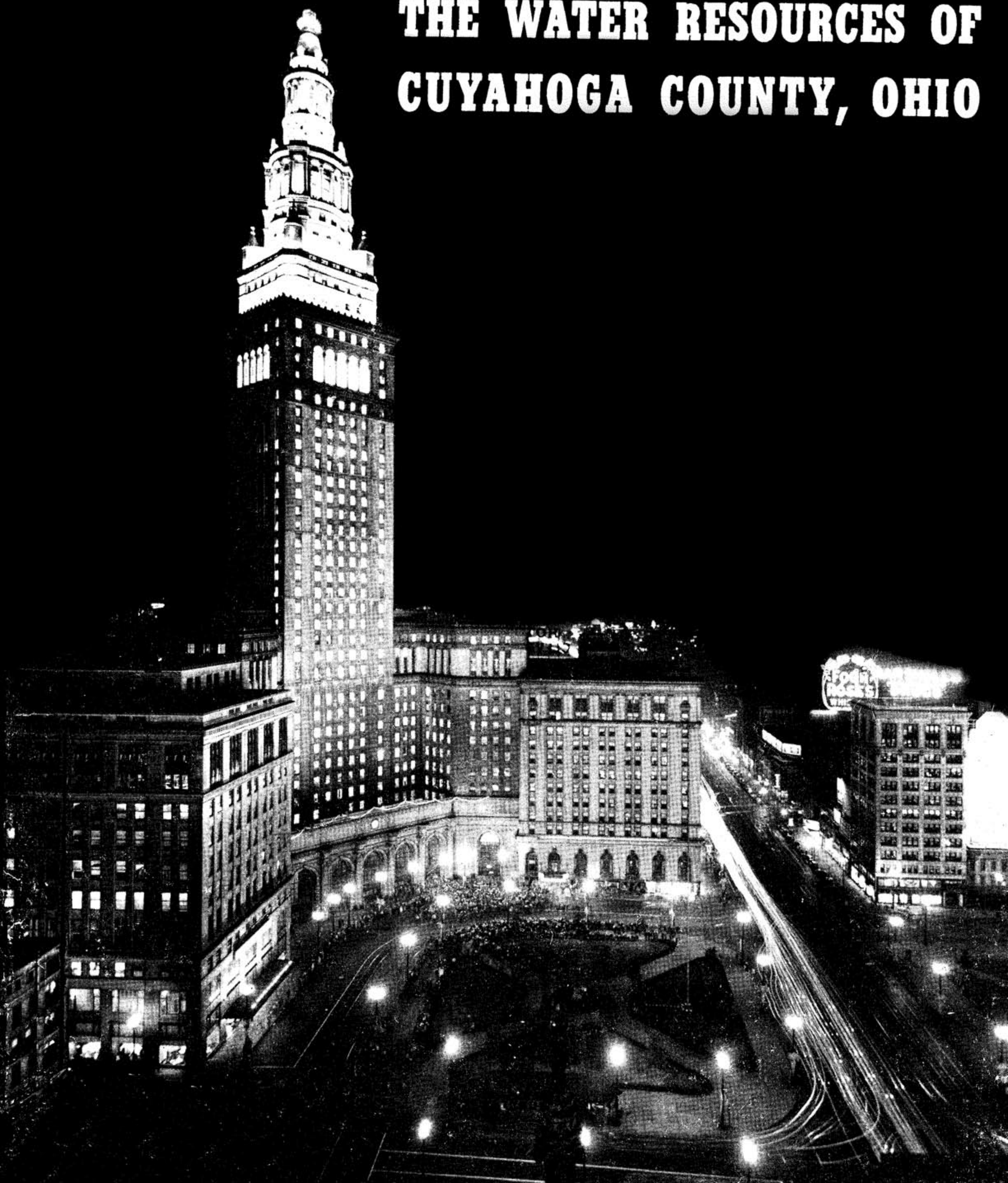
THE WATER RESOURCES OF CUYAHOGA COUNTY, OHIO



COVER

Night view of Terminal Tower and part of Public Square, Cleveland, Ohio

(Photograph courtesy of the Cleveland Chamber of Commerce)

STATE OF OHIO
FRANK J. LAUSCHE, *Governor*

DEPARTMENT OF NATURAL RESOURCES
A. W. MARION, *Director*

DIVISION OF WATER
C. V. YOUNGQUIST, *Chief*

THE WATER RESOURCES OF CUYAHOGA COUNTY, OHIO

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Prepared in cooperation with the
UNITED STATES GEOLOGICAL SURVEY
WATER RESOURCES DIVISION

Bulletin 26—COLUMBUS, OHIO—August, 1953

FRANK J. LAUSCHE
GOVERNOR

A. W. MARION
DIRECTOR

**OHIO
DEPARTMENT OF
NATURAL RESOURCES
COLUMBUS 15**

1500 Dublin Road

November 20, 1953

Mr. A. W. Marion, Director
Ohio Department of Natural Resources
State Office Building
Columbus 15, Ohio

Dear Director Marion:

Herewith is a report on the investigation of the water resources of Cuyahoga County, the field work for which was conducted during the summers of 1951 and 1952.

The complex geology of Cuyahoga County and the great depth of some of the buried valley systems made this investigation a difficult one. It will, however, be an invaluable guide in the development and use of water in the County.

The cooperation of the County Commissioners of Cuyahoga County in financing this survey is gratefully acknowledged.

Very truly yours,

C. V. Youngquist, Chief
Division of Water

CVY/ps

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The Water Resources of Cuyahoga County, Ohio

ABSTRACT

This report describes the water resources of Cuyahoga County, Ohio, which includes the city of Cleveland. The county covers an area of 463 square miles and has a population of 1,389,532 (according to the 1950 census), 17.4 percent of the total population of the State. The average annual precipitation is 33.61 inches, fairly evenly distributed over the year. The average annual temperature is 49.2° F., and average monthly temperatures range from 71.4° F. in July to 26.5° F. in January.

The county is covered by glacial drift deposited during two or more of the four glacial stages. The Wisconsin glacial deposits consist primarily of glacial till and glacial lake deposits, which generally are a poor source of ground water. The Illinoian glacial deposits consist mostly of till and, in places, outwash gravels, which fill a pre-Illinoian valley system. The best area for the development of ground-water supplies in Cuyahoga County is the Mill Creek valley where the gravel deposits of Illinoian age are recharged by Mill Creek. These gravel deposits yield approximately 1½ million gallons per day at the plant of the Cleveland Chain & Manufacturing Co. in Newburg Township, and probably have a much larger potential yield. Other buried valleys generally contain gravel lenses that have good water-bearing properties and yields of 350 gallons per minute have been reported, but in many places these deposits are of small areal extent and their presence cannot ordinarily be predicted in advance of drilling.

The Sharon conglomerate and the Berea sandstone are the best aquifers among the consolidated rocks. Both these formations are coarse-grained sandstones having average thicknesses of approximately 60 feet. The Sharon has yielded as much as 125 gallons per minute and the Berea as much as 350 gallons per minute to industrial wells. The larger areal extent of the Berea sandstone makes it the more important of the two principal consolidated-rock aquifers.

The shales and the interbedded sandstones of the Cuyahoga group generally yield sufficient water for domestic supplies. The Bedford, Ohio, and Chagrin shales are poor sources of ground water and, although wells in these formations generally yield 2 to 3 gallons per minute, many wells are total failures.

The streams that drain Cuyahoga County are the Cuyahoga River, the Rocky River, the Chagrin River, and their tributaries, together with several short streams that drain directly into Lake Erie. The best available source of surface water in Cuyahoga County so far as quantity and regularity of flow are concerned, excluding Lake Erie, is the Cuyahoga River. By storing flood waters the Chagrin River could be made an excellent source of supply. The other streams in Cuyahoga County are generally poor sources of surface-water supply because of their low base flows and large volumes of storage required to maintain specified flows.

The chemical quality of the ground water in Cuyahoga County is generally satisfactory for most purposes. The pH of all the waters analyzed, except one, was 7.0 or above. Iron was present in all samples, ranging from 0.13 to 17 parts per million. The sodium content of the waters ranged from 6.4 to 2,970 parts per million, bicarbonate ranged from 112 to 1,120 parts per million, and sulfate ranges from 1.2 to 682 parts per million. The dissolved solids ranged from 228 to 7,400 parts per million and the total hardness ranged from 11 to 889 parts per million. Surface water is derived from surface runoff and also from ground-water discharge and therefore generally contains, in varying but lesser amounts, the same mineral constituents found in the ground water. In addition, surface water frequently contains suspended solids such as silt, clay, and organic material derived from the natural decomposition of soil and from pollution.

INTRODUCTION

PURPOSE AND SCOPE OF THE INVESTIGATION

This report is based upon field investigations of the geology and the water resources of Cuyahoga County, Ohio, that were made in 1951-52 to determine the availability and the quality of the ground and surface water. It is intended as a guide for the development of domestic, public, and industrial water supplies in Cuyahoga County.

The report has been prepared as part of the cooperative investigation of the water resources of Ohio being made by the Division of Water, Ohio Department of Natural Resources, and the United States Geological Survey. Part of the cost of this particular study was borne by Cuyahoga County, as a civil-defense measure; in anticipation of a possible emergency it was considered advisable to evaluate the water resources of the county.

DIVISION OF WORK AND ACKNOWLEDGMENTS

The collection and interpretation of most of the basic data in this report were by John D. Winslow, Geologist, U. S. Geological Survey, who is the principal author. George W. White, Geologist, U. S. Geological Survey, and Head of the Department of Geology, University of Illinois, studied the surficial and the glacial geology of the area and is the author of the portion of this report entitled "Geology and water-bearing characteristics of the unconsolidated deposits." The portion of the report entitled "Surface-water resources" was prepared by Earl E. Webber, Hydraulic Engineer, Surface Water Branch, U. S. Geological Survey.

Chemical analyses of 36 samples of ground water from wells in Cuyahoga County were made by the Columbus regional laboratory of the Quality of Water Branch, U. S. Geological Survey. W. L. Lamar, District Chemist, reviewed the portion of the report dealing with the chemical quality of water and offered many helpful suggestions. The electrical resistivity of the earth was measured at 20 sites in Cuyahoga County by George Edwards and Raymond Miller, Geophysicists, Geologic Branch, U. S. Geological Survey, working under the general supervision of H. Cecil Spicer, Senior Geophysicist. These measurements were used to determine the character of the unconsolidated materials in areas where other information was not available.

Cuyahoga County is represented in this investigation by County Commissioners John F. Curry, Joseph F. Gorman, and Henry W. Speeth, and by County Administrator John F. Hehir. The Ohio Department of Natural Resources is represented by A. W. Marion, Director, and C. V. Youngquist, Chief, Division of Water. The Ground Water Branch, U. S. Geological Survey, is represented by S. E. Norris, Acting District Geologist, and A. N. Sayre, Geologist in Charge, Washington, D. C. The Surface Water Branch, U. S. Geological Survey, is represented by L. C. Crawford, District Engineer, and J. V. B. Wells, Chief, Washington, D. C. The Quality of Water Branch, U. S. Geological Survey, is represented by W. L. Lamar, District Chemist, and S. K. Love, Chief, Washington, D. C.

The authors acknowledge the assistance of G. D. Dove, Geologist, Geological Survey, who collected numerous well records in the western part of the county. R. L. Schuster, Hydrologic Field Assistant, Geological Survey, collected 35 water samples for chemical analysis. The authors are indebted to the well drillers in Cuyahoga County, especially to J. L. Harper and to George and Robert Bennett, who were unstinting in their cooperation and who furnished many of the well records in this report. The authors are also grateful to J. J. Schmidt, Assistant to the President, and to W. M. Tipka, Geologist, of the East Ohio Gas Co. They assisted in the selection of about 100 of the most informative oil- and gas-well records in the company files. Test-hole records were obtained from the files of the Cleveland Department of Water and Heat, the Cuyahoga County Sanitary Engineer's Office, the Cleveland Sewer Department, and Cleveland Union Terminal Co.

John H. Byrne, noted Ohio conservationist, created intensive public interest in the need for a report on the water resources of Cuyahoga County. The authors acknowledge and appreciate his assistance and his many courtesies to them during the course of investigation.

The authors also acknowledge the excellent service rendered by John C. Krolczyk and Mrs. Evelyn Wheaton of the Ohio Division of Water, who prepared the maps and illustrations in this report.

PREVIOUS WORK AND SOURCES OF INFORMATION

Charles Whittlesey (1838)* made one of the earliest studies of the geology of Cuyahoga County. He named and described the various geologic formations. J. S. Newberry (1873) reported on the geology of Cuyahoga County in Volume I of the Geological Survey of Ohio, discussing the geologic formations and their economic worth. C. S. Prosser (1912) included geologic sections from Cuyahoga County in his description of the Devonian and Mississippian of northeastern Ohio. H. P. Cushing, Frank Leverett, and Frank Van Horn (1931), mapped and reported the geology and mineral resources of the Cleveland district, Ohio, covering the Berea, Cleveland, and Euclid quadrangles in their investigation. A. B. Williams (1940) wrote a descriptive pamphlet of the geology of the Cleveland region for the Cleveland Museum of Natural History. Wallace de Witt (1951) studied the stratigraphy of the Berea sandstone and associated rocks in northeastern Ohio and northwestern Pennsylvania.

Wilber Stout (1943) discussed the ground-water resources of Cuyahoga County and presented general information of the ground-water possibilities at some of the larger communities.

The subsurface geological information in this report has been compiled from data obtained from records of wells drilled for water, oil, and gas, from test holes, and from electrical-resistivity measurements.

Aerial photographs, obtained from the Production and Marketing Authority, Department of Agriculture, were used as an aid in mapping geology of the county.

Stream-gaging stations have been operated by the U. S. Geological Survey on the three principal streams in Cuyahoga County for various periods since 1921. Streamflow data have been published annually in water-supply papers.

The maps in this report, plates 1, 2, 3, and 26, are based on field studies, well records, and aerial photographs. The reports and maps of Frank Carney[1] and Frank Leverett (Cushing and others, 1931) especially relative to the glacial lakes and their shorelines, were freely used. Neither Carney nor Leverett included in their reports the eastern part of Cuyahoga County that lies in the Mentor and Chagrin Falls quadrangles.

* See list of references at end of this report.

[1] Carney, Frank, 1913, Report and maps of the glacial geology of the Berea and Cleveland quadrangles: Ohio Geol. Survey manuscript rept.

Plate 4. Map of Ohio, showing location of the area included in this report.

GEOGRAPHY

LOCATION AND SIZE OF THE AREA

Cuyahoga County, Ohio, lies on the southern shore of Lake Erie, between 41° 16′ and 41° 38′ north latitude, and between 81° 22′ and 81° 59′ west longitude. The city of Cleveland and its suburbs cover, almost entirely, the 463 square miles of the county. The county is bordered by Lake Erie on the north, Lorain County on the west, Medina and Summit Counties on the south, and Geauga and Lake Counties on the east (see pl. 4). On the U. S. Geological Survey topographic maps, Cuyahoga County occupies parts of the Berea, Chagrin Falls, Cleveland, Euclid, and Mentor quadrangles.

TOPOGRAPHY AND DRAINAGE

Cuyahoga County occupies parts of two physiographic provinces, the glaciated Allegheny Plateau (southern New York section) (Fenneman, 1938, p. 243) of the Appalachian Plateaus province on the south and east, and the Eastern lake and Till Plains sections of the Central Lowlands province on the west and north. The line of demarcation between the two provinces is the Portage Escarpment, which crosses the county diagonally in approximately a northeast-southwest line. Northwest of the Portage Escarpment the terrain is relatively flat, rising gradually to the southeast in a series of steps formed by beach ridges that were developed during late glacial time, when the levels of Lake Erie were higher than at present. Southeast of the Portage Escarpment the foreslope of the glaciated Allegheny Plateau section of the Appalachian Plateaus province rises gradually to the 1,200-foot general elevation of the glaciated Allegheny Plateau. The northwestern edge of the plateau has been deeply dissected by streams that flow across the Portage Escarpment and drain into Lake Erie. Cuyahoga County is drained principally by the Cuyahoga, Chagrin, and Rocky Rivers and their tributaries. The valleys of the principal streams lie 100 to 150 feet below the general land surface.

CLIMATE

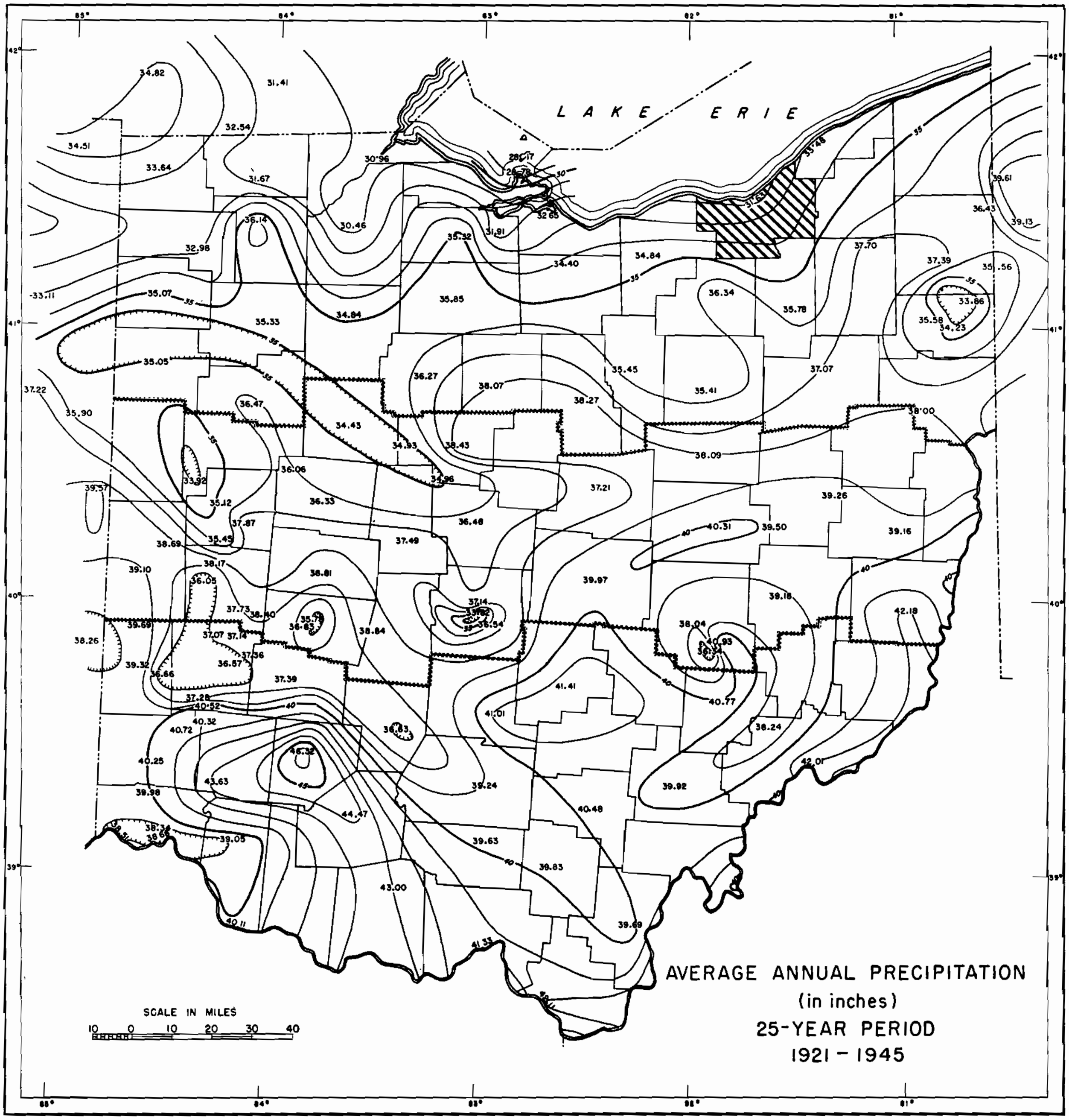
Cuyahoga County has a humid climate, with rainfall fairly evenly distributed over the year. The average annual precipitation at Cleveland, over an 80-year period of record, is 33.61 inches. July has the highest average monthly precipitation, 3.45 inches. April and December are the months of minimum average rainfall; the 80-year average for both is 2.44 inches. The isohyetal map of Ohio, plate 5, shows the comparison between the precipitation in Cuyahoga County and that in the remainder of the State. Plate 6 shows maximum, minimum, and mean monthly precipitation at Cleveland (1921-41). The average precipitation in the Erie Basin was considerably above normal during the years 1946 to 1951.

Lake Erie moderates the temperature of Cuyahoga County, causing relatively cool summers and mild winters. The 80-year average annual temperature at Cleveland is 49.2° F. July, the warmest month, has an 80-year average temperature of 71.4° F.; January, the coldest month, has an 80-year average of 26.5° F. Plate 7 shows maximum, minimum and average monthly temperatures at Cleveland, recorded by the city weather bureau, in the period 1921-41.

The average growing season in Cuyahoga County ranges from 200 days on the Lake plain to 163 days on the heights south of Cleveland. The average first and last dates of the growing season are April 17 and November 3, respectively, for the Lake plain, and May 4 and October 14, respectively, for the higher areas. These are the average dates of the last killing frost in the spring and the first killing frost in the fall.

The Cleveland Weather Bureau office was established in 1870 at the street intersection of West 9th and Superior West. The office was moved several times between 1870 and 1940, but until 1940 its location was always within a 3-block radius of Cleveland's Public Square. In 1940 the Weather Bureau was moved to the Cleveland (Hopkins) Municipal Airport, 10 miles southwest of Cleveland's Public Square. Data for plates 6 and 7 are from the climatological records, 1921-41. Plate 8 shows, from these records, the yearly average precipitation at Cleveland during the period 1872-1951. Also on plate 8, for comparison, is a graph showing precipitation for the years 1860 to 1951 at Sandusky, Ohio, where the climate is very similar to that of Cleveland.

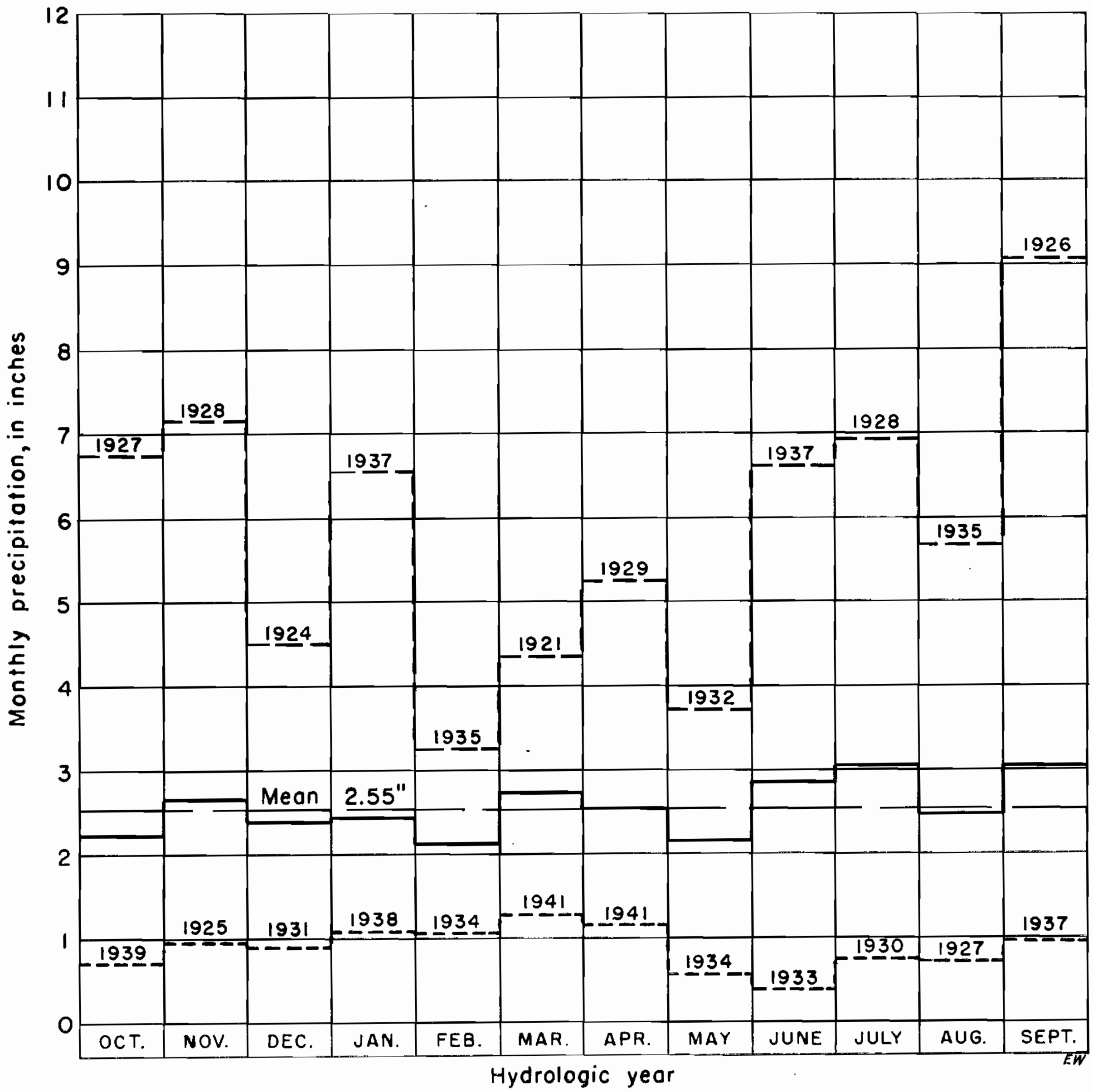
The hydrologic year, October 1 through September 30, is used because October is a month of low average precipitation and streamflow, and ground-water storage in stream basins is near a minimum. The use of the hydrologic year instead of the calendar year is desirable also because it avoids splitting the snow season.



(After E. E. Sanderson, 1950)

Plate 5. Isohyetal map of Ohio.

(Crosshatched area shows location of Cuyahoga County.)



EXPLANATION

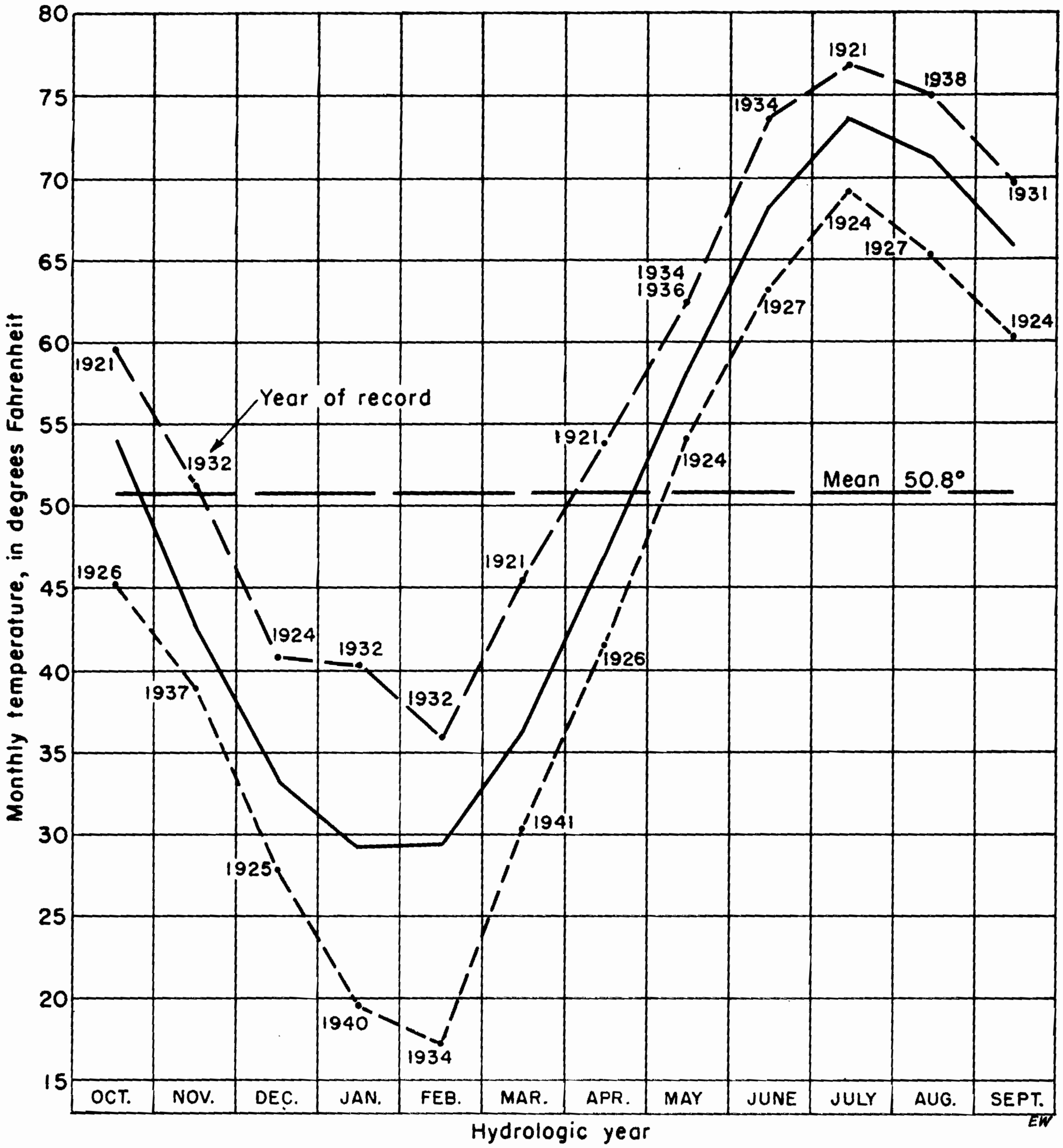
— — — Maximum monthly precipitation of record.

- - - - - - Minimum monthly precipitation of record.

——— Average precipitation each month for 21 years of record.

Date indicates year in which maximum or minimum occurred.

Plate 6. Maximum, minimum, and mean monthly precipitation at the Cleveland Weather Bureau, 1921-1941.



EXPLANATION

— — — Maximum monthly average temperature.

——— 21-year monthly average temperature.

- - - - - - Minimum monthly average temperature.

Plate 7. Maximum, minimum, and average monthly temperatures at the Cleveland Weather Bureau, 1921-1941.

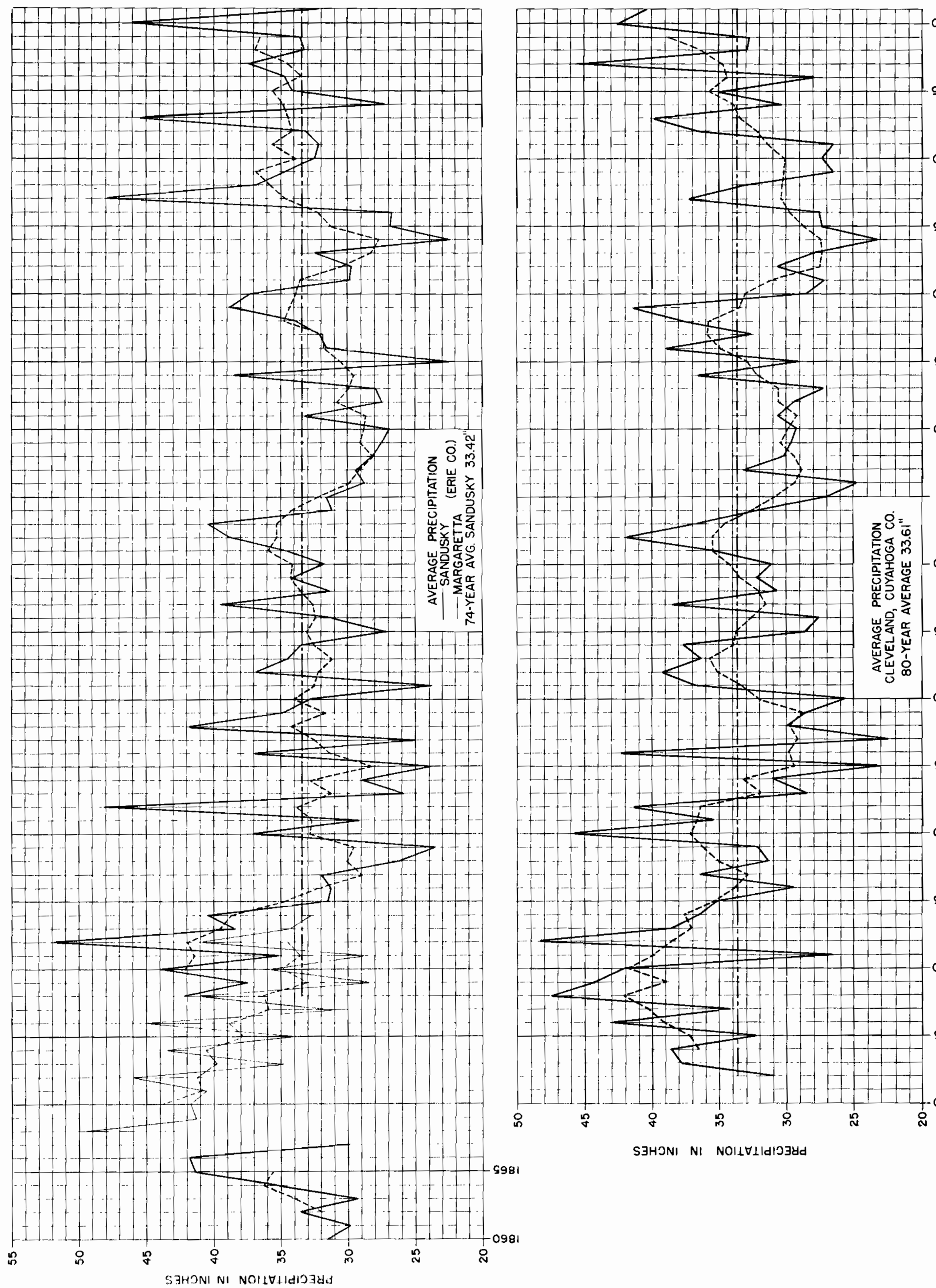


Plate 8. Annual precipitation by hydrologic years.

POPULATION

The population of Cuyahoga County, according to the 1950 census, was 1,389,532. This represents an average concentration of 3,000 persons per square mile, and is 17.4 percent of the total population of the State. It is an increase of 172,282, or 14.2 percent, over the population in 1940. The city of Cleveland has a population of 914,808. The suburban cities having populations of 9,000 or more are: Euclid, 41,396; South Euclid, 15,432; East Cleveland, 40,047; Cleveland Heights, 59,141; University Heights, 11,566; Shaker Heights, 28,222; Bedford, 9,105; Maple Heights, 15,586; Garfield Heights, 21,662; Parma, 28,897; Berea, 12,051; Fairview Park, 9,311; Lakewood, 68,071; and Rocky River, 11,237.

ECONOMIC DEVELOPMENT

Industrial Development

Cleveland is a manufacturing city of importance to industry the world over. According to the Cleveland Chamber of Commerce, in 1947 there were 3,162 manufacturing establishments in Cuyahoga County, employing 211,789 production workers. Industry ranges from the production of iron and steel to the final assembly of motor trucks. In Ohio, Cleveland is second only to Cincinnati in the manufacture of machine tools and industrial equipment. Other Cleveland industries include petroleum refining and the manufacture of chemical and electrical products.

Transportation and Public Utilities

Cuyahoga County is served by 5 railroads, 9 airlines, 13 foreign and domestic freight forwarders, 89 motor freight lines, 2 passenger steamship lines, and 7 intercity and 7 suburban motor buslines. Boats bringing iron ore from the mines of Minnesota, as well as ocean-going freighters, call at the harbor. Excellent roads connect Cleveland with the rest of the Nation.

Agriculture

Cuyahoga County is an important center of the greenhouse - vegetable - growing industry. Tomatoes, radishes, cucumbers, and other products, having an annual aggregate value of nearly $7,000,000, are grown under glass, mostly in the central and western portions of the county.

Alfalfa, wheat, corn, oats, and orchard fruit are other agricultural products of the county.

Mineral Resources

The mineral resources of Cuyahoga County are of minor value compared to its industry, although the sandstone quarries at Berea and Euclid were once important sources of high-quality building stone. The Orangeville shale and the Bedford shale are quarried to a small extent in Newburg Township in connection with the manufacture of brick and clay products. Gravel pits in valley-train, kame, and kame-terrace deposits of glacial origin produced most of the sand (498,050 tons) and gravel (488,910 tons) used in the county in 1950. The deposits are described by Smith (1949), who reported on the sand and gravel deposits in northeastern Ohio.

Deep wells produce brine from the Salina formation, and small amounts of oil and gas from the Clinton sand and the Bass Islands dolomite. These formations are all of Silurian age and are not exposed in Cuyahoga County.

WATER UTILIZATION

Water for public, domestic, and industrial use is from three principal sources in Cuyahoga County: Lake Erie, the Cuyahoga and Rocky Rivers, and wells.

Municipal Supplies

The city of Cleveland obtains its water supply from Lake Erie, through three intake cribs located approximately 4 miles from shore. In 1950 an average of 241.5 million gallons a day was pumped to supply metropolitan Cleveland. The Cleveland water-supply system serves parts of all the townships in Cuyahoga County.

The city of Berea, in Middleburg Township, obtains its water from Rocky River and from a system of reservoirs, formerly the famous Berea sandstone quarries. In 1950 the average daily consumption was 970,000 gallons.

The Chagrin Falls water department pumped an average of 200,000 gallons of water a day in 1950. Its supply is from 22 springs and 17 wells drilled into the Sharon conglomerate in Bainbridge Township, Geauga County.

Industrial Water Supplies From Lake Erie and the Cuyahoga River

Most of the industrial establishments in Cuyahoga County obtain water from the municipal system. In addition to the municipal supply, some industrial plants that require large amounts of water for cooling obtain water from the Cuyahoga River or from Lake Erie. An industrial pumpage survey conducted by the Ohio Division of Water in 1950 showed that industrial pumpage averaged 570 million gallons a day from the Cuyahoga River and about the same amount from Lake Erie. Most of the water is used for cooling and it is returned to its source after use.

Ground-Water Utilization

In Cuyahoga County most of the ground water is obtained from drilled wells; a small amount is obtained from dug wells, and a very small percentage from springs.

Domestic water requirements are generally estimated to be about 55 gallons per person each day (for the residential city of Shaker Heights, Ohio, 1950). That is less than 1 gallon a minute for a family of four. However, because most of the water is pumped during short periods of time and because most electrically powered pumps have a capacity of at least 3 gallons a minute, a well equipped with an electric pump should yield not less than this larger amount.

There are not many industrial wells in Cuyahoga County because the water demand greatly exceeds the available supply in most areas. As a result, industrial pumpage of ground water is less than 2 million gallons a day.

Most drilled wells in Cuyahoga County are cased with black iron pipe, those for domestic use ranging from 4¼ to 6 inches in diameter. Wells of all types range in depth from less than 30 feet to more than 300 feet, the average well being slightly more than 100 feet in depth. Wells that tap the glacial drift generally are finished with the lower end of the casing in permeable water-bearing sand or gravel that is sufficiently coarse to remain outside the casing when the wells are pumped. Some wells, however, penetrate sand of such fineness that it is carried into the casing whenever the well is pumped. In some the sand gradually fills the casing to the level of the pump intake and clogs the pump. Wells of this type are therefore not satisfactory, except for short periods. Wells drilled into the consolidated rock formations are cased generally only to the top of the bedrock. A second casing may be placed within the drive pipe of a bedrock well and cemented in place to shut off those zones of the consolidated rocks that yield water of undesirable mineral content.

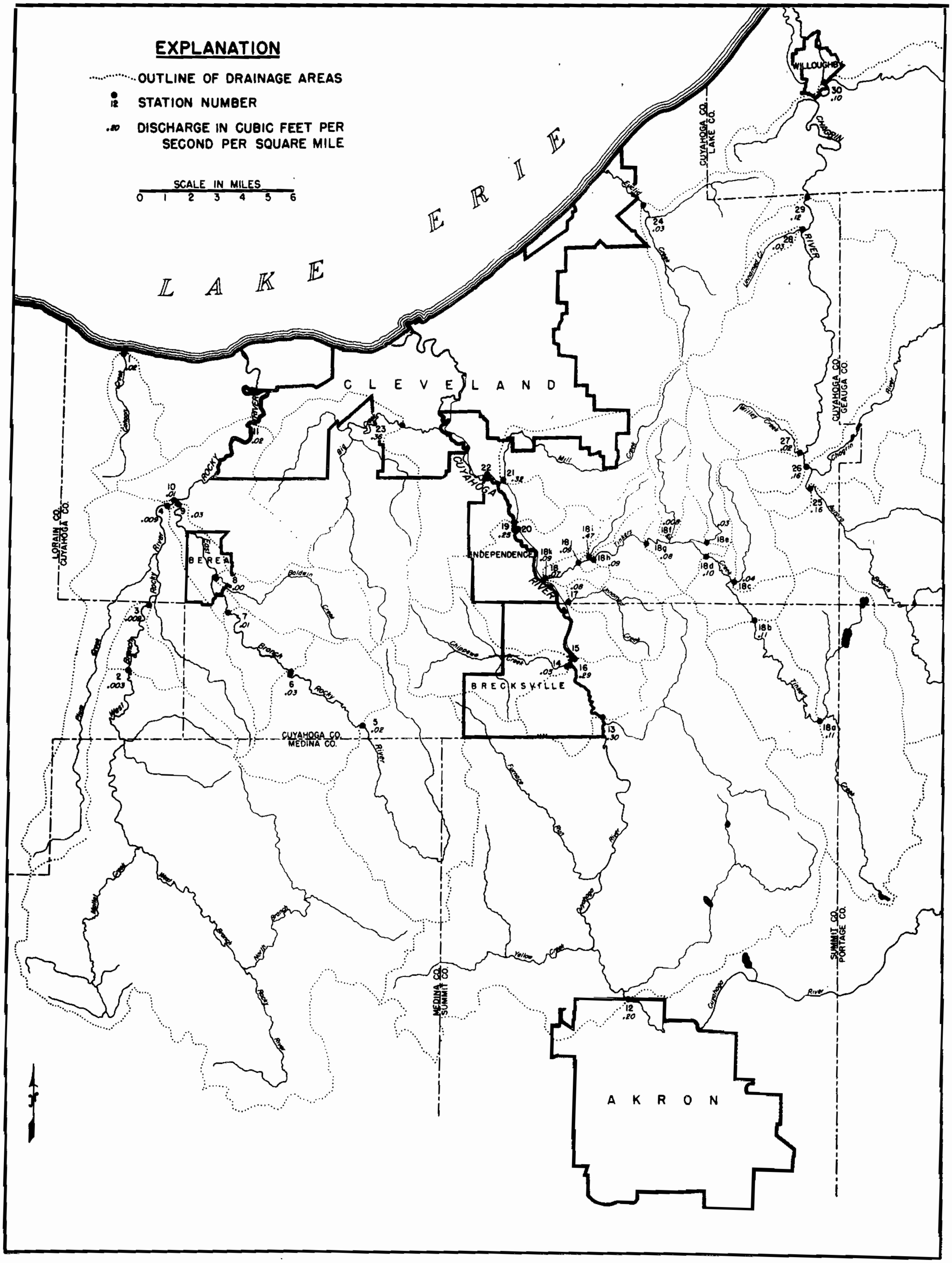


Plate 9.- Map of Cuyahoga County and vicinity showing locations of stations at which low-flow investigations were made on October 3, 1948 and August 27-29, 1951.

SURFACE WATER RESOURCES

By Earl E. Webber*

The principal river in Cuyahoga County is the Cuyahoga, which enters the county near Brecksville and flows in a northerly direction until it empties into Lake Erie at Cleveland. The Rocky River drains the western portion of the county and empties into Lake Erie at Lakewood. The Chagrin River flows along the eastern boundary of the county, and empties into Lake Erie near Willoughby in Lake County. These three rivers and their tributaries, along with numerous small streams that discharge directly into the lake, constitute the drainage system of Cuyahoga County.

STREAMFLOW RECORDS

Streamflow records on the three principal streams in Cuyahoga County have been obtained at gaging stations for various periods since 1921. Table 1 lists the gaging stations and their locations, periods of record, and drainage areas. The locations of the gages are shown on plate 9. At the present time streamflow measurement stations are being maintained on the Rocky River, the Cuyahoga River and the Ohio Canal in the county, and on the Cuyahoga River at Old Portage (north of Akron) and on the Chagrin River at Willoughby. Discharge records for the Ohio Canal were obtained in conjunction with the Cuyahoga River flow in order to determine the amount of water diverted from the river to the canal near Brecksville. The stream-gaging program in Cuyahoga County and vicinity is carried on by the U. S. Geological Survey, in cooperation with the Division of Water, Department of Natural Resources, State of Ohio, and the Corps of Engineers, U. S. Army. Daily mean discharges for the stations listed in table 1 are published annually in water-supply papers of the U. S. Geological Survey.

TABLE 1
Stream-Gaging Stations in Cuyahoga County and Vicinity

Station and location	County	Period of Record	Drainage area in square miles
Rocky River near Berea	Cuyahoga	Nov. 2, 1923 to Sept. 30, 1935; Sept. 16, 1943 to Sept. 30, 1950	269
Cuyahoga River at Old Portage	Summit	Oct. 1, 1921 to Dec. 31, 1935; Mar. 1, 1939 to Sept. 30, 1950	405
Cuyahoga River at Brecksville	Cuyahoga	Mar. 1, 1923 to June 12, 1924	584
Cuyahoga River at Independence	Cuyahoga	Oct. 1, 1921 to May 31, 1923; Sept. 5, 1927 to Dec. 31, 1935; Mar. 5, 1940 to Sept. 30, 1950	709
Ohio Canal at Brecksville	Cuyahoga	Mar. 1, 1923 to June 12, 1924	
Ohio Canal at Independence	Cuyahoga	Oct. 1, 1921 to May 31, 1923; Aug. 29, 1927 to Dec. 31, 1935; Oct. 1, 1940 to Sept. 30, 1950	
Chagrin River at Willoughby	Lake	July 9, 1924 to Nov. 30, 1935; Oct. 1, 1939 to Sept. 30, 1950	251

Streamflow is a phenomenon of nature, and as such its magnitude and distribution cannot be predicted accurately. However, if an accurate and continuous record of flow has been obtained for a period of at least 10 years, the regimen of streamflow established during such a period may be used to predict the magnitude and duration of flow in the future with a fair degree of accuracy. Longer records, being larger samples, give more dependable results, but flows larger or smaller than those recorded may occur at any time, owing to the uncontrollable vagaries of nature. Similarly, longer records reduce the chance that new extremes of flow will occur during an additive year of record. The average length of record for the four stations included in this report is 21 years, extending from the early twenties

* Hydraulic Engineer, U. S. Geological Survey.

through 1950, with a break in three records from 1936 to 1939 and in the fourth from 1936 to 1943. Examination of the precipitation records for the northern part of Ohio reveals that no severe droughts occurred during the breaks in streamflow records, but that there was a period of high flow in January 1937.

Average discharge throughout Ohio at streamflow stations with 10 years or more of record is about 0.9 cfs (cubic foot per second) per square mile with extreme values of 0.58 and 1.36. As shown by table 2, the flow of Rocky River is near the average discharge for streams in Ohio, the Cuyahoga River is slightly above average, and the Chagrin River has one of the higher average discharges in the State. Adjusting the average discharge at Old Portage for the 50 cfs diverted for municipal supply of Akron would increase it to 1.14 cfs per square mile of drainage area. As the major factors affecting average streamflow for a long period of time (rainfall and temperature) are approximately uniform for all parts of the area, it would appear that Cuyahoga County is about average in the conversion of rainfall to runoff, the surface-water yield in the Chagrin River basin being the greatest in the area.

FLOW-DURATION CURVES

An important aspect of streamflow characteristics is the percent of time that flows of certain magnitude may be expected. If specified discharges of a stream are plotted against the percentages of time during which those discharges were equaled or exceeded, a flow duration curve is developed as shown on plates 10 to 13. The resulting curve illustrates the percent of time that flows of indicated magnitudes were equaled or exceeded during the period of record. This curve gives a fairly reliable indication of future stream performance for water supply and related purposes. The main disadvantage of such a presentation is that the time sequence of occurrence is lost, and for that reason other methods such as mass diagrams should be used in conjunction with the duration curve in order to make a complete study.

Duration curves with gentle slopes indicate the basins that have sustained high base flows and low peak discharges due to permeable geologic formations or to large storage facilities such as swamps, lakes, and reservoirs. Duration curves with steep slopes are identified with basins having low sustained base flows and high peak

TABLE 2

Summary of Streamflow Data for Streams in Cuyahoga County and Vicinity

Station No.	169	173[1]	174[2]	178[3]
Stream	Rocky River	Cuyahoga River	Cuyahoga River	Chagrin River
Location	Near Berea	At Old Portage	At Independence	At Willoughby
County	Cuyahoga	Summit	Cuyahoga	Lake
Drainage area in square miles	269	405	709	251
Years of record and period included[4]	18 {1925-35, 1944-50}	25 {1922-35, 1940-50}	19 {1922, 1928-35, 1941-50}	21 {1926-35, 1940-50}
Average discharge				
in cfs/sq. mi.	0.903	1.02	1.06	1.18
in in.	12.26	13.85	14.39	16.02
Minimum discharge, cfs/sq. mi.	.0007	.035	.068	.012[5]
Maximum discharge, cfs/sq. mi.	63.2	9.43	15.7	112
Ratio max. to min.	90,300	269	231	9,330
Flow duration discharge equaled or exceeded in cfs per sq. mi. for percent of time:				
10	2.08	2.44	2.52	2.83
25	.628	1.32	1.24	1.16
50	.163	.593	.523	.418
75	.054	.296	.291	.195
90	.021	.183	.213	.111
Storage[6] required in million cu. ft. per sq. mi. to maintain a flow of:				
0.5 cfs/sq. mi.	15.0	6.1	5.6	5.9
Average discharge	72.8	71.2	79.0	85.6

[1] Does not include diversion of about 50 cfs for Akron water supply. (Low flow regulated by industrial use above station.)
[2] Includes canal flow.
[3] Does not include diversion for water supply of Willoughby. Diversion averaged about 2 cfs during 1950.
[4] Complete water years through 1950.
[5] Based on minimum daily discharge.
[6] Adjusted to base period 1921-45.

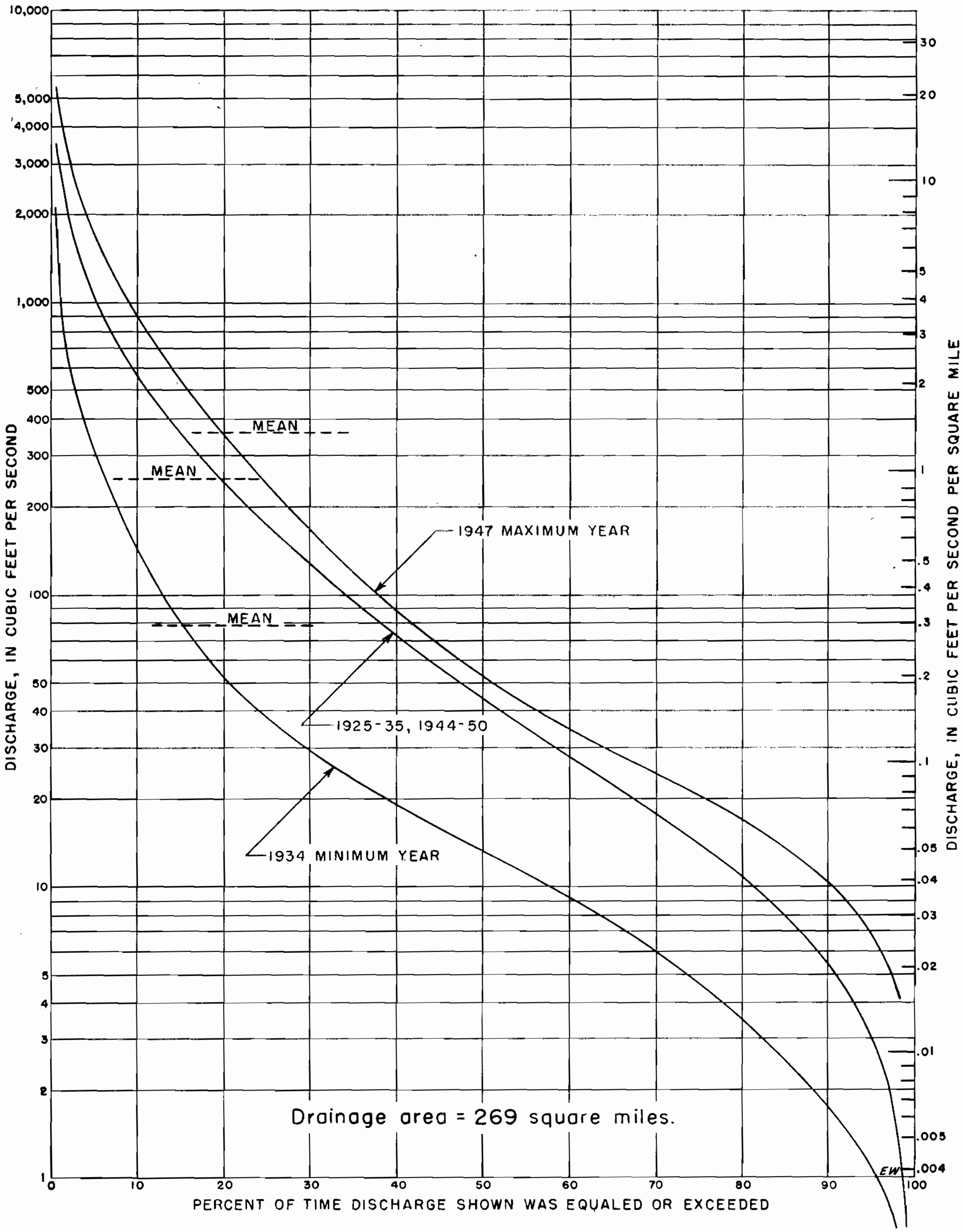


Plate 10. Duration curves, Rocky River near Berea.

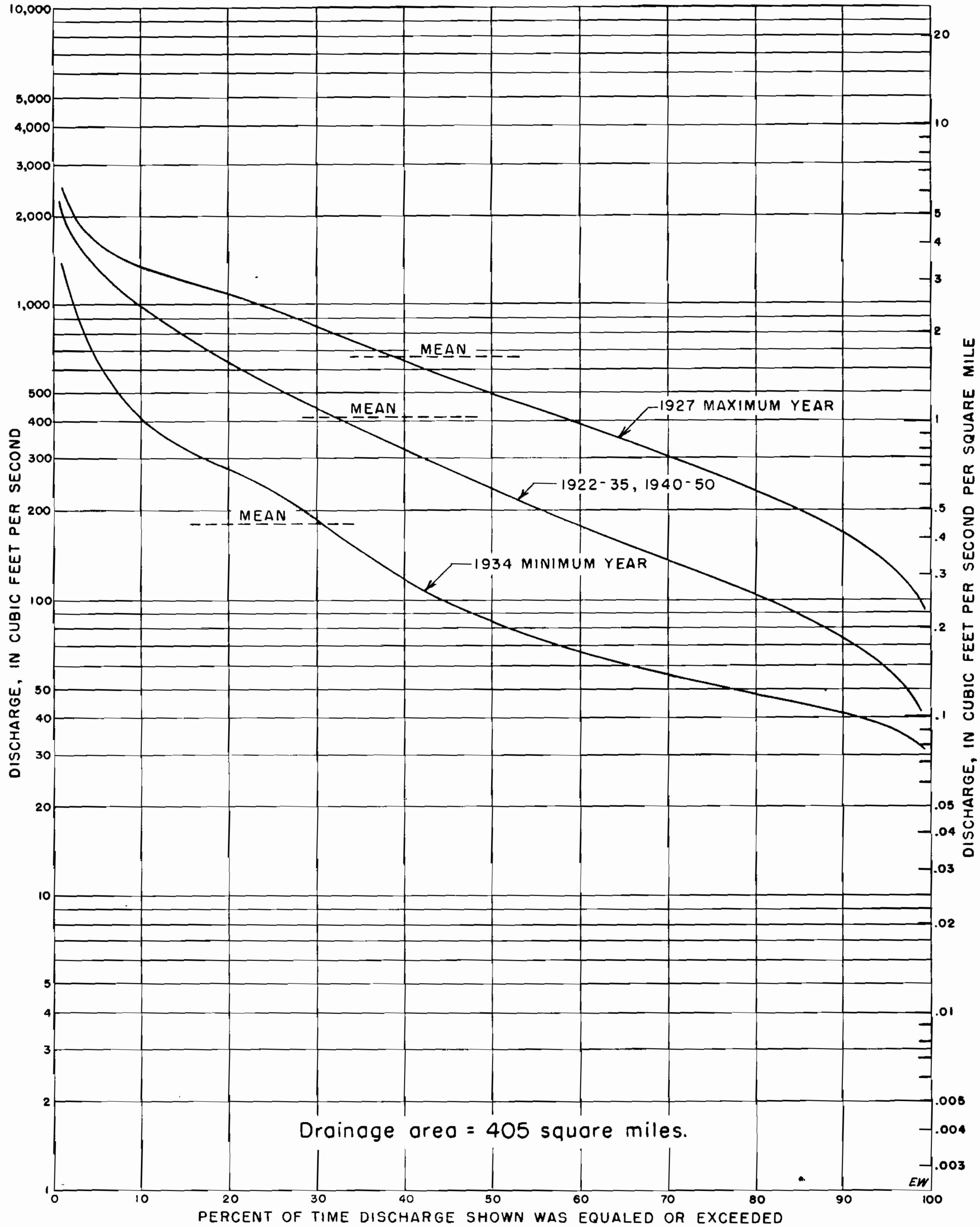


Plate 11. Duration curves, Cuyahoga River at Old Portage.
(Akron water supply diversion not included.)

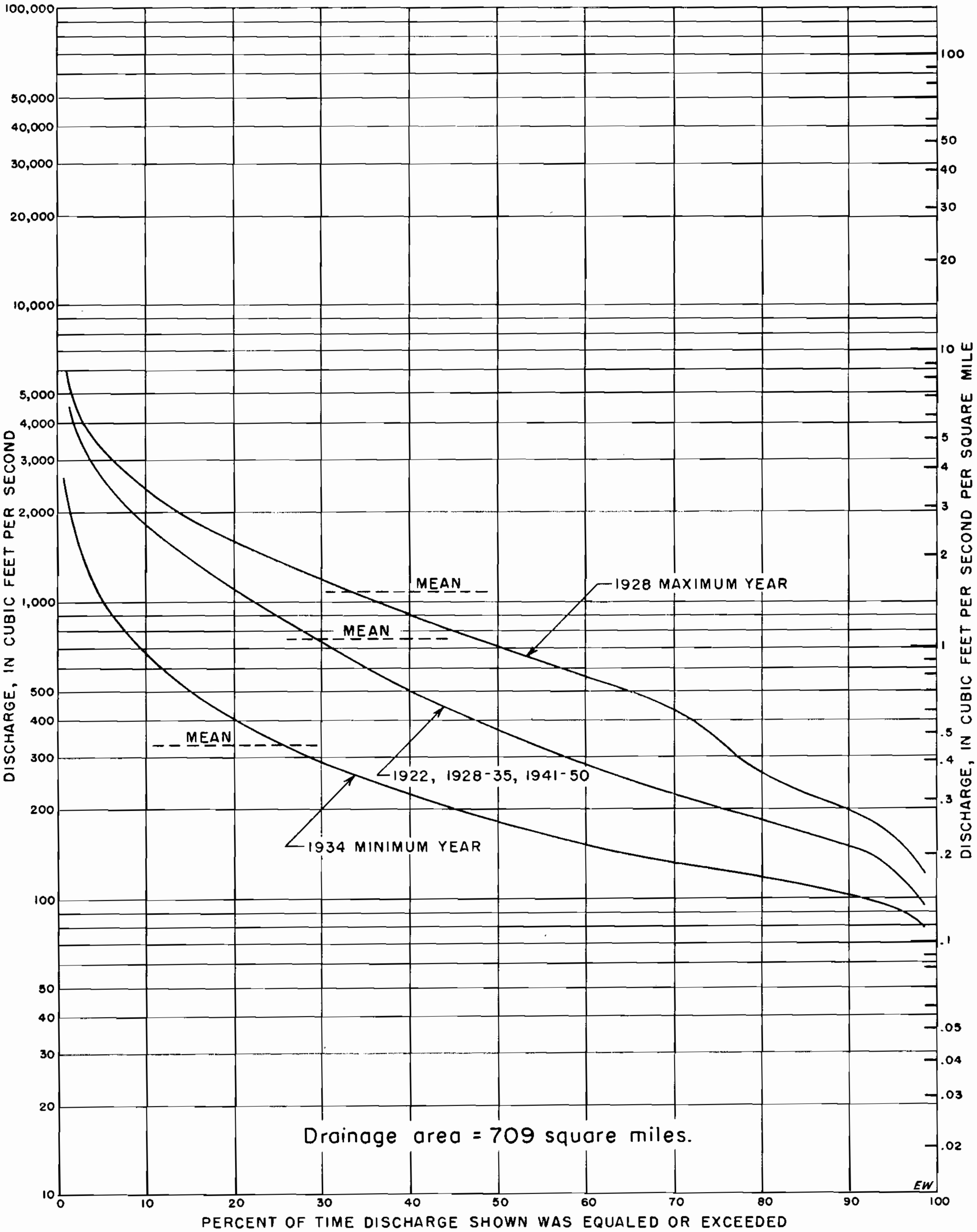


Plate 12. Duration curves, Cuyahoga River at Independence.
(Includes flow in Ohio Canal.)

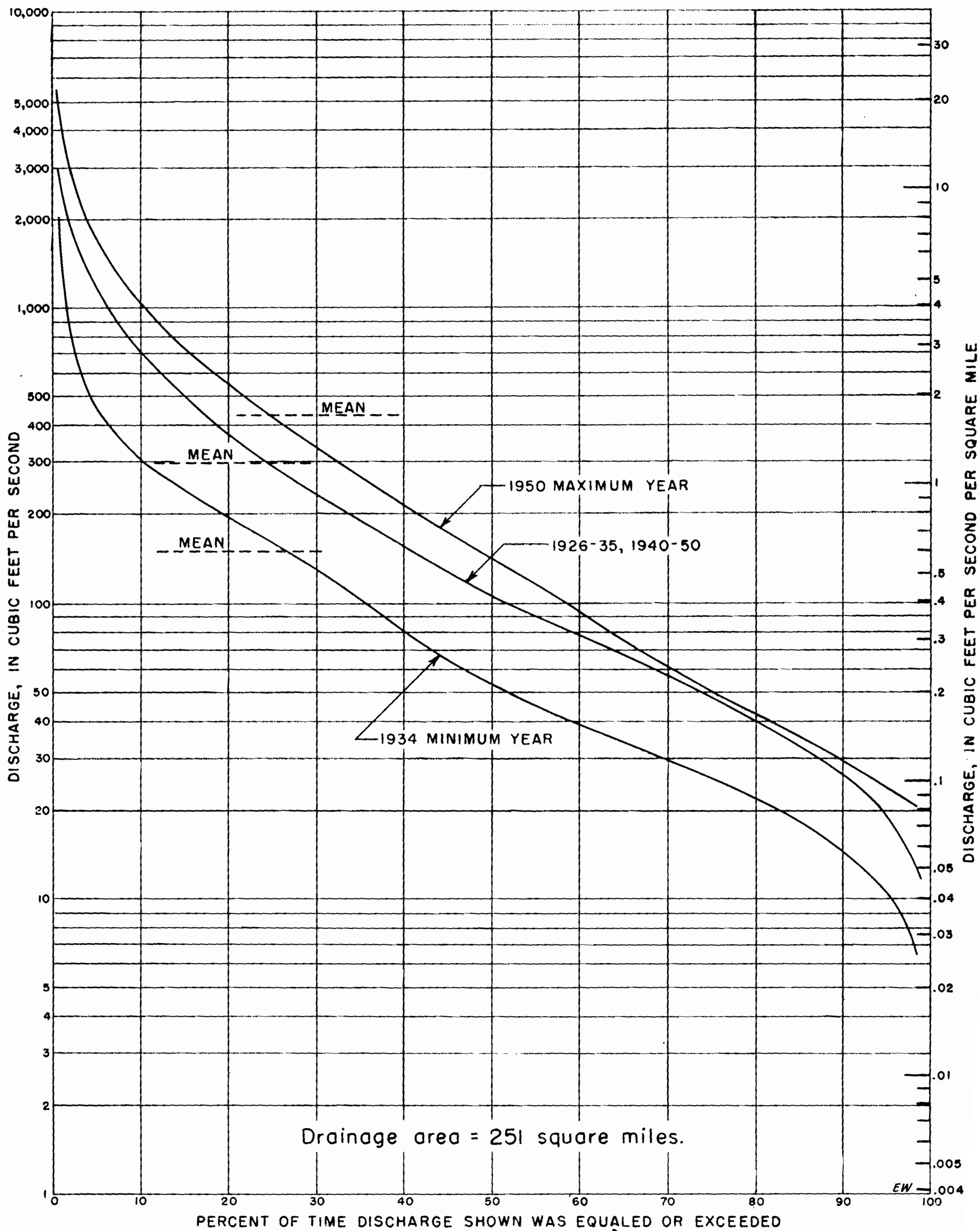


Plate 13. Duration curves, Chagrin River at Willoughby.
(Willoughby water supply diversion not included.)

discharges due to impermeable geologic formations and the absence of storage facilities. Rocky River (see pl. 10) is an example of the later type of basin, and the Cuyahoga River (see pls. 11 and 12) is an outstanding example of the former. The duration curve for Chagrin River, plate 13, presents a combination of the two extremes in that, while the slope of the duration curve is about average, the upper portion is steep, indicating flood-producing topography and the lower end flattens out, indicating higher sustained low flows than are found in the Rocky River basin. The brief tabular form of these curves may be found in table 2.

