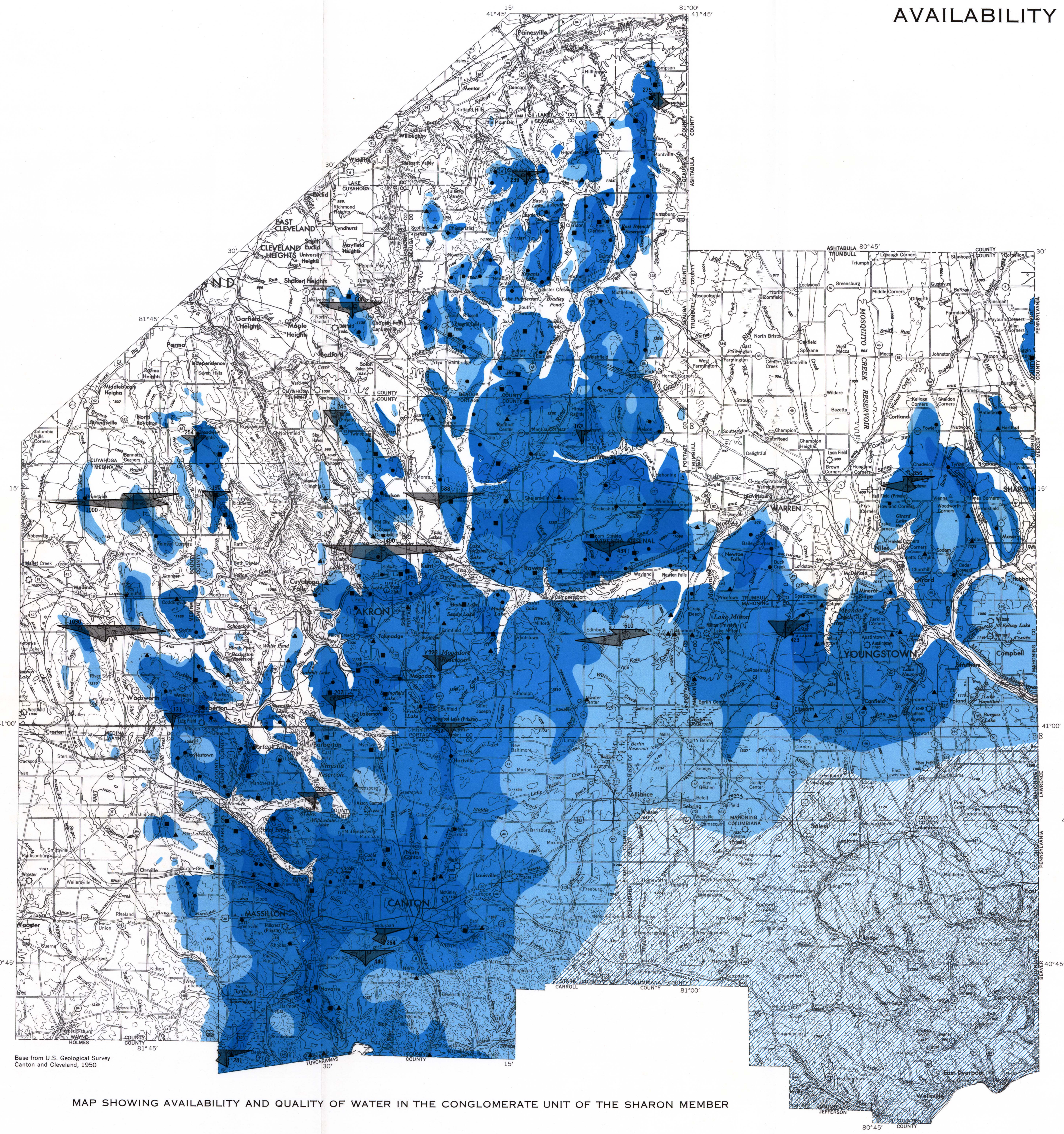
PREPARED IN COOPERATION WITH THE
OHIO DEPARTMENT OF NATURAL RESOURCES
DIVISION OF WATER

