

ISWS/BUL-60(14)/75

BULLETIN 60-14

STATE OF ILLINOIS

DEPARTMENT OF REGISTRATION AND EDUCATION



*Public Groundwater Supplies
in Massac County*

by DOROTHY M. WOLLER

ILLINOIS STATE WATER SURVEY

URBANA

1975

PUBLIC GROUNDWATER SUPPLIES IN MASSAC COUNTY

by Dorothy M. Woller

Introduction

This publication presents all available information on production wells used for public groundwater supplies in Massac County. Bulletin 60, which is divided by county into separate publications, supersedes Bulletin 40 and its Supplements 1 and 2.

The definition of public water supply as contained in the Environmental Protection Act of 1970 was used to determine those water systems and wells to be included. Systems and wells described furnish water for drinking or general domestic use in: 1) incorporated municipalities; 2) unincorporated communities where 10 or more separate lots or properties are being served or are intended to be served; 3) state-owned parks and memorials; and 4) state-owned educational, charitable, or penal institutions.

This report includes separate descriptions for groundwater supplies of 3 municipalities and 1 water district in Massac County. These are preceded by brief summaries of the groundwater geology of the county and the development of groundwater sources for municipal use. An explanation of the format used in the descriptions is also given.

Acknowledgments. This report was prepared under the general direction of Dr. William C. Ackermann, Chief of the Illinois State Water Survey, and John B. Stall, Head of the Hydrology Section. The work was done under the direct guidance of William H. Walker, Hydrologist. Special thanks are given to J. P. Gibb, Assistant Engineer, who checked all of the data and reviewed the manuscript. Mrs. J. L. Ivens and Miss Nancy Scott edited the manuscript, Mrs. Suzi O'Connor typed the camera-copy, and John W. Brother, Jr., prepared the illustration. The chemical analyses, unless otherwise stated, were made by personnel of the Water Survey Chemistry Section under the supervision of Laurel M. Henley. The analyses made by personnel of the Illinois Environmental Protection Agency were under the supervision of Ira M. Markwood. Ross D. Brower, Assistant Geologist, Illinois State Geological Survey, reviewed the geological discussion. Grateful acknowledgment also is given to consulting engineers, well drillers, water superintendents, and municipal officials who have provided valuable information used in this report.

Geology

The geology of Massac County is described generally in Illinois State Geological Survey Circular 212, *Groundwater Geology in Southern Illinois*. The following brief discussion of geologic conditions in the county is taken largely from that publication. For a more detailed definition of the geology in this portion of the state, the reader is referred to the State Geological Survey which is located on the University of Illinois campus, Urbana.

The unconsolidated materials forming the present day land surface in Massac County range in thickness from about 5 ft in the upland areas to about 130 ft in the Cache River Valley. In the upland areas, wind blown silt (loess) and residual soils 5 to 25 ft thick are present and yield little or no water. In the bottomlands along the Cache and Ohio River Valleys, permeable sand and gravel deposits up to 50 ft in thickness are capable of yielding small to moderate municipal and industrial groundwater supplies.

Semi-consolidated deposits (Cretaceous) of sand and silt are present in the southern two-thirds of the county and are potential sources for moderate to large municipal and industrial supplies, particularly in the southern portions of the county. These materials range in thickness from a feather-edge along the northern boundary to 250 ft in the southern parts of the county. Locally, a chert gravel or limestone rubble is often present at the consolidated bedrock surface and can be a significant source of water for larger groundwater developments.

The consolidated bedrock units underlying Massac County are of Mississippian age and consist of shales, limestones, and sandstones of the Chester series in the north-eastern part and the Valmeyeran limestones in the south-western part of the county. Northeast trending faults have produced moderate vertical displacements of these units throughout the county. In the southern portions of the county, the Valmeyeran limestones are potential sources of municipal and industrial water supplies.

Groundwater Development for Municipal Use

Groundwater is used as a source of municipal water supply at Brookport, Joppa, Metropolis, and the Millstone Public Water District. The locations of these supplies are shown in figure 1.