LOW-FLOW MEASUREMENTS

On October 3, 1948, and August 27-29, 1951, low-flow characteristics of the streams in Cuyahoga County were examined in a more detailed manner than possible from analysis of stream-gaging records. The discharge of a stream at the 90 percent point on the duration curve has been utilized as a "low-flow index." When the streamflow recedes to this value, the discharge is generally supplied by ground-water sources and, therefore, becomes an index of the sustaining or base-flow qualities of the area upstream from the point in question. Simultaneous discharge measurements made at the time when the flow is near the index point are clues to possible ground-water supplies if there is no regulation or diversion upstream.

Tinkers Creek is tributary to the Cuyahoga River and drains an area of about 100 square miles southeast of Cleveland. On October 3, 1948, 11 discharge measurements were made in Tinkers Creek basin to study its low-flow characteristics. The results are listed in table 3, in which the station numbers correspond to those

TABLE 3
Low Flow Measurements in Tinkers Creek Basin on October 3, 1948

Station Number	Stream	Location	Drainage area (sq. mi.)	Flow (cfs)	Flow (cfs per sq. mi.)	Flow index (cfs per sq. mi.[1])
18a	Tinkers Creek	0.5 mile below Pond Brook, 400 feet below bridge on State Highway 14, and 2½ miles southeast of Twinsburg, Summit County	42.4	4.57	0.11	0.08
18b	Tinkers Creek	200 feet below bridge on Glenwood Road, and 2 miles northwest of Twinsburg, Summit County	56.2	6.07	.11	.08
18c	Unnamed tributary	0.2 mile above mouth at bridge on Cochran Road, 4 miles northwest of Twinsburg, and in Cuyahoga County	6.53	.26	.04	.03
18d	Tinkers Creek	500 feet above bridge on Richmond Road, and 2½ miles east of Bedford, Cuyahoga County	69.7	6.90	.10	.08
18e	Unnamed tributary	0.7 mile above mouth, 100 feet above bridge on Richmond Road, and 2½ miles east of Bedford, Cuyahoga County	6.25	.16	.03	.02
18f	Unnamed tributary	0.3 mile above mouth and 200 feet below bridge 1 mile east of Bedford, Cuyahoga County	5.10	.04	.008	.006
18g	Tinkers Creek	500 feet above Pennsylvania R. R. bridge at Bedford, Cuyahoga County	86.0	7.06	.08	.06
18h	Tinkers Creek	2.4 miles above mouth, ⅓ mile above Dunham Road, and 2¼ miles west of Bedford, Cuyahoga County	91.6	7.94	.09	.07
18i	Unnamed tributary	0.1 mile above mouth, ¼ mile above Dunham Road, and 2½ miles west of Bedford, Cuyahoga County	2.68	1.25	.47	.36
18j	Tinkers Creek	1.8 miles above mouth, ¼ mile below Dunham Road, and 2¾ miles west of Bedford, Cuyahoga County	94.6	8.71	.09	.07
18k	Tinkers Creek	0.2 mile above mouth, 500 feet above Canal Road bridge, near Independence, Cuyahoga County	96.5	8.79	.09	.07

[1] Computed by multiplying measured flow by 0.761.

TABLE 4

Low-Flow Measurements in Cuyahoga County and Vicinity During August 27-29, 1951

Station Number	Date	Stream	Location	Drainage area in sq. mi.	Discharge in cfs	Flow index cfs per sq. mi.
	Aug.					
1	27	Cahoon Creek	At mouth, Cuyahoga County	7.92	0.12	0.02
2	28	West Branch Rocky River	At bridge on State Highway 82 at Columbia Center, Lorain County	143	.49	.003
3	28	West Branch Rocky River	At bridge on State Highway 252 at Westview, Cuyahoga County	148	1.29	.009
4	28	West Branch Rocky River	0.3 mile above mouth, Cuyahoga County.	188	1.76	.009
5	28	East Branch Rocky River	At bridge on State Highway 3, 2 miles south of North Royalton, Cuyahoga County	36.3	.78	.02
6	28	East Branch Rocky River	At bridge on State Highway 82, 2 miles east of Strongsville, Cuyahoga County	55.8	1.46	.03
7	28	East Branch Rocky River	2.2 miles above Baldwin Creek, Cuyahoga County	63.5	.76	.01
8	28	Baldwin Creek	At mouth, Cuyahoga County	11.4	0	0
9	28	East Branch Rocky River	At mouth, Cuyahoga County	79.7	2.05	.03
10	28	Rocky River	At gaging station near Berea, Cuyahoga County	269	3.44	.01
11	27	Rocky River	0.2 mile above State Highway 10, Cuyahoga County	288	5.63	.02
12	28	Cuyahoga River	At gaging station at Old Portage, Summit County	405	81.1	.20
13	28	Cuyahoga River	0.3 mile below Brandywine Creek, Cuyahoga County	557	167	.30
14	28	Chippewa Creek	0.3 mile above mouth, Cuyahoga County.	16.6	.84	.05
15	28	Cuyahoga River	0.4 mile below Chippewa Creek and 600 feet below diversion into Ohio Canal, Cuyahoga County	585	79.3	.29 (15 and 16 combined)
16	28	Ohio Canal	¼ mile below Chippewa Creek at diversion from Cuyahoga River, Cuyahoga County		90.1	
17	28	Unnamed Creek	0.1 mile above mouth at Cuyahoga-Summit County line	7.14	0.56	.08
18	28	Tinkers Creek	0.1 mile above mouth, Cuyahoga County.	96.5	6.69	.07
19	28	Cuyahoga River	At gaging station at Independence, Cuyahoga County	709	109	.25 (19 and 20 combined)
20	28	Ohio Canal	At gaging station at Independence, Cuyahoga County		66.6	
21	28	Mill Creek	0.1 mile above mouth, Cuyahoga County.	18.1	5.86	.32
22	28	Ohio Canal	At bridge, 0.7 mile below Mill Creek Crossing, Cuyahoga County		82.6	
23	28	Big Creek	At Brookside Park, 1.8 miles above mouth, Cuyahoga County	37.4	13.4	.36
24	29	Euclid Creek	900 feet above bridge on U. S. Highway 20, Cuyahoga County	21.1	.69	.03
25	28	Aurora Branch	0.9 mile above mouth, 500 feet below Solon Road bridge, Cuyahoga County	55.0	8.60	.16
26	28	Chagrin River	At Miles Road bridge, 0.2 mile below mouth of Aurora Branch, Cuyahoga County	119	18.8	.16
27	28	Willey Creek	0.1 mile above mouth, Cuyahoga County.	5.08	.09	.02
28	28	Unnamed Creek	At junction of State Highway 174 and Wilson Mills Road at Wilson Mills, Cuyahoga County	1.92	.05	.03
29	28	Chagrin River	800 feet above Cuyahoga-Lake County line	175	21.4	.12
30	28	Chagrin River	At gaging station at Willoughby, Lake County	251	24.8	.10

on plate 9. At that time the flow was 37 cfs in the Chagrin River at Willoughby and 13 cfs in the Rocky River near Berea. These flows correspond to duration curve percentages of 82 and 77 respectively, or somewhat higher than the 90 percent points, or index flows. Accordingly, it is assumed that the observed flows in the Tinkers Creek basin also were higher than the index flow. This is verified by measurement 18, made on August 8, 1951, at the same location as measurement 18k, made on October 3, 1948. On August 8, 1951, Tinkers Creek was near index flow, on the basis of records at the nearby gaging stations. The discharge ratio of 18 to 18k ($6.69 \div 8.79 = 0.761$) was applied to the measured flows of October 3, 1948 to reduce them to index flows as listed in table 3. From the adjusted flows it appears that Tinkers Creek basin has about average base flow[1], with the exception of three tributaries (18c, 18g, 18f) draining from the north in the upper end of the basin, which are below the average, and one tributary (18i) draining 2.68 sq. mi. near Bedford, which is among the highest in the State. However, a large part of the high sustained flow in this stream is sewage from the Maple Heights and Bedford sewage disposal plants, and is a diversion from Lake Erie by way of the Cleveland water supply.

The county-wide investigation of low flow made August 27-29, 1951, consisted of 30 discharge measurements, the results of which are in table 4 with corresponding locations shown on plate 9. Only two of the four streamflow stations in the area (Rocky and Chagrin Rivers) are unaffected by serious regulation or diversion and they were at 94 and 92 percent levels, respectively, on the duration curves. The western portion of the county, drained by Rocky River and its tributaries and small streams flowing directly into the lake, has a small sustained low flow as was indicated by the steep duration curve for Rocky River near Berea. Low flow of the Cuyahoga River is relatively high, as indicated in table 4, due to regulation by natural and artificial storage in the upper reaches of the basin. The central portion of Cuyahoga County is drained by Chippewa, Tinkers, Mill, and Big Creeks, tributaries of the Cuyahoga River. Chippewa and Tinkers Creeks have about average sustained low flows but Mill and Big Creeks rank with the highest in the State. The high flow in Big Creek on August 28, 1951 probably was due to sewage augmentation of the natural flow, as the geologic formations in the valley do not substantiate the high flow measured. Although the extreme pollution of Mill Creek during periods of low flow indicates augmentation from sewage or industrial wastes, it seems probable that the high sustained flow was due in part to better-than-average ground-water effluent. The northeastern part of the county, which drains directly into Lake Erie, has low base flows as shown by the Euclid Creek measurement.

Data on the Chagrin River basin, part of which covers the eastern portion of Cuyahoga County, is interesting. The low-flow index of 0.10 at the stream-gaging station at Willoughby (drainage area 251 sq. mi.) is higher than the average for the State, but measurement No. 26 shows that about 76 percent of the flow at Willoughby comes from the 119 sq. mi. area that is drained by Aurora Branch and the Chagrin River above Aurora Branch. Low flow in the Chagrin River above Aurora Branch is augmented by storage in small reservoirs and sewage from Chagrin Falls. The Aurora Branch low flow discharge indicates the possibility of ground-water supplies in that basin. That portion of the county drained by the Chagrin River below Aurora Branch is unproductive, as shown by measurements 26-30. In general, the areas in and adjacent to Cuyahoga County that have the best possibilities of ground-water supplies, as indicated by measurements of surface flow, are the Mill Creek and Aurora Branch basins and the basins of the upper tributaries to Chippewa Creek.

DROUGHT FREQUENCY AND UNIT-STORAGE CURVES

An important feature of low-flow investigation is the time element, or the number of consecutive days that flows of certain magnitudes have been recorded. Minimum consecutive flows for periods of 1, 7, 20, 30, 60, 120, and 183 days for each year at the four stream-gaging stations were tabulated, arrayed in descending order of magnitude, and plotted on probability paper. Average curves were drawn through the widely scattering points. See pls. 14-17. The curves indicate the probable recurrence interval, in years, of various minimum consecutive flows. Extrapolation beyond the period of record (18-25 years) is not advisable. These curves further substantiate the duration curves, as they show Rocky River having very low flow over extended periods, the Chagrin River having about average low flow, and the Cuyahoga River having well-sustained flow during dry periods.

Another method of analysis of streamflow, which takes into account the duration of various minimum consecutive flows, is to prepare curves showing the storage required to maintain flow at specified levels. The smallest quantities of water discharge during various periods from 1 to 7 years for the entire period of record at the four stream-gaging stations were tabluated. The difference between these minimum quantities and the quantities needed to maintain specified flows is the storage required.

[1] The average low-flow index of 98 streamflow stations in the State is 0.08 cfs per square mile with extreme values of 0.002 and 0.35, (Cross, and Bernhagen, 1949).

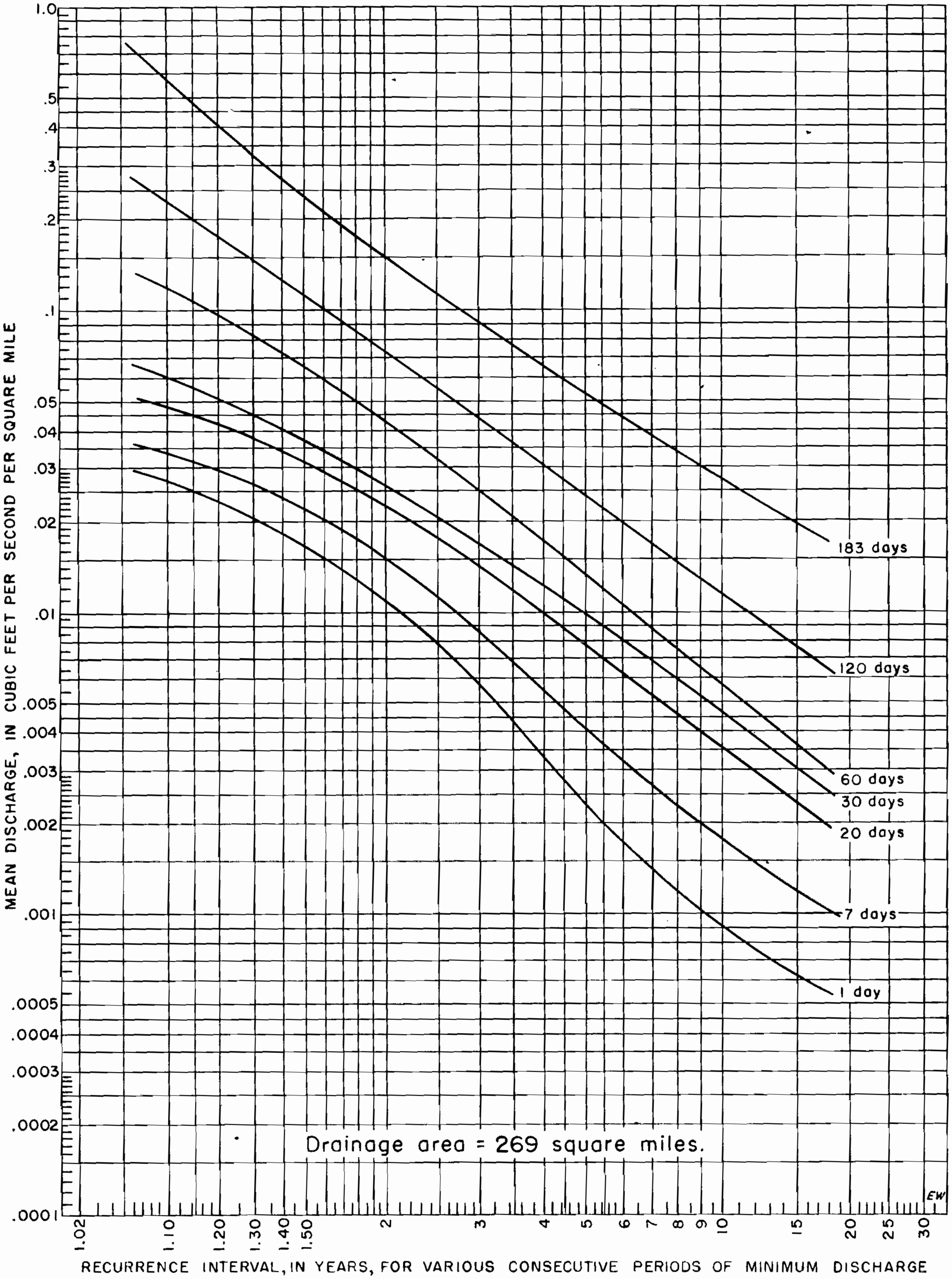


Plate 14. Drought-frequency curves, Rocky River near Berea.

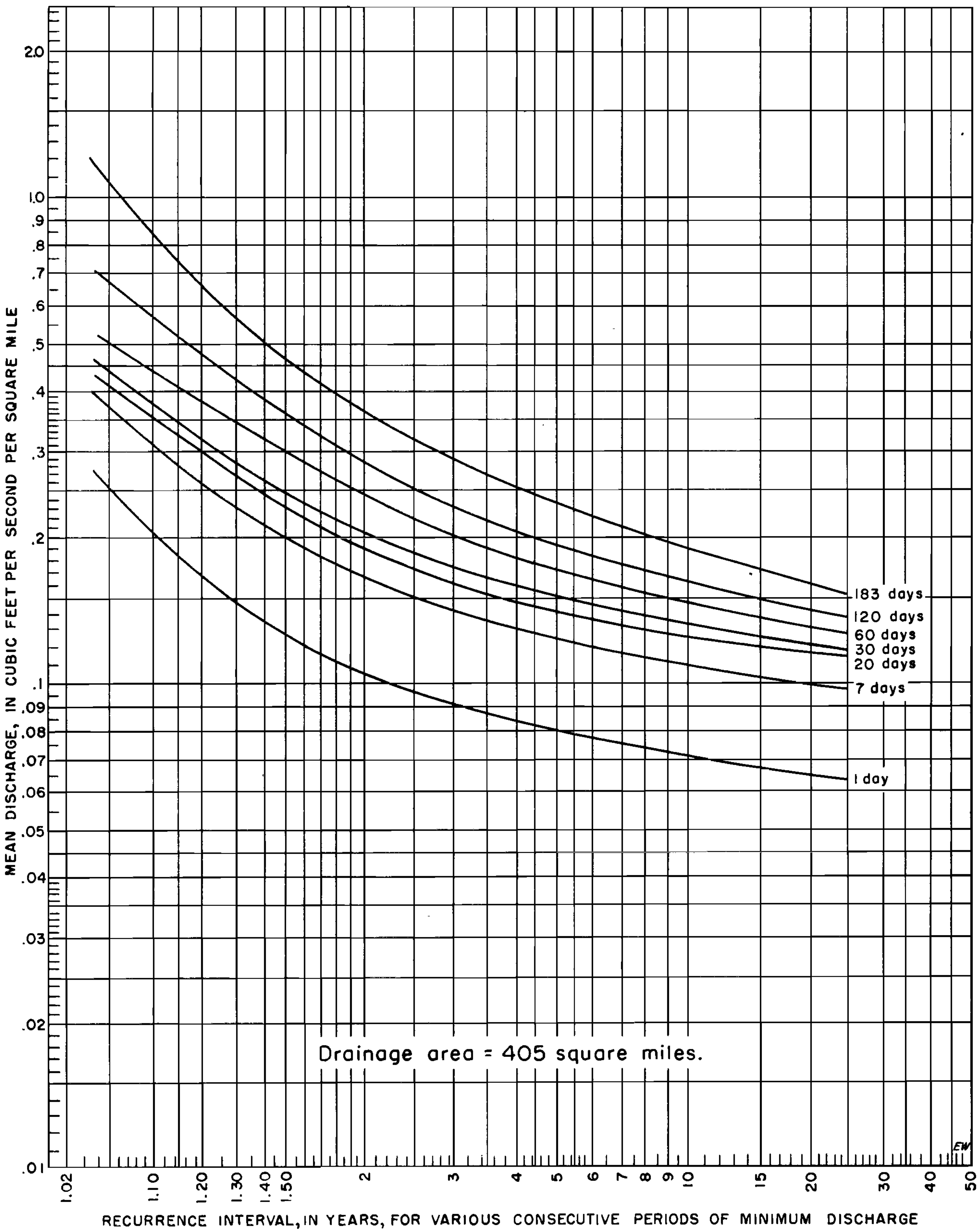


Plate 15. Drought-frequency curves, Cuyahoga River at Old Portage.
(Akron water supply diversion not included.)

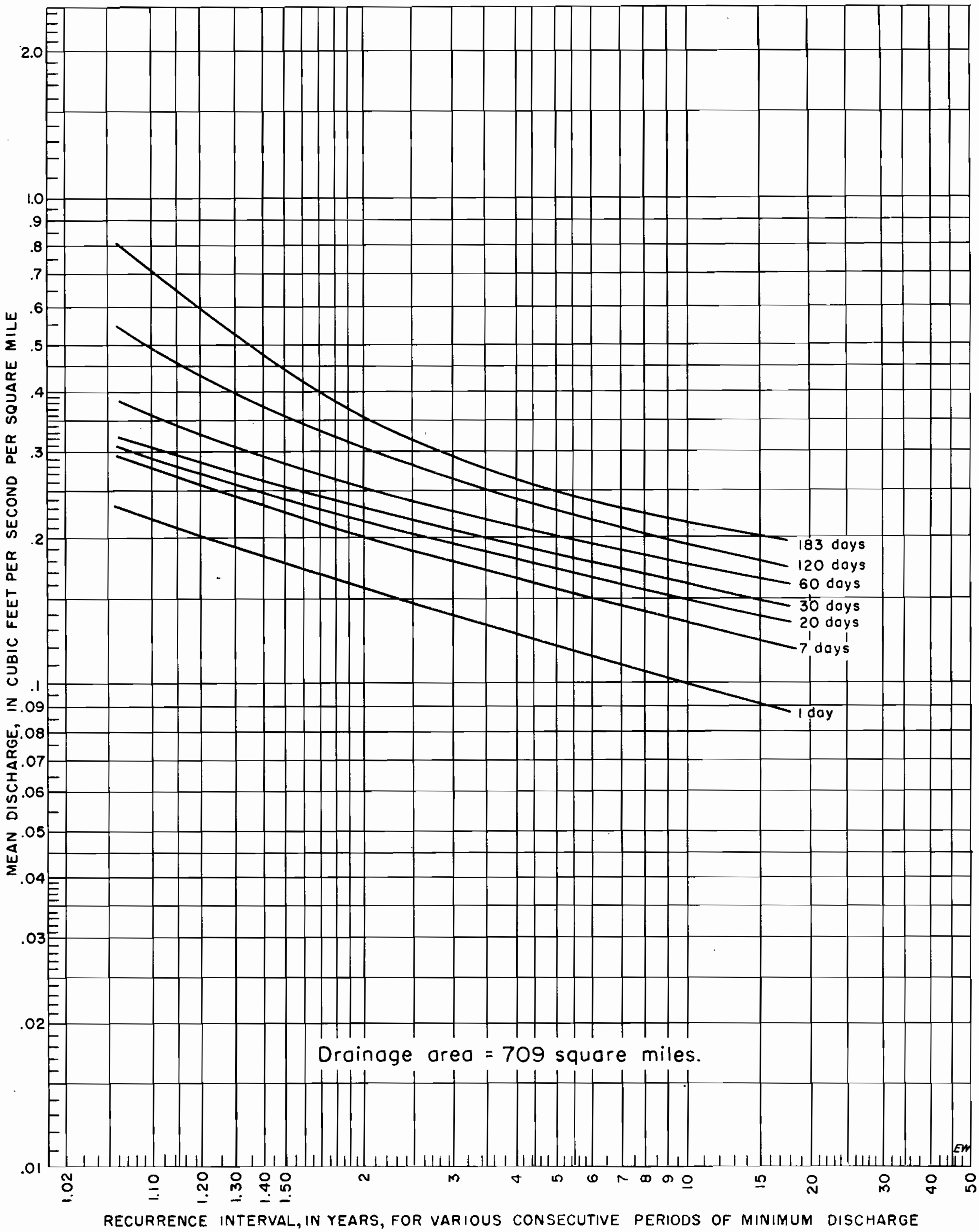


Plate 16. Drought-frequency curves, Cuyahoga River at Independence.
(Includes flow in Ohio Canal.)

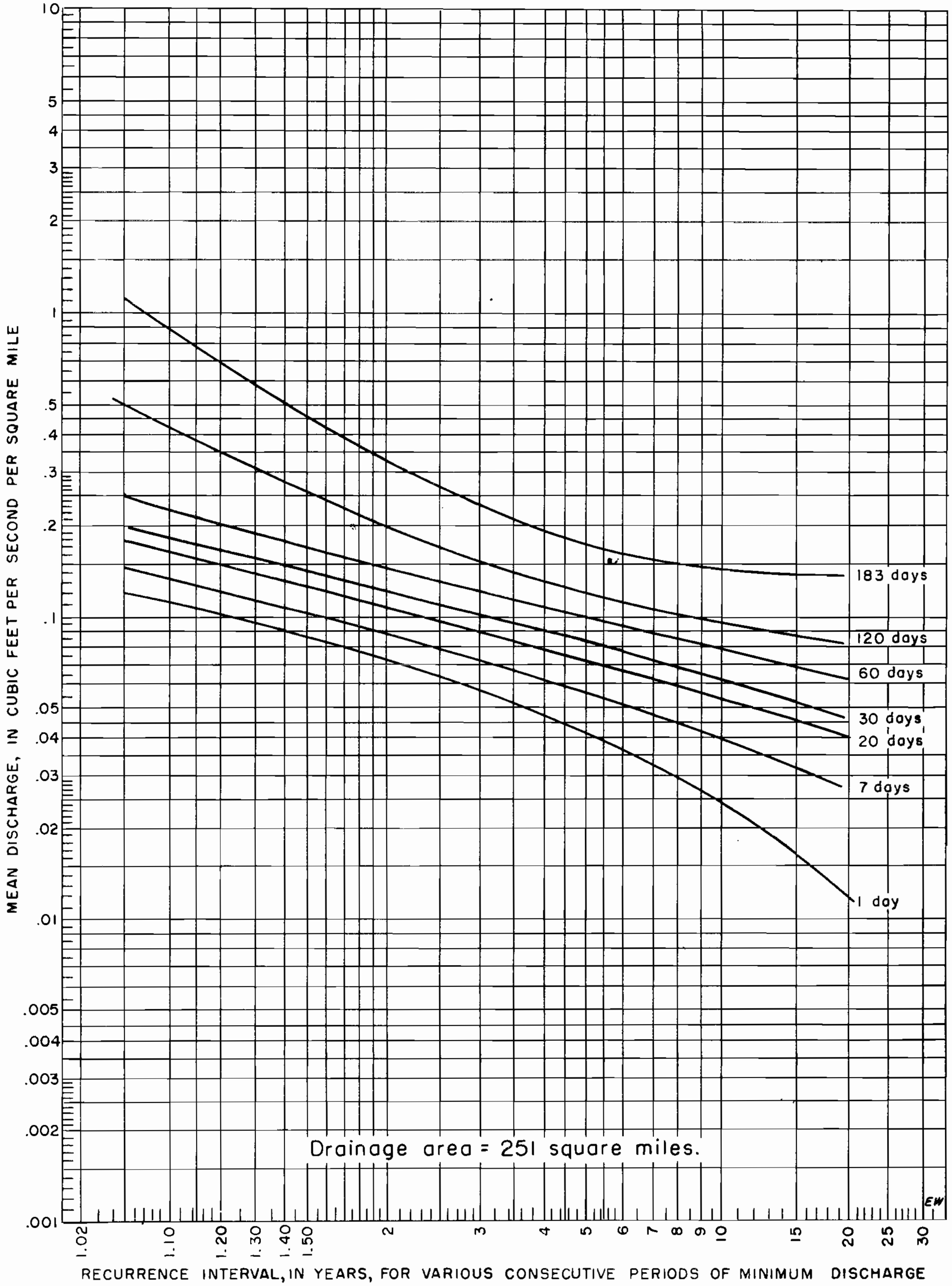


Plate 17. Drought-frequency curves, Chagrin River at Willoughby.
(Willoughby water supply diversion not included.)

Although evaporation and transpiration losses are not included, the resulting storage required is an important factor in the selection of reservoir sites to be used for low flow regulation. The storage required in million cubic feet per square mile to maintain a specified regulated flow was plotted against the regulated flow, and the resulting unit-storage graphs were developed as shown by the solid lines in plates 18 to 21, inclusive. Critical periods of time were listed beside each point, and smooth curves were drawn through or to the right of all points. As the records of all four stations have breaks of varying lengths, they were adjusted to the 25-year base period 1921-45 by utilizing the continuous record at the four stations listed in table 6. The resulting curves are shown by dashed lines. The Statewide average storage required to maintain a regulated flow of 0.5 cfs per sq. mi., adjusted to the 25-year base period, is 14.3 million cu. ft. per sq. mi., with extreme values of 30.0 and 5.2, (Cross, and Webber, 1950). Referring to table 2, it is apparent that Rocky River is about average in this aspect, and the other three stations are definitely below average in storage requirements, which again points out their high sustained-flow characteristics.

Floods

The magnitude and frequency of floods are complicated by numerous interrelated factors that affect analyses in varying and unknown amounts. At the present time there is no comprehensive flood formula that integrates the major factors such as drainage area, rate of rainfall, type of topography, type of soil, or condition of soil due to antecedent rain. Although melting of snow in Ohio is generally a minor flood factor, it could increase the severity of floods in the northern portion of the State.

The greatest discharges occurring in each water year at the two Cuyahoga River stations and at the Chagrin River station have been plotted against the computed recurrence interval in years and the flood-frequency curves were developed as shown on plates 22 to 24 inclusive. The average flood, plotted at the 2.33-year recurrence interval, is probably good to within 20 percent and the 10 year flood within 40 percent. The Geological Survey considers regional flood-frequency studies to be more reliable than studies based on individual station records as presented in this report. However, no regional flood-frequency is available and the method used here, based on individual station records, is for the purpose of indicating the probable frequency of floods in the range experienced during the period of record. Ten-year frequency floods for these three stations are tabulated in table 5 along with other streams having about the same drainage areas that are known to be high- and low-flood producers, (Cross, 1946). The Myers rating (Cross, 1948), a method of comparing floods for different drainage areas, has been computed. The general conclusions are that the Cuyahoga River probably will not produce floods of serious magnitude (as was indicated by the duration curve), but that the Chagrin River has flood producing characteristics of a higher order.

TABLE 5
Comparison of Floods of 10-Year Frequency for Selected Ohio Streams

Stream and location	Drainage area (sq. mi.)	Flood discharge (cfs)	Flood discharge (in cfs per sq. mi.)	Myers Rating %
Chagrin River at Willoughby, Lake County	251	17,800	70.9	11.2
Twin Creek near Germantown	275	10,000	35.4	5.9
Whiteoak Creek near Georgetown	221	18,000	81.4	12.1
Cuyahoga River at Old Portage, Summit County	405	3,740	9.2	1.9
Killbuck Creek at Killbuck	466	7,500	16.1	3.5
East Fork Little Miami River at Perintown	477	36,000	75.5	16.5
Cuyahoga River at Independence, Cuyahoga County	709	10,400	14.7	3.9
Raccoon Creek at Adamsville	587	10,500	17.9	4.3
Licking River at Toboso	672	27,000	40.2	10.4

TABLE 6
Maximum and Minimum Discharges for Selected Ohio Streams During 25-Year Period 1921-45

Station	Drainage area (sq. mi.)	Average discharge cfs/sq. mi.	Average discharge inches	Maximum discharge cfs/sq. mi.	Minimum discharge cfs/sq. mi.	Ratio max. to min.
Little Beaver Creek near East Liverpool	505	1.03	13.98	49.5	0.024	2,060
Hocking River at Athens	944	1.04	14.12	32.2	.010*	3,220
Scioto River at Chillicothe	3,847	.833	11.31	26.3	.042†	626
Mad River at Springfield	485	.973	13.21	47.4	.144	329

* Slightly regulated by mill upstream.
† Slightly regulated at O'Shaughnessy and Griggs Reservoirs.

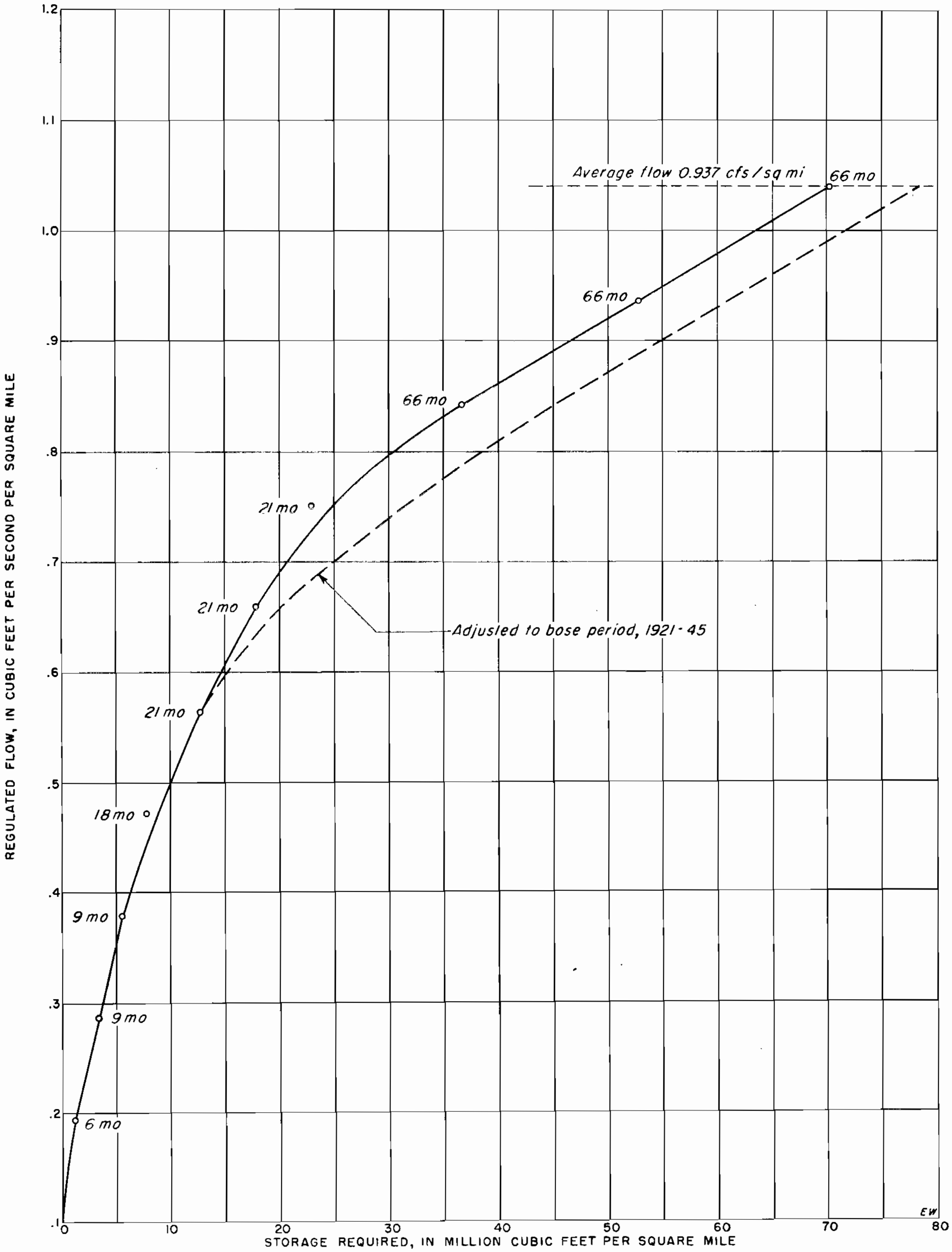


Plate 18. Unit-storage curve, Rocky River near Berea.
[Period of record: 1923-35, 1943-50.]

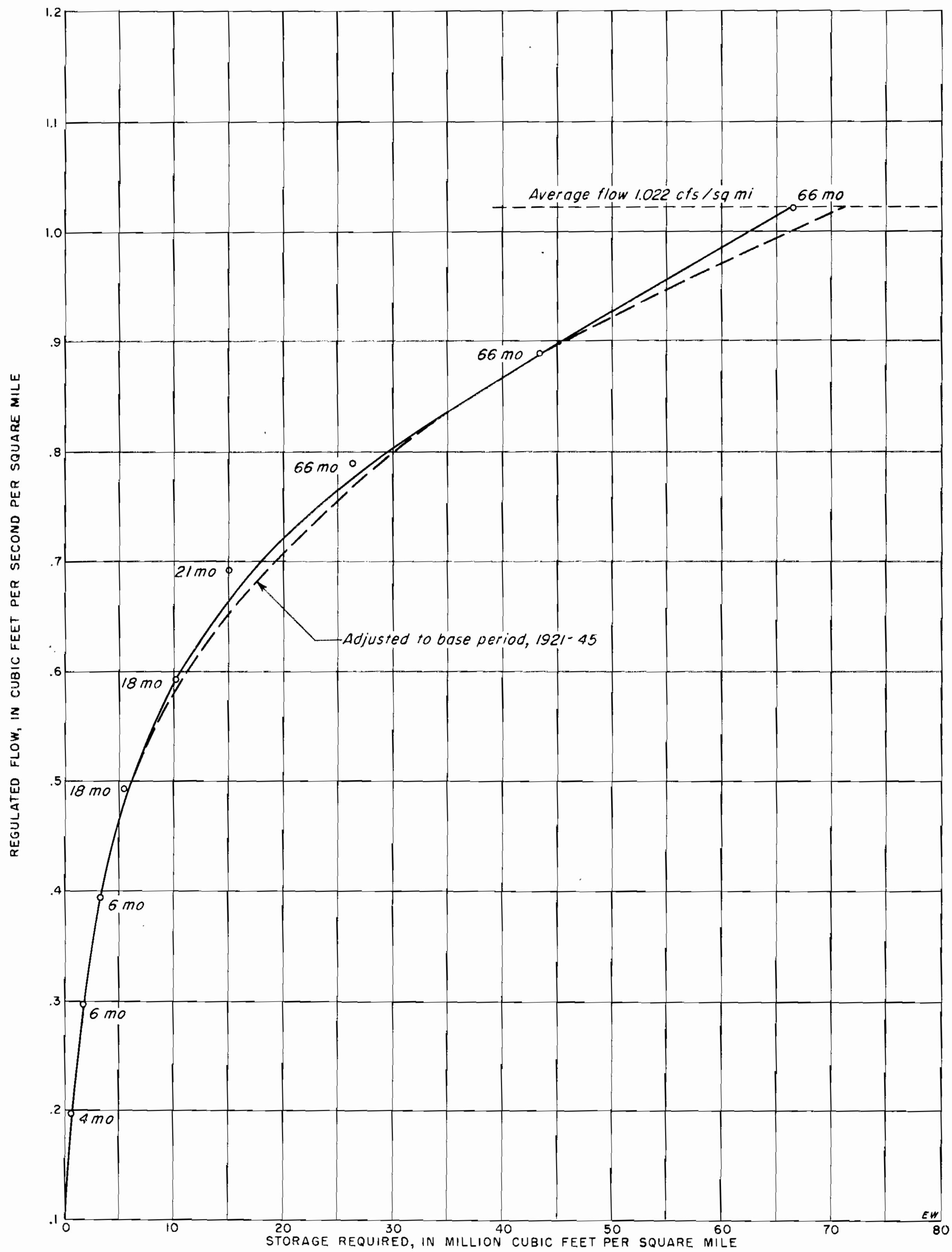


Plate 19. Unit-storage curve, Cuyahoga River at Old Portage.
(Akron water supply diversion not included.)
[Period of record: 1921-35, 1940-50.]

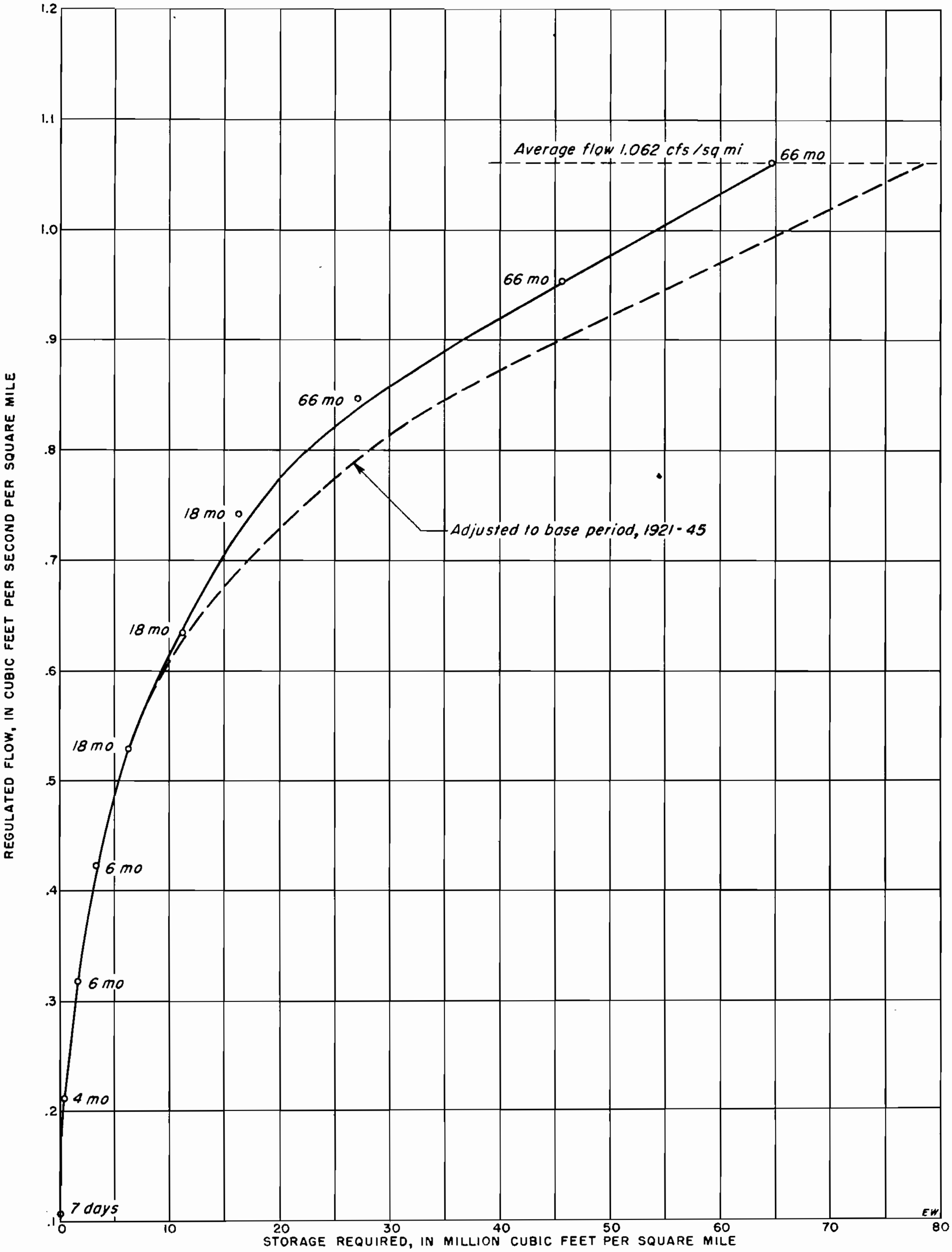


Plate 20. Unit storage curve, Cuyahoga River at Independence.
(Includes flow in Ohio Canal.)
[Period of record: 1922, 1928-35, 1941-50.]

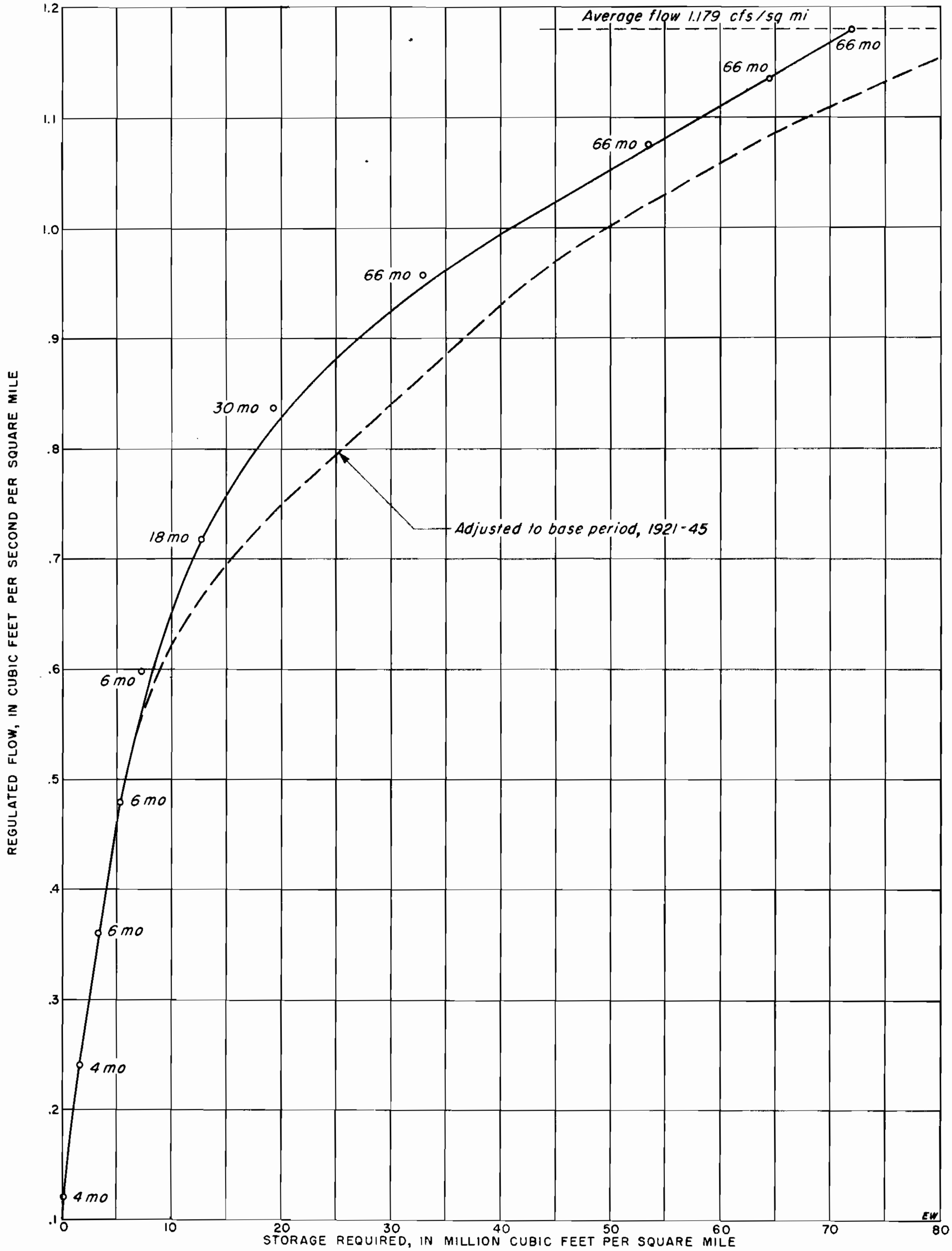


Plate 21. Unit-storage curve, Chagrin River at Willoughby.
(Willoughby water supply diversion not included.)
[Period of record: 1925-35, 1939-50.]

Also, from the information available and the duration curve for Rocky River, it appears that floods of a serious nature will probably occur in this basin. The ratio of maximum to minimum flows on a square-mile basis is a rough indication of the drought- or flood-producing qualities of a basin. Comparison of these ratios, as given in table 6 for the four stations with record during the base period 1921-45, with those for the Cuyahoga County stations in table 2 substantiates the conclusions concerning floods which are listed above. Floods from areas under 100 sq. mi. are caused primarily by rains of high-intensity and short duration concentrated over the drainage basin. Such storms may reach cloudburst proportions; they occur almost yearly somewhere in Ohio, particularly during the summer months, but are of only occasional or infrequent occurrence in any specific area. As a large part of Cuyahoga County is occupied by small drainage basins subject to these high-intensity storms, it is logical to assume that local floods of serious magnitude probably will occur. Peak-flow determinations were made in March 1948 on Big Creek with a drainage area of 37.5 sq. mi. and discharge of 5,900 cfs, and on a branch of Euclid Creek with a drainage area of 1.81 sq. mi. and discharge of 922 cfs. These were not major floods but they indicated the possibility of serious floods on smaller drainage areas in Cuyahoga County at infrequent intervals.

General Relations of Streamflow to Climate and Geology

Although precipitation includes the various forms of water reaching the ground as rain, snow, and dew, rain is by far the largest contributor in Cuyahoga County. Average annual precipitation in the county is about 33 inches and is well distributed throughout the year (Sanderson, 1950). A small part of the precipitation leaves the area immediately as direct runoff, and the remainder either returns to the atmosphere as evaporation and transpiration or seeps into the ground, a portion of which eventually reappears as streamflow. On the average, about one-third (10-12 inches) of the precipitation in Cuyahoga County eventually passes out of the area as streamflow (direct runoff and return flow from water that seeped into the ground). The effect of temperature is a complex phenomenon and it plays an important role during prolonged hot, dry periods, through excessive evapotranspiration losses. Average annual temperature in Cuyahoga County is 50° F with extreme monthly averages of 31° (Feb.) and 74° (July).

Although temperature and precipitation have a direct bearing on the average streamflow over long periods of time, the effect of various geologic formations is to regulate the annual distribution of streamflow. Buried valleys that have been filled with permeable glacial deposits will act as storage reservoirs by reducing the peak flows and releasing ground water to sustain low flows during periods of no direct surface runoff. Impermeable soil and steep topography help to produce high peak flows and very low sustained dry-weather flows. Both extremes are represented in Cuyahoga County. Buried valleys filled with permeable glacial deposits contribute to the high sustained flows of several small streams as is revealed by the low flow measurements.

The flow characteristics of streams, as indicated by the several analyses, such as flow-duration curves, drought- and flood-frequency diagrams, and other studies, are thus the integrated result of many climatic and drainage-basin characteristics.

TABLE 7
Principal Reservoirs in the Cuyahoga and Rocky River Basins

Name	Stream	Location	Drainage area (sq. mi.)	Total storage (acre-ft.)	Surface area (acres)	Date completed (year)	Use	Owner
Lake Rockwell ... (Akron Reservoir)	Cuyahoga River	Lat. 41° 11'; long. 81° 20'; Portage County	207	7,060	769	1914	Municipal	City of Akron
Mogadore	Little Cuyahoga River	Lat. 41° 04'; long. 81° 22'; Portage County	12	6,900	900	1939	Recreational Industrial	City of Akron
East Branch	East Branch Cuyahoga River	Lat. 41° 30'; long. 81° 06'; Geauga County	17	4,600	420	1939	Municipal	City of Akron
	East Branch Rocky River	Hinckley T., Medina County	22	1,070	...	....	Recreational	City of Cleveland
Portage Lakes	Tuscarawas River	Coventry, Franklin, Greene Tps., Summit County	..	....	2,250	....	Recreational	State of Ohio
Springfield Lake ..	Little Cuyahoga River	Springfield T., Summit County	..	....	400	....	Industrial Recreational	....
Fritch Lake	Little Cuyahoga River	Suffield T., Portage County	..	....	270	....	Industrial	....

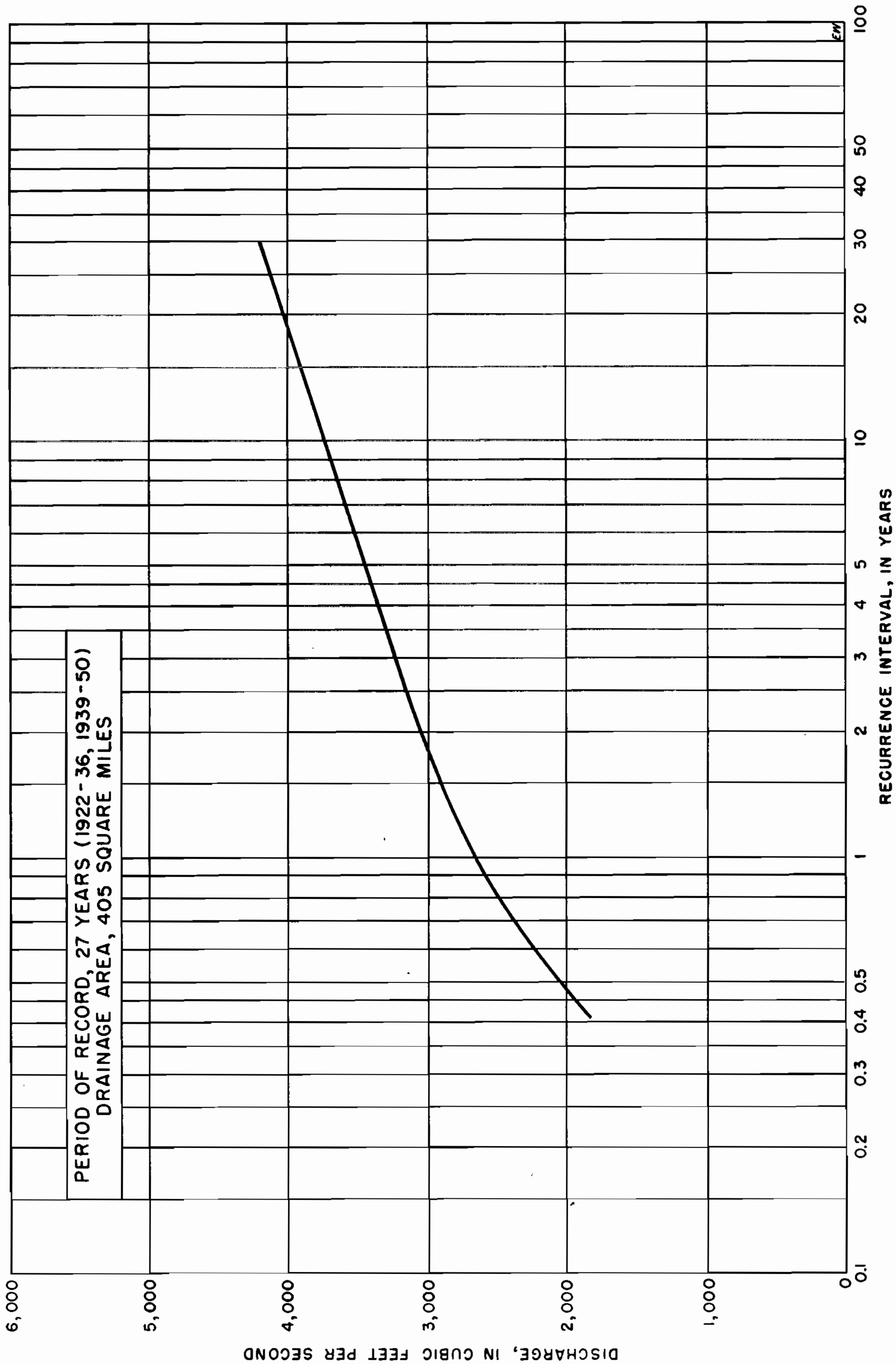


Plate 22. Flood-frequency plot, Cuyahoga River at Old Portage.

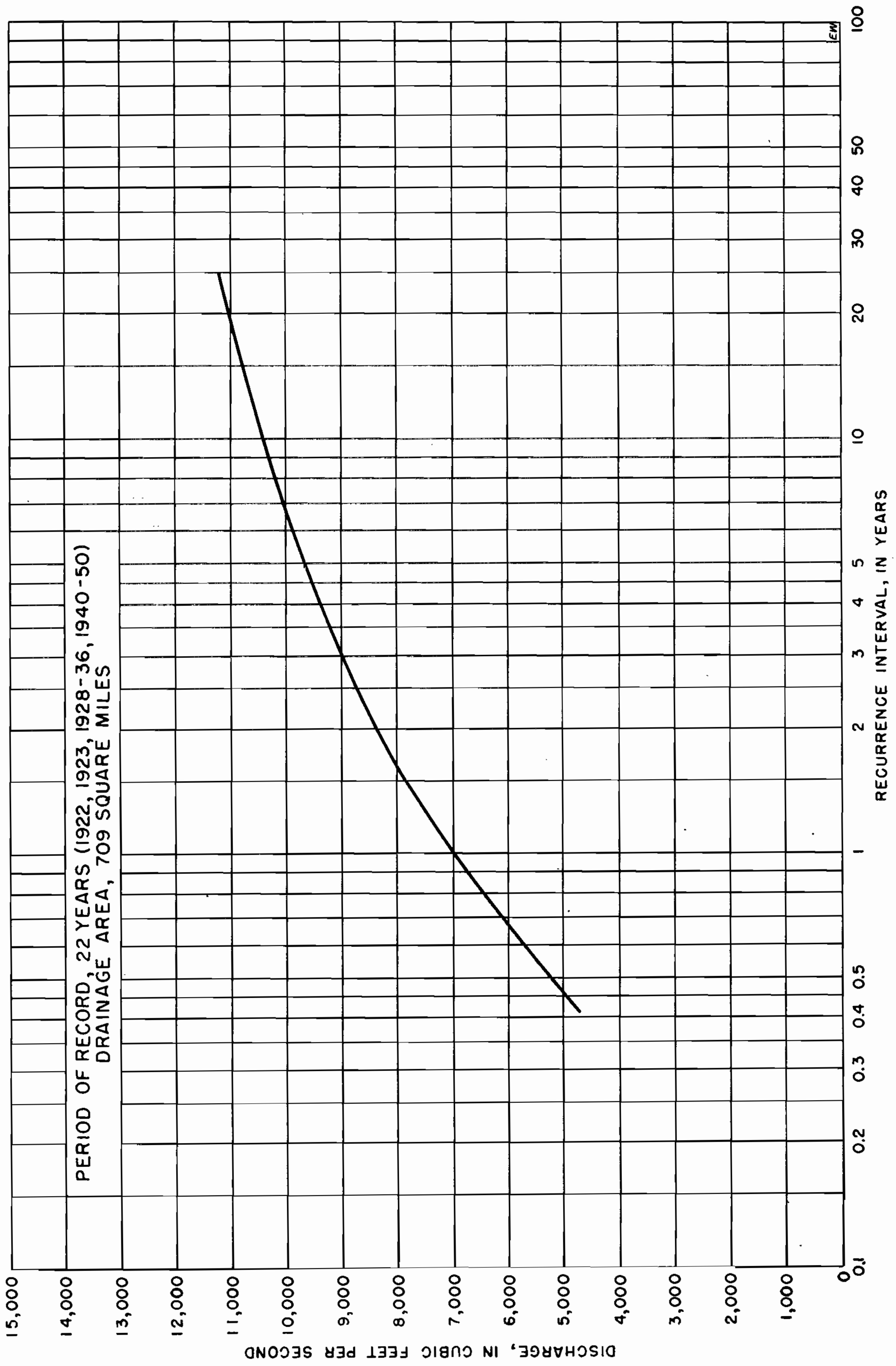


Plate 23. Flood-frequency plot, Cuyahoga River at Independence.

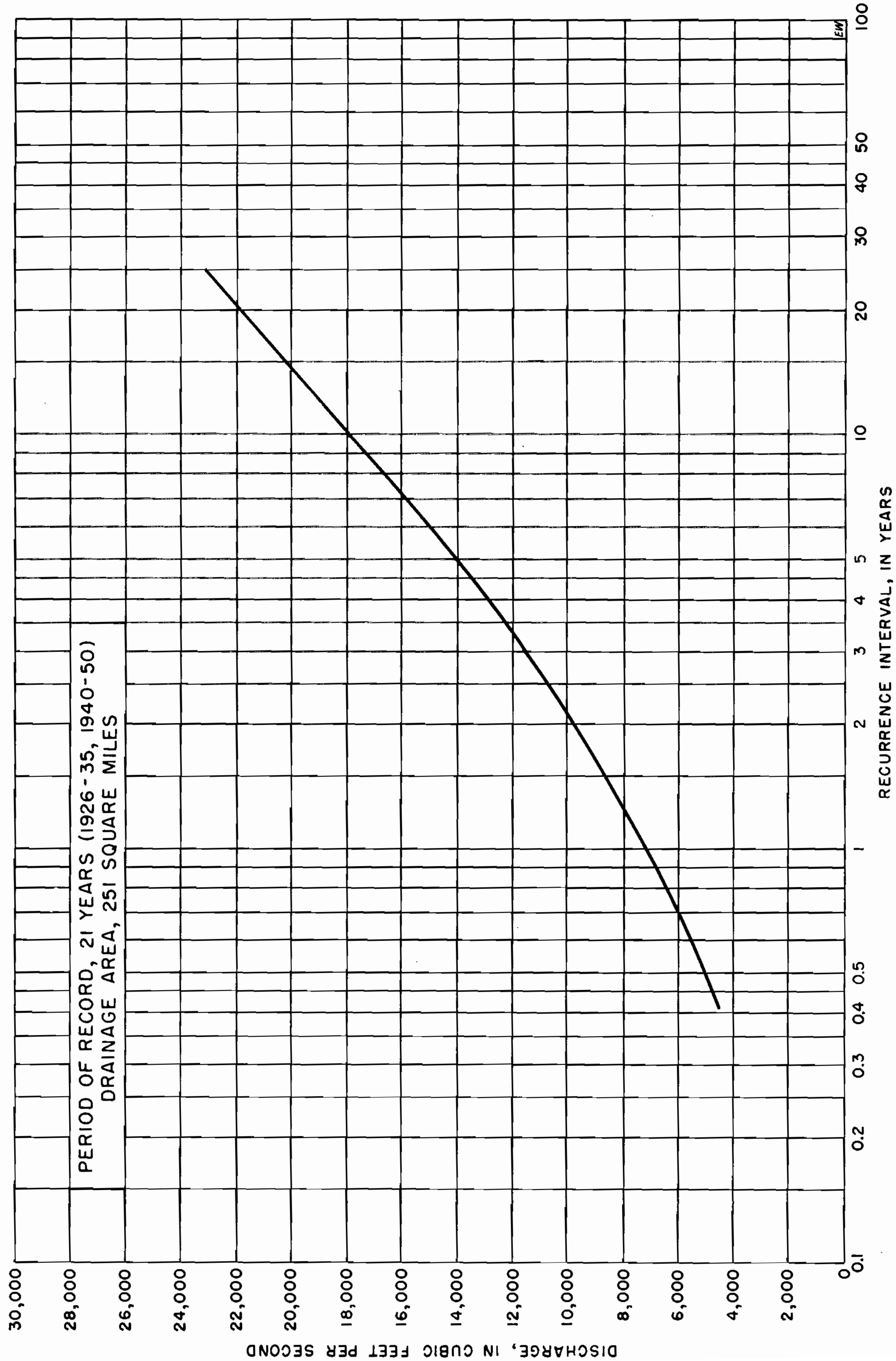


Plate 24. Flood-frequency plot, Chagrin River at Willoughby.

GROUND-WATER RESOURCES

GROUND-WATER HYDROLOGY

In Cuyahoga County ground water occurs in both the glacial drift and the consolidated rock formations. Well-sorted, stratified sand and gravel deposits laid down by glacial meltwater streams yield most of the ground water obtained from glacial drift. The glacial till was deposited directly by the ice and is a dense, poorly sorted material that generally yields but meager supplies of water. There are two basic types of consolidated rocks in Cuyahoga County, sandstone and shale; they are marine sedimentary rocks of Devonian and Carboniferous age. The sandstones are the better aquifers because of their greater porosity and permeability.

The amount of water that can be stored in a deposit and the rate at which water can move through the deposit is determined by the size, shape, and arrangement of the constituent rock particles. In a course, well-sorted gravel deposit the space between the individual pebbles is relatively large, affording good porosity and comparatively free flow of water through the material. In equally well sorted deposits of finer materials, such as clay, interstices exist, but they are smaller and more numerous. The porosity of clay is roughly the same as that of gravel but since the space between the individual grains is relatively small the flow of water through the material is impeded.

In a poorly sorted deposit (a mixture of rock particles of all sizes) the space between the larger grains is filled with smaller grains. The porosity of a poorly sorted deposit, such as till, is therefore less than that of a well-sorted deposit, such as gravel. The permeability also is less because the particles are closer together and they offer greater resistance to the flow of water.

When clay is compacted into shale, some of the water is squeezed out and the remainder is tightly held by capillary attraction thereby reducing the permeability. When sand is consolidated into sandstone, the sand grains become cemented together by minerals precipitated by the circulating ground water. The greater the amount of cementing material, the smaller the remaining space that may contain water. Thus the consolidation process tends to reduce both porosity and permeability.

Movement of the consolidated rocks may cause them to fracture along joints, or to move slightly along their bedding planes. Since the surfaces of the planes of weakness are irregular, movement along them causes the high points to move out of phase with the low points, thus creating a space between the two surfaces. Unless cementing materials are deposited between the two surfaces, the crack or joint will form a passage through which ground water may flow.

Recharge to the aquifers in Cuyahoga County is from local precipitation. When rain falls or snow melts some of the water flows directly into the surface streams, some evaporates, some is transpired by plants, and the remainder seeps into the ground. It moves downward through the zone of aeration and the capillary fringe to the zone of saturation. The top of the zone of saturation is called the water table, and it generally conforms roughly to the ground surface. Water in the zone of saturation slowly percolates through the ground, controlled by gravity and the hydraulic gradient, to an area of discharge such as a surface stream or a pumped well. Over a long period, the average recharge to an aquifer is approximately equal to its average discharge.