AVAILABILITY AND QUALITY OF WATER



Base from U.S. Geological Survey
Canton and Cleveland, 1950

MAP SHOWING AVAILABILITY AND QUALITY OF WATER IN THE CONGLOMERATE UNIT OF THE SHARON MEMBER

EXPLANATION

GOOD TO EXCELLENT SOURCE OF GROUND WATER

Wells commonly yield 25 gallons per minute or more

Aquifer is generally less than 100 feet deep and more than one water bearing zone may contribute to the well. Yields of several hundred gpm from specially constructed wells are possible in localities where the aquifer is overlain by thick gravels and sands near streams

FAIR TO GOOD SOURCE OF GROUND WATER

Wells commonly yield 10 to 25 gallons per minute

Aquifer is generally less than 300 feet deep. Shallower sections may be located where recharge is mostly by precipitation. Deeper sections are generally covered by confining rocks

POOR TO FAIR SOURCE OF GROUND WATER

Wells commonly yield less than 10 gallons per minute

Low yields may be expected in certain localities where at shallow depths the aquifer is not favorably situated with respect to recharge. At greater depths thick confining layers, typically shale of low permeability, limit yields

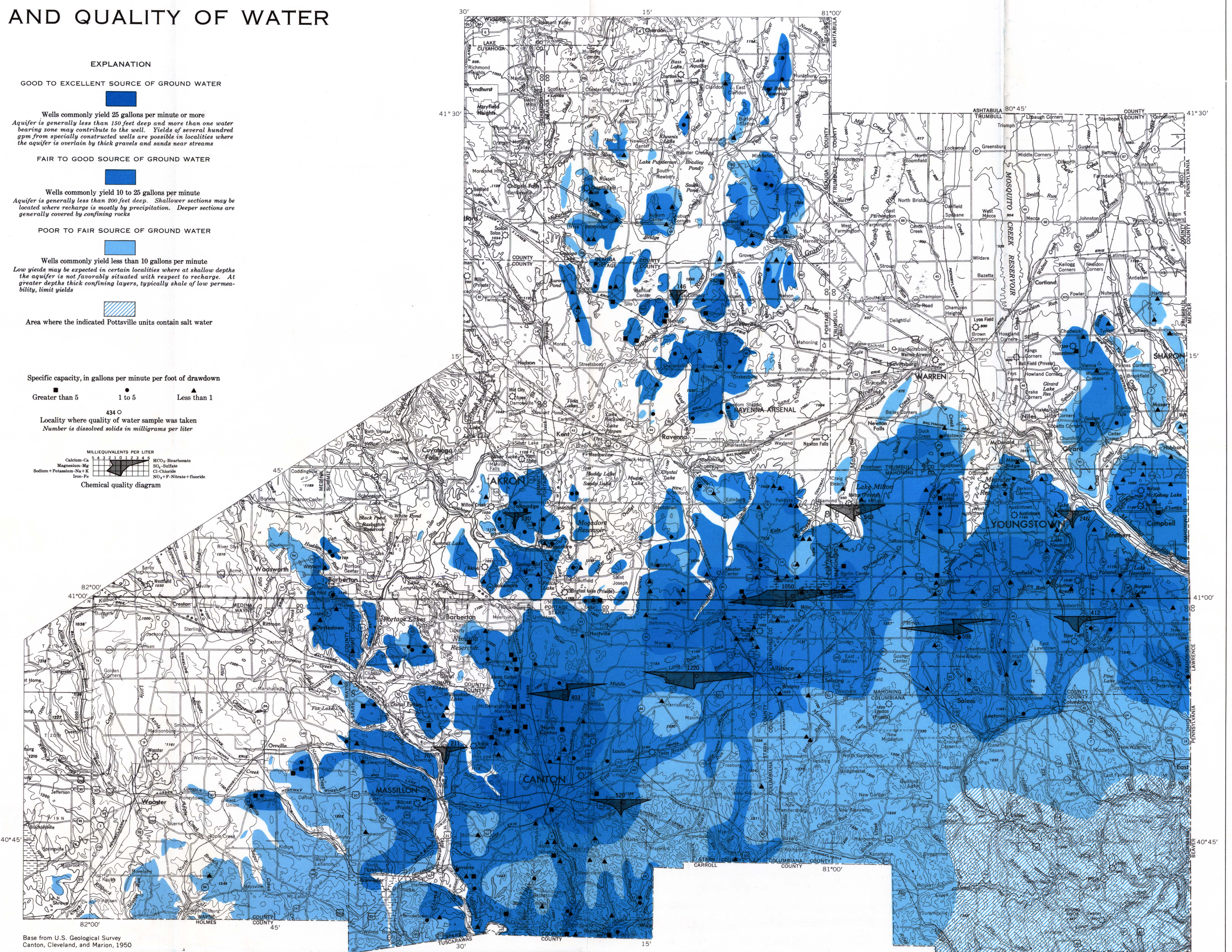
Area where the indicated Pottsville units contain salt water