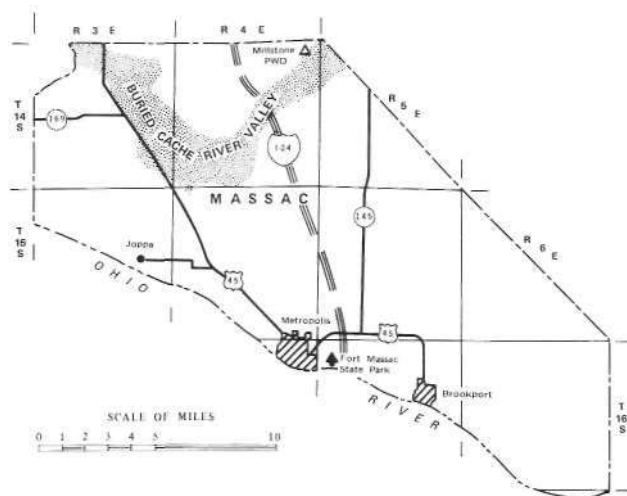


Figure 1. Location map of Massac County

Unconsolidated sand and gravel deposits associated with the Ohio and Cache River Valleys and semi-consolidated sand, silt, and gravel in the southern two-thirds of the county are tapped as sources of municipal water supplies for the city of Brookport, the Millstone Public Water District, and two wells (Nos. 1 and 2) at Metropolis. Seven public supply wells in Massac County presently tap these aquifers to depths ranging from 96 to 270 ft. Their reported yields range from 94 to 1000 gpm depending primarily on the type of well constructed and the permeability, thickness, and areal extent of the sand and gravel unit tapped by each well. Production from these wells in 1974 was estimated to be 1,070,000 gpd. Past and recent analyses of water they produce indicate that the iron content ranges from 0.3 to 3.4 mg/l and the hardness from 172 to 217 mg/l. Water for Brookport is fluoridated; water for Metropolis is chlorinated and fluoridated; and that for the Millstone Public Water District is lime softened, chlorinated, and fluoridated.

A consolidated limestone aquifer of Mississippian age is tapped by two of the city wells (Nos. 3 and 4) at Metropolis. This aquifer system is also tapped at Joppa as the primary source of supply. Four wells ranging from 240 to 448 ft deep, have been constructed in this aquifer during past years. Their reported yields range from 73 to 1800 gpm. The estimated production of these municipal wells was 795,000 gpd in 1974. Past and recent analyses of water they produce indicate that the iron content ranges from 0.3 to 3.6 mg/l and the hardness from 200 to 280 mg/l. Water for Joppa is untreated.

Format

In this publication the descriptions of public groundwater supplies are presented in alphabetical order by place name.

At the beginning of each description, the U.S. Census of population for 1970 is given for incorporated places. For unincorporated places, the population is estimated on the basis of the number of services or residential units and an assumed number of 3.5 persons per service.

The number of services and quantity of water distributed at each supply are given where available for the earliest and the latest reported values.

Individual production wells for each supply are described in the order of their construction. The description for each well includes the *aquifer tapped, date drilled, depth, driller, legal location, elevation in feet above mean sea level, log, construction features, yield, pumping equipment, and chemical analyses.*

When available, sample study logs by the Illinois State Geological Survey are presented. When these are not available, drillers logs are used as reported. Commonly used drillers terms such as clay, silt, or pebbly clay generally are synonymous with the glacial tills tabulated by the State Geological Survey.

The screen sizes given in this publication are for continuous slot screens. The slot sizes given indicate the width of the slot openings in thousandths of an inch. For example, a 20 slot screen has slot openings 0.020 in. wide and a 100 slot screen has openings 0.100 in. wide.

Abbreviations Used

est.....	estimated
ft.....	foot (feet)
gpd.....	gallons per day
gpm.....	gallons per minute
hp.....	horsepower
hr.....	hour(s)
in.....	inch(es)
Lab.....	laboratory
me/l.....	milliequivalents per liter
mg/l.....	milligrams per liter
min.....	minute(s)
No.(s).....	number(s)
OD.....	outside diameter
pc/l.....	picocuries per liter
R.....	range
rpm.....	revolutions per minute
T.....	township
TDH.....	total dynamic head

BROOKPORT

The city of Brookport (1046) installed a public water supply in 1907. One well (No. 2) is in use and another well (No. 1) is available for emergency use. In 1952 there were 450 to 500 services, none metered; the estimated average and maximum daily pumpages were 120,000 and 170,000 gpd, respectively. In 1974 there were about 400 services, none metered; the average and maximum daily pumpages were 129,000 and 216,000 gpd, respectively. The water is fluoridated.

Water was initially obtained from an 8-in. well completed in 1907 to a depth of 208 ft by John Woodworth, Brookport. The well was located about 27 ft south of Elizabeth St. and 65 ft west of Ohio St. In attempting to repair the well in 1917, a swedge block dropped into the well, lodged in an inverted position, and cut off the supply. Attempts to remove the block failed, a 2-in. hole was drilled through the block, and the well furnished about 20 gpm. In 1921 an attempt was made to dislodge the block with dynamite, but the casing broke about 65 ft below the surface and the well was abandoned.

WELL NO. 1 (East Well), finished in sand, was completed in 1921 to a depth of 207 ft by W. W. Elwood, Bay City. This well, which is available for emergency use, is located near the intersection of Elizabeth and Ohio Sts., adjacent to the City Hall, approximately 2950 ft S and 1950 ft W of the NE corner of Section 14, T16S, R5E. The land surface elevation at the well is approximately 333 ft.

A 6-in. diameter hole was drilled to a depth of 207 ft. The well is cased with 6-in. pipe to a depth of 189 ft followed by 18 ft of 5.2-in. special Cook screen.

Upon completion, the nonpumping water level was reported to be 20 ft below land surface, and in 1924, it was reported to be 30 ft.