When water is pumped from a well a cone of depression is formed around the well. The dimensions of the cone are determined by the rate at which the well is pumped, and by the permeability, thickness, extent, and storage properties of the aquifer. The volume of the cone of depression represents the water pumped from storage and the cone will expand until the hydraulic gradient is sufficient to supply water to the well in the amount being pumped. The natural discharge from the aquifer will be diminished in the amount being pumped from the well. Should the pumpage exceed the natural discharge from the aquifer, either additional recharge will be induced to the aquifer or overdevelopment will occur with continued depletion of storage.

Where a stream traverses an area of permeable material an ideal condition exists for the development of a ground-water supply. When the cone of depression caused by pumping is extended to the stream the discharge of ground water into the stream is reduced. If the water table adjacent to the stream is lowered below the stream level, recharge is induced to the aquifer from the stream.

At a given location in Cuyahoga County several aquifers are generally encountered at different depths. If several wells are drilled, each cased to a different aquifer, the water level may be different in each well. Shallow dug wells generally extend only to the uppermost aquifer, and in most cases the water level in those wells represents the water table. The water in other aquifers is generally confined under pressure by impermeable strata both above and below. Such aquifers are said to be artesian and their hydrostatic pressure is determined by the porosity and permeability of the aquifer and by the difference in elevation between the water surface in the intake area of the aquifer and the upper surface of the aquifer at the well location. The intake area may be located where the aquifer crops out at the surface or where the impermeable confining beds are absent and water may enter from other aquifers. The surface that represents the heights to which water levels will rise in wells tapping an artesian aquifer is called the piezometric surface. Where the piezometric surface is above the surface of the ground the well will flow. Artesian wells do not necessarily flow at the surface; in most cases the water merely rises in the well to an elevation greater than that of the upper surface of the water-bearing zone.

GEOLOGY AND WATER-BEARING CHARACTERISTICS OF THE UNCONSOLIDATED DEPOSITS OF CUYAHOGA COUNTY

By George W. White*

Almost all the mantel of unconsolidated material that overlies the bedrock in Cuyahoga County is of glacial origin, having been deposited either directly by ice sheets, or by meltwater streams flowing from the ice, or in glacial lakes that were the predecessors of Lake Erie. A very minor amount of the unconsolidated material in the valleys was deposited by present-day streams or by earlier postglacial streams that flowed into Lake Erie, when the lake filled its basin to variously higher levels.

Four times during the Pleistocene or "Glacial" epoch ice sheets invaded the northern United States. Evidence that one or both of the first two ice sheets (Nebraskan and Kansan) invaded Ohio is indirect and is based on early drainage changes in the buried valleys. Evidence of the third glacial stage, the Illinoian, is in the form of glacial deposits buried beneath drift of later age. The ice of the fourth glacial stage, the Wisconsin, advanced over Cuyahoga County at least three times, in substages known as Tazewell, early Cary, and late Cary (table 8).

In Cuyahoga County the ice modified the hills by erosion, but it probably did not reduce the upland more than about 10 or 20 feet, except possibly in a few exposed places. Considerable bedrock material was removed from valleys that lay parallel to the direction of ice movement, but the amount of their deepening is not known. In the waning stages of glaciation deposits hundreds of feet thick were laid down in the valleys, either directly by the ice or in water dammed by the ice. All the ancient valleys are partly filled with drift, and some are completely filled and obscured.

Illinoian Deposits

The ice of the Illinoian stage, the third major stage of Pleistocene glaciation, advanced at least once over Cuyahoga County to Stark County. In Stark County Illinoian drift occurs at the surface beyond the border of later Wisconsin deposits (Schaefer, White, and Van Tuyl, 1946; White, 1951b); at several localities in Cuyahoga County Illinoian drift crops out beneath the younger drift of Wisconsin age.

The most extensive of these Illinoian drift exposures are in gravel pits located southeast of Garfield Park along both sides of the Mill Creek valley between the intersection of Henry Street and Broadway (designated as Henry on the topographic map) and the intersection of Broadway and McCracken Road (pl. 3). The material is sand and gravel (Smith, 1949, p. 13), ranging from 1 to 70 feet or more in thickness. It is overlain by Wisconsin till and by lake deposits. The pre-Wisconsin age of the buried deposits is proved at some places by the presence at the top of the gravel of an ancient soil layer that ranges from 1 to 5 feet in thickness. Plate 25 shows a diagrammatic sketch of the deposits in the pit of the Cleveland Sand & Gravel Co., about 400 yards west of the corner of Broadway and McCracken Road, and 200 yards west of the common corner of Newburg, Bedford, and Warrensville Townships. Exposed there, from the bottom up, are Illinoian gravel, soil formed in Sangamon, or post-Illinoian, interglacial time, loess (windblown silt) including a weathered zone that may represent the Farmdale of Leighton (1950), Wisconsin lake deposits, and Wisconsin (late Cary) till. Soil of Sangamon age also crops out high up on the walls of the large abandoned pit of the Cleveland Builders Supply Co. to the northwest. A few remnants of weathered Sangamon deposits also occur in small pockets at the top of the gravel and below the overlying till in the walls of the Newburg Sand & Gravel Co.'s large dredge pit, located north of Broadway, between East 131st Street and Henry.

The gravel of Illinoian age exposed in all these pits is of medium to fine grain size: the pebbles are well rounded and moderately well washed. This gravel con-

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tains a distinctively high proportion of crystalline rock and limestone pebbles and thus differs from the Wisconsin till and gravel deposits of the county.

The sands and gravels of Illinoian age may have been deposited as a kame terrace. The meager surface indications and a few well records indicate that the principal sand and gravel deposit it confined to that portion of the valley between Henry and a point about 1 mile southwest of North Randall (designated Randall on the topographic map).

Two other buried Illinoian gravel deposits are much less extensively exposed (pl. 3). Fifteen feet of gravel underlies four feet of till in the valley of Chippewa Creek where it is crossed by Avery Road, 2½ miles west of Brecksville Center. This appears to be the only exposure of the sand and gravel, elsewhere concealed, that occurs in the buried valley (pl. 2) between a point 1 mile south of North Royalton and the west wall of the Cuyahoga Valley in northern Brecksville Township. The deposits of the buried valley are cut out by the Cuyahoga Valley, but the buried Illinoian valley appears to continue on the eastern side of the Cuyahoga Valley, northeast to the buried valley that underlies the area between Henry and Randall. Well records are lacking in the portion of the buried valley that lies east of the Cuyahoga Valley, but sand and gravel may be present. It appears to be valley fill similar to the Mill Creek deposit, but more deeply covered by till.

Sand and gravel, probably of Illinoian age, is also reported in the records of wells in the buried valley that extends from Randall south-eastward to the eastern margin of Solon Township (pl. 2). In this area the sand and gravel deposits are finer grained than those in the buried valley between Henry and Randall, and

TABLE 8
Division of Glacial and Post-Glacial Deposits in Cuyahoga County, Ohio

EPOCH	STAGE	SUBSTAGE		DIVISION
RECENT				Flood plain deposits along major streams; usually silty. Thin and scanty beach sands.
PLEISTOCENE	WISCONSIN	MANKATO and CARY		Beach deposits of glacial lakes; sand and gravel. Lake-bottom deposits; silt and fine sand, usually thin except in Cuyahoga County.
		?		
		CARY	Late	Ground moraine which covers much of county; silty clay till. Includes Defiance moraine.
			Early	Mainly subsurface deposits of silty and sandy till; forms surface material in a few areas.
		TAZEWELL		Discontinuous subsurface deposits of sandy till; not well known in Cuyahoga County.
		FARMDALE (?) (of Leighton)		Thin loess known only in Mill Creek valley.
	SANGAMON and ILLINOIAN			Sangamon weathered zone or old soil at top in a few places. Discontinuous till deposits. Distinctive buried gravel deposits in certain old valleys.
	KANSAN			Not known from deposits but ice is believed to have been present in Cuyahoga County because of early drainage changes.
	NEBRASKAN			Possibly present; no deposits known in county.

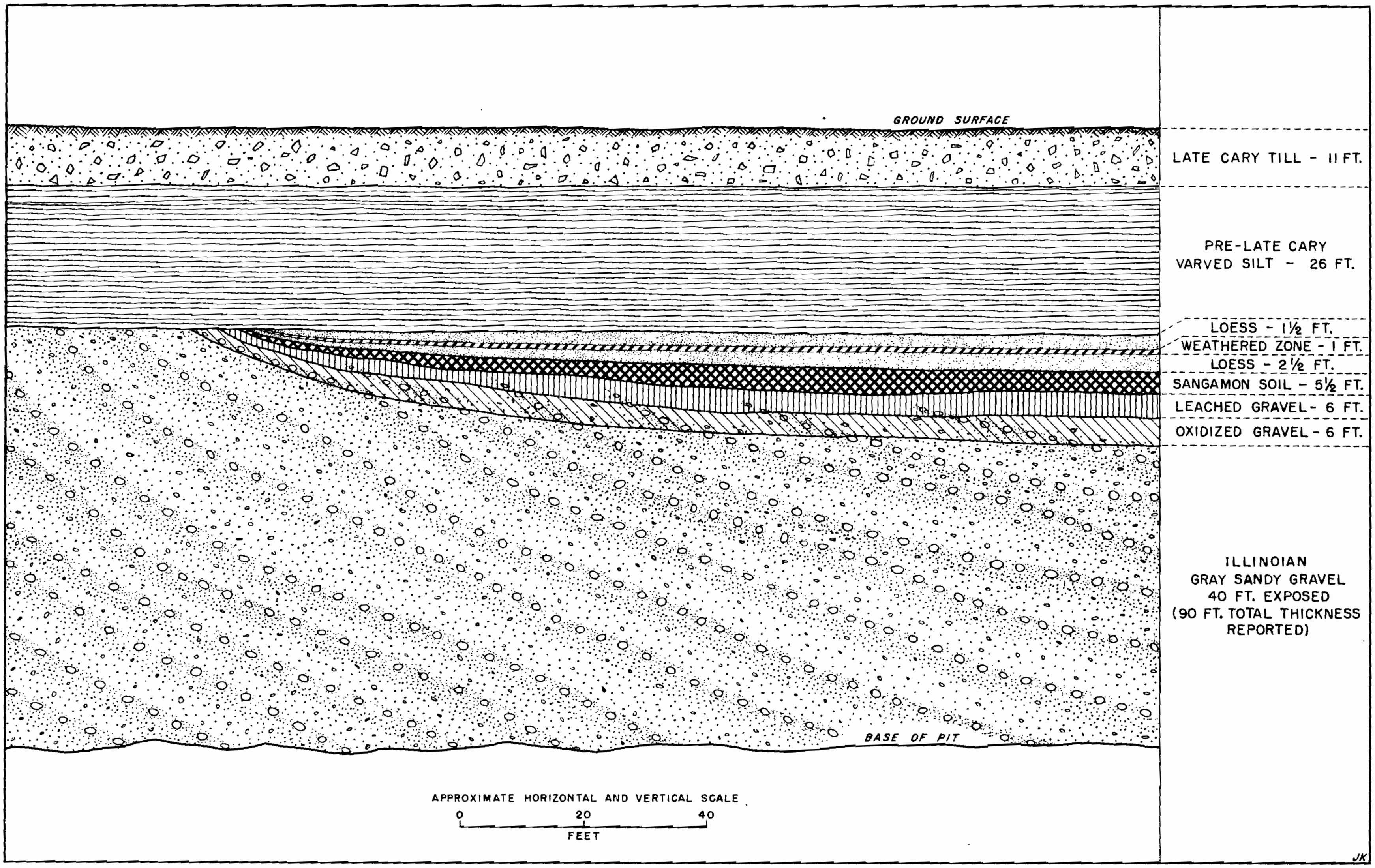
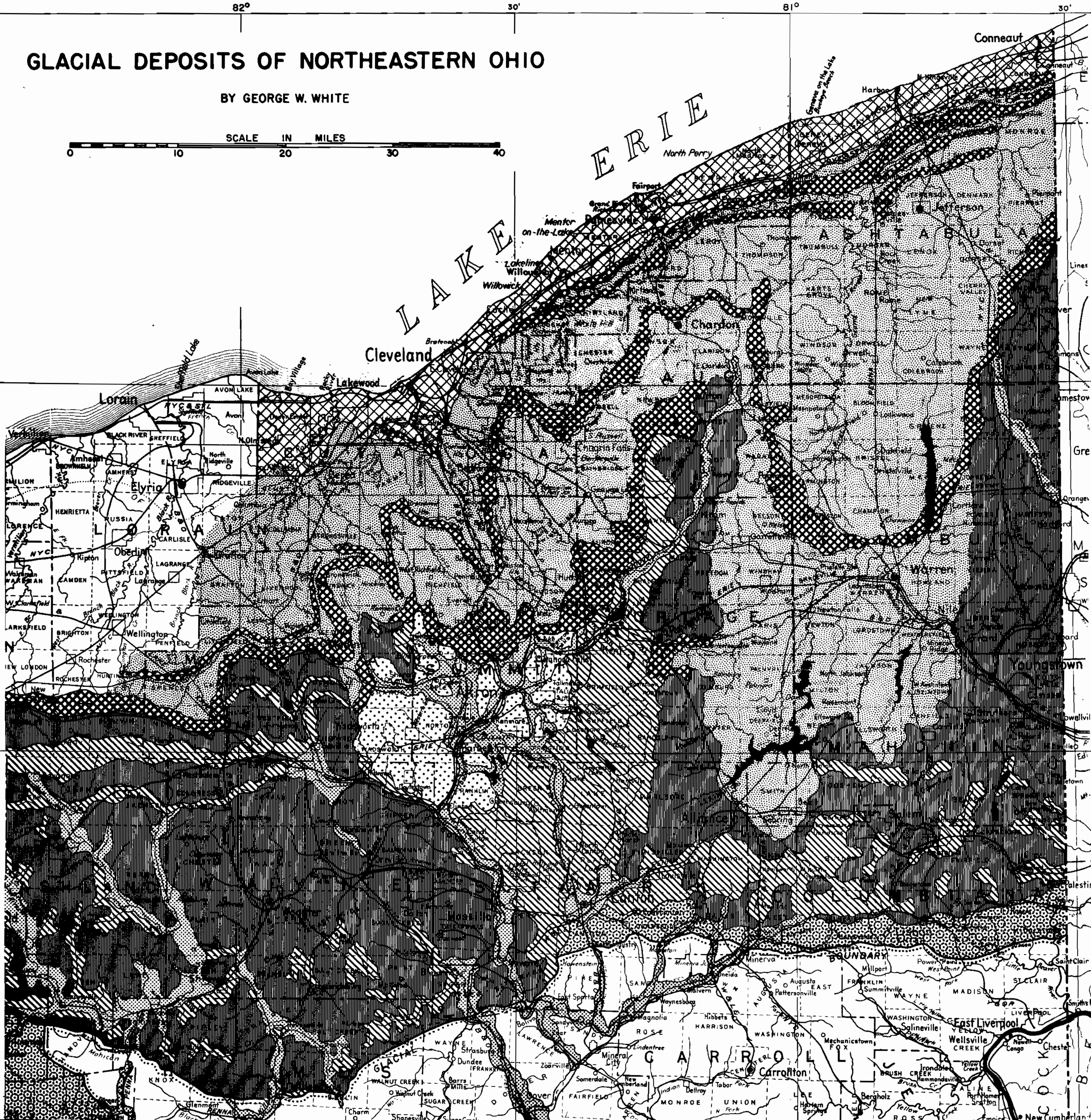


Plate 25. Section exposed in pit of Cleveland Sand and Gravel Company, 1 mile southeast of Garfield Park, Cleveland.



EXPLANATION

PLEISTOCENE

WISCONSIN

LATE WISCONSIN

LAKE DEPOSITS

Deposits of glacial lakes in Erie Basin. Sand, silt, and clay, usually thin and underlain by till.

CARY

Late Cary

END MORAINE

Hummocky and undulating topography; tight, compact, clayey till; sand or gravel very minor. Underlying earlier drift in Summit and northwest Portage Counties generally more coarse and permeable.

GROUND MORAINE

Flat to gently undulating topography; tight, compact, clayey till; at many places less than 20 feet thick.

Early Cary

END MORAINE

Hummocky to very hummocky topography. Gravel, or silty to sandy till with much sand and gravel intermixed. (Areas in southern Wayne, Holmes, southern Ashland and parts of Columbiana and Mahoning Counties not true end moraine but hummocky areas of thicker drift related to valleys and lowlands.)

GROUND MORAINE

Flat or gently undulating topography to hilly, bedrock-controlled topography. Silty to sandy till.

TAZEWELL

GROUND MORAINE

Gently undulating to hilly, bedrock-controlled topography. Coarse, stony, sandy till. Includes small areas of hummocky topography in which drift is more gravelly.

ILLINOIAN

GROUND MORAINE

Thin drift over bedrock. Mainly coarse till, in part discontinuous. A few very small areas of thicker, coarser, drift with somewhat hummocky topography.

GLACIAL OUTWASH, UNDIFFERENTIATED

Mainly valley trains, but includes kame terraces, especially in Ashland and Holmes Counties. Alluvium of flood plains of central part of many valleys included. Mainly sand and gravel, but some silt included, especially in southern Summit County.

(Note: Wayne County in part after Conrey, 1921.)

Plate 26.

they are encountered beneath the cover of till at progressively greater depths to the east.

In Orange Township, gravel lithologically similar to that exposed between Henry and Randall crops out along Griswold Creek, half a mile east of Chagrin River and a quarter of a mile north of the Chagrin Falls Township line. It is associated with lithologically similar till; both probably are of Illinoian age. The gravel appears to be part of a larger deposit that extends northeast of the county line.

Water-bearing Properties of the Illinoian Deposits

The Illinoian sand and gravel deposits in the buried valleys are among the best ground-water reservoirs in the county. A well at the Cleveland Chain & Manufacturing Co. near the intersection of Broadway and Henry Street, Newburg Township, is reported to have yielded 1,500 gallons per minute. Domestic wells penetrating Illinoian sand and gravel in other areas fulfill their requirements, but domestic wells are drilled as economically as possible and are therefore small in diameter and only deep enough to supply the small amount of water necessary for household needs. Pumps used in domestic wells are of small capacity and, because well screens are seldom used, the full capacity of such wells may not be realized. Therefore, it is not possible from the well data at hand to determine fully the ground-water resources of the Illinoian sand and gravel deposits.

The best area in which to prospect for water in the Illinoian sand and gravel deposits is the Mill Creek valley, shown in plate 2. In the other buried valleys sand and gravel lenses are in places penetrated by wells and they yield fair supplies of water.

Illinoian till and silt are exposed at a few places in the county. The material is compact and impermeable, and is a very poor source of ground water.

Wisconsin Deposits

Most of the surface of Cuyahoga County is covered by glacial deposits of Wisconsin age, deposited during three ice advances, called the Tazewell, early Cary, and late Cary substages. These advances were in the form of lobes. East of the Highland of Geauga County the ice of the "Grand River lobe" advanced into the Grand River lowland in Ashtabula and Trumbull Counties, and from there it spread into the adjacent counties (pl. 26). West of the Geauga County highland the Killbuck lobe advanced into Ashland, Wayne, Holmes, and western Stark Counties.

Tazewell Substage[1]

The ice of the earliest substage of the Wisconsin, the Tazewell, advanced over Cuyahoga County but it did not advance south as far as the ice of a late Wisconsin substage. Tazewell drift is exposed in an area in Summit County that was not covered by the late Wisconsin advances (pl. 26), and also from localities where it is found beneath younger drift. In Cuyahoga County the lower of two tills that are exposed along the lake shore is similar to the Tazewell till that occurs at the surface in Summit County and it may also be Tazewell in age. It is a coarse, stony, sandy, boulder clay. Another coarse till that crops out in the Chagrin Valley at Chagrin Falls also appears to be of Tazewell age. No gravel has been found associated with the Tazewell till in Cuyahoga County, and it is therefore a very poor source of ground water.

Cary Substage

The next advance of the Wisconsin ice, after the Tazewell, extended beyond the borders of Cuyahoga County shown on plate 26. The Cary drift is of two distinct kinds, indicating an early Cary advance, a very considerable retreat, during which the area was free of ice, and a re-advance.

Early Cary: Ice of the earlier Cary advance covered all of Cuyahoga County and deposited a sheet of till that is in large part covered by later deposits. Early Cary deposits are exposed in many small areas, shown on plate 3. These small areas are irregular in shape and may contain small deposits of late Cary till here and there within them. They have not been mapped in detail, nor will this be possible until a detailed study is made of the surface soils. The soils in these areas are silt loams and loams, similar in character to Ravenna or Wadsworth loams and silty clay loams developed on late Cary till.

The early Cary till is a silty to silty and sandy, pebbly boulder clay. It contains a moderate number of cobbles, and an occasional boulder. Early Cary till is blue-gray where fresh, but in its upper portion it is weathered brown or yellow-brown. The calcium carbonate has been leached to an average depth of 53 inches (base of horizon 3) by the weathering processes. Early Cary till is compact and relatively impervious. It is a poor source of water.

The early Cary drift in Cuyahoga County contains little or no gravel and sand. This is in contrast to the large amount of washed material in the early Cary drift in Geauga, Portage and Stark Counties (pl. 26). No subsurface gravels in Cuyahoga County have been related to this stage of Wisconsin glaciation.

[1] A pre-Tazewell Wisconsin deposit may be represented by the lower of the two loesses above the soil of the Sangamon stage in the Mill Creek valley (pl. 25). It may record a very early Wisconsin ice advance which did not reach Cuyahoga County. It is similar to such a deposit in the Mississippi Valley (Leighton and Willman, 1951). The loesses are thin and discontinuous and are not important in the consideration of ground water, but they may prove to be useful horizon markers in the study of subsurface geology from well samples.

Late Cary[3]: After the deposition of the early Cary drift the ice retreated into the Erie Basin. It then re-advanced to the line shown on plate 26, transporting debris quite different than early Cary drift. A Grand River lobe was again formed to the east of the Geauga County highlands, but the advance south of Cuyahoga County was not of sufficient extent to form a second Killbuck lobe; it only resulted in a bulge from the main Erie lobe, which might be thought of as a very minor "Cuyahoga sublobe." The "sublobe" pushed across Cuyahoga County into northern Summit County and northwestern Portage County. The length of time between the early and late Cary advances was comparatively short; the effects of weathering are not apparent on the surface of early Cary till where it is exposed beneath late Cary drift.

Late Cary till is a silty, clayey, sparingly pebbly boulder clay. It is tight and compact, even more so than the till of early Cary age, because of its greater clay content. It is generally characterized by a high proportion of black shale fragments. Its weathered zones are thinner than those of early Cary drift, probably because of its lower permeability. The average depth of leaching in late Cary till is 33 inches compared to 53 inches in early Cary till. The soils developed on late Cary till are clay loams and silty clay loams of the Mahoning series (Conrey, 1934).

Most of the glacial drift at the surface in Cuyahoga County is late Cary in age. It mantles the bedrock and the earlier drift generally to a depth not greater than 20 to 30 feet. At most places it is less than 10 feet thick. The topography is mostly that of gently undulating ground moraine. There are, however, areas of more irregular, definitely hummocky topography in western Solon Township, and also in an irregular and winding belt extending across the county from Chagrin Falls to North Royalton. They are shown on plate 3 as "morainic areas." The continuous belt extending west from Chagrin Falls is an end moraine, called the Defiance moraine, which has been traced from Michigan across northern Ohio to the Pennsylvania line (Cushing and others, 1931, fig. 8). Its course in northeastern Ohio is shown on plate 26, and in Cuyahoga County on plate 3. The moraine records a brief retreat and a subsequent readvance of the late Cary ice. The heavy clay till in the Defiance moraine is similar to that of the ground moraine on either side. No sand or gravel has been found in the Defiance moraine in Cuyahoga County, but it is likely that a few small pockets of sand do occur. They are probably so small that the moraine in most places is no better as a source of water than the adjacent ground moraine. In Northfield Township, Summit County, and in an area south of Bedford, Cuyahoga County, sand lenses in the Defiance moraine are more common.

A few sand and gravel kames occur in the morainic area near Glenwillow in southwestern Solon Township. One kame is large enough to have formerly supported a small gravel pit.

The lake-border morainic system, which lies along the edge of the upland where it joins the lake plain, is represented in Cuyahoga County by a single ridge in Euclid Township (pl. 3), called the Euclid moraine (Cushing and others, 1931). The narrow morainic tract in Brooklyn (pl. 3) may be of the same age as the Euclid moraine. The material of both is impervious till, and is not a source of ground water.

Water-bearing Properties of the Wisconsin Deposits

The Wisconsin glacial deposits generally are poor sources of ground water, even for domestic requirements. Gravel and sand deposits are notably few in number and they generally lack both the areal extent and the thickness necessary for the development of large water supplies. The till of the Tazwell, early Cary, and late Cary substages is compact, relatively impermeable, and a very poor source of ground water. Infrequently, a well of small yield is developed in the moraine areas.

Glacial Great Lakes[4]

When the last ice sheet melted back to the north of the St. Lawrence-Ohio divide, water became ponded between the ice front and the divide. A lake was formed which at various times had outlets to the Mississippi drainage via Ft. Wayne, Ind. and Imlay, Mich. This lake, known as glacial Lake Maumee, formed beaches in the Cleveland area that mark the different levels at which the water stood. Important Lake Maumee beaches are Chestnut Ridge and Butternut Ridge (both about 780 feet above sea level), along which, west of the Rocky River, lies Lorain Road.

Further retreat of the ice uncovered a lower drainage outlet in Michigan, but a readvance covered this outlet and raised the lake to the level of an outlet at Ubly, Mich. This lake stage is known as glacial Lake Whittlesey. Prominent beaches were formed about 735 feet above sea level. One such beach is Middle Ridge, along which runs Center Ridge Road west of Rocky River, and a part of Dennison Avenue. Another beach forms a cliff,

[3] The Lake Border moraines northeast of Cuyahoga County, which are also Cary, may prove to be considerably later than the drift here called "late Cary." If that be so, then what is here called "late Cary" may really be "middle Cary."

[4] This brief summary of the glacial Great Lakes is based on Leverett's report in U. S. Geol. Survey Bulletin 818 (Cushing and others, 1931); the beaches shown on plate 3 are from his map in the same bulletin. A useful summary of Cleveland and vicinity is given by Williams (1940).

at an elevation of about 720 feet above sea level, along the margin of the upland extending from the Cuyahoga River to the northeastern part of the county.

A later stage of the glacial lakes was glacial Lake Warren, which had an outlet in Michigan. At this level Warren beach was formed at an elevation of about 680 feet above sea level. This beach is represented by North Ridge, along which Detroit Avenue is located, and by the ridges that are followed by Euclid Avenue and Woodland Avenue.

After a complex series of changes in outlets and lake levels, the present outlet and lake level were established. The strong cliff formed along the present shoreline indicates that the lake has maintained its present level for at least as long as it stood at any of the earlier levels.

Part of the beach and lacustrine deposits may have been deposited during the Mankato substage. Present data are insufficient to permit differentiation between these deposits with respect to their origin in either latest Cary, Mankato, or post-Mankato time.

The deposits of the glacial lakes are of two major kinds: the sand and gravel beaches, and the fine sand, silt, and clay deposits that were laid down in deeper waters away from the shores.

The beaches are composed of sand and fine gravel, and in most places they do not exceed 15 feet in thickness. Small sand and gravel pits are operated in some of them. Northeast of Cuyahoga County the beaches are of greater thickness locally and are a source of water.

The finer grained lake-bottom deposits are discontinuous over the surface that was submerged beneath the waters of the glacial lakes. The deposits rest on shale west of Cleveland; east of that city the underlying material is either shale or till. About the level of the Whittlesey beach the lake deposits generally are not more than a very few feet in thickness, and they may not be present at all. Below the Whittlesey beach the thickness of the deposits is slightly greater, but it is generally not more than 10 feet. The lake-bottom deposits range from stiff, silty clay to silty sand. They are massive to laminated in structure.

The buried valleys that underlie the Rocky River and the Cuyahoga River contain a complex and very thick series of interbedded sands, silts, clays, and tills. The drift is approximately 700 feet thick in the buried valley west of Gordon Park, near the lake shore. At least four till sheets, separated by stratified lake deposits, are encountered in borings in the Cuyahoga Valley (Bagley, 1950). The stratified deposits record the presence of earlier glacial lakes of several stages, each series of which probably had as complex a history as the last series, that of the Maumee, Whittlesey, Warren, and Erie beaches, whose record has been described.

Water-bearing Properties of Glacial-lake Deposits

The sand and gravel of the ancient beaches is not thick enough in Cuyahoga County to be important for water supply. The generally thin and fine-grained lake-bottom deposits are also unfavorable sources of ground water. The lake deposits in the Cuyahoga Valley contain some gravel and sand, as shown in the pit of the Canal Sand & Gravel Co., and in the excavations along the Willow Freeway, but well records show that most of the unconsolidated deposits, which reach a thickness of over 600 feet in some places in the Cuyahoga Valley, are fine grained. Some lenses and layers of sand and fine gravel are encountered, however, that yield satisfactory supplies of water. These layers are irregular and discontinuous and it is difficult to predict their presence or depth at any given locality. Some wells may penetrate the entire thickness of valley fill without penetrating a water-bearing zone.

BURIED VALLEYS

Valleys buried by glacial drift are shown on plate 1 by the approximate contours on the bedrock surface. These valleys were cut by streams before and during the glacial epoch. Except where they have been uncovered by present streams, they are filled with glacial drift and lacustrine deposits. The present streams roughly coincide with the courses of the buried valleys because the settling and compaction of the unconsolidated materials has caused linear depressions that were utilized by the streams upon the reestablishment of drainage after the retreat of the ice. Another factor is that the unconsolidated materials in the valleys are generally more easily eroded than the adjacent bedrock formations.

These buried valleys are an important feature, not only of the geology but also of the water resources of Cuyahoga County. The valleys contain, together with glacial till and lacustrine deposits, coarse sand and gravel deposits, generally lens-shaped, of various widths and thicknesses, and of unknown continuity. It is not easy nor is it often possible to predict the location and the depth of gravel lenses in the buried valleys, but where they are penetrated by wells they often are excellent sources of ground water. The water-bearing characteristics of the buried-valley deposits are discussed by areas in the part of this report entitled "Ground-Water Conditions in Specific Areas."

Some of the buried valleys in Cuyahoga County appear to have been formed by north-flowing streams; others seem to have drained southward. The buried valleys that underlie approximately the present Rocky and Cuyahoga Rivers are of the former type. The buried valley system that extends roughly eastward from Royalton to Solon Township is an example of the latter type. The latter valley is joined by the Chagrin buried valley, which extends southward from Lake County.

The buried valley underlying the present Rocky River and the one that generally underlies the course of the Cuyahoga River are similar in that their floors have a northward gradient. The buried channel under the Rocky River is not as deep nor as wide as the one beneath the Cuyahoga River, and it may have been a tributary to the latter, joining it beneath the present Lake Erie. Drive-pipe records of oil and gas wells indicate the rock floor of the Rocky River buried channel to be about 470 feet above sea level in northern Strongsville Township, and probably less than 400 feet above sea level at the lake shore in Rockport Township. Drive-pipe records of oil and gas wells in the Cuyahoga River buried valley indicate the valley floor to be 42 feet below sea level in Newburg Township, and 100 feet or more below sea level near Gordon Park at the lake shore. The Cuyahoga River and Rocky River buried valleys initially may have been cut by preglacial streams that drained part or all of the Great Lakes area.

The other buried-valley system in Cuyahoga County appears to have had an outlet to the south. That system has little or no surface trace except in the Chagrin River and Mill Creek valleys. In the Mill Creek valley extensive Illinoian sand and gravel deposits are found with a Sangamon age soil developed in their upper part. Lithologically similar gravels are also exposed in the valley of Chippewa Creek in Brecksville Township, and in the valley of Griswold Creek in Orange Township. Coarse sand and gravel lenses are penetrated by wells in most of this buried-valley system.

The Brecksville-Randall buried channel drained from Parma Township southward into Royalton Township, thence northeastward, across the then filled ancient Cuyahoga River valley to a point near Randall, where it was joined by the Mill Creek channel. From Randall, its course was southeastward into Solon Township, and from there it trended eastward to the Chagrin River buried valley. The buried Chagrin River channel extends southward from Lake County through eastern Mayfield, Orange, and Solon Townships, Cuyahoga County, into Portage and Summit Counties. It has two tributaries in Orange Township, one that follows generally the present course of Griswold Creek and another that heads in the northwestern part of Orange Township and joins the Chagrin River channel near the intersection of Kinsman Road and Chagrin River Road. The elevations of the buried-valley floors range from about 800 feet above sea level in Parma Township and 500 feet above sea level in Mayfield Township to less than 400 feet above sea level in Solon Township.

The now buried valleys that drained to the north were likely to have had their outlet blocked by advancing ice, which would create ice-dammed lakes in which fine-grained sediments would be laid down. The valleys that had their outlets to the south, however, would carry glacial outwash material that is generally well washed and coarse. Therefore, the valleys that drained southward are probably the better ground-water sources, because of the coarser materials contained in them.

The buried-valley systems in Cuyahoga County are not necessarily the product of any one stage or substage of glaciation. The buried valley of the Cuyahoga River was probably cut initially in preglacial time and has been filled and reopened several times since then, perhaps several times during Wisconsin time. Although the Chagrin River valley appears to have been cut initially by a south-flowing stream, the buried channel may have been filled and reopened several times, providing a course for north-flowing as well as for south-flowing streams. It is interesting to note that the Brecksville-Randall buried channel, filled in Illinoian time, extended across the then buried Cuyahoga valley. Therefore, The Brecksville-Randall channel must, because of its Illinoian fill, be pre-Illinoian, possibly Yarmouth (second interglacial stage) in age. If this be so, then the early filling in the Cuyahoga Valley was pre-Yarmouth or at least Kansan in age.

GEOLOGY AND WATER-BEARING PROPERTIES OF THE CONSOLIDATED ROCKS

Consolidated rocks of Devonian and Carboniferous age are exposed in Cuyahoga County. For convenience the author has arranged these formations into four divisions, the individual units within each division having similar water-bearing characteristics. They are, in descending order as penetrated by the drill: (1) the Sharon conglomerate of Pennsylvanian age, (2) the Cuyahoga group of Mississippian age, (3) the Berea sandstone of Mississippian age, and (4) the shales and interbedded sandstones that underlie the Berea sandstone, namely, the Bedford shale of Mississippian age, the Cleveland member of the Ohio shale, and the Chagrin shale, the last two of Devonian age.

The consolidated rocks in Cuyahoga County generally dip southward about 20 feet per mile. Unconformities exist at the bases of the Sharon sandstone, the Berea sandstone, and the Cleveland member of the Ohio shale. Either a fault or a monoclinal fold exists in the Berea sandstone and the Bedford shale in central Orange Township. The southern flank of the structure has been stratigraphically lowered about 40 feet. The beds in two exposures on the Halferd Farms property dip southeast 30° and 40°, respectively.

There is a small domelike structure in northwestern Mayfield Township which causes the Berea escarpment to be farther south than it would if controlled by the regional dip. Wells drilled on this structure have yielded small amounts of oil and gas.

Many other small structural features in the county include a small flexure in the Chagrin shale, nicely exposed in the bank of Rocky River in the Rocky River Reservation of the Cleveland Metropolitan Park District. Small faults also exist in the county; one, in the basal portion of the Sharpsville sandstone, is shown in the photograph, plate 28 B.

The Sharon conglomerate and Berea sandstone have good water-bearing properties and are the most favorable of the consolidated rocks for the development of ground-water supplies. The rocks of the Cuyahoga group generally yield sufficient water for domestic purposes except in a few areas. In those areas domestic supplies are commonly obtained from deeper wells drilled into the underlying Berea sandstone.

The rocks that underlie the Berea sandstone are not uniform in their water-bearing properties. Yields are generally small and may vary widely in quality and quantity. Brine may be encountered at any depth below the Berea sandstone.

Permeable glacial materials that occur in some areas in the buried valleys improve the water-bearing properties of the consolidated rocks. For example, in the Mill Creek valley and at West Hill Colony in Orange Township, the yields from some wells in the Berea sandstone are much larger than average because of the recharge contributed by the permeable materials.

SHARON CONGLOMERATE

(Pennsylvanian System)

In Cuyahoga County the top of the Sharon conglomerate generally conforms to the 1,200-foot elevation of the glaciated Allegheny Plateau, and forms the northwestern edge of the plateau along the Portage Escarpment. Glacial erosion and the erosion of streams cutting across the Portage Escarpment have dissected the edge of the plateau and cut the Sharon sandstone into a series of discontinuous ridgelike patches and outliers that form knobs and promontories in the southern and eastern parts of the county. The Sharon conglomerate in the county averages about 50 feet in thickness, but it may be considerably thicker or thinner at a particular location because of the unconformity at its base and the erosion of its upper surface.

Lithologically, the Sharon conglomerate is a porous, coarse- to medium-grained, gray-white to light red-tan quartzose sandstone. The stone is very friable; the grains are only weakly cemented together by silica and iron oxide. The lower few feet of the Sharon generally contains a large number of quartz pebbles.

Water-bearing Characteristics

The Sharon conglomerate is one of the most productive aquifers in Cuyahoga County. The average yield of 5- to 6-inch domestic wells is between 5 and 10 gallons a minute, a sufficient quantity for household purposes. One 10-inch well (Brecksville T. 83) drilled 40 feet into the Sharon produced 125 gallons of water a minute with a drawdown of 23 feet during a pumping period of 10 hours. The same well when pumped at the rate of 230 gallons a minute for several hours had a drawndown of 41 feet.

CUYAHOGA GROUP

(Mississippian System)

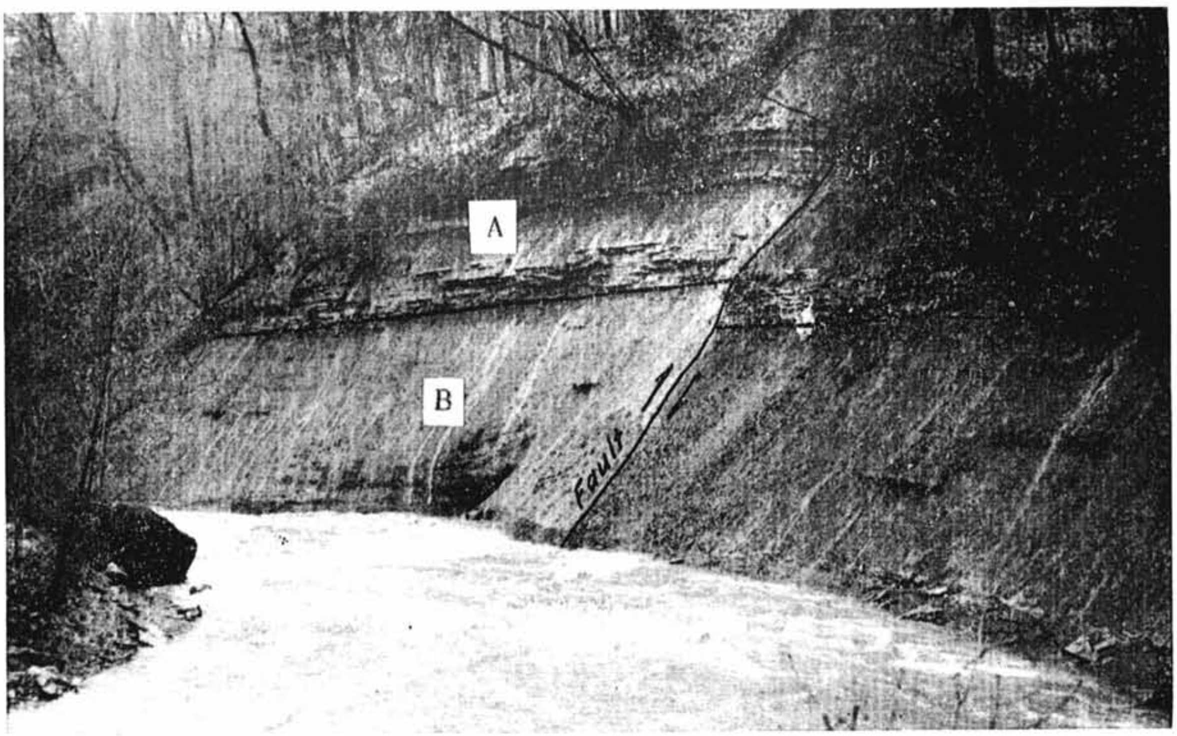
The formations between the Sharon conglomerate and the Berea sandstone constitute the Cuyahoga group. In descending order, the beds are: the Meadville shale, the Sharpsville sandstone, and the Orangeville shale. The

A. Photograph of the Sharon conglomerate along State Route 91, 1½ miles north of Twinsburg, Summit County, Ohio, showing the crossbedded character of the rock.

B. Photograph showing the character of the Meadville formation along Chippewa Creek, 2¼ miles west of Brecksville, Cuyahoga County, Ohio.

PLATE 27

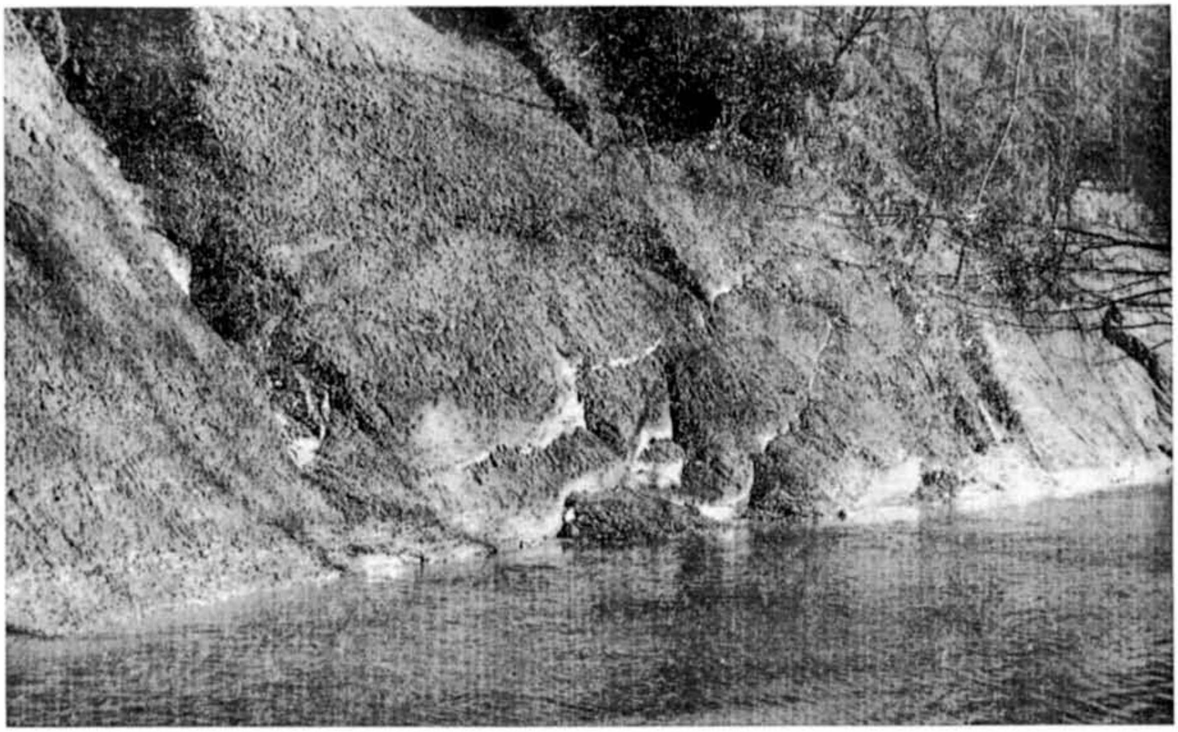
A. Photograph of a fall over one of the thin sandstone layers of the Sharpsville sandstone along Chippewa Creek, 2 miles west of Brecksville, Cuyahoga County, Ohio.



B. Photograph of the Sharpsville sandstone (A) and the Orangeville shale (B) 2 miles west of Brecksville, Cuyahoga County, Ohio. A small reverse fault and the direction of movement of the strata are shown by the oblique line and arrows.

PLATE 28

A. Photograph of the Orangeville shale along Chippewa Creek, 100 yards east of the bridge on Harris Road, Brecksville Township, Cuyahoga County, Ohio. The uniform character of the shale and the gullies caused by weathering and erosion are shown.



B. Photograph of the Orangeville shale along Chippewa Creek 200 yards east of the bridge on Harris Road, Brecksville Township, Cuyahoga County, Ohio, showing the joint planes along which ground water may find passage.

PLATE 29

Cuyahoga group crops out along the gentle, wide slope that lies below the base of the Sharon sandstone and above the Berea sandstone terrace. Good exposures of the Cuyahoga group occur also in the walls of some of the valleys. The three major units of the Cuyahoga group are generally similar in their water-bearing and lithologic characteristics. For this reason they are not differentiated in this report.

Water-bearing Characteristics

The Cuyahoga group is not as productive of ground water as the overlying Sharon conglomerate. Wells drilled into the shales and interbedded sandstones of the Cuyahoga group generally yield sufficient water for domestic purposes; 3 to 5 gallons a minute is the average yield for a 5⅝-inch domestic well. Ground water occurs in the joints and crevices of the rocks. In areas where there are few joints and crevices the rocks are less permeable and productive. In these areas water is obtained by drilling deeper, into the underlying Berea sandstone.

Meadville Formation

The Meadville formation consists of shale alternating with thin sandstone beds. The shale is a spongy medium- to dark-gray fissile arenaceous shale. The sandstone layers range in thickness from 1 to 10 inches and consist of thin beds of hard blue-gray fine-grained calcareous sandstone. Numerous clay ironstone concretions have formed along the bedding planes of the formation.

The thickness of the Meadville formation ranges from 30 to 250 feet. This is because of the unconformity between the shale and the overlying Sharon sandstone. On the average, the shale is thicker in the western part of the county; in Strongsville Township it is about 200 feet thick; in Orange and Solon Townships,in the eastern part of the county, it is only about 30 feet thick.

Sharpsville Sandstone

The Sharpsville sandstone has an average thickness of 45 feet. The rock consists of interbedded shales and sandstones. The sandstone layers are generally 1 to 14 inches thick, and consist of hard, limy gray-brown to tan-gray fine-grained calcareous beds. The interbedded blue-gray shale is weak and fissile.

Orangeville Shale

The Orangeville shale consists of 100 feet of rather uniform soft, fissile dark-blue to tan-grey shale. The 7-foot-thick Aurora siltstone member and the 10-foot-thick Sunbury member occur at the base of the Orangeville shale. The Aurora siltstone member consists of thinly bedded hard blue-gray fine-grained sandstone lenses with thin gray shale partings. The Sunbury member (de Witt, 1951) is a soft, fissile black bituminous shale.

BEREA SANDSTONE
(Mississippian System)

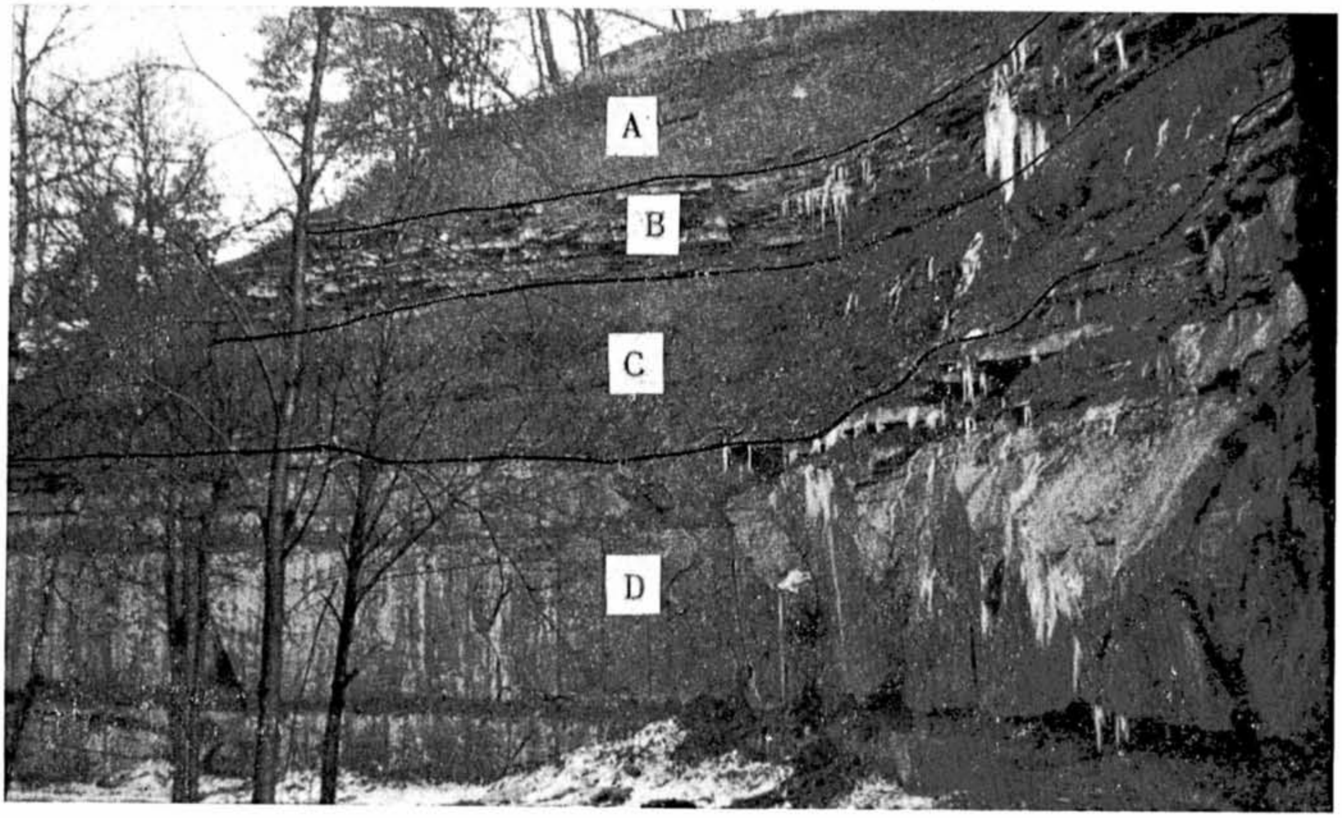
In Cuyahoga County the Berea sandstone forms a northeast-southwest escarpment extending from Mayfield to Dover Township. The escarpment ranges from 5 to 50 feet in height, being highest in the eastern part of the county, diminishing in height westward, and becoming unnoticeable or nearly so in Dover Township. The Berea escarpment is broken by the Chagrin, Cuyahoga, and Rocky River valleys, along which the Berea sandstone crops out, forming small falls or cascades where tributary streams flow across it.

The thickness of the Berea sandstone averages about 60 feet in Cuyahoga County, but locally its thickness varies considerably because of the unconformity at its base. At Berea it is about 150 feet thick. Along Rocky River, in Brooklyn Township, and in other areas, channels that were cut into the top of the Bedford shale prior to Berea deposition have resulted in an additional 30 to 40 feet being added to the 60-foot average thickness. In southeastern Brecksville Township the Berea sandstone is thinner than average, and near the intersection of Snowville and Dewey Roads the sandstone is absent, the Cuyahoga group lying directly on the Bedford shale.

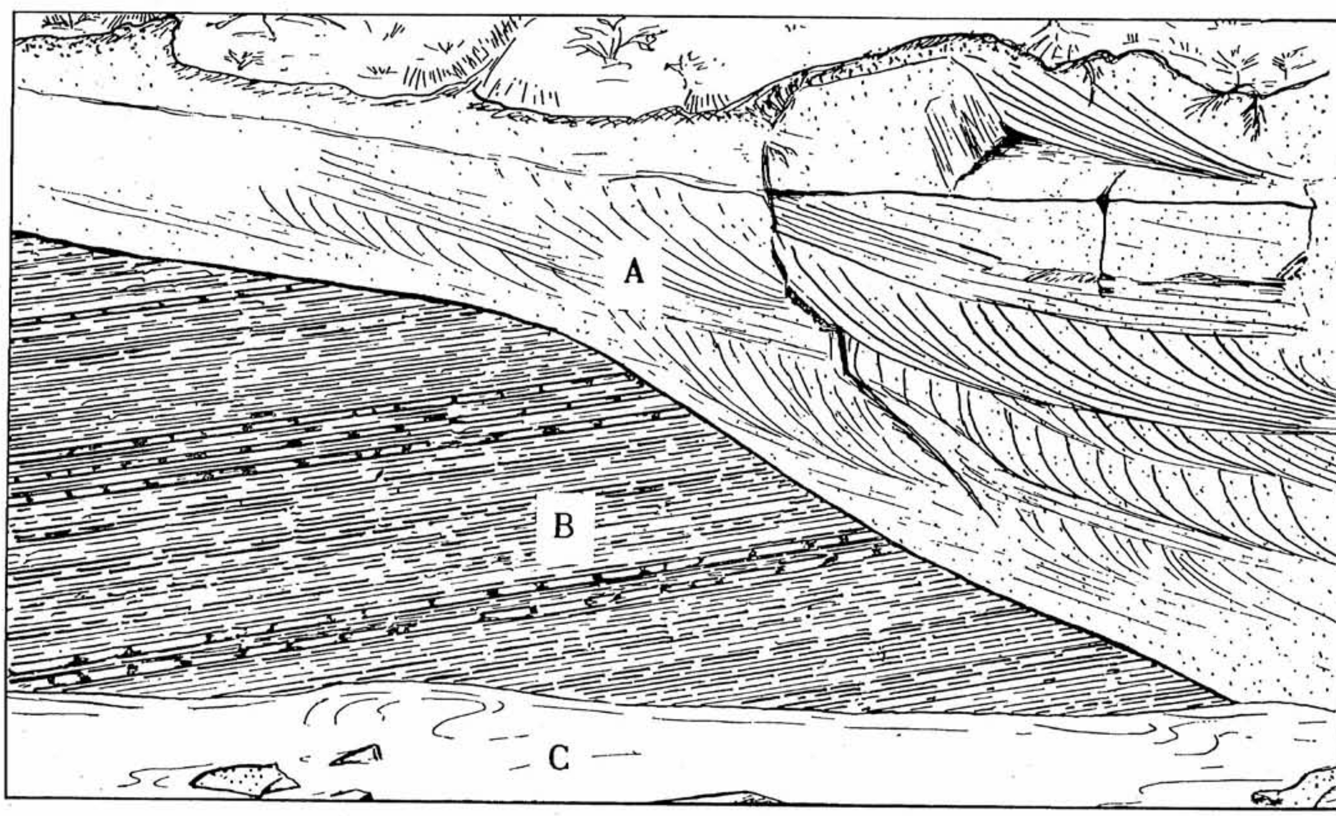
The Berea sandstone may be subdivided, lithologically, into three separate zones in Cuyahoga County: the thinly bedded upper zone, the massive middle portion, and the lower basal portion of the channel areas. The upper zone is a thinly bedded light-gray to tan fine-grained calcareous sandstone, with occasional thin shale partings. The middle portion of the sandstone is a massive, moderately hard medium- to coarse-grained quartz sandstone, light gray on a fresh surface, tan to light-brown when weathered. The lower zone occurs in channels in the underlying Bedford shale. It consists of profusely crossbedded tan to red-brown well-indurated coarse-grained sandstone.

Water-bearing Characteristics

The Berea sandstone is one of the best aquifers in Cuyahoga County. It does not necessarily yield more than the Sharon sandstone on the average, but its areal extent makes it the more important aquifer. The average domestic well yields 5 to 10 gallons a minute from the Berea sandstone. At the Bailey Walker Co. on Solon Road in Bedford Township, a 10-inch industrial well drilled 58 feet into the Berea sandstone yielded 260 gallons a minute in a pumping test conducted by the driller.

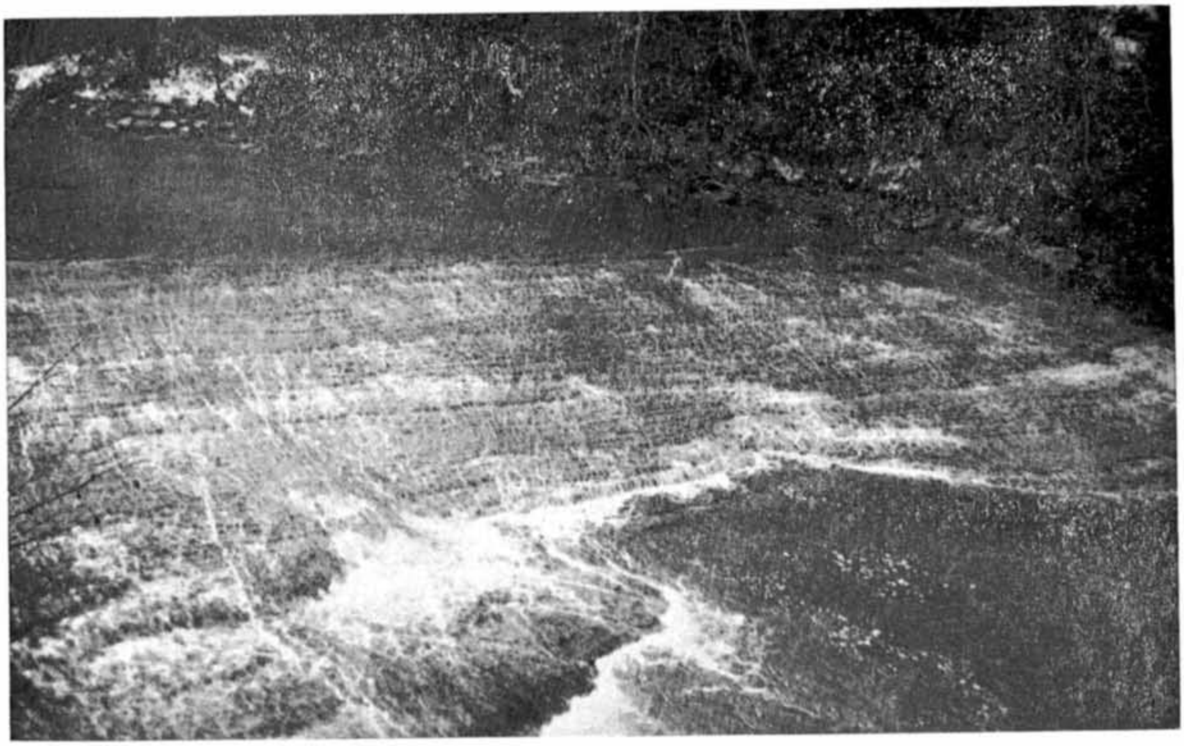


A. Photograph of the north wall of the Independence Quarry on Solon Road, Chagrin Falls Township, Cuyahoga County, Ohio. The Orangeville shale (A), the Aurora siltstone (B) and Sunbury (C) members of the Orangeville shale, and the Berea sandstone (D). The shale partings in the upper portion of the Berea sandstone are shown.



B. Sketch of the unconformable contact between the Berea sandstone (A) and the Bedford shale (B) along the Aurora Branch of the Chagrin River (C) at Independence Quarry, on Solon Road in Chagrin Falls Township, Cuyahoga County, Ohio. Scale: 1 inch equals approximately 10 feet. The dip of the Bedford shale is slightly exaggerated.

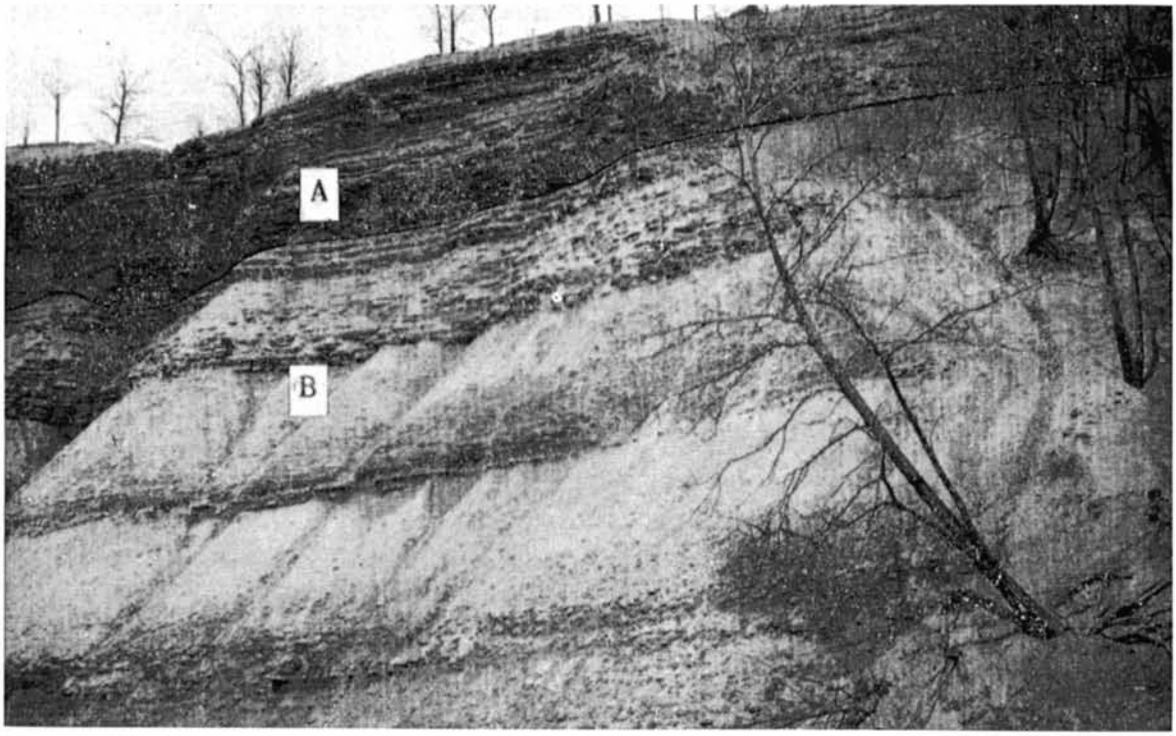
PLATE 30



A. Photograph of a small cascade over the Bedford shale as exposed in the Aurora Branch of the Chagrin River at Independence Quarry on Solon Road, Chagrin Falls Township, Cuyahoga County, Ohio.

B. Photograph of the Cleveland member of the Ohio shale along a tributary of Tinkers Creek near the Bedford sewage treatment plant on W. Glendale St., Bedford Township, Cuyahoga County, Ohio, showing the slablike character of the shale and the jointing planes.

PLATE 31



A. Photograph of the Cleveland member of the Ohio shale (A) overlying the Chagrin shale (B) in Euclid Creek Park, Euclid Township, Cuyahoga County, Ohio.

B. Photograph of the Chagrin shale along Rocky River Road in the Rocky River Park, Rockport Township, Cuyahoga County, Ohio.

PLATE 32

In Orange Township, near West Hill Colony, there are a number of flowing wells, 6 and 8 inches in diameter, drilled into the Berea sandstone. A few of these wells have been pumped for several years, at an average rate of 35 gallons a minute.

The water in the Berea sandstone is generally under artesian pressure and in a well it rises above the top of the sandstone, in some places flowing at the land surface. There are areas, however, where the water in the sandstone occurs under water-table conditions and the water level may be 20 to 30 feet below the upper surface of the rock. The sandstone is 60 or more feet thick in those areas and it has sufficient permeability that household and small industrial requirements are easily supplied. The water possibilities of the Berea sandstone are further discussed in the portion of this report entitled "Ground-Water Conditions in Specific Areas."

BEDFORD, OHIO, AND CHAGRIN SHALES

The three formations that immediately underlie the Berea sandstone are, in descending order: the Bedford shale, the Cleveland member of the Ohio shale, and the Chagrin shale. These beds are somewhat similar lithologically and have similar water-bearing properties. For these reasons they are placed as a single group, on the maps and in the text, to meet more clearly the purposes of the report.

The shales that underlie the Berea crop out beneath the thin glacial deposits on the Erie plain, and along the face of the Portage Escarpment in the northeastern part of the county. Exposures occur along the walls of the major valleys. The Chagrin shale is well exposed in the lake-shore cliffs west of the Cuyahoga River.

Water-bearing Characteristics

The three shale formations differ only slightly in their water-bearing characteristics. In certain local areas (discussed under "Ground-Water Conditions in Specific Areas") these formations are completely unproductive of ground water. Generally, however, small domestic supplies can be developed from them, though the wells generally are deeper than wells of corresponding yields in the other aquifers. Ground water occurs primarily along the jointing planes.

Bedford Shale
(Mississippian System)

The Bedford shale is a soft blue-gray shale with thin calcareous sandstone lenses in places. In the central part of the county the shale of the uppermost beds is brownish red and very soft. The percentage of sandstone is greater at the base of the Bedford shale, and in the northeastern part of the county it thickens into the 25-foot massive basal Euclid sandstone lentil. The sandy portions are generally well indurated, fine-grained light blue-gray calcareous sandstone.

The Bedford shale averages about 75 feet in thickness but may range as much as 40 feet from the average owing to the unconformity between the Bedford shale and the overlying Berea sandstone.