Specific capacity, in gallons per minute per foot of drawdown

Greater than 5 — 1 to 5 — Less than 1

Locality where quality of water sample was taken
Number is dissolved solids in milligrams per liter

Chemical quality diagram

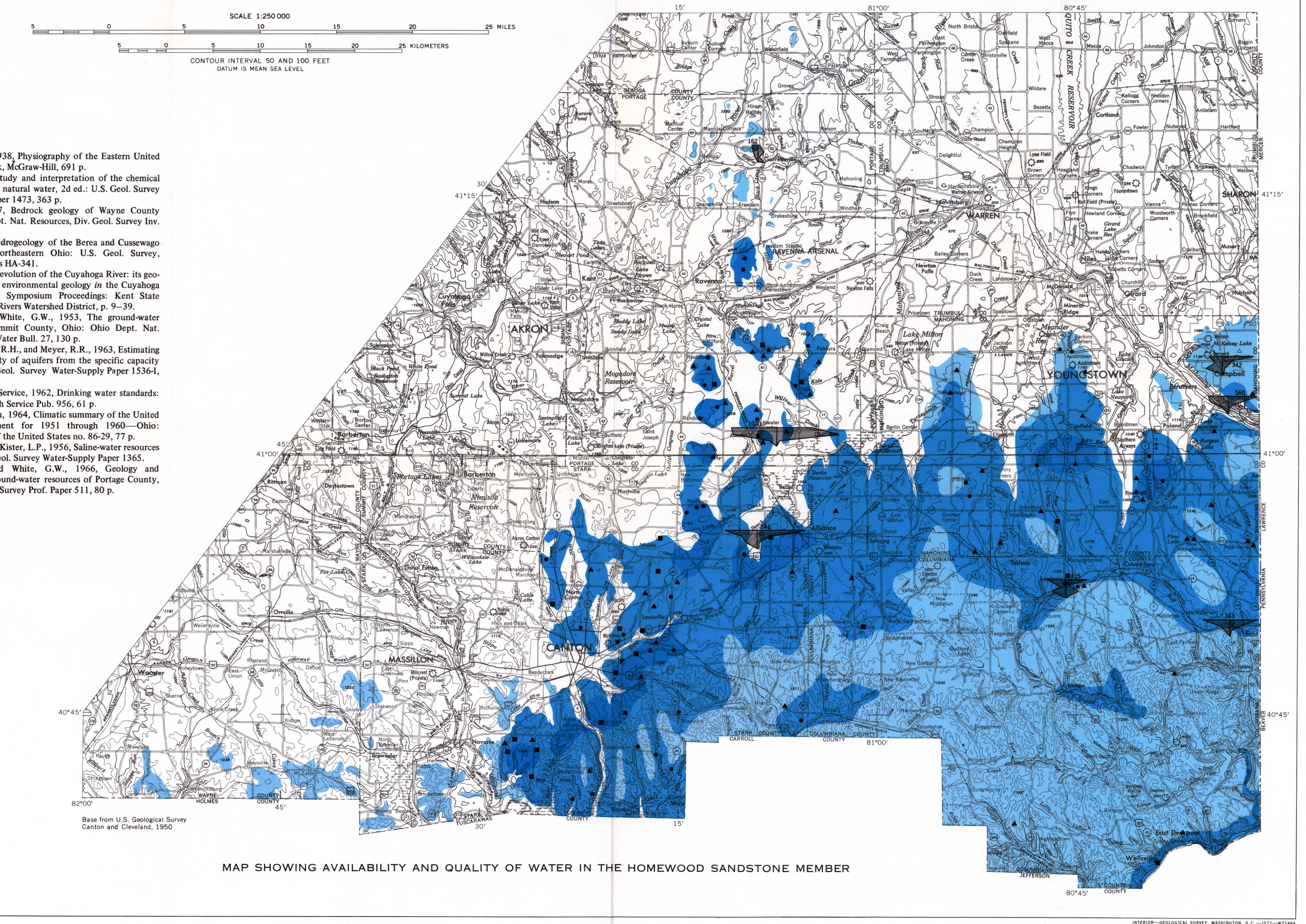


Base from U.S. Geological Survey
Canton, Cleveland, and Marion, 1950

MAP SHOWING AVAILABILITY AND QUALITY OF WATER IN THE CONNOQUENESSING SANDSTONE MEMBER

SCALE 1:250 000

CONTOUR INTERVAL 50 AND 100 FEET
DATUM IS MEAN SEA LEVEL



Base from U.S. Geological Survey
Canton and Cleveland, 1950

MAP SHOWING AVAILABILITY AND QUALITY OF WATER IN THE HOMEWOOD SANDSTONE MEMBER

WATER YIELDING PROPERTIES OF THE POTTSVILLE FORMATION

The water-yielding characteristics of the Sharon, Connoquenessing Sandstone, and Homewood Sandstone Members of the Pottsville Formation are shown on the accompanying maps, together with water-quality data.

Average transmissivity values for the Pottsville aquifers are shown in the table below. The values were computed from specific capacity data derived from drillers' logs, similar to the method used by Rau (1969) for the Berea and Cussewago Sandstones in northeast Ohio. Computation of transmissivity was based on a graphical method developed by Theis, Brown, and Meyer (1963). Computed values vary over a wide range for each of the Pottsville aquifers chiefly because of variations in aquifer thickness. Even where the thickness and permeability are constant, differences in apparent transmissivity result from differences in depth of penetration of the wells, and the use of specific capacity data based on aquifer tests of varying duration. Specific capacity data from about 850 well records were used to determine the transmissivity values. Anomalously high values were eliminated from the averages.