During the Ohio River flood in 1937, the nonpumping water level was reported to be 20 ft below land surface until the flood stage exceeded the elevation at the top of the well and water entered the well at the top of the casing.

The pumping equipment presently installed is a 14-stage Diehl turbine pump set at 110 ft, rated at 120 gpm, and powered by a 7 1/2-hp U.S. electric motor.

A mineral analysis made by the Illinois Environmental Protection Agency (Lab. No. A102621) of a sample collected August 13, 1974, after pumping for 3 hr at 120 gpm,

showed the water to have a hardness of 210 mg/l, total dissolved minerals of 260 mg/l, and an iron content of 0.5 mg/l.

WELL NO. 2 (West Well), finished in sand, was completed in 1924 to a depth of 208 ft (measured in 1946 at 206.5 ft) by William Conley, Brookport. The well is located about 50 ft south and 80 ft west of Well No. 1, to the rear of the fire station, approximately 3000 ft S and 2030 ft W of the NE corner of Section 14, T16S, R5E. The land surface elevation at the well is approximately 330 ft.

An 8-in. diameter hole was drilled to a depth of 145 ft and finished 6 in. in diameter from 145 to 208 ft. The well is cased with 8-in. pipe to a depth of 145 ft, 6-in. pipe from 135 ft to about 190 ft, and 6-in. perforated pipe base Cook screen to 208 ft.

In January 1948, the well reportedly produced 133 gpm for 7 hr with no noticeable drawdown from a non-pumping water level of 20 ft below the top of the casing. In 1971, the nonpumping water level was reported to be about 15 ft. The pumping equipment presently installed is a 9-stage submersible turbine pump set at 147.5 ft, rated at 225 gpm, and powered by a 20-hp 1800 rpm U.S. Holloshaft electric motor.

The following mineral analysis made by the Illinois Environmental Protection Agency (Lab. No. B106417) is for a water sample from the well collected January 23, 1973, after 60 min of pumping at 247 gpm.

WELL NO. 2, LABORATORY NO. B106417

		mg/l	me/l			mg/l	me/l
Iron	Fe	0.48	0.00	Silica	SiO ₂	12	
Manganese	Mn	0.06	0.00	Fluoride	F	0.1	0.00
Ammonium	NH ₄	0		Boron	B		0.00
Sodium	Na	10	0.43	Nitrate	NO ₃	0	
Potassium	K	1.5	0.04	Chloride	Cl	4	0.11
Calcium	Ca	61	3.04	Sulfate	SO ₄	25	0.52
Magnesium	Mg	13	1.07	Alkalinity (as CaCO ₃)		194	3.88
Arsenic	As	0.00		Hardness (as CaCO ₃)		206	
Barium	Ba	0.0					
Copper	Cu	0.00		Total dissolved minerals		220	
Cadmium	Cd	0.00					
Chromium	Cr	0.00					
Lead	Pb	0.00		pH (as rec'd)		7.8	
Mercury	Hg	0.0000		Radioactivity			
Nickel	Ni	0.0		Alpha pc/l		2.8	
Selenium	Se	0.00		±deviation		1.4	
Silver	Ag	0.00		Beta pc/l		5.6	
Zinc	Zn	0.0		±deviation		1.6	

JOPPA

The village of Joppa (531) installed a public water supply in 1953. Two wells are in use. In 1955 there were 167 services, all metered; the average and maximum daily pumpages were 15,000 and 18,000 gpd, respectively. In

1972 there were 190 services, 50 percent metered; the estimated average daily pumpage was 50,000 gpd. The water is not treated.

WELL NO. 1, finished in limestone of Mississippian age,

was completed to a depth of 448 ft. The well is located about 1650 ft east of the business district, approximately 500 ft S and 500 ft E of the NW corner of Section 24, T15S, R3E. The land surface elevation at the well is approximately 360 ft.

A 10-in. diameter hole was drilled to a depth of 75 ft and finished 6 in. in diameter from 75 to 448 ft. The well is cased with 10-in. pipe from 0.5 ft above the pump-house floor to a depth of 75 ft and 6-in. pipe from 1 ft above land surface to an unknown depth.

A production test was conducted on December 9-10, 1952, by representatives of the village, the State Water Survey, and Rochester & Goodell, Consulting Engineers. After 24 hr of pumping at rates ranging from 73 to 91 gpm, the drawdown was 58.0 ft from a nonpumping water level of 31.0 ft below the pump base.

The pumping equipment presently installed is a Worthington vertical turbine pump (Serial No. A1411141) rated at 250 gpm at about 300 ft TDH and powered by a 30-hp 1750 rpm Fairbanks-Morse electric motor.

The following mineral analysis made by the Illinois Environmental Protection Agency (Lab. No. B106095) is for a water sample from the well collected January 16, 1973, after 8 hr of pumping at 190 gpm.