Ohio Shale—Cleveland Member
(Devonian System)

The Cleveland member of the Ohio shale averages 50 feet in thickness. It consists of a massive black bituminous shale, and contains pyrite concretions. In stream beds the jointing system of the shale is well exposed, as is shown in the photograph, plate 32 B. The photograph was taken in Bedford Township where the shale is blue black and has a vitreous appearance.

Chagrin Shale
(Devonian System)

The Chagrin shale is the lowest formation exposed in Cuyahoga County and the oldest formation discussed in this report. The base of the formation does not occur at the surface in Ohio. In Cuyahoga County only the upper 200 feet of the total thickness of 500 feet is exposed above the level of Lake Erie. The Chagrin shale is a blue-gray to dark-gray silty shale, containing light blue-gray iron carbonate concretions, and thin hard light-gray calcareous sandstone beds.

GROUND-WATER CONDITIONS IN SPECIFIC AREAS

Plate 2 is a map showing the ground-water conditions in Cuyahoga County, Ohio. This map was compiled from plates 1 and 3 and from the water-supply data in tables 9 to 27. The hydrologic areas shown on plate 2 correspond generally to the areas underlain by the different geologic formations, whose water-bearing properties have been discussed.

The best ground-water area in the county is in the Mill Creek valley where a thick deposit of Illinoian sand and gravel is traversed by Mill Creek. Wells in this area are favorably situated to receive recharge by infiltration from Mill Creek, and consequently the water-bearing capacity of the deposit is determined largely by the total amount of stream water that can be induced by pumping to enter the deposit.

The other buried valleys in the county also contain sand and gravel deposits, but these are generally in the form of thin, narrow, and discontinuous sand and gravel lenses. They are in places surrounded by finer grained and relatively impermeable silt, clay, or till deposits, which retard stream infiltration. Consequently the sustained yields of wells in those areas may be much less than from wells that receive stream infiltration.

The Sharon conglomerate and the Berea sandstone aquifers in Cuyahoga County are good sources of ground water, yielding up to 250 gallons per minute to wells. The shales and interbedded sandstones of the Cuyahoga group in most places yield sufficient water for domestic requirements. Where insufficient water is available, the wells are generally drilled into the underlying Berea sandstone.

The Bedford, Ohio, and Chagrin shales underlie the Berea sandstone, and are not a reliable source of ground water. Wells in these formations ordinarily yield 2 to 3 gallons per minute, but many are failures regardless of their depth. Saline water is encountered in the Chagrin shale, being reported in the logs of oil and gas wells and of some water wells.

On plates 1 and 2 are shown approximate contour lines on the bedrock surface. The approximate thickness of the unconsolidated material covering the bedrock in a specific area can be calculated by subtracting the bedrock elevation from the elevation of the ground surface, also indicated by contour lines. The contour interval for the approximate contour lines on the bedrock surface is 100 feet. The contour interval for the ground-surface contour lines is 20 feet for the central and eastern parts of the county and 10 feet for the western part. The Berea, Chagrin Falls, Cleveland, Euclid, and Mentor quadrangle maps of the U. S. Geological Survey form the base map for plates 1, 2, and 3 and for the well-index maps. The first consolidated rock formation that will be encountered in drilling at a specific location can be determined from plate 1. The symbol "O" on plate 2 indicates the location of a water, oil, or gas well, a test hole, or an electrical-resistivity measurement from which the data were derived; the identifying number is shown on the township index maps. The approximate contours on the bedrock surface were computed from the logs of wells, earthresistivity measurements, and numerous surface exposures of the consolidated rock formations. The well-index maps for specific townships show the locations of wells; the type of well is indicated by the following numbering system: water well, 1 to 200; oil and gas wells, 201 to 300; test holes, 301 to 400; and earth-resistivity-measurement sites, 401 to 500.

Data on the wells are given in the well tables for each township. The logs of many of the water wells are shown diagrammatically, and the interpretations of the electrical-resistivity measurements is given in table 29.

Explanation of Terms and Symbols

Number.—The number of the well shown on the well index map for the specific township. The type of well is indicated by the numbering system: water wells, 1 to 200; oil and gas wells, 201 to 300; test wells, 301 to 400; earth-resistivity-measurement sites, 401 to 500.

File No.—The number under which the driller's log of the well is filed in the offices of the Ohio Division of Water, Department of Natural Resources.

Owner or name.—The name of the land owner or tenant at the time the well was drilled or at the time of the well survey.

Elevation of well.—Determined approximately from the topographic maps of the U. S. Geological Survey.

Depth to bedrock.—Depth to the top of the consolidated rocks; a plus sign indicates that bedrock was not reached.

Depth of well.—Depth reported by driller, owner, or tenant.

Character of material.—Geologic material from which water was obtained or in which well was terminated: Ss, sandstone; Sh, shale; S, sand; G, gravel; Un, unknown.

Geologic horizon.—Refers to the geologic age of the water-bearing material; Gla, glacial drift; Shar, Sharon conglomerate; Cuy, Cuyahoga group; Ber, Berea sandstone; P-B, the three formations immediately underlying the Berea sandstone (Bedford shale, Ohio shale, Chagrin shale).

Water level below land surface.—The depth to water in the well as reported by the driller, land owner, or tenant.

Date.—The date of determination of the static water level, yield, or drawdown.

Yield.—The rate at which the well was pumped or bailed.

Drawdown.—The amount of lowering of the water level in the well caused by the withdrawal of water at the rate indicated in the yield column.

Type of well.—Method used in constructing well: Dr, drilled; Spr, spring.

Type of pump.—Hand, hand pump; jet, electric-powered ejector pump; lift, electric-powered pump jack; turb, electric-powered turbine pump.

Diameter of well.—Approximate inside diameter of casing.

Use.—I, industrial cooling and washing processes; D, domestic supply; G, gas well; Irr, irrigation; O, oil well; P, public supply.

Remarks.—A, chemical analysis shown in table 28.
L, well logs shown graphically on plates 34, 38, 42, 44, 48, 50, 54, 56, and 59.
R, earth-resistivity measurement, interpreted in table 29.

BEDFORD TOWNSHIP

Part of Bedford Township is underlain by buried valleys that are partially filled with outwash material deposited during the Illinoian stage of glaciation. As is shown on plate 2, the buried valley that underlies the northwestern part of the township contains water-bearing gravel. No wells are reported in this buried valley, but in adjoining Newburg Township a well in similar gravel deposits is reported to have yielded 1,500 gallons per minute with a drawdown of only 6 feet (pl. 33, table 9).

Elsewhere within the buried valleys in Bedford Township the materials are predominately glacial till and fine sand. These deposits in places contain gravel lenses that yield as much as 15 gallons per minute to wells.

Rocks of the Cuyahoga group, the Berea sandstone, and the three shale formations that underlie the Berea sandstones have been tapped by water wells (pl. 34). The rocks of the Cuyahoga group yield as much as 12 gallons per minute in some areas and, if this yield is insufficient, wells may be finished in the underlying Berea sandstone which generally yields up to 25 gallons per minute. A yield of 260 gallons per minute is reported from an 8-inch industrial well drilled for the Bailey Walker China Co. on Solon Road. The shale formations below the Berea sandstone yield as much as 5 gallons per minute to some wells, but others are dry.

Records of wells in Bedford Township are shown in table 9; the locations of the wells are shown on plate 33. The logs of some of the wells are shown on plate 34.

BRECKSVILLE TOWNSHIP

The Sharon conglomerate, rocks of the Cuyahoga group, the Berea sandstone, and the three shale formations below the Berea sandstone crop out beneath a thin cover of glacial drift and along the walls of the buried valleys in Brecksville Township.

The buried-valley deposits, lake clay and glacial drift, are predominantly non-water-bearing, but wells that penetrate the infrequent sand and gravel lenses may yield as much as 40 gallons per minute.

The Sharon conglomerate yielded 125 gallons per minute from a 10-inch well at the Veterans Hospital at Brecksville. Domestic wells in the Sharon generally yield from 5 to 10 gallons per minute.

The Cuyahoga group may yield as much as 15 gallons per minute. However, many wells are drilled through the shale formations into the underlying Berea sandstone before encountering sufficient water. The Berea sandstone commonly yields up to 15 gallons per minute to domestic wells.

No wells are reported in the rocks that underlie the Berea sandstone in Brecksville Township.

Records of wells in Brecksville Township are shown in table 10; the locations of the wells are shown on plate 35. The logs of some of the wells are shown on plate 38.

BROOKLYN TOWNSHIP

In Brooklyn Township the Bedford shale, the Cleveland member of the Ohio shale, and the Chagrin shale crop out beneath a thin cover of glacial drift and along the banks of Big Creek.

The glacial drift consists predominantly of clay and till and is a poor source of ground water. The shale formations also are poor sources of ground water. Only a few wells have been reported, because of the poor prospect of an adequate ground-water supply and because the Cleveland water system services the greater part of the township. Wells in the shale are likely to be failures regardless of the depth to which they are drilled. Small amounts of brine may be encountered in the deeper wells.

Records of wells in Brooklyn Township are shown in table 11; the locations of the wells are shown on plate 36. The logs of some of the wells are shown on plate 38.

CHAGRIN FALLS TOWNSHIP

In Chagrin Falls Township the rocks of the Cuyahoga group, the Berea sandstone, and the shale formations below the Berea sandstone crop out beneath a thin cover of glacial drift or along the walls of the Chagrin River buried valley. The buried valley is about 400 feet deep and lies in a northwest-southeast direction. It is crossed by Miles Road between the bridge near Bentleyville Road and the bridge near Solon Road.

The material filling the buried channel is predominantly silt and clay but contains an occasional thin, discontinuous water-bearing sand-and-gravel lens. Wells that penetrate only silt and clay commonly are unproductive, but domestic wells that encounter gravel lenses yield up to 6 gallons per minute.

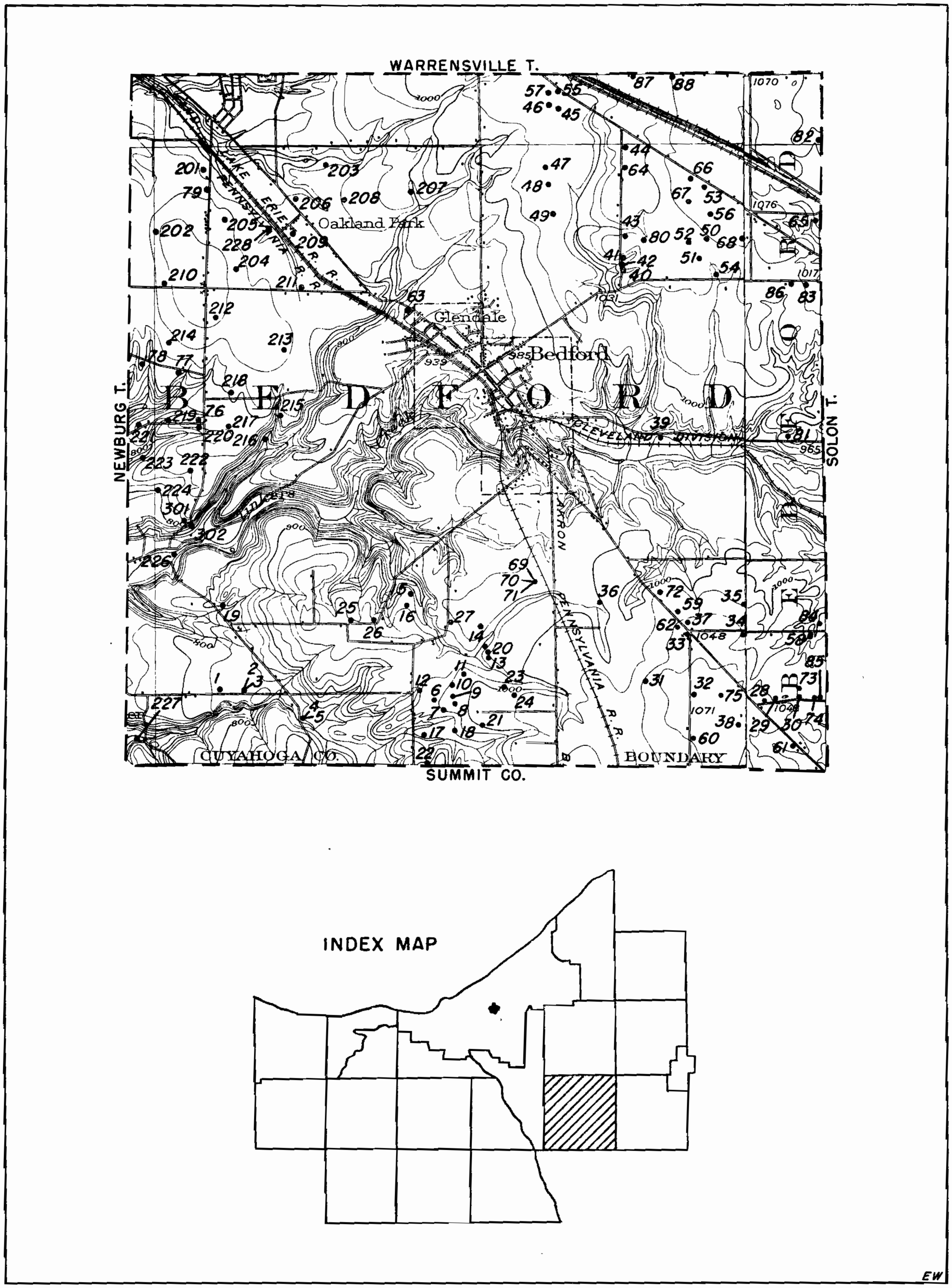


Plate 33. Map showing location of wells in Bedford Township.

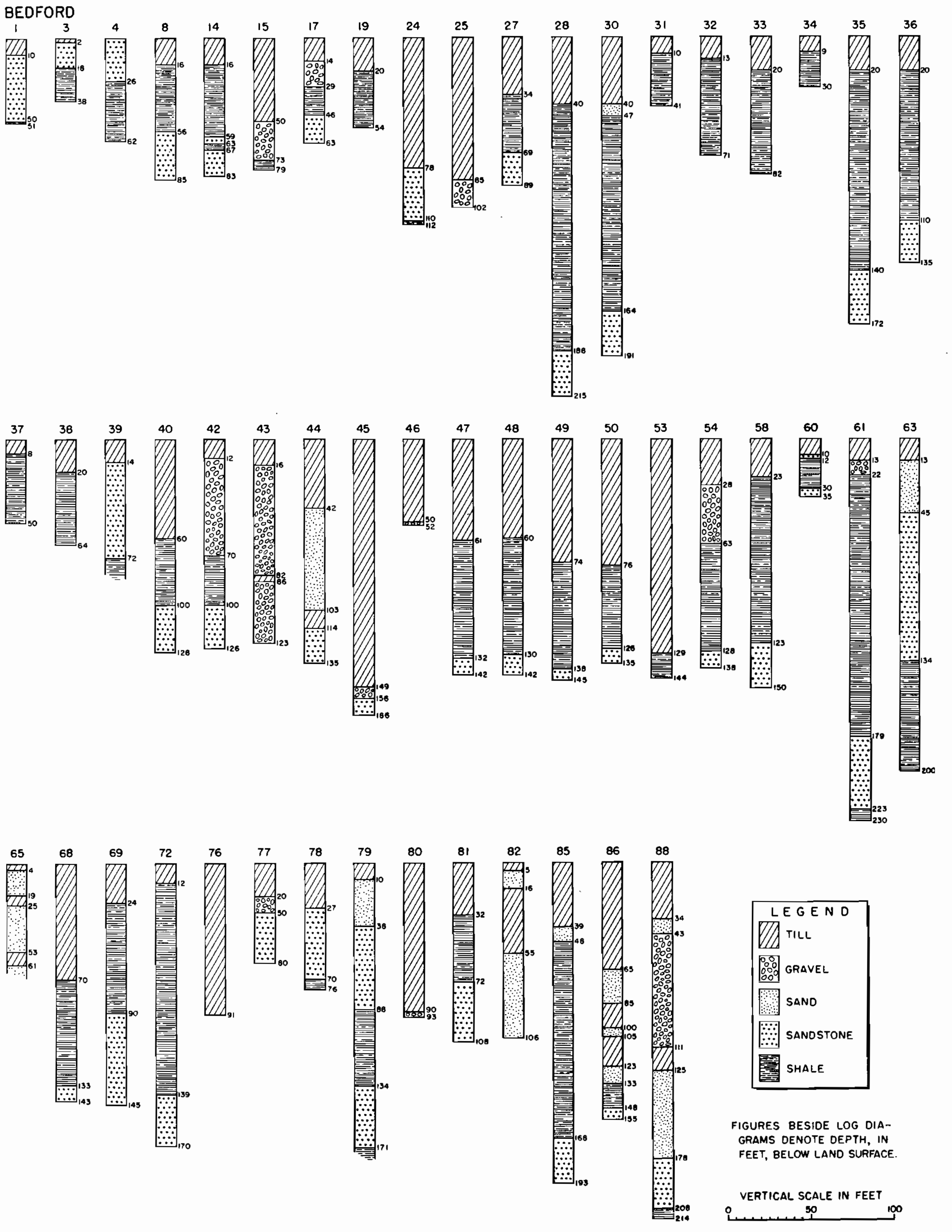


Plate 34. Logs of wells in Bedford Township.
[Well numbers refer to locations shown on plate 33.]

TABLE 9. RECORDS OF WELLS IN BEDFORD TOWNSHIP

No.	File No. (Ohio Division of Water)	Owner or name	Elevation at well (feet above sea level)	Depth to bedrock (feet)	Depth of well (feet)	Principal water-bearing bed: Character of material	Principal water-bearing bed: Geologic horizon	Water level: Below land surface (feet)	Water level: Date	Yield: Rate (g.p.m.)	Yield: Drawdown (feet)	Type of well	Type of pump	Diameter of well (inches)	Use	Remarks
1	138	G. Urban	825	10	51	Ss	Ber	40	3-28-46	8		Dr		5½	D	L
2	181	Frank Hinsbal	835	3	38	Ss	Ber	28	8- 3-46	2½		Dr		5½	D	
3	180	E. Hinsbal	835	2	38	Ss	Ber	28	8- 2-46	3		Dr		5½	D	L
4	175	L. Chuatch	840	0	62	Ss	Ber	55	6-28-46	4		Dr		6	D	L
5	567	R. Cheatal	840	5	70	Sh	P-B	20	9-27-49	1		Dr		8	D	
6		E. Bahensky	975	61	95	Ss	Ber	29	10-29-48			Dr		5	D	
7		R. M. Clements	980	26	70	Ss	Ber	25	6-28-49	15		Dr		6	D	
8		R. Vargo	985	16	85	Ss	Ber	65	9-21-49	4	10	Dr		6	D	L,A
9		P. Hackhart	990	20	85	Ss	Ber	20	6-24-49	10		Dr		6	D	
10		A. E. Wagner	985	40	79	Ss	Ber	60	6-30-48	10		Dr		6	D	
11		D. W. Smith	985	15	79	Ss	Ber	64	6- 6-50	5		Dr		6	D	
12		A. C. Allison	960	35	96	Ss	Ber	46	7- 5-49	14		Dr		5½	D	
13		Fisher	970	8	75	Ss	Ber	55	9-10-49	9	5	Dr		5½	D	
14		John Brenner	960	16	83	Ss	Ber	20	1- 6-49	4		Dr		5½	D	L
15		Connelly Realty	920	73	79	Sh	Cuy	55		1	17	Dr		5½	D	L
16		R. E. Flanigan	940	103	143	Sh	Cuy	55	10-10-49	2	85	Dr		5½	D	
17		C. A. Hunt	940	29	63	Ss	Ber	40	4-16-50	16		Dr		5½	D	L
18		D. H. Russel	960	18	84	Ss	Ber	20	3-17-50	20		Dr		6	D	
19		S. Rameos	800	20	54	Sh	P-B	30		5		Dr		5½	D	L
20		E. Toth	975	16	102	Ss	Ber	30	5-31-50	25		Dr		6	D	
21		E. Featherstone	1,000	20	108	Ss	Ber	28	5-20-50	20		Dr		6	D	
22		Whikham	1,002	10	53	Sh	Cuy	Flow	12-10-49	7	20	Dr		8	D	
23		C. Podunski	1,000	18	134	Ss	Ber	45	8- 6-46			Dr		5½	D	
24	220	Don Leach	1,020	78	112	Ss	Ber	70	4- 1-47	10		Dr		6	D	L
25	219	H. R. Sharp	960	102+	102	S & G	Gla	40	7-11-47			Dr	Hand	5½	D	L
26	257	N. Gesne	960	133+	133	S & G	Gla	90	2-12-48	5	25	Dr		5	D	
27	611	J. D. Walton	970	34	89	Ss	Ber	18	10- 1-49	10		Dr		6	D	L
28		W. Hague	1,062	40	215	Ss	Ber	145	11-18-49	4	25	Dr	Hand	5½	D	L
29		Mary Baciak	1,060	35	71	Sh	Cuy	21	5- 6-49	10		Dr		4¼	D	
30		W. Grabiski	1,055	47	191	Ss	Ber	135	3-20-50	6	56	Dr		5	D	L
31	415	E. Thompson	1,040	10	41	Sh	Cuy	10	12- 9-47	5	10	Dr		5	D	L
32	195	P. B. Seeman	1,070	13	82	Sh	Cuy	9	7- 2-47			Dr		5	D	L
33	306	J. Douglas	1,048	26	82	Sh	Cuy	20	5- 5-48			Dr		6	D	L
34	37	May V. McKinney	1,040	9	30	Sh	Cuy					Dr		5	D	L
35	307	Daniels	1,020	20	172	Ss	Ber	140	5-20-48			Dr		6	D	L
36	55	S. Martin	1,000	20	135	Ss	Ber					Dr			D	L
37	396	C. Crosby	1,042	8	50	Sh	Cuy	3	12- 8-48	5	20	Dr		5	D	L
38		E. Marak	925	11	64	Sh	Cuy	19	8-26-48	2		Dr		4	D	L
39	127	Bailey Walker Co.	960	11	72	Ss	Ber	12		260		Dr		10	I	L,A
40	22	Lloyd Covert	1,010	60	128	Ss	Ber			10		Dr			D	L
41	70	L. J. Raus	1,030	94	110	Ss	Ber			12		Dr			D	
42	42	John Kable	1,010	70	126	Ss	Ber			10		Dr			D	L
43	23	H. Cramer	1,040	123+	123	S & G	Gla			3		Dr			D	L
44	30	A. Jablonowski	1,044	114	135	Ss	Ber					Dr			D	L
45	391	Mary Kosma	1,035	156	166	Ss	Ber	37	9-27-48	7	13	Dr		4	D	L
46	153	McChap Supplies Co.	1,035	55+	55	G	Gla		8- -46			Dr		5	I	L
47	217	W. Chittenden	1,030	61	142	Ss	Ber	52	10-31-47	10	10	Dr	Hand	5½	D	L
48	216	H. A. Baker	1,030	60	142	Ss	Ber	55	10-27-47	10	10	Dr		5½	D	L
49	633	Zion Cemetery	1,030	74	145	Ss	Ber	50	1-31-50	10	40	Dr		6	P	L
50	308	R. Cummings	1,060	76	135	Ss	Ber	40	6- 5-48	5	1	Dr	Jet	5	D	L
51	309	W. Giljahn	1,050	81	135	Ss	Ber	38	6-10-48	7	25	Dr	Jet	4	D	
52	397	W. Spencer	1,050	74	145	Ss	Ber	40	11- 2-48	5	60	Dr	Jet	5	D	
53	390	E. W. Boulis	1,065	129	144	Sh	Cuy	51	10-30-48	8	12	Dr		5	D	L
54	43	R. Keene	1,040	63	138	Ss	Ber			25		Dr			D	L

TABLE 9 (Continued). RECORDS OF WELLS IN BEDFORD TOWNSHIP

No.	File No. (Ohio Division of Water)	Owner or name	Elevation at well (feet above sea level)	Depth to bedrock (feet)	Depth of well (feet)	Principal water-bearing bed: Character of material	Principal water-bearing bed: Geologic horizon	Water level: Below land surface (feet)	Water level: Date	Yield: Rate (g.p.m.)	Yield: Drawdown (feet)	Type of well	Type of pump	Diameter of well (inches)	Use	Remarks
55	75	L. Rezabeck	1,025	158+	155	G	Gla			15		Dr			D	
56	756	E. Parker	1,065	99+	99	S & G	Gla	44	7– 6–50	6	10	Dr		4	D	
57		E. Kvasnicka	1,030	158	171	Ss	Ber	36	11– 3–49	6	11	Dr		4	D	
58	719	W. White	1,000	23	150	Ss	Ber	75	5–12–50	3	30	Dr		4	D	L
59		A. Brooks	1,032	13	50	Sh	Cuy	10	6– 8–49	2	35	Dr		5½	D	
60	152	E. Thompson	1,062	10	35	Sh	Cuy	12	8– 7–49			Dr		4½	D	L
61		Hiway Trailer Camp	1,045	22	230	Ss	Ber	135	8–16–49	7	65	Dr		8	P	L
62		F. Guarino	1,040	15	61	Sh	Cuy	8	9–14–48	8		Dr		4	D	
63		Stillwell Theater	940	45	200	Ss	Ber	38	7–31–47	10	138	Dr		8	D	L
64		D. G. Shom	1,050	132	163	Ss	Ber	35	3– 8–48	10	55	Dr		5½	D	
65		E. Manak	1,040	62+	62	S	Gla	32	8–13–48	10	8	Dr		4	D	L
66		G. E. Wallace	1,065	100+	100	S & G	Gla	40	8– 4–50	5	40	Dr		5½	D	
67		A. D. McFarland	1,069	61	140	Ss	Ber	36		8	18	Dr		4	D	
68		J. Syrara, Jr.	1,060	70	143	Ss	Ber	35	3– 9–49	3	65	Dr		5½	D	L
69	129	Ferro Drier Co.	990	24	145	Ss	Ber	95	1944	20		Dr		8	I	L
70	130	Ferro Enamel Co.	990	15	178	Ss	Ber	100	1944	20		Dr		8	I	
71	32	Ferro Enamel Co.	990	15	125	Ss	Ber	95	1943	20		Dr			I	
72		A. Cooper, Jr.	1,020	12	170	Ss	Ber	125	6– 1–49	1½	35	Dr		5½	D	L
73	149	Frank Steckel	1,040	48	197	Ss	Ber	105	7–25–46	8	60	Dr		5	D	
74	171	A. C. Allison	1,058	46	186	Ss	Ber	136	5–10–47	3		Dr		5	D	
75	66	R. E. Pearce	1,070	15	58	Sh	Cuy			12		Dr			D	
76	430	A. G. Gordon	880	91+	91	S	Gla	74	3– 4–49	15		Dr		5½	D	L
77	703	E. Toth	1,000	30	60	Ss	Ber	30	5–29–50	20	30	Dr		5½	D	L
78	164	M. Grajeck	900	27	76	Ss	Ber	33	10–23–46	10		Dr		5	D	L
79	50	Lempco. Prod. Co.	915	38	172	Ss	Ber			20		Dr			I	L
80		Jack Cox	1,043	93+	93	G	Gla	40	8–11–49	5	25	Dr		4	D	A
81		M. Cameron	980	32	108	Ss	Ber	52	8– 6–47	10		Dr		5	D	L
82		J. Slechita	1,060	106+	106	S	Gla	42	9– 7–50	5		Dr		5	D	L
83		A. Delda	1,060	140+	140	S	Gla	44	9–11–50	10		Dr		5	D	
84		W. A. Tiburski	1,000	61	132	Ss	Ber	80	9–26–50	5		Dr		5	D	
85		R. Evans	1,050	48	193	Ss	Ber	129	7–19–48	5	50	Dr		5	D	L
86		W. M. Gall	1,040	133	155	Ss	Ber	55	6–20–51	6	10	Dr		5½	D	L
87	61	J. Prozen	1,050	145+	145	S & G	Gla			3		Dr			D	
88	215	Louis Smith	1,060	178	214	Ss	Ber	45	12–11–47	6	112	Dr		6	D	
201		E.O.G. Co.—Dunham Sta.	920	108								Dr		10	O	
202		A. Hathaway	950	41								Dr		10	G	
203		E. Helwick	920	102								Dr		10	G	
204		B. W. Jackson	950	41								Dr		10	G	
205		Benhoff—Helper	945	74								Dr		10	O	
206		E. Helwick	928	130								Dr		10	O	
207		Friend	960	68								Dr		10	O	
208		R. R. Libby	940	50								Dr		10	G	
209		A. Roever #1	920	309								Dr		8	G	
210		W. Bahr	950	25								Dr		10	O	
211		J. G. Bingham	920	315								Dr		8	O	
212		F. Klamors	960	31								Dr		10	G	
213		J. & O. Hladick #3	924	137								Dr		10	O	
214		J. Norotry	930	36								Dr		10	O	
216		H. J. Meilander #2	900	132								Dr		10	O	
217		H. J. Meilander #1	880	105								Dr		10	O	
218		H. J. Meilander #3	900	70								Dr		10	G	
219		J. Cohen	850	104								Dr		10	O	
220		S. Danider #1	860	75								Dr		10	O	
221		P. Duenisch	860	104								Dr		10	O	

TABLE 9 (Continued). RECORDS OF WELLS IN BEDFORD TOWNSHIP

No.	File No. (Ohio Division of Water)	Owner or name	Elevation at well (feet above sea level)	Depth to bedrock (feet)	Depth of well (feet)	Principal water-bearing bed: Character of material	Principal water-bearing bed: Geologic horizon	Water level: Below land surface (feet)	Water level: Date	Yield: Rate (g.p.m.)	Yield: Drawdown (feet)	Type of well	Type of pump	Diameter of well (inches)	Use	Remarks
222		M. & M. Manke	860	19								Dr		10	O	
223		A. J. Lytle	800	97								Dr		10	O	
224		J. Tansing	800	87								Dr		10	O	
226		Howard Carey	660	124								Dr		8	O	
227		T. V. Hart #1	630	20								Dr		8	O	
228		Helper Realty Co.	920	212								Dr		8	O	
301			810	44		Sh	P-B					Dr				Test hole.
302			860	72		Sh	P-B					Dr				Test hole.

TABLE 10. RECORDS OF WELLS AND RESISTIVITY MEASUREMENTS IN BRECKSVILLE TOWNSHIP

No.	File No. (Ohio Division of Water)	Owner or name	Elevation at well (feet above sea level)	Depth to bedrock (feet)	Depth of well (feet)	Principal water-bearing bed: Character of material	Principal water-bearing bed: Geologic horizon	Water level: Below land surface (feet)	Water level: Date	Yield: Rate (g.p.m.)	Yield: Drawdown (feet)	Type of well	Type of pump	Diameter of well (inches)	Use	Remarks
1	580	Charles Hull	1,099	9	37	Sh	Cuy	8	11- 7-49	5	10	Dr		5	D	
2	227	C. Manonsik	1,090	12	70	Sh	Cuy	60	10-22-47	5	10	Dr		6	D	
3	507	Frank Jaros	1,135	15	78	Sh	Cuy	20	7- 5-49	3		Dr		6½	D	L
4	566	J. J. Mahoney, Jr.	1,145	20	125	Sh	Cuy	20	9-15-49	2		Dr		5½	D	L
5	209	W. Rust	1,000	40	185	Sh	Cuy	46	10-26-47	1	89	Dr		5¼	D	L,A
6	603	D. Jesionanski	1,000	20	90	Sh	Cuy	70	6- 1-49	5		Dr		6	D	
7	229	H. C. Smith	1,020	20	63	Sh	Cuy	40	11-20-46	5	23	Dr		6	D	L
8	361	I. McLaughlin	993	23	64	Sh	Cuy	50	9-16-49	15		Dr		6	D	
9		N. R. Bordra	1,020	20	108	Sh	Cuy	20		2	68	Dr		6½	D	L
10	185	F. Trater	1,155	10	70	Sh	Cuy	50	9-14-46	3		Dr		6	D	
11	326	A. Dzurnak	1,200	28	36	Ss	Shar	14	6-22-48	15	2	Dr	Hand	5	D	L
12	382	G. J. Braun	1,230	15	58	Ss	Shar	22	8-10-48	25	15	Dr		5¼	D	L
13	360	J. Nausbaum	1,160	40	88	Sh	Cuy	22	8-13-48	10		Dr		6½	D	L
14	428	James Kasney	1,227	25	47	Ss	Shar	22	5- 3-49	15	7	Dr		5¼	D	
15	410	W. Knight	1,215	25	62	Ss	Shar	25	8-19-48	8	8	Dr		5¼	D	L
17	699	A.Strobek	1,237	12	39	Ss	Shar	17		8	10	Dr		5¼	D	L
18	724	F. Miskolgy	1,210	14	52	Ss	Shar	3		12	17	Dr		5½	D	L
19	606	J. C. Lyons	1,200	40	64	Ss	Shar	58	6-11-49	15		Dr		6	D	
20	386	Wm. Molnar	1,194	44	65	Ss	Shar	48	10-11-48	30		Dr		6	D	
21		V. P. Rickabaugh	1,200	44	63	Ss	Shar	30	8-10-48	15	10	Dr	Jet	6	D	
22	707	G. Farrar	1,200	41	65	Ss	Shar	50	5-12-50	25	10	Dr			D	L
23	120	C. Clank	900	22	70	Ss	Ber	50	10- -45	6		Dr		5½	D	L
24	351	W. T. White	920	9	118	Ss	Ber	26	6-15-48	15		Dr	Lift	5½	D	L
25		T. L. Bellitto	1,035	125	224	Ss	Ber	125	11-18-49	2		Dr		6½	D	L
26		W. Minch	940	10	135	Ss	Ber	45	1-13-49	2		Dr		5½	D	L
27	607	E. P. Edwards	820	9	60	Ss	Ber	32	6-20-49	2		Dr		6	D	L
28		A. D. Fernengle	870	35	128	Ss	Ber	78	8-25-49	1		Dr		6½	D	L
29	247	Wm. Claire	860	0	90	Ss	Ber	18	12-10-47	7	20	Dr	Jet	6½	D	L
30	228	H. Rose	1,122	34	85	Sh	Cuy	55	9-15-47	5	25		Jet	6	D	L
31	435	A. F. Fulton	1,140	77+	77	S	Gla	10	6-18-49	2½	55	Dr		5½	D	
32	211	A. Sabol	1,145	12	70	Sh	Cuy	24	10- 7-47	8	30	Dr		5	D	
33	427	John Juhas	1,152	32	53	Sh	Cuy	12	4-11-49	10		Dr		5¼	D	L,A
34	426	L. H. Vyrostek	1,145	0	80	Ss	Shar	25	3-26-49	10	30	Dr		5¼	D	L
35	515	S. J. Valko	1,047	92	135			105	7- 4-49			Dr		5½	D	Dry hole. L
36	527	S. J. Valko	1,065	102+	102	G	Gla	45	8- 6-49	40	4	Dr		5½	D	
37	602	T. A. Cromcia	1,065	90	96	Ss	Ber	25	5-12-49	5		Dr		6	D	L
38	429	C. Schmidt	1,065	20	136	Sh	Cuy	96	11- 6-48	2		Dr	Hand	5½	D	L
40	230	O. Kossman	1,100	55	206	Sh	Cuy	180	6- 5-47	5	20	Dr	Lift	6	D	L
41	265	G. E. Darmstatter	890	20	78	Ss, Sh	Cuy	45	4- 1-48	2		Dr		6	D	L
42	772	F. W. Altzner	1,180	26	90	Ss	Shar	30	7- 1-50	5	30	Dr		6½	D	L
43	723	C. Lutz	1,200	25+	25	S & G	Gla	8	7- 1-50	15	10	Dr		6½	D	L
44	608	W. R. Rhoton	1,160	33	58	Ss	Shar	28	7- 5-49	10		Dr		6	D	L

TABLE 10 (Continued). RECORDS OF WELLS AND RESISTIVITY MEASUREMENTS IN BRECKSVILLE TOWNSHIP

No.	File No. (Ohio Division of Water)	Owner or name	Elevation at well (feet above sea level)	Depth to bedrock (feet)	Depth of well (feet)	Principal water-bearing bed: Character of material	Principal water-bearing bed: Geologic horizon	Water level: Below land surface (feet)	Water level: Date	Yield: Rate (g.p.m.)	Yield: Drawdown (feet)	Type of well	Type of pump	Diameter of well (inches)	Use	Remarks
45	516	Novfotnia	1,060	0	95	Sh	Cuy	21	6–21–49			Dr		5½	D	L
46	613	J. Junglas	791	80	86	Ss	P-B	20	10–24–49	2		Dr	Hand	6	D	L
47	352	E. P. Edwards	820	5	50	Ss	Ber	20	6–11–48	7	20	Dr		6	D	
48		L. Schneider				Un	Gla	Flow	4–16–51	15		Spr			D	
49		C. Schneider	780	11+	11	Un	Gla	2	4–16–51	3		Dug		24	D	
50		W. Vagan	650	19+	19	Un	Gla	6	4–16–51	15		Dug	Hand	35	D	
51		M. Gynn	715	16+	16	Un	Gla	10	4–16–51	10		Dug	Hand	43	D	
52		J. Volkert	725	20+	20	Un	Gla	11	4–16–51	10		Dug	Jet	36	D	
53		Contizano	635	16+	16	Un	Gla	4	4–16–51	2		Dug	Hand	35	D	
54		R. Krumhansi	640	18+	18	Un	Gla	6	4–16–51	2		Dug	Hand	36	D	
55		Whyte	670	20+	20	Un	Gla	5	4–16–51	2		Dug	Hand	36	D	
56			735	12+	12	Un	Gla	8	4–16–51			Dug	Hand	30	D	
57		O. Piskac	735	12+	12	Un	Gla	6	4–16–51			Dug	Hand		D	
58		E. C. Radyour	730	12+	12	Un	Gla	9	4–16–51			Dug	Jet	36	D	
59		A. Tssnow	725	11+	11	Un	Gla	6	4–16–51			Dug		36	D	
60		A. V. Jaruela	730	8+	8	Un	Gla	4	4–16–51	10		Dug	Jet	60	D	
61			640	8+	8	Un	Gla	4	4–16–51	4		Dug		48	D	
62		J. J. Chojneck	630	11+	11	Un	Gla	2	4–16–51			Dug	Hand	43	D	
63		A. W. Berg	740	15+	15	Un	Gla	Flow	4–16–51	15		Dug		72	D	
64		B. B. Hinkley	750	6+	6	Un	Gla	5	4–16–51	2		Dug	Jet	60	D	
65			775	80+	80	S & G	Gla	5	4–16–51			Dr		5½	D	
66		W. G. Lehmann	1,120	16	65	Sh	Cuy	7	4–16–51	6		Dr	Jet	5½	D	
67		C. Carlscella			90	Sh	Cuy			16		Dr	Lift	5½	D	
68		J. D. Ortiz	950	21+	21	Un	Gla	3	4–18–51			Dug			D	
69		L. E. Smith	985	21+	21	Un	Gla	3	4–18–51			Dug			D	
70		W. J. Metzel	960	25	44	Sh	Cuy	6	4–18–51			Dr	Hand	4	D	
71		E. J. Lund	1,085	45	315	Ss	Ber	115+	4–18–51			Dr	Lift	6	D	
72		C. Slawansky	1,130	20	124	Sh	Cuy	13	4–18–51			Dr		4	D	
73		M. Cinadr	1,165	41+	41	Un	Gla	25	4–18–51			Dug	Jet		D	
74		J. Stoveck	1,225	36+	36	Un	Gla	25	4–18–51			Dug	Jet		D	
75		F. Lirsch	1,240		73	Un	Gla	44	4–18–51			Dug		5½	D	
76		W. E. Long	1,180	8+	8	Un	Gla	3	4–19–51			Dug	Jet		D	
77		J. L. Barrett	1,150	50+	50	S & G	Gla	16	4–19–51	5		Dr	Jet		D	
78		G. B. Billetter	1,123	78+	78	S & G	Gla	10	4–19–51			Dr	Jet	6	D	
79		C. H. Bourne	1,105	87	90	Sh	Cuy	17	4–19–51			Dr	Turb	6	D	
80			1,150	11+	11	Un	Gla	1	4–19–51			Dug			D	
81		A. W. Fayne	1,100	14+	14	Un	Gla	4	4–19–51			Dug	Jet		D	
82		Gecei	1,070	90	275	Ss	Ber	185	5– -51	5		Dr		6½	D	L,A
83		V. A. Hospital	1,222	73	120	Ss	Shar	35	11–20–51			Dr		10	I	L
84		G. Kitson	900	20	128	Sh	Cuy			15		Dr	Lift	5½	D	
201		J. Kudej	1,180	64								Dr		10	G	
202		E. G. Wrohhel	1,050	325								Dr		8	G	
203		Kundtz Prop. Co.	1,210	35								Dr		12	G	
204		Cleve. Metro. Park	900	52								Dr		10	G	
205		J. C. Feller	860	18								Dr		10	G	
206		W. F. Lister	940	20								Dr		10	G	
207		M. M. Long	630	342								Dr		8	G	
208		D. H. McCreery	610	200								Dr		8	G	
209		E. McCreery	620	354								Dr		8	G	
210		S. McCreery	620	377								Dr		8	G	
301			900	4		Sh	Cuy					Dr				Test hole.
302			884	4		Sh	Cuy					Dr				Test hole.
401			1,115	90					8– -51							R
402			858	108					8– -51							R

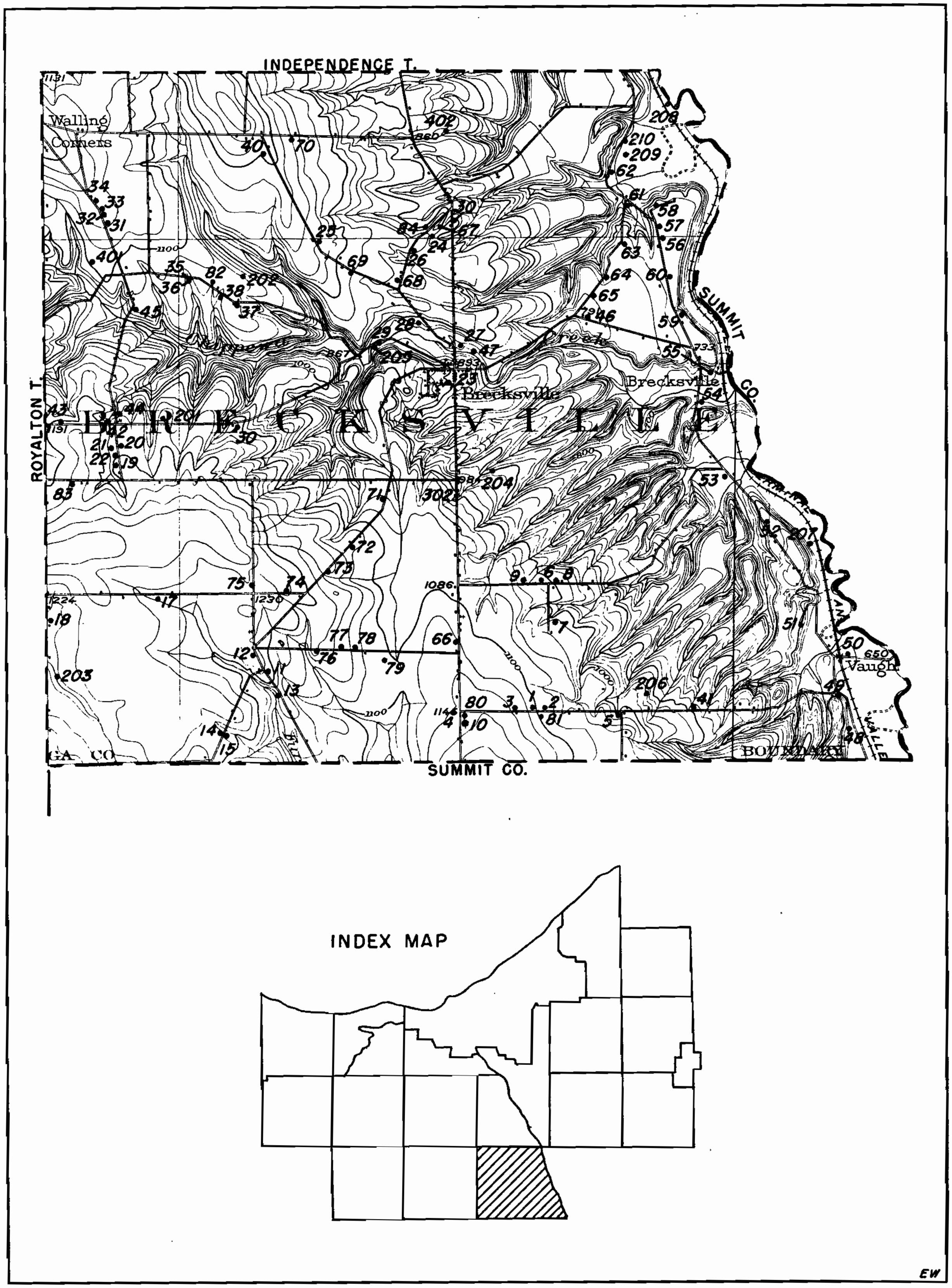


Plate 35. Map showing location of wells in Brecksville Township.

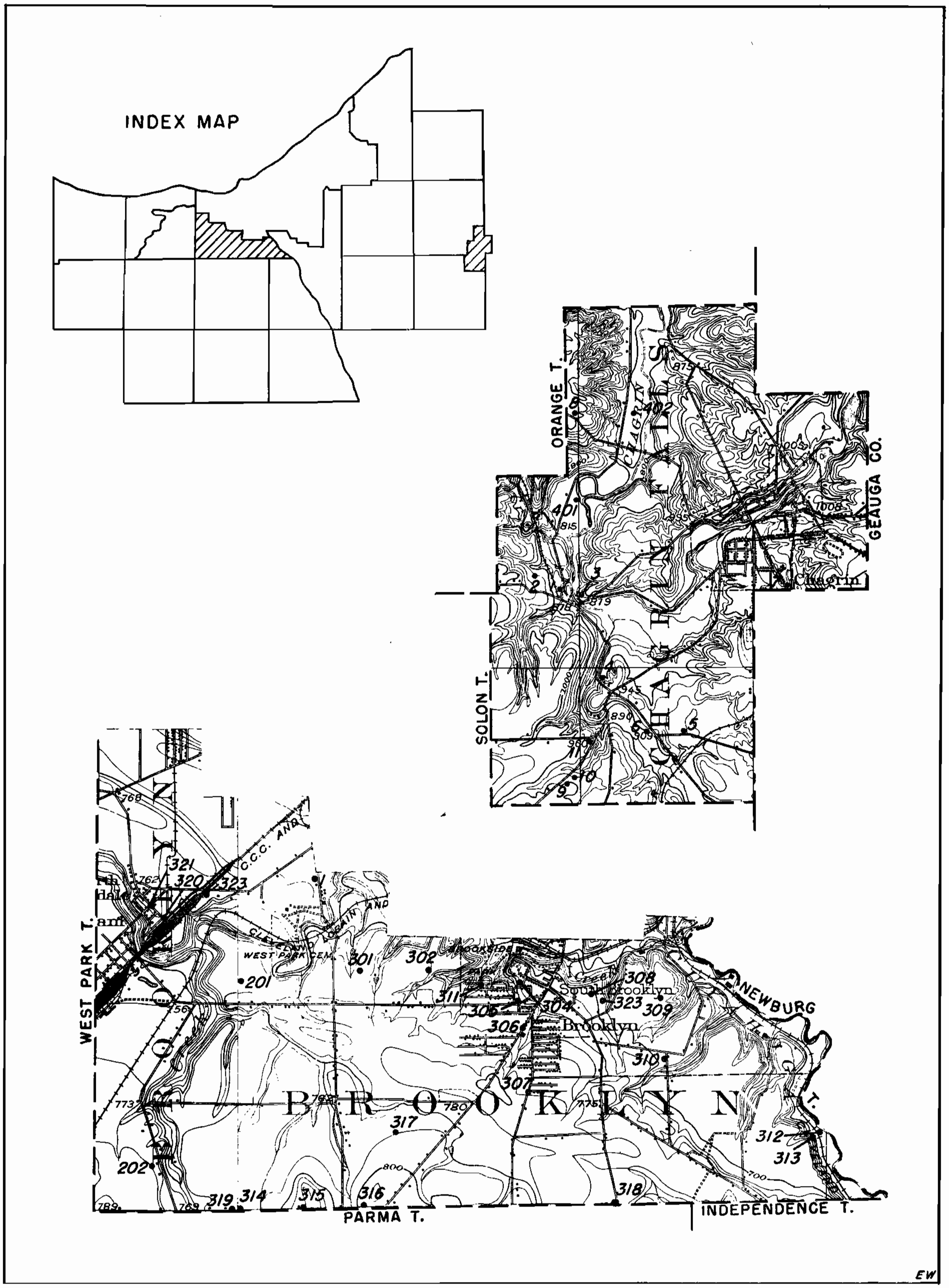


Plate 36. Map showing location of wells in Brooklyn and Chagrin Falls Townships.

TABLE 11. RECORDS OF WELLS IN BROOKLYN TOWNSHIP

No.	File No. (Ohio Division of Water)	Owner or name	Elevation at well (feet above sea level)	Depth to bedrock (feet	Depth of well (feet)	Principal water-bearing bed: Character of material	Principal water-bearing bed: Geologic horizon	Water level: Below land surface (feet)	Water level: Date	Yield: Rate (g.p.m.)	Yield: Drawdown (feet)	Type of well	Type of pump	Diameter of well (inches)	Use	Remarks
1	677	Mathews	735	34	45	Sh	P-B	10	4-23-50			Dr		5½	D	L
201		H. C. Huy	745	20								Dr		10	G	
202		Mary Orth	780	23								Dr		10	G	
301			745	32		Sh	P-B					Dr				Test hole
302			742	33		Sh	P-B					Dr				Test hole.
303			690	16		Sh	P-B					Dr				Test hole.
304			710	11		Sh	P-B					Dr				Test hole.
305			715	11		Sh	P-B					Dr				Test hole.
306			735	17		Sh	P-B					Dr				Test hole.
307			775	18		Sh	P-B					Dr				Test hole.
308			690	3		Sh	P-B					Dr				Test hole.
309			685	50		Sh	P-B					Dr				Test hole.
310			695	2		Sh	P-B					Dr				Test hole.
311			715	9		Sh	P-B					Dr				Test hole.
312			595	49		Sh	P-B					Dr				Test hole.
313			620	48		Sh	P-B					Dr				Test hole.
314			790	9		Sh	P-B					Dr				Test hole.
315			840	5		Ss	Ber					Dr				Test hole.
316			805	8		Sh	P-B					Dr				Test hole.
317			780	5		Sh	P-B					Dr				Test hole.
318			790	4		Sh	P-B					Dr				Test hole.
319			778	8		Sh	P-B					Dr				Test hole.
320			759	15		Sh	P-B					Dr				Test hole.
321			762	18		Sh	P-B					Dr				Test hole.
322			752	9		Sh	P-B					Dr				Test hole.
323			690	20		Sh	P-B					Dr				Test hole.
324			490	32		Sh	P-B					Dr				Test hole.

TABLE 12. RECORDS OF WELLS AND RESISTIVITY MEASUREMENTS IN CHAGRIN FALLS TOWNSHIP

No.	File No. (Ohio Division of Water)	Owner or name	Elevation at well (feet above sea level)	Depth to bedrock (feet)	Depth of well (feet)	Principal water-bearing bed: Character of material	Principal water-bearing bed: Geologic horizon	Water level: Below land surface (feet)	Water level: Date	Yield: Rate (g.p.m.)	Yield: Drawdown (feet)	Type of well	Type of pump	Diameter of well (inches)	Use	Remarks
1		A. Vince	980	1	150	Sh	P-B	53	5-28-50	2		Dr		5½	D	L
2	40	E. W. Jones	925	15	132	Ss	Ber			10		Dr			D	L
3		F. F. Tussel	860	18	105	Sh	P-B	43	7-20-49	½	100	Dr		5½	D	L
4		L. Peterman	900	51	103	Ss	Ber	56	4-19-48			Dr	Hand	5½	D	L
5	17	Clements	918	132+	132	S	Gla					Dr			D	L
6		D. F. Cain	900	58+	58	S & G	Gla	17	5-28-49	5	35	Dr		5½	D	L,A
7	131	Gen'l Byproduct Chem. Co.	950	49	134	Ss	Ber			70		Dr		8	I	L
8		G. Kneip	1,000	359+	359	Silt	Gla					Dr			D	
9		J. Murtaugh	990	40	120	Ss	Ber	55	5-29-51			Dr		5½	D	L
10		J. C. Mady	980	42	117	Ss	Ber	42	6- 3-51	6	1	Dr		5½	D	L,A
11		C. A. Irish	980	25	110	Ss	Ber	65	5-26-51	6	4	Dr		5½	D	L
401			806	180					8- -51							R
402			810	240					8- -51							R

No wells are reported in the shale of the Cuyahoga group; all are drilled through the shale into the underlying Berea sandstone. These generally yield 5 to 10 gallons per minute for domestic needs, and a well of the General Byproduct Chemical Co. (Chagrin Falls Township well 7) in the village of Chagrin Falls yields 70 gallons per minute. Wells drilled into the Bedford shale and into the Cleveland member of the Ohio shale yield up to 3 gallons per minute.

The Chagrin Falls Water Department obtains its water from the Sharon conglomerate from wells and springs southeast of the village in Geauga County.

Records of wells in Chagrin Falls Township are shown in table 12; the locations of the wells are shown on plate 36. The logs of some of the wells are shown on plate 38.

CITY OF CLEVELAND AND EAST CLEVELAND TOWNSHIP

The area comprising the city of Cleveland and East Cleveland Township is served entirely by the Cleveland municipal water-supply system, and because of this the only wells reported are those drilled for air conditioning and for industrial purposes.

The Berea sandstone underlies the glacial drift in the southeastern part of East Cleveland Township. A well at the Highland Dairy on Noble Road is reported to yield 30 gallons per minute from the Berea. No other wells are reported in the Berea sandstone, but the formation can be expected to yield as much as 100 gallons per minute, or more, to properly constructed wells.

The Bedford, Ohio, and Chagrin shales crop out beneath glacial drift of variable thickness in most of East Cleveland Township and in all of Cleveland. Four wells are reported to have been drilled into these shale formations and all were unsuccessful. This is indicative of their poor water-bearing quality.

The buried Cuyahoga River valley crosses Cleveland from south to north, and passes under Lake Erie west of Gordon Park. The thickness of the glacial drift in the valley ranges from 150 feet along the western edge, near the mouth of the present Cuyahoga River, to more than 600 feet near Gordon Park where the deepest part of the channel lies.

The materials in the buried valley are predominantly fine sand, silt, and clay, which yield almost no water. There are a few thin, narrow, and discontinuous gravel lenses that are good sources of ground water. A well on the property of the Lowenthal Distilling Co., is reported to yield more than 300 gallons per minute from such a lens. It is not uncommon for wells to penetrate the entire body of valley fill without encountering a satisfactory aquifer.

Records of wells in Cleveland and East Cleveland Township are shown in table 13; the locations of the wells are shown on plate 37. The logs of some of the wells are shown on plate 38.

DOVER TOWNSHIP

In Dover Township the Berea sandstone and the rocks of the three shale formations that underlie the Berea sandstone (the Bedford shale, the Ohio shale, and the Chagrin shale) crop out beneath the thin cover of glacial drift on the Erie Plain.

The Berea sandstone is limited in areal extent to the southwestern corner of the township. Wells in the sandstone yield as much as 24 gallons per minute. The shale formations are poor sources of ground water; successful wells yield as much as 15 gallons per minute, but most shale wells are failures irrespective of the depths to which they may be drilled.

The glacial drift generally is less than 20 feet thick and consists of till and lacustrine clay which are poor sources of ground water. The beach ridges, which were formed by the waters of the glacial lakes, contain some sand at their crests, but the small areal extent and the thinness of these deposits constitute only a very limited water resource.

Records of wells in Dover Township are shown in table 14; the locations of the wells are shown on plate 39. The logs of some of the wells are shown on plate 42.

EUCLID TOWNSHIP

In Euclid Township rocks of the Cuyahoga group, the Berea sandstone, and the shale formations that underlie the Berea sandstone crop out beneath a mantle of glacial drift. North of Euclid Avenue, at the foot of the Portage Escarpment, the unconsolidated material covering the bedrock ranges in thickness from 20 feet in the western part to 85 feet in the northeastern part of the township. South of the Portage Escarpment the drift is thin, the bedrock cropping out in many places, especially in the stream beds.

The unconsolidated deposits consist of glacial till, lake clay, and a few thin, narrow, discontinuous beach ridges. No wells are reported in the unconsolidated materials, as these deposits are a poor source of ground water.

The Cleveland municipal water system supplies the southern portion of the township where the shale of the Cuyahoga group crops out beneath the mantle of glacial drift. In that area no wells are reported. Wells in adjacent Mayfield and East Cleveland Townships are drilled through the rocks of the Cuyahoga group into the underlying Berea sandstone. This indicates that insufficient water for supply was encountered in the Cuyahoga group. Domestic wells are reported to yield about 5 gallons per minute from the Berea sandstone. The

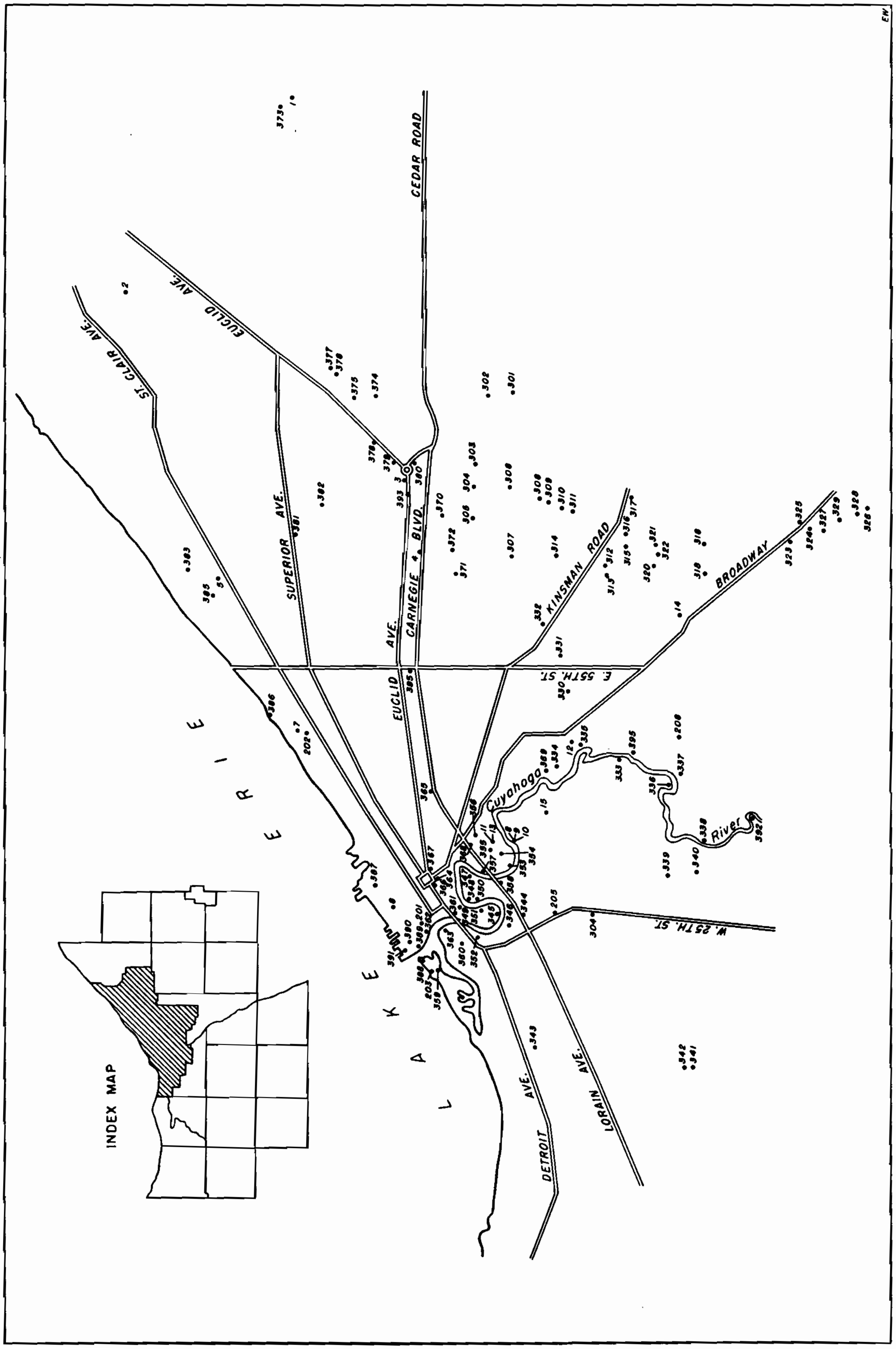


Plate 37. Map of central Cleveland and East Cleveland Township showing location of wells.

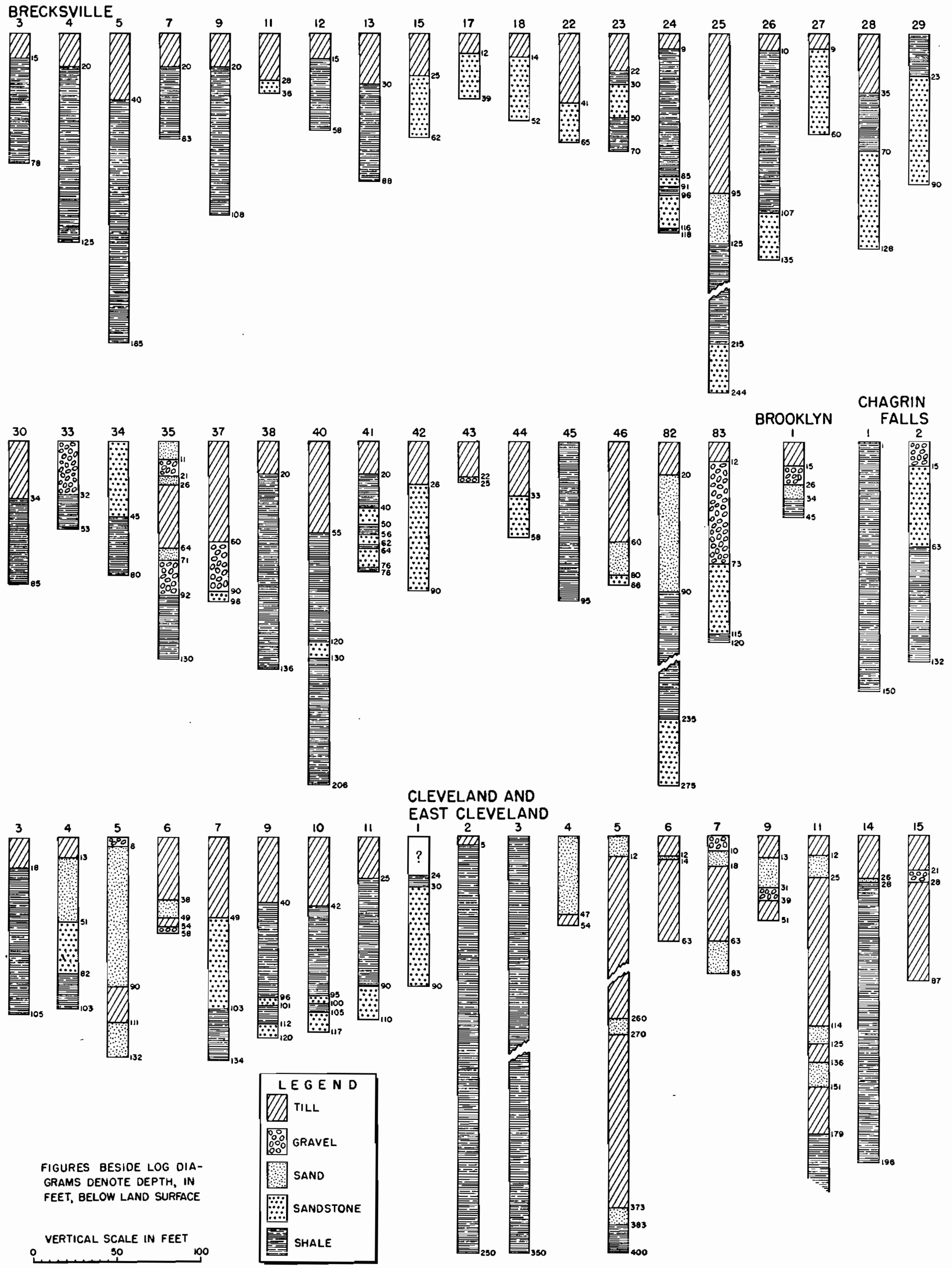


Plate 38. Logs of wells in Brecksville, Brooklyn, Chagrin Falls Townships, the city of Cleveland and East Cleveland Township.
[Well numbers refer to locations shown on plates 35, 36, and 37]

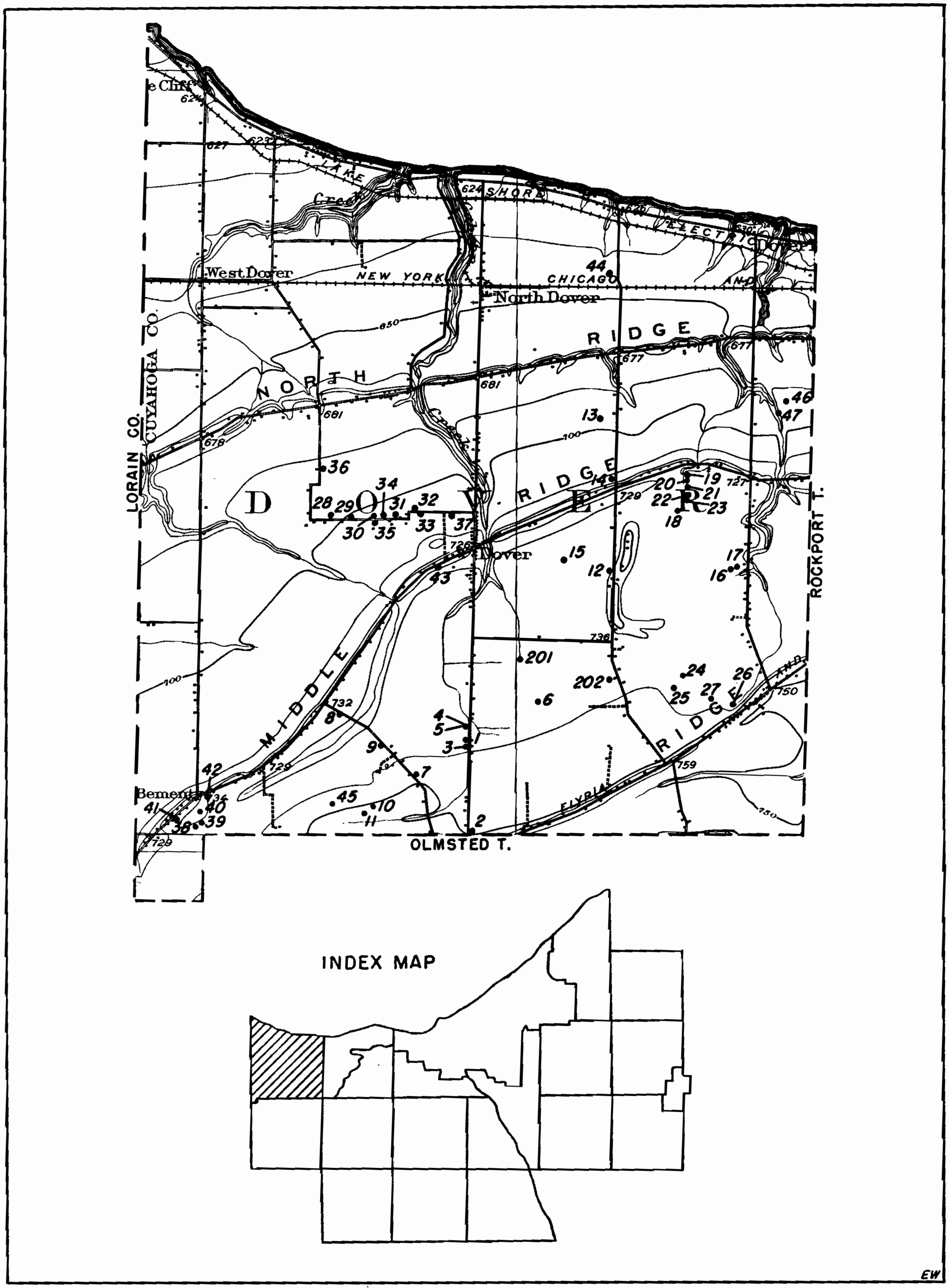


Plate 39. Map showing location of wells in Dover Township.