Average transmissivity (gallons per day per foot)

County	Sharon Member	Connoquenessing Sandstone Member	Homewood Sandstone Member
Cuyahoga	2,500	------------	------------
Medina	3,200	------------	------------
Wayne	3,100	3,300	------------
Summit	4,300	3,700	------------
Geauga	3,400	2,200	------------
Trumbull	2,600	2,000	------------
Portage	4,400	3,600	3,300
Stark	2,900	2,600	4,600
Mahoning	2,400	2,500	2,600
Columbiana	------------	1,200	2,300

SHARON MEMBER

The conglomerate unit of the Sharon Member is an important aquifer in Geauga, Portage, and Summit Counties. The unit, less conglomeratic in composition, extends as a thick sandstone into Stark County. In these areas, yields to wells of as much as 250 gpm (gallons per minute) are not uncommon.

Specific capacities reported for many wells are in the range of 2 to 5 gpm per foot of drawdown. A few wells in Portage and Stark Counties have specific capacities of more than 10 gpm per foot of drawdown. A few wells in Portage and Stark Counties have specific capacities that are unrealistically high, which probably can be attributed to ground-water movement into the aquifer from overlying glacial sand and gravel or from permeable zones in the underlying Cuyahoga Formation.

The conglomerate unit of the Sharon Member is irregular in distribution and thickness. Locally in Portage and Stark Counties the conglomerate unit may be as much as 250 feet thick, whereas in parts of Trumbull, Mahoning, and Wayne Counties the unit is missing altogether and only the shale unit of the Sharon Member is present. Where the sandstone is thin or shaly, wells generally yield less than 25 gpm and specific capacities are typically less than 1 gpm per foot of drawdown.

