

ILLINOIS
—
STATE WATER SURVEY
—
BULLETIN NO. 34

SANDSTONE WATER SUPPLIES
OF THE
JOLIET AREA

ISSUED BY

STATE WATER SURVEY DIVISION

A. M. BUSWELL, Chief

URBANA, ILLINOIS

ORGANIZATION

STATE OF ILLINOIS
DWIGHT H. GREEN, *Governor*
DEPARTMENT OF REGISTRATION AND EDUCATION
FRANK G. THOMPSON, *Director*

Board of Natural Resources and Conservation Advisers.

FRANK G. THOMPSON, *Chairman*

Louis R. HOWSON, *Engineering*
EDSON S. BASTIN, *Geology*
E. J. KRAUS, *Forestry*

WILLMAN TRELEASE, *Biology*
ARTHUR C. WILLARD, *President of*
the University of Illinois,

State Water Survey Division Committee.

FRANK G. THOMPSON
ARTHUR C. WILLARD

LOUIS R. HOWSON

STATE WATER SURVEY DIVISION

A. M. BUSWELL, *Chief*

LETTER OF TRANSMITTAL.

STATE OF ILLINOIS

DEPARTMENT OF REGISTRATION AND EDUCATION
STATE WATER SURVEY DIVISION

URBANA, ILLINOIS, *December 15, 1941.*

Frank G. Thompson, Chairman, and Members of the Board of Natural Resources and Conservation:

GENTLEMEN: Herewith I submit a report entitled, "Sandstone Water Supplies of the Joliet Area" and recommend that it be published as Illinois State Water Survey Bulletin No. 34.

This report was prepared under the direct supervision of Mr. W. D. Gerber, Engineer, with the assistance of J. S. Gobble, V. H. Moore, H. E. Romine, and T. G. Lively, Assistant Engineers. Professor W. M. Lansford assisted in part of the organization of this report and Dr. T. E. Larson, Chemist for the State Water Survey, prepared and assembled the chemical data and prepared the discussion.

Respectfully submitted,

A. M. BUSWELL, *Chief.*

INTRODUCTION.

This report on the well water supplies in the Joliet-Wilmington-Morris area includes municipal and industrial well water supplies in Lockport, Stateville, Joliet, Eockdale, Kankakee Ordnance Works, Elwood Ordnance Plant, Wilmington, Braidwood, Morris, and Minooka (Figure 1). The report enumerates 49 supplies obtained from 92 wells, drilled into the St. Peter, Galesville and Mt. Simon sandstones, and 7 of shallower depths. It was not feasible to include in this report a large number of limestone wells.

The report was prompted by the increasing demand in the various municipalities accompanied by a steady recession of water level and the greatly increased demand occasioned by the construction of the Kankakee Ordnance Works and the Elwood Ordnance Plant some eight miles south of Joliet.

Much time and effort has been expended in collecting authentic historical data on these wells and it is believed the material here presented represents as true a report as can be compiled at this late date.

SOURCE OF THE WELL WATER SUPPLY.

Since a high percentage of the municipal and industrial supplies are obtained from wells penetrating the deep-lying sandstones and also because the high production schedules of these wells are known to produce changes in water levels over a considerable area, it was deemed best to confine this report to those wells penetrating the St. Peter, Galesville and Mt. Simon sandstones. To have included the very great number of wells which terminate in formations above the St. Peter sandstone would have added little if anything to the more important data on the performance of the high capacity sandstone wells.

The three water producing sandstones, namely the St. Peter, Galesville and Mt. Simon, underlie the surface for practically the entire area of the state but vary greatly from place to place in thickness, depth and yield. They have a gentle southerly slope from their absorption area in southern and central Wisconsin and rain and snow water falling on these areas is absorbed and moves down the slope into Illinois. The rate of movement is very slow. The normal rate of movement is generally accepted as about 100 feet per year or a mile in about 53 years. This means that the recharge of the storage or replacement of the water extracted is too slow to be of value to the user in Illinois regardless of the amount of precipitation on the absorption area.

The St. Peter sandstone is separated from the Galesville sandstone by a considerable thickness of impervious material, also there is considerable intervening material between the Galesville and the Mt. Simon sandstone. These intervening materials when undisturbed not only keep the sandstone separated but also the water that is stored in them.

It should be noted that the limestones above the St. Peter sandstone are water-producing to a varying degree depending on the extent to which they are cracked and creviced as the water is stored in these channel-like openings.

HYDROLOGY OF THE GROUND WATER.

Each formation has its own hydrostatic pressure at any particular location. That is to say not only is the hydrostatic pressure different for each formation but this pressure is not uniformly the same within each formation but varies from place to place.

When wells are drilled and every water-bearing formation is left open the resulting hydrostatic pressure is a balancing of the respective individual pressures and the resulting mineral quality is a blending of the respective qualities.

It is entirely possible to have a well penetrate a formation with a high hydrostatic pressure and a low yield capacity. It likewise is possible to have just an opposite condition.

In the area under consideration the St. Peter sandstone has a thickness of 150 to 200 feet and is found at a depth of 650 to 700 feet depending somewhat on the elevation of the ground surface at the well site. The static water level in a new well located outside the circle of influence of a producing well likely will be at a depth of 150 to 200 feet. The yield or rate of production may be as low as 75 gallons per minute and as high as 500 gallons per minute but these are extremes and the normal and safe pumping capacity of the St. Peter sandstone should be from 90 to 130 gallons per minute.

The Galesville sandstone has a thickness of around 100 to 250 feet and is found at a depth of 1350 feet or more. This formation is very prolific and production rates of as high as 1300 gallons per minute have been found at the time of the test, however, if possible, a rate of 500 to 600 gallons per minute would be better for daily operation. A wide circle of influence in wells of this depth have been observed as well as a considerable range in both static and operating water levels.

The Mt. Simon sandstone while prolific in yield produces a water that is generally undesirable for a public or industrial supply because of its high salt content, hence it is not usually penetrated. In fact in several instances it has been found necessary to plug back a number of wells that penetrated below the base of the Galesville sandstone in order to obtain a water that was of suitable character.

WATER RECESSION.

Early records of water levels in the deep sandstone wells at the Washington Street pumping station in Joliet indicate that the water level when the wells were not being pumped was 40 feet below the ground surface. When the new well, now known as well number 1, was drilled in 1937 non-pumping water level was reported at a depth of 270 feet. This represents a recession of 230 feet in 37 years or an average rate of 6.2 feet per year. Apparently the larger part of this recession

occurred during the latter 25 years, a period in which the water demands increased rapidly.

At Morris, Illinois the first well was drilled into the St. Peter sandstone in 1894. When completed the water level was above the ground surface. A second well into, the same aquifer was drilled in 1902 and a third in 1915. In 1927 the water level in well number 3 when it was not being pumped was 133 feet below the ground surface, representing a recession of 133 feet in 33 years, an average rate of 4 feet per year. In 1938 well number 4 was completed to a depth of 1501 feet and completely penetrated the Galesville sandstone. The St. Peter sandstone water was cased off and the non-pumping water level was reported at a depth of 16 feet. This indicates very clearly the independence observed in water levels or hydrostatic pressure in the separate aquifers.

Water levels have steadily receded in all the deep sandstone wells not only in the Joliet-Morris-Wilmington area but in the metropolitan area of Chicago and at other heavily pumped areas throughout the state. The recession of water levels represents a definite increase in pumping and maintenance costs. A detailed study of recessions in the Joliet area is in progress.

CHEMICAL CHARACTER OF THE WATER.

All available data indicate that water from any one formation at a particular location is of distinct composition which can be altered only by blending with water from other formations. The extent of the casing and effectiveness of sealing can control the mineral quality of the water to that available from any aquifer. For instance, wells drilled to the Mt. Simon sandstone are capable of influencing the mineral quality of wells in the immediate vicinity due to the high hydrostatic pressure forcing salt water into the upper aquifers of lesser hydrostatic pressure. The effectiveness of sealing such wells is important in controlling the mineral quality of nearby wells.

Any discussion of the mineral quality of sandstone waters in this territory necessitates first a consideration of waters from the upper limestone, shale and dolomite. These waters in and east of Joliet and Lockport are characterized by their high sulfate content and exceptional hardness. Table I illustrates the characteristic quality of these waters.

TABLE I.—MINERAL QUALITY OF LIMESTONE WATERS.

Owner.	Depth.	Chloride.	Sulfate.	Alkalinity.	Hardness.	Residue.
Runyan Subdivision.....	119	13	201	358	590	650
Pilcher Park.....	204	5	171	309	459	547
Marshall School— (1906).....	280	11	1421	790	2440	2647
(1940).....		16	739	438	1216	1499
Silver Cross Hospital.....	487	15	475	396	877	1096
Moore Stove Co.....	503	72	516	370	832	1300
Farm Bureau.....	246	50	242	312	562	777
Woodruff Building.....	400	3	41	372	280	457
Adler Packing Co.....	354	50	215	230	530	761
Porter Brewing Co.....	512	320	198	310	718	1289
Keeley.....	209	76	359	488	916	1065
Ring.....	130	131	282	534	882	1080
McKinley Park.....	105	26	193	360	600	718
Welsh Block Co.....	210	18	275	294	572	695

It is noted that most of these wells penetrate the Galena-Platteville dolomite. This high sulfate and hardness characteristic has also been noted for limestone wells northward at Western Springs, Westmont, and Mt. Prospect and eastward at Tinley Park, Flossmoor, Matteson, Chicago Heights and Thornton. As in Lake County,* occasional zones of soft water in limestone are present. Three wells in Sections 9, 21 (penetrating the Galena-Platteville dolomite) and 29 in T. 34 N., R. 9 E. are of 28, 91 and 28 parts per million hardness and 479, 373 and 807 parts per million mineral content, respectively. Eight other wells in the eastern third of this township and south of the river are of 122-484 parts per million sulfate content, 398-856 parts per million hardness, and 467-1152 parts per million mineral content.

In contrast are records of fourteen samples from wells (67-148 feet) into limestone in the next township east (T. 34 N., R. 10 E.) where the waters were of 10-164 parts per million sulfate content, 353-462 parts per million hardness and 352-498 parts per million mineral content. Here, only three samples were of sulfate content greater than 40 parts per million and two of hardness greater than 359 parts per million. These latter were from wells which penetrated shale below the limestone.

Also, five wells in the central third of T. 34 N., R. 9 E. were of 20-90 parts per million sulfate content, 142-369 parts per million hardness and 334-574 parts per million mineral content.

It is evident that consideration of sandstone waters must involve casing records and the possibility of more or less dilution of the sandstone water with limestone water of quality peculiar to that vicinity, particularly if the limestone and dolomite are capable of producing as much as 100-500 gallons per minute as has been occasionally recorded.

This section is representative of the transition zone in the state where St. Peter sandstone water is of low chloride content to the north of Lockport and high chloride content south of Wilmington. The hardness appears to decrease southward and the sulfate content varies somewhat as apparently more or less water is found in the uncased Galena-Platteville formation.

In Table II are listed analyses of samples of water collected from wells penetrating the St. Peter sandstone but not the Galesville sandstone. The order of the tabulation follows the north-south location of the respective wells. The off-set column to the right represents analyses of samples not characteristic of St. Peter sandstone water due to the presence of some water from the limestone; The temperature of St. Peter sandstone water is 57-58° F.

The exceptional hardness of the water from the Phoenix Manufacturing Company well suggests that the casing may not be sealed properly. The analysis of the Eockdale village well was made in 1914. Three later analyses (1922, 1938 and 1941) indicate a decrease in chlorides to 11 and 0 parts per million and a hardness increase to 454 and 462 parts per million. These may be due to damage to the casing.

At Minooka the well is within but a few hundred feet of an uncased flowing 2100-foot well into the Mt. Simon sandstone. The water from

* Illinois State Water Survey Circular No. 17.

TABLE II.—MINERAL QUALITY OF WATERS FROM WELLS PENETRATING ST. PETER SANDSTONE.

Owner.	Depth.	Casing.	Chloride.	Sulfate.	Alkalinity.	Hardness.	Residue.
Northern Illinois Cereal Co.....	875	50	75	191	332	554	778
Stateville Penitentiary.....	1100	60	3	40	372	325	422
War Department, Lockport Lock.....	812		34	93	274	205	468
Chicago Sanitary District.....	852	377	32	94	270	201	465
Carnegie-Illinois Steel.....	830		44	235	286	318	710
Ruberoid.....	796	365	37	143	298	260	522
Phoenix.....	1000	375(a)	34	117	278	469	587
Weber Dairy.....	855	390	45	116	290	206	557
Joliet High School.....	825	326	59	117	260	200	550
Will County Court House.....	970		75	193	310	350	725
Citizens Brewery.....	1350	to lime	52	251	308	548	781
Joliet Wall Paper.....	775	350	30	467	306	806	1063
Prairie State Paper.....	700		15	195	320	532	641
Joyce 7-Up.....	724	61	8	114	332	451	516
Government Moorings.....	555	353	63	109	252	249	546
Rockdale.....	662	260	37	111	306	266	500
Rockdale.....	662	260	8	(140)	376	462	584
American Steel & Wire, Rockdale.....	950	96	44	124	276	239	536
Pioneer Brewing.....	1030		40	130	284	277	547
St. Francis Convent.....	946	70	48	123	284	199	545
Brandon Lock.....	864		44	114	262	232	511
Minooka.....	620	124	267	21	352	169	788
Kankakee Ordnance (3 wells).....	785 ±	277 ±	68	184	272	240	662
Kankakee Ordnance No. 5.....	889	293	84	158	294	217	677
Morris.....	728	40	36	54	298	276	452
Elwood Ordnance No. 2.....	834	332	23	45	412	180	590
Illinois Clay Products.....	502	448	91	151	270	240	637
Elwood Ordnance No. 1.....	803	332	175	171	280	126	846
Wilmington.....	710	21	275	286	260	450	1187
Gardner.....	972	290	280	109	324	98	980

(a) Casing imperfectly sealed or considerable water from the Galena-Platteville formation.

this latter well is of 1800 parts per million mineral content, 910 parts per million chloride content, 41 parts per million sulfate content and 302 parts per million hardness. Several analyses of water from the 620-foot well showed variable chloride content indicating penetration of the Mt. Simon water from the 2100-foot well into the St. Peter sandstone formation.

Three wells at the Kankakee Ordnance Works were consistent in mineral content. The Group Two well at the Elwood Ordnance Works was reported to have penetrated a prolific zone of the Galena-Platteville dolomite, thereby somewhat altering the mineral content of this sample from the St. Peter sandstone.

Although only 40 feet of casing is present in the Morris No. 1 well, no limestone is present at this location. At the Wilmington number 1 well limestone water is permitted to enter resulting in very high sulfate and hardness.

Analyses are available from only five wells which penetrate Galesville sandstone and case out the upper formations. These waters are of the following rather consistent mineral quality. The temperature of the water from these wells varies from 60-62° F. (Table III.)

TABLE III.—MINERAL QUALITY OF GALESVILLE SANDSTONE WATER.

Location.	Depth.	Casing.	Chloride.	Sulfate.	Alkalinity.	Hardness.	Residue.
Joslyn Mfg. Co.	1696	1250	35	92	274	218	473
Blockson No. 1.	1520	1296	38	93	264	244	455
Blockson No. 2.	1510	1290	32	112	296	285	540
Northern Illinois Public Service.	1508	1325	27	102	306	314	528
Morris No. 4.	1501	915	38	32	300	282	426

It is to be noted that these waters are quite similar to typical St. Peter sandstone waters in these vicinities.

Most wells in this vicinity obtain water from both the St. Peter and the Galesville sandstones.

Table IV represents typical analysis of samples from the various, locations. A north-south order is maintained and non-conforming data is offset in the column to the right.

The two samples collected from the Stateville No. 1 well were both collected after the well had been deepened and a new casing to 424 feet installed. The first sample collected, February 19, 1941 showed the presence of limestone water, being of 431 parts per million hardness and 149 parts per million sulfates. The second sample collected October 31, 1941 showed the water to be typical in character of Galesville and St. Peter sandstones. The temperature was 57° F.

The temperature of the Stateville No. 2 well water was 53-55° F. which also is an indication of the presence of limestone water. Water from the American Institute of Laundering well is known to vary in mineral content with rate and length of time of pumping. This too is an indication of water from limestone.

The temperature of the Elwood Ordnance west deep well was 53-54° F. which is a strong indication of the presence of limestone water.

TABLE IV.—MINERAL QUALITY OF WATERS FROM WELLS PENETRATING BOTH ST. PETER AND GALESVILLE SANDSTONES.

Owner.	Depth.	Casing.	Chloride.	Sulfate.	Alkalinity.	Hardness.	Residue.
Lockport No. 2.....	1475	365	80	82	270	272	537
Lockport No. 3.....	1579	442	34	90	284	219	487
Stateville No. 1.....	1599	424	4	149	402	431	660
Stateville No. 1.....	1599	424	15	(100)	264	251	452
Stateville No. 2.....	1577		3	125	350	447	528
Stateville No. 3.....	1527	400	23	65	276	206	427
Western United Gas & Electric.....	1500+		20	240	268	518	658
Northern Illinois Public Service.....	1558	359	24	75	270	224	427
Old Penitentiary No. 3.....	1550	353(a)	101	224	236	499	780
J. G. Heggie Mfg. Co.....	1500		33	447	346	800	986
Williamson Avenue.....	1608	391(a)	28	151	286	428	558
American Steel and Wire, Collins St.....	1602	327	55	85	276	248	520
Acme Brewing Co.....	1575		107	561	355	859	1397
Ottawa Street.....	1621	198	32	98	276	244	479
Beatrice Dairy.....	1490		32	104	230	270	439
Van Buren Street.....	1547	328(a)	54	109	264	238	515
Des Plaines Street.....	1575	300(a)	44	116	272	246	532
Washington Street No. 5.....	1658	400(a)	30	117	272	306	507
Washington Street new No. 1.....	1608	68	25	160	288	392	554
Spruce Slip.....	1565	320(a)	50	161	262	322	607
Jasper Street.....	1563	300	34	89	272	284	469
Citizens Brewery.....	1484	310(a)	49	264	296	540	776
American Institute of Laundering.....	1603		40	125	282	360	483
American Cyanamid.....	1604		41	107	276	246	519
American Can.....	1372	347(a)	27	160	332	381	624
Kankakee Ordnance No. 9.....	1602	310	49	129	278	280	582
Kankakee Ordnance No. 8.....	1639	331	71	145	273	241	650
Kankakee Ordnance No. 7.....	1649	327	105	136	278	299	688
Kankakee Ordnance No. 6.....	1643	300	87	160	276	267	689
Kankakee Ordnance Nos. 1, 2 and 3.....	1593 =	277 =	99	156	250	265	657
Elwood Ordnance, West.....	1645	328(a)	11	58	336	321	462
Elwood Ordnance, East.....	1672	327	137	159	270	246	770
Wilmington No. 2.....	1566	218	279	312	244	428	1161
Carbon Hill.....	1900	150	290	377	243	510	1300

(a) Casing imperfectly sealed or appreciable water from the Galena-Platteville formation.

Mt. Simon sandstone water is characterized throughout this vicinity by its very high chloride content. The No. 1 well at Lockport was reported to be salty at the original depth of 1922 feet. After plugging to 1650 feet the chloride content was 410 parts per million, sulfate content 188 parts per million and the total mineral content 1376 parts per million in 1915. In 1922 the chloride content was 560 parts per million, sulfate content 161 parts per million and total mineral content 1458 parts per million. It appears that plugging the well was not completely effective.

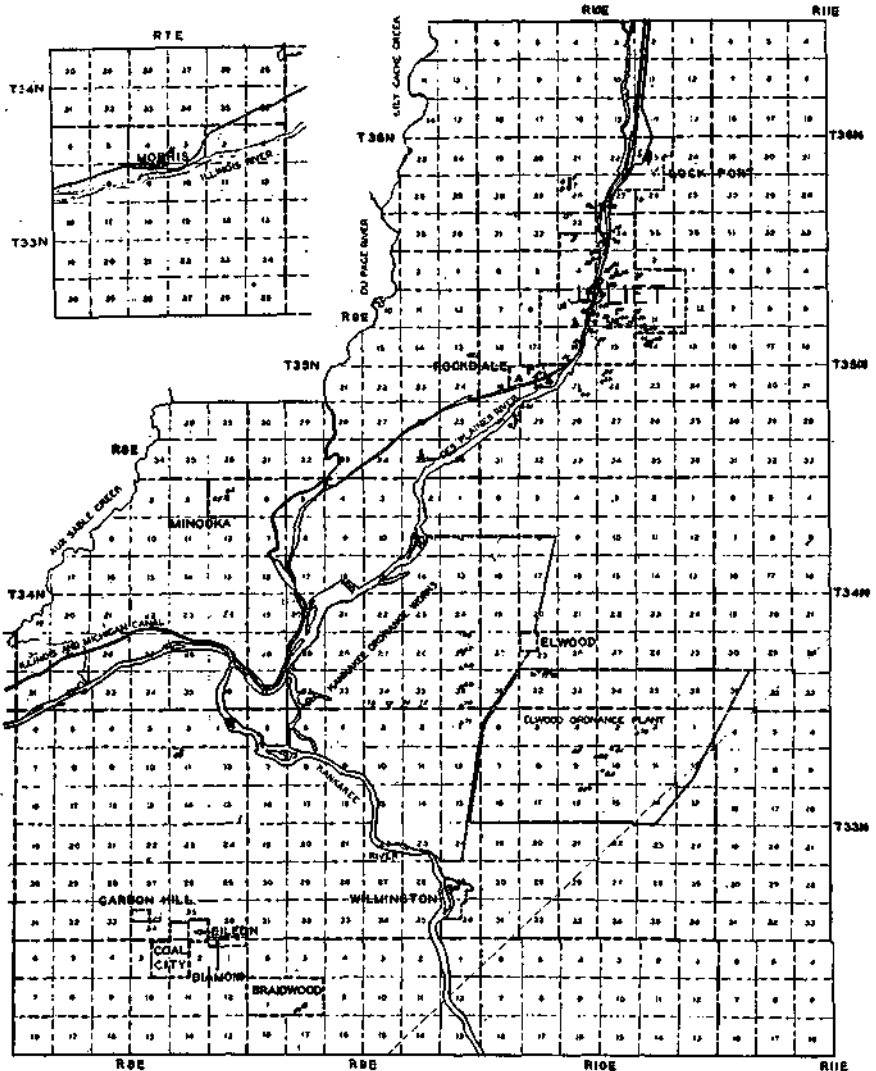


Figure 1. Map of Joliet-Wilmington Area Showing Locations of Deep Wells.