WELL NO. 1, LABORATORY NO. B106095

		mg/l	me/l			mg/l	me/l
Iron	Fe	2.4	0.09	Silica	SiO ₂	13	
Manganese	Mn	0.80	0.03	Fluoride	F	0.3	0.02
Ammonium	NH ₄	0.5	0.03	Boron	B	0.2	
Sodium	Na	8	0.35	Nitrate	NO ₃	0	
Potassium	K	2.0	0.05	Chloride	Cl	4	0.11
Calcium	Ca	75	3.74	Sulfate	SO ₄	10	0.21
Magnesium	Mg	20	1.64	Alkalinity (as CaCO ₃)		268	5.36
Arsenic	As	0.00		Hardness (as CaCO ₃)		269	
Barium	Ba	0.1		Total dissolved minerals		280	
Copper	Cu	0.04		pH (as rec'd)		7.9	
Cadmium	Cd	0.00		Radioactivity			
Chromium	Cr	0.00		Alpha pc/l		4.8	
Lead	Pb	0.00		±deviation		2.1	
Mercury	Hg	0.0000		Beta pc/l		7.1	
Nickel	Ni	0.0		±deviation		1.9	
Selenium	Se	0.00					
Silver	Ag	0.00					
Zinc	Zn	0.2					

WELL NO. 2, finished in limestone of Mississippian age, was constructed in September 1962 to a depth of 176 ft and reportedly deepened in March 1963 to a depth of 240 ft by the S & B Drilling Co., Metropolis. The well is located in the southeast part of the village, approximately 350 ft S and 400 ft W of the NE corner of Section 23, T15S, R3E. The land surface elevation at the well is approximately 320 ft.

A 10-in. diameter hole was drilled to a depth of 179 ft and finished 8 in. in diameter from 179 to 240 ft. The well is cased with 10-in. steel pipe from 1 ft above land surface to a depth of 179 ft.

Before deepening, a production test was conducted on

October 30, 1962, by representatives of the village and the State Water Survey. After 3 hr of pumping at rates of 172 to 160 gpm, the final drawdown was 73.0 ft from a non-pumping water level of 33.5 ft below land surface. Thirty min after pumping was stopped, the water level had recovered to 36.0 ft. On the basis of the production test data, it was estimated that this well would yield 150 gpm (216,000 gpd) on a long-term basis.

After deepening, a production test was conducted on April 10, 1963, by representatives of the village and the State Water Survey. After 4.6 hr of pumping at a rate of 100 gpm, the drawdown was 52.98 ft from a nonpumping water level of 25.12 ft below land surface. Fifteen min after pumping was stopped, the water level had recovered to 29.20 ft. On the basis of the production test data, it was estimated that this well would yield 100 gpm (144,000 gpd) on a long-term basis.

A drillers log of Well No. 2 follows:

Strata	Thickness (ft)	Depth (ft)
Soil	4.5	4.5
Gravel	59	104
Sand	30	134
Blue shale and mud	17	151
Broken lime with blue and gray mud	9	160
Blue mud and lime	5	165
Broken lime	11	176
Solid limestone	12	188
Broken limestone	10	198
Hard, solid limestone	10	208
Layers of solid limestone and broken stone	32	240

The pumping equipment presently installed consists of a 24-hp A. O. Smith electric motor, a 10-stage A. O. Smith turbine pump set at 157 ft and rated at 150 gpm, and 150 ft of 5-in. column pipe.

The following mineral analysis made by the Illinois Environmental Protection Agency (Lab. No. A102283) is for a water sample from the well collected August 7, 1974, after 1 hr of pumping at 90 gpm.

WELL NO. 2, LABORATORY NO. A102283

		mg/l	me/l			mg/l	me/l
Iron	Fe	1.0		Silica	SiO ₂	13	
Manganese	Mn	0.5		Fluoride	F	0.2	0.01
Ammonium	NH ₄	0.4	0.02	Boron	B	0.1	
Sodium	Na	8.4	0.36	Nitrate	NO ₃	0.0	0.00
Potassium	K	1.5	0.04	Chloride	Cl	3	0.08
Calcium	Ca	75	3.74	Sulfate	SO ₄	10	0.21
Magnesium	Mg	17	1.40	Alkalinity (as CaCO ₃)		250	5.00
Arsenic	As	0.00		Hardness (as CaCO ₃)		260	5.20
Barium	Ba	0.0		Total dissolved minerals		260	
Copper	Cu	0.00		pH (as rec'd)		7.1	
Cadmium	Cd	0.00		Radioactivity			
Chromium	Cr	0.00		Alpha pc/l		0.3	
Lead	Pb	0.00		±deviation		1.0	
Mercury	Hg	0.0000		Beta pc/l		2.2	
Nickel	Ni	0.0		±deviation		1.8	
Selenium	Se	0.00					
Silver	Ag	0.00					
Cyanide	CN	0.000					
Zinc	Zn	0.0					

METROPOLIS

The city of Metropolis (6940) installed a public water supply in 1892. Four wells (Nos. 1-4) are in use and another well (No. 5) is available for emergency use. In 1952 there were 2875 services, none metered. In 1972 there were 3300 services, none metered; the average daily pumpage was 1,481,450 gpd. The water is chlorinated and fluoridated.