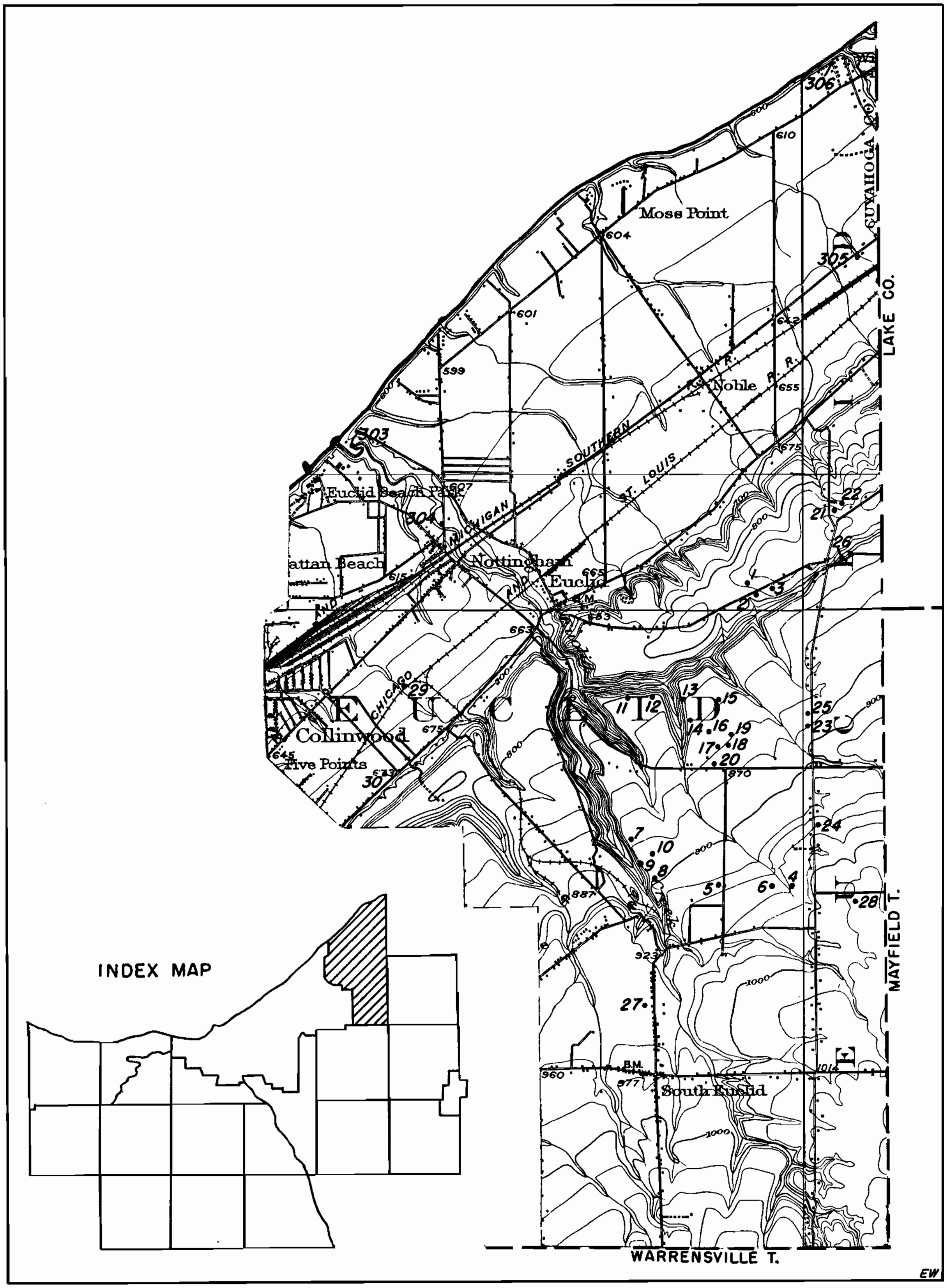


Plate 40. Map showing location of wells in Euclid Township.

TABLE 13. RECORDS OF WELLS IN THE CITY OF CLEVELAND AND IN EAST CLEVELAND TOWNSHIP

No.	File No. (Ohio Division of Water)	Owner or name	Elevation at well (feet above sea level)	Depth to bedrock (feet)	Depth of well (feet)	Principal water-bearing bed: Character of material	Principal water-bearing bed: Geologic horizon	Water level: Below land surface (feet)	Water level: Date	Yield: Rate (g.p.m.)	Yield: Drawdown (feet)	Type of well	Type of pump	Diameter of well (inches)	Use	Remarks
1	96	Hillside Dairy	955	24	90	Ss	Ber			30		Dr			I	L,A
2	135	Tow Motor Co.	635	5	250	Sh	P-B					Dr		8	I	Dry hole. L
3	136	Fennway Hall	690	6	350	Sh	P-B			105		Dr			P	L
4	118	Sears Roebuck Co.	675	54+	54	S	Gla					Dr			I	Dry hole. L
5	137	White Motor Co.	625	383	400	S	Gla	100				Dr			I	Dry hole. L
6	111	Lake Front Stadium	573	63+	63	S	Gla					Dr			P	L
7		Nimmons Cart & Wright	622	83+	83	S	Gla					Dr			I	L
8		Sherwin Williams	590	31+	31	S & G	Gla	10	1945	150		Dr		18	I	
9		Sherwin Williams	590	51+	51	S & G	Gla	14	10-11-39	150		Dr		10	I	L
10		Sherwin Williams	590	38+	38	S & G	Gla	10		150		Dr		10	I	
11		Loewenthal Dist. Co.	600	179	179	S & G	Gla	41		250		Dr			I	L
12		Grasselli Chem. Corp.	600	35+	35	G	Gla			75		Dr			I	
13	103	Loewenthal Dist. Co.	600	177	302	Sh	P-B					Dr			I	
14	133	Forest City Brewery	680	28	196	S	Gla					Dr			I	Dry hole. L
15	113	Standard Oil Co.	600	87+	87	S	Gla					Dr				L
201		E.O.G. Co. Works	620	158								Dr		10	G	
202		N.Y.C.R.R. #3	625	260								Dr		10	G	
203		Spang Baking Co.	575	246								Dr		8	G	
204		Cleveland Twist Drill Co.	680	135								Dr		8	G	
205		Borre Steel Range	620	92								Dr		8	G	
206		Mary Wensink	680	602								Dr		8	G	
301			890	5		Ss	Ber					Dr				Test hole.
302			865	3		Ss	Ber					Dr				Test hole.
303			725	2		Sh	P-B					Dr				Test hole.
304			705	8		Sh	P-B					Dr				Test hole.
305			695	27		Sh	P-B					Dr				Test hole.
306			740	5		Sh	P-B					Dr				Test hole.
307			685	39		Sh	P-B					Dr				Test hole.
308			770	6		Sh	P-B					Dr				Test hole.
309			780	4		Sh	P-B					Dr				Test hole.
310			790	6		Sh	P-B					Dr				Test hole.
311			790	8		Sh	P-B					Dr				Test hole.
312			670	23		Sh	P-B					Dr				Test hole.
313			660	12		Sh	P-B					Dr				Test hole.
314			685	22		Sh	P-B					Dr				Test hole.
315			740	60		Sh	P-B					Dr				Test hole.
316			760	2		Sh	P-B					Dr				Test hole.
317			800	11		Sh	P-B					Dr				Test hole.
318			738	11		Sh	P-B					Dr				Test hole.
319			775	22		Sh	P-B					Dr				Test hole.
320			720	7		Sh	P-B					Dr				Test hole.
321			760	18		Sh	P-B					Dr				Test hole.
322			750	25		Sh	P-B					Dr				Test hole.
323			770	1		Sh	P-B					Dr				Test hole.
324			775	8		Sh	P-B					Dr				Test hole.
325			800	24		Sh	P-B					Dr				Test hole.
326			872	1		Ss	Ber					Dr				Test hole.
327			817	6		Ss	Ber					Dr				Test hole.
328			870	5		Ss	Ber					Dr				Test hole.
329			840	4		Ss	Ber					Dr				Test hole.
330			650	47+		Un	Gla					Dr				Test hole.
331			670	63+		Un	Gla					Dr				Test hole.
332			660	49+		Un	Gla					Dr				Test hole.
333			580	273		Sh	P-B					Dr				Test hole.

TABLE 13 (Continued). RECORDS OF WELLS IN THE CITY OF CLEVELAND AND IN EAST CLEVELAND TOWNSHIP

No.	File No. (Ohio Division of Water)	Owner or name	Elevation at well (feet above sea level)	Depth to bedrock (feet)	Depth of well (feet)	Principal water-bearing bed: Character of material	Principal water-bearing bed: Geologic horizon	Water level: Below land surface (feet)	Water level: Date	Yield: Rate (g.p.m.)	Yield: Drawdown (feet)	Type of well	Type of pump	Diameter of well (inches)	Use	Remarks
334			680	337		Sh	P-B					Dr				Test hole.
335			575	300		Sh	P-B					Dr				Test hole.
336			580	185		Sh	P-B					Dr				Test hole.
337			600	255		Sh	P-B					Dr				Test hole.
338			590	59		Sh	P-B					Dr				Test hole.
339			595	65		Sh	P-B					Dr				Test hole.
340			605	74		Sh	P-B					Dr				Test hole.
341			737	36		Sh	P-B					Dr				Test hole.
342			715	14		Sh	P-B					Dr				Test hole.
343			675	35		Sh	P-B					Dr				Test hole.
344			685	70		Un	Gla					Dr				Test hole.
345			580	105		Sh	P-B					Dr				Test hole.
346			620	141		Sh	P-B					Dr				Test hole.
347			585	149		Sh	P-B					Dr				Test hole.
348			585	146		Sh	P-B					Dr				Test hole.
349			585	145		Sh	P-B					Dr				Test hole.
350			580	158		Sh	P-B					Dr				Test hole.
351			585	176		Sh	P-B					Dr				Test hole.
352			600	165		Sh	P-B					Dr				Test hole.
353			575	148		Sh	P-B					Dr				Test hole.
354			590	168		Sh	P-B					Dr				Test hole.
355			600	189		Sh	P-B					Dr				Test hole.
356			660	235		Sh	P-B					Dr				Test hole.
357			757	159		Sh	P-B					Dr				Test hole.
358			590	179		Sh	P-B					Dr				Test hole.
359			580	125		Sh	P-B					Dr				Test hole.
360			590	155		Sh	P-B					Dr				Test hole.
361			595	167		Sh	P-B					Dr				Test hole.
362			580	137		Sh	P-B					Dr				Test hole.
363			575	151		Sh	P-B					Dr				Test hole.
364			665	191		Sh	P-B					Dr				Test hole.
365			675	380		Sh	P-B					Dr				Test hole.
366			660	210		Sh	P-B					Dr				Test hole.
367			660	202		Sh	P-B					Dr				Test hole.
368			660	203		Sh	P-B					Dr				Test hole.
369			660	320		Sh	P-B					Dr				Test hole.
370			690	30		Sh	P-B					Dr				Test hole.
371			680	225		Sh	P-B					Dr				Test hole.
372			685	85		Sh	P-B					Dr				Test hole.
373			950	35		Sh	P-B					Dr				Test hole.
374			730	51		Sh	P-B					Dr				Test hole.
375			720	9		Sh	P-B					Dr				Test hole.
376			725	10		Sh	P-B					Dr				Test hole.
377			735	9		Sh	P-B					Dr				Test hole.
378			690	20		Sh	P-B					Dr				Test hole.
379			680	15		Sh	P-B					Dr				Test hole.
380			660	5		Sh	P-B					Dr				Test hole.
381			640	90		Sh	P-B					Dr				Test hole.
382			640	55		Sh	P-B					Dr				Test hole.
383			610	430		Sh	P-B					Dr				Test hole.
384			620	489		Sh	P-B					Dr				Test hole.
385			665	490		Sh	P-B					Dr				Test hole.
386			575	132		Sh	P-B					Dr				Test hole.
387			580	91		Sh	P-B					Dr				Test hole.

TABLE 13 (Continued). RECORDS OF WELLS IN THE CITY OF CLEVELAND AND IN EAST CLEVELAND TOWNSHIP

No.	File No. (Ohio Division of Water)	Owner or name	Elevation at well (feet above sea level)	Depth to bedrock (feet)	Depth of well (feet)	Principal water-bearing bed: Character of material	Principal water-bearing bed: Geologic horizon	Water level: Below land surface (feet)	Water level: Date	Yield: Rate (g.p.m.)	Yield: Drawdown (feet)	Type of well	Type of pump	Diameter of well (inches)	Use	Remarks
388			575	144		Sh	P-B					Dr				Test hole.
389			575	145		Sh	P-B					Dr				Test hole.
390			575	134		Sh	P-B					Dr				Test hole.
391			575	133		Sh	P-B					Dr				Test hole.
392			580	42		Sh	P-B					Dr				Test hole.
393			685	26		Sh	P-B					Dr				Test hole.
395			580	308		Sh	P-B					Dr				Test hole.

TABLE 14. RECORDS OF WELLS IN DOVER TOWNSHIP

No.	File No. (Ohio Division of Water)	Owner or name	Elevation at well (feet above sea level)	Depth to bedrock (feet)	Depth of well (feet)	Principal water-bearing bed: Character of material	Principal water-bearing bed: Geologic horizon	Water level: Below land surface (feet)	Water level: Date	Yield: Rate (g.p.m.)	Yield: Drawdown (feet)	Type of well	Type of pump	Diameter of well (inches)	Use	Remarks
1	551	E. C. Lewis	740	6	35	Sh	P-B	6	9- 8-49	¼		Dr		5½	D	L
2	319	Carmichael	750	24	42	Ss	Ber					Dr	Jet	5½	D	L
3	555	A. L. Lewis	740	12	35	Sh	P-B	8	9-13-49	¼		Dr		5½	D	
4	363	M. Bobby	735	25	35							Dr				Dry hole.
5	364	M. Bobby	735	10	74							Dr				Dry hole. L
6	255	S. Hanchary	735	21	75	Sh	P-B					Dr		5½	D	L
7	479	R. Serne	745	0	62	Sh	P-B	8	6- -50	15	16	Dr	Lift	5	D	L
8	622	T. Dean	732	19	40	Ss	Ber					Dr	Hand	8	D	L
9	656	G. Goellner	735	0	20	Ss	Ber	2	3-27-50	24		Dr		5½	D	L
10	492	J. Murphy	750	34	50	Ss	Ber					Dr		5½	D	L
11	488	W. E. Porter	750	8	37	Ss	Ber					Dr		5½	D	L
12	529	W. Dorsey	740	11	70	Sh	P-B					Dr		5½	D	L
13	587	W. S. Sawary	695	5	80	Sh	P-B					Dr		5½	D	L
14	256	A. Traganovsky	715	9	60	Sh	P-B					Dr	Hand	5½	D	L
15	463	C. S. Albright	732	20	65	Sh	P-B					Dr	Hand	5½	D	L
16	432	Brass	730	15	70	Sh	P-B					Dr		5½	D	L
17	649	E. D. Thompson	730	19	70	Sh	P-B					Dr		5½	D	
18	614	J. T. Frouthrath	735	18	65	Sh	P-B					Dr		5½	D	L
19	278	Mrs. Baird	732	8	65	Sh	P-B	13	3-31-48	6	18	Dr		5½	D	L
20	281	Kohler	733	9	65	Sh	P-B	13	3-25-48	8	14	Dr		5½	D	
21	258	Youngquist	735	8	62	Sh	P-B	13	2-10-48	5	7	Dr		5½	D	
22	280	Calvert	735	7	61	Sh	P-B	10	3-26-48	2	20	Dr		5½	D	
23	279	Wilkins	735	9	51	Sh	P-B	13	3-29-48	10	8	Dr		5½	D	
24		D. Bickford	738	5	100	Sh	P-B	10	6- -49	10		Dr		5½	D	L
25	570	W. R. Galloway	738	16	70	Sh	P-B	18	9- 1-49	5		Dr		6½	D	
26	489	L. Freihert	740	10	50	Sh	P-B					Dr	Hand	5½	D	L
27	491	E. M. Christman	738	8	44	Sh	P-B					Dr		5½	D	
28	436	C. Koch	697	7	55	Sh	P-B					Dr			D	L
29	376	R. C. Ksone	700	8	60	Sh	P-B					Dr		6	D	
30	377	M. Krone	702	9	60	Sh	P-B					Dr		5½	D	L
31	615	L. W. Mikkila	704	9	65	Sh	P-B					Dr		5½	D	L
32	378	C. R. Hofman	704	10	65	Sh	P-B					Dr		6	D	
33	620	F. Koch	704	10	65	Sh	P-B					Dr		5½	D	
34	394	H. Caldwell	703	15	60	Sh	P-B					Dr		5½	D	
35	618	C. Ruprecht	704	8	65	Sh	P-B					Dr		6	D	
36	475	L. Albers	692	16	58	Sh	P-B					Dr		5½	D	L
37	471	F. Boone	706	10	60	Sh	P-B					Dr		5½	D	L
38		G. D. Moore	731	7	35	Ss	Ber					Dr		5½	D	
39		G. D. Moore	730	4	40	Ss	Ber					Dr		5½	D	L
40		G. D. Moore	728	6	26	Ss	Ber					Dr		5½	D	
41	402	T. Hopes	731	17	45	Ss	Ber					Dr		5½	D	L
42	288	E. L. Merrsfield	730	10	30	Ss	Ber					Dr		5½	D	L
43	474	W. Graff	730	13	65	Sh	P-B					Dr		5½	D	L

TABLE 14 (Continued). RECORD OF WELLS IN DOVER TOWNSHIP

No.	File No. (Ohio Division of Water)	Owner or name	Elevation at well (feet above sea level)	Depth to bedrock (feet)	Depth of well (feet)	Principal water-bearing bed: Character of material	Principal water-bearing bed: Geologic horizon	Water level: Below land surface (feet)	Water level: Date	Yield: Rate (g.p.m.)	Yield: Drawdown (feet)	Type of well	Type of pump	Diameter of well (inches)	Use	Remarks
44		E. F. Wahl	645	4	80	Sh	P-B					Dr		5½	D	L
45		P. Wasnich	745	5	45	Ss	Ber					Dr		5½	D	
46		W. M. Barth	693	14	80	Sh	P-B			¼		Dr	Jet	5½	D	L
47		F. P. Haynes	696	15	37	Sh	P-B					Dr		5½	D	
201		G. M. Winslow	735	32								Dr		10	G	
202		Mors Wager	735	17								Dr		10	G	

TABLE 15. RECORDS OF WELLS IN EUCLID TOWNSHIP

No.	File No. (Ohio Division of Water)	Owner or name	Elevation at well (feet above sea level)	Depth to bedrock (feet)	Depth of well (feet)	Principal water-bearing bed: Character of material	Principal water-bearing bed: Geologic horizon	Water level: Below land surface (feet)	Water level: Date	Yield: Rate (g.p.m.)	Yield: Drawdown (feet)	Type of well	Type of pump	Diameter of well (inches)	Use	Remarks
1		J. Waterwash	825	17	103	Sh	P-B	17	12-23-46			Dr		5	D	L
2		J. Horton	816	26	60	Sh	P-B	20	9-28-50			Dr		5½	D	L
3	668	Paul Gregor	830	18	70	Sh	P-B					Dr		5½	D	L
4		J. E. Brod	960	11	37	Ss	Ber	8	7-12-49			Dr		5½	D	L
5		Ed Knouer	930	2	30	Ss	Ber	12	7- 7-49			Dr		5½	D	L
6	759	W. B. Harrison	950	6	40	Ss	Ber	10	7-26-50			Dr			D	L
7		L. R. Zilke	875	8	70	Sh	P-B	50	10-15-49			Dr			D	L
8		H. B. Gerlach	895	5	60	Sh	P-B	10	6- 7-50			Dr		5½	D	L
9		G. Schaefer	884	12	58	Sh	P-B	16	1- 9-50	15	4	Dr	Hand	5½	D	L
10		S. Russell	890	9	35	Sh	P-B	8	10-18-49	8		Dr		5½	D	L
11	442	Burrows	790	12	75	Sh	P-B			¼	4	Dr	Hand	5	D	
12	544	G. Vincent	800	10	79	Sh	P-B	13	8-10-49	½	3	Dr		5½	D	L,A
13	441	T. Sedmack	807	12	66	Sh	P-B			½	5	Dr	Hand	5	D	L
14	557	C. Morris	835	8	66	Sh	P-B	50	9- -49	½		Dr		5½	D	L
15		S. Clevey	835	10	60	Sh	P-B	19	4-19-50	6	20	Dr		5½	D	L
16		Percy Rider	850	14	100							Dr		5½		Dry hole. L
17		D. Oviat	860	10	60							Dr				Dry hole. L
18			860	10	57	Sh	P-B	7	4-26-51					8	D	
19		Steven	860	10	60	Sh	P-B	10	5-17-50	1		Dr	Hand	5½	D	L
20		S. Atraw	870	6	65	Sh	P-B	10	11-19-49	½		Dr	Hand	5½	D	L,A
21		Skully	845	36	50	Sh	P-B	20	10-27-49	10		Dr		5½	D	L
22	599	Walter Fagar	840	36	100	Sh	P-B			15	10	Dr		5½	D	L
23	582	Tony Jagodnick	880	5	60	Sh	P-B	50	11- -49	3		Dr		5½	D	L
24	598	Mentor	950	6	35	Sh	P-B					Dr		5½	D	
25		S. Paratone	870	9	50	Sh	P-B	25	9-25-50	4		Dr		5½	D	L
26		E. Brooks	820	14	40	Sh	P-B	15	8-25-50	5		Dr		5½	D	L
27		Don Crundier	950	10	50	Ss	Ber	13	9-12-50	5		Dr		5½	D	L
28		L. S. Hahian	1,020	2	40	Ss	Ber	12	5- 9-51	5		Dr		5½	D	L
29	134	Cleve. Graphite Bronze Co.	645	60	633	Sh	P-B					Dr			I	L
30	125	Parker Appliance Co.	670	10	450	Sh	P-B					Dr		8	I	L
301				123+		Sh	P-B					Dr				
302				58+		Sh	P-B					Dr				
303			575	53		Sh	P-B					Dr				
304			595	3		Sh	P-B					Dr				
305			640	9		Sh	P-B					Dr				
306			604	85		Sh	P-B					Dr				

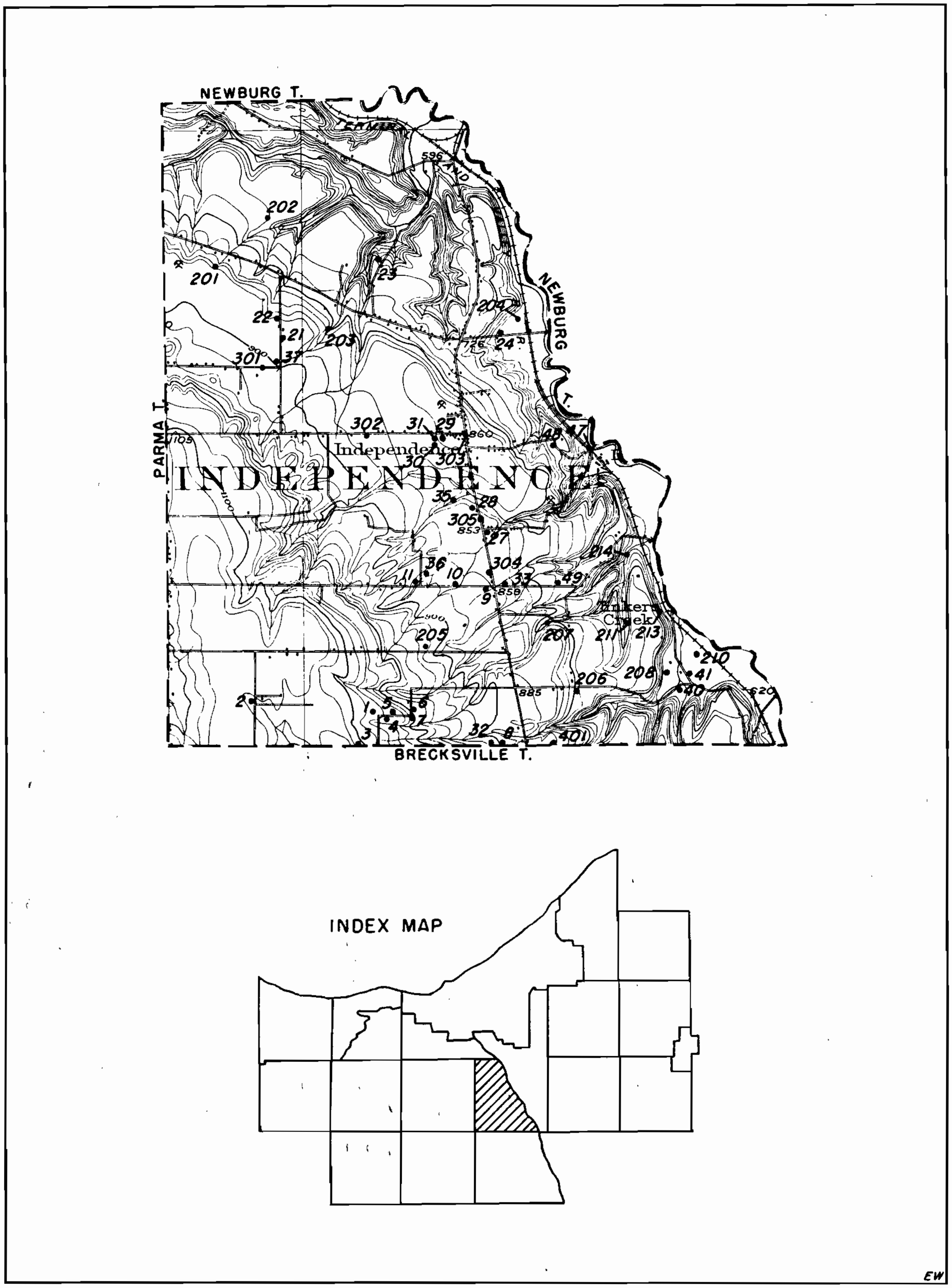


Plate 41. Map showing location of wells in Independence Township.

Hillside Dairy on Noble Road in adjoining East Cleveland Township pumps 30 gallons per minute from the Berea sandstone, and yields of similar quantity may be available from this formation in Euclid Township.

Wells produce up to 15 gallons per minute from the shale formations beneath the Berea sandstone. The ordinary yield from these rocks is between 2 and 5 gallons per minute, but in many places the wells are dry.

Records of wells in Euclid Township are shown in table 15; the locations of the wells are shown on plate 40. The logs of some of the wells are shown on plate 42.

INDEPENDENCE TOWNSHIP

Thin glacial drift covers most of the surface of Independence Township. Along the eastern boundary, where the township line is roughly coincident with the course of the Cuyahoga River buried valley, the bedrock surface is as much as 600 feet below land surface.

Rocks of the Cuyahoga group, the Berea sandstone, and the formations beneath the Berea sandstone crop out under the glacial drift. The Berea sandstone and the shales of the Cuyahoga group yield as much as 20 gallons per minute to domestic wells. Two wells are reported to have been drilled into the shale formations that lie beneath the Berea sandstone. One (well 24) has a reported yield of 1 gallon per minute, and the other (well 23) has a reported yield of ¼ gallon per minute. The shale formations that lie stratigraphically below the Berea sandstone in Cuyahoga County generally yield 2 to 3 gallons per minute.

Wells dug or drilled into the glacial drift may encounter water-bearing gravel lenses, but the glacial material in the buried valleys is predominantly non-water-bearing silt, clay, and till.

Records of wells in Independence Township are shown in table 16; the locations of the wells are shown on plate 41. The logs of some of the wells are shown on plate 42.

MAYFIELD TOWNSHIP

The topography of Mayfield Township is flat to slightly undulating. The surface elevation ranges from about 900 feet above sea level in the north to slightly more than 1,100 feet in the south. The Chagrin River flows northward across the eastern part of the township in a valley whose floor is about 200 feet lower than the general land surface.

Rocks of the Cuyahoga group, the Berea sandstone, and the formations underlying the Berea sandstone, crop out beneath the thin covering of glacial drift (pl. 1). The Berea sandstone is the most dependable aquifer in the township; it yields about 5 gallons per minute to most domestic wells and as much as 20 gallons per minute to some wells. In the areas where the Cuyahoga group overlies the Berea sandstone, all but one of the wells investigated was drilled through the shale into sandstone below.

The formations underlying the Berea sandstone do not yield large quantities of water and in some places they are totally unproductive. Generally, however, domestic supplies of sufficient quantity are available. Most wells yield less than 5 gallons per minute.

A buried valley, containing thin and discontinuous water-bearing sand and gravel lenses interspersed through lake-clay deposits, underlies the Chagrin Valley. These sand and gravel lenses are penetrated by many wells in the valley and yield most of the water used in the village of Gates Mill, providing as much as 20 gallons per minute to domestic wells.

The depths of wells obtaining water from the Berea sandstone range from 35 to 180 feet. This is in contrast to ranges of 10 to 450 feet and 56 to 270 feet for wells that obtain water from the pre-Berea rocks and the glacial drift, respectively.

Records of wells in Mayfield Township are shown in table 17; the locations of the wells are shown on plate 43. The logs of some of the wells are shown on plate 44.

MIDDLEBURG TOWNSHIP

The buried valley of the Rocky River traverses the central part of Middleburg Township in a north-south direction. The buried valley deposits are predominantly glacial till and lake clay, but occasional thin, narrow, and discontinuous sand and gravel lenses are encountered by wells. Wells in such lenses yield as much as 25 gallons per minute.

Rocks of the Cuyahoga group, the Berea sandstone, and the Bedford, Ohio, and Chagrin shales crop out beneath the thin mantle of glacial drift. In the areas where the shales of the Cuyahoga group form the bedrock surface, all but 1 of the 32 wells reported was drilled through the shale into the underlying Berea sandstone. That one well bottomed in the Cuyahoga group and yielded 3 gallons of water per minute. The Berea sandstone yields as much as 60 gallons per minute to 5- or 6-inch wells, 5 to 10 gallons per minute being the normal yield. The three shale formations below the Berea sandstone are poor sources of ground water. Many shale wells yield no water irrespective of their depth, and only a few of the successful wells yield as much as 3 gallons per minute.

Records of wells in Middleburg Township are shown in table 18; the locations of the wells are shown on plate 45. The logs of some of the wells are shown on plate 48.

TABLE 16. RECORDS OF WELLS AND A RESISTIVITY MEASUREMENT IN INDEPENDENCE TOWNSHIP

No.	File No. (Ohio Division of Water)	Owner or name	Elevation at well (feet above sea level)	Depth to bedrock (feet)	Depth of well (feet)	Principal water-bearing bed: Character of material	Principal water-bearing bed: Geologic horizon	Water level: Below land surface (feet)	Water level: Date	Yield: Rate (g.p.m.)	Yield: Drawdown (feet)	Type of well	Type of pump	Diameter of well (inches)	Use	Remarks
1	569	J. Reynolds	1,070	10	296	Ss	Ber	221	8-15-49	3		Dr		6½	D	L
2		M. Wawalonic	1,138	30	90	Sh	Cuy	80	6- -46	3		Dr		5½	D	L
3	560	F. Boers	1,100	22	70	Sh	Cuy	15	10- 3-49	10		Dr		5½	D	L
4	122	J. Morris	1,050	14	64	Sh	Cuy	50	1- -46	5		Dr		5½	D	L
5	357	C. Mennis	1,050	10	64	Sh	Cuy	42	9-11-48	3		Dr		6	D	L
6	610	R. Bokmuller	990	18	178	Ss	Ber	38	7-25-49	3		Dr		5½	D	L
7	708	C. R. Peters	1,020	12	27	Ss	Cuy	17	5- -50	15		Dr		6	D	
8	183	H. Sadawski	900	16	66	Sh	Cuy	40	8- 9-46	3		Dr		5½	D	
9	121	E. Fraschetti	865	10	60	Ss	Ber	42	12- -45	3		Dr		5½	D	L
10	291	M. Langalco	870	10	25	Sh	Cuy	24	5-26-48	5		Dr		5½	D	L
11	765	J. F. Walsh	880	8	83	Ss	Ber	30	5- -50	3		Dr		6¼	D	L
21	140	O. Bvorak	890	10	28	Ss	Ber	18	5- -46	5		Dr		5½	D	
22	689	C. Hlavac	880	0	30	Ss	Ber	5	5- 7-50			Dr		5½	D	
23	417	G. Tracz	700	48	90	Sh	P-B	35	11-26-49	¼		Dr	Hand	5½	D	L
24	287	J. B. Crane	620	30	109	Sh	P-B	3	5- 6-48	1	10	Dr		6½	D	L
27	233	L. Wididka	853	8	38	Ss	Ber	20	11-21-46	10		Dr		6	D	L
28		L. Denk	835	15	45	Ss	Ber	10	11- -48	3		Dr		5½	D	L
29		A. Shingle	860	12	28	Ss	Ber	24	12- -47	20		Dr		6	D	L
30		J. Dylaski	860	10	26	Ss	Ber	20	12- -47	4		Dr		5½	D	
31		E. Padowski	860	15	20	Ss	Ber	15	10- -48	15		Dr		6	D	
32	212	C. Czarnecki	915	10	125	Ss	Ber	8	4- 3-51			Dr	Jet	5	D	L
33	573	A. Vondrak	845	18	55	Ss	Ber	10	7-28-49	3		Dr		6½	D	
35		A. Godlenski	815	4	34	Ss	Ber	20	9-16-46			Dr		6	D	
36	293	A. George	880	12	43	Sh	Cuy	27	5-23-48	1		Dr		6	D	
37	683	E. Bazzo	895	8	30	Ss	Ber	6	4-29-50			Dr	Lift	5½	D	L
40		J. Slifko	610	11	11	Un	Gla	3	5- 4-51			Dug	Lift	60	D	
41		Haffner	610	10+	9	Un	Gla	5	5-18-51			Dug	Hand	36	D	
47		Ind. Fuel Supply	610	12				5	5-18-51			Dug	Lift	36	I	
48		Boerwinkle	715	11				3	5-18-51			Dug	Lift	36	D	
49		Myers	780	36	80							Dr		5½	D	
201		Cleveland Trust #3	880	12								Dr		10	G	
202		Buhl	760	14								Dr		10	G	
203		B. Schramm	820	45								Dr		10	G	
204		J. Grane	615	110								Dr		10	G	
205		J. Hays	925	44								Dr		10	G	
206		R. G. Hascull	786	48								Dr		10		
207		F. Bramley	800	18								Dr		10	G	
208		F. Bramley #1	615	21								Dr		10	G	
210		Douhler	615	140								Dr		8	G	
211		Geissendorfer	700	72								Dr		10	G	
213		M. Svoboda	660	29								Dr		10	G	
219		A. W. Henn	960	21								Dr		10	G	
301			910	6		Sh	Cuy					Dr				Test hole.
302			870	7		Sh	Cuy					Dr				Test hole.
303			860	2		Ss	Ber					Dr				Test hole.
304			856	5		Ss	Ber					Dr				Test hole.
305			845	3		Ss	Ber					Dr				Test hole.
401			884	75					8- -51							R

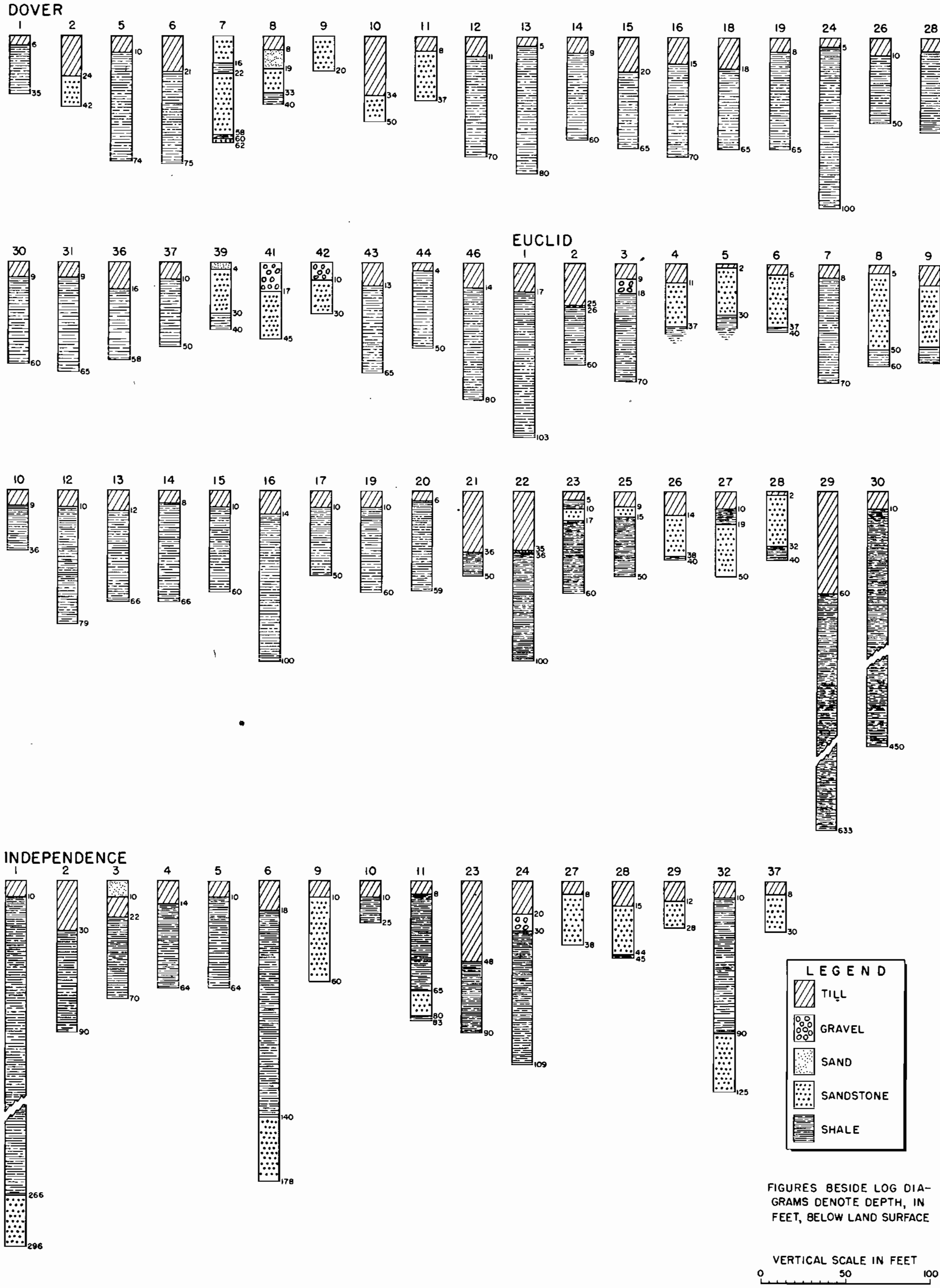


Plate 42. Logs of wells in Dover, Euclid, and Independence Townships.
[Well numbers refer to locations shown on plates 39, 40, and 41.]

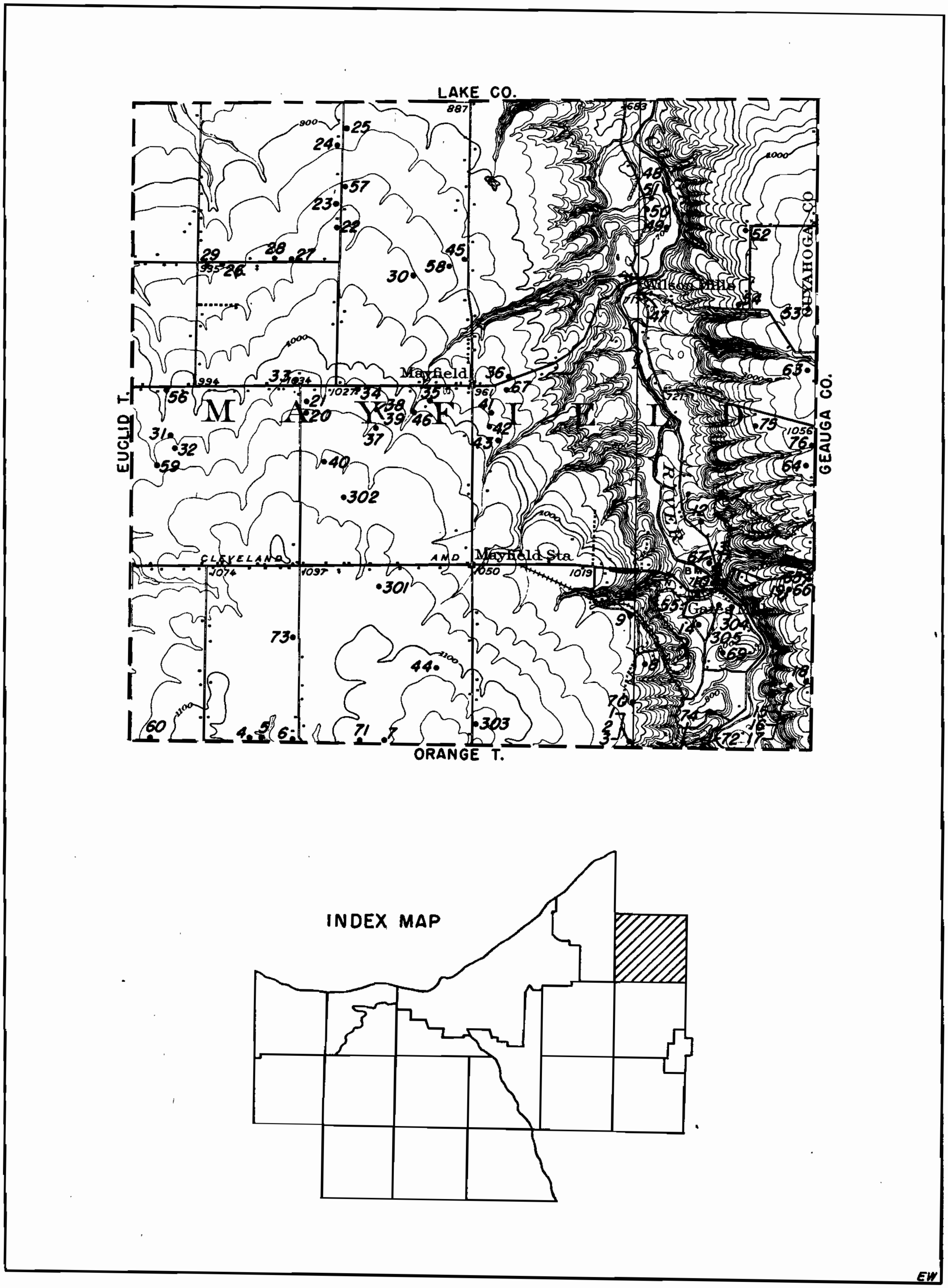


Plate 43. Map showing location of wells in Mayfield Township.

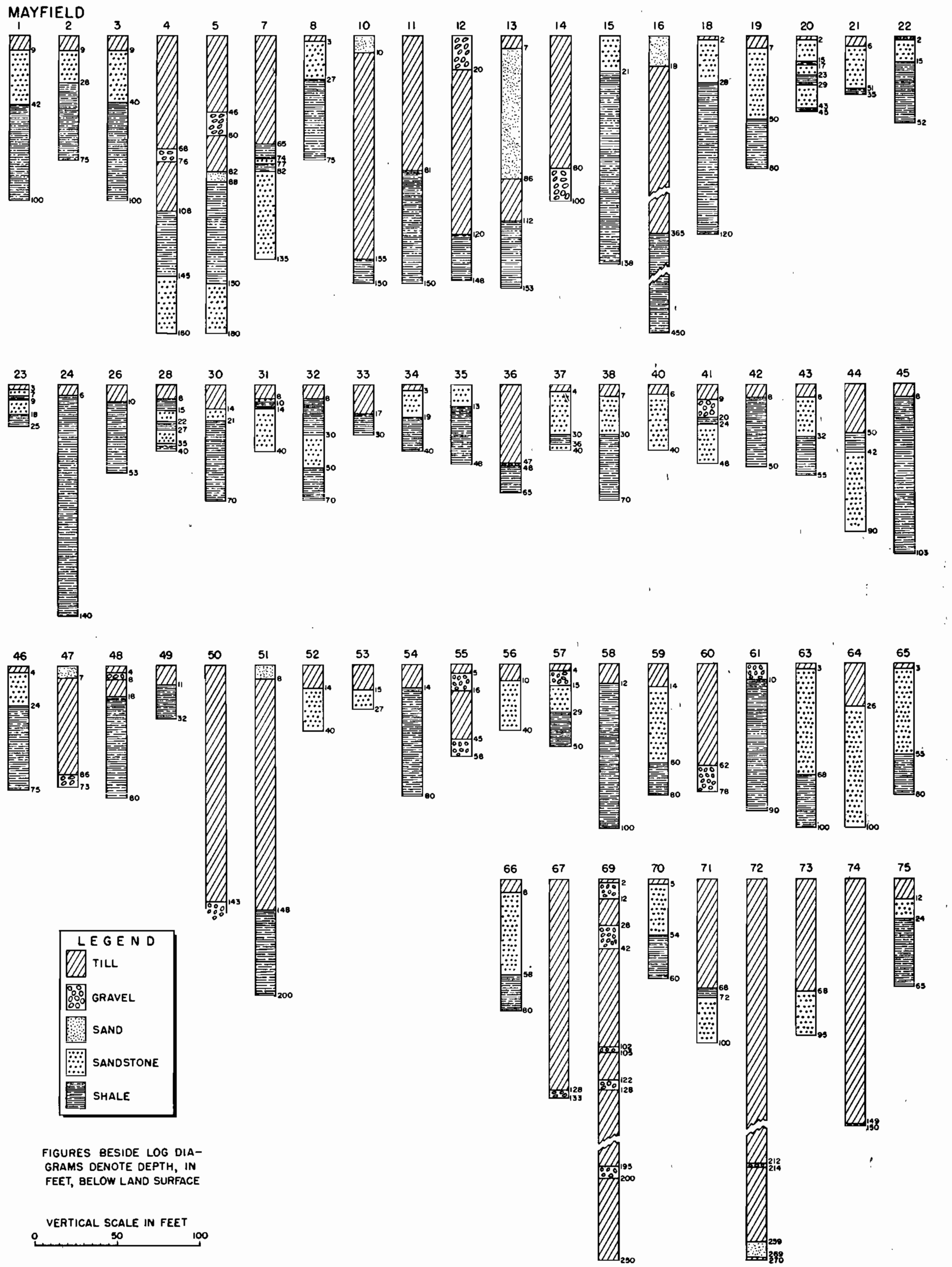


Plate 44. Logs of wells in Mayfield Township.
[Well numbers refer to locations shown on plate 43.]

TABLE 17. RECORDS OF WELLS IN MAYFIELD TOWNSHIP

No.	File No. (Ohio Division of Water)	Owner or name	Elevation at well (feet above sea level)	Depth to bedrock (feet)	Depth of well (feet)	Principal water-bearing bed: Character of material	Principal water-bearing bed: Geologic horizon	Water level: Below land surface (feet)	Water level: Date	Yield: Rate (g.p.m.)	Yield: Drawdown (feet)	Type of well	Type of pump	Diameter of well (inches)	Use	Remarks
1	673	C. W. Wyckoff	1,040	9	100	Ss	Ber	20	4–22–50	5		Dr		5½	D	L
2	674	C. W. Wyckoff	1,040	9	75	Ss	Ber	25	4–25–50	5		Dr		5½	D	L
3	667	C. W. Wyckoff	1,040	9	100	Ss	Ber	22	4–18–50	5		Dr		5½	D	L
4	712	J. E. Rehar	1,085	106	180	Ss	Ber	44	6–15–50	8		Dr		5½	D	L
5		P. Nelson	1,085	88	180	Ss	Ber	60	1–31–50	8	100	Dr		5½	D	L
6	727	A. More	1,085	30	131	Sh	Cuy	51	6–29–50	8	20	Dr		5½	D	
7	675	J. D. Schenker	1,115	65	135	Ss	Ber	30	4–22–50	5		Dr		4¼	D	L
8	702	H. T. Bradner	970	3	75	Ss	Ber	30	5–25–50	9		Dr		5½	D	L
9		R. T. King	1,000	40—	58	Sh	P-B	6	6–11–49	15	18	Dr			D	
10		J. Bell	620	135	150	Sh	P-B	65	5–19–50	5		Dr		5½	D	L
11	642	J. K. Howell	660	81	150	Sh	P-B	26	1–14–50	2		Dr		5½	D	L
12		E. S. Geffine	740	120	148	Sh	P-B	32	8–16–48	4	93	Dr		5½	D	L
13	90	Gates Mills Garage	730	112	153	Sh	P-B			6		Dr			D	L
14		K. Oglebay	745	100+	100	G	Gla	50	12– 3–47	20	10	Dr		6	D	L
15	301	H. B. Cain	960	33	138	Sh	P-B	55	6– 4–48	4	40	Dr		5½	D	L
16	300	H. B. Cain	960	31	450	Sh	P-B					Dr		5½	D	Dry hole. L
17			960	21	120			11	4–11–51			Dr		5½		Not used.
18	652	R. J. Tishey	1,000	2	120	Ss	Ber	37	3– 8–50	5		Dr		5½	D	L
19	666	John Marston	1,015	7	80	Ss	Ber	25	4–14–50	9		Dr		5½	D	L
20	524	Ted Spangler	1,042	2	45	Ss	Ber	10	3–17–49	5	15	Dr		5½	D	L
21		R. Weiss	1,030	6	35	Ss	Ber	5	9–29–50	8		Dr		5½	D	L
22		C. W. Martin	962	2	52	Sh	P-B	14	3–11–49	20	15	Dr		5½	D	L
23	730	R. E. Richie	950	3	25	Sh	P-B	7	6–25–50	5		Dr		5½	D	L
24	631	G. Minafo	920	6	140	Sh	P-B	10	1–17–50	2	90	Dr		5½	D	L
25	550	L. H. Hunter	905	2	10	Sh	P-B	10	8–10–49	3		Dr		5½	D	
26	546	J. H. Coffey	940	10	60	Sh	P-B	10	8–16–49	3	5	Dr		5½	D	L,A
27	597	A. Dziewreke	950	13	37	Sh	P-B			3	10	Dr	Hand	5½	D	
28	718	J. Dinishak	945	8	40	Sh	P-B	3	6–12–50	5		Dr		5½	D	L
29		A. Zrolka	935	10	40	Sh	P-B	30	12–20–49	2	4	Dr			D	
30	745	D. L. Smith	960	14	70	Sh	P-B	35	7– 3–50	2		Dr		5½	D	L
31	715	M. Sturges	1,020	8	40	Sh	P-B	6	6–10–50	4½		Dr		5½	D	L
32	716	Baldwin	1,020	8	70	Sh	P-B	20	6– 8–50	4		Dr		5½	D	L
33	594	Bert Brehm	1,034	17	30	Sh	P-B	12	11–11–49	10		Dr		6	D	L
34		K. W. Gest	1,028	3	40	Ss	Ber	9	9–19–51	5		Dr		5½	D	L
35	8	P. A. Frye	1,010	0	48	Sh	P-B			3		Dr			D	L
36	591	Fred Slingo	940	48	65	Sh	P-B	25	8– 5–49	4½	5	Dr		5½	D	L
37		F. Sowin	1,043	4	40	Ss	Ber	10	6–28–50	5		Dr		5½	D	L
38	640	Carl Welder	1,030	7	70	Ss	Ber	12	2– 1–50	5		Dr		5½	D	L
39		Carl Welder	1,030	7	80	Ss	Ber	25	2– 7–50	7		Dr		5½	D	

TABLE 17 (Continued). RECORDS OF WELLS IN MAYFIELD TOWNSHIP

No.	File No. (Ohio Division of Water)	Owner or name	Elevation at well (feet above sea level)	Depth to bedrock (feet)	Depth of well (feet)	Principal water-bearing bed: Character of material	Principal water-bearing bed: Geologic horizon	Water level: Below land surface (feet)	Water level: Date	Yield: Rate (g.p.m.)	Yield: Drawdown (feet)	Type of well	Type of pump	Diameter of well (inches)	Use	Remarks
40		Miller & Olson	1,060	6	40	Ss	Ber	8	11– 8–49	2½		Dr		6	D	L
41	651	Harold Panek	1,070	20	50	Sh	P-B	12	3– 8–50	5		Dr		5½	D	L
42		Jack Wollen	1,080	8	50	Sh	P-B	8	4–17–50	5		Dr		5½	D	L
43		John Levack	1,080	8	55	Sh	P-B	16	6–20–50	3		Dr		5½	D	L
44		James Franklin	1,120	30	90	Ss	Ber	67	5–13–50	9		Dr		5½	D	L
45		H. M. Danner	932	50	103	Sh	P-B			3		Dr			D	L
46		J. Stankus	1,030	4	75	Ss	Ber	18	5–18–50	5		Dr		5	D	L
47	624	Little Church in the Vale	700	73+	73	G	Gla	20	10– 6–49	9		Dr	Jet	5½	D	L
48	686	Melvin Teschke	700	18	80	Sh	P-B	28	5– 3–50	2		Dr		5½	D	L
49		J. Svette	700	11	32	Sh	P-B	8	10–21–49	3		Dr		5½	D	L
50	84	H. Stratar	745	143+	143	S & G	Gla			8		Dr		5½	D	L
51	747	G. Troppman	735	148	210	Sh	P-B	65	7–19–50	1		Dr		5½	D	L
52	33	Battles	1,014	14	40	Ss	Ber					Dr	Hand		D	L
53		L. N. Matheson	1,060	15	27	Ss	Ber	4	1950	8	16	Dr		8	D	L
54	641	Luke Brown	980	14	80	Sh	P-B	27	2– 1–50	5		Dr		5½	D	L
55	643	L. S. Robbins. Jr.	725	56+	56	G	Gla	10	1– 3–50	20	12	Dr		5½	D	L
56		Manzo	950	10	44	Sh	P-B	7	5–17–50	7	8	Dr		5½	D	L
57		Wassel	945	13	50	Sh	P-B			15		Dr		5½	D	L
58		E. H. Hall	940	12	100	Sh	P-B	20	1–18–49	½	70	Dr		5½	D	L
59		F. Martello	1,030	14	80	Ss	Ber	30	6– 7–50	5		Dr		5½	D	L
60		G. Hein	1,090	78+	78	G	Gla	30	7–24–50	20	10	Dr		5½	D	L
61		H. J. Krebs	945	22	90	Sh	P-B	12	10–23–50	½		Dr		5½	D	L
63		J. S. Lucas	1,045	3	100	Ss	Ber	29	12–21–50	20	29	Dr		5½	D	L
64		W. Newman	1,050	26	100	Ss	Ber					Dr		5½	D	L
65		Outstanding Homes	1,050	3	80	Ss	Ber	20	4–21–51	5		Dr		5½	D	L
66		Outstanding Homes	1,050	8	133	Ss	Ber	24	4–23–51	4		Dr		5½	D	L
67		Sam Kahil	725	134+	133	S & G	Gla	42	12–23–50	4		Dr		5½	D	L
69		D. Wick	820	200	250	S & G	Gla	90	9–29–50	3		Dr		5½	D	L
70		J. P. O'Connor	1,000	3	60	Ss	Ber	16	10–20–50	5		Dr		5½	D	L
71		E. L. Fagin	1,070	66	100	Ss	Ber	78	11– 2–50	9	2	Dr		5½	D	L
72		I. Bolton	800	270+	270	S	Gla	90	9–20–50	2	175	Dr		8	D	L
73		J. Haydocy	1,090	68	95	Ss	Ber	50	9–13–51	10		Dr		5½	D	L
74		Emil Raza	860	156+	150	G	Gla	130	6– 7–51	5	15	Dr		5½	D	L,A
75		A. S. Austin	1,020	12	65	Ss	Ber	28	5–24–51	15	28	Dr		6	D	L
76		E. J. Steffner	1,040	26	100	Ss	Ber	27	6–14–51	5	27	Dr		5½	D	
301			990	4		Ss	Ber					Dr				Test hole.
302			970	5		Ss	Ber					Dr				Test hole.
303			1,125	8		Sh	Cuy					Dr				Test hole.
304			730	166+		Un	Gla					Dr				Test hole.
305			735	105+		Un	Gla					Dr				Test hole.

TABLE 18. RECORDS OF WELLS IN MIDDLEBURG TOWNSHIP

No.	File No. (Ohio Division of Water)	Owner or name	Elevation at well (feet above sea level)	Depth to bedrock (feet)	Depth of well (feet)	Principal water-bearing bed: Character of material	Principal water-bearing bed: Geologic horizon	Water level: Below land surface (feet)	Water level: Date	Yield: Rate (g.p.m.)	Yield: Drawdown (feet)	Type of well	Type of pump	Diameter of well (inches)	Use	Remarks
1		P. Whitestine	800	5	96	Ss	Ber	35	7– –50	5½	15	Dr		6½	D	L
2	522	O. Rolbes	790	12	84	Ss	Ber	40	8– –49	30		Dr		5½	D	L
3		B. J. Klein	940	16	62	Sh	Cuy	42	8– –48	3		Dr		6	D	L
4	657	J. Kiefer	880	10	158	Ss	Ber					Dr		5	D	L
5	655	W. Schimnowski	870	35	75	Ss	Ber	25	3–24–50	3		Dr		5½	D	L
6	754	C. H. Sabon	830	6	36	Ss	Ber	4	7– –50	7		Dr		5½	D	L
7	752	F. Whalen	787	5	45	Sh	P-B	6	7– –50	2½		Dr		5¼	D	L
8	117	A. Kahn Ass. Arch. & Engrs.	787	50+	50	Un	Gla					Dr				
9	139	Cleveland Elec. Co.	802	10	75							Dr				Dry hole. L
10	564	W. Schenck	820	149+	149	G	Gla	70	9–20–49	3		Dr		6½	D	L
11		A. Strojny	830	11	40	Sh	Cuy	18	7– –50	5		Dr		5½	D	
12	286	A. Chermuskin	835	47	75	Ss	Ber	35	4–29–48	5		Dr		5½	D	L
13		Deutsch	848	12	38	Ss	Ber	4	5– –50	60		Dr		5½	D	
14		D. F. Rodgers	845	12	40	Ss	Ber	3	7– –50	50		Dr		5½	D	L
15		C. J. Plan	797	23	65	Ss	Ber	20	8– –49	7		Dr		6½	D	L
16		Cleve. Y.M.C.A.	806	35	82	Ss	Ber	10	5– –49	25	48	Dr		6½	D	L
17		C. Eddy	846	14	48	Ss	Ber	2	5– –50			Dr		5½	D	
18		C. Eddy	839	14	48	Ss	Ber	3	5– –50	25		Dr		5½	D	L
19		Nock	775	24+	24	Un	Gla	3	5–23–51			Dug	Hand	48		Not used.
20		Lutty	765	3+	3	Un	Gla	1	5–23–51			Dug	Lift	36	D	
21		L. W. Muzlay	840	80+	80	G	Gla	50	6–28–51	25		Dr		5½	D	L,A
22		A. McGilvray	835	80	96							Dr		5½	D	
23		J. Gorisek	815	62	73							Dr	Hand		D	
24		W. Crumbaker	805	35	40			4	5–24–51			Dr	Lift	5½	D	
25		Mrs. Arnokl	825	25+	25							Dr	Lift	6	D	
27		L. Eavensen	875	19	56	Sh	P-B	8	10–19–51	5		Dr		5½	D	
28		L. Eavensen	775	38	66	Sh	P-B	10	6–16–51			Dr		6½	D	L
30		C. J. Wilchek	780	95	106							Dr	Jet	5½	D	
31		C. O. Plum	780	195+	195							Dr		5½	D	
32		S. Zegarac	775		120							Dr	Lift		D	
33		Lange	805	35	77			14	5–24–51			Dr	Lift	4	D	
34		J. W. Nick	855	16	45	Ss	Ber	20	6–25–51			Dr		5½	D	L,A

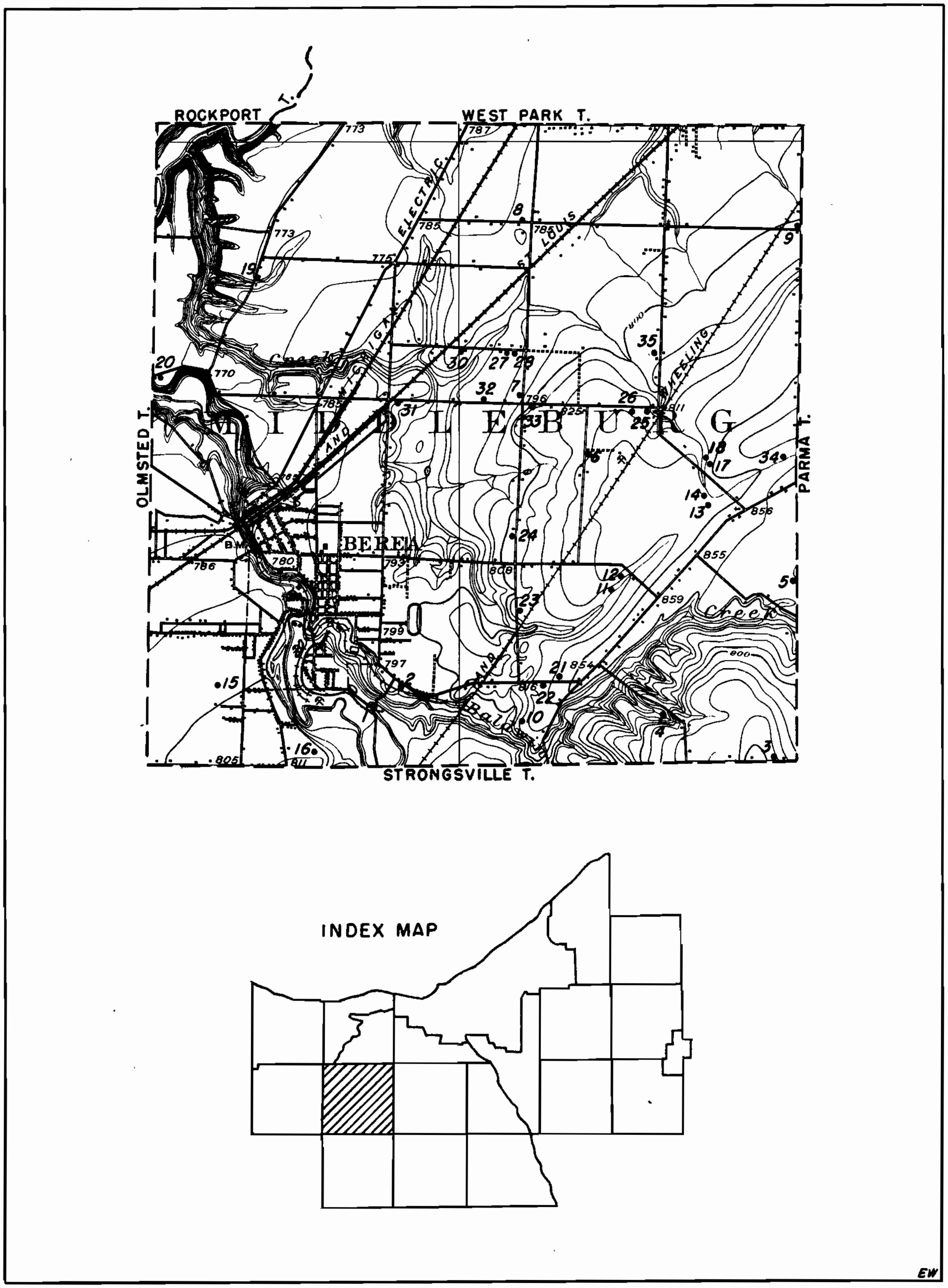


Plate 45. Map showing location of wells in Middleburg Township.