The number 4 well at Stateville is 2007 feet deep entering 42 feet of Mt. Simon sandstone. This well is cased to the top of the Galesville sandstone. A sample of water collected April 20, 1937 when pumping at the excessive rate of about 600 gallons per minute indicated 836 parts

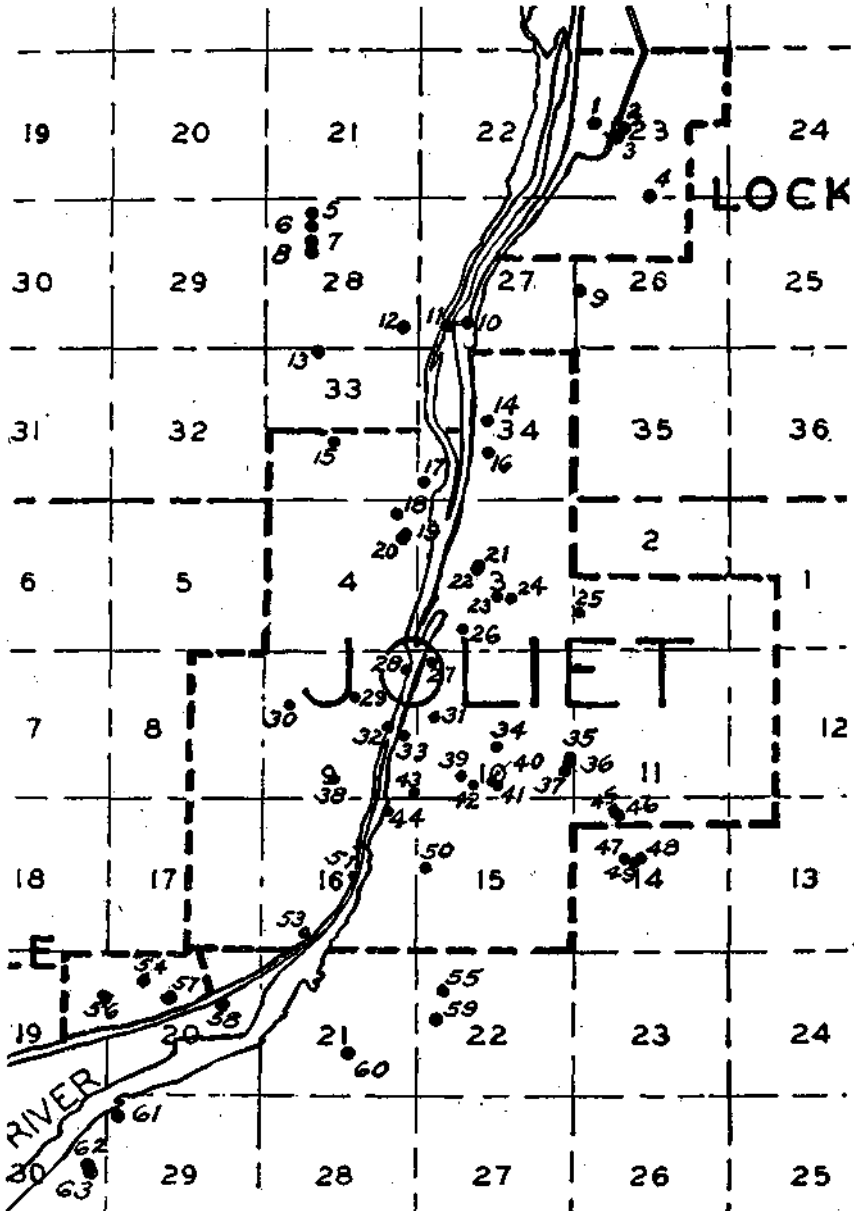


Figure 1A. Map of Joliet and Immediate Vicinity Showing Locations of Deep Wells.

per million chlorides, 175 parts per million sulfates and 1870 parts per million mineral content. A sample collected April 27 when pumping at 240 gallons per minute indicated 502 parts per million chlorides, 59 parts per million sulfates and 1256 parts per million mineral content. A sample collected in 1940 indicated 118 parts per million chlorides, 65 parts per million sulfates, and 627 parts per million mineral content. The temperature was 63° F. indicating considerable Galesville sandstone water. A sample collected October 31, 1941 indicated 95 parts per million chlorides and 533 parts per million mineral content. The temperature was 62° F.

Mt. Simon sandstone water at the 2100-foot Minooka well is of 910 parts per million chlorides, 41 parts per million sulfates, and 1802 parts per million mineral content.

Water from two wells has been reported to be supersaturated with gas. At the number 2 Blockson Chemical Co. well 2.9 cubic feet nitrogen per 1000 gallons was found. At Eockdale gas has been reported to be present.

SANDSTONE WATER SUPPLIES OF THE JOLIET AREA.

The water supplies reported in this bulletin are grouped under the name of the municipality or defense area within which they are located.

The supplies are arranged in alphabetical order with the municipal wells first, followed in alphabetical order by the private or industrial wells.

The wells are geographically located on the map, Figure 1, and identified thereon by a number. The numbering starts with the most northerly well and extends south and west. This same number also appears within a bracket opposite the well in the list of wells reported.

A list of the various water supplies with page reference is given below:

Supplies.	Well No.	Page.
Braidwood village well	(87)	16
Carbon Hill village well	(88)	17
Elwood Ordnance Plant—		
West well	(80)	18
East well	(82)	19
Group 1 well	(84)	20
Group 2 well	(81)	22
Group 3 well	(79)	23
Group 3A well	(83)	24
Batch Mixing Plant—		
Well number 1	(77)	25
Well number 2	(78)	25
Well number 3	(76)	26
Joliet City Wells—		
Washington Street—		
Well number 1	(46)	30
Well number 2	(45)	30
Canal Street	(32)	32
DeaPlaines Street	(44)	32
Jasper Street	(51)	33
Ottawa Street	(33)	35
Ruby Street	(28)	37
Spruce Slip	(50)	38

Supplies.	Well No.	Page.
Joliet City Wells—Continued.		
Van Buren Street	(39)	39
Williamson Avenue	(25)	40
Joliet Industrial Wells—		
Acme Brewing Company	(31)	42
American Cyanamid and Chemical Company	(60)	43
American Institute of Laundering	(55)	44
American Steel and Wire Co., Collins Street	(26)	45
American Steel and Wire Co., Scott Street	(27)	47
Beatrice Meadow Gold Dairies, Inc.	(34)	48
Blockson Chemical Company—		
Well number 1	(62)	49
Well number 2	(63)	50
Carnegie-Illinois Steel Corp., Coke Plant—		
Well number 1	(16)	52
Well number 2	(14)	53
Chaney School	(15)	53
James G. Heggie Manufacturing Company—		
Well number 1	(23)	54
Well number 2	(24)	55
Illinois Penitentiary, Joliet Branch—		
Well number 1	(21)	55
Well number 2	(22)	56
Illinois Penitentiary, Stateville Branch—		
Well number 1	(6)	57
Well number 2	(7)	59
Well number 3	(5)	60
Well number 4	(8)	61
Joliet Citizens Brewing Company—		
Well number 1	(40)	64
Well number 2	(41)	64
Joliet Township High School	(42)	66
Joliet Wall Paper Company	(47)	67
Joslyn Manufacturing and Supply Company—		
Well number 1	(20)	68
Well number 2	(19)	68
The Lindborg Company	(37)	69
Nowell Park	(59)	70
Phoenix Manufacturing Company	(18)	71
Pioneer Brewing Company	(29)	72
Prairie State Paper Company—		
Well number 1	(49)	73
Well number 2	(48)	74
Public Service Company of Northern Illinois—		
Station 55	(13)	75
Station 9	(61)	77
Ruberoid Company	(17)	78
St. Francis Convent	(30)	79
Sisters of St. Joseph	(9)	81
United States War Department, Brandon Lock	(58)	81
United States War Department, Moorings	(53)	82
Weber Dairy Company	(38)	84
Western United Gas and Electric Company	(12)	85
Will County Court House	(43)	86
Zero Ice Company—		
Well number 3	(35)	87
Well number 4	(36)	87
Kankakee Ordnance Works—		
Well number 1	(75)	88
Well number 2	(74)	91
Well number 2A	(74A)	104
Well number 3	(73)	93
Well number 4	(72)	96

Supplies.	Well No.	Page.
Kankakee Ordnance Works—Continued.		
Well number 5.....	(71)	97
Well number 6.....	(70)	97
Well number 7.....	(69)	99
Well number 8.....	(68)	100
Well number 9.....	(67)	102
Well number 10.....	(66)	103
Lockport—		
Well number 1.....	(1)	105
Well number 2.....	(2)	107
Well number 3.....	(4)	109
Northern Illinois Cereal Company.....	(3)	111
Sanitary District of Chicago, Power Plant.....	(11)	112
United States War Department, Lockport Lock.....	(10)	113
Minooka—		
Well number 1.....	(65)	114
Well number 2.....	(64)	114
Morris—		
Well number 1.....	(90)	115
Well number 2.....	(91)	116
Well number 3.....	(92)	117
Well number 4.....	(93)	118
Gebhard Brewing Company.....	(94)	119
Illinois Clay Products Company.....	(89)	120
Rockdale—		
Village well.....	(54)	121
American Can Company.....	(56)	122
American Steel and Wire Company.....	(57)	123
Joyce 7-Xjp Company.....	(52)	125
Wilmington—		
Well number 1.....	(86)	126
Well number 2.....	(85)	127

BRAIDWOOD.

BRAIDWOOD CITY WELL (87). The public water supply for Braidwood was installed in 1883 when seven 3-inch driven wells and a dug well 6 by 10 feet in plan by 20 feet deep were constructed in the rear of the village hall, at a site approximately 1300 feet south and 200 feet west of the center of Section 8, T. 32 N., R. 9 E. Wells of the drive point type in this same area are still supplying the village needs.

A deep well located in this same area was started in 1936 and finished in 1937. It was drilled to a depth of 1410 feet by C. W. Varner of Dubuque, Iowa, and deepened to 1647 feet by the W. L. Thorne Company of Des Plaines, Illinois. It was drilled 19 inches in diameter to a depth of 32 feet, 15 inches in diameter to a depth of 61 feet, 12 inches in diameter to a depth of 143 feet, and 10 inches in diameter to the bottom at a depth of 1647 feet. It was cased from the surface to a depth of 32 feet with 16-inch O. D. pipe, from the surface to a depth of 61 feet with 12½-inch O. D. pipe and from the surface to a depth of 143 feet with 10-inch pipe. Below a depth of 143 feet no additional pipe was reported. The ground surface elevation is 574 feet above sea level.

Because of the low yield of but 50 gallons per minute with a pump setting of 200 feet the well was never equipped. The static water level was 70 feet below the pump base at the time of the test, and 85.4 feet on December 4, 1941.

A log of the materials penetrated, supplied by the State Geological Survey, is as follows¹:

Formations.	Thickness in feet.	Depth in feet.
PLEISTOCENE SYSTEM		
Glacial drift	45	45
PENNSYLVANIAN SYSTEM		
Shale, sandstone, and coal	100	145
ORDOVICIAN SYSTEM		
Maquoketa formation		
Limestone	43	188
Shale	72	260
Galena-Platteville limestone	380	640
Glenwood sandstone; dolomite and shale at base	100	740
St. Peter sandstone, water-bearing	135	875
Shakopee dolomite	85	960
New Richmond sandstone	35	995
Onyota dolomite	195	1190
CAMBRIAN SYSTEM		
Jordan dolomite and sandstone	20	1210
Trempealeau dolomite	175	1385
Franconia sandstone and dolomite	163	1548
Galesville sandstone, water-bearing	99	1647

CARBON HILL.

CARBON HILL VILLAGE WELL (88). Carbon Hill is located in the east central part of Grundy County on the drainage area of Mazon Eiver, a tributary of Illinois River. A public water supply was installed by the village about 1893.

Water has always been obtained from a well located in the eastern part of the village near the station of the Elgin, Joliet and Eastern Eailway Company, or at a site approximately 500 feet north and 300 feet west of the center of Section 34, T. 33 N, R. 8 E. It is reported that the well was drilled in 1893 to a depth of 1787½ feet and was cased with 8-inch pipe to a depth of about 150 feet.

The well is equipped with a Gould deep-well pump with a cylinder set at a depth of 82 feet. The pump is driven by a 4-horsepower gasoline engine.

When the well was new the hydrostatic pressure was sufficient to make pumping unnecessary, the water flowing directly to the mains. In 1900 it was necessary to install a small rotary pump and in 1908 a deep-well pump. In 1914 the water level when not pumping was 20 feet below the ground surface and the cylinder was set at a depth of 60 feet. In 1938 the cylinder had been lowered to a depth of 82 feet due to the decreased yield of the well.

The water had a residue of 1253, a total hardness of 442, and an iron content of 0.3 parts per million as shown by the analysis of sample number 53081, collected January 15, 1925. The temperature of the water was 57° F. on December 4, 1941.

Analysis of Sample Number 53081 from Carbon Hill Village Well.
 Determinations Made. Hypothetical Combinations.

Determinations Made.		Hypothetical Combinations.	
	Pts. per million.		Pts. per million. Grs. per gallon.
Iron.....Fe	0.3	Potassium Nitrate.....KNO ₃	0.9 0.05
Manganese..Mn	0.0	Potassium Chloride....KCl	58.4 3.42
Silica.....SiO ₂	6.9	Sodium Chloride.....NaCl	415.9 24.32
Nonvolatile.....	1.6	Sodium Sulfate.....Na ₂ SO ₄	252.3 14.75
Alumina....Al ₂ O ₃	11.0	Ammonium Sulfate.....(NH ₄) ₂ SO ₄	8.7 0.51
Calcium....Ca	104.0	Magnesium Sulfate....MgSO ₄	219.4 12.82
Magnesium..Mg	44.3	Calcium Sulfate.....CaSO ₄	27.5 1.61
Ammonium..NH ₄	2.4	Calcium Carbonate....CaCO ₃	239.3 14.00
Sodium.....Na	245.4	Iron Oxide.....Fe ₂ O ₃	0.4 0.02
Potassium...K	31.0	Alumina.....Al ₂ O ₃	11.0 0.65
Sulfate.....SO ₄	371.6	Silica.....SiO ₂	0.9 0.41
Nitrate.....NO ₃	0.5	Nonvolatile.....	1.6 0.09
Chloride....Cl	280.0		
Alkalinity (as CaCO ₃)		Total.....	1242.3 72.65
Phenolphthalein..	0.0		
Methyl Orange...	254.0		
Residue.....	1253.0		
Hardness (as CaCO ₃)	442.0		

ELWOOD ORDNANCE PLANT.

ELWOOD ORDNANCE PLANT. The Elwood Ordnance Plant is a shell-loading plant covering about 15,000 acres and located south-east of Elwood between the right-of-ways of the Alton Railroad Company and the Wabash Railway Company. Water for all purposes is secured from rock wells of which nine were drilled between January and October 1941.

THE WEST DEEP WELL (80), located approximately 100 feet south and 2100 feet west of the northeast corner of Section 9, T. 33 N., R. 10 E., was drilled by the J. P. Miller Artesian Well Company of Chicago to a depth of 1645 feet below a ground surface elevation of 641.5 feet above sea level. It is 12 inches in diameter at the bottom and cased with 16-inch pipe to a depth of 61 feet and with 12-inch pipe from the surface to a depth of 326 feet.

A log of material penetrated by the well, furnished by the State Geological Survey, is as follows:

Formations.	Thickness in feet.	Depth in feet.
PLEISTOCENE SYSTEM		
Glacial drift.....	56	56
SILURIAN SYSTEM		
Alexandrian series		
Dolomite.....	54	110
Siltstone and shale.....	35	145
ORDOVICIAN SYSTEM		
Maquoketa formation		
Shale.....	15	160
Limestone.....	40	200
Shale.....	95	295
Galena-Platteville dolomite.....	350	645
Glenwood sandstone.....	5	650
St. Peter sandstone.....	160	810

Formations.	Thickness in feet.	Depth in feet.
ORDOVICIAN AND CAMBRIAN SYSTEMS		
Shakopee, Oneota, Jordan and Trempealeau dolomites	545	1355
CAMBRIAN SYSTEM		
Franconia sandstone and dolomite	150	1505
Galesville sandstone	115	1620
Eau Claire dolomitic sandstone	25	1645

The well is equipped with a 12-inch Peerless turbine pump consisting of 350 feet of 8-inch column pipe, a 10-stage bowl assembly having an over-all length of 8 feet, and 20 feet of 8-inch suction pipe. The pump is directly connected to a 2-speed, 150-horsepower motor and is rated at 500 and 1000 gallons per minute against respective heads of 239 and 478 feet at respective speeds of 1150 and 1800 revolutions per minute. A small air line for measuring water levels was reported to be 359 feet in length but is now thought to be longer.

Static level on July 14, 1941 was 138 feet below the top of the well casing. Two weeks later the well was tested by the State Water Survey and the water level was lowered 59, 92, and 135 feet by pumping at rates of 892, 1110, and 1345 gallons per minute, respectively.

The temperature of the water was 53°F. The water had a residue of 462 and a total hardness of 321.5 parts per million with a trace of iron as shown by the analysis of sample number 91163, collected July 31, 1941.

Analysis of Sample Number 91163 from West Deep Well.

Determinations Made.		Hypothetical Combinations.		
	Pts. per million.		Pts. per million.	
Turbidity	10	Sodium Nitrate..... NaNO ₃	4.3	0.25
Color	0	Sodium Chloride..... NaCl	18.1	1.05
Odor	0	Sodium Sulfate..... Na ₂ SO ₄	85.2	4.97
Iron..... Fe		Sodium Carbonate..... Na ₂ CO ₃	15.4	0.90
(filtered at well)	trace	Magnesium Carbonate... MgCO ₃	103.3	6.02
(unfiltered)	0.6	Calcium Carbonate..... CaCO ₃	199.2	11.61
Manganese.. Mn	0.0	Silica..... SiO ₂	13.5	0.79
Silica..... SiO ₂	13.5			
Calcium..... Ca	79.7	Total.....	439.0	25.59
Magnesium.. Mg	29.8			
Ammonium.. NH ₄	trace			
Sodium..... Na	42.5			
Sulfate..... SO ₄	57.8			
Nitrate..... NO ₃	2.8			
Chloride..... Cl	11.0			
Alkalinity(as CaCO ₃)				
Phenolphthalein..	0.0			
Methyl Orange...	336.0			
Hardness (as CaCO ₃)	321.5			
Residue.....	462.0			
pH = 7.1				
Free CO ₂ (calc.)....	50			

THE EAST DEEP WELL (82), located approximately 120 feet west and 1500 feet south of the northeast corner of Section 9, T. 33 N., R. 10 E., was drilled by the J. P. Miller Artesian Well Company of Chicago, Illinois, to a depth of 1672 feet deep below a ground surface elevation of 646.5 feet above sea level. It is 12 inches in diameter at

the bottom and cased with 16-inch pipe to a depth of 51 feet and with 12-inch pipe from the surface to a depth of 327 feet.

The well is equipped with a 12-inch Peerless turbine pump consisting of 350 feet of 8-inch column pipe, a 10-stage bowl assembly having an over-all length of 8 feet, and 20 feet of 8-inch suction pipe. The pump is driven by a direct-connected, 2-speed, 150-horsepower electric motor and is rated at 500 and 1000 gallons per minute against respective heads of 239 and 478 feet at respective speeds of 1150 and 1800 revolutions per minute.

When tested by the State Water Survey on August 23-24, 1941 the water level was at a depth of 161 feet when not pumping and was lowered 70, 57½, and 30 feet by pumping at rates of 1080, 900 and 500 gallons per minute, respectively.

The temperature of the water was 59° F. The water had a residue of 770, a total hardness of 246, and a content of iron of 0.1 parts per million as shown by the analysis of sample number 91291, collected August 23, 1941.

Analysis of Sample Number 91291 from East Deep Well.

Determinations Made.		Hypothetical Combinations.		
	Pts. per million.			
		Pts. per million.	Grs. per gallon.	
Turbidity.....	20	Sodium Nitrate..... NaNO ₃	2.5	0.15
Color.....	0	Sodium Chloride..... NaCl.....	225.8	13.16
Odor.....	0	Sodium Sulfate..... Na ₂ SO ₄	235.1	13.71
Iron..... Fe		Sodium Carbonate..... Na ₂ CO ₃	21.8	1.27
(filtered at well)...	0.1	Ammonium Carbonate.. (NH ₄) ₂ CO ₃	2.9	0.16
(unfiltered).....	0.4	Magnesium Carbonate.. MgCO ₃	84.3	4.91
Manganese... Mn	0.0	Calcium Carbonate..... CaCO ₃	146.6	8.55
Silica..... SiO ₂	9.3	Silica..... SiO ₂	9.3	0.54
Calcium..... Ca	58.7			
Magnesium... Mn	24.4	Total.....	728.3	42.45
Ammonium... NH ₄	1.0			
Sodium..... Na	174.9			
Sulfate..... SO ₄	158.9			
Nitrate..... NO ₃	1.8			
Chloride..... Cl	137.0			
Alkalinity (as CaCO ₃)				
Phenolphthalein..	0.0			
Methyl Orange...	270.0			
Hardness (as CaCO ₃)	246.0			
Residue.....	770.0			
pH = 7.3				
Free CO ₂ (calc.)....	25.0			

THE GEOP 1 WELL (84), located approximately 1000 feet west and 500 feet south of the northeast corner of Section 16, T. 33 1ST, E. 10 E., was drilled by S. B. Geiger and Company of Chicago to a depth of 803 feet below a ground surface elevation of 643 feet above sea level. It is 10 inches in diameter at the bottom and cased with 12-inch pipe to a depth of 58 feet and with 10-inch pipe from the surface to a depth of 332 feet.

A log of the formations penetrated by the well as furnished by the State Geological Survey is as follows:

Formations.	Thickness in feet.	Depth in feet.
PLEISTOCENE SYSTEM		
Glacial drift	50	50
SILURIAN SYSTEM		
Niagaran-Alexandrian dolomite, water-bearing... .	117	167
ORDOVICIAN SYSTEM		
Maquoketa formation		
Shale	8	175
Limestone	37	212
Shale	92	304
Galena-Platteville dolomite	351	655
Glenwood sandstone	5	660
St. Peter sandstone, water-bearing	140	800
Shakopee dolomite	3	803

The well is equipped with a 6-inch Pomona turbine pump consisting of 290 feet of 4½-inch column pipe, a 31-stage bowl assembly having an over-all length of 13 feet, and 10 feet of 4½-inch suction pipe. The pump is driven by a direct-connected, 20-horsepower electric motor and is rated at 100 gallons per minute against a head of 398 feet at a speed of 1760 revolutions per minute. A small air line for determining water levels terminates at a depth of 290 feet.

When tested by the State Water Survey the water level was at a depth of 167¼ feet when not pumping and was lowered 75½ feet by pumping at a rate of 63 gallons per minute.

The temperature of the water was 57° F. The water had a residue of 846, a total hardness of 126, and a content of iron of 0.4 parts per million as shown by the analysis of sample number 90431, collected April 21, 1941.

Analysis of Sample Number 90431 from Group 1 Well.

Determinations Made.	Pts. per million.	Hypothetical Combinations.	Pts. per million.	Grs. per gallon.
Turbidity	10	Sodium Nitrate NaNO ₃	0.9	0.05
Color	0	Sodium Chloride NaCl	288.9	16.33
Odor	0	Sodium Sulfate Na ₂ SO ₄	252.9	14.74
Iron Fe		Sodium Carbonate Na ₂ CO ₃	161.1	9.39
(filtered at well)	0.4	Ammonium Carbonate . (NH ₄) ₂ CO ₃	2.4	0.14
(unfiltered)	1.2	Magnesium Carbonate . MgCO ₃	42.6	2.48
Manganese Ma	0.0	Calcium Carbonate CaCO ₃	73.6	4.29
Silica SiO ₂	19.5	Silica SiO ₂	19.5	1.14
Calcium Ca	29.4			
Magnesium Mg	12.7	Total	841.9	49.07
Ammonium NH ₄	0.8			
Sodium Na	265.7			
Sulfate SO ₄	170.9			
Nitrate NO ₃	0.7			
Chloride Cl	175.0			
Alkalinity (as CaCO ₃)				
Phenolphthalein	0.0			
Methyl Orange	280.0			
Residue	846.0			
Hardness (as CaCO ₃)	126.0			
pH = 7.8				
Free CO ₂ (calc.)	8.0			

THE GROUP 2 WELL (81), located approximately 2100 feet east and 400 feet south of the northwest corner of Section 10, T. 33 1ST, E. 10 E., was drilled by S. B. Geiger and Company of Chicago to a depth of 834 feet below a ground surface elevation of 642 feet above sea level. It is 10 inches in diameter at the bottom and cased with 12-inch pipe to a depth of 58½ feet and with 10-inch pipe from the surface to a depth of 332 feet.

A log of the formations penetrated by the well as furnished by the State Geological Survey is as follows:

Formations.	Thickness in feet.	Depth in feet.
PLEISTOCENE SYSTEM		
Glacial drift	50	50
SILURIAN SYSTEM		
Niagaran-Alexandrian dolomite, water-bearing... .	110	160
ORDOVICIAN SYSTEM		
Maquoketa formation		
Shale	15	175
Limestone and dolomite	35	210
Shale	90	300
Galena-Platteville dolomite	355	655
Glenwood sandstone	5	660
St. Peter formation		
Sandstone, water-bearing	137	797
Shale, caving	7	804
Shakopee dolomite	30	834

The well is equipped with a 29-stage, 6-inch Pomona turbine pump consisting of 250 feet of 5-inch column pipe, a bowl section 12 feet long, and 10 feet of 4-inch suction pipe. The pump is driven by a direct-connected, 20-horsepower electric motor and is rated at 150 gallons per minute against a head of 322 feet at a speed of 1760 revolutions

Analysis of Sample Number 89960 from Group 2 Well.

Determinations Made.

Hypothetical Combinations.