Fort Massac State Park, located on the east edge of Metropolis and extending along the Ohio River for 3 miles, also obtains its water supply from this system.

Water was obtained from the Ohio River from 1892 to 1906. Since then the supply has been obtained from wells.

WELL NO. 1, finished in sand and gravel, was completed in 1906 to a reported depth of 270 ft. The well is located about 40 ft north of the center of Front St. and on the west side of Catherine St., approximately 650 ft S and 900 ft W of the NE corner of Section 11, T16S, R4E. The land surface elevation at the well is approximately 325 ft.

The well is cased with 8-in. pipe followed by 35 or 40 ft of brass screen.

In 1915 after pumping at 625 gpm, the drawdown was about 7 ft from a nonpumping water level of about 13 ft below land surface. In 1923, the well reportedly produced 1200 gpm for 12 hr and the water level was lowered to a depth of 25 ft below land surface. In 1937 and 1941, the nonpumping water level was reported to be 11 ft below land surface.

The pumping equipment presently installed consists of a 25-hp electric motor, a 5-stage Worthington turbine pump rated at 650 gpm, and 70 ft of column pipe. A 10-ft section of suction pipe is attached to the pump intake.

A mineral analysis made by the Illinois Environmental Protection Agency (Lab. No. A108494) of a sample collected December 19, 1973, after pumping at 500 gpm, showed the water to have a hardness of 199 mg/l, total dissolved minerals of 244 mg/l, and an iron content of 0.60 mg/l.

WELL NO. 2, finished in limestone of Mississippian age, was completed in 1924 to a depth of 420 ft by Fred M. Luth, St. Louis, Mo. The well is located about 50 ft southwest of Well No. 1, approximately 675 ft S and 925 ft W of the NE corner of Section 11, T16S, R4E. The land surface elevation at the well is approximately 325 ft.

A 12-in. diameter hole was drilled to a depth of 290 ft and finished 10 in. in diameter from 290 to 420 ft. The well is cased with 12.5-in. OD pipe to a depth of 290 ft, and 6 or 8 slots were ripped in the pipe at different elevations between 229 and 290 ft. Water from this well reportedly comes almost entirely from the sand and gravel deposits opposite the slotted pipe.

Upon completion, the well was reported to produce 1000 gpm and the nonpumping water level was 11 ft below land surface.

The pumping equipment presently installed consists of a 40-hp electric motor, a 9-stage Worthington turbine pump set at 110 ft and rated at 1000 gpm, and 100 ft of 8-in. column pipe. A 20-ft section of suction pipe is attached to the pump intake.

A mineral analysis made by the Illinois Environmental Protection Agency (Lab. No. A108493) of a sample collected December 19, 1973, after pumping at 1500 gpm, showed the water to have a hardness of 191 mg/l, total dissolved minerals of 242 mg/l, and an iron content of 0.75 mg/l.

A sample study and drillers log of Well No. 2 furnished by the State Geological Survey follows:

<i>Strata</i>	<i>Thickness (ft)</i>	<i>Depth (ft)</i>
PLEISTOCENE SYSTEM		
"Soil and clay, yellow"	31	31
Lafayette sand and gravel	26	57
CRETACEOUS SYSTEM		
Silt and silty sand	16	73
Sand, clean	10	83
Sand, silty, silt, and "clay"	42	125
Sand, fine, clean	22	147
"Clay and brown sand"	18	165
Sand, clean	30	195
Clay	25	220
"Sand, white, fine"	25	245
"Clay"	2	247
Sand and gravel, slightly silty	21	268
Gravel, coarse, clean	13	281
MISSISSIPPIAN SYSTEM		
St. Louis and Salem Formations		
"Limestone" (no water was encountered)	139	420

WELL NO. 3, finished in limestone of Mississippian age, was completed in July 1950 to a depth of 285 ft by the Diehl Pump & Supply Co., Louisville, Ky. The well is located east of the municipal electric plant, about 180 ft southwest of Well No. 1, approximately 800 ft S and 1000 ft W of the NE corner of Section 11, T16S, R4E. The land surface elevation at the well is approximately 310 ft.

A drillers log of Well No. 3 follows:

<i>Strata</i>	<i>Thickness (ft)</i>	<i>Depth (ft)</i>
Soil and clay	33	33
Sand and gravel, brown, coarse	26	59
Blue mud, sand and gravel, brown and fine	140	199
Blue mud	25	224
Blue mud, sand and gravel, white and fine	28	252
Blue mud	2	254
Honeycomb limestone	31	285

A 12-in. diameter hole was drilled to a depth of 285 ft. The well is cased with 12-in. steel pipe from 0.5 ft above the well house floor to a depth of 261 ft.

