the overlying unconsolidated material and indicates a natural softening process whereby calcium ions are exchanged for the sodium ions contained in the clay minerals composing the shale. The softening occurs as ground water of the calcium bicarbonate type moves from the overlying unconsolidated deposits into the bedrock.

The limestone-dolomite unit and the dolomite unit contain water higher in hardness, dissolved solids, and sulfate than that contained in the upper shale-sandstone unit. These waters are of the calcium and magnesium bicarbonate type.

Water moving through the gypsum-shale unit gradually dissolves the gypsum (calcium sulfate) and produces a sulfate type water which has a hardness and dissolved-solids content several times higher than that in the other units.

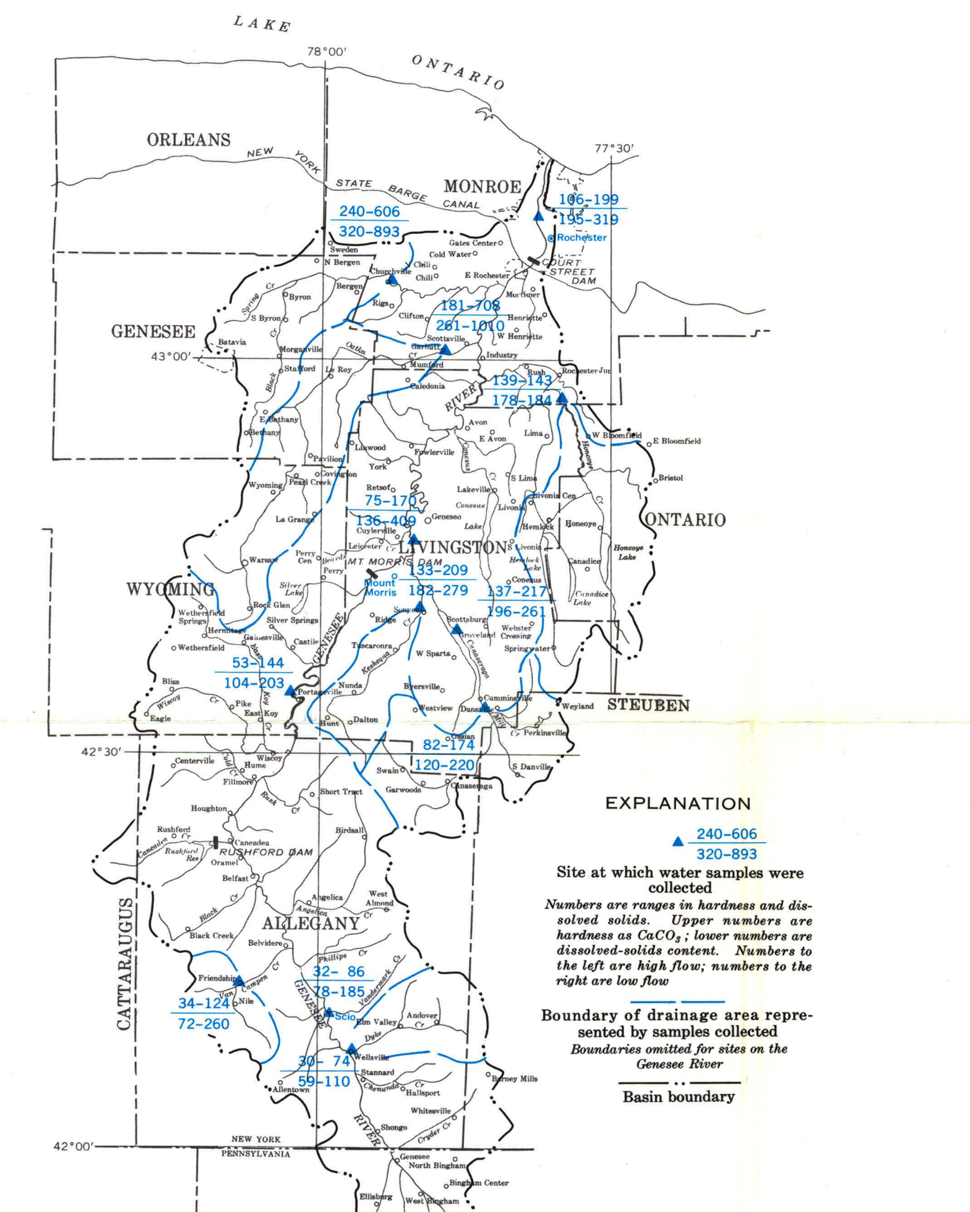
High chloride concentrations (greater than 100 mg/l) occur in water from wells in the upper shale-sandstone, limestone-dolomite, and gypsum-shale units, and to a lesser extent in the overlying sand and gravel deposits, indicating that at least a part of the ground water found in such deposits has circulated up through underlying bedrock containing a source of salty water. Such deep circulation of ground water also causes the high sulfate concentrations of water in sand and gravel deposits overlying the gypsum-bearing shale of the gypsum-shale bedrock unit. Thus, water from separate sand and gravel aquifers at the same place, but at different depths, may differ greatly in chemical quality.