	Pts. per million.		Pts. per million.	Grs. per gallon.	
Turbidity	trace	Sodium Nitrate	NaNO ₃	2.6	0.15
Color	0	Sodium Chloride	NaCl	36.2	2.11
Odor	0	Sodium Sulfate	Na ₂ SO ₄	66.0	3.85
Iron	Fe	Sodium Carbonate	Na ₂ CO ₃	244.3	14.24
(filtered at well)	0.0	Ammonium Carbonate	(NH ₄) ₂ CO ₃	0.9	0.05
(unfiltered)	1.0	Magnesium Carbonate	MgCO ₃	71.7	4.18
Manganese	Mn	Calcium Carbonate	CaCO ₃	95.6	5.57
Silica	SiO ₂	Silica	SiO ₂	16.5	0.96
Calcium	Ca				
Magnesium	Mg	Total		533.8	31.11
Ammonium	NH ₄				
Sodium	Na				
Sulfate	SO ₄				
Nitrate	NO ₃				
Chloride	Cl				
Alkalinity (as CaCO ₃)					
Phenolphthalein	8.0				
Methyl Orange	412.0				
Hardness (as CaCO ₃)	180.5				
Residue	550.0				
pH = 7.6					
Free CO ₂ (by test)	16.0				
Free CO ₂ (calc.)	20.0				

per minute. A small air line for determining water levels terminates at a depth of 250 feet.

When tested by the State Water Survey the water level was at a depth of 142½ feet when not pumping and was lowered 25½, 21½, and 17 feet by pumping at rates of 196, 149, and 96 gallons per minute, respectively.

The temperature of the water was 53° F. The water had a residue of 550 and a total hardness of 180.5 parts per million with no iron as shown by the analysis of sample number 89960, collected February 22, 1941.

THE GEOUP 3 WELL (79), located approximately 50 feet east and 1700 feet north of the southwest corner of Section 2, T. 33 N., R. 10 E., was drilled by S. B. Geiger and Company of Chicago to a depth of 388 feet below a ground surface elevation of 639 feet above sea level. It is 12 inches in diameter at the bottom and cased with 12-inch pipe to a depth of 83 feet.

A log of the formations penetrated by the well, furnished by the State Geological Survey, is as follows:

Formations.	Thickness in feet.	Depth in feet.
PLEISTOCENE SYSTEM		
Glacial till	40	40
SILURIAN SYSTEM		
Niagaran and Alexandrian series		
Dolomite	135	175
Shale and dolomite	35	210
ORDOVICIAN SYSTEM		
Maquoketa formation		
Shale and limestone	20	230
Limestone	38	268
Shale, some limestone	90	358
Galena dolomite	30	388

The well is equipped with a 6-inch Pomona turbine pump consisting of 150 feet of 4½-inch column pipe, a 31-stage bowl assembly having an over-all length of 13 feet, and 10 feet of 4½-inch suction pipe. The pump is driven by a direct-connected, 20-horsepower electric motor and is rated at 100 gallons per minute against a head of 398 feet at a speed of 1760 revolutions per minute. A small air line for determining water levels terminates at a depth of 150 feet.

When tested by the State Water Survey the water level was, at a depth of 21 feet when not pumping and was lowered 92½, 49½ and 31 feet by pumping at rates of 246, 158, and 113 gallons per minute, respectively.

The temperature of the water was 53° F. The water had a residue of 485, a total hardness of 241, and a content of iron of 0.8 parts per million as shown by the analysis of sample number 90631, collected May 26, 1941.

Analysis of Sample Number 90631 from Group 3 Well.

Determinations Made.		Hypothetical Combinations.		
	Pts. per million.		Pts. per million.	Grs. per gallon.
Turbidity.....	100	Sodium Nitrate..... NaNO ₃	3.4	0.20
Color.....	0	Sodium Chloride..... NaCl	3.5	0.20
Odor.....	0	Sodium Sulfate..... Na ₂ SO ₄	68.2	3.97
Iron..... Fe		Sodium Carbonate..... Na ₂ CO ₃	155.4	9.06
(filtered at well)...	0.8	Ammonium Carbonate... (NH ₄) ₂ CO ₃	1.4	0.08
(unfiltered).....	4.2	Magnesium Carbonate... MgCO ₃	88.9	5.18
Manganese... Mn	0.0	Calcium Carbonate.... CaCO ₃	136.5	7.96
Silica..... SiO ₂	10.0	Silica..... SiO ₂	10.0	0.58
Calcium..... Ca	54.6			
Magnesium... Mg	25.5	Total.....	467.3	27.23
Ammonium... NH ₄	0.5			
Sodium..... Na	91.8			
Sulfate..... SO ₄	45.9			
Nitrate..... NO ₃	2.2			
Chloride.... Cl	2.0			
Alkalinity (as CaCO ₃)				
Phenolphthalein..	0.0			
Methyl Orange...	390.0			
Residue.....	485.0			
Hardness (as CaCO ₃)	242.0			
pH = 7.1				
Free CO ₂ (by test) ..	20.0			
Free CO ₂ (calc.)....	57.5			

THE GROUP 3A WELL (83), located approximately 750 feet east and 1800 feet north of the southwest corner of Section 10, T. 33 N., R. 10 E., was drilled by Henry Boysen, Jr., of Libertyville, Illinois, to a depth of 135 feet below a ground surface elevation of 635 feet above sea level. It is 12 inches in diameter at the bottom and is cased with 12-inch pipe to a depth of 40 feet.

The log of material penetrated by the well, furnished by the State Geological Survey, is as follows:

Formations.	Thickness in feet.	Depth in feet.
PLEISTOCENE SYSTEM		
Glacial clay.....	40	40
SILURIAN SYSTEM		
Niagaran and Alexandrian limestone.....	90	130
ORDOVICIAN SYSTEM		
Maquoketa shale.....	5	135

The well is to be equipped with a turbine pump driven by a direct-connected electric motor and rated at 200 gallons per minute.

When tested by the State Water Survey the water level was at a depth of 22½ feet when not pumping and was lowered 11½ and 15½ feet by pumping at rates of 107 and 152 gallons per minute, respectively. Two months later the well was re-tested with a larger pump. At this time the water level was at a depth of 21 feet when not pumping and was lowered 87 feet by pumping at a rate of 240 gallons per minute.

The temperature of the water was 53° F. The water had, a residue of 414, a total hardness of 351, and a content of iron of 0.1 parts per million as shown by the analysis of sample number 91402, collected September 10, 1941.

Analysis of Sample Number 91402 from Group 3A Well.

Determinations Made.		Hypothetical Combinations.		
	Pts. per million.		Pts. per million.	Grs. per gallon.
Turbidity.....	5	Sodium Nitrate..... NaNO ₃	1.7	0.10
Color.....	0	Sodium Chloride..... NaCl	6.4	0.37
Odor.....	0	Sodium Sulfate..... Na ₂ SO ₄	50.4	2.94
Iron..... Fe		Ammonium Sulfate..... (NH ₄) ₂ SO ₄	2.0	0.12
(filtered at well)...	0.1	Magnesium Sulfate..... MgSO ₄	6.0	0.35
(unfiltered).....	1.4	Magnesium Carbonate... MgCO ₃	155.6	9.07
Manganese... Mn	0.0	Calcium Carbonate.... CaCO ₃	161.6	9.42
Silica..... SiO ₂	12.0	Silica..... SiO ₂	12.0	0.70
Calcium..... Ca	64.7			
Magnesium... Mg	46.2	Total.....	395.7	23.07
Ammonium... NH ₄	0.6			
Sodium..... Na	19.3			
Sulfate..... SO ₄	40.2			
Nitrate..... NO ₃	1.5			
Chloride.... Cl	4.0			
Alkalinity (as CaCO ₃)				
Phenolphthalein..	0.0			
Methyl Orange...	346.0			
Hardness (as CaCO ₃)	351.0			
Residue.....	414.0			
pH = 7.2				
Free CO ₂ (calc.)...	41.0			

WELL NUMBER 1 (77), at the concrete batch mixing plant, located approximately 400 feet south and 2820 feet east of the north-west corner of Section 32, T. 34 N., R. 10 E., was drilled by Schorie and Dreher of Joliet, Illinois, to a depth of 203 feet below a ground surface elevation of 652 feet above sea level. It is 8 inches in diameter at the bottom and cased with 8-inch pipe to a depth of 41 feet.

A record of material penetrated as furnished by the driller is as follows:

Formations.	Thickness in feet.	Depth in feet.
Top soil.....	2	2
Clay mantle.....	36½	38½
Niaganan dolomite.....	101½	140
Maquoketa shale.....	52	192
Galena-Platteville dolomite.....	11	203

The well is equipped with a 6-inch Deming turbine pump consisting of 100 feet of 4-inch column pipe, a 17-stage bowl section having an over-all length of 10 feet, and 20 feet of 3-inch suction pipe. The pump is driven by a direct-connected, 7½-horsepower electric motor and is rated at 60 gallons per minute against a head of 160 feet at a speed of 1750 revolutions per minute. A small air line for determining water levels extends to a depth of 100 feet.

The yield of the well is reported to be about 43 gallons per minute. No analysis of the water from this well is available.

WELL NUMBER 2 (78), at the concrete batch mixing plant, located approximately 385 feet south and 3320 feet east of the north-west corner of Section 32, T. 34 N., R. 10 E., was drilled by the

John Iten Company of St. Charles, Illinois, to a depth of 208 feet below a ground surface elevation of 663 feet above sea level. It is 10 inches in diameter at the bottom and cased with 10-inch pipe to bedrock.

A record of material penetrated as furnished by the driller is as follows:

Formations.	Thickness in feet.	Depth in feet.
Top soil . . . . .	.2	2
Yellow clay . . . . .	.6	8
Blue clay . . . . .	.22	30
Clay and gravel . . . . .	.5	35
Hard pan . . . . .	.7	42
Sand . . . . .	.9	51
Sand and clay . . . . .	.2	53
Niagaran dolomite . . . . .	.99	152
Maquoketa shale . . . . .	.50	202
Galena-Platteville dolomite . . . . .	.6	208

The well is equipped with a 6-inch Deming turbine pump consisting of 150 feet of 3-inch column pipe, a 12-stage bowl section having an over-all length of 7 feet, and 10 feet of 3-inch suction pipe. The pump is driven by a direct-connected, 7½-horsepower electric motor and is rated at 60 gallons per minute against a head of 160 feet at a speed of 1750 revolutions per minute. A small air line for determining water levels extends to a depth of 157 feet.

The water level is reported to have been at a depth of 39 feet when not pumping and to have been lowered 55 feet by pumping at a rate of 40 gallons per minute.

No analysis of the water from this well is available.

WELL NUMBER 3 (76), at the concrete batch mixing plant, located approximately 280 feet south and 1930 feet east of the northwest corner of Section 32, T. 34 N., R. 10 E., was drilled by Henry Boysen, Jr. of Libertyville, Illinois, to a depth of 187 feet below a ground surface elevation of 641 feet above sea level. It is 10 inches in diameter at the bottom and cased with 10-inch pipe to a depth of 61 feet.

The log of the formations penetrated, furnished by the State Geological Survey, is as follows:

Formations.	Thickness in feet.	Depth in feet.
PLEISTOCENE SYSTEM		
Glacial till . . . . .	.47	47
SILURIAN SYSTEM		
Niagaran and Alexandrian dolomites . . . . .	.123	170
No samples . . . . .	.17	187

The well is equipped with an 8-inch Cook turbine pump consisting of 90 feet of 4-inch column pipe, a 5-stage bowl assembly having an over-all length of 3½ feet, and 10 feet of suction pipe. The pump is driven by a direct-connected, 5-horsepower electric motor and is rated at 100 gallons per minute against a head of 128 feet at a speed of 1735 revolutions per minute.

When tested by the State Water Survey the water level was at a depth of 18 feet when not pumping and was lowered 26 and 35 feet by pumping at rates of 80 and 100 gallons per minute, respectively.

The temperature of the water was 53° F. The water had a residue of 426 and a total hardness of 253 parts per million with no iron as shown by the analysis of sample number 90375, collected April 15, 1941.

Analysis of Sample Number 90375 from Batch Mixing Plant Well Number 3.

Determinations Made.		Hypothetical Combinations.	
	Pts. per million.		Pts. per million. Grs. per gallon.
Turbidity.....	110	Sodium Nitrate.....NaNO ₃	1.7 0.10
Color.....	0	Sodium Chloride.....NaCl.....	3.5 0.20
Odor.....	0	Sodium Sulfate.....Na ₂ SO ₄	63.2 3.68
Iron.....Fe		Sodium Carbonate.....Na ₂ CO ₃	98.6 5.75
(filtered at well)..	0.0	Ammonium Carbonate..(NH ₄) ₂ CO ₃	2.4 0.14
(unfiltered).....	1.6	Magnesium Carbonate..MgCO ₃	61.1 3.56
Manganese..Mn	0.2	Calcium Carbonate....CaCO ₃	180.1 10.50
Silica.....SiO ₂	13.5	Silica.....SiO ₂	13.5 0.79
Calcium....Ca	71.9		
Magnesium..Mg	17.7	Total.....	424.1 24.72
Ammonium..NH ₄	0.9		
Sodium.....Na	65.1		
Sulfate.....SO ₄	42.8		
Nitrate.....NO ₃	1.3		
Chloride....Cl	2.0		
Alkalinity (as CaCO ₃)			
Phenolphthalein..	0.0		
Methyl Orange...	348.0		
Hardness (as CaCO ₃)	253.0		
Residue.....	426.0		
pH = 7.1			
Free CO ₂ (by test)..	18.0		
Free CO ₂ (calc.)....	51.0		

Additional wells may be drilled for standby units but may not be equipped with pumps until needed. No water from surface sources is to be used.

JOLIET.

JOLIET CITY WELLS.

WASHINGTON STREET STATION. A public water supply was installed in Joliet by a private company in 1884 and was purchased by the city in 1888. Water was first secured from wells into sand and gravel north of Washington Street near the eastern limits of the city. Later, wells were drilled into the rock and at times water has been taken from Hickory Creek and from a stone quarry nearby.

The original wells, located at what is known as the Washington Street Station near the eastern limits of Joliet, were 6 inches in diameter and 40 feet deep in glacial drift. Water was drawn from the wells by suction. No accurate test of the twenty wells used was ever made but their total yield was estimated to be 1,250,000 gallons per day.

The first rock wells were drilled near the drift wells at the Washington Street Station.

A record of the material penetrated by one of these wells as furnished by the State Geological Survey is as follows:

Materials.	Thickness in feet.	Depth in feet.
Sand and gravel, coarse.....	34	34
Clay and gravel.....	3	37
Lime, gray.....	64	101
Lime, brownish gray.....	15	116
Lime, gray.....	57	173
Lime, brown.....	10	183
Lime, brownish gray.....	12	195
Lime, brown.....	13	208
Lime, dark gray.....	12	220
Lime, white.....	18	238
Lime, gray.....	18	256
Shale, brown.....	.74	330
Lime, brown.....	345	675
Sand.....	254	929
Shale.....	.17	946

The elevation of the top of this well above sea level is reported in the State Geological Survey Bulletin 51 as 565 feet.

The following data concerning the six deep wells located at the Washington Street Station were taken from the records in the city engineer's office in 1900:

Well No.	Size of casing in.	Depth of well ft.	Size of air line in.	Depth of air line ft.	Normal depth of water below ground ft.	Water level while pumping ft.	Discharge gallons per day.
1.....	8	1700	2½	225	40	80	471,422
2.....	8	1600	1½	150	40	80	237,216
3.....	4	1600	1½	210	40	80	130,804
4.....	8	1600	2½	225	40	80	289,128
5.....	8	1700	2	219	40	80	258,600
6.....	6	1200	1½	225	40	80	336,203

All the wells were cased to a depth of 400 feet. It is not known whether the quantity of discharge as given is correct when all wells were being pumped, probably not.

A test yield of these six wells was made by Daniel W. Mead on April 26 and 27, 1900.

Well number 1, when pumped alone, yielded 425 gallons per minute and the average distance below the floor of the station from which the water was raised was 85 feet. Wells numbered 1 and 2 produced a combined yield of 608 gallons per minute with the pumping level at a depth of 107 feet. Pumping more wells did not lower the water level, due undoubtedly to the too small capacity of the air compressor, as stated by Mr. Mead. When all six wells were pumped the maximum combined discharge was 979 gallons per minute and the average depth from which water was raised was 81½ feet.

In 1900 about 80 to 85 pounds per square inch air pressure was required to start pumping the wells, after which the working pressure ranged from 45 to 65 pounds per square inch. In 1913 the pressure

required to start pumping the wells ranged from about 80 to 100 pounds per square inch although the working pressures remained about the same as in 1900. Apparently there had been no appreciable reduction in the capacity of the wells from 1900 to 1913.

In February 1923 the following information was reported on four of the wells at the Washington Street Station. No mention was made of the other wells at that station.

No. of well	1	4	5	6
Depth of well in feet	1785	1686	1704	1419
Static head in feet (measured while all other wells were pumping)				209
Total lift in feet (Static level assumed the same for all wells)	357.6	299.5	312.6	280
Drawdown in feet	148.6	90.5	103.6	71
Running pressure in lbs. per sq. in. . . . .	.78	74	62	74

The yield from these wells could not be measured. The elevation of the top of well No. 6 was given later as 565 feet by the State Geological Survey. These data indicate that there has been an appreciable reduction in the capacity of wells numbered 1, 4, 5 and 6 since 1913.

In 1929 wells numbered 4, 5 and 6 were in service. A Pomona deep well turbine pump was placed in well number 4 in October 1929 at which time the following data was obtained: depth of well, 1409 feet; static water level, 248 feet 8 inches; and the production rate, 78 gallons per minute. This information would indicate a lowering of the static water level of 39 feet since 1923.

In December 1929 a 12-stage deep-well Pomona pump was placed in well number 5. The static water level in this well was 240 feet and the pumping water level 381 feet when the production rate was 800 gallons per minute.

In 1931 the capacity of the pumps in wells numbered 1, 5 and 6 was given as 100, 840 and 100 gallons per minute, respectively. In October 1933 none of these wells were in use. The static water level in well number 5 was 223 feet below the top of the well. This measurement indicated a rise of 17 feet since 1929. In well number 4 the static

Analysis of Sample Number 68215 Collected in 1931 from Well Number 5.

Determinations Made.		Hypothetical Combinations.	
	Pts. per million.		Pts. per million. Grs. per gallon.
Iron. Fe	0.2	Sodium Nitrate. NaNO ₃	1.7 0.10
Manganese. . Mn	0.1	Sodium Chloride. NaCl	49.7 2.90
Silica. SiO ₂	24.0	Sodium Sulfate. Na ₂ SO ₄	120.7 7.03
Turbidity.	0	Ammonium Sulfate. (NH ₄) ₂ SO ₄	2.6 0.15
Calcium. Ca	79.1	Magnesium Sulfate. MgSO ₄	41.6 2.43
Magnesium. . Mg	26.4	Magnesium Carbonate. . MgCO ₃	62.5 3.64
Ammonium. . NH ₄	0.6	Calcium Carbonate. CaCO ₃	198.0 11.54
Sodium. Na	59.1	Iron Oxide. Fe ₂ O ₃	0.3 0.02
Sulfate. SO ₄	116.8	Manganese Oxide. MnO	0.1 0.01
Nitrate. NO ₃	1.5	Silica. SiO ₂	24.0 1.40
Chloride. Cl	30.0		
Alkalinity (as CaCO ₃)		Total.	501.2 29.22
Phenolphthalein. .	0.0		
Methyl Orange. . .	272.0		
Total hardness. . . .	306.0		
Residue.	507.0		

water level was found to be 229 feet below the well top indicating a rise of 45 feet since the measurement of 274 feet recorded in 1932.

Analysis of Sample Number 76687 Collected in 1935 from Well Number 5.
Determinations Made.

	Pts. per million.
Iron Fe	
(unfiltered)	0.2
Turbidity	0.0
Odor	0.0
Chloride Cl	38.0
Alkalinity (as CaCO ₃)	
Phenolphthalein	0.0
Methyl Orange	272.0
Sulfate SO ₄	
(gravimetric)	123.5
Total hardness	340.0
Residue	519.0

WELL NO. 2 (45). In 1937 well number 5, which is located 367 feet north of the center line of Washington Street and 337 feet west of the center line of the Elgin, Joliet & Eastern Railway, or 1535 feet east and 350 feet south of the northwest corner of Section 14, T. 35 N., R. 10 E., was shot with 50 pounds of dynamite at 1540 feet and cleaned out by C. W. Varner of Dubuque, Iowa. This well was then designated as number 2. Total depth is now thought to be 1704 feet below a ground surface elevation of 560 feet above sea level. The well yielded 450 gallons per minute with a drawdown of 114 feet below a static water level of 242 feet. It was equipped with a 7-stage, 10-inch Peerless turbine pump having 400 feet of column pipe, 10 feet of bowls, and 20 feet of suction pipe. The temperature of the water was 61° F. It was reported October 1, 1940 that this well was seldom used. In 1938 static level was 326½ feet when well number 1 was being pumped.

WELL NO. 1 (46). A new well known as number 1 was drilled by C. W. Varner in 1937 at the Washington Street Station at a site 137 feet north of the center line of Washington Street and 312 feet west of the center line of the Elgin, Joliet & Eastern Railway, or 1560 feet east and 580 feet south of the northwest corner of Section 14, T. 35 N., R. 10 E., to a depth of 1608 feet below a ground surface elevation of 563 feet above sea level. In 1938 this well produced at the rate of 1050 gallons per minute with a drawdown of 125 feet below a static water level of 270 feet. It is cased from the surface to a depth of 39 feet with 24-inch pipe, from the surface to a depth of 68¼ feet with 18-inch pipe, from 239 feet to 350 feet with 18-inch pipe, from 917½ feet to 980 feet with 12-inch pipe, and from 1067½ feet to 1134 feet with 10-inch pipe. Between depths of 1134 and 1608 feet the diameter of the hole is 10 inches.

It is equipped with a 9-stage, 12-inch Peerless deep well turbine pump directly connected to a 150-horsepower electric motor. The pump assembly consists of 430 feet of 8-inch column pipe, 9 feet of bowls, and 40 feet of 8-inch suction pipe, and is rated at 1000 gallons per minute

against a head of 450 feet. A small airline for measuring water levels extends to a depth of 430 feet.

The temperature of the water was 59° F. The water had a residue of 544 and a total hardness of 392 parts per million without any iron as shown by the analysis of sample number 81613, collected July 13, 1937.

Analysis of Sample Number 81613 from Washington Street Well Number 1.			
Determinations Made.		Hypothetical Combinations.	
	Pts. per million.		Pts. per million. Grs. per gallon.
Iron..... Fe		Sodium Nitrate..... NaNO ₃	1.7 0.10
(filtered).....	0.0	Sodium Chloride..... NaCl	40.9 2.38
(unfiltered).....	0.0	Sodium Sulfate..... Na ₂ SO ₄	86.6 5.05
Manganese.. Mn	0.0	Ammonium Sulfate..... (NH ₄) ₂ SO ₄	1.3 0.08
Silica..... SiO ₂	10.0	Magnesium Sulfate..... MgSO ₄	125.2 7.30
Turbidity.....	0.0	Magnesium Carbonate.. MgCO ₃	41.7 2.43
Odor.....	Chl	Calcium Carbonate..... CaCO ₃	238.5 13.90
Calcium..... Ca	95.3	Silica..... SiO ₂	10.0 0.58
Magnesium.. Mg	36.9		
Ammonium.. NH ₄	0.4	Total.....	545.9 31.82
Sodium..... Na	44.6		
Sulfate..... SO ₄	159.5		
Nitrate..... NO ₃	1.5		
Chloride.... Cl	25.0		
Alkalinity (as CaCO ₃)			
Phenolphthalein..	0.0		
Methyl Orange...	288.0		
Residue.....	554.0		
Hardness (as CaCO ₃)	392.0		

A log of the material penetrated by this well, furnished by the State Geological Survey, is as follows:

Formations.	Thickness in feet.	Depth in feet.
PLEISTOCENE SYSTEM		
Glacial drift	37	37
SILURIAN SYSTEM		
Niagaran and Alexandrian dolomites, water-bearing	183	220
ORDOVICIAN SYSTEM		
Maquoketa formation		
Limestone	36	256
Shale.....	74	330
Galena-Platteville dolomite	345	675
St. Peter formation		
Sandstone, water-bearing	254	929
Shale and lime, caving	53	982
ORDOVICIAN-CAMBRIAN SYSTEMS		
Oneota-Jordan-Trempealeau-Franconia dolomite and sandstone	449	1431
CAMBRIAN SYSTEM		
Galesville sandstone, water-bearing	116	1547
Eau Claire shale and dolomite	61	1608

Washington Street well number 1 was the only well at this location in use October 1, 1940. This well was being pumped at the rate of 990 gallons per minute 24 hours daily. The temperature of the water was found to be 61½° F. On July 25, 1941 it was impossible to measure the water levels in either well number 1 or well number 2 because the air lines were out of order.