The pumping equipment presently installed is a Cook turbine pump rated at 1800 gpm and powered by a 40-hp electric motor.

The following mineral analysis made by the Illinois Environmental Protection Agency (Lab. No. A105933) is for a water sample from the well collected November 7, 1973, after pumping at 1000 gpm.

WELL NO. 3, LABORATORY NO. A105933

		mg/l	me/l			mg/l	me/l
Iron	Fe	0.49		Silica	SiO ₂	8.9	
Manganese	Mn	0.01		Fluoride	F	0.1	0.01
Ammonium	NH ₄	0.00	0.00	Boron	B	0.0	
Sodium	Na	6.4	0.28	Nitrate	NO ₃	0.0	0.00
Potassium	K	1.7	0.04	Chloride	Cl	5	0.14
Calcium	Ca	65	3.24	Sulfate	SO ₄	18	0.37
Magnesium	Mg	9.5	0.78	Alkalinity (as CaCO ₃)		187	3.74
Arsenic	As	0.00					
Barium	Ba	0.0		Hardness (as CaCO ₃)		202	4.04
Copper	Cu	0.02					
Cadmium	Cd	0.00		Total dissolved minerals		300	
Chromium	Cr	0.00					
Lead	Pb	0.00					
Mercury	Hg	0.0000		pH (as rec'd)		7.5	
Nickel	Ni	0.0		Radioactivity			
Selenium	Se	0.00		Alpha pc/l		4.8	
Silver	Ag	0.00		±deviation		1.5	
Cyanide	CN	0.000		Beta pc/l		5.3	
Zinc	Zn	0.0		±deviation		1.1	

WELL NO. 4 (Metropolitan Ice & Fuel Co. Well), finished in limestone of Mississippian age, was completed to a depth of 400 ft. This well was put in service for the city in 1952. The well is located at the south edge of town just east of the main street running through the old business section, approximately 1500 ft W and 100 ft S of the NE corner of Section 11, T16S, R4E. The land surface elevation at the well is approximately 335 ft.

The well is cased with 8-in. pipe from 4 ft above land surface to an unknown depth.

The pumping equipment presently installed is a Pomona turbine pump rated at 600 gpm and powered by a 40-hp electric motor.

The following mineral analysis made by the Illinois Environmental Protection Agency (Lab. No. A105932) is for a water sample from the well collected November 7, 1973, after pumping at 500 gpm.

WELL NO. 4, LABORATORY NO. A105932

		mg/l	me/l			mg/l	me/l
Iron	Fe	0.98		Silica	SiO ₂	8.4	
Manganese	Mn	0.02		Fluoride	F	0.2	0.01
Ammonium	NH ₄	0.00	0.00	Boron	B	0.0	
Sodium	Na	6.8	0.30	Nitrate	NO ₃	0.0	0.00
Potassium	K	1.0	0.03	Chloride	Cl	5.5	0.16
Calcium	Ca	63	3.14	Sulfate	SO ₄	20	0.42
Magnesium	Mg	10	0.82	Alkalinity (as CaCO ₃)		195	3.90
Arsenic	As	0.00					
Barium	Ba	0.0		Hardness (as CaCO ₃)		200	4.00
Copper	Cu	0.00					
Cadmium	Cd	0.00		Total dissolved minerals		288	
Chromium	Cr	0.00					
Lead	Pb	0.00					
Mercury	Hg	0.0000		pH (as rec'd)		7.5	
Nickel	Ni	0.0		Radioactivity			
Selenium	Se	0.00		Alpha pc/l		2.3	
Silver	Ag	0.00		±deviation		1.1	
Cyanide	CN	0.000		Beta pc/l		2.9	
Zinc	Zn	0.0		±deviation		0.9	

WELL NO. 5, finished in limestone of Mississippian age, was completed in May 1955 to a depth of 400 ft by the Layne-Western Co., Kirkwood, Mo. This well is available for emergency use. The well is located about 1.5 miles

northwest of Well No. 2, about 100 yards north of U.S. Highway 45 near the Massac Memorial Hospital, approximately 1200 ft N and 1750 ft E of the SW corner of Section 35, T15S, R4E. The land surface elevation at the well is approximately 360 ft.

A drillers log of Well No. 5 follows:

Strata	Thickness (ft)	Depth (ft)
Sandy yellow clay	48	48
Mixed gravel	37	85
Gravel and clay, blue to brown	5	90
Dark gray shale	15	105
Sand and gravel	15	120
Dark gray sandy shale	35	155
Soft white sand	5	160
Dark gray sandy shale	40	200
Soft white sand	33	233
Gray sand, lime, shale	2	235
White sand	6	241
Lime and sand	4	245
Lime and shale	5	250
Lime	4	254
Sand, lime, shale	6	260
Lime and sand	10	270
Lime and shale	15	285
Lime and sand	5	290
Gray shale and sand	10	300
Gray lime and sand	15	315
Lime and flint	5	320
Hard lime, flint streaks	16	336
Soft gray sand, heaving	1	337
Lime and flint	5	342
Gray sand, heaving	3	345
Lime, sand, and shale	2	347
Lime and flint	5	352
Sand, gravel, lime, shale	18	370
Sand, lime, flint, shale, boulders	8	378
Heaving sand, shale, gravel, lime, and boulders	22	400