Water from wells in limestone, dolomite, or shale sometimes contains hydrogen-sulfide gas which smells like rotten eggs. The most persistent occurrence of hydrogen sulfide is in the dolomite. The gas may be eliminated by aerating the water or by the addition of chlorine.



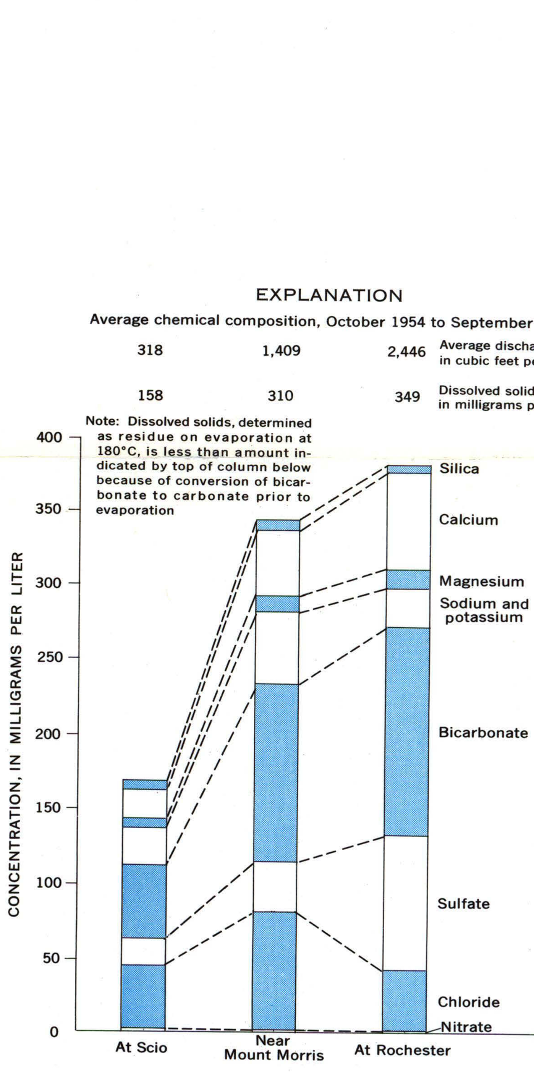
SAMPLES OF STREAMS AT LOW BASE FLOW SHOW SEVEN ZONES OF GROUND WATER WITH SIMILAR CHARACTERISTICS OF HARDNESS, SULFATE, AND DISSOLVED-SOLIDS CONTENT.

The zones are closely related to, and show transition between, the three main categories of chemical quality of ground water discussed previously. The southward fingering of some of the zones occurs because of the movement of deeper and more highly mineralized ground water toward points of discharge in the valleys.