CANAL STEEET STATION (32). The Canal Street well was drilled in 1911 by the Ohio Drilling Company at a site in the center of Division Street 160 feet east of the center line of Bluff Street near the west bank of the DesPlaines River, or 2640 feet south and 1125 feet west of the northeast corner of Section 9, T. 35 N., R. 10 E. It was drilled 16 inches in diameter at the top, 8 inches in diameter at the bottom and 1575 feet deep.

A log of the formations penetrated, furnished by the State Geological Survey, is as follows:

Formations.	Thickness in feet.	Depth in feet.
PLEISTOCENE SYSTEM		
Glacial drift	3	3
SrLURIAN SYSTEM		
Niaganan and Alexandrian dolomite, water-bearing	212	215
ORDOVICIAN SYSTEM		
Maquoketa formation		
Dolomite	10	225
Shale, some dolomite	70	295
Galena-Platteville dolomite	325	620
St. Peter sandstone, water-bearing	200	820
Shakopee—Oneota dolomites	225	1045
CAMBRIAN SYSTEM		
Jordan sandy dolomite	30	1075
Trempealeau dolomite	165	1240
Franconia sandstone and dolomite	90	1330
Galesville sandstone, water-bearing	185	1515
Eau Claire sandstone and dolomite	55	1570

A small quantity of oil was encountered at 220 feet. The well was cased with 14-inch pipe to a depth of 318 feet and with 10 5/8-inch pipe to a depth of 893 feet. The space around the inner casing was filled with concrete but the taste of oil was not eliminated and an aerator was installed.

The well was equipped with an air lift pump and in 1913 the yield was 800,000 gallons per day. In 1922 with a Harris air lift pump attached to a 2½-inch air line at a depth of 450 feet and with 398 cubic feet of free air per minute the well produced at the rate of 292 gallons per minute with a drawdown of 160 feet below a static or non-pumping water level of 129 feet below the well top. The elevation of the top of the well is 532 feet above sea level as reported in Bulletin No. 51 of the Illinois State Geological Survey.

The well was shut down in August 1931 and in September 1938 it was reported it was no longer equipped. The static water level was 187 feet below the floor of the station on October 5, 1933.

DESPLAINES STEEET STATION (44). The DesPlaines Street well was completed in 1913 by the Ohio Drilling Company at a site 45 feet west of center line of DesPlaines Street and 360 feet south of the center line of Washington Street near the east bank of the DesPlaines River, or 360 feet south and 1240 feet west of the northeast corner of Section 16, T. 35 N., R. 10 E. It was drilled to a depth of 1575 feet and is cased to a depth of 300 feet with 14-inch pipe, between depths

of 600 and 824 feet with 7-inch pipe, and between depths of 1200 and 1300 feet with 5 7/8-inch pipe.

A log of the formations penetrated, furnished by the State Geological Survey, is as follows:

Formations.	Thickness in feet.	Depth in feet.
SFLURIAN SYSTEM		
Niagaran and Alexandrian dolomite and limestone	190	190
ORDOVICIAN SYSTEM		
Maquoketa formation		
Dolomite	10	200
Shale	80	280
Galena-Platteville dolomite and limestone	350	630
St. Peter formation		
Sandstone, incoherent	450	1080
Shale and chert, caving	20	1100
CAMBRIAN SYSTEM		
Trempealeau limestone	150	1250
Franconia sandy limestone and sandstone	150	1400
Galesville sandstone, water-bearing	160	1560

When completed the water level was 64 feet below the ground surface when not pumping and was lowered to a depth of 180 feet when pumping at a rate of 650,000 gallons per day.

In 1922 with a Harris air-lift pump at the bottom of 448 feet of 2½-inch air pipe and with 504 cubic feet of air per minute, the rate of discharge was 305 gallons per minute. The drawdown, as determined by air pressures, was 89 feet below a non-pumping water level of 189 feet.

The elevation of the top of the well is 528 feet above sea level.

In 1933 the static water level was reported as 222 feet below the ground surface. This well was used infrequently until 1941 when the pumping machinery was removed and the pump house remodeled for the installation of a water level recorder for recording changes in water level.

JASPEE STREET STATION (51). The Jasper Street well was completed in 1924 by William Cater of Chicago at a site 25 feet north of the center line of Jasper Street and 10 feet west of the center line of Center Street close to the west bank of the DesPlaines River, or 2000 feet north and 2630 feet east of the southwest corner of Section 16, T. 35 N., R. 10 E., to a depth of 1565 feet. Seventeen-inch casing was set from the surface to a depth of 341 feet. Below this the hole is uncased and 15 inches in diameter to the bottom.

A log of the formations penetrated, furnished by the State Geological Survey, is as follows:

Formations.	Thickness in feet.	Depth in feet.
SILURIAN SYSTEM		
Niagaran and Alexandrian dolomite, water-bearing	170	170
ORDOVICIAN SYSTEM		
Maquoketa formation		
Dolomite	20	190
Shale and some dolomite	80	270
Galena-Platteville dolomite	325	595

Formations.	Thickness in feet.	Depth in feet.
Glenwood dolomite and sandstone. . . . .	.35	630
St. Peter sandstone, water-bearing. . . . .	.160	790
Shakopee dolomite. . . . .	.55	845
Oneota dolomite. . . . .	.165	1010
CAMBRIAN SYSTEM		
Jordan dolomite, sandy. . . . .	.65	1075
Trempealeau dolomite. . . . .	.160	1235
Franconia dolomite and sandstone. . . . .	.140	1375
Galesville sandstone, water-bearing. . . . .	.165	1540
Eau Claire shale and sandstone. . . . .	.25	1565

The elevation of the top of the well above sea level is 534 feet.

The well was equipped with a Layne-Bowler deep-well turbine pump which produced at a rate of 1250 gallons per minute with a draw-down of 100 feet below a static water level of 165 feet.

In 1927 William Cater made repairs to the well by sealing in the 17-inch casing with cement grout. It was reported at that time that the casing terminated at a depth of 303 feet below the surface.

The water had a residue of 493, a total hardness of 244¹, and an iron content of 0.2 parts per million as shown by the analysis of sample number 64067, collected May. 22, 1929.

Analysis of Sample Number 64067 from Jasper Street Well.

Determinations Made.		Hypothetical Combinations.		
	Pts. per million.		Pts. per million.	Grs. per gallon.
Iron. Fe	0.2	Sodium Nitrate. NaNO ₃	0.9	0.05
Manganese. . Mn	0.0	Sodium Chloride. NaCl	61.0	3.57
Silica. SiO ₂	12.0	Sodium Sulfate. Na ₂ SO ₄	128.3	7.50
Calcium. . . . Ca	32.5	Sodium Carbonate. . . . Na ₂ CO ₃	28.6	1.67
Magnesium. . Mg	21.5	Ammonium Carbonate. . (NH ₄) ₂ CO ₃	2.4	0.14
Ammonium. . NH ₄	0.9	Magnesium Carbonate. . MgCO ₃	74.6	4.36
Sodium. . . . Na	78.2	Calcium Carbonate. . . CaCO ₃	156.2	9.13
Sulfate. . . . SO ₄	86.8	Silica. SiO ₂	12.0	0.70
Nitrate. . . . NO ₃	0.6	Iron Oxide. Fe ₂ O ₃	0.3	0.02
Chloride. . . . Cl	37.0	Manganese Oxide. . . . MnO	0.0	0.00
Alkalinity (as CaCO ₃)				
Phenolphthalein. .	0.0	Total.	464.3	27.14
Methyl Orange. . .	274.0			
Residue.	493.0			
Total hardness. . . .	244.0			

In 1933 the Layne-North Central Company of Chicago shot the well by exploding four charges of 25 quarts each of nitroglycerine at depths of 1207 feet, 1321 feet, 1435 feet and 1549 feet. Upon completion of the work it was reported the well had a total depth of 1558 feet.

The well was equipped with a 15-inch Layne-Bowler deep-well turbine pump, the assembly of which consisted of 349 feet of 10-inch column pipe, an 11-stage bowl section having an over-all length of 11 feet, and 40 feet of suction pipe.

On August 24, 1933 static water level was reported as 165 feet below the ground surface and on this date a discharge of 1250 gallons per minute was obtained. Figures on drawdown and the water level during the period of pumping were not secured.

The water had a residue of 477, a total hardness of 239, and an iron content of 0.1 parts per million as shown by the analysis of sample number 73620, collected October 4, 1933.

Analysis of Sample Number 73620 from Jasper Street Well.			
Determinations Made.		Hypothetical Combinations.	
	Pts. per million.		
Iron..... Fe	0.1	Sodium Nitrate..... NaNO ₃	0.9
Manganese... Mn	0.0	Sodium Chloride..... NaCl	56.1
Silica..... SiO ₂	15.0	Sodium Sulfate..... Na ₂ SO ₄	135.1
Turbidity.....	0	Sodium Carbonate..... Na ₂ CO ₃	56.7
Calcium..... Ca	63.0	Ammonium Carbonate.. (NH ₄) ₂ CO ₃	2.4
Magnesium... Mg	19.8	Magnesium Carbonate.. MgCO ₃	68.7
Ammonium... NH ₄	0.9	Calcium Carbonate.... CaCO ₃	132.5
Sodium..... Na	90.7	Calcium Silicate..... CaSiO ₃	29.0
Sulfate..... SO ₄	91.4	Iron Oxide..... Fe ₂ O ₃	0.1
Nitrate..... NO ₃	0.5		
Chloride..... Cl	34.0	Total.....	481.5
Alkalinity (as CaCO ₃)			28.10
Phenolphthalein..	4.0		
Methyl Orange...	270.0		
Residue.....	477.0		
Total hardness.....	239.0		

In 1937 the Layne-Bowler pump was removed and a new installation made consisting of 450 feet of column pipe, part Layne-Bowler and part Peerless Pump Company, 13 stages of A. D. Cook bowls having a diameter of 14 inches and an over-all length of 12 feet, and 40 feet of suction pipe. The Cook bowl assembly was rated at 1000 gallons per minute against a head of 450 feet and did produce 1000 gallons per minute with a pumping level at a depth of 440 feet. The pump is directly connected to a 150-horsepower General Electric Company electric motor. A small air pipe for measuring water levels extends to a depth of 450 feet.

On July 25, 1941 the pump was not in operation but the water level measuring equipment was in working order and static water level was determined as 259 feet below the pump base. On September 8, 1938 the static water level was 261 feet and pumping level 427 feet when pumping at the rate of 940 gallons per minute.

OTTAWA STREET STATION (33). The Ottawa Street well was completed in 1907 by L. Wilson and Company of Chicago, Illinois at a site 45 feet west of center line of Ottawa Street and 45 feet south of the center line of Crowley Street or 2270 feet north and 480 feet west of the southeast corner of Section 9, T. 35 N., R. 10 E., to a reported depth of 1621 feet. The elevation of the top of the well above sea level is reported in the State Geological Survey Bulletin 51 as 533 feet.

A log of the formations penetrated, furnished by the State Geological Survey, is as follows:

Formations.	Thickness in feet.	Depth in feet.
SILURIAN SYSTEM		
Niagaran and Alexandrian dolomite, water-bearing.....	218	218

Formations.	Thickness in feet.	Depth in feet.
ORDOVICIAN SYSTEM		
Maquoketa shale	140	358
Galena-Platteville dolomite	360	718
St. Peter formation		
Sandstone, water-bearing	410	1128
Shale and marl	59	1187
CAMBRIAN SYSTEM		
Trempealeau dolomite, Franconia dolomite and sandstone, and Galesville sandstone	409	1596
Eau Claire shale	25	1621

The well was drilled 19 inches in diameter to a depth of 198 feet, 10 inches in diameter to a depth of 1195 feet, 8 inches in diameter to a depth of 1288 feet and 7 inches in diameter to the finished depth of 1621 feet. It was cased with 16-inch 0. D. pipe from the surface to a depth of 198 feet, with an 8-inch liner pipe between depths of 1102 and 1195 feet and with 7-inch liner pipe between depths of 1195 and 1288 feet.

When completed in 1907 static water level was 8 feet below ground surface and the production 1,225,000 gallons per day with an air lift pump. In July 1913 the well produced at the rate of 1,000,000 gallons per day with a drawdown of 82 feet below a static water level of 58 feet. In 1923 the static water level had receded to 180 feet and the pumping level to 246 feet below ground surface. In 1927 the yield of this well was at the rate of 700,000 gallons per day while in October 1929 it was producing at a rate of only 363,000 gallons per day.

The well was rehabilitated by shooting with nitroglycerine and cleaning by J. O. Heflin of Joliet, Illinois, and upon completion of the work in February 1932 static water level was recorded as being at a depth of 246 feet. In October 1933 static water level had receded to a depth of 264 feet.

The water had a residue of 499, a total hardness of 262, and an iron content of 0.2 parts per million as shown by the analysis of sample number 71518, collected August 17, 1932.

Analysis of Sample Number 71518 from the Ottawa Street Well.

Determinations Made.		Hypothetical Combinations.		
	Pts. per million.		Pts. per million.	Grs. per gallon.
Iron Fe	0.2	Sodium Nitrate NaNO ₃	4.3	0.25
Manganese Mn	0.0	Sodium Chloride NaCl	59.6	3.48
Silica SiO ₂	11.0	Sodium Sulfate Na ₂ SO ₄	156.3	9.12
Turbidity	0	Sodium Carbonate Na ₂ CO ₃	8.0	0.47
Calcium Ca	68.7	Ammonium Carbonate (NH ₄) ₂ CO ₃	0.5	0.03
Magnesium Mg	22.1	Magnesium Carbonate MgCO ₃	76.4	4.46
Ammonium NH ₄	0.05	Calcium Carbonate CaCO ₃	172.0	10.04
Sodium Na	78.7	Iron Oxide Fe ₂ O ₃	0.3	0.02
Sulfate SO ₄	105.6	Silica SiO ₂	11.0	0.64
Nitrate NO ₃	0.3			
Chloride Cl	36.0	Total	488.4	28.51
Alkalinity (as CaCO ₃)				
Phenolphthalein	0.0			
Methyl Orange	270.0			
Residue	499.0			
Total hardness	262.0			

The well was again repaired in 1937 by C. W. Varner of Dubuque, Iowa, who did some further shooting and placed 100 feet of 5-inch perforated pipe on the bottom. At the time of the production test on April 21, 1937 static water level was found to be at a depth of 236 feet. At the end of five hours pumping the well was discharging at a rate of 835 g. p. m. with a drawdown of 87 feet.

The pump assembly consisted of a Peerless deep well turbine with 450 feet of column pipe, a 15-stage bowl section having an over-all length of 12 feet, and 30 feet of suction pipe. The air pipe for determining water levels had its bottom at a depth of 450 feet or at the top of the bowl assembly.

Later in 1937 a new A. D. Cook 10-inch deep well turbine was installed, the assembly of which consisted of 430 feet of 8-inch column pipe, a 19-stage bowl section having an over-all length of 13 1/3 feet, and 3 feet of 8-inch suction pipe. The pump, directly connected to a 125-horsepower U. S. Electric Company electric motor, was rated at 750 g. p. m. against a head of 450 feet when operating at the full-load speed of 1775 revolutions per minute. In 1940 this pump operated 24 hours per day. On July 25, 1941 the pump was operating but the air pipe and gage for determining water levels were not functioning. In December 1938 static level was 236 feet and pumping level was 329 feet when pumping at the rate of 800 gallons per minute.

The water had a residue of 479, a total hardness of 244, and an iron content of 1.2 parts per million as shown by the analysis of sample number 79942, collected April 21, 1937.

Analysis of Sample Number 79942 from the Ottawa Street Well.

Determinations Made.		Hypothetical Combinations.	
	Pts. per million.		Pts. per million. Grs. per gallon.
Iron.....Fe		Sodium Nitrate.....NaNO ₃	1.7 0.10
(filtered).....	0.0	Sodium Chloride.....NaCl	52.6 3.07
(unfiltered).....	1.2	Sodium Sulfate.....Na ₂ SO ₄	145.6 8.50
Manganese..Mn	0.0	Sodium Carbonate.....Na ₂ CO ₃	31.8 1.85
Silica.....SiO ₂	10.0	Ammonium Carbonate..(NH ₄) ₂ CO ₃	1.9 0.11
Turbidity.....	5.0	Magnesium Carbonate..MgCO ₃	56.5 3.29
Odor.....M l		Calcium Carbonate.....CaCO ₃	177.0 10.32
Calcium.....Ca	70.7	Silica.....SiO ₂	10.0 0.58
Magnesium..Mg	16.3		
Ammonium..NH ₄	0.7	Total.....	477.1 27.82
Sodium.....Na	82.1		
Sulfate.....SO ₄	98.3		
Nitrate.....NO ₃	1.3		
Chloride....Cl	32.0		
Alkalinity (as CaCO ₃)			
Phenolphthalein..	6.0		
Methyl Orange...	276.0		
Residue.....	479.0		
Total hardness.....	244.0		

RUBY STREET STATION (28). The Euby Street well was completed in 1915' by the Ohio Drilling Company of Massillon, Ohio, at a site 175 feet east of the center line of Bluff Street and 100 feet south of the center line of Euby Street near the west bank of the Des-Plaines River or 650 feet south and 585 feet west of the northeast corner

of Section 9, T. 35 N., R. 10 E., to a depth of 1564 feet below a ground surface elevation above sea level of 546 feet.

A log of the formations penetrated, furnished by the State Geological Survey, is as follows:

Formations.	Thickness in feet.	Depth in feet.
SILURIAN SYSTEM		
Niagaran and Alexandrian dolomite, water-bearing	180	180
ORDOVICIAN SYSTEM		
Maquoketa shale	80	260
Galena-Platteville dolomite	340	600
St. Peter sandstone, water-bearing	390	990
ORDOVICIAN-CAMBRIAN SYSTEMS		
Oneota-Jordan-Trempealeau dolomite and sandstones	240	1230
CAMBRIAN SYSTEM		
Franconia dolomite and sandstone	120	1350
Galesville sandstone, water-bearing	130	1480
Eau Claire dolomite and shale	80	1560

At the time of completion the yield was 1,500,000 gallons per day. This well was repaired in 1931, and the final depth reached was reported as 15651 feet. New 12-inch casing was installed to a depth of 410 feet, 10-inch casing from 410 to 1237½ feet and 8-inch perforated liner pipe from 1237½ to 1438 feet. In 1933 the static water level was 210 feet below the surface. This was a rise of 32 feet since 1932 and a rise of 93 feet since 1931. The well was used very little after repair. In 1940 static level was 234 feet and pumping level was 417 feet when pumping at the rate of 1075 gallons per minute.

In 1938 a new 12-inch Peerless deep-well turbine pump number 11008, directly connected to a 150-horsepower electric motor was installed. The pump assembly consisted of 425 feet of 8-inch column pipe, a 9-stage bowl section having an over-all length of 8 feet, and 35 feet of 8-inch suction pipe. A small air pipe for determining water levels terminates at a depth of 426 feet.

The unit is rated at 1000 gallons per minute against a 450-foot head when operating at 1750 revolutions per minute.

The well now furnishes part of the city demand at times. On July 25, 1941 the pump was operating but the air pipe for measuring water levels was out of order.

SPRUCE SLIP STATION (50). A well known as the Spruce Slip well was drilled by the Ohio Drilling Company of Massillon, Ohio, in 1912 at a site 255 feet east of the center line of Chicago Street and 35 feet north of the center line of Spruce Street, or 2325 feet south and 255 feet east of the northwest corner of Section 15, T. 35 N., R. 10 E. The well was 1565 feet deep, 14 inches in diameter at the top and 10 inches in diameter at the bottom.

A log of the formation penetrated, furnished by the State Geological Survey, is as follows:

Formations.	Thickness in feet.	Depth in feet.
SILURIAN SYSTEM		
Niagaran and Alexandrian dolomites	200	200

Formations.	Thickness in feet.	Depth in feet.
ORDOVICIAN SYSTEM		
Maquoketa dolomite and shale	80	280
Galena-Platteville dolomite	330	610
Glenwood-St. Peter sandstone, water-bearing	230	840
ORDOVICIAN AND CAMBRIAN SYSTEMS		
Prairie du Chien and Trempealeau dolomites....	395	1235
CAMBRIAN SYSTEM		
Franconia sandstone and dolomite	105	1340
Galesville (Dresbach) sandstone, water-bearing..	180	1520
Eau Claire formation	10	1530

After completion the water stood 36 feet below the ground surface. The well was pumped at the rate of 577,000 gallons per day and the water level was lowered to a depth of 142 feet. In 1922, during tests, the discharge was at the rate 184 gallons per minute but the equipment was evidently not in good condition. In 1923 static water level was reported to be at a depth of 143 feet. This well has not been used since June 1931. In July 1941 the well was reported as abandoned and all machinery and the pump house removed and a steel plate securely clamped over the top end of the casing.

The elevation of the top of the well is 525 feet above sea level.

VAN BUREN STREET STATION (39). The Van Buren Street well was completed in 1913 by the Ohio Drilling Company of Massillon, Ohio at a site 90 feet north of the center line of Van Buren Street and 425 feet west of the center line of Eastern Avenue or 780 feet north and 1400 feet east of the southwest corner of Section 10, T. 35 N., R. 10 E., to a depth of 1547 feet. It is cased with 14-inch pipe to a depth of 328 feet and with 100 feet of 10-inch pipe at a depth of about 800 feet, and below which the diameter to the bottom was 8 inches.

A log of the formation penetrated, furnished by the State Geological Survey, is as follows:

Formations.	Thickness in feet.	Depth in feet.
No record	330	330
ORDOVICIAN SYSTEM		
Galena-Platteville dolomite	290	620
St. Peter sandstone, water-bearing	300	920
Oneota dolomite	100	1020
CAMBRIAN SYSTEM		
Jordan sandstone	30	1050
Trempealeau dolomite	170	1220
Franconia dolomite and sandstone	140	1360
Galesville sandstone	160	1520
Eau Claire sandstone and shale	30	1550

When completed the water level was 63 feet below the ground surface when not pumping and was lowered to a depth of 240 feet when pumping at the rate of 650,000 gallons per day. During tests in 1922 with a Harris air-lift pump attached to the bottom of 690 feet of 2½-inch air pipe, the rate of discharge was 485 gallons per minute with the water level during the pumping period at a depth of 418 feet. The equipment was not in good running order at this time. In 1927 the well was not used regularly.

According to the Illinois State Geological Survey Bulletin No. 51 the elevation of the top of this well is 538 feet above sea level. A direct measurement to the static water level in this well was made in October 1933 when it was found to be 223.5 feet below the ground surface. This indicated a rise of 2½ feet since February 1932. In September 1938 the equipment was still in the well but it had not been used since 1935. In July 1941 all machinery and the pump house had been removed and a steel plate securely fastened over the top of the well casing.

WILLIAMSON AVENUE STATION (25). The Williamson Avenue well was completed by the Sewell Well Company of St. Louis, Missouri, in 1924 at a site 135 feet south of the center line of Williamson Avenue and 180 feet east of the center line of Charlesworth Avenue in the northeast part of the city, or 1300 feet north and 180 feet east of the southwest corner of Section 2, T. 35 N., R. 10 E., to a reported depth of 1608 feet. The elevation of the top of the well above sea level was reported in the State Geological Survey Bulletin No. 51 as 555 feet.

The well was drilled 19 inches in diameter to a depth of 346 feet, 17 inches in diameter to 1161 feet, and 12 inches in diameter to the bottom. It was cased with 16-inch pipe from the surface to a depth of 346 feet, and with 13-inch pipe between depths of 1101 and 1161 feet.

A log of the formation penetrated, furnished by the State Geological Survey, is as follows:

Formations.	Thickness in feet.	Depth in feet.
PLEISTOCENE SYSTEM		
Glacial drift . . . . .	.10	10
SILURIAN SYSTEM		
Niagaran and Alexandrian dolomites, water-bearing . . . . .	.195	205
ORDOVICIAN SYSTEM		
Maquoketa formation		
Dolomite . . . . .	.35	240
Shale . . . . .	.75	315
Galena-Platteville dolomite and limestone . . . . .	.330	645
Glenwood sandstone . . . . .	.95	740
St. Peter formation		
Sandstone, water-bearing . . . . .	.405	1145
Shale and chert . . . . .	.15	1160
CAMBRIAN SYSTEM		
Trempealeau dolomite . . . . .	.60	1220
Franconia sandstone and dolomite . . . . .	.125	1345
Galesville sandstone, water-bearing . . . . .	.185	1530
Eau Claire sandstone and shale . . . . .	.78	1608

In March 1927 the deep-well turbine pump had a setting of 360 feet and produced 1,100,000 gallons per day with a drawdown of 100 feet below a static water level of 195 feet.