A 16-in. diameter hole was drilled to a depth of 335 ft and finished 12 in. in diameter from 335 to 400 ft. The well is cased with 16-in. welded pipe from land surface to a depth of 243.3 ft, 12-in. threaded and coupled pipe from land surface to 335 ft, and 10-in. threaded and coupled pipe from 308 ft to 398 ft (the bottom 66 ft is slotted). The annulus between the 16-in. and 12-in. casings was pressure grouted with 205 sacks of cement.

A production test was conducted on May 16, 1955, by representatives of the driller, the city, the State Water Survey, and J. W. Blankinship, Consulting Engineer. After 6 hr of pumping at rates of 280 to 305 gpm, the final drawdown was 54 ft from a nonpumping water level of 35 ft below the top of the casing. Three min after pumping was stopped, the water level had recovered to 39 ft.

The pumping equipment presently installed is a Fairbanks-Morse turbine pump rated at 500 gpm and powered by a 60-hp Fairbanks-Morse electric motor.

A partial analysis of a sample (Lab. No. 155597) collected August 30, 1961, after pumping for 30 min at 520 gpm, showed the water to have a hardness of 202 mg/l, total dissolved minerals of 245 mg/l, and an iron content of 1.6 mg/l. Hydrogen sulfide also was apparent when this sample was collected.

MILLSTONE PUBLIC WATER DISTRICT

Millstone Public Water District (est. 4000) installed a public water supply in 1974. The Water District treatment plant is located 0.5 mile south of Reevesville and serves an area of 220 square miles which surrounds and includes Reevesville, Eddyville, and Golconda. Three wells (Illinois Central RR Well Nos. 1 and 3 and Millstone Well No. 1) are in use. In 1974 there were 780 services, all metered; the average and maximum daily pumpages were 200,000 and 360,000 gpd, respectively. The water is lime softened, chlorinated, and fluoridated.

The Illinois Central RR wells now owned by Millstone Public Water District were formerly used for locomotive watering. Starting in 1928, residents of Reevesville obtained water from the railroad water system. By 1957, locomotive watering was abandoned, but the railroad continued to furnish water to the residents until August 1969. At that time, the Reevesville Mutual Water Service organization was formed to maintain the water system for the residents until the Millstone Water District was completed.

ILLINOIS CENTRAL RR WELL NO. 1, finished in sand and gravel, was completed about 1926 to a depth of 96 ft by Illinois Central RR personnel. The well is located approximately 10 yards south of the southwest corner of the pumping station, approximately 1425 ft S and 2600 ft E of the NW corner of Section 1, T14S, R4E. The land surface elevation at the well is approximately 345 ft.

The following mineral analysis made by the Illinois Environmental Protection Agency (Lab. No. A113441) is for a water sample from the well collected March 27, 1974, after 3 hr of pumping at 200 gpm.

WELL NO. 1, LABORATORY NO. A113441

	<i>mg/l</i>	<i>me/l</i>		<i>mg/l</i>	<i>me/l</i>
Iron	Fe	3.0	Silica	SiO ₂	13
Manganese	Mn	0.14	Fluoride	F	0.2 0.01
Ammonium	NH ₄	0.8 0.04	Boron	B	0.05
Sodium	Na	7.3 0.32	Nitrate	NO ₃	0.0 0.00
Potassium	K	0.5 0.01	Chloride	Cl	2 0.0 6
Calcium	Ca	48 2.40	Sulfate	SO ₄	8 0.17
Magnesium	Mg	11 0.90	Alkalinity (as CaCO ₃)		184 3.68
Arsenic	As	0.02			
Barium	Ba	0.0	Hardness (as CaCO ₃)		172 3.44
Copper	Cu	0.0 0			
Cadmium	Cd	0.00	Total dissolved minerals		214
Chromium	Cr	0.00			
Lead	Pb	0.00			
Mercury	Hg	0.0002	pH (as rec'd)	7.6	
Nickel	Ni	0.0	Radioactivity		
Selenium	Se	0.00	Alpha <i>pci</i>	0.0	
Silver	Ag	0.00	± deviation	0.0	
Cyanide	CN	0.000	Beta <i>pci</i>	1.0	
Zinc	Zn	0.00	± deviation	0.1	

An 8-in. diameter hole was drilled to a depth of 96 ft. The well is cased with 8-in. pipe from 0.7 ft above the bottom of a 14-ft deep pit to a depth of 61.3 ft followed by 34.7 ft of 8-in. Cook screen.

On July 29, 1952, the well reportedly produced 103 gpm for 3 hr with a drawdown of 6.6 ft from a nonpumping water level of 13.2 ft below the top of the pit.