Most of the specific capacity data are based on relatively short acceptance tests of wells. Controlled aquifer tests of the Sharon Member were made in Portage County to obtain hydraulic constants, but were considered inconclusive because of unevaluated boundary effects (Winslow and White, 1966, p. 41). A test of an aquifer 96 feet thick that included both the Sharon Member and the Connoquenessing Sandstone Member yielded a transmissivity of 13,000 gpd (gallons per day) per foot and a storage coefficient of 0.0002. This transmissivity value is higher than the sum of the average transmissivities for the Sharon and Connoquenessing as given in the table for Portage County. Locally, transmissivities can be much higher than those listed, especially when calculated from tests of industrial wells producing from thick, well-developed aquifer sections, in contrast to average values which are typically based on short tests of domestic wells.

The hydraulic conductivity of the Sharon Member varies widely in northeastern Ohio. Exceptionally high values of the hydraulic conductivity (more than 2,000 gpd per square foot) were determined for scattered localities in Geauga, Summit, and Portage Counties. By contrast, values as low as 5 gpd per square foot were determined locally, possibly resulting from the presence of a shale lens interbedded with the aquifer. Calculations of the hydraulic conductivity—the tiansmissivity divided by the saturated thickness of the aquifer—were based on the same drillers' records used in computing the transmissivity. Only those records were used in which information on the aquifer thickness was considered reliable. In areas where the Sharon Member is exposed at the surface or crops out beneath a thin covering of glacial drift, the hydraulic conductivity is relatively high because the rocks are loosely cemented and secondary openings such as joints and fractures have been enlarged by solution.

The hydraulic conductivity of the Sharon Member in Geauga County, based on records from about 100 wells, ranges from 100 to 500 gpd per square foot. Hydraulic conductivity values south of the outcrop area where the Sharon Member is more deeply buried are typically lower, ranging from 25 to 100 gpd per square foot. This variation can be inferred somewhat from the range of depths shown for the unit on the map on sheet 1.

CONNOQUENESSING SANDSTONE MEMBER

The Connoquenessing Sandstone Member north of Stark and Mahoning Counties is characterized by patchy distribution and variable thickness. Some of these deposits in Portage County yield as much as 30 gpm. Farther south, in Stark and Mahoning Counties, the Connoquenessing Sandstone Member is more massively developed and is the principal bedrock aquifer in areas where the Sharon Member is deeply buried or poorly developed. Although not generally as productive as the Sharon Member, yields of 50 gpm from the Connoquenessing are fairly common. Wells formerly used to supply the community of Canfield in Mahoning County yielded as much as 500 gpm from the Connoquenessing Sandstone Member (Cross and others, 1952, p. 44).

The average transmissivity values shown above were obtained in the same manner as already described for the Sharon Member. Its relatively high transmissivity in Portage County indicates that where the Connoquenessing is situated at or near the surface the unit is relatively permeable, probably because fractures and joints have been enlarged by solution. The Connoquenessing Sandstone Member is thinner in Geauga and Trumbull Counties and has a correspondingly lower transmissivity. In Stark and Mahoning Counties the Connoquenessing is more deeply buried by overlying strata, also reducing its transmissivity.

An aquifer test of the Connoquenessing Sandstone Member in Portage County has already been mentioned. Similar tests in western Pennsylvania where the Connoquenessing Sandstone Member ranges from a thin shaly unit to a clean sandstone as much as 130 feet thick gave transmissivities ranging from very low to 30,000 gpd per foot (Carswell and Bennett, 1963, p. 58). The hydraulic conductivity is reported to range from 5 to 300 gpd per square foot. Similar values probably are applicable to the Connoquenessing Sandstone Member in Trumbull and Mahoning Counties.

In most of the area where the Connoquenessing is near the surface the coefficient of permeability typically ranges between 50 and 150 gpd per square foot. As with the Sharon Member a few hydraulic conductivity values are exceptionally high.