The well was reconditioned in 1929 by S. B. Geiger and Company of Chicago, Illinois. The well was shot with 1500 pounds of 40 per cent dynamite at a depth of about 1550 feet. After cleaning, the contractor reported the well depth to be 1613 feet. Twenty-inch casing was set from the surface to a depth of 20 feet. Inside the 20-inch casing a line of 15¼-inch inside diameter pipe was installed from the ground surface to a depth of 391 feet and cemented in place. A liner

of 8-inch pipe was set between depths of 1260 feet and 1408 feet, below which was 160 feet of perforated 8-inch pipe, and below this 45 feet of blank pipe. A wooden plug was placed at the bottom in the 8-inch pipe.

In 1939 the water had a residue of 590, and a total hardness of 407 parts per million with a trace of iron as shown by the analysis of sample number 65594, collected December 10, 1929 at the well.

Analysis of Sample Number 65594 from Williamson Avenue Well.

Determinations Made.		Hypothetical Combinations.	
	Pts. per million.		Pts. per million. Grs. per gallon.
Iron..... Fe	trace	Sodium Nitrate..... NaNO ₃	1.7 0.10
Manganese.. Mn	0.0	Sodium Chloride..... NaCl	46.2 2.69
Turbidity.....	0.0	Sodium Sulfate..... Na ₂ SO ₄	135.7 7.90
Silica..... SiO ₂	14.0	Ammonium Sulfate..... (NH ₄) ₂ SO ₄	2.0 0.12
Calcium..... Ca	91.5	Magnesium Sulfate.... MgSO ₄	115.0 6.72
Magnesium.. Mg	43.4	Magnesium Carbonate.. MgCO ₃	70.4 4.10
Ammonium.. NH ₄	0.6	Calcium Carbonate.... CaCO ₃	228.5 13.32
Sodium..... Na	62.6	Silica..... SiO ₂	14.0 0.82
Sulfate..... SO ₄	185.1	Iron Oxide..... Fe ₂ O ₃	trace trace
Nitrate..... NO ₃	1.1	Manganese Oxide..... MnO	0.0 0.00
Chloride.... Cl	28.0		
Alkalinity (as CaCO ₃)		Total.....	613.5 35.77
Phenolphthalein..	0.0		
Methyl Orange...	312.0		
Residue.....	590.0		
Total hardness.....	407.0		

In September 1933 the Layne-Bowler deep-well turbine pump was repaired and the assembly of the reinstalled unit consisted of 369 feet of 10-inch column pipe, a 10-stage bowl section having an over-all length of 10 feet, and 40 feet of suction pipe. This unit produced at a rate of 904 gallons per minute.

In 1936 a new 15-inch Layne-Bowler deep-well turbine pump was installed, the assembly of which consisted of 367 feet of 10-inch column, a 10-stage bowl section having an over-all length of 10 feet 10 inches, and 40 feet of 10-inch suction pipe. An air pipe for determining water levels was also installed at this time. This unit produced at a rate of 1080 gallons per minute with a drawdown of 79.8 feet.

In September 1938 it was reported that the length of column pipe had been increased to 400 feet, the static level was 209 feet, and the pumping level below 400 feet when pumping 960 gallons per minute.

On July 25, 1941 it was reported this well and its pumping unit were in operating condition but had not been operated for the past two years. The air pipe and gage were not in working condition.

INDUSTRIAL WELLS

ACME BREWING COMPANY (31). The plant of the Acme Brewing Company, formerly the Fred Sehring Brewing Company, is located at 412 Scott Street.

Water is obtained from a well located 90 feet north of the center line of Clay Street and 150 feet east of the center line of Scott Street, or approximately 2350 feet south and 525 feet east of the northwest corner of Section 10, T. 35 N., R. 10 E., at a surface elevation of 538 feet above sea level. The well was drilled in 1903 by the J. P. Miller Artesian Well Company of Chicago to a depth of 1575 feet and cased to a reported depth of 330 feet.

A log of the formation penetrated, furnished by the State Geological Survey, is as follows:

Formations.	Thickness in feet.	Depth in feet.
PLEISTOCENE SYSTEM		
Clay, sand and gravel	?	?
SILURIAN SYSTEM		
Niagaran and Alexandrian series		
Limestone	?	222
ORDOVICIAN SYSTEM		
Richmond formation		
Shale, with streaks of limestone	107	329
Galena-Platteville limestone		
Limestone	361	690
St. Peter formation		
Sandstone	95	785
Limestone, sandy	15	800
Sandstone	42	842
Prairie du.Chien series		
Limestone, sandy	20	862
Shale, sandy	74	936
Limestone	354	1290
Shale	73	1363
Limestone	62	1425
CAMBRIAN SYSTEM		
Croixan (Potsdam) sandstone		
Sandstone	150	1575

In 1941 the well had not been used for several years but was still equipped with a steam-driven American deep-well cylinder pump.

Analysis of Sample Number 31686 from Well 1575 Feet Deep.

Determinations Made.		Hypothetical Combinations.		
	Pts. per million.		Pts. per million.	Grs. per gallon.
Iron Fe	0.0	Sodium Nitrate NaNO ₃	27.0	1.57
Chloride Cl	107.0	Sodium Chloride NaCl	177.0	10.32
Sodium Na	103.1	Sodium Sulfate Na ₂ SO ₄	114.0	6.65
Calcium Ca	203.2	Magnesium Sulfate MgSO ₄	422.0	24.62
Magnesium Mg	82.2	Calcium Sulfate CaSO ₄	208.0	12.13
Nitrate NO ₃	19.4	Calcium Carbonate CaCO ₃	355.0	20.71
Sulfate SO ₄	561.0			
Alkalinity (as CaCO ₃)		Total	1303.0	76.00
Phenolphthalein	0.0			
Methyl Orange	355.0			
Residue	1379.0			
Total hardness	859.0			

The water had a residue of 1379 and a total hardness of 859 parts per million with no iron as shown by the analysis of sample number 31G8G, collected September 23, 1915.

AMERICAN CYANAMID AND CHEMICAL CORPORATION (60). The plant of the American Cyanamid and Chemical Corporation is located at 1306 McKinley Avenue in Joliet.

Water is obtained from a well located 300 feet east of the center line of McKinley Avenue and 800 feet south of the center line of Jacob Avenue, or approximately 1500 feet north and 2300 feet west of the southeast corner of Section 21, T. 35 N., R. 10 E.

The well was drilled in 1920 by the J. P. Miller Artesian Well Company of Chicago, Illinois, to a depth of 1604 feet below a ground surface elevation of 586 feet above sea level. It is reported to have been drilled 10 inches in diameter to a depth of 385 feet, 8 inches in diameter to a depth of 1000 feet, and 6 inches in diameter to the bottom of the well. It is cased to an unknown depth.

A log of the formation penetrated, furnished by the State Geological Survey, is as follows:

Formations.	Thickness in feet.	Depth in feet.
SILURIAN SYSTEM		
Niagan and Alexandrian formations		
Limestone . . . . .	.185	185
Shale . . . . .	.15	200
Limestone . . . . .	.8	208
ORDOVICIAN SYSTEM		
Maquoketa shale . . . . .	.135	343
Galena-Platteville dolomite	357?	700?
St. Peter sandstone		
"Lime" (probably sandstone) . . . . .	.90	790
"Sandy lime and streaks of shale" (probably sandstone with shale near base) . . . . .	.65	855
Sandstone . . . . .	.15	870
Prairie du Chien dolomite	257	1127
CAMBRIAN SYSTEM¹		
Jordan sandstone and dolomite . . . . .	.23	1150
Trempealeau dolomite . . . . .	.150	1300
Praconia formation		
Green sandy shale . . . . .	.60	1360
Sandstone . . . . .	.80?	1440?
Galesville sandstone, water-bearing . . . . .	.164	1604

In 1932 the static water level was 217½ feet below the pump base and in 1941 it was 231½ feet below the pump base.

The well is equipped with an 8-inch American deep-well turbine pump consisting of 280 feet of 5-inch column pipe, a 14-stage bowl section 7 feet 9 inches long, and 20 feet of 5-inch suction pipe. The pump is driven by a direct-connected, 40-horsepower electric motor and is rated at 250 gallons per minute against a head of 360 feet at a speed of 1750 revolutions per minute.

A small air pipe for determining water level has its lower end at a depth of 275 feet below the pump base or 5 feet above the top of the bowls.

The temperature of the water after 6 hours pumping was 60° F. The water had a residue of 519, a total hardness of 246.5, and an iron content of 0.1 parts per million as shown by analysis of sample number 91634, collected October 23, 1941.

Analysis of Sample Number 91634 from 1604-Foot Well.

Determinations Made.		Hypothetical Combinations.			
	Pts. per million.		Pts. per million.	Grs. per gallon.	
Turbidity.....	0	Sodium Nitrate.....	NaNO ₃	1.7	0.10
Color.....	0	Sodium Chloride.....	NaCl	67.8	3.95
Odor.....	0	Sodium Sulfate.....	Na ₂ SO ₄	158.4	9.23
Iron.....	Fe	Sodium Carbonate.....	Na ₂ CO ₃	28.1	1.64
(filtered at well)...	0.1	Ammonium Carbonate.....	(NH ₄) ₂ CO ₃	2.9	0.17
(unfiltered).....	0.3	Magnesium Carbonate.....	MgCO ₃	74.6	4.35
Manganese.....	Mn	Calcium Carbonate.....	CaCO ₃	158.1	9.22
Silica.....	SiO ₂	Silica.....	SiO ₂	10.5	0.61
Calcium.....	Ca				
Magnesium.....	Mg	Total.....		502.1	29.27
Ammonium.....	NH ₄				
Sodium.....	Na				
Sulfate.....	SO ₄				
Nitrate.....	NO ₃				
Chloride.....	Cl				
Alkalinity (as CaCO ₃)					
Phenolphthalein...	0.0				
Methyl Orange...	276.0				
Residue.....	519.0				
Hardness (as CaCO ₃)	246.5				
pH = 7.2					
Free CO ₂ (calc.)....	32.0				

AMERICAN INSTITUTE OF LAUNDERING (55). The plant of the American Institute of Laundering is located on the northeast corner of the intersection of Chicago Avenue and Doris Street. The well is located at the plant at a site about 300 feet north of the center line of Doris Street and about 300 feet east of the center line of Chicago Avenue or about 900 feet east and 1200 feet south of the northwest corner of Sections 22, T. 35 N., R. 10 E. It was drilled by W. H. Cater of Chicago, Illinois in 1929 to a depth of 1603 feet below a ground surface elevation above sea level of 568 feet, and was cased with 10-inch pipe from the ground surface to a depth of 348 feet and with 8-inch pipe from the ground surface to a depth of 720 feet.

A log of the materials penetrated, furnished by the State Geological Survey, is as follows:

Formations.	Thickness in feet.	Depth in feet.
PLEISTOCENE SYSTEM		
Glacial till.....	5	5
SILURIAN SYSTEM		
Niagaran and Alexandrian dolomites, water in joints and cavities.....	185	190
ORDOVICIAN SYSTEM		
Maquoketa formation		
Dolomite.....	50	245
Shale.....	70	315
Galena-Platteville dolomites.....	330	645
St. Peter sandstone, water-bearing.....	205	850
Shakopee dolomite and New Richmond sandstone	50	900

Formations.	Thickness in feet.	Depth in feet.
ORDOVICIAN AND CAMBRIAN SYSTEMS		
Oneota, Jordan, and Trempealeau dolomites.....	400	1300
CAMBRIAN SYSTEM		
Franconia sandstone, shale, and dolomite	100	1400
Galesville (Dresbach) sandstone, water-bearing.	160	1560
Eau Claire dolomite and sandstone.	43	1603

The well was equipped with a deep-well turbine pump consisting of a Byron Jackson Machine Company pump head and Peerless Pump Company bowls, directly connected to a 60-horsepower electric motor. The pump assembly consisted of 300 feet of 6-inch column pipe, 10 stages of 10-inch bowls having an over-all length of 7.5 feet, and 26 feet of 6-inch suction pipe. The unit was rated at 500 gallons per minute against a head of 319 feet when operating at a speed of 1760 revolutions per minute. A small air pipe for measuring water levels was installed with its lower end at a depth of 300 feet below the pump base or at the top of the bowl assembly.

On December 10, 1929 at the time of completion of the well the static water level was reported as 227 feet and the pumping level 270 feet when the production rate was 430 gallons per minute. The temperature of the water was 59° F. In October 1933 the water level was measured at 213.6 feet, a rise of 13.4 feet since December 1929. In October 1940 the water level was measured by an engineer of the State Water Survey and found to be 234 feet, or a recession of 7 feet since December 1929 and of 20.4 feet since October 1933.

The water had a residue of 495, a total hardness of 277 and an iron content of 0.6 parts per million as shown by the analysis of sample number 65593, collected December 1929.

Analysis of Sample Number 65593 taken from the American Institute of
Laundering Well.

Determinations Made.		Hypothetical Combinations.	
	Pts. per million.		Pts. per million.
Iron.....Fe	0.6	Sodium Nitrate.....NaNO ₃	0.9
Manganese..Mn	0.0	Sodium Chloride.....NaCl	56.2
Turbidity.....	10	Sodium Sulfate.....Na ₂ SO ₄	163.4
Silica.....SiO ₂	14.0	Sodium Carbonate.....Na ₂ CO ₃	5.3
Calcium....Ca	74.5	Ammonium Carbonate..(NH ₄) ₂ CO ₃	2.4
Magnesium..Mg	21.9	Magnesium Carbonate..MgCO ₃	76.3
Ammonium..NH ₄	0.9	Calcium Carbonate....CaCO ₃	186.2
Sodium.....Na	77.6	Silica.....SiO ₂	14.0
Sulfate.....SO ₄	110.6	Iron Oxide.....Fe ₂ O ₃	0.9
Nitrate.....NO ₃	0.2	Manganese Oxide.....MnO	0.0
Chloride....Cl	34.0		
Alkalinity (as CaCO ₃)		Total.....	505.6
Phenolphthalein..	0.0		
Methyl Orange...	284.0		
Residue.....	495.0		
Total Hardness....	277.0		
			29.48

AMERICAN STEEL AND WIRE COMPANY — COLLINS STREET PLANT (26). The Collins Street plant of the American Steel and Wire Company is located at 927 Collins Street in Joliet. There have been three wells at this plant but in 1941 only one was in use.

The so-called tool room well is located approximately 730 feet north and 1125 feet west of the southeast corner of the southwest quarter of Section 3, T. 35 N., R. 10 E., at a surface elevation of 543 feet above sea level. It was drilled in 1914 by W. H. Gray and Bros of Chicago, Illinois, to a depth of 1602 feet and is cased with 10-inch pipe to a depth of 327 feet and with 8-inch pipe from 1151½ to 1189 feet. The uncased portion of the well is 10 inches in diameter from 327 to 1151½ feet and 8 inches in diameter from 1189 to 1602 feet. In 1941 the W. J. Fulton Engineering Company of Waukegan was installing 327 feet of 8-inch casing with a packer at the lower end inside the old 10-inch casing.

The following records of depth to static water level were compiled by the well owner and show a steady recession of water; level since the well was drilled:

Year.....	1913	1917	1919	1920	1922	1927	1931
Feet to water.....	100	123	161	173	191	259	285

Early in 1941 this well was equipped with an air-lift pump but the program of repairs called for its replacement with a turbine pump.

The new pump will be an 8-inch Johnston turbine pump consisting of 450 feet of 6-inch column pipe, a 22-stage bowl assembly, and an undetermined length of suction pipe. The pump will be driven by a 75-horsepower, direct-connected electric motor and is rated at 400 gallons per minute. A small air line for determining water levels will extend to a depth of 450 feet below the pump base.

The water had a residue of 520, a total hardness of 248, and an iron content of 0.2 parts per million as shown by the analysis of sample number 91639, collected October 23, 1941. The temperature of the water was 59° F.

Analysis of Sample Number 91639 from Well 1602 Feet Deep.

Determinations Made.		Hypothetical Combinations.	
	Pts. per million.		Pts. per million.
Turbidity.....	trace	Sodium Nitrate.....	NaNO ₃ 5.1
Color.....	0	Sodium Chloride.....	NaCl 90.6
Odor.....	0	Sodium Sulfate.....	Na ₂ SO ₄ 125.7
Iron..... Fe		Sodium Carbonate.....	Na ₂ CO ₃ 29.7
(filtered at well) ..	0.2	Magnesium Carbonate..	MgCO ₃ 74.6
(unfiltered).....	0.3	Calcium Carbonate.....	CaCO ₃ 159.6
Manganese.. Mn	0.1	Silica.....	SiO ₂ 9.5
Silica..... SiO ₂	9.5		
Calcium..... Ca	63.7	Total.....	494.8
Magnesium.. Mg	21.5		
Ammonium.. NH ₄	0.1		
Sodium..... Na	90.6		
Sulfate..... SO ₄	85.1		
Nitrate..... NO ₃	3.5		
Chloride..... Cl	55.0		
Alkalinity (as CaCO ₃)			
Phenolphthalein...	0.0		
Methyl Orange...	276.0		
Hardness (as CaCO ₃)	248.0		
Residue.....	520.0		
pH = 8.0			
Free CO ₂ (calc.)....	5.0		

A second well, which is now plugged, is located approximately 900 feet north and 1120 feet west of the southeast corner of the southwest quarter of Section 3, T. 35 N., R. 10 B. This well was relatively shallow and is thought to have penetrated only the upper limestone.

A third well was abandoned many years ago and very little is known about it now. It was thought to have been located about 600-700 feet north and 1900 feet west of the southeast corner of the southwest quarter of Section 3, T. 35 N., R. 10 E. A record of 1888 shows the depth as 1215 feet and the material penetrated as follows:

Formations.	Thickness in feet.	Depth in feet.
Limestone	260	260
Shale	110	370
Limestone	330	700
White sand and quicksand	350	1050
Clay pocket	40	1090
White sand	10	1100
Clay pocket	65	1165
Gray sand	50	1215

The record, which was rather incoherent, showed that the well was cased with 8-inch pipe to 32 feet, with 5-inch pipe from 0 to 575 feet, and with 3½-inch pipe from 765 to 835 feet. There may also have been casing from 1050 to 1090 feet and from 1100 to 1165 feet. The well had a diameter of 3 inches at the bottom.

AMERICAN STEEL AND WIRE COMPANY—SCOTT STREET PLANT (27). The Scott Street Plant of the American Steel and Wire Company is located north of Columbia Street at its intersection with Scott Street.

Water was formerly obtained from a well which was abandoned several years before 1941. There is some doubt as to the accuracy of the information concerning this well but it is thought to have been drilled before 1896 by A. K. Wallen of Morris, Illinois, to a depth of about 2200 feet. The water was salty and the well was plugged back to a depth of about 1600 feet.

A log of material penetrated, furnished by the State Geological Survey, is as follows:

Formations.	Thickness in feet.	Depth in feet.
PLEISTOCENE SYSTEM		
Glacial drift	7	7
SILURIAN SYSTEM		
Niagaran and Alexandrian dolomite, water-bearing	230	237
ORDOVICIAN SYSTEM		
Maquoketa shale	68	305
Galena-Platteville dolomite	334	639
St. Peter formation		
Sandstone, water-bearing	217	856
Shale, caving	40	896
ORDOVICIAN AND CAMBRIAN SYSTEMS		
Oneota, Jordan, Trempealeau and Franconia dolomites and sandstones	450	1346
CAMBRIAN SYSTEM		
Galesville (Dresbach) sandstone, water-bearing.	175	1521
Eau Claire shale and dolomite	405	1926
Mt. Simon sandstone, water-bearing	150	2076

One report indicates that this may be the log of a well at the Carnegie-Illinois Steel Corporation Coke Plant about 1½ miles farther north. However, the best available information indicates that it is the log of the well at the Scott Street Plant.

No analysis of the water from this well is available.

BEATEICE MEADOW GOLD DAIRIES, INC. (34). The Joliet plant of the Beatrice Meadow Gold Dairies, Incorporated, is located at 312 Collins Street.

Water is obtained from an 8-inch well originally drilled to a depth of 803 feet by J. Otis Heflin of Joliet, Illinois, at a site in the basement of the dairy building, 200 feet north of the center line of Benton Street and 100 feet east of the center line of Collins Street or approximately 1800 feet north and 2600 feet west of the southeast corner of Section 10, T. 35 N., R. 10 E.

In 1938 it was cleaned and deepened by the Sewell Well Company of St. Louis, Missouri to a final depth of 1460 feet below a ground surface elevation above sea level of 550 feet. The elevation of the pump base is 6 feet below ground surface or 543.96 feet above sea level. The well was reported to have been cased from the surface to an unknown depth with 8-inch pipe. It is finished as a 6-inch open hole below the original depth.

A log of the formations penetrated by the well, below 803 feet, furnished by the State Geological Survey, is as follows:

Formations.	Thickness in feet.	Depth in feet.
PLEISTOCENE, SILURIAN AND ORDOVICIAN SYSTEMS		
No record	803	803
ORDOVICIAN SYSTEM		
Oneota dolomite	177	980
CAMBRIAN SYSTEM		
Jordan dolomite	55	1035
Trempealeau dolomite	195	1230
Franconia sandstone and dolomite	125	1355
Galesville (Dresbach) sandstone, water-bearing..	105	1460

Upon completion of the well to the final depth of 1460 feet static water level was 196 feet below the pump base.

The well is equipped with a 7-inch Sterling deep-well turbine pump consisting of 350 feet of 4-inch column pipe, 29 stages of bowl assembly having an over-all length of 11 2/3 feet, and 20 feet of 4-inch suction pipe. It is rated at 100 gallons per minute against a 454-foot head when operating at a speed of 1760 revolutions per minute. It was reported that with a production of 100 gallons per minute the drawdown was four feet below the static level of 196 feet.

The pump is direct-connected to a 20-horsepower General Electric Company electric motor which operates at a full load speed of 1760 revolutions per minute. A small air pipe for measuring water levels extends to a depth of 330 feet or to within 20 feet of the top of the bowl assembly. The motor and pump are automatically controlled by a float in the water supply tank on the roof of the building.

The water had a residue of 439, a total hardness of 269.5, and a content of iron of 0.1 parts per million as shown by the analysis of sample number 91635, collected October 23, 1941. The temperature of the water on that date was 61½° F.

Analysis of Sample Number 91635 from Beatrice Creamery 1460-Foot Well.		Hypothetical Combinations.		
Determinations Made.				
	Pts. per million.		Pts. per million.	Grs. per gallon.
Turbidity.....	trace	Sodium Nitrate.....NaNO ₃	1.7	0.10
Color.....	0	Sodium Chloride.....NaCl	52.6	3.07
Odor.....	0	Sodium Sulfate.....Na ₂ SO ₄	93.0	5.42
Iron.....Fe		Ammonium Sulfate.....(NH ₄) ₂ SO ₄	4.0	0.23
(filtered at well)...	0.1	Magnesium Sulfate.....MgSO ₄	47.6	2.78
(unfiltered).....	0.5	Magnesium Carbonate..MgCO ₃	46.4	2.71
Manganese..Mn	0.2	Calcium Carbonate.....CaCO ₃	175.1	10.21
Silica.....SiO ₂	11.0	Silica.....SiO ₂	11.0	0.64
Calcium.....Ca	69.9			
Magnesium..Mg	22.9	Total.....	431.4	25.16
Ammonium..NH ₄	1.1			
Sodium.....Na	51.3			
Sulfate.....SO ₄	103.9			
Nitrate.....NO ₃	1.4			
Chloride....Cl	32.0			
Alkalinity (as CaCO ₃)				
Phenolphthalein..	0.0			
Methyl Orange...	230.0			
Residue.....	439.0			
Hardness (as CaCO ₃)	269.5			
pH = 7.2				
Free CO ₂ (calc.)....	27.0			

BLOCKSON CHEMICAL COMPANY. The plant of the Blockson Chemical Company is located in the southeast quarter of the northeast quarter of Section 30, T. 35 N., R. 10 E. and southwest of the Brandon Road bridge over the DesPlaines River which is near the southern city limits of Joliet.

WELL NUMBER 1 (62). This plant has two wells. The old well, number 1, drilled by the J. P. Miller Artesian Well Company in about 1925 at a site 168 feet north and 580 feet west of the southeast corner of the northeast quarter of Section 30, is reported to be 1520 feet deep below a ground surface elevation of 547 feet above sea level. It is cased with 10-inch wrought steel pipe to a depth of 501 feet and with 8-inch wrought steel pipe from 488 feet to 1296 feet. A lead seal closes the annular space between the two sizes of casing thus producing a continuous line of casing from the surface to a depth of 1296 feet. The diameter at the bottom of the well is, 8 inches.