On September 19, 1955, after 5 hr of pumping at a rate of 150 gpm, the drawdown was 5.6 ft from a nonpumping water level of 14.7 ft below the top of the pit.

The pumping equipment presently installed consists of a 10-hp electric motor, a Worthington vertical turbine pump set at 56 ft and rated at 300 gpm, and 56 ft of 6-in. column pipe.

ILLINOIS CENTRAL RR WELL NO. 2, finished in sand and gravel, was completed about 1927 to a depth of 105.5 ft by E. L. Geer, Marion. The well, which is not in use, is located approximately 7 yards north of the northwest corner of the pumphouse, approximately 1350 ft S and 2600 ft E of the NW corner of Section 1, T14S, R4E. The land surface elevation at the well is approximately 345 ft.

The well is cased with 10-in. wrought iron pipe from 0.7 ft above the bottom of a 12-ft deep pit to a depth of 76.5 ft followed by 29 ft of 10-in. Cook screen.

On July 25, 1952, the well reportedly produced 94 gpm for 4 hr with a drawdown of 14.7 ft from a nonpumping water level of 10.5 ft below land surface. On September 27, 1955, after 5 hr of pumping at a rate of 150 gpm, the drawdown was 8.6 ft from a nonpumping water level of 12.8 ft below the top of the pit.

ILLINOIS CENTRAL RR WELL NO. 3, finished in sand and gravel, was completed in 1947 to a depth of 99 ft by Illinois Central RR personnel. The well is located 30 yards south of the pumping station, approximately 1500 ft S and 2600 ft E of the NW corner of Section 1, T14S, R4E. The land surface elevation at the well is approximately 345 ft.

A drillers log of Illinois Central RR Well No. 3 follows:

<i>Strata</i>	<i>Thickness (ft)</i>	<i>Depth (ft)</i>
Soft clay	31	31
Sand	6	37
Gravel	10	47
Coarse sand	16	63
Pea gravel	10	73
Coarse gravel	26	99

A 10-in. diameter hole was drilled to a depth of 99 ft. The well is cased with 10-in. pipe from 0.7 ft above the bottom of a 12.3-ft deep pit to a depth of 63.9 ft and equipped with 37 ft (overall length) of 10-in. No. 24 slot Cook screen.

On June 20, 1952, the well reportedly produced 110 gpm for 2 hr with a drawdown of 2.8 ft from a nonpumping water level of 6.8 ft. On September 30, 1955, the well reportedly produced 150 gpm for 4 hr with a drawdown of 3.2 ft from a nonpumping water level of 12.3 ft below the top of the pit.

A production test was conducted by Luhr Bros., Columbia, on January 6, 1972. After 2 hr of pumping at a rate of 390 gpm, the drawdown was 7.48 ft from a nonpumping water level of 9.25 ft below the top of the pit. Thirty min after pumping was stopped, the water level had recovered to 9.76 ft.

The pumping equipment presently installed consists of a 10-hp General Electric motor, a 6-in. Worthington vertical turbine pump set at 56 ft and rated at 300 gpm, and 56 ft of 6-in. column pipe.

A partial analysis of a sample (Lab. No. 187557) collected on January 6, 1972, after pumping for 2 hr at 390 gpm, showed the water to have a hardness of 176 mg/l, total dissolved minerals of 204 mg/l, and an iron content of 3.4 mg/l.

Prior to the construction of Millstone Well No. 1, a test hole was completed in January 1972 to a depth of 135 ft by Luhr Bros., Columbia. The test hole was located 55 ft west of the railroad center line and 33 ft south of Illinois Central RR Well No. 3. Upon completion, the nonpumping water level was reported to be 4.5 ft.

MILLSTONE WELL NO. 1, finished in sand and gravel, was completed in August 1972 to a depth of 115 ft by Luhr Bros., Columbia. The well is located 1 mile south of Reevesville, approximately 1800 ft S and 2550 ft E of the NW corner of Section 1, T14S, R4E. The land surface elevation at the well is approximately 345 ft.

A drillers log of Millstone Well No. 1 follows:

<i>Strata</i>	<i>Thickness (ft)</i>	<i>Depth (ft)</i>
Clay	33	33
Sand, very coarse	42	75
Sand and gravel	41	116

A 28-in. diameter hole was drilled to a depth of 116 ft. The well is cased with 12-in. pipe from 3 ft above land surface to a depth of 85 ft followed by 30 ft of 12-in. No. 60 slot Johnson stainless steel screen.

A production test with one observation well was conducted by the driller on August 14, 1972. After 4 hr of pumping at rates ranging from 844 to 882 gpm, the final drawdown was 9.30 ft from a nonpumping water level of 6.22 ft below land surface. Fifty min after pumping was stopped the water level had recovered to 7.18 ft.

The pumping equipment presently installed is a Worthington vertical turbine pump set at 74 ft, rated at 700 gpm, and powered by a 20-hp General Electric motor.