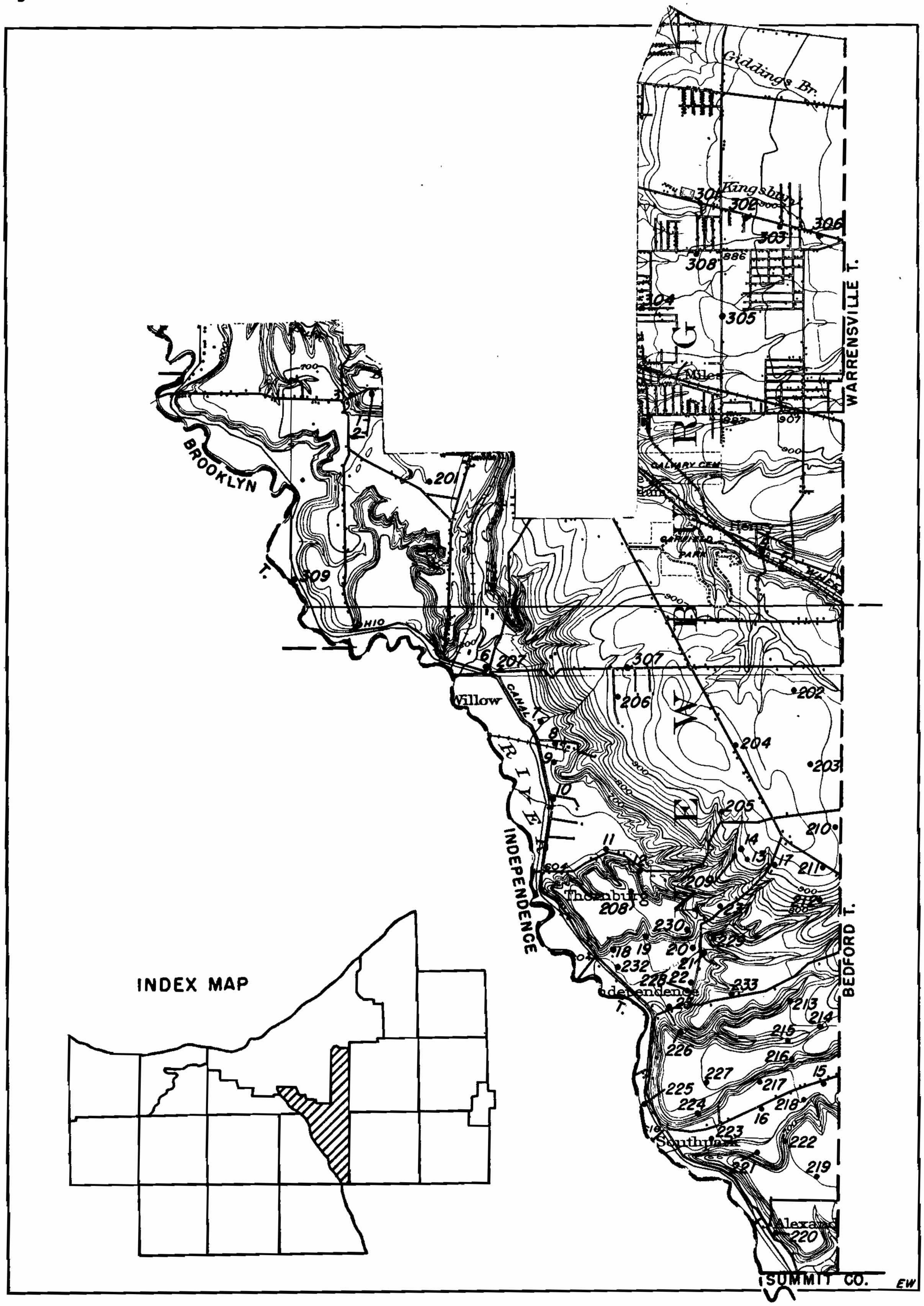


Plate 46. Map showing location of wells in Newburg Township.

TABLE 19. RECORDS OF WELLS IN NEWBURG TOWNSHIP

No.	File No. (Ohio Division of Water)	Owner or name	Elevation at well (feet above sea level)	Depth to bedrock (feet)	Depth of well (feet)	Principal water-bearing bed: Character of material	Principal water-bearing bed: Geologic horizon	Water level: Below land surface (feet)	Water level: Date	Yield: Rate (g.p.m.)	Yield: Drawdown (feet)	Type of well	Type of pump	Diameter of well (inches)	Use	Remarks
1	162	Ferro Enamel Corp.	700	508	523	G	Gla			175		Dr		8	I	L
2	163	Ferro Enamel Corp.	700	501	523	G	Gla					Dr			I	
3		Klausner Cooperage Co.	680	200+	200	S	Gla					Dr			I	Dry hole. L
4	29	Horn Welding Co.	840	45+	45	S & G	Gla			12		Dr			D	L
5		Cleveland Chain & Mfg. Co.	830	65+	65	S & G	Gla	30	5- 2-51	1500	6	Dr		20	I	L,A
6	767	Lombardo Bros. Const. Co.	600	484+	484	G	Gla	Flow	5-21-51	40		Dr		6½	P	L
7		B. Mathews	600	166+	166	S & G	Gla	14	7-11-51	20	2	Dr		5½	D	L
8		Terranova	615	33+	33	G	Gla	3	10-10-50	10		Dr	Lift	5½	D	L
9	682	B. Mathews	620	186+	183	S & G	Gla	15	4-15-50	15	15	Dr		5½	D	L
10	589	J. Krupiemski	600	45+	45	S & G	Gla	3	10-26-49	11	3	Dr		5½	D	L
11	568	F. DeBlasier	620	360+	264	G	Gla	100	8-25-49	3		Dr		6½	D	L
12	669	M. P. Hyberd	640	100+	100	G	Gla	15	4-12-50			Dr		5½	D	L
13		H. Kail	920	12	42	Ss	Ber	30	12- -47	5	40	Dr		6	D	
14		Timco	920	20	90	Ss	Ber	58	2-19-48			Dr	Jet	6	D	L
15		Mrs. Wiese	645	13+	13	Un	Gla	9				Dug	Lift	36	D	
16		Kowalhi	630	12+	12	Un	Gla	7				Dug	Lift	36	D	
17	299	M. Pannim	920	16	25	Sh	P-B	24	5- -48			Dr		6	D	
18		L. C. Alexander	630		16			7				Dug	Lift		D	
19		C. F. Allen	660		14			6				Dug	None	36	D	
20		A. E. Luedy	640		14			10				Dug	Lift	36	D	
21		Mrs. Lang	640		18			9				Dug	Lift		D	
22		Cassill	635	55+	55			2				Dr		6	D	
23		Walcher	620		13			7				Dug	None	36	D	
201		Belt Terminal & Realty	740	500								Dr		10	G	
202		Barfield Park	930	24								Dr		10	G	
203		A. W. Henn	940	38								Dr		10	G	
204		C. J. Green	640	20								Dr		10	G	
205		J. Murray	940	38								Dr		10	G	
206		V. Blazel	915	24								Dr		10	G	
207		Reimer	595	140								Dr		10		
208		A. C. Allen	740	782								Dr		7	G	
209		A. Blackledge	880	210								Dr		10	G	
210		Carpenter & Blackledge	940	45								Dr		10	G	
211		Coughlin	950	38								Dr		10	G	
212		E. Coughlin	860	114								Dr		10	G	
213		E. Bohning	760	682								Dr		8	G	
214		M. & J. Walsh	760	571								Dr		8	G	
215		C. Mehling	730	762								Dr		7	G	
216		C. Green	760	689								Dr		8	G	
217		C. Green	640	515								Dr		8	G	
218		K. Kwealkowsky	640	640								Dr		8	G	
219		C. E. Brown	760	297								Dr		10	G	
220		T. Wilson	700	372								Dr		10	G	
221		C. Mehling	640	648								Dr		8	G	
222		C. H. Green	680	617								Dr		7	G	
223		M. Carey	618	424								Dr		10		
224		M. Carey	700	196								Dr		10	G	
225		C. Carey	610	108								Dr		8	G	
226		J. W. Edgar	640	192								Dr		10	G	
227		S. Franz	760	404								Dr		8	G	
228		C. M. Swan	635	324								Dr		10	G	
229		B. J. Loderick	740	603								Dr		8	G	
230		J. & A. Cerney	740	772								Dr		7	G	
231		I. Fneark	740	570								Dr		8	G	

TABLE 19 (Continued). RECORDS OF WELLS IN NEWBURG TOWNSHIP

No.	File No. (Ohio Division of Water)	Owner or name	Elevation at well (feet above sea level)	Depth to bedrock (feet)	Depth of well (feet)	Principal water-bearing bed: Character of material	Principal water-bearing bed: Geologic horizon	Water level: Below land surface (feet)	Water level: Date	Yield: Rate (g.p.m.)	Yield: Drawdown (feet)	Type of well	Type of pump	Diameter of well (inches)	Use	Remarks
232		L. I. Gleason	610	243								Dr		10	G	
233		A. Hogue	740	406								Dr		8	G	
301			865	8		Ss	Ber					Dr				Test hole.
302			895	2		Sh	Cuy					Dr				Test hole.
303			905	10		Sh	Cuy					Dr				Test hole.
304			850	4		Ss	Ber					Dr				Test hole.
305			885	17		Sh	Cuy					Dr				Test hole.
306			920	11		Sh	Cuy					Dr				Test hole.
307			920	10		Sh	Cuy					Dr				Test hole.
308			875	8		Ss	Ber					Dr				Test hole.
309			590	51		Sh	P-B					Dr				Test hole.

TABLE 20. RECORDS OF WELLS IN OLMSTED TOWNSHIP

No.	File No. (Ohio Division of Water)	Owner or name	Elevation at well (feet above sea level)	Depth to bedrock (feet)	Depth of well (feet)	Principal water-bearing bed: Character of material	Principal water-bearing bed: Geologic horizon	Water level: Below land surface (feet)	Water level: Date	Yield: Rate (g.p.m.)	Yield: Drawdown (feet)	Type of well	Type of pump	Diameter of well (inches)	Use	Remarks
1	289	A. Nenbauer	781	23	50	Ss	Ber					Dr		5½	D	L
2	342	C. Johnston	787	28	45	Ss	Ber	8	5-28-48	30	22	Dr		5½	D	L
3	944	A. Stella	774	16	60	Ss	Ber					Dr		5½	D	L
4	249	M. E. Gaspard	780	8	106	Ss	Ber	15	10-25-47	20	15	Dr		6½	D	L
5	721	Metteur	780	14	53	Ss	Ber	18	6- -50	10	20	Dr		5½	D	L
6	335	H. Worster	780	18	40	Ss	Ber					Dr		5½	D	L
7	336	O. W. Weiss	770	20	45	Ss	Ber					Dr		5½	D	L
8	320	O. Holzerinniser	775	26	80	Ss	Ber					Dr		6	D	L
9	368	J. Meder	782	20	51	Ss	Ber	8	8-26-48	20	42	Dr		5½	D	L
10	369	K. Campbell	782	24	56	Ss	Ber	10	8-25-48	30	20	Dr		5¼	D	L
11	737	O. L. Dover	782	29	55	Ss	Ber					Dr		5½	D	L
12	404	T. D. Ballard	773	24	65	Ss	Ber					Dr		5½	I	
13	572	D. Mulholland	773	30	65	Ss	Ber	20	8- 2-49	5		Dr		6½	D	L
14	323	T. D. Ballard	773	30	65	Ss	Ber					Dr		5½	I	
15	743	W. Barnard	770	25	60	Ss	Ber					Dr		5½	D	
16	600	T. D. Ballard	774	29	65	Ss	Ber					Dr		5½	I	L
18	337	H. Q. Verrell	776	52	74	Ss	Ber	27	7-23-48	4		Dr		5½	D	L
20	373	Schartman Bros.	774	46	80	Ss	Ber					Dr		5½	D	L
21	512	J. Babik	785	38	80	Ss	Ber	30	1- 1-49	50	10	Dr		6½	D	L
22		C. Mann	770	26	60	Ss	Ber					Dr		5½	D	L
23	695	W. C. Allen	770	26	60	Ss	Ber					Dr		5½	D	L
24	446	J. Gammala	770	21	50	Ss	Ber					Dr		5½	D	L
25	264	Murphy	780	20	50	Ss	Ber					Dr		5½	D	L

TABLE 20 (Continued). RECORDS OF WELLS IN OLMSTED TOWNSHIP

No.	File No. (Ohio Division of Water)	Owner or name	Elevation at well (feet above sea level)	Depth to bedrock (feet)	Depth of well (feet)	Principal water-bearing bed		Water level		Yield		Type of well	Type of pump	Diameter of well (inches)	Use	Remarks
						Character of material	Geologic horizon	Below land surface (feet)	Date	Rate (g.p.m.)	Drawdown (feet)					
26	409	Summers	788	22	50	Ss	Ber					Dr		5½	D	L
27	574	G. L. Hoss	787	30	57	Ss	Ber	20	7- 4-49	8		Dr		5¼	D	L
28	372	G. S. Dorsey	787	19	48	Ss	Ber					Dr		5½	D	L
29	312	W. P. Merphey	777	20	50	Ss	Ber					Dr		5½	D	L
30	321	W. Lehman	777	25	50	Ss	Ber					Dr		5½	D	L
31	313	J. W. Myland	777	37	55	Ss	Ber					Dr		6	D	L
32	262	Glazer	776	15	50	Ss	Ber					Dr		5½	D	L
33	263	Mrs. E. Stoll	775	18	50	Ss	Ber					Dr		5½	D	L
34	317	Thomas H. Ray	772	30	45	Ss	Ber					Dr		5½	D	L
35	318	A. Valerino	772	32	55	Ss	Ber					Dr		6	D	L
36	621	R. Weber	772	30	55	Ss	Ber					Dr		5½	D	
37	692	F. Gassan	772	24	52	Ss	Ber					Dr		5½	D	
39	753	J. Lehman	773	14	40	Ss	Ber	6	7- -50			Dr		5½	D	
40		H. Simerer	773	18	40	Ss	Ber					Dr		5½	D	
41	314	F. A. Spence	773	22	50	Ss	Ber					Dr		5½	D	
42	736	L. Miller	760	10	35	Ss	Ber					Dr		5½	D	
43	532	E. F. Culhton	760	8	30	Ss	Ber					Dr		5½	D	
44	493	Nichols	767	8	35	Ss	Ber					Dr		5½	D	
45	575	B. Hall	780	22	55	Ss	Ber	35	5-28-49	5		Dr		5½	D	
46	576	Olmsted Falls Greenhouse	775	50	65	Ss	Ber	4	4- 9-51	5		Dr		5½	I	
47	456	P. Getz	775	30	45	Ss	Ber					Dr		5½	D	L
48	458	L. Sober	768	23	47	Ss	Ber					Dr		5½	D	L
49	461	H. Losley	772	32	55	Ss	Ber					Dr		5½	D	L
50	586	C. Munhollon	780	28	63	Ss	Ber					Dr		5½	D	L,A
51	457	W. J. Adams	780	30	60	Ss	Ber					Dr		5½	D	L
52	399	J. Losh	780	29	60	Ss	Ber					Dr		5½	D	L
53	400	R. Staveley	775	28	60	Ss	Ber					Dr		5½	D	L
54	452	C. Hann	775	39	62	Ss	Ber					Dr		5½	D	L
55	731	C. D. Frawley	770	18	60	Ss	Ber					Dr		5½	D	L
56	453	A. B. Mattson	745	16	45	Ss	Ber					Dr		5½	D	L
57	334	Aihar	781	32	52	Ss	Ber					Dr		5½	D	L
58	733	J. Halsinger	781	43	60	Ss	Ber					Dr		5½	D	L
59		E. Vererka	792	24	59	Ss	Ber	8	7- -48	50	12	Dr		5¼	D	L
60	734	R. Donaldson	785	15	50	Ss	Ber					Dr		5½	D	L
61		F. Sojka	775	19	60	Ss	Ber					Dr		5½	D	L
62		P. Kramer	760	25	268							Dr		5½	D	Dry hole. L
63	367	J. Ludwig	660	5	50	Sh	P-B	10	9-13-48	3		Dr		8	D	L,A
64	585	E. Stephen	775	30	60	Ss	Ber					Dr		5½	D	L
65	528	H. Quinn	778	22	55	Ss	Ber					Dr		5½	D	L
66		L. Schenk	770	24	50	Ss	Ber	25	7- -49	10	12	Dr		5½	D	L
67	316	M. H. Mareachren	778	25	50	Ss	Ber					Dr		5½	D	L
68		E. Standen	771	30+	30	S	Gla	12	7- -50	2½		Dr		5¼	D	L
70	654	Pillipek Bros.	770	25	47	Ss	Ber	29	3-17-50			Dr		5½	D	L
71	480	R. Daniels	760	8	35	Ss	Ber					Dr		5½	D	L
72	477	O. W. Harrison	760	5	30	Ss	Ber					Dr		5½	D	L

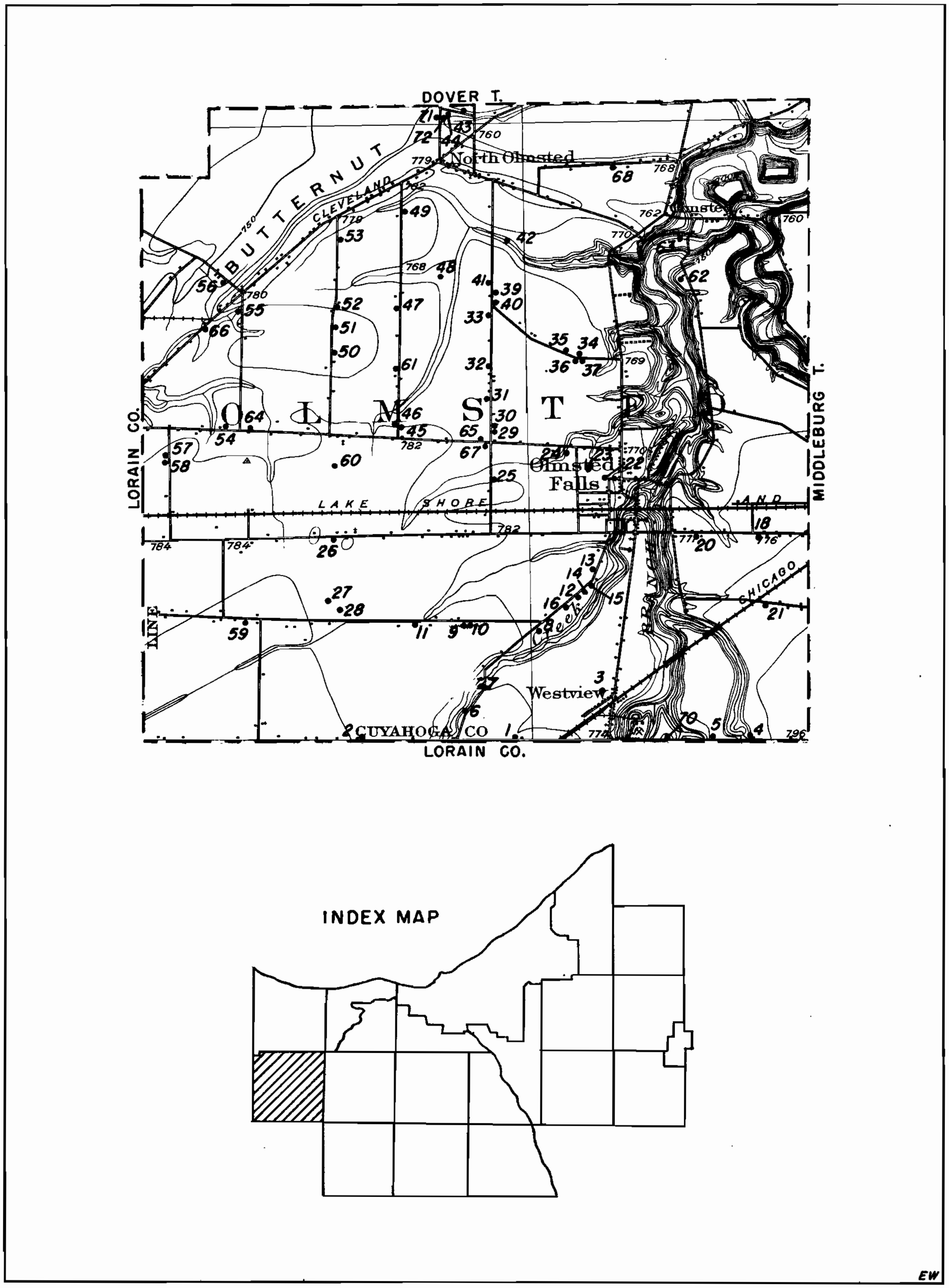


Plate 47. Map showing location of wells in Olmsted Township.

NEWBURG TOWNSHIP

Parts of two buried valley systems traverse Newburg Township, one valley rudely coinciding with the course of the Cuyahoga River, the other lying roughly parallel to Broadway (State Route 14).

The Mill Creek buried valley that is coincident with Broadway contains a thick deposit of sand and gravel, the principal commercial source of this material in Cuyahoga County. Four wells in Newburg Township are reported to be drilled into the sand and gravel deposits in this valley. One 20-inch well (no. 5), 65 feet deep and provided with a well screen, is reported to have yielded 1,500 gallons per minute with a drawdown of only 6 feet during a pumping test conducted by the driller.

The buried valley that underlies the Cuyahoga River is filled with glacial lake deposits, predominantly non-water-bearing silt and clay. There are a few gravel lenses, however, which will yield as much as 175 gallons per minute. The normal yield of domestic wells in these gravel lenses is 10 to 15 gallons per minute.

Rocks of the Cuyahoga group, the Berea sandstone, and the shale formations that underlie the Berea sandstone crop out beneath a thin blanket of glacial till and along the walls of the buried valleys. No wells are reported in the shale of the Cuyahoga group. The Berea sandstone wells yield as much as 40 gallons per minute. The shale formations below the Berea sandstone may yield small amounts of water but these formations are generally considered a poor source of ground water.

Records of wells in Newburg Township are shown in table 19; the locations of the wells are shown on plate 46. The logs of some of the wells are shown on plate 48.

OLMSTEAD TOWNSHIP

All of Olmstead Township is covered by thin till plain deposits except where the land surface has been dissected by the Rocky River and its tributaries. The Berea sandstone underlies all but the northeastern part of Olmstead Township, where the underlying shale formations crop out beneath a thin cover of glacial drift. The consolidated rocks are nicely exposed in the steep valley walls of the Rocky River.

The Berea sandstone yields up to 50 gallons per minute to domestic wells. The shale formations below the Berea sandstone are poor sources of ground water and most wells in these formations are failures. Wells that are successful rarely yield more than 3 gallons per minute.

The glacial drift generally is not productive of ground-water supplies. Locally, in the beach ridges wells penetrate sand lenses that yield up to 2 gallons per minute.

Records of wells in Olmstead Township are shown in table 20; the locations of the wells are shown on plate 47. The logs of some of the wells are shown on plate 48.

ORANGE TOWNSHIP

The topography of Orange Township is moderately rolling, owing to the presence of the Defiance moraine and to stream erosion. The township is in part underlain by the buried valleys of an ancient drainage system. The material filling the buried valleys contains lenses of coarse sand and gravel, which may yield as much as 35 gallons per minute to wells.

Of the consolidated rocks that crop out beneath the glacial drift, the Sharon conglomerate and the rocks of the Cuyahoga group yield as much as 20 gallons per minute and the Berea sandstone yields as much as 35 gallons per minute to domestic wells. Northeast of the intersection of Lander Boulevard and Shaker Boulevard a number of Berea sandstone wells flow at the surface. The shale formations below the Berea sandstone yield water where they are fractured and jointed. Some shale wells yield as much as 3 gallons per minute, but others are failures.

Records of wells in Orange Township are shown in table 21; the locations of the wells are shown on plate 49. The logs of some of the wells are shown on plate 50.

PARMA TOWNSHIP

Parma Township is underlain by the shales of the Cuyahoga group, the Berea sandstone, and the shale formations that underlie the Berea sandstone. Wells in the Cuyahoga group yield as much as 5 gallons per minute, and wells in the Berea sandstone yield as much as 30 gallons per minute. The formations below the Berea sandstone are poor sources of ground water as wells in these formations, even where productive, yield only 1 to 2 gallons per minute.

Glacial drift is thin within the township except in the southwestern corner, which is underlain by a shallow buried valley. Wells that encounter gravel in the buried valley are reported to yield up to 15 gallons per minute.

Records of wells in Parma Township are shown in table 22; the locations of the wells are shown on plate 51. The logs of some of the wells are shown on plate 54.

ROCKPORT AND WEST PARK TOWNSHIPS

The Bedford shale, the Cleveland member of the Ohio shale, and the Chagrin shale crop out beneath the thin mantle of glacial drift in Rockport and West Park Townships. The glacial drift ranges from 6 to 40 feet in thickness except in the buried valley of the Rocky River, where it exceeds 200 feet in thickness.

The glacial drift is a poor source of ground water, except in the buried valley along the Rocky River, where a few thin, narrow, discontinuous sand and gravel lenses yield up to 5 gallons per minute.

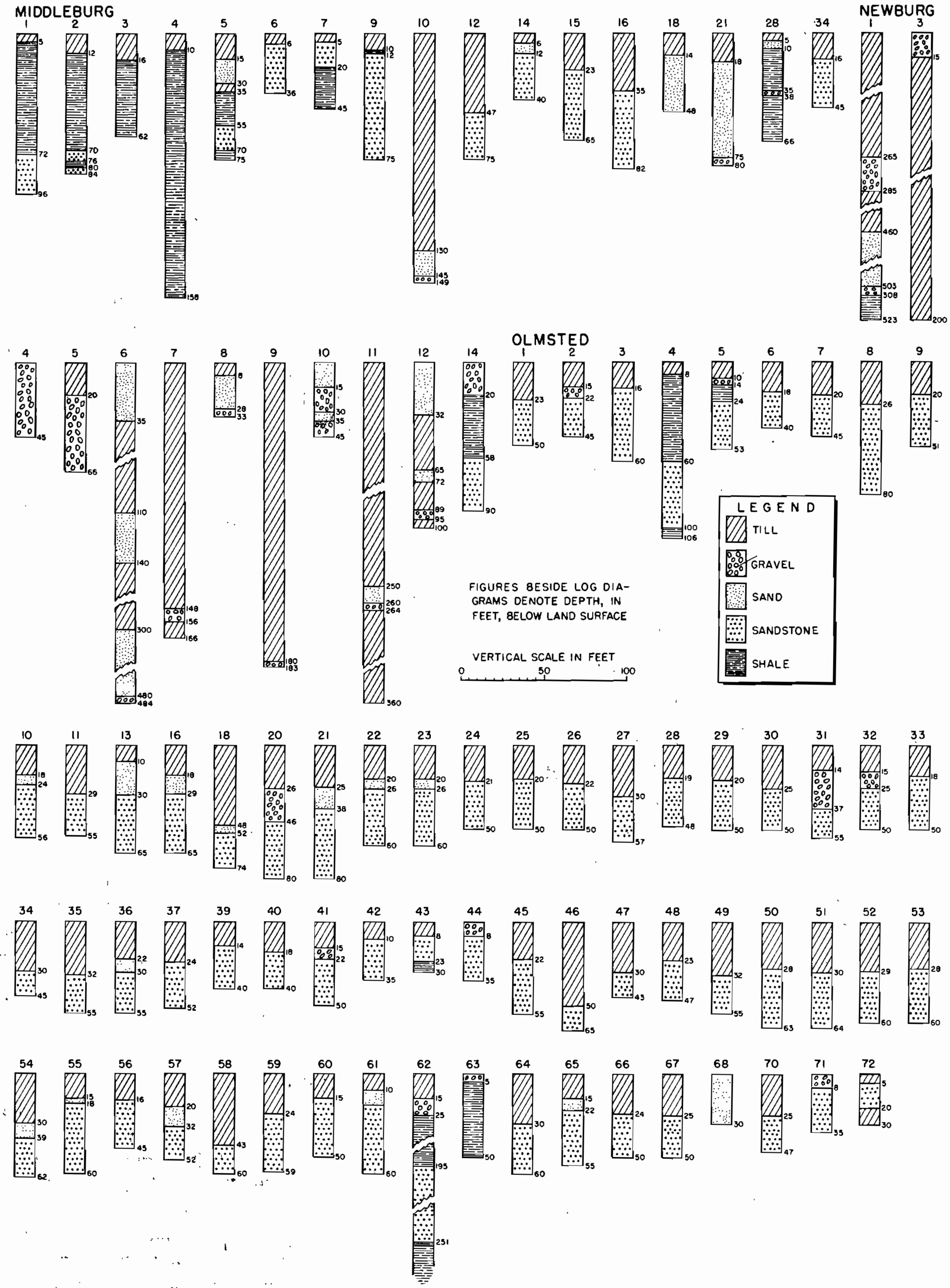


Plate 48. Logs of wells in Middleburg, Newburg, and Olmsted Townships.
[Well numbers refer to locations shown on plates 45, 46, and 47.]

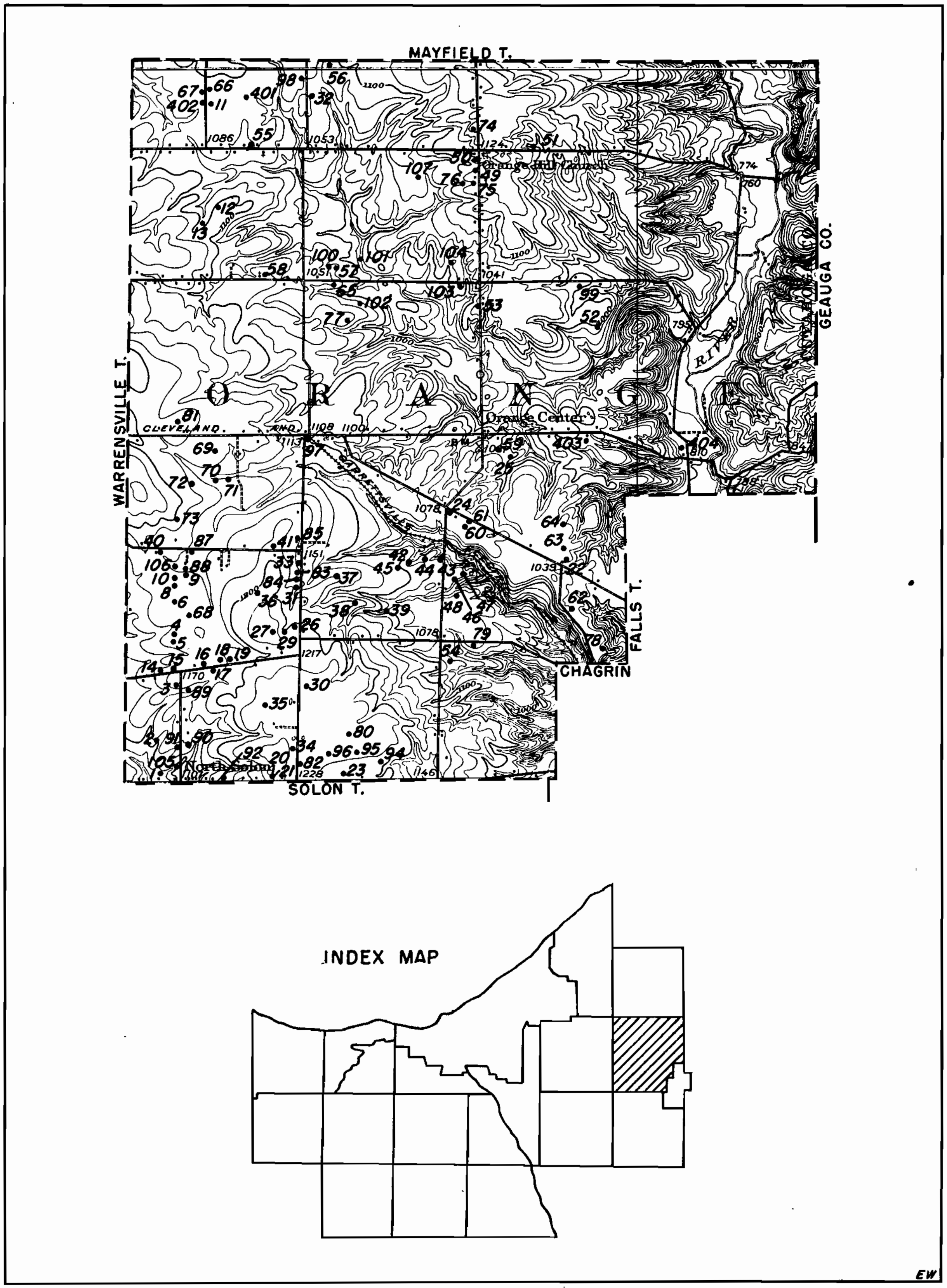


Plate 49. Map showing location of wells in Orange Township.

TABLE 21. RECORDS OF WELLS AND RESISTIVITY MEASUREMENTS IN ORANGE TOWNSHIP

No.	File No. (Ohio Division of Water)	Owner or name	Elevation at well (feet above sea level)	Depth to bedrock (feet)	Depth of well (feet)	Principal water-bearing bed: Character of material	Principal water-bearing bed: Geologic horizon	Water level: Below land surface (feet)	Water level: Date	Yield: Rate (g.p.m.)	Yield: Drawdown (feet)	Type of well	Type of pump	Diameter of well (inches)	Use	Remarks
1		R. Humpal	1,075	60	72	Ss	Ber	18	6–29–49	12	25	Dr		5½	D	L
2	68	R. Parker	1,100	30	160	Ss	Ber			2	60	Dr			D	L
3	625	Steve Szachury	1,160	54+	54	G	Gla	25	10–26–49	7		Dr		5½	D	L
4	296	D. W. Paul	1,165	50	96	Sh	Cuy	27	6–14–48	20	30	Dr	Hand	5½	D	L
5	270	John E. Mallett	1,170	65	87	Ss	Ber	28	4–23–48	25	30	Dr		5½	D	
6	295	J. E. Musil	1,170	59	84	Sh	Shar	28	5–20–48	5		Dr		5	D	L
8		E. J. Sorna	1,160	35+	35	S	Gla	19	6–26–49	10	7	Dr		5½	D	
9	661	J. Maresh	1,165	65	83	Ss	Shar	30	2–28–50	10	7	Dr		5	D	
10		Z. A. Prazek	1,165	81+	81	S	Gla	20	6–24–48	10	45	Dr		4	D	L
11	330	Elie George	1,075	214+	214	G	Gla	100	5–20–48	3		Dr		6½	D	L
12	713	A. N. Metzger	1,100	40	80	Sh	Cuy	30	6– 6–50	8		Dr		5½	D	L
13	714	C. Metzger	1,100	36	80	Sh	Cuy	28	6– 6–50	8		Dr		5½	D	
14	89	N. Troyan	1,140	55	92	G	Gla	18		36		Dr			D	
15	663	Louis Sister	1,160	49	56	Sh	Cuy	25	3–30–50	5		Dr		5½	D	
16	150	E. F. Kral	1,170	32	87	Ss	Ber	28	8– 1–46			Dr		5	D	
17	160	Wm. Vajner	1,165	31	89	Ss	Ber	38	8–21–46			Dr		5	D	
18		J. Novatney	1,172	32	86	Ss	Ber	30	5–27–49	10		Dr		5	D	L
19		E. Surman	1,179	29	87	Ss	Ber	38	7–10–48	10	2	Dr		5	D	
20	159	Frank Picone	1,240	34	101	Ss	Ber	55	8–27–46	10	30	Dr		5	D	
21	156	Frank Picone	1,240	34	108	Ss	Ber	60	10–19–46			Dr		5	D	L
22	65	S. Pence	1,040	126	127	Ss	Ber			12		Dr			D	
23	168	Ray Falarski	1,210	19	88	Ss	Shar	17	1–18–47	10	11	Dr		5	D	
24	554	Standard Oil Co.	1,078	50	205	Ss	Ber	105	9– 2–49	10	35	Dr		5½	I	L
25	541	Robt. Stern, Jr.	1,010	142	175	Ss	Ber	75	4–20–49	5	100	Dr		5½	D	
26	63	Stevens	1,204	44	96	Ss	Shar			20		Dr			D	L
27	646	Frank Daley	1,219	49	72	Ss	Shar	35	3–13–50	5	5	Dr	Hand	5½	D	
29		John Antat	1,218	58	62	Ss	Shar	40	6–29–50	5		Dr		5½	D	
30	157	Frank Tretera	1,229	39	100	Ss	Shar	42	10– –46	10		Dr		5	D	L
31		E. Kopecky	1,160	25	77	Ss	Shar	24	7–23–48			Dr		5	D	L
32	540	Steve Preszichen	1,075	85+	85	S & G	Gla	55	5– 9–49	5		Dr		5½	D	L
33		E. J. Howrath	1,160	0	66	Ss	Shar	16	8–28–47	16	6	Dr		5½	D	L
34	205	Joe Melvald	1,239	19	97	Ss	Shar	42	10– 4–47	10	50	Dr		5½	D	L
35		D. D. Hinman	1,230	60	85	Sh	Cuy	32		12	35	Dr		5½	D	L
36		M. DePavla	1,203	16	72	Ss	Shar	18	5–25–50	10	7	Dr		5½	D	L
37		H. J. Thomas	1,179	39	55	Sh	Cuy	10	1– 5–48	5	25	Dr		5½	D	L
38		J. F. Hosken	1,140	18	75	Sh	Cuy	25	5–19–50	9		Dr		5½	D	L
39		J. E. Thomas	1,100	185	250	Ss	Ber	125	9– 7–49	1½	105	Dr		5½	D	L
40		J. Hudec	1,168	9	46	Ss	Shar	8	6–12–50	10		Dr		5½	D	L
41		Geo. Humpal	1,190	0	50	Ss	Shar	8	5–26–50	2	20	Dr		5½	D	L,A
42	302	Ralph Harrington		12	195	Ss	Ber	85	6–11–48	2½	35	Dr	Hand	5½	D	
43		Neighborhood Settlement Assn.	1,040	31	195	Ss	Ber	95	10–19–48	2½	85	Dr		5½	D	L
44	303	R. Kinerson	1,080	25	200	Ss	Ber	85	5–27–48	2	45	Dr	Hand	5½	D	
45		F. Benes	1,100	48	200	Ss	Ber	95	3–28–47	2½	70	Dr		5½	D	L
46		A. Woolert	1,060	7	180	Ss	Ber	173	6–22–50	3		Dr	Hand	5½	D	L
47			1,060	18	29	Sh	Cuy	14	3–31–51			Dr	Hand	5½	D	
48	627	Walter Hughes	1,061	11	100	Sh	Cuy	12	1–11–50	3		Dr		6¼	D	L
49	80	F. Skrinjar	1,120	92	158	Ss	Ber			3		Dr			D	L
50	4	D. O. Summers	1,100	31	67	Sh	Cuy					Dr			D	
51	590	P. Morgan	1,100	12	250	Ss	Ber	155	8– 1–49			Dr		5½	D	L
52	777	W. T. White	800	44	430	Sh	P-B	105	5– 1–50	1	35	Dr		5½	D	L
53		W. W. Peresmeyer	1,020	80	107	Ss	Ber	50		15	10	Dr		5½	D	L
54		B. D. Seidel	1,070	38	182	Ss	Ber	115	10–19–29	2	55	Dr		5½	D	L
55	728	R. J. Leavitt	1,080	75+	75	S & G	Gla	35	6–19–50	3		Dr	Hand	5½	D	L

TABLE 21 (Continued). RECORDS OF WELLS AND RESISTIVITY MEASUREMENTS IN ORANGE TOWNSHIP

N	File No. (Ohio Division of Water)	Owner or name	Elevation at well (feet above sea level)	Depth to bedrock (feet)	Depth of well (feet)	Principal water-bearing bed: Character of material	Principal water-bearing bed: Geologic horizon	Water level: Below land surface (feet)	Water level: Date	Yield: Rate (g.p.m.)	Yield: Drawdown (feet)	Type of well	Type of pump	Diameter of well (inches)	Use	Remarks
56	593	Lloyd Nelson	1,090	107+	107	G	Gla	65	8–23–49	9	5	Dr		5½	D	L
57		E. Paynton	1,120	99	135	Ss	Ber			30	60	Dr		8	D	L
58	623	Roy Brown	1,085	112+	112	S & G	Gla	60	9– 3–49	5		Dr		5½	D	L
59		Robert Stern	1,000	22	248	Ss	Ber	25	12– 5–49	5	175	Dr			D	L
60		A. A. Hutton	1,070	29	225	Ss	Ber	85	1–16–50	3		Dr		5½	D	L
61		G. W. Hauth	1,070	23	105	Sh	Cuy	12	5– 8–50	8	62	Dr		5½	D	
62	102	A. B. Rothschul	1,040	106	143	Sh	Cuy					Dr			D	
63		J. Wilker	1,040	130	143	Ss	Ber	85	2–28–50	8		Dr		5½	D	L
64		W. S. Parker	1,040	130	160	Sh	P-B	75	6– 2–49	1	55	Dr		5½	D	L,A
65		J. B. Lewis	1,040	196	212	Ss	Ber	65	10–22–46	12	55	Dr		6	D	L
66		C. H. Fisher	1,075	170+	170	G	Gla	56	10–22–46	12	65	Dr		6	D	L
67		A. Schreibman	1,075	222+	222	S & G	Gla	63	12– –46	6	57	Dr		6	D	L
68		J. Bodig	1,170	54	85	Ss	Ber	28	6– 9–50	14	8	Dr		5½	D	
69		D. Petrilli	1,165	42	69	Ss	Shar	24	9– 3–46	10		Dr		5	D	L
70		P. Trombitas	1,140	50	81	Ss	Shar	20	9– 6–46	10	9	Dr			D	L
71		Mrs. E. Wander	1,140	42	52	Ss	Shar	26	11–29–49	15	1	Dr		5½	D	
72		Jas. Risko	1,165	12	65	Sh	Cuy	14	8–20–48	36	14	Dr		5½	D	L
73	206	Rebell	1,200	41	84	Ss	Ber	15	7–24–47	15	4	Dr		5	D	L
74		O. D. Clark	1,160	4	175	Ss	Ber	125	8–21–50	3		Dr		5½	D	L
75		J. C. Robbins, Jr.	1,120	27	75	Sh	Cuy	21	2–12–51	5		Dr		5½	D	
76		S. B. Ketchum	1,100	28	120	Ss	Ber	90	2–26–51	5		Dr		5½	D	L
77		H. E. Kinsey	1,065	175	210	Ss	Ber	50	8–15–50	2		Dr		5½	D	L,A
78		J. B. Skuse	1,040	173	250	Sh	P-B	165	3–12–51	½		Dr		5½	D	L
79		E. Becka	1,065	41	140	Sh	Cuy	40	2–14–51	3		Dr		5½	D	L
80		J. A. Lima	1,230	28	80	Ss	Shar	30	4– 5–51	6		Dr		5½	D	L
81		A. Miklos	1,185	65	85	Ss	Ber	43	11– 2–50	5	22	Dr		5½	D	L
82		F. Novak	1,228	25	92	Ss	Shar	32	6–24–50	14	8	Dr		5½	D	
83		J. Bochick	1,160	28	64	Ss	Shar	20	6–20–47	10		Dr		5½	D	
84		H. Bruck	1,160	3	60	Ss	Shar	6	8– 1–50	14		Dr		5½	D	
85		V. Kolosinski	1,160	32	70	Ss	Shar	38	11–30–48	10		Dr		5	D	L
87		V. Kolosinski	1,160	48	82	Ss	Shar	11	3–16–50	14	9	Dr		5	D	L
88		S. Pietrzyk	1,160	63+	63	S	Gla	13	7–19–50	10		Dr		5	D	
89		J. Lazor	1,140	63+	63	S	Gla	36	5– 9–51	8	14	Dr		5½	D	
90		A. E. Boals	1,140	98+	98	S	Gla	36	8–11–50	10	6	Dr		4	D	
91		A. Wehler	1,130	50	110	Sh	Cuy					Dr		4	D	
92		R. Lunn	1,160	74	104	Sh	Cuy	22	8–19–47	3		Dr		5	D	L
94		E. J. Pinta	1,205	22	60	Ss	Shar	22	8–27–48	12		Dr		5½	D	L
95		S. Nemeth	1,230	20	80	Ss	Shar	20	7–11–50	14	44	Dr		5½	D	L
96		L. E. Good	1,230	31	82	Ss	Shar	32	3– 8–50	14	20	Dr		5½	D	
97		Louise Killian	1,100	40	80	Sh	Cuy	10	6–21–51	5		Dr		5½	D	L,A
98		F. R. Csziazko	1,080	89	140	Ss	Ber	52	6– 4–51	5	38	Dr		5½	D	L
99		A. W. Richards	1,000	60	90	Sh	P-B					Dr			D	L
100		West Hill Colony	1,040	115	125	Ss	Ber	Flow				Dr			P	Not used. L
101		West Hill Colony	980	66	126	Ss	Ber	Flow		35		Dr			P	L
102		B. W. Smith	1,030	207+	207	S & G	Gla			10		Dr			D	
103		A. L. Sackett	1,120	85	117	Ss	Ber			5		Dr			D	L
104		Pepper Pike Club	1,000	56	56	Ss	Ber	Flow		5		Dr		8	D	
105		M. Steno	1,100	48	81	Sh	Cuy	13	9–28–51	14	20	Dr		5½	D	
106	688	Helmer Nelson	1,155	84+	84	S & G	Gla	28	5– 6–50	5		Dr		5½	D	
107		E. M. Hodgeman	1,070	95	150	Ss	Ber	75	3–26–51	27	10	Dr	Hand	5½	D	L
401			1,093	110					8– –51							R
402			1,088	270					8– –51							R
403			1,001	260					8– –51							R
404			820	225					8– –51							R

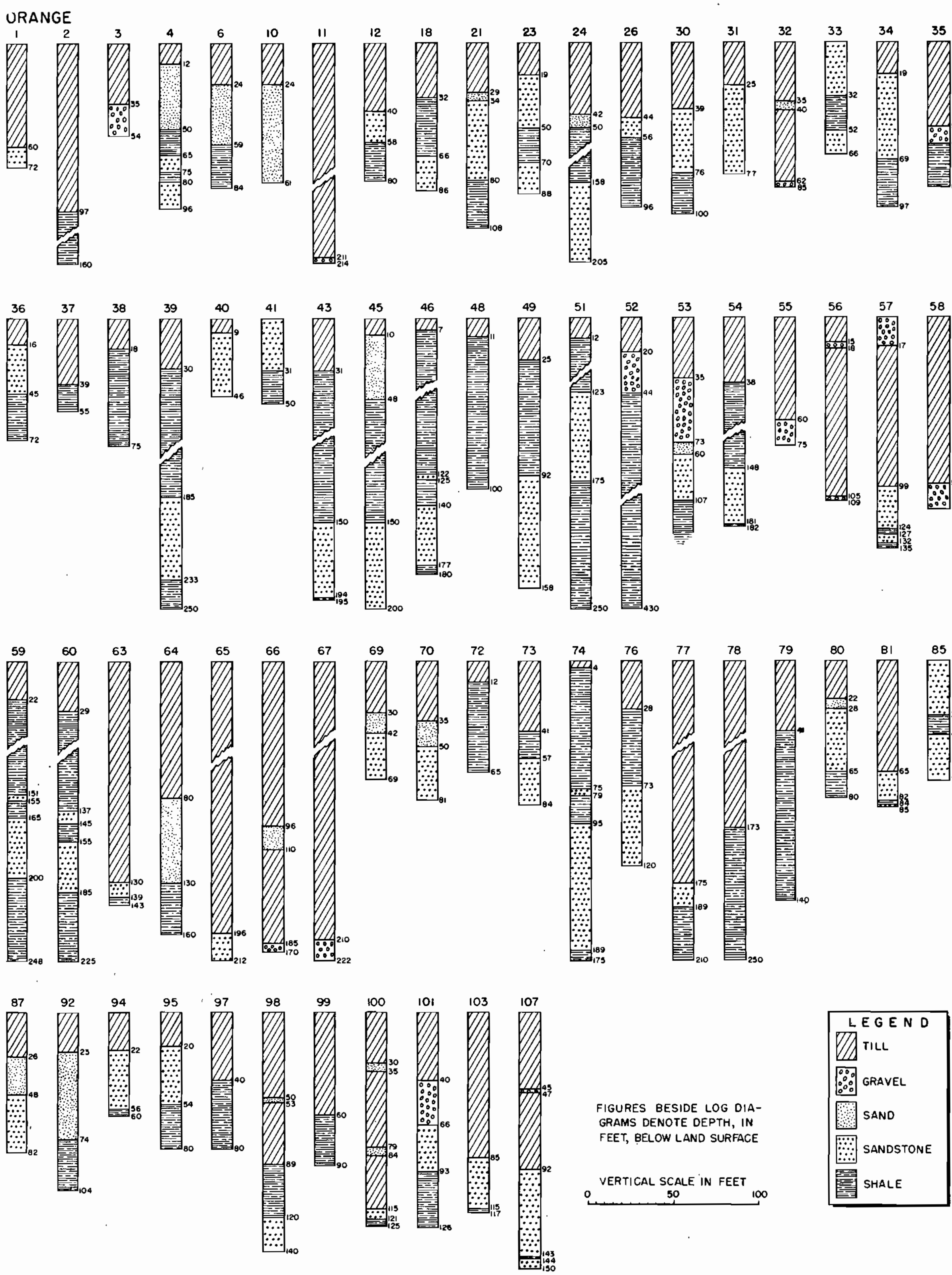


Plate 50. Logs of wells in Orange Township.
[Well numbers refer to locations shown on plate 49.]

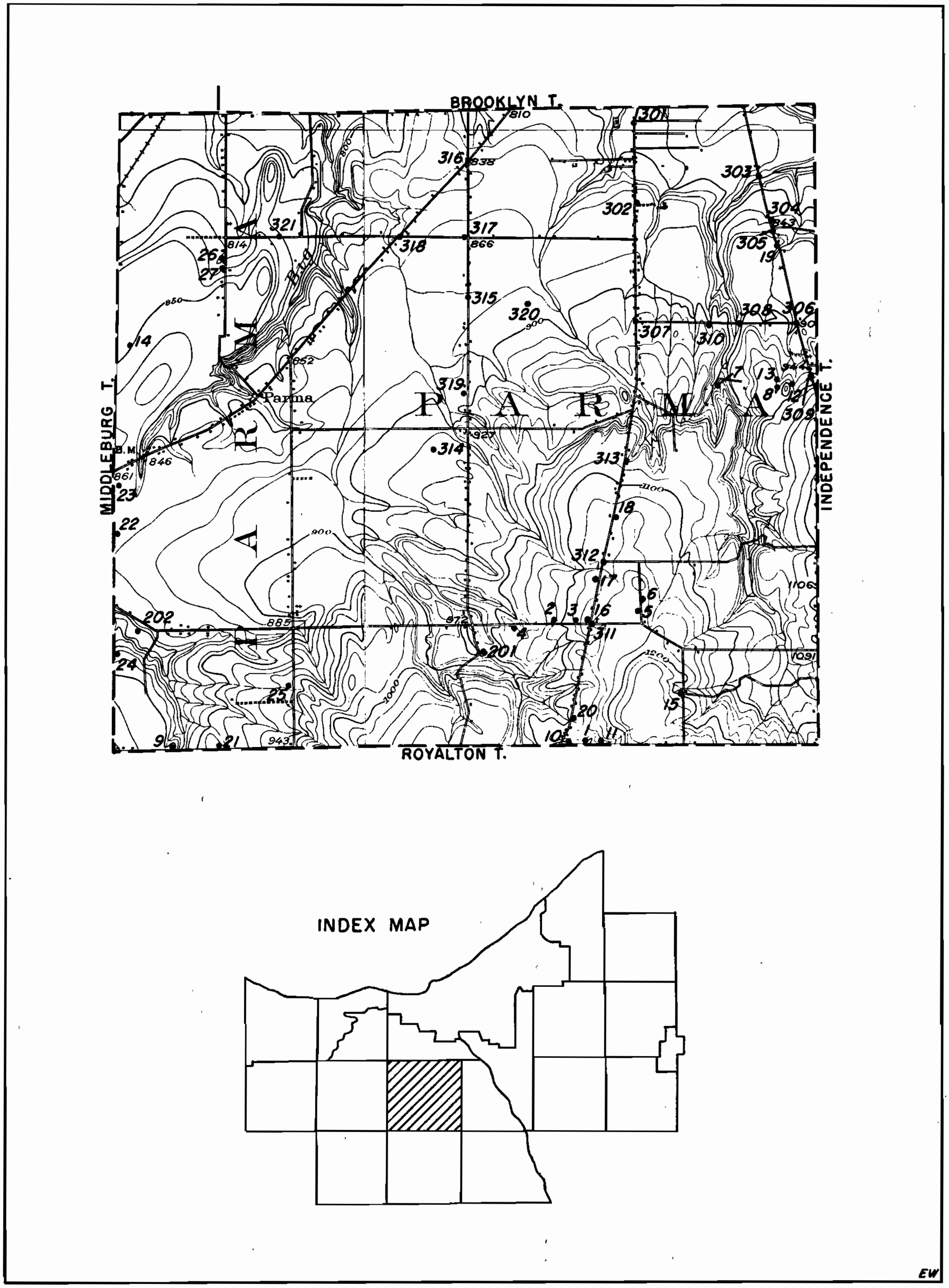


Plate 51. Map showing location of wells in Parma Township.

TABLE 22. RECORDS OF WELLS IN PARMA TOWNSHIP

No.	File No. (Ohio Division of Water)	Owner or name	Elevation at well (feet above sea level)	Depth to bedrock (feet)	Depth of well (feet)	Principal water-bearing bed: Character of material	Principal water-bearing bed: Geologic horizon	Water level: Below land surface (feet)	Water level: Date	Yield: Rate (g.p.m.)	Yield: Drawdown (feet)	Type of well	Type of pump	Diameter of well (inches)	Use	Remarks
1		W. Enderlein	1,100	45	95	Sh	Cuy	30	4- -50	1		Dr		6½	D	L
2	272	G. Sheffner	1,080	20	100	Sh	Cuy	30	2-19-48	3		Dr		6	D	L
3	191	C. Sanderson	1,120	18	100	Sh	Cuy	80	10-10-46	2		Dr		5	D	
4		C. Kokora	1,020	0	119	Sh	Cuy	22	2- -50			Dr		5½	D	
5	510	M. Yerga	1,170	15	75	Sh	Cuy	5	5-13-49	2		Dr		6½	D	L
6	760	J. Nedla	1,170	15	95	Sh	Cuy	25	11- -49	1		Dr		6½	D	
7	711	Claude Harrison	930	6	20	Ss	Ber	2	6- -50	30		Dr		5½	D	
8	725	W. Cleveland Veterans Post #301	980	16	40	Ss	Ber	15	6- -50	15	5	Dr		5½	D	L,A
9	634	E. V. Blaessle	900	50	155	Ss	Ber			2½		Dr		5½	D	L
10		Ruel Elwin	1,100	35	102	Sh	Cuy	30	10-16-50	5		Dr		6½	D	
11		Walter Johansson	1,130	20	80	Sh	Cuy	10	10- 7-50	3		Dr		6½	D	
12		V. McGavin	980	8	73	Ss	Ber	20	8-13-48	1		Dr	Hand	6	D	L
13	412	S. Kraugh	970	20	50	Ss	Ber	10	4-20-48	2	38	Dr	Hand	5	D	L
14	422	G. Bruck	848	20	24	Ss	Ber	3	5- 6-49	1½	1½	Dr		5½	D	L
15		Ukranan Grove	1,200	50	300			29	4-27-51			Dr	Jet	5½	D	
16		F. Malott	1,150	25	78			1	5- 1-51			Dr	Hand	6	D	
17		M. Gottdiner	1,130	16+	16	Un	Gla	11	5- 1-51			Dug	None	60	D	
18		Hoehn	1,130	28+	28	Un	Gla	8	5- 1-51			Dug	None	60	D	
19		St. John's Picnic Grove	890	23+	23	Un	Gla	11	5- 1-51			Dug	Hand	60	D	
20		Mishko	1,100	12+	12	Un	Gla	3	5- 1-51			Dug			D	
21		Harry Black	910	68+	68	G	Gla			10		Dr		5½	D	
22		Buchko	868	50	80							Dr	Jet		D	
23		T. F. Shannon	860	35	35			20	5- 3-51			Dr		5½	D	
24		Roy Billow	885	35	130	Ss	Ber	40	8-22-51	4		Dr	Jet	5½	D	L
25		Dawson	940	12+	12	Un	Gla	3	5- 3-51			Dug	Hand		D	
26		Novak	820	7+	7	Un	Gla	2	5- 3-51			Dug	Lift		D	
27		Semenak	830	16	29			3	5- 3-51			Dr	Jet		D	
201			990	21								Dr		10	G	
202			850	51								Dr		10	G	
301			790	4		Sh	P-B					Dr				Test hole.
302			865	8		Ss	Ber					Dr				Test hole.
303			760	18		Sh	P-B					Dr				Test hole.
304			840	7		Sh	P-B					Dr				Test hole.
305			859	1		Sh	P-B					Dr				Test hole.
306			900	5		Sh	Cuy					Dr				Test hole.
307			925	7		Sh	Cuy					Dr				Test hole.
308			890	3		Ss	Ber					Dr.				Test hole.
309			970	5		Sh	Cuy					Dr				Test hole.
310			905	2		Sh	Cuy					Dr				Test hole.
311			1,155	10		Sh	Cuy					Dr				Test hole.
312			1,125	8		Sh	Cuy					Dr				Test hole.
313			1,063	8		Sh	Cuy					Dr				Test hole.
314			925	6		Sh	Cuy					Dr				Test hole.
315			875	6		Ss	Ber					Dr				Test hole.
316			840	2		Ss	Ber					Dr				Test hole.
317			866	2		Ss	Ber					Dr				Test hole.
318			840	4		Sh	P-B					Dr				Test hole.
319			890	4		Ss	Ber					Dr				Test hole.
320			890	2		Ss	Ber					Dr				Test hole.
321			822	7		Sh	P-B					Dr				Test hole.

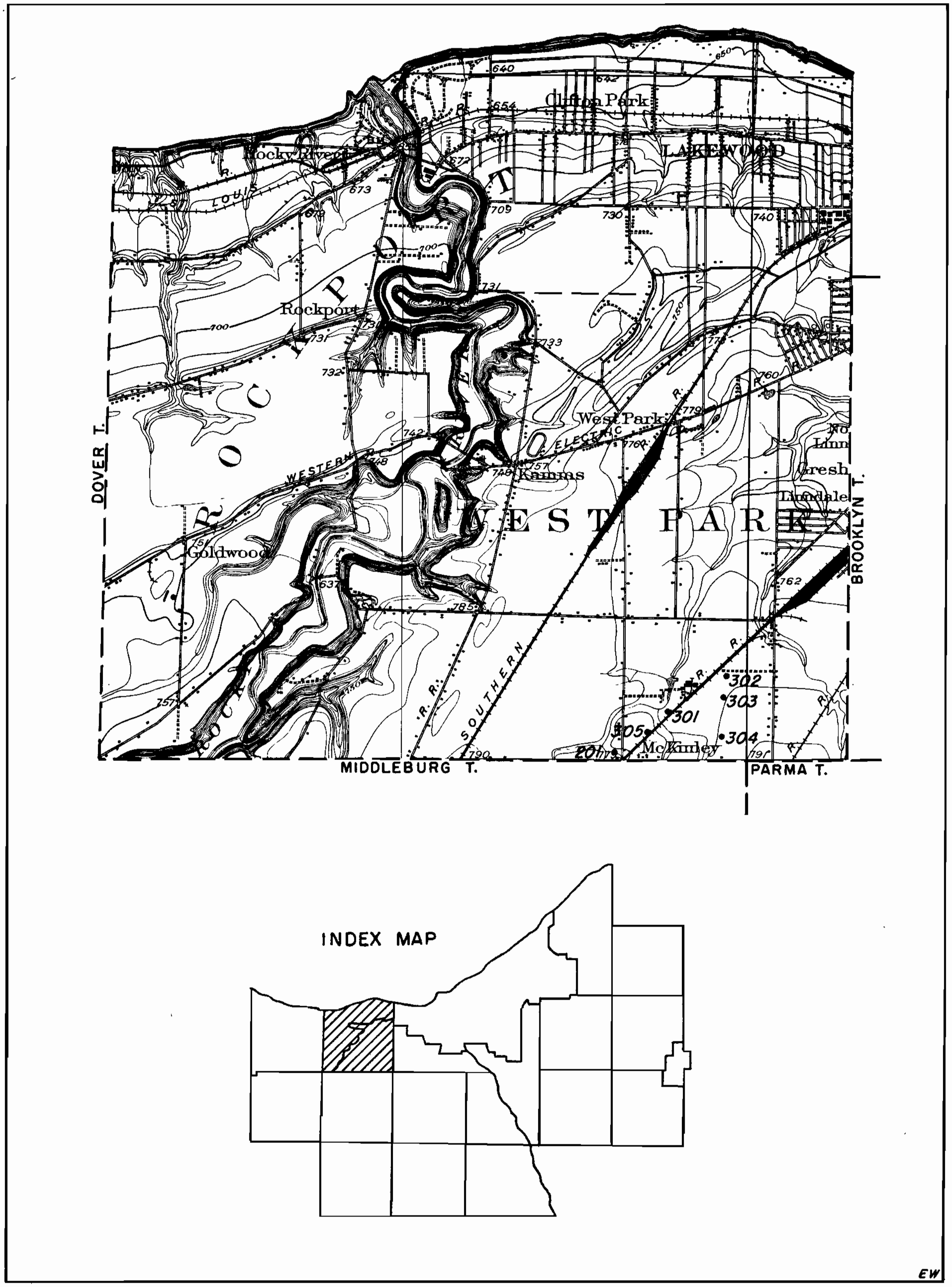


Plate 52. Map showing location of wells in Rockport and West Park Townships.

TABLE 23. RECORDS OF WELLS AND A RESISTIVITY MEASUREMENT IN ROCKPORT AND WEST PARK TOWNSHIPS

No.	File No. (Ohio Division of Water)	Owner or name	Elevation at well (feet above sea level)	Depth to bedrock (feet)	Depth of well (feet)	Principal water-bearing bed: Character of material	Principal water-bearing bed: Geologic horizon	Water level: Below land surface (feet)	Water level: Date	Yield: Rate (g.p.m.)	Yield: Drawdown (feet)	Type of well	Type of pump	Diameter of well (inches)	Use	Remarks
1		A. Blasing	750	45	85	Sh	P-B					Dr	Hand	5½	D	L,A
201		May Wensik	880	130								Dr		8	G	
301			778	11		Sh	P-B					Dr				Test hole.
302			778	15		Sh	P-B					Dr				Test hole.
303			779	13		Sh	P-B					Dr				Test hole.
304			782	19		Sh	P-B					Dr				Test hole.
305			782	15		Sh	P-B					Dr				Test hole.
401			694	120					8- -51							R

The shale formations are poor sources of ground water and few shale wells yield as much as 3 gallons per minute, regardless of the depth to which they are drilled.