HOMEWOOD SANDSTONE MEMBER

The Homewood Sandstone Member in Stark, Mahoning, and Columbiana Counties, where it is prevalent, is largely overlain by coal-bearing strata of the Allegheny Formation, and gradation of the sandstone to shale is common. Where the sandstone is relatively thick, yields to wells of as much as 30 gpm are available.

The area in which the Homewood yields most water to wells extends northeastward from the center of Stark County across the middle of Mahoning County, where the unit crops out beneath thin glacial cover. Southward, under the increasing thickness of the Allegheny Formation, yields from the Homewood diminish to less than 10 gpm.

Yields of less than 10 gpm are also typical near the western and northern margins of the Homewood, where the unit is thin, shaly, or situated in upland areas above the influence of recharging streams. Exceptions are areas in Portage County where relatively small remnants of the Homewood yield as much as 30 gpm. An exceptional well reportedly yielded 175 gpm (Winslow and White, 1966, p. 74), in an area where the sandstone is thick and overlain by permeable glacial drift.

An aquifer test of the Homewood Sandstone, made near Lowellville in Mahoning County, gave a transmissivity of 19,000 gpd per foot and a storage coefficient of 0.0002. In nearby areas of Pennsylvania, Carswell and Bennett (1963, p. 57) report transmissivity values of 200 to 1,400 gpd per foot for the Homewood Sandstone. Excluding results of the Lowellville test, the average transmissivity for the Homewood in Mahoning County is about 1,800 gpd per foot. Hydraulic conductivity values range between 5 and 200 gpd per square foot and typically are less than 100 gpd per square foot.

CHEMICAL QUALITY OF GROUND WATER

The chemical quality of the ground water is shown by Stiff diagrams on the accompanying maps of the Sharon, Connoquenessing Sandstone, and Homewood Sandstone Members. The diagrams indicate the chief chemical constituents, expressed in milliequivalents per liter. Analyses were by the U.S. Geological Survey.

For comparison of the diagrams with standards for potable water, drinking water standards of the U.S. Public Health Service (1962) are listed below:

	Recommended limit in	
	milligrams per liter (mg/l)	milliequivalents per liter (meq/l)
Chloride	250	7.05
Iron	.3	.02
Manganese	.05	.001
Nitrate	45	.97
Sulfate	250	5.10
Dissolved solids	500	------------------

The Stiff diagrams do not give the hardness value directly, but hardness can be inferred from the amount of calcium (Ca) and magnesium (Mg) indicated by the figure. Calcium and magnesium are the principal constituents that cause hardness in water and are generally reported in terms of their equivalent of calcium carbonate ($CaCO_3$). The sum of the milliequivalents of calcium and magnesium may also be multiplied by 50 to give the hardness value (Hem, 1970, p. 224). Conversely, if the hardness, expressed as milligrams per liter of calcium carbonate, is divided by 50 the result is the sum of the calcium and magnesium milliequivalents. Hardness ranges listed below are classified according to Durfor and Becker (1964, p. 27). The right hand column gives the corresponding ranges of the sums of the calcium and magnesium milliequivalents.

	Hardness range	
	(as mg/l of $CaCO_3$)	(as sum of meq/l of Ca and Mg)
Soft	0 – 60	0 – 1.2
Moderately hard	61 – 120	1.21 – 2.4
Hard	121 – 180	2.41 – 3.6
Very hard	More than 180	More than 3.6

AREAS WHERE SALT WATER OCCURS

Detailed information is lacking concerning the quality of water in the Sharon Member beyond the region where it is commonly tapped for water supplies. According to a classification used by the U.S. Geological Survey, water containing less than 1,000 milligrams per liter of dissolved solids is fresh and above this amount is saline (Winslow and Kister, 1956). The line on the map marking the limit of fresh water is based on reports of highly mineralized water from scattered localities in Stark and Mahoning Counties. Little is known of the Sharon Member in Columbiana County; however, at depths at which the unit occurs ground-water circulation is probably small. Water of high salinity probably occurs in areas down dip from the line shown on the map.

As with the Sharon Member, information necessary to accurately map a line separating fresh from salt water in the Connoquenessing Sandstone Member is meager. The line shown on the map is based on reports of mineralized water in the Connoquenessing in Columbiana County. In northwestern Pennsylvania, according to Carswell and Bennett (1963, p. 62), the fresh water-salt water contact "will rise in the direction of fresh-water flow, attaining a maximum elevation under channels of ground-water discharge and a maximum depth under major ground-water divides." If this hypothesis is applicable everywhere salt water may occur in the Connoquenessing in areas where it is closer to the surface, such as in the Ohio River valley and the valley of Little Beaver Creek.

The Homewood Sandstone Member probably does not contain saline water within the region of this study.

REFERENCES

Carswell, L.D., and Bennett, G.D., 1963, Geology and hydrology of the Neshannock quadrangle, Mercer and Lawrence Counties, Pennsylvania: Pennsylvania Geol. Survey Bull. W-15, 90 p.

Cross, W.P., 1968, Flow duration of Ohio streams, based on gaging-station records through 1965: Ohio Dept. Nat. Resources, Div. Water Bull. 42, 68 p.

Cross, W.P., and Hedges, R.E., 1959, Flow duration of Ohio streams: Ohio Dept. Nat. Resources, Div. Water Bull. 31, 152 p.

Cross, W.P., Schroeder, M.E., and Norris, S.E., 1952, Water resources of the Mahoning River basin, Ohio: U.S. Geol. Survey Circ. 177, 57 p.

Delong, R.M., and White, G.W., 1963, Geology of Stark County: Ohio Dept. Nat. Resources, Div. Geol. Survey Bull. 61, 209 p.

Durfor, C.N., and Becker, Edith, 1964, Public water supplies of the 100 largest cities in the United States, 1962: U.S. Geol. Survey Water-Supply Paper 1812, 364 p.

Fenneman, N.M., 1938, Physiography of the Eastern United States: New York, McGraw-Hill, 691 p.

Hem, J.D., 1970, Study and interpretation of the chemical characteristics of natural water, 2d ed.: U.S. Geol. Survey Water-Supply Paper 1473, 363 p.

Multer, H.G., 1967, Bedrock geology of Wayne County (map): Ohio Dept. Nat. Resources, Div. Geol. Survey Inv. Rept. 61.

Rau, J.L., 1969, Hydrogeology of the Berea and Cussewago sandstones in northeastern Ohio: U.S. Geol. Survey, Hydrol. Inv. Atlas HA-341.

——— 1970, The evolution of the Cuyahoga River: its geomorphology and environmental geology *in* the Cuyahoga River Watershed Symposium Proceedings: Kent State Univ. and Three Rivers Watershed District, p. 9–39.

Smith, R.C., and White, G.W., 1953, The ground-water resources of Summit County, Ohio: Ohio Dept. Nat. Resources, Div. Water Bull. 27, 130 p.

Theis, C.V., Brown, R.H., and Meyer, R.R., 1963, Estimating the transmissibility of aquifers from the specific capacity of wells: U.S. Geol. Survey Water-Supply Paper 1536-I, p. 331–341.

U.S. Public Health Service, 1962, Drinking water standards: U.S. Public Health Service Pub. 956, 61 p.

U.S. Weather Bureau, 1964, Climatic summary of the United States—Supplement for 1951 through 1960—Ohio: Climatography of the United States no. 86-29, 77 p.

Winslow, A.G., and Kister, L.P., 1956, Saline-water resources of Texas: U.S. Geol. Survey Water-Supply Paper 1365.

Winslow, J.D., and White, G.W., 1966, Geology and hydrology of ground-water resources of Portage County, Ohio: U.S. Geol. Survey Prof. Paper 511, 80 p.

INTERIOR—GEOLOGICAL SURVEY, WASHINGTON, D.C.—1973—W72464

HYDROGEOLOGY OF THE POTTSVILLE FORMATION IN NORTHEASTERN OHIO

By
Alan C. Sedam

1973