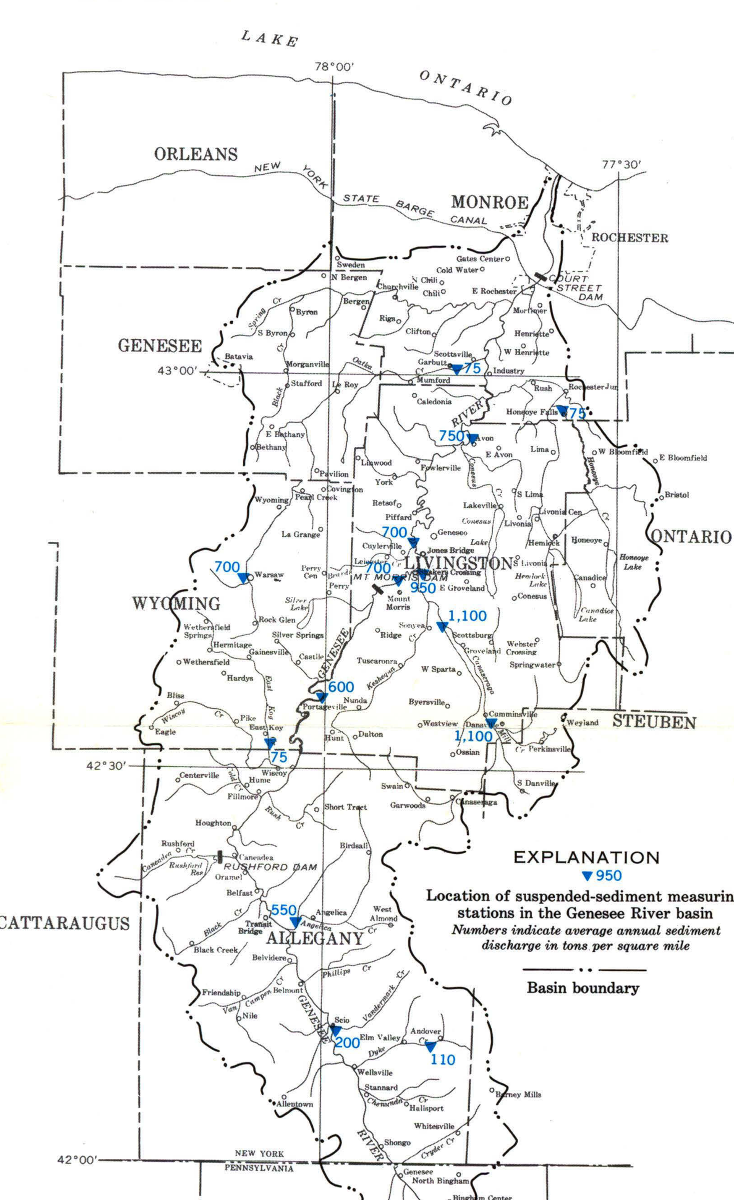
IN GENERAL, DISSOLVED-MINERAL CONCENTRATION TENDS TO INCREASE AS STREAMFLOW DECREASES, BECAUSE DRY-WEATHER LOW FLOWS ARE SUSTAINED BY SLOW-MOVING GROUND WATER (OR BASE FLOW) WHICH CARRIES A SOMEWHAT HIGHER MINERAL CONTENT INTO THE STREAM.

Rainfall and direct runoff are relatively free of mineral matter and tend to dilute the mineral concentrations derived from ground water. The high flows were sampled within the range of 1 to 8 percent on the duration curve, and the low flows were sampled between 80 and 99 percent. The higher concentrations of dissolved solids in much of the northern part of the basin are mainly the result of solution of minerals from limestone, dolomite, and gypsum-bearing shale. The concentrations at sites downstream from Honeoye, Hemlock, and Canadice Lakes show less variation in concentration than at other sites as a result of the temporary impoundment and mixing in the lakes, which also results in lesser extremes of streamflow.



THE GENESEE RIVER RECEIVES MORE HIGHLY MINERALIZED GROUND WATER AS IT FLOWS NORTHWARD TOWARD LAKE ONTARIO.

In addition to the general increase in mineralization from south to north, the increase in sodium and chloride near Mt. Morris is, at least partly, the result of high chloride water from salt-mining operations reaching the Genesee River through Wolf Creek.



THE AVERAGE ANNUAL SEDIMENT DISCHARGE OF STREAMS IN THE BASIN RANGES FROM 75 TO 1,100 TONS PER SQUARE MILE OF DRAINAGE AREA.

Sediment discharges are great enough in many locations to be a critical consideration in the evaluation of proposed dams, water-treatment facilities, and other structures affected by streamflow. At the present stage of development, the most troublesome aspect of sedimentation in the basin is deposition rather than erosion. Annual dredging of Rochester Harbor by the U.S. Corps of Engineers is the most costly and significant problem experienced. However, localized losses of farmland and buildings occasionally take place because of streambank erosion.

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HYDROLOGY OF THE GENESEE RIVER BASIN, NEW YORK AND PENNSYLVANIA

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