Few wells are reported in Rockport and West Park Townships because the Cleveland water system services the greater part of the area.

Records of wells in Rockport and West Park Townships are shown in table 23; the locations of the wells are shown on plate 52. The logs of some of the wells are shown on plate 54.

ROYALTON TOWNSHIP

The Sharon conglomerate and the shales of the Cuyahoga group are exposed beneath a thin cover of glacial till in Royalton Township. The Berea sandstone and the underlying shale formations crop out along the walls of the buried channel of the Rocky River, which underlies the southwestern part of the township.

Wells in the Sharon yield as much as 15 gallons per minute and wells drilled in the Cuyahoga group yield as much as 70 gallons per minute, although most wells in either the Sharon or the Cuyahoga yield 5 to 10 gallons per minute. Wells in the Berea sandstone yield as much as 25 gallons per minute. No water wells are reported in the formations that underlie the Berea sandstone.

The buried valley deposits are predominantly till and clay, but they contain some gravel lenses. Wells that have penetrated these lenses yield as much as 30 gallons per minute. The till and clay deposits do not yield water.

Records of wells in Royalton Township are shown in table 24; the locations of the wells are shown on plate 53. The logs of some of the wells are shown on plate 54.

SOLON TOWNSHIP

Solon Township is underlain by parts of two buried-valley systems, as is shown on plate 1. The glacial drift is thick in the buried valleys, especially along the eastern margin of the township where thickness exceeds 500 feet.

Sand and gravel lenses occur in the buried valleys, but in Solon Township they are deeply buried (100 to 200 feet or more) and it is not possible to determine their location except by drilling. Gravel is reported in the logs of wells in the northwestern corner of the township. Earth-resistivity measurements indicate 200 feet of clay or till covering 300 feet of sand and gravel near the intersection of Liberty and Bainbridge Roads. Two wells in that vicinity encountered water-bearing gravel at about 200 feet, which partly bears out the analysis of the resistivity measurements.

The Sharon conglomerate, the shales and interbedded sandstones of the Cuyahoga group, the Berea sandstone, and the formations below the Berea sandstone, crop out beneath a thin cover of glacial drift and along the walls of the buried valleys. Domestic wells in the Sharon yield as much as 10 gallons per minute, and similar wells in the Cuyahoga group yield 5 to 10 gallons per minute. The Berea sandstone yields up to 20 gallons per minute to domestic wells. An 8-inch well drilled into the Berea sandstone at Glenwillow, for the Wheeling and Lake Erie Railroad, yields 250 gallons per minute. This yield indicates the water possibilities of the Berea sandstone where large pumps can be used. No wells in Solon Township penetrate the formations below the Berea sandstone.

Records of wells in Solon Township are shown in table 25; the locations of the wells are shown on plate 55. The logs of some of the wells are shown on plate 56.

STRONGSVILLE TOWNSHIP

The buried valley of the Rocky River underlies the northeastern quarter of Strongville Township in a northwest-southeast direction. The glacial drift in the township averages about 10 feet in thickness, except in the buried valley where it may exceed 500 feet. Although the material filling the buried valley is predominantly silt

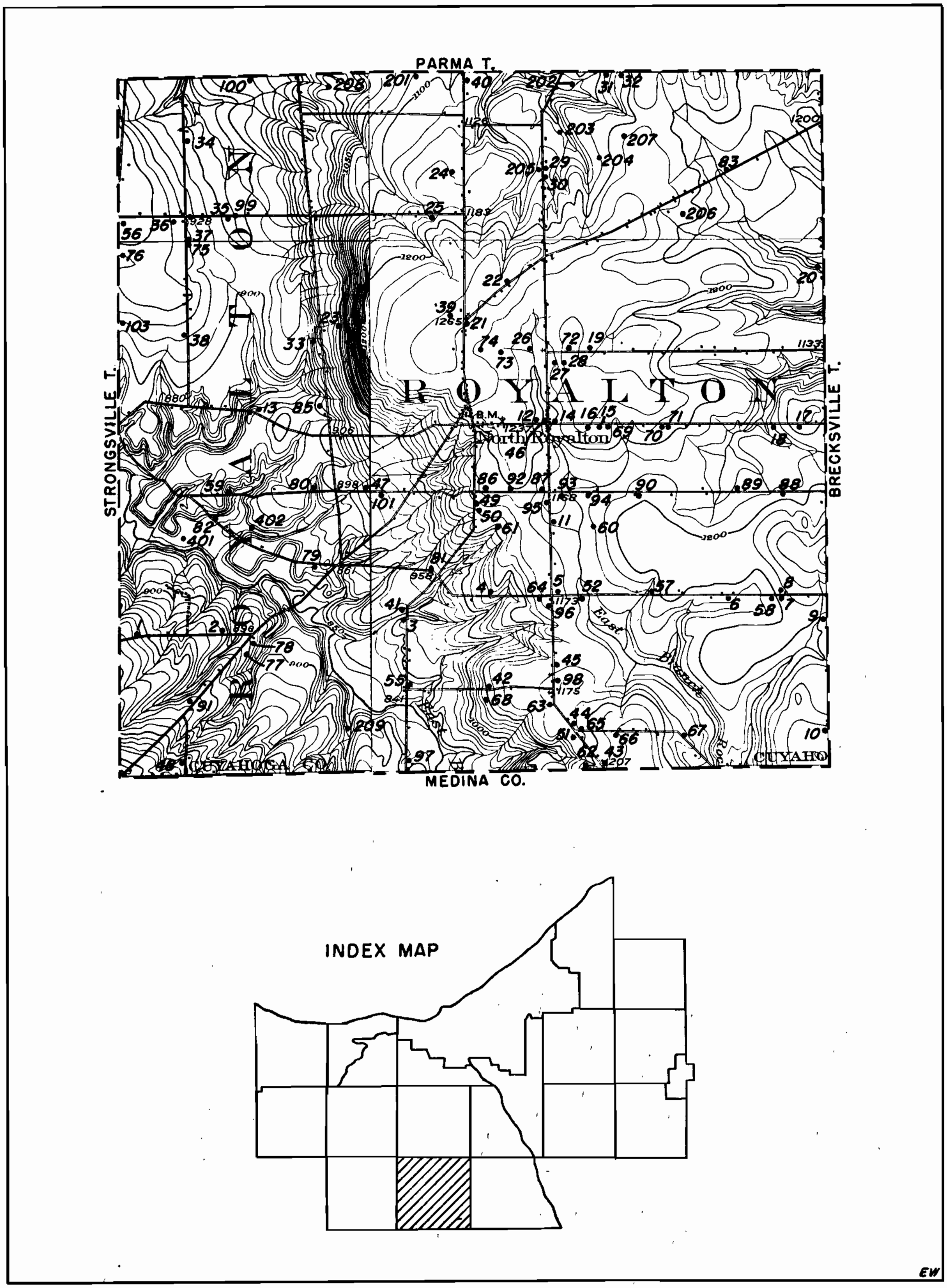


Plate 53. Map showing location of wells in Royalton Township.

TABLE 24. RECORDS OF WELLS AND RESISTIVITY MEASUREMENTS IN ROYALTON TOWNSHIP

No.	File No. (Ohio Division of Water)	Owner or name	Elevation at well (feet above sea level)	Depth to bedrock (feet)	Depth of well (feet)	Principal water-bearing bed: Character of material	Principal water-bearing bed: Geologic horizon	Water level: Below land surface (feet)	Water level: Date	Yield: Rate (g.p.m.)	Yield: Drawdown (feet)	Type of well	Type of pump	Diameter of well (inches)	Use	Remarks
1	768	C. Vaughn	950	12	275	Ss	Ber	95	6– –50	4		Dr		6½	D	L,A
2	253	E. F. Mason	910	15	65	Sh	Cuy	5	12–29–47	3		Dr		5½	D	A
3	353	G. Medas	920	140	163	Ss	Ber	15	9– 8–48	5		Dr		6½	D	L
4	502	C. Kuchle	1,070	100+	100	G	Gla	35	7–11–48	3		Dr	Jet	6½	D	L
5	327	Joe Drab	1,175	160+	160	S	Gla	40	7– –48			Dr		5	D	L
6	521	F. J. Villwock, Sr.	1,185	95	105	Sh	Cuy	34	3–21–51	8	55	Dr		6½	D	L
7	556	G. Kofskey	1,205	55	75	Sh	Cuy	18	8– 5–49	10	40	Dr		5¼	D	L
8	325	G. R. Miller	1,210	73+	73	Sh	Cuy	17	6–24–48	6	50	Dr		5¼	D	L
9	210	J. F. McClaren	1,200	40	48	Ss	Shar	8	10– –47	15	10	Dr		5½	D	L
10	154	P. Gynn	1,240	40	66	Ss	Shar	32	8– –46	13	3	Dr		7	D	L
11	235	M. R. Chahas	1,150	92+	92	S & G	Gla	40	5– 5–47	10		Dr	Hand	6	D	L
12	237	G. Simandt	1,190	50	70	Ss	Shar	1	3–21–51	10		Dr	Jet	5½	D	L
13	142	Soph & Habert	890	96	160	Ss	Ber	100	4–18–46	15		Dr		5½	D	L
14	395	E. Bassett	1,200	38	73	Sh	Cuy	4	3–21–51	5	30	Dr		5	D	L
15	443	D. A. Halupka	1,235	70	85	Ss	Ber					Dr		5½	D	L
16	236	Tom Cirach	1,240	60	115	Sh	Cuy	12	6– –50			Dr	Jet	6½	D	L
17	700	A. Chualenski	1,210	10	130	Sh	Cuy	24	3–21–51			Dr	Jet	5¼	D	L
18	379	V. Hodapp	1,180	63	111	Sh	Cuy	21	5–17–48	6	54	Dr		5	D	L
19	518	A. Niksich	1,235	18	50	Ss	Shar	6	3–21–51			Dr	Hand	5½	D	L
20	232	E. Kahonn	1,100	48	98	Sh	Cuy	40	8–26–47	6		Dr		5½	D	L
21	275	E. Olsen	1,260	52	69	Ss	Shar	25	3–27–48	7		Dr		6	D	L
22	208	R. A. Grumbling	1,265	60	80	Sh	Cuy	52	11–11–47			Dr		5¼	D	L
23	355	H. Suitclifte	1,000	11	76	Sh	Cuy	50	8–21–48	3		Dr		6	D	L
24	298	Cleve. Brodcasting Co.	1,160	26	80	Sh	Cuy	70	5– 3–48	8		Dr		6	D	L
25	346	Arthur Woika	1,180	10	100	Sh	Cuy	10	8– 7–48	1		Dr		5¼	D	L
26	188	H. E. Robb	1,215	35	44	Sh	Cuy	40	9–20–46	10		Dr		6	D	L
27	277	R. J. Kliment	1,240	51	72	Sh	Cuy	25	3– 4–48	5		Dr		5½	D	L
28	276	R. J. Kliment	1,220	49	75	Sh	Cuy	25	3– 8–48	10		Dr		5½	D	L
29	519	P. Klepacz	1,160	54+	54	S & G	Gla	15	7–19–49	10	30	Dr	Jet	6½	D	L
30	520	G. Legg	1,160	52	65	Sh	Cuy	22	7–22–49	3	39	Dr		6½	D	L
31	500	L. Ford	1,120	70	90	Sh	Cuy	39	3–22–51	2		Dr		6½	D	L,A
32	499	D. Diluzio	1,170	48+	48	S & G	Gla	8	6– –50	15	14	Dr		5½	D	L
33	577	E. B. Kuonen	920	185	203	Ss	Ber	55	7–22–49	25	75	Dr		6½	D	L
34	418	C. E. Haga	895	12	305	Sh	Cuy	2	5–14–49	5	2	Dr		5½	D	L
35	678	L. Janke	897	67+	67	S	Gla	30	4–16–50			Dr		5½	D	L
36	565	J. D. McGough	940	10	60	Sh	Cuy					Dr	Jet	5	D	L
37	503	C. Atwell	930	20	50	Sh	Cuy	10	4– 9–49	5		Dr	Jet	6½	D	L
38	653	N. E. Guther	920	75	209	Ss	Ber	35	3–15–50	10		Dr		5½	D	L
39	274	L. L. Sharp	1,260	18	45	Ss	Shar	22	2–23–48	5		Dr	Jet	6	D	L
40	501	M. Maxin	1,105	15	64	Sh	Cuy	20	6–27–49	4		Dr		5½	D	L
41	755	R. J. Eckstein	900	165	170			20	6– –50	15	60	Dr	Jet	5½	D	L
42	604	T. J. Andel	1,000	16	72	Sh	Cuy	50	6–10–49	5		Dr	Hand	6	D	L
43	344	M. Opsince	1,220	28	91	Sh	Cuy	18	6–28–48	25	50	Dr	Jet	6½	D	L
44	439	G. I. Dunkel	1,180	8	35	Sh	Cuy	8	5–21–49	7	15	Dr		5¼	D	L
45	354	Steve Kulez	1,155	30	103	Sh	Cuy	26	8–19–48	25	50	Dr	Jet	5½	D	L,A
46	231	F. Hanesek	1,190	34	60	Ss	Ber	1	3–27–51	3		Dr		5½	D	L
47	420	L. LaFord	910	191+	191	G	Gla	100	12–21–48	5		Dr		5	D	L
48	387	Art Tunske	980	15	31	Sh	Cuy	24	9–21–48	4		Dr		6	D	L
49	356	A. G. Benzle	1,150	60	100	Sh	Cuy	80	9– 3–48			Dr		6	D	L
50	234	C. Sawer	1,140	60	91	Sh	Cuy	60	10– 7–47	5	20	Dr		6	D	L
51	406	A. Bihan	1,170	22	170	Sh	Cuy	150	6–21–48	3		Dr		5	D	L
52	343	W. E. Munshower	1,135	80	129	Sh	Cuy	20	6–18–48	3		Dr		6½	D	L
55		J. Dendorfer	880	104+	104	S	Gla	30	3–28–51			Dr		6½	D	L
56		S. Ryda	955	8	12	Sh	Cuy	4	3–30–51			Dr	Lift		P	L

TABLE 24 (Continued). RECORDS OF WELLS AND RESISTIVITY MEASUREMENTS IN ROYALTON TOWNSHIP

No.	File No. (Ohio Division of Water)	Owner or name	Elevation at well (feet above sea level)	Depth to bedrock (feet)	Depth of well (feet)	Principal water-bearing bed: Character of material	Principal water-bearing bed: Geologic horizon	Water level: Below land surface (feet)	Water level: Date	Yield: Rate (g.p.m.)	Yield: Drawdown (feet)	Type of well	Type of pump	Diameter of well (inches)	Use	Remarks
57		C. O. Hibbard	1,180	52	90	Sh	Cuy	23	9- 7-50	5		Dr		5½	D	L
58		M. Kofskey	1,200	75	86	Sh	Cuy	20	10-13-50	4		Dr		6½	D	L
59	671	G. Desoffy	880	292+	292	G	Gla	70	4- 7-50			Dr		5½	D	L
60		L. Deming	1,160	80	140	Sh	Cuy	35	7- -50	2		Dr	Hand	6½	D	L
61		Ken Ross Borough	1,100	125+	125	S	Gla	40	3-10-50			Dr		5½	D	L
62		A. Sindelar	1,112	46	112	Sh	Cuy	25	5-17-50	3		Dr		6½	D	L
63	440	P. T. Bettey	1,165	15	75	Sh	Cuy	20	5-19-49	2	40	Dr		5¼	D	L
64		Ralph McConnell	1,160	112	153	Sh	Cuy	65	3-15-50	3		Dr		6½	D	L
65		A. F. Tacnik	1,180	20	40	Sh	Cuy	32	9- 7-48	15		Dr		6	D	L
66		H. Heckendorf	1,230	26	60	Ss	Shar	20	12- 4-47	8		Dr	Hand	6	D	L
67		J. E. Jerman	1,160	90+	90	G	Gla	50	12- 6-47	20		Dr		6	D	L
68		L. Sustensick	1,080	17	70	Sh	Cuy	42	7-12-46	3		Dr		6	D	L
69		I. E. Spaling	1,220	48	74	Ss	Ber	8	6-27-47	25		Dr		5	D	L
70		R. P. Krause	1,210	84	97	Sh	Cuy	20	8- 8-50	5		Dr		6½	D	L
71		R. P. Krause	1,210	90	103	Sh	Cuy	20	8-12-50	4		Dr		6½	D	L
72		M. Talishchak	1,242	40	45	Sh	Cuy	20	3- 9-48	50	15	Dr		5½	D	L
73		H. Vandinnik	1,230	30	50	Ss	Shar	45	12- 5-47	15		Dr		5½	D	L
74		A. Schmidt	1,238	48	71	Sh	Cuy	15	7-23-50	2½		Dr		5¼	D	
75		S. Kaschyk	930	10	42	Ss	Ber	38	12- -47	4		Dr		6	D	L
76	593	M. Demko	965	28	36	Sh	Cuy	10	6- -50	5		Dr		5½	D	L
77		C. Slavik	900	66	223	Sh	Cuy	60	3-19-48	70	135	Dr		6½	D	L
78		L. A. Slavik	895	37	60							Dr		5½	D	
80		Geo. Gordon	875	190+	190	Un	Gla					Dr		5½	D	
81			971	5+	5	Un	Gla	3	4-25-51			Dug			D	
82		L. Edgerton	840	19+	19	G	Gla	5	4-25-51			Dug			D	
83		Davidson	1,160	60	65			50	4-26-51			Dr			D	
85		J. Brausil	910	200	210	Ss	Ber					Dr		5½	D	
86		J. Nelich	1,185	56	68			3	4-26-51			Dr	Jet	5½	D	
87		A. Sabo	1,180	66	76	Sh	Cuy	Flow	4-26-51	3		Dr	None	5¼	D	L
88		W. Hartstock	1,190	63	81			12				Dr	Jet	5	D	
89		H. N. Snyder	1,160	78	80			16	1938			Dr	Jet	5½	D	
90		Sellers	1,180		125			3		5		Dr	Jet		D	
91		E. Loeffler	965	40	273							Dr		5	D	
92		R. F. Stiegle	1,200	37+	37	S	Gla	Flow	11- 1-50	15	10	Dr		5¼	D	
93		J. Aron	1,160	100+	100	S & G	Gla	55	10-30-50	12		Dr		5¼	D	L
94		C. Caton	1,155	115+	115	G	Gla	35	10-10-50	1	50	Dr		5¼	D	L
95		G. H. Cahoon	1,162	105+	105	S & G	Gla	55	10-28-50	30	30	Dr		5¼	D	L
96		R. H. Jones	1,160	90+	90	G	Gla	35	8-26-50	6	40	Dr		5¼	D	L
97		J. Buckley	880	55+	55	S	Gla					Dr		5	D	L
98		J. F. Blaha	1,170	29	150	Sh	Cuy	25	9-16-50	1	100	Dr		6½	D	
99		A. Lawson	897	150	175	Ss	Ber	32	8-29-50	5	70	Dr		5¼	D	
100		F. Hussey	918	54+	54	G	Gla	20	6-23-51			Dr		5½	D	L
101		J. W. Keescher	940	163	220	Ss	Ber	80	10-11-51	10	70	Dr		5½	D	L
103		E. Ottenweller	920	170	228	Ss	Ber	85	10-20-50	15	90	Dr		6½	D	L
201		A. Schroeder	1,080	15								Dr		10	G	
202		M. Keller	1,080	78								Dr		10	G	
203		C. & H. Huelaman	1,120	44								Dr		10	G	
204		J. C. Annis	1,180	108								Dr		10	G	
205		H. Mathews	1,140	87								Dr		10	G	
206		J. Ryhak	1,210	43								Dr		10		
207		Newman #1	1,210	94								Dr		10	G	
208		T. Green	990	21								Dr		10	G	
209		E. Swartz	900	290								Dr		8	G	
401			843	96					8- -51							R
402			856	135					8- -51							R

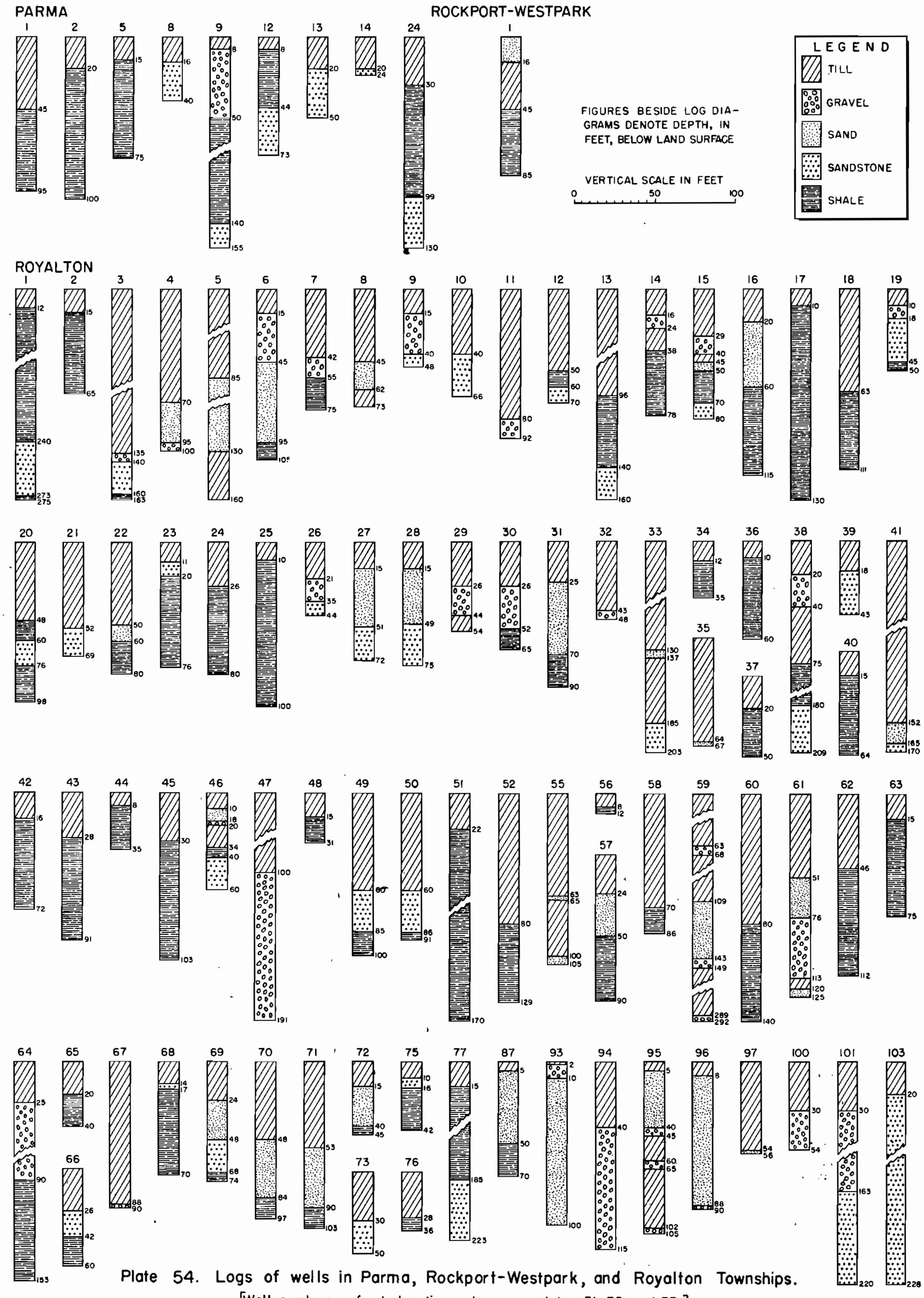


Plate 54. Logs of wells in Parma, Rockport-Westpark, and Royalton Townships.

[Well numbers refer to locations shown on plates 51, 52, and 53.]

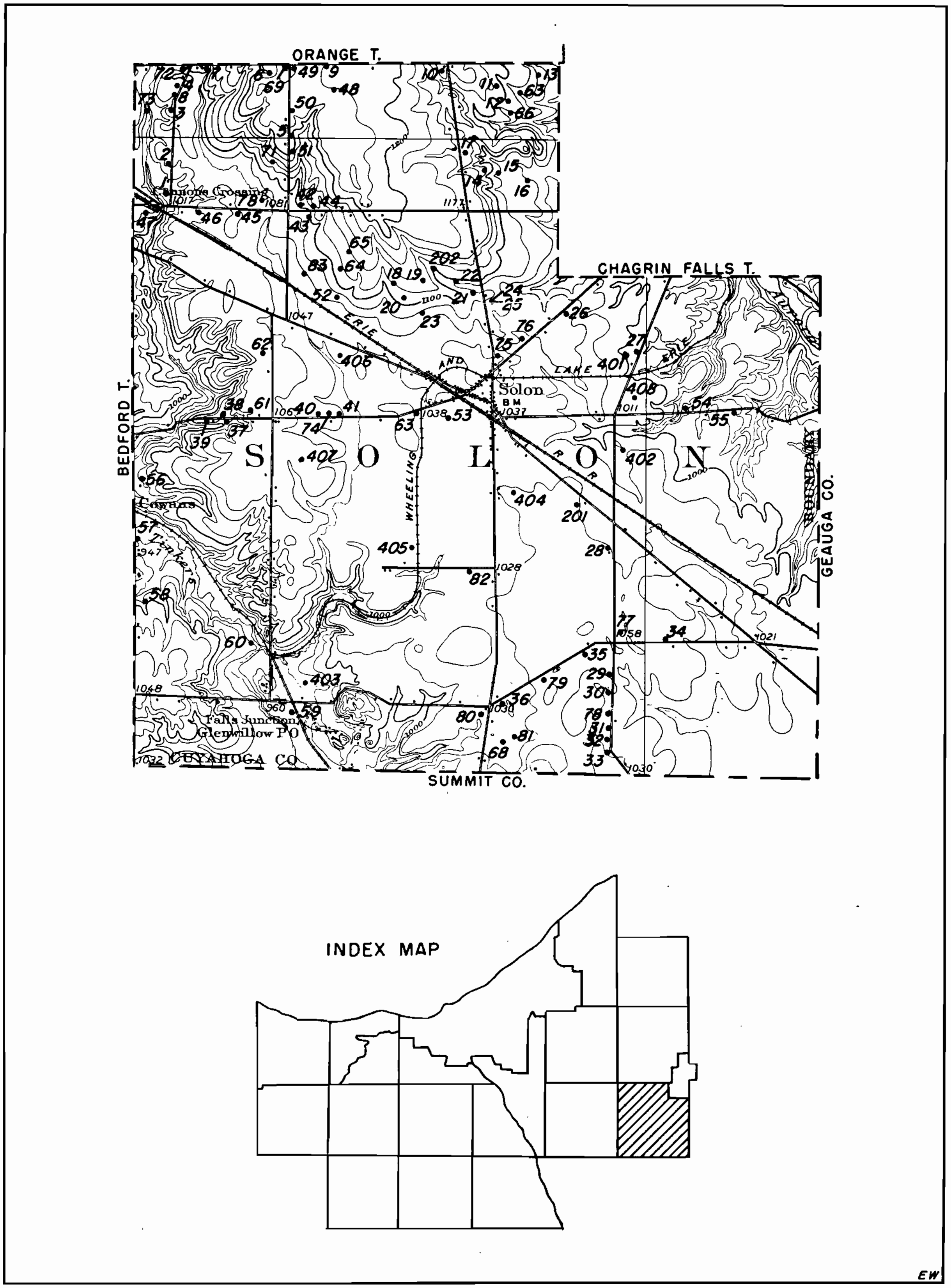


Plate 55. Map showing location of wells in Solon Township.

TABLE 25. RECORDS OF WELLS AND RESISTIVITY MEASUREMENTS IN SOLON TOWNSHIP

No.	File No. (Ohio Division of Water)	Owner or name	Elevation at well (feet above sea level)	Depth to bedrock (feet)	Depth of well (feet)	Principal water-bearing bed: Character of material	Principal water-bearing bed: Geologic horizon	Water level: Below land surface (feet)	Water level: Date	Yield: Rate (g.p.m.)	Yield: Drawdown (feet)	Type of well	Type of pump	Diameter of well (inches)	Use	Remarks
1		M. Bayun	1,020	124+	124	S	Gla	1	7– 9–49			Dr		5	D	L
2		J. Pasak	1,060	142	160	Ss	Ber	34	9–11–48	10	24	Dr		5	D	L
3		F. Frazer	1,080	83+	83	S	Gla	50	11–19–49	14	12	Dr		5½	D	L
4		A. Commander	1,090	93+	93	S	Gla	47	4–13–50	8	31	Dr		5½	D	L,A
5		R. S. Sawdey	1,200	30	60	Ss	Shar	40	7– 9–49	3		Dr		5½	D	L
6		R. Schneider	1,200	30	100	Ss	Shar	62	10–13–48	10		Dr		4¼	D	L
7		Joe Black	1,100	53	86	Sh	Cuy	5	1–17–48	10	45	Dr		5	D	L
8		D. A. Becker	1,080	112	128	Sh	Cuy	40	7– 5–50	2	65	Dr	Hand	5½	D	L
9		J. Cucelli	1,240	23	80	Ss	Shar	20	7–16–49	6		Dr		5	D	L
10	717	J. Weber	1,140	32	90	Sh	Cuy	21	6–14–50	7		Dr		5½	D	L
11	705	A. B. Kelley	1,120	20	60	Sh	Cuy	25	5–31–50	5		Dr		5½	D	L
12		S. R. Illes	1,090	40	82	Sh	Cuy	40	7–18–50	10	42	Dr		5½	D	L
13		A. B. Clarke	1,060	10	100	Sh	Cuy	4	5–10–50	5		Dr		5½	D	L
14	676	H. J. Arthur	1,120	16	60	Sh	Cuy	25	5– 3–50	7		Dr		5½	D	L
15		C. Kopacy	1,080	17	72	Sh	Cuy	26	10– 6–48	15		Dr		5	D	L
16		M. Bretschneider	1,060	70	140	Ss	Ber	105	6–10–49	8	5	Dr		5½	D	L
17		F. Thuringer	1,139	9	60	Ss	Shar	28	1–22–48	10	6	Dr		5	D	L
18		Pulley & Beans	1,120	77	120	Sh	Cuy	20	12–20–47	8	25	Dr		5½	D	L
19		H. H. Gorrie	1,125	7	60			29	4–28–50	9		Dr		5½	D	L
20	629	E. Mills	1,110	71	185	Sh	Cuy			3		Dr		5½	D	L
21		J. B. Lowe	1,090	50	60	Ss	Ber	30	8–15–50	22	10	Dr	Hand	5½	D	L
22		R. W. Crist	1,090	18	60	Sh	Cuy	28	7–20–48	15	30	Dr		5½	D	L
23	628	Fred Borch	1,080	83+	83	G	Gla	50	1– 4–50	7		Dr		5½	D	L
24	241	E. Svec	1,070	110	170	Ss	Ber	45	1– 8–48	4½	75	Dr	Jet	5½	D	L
25	242	E. Svec	1,070	120	170	Ss	Ber	45	1– 8–48	4	75	Dr	Jet	5½	D	L
26	1	Harry Ink	1,042	103	133	Ss	Ber	50	5– –46			Dr		4½	D	L
27	146	N. P. Bard	990	45+	45	G	Gla					Dr		5	D	L
28	202	Tom Solkowski	1,030	48	99	Sh	Cuy	14	10–14–47	15	85	Dr		6	D	L
29	94	Albert Barth	1,060	116+	116	G	Gla			30		Dr			D	
30	579	J. A. Parvlak	1,060	110+	110	S	Gla	55	10–14–49	10	25	Dr	Jet	5½	D	L
31	268	A. L. Subo	1,040	71+	71	S	Gla	19	3–24–48	5		Dr		5½	D	L
32	95	O. Fromwiller	1,040	77	205	Ss	Ber					Dr			D	L
33	310	J. Blechschmid	1,040	63+	63	S	Gla	23	6– 9–48	2		Dr		5½	D	L,A
34	201	P. Wolf	1,050	65	200	Ss	Ber	86	10–10–47	7	110	Dr		6	D	L
35	269	W. G. Wagner	1,055	109+	109			40	4– 6–48	7	25	Dr		5½	D	L
36	76	C. W. Reichwein	1,040	90	192	Ss	Ber			3		Dr			D	L
37	424	G. Hagerman	1,000	108	168	Ss	Ber	65	4–16–49	10	5	Dr		4	D	L
38		A. Arnost	1,020	117	174	Ss	Ber	65	4–29–49	10		Dr		4	D	L
39		F. Hrdlicka	1,000	82	132	Ss	Ber	40	7–21–49	10		Dr		4	D	L
40	238	H. J. Yorkievitz	1,040	133	172	Ss	Ber	50	12–24–47	7	40	Dr		5	D	L
41		S. Tunder	1,040	66+	66	S	Gla	18	1–11–49	14	16	Dr		5½	D	L
42	267	J. Vedrinski	1,100	40	79	Sh	Cuy	21	4– 7–48	10		Dr		5½	D	L
43		J. Vavro	1,100	30	76	Sh	Cuy	Flow	7– 7–48	26	8	Dr		5	D	L
44		H. C. Taylor	1,120	29	56	Ss	Ber	36	10– 2–48	10		Dr		5½	D	L
45	329	J. H. Konewich	1,085	161	200	Ss	Ber	60	7–14–48	10	58	Dr	Hand	5½	D	L
46	290	A. Vajacek	1,060	156	170	Ss	Ber	38	12– 5–47	10	38	Dr		4	D	L
47	169	Cloyd Steininger	1,040	110+	110	S	Gla	5	4–28–47			Dr		5	D	L
48		G. Vondrasek	1,230	21	90	Ss	Shar	28	12–13–48	10	5	Dr		5	D	L
49	393	A. Friskson	1,240	20	89	Ss	Shar	60	1– 6–49	5	15	Dr		5½	D	L

TABLE 25 (Continued). RECORDS OF WELLS AND RESISTIVITY MEASUREMENTS IN SOLON TOWNSHIP

No.	File No. (Ohio Division of Water)	Owner or name	Elevation at well (feet above sea level)	Depth to bedrock (feet)	Depth of well (feet)	Principal water-bearing bed: Character of material	Principal water-bearing bed: Geologic horizon	Water level: Below land surface (feet)	Water level: Date	Yield: Rate (g.p.m.)	Yield: Drawdown (feet)	Type of well	Type of pump	Diameter of well (inches)	Use	Remarks
50		G. E. Roof	1,227	27	61	Ss	Shar	45	9–28–48	10	5	Dr		5	D	L
51	636	W. B. Hickman	1,190	42	80	Ss	Shar	54	2–13–50	9		Dr		5½	D	L
52	200	F. Jones	1,060	111	185	Ss	Ber	40	9–30–47			Dr		4	D	L
53		St. Rita Church	1,030	105+	105	G	Gla	20	1–20–48			Dr		8	D	L
54	259	A. Klnigel, Jr.	980	208+	208	S & G	Gla	30	3–10–48			Dr	Hand	5½	D	L,A
55	19	J. Hasman	860	286+	286							Dr		4	D	Dry hole. L
56	78	Mrs. A. Schultz	970	76	110	Ss	Ber			20		Dr			D	L
57	311	Emil Peters	940	55	105	Ss	Ber	10	4–22–48			Dr		5	D	L
58		Pergl	990	97	131	Ss	Ber	64	8–20–48			Dr		5	D	L
59	174	Wheeling & Lake Erie R.R.	955	105	175	Ss	Ber	11	7–10–47	250	73	Dr		8	I	L
60	383	Emil Sounik	940	60+	60	G	Gla	5	7– 6–48	50	5	Dr		5½	D	L
61		A. B. Cross	1,060	140	185	Ss	Ber	80	3–12–47	8	50	Dr		5	D	L
62	81	J. Sotak	1,070	160+	160	G	Gla			4		Dr			D	L
63	49	J. Lavelle	1,040	54+	54	S & G	Gla			12		Dr			D	L
64	644	Stanky Wolf	1,120	70	105	Sh	Cuy	75	2–18–50	7		Dr		5½	D	L
65		J. J. Manak	1,140	70	216	Ss	Ber	54	11–20–48	10	82	Dr		5	D	L
66		Humel Const. Co.	1,080	40	75	Sh	Cuy	35	3–10–51	5	25	Dr		5½	D	L
67		F. W. Rogers	1,060	20	100	Sh	Cuy	21	4–25–51	5		Dr		5½	D	L
68		E. R. Klein	1,035	46+	45	G	Gla	10	11–13–50	8	8	Dr		5½	D	L
69		Warren Ayers	1,240	30	100	Ss	Shar	65	9–13–50	5		Dr		5½	D	L
70		A. C. Allison	1,060	68+	68	S	Gla	32	12–23–48	5		Dr		4	D	L
71		J. L. Gedeon	1,140	14	40	Ss	Shar	18	1–24–51	5		Dr		5½	D	L
72			1,100	100+	100	S & G	Gla	Flow	1936			Dr		4	D	
73		D. C. Seither	1,060	180+	180	S & G	Gla	40	4– –51			Dr		5½	D	
74		L. E. Bellemy	1,045	131+	131	G	Gla	32	1–29–47	10		Dr		5	D	L
75		H. W. Scott	1,040	125	148	Ss	Ber	16	5– 2–50	14	20	Dr		5½	D	
76		D. Imhoff	1,040	136	160	Ss	Ber	76	11– 6–50	14	6	Dr		5½	D	L
77	196	James Head	1,055	54	198	Ss	Ber	62	7–18–47	5	124	Dr		5	D	L
78		A. C. Kurinsky	1,055	93+	93	S	Gla	26	11–28–50	3		Dr		5½	D	L
79	167	J. T. Patrick	1,055	121	197			105	12–13–46	10	52	Dr		5	D	
80	173	R. Schrock	1,040	45	109	Sh	Cuy	5	5–21–47	3		Dr		5½	D	L
81		F. A. Rodwick	1,035	53	195	Ss	Ber	76	10–17–50	3		Dr		4	D	L
82		H. F. Harper	1,025	130	155			40				Dr		4	D	
83		J. Rivacuk	1,055	117	173	Ss	Ber	40	8–23–50	14		Dr		5	D	L
201		C. W. & E. F. Clover #1	1,042	200								Dr		8	G	
202		L. M. Menkle #1	1,100	405								Dr		8	G	
401			1,015	185					8– –51							R
402			1,021	325					8– –51							R
403			960	185					8– –51							R
404			1,032	420					8– –51							R
405			1,035	250					8– –51							R
406			1,046	220					8– –51							R
407			1,071	500					8– –51							R
408			1,005	520					8– –51							R

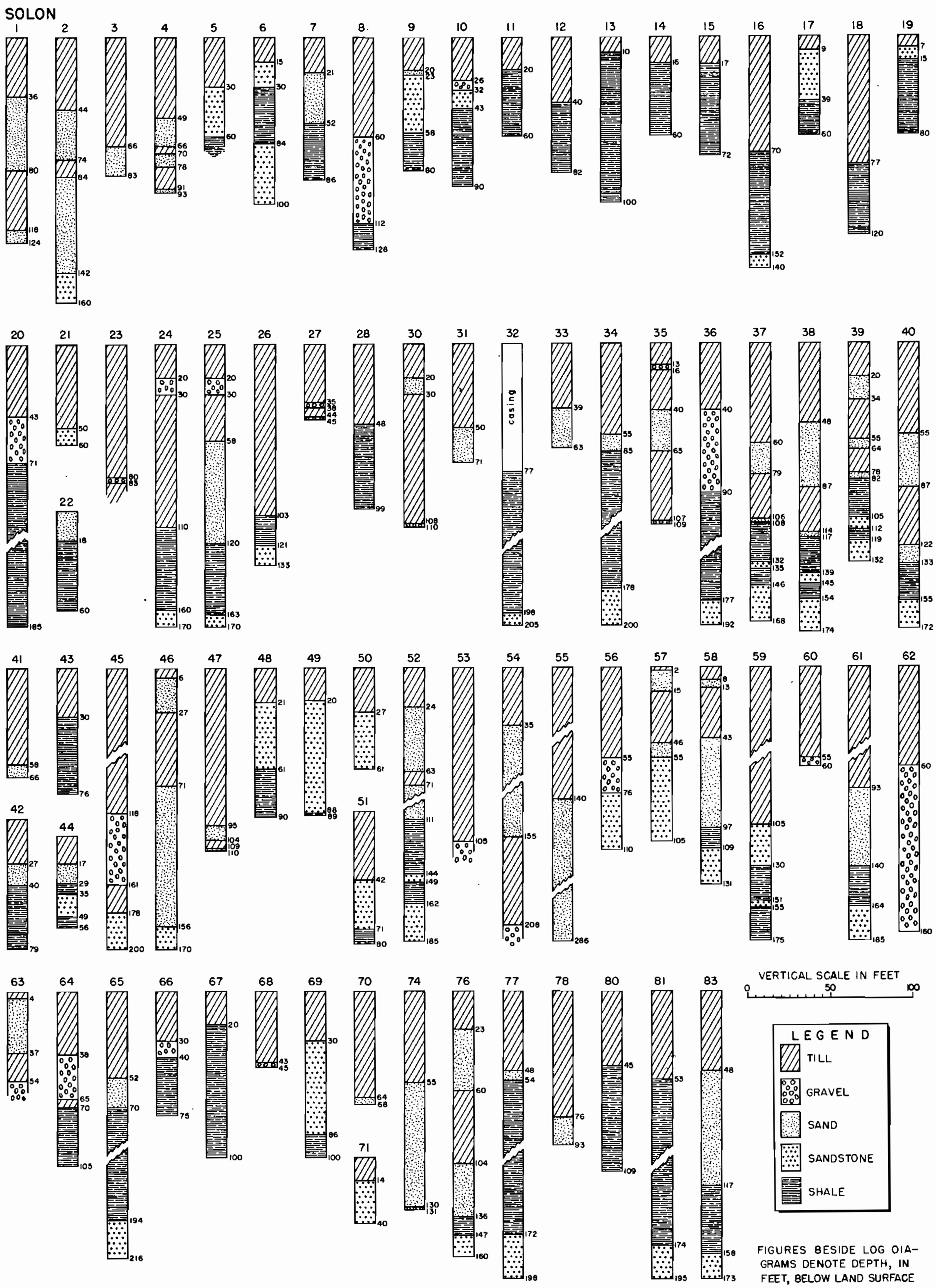


Plate 56. Logs of wells in Solon Township.
[Well numbers refer to locations shown on plate 55.]

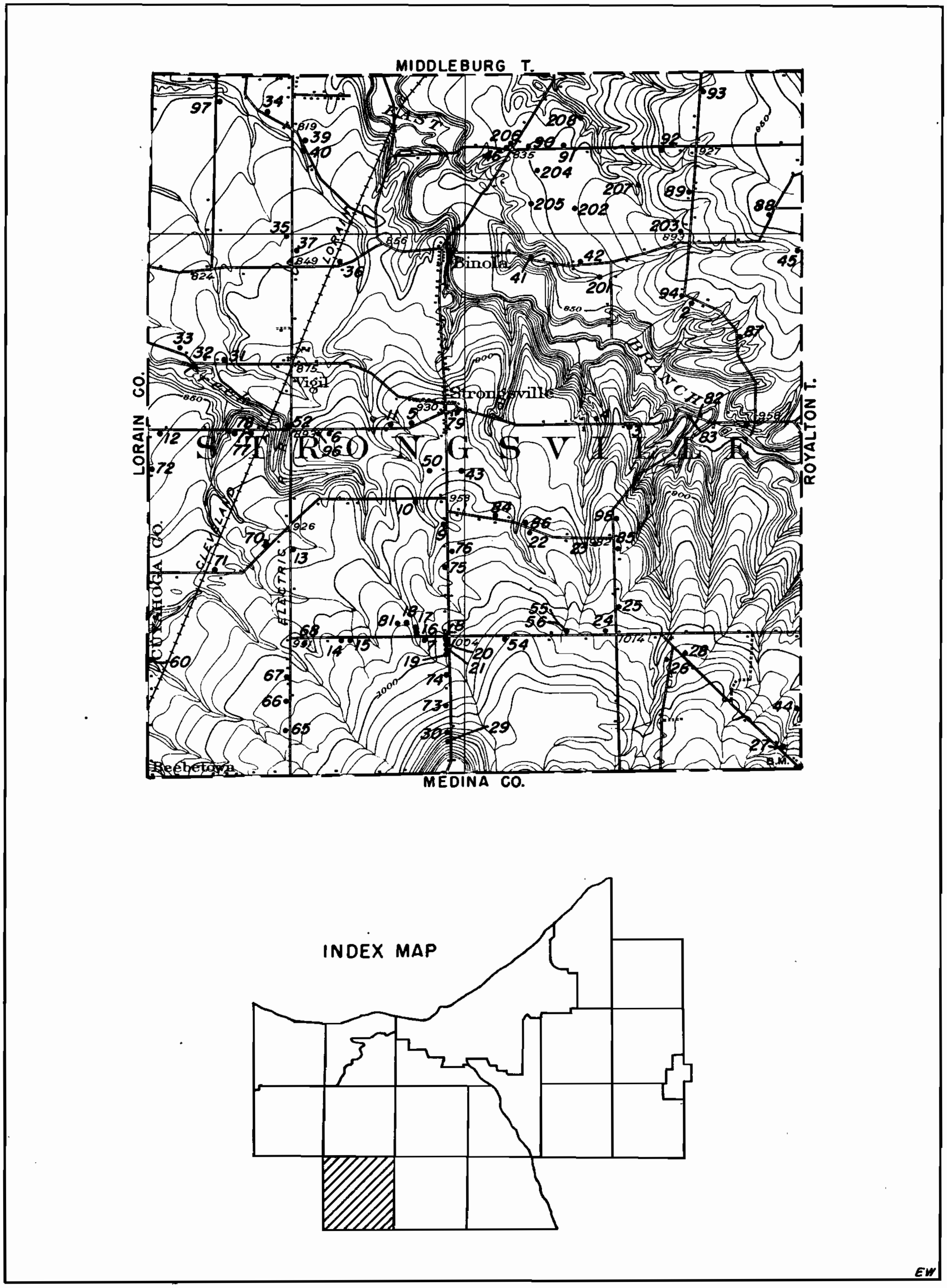


Plate 57. Map showing location of wells in Strongsville Township.

TABLE 26. RECORDS OF WELLS IN STRONGSVILLE TOWNSHIP

No.	File No. (Ohio Division of Water)	Owner or name	Elevation at well (feet above sea level)	Depth to bedrock (feet)	Depth of well (feet)	Principal water-bearing bed		Water level		Yield		Type of well	Type of pump	Diameter of well (inches)	Use	Remarks
						Character of material	Geologic horizon	Below land surface (feet)	Date	Rate (g.p.m.)	Drawdown (feet)					
1		State Roadside Park	925		40			6	3–16–51			Dr	Hand	5½	D	
2	252	H. Geringer	890	132+	132	G	Gla	65	3–14–51	12	20	Dr	Jet	6½	D	L
3	495	A. Schmidt	900	15	224	Ss	Ber	90	7– 9–49	3		Dr		5¼	D	L
4	283	F. Bowditch	890	15	218	Ss	Ber	100	5– 7–48	15	75	Dr	Lift	5½	D	L
5	571	Montgomery	925	10	75	Sh	Cuy	6	8– 3–49	2		Dr	Jet	6½	D	L
6	626	L. Somsak	924	14	80	Sh	Cuy					Dr		5	D	
7	385	C. Washak	984	4	62	Sh	Cuy	12	9–21–48	5		Dr		5½	D	L
8	282	C. Kleppe	1,004	10	70	Sh	Cuy	4	5–10–48	4		Dr		5½	D	L
9	250	Collier Const. Co.	960	10	85	Sh	Cuy	8	10–15–47	10	30	Dr	Jet	6½	D	L
10	670	F. Vacka	896	16	62	Sh	Cuy	7	3–14–51	20		Dr		5½	D	L
11	658	D. C. Stahlman	912	10	110	Sh	Cuy					Dr		5	D	L
12	251	H. Dedina	855	15	75	Sh	Cuy	10	11– –47	10	20	Dr		5½	D	L
13	271	Mairs	932	5	65	Sh	Cuy	8	3–15–48	2		Dr		6½	D	L
14	339	J. L. Bergen	966	6	75	Sh	Cuy	6	3–16–51	3		Dr		6½	D	L
15		F. Arden	962	20	70	Sh	Cuy	14	5– –50	5		Dr		5½	D	L,A
16		B. C. J. Realty Co.	980	6	55	Sh	Cuy	9	7– –50	9		Dr		5½	D	L
17		B. C. J. Realty Co.	980	0	50	Sh	Cuy	9	7– –50	8		Dr		5½	D	L
18		R. R. Pierce	980	18	40	Sh	Cuy	6	3–16–51	10	25	Dr		6½	D	L
19		Mrs. Solomon	1,005	32	45	Ss	Ber	5	3–16–51			Dr	Lift	5½	D	L
20	526	J. Siodla	1,005	12	68	Sh	Cuy					Dr		5½	D	L
21	637	J. Siodla	1,005	15	72	Sh	Cuy	4	1–14–50			Dr		5½	D	L
22	776	E. Horstman	972	8	92	Sh	Cuy	12	7– –50	1		Dr		8	D	L
23	565	H. N. Gifford	975	10	65	Sh	Cuy	12	10–11–49	1		Dr		6½	D	L
24	766	R. Drake	1,015	10	57	Sh	Cuy	8	5– –50	4		Dr		8	D	L
25	774	H. Herz	992	6	80	Sh	Cuy	8	8– –50	½		Dr		8	D	L
26	341	E. J. Fink	1,010	10	60	Sh	Cuy	15	7–18–48	4		Dr		5½	D	L
27	384	A. Kemski	1,050	12	64	Sh	Cuy	8	3–16–51	3		Dr		6½	D	L
28	762	N. F. Fetzer	1,018	5	102	Sh	Cuy	5	3–16–51	3		Dr		8	D	L
29		A. Reese	890	28	45			7	3–17–51			Dr		5½	D	
30	284	C. Woods	930	5	65	Sh	Cuy	18	4–30–48			Dr		5½	D	L
31	254	E. Nedelau	852	8	190	Ss	Ber	85	3– 3–48	6	25	Dr	Lift	6½	D	L
32		McDowell	840	24	155							Dr	Jet	5½	D	
33	775	J. Riggi	835	34	160	Ss	Ber	80	7– –50	3		Dr	Hand	6½	D	L
34	496	R. W. Huge	812	20	100	Ss	Ber	30	4–11–49	4		Dr	Jet	5½	D	L
35	559	G. Klink	840	59	136	Ss	Ber	55	10–19–49			Dr		5½	D	L
36	285	Richter	852	12	124	Ss	Ber					Dr		5½	D	L
37	350	M. Roche	848	45	198	Ss	Ber	80	7– 7–48	4		Dr		6½	D	L
39	497	T. Goss	822	15	170	Ss	Ber	70	4– 6–49	20	55	Dr		5¼	D	L
40		G. Roche	820	18	90	Sh	Cuy					Dr		5½	D	L
41	672	L. B. Wilder	850	55	133	Ss	Ber	50	4–29–50	90	25	Dr		5½	D	L
42	749	D. C. Babb	852	75+	75	S	Gla	26	3–19–51	4		Dr	Hand	5½	D	L
43		Taylor	940	8	50	Sh	Cuy	9	10– –49	2		Dr		5½	D	L
44	595	M. Sadowski	1,005	20	50	Sh	Cuy	18	11– 4–49			Dr	Jet	5½	D	L
45	494	P. Spera	940	20	72	Sh	Cuy	5	3–20–51	5		Dr		6½	D	L,A
46	523	A. L. Gough	842	12	116	Ss	Ber	55	8– –49	10		Dr	Jet	5½	D	

TABLE 26 (Continued). RECORDS OF WELLS IN STRONGSVILLE TOWNSHIP

No.	File No. (Ohio Division of Water)	Owner or name	Elevation at well (feet above sea level)	Depth to bedrock (feet)	Depth of well (feet)	Principal water-bearing bed: Character of material	Principal water-bearing bed: Geologic horizon	Water level: Below land surface (feet)	Water level: Date	Yield: Rate (g.p.m.)	Yield: Drawdown (feet)	Type of well	Type of pump	Diameter of well (inches)	Use	Remarks
50		J. DePaul	935	10	50	Sh	Cuy	10	10- 3-50	7		Dr		6½	D	L
52		P. Pattee	865		45			7	3-28-51			Dr	Lift	5½	D	
54		J. Taliak	1,038		29			5	3-28-51			Dr		6¼	D	
55		C. Miller	1,020	3	9	Sh	Cuy	3	3-28-51			Dug	Lift		D	
56		C. Miller	1,020	3	12	Sh	Cuy	3	3-28-51			Dug	Lift		D	
65			973	14	51			4	4-18-51			Dr	Hand	6	D	
66		O. Wallash	965	23	28			3	4-18-51			Dr	Lift	5½	D	
67		T. F. Kendall	908	25	57			4	4-18-51			Dr	Hand	6	D	
68		A. J. Fedack	950	4	18	Sh	Cuy	3	4-18-51			Dug	Lift		D	
70		C. Hawk	920	18	18	Un	Gla	9	4-18-51			Dug	Lift		D	
71		Mrs. McLeod	915	12+	12	Un	Gla	5	4-18-51			Dug	Hand		D	
72		J. Petraitis	862	26	101			1	4-18-51			Dr		6	D	
73		C. Cooks	1,030	23	61			3	4-18-51			Dr	Hand	5½	D	
74		J. Moser, Sr.	1,015	14	14	Un	Gla	8				Dug	Lift	60	D	
75		S. Trzeciak	982		20			5	4-18-51			Dug	Jet		D	
76		H. Christensen	975	16	58			5	4-18-51			Dr	Hand	5½	D	
77		H. V. Pope	885	5	10	Ss	Cuy	5	4-18-51			Dug	Hand		D	
78		H. V. Pope	875	10	13	Sh	Cuy	7	4-18-51			Dug	Hand		D	
79		Neuberger	932	4	13	Sh	Cuy	8				Dug	Hand	42	D	
81		H. Noreen	978	10	70			10	7- -48	3		Dr		5½	D	L
82			810		14			6	4-19-51			Dug	Hand	48	D	
83		G. Lobas	820	23	100			1	4-19-51			Dr	Jet	6	D	
84		Tomson	962	15	60	Sh	Cuy	12	4-19-51			Dr	Jet	6	D	L
85		H. Whinch	980	5	20	Sh	Cuy	15	4-19-51			Dug	Hand	48	D	
86		R. Schrock	965	19	80							Dr	Jet	5½	D	
87		E. A. Sprague	890		28			18	4-20-51			Dug	Lift		D	
88		J. Childs	952		57			10	4-20-51			Dr	Jet	6	D	
89		C. Docker	920	60	198			80	4-20-51			Dr	Lift	5	D	
90		A. T. Monton	850	20	20	S	Gla	7	4-20-51			Dug	Lift		D	
91		Dan Rice	850	190	224							Dr	Hand	6	D	
92		Parsson	945		200							Dr	Lift		D	
93	697	W. Kellar	930	12	47			4				Dr	Lift	5½	D	
94		H. M. Jacobs	893	190	200							Dr		5½	D	
96		B. Cambridge	910	15	80	Sh		12	9-15-50	3		Dr		6½	D	L
97		M. Mucha	802	26	95							Dr	Hand	5½	D	
98		C. C. Voshall	980	19	65							Dr	Jet	5½	D	
201		A. Borchert	850	265								Dr		8	G	
202		O. Mandelkow	860	393								Dr		8	G	
203		A. Zoke	900	21								Dr		10	G	
204		J. W. Dorsey #1	850	383								Dr		8	G	
205		G. Beriswell	840	126								Dr		10	G	
206		B. H. Adams	840	280								Dr		8	G	
207		M. Goehel	860	145								Dr		10	G	
208		South Hills Land Co.	830	87								Dr		10	G	

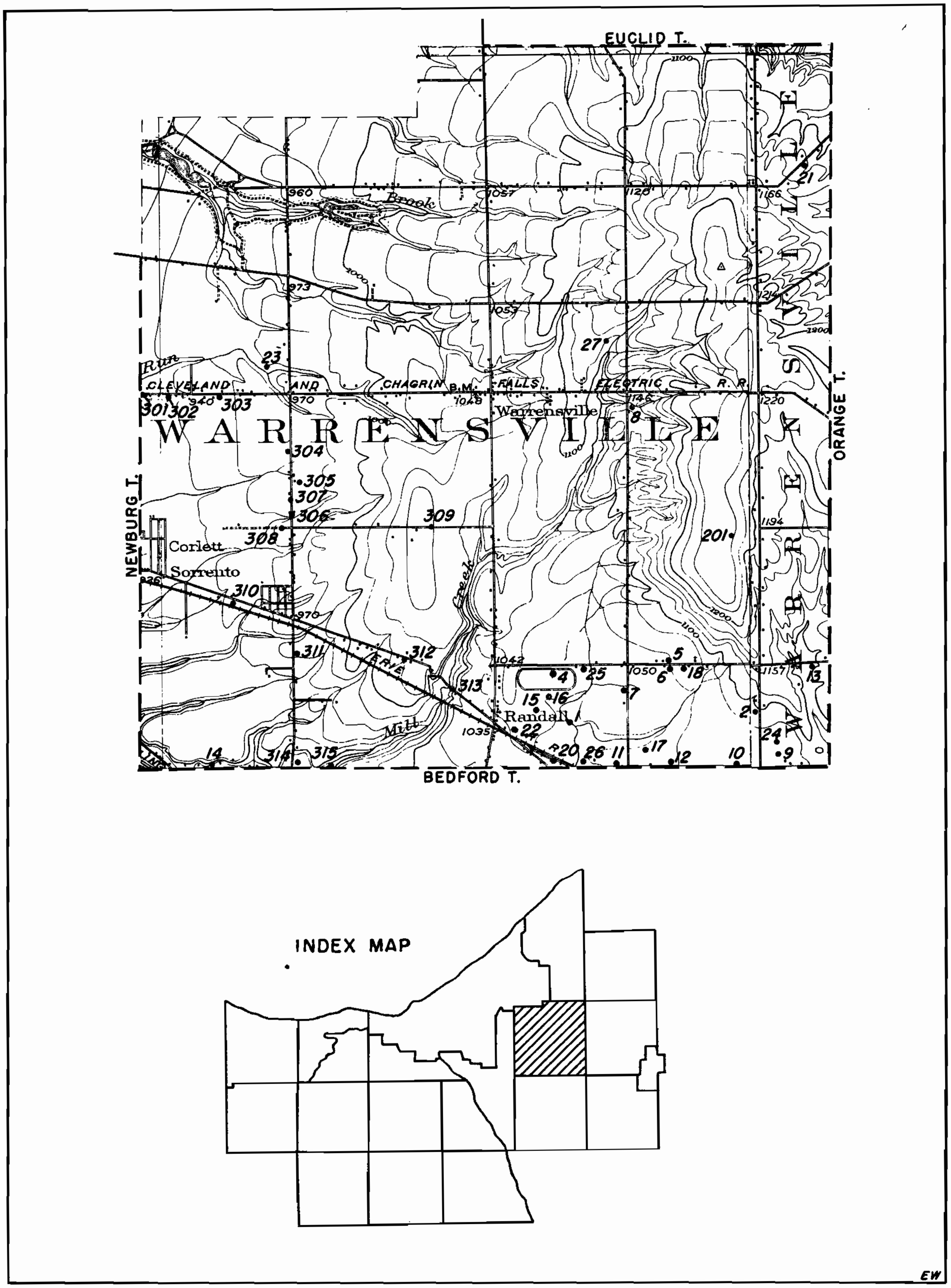


Plate 58. Map showing location of wells in Warrensville Township.

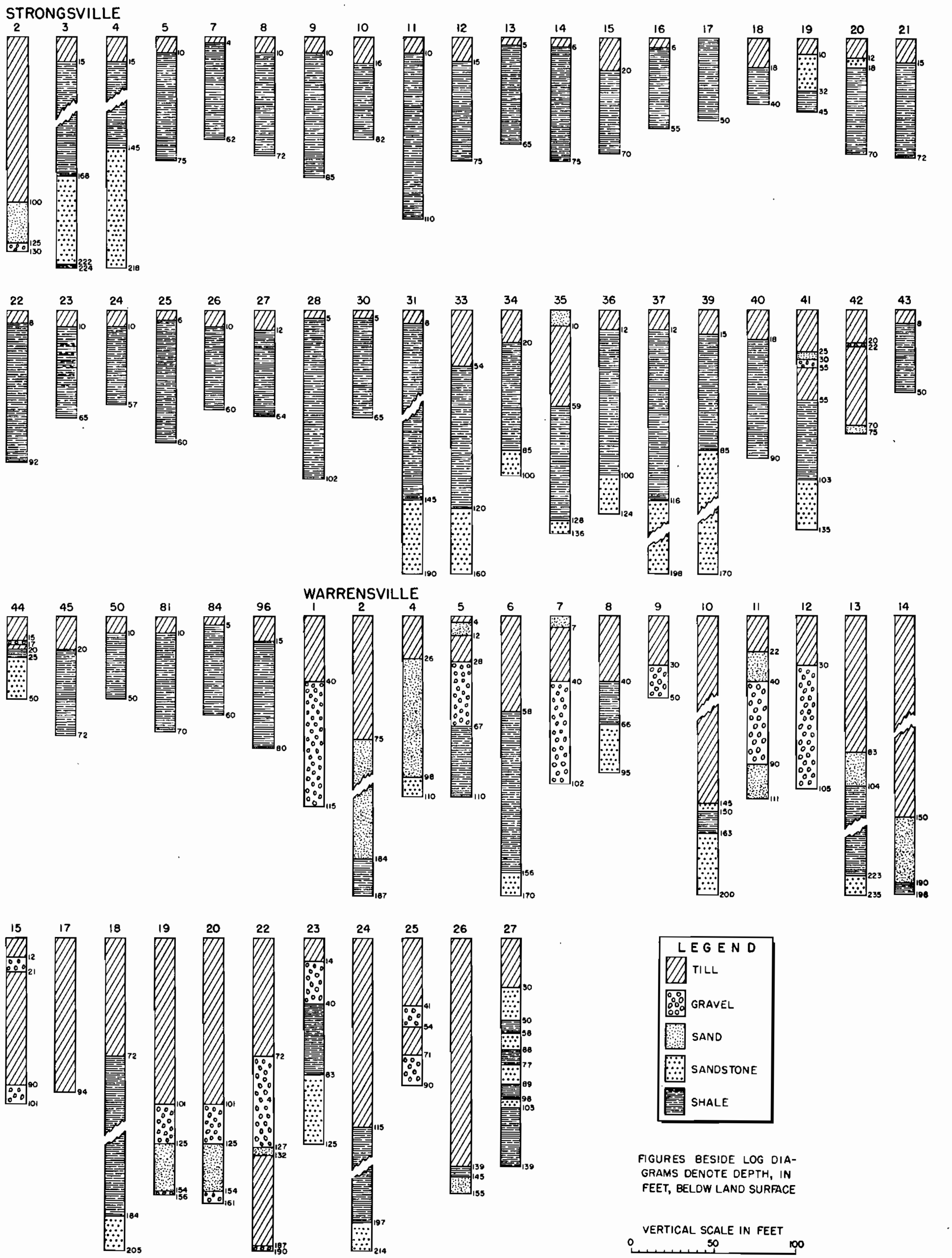


Plate 59. Logs of wells in Strongsville and Warrensville Townships.

[Well numbers refer to locations shown on plates 57 and 58.]

and sand, scattered thin gravel lenses are encountered which yield as much as 12 gallons per minute to wells.

The Sharon conglomerate and the rocks of the Cuyahoga group crop out beneath the thin cover of glacial drift. The Berea sandstone and the three shale formations beneath it crop out along the walls of the buried valley.

The Sharon conglomerate forms a short ridge in the south-central part of the township where U. S. Route 42 enters Cuyahoga County. Within the township the areal extent of the Sharon is small, but wells that penetrate a 20- to 30-foot thickness of the sandstone generally yield up to 10 gallons per minute.

The Cuyahoga group is as much as 300 feet thick in parts of Strongsville Township. Some wells drilled into the Cuyahoga group yield as much as 200 gallons per minute, although 3 to 5 gallons per minute is the common yield. Berea sandstone wells have been reported to yield as much as 90 gallons per minute, though 10 gallons per minute is the more common yield from this formation. No wells are reported in the shales that underlie the Berea sandstone but these formations have proved to be poor sources of water in adjoining Middleburg Township.

Records of wells in Strongsville Township are shown in table 26; the locations of the wells are shown on plate 57. The logs of some of the wells are shown on plate 59.