The static water level was at 160 feet below the pump base and the pumping water level 310 feet in March 1936. In June 1941 the air line was not functioning properly and water level readings could not be taken at the time the new well was tested.

This well is equipped with an 8-inch Pomona deep-well turbine pump, the assembly of which consists of 330 feet of 7-inch column pipe, a 23-stage bowl section having a over-all length of 11 feet 5 inches,

and 10 feet of 6-inch suction pipe with a 2-foot strainer on the bottom. The pump base is at elevation 549.78 feet above sea level.

The pump is directly connected to a 50-horsepower electric motor which operates at a full-load speed of 1760 revolutions per minute. The unit is rated to deliver 300 gallons per minute against a head of 400 feet when operating at the full load speed.

On October 25, 1941 the temperature of the water was 61° F. The water had a residue of 455, a total hardness of 244 parts per million and a trace of iron as shown by the analysis of sample number 91686, collected on that date.

Analysis of Sample Number 91686 from Well Number 1.
Determinations Made.

	Pts. per million.
Turbidity	0
Color	0
Odor	0
Iron	Fe
(filtered at well)	trace
(unfiltered)	0.9
Chloride	Cl 33.0
Sulfate	SO ₄ 93.4
Alkalinity (as CaCO ₃)	
Phenolphthalein	0.0
Methyl Orange	264.0
Calcium	Ca 62.0
Magnesium	Mg 21.6
Residue	455.0
Total hardness (as CaCO ₃)	244.0

WELL NUMBER 2 (63). The new well, number 2, was drilled by S. B. Geiger and Company of Chicago, Illinois in 1941 to a finished depth of 1510 feet below the ground surface elevation of 547 feet above sea level at a site 15 feet north and 520 feet west of the southeast corner of the northeast quarter of Section 30, T. 35 N., R. 10 E. It is about 165 feet southeasterly of well number 1. The hole was drilled 17 inches in diameter to a depth of 526 feet, 12½ inches in diameter to a depth of 1291 feet and 10 inches in diameter to the bottom.

The well is cased from the pump room floor level to a depth of 526¾ feet with 12-inch casing and below which is 770 1/3 feet of 10-inch casing set with the bottom at a depth of 1291 feet. A lead seal fills the annular space between the two sizes of casing at a depth of about 520 feet. The well was shot with 400 pounds of blasting gelatin between depths of 1455 feet and 1470 feet and again with 800 pounds of blasting gelatin between depths of 1420 feet and 1450 feet.

A log of the material penetrated, furnished by the State Geological Survey, is as follows:

	Thickness in feet.	Depth in feet.
Formations.		
PLEISTOCENE SYSTEM		
Glacial till	8	8
SILURIAN SYSTEM		
Niagaran and Alexandrian dolomite, water-bearing	127	135

Formations.	Thickness in feet.	Depth in feet.
ORDOVICIAN SYSTEM		
Maquoketa formation		
Shale and dolomite	40	175
Shale	70	245
Galena-Platteville dolomite	340	585
St. Peter formation		
Sandstone, water-bearing	160	745
Shale and chert, cavey	15	760
ORDOVICIAN AND CAMBRIAN SYSTEMS		
Oneota, Jordan and Trempealeau dolomites	440	1200
Franconia sandstone, dolomite, and shale	135	1335
Galesville (Dresbach) sandstone, water-bearing.	160?	1495?
Eau Claire formation	24½	1519½

At the time of the production test on June 20, 21, and 22, 1941 the well was temporarily equipped with a Pomona deep-well turbine pump set with the top of the bowl assembly at a depth of 430 feet below the top of the pump base which was 2 feet above the pump room floor. The pump was directly connected to a 75-horsepower electric motor. The pump in well number 1 was in operation all the time the test on well number 2 was, in progress.

At the end of 34 hours continuous pumping the well produced at a rate of 490 gallons per minute with 140 feet of drawdown below a static or non-pumping water level of 211 feet below the pump base. The well recovered to within 8 feet of the original static water level within 4 hours following the end of the test.

The water had a residue of 540, a total hardness of 285 and a content of Iron of 0.6 parts per million as shown by the analysis of sample number 90765, collected June 17, 1941.

Analysis of Sample Number 90765 from 1510-Foot Blockson Chemical Company Well.

Determinations Made.		Hypothetical Combinations.		
	Pts. per million.		Pts. per million.	Grs. per gallon.
Turbidity	10	Sodium Nitrate NaNO ₃	3.4	0.20
Color	0	Sodium Chloride NaCl	52.6	3.07
Odor	0	Sodium Sulfate Na ₂ SO ₄	166.2	9.69
Iron Fe		Sodium Carbonate Na ₂ CO ₃	8.0	0.47
(filtered at well)	0.5	Ammonium Carbonate (NH ₄) ₂ CO ₃	1.9	0.11
(unfiltered)	0.6	Magnesium Carbonate MgCO ₃	92.3	5.38
Manganese Mn	0.0	Calcium Carbonate CaCO ₃	177.1	10.32
Silica SiO ₂	10.0	Silica SiO ₂	10.0	0.58
Calcium Ca	70.9			
Magnesium Mg	26.6	Total	511.5	29.82
Ammonium NH ₄	0.6			
Sodium Na	78.9			
Sulfate SO ₄	112.5			
Nitrate NO ₃	2.2			
Chloride Cl	32.0			
Alkalinity (as CaCO ₃)				
Phenolphthalein	0.0			
Methyl Orange	296.0			
Hardness (as CaCO ₃)	285.0			
Residue	540.0			

The well is permanently equipped with a 10-inch Pomona deep-well turbine pump, the assembly of which consists of 430 feet of 7-inch

column, a 15-stage bowl section having an outside diameter of 9 3/8 inches and an over-all length of 11 feet, and 10 feet of 7-inch suction pipe.

The pump is directly connected to a 75-horsepower General Electric Company electric motor, the full-load speed of which is 1760 revolutions per minute. The pumping unit is rated at 600 gallons per minute against a 380-foot head when operating at the full-load speed. The small air pipe for determining water levels terminates at the top of the bowl assembly or at a depth of 430 feet below the pump base. The top of the concrete pump foundation is at elevation 549.72 feet above sea level.

On August 18, 1941 static water level in well number 2 was reported as 235 feet below the pump base and the average pumpage 319,000 gallons per day while on August 25, 1941 the static water level was 240 feet and the average pumpage 298,000 gallons per day.

At the time the production test was made on the new well of the Public Service Company of Northern Illinois located some 1500 feet northeasterly, the water levels in the Blockson Chemical Company wells were noticeably affected.

CARNEGIE - ILLINOIS STEEL CORPORATION, COKE PLANT. The coke plant of the Carnegie-Illinois Steel Corporation is located about one mile north of Joliet between the Lockport Road and the DesPlaines River. There are two wells at this plant but the deeper of the two is not in use.

WELL NUMBER 1 (16), is located at a site approximately 250 feet west and 665 feet south of the center of Section 34, T. 36 N.,

Analysis of Sample Number 91472 from Well Number 1.

Determinations Made.		Hypothetical Combinations.		
	Pts. per million.		Pts. per million.	Grs. per gallon.
Turbidity.....	25	Sodium Nitrate.....NaNO ₃	1.7	0.10
Color.....	0	Sodium Chloride.....NaCl	72.5	4.22
Odor.....	0	Sodium Sulfate.....Na ₂ SO ₄	296.2	17.27
Iron.....Fe		Ammonium Sulfate.....(NH ₄) ₂ SO ₄	4.0	0.23
(filtered at well) ..	0.5	Magnesium Sulfate.....MgSO ₄	39.1	2.28
(unfiltered).....	0.9	Magnesium Carbonate..MgCO ₃	59.4	3.46
Manganese..Mn	0.0	Calcium Carbonate....CaCO ₃	215.8	12.58
Silica.....SiO ₂	8.5	Silica.....SiO ₂	8.5	0.49
Calcium....Ca	86.3			
Magnesium..Mg	25.0	Total.....	697.2	40.63
Ammonium..NH ₄	1.1			
Sodium.....Na	124.9			
Sulfate.....SO ₄	234.7			
Nitrate.....NO ₃	1.1			
Chloride....Cl	44.0			
Alkalinity (as CaCO ₃)				
Phenolphthalein..	0.0			
Methyl Orange...	286.0			
Hardness (as CaCO ₃)	318.5			
Residue.....	710.0			
pH = 7.1				
Free CO ₂ (calc.)....	43.0			

R. 10 E., with a surface elevation of 562 feet above sea level. It was drilled about 1917 by F. M. Gray, Jr., of Milwaukee. After having been out of service for over twelve years the well was cleaned and deepened in 1941 by the J. P. Miller Artesian Well Company of Chicago. The casing was found to be 12 inches in diameter and the original bottom of the well at a depth of 784 feet; although previous reports had indicated an original depth of 868 feet. The well was deepened to the base of the St. Peter sandstone at a depth of 830 feet, being finished as a 10-inch open hole at a depth of 832 feet.

Static water level was reported to be at a depth of 244 feet. When tested by the State Water Survey the water level was lowered to depths of 381½ and 397 feet by pumping at rates of 575 and 640 gallons per minute, respectively.

The temperature of the water was 57° F. The water had a residue of 710, a total hardness of 318.5, and an iron content of 0.5 parts per million as shown by the analysis of sample number 91472, collected September 24, 1941.

WELL NUMBER 2 (14), is located approximately 300 feet west and 300 feet north of the center of Section 34, T. 36 N., R. 10 E. It is reported to be 1600 feet deep below a ground surface, elevation of 563 feet above sea level. It was drilled about 1917 by F. M. Gray, Jr., of Milwaukee.

In 1941 this well was equipped with an air-lift pump but it was not in service.

CHANEY SCHOOL (15). The Chaney School, District Number 88, is located in Lockport Township near the northwest part of Joliet.

Water is obtained from a well located 190 feet north of the center line of Rose Street and 45 feet east of the center line of Dearborn Street, or approximately 2100 feet north and 2350 feet east of the southwest corner of Section 33, T. 36 N., R. 10 E. The well was drilled in 1937 by J. A. Kramer of Joliet, Illinois, to a depth of 952 feet below a ground surface elevation of 636 feet above sea level. It was cased with 10-inch pipe from the surface to a depth of 35 feet and with 8-inch pipe from the surface to a depth of 435 feet, the smaller pipe being sealed in place with cement grout. After completion both pipes were cut off 5¾ feet below ground level, or at an elevation above sea level of 629.99 feet to permit the pump installation in a pit.

A record of material penetrated, furnished by the driller, is as follows:

Formations.	Thickness in feet.	Depth in feet.
Clay and gravel	35	35
Limestone	272	307
Shale	98	405
Limestone	20	425
Marl	2	427
Limestone	308	735
Sandstone, very hard	123	858
Sandstone, softer	89	947
Limestone	5	952

The well is equipped with a Pomona turbine pump with 2 bowl assemblies driven by a 25-horsepower electric motor. The pump assembly consists of 140 feet of 5-inch column pipe, a 26-stage, 6-inch bowl section having an over-all length of 10 1/3 feet, 300 feet of 4½-inch column pipe, 34-stage, 6-inch bowl section having an over-all length of 13 feet, and 10 feet of 4½-inch suction pipe. It is rated at 100 gallons per minute against a head of 555 feet when operating at a speed of 1765 revolutions per minute. A small air line for determining water levels extends to a depth of 450 feet below the pump base.

In 1937 the water level was reported to be 348 feet below the ground surface when not pumping and was lowered 50 or 60 feet by pumping at a rate of 100 gallons per minute. In 1941 after the well had not been pumped for a month the non-pumping level was 342 feet below the ground surface.

No analysis of the water from this well is available.

JAS. G. HEGGIE MANUFACTURING COMPANY. The plant of the Jas. G. Heggie Manufacturing Company is located at 1102 Collins Street.

WELL NUMBER 1 (24). Water is obtained from a 6-inch well known as well number 1 drilled about 1900 by A. K. Wallen of Morris, Illinois, to a depth of about 1500 feet below a ground surface elevation above sea level of 553 feet at a site 500 feet north of the center line of Williamson Avenue and 675 feet east of the center line of Collins Street or 1850 feet north and 2140 feet west of the southeast corner of Section 3, T. 35 N., R. 10 E. The well is thought to have been recased later by John Mathews of Joliet.

Analysis of Sample Number 91734 from Well 1500 Feet Deep.

Determinations Made.		Hypothetical Combinations.	
	Pts. per million.		Pts. per million. Grs. per gallon.
Turbidity.....	10	Sodium Nitrate..... NaNO ₃	2.6 0.15
Color.....	0	Sodium Chloride..... NaCl	54.4 3.17
Odor.....	0	Sodium Sulfate..... Na ₂ SO ₄	14.9 0.87
Iron..... Fe		Ammonium Chloride..... NH ₄ Cl	0.5 0.03
• (filtered at well) ..	0.1	Magnesium Sulfate..... MgSO ₄	422.5 24.63
(unfiltered).....	1.0	Calcium Sulfate..... CaSO ₄	140.4 8.19
Manganese.. Mn	0.0	Calcium Carbonate..... CaCO ₃	346.3 20.19
Silica..... SiO ₂	10.5	Silica..... SiO ₂	10.5 0.61
Calcium..... Ca	179.8		
Magnesium.. Mg	85.4	Total.....	992.1 57.84
Ammonium.. NH ₄	0.2		
Sodium..... Na	26.9		
Sulfate..... SO ₄	447.0		
Nitrate..... NO ₃	1.9		
Chloride.... Cl	33.0		
Alkalinity (as CaCO ₃)			
Phenolphthalein..	0.0		
Methyl Orange...	346.0		
Residue.....	986.0		
Hardness (as CaCO ₃)	800.0		
pH = 7.0			
Free CO ₂ (calc.)....	65.0		

The well is cased with 6-inch pipe and is equipped with an American Well Works cylinder pump belt driven by a 5-horsepower electric motor. The assembly of the pump consists of 60 feet of 2½-inch drop pipe, and a 3-inch double acting cylinder 48 inches long. The pump operates with an 18-inch stroke at a speed of 24 strokes per minute.

The water from well Number 1 had a residue of 986, a total hardness of 800, and a content of iron of 0.1 parts per million as shown by the analysis of sample number 91734, collected October 29, 1941.

WELL NUMBER 2 (23). Well number 2 is a 3-inch well drilled by A. K. Wallen of Morris, Illinois, to a depth of about 600 feet below a ground surface elevation above sea level of 553 feet, at a site 550 feet north of the center line of Williamson Avenue and 245 feet east of the center line of Collins Street or 1900 feet north and 2570 feet west of the southeast corner of Section 3, T. 36 N., R. 10 E.

The well is cased with 3-inch pipe but was not equipped with a pump in 1941.

ILLINOIS STATE PENITENTIARY — JOLIET BRANCH. The Joliet Branch of the Illinois State Penitentiary, generally known as the Old Prison, is located at the north edge of the city of Joliet at 806 Collins Street.

WELL NUMBER 1 (21). In 1920 the drinking water supply was obtained from a well reported to be 575 feet deep and designated as well number 1. It is located 2915 feet north and 3240 feet west of the southeast corner of Section 3, T. 35 N., R. 10 E. It was equipped with a small air-lift pump and in 1921 the water level when not pumping was reported as 35 feet below a ground surface elevation above sea level of 544.5 feet. In 1933 a well, probably this one, was reported as 6 inches in diameter and 780 feet deep. The equipment in use that year was a 6-inch Cook double-acting plunger pump which produced at a rate of 132 gallons per minute.

In 1920 water for sprinkling and fire protection was obtained from a nearby quarry and a 1500-foot well nearby. During this same year there was also in service a well reported to be 1600 feet deep. This latter well was located back of the boilers and equipped with an air-lift pump. Non-pumping water level was reported to be 210 feet below the ground surface. A test was run in that year and a yield of 700 gallons per minute obtained. It was reported that the water level in this and the other wells was affected by the pumping of the Joliet city wells.

The J. P. Miller Artesian Well Company of Chicago, Illinois, published in 1901 a list of wells drilled by them up to that time and in which is given a 2300-foot well at the Joliet State Prison. A later edition of this list (1925) gives this well as 2500 feet deep. Without doubt salt water was encountered at this depth and it may have been plugged back to 1500 or 1600 feet and be one or the other of the two wells mentioned above.

WELL NUMBER 2 (22). In 1928 the Gray Well Drilling Company of Milwaukee, Wisconsin, completed a well to a depth of 1550 feet below a ground surface elevation of 545 feet above sea level at a site 14 feet west of the southwest corner of the power house or 3265 feet west and 2880 feet north of the southeast corner of Section 3, T. 35 N, R. 10 E.

A record of the formations penetrated, supplied by the State Geological Survey, is as follows:

Formations.	Thickness in feet.	Depth in feet.
No record.....	40	40
SILURIAN SYSTEM		
Niagaran-Alexandrian dolomites, water-bearing.	155	195
ORDOVICIAN SYSTEM		
Maquoketa formation		
Dolomite and some shale.....	35	230
Shale.....	75	305
Galena-Platteville dolomite.....	330	635
Glenwood sandstone and dolomite.....	40	675
St. Peter formation		
Sandstone, water-bearing.....	195	870
Sandy shale and chert.....	73	943
ORDOVICIAN-CAMBRIAN SYSTEMS		
Oneota-Trempealeau dolomites.....	287	1230
CAMBRIAN SYSTEM		
Franconia sandstone, dolomitic.....	155	1385
Galesville (Dresbach) sandstone, water-bearing.	150	1535
Eau Claire shale and sandstone.....	15	1550

The well was cased with 20-inch O. D. pipe from the ground surface to a depth of 8 feet, with 16-inch O. D. pipe from the ground surface to a depth of 40 feet which was grouted in with 12½-inch O. D. steel pipe from the ground surface to a depth of 552 feet 11 inches, and with 10-inch steel pipe between depths of 602 and 944 feet. The well was finished 10 inches in diameter at the bottom.

Analysis of Sample Number 73621 from 1550-Foot Well.

Determinations Made.		Hypothetical Combinations.		
	Pts. per million.			
		Pts. per million.	Grs. per gallon.	
Iron..... Fe.	0.7	Sodium Nitrate..... NaNO ₃	5.1	0.30
Manganese..... Mn	0.0	Sodium Chloride..... NaCl	166.7	9.72
Silica..... SiO ₂	17.0	Sodium Sulfate..... Na ₂ SO ₄	68.9	4.02
Turbidity.....	0.0	Magnesium Sulfate..... MgSO ₄	222.2	12.97
Calcium..... Ca	116.0	Magnesium Carbonate..... MgCO ₃	20.6	1.20
Ammonium..... NH ₄	.01	Calcium Carbonate..... CaCO ₃	261.5	15.26
Magnesium..... Mg	50.8	Calcium Silicate..... CaSiO ₃	33.1	1.93
Sodium..... Na	89.3	Iron Oxide..... Fe ₂ O ₃	1.0	0.06
Sulfate..... SO ₄	224.0			
Nitrate..... NO ₃	3.8	Total.....	779.1	45.46
Chloride..... Cl	101.0			
Alkalinity (as CaCO ₃)				
Phenolphthalein..	0.0			
Methyl Orange...	286.0			
Residue.....	780.0			
Total hardness.....	499.0			

In 1931 a 10-inch Cook deep-well turbine pump was installed, the assembly of which consisted of 270 feet of 8-inch column pipe, a 9-stage

bowl section having an over-all length of 9 feet, and 20 feet of 6-inch suction pipe. The pump was powered by a direct connected 60-horsepower U. S. Electric Company electric motor which operated at a full-load speed of 1760 revolutions per minute. At the time of installation the water level when not pumping was reported as 245 feet and the pumping level 253 feet. In 1933 the water level when not pumping was found by direct measurement to be 221.75 feet and the pumping level 227.75 feet at the end of one hour when the pump produced at the rate of 600 gallons per minute.

The water had a residue of 780, a total hardness of 499, and an iron content of 0.7 parts per million as shown by the analysis of sample number 73621, collected October 4, 1933.

ILLINOIS STATE PENITENTIARY — STATEVILLE BRANCH. The Stateville Branch of the Illinois State Penitentiary is located about 3½ miles north of the center of Joliet on the west side of DesPlaines River. In 1941 water was obtained from four deep wells and a fifth well which is probably shallow and which is known as the "feeder well".

WELL NUMBER 1 (6), formerly number 15, is located approximately 965 feet south and 1565 feet east of the northwest corner of Section 28, T. 36 N., R. 10 E. It was drilled before 1920 to a depth of 1095 feet below a ground surface elevation of 644 feet above sea level and was cased to the top of the rock.

The well was equipped with an air-lift pump and the static water level was reported to be 40 feet below the ground surface in 1923.

The water from the well had a residue of 422, a total hardness of 325, and an iron content of 3.6 parts per million as shown by the analysis of sample number 65382, collected November 9, 1929.

Analysis of Sample Number 65382 from Well 1095 Feet Deep.

Determinations Made.		Hypothetical Combinations.		
	Pts. per million.		Pts. per million.	Grs. per gallon.
Iron.....Fe	3.6	Sodium Nitrate.....NaNO ₃	1.2	0.07
Manganese..Mn	0.0	Sodium Chloride.....NaCl	5.0	0.29
Silica.....SiO ₂	10.0	Sodium Sulfate.....Na ₂ SO ₄	59.3	3.47
Calcium....Ca	59.0	Sodium Carbonate.....Na ₂ CO ₃	44.7	2.61
Magnesium..Mg	44.1	Ammonium Carbonate..(NH ₄) ₂ CO ₃	1.2	0.07
Ammonium..NH ₄	0.5	Magnesium Carbonate..MgCO ₃	153.0	8.95
Sodium.....Na	40.9	Calcium Carbonate....CaCO ₃	147.2	8.61
Sulfate.....SO ₄	40.1	Silica.....SiO ₂	10.0	0.58
Nitrate.....NO ₃	0.9	Iron Oxide.....Fe ₂ O ₃	5.1	0.30
Chloride....Cl	3.0	Manganese Oxide.....MnO	0.0	0.00
Alkalinity (as CaCO ₃)				
Phenolphthalein..	0.0	Total.....	426.7	24.95
Methyl Orange...	372.0			
Residue.....	422.0			
Total hardness.....	325.0			

About 1930 a screen was placed in this well at the base of the glacial drift by Joseph A. Mesiroff of Milwaukee, Wisconsin. This was installed and gravel-packed by the use of small pilot holes in order to admit water from the glacial drift.

In 1940-41 the well was deepened by the J. P. Miller Artesian Well Company of Chicago, Illinois, to a final depth of 1599 feet. The screen and old casing were removed at this time and the Galesville sandstone was shot three times.

A log of material penetrated, furnished by the State Geological Survey, is as follows:

Formations.	Thickness in feet.	Depth in feet.
PLEISTOCENE SYSTEM		
Glacial drift . . . . .	.65	65
SILURIAN SYSTEM		
Niagaran and Alexandrian dolomites, water-bearing . . . . .	.315	380
ORDOVICIAN SYSTEM		
Maquoketa shale . . . . .	.110	490
Galena-Platteville dolomite . . . . .	.340	830
St. Peter formation		
Sandstone, water-bearing . . . . .	.124	954
Shale, caving . . . . .	.10	964
ORDOVICIAN AND CAMBRIAN SYSTEMS		
Prairie du Chien dolomite, Jordan sandy dolomite . . . . .	.131	1095
CAMBRIAN SYSTEM		
Trempealeau dolomite . . . . .	.180	1275
Franconia dolomite and sandstone . . . . .	.118	1393
Galesville sandstone, water-bearing . . . . .	.157	1550
Eau Claire dolomite and shale . . . . .	.50	1600

A charge of 150 pounds of explosive was set off at a depth of 1552 feet. Next a charge of 105 pounds was exploded at a depth of 1537 feet, whereupon the static water level dropped from 95 to 151 feet on the following day. A final charge was exploded at a depth of 1520 feet. The static water level then dropped to 224 feet the following day but rose to 205 feet three days later. Static level was reported at 205 feet but

Analysis of Sample Number 89959 from Well Number 1.

Determinations Made.	Pts. per million.	Hypothetical Combinations.	Pts. per million.	Grs. per gallon.
Turbidity	trace	Sodium Nitrate NaNO ₃	0.9	0.05
Color	0	Sodium Chloride NaCl	6.4	0.37
Odor	0	Sodium Sulfate Na ₂ SO ₄	177.6	10.35
Iron Fe		Ammonium Sulfate (NH ₄) ₂ SO ₄	1.3	0.08
(filtered at well)	0.0	Magnesium Sulfate MgSO ₄	34.9	2.03
(unfiltered)	0.4	Magnesium Carbonate MgCO ₃	134.5	7.84
Manganese Mn	0.1	Calcium Carbonate CaCO ₃	242.7	14.15
Silica SiO ₂	15.0	Silica SiO ₂	15.0	0.87
Calcium Ca	96.9			
Magnesium Mg	45.9	Total	613.3	35.74
Ammonium NH ₄	0.4			
Sodium Na	60.3			
Sulfate SO ₄	148.9			
Nitrate NO ₃	0.9			
Chloride Cl	4.0			
Alkalinity (as CaCO ₃)				
Phenolphthalein	0.0			
Methyl Orange	402.0			
Hardness (as CaCO ₃)	431.0			
Residue	660.0			
pH = 7.1				

a level of 290 feet was indicated by the air pressure in the air line which terminates at the bottom of the pump bowls at a depth of 394 feet. It is thought that there may have been a leak in the air line at a point below the water surface.

The well is now cased with 10-inch pipe to a depth of 424 feet and with 8-inch pipe from 1060 to 1102 feet. There is a steel shoe at the top of the 8-inch pipe and the open hole below 1102 feet is 8 inches in diameter.

The well is equipped with an 8-inch Pomona turbine pump consisting of 380 feet of 5-inch column pipe, a 21-stage bowl assembly 14 feet long, and 30 feet of 5-inch suction pipe.

A production test of the well was made by the State Water Survey on February 18-19, 1941. This test showed a drawdown of 50 feet below the indicated static level of 290 feet when the discharge rate of approximately 270 gallons per minute was maintained for several hours.

The water had a residue of 660, and a total hardness of 431 parts per million with no iron as shown by the analysis of sample number 89959, collected February 19, 1941.

WELL NUMBEE 2 (7), formerly number 16, is located approximately 1500 feet south and 1565 feet east of the northwest corner of Section 28, T. 36 N., R. 10 E. It was drilled in 1921 by the J. P. Miller Artesian Well Company of Chicago, Illinois, to a depth of 1577 feet below a ground surface elevation of 642 feet above sea level. It was cased with 16-inch pipe to a depth of 70 feet, with 12-inch pipe from the ground surface to a depth of 178½ feet, with 10-inch pipe between depths of 232 and 370 feet, and with 8-inch pipe between depths of 883 and 933 feet. Below 933 feet the open hole is 8 inches in diameter.

A record of material penetrated by the well, furnished by the State Geological Survey, is as follows:

Formations.	Thickness in feet.	Depth in feet.
PLEISTOCENE SYSTEM		
Glacial drift	49	49
SILURIAN SYSTEM		
Niagaran and Alexandrian dolomites, water-bearing	206	255
ORDOVICIAN SYSTEM		
Maquoketa shale	110	365
Galena-Platteville dolomite	335	700
St. Peter formation		
Sandstone, water-bearing	130	830
Sandy shale and lime, caving	45	875
ORDOVICIAN AND CAMBRIAN SYSTEMS		
Shakopee-Oneota-Trempealeau dolomite	425	1300
CAMBRIAN SYSTEM		
Pranconia lime and shale	130	1430
Galesville (Dresbach) sandstone, water-bearing	147	1577

The well is equipped with an air-lift pump. The combined yield of this well and the feeder well is about 200 gallons per minute. The depth to water level when not pumping was reported to be 55 feet in 1921, 82 feet in September 1941, 88 feet in October 1941, and 70 feet in November 1941.

The water had a residue of 405, a total hardness of 327, and an iron content of 0.6 parts per million as shown by the analysis of sample number 50815, collected December 29, 1923. The temperature of the water was 53° F. in 1941.

Analysis of Sample Number 50815 from Well Number 2.

Determinations Made.		Hypothetical Combinations.		
	Pts. per million.		Pts. per million.	Grs. per gallon.
Iron..... Fe	0.6	Potassium Nitrate..... KNO ₃	2.6	0.15
Manganese... Mn	0.0	Potassium Chloride.... KCl	6.3	0.37
Silica..... SiO ₂	12.7	Potassium Sulfate..... K ₂ SO ₄	2.0	0.11
Nonvolatile.....	1.4	Sodium Sulfate..... Na ₂ SO ₄	60.6	3.54
Alumina.... Al ₂ O ₃	1.2	Ammonium Sulfate..... (NH ₄) ₂ SO ₄	0.5	0.03
Calcium..... Ca	66.0	Magnesium Sulfate.... MgSO ₄	13.9	0.81
Magnesium... Mg	39.5	Magnesium Carbonate.. MgCO ₃	127.0	7.42
Ammonium... NH ₄	0.1	Calcium Carbonate.... CaCO ₃	164.8	9.62
Sodium..... Na	19.6	Iron Oxide..... Fe ₂ O ₃	0.8	0.05
Potassium... K	5.2	Alumina..... Al ₂ O ₃	1.2	0.07
Sulfate..... SO ₄	53.6	Silica..... SiO ₂	12.7	0.74
Nitrate..... NO ₃	1.6	Silica bases.....	1.4	0.08
Chloride.... Cl	3.0			
Alkalinity (as CaCO ₃)		Total.....	393.8	22.99
Phenolphthalein..	0.0			
Methyl Orange...	318.0			
Residue.....	405.0			
Hardness (as CaCO ₃)	327.0			

WELL NUMBER 3 (5), located approximately 445 feet south and 1565 feet east of the northwest corner of Section 28, T. 36 N., R. 10E., was drilled in 1926 by the Gray "Well Drilling Company of Milwaukee, Wisconsin, to a depth of 1527 feet below a ground surface elevation of 644 feet above sea level. It was drilled 21 inches in diameter to a depth of 73 feet, 15 inches in diameter between depths of 73 and 305 feet, 12 inches in diameter from 305 to 400 feet, 10 inches in diameter from 400 to 1400 feet, and 8 inches in diameter from 1400 to 1527 feet. It is cased with 16-inch pipe to a depth of 73 feet, with 10-inch pipe from 260 to 400 feet, and with 8-inch pipe from 776 to 1400 feet. After drilling was completed the well was shot in the Galesville sandstone.

A record of material penetrated, furnished by the State Geological Survey, is as follows:

Formations.	Thickness in feet.	Depth in feet.
PLEISTOCENE SYSTEM		
Glacial drift.....	60	60
SILURIAN SYSTEM		
Niagaran-Alexandrian dolomites, water-bearing..	190	250
ORDOVICIAN SYSTEM		
Maquoketa formation		
Shale.....	15	265
Dolomite.....	25	290
Shale.....	75	365
Galena-Platteville dolomite.....	325	690
Glenwood sandstone.....	10	700
St. Peter formation		
Sandstone, water-bearing.....	120	820
Sandy shale and chert (caving).....	40	860
Oneota dolomite.....	170	1030

Formations.	Thickness in feet.	Depth in feet.
CAMBRIAN SYSTEM		
Jordan dolomite and sandstone	40	1070
Trempealeau dolomite	190	1260
Franconia sandstone and shale	120	1380
Galesville (Dresbach) sandstone, water-bearing.	147	1527

The well is equipped with an air-lift pump having a capacity of less than 200 gallons per minute.

The static water level was reported to be 324 feet below the ground surface and the temperature of the water 58° F. in November 1941.

The water had a residue of 427, a total hardness of 206, and an iron content of 0.2 parts per million as shown by the analysis of sample number 65384, collected November 9, 1929.

Analysis of Sample Number 65384 from Well Number 3.

Determinations Made.		Hypothetical Combinations.		
	Pts. per million.		Pts. per million.	Grs. per gallon.
Iron Fe	0.2	Sodium Nitrate NaNO ₃	0.3	0.02
Manganese Mn	0.0	Sodium Chloride NaCl	37.9	2.22
Turbidity	0	Sodium Sulfate Na ₂ SO ₄	96.4	5.64
Silica SiO ₂	12.0	Sodium Carbonate Na ₂ CO ₃	64.3	3.76
Calcium Ca	49.7	Ammonium Carbonate (NH ₄) ₂ CO ₃	1.6	0.10
Magnesium Mg	19.9	Magnesium Carbonate MgCO ₃	68.9	4.03
Ammonium NH ₄	0.6	Calcium Carbonate CaCO ₃	124.1	7.25
Sodium Na	74.1	Silica SiO ₂	12.0	0.70
Sulfate SO ₄	65.2	Iron Oxide Fe ₂ O ₃	0.3	0.02
Nitrate NO ₃	0.3	Manganese Oxide MnO	0.0	0.00
Chloride Cl	23.0			
Alkalinity (as CaCO ₃)		Total	405.8	23.74
Phenolphthalein	0.0			
Methyl Orange	268.0			
Residue	427.0			
Total hardness	206.0			

WELL NUMBER 4 (8), located approximately 1760 feet south and 1565 feet east of the northwest corner of Section 28, T. 36 N., R. 10 E., was drilled in 1937 by W. L. Thorne Company of DesPlaines, Illinois, to a depth of 2007 feet below a ground surface elevation of 641 feet above sea level. It is cased with 12-inch pipe from the surface to a depth of 1413 feet and with 10-inch pipe from 1587 to 1909 feet, and is 10 inches in diameter at the bottom.

A log of material penetrated, furnished by the State Geological Survey, is as follows:

Formations.	Thickness in feet.	Depth in feet.
PLEISTOCENE SYSTEM		
Glacial drift	65	65
SILURIAN SYSTEM		
Niagaran and Alexandrian dolomites, water-bearing	180	245
ORDOVICIAN SYSTEM		
Maquoketa formation		
Shale	15	260
Dolomite	20	280
Shale and some dolomite	80	360

Formations.	Thickness in feet.	Depth in feet.
Galena-Platteville dolomite.....	340	700
St. Peter sandstone, water-bearing.....	127	827
Shakopee dolomite, shaly.....	53	880
Oneota dolomite.....	175	1055
CAMBRIAN SYSTEM		
Jordan dolomite and sandstone.....	32	1087
Trempealeau dolomite.....	193	1280
Franconia shale, dolomite and sandstone.....	130	1410
Galesville (Dresbach) sandstone, water-bearing..	160	1570
Eau Claire dolomite, shale, and sandstone.....	395	1965
Mt. Simon sandstone, water-bearing.....	42	2007

The well is equipped with an 8-inch Pomona turbine pump consisting of 400 feet of 6-inch column pipe, a 25-stage bowl assembly 12 1/3 feet long, and 40 feet of 6-inch suction pipe. The pump is driven by a 50-horsepower electric motor and is rated at 300 gallons per minute against a head of 446 feet at a speed of 1760 revolutions per minute. A small air pipe for determining water levels extends to a depth of 442 feet below the pump base.

A production test of this well was made by the State Water Survey in 1937. At this time the water level was reported to be at a depth of 70 feet when not pumping and was lowered more than 304 feet by pumping at a rate of 240 gallons per minute for 4½ hours. In 1941 the static level was reported to be at a depth of 140 feet.

The water had a residue of 1256, a total hardness of 119.5, and an iron content of 17.5 parts per million as shown by the analysis of sample number 79972, collected April 27, 1937.

Analysis of Sample Number 79972 from Well Number 4.

Determinations Made.		Hypothetical Combinations.		
	Pts. per million.			
Iron..... Fe		Sodium Nitrate..... NaNO ₃	1.7	0.10
(filtered).....	3.2	Sodium Chloride..... NaCl	828.0	48.25
(unfiltered).....	17.5	Sodium Sulfate..... Na ₂ SO ₄	86.6	5.04
Manganese... Mn	0.0	Sodium Carbonate..... Na ₂ CO ₃	214.5	12.51
Silica..... SiO ₂	8.0	Ammonium Carbonate... (NH ₄) ₂ CO ₃	1.9	0.11
Turbidity.....	800.0	Magnesium Carbonate... MgCO ₃	9.7	0.56
Calcium..... Ca	43.1	Calcium Carbonate..... CaCO ₃	108.1	6.30
Magnesium... Mg	2.8	Silica..... SiO ₂	8.0	0.47
Ammonium... NH ₄	0.6			
Sodium..... Na	447.1	Total.....	1258.5	73.34
Sulfate..... SO ₄	58.6			
Nitrate..... NO ₃	1.0			
Chloride.... Cl	502.0			
Alkalinity (as CaCO ₃)				
Phenolphthalein...	10.0			
Methyl Orange...	324.0			
Residue.....	1256.0			
Total hardness.....	119.5			

In October 1940 the temperature of the water was 63° F. and the yield of the well about 300 gallons per minute. At this time the water had a total mineral content of 627, a total hardness of 237, and an iron content of 1.3 parts per million as shown by the analysis of sample number 89025, collected October 1, 1940.

Analysis of Sample Number 89025 from Well Number 4.

Determinations Made.

	Pts. per million.
Turbidity.....	10
Color.....	0
Odor.....	0
Iron..... Fe (unfiltered).....	1.3
Chloride.... Cl	118.0
Sulfate.... SO ₄	65.2
Alkalinity (as CaCO ₃) Phenolphthalein.....	0.0
Methyl Orange.....	284.0
Total hardness.....	237.0
Total mineral content.....	627.0
pH = 7.3	

The "feeder well" is located 20 feet south of well number 2 or approximately 1520 feet south and 1565 feet east of the northwest corner of Section 28, T. 36 N., R. 10E.

Information regarding this well is almost entirely lacking but it is probably a shallow well terminating in the Silurian dolomite. It is cased with 8-inch pipe to an unknown depth and is equipped with an air-lift pump which discharges to a small tank above well number 2.

In September 1941 the static water level was about 81 feet below the ground surface after the pump had been stopped for about fifteen minutes.

On October 31, 1941 the water had a residue of 441, a total hardness of 467.5, and an iron content of 0.4 parts per million as shown by the analysis of sample number 91724, collected on that date. The temperature of the water was 51° F.

Analysis of Sample Number 91724 from "Feeder Well".

Determinations Made.

Hypothetical Combinations.

	Pts. per million.		Pts. per million.	Grs. per gallon.
Turbidity.....	85	Sodium Nitrate..... NaNO ₃	3.4	0.20
Color.....	0	Sodium Chloride..... NaCl	4.7	0.27
Odor.....	0	Sodium Sulfate..... Na ₂ SO ₄	40.5	2.36
Iron..... Fe (filtered at well)...	0.4	Ammonium Sulfate..... (NH ₄) ₂ SO ₄	0.7	0.04
(unfiltered).....	8.3	Magnesium Sulfate.... MgSO ₄	62.0	3.61
Manganese.. Mn	0.0	Magnesium Carbonate.. MgCO ₃	109.1	6.36
Silica..... SiO ₂	13.0	Calcium Carbonate.... CaCO ₃	182.7	10.65
Calcium.... Ca	73.0	Silica..... SiO ₂	13.0	0.76
Magnesium.. Mg	44.0	Total.....	416.1	24.25
Ammonium... NH ₄	0.7			
Sodium.... Na	15.9			
Sulfate.... SO ₄	77.3			
Nitrate.... NO ₃	2.2			
Chloride... Cl	3.0			
Alkalinity (as CaCO ₃) Phenolphthalein..	0.0			
Methyl Orange...	312.0			
Residue.....	441.0			
Hardness (as CaCO ₃)	467.5			
pH = 7.8				
Free CO ₂ (calc.)....	26.0			

JOLIET CITIZENS BREWING COMPANY. The plant of the Joliet Citizens Brewing Company is located at the northeast corner of the intersection of Collins Street and Van Buren Street.

WELL NUMBER 1 (40). A well was completed about 1905 by W. H. Gray and Bros. of Chicago, Illinois, to a depth of 1350 feet below a ground surface elevation 543 feet at a site 105 feet east of the center line of Collins Street and 230 feet north, of the center line of Van Buren Street or 2600 feet east and 590 feet north of the southwest corner of Section 10, T. 35 N., R. 10 E. It has not been used since about 1936.

The water had a residue of 781 and a total hardness of 548.5 parts per million with no iron as shown by the analysis of sample number 80818, collected March 5, 1934.

Analysis of Sample Number 80818 from Well 1350 Feet Deep.

Determinations Made.		Hypothetical Combinations.	
	Pts. per million.		Pts. per million. Grs. per gallon.
Iron.....Fe	0.0	Sodium Nitrate.....NaNO ₃	28.1 1.63
Manganese..Mn	0.0	Sodium Chloride.....NaCl	85.3 4.97
Silica.....SiO ₂	9.0	Sodium Sulfate.....Na ₂ SO ₄	30.5 1.78
Turbidity.....	0.0	Magnesium Sulfate....MgSO ₄	278.9 18.25
Calcium.....Ca	127.0	Calcium Sulfate.....CaSO ₄	12.9 0.75
Magnesium..Mg	56.2	Calcium Carbonate....CaCO ₃	308.0 17.95
Ammonium..NH ₄	0.01	Silica.....SiO ₂	9.0 0.52
Sodium.....Na	51.0		
Sulfate.....SO ₄	251.3	Total.....	752.7 43.85
Nitrate.....NO ₃	20.4		
Chloride....Cl	52.0		
Alkalinity (as CaCO ₃)			
Phenolphthalein..	0.0		
Methyl Orange...	308.0		
Residue.....	781.0		
Total hardness.....	548.5		

WELL NUMBER 2 (41). A well was drilled by the Sewell Well Company of St. Louis, Missouri in 1938 to a finished depth of 1484 feet below a ground surface elevation above sea level of 543 feet at a site approximately 155 feet east of the center line of Collins Street and 200 feet north of the center line of Van Buren Street or 2650 feet east and 560 feet north of the southwest corner of Section 10, T. 35 N., R. 10 E.

The well was drilled 15 inches in diameter to a depth of 23½ feet, 12 inches in diameter to a depth of 310 feet, 10 inches in diameter to a depth of 878 feet and 8 inches in diameter to the bottom. It is cased with 12-inch steel pipe to a depth of 23½ feet, 10-inch genuine wrought iron pipe from the surface to a depth of 310 feet, and 81 feet 7 inches of 8-inch genuine wrought iron pipe between depths of 796 feet 5 inches and 878 feet.

A log of the materials penetrated, furnished by the State Geological Survey, is as follows:

Formations.	Thickness in feet.	Depth in feet.
PLEISTOCENE SYSTEM		
Glacial drift.....	23	23
SILURIAN SYSTEM		
Niagaran and Alexandrian dolomites, water-bearing.....	162	185

Formations.	Thickness in feet.	Depth in feet.
ORDOVICIAN SYSTEM		
Maquoketa formation		
Dolomite.....	35	220
Shale.....	75	295
Galena-Platteville dolomite.....	325	620
Glenwood sandstone and dolomite.....	10	630
St. Peter formation		
Sandstone, water-bearing.....	195	825
Shale, soft.....	7	832
Shakopee dolomite.....	40	872
New Richmond sandstone.....	13	885
Oneota dolomite.....	95	980
CAMBRIAN SYSTEM		
Jordan dolomite and sandstone.....	65	1045
Trempealeau dolomite.....	166	1211
Franconia dolomite and sandstone.....	125	1336
Galesville (Dresbach) sandstone, water-bearing..	118	1454
Eau Claire shaly sandstone.....	29	1483

On August 25, 1938 the static water level was 249 feet below the pump base or 247.75 feet below ground level. On August 30, 1938 static water level was; 254 feet below the pump base after the pump had been idle overnight.

On September 8, 1938 a 10-hour production test of the well was made by the State Water Survey. Static water level was found to be 257 feet below the pump base. This was 3 feet lower than the level observed on August 30 but the difference may have been due to the fact that the pump had been in operation up to within a few hours of the start of the test and the well had not had sufficient time for a full recovery.

The test was conducted with the permanent pump in place. This was a Pomona 10-inch deep-well turbine pump, the assembly of which consisted of 370 feet of 6-inch column pipe, a 12-stage bowl section

Analysis of Sample Number 84225 from Joliet Citizens Brewing Company 1484-Foot Well.

Determinations Made.

Hypothetical Combinations.

	Pts. per million.		Pts. per million.	Grs. per gallon.
Iron..... Fe		Sodium Nitrate..... NaNO_3	5.1	0.30
(filtered).....	trace	Sodium Chloride..... NaCl	85.3	4.97
(unfiltered).....	trace	Sodium Sulfate..... Na_2SO_4	92.3	5.39
Manganese.. Mn	0.0	Magnesium Sulfate..... MgSO_4	231.0	13.47
Silica..... SiO_2	17.0	Magnesium Carbonate.. MgCO_3	18.1	1.05
Turbidity.....	4	Calcium Carbonate..... CaCO_3	272.5	15.89
Color.....	0	Silica..... SiO_2	17.0	0.99
Odor.....	0			
Calcium.... Ca	109.0	Total.....	721.3	42.06
Magnesium.. Mg	52.0			
Ammonium.. NH_4	trace			
Sodium..... Na	64.9			
Sulfate..... SO_4	246.8			
Nitrate..... NO_3	3.7			
Chloride.... Cl	52.0			
Alkalinity (as CaCO_3)				
Phenolphthalein..	0.0			
Methyl Orange...	294.0			
Residue.....	749.0			
Total hardness.....	486.0			

having an over-all length of 12 feet, and 10 feet of 6-inch suction pipe. A copper air tube for determining water levels was installed with its lower end at a depth of 370 feet below the pump base.

At the end of 8 hours continuous pumping equilibrium was established with a production rate of 325 gallons per minute and a draw-down of 103 feet below the static water level of 257 feet.

It was planned to pump this well at a rate of 250 gallons per minute.

The water had a residue of 749, and a total hardness of 486 parts per million with only a trace of iron as shown by the analysis of sample number 84225, collected September 8, 1938.

JOLIET TOWNSHIP HIGH SCHOOL (42). The Joliet Township High School is located at the northwest corner of the intersection of Jefferson Street and Herkimer Street. Water for all purposes is obtained from a well located about 200 feet north of the center line of Jefferson Street and 75 feet west of the center line of Herkimer Street, or approximately 500 feet north and 1900 feet east of the southwest corner of Section 10, T. 35 N., R. 10 E.

The well was drilled before 1914 by the Ohio Drilling Company of Massillon, Ohio, to a reported depth of 881 feet below a ground surface elevation of 543 feet above sea level and was cased with 326 feet of 8-inch pipe. In 1940 it was repaired by the J. P. Miller Artesian Well Company of Chicago, Illinois, at which time the old casing was replaced with 326 feet of 7-inch wrought iron pipe equipped with a Larkin bottom hole packer. A depth of 828 feet was reported at this time.

A record of materials penetrated, furnished by the State Geological Survey, is as follows:

Formations.	Thickness in feet.	Depth in feet.
Silurian dolomite.....	160	160
Maquoketa shale.....	140	300
Galena-Platteville dolomite.....	300	600
St. Peter sandstone.....	281	881

The well was originally equipped with an air-lift pump which was later dropped and not removed until 1940. A second air-lift pump was installed and used until 1930 when a turbine pump was installed. In 1940 a new 20-stage, 7-inch Peerless turbine pump was installed consisting of 380 feet of 4-inch column pipe, a bowl section 10½ feet long, and 35 feet of 3-inch suction pipe. This pump is driven by a direct-connected, 25-horsepower electric motor and delivers 80 gallons per minute.

The pump base has an elevation above sea level of 535.45 feet or 8 feet below ground level.

The temperature of the water is 58½° F. The water had a residue of 550, a total hardness of 210, and a content of iron of 0.2 parts per million as shown by the analysis of sample number 31693, collected September 27, 1915.

Analysis of Sample Number 31693 from 828½-Foot Well.

Determinations Made.

Hypothetical Combinations.

	Pts. per million.		Pts. per million.	Grs. per gallon.
Iron.....Fe	0.2	Potassium Nitrate.....KNO ₃	0.6	0.03
Manganese...Mn	0.0	Potassium Chloride.....KCl	38.9	2.27
Silica.....SiO ₂	10.0	Sodium Chloride.....NaCl	65.2	3.80
Alumina.....Al ₂ O ₃	2.8	Sodium Sulfate.....Na ₂ SO ₄	173.0	10.09
Calcium.....Ca	50.0	Sodium Carbonate.....Na ₂ CO ₃	58.0	3.38
Magnesium...Mg	20.7	Ammonium Carbonate..(NH ₄) ₂ CO ₃	2.4	0.14
Ammonium...NH ₄	0.9	Magnesium Carbonate..MgCO ₃	71.7	4.18
Potassium...K	20.6	Calcium Carbonate....CaCO ₃	124.8	7.28
Sodium.....Na	106.8	Iron Carbonate.....FeCO ₃	0.4	0.02
Sulfate.....SO ₄	116.9	Alumina.....Al ₂ O ₃	2.8	0.16
Nitrate.....NO ₃	0.4	Silica.....SiO ₂	10.0	0.58
Chloride.....Cl	59.0			
Alkalinity (as CaCO ₃)		Total.....	547.8	31.93
Phenolphthalein..	0.0			
Methyl Orange...	268.0			
Hardness (as CaCO ₃)	210.0			
Residue.....	550.0			

JOLIET WALL PAPER COMPANY (47). The plant of the Joliet Wall Paper Company is located at 225 Logan Avenue.

Water is obtained from a 10-inch well drilled about 1927 by J. Otis Heflin of Joliet, Illinois to a depth of 754 feet below a ground surface elevation above sea level of 577 feet, at a site 200 feet south of the center line of Park Place and 150 feet west of the center line of Logan Street or 2150 feet south and 1800 feet east of the northwest corner of Section 14, T. 35 N., R. 10 E.

The well was cased with 350-400 feet of 10-inch pipe and with over 300 feet of 8-inch pipe which has been split in several places.

Analysis of Sample Number 91643 from 754-Foot Well.

Determinations Made.

Hypothetical Combinations.

	Pts. per million.		Pts. per million.	Grs. per gallon.
Turbidity.....	trace	Sodium Nitrate.....NaNO ₃	30.6	1.78
Color.....	0	Sodium Chloride.....NaCl	32.7	1.90
Odor.....	0	Magnesium Chloride...MgCl ₂	13.8	0.80
Iron.....Fe		Magnesium Sulfate.....MgSO ₄	298.5	17.40
(filtered at well) ..	0.1	Calcium Sulfate.....CaSO ₄	324.0	18.89
(unfiltered).....	0.1	Calcium Carbonate....CaCO ₃	306.2	17.85
Manganese...Mn	0.2	Silica.....SiO ₂	12.5	0.73
Silica.....SiO ₂	12.5			
Calcium.....Ca	217.6	Total.....	1018.3	59.35
Magnesium...Mg	63.8			
Ammonium...NH ₄	trace			
Sodium.....Na	21.2			
Sulfate.....SO ₄	467.4			
Nitrate.....NO ₃	22.2			
Chloride.....Cl	30.0			
Alkalinity (as CaCO ₃)				
Phenolphthalein..	0.0			
Methyl Orange...	306.0			
Residue.....	1068.0			
Hardness (as CaCO ₃)	806.5			
pH = 7.4				
Free CO ₂ (calc.)....	23.0			

The well is equipped with an 8-inch Cook deep-well turbine pump directly connected to a 25-horsepower electric motor. The assembly of the pump consists of 320 feet of 6-inch column pipe, 100 feet of 4½-inch column pipe, a 19-stage bowl section having an outside diameter of 75/8 inches and an over-all length of 7½ feet, and 20 feet of 4-inch suction pipe. The pump is rated at 140 gallons per minute against a head of 455 feet at a speed of 1750 revolutions per minute. Actual capacity of the well is less than this amount. A small air pipe for determining water levels was installed.

The water had a residue of 1068, a total hardness of 806.5, and an iron content of 0.1 parts per million as shown by the analysis of sample number 91643, collected October 24, 1941. The temperature of the water on that date was 60½° E.

JOSLYN MANUFACTURING AND SUPPLY COMPANY. The plant of the Joslyn Manufacturing and Supply Company, formerly the Calumet Chemical Company and later the Joliet Terminals, is located south of Industry Avenue and east of Broadway Road. There are two wells at this plant but only the deeper one is used.

WELL NUMBER 1 (20), located about 300 feet south of the center line of Industry Avenue and 850 feet east of the center line of Broadway Road or approximately 1300 feet south and 500 feet west of the northeast corner of Section 4, T. 35 N., R. 10 E., was drilled in 1923 to a reported depth of 817 feet below a ground surface elevation of 547 feet above sea level. It is reported to be 12 inches in diameter to a depth of 290 feet and 10 inches in diameter below this depth. The casing extends about 4 feet above ground surface.

In 1923 the water level was reported to be 89 feet below the ground surface when not pumping and was lowered 252 feet by pumping at a rate of 89 gallons per minute. In 1941 this well was equipped with an air-lift pump but had not been used for several years.

WELL NUMBER 2 (19), located about 150 feet north and 50 feet east of well number 1 or approximately 1150 feet south and 450 feet west of the northeast corner of Section 4, T. 35 N., R. 10 E., was drilled in 1925 by William Cater of Chicago to a depth of 1596 feet below a ground surface elevation of 548 feet above sea level. It is reported to have been drilled 19 inches in diameter to a depth of 400 feet, 12½ inches in diameter to a depth of 1250 feet, and 10 inches in diameter to the bottom. It is reported by the driller to be cased with 16-inch pipe to a depth of 400 feet where a 16-inch by 10-inch swedge nipple connects the large pipe to a string of 10-inch pipe which extends to a depth of 1250 feet. The annular space outside the casing is filled with cement grout from the surface to the 1250-foot depth.

The static water level was reported to be at a depth of 248½ feet in 1930, while in 1941 it was found to be at a depth of 254½ feet.

A record of material penetrated, furnished by the driller with correlations by the State Geological Survey, is as follows:

Formations.	Thickness in feet.	Depth in feet.
SILURIAN SYSTEM		
Niagaran and Alexandrian dolomites, water-bearing	220	220
ORDOVICIAN SYSTEM		
Maquoketa shale	90	310
Galena-Platteville dolomite	330	640
St. Peter sandstone, water-bearing	375	1015
CAMBRIAN SYSTEM		
Jordan - Trempealeau - Franconia dolomite and sandstone	335	1350
Galesville sandstone, water-bearing	190	1540
Eau Claire sandstone	56	1596

The well is equipped with a Peerless deep-well turbine pump the assembly of which consists of 300 feet of 5-inch column pipe, a 14-stage bowl section 8 inches in diameter by 8½ feet long, and 20 feet of 5-inch suction pipe. The pump is powered by a direct-connected 20-horsepower U. S. Electric Company electric motor and is rated at 150 gallons per minute against a head of 367 feet when operating at a speed of 1760 revolutions per minute.

The water had a residue of 472, a total hardness of 218, and a content of iron of 1.7 parts per million as shown by the analysis of sample number 86242, collected August 22, 1939. The temperature of the water is 58° F.

Analysis of Sample Number 86242 from a 1596-Foot Well.

Determinations Made.		Hypothetical Combinations.	
	Pts. per million.		Pts. per million.
Iron.....Fe		Sodium Nitrate.....NaNO ₃	0.8
(filtered).....	0.0	Sodium Chloride.....NaCl	57.9
(unfiltered).....	1.7	Sodium Sulfate.....Na ₂ SO ₄	135.6
Manganese..Mn	0.0	Sodium Carbonate.....Na ₂ CO ₃	56.7
Silica.....SiO ₂	12.0	Ammonium Carbonate..(NH ₄) ₂ CO ₃	2.4
Turbidity.....	15	Magnesium Carbonate..MgCO ₃	64.1
Color.....	0	Calcium Carbonate.....CaCO ₃	142.1
Odor.....	0	Silica.....SiO ₂	12.0
Calcium.....Ca	56.8		
Magnesium..Mg	18.5	Total.....	471.6
Ammonium..NH ₄	0.9		27.57
Sodium.....Na	91.5		
Sulfate.....SO ₄	91.6		
Nitrate.....NO ₃	0.8		
Chloride....Cl	35.0		
Alkalinity (as CaCO ₃)			
Phenolphthalein..	0.0		
Methyl Orange....	274.0		
Residue.....	473.0		
Total hardness.....	218.0		

THE LINDBORG COMPANY (37). The plant of The Lindborg Company which previous to 1937-38 was known as the Union Coal, Transfer and Warehouse Company, is located at 110 Henderson Avenue.

Water is obtained from a well drilled in 1935 by J. Otis Heflin of Joliet, Illinois to a depth of 1507 feet below a ground surface elevation above sea level of 547 feet, at a site 50 feet south of the center line of Jerome Avenue and 100 feet east of the center line of Henderson Avenue, or 950 feet north and 300 feet west of the southeast corner of Section 10, T. 35 N., R. 10 E.

The well was reported to have been drilled 14 inches in diameter to a depth of 400 feet, 10 inches in diameter to a depth of 900 feet, and 6 inches in diameter to the bottom, and cased with 12-inch pipe to a depth of 400 feet.

The well was equipped with an 8-inch Sterling deep-well turbine pump directly connected to a 50-horsepower electric motor which operates at a full load speed of 1760 revolutions per minute. The assembly of the pump consists of 380 feet of 6-inch column pipe, a 21-stage bowl section having an over-all length of 11½ feet, and 10 feet of 6-inch suction pipe. The pump is rated at 325 gallons per. minute against a 410-foot head when operating at 1760 revolutions per minute.

The static water level was 238 feet below the pump base at the time the well was completed in 1935. No air pipe for determining water levels was installed. The elevation of the pump base above sea level is 547.68 feet or 0.5 feet above ground surface. No analysis of water from this well is available.

NOWELL PARK (59). Nowell Park is located north of Mills Road and east of Chicago Street near the southern limits of Joliet.

Water is obtained from a well drilled in 1937 by Peter W. Dittmyer of Joliet at a location 325 feet north of the center line of Mills Road and 770 feet east of the center line of Chicago Street, or approximately 2300 feet south and 770 feet east of the northwest corner of Section 22, T. 35 N, R. 10 E. The ground surface elevation at this point is 579 feet above sea level.

The well was cased with 8-inch pipe to a depth of 24 feet and with 6¼-inch pipe from the top to a depth of 456 feet. The casing was later cut off at a point 5 feet below ground surface and a pump pit constructed around the top of the well. The open hole from 456 feet to the bottom of the well at a depth of 885 feet is 5½ inches in diameter.

When the well was completed the static water level was 236 feet below the surface and a pumping rate of 100 gallons per minute was reported to produce only a little drawdown.

A record of material penetrated, furnished by the driller, is as follows:

Formations.	Thickness in feet.	Depth in feet.
Hard, white limestone.	190	190
Shale.	90	280
Limestone, not so hard.	390	670
St. Peter sandstone.	105	775
	110	885

The well is equipped with a Pomona turbine pump directly connected to a 15-horsepower electric motor. The assembly of the pump

consists of 300 feet of 4½-inch column pipe, a 6-stage, 6-inch bowl section having a diameter of 5½ inches and an over-all length of 3 feet, and 10 feet of 3½-inch suction pipe. The unit is rated at 70 gallons per minute against a head of 294 feet when operating at a speed of 3500 revolutions per minute. A small air line for determining water levels has been installed. The bottom of this air line is probably at the top of the bowl assembly.

No analysis of the water from this well is available.

PHOENIX MANUFACTURING COMPANY (18). The plant of the Phoenix Manufacturing Company is located on Industry Avenue east of Broadway Road.

Water is obtained from a well completed in 1941 by S. B. Geiger and Company of Chicago, Illinois to a depth of 1000 feet below a ground surface elevation above sea level of 552 feet, at a site 300 feet north of Industry Avenue and 1000 feet east of Broadway Road or 410 feet south and 706 feet west of the northeast corner of Section 4, T. 35 N., R. 10 E.

The well was reported to have been drilled 15 inches in diameter to a depth of 330 feet and 12 inches in diameter to the bottom and was cased with 10-inch pipe to a depth of 375 feet.

A log of the materials penetrated, furnished by the State Geological Survey, is as follows:

Formations.	Thickness in feet.	Depth in feet.
PLEISTOCENE SYSTEM		
Glacial drift.....	5	5
SILURIAN SYSTEM		
Niagaran and Alexandrian dolomites, water-bearing.....	179	184
Maquoketa formation		
Dolomite and shale.....	36	220
Shale.....	75	295
Galena-Platteville dolomite.....	340	635
St. Peter sandstone, water-bearing.....	365	1000

The well was equipped with an 8-inch Sterling deep-well turbine pump directly connected to a 40-horsepower electric motor. The assembly of the pump consists of 380 feet of 5-inch column pipe, a 17-stage bowl section with an outside diameter of 7½ inches and an over-all length of 9 feet 4 inches, 20 feet of 5-inch suction pipe, and 1 foot of galvanized iron trash pipe. The unit is rated at 200 gallons per minute against a 420-foot head when operating at 1750 revolutions per minute. The well was also equipped with a ¼-inch galvanized iron air pipe for determining water levels, the bottom of which terminated at a depth of 380 feet below the pump base.

On April 2 and 3, 1941 a production test was made of this well by the State Water Survey at which time a discharge of 260 gallons per minute was obtained with a drawdown of 183.5 feet below a static or non-pumping water level of 166.5 feet below the pump base. The temperature of the water was 58° F.

The water from this well had a mineral content of 587, a total hardness of 469, and an iron content of 0.1 parts per million as shown by the analysis of sample number 90264, collected April 3, 1941.

Analysis of Sample Number 90264 from Phoenix Manufacturing Company Well.
Determinations Made.

	Pts. per million.
Turbidity.....	5
Color.....	0
Odor.....	0
Iron..... Fe	
(filtered).....	0.0
(unfiltered).....	0.1
Chloride..... Cl	34.0
Sulfate.....SO ₄ (T.H.Q.)	177.0
Alkalinity (as CaCO ₃)	
Phenolphthalein.....	0.0
Methyl Orange.....	278.0
Calcium..... Ca	100.8
Magnesium.....Mg	52.7
Total hardness (as CaCO ₃).....	469.0
Total mineral content.....	587.0

PIONEER BREWING COMPANY (29). The plant of the Pioneer Brewing Company, formerly the Fred Sehring Brewing Company, and before that the H. L. Eder Brewing Company, is located at 515 Summit Street.

Water is obtained from a well drilled about 50 years ago by the J. P. Miller Artesian Well Company of Chicago, Illinois, but cleaned and repaired by J. A. Kramer, of Joliet, Illinois, in 1941 to a depth of 1030 feet below a ground surface elevation of 596 feet above sea level at a site 200 feet south of the center line of Stone Street and 25 feet west of the center line of Summit Street or 1600 feet south and 2150 feet west of the northeast corner of Section 9, T. 35 N, R. 10 E. The original depth is thought to have been 1575 feet.

Analysis of Sample Number 91644 from 1030-Foot Well.
Determinations Made.

	Pts. per million.	Hypothetical Combinations	Pts. per million.	Grs. per gallon.
Turbidity.....	0	Sodium Nitrate.....NaNO ₃	16.2	0.95
Color.....	0	Sodium Chloride.....NaCl	66.1	3.85
Odor.....	0	Sodium Sulfate.....Na ₂ SO ₄	192.6	11.23
Iron..... Fe		Sodium Carbonate.....Na ₂ CO ₃	6.9	0.40
(filtered at well).....	0.1	Magnesium Carbonate...MgCO ₃	102.9	6.00
(unfiltered).....	0.2	Calcium Carbonate.....CaCO ₃	155.6	9.07
Manganese..... Mn	0.1	Silica.....SiO ₂	13.0	0.76
Silica..... SiO ₂	13.0			
Calcium..... Ca	62.2	Total.....	553.3	32.26
Magnesium..... Mg	29.7			
Ammonium.....NH ₄	trace			
Sodium..... Na	95.7			
Sulfate.....SO ₄	130.4			
Nitrate.....NO ₃	11.9			
Chloride..... Cl	40.0			
Alkalinity (as CaCO ₃)				
Phenolphthalein.....	0.0			
Methyl Orange....	284.0			
Residue.....	547.0			
Hardness (as CaCO ₃)	277.5			
pH = 7.3				
Free CO ₂ (calc.)....	26.0			

The well was cased with 8-inch pipe to an unknown depth, the bottom of the well being 4-inches in diameter.

The well was equipped with an 8-inch Pomona deep-well turbine pump directly connected to a 20-horsepower electric motor. The assembly of the pump consisted of 350 feet of 5-inch column pipe, an 18-stage bowl section having an over-all length of, 10 feet, and 10 feet of 5-inch suction pipe. The pump is rated at 100 gallons per minute against a head of 415 feet. The elevation of the pump base is 591.29 feet above sea level or 5 feet below the ground surface. The temperature of the water was about 57° F.

The water had a residue of 547, a total hardness of 277.5, and a content of iron of 0.1 parts per million as shown by the analysis of sample number 91644, collected October 23, 1941.

PRAIRIE STATE PAPER COMPANY. The plant of the Prairie State Paper Company is located at 292 Logan Avenue.

WELL NUMBER 1 (49). Water is obtained from a 12-inch well, known as number 1, thought to have been drilled about 1911 by Charles Brandt, but repaired recently by the J. P. Miller Artesian Well Company of Chicago, Illinois, to a depth of about 700 feet below a ground surface elevation of 576 feet above sea level, at a site 300 feet south of the center line of Park Place and 75 feet east of the center line of Logan Street or approximately 2050 feet east and 2250 feet south of the northwest corner of Section 14, T. 35 N., R. 10 E.

The well is cased with 12-inch pipe to an unknown depth and is equipped with an 8-inch Peerless deep-well turbine consisting of 220 feet of 6-inch column pipe, an 8-stage bowl section having an over-all

Analysis of Sample Number 91645 from Well Number 1.

Determinations Made.		Hypothetical Combinations.	
	Pts. per million.		Pts. per million. Grs. per gallon.
Turbidity.....	0	Sodium Nitrate.....NaNO ₃	4.3 0.25
Color.....	0	Sodium Chloride.....NaCl	13.4 0.78
Odor.....	0	Magnesium Chloride....MgCl ₂	9.0 0.52
Iron.....Fe		Magnesium Sulfate....MgSO ₄	243.4 14.19
(filtered at well) ..	0.1	Magnesium Carbonate..MgCO ₃	30.8 1.80
(unfiltered).....	0.2	Calcium Carbonate.....CaCO ₃	283.7 16.54
Manganese..Mn	0.2	Silica.....SiO ₂	12.5 0.73
Silica.....SiO ₂	12.5		
Calcium....Ca	113.4	Total.....	597.1 34.81
Magnesium..Mg	60.6		
Ammonium..NH ₄	trace		
Sodium.....Na	6.4		
Sulfate.....SO ₄	194.8		
Nitrate.....NO ₃	3.3		
Chloride....Cl	15.0		
Alkalinity (as CaCO ₃)			
Phenolphthalein..	0.0		
Methyl Orange...	320.0		
Residue.....	641.0		
Hardness (as CaCO ₃)	532.5		
pH = 7.1			
Free CO ₂ (calc.)....	48.0		

length of 7 feet, and 31 feet of 6-inch suction. The pump is powered by a direct-connected, 30-horsepower U. S. Electric Company electric motor and is rated at 300 gallons per minute against a head of 280 feet when operating at a speed of 1760 revolutions per minute. This well is also equipped with an air line which extends to a depth of 220 feet below the base of the pump.

In July 1941 the static water level in well number 1 was reported as 35 feet below the pump base and the pumping level 190 feet below the pump base when the yield was about 300 gallons per minute. The elevation of the pump base is 575.46 feet above sea level or 1 foot below ground surface.

The temperature of the water was 55° F. The water had a residue of 641, a total hardness of 532.5, and an iron content of 0.1 parts per million as shown by the analysis of sample number 91645, collected October 24, 1941.

WELL NUMBER 2 (48). Some water is obtained from a 12½-inch well, known as well number 2, drilled a number of years ago by J. Otis Heflin of Joliet, Illinois to a depth of 1603 feet below a ground surface elevation above sea level of 581 feet at a site 200 feet south of center line of Park Place and 300 feet east of the center line of Logan Street or approximately 2300 feet east and 2150 feet south of the north-west corner of Section 14, T. 35 N., R. 10 E. This well was repaired and shot by the J. P. Miller Artesian Well Company of Chicago in 1941.

A log of the materials penetrated, furnished by the State Geological Survey, is as follows :

Formations.	Thickness in feet.	Depth in feet.
PLEISTOCENE SYSTEM		
Glacial drift	20	20
SILURIAN AND ORDOVICIAN SYSTEMS		
Niagaran, Alexandrian and Maquoketa dolomites, water-bearing	255	275
ORDOVICIAN SYSTEM		
Maquoketa shale	84	359
Galena-Platteville dolomite	341	700
St. Peter sandstone, water-bearing	280	980
ORDOVICIAN AND CAMBRIAN SYSTEMS		
Oneota, Jordan, Trempealeau and Franconia dolomites and sandstones	425	1405
CAMBRIAN SYSTEM		
Galesville (Dresbach) sandstone, water-bearing	170	1575
Eau Claire dolomite	28	1603

The well is reported to be cased with 12½-inch pipe from the surface to a depth of 620 feet, with 10-inch pipe between depths of 570 and 1083 feet, and with 8-inch pipe between depths of 1012 and 1220 feet. The open bore hole below a depth of 1220 feet is 8 inches in diameter. The casing through the St. Peter sandstone section is known to be perforated, and it is possible that the casing through the Silurian dolomite has also been perforated.

It is equipped with a Layne 12-inch deep-well turbine pump powered by a direct-connected, 75-horsepower Allis-Chalmers electric motor. The pump assembly consists of 400 feet of 8-inch column pipe, a 12-stage

bowl section having an over-all length of 11 feet, and 40 feet of 8-inch suction pipe. The well is also equipped with a ¼-inch copper pipe for determining water levels, the lower end of which terminates at a depth of 400 feet below the pump base. The pump is rated at 500 gallons per minute against a head of 350 feet when operating at a speed of 1150 revolutions per minute. The elevation of the pump base is 576.29 feet above sea level or 4.25 feet below the ground surface.

After well number 2 was repaired the water level when not pumping was reported to be 35 feet below the pump base and 430 feet when pumping at a rate of 400 gallons per minute.

The temperature of the water was 56° F. The water had a residue of 681, a total hardness of 531, and an iron content of 0.1 parts per million as shown by the analysis of sample number 91729, collected October 30, 1941.

Analysis of Sample Number 91729 from 1603-Foot Well.

Determinations Made.		Hypothetical Combinations.	
	Pts. per million.		Pts. per million. Grs. per gallon.
Turbidity.....	30	Sodium Nitrate..... NaNO ₃	0.9 0.05
Color.....	0	Sodium Chloride..... NaCl	32.8 1.91
Odor.....	0	Sodium Sulfate..... Na ₂ SO ₄	24.9 1.45
Iron..... Fe		Magnesium Sulfate..... MgSO ₄	251.0 14.63
(filtered at well) ..	0.1	Magnesium Carbonate..... MgCO ₃	35.8 2.09
(unfiltered).....	9.7	Calcium Carbonate..... CaCO ₃	279.9 16.32
Manganese..... Mn	0.45	Silica..... SiO ₂	14.5 0.85
Silica..... SiO ₂	14.5		
Calcium..... Ca	111.8	Total.....	639.8 37.30
Magnesium..... Mg	61.2		
Ammonium..... NH ₄	trace		
Sodium..... Na	21.2		
Sulfate..... SO ₄	217.8		
Nitrate..... NO ₃	0.7		
Chloride..... Cl	20.0		
Alkalinity (as CaCO ₃)			
Phenolphthalein.....	0.0		
Methyl Orange.....	322.0		
Residue.....	681.0		
Hardness (as CaCO ₃)	531.0		
pH = 7.2			
Free CO ₂ (calc.)....	38.0		

PUBLIC SERVICE COMPANY OF NORTHERN ILLINOIS.

The Public Service Company of Northern Illinois has two plant properties near Joliet.

STATION 55 (13). At a northern site known as Station 55, a well was drilled in 1932 by the J. P. Miller Artesian Well Company of Chicago, Illinois, to a depth of 1558 feet below a ground surface elevation above sea level of 595 feet, at a site approximately 200 feet south of the south line of Stateville Penitentiary farm and about 2000 feet west of the center line of Broadway or 94 feet south and 793 feet west of the northeast corner of the northwest quarter of Section 33, T. 36 N., R. 10 E.

The well was drilled 26 inches in diameter to a depth of 57.25 feet, 23 inches in diameter to a depth of 157 feet, 20 inches in diameter to a

depth of 359.25 feet, 15 inches in diameter to a depth of 885 feet and 12 inches in diameter for the balance of the depth to 1558 feet. It is cased with 24-inch O. D. drive pipe from the surface to a depth of 57.25 feet, with 15½-inch O. D. pipe from the surface to a depth of 359.25 feet and with 12½-inch O. D. pipe between depths of 812 feet and 885 feet.

A log of the materials penetrated, furnished by the State Geological Survey, is as follows:

Formations.	Thickness in feet.	Depth in feet.
PLEISTOCENE SYSTEM		
Glacial till . . . . .	.10	10
POST-SILURIAN CLAY.		
	40	50
SILURIAN SYSTEM		
Niagaran - Alexandrian dolomite, water-bearing, shaly at base . . . . .	.190	240
ORDOVICIAN SYSTEM		
Maquoketa