WARRENSVILLE TOWNSHIP

A thin mantle of glacial till covers almost all of Warrensville Township. The southern portion of the township is underlain by a buried valley, which is filled predominantly with clay and silt but which also contains some water-bearing sand and gravel lenses. These lenses yield up to 65 gallons per minute to domestic wells. The normal yield of such wells is about 5 gallons per minute.

The Sharon conglomerate and the Berea sandstone, rocks of the Cuyahoga group, and the shale formations below the Berea sandstones crop out beneath the mantle of glacial till and along the walls of the buried valley. No wells are reported in the Sharon conglomerate. The Cuyahoga group yields as much as 10 gallons per minute to some wells, but most wells that encounter shale in the Cuyahoga group are drilled into the underlying Berea sandstone. Wells in the Berea sandstone yield as much as 87 gallons per minute; the average yield of domestic wells is about 10 to 15 gallons per minute. No wells are reported to have been drilled into the formations underlying the Berea sandstone.

Records of wells in Warrensville Township are shown in table 27; the locations of the wells are shown on plate 58. The logs of some of the wells are shown on plate 59.

TABLE 27. RECORDS OF WELLS IN WARRENSVILLE TOWNSHIP

No.	File No. (Ohio Division of Water)	Owner or name	Elevation at well (feet above sea level)	Depth to bedrock (feet)	Depth of well (feet)	Principal water-bearing bed: Character of material	Principal water-bearing bed: Geologic horizon	Water level: Below land surface (feet)	Water level: Date	Yield: Rate (g.p.m.)	Yield: Drawdown (feet)	Type of well	Type of pump	Diameter of well (inches)	Use	Remarks
1		A. Frick	1,040	115+	115	S & G	Gla	25	5–25–49	2	65	Dr		5½	D	L
2	69	D. Pupp	1,090	164	187	Sh	Cuy			2½		Dr			D	L
4	161	Derbyshire Little Farm, Inc.	1,050	98	110	Ss	Ber	23	9–10–46	12	58	Dr		6½	D	L
5	82	L. J. Stepik	1,060	67	110	Sh	Cuy			3	10	Dr			D	L
6	746	S. L. Hayman	1,060	58	170	Ss	Ber	37	7–22–51	5	87	Dr		5½	D	L
7		Bernard Tessler	1,047	102+	102	S & G	Gla	30	10–29–49	3	42	Dr		5½	D	L
8		Best Golf Range	1,130	40	95	Ss	Ber	62	5–28–48	25	10	Dr		5½	D	L
9		J. Szarko	1,095	50+	50	S & G	Gla	38	5–16–50	2½		Dr	Hand	5½	D	L
10	645	J. Nagy	1,070	80	200	Ss	Ber	55	2–20–50	5		Dr		5½	D	L
11	52	P. Lubanobich	1,045	111+	111	S & G	Gla			2		Dr			D	L
12	51	R. Lovell	1,105	106+	105	S & G	Gla			2		Dr			D	L
13	31	H. J. Ellicott	1,080	104	235	Ss	Ber			1		Dr			D	L
14	632	Geo. Milligan	920	190	196	S	Gla	80	12–27–49	5	50	Dr		5½	D	L
15		Louis Lanero	1,041	101+	101	S & G	Gla	20	6– 8–48	3	45	Dr		5½	D	L
16		Joe Malkowsky	1,040	98+	98	S & G	Gla	20	9–23–49	5	50	Dr		5½	D	
17	96	A. Kostelie	1,031	95+	95	G	Gla			4		Dr			D	L
18		Frank Melkorsky	1,070	16	205	Ss	Ber	61	3–29–51	53	25	Dr		5½	D	L
20	126	Monroth Inc.	935	161+	161	G	Gla	130		19		Dr		8	I	L,A
21			1,120	38	68			6	4– 7–51			Dr		4	D	
22		Nutritional Biochemical Lab. Corp.	1,040	190+	190	G	Gla	55	8– 8–50	18		Dr		5½	D	L

TABLE 27 (Continued). RECORD OF WELLS IN WARRENSVILLE TOWNSHIP

No.	File No. (Ohio Division of Water)	Owner or name	Elevation at well (feet above sea level)	Depth to bedrock (feet)	Depth of well (feet)	Principal water-bearing bed: Character of material	Principal water-bearing bed: Geologic horizon	Water level: Below land surface (feet)	Water level: Date	Yield: Rate (g.p.m.)	Yield: Drawdown (feet)	Type of well	Type of pump	Diameter of well (inches)	Use	Remarks
23		E. F. Brunner	960	40	125	Ss	Ber	80	2-22-50	9	5	Dr		5½	D	L,A
24		Mike Bencie	1,075	115	214	Ss	Ber	72	5-14-51	6	15	Dr		5½	D	L
25		P. Menilli	1,050	90+	90	S & G	Gla	25	7-23-51	8	10	Dr		5½	D	L
26		G. H. Tipling	1,040	155+	155	S	Gla	28	4-21-51	3	12	Dr		5½	D	L
27		Canterbury Golf Club	1,120	30	139	Ss	Ber	49		75		Dr			D	L
201		Infirmary Grounds	1,240	60								Dr		10	G	
301			925	35+		Un	Gla									Test hole.
302			935	34		Sh	Cuy									Test hole.
303			945	26		Sh	Cuy									Test hole.
304			972	2		Sh	Cuy									Test hole.
305			973	2		Sh	Cuy									Test hole.
306			965	9		Sh	Cuy									Test hole.
307			968	6		Sh	Cuy									Test hole.
308			962	6		Sh	Cuy									Test hole.
309			1,060	8		Sh	Cuy									Test hole.
310			945	8		Sh	Cuy									Test hole.
311			965	10		Sh	Cuy									Test hole.
312			1,020	4		Sh	Cuy									Test hole.
313			1,000	10		Sh	Cuy									Test hole.
314			870	17		Ss	Ber									Test hole.
315			890	5+		Un	Gla									Test hole.

CHEMICAL QUALITY OF THE GROUND AND SURFACE WATER[1]

Samples of ground water from 36 wells in Cuyahoga County were analyzed by the Quality of Water Branch, U. S. Geological Survey. The samples were taken from wells in the different water-bearing formations that were considered representative in their respective areas. Analyses of water from the Rocky and Cuyahoga Rivers also were made by the Quality of Water Branch.

The analyses show the dissolved mineral content of the waters, and do not necessarily indicate their sanitary condition. The results of the analyses are given in table 28 and are also illustrated on plate 60. The locations of the wells from which the samples were taken are shown on the maps in the part of the report entitled "Ground-Water Conditions in Specific Areas."

CHEMICAL QUALITY OF THE GROUND WATER

The chemical quality of ground water in Cuyahoga County varies over a wide range in both quality and quantity of dissolved mineral constituents. Because of the thinness of the geologic formations, water enters most of the wells drilled into the consolidated rocks at a number of different depths and from different types of rocks. Thus frequently the water from a well is a mixture of water from several different water-bearing zones. On the basis of a limited number of chemical analyses, the following general description of the chemical quality of the ground water is presented.

In Cuyahoga County ground water is generally hard to very hard, and contains moderate to excessive amounts of dissolved mineral constituents. Some natural water is soft but is not necessarily low in mineral content. The softest water found had a total hardness of 11 parts per million. This was from a well (Middleburg T. 21) 80 feet deep in the glacial drift. The minimum hardness in water from the Berea sandstone was 12 parts per million, but the dissolved-solids concentration of this sample was 1,145 parts per million. This water was from a well (Brecksville T. 82) 275 feet deep.

The soft waters showed variable amounts of the sodium salts of bicarbonate (including carbonate), sulfate, and chloride. The hard waters were generally the calcium-magnesium bicarbonate type and these samples also contained various amounts of the other principal ions such as: sodium, sulfate, and chloride.

[1] In part from the report on the chemical character of the surface waters in Ohio (Lamar and Schroeder, 1951).

The pH of all but one of the samples was 7.0 or above, indicating water of an alkaline character. Iron was present in all samples in concentrations ranging from 0.13 to 17 parts per million. Most of the waters contained an objectionable quantity of iron. Manganese was present in a number of samples in amounts ranging up to 0.82 part per million. Manganese has objectionable staining qualities similar to those of iron. The sodium content of the samples covered a wide range, from 6.4 to 2,974 parts per million. The bicarbonate content also covered a wide range, from 112 to 1,124 parts per million. The sulfate content ranged from 1.2 to 682 parts per million, but generally it was less than 100 parts per million. In general the chloride content was low except in a few samples that contained large amounts of dissolved solids. Fluoride ranged from 0.1 to 1.2 parts per million. Dissolved solids ranged from 228 to 7,404 parts per million and the total hardness from 11 to 889 parts per million.

Table 28 shows the analyses of ground water from 36 wells in the various water-bearing formations. The locations of these wells are shown on the well-index map for the respective townships. The wells ranged between 40 and 275 feet in depth. No samples were obtained from deeper zones. However, brine has been reported, in oil and gas records, in the lower portion of the Chagrin shale and in the underlying formations.

Glacial Drift. Nine samples of water from the glacial drift were analyzed. There was a rather wide variance in the quality of the water. Dissolved solids ranged from 274 to 630, total hardness from 11 to 474, and bicarbonate from 112 to 509 parts per million. Sodium chloride was most prominent in the soft waters. The iron content ranged from 0.14 to 5.7 parts per million. Manganese was present in some samples in low concentrations, the maximum being 0.21 part per million.

Sharon Conglomerate. Two samples were collected from wells drilled in the Sharon conglomerate. These showed a variance in quality. One had dissolved solids of 660 parts per million, and total hardness of 524 parts per million. The other sample had 254 parts per million of dissolved solids and a total hardness of 188 parts per million. Both samples contained iron and manganese.

Cuyahoga Group. Water from rocks of the Cuyahoga group showed an extremely wide variance in mineral constituents. The dissolved solids ranged from 331 to 2,576 parts per million, and the total hardness ranged from 44 to 889 parts per million. The iron content

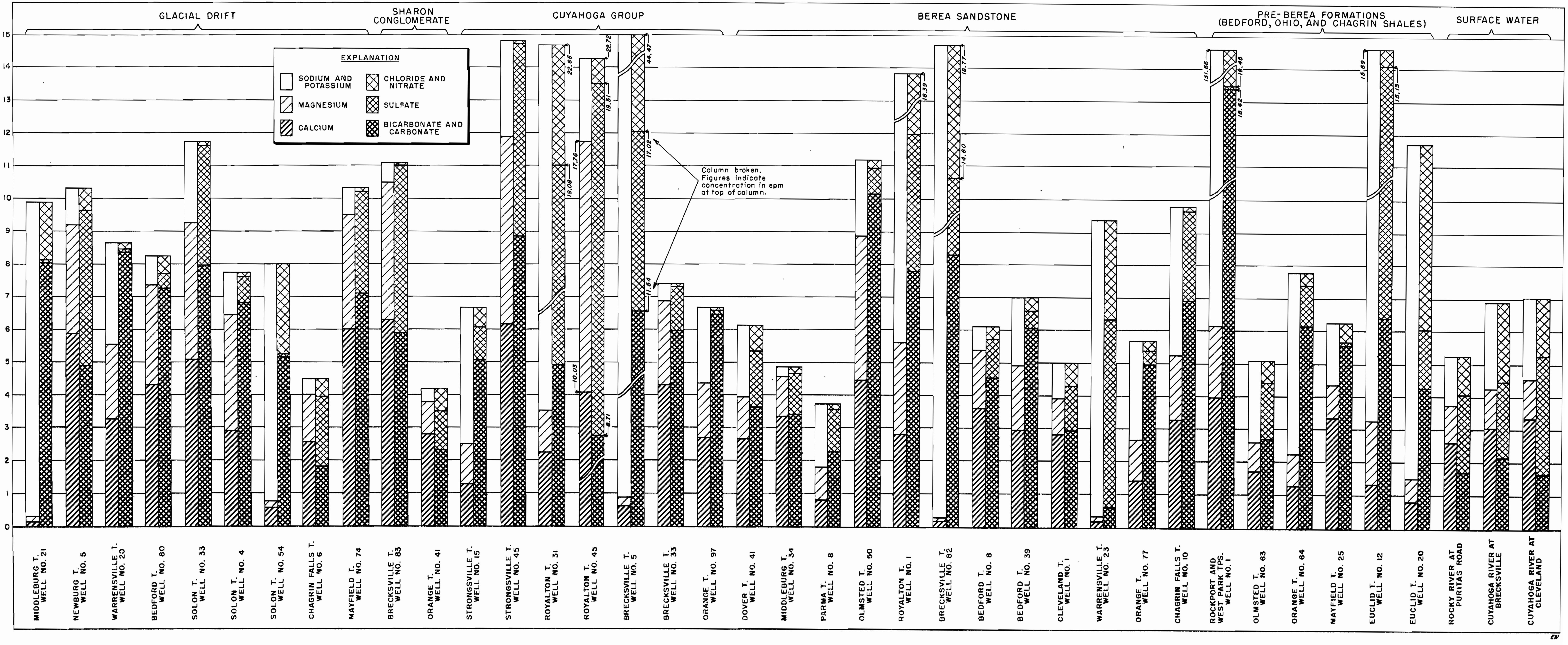


Plate 60. Chemical analyses of water from Cuyahoga County, Ohio.

ranged from 0.20 to 1.4 parts per million. Manganese was found in only two of the seven samples, the higher concentration being 0.08 part per million.

Berea Sandstone. Table 28 shows the analyses of 12 samples of water from the Berea sandstone. The range of the mineral constituents is wide. Dissolved solids ranged from 228 to 1,145 parts per million and total hardness from 12 to 443 parts per million. The noncarbonate hardness was low in many samples. The iron concentration ranged from 0.13 to 17 parts per million. The maximum concentration of manganese was 0.82 part per million.

Pre-Berea Rocks. (The Bedford, Ohio, and Chagrin shales.) The water from these formations ranged from fairly soft to hard, the total hardness in the samples being from 74 to 308 parts per million. The dissolved solids ranged from 296 to 7,404 parts per million, and consisted principally of calcium and magnesium bicarbonate, sodium bicarbonate, sodium sulfate, and sodium chloride. Noncarbonate hardness was present only to the extent of 4 parts per million.

CHEMICAL QUALITY OF THE SURFACE WATER

Ground water contains mineral constituents dissolved from the rocks or soil through which it moves. Surface water, derived from overland runoff and also from ground-water discharge, generally contains, in varying but lesser amounts, the same mineral constituents found in the ground water. In addition, surface water frequently contains suspended solids such as silt, clay, sand, and organic material derived from the natural decomposition of soil and from pollution. The maximum concentrations of dissolved mineral constituents and the minimum concentrations of suspended sediment in surface water generally occur during periods of low flow. Conversely, during periods of high flow the concentration of dissolved mineral constituents is lower because the proportion of dilute surface runoff is greater. The increased stream velocity generally increases the amount of suspended solids also. Thus, roughly, for most streams, it may be stated that the concentration of dissolved solids varies inversely and the amount of suspended solids varies directly with the stream velocity.

Analyses of water from the Cuyahoga River at Cleveland and at Brecksville and from the Rocky River at Cleveland covering the period March 1950 to February 1951, are shown in table 28 and, graphically, on plate 60. Analyses of water from the Cuyahoga River at Independence for the period October 1948 to September 1949 are given in the report on the "Chemical Character of Surface Waters of Ohio" (Lamar and Schroeder, 1951). A daily suspended-sediment record is maintained on the Cuyahoga River at Independence. At this station, the suspended sediment discharge was 260,463 tons for the water year October 1, 1950, to September 30, 1951. This amounts to 367 tons of suspended sediment per square mile of drainage area.

Pollution is a factor in the streams in Cuyahoga County (Lake Erie Pollution Survey, Final Report, 1953). There is a progressive downstream increase in pollution in the Cuyahoga River and in the other streams in the county.

EXPRESSION OF RESULTS OF ANALYSIS

The dissolved mineral constituents in the water are reported in parts per million. A part per million is a unit weight of a constituent in a million unit weights of water. Thus, in a water analysis 1 part per million indicates 1 milligram of a particular substance in a million milligrams of aqueous solution (water). Results in parts per million may be converted to grains per United States gallon by dividing the parts per million by 17.12. Hardness is reported in parts per million as calcium carbonate ($CaCO_3$) equivalent to the calcium and magnesium. The hardness caused by bicarbonate or carbonate of calcium and magnesium is called carbonate hardness; the hardness in excess of this quantity is called noncarbonate hardness.

Color is expressed in units of the platinum-cobalt scale. The unit of color is that produced by one milligram of platinum per liter of water, dissolved as platinic chloride, with the addition of enough cobalt chloride to give a color matching the shade of color in natural water. Hydrogen-ion concentration is reported as pH, which is the negative logarithm of the number of moles of ionized hydrogen per liter. The results for specific conductance (a measure of the ionized constituents in water) are reported as micromhos at 25° C. Micromho units are calculated by multiplying the reciprocal of the resistance of the water in ohms by one million.

On plate 53 the water analyses are shown diagrammatically in equivalents per million. The equivalents per million for each ionic constituent may be determined by dividing its concentration in parts per million by its equivalent combining weight. One equivalent per million of a cationic constituent, such as calcium, magnesium, sodium, or potassium, will exactly combine with an equivalent per million of an anionic constituent, such as bicarbonate, sulfate, chloride, fluoride, or nitrate. Thus in any natural water containing dissolved solids the sum of the negative ions (anions) would equal the sum of the positive ions (cations) in terms of equivalents. These comparisons cannot be made when the constituents are expressed in parts per million. Equivalents per million are useful in that waters differing widely in

TABLE 28. ANALYSES OF WATER IN CUYAHOGA COUNTY

Analyzed by Quality of Water Branch, U. S. Geological Survey

GROUND WATER

Well No. a/	Principal water bearing bed e/		Date of collection	Temperature (°F.)	Color	pH	Chemical Constituents in Parts Per Million																
	Character of material	Geologic horizon					Specific conductance (micromhos at 25° C.)	Silica (SiO_2)	Iron (Fe) b/	Manganese (Mn) b/	Calcium (Ca)	Magnesium (Mg)	Sodium (Na)	Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids	Hardness as $CaCO_3$ Total	Hardness as $CaCO_3$ Non-carbonate
Middleburg T. —21	G	Gla	1-15-52	—	0	8.3	923	7.3	0.14	—	2.2	1.5	221	1.2	490 c/	1.2	54	0.5	0.1	549	11	0
Newburg T. —38	G	Gla	1-18-52	53	3	7.5	868	7.4	5.7	0.21	128	34	21	4.3	328	206	23	.1	.3	615	459	190
Warrensville T. —20	G	Gla	1-18-52	—	7	7.6	724	6.6	2.7	.08	65	28	54	3.2	509	5.4	6.0	.6	.2	401	276	0
Bedford T. —80	S	Gla	1-17-52	—	2	7.5	684	19	2.4	.07	86	37	15	2.3	442	46	1.6	.3	.7	405	367	4
Solon T. —33	S	Gla	1-17-52	—	0	7.4	935	17	.90	.08	101	51	54	6.8	485	179	3.0	.2	.1	630	462	64
Solon T. —4	S	Gla	1-17-52	—	3	7.6	679	17	1.7	.00	59	41	27	2.4	416	41	1.8	.3	.3	393	314	0
Solon T. —54	S	Gla	1-17-52	52	25	7.7	781	3.4	1.2	.00	11	2.4	165	4.8	313	3.7	100	.6	.1	440	38	0
Chagrin Falls T. —6	G	Gla	1-17-52	—	7	6.6	442	6.2	1.1	.00	51	17	8.2	.3	112	100	18	.1	3.4	274	198	105
Mayfield T. —74	G	Gla	1-16-52	51	0	7.5	841	20	1.5	.00	119	43	13	2.5	434	151	3.0	.1	.1	565	474	118
Brecksville T. —83	Ss	Shar	11-21-51	52	3	7.3	881	15	.43	.19	128	50	13	2.0	360	249	2.2	.1	.1	660	524	230
Orange T. —41	Ss	Shar	1-17-52	52	2	7.0	411	11	2.2	.22	57	11	8.9	3.0	141	58	15	.1	22	254	188	72
Strongsville T. —15	Sh	Cuy	1-15-52	—	0	7.5	604	11	.27	.08	27	14	93	5.8	308	50	19	.2	2.8	362	126	0
Strongsville T. —45	Sh	Cuy	1-15-52	52	0	7.3	1,180	19	1.3	.00	123	70	61	2.2	539	283	3.5	.4	.1	844	597	153
Royalton T. —31	Sh	Cuy	1-15-52	—	3	7.8	2,190	10	.32	.00	45	16	436	5.4	298	682	111	.6	4.9	1,449	176	0
Royalton T. —45	Sh	Cuy	1-15-52	—	3	7.4	1,450	18	1.1	.00	201	94	48	8.2	532	519	24	.2	3.7	1,245	889	452
Brecksville T. —5	Sh	Cuy	1-14-52	—	6	7.6	4,460	6.6	.20	.00	12	3.5	1,000	3.9	704	263	935	1.2	3.9	2,576	44	0
Brecksville T. —33	Sh	Cuy	1-14-52	—	2	7.2	634	18	1.4	.06	86	31	12	2.7	365	67	3.0	.1	.0	400	344	43
Orange T. —97	Sh	Cuy	1-16-52	—	2	7.8	566	18	.94	.01	55	20	47	5.3	394	8.6	1.5	.2	.1	331	221	0
Dover T. —41	Ss	Ber	1-15-52	—	3	7.2	568	17	17	.31	54	15	48	2.8	222	81	28	.3	.1	359	196	15
Middleburg T. —34	Ss	Ber	1-15-52	52	2	7.6	439	15	1.0	.13	67	15	6.4	.6	206	63	6.5	.2	.1	283	229	60
Parma T. —8	Ss	Ber	1-18-52	52	6	7.2	383	18	3.2	.82	16	12	43	2.3	137	65	5.8	.4	.3	228	90	0
Olmsted T. —50	Ss	Ber	1-15-52	—	1	7.5	919	19	.80	.06	90	53	48	4.4	620	39	7.5	.1	.1	554	443	0
Royalton T. —1	Ss	Ber	1-15-52	53	5	7.5	1,700	8.4	.17	.00	56	34	288	4.0	474	223	211	.5	.1	1,060	280	0
Brecksville T. —82	Ss	Ber	1-14-52	52	-	7.8	1,870	8.9	.24	.00	3.2	1.0	424	3.6	505	304	144	.8	.4	1,145	12	0
Bedford T. —8	Ss	Ber	1-17-52	—	0	7.5	530	14	.60	.01	72	21	14	2.1	280	54	12	.2	.7	308	265	37
Bedford T. —39	Ss	Ber	1-17-52	—	5	7.6	641	16	.18	.06	60	24	40	2.8	369	29	14	.3	.3	364	250	0
Cleveland T. —1	Ss	Ber	1-16-52	55	1	7.0	456	16	3.5	.45	57	13	20	1.8	179	66	24	.2	.1	286	196	49
Warrensville T. —23	Ss	Ber	1-18-52	52	5	8.7	937	6.1	.13	.05	3.0	1.8	201	2.7	383 d/	119	21	.2	.2	564	15	0
Orange T. —77	Ss	Ber	1-17-52	53	3	7.7	498	12	1.2	.00	28	15	66	3.5	301	21	10	.2	1.6	294	132	0
Chagrin Falls T. —10	Ss	Ber	1-17-52	—	2	7.7	846	13	1.4	.09	65	24	97	5.8	424	130	3.0	.3	.2	529	260	0
Rockport-Westlake T. —1	Sh	P-B	1-15-52	52	0	7.6	12,000	6.4	.54	.00	72	31	2,974	4.2	1,124	1.3	3,875	.3	.2	7,404	308	0
Olmsted T. —63	Sh	P-B	1-15-52	53	3	7.4	502	13	5.5	.31	34	10	57	3.0	149	67	44	.4	.1	296	125	4
Orange T. —64	Sh	P-B	1-16-52	—	2	7.8	698	11	1.0	.00	26	11	123	5.0	373	63	13	.4	1.2	430	111	0
Mayfield T. —26	Sh	P-B	1-16-52	53	3	7.2	545	15	8.5	.60	67	18	31	3.7	340	5.6	18	.1	.1	318	241	0
Euclid T. —12	Sh	P-B	1-16-52	51	0	7.4	1,420	8.9	.43	.25	26	24	275	3.9	391	419	17	.3	3.9	969	163	0
Euclid T. —20	Sh	P-B	1-16-52	51	4	7.8	1,110	7.7	.46	.01	16	8.5	213	4.6	260	88	168	.4	14	644	74	0

a/ Locations of wells shown on index maps.
b/ Samples for iron and manganese determination filtered at time of sampling.
c/ Includes equivalent of 13 parts per million carbonate (CO_3).
d/ Includes equivalent of 17 parts per million carbonate (CO_3).
e/ Abbreviations: G: gravel; S: sand; Ss: sandstone; Sh: shale; Gla: glacial drift; Shar: Sharon conglomerate; Cuy: Cuyahoga group; Ber: Bera sandstone; P-B: the pre-Berea shale formations (i.e. Bedford, Ohio, and Chagrin shale formations).

TABLE 28 (Continued). ANALYSES OF WATER IN CUYAHOGA COUNTY

Analyzed by Quality of Water Branch, U. S. Geological Survey

SURFACE WATER [f]

Collection Point	Dates	Temperature (°F.)	Oxygen consumed: Unfiltered	Oxygen consumed: Filtered	Color	pH	Specific conductance (micromhos at 25°C.)	Silica (SiO_2)	Iron (Fe)	Copper (Cu)	Chromium (Cr)	Calcium (Ca)	Magnesium (Mg)	Sodium (Na) and Potassium (K)	Bicarbonate (HCO_3)	Sulfate (SO_4)	Chloride (Cl)	Fluoride (F)	Nitrate (NO_3)	Dissolved solids	Hardness as $CaCO_3$: Total	Hardness as $CaCO_3$: Noncarbonate
							Chemical Constituents in Parts Per Million															
Rocky River at Puritas Spring Road—Cleveland.	3/50 to 2/51[g]	—	5.9	4.4	12	7.9	525	5.4	0.06	0.00	0.00	51	15	33	105	112	38	0.20	3.7	328	189	103
Cuyahoga River at Bridge at Station Road—Brecksville	3/50 to 2/51[h]	—	9.1	6.9	18	7.6	697	7.1	.10	.00	.00	62	14	61	133	110	83	.40	4.5	425	212	103
Cuyahoga River at Center Street Bridge—Cleveland	3/50 to 2/51[i]	64	10	5.7	12	7.3	728	7.9	.82	.00	.00	68	14	58	100	174	61	1.2	.7	441	227	145

[f] Arithmetical averages.
[g] Daily 3/1/50— 8/31/50—Monthly 9/50 to 2/51.
[h] Daily 3/1/50—10/31/50—Monthly 11/50 to 2/51.
[i] Daily.

concentration but similar in chemical character or composition may be grouped together. Thus the unit of expression is a helpful guide to the solution of geologic problems involving chemical processes.

Temperature

The temperature of natural waters is related to the atmospheric temperature of the area considered. The temperature of ground water approximates the mean annual air temperature, regardless of season, except near the ground surface where the water temperature is affected by seasonal temperature variations; at greater depths the water has a higher temperature, corresponding to the higher temperature of the earth. In Cuyahoga County ground-water temperatures at the time of collection of the samples ranged between 51° F and 53° F.

Surface-water temperatures are regulated by the air temperature, by the seasonal precipitation, and locally by the proportion of ground water that is contributed to streamflow. The temperature of surface water is increased by water used for cooling purposes as well as by sewage and some industrial wastes. The mean annual temperature of the Cuyahoga River at the Center Street Bridge, Cleveland, for the year beginning in March 1950 was 64° F; the maximum observed temperature was 89° F on August 1 and September 1, 1950, and the minimum observed temperature was 39° F on December 9, 1950, and February 14, 1951.

Water with a consistently low temperature is preferred for cooling and air-conditioning purposes. In this respect ground water is generally superior to surface water.

Color

In water analyses, color refers to the appearance of the water free of suspended solids. The color of natural water is caused primarily by organic matter derived from decaying plants and, in polluted water, from sewage and industrial wastes.

pH

The degree of acidity and alkalinity is expressed as pH. A pH of 7 indicates that the water is neither acid nor alkaline. Values lower than 7 denote increasing acidity and values higher than 7 denote increasing alkalinity. In Cuyahoga County the natural ground water is generally alkaline, and its range in pH is from 6.6 to 8.7.

The corrosiveness of water causes the deterioration of water pipes, steam boilers, water heaters, and other metallic equipment. The pH of water indicates its activity on metal surfaces. Some water that does not appreciably corrode cold-water lines will corrode hot-water lines. The principal constituents in water that cause corrosion of metals are free acid, acid-generating salts, and dissolved gases, such as oxygen, carbon dioxide, and hydrogen sulfide. Very soft water of low mineral content is frequently more corrosive than water of moderate mineral content and hardness.

Specific Conductance

The specific conductance of a water is a measure of its ability to conduct an electrical current. Specific conductance is the reciprocal of the resistance in ohms measured between two electrodes (1 centimeter square placed 1 centimeter apart in the water) at a specified temperature. Simply it is this: water with chemicals or minerals that ionize in solution will conduct an electric current. The greater the concentration of chemicals and their degree of ionization the greater is the specific conductance. Changes in mineralization of water, in surface streams for example, can be detected quickly by changes in the specific conductance.

Silica (SiO_2)

Silica is dissolved from practically all rocks. Most natural waters contain 5 to 30 parts per million of silica. Silica affects the usefulness of water since it contributes to the formation of boiler scale. It is particularly troublesome in high-pressure boilers. The hard silica scale prevents the rapid transfer of heat and thus causes boiler tube failure. It also forms deposits on the blades of steam turbines. Some silica in water is advantageous when zeolite softening is employed. The silica in the water helps prevent the deterioration of the zeolite materials by inhibiting the solution of silica from the zeolite.

Iron (Fe) and Manganese (Mn)

Iron is found in natural water because it is present in practically all rocks. Frequently it is dissolved from iron pipes through which the water flows. Iron is objectionable in that is makes reddish-brown stains on porcelain or enameled ware and on clothing when it exceeds the concentration of about 0.3 part per million. It is also troublesome in water used for many industrial purposes, including the manufacture of food, carbonated beverages, beer, textiles, dyed fabrics, high-grade paper, and ice. Manganese in water has about the same objectionable characteristics as iron but its presence is not as widespread. Iron and manganese may be removed by appropriate treatment of the water.

Calcium (Ca) and Magnesium (Mg)

Calcium is dissolved from practically all rocks, but especially from limestone, dolomite, and gypsum. Calcium carbonate is only slightly soluble in pure water but it is appreciably soluble in water containing carbon dioxide. Calcium and magnesium make water hard and are largely responsible for the formation of boiler scale.

Sodium (Na) and Potassium (K)

All natural waters contain sodium and potassium dissolved from rocks and soils, but usually these constituents make up only a small part of the dissolved mineral matter in natural unpolluted surface water in humid regions. The sodium content of some surface water is increased by polluting materials and this is noticeable in the lower Cuyahoga and Rocky Rivers. Ground water contains variable quantities of sodium salts, ranging from a few parts per million to excessive quantities.

Carbonate (CO_3) and Bicarbonate (HCO_3)

Bicarbonate occurs in natural water largely through the action of carbon dioxide, which enables the water to dissolve the carbonates of calcium and magnesium. Carbonate is not present in most natural surface water and is usually not present in ground water in this area. Bicarbonate in water from siliceous rocks and soils may be less than 10 parts per million; water from limestone contains as much as 400 parts per million; and water in contact with carbonates or bicarbonates or sodium may carry 1,000 or more parts per million of bicarbonate. Bicarbonate and carbonate in water increase the pH value and tend to make the water less corrosive for some purposes. However, bicarbonates may break down in steam boilers and hot-water systems and release corrosive carbon dioxide. Bicarbonate or carbonate aids coagulation in the removal of suspended matter from water. In Cuyahoga County the bicarbonate content of the ground water generally ranges from 200 to 500 parts per million.

Sulfate (SO_4)

Sulfate is dissolved from rocks and soils, and in large quantities from gypsum, anhydrite, and deposits of sodium sulfate. Sulfate in water that contains calcium and magnesium causes the formation of hard scale in steam boilers. It may increase the cost or influence the choice of the method of softening the water. In ice manufacture, calcium sulfate may cause the formation of white butts in the core.

Chloride (Cl)

Chloride is dissolved from rocks and soils. Natural surface water in humid regions is usually low in chloride, but polluted water in any region may have a high chloride content. Ground water may contain chloride derived from connate water (water contained in the rocks at the time of deposition).

Small quantities of chloride have little effect on the use of water. Large quantities, in water that contains considerable calcium and/or magnesium, increase the corrosiveness of the water. Large quantities of soluble salts such as sodium chloride cause foaming and priming in steam boilers. Sodium chloride gives the characteristic salty taste to water that is generally detectable when the sodium chloride content in terms of chloride exceeds about 250 parts per million.

Fluoride (F)

Fluoride has been reported to be present in some rocks to the same extent as chloride. However, it is present in natural water in much smaller quantities than chloride. Considerable evidence indicates that about 1 part per million of fluoride in water decreases the incidence of dental caries (decay of teeth) when the water is consumed by children during calcification or formation of the teeth. However, fluoride in water exceeding about 1.5 parts per million is associated with dental fluorosis, a permanent staining of the teeth, when the water is used for drinking by children (Dean, 1936).

Nitrate (NO_3)

Nitrate in excess of 10 parts per million may indicate contamination by sewage or other organic matter. Other sources of nitrate in surface water are wastes from industrial processing, return drainage from irrigation, and fertilizers. Nitrate is of importance in the inhibiting of intercrystalline cracking of boiler steel. Because the nitrate is concentrated in the boiler, as little as 2 parts per million in the feed water may be sufficient to protect the boiler steel.

Dissolved Solids

The quantity reported as dissolved solids (the residue after evaporation) consists of the dissolved constituents in the water. It usually consists primarily of the dissolved mineral constituents, but it also includes the organic matter and water of crystallization when dehydration is incomplete. The quantity of dissolved solids is determined by evaporating a given quantity of the clear water and weighting the residue after it has been dried for 1 hour or more at 180° C.

Water containing less than 500 parts per million of dissolved solids is used for domestic and many industrial purposes. In industrial processes where chemical quality is critical, much lower concentrations than 500 parts per million are necessary. In other processes, such as cooling, the permissible concentration may be higher. Water with more than 1,000 parts per million of dissolved solids is likely to be unsuitable for most purposes.

Hardness

Hardness of water is recognized by the quantity of soap required to produce a lather. Soap is precipitated by polyvalent metallic ions such as calcium, magnesium, iron, manganese, aluminum, barium, and strontium, and by hydrogen ions. However, hardness of water is caused primarily by calcium and magnesium.

The results for hardness given in the tables is reported in parts per million as calcium carbonate ($CaCO_3$) equivalent to the calcium and magnesium. The hardness caused by bicarbonate or carbonate of calcium and magnesium is called carbonate hardness; the balance of the hardness of the water is called noncarbonate hardness.

Among the industries requiring soft water are laundries, power plants, railroads, textile processing and dyeing concerns, food processing plants, and manufacturers of certain grades of paper. Hardness is objectionable because it results in the formation of scale in boilers, water heaters, radiators, and pipes, with a resulting loss in heat transfer, loss in flow, and possibility of boiler failure. It is objectionable in the home because it causes more soap to be used.

Water of hardness up to 60 parts per million is considered soft and is satisfactory for domestic purposes. Water with hardness in the range of 61 to 120 parts per million is considered moderately hard, but still may be used for many purposes. Water with hardness ranging from 121 to 200 parts per million is considered hard. Such hardness will be noticeable in the home, and the water will be unsatisfactory without softening for industrial processes in which hardness is of particular significance. Water with hardness above 200 parts per million is considered to be very hard. At many places such is used in the home, but it cannot be considered satisfactory. Softening is required for many industrial uses of the water. The hardness of ground and surface waters in Cuyahoga County generally ranges from 200 to 400 parts per million, although the analyses indicate that much harder water is encountered.

ELECTRICAL-RESISTIVITY MEASUREMENTS[1]

Field measurement of the apparent electrical resistivity of the subsurface materials were made at 20 sites in Cuyahoga County by the Geophysics Branch, U. S. Geological Survey. This was done to determine the character of the unconsolidated deposits and the types and depths of the consolidated rock formations where other data were not available.

The electrical resistivity of a material, usually measured in ohm-centimeters, is related to the porosity of the material and to the chemical character of its fluid content; a coarse sand or gravel has a high resistivity compared to that of a clay or a shale; a material containing chemically pure water has a much greater resistivity than the same material containing water high in dissolved mineral constituents.

There are several limiting factors which occasionally make the interpretation of the measurements difficult. The resistivity of shale may be very similar to that of clay or glacial till, so similar, in fact, that is may be impossible to determine one formation from the other by the earth-resistivity method. The same difficulty holds true with sand as related to sandstone. In order that results might be as accurate as possible, test measurements of the resistivity of each of the gologic formations were made in the parts of the county where they are exposed. It must be brought out, however, that the lithologic as well as the chemical characteristics of a formation may vary in the distance between the point at which the individual formation is tested and the sites at which measurements were taken to, determine the depth to bedrock.

Measurements were taken with the earth resistivity apparatus, Gish-Rooney-type. The electrodes, copper-clad steel rods with steel driving heads, were pushed or driven into the earth to make contact for the potential and current measurements. Whenever contact with the earth was poor, the soil around the electrodes was wetted and tamped. A modification of the Lee variation of the Wenner electrode configuration was used to obtain the depth profiles.

A partial list of references describing electrical-resistivity methods and procedures is included under "General References," at the end of this report. The interpretations of the results obtained by these measurements are given in Table 29; the locations of the measurement sites are shown on the maps of the respective townships in the part of the report entitled "Ground Water Conditions in Specific Areas."

[1] Extracted in part from U. S. Geol. Survey Circ. 69, by H. C. Spicer, March 1950.

TABLE 29
Interpretation of Electrical-Resistivity Measurements

Township	Well No.	Depth, in feet below land surface From	To	Material
Brecksville	401	0	8	Sand, gravel, and clay
		8	11	Clay and sand
		11	23	Gravel
		23	96	Clay
		96	180	Shale
		180	400	Shale
	402	0	4	Gravel and clay
		4	5	Clay
		5	33	Gravel and clay
		33	60	Clay
		60	108	Sand
		108	325	Shale
Chagrin Falls	401	0	2	Soil
		2	9	Gravel and sand
		9	20	Clay and gravel
		20	33	Gravel and sand
		33	110	Clay
		110	180	Gravel and clay
		180	675	Shale
	402	0	7	Soil and clay
		7	13	Sand and gravel
		13	35	Clay and gravel
		35	125	Sand and gravel
		125	240	Clay
		240	700	Shale
Independence	401	0	4	Soil
		4	15	Clay
		15	75	Sandstone
		75	300	Shale
Orange	401	0	3	Soil
		3	13	Clay
		13	53	Gravel
		53	110	Clay and gravel
		110	600	Shale
	402	0	3	Soil
		3	13	Clay
		13	22	Gravel
		22	35	Clay
		35	95	Sand
		95	270	Clay and sand
		270	475	Shale

TABLE 29—Continued
Interpretation of Electrical-Resistivity Measurements

Township	Well No.	Depth, in feet below land surface From	To	Material
Orange	403	0	10	Clay and gravel
		10	19	Clay
		19	34	Sand
		34	137	Clay
		137	250	Gravel
		250	500	Shale
	404	0	5	Gravel and clay
		5	21	Sand
		21	115	Clay and gravel
		115	225	Clay
		225	400	Shale
Rockport and West Park	401	0	9	Soil and clay
		9	35	Gravel
		35	120	Clay
		120	340	Shale
Royalton	401	0	8	Sand, gravel, and clay
		8	11	Clay and sand
		11	23	Gravel
		23	96	Clay
		96	180	Shale
		180	400	Shale
	402	0	6	Soil and clay
		6	8	Clay
		8	32	Clay and sand
		32	135	Gravel
		135	450	Shale
Solon	401	0	15	Soil and clay
		15	19	Clay
		19	40	Gravel and clay
		40	60	Clay
		60	120	Gravel
		120	185	Clay
		185	450	Shale
	402	0	4	Soil
		4	7	Clay
		7	59	Gravel
		59	145	Clay and gravel
		145	325	Gravel
		325	700	Shale
Solon	403	0	10	Soil and clay
		10	45	Gravel
		45	130	Clay and gravel
		130	185	Gravel and clay
		185	500	Shale
	404	0	5	Soil and clay
		5	7	Clay
		7	23	Clay and gravel
		23	58	Clay
		58	145	Clay and gravel
		145	290	Clay
		290	420	Clay and gravel
		420	1000	Shale
	405	0	7	Soil and clay
		7	14	Clay
		14	28	Sand and gravel
		28	94	Gravel and clay
		94	250	Clay and gravel
		250	1000	Shale
	406	0	6	Soil and clay
		6	7	Clay
		7	42	Gravel and clay
		42	51	Clay
		51	220	Sand and gravel
		220	700	Shale
	407	0	4	Soil and clay
		4	7	Clay
		7	36	Gravel and clay
		36	240	Sand and clay
		240	500	Gravel and clay
		500	700	Shale
	408	0	5	Soil
		5	230	Clay and gravel
		230	520	Gravel and sand
		520	850	Shale

SUMMARY

GROUND WATER

Plate 2 is a general guide to the water resources of Cuyahoga County. The best ground-water area in the county is in the Mill Creek valley, where a sand-and-gravel deposit of Illinoian age is recharged by Mill Creek. A well (Newburg T. 5) drilled for the Cleveland Chain & Manufacturing Co., yielded 1,500 gallons per minute with a drawdown of 6 feet. The company has three wells, which together yield approximately 1½ million gallons of water a day. It is not possible to give a quantitative estimate of the ground-water resources of the Mill Creek area, but its potential yield is far greater than the present pumpage.

The other buried valleys in the county also contain sand and gravel deposits but these are in the form of lenses and generally are not thick enough nor large enough to be productive of large ground-water supplies. Infiltration to these gravels from surface streams is impeded by intervening clay layers. Consequently, the sustained yields of wells in the sand and gravel lenses are much less than those of wells that receive recharge from streams.

The two sandstone aquifers in the county (the Sharon conglomerate and the Berea sandstone) provide a good source of ground water, and they yield as much as 250 gallons per minute to large wells. The shales and interbedded sandstones of the Cuyahoga group generally yield sufficient water for domestic requirements.

The Bedford, Ohio, and Chagrin shales are poor sources of ground water. Wells in these formations commonly yield 2 to 3 gallons per minute, but many are total failures regardless of depth. Brine is reported in the logs of oil and gas wells from the lower part of the Chagrin shale and the underlying formations.

SURFACE WATER

The streams that drain Cuyahoga County are the Cuyahoga River, the Rocky River, the Chagrin River, their tributaries, and several smaller streams that flow directly into Lake Erie. The Cuyahoga River has a good average flow and a high sustained dry-weather flow, and it is not seriously affected by floods or extreme droughts. A few of the small tributaries of the Cuyahoga River in Cuyahoga County have relatively high dry-weather flows, partly from sewage and other wastes and partly from ground-water inflow. These high sustained flows suggest possible ground-water sources. These streams are not suitable for the development of surface-water supplies.

The tributaries of the Cuyahoga River, Rocky River and its tributaries, and the several small streams that flow directly into the lake, are subject to extreme droughts and floods. The average flow in these streams is slightly below the average for the State, and considerable storage would be required to maintain surfacewater supplies from these sources. Cloudburst-type floods have occurred and will recur in Cuyahoga County. The Chagrin River has a high average flow and a good sustained flow in dry weather, but it is subject to extreme floods.

The best available source of surface water in Cuyahoga County, excluding Lake Erie, is the Cuyahoga River, so far as quantity and regularity of flow are concerned. By storing flood waters, the Chagrin River could be made an excellent source of supply. Other streams in the Cuyahoga County area are of limited utility for surface-water supplies because of their low dry-weather flows and extreme floods, and the large volumes of storage required to maintain continuous flows.

QUALITY OF WATER

In Cuyahoga County the rocks generally contain hard to very hard water with moderate to excessive amounts of dissolved constituents. Some of the waters are soft but these waters are not necessarily low in mineral content. There appear to be no notable differences in the characteristics of water, either between the different aquifers or within the areal distribution of any one aquifer.

The pH of all the samples examined, except one, was 7.0 or above, indicating an alkaline character of the water. Iron was present in all samples, ranging from 0.13 to 17 parts per million. The sodium content of the waters covered a wide range, from 6.4 to 2,974 parts per million. Bicarbonate also covered a wide range, from 112 to 1,124 parts per million. The sulfate content ranged from 1.2 to 682 parts per million. In general the chloride content was low. Dissolved solids ranged from 228 to 7,400 parts per million and total hardness from 11 to 889 parts per million.

Surface water is derived from surface runoff and also from ground-water discharge. Surface water generally contains, in varying amounts, the same mineral constituents found in the ground water. In addition, surface waters frequently contain suspended solids such as silt, clay, and organic material derived from the natural erosion or decomposition of soil or from pollution. The latter is a factor in the streams in Cuyahoga County, there being a progressive increase in pollution downstream.

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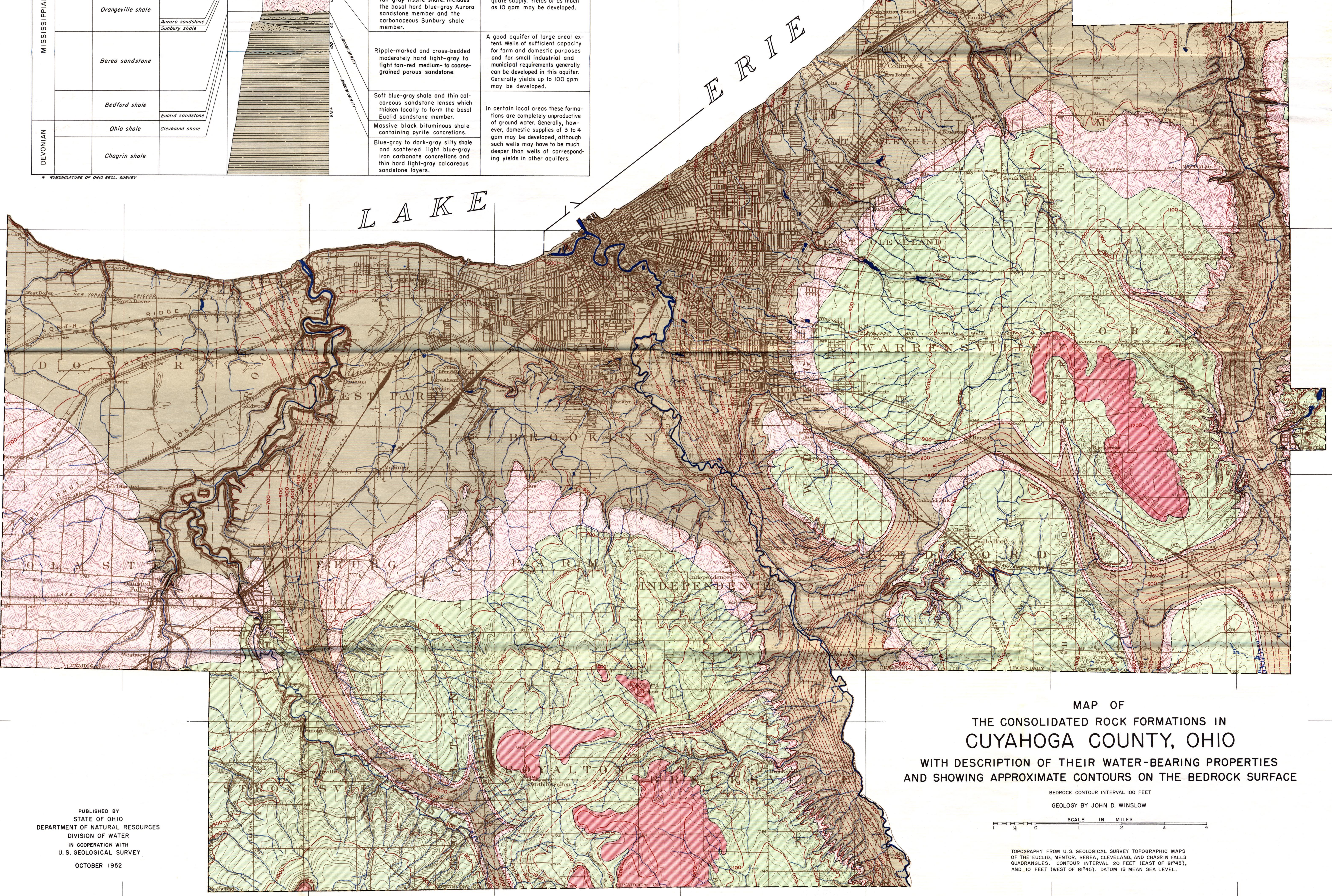
GENERALIZED GEOLOGIC SECTION OF THE CONSOLIDATED ROCKS EXPOSED IN CUYAHOGA COUNTY, OHIO

SYSTEM*	GROUP	FORMATION	MEMBER	CHARACTER OF MATERIAL	WATER BEARING CHARACTERISTICS
PENNSYLVANIAN		Sharon conglomerate		Ripple-marked and cross-bedded porous, poorly cemented, coarse- to medium-grained gray-white to light red-tan quartzose sandstone containing numerous pebbles in its basal portion.	Wells of sufficient yield for farm and domestic purposes and for small industrial and municipal requirements generally can be developed in this aquifer. Yields of as much as 125 gpm may be developed.
MISSISSIPPIAN	CUYAHOGA	Meadville shale		Medium- to dark-gray arenaceous shale alternating with hard thinly bedded blue-gray sandstone layers and zones of iron carbonate concretions.	Wells of sufficient yield for farm and domestic purposes generally can be developed in this aquifer. In the areas where this aquifer proves unsatisfactory, drilling to the underlying Berea sandstone usually produces an adequate supply. Yields of as much as 10 gpm may be developed.
		Sharpsville sandstone		Hard fine-grained blue-gray sandstone layers interbedded with blue-gray fissile shale.	
		Orangeville shale	Aurora sandstone Sunbury shale	Uniform soft dark blue-gray to tan-gray fissile shale. Includes the basal hard blue-gray Aurora sandstone member and the carbonaceous Sunbury shale member.	
		Berea sandstone		Ripple-marked and cross-bedded moderately hard light-gray to light tan-red medium- to coarse-grained porous sandstone.	A good aquifer of large areal extent. Wells of sufficient capacity for farm and domestic purposes and for small industrial and municipal requirements generally can be developed in this aquifer. Generally yields up to 100 gpm may be developed.
		Bedford shale	Euclid sandstone	Soft blue-gray shale and thin calcareous sandstone lenses which thicken locally to form the basal Euclid sandstone member.	In certain local areas these formations are completely unproductive of ground water. Generally, however, domestic supplies of 3 to 4 gpm may be developed, although such wells may have to be much deeper than wells of corresponding yields in other aquifers.
DEVONIAN		Ohio shale	Cleveland shale	Massive black bituminous shale containing pyrite concretions.	
		Chagrin shale		Blue-gray to dark-gray silty shale and scattered light blue-gray iron carbonate concretions and thin hard light-gray calcareous sandstone layers.	

* NOMENCLATURE OF OHIO GEOL. SURVEY



MAP OF THE CONSOLIDATED ROCK FORMATIONS IN CUYAHOGA COUNTY, OHIO

WITH DESCRIPTION OF THEIR WATER-BEARING PROPERTIES AND SHOWING APPROXIMATE CONTOURS ON THE BEDROCK SURFACE

BEDROCK CONTOUR INTERVAL 100 FEET

GEOLOGY BY JOHN D. WINSLOW

SCALE IN MILES

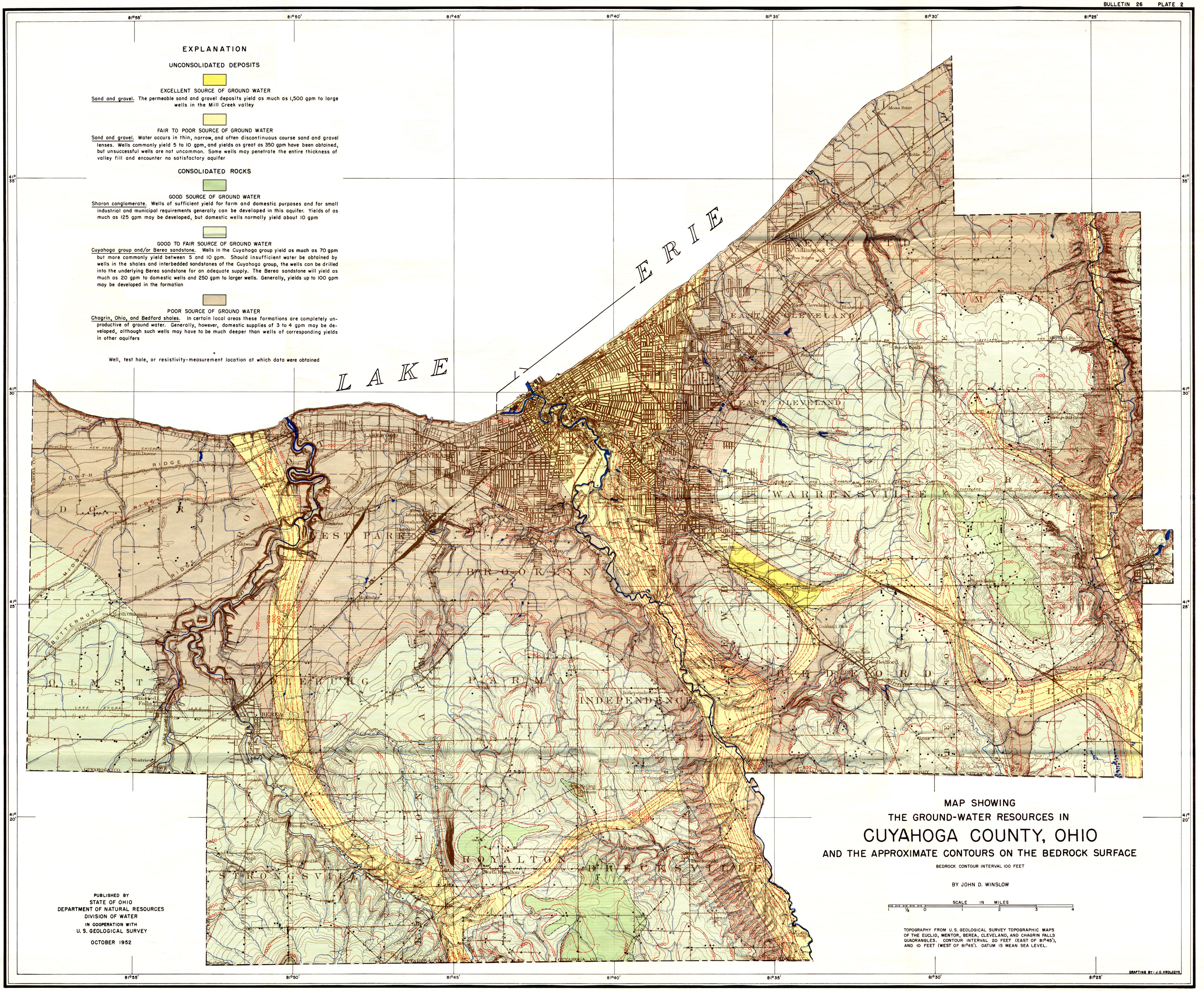
1 ½ 0 1 2 3 4

TOPOGRAPHY FROM U. S. GEOLOGICAL SURVEY TOPOGRAPHIC MAPS OF THE EUCLID, MENTOR, BEREA, CLEVELAND, AND CHAGRIN FALLS QUADRANGLES. CONTOUR INTERVAL 20 FEET (EAST OF 81°45'), AND 10 FEET (WEST OF 81°45'). DATUM IS MEAN SEA LEVEL.

PUBLISHED BY
STATE OF OHIO
DEPARTMENT OF NATURAL RESOURCES
DIVISION OF WATER
IN COOPERATION WITH
U. S. GEOLOGICAL SURVEY

OCTOBER 1952

DRAFTING BY - J. G. KROLCZYK



EXPLANATION
UNCONSOLIDATED DEPOSITS
EXCELLENT SOURCE OF GROUND WATER
Sand and gravel. The permeable sand and gravel deposits yield as much as 1,500 gpm to large wells in the Mill Creek valley
FAIR TO POOR SOURCE OF GROUND WATER
Sand and gravel. Water occurs in thin, narrow, and often discontinuous course sand and gravel lenses. Wells commonly yield 5 to 10 gpm, and yields as great as 350 gpm have been obtained, but unsuccessful wells are not uncommon. Some wells may penetrate the entire thickness of valley fill and encounter no satisfactory aquifer
CONSOLIDATED ROCKS
GOOD SOURCE OF GROUND WATER
Sharon conglomerate. Wells of sufficient yield for farm and domestic purposes and for small industrial and municipal requirements generally can be developed in this aquifer. Yields of as much as 125 gpm may be developed, but domestic wells normally yield about 10 gpm
GOOD TO FAIR SOURCE OF GROUND WATER
Cuyahoga group and/or Berea sandstone. Wells in the Cuyahoga group yield as much as 70 gpm but more commonly yield between 5 and 10 gpm. Should insufficient water be obtained by wells in the shales and interbedded sandstones of the Cuyahoga group, the wells can be drilled into the underlying Berea sandstone for an adequate supply. The Berea sandstone will yield as much as 20 gpm to domestic wells and 250 gpm to larger wells. Generally, yields up to 100 gpm may be developed in the formation
POOR SOURCE OF GROUND WATER
Chagrin, Ohio, and Bedford shales. In certain local areas these formations are completely unproductive of ground water. Generally, however, domestic supplies of 3 to 4 gpm may be developed, although such wells may have to be much deeper than wells of corresponding yields in other aquifers
Well, test hole, or resistivity-measurement location at which data were obtained
LAKE ERIE
DOVER
WEST PARK
BROOKLYN
OLMSTED
PARMA
INDEPENDENCE
WARRENSVILLE
BEDFORD
SOLON
ROYALTON
BRECKSVILLE
STRONGSVILLE
EAST CLEVELAND
MAP SHOWING
THE GROUND-WATER RESOURCES IN
CUYAHOGA COUNTY, OHIO
AND THE APPROXIMATE CONTOURS ON THE BEDROCK SURFACE
BEDROCK CONTOUR INTERVAL 100 FEET
BY JOHN D. WINSLOW
SCALE IN MILES
1 ½ 0 1 2 3 4
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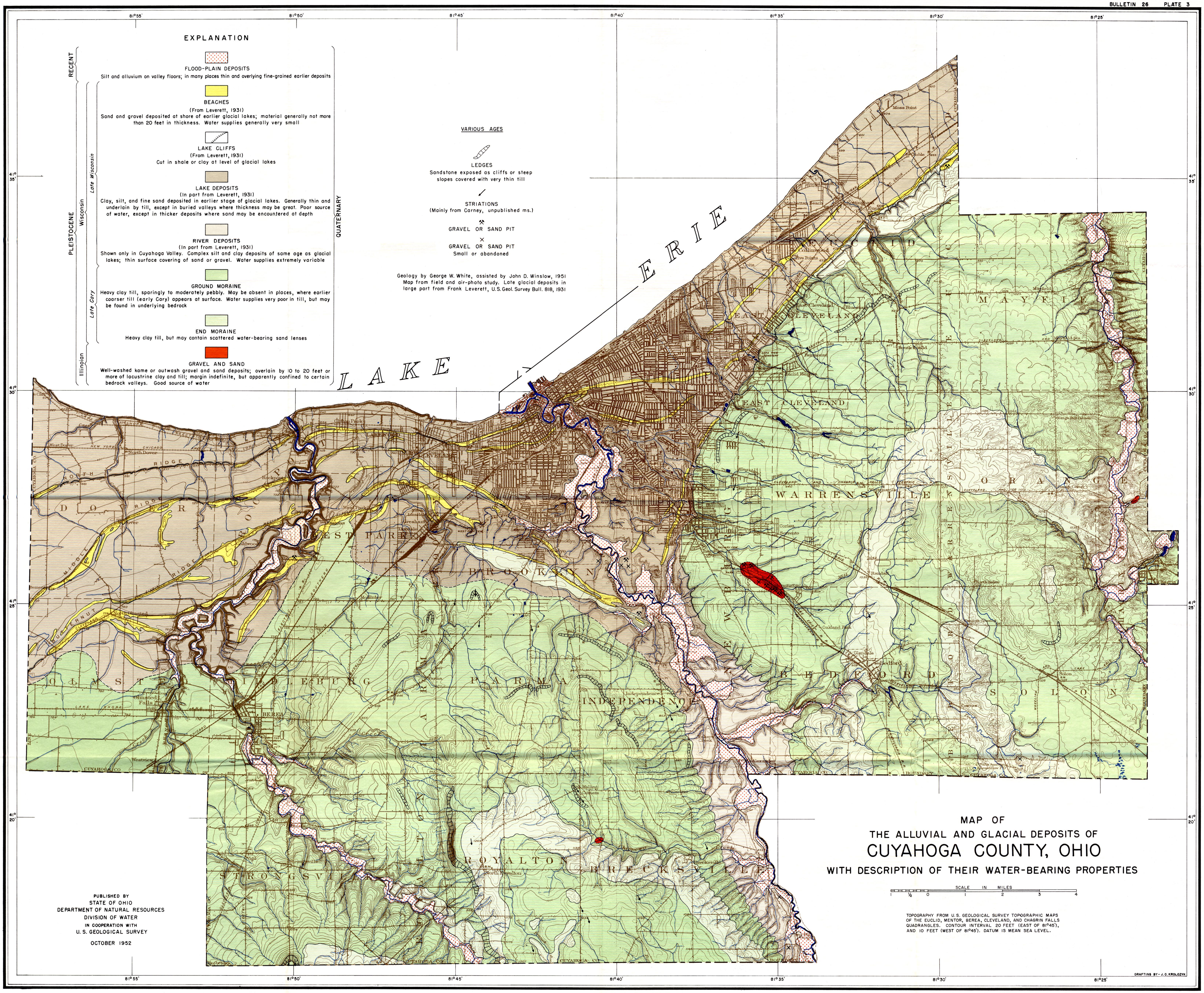
DRAFTING BY - J. C. KROLOZYK
81°55'
81°50'
81°45'
81°40'
81°35'
81°30'
81°25'
41° 35'
41° 30'
41° 25'
41° 20'


EXPLANATION
RECENT
FLOOD-PLAIN DEPOSITS
Silt and alluvium on valley floors; in many places thin and overlying fine-grained earlier deposits
BEACHES
(From Leverett, 1931)
Sand and gravel deposited at shore of earlier glacial lakes; material generally not more than 20 feet in thickness. Water supplies generally very small
LAKE CLIFFS
(From Leverett, 1931)
Cut in shale or clay at level of glacial lakes
LAKE DEPOSITS
(In part from Leverett, 1931)
Clay, silt, and fine sand deposited in earlier stage of glacial lakes. Generally thin and underlain by till, except in buried valleys where thickness may be great. Poor source of water, except in thicker deposits where sand may be encountered at depth
RIVER DEPOSITS
(In part from Leverett, 1931)
Shown only in Cuyahoga Valley. Complex silt and clay deposits of same age as glacial lakes; thin surface covering of sand or gravel. Water supplies extremely variable
GROUND MORAINE
Heavy clay till, sparingly to moderately pebbly. May be absent in places, where earlier coarser till (early Cary) appears at surface. Water supplies very poor in till, but may be found in underlying bedrock
END MORAINE
Heavy clay till, but may contain scattered water-bearing sand lenses
GRAVEL AND SAND
Well-washed kame or outwash gravel and sand deposits; overlain by 10 to 20 feet or more of lacustrine clay and till; margin indefinite, but apparently confined to certain bedrock valleys. Good source of water
PLEISTOCENE
Wisconsin
Late Wisconsin
Late Cary
Illinoian
QUATERNARY
VARIOUS AGES
LEDGES
Sandstone exposed as cliffs or steep slopes covered with very thin till
STRIATIONS
(Mainly from Carney, unpublished ms.)
GRAVEL OR SAND PIT
GRAVEL OR SAND PIT
Small or abandoned
Geology by George W. White, assisted by John D. Winslow, 1951
Map from field and air-photo study. Late glacial deposits in large part from Frank Leverett, U.S. Geol. Survey Bull. 818, 1931
LAKE ERIE
DOVER
OLMSTED
STRONGSVILLE
ROYALTON
BRECKSVILLE
PARMA
INDEPENDENCE
BROOKLYN
WEST PARK
EAST CLEVELAND
EUCLID
MAYFIELD
WARRENSVILLE
ORANGE
BEDFORD
SOLON
MAP OF
THE ALLUVIAL AND GLACIAL DEPOSITS OF
CUYAHOGA COUNTY, OHIO
WITH DESCRIPTION OF THEIR WATER-BEARING PROPERTIES
SCALE IN MILES
1 ½ 0 1 2 3 4
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81°55' 81°50' 81°45' 81°40' 81°35' 81°30' 81°25'
41° 35' 41° 30' 41° 25' 41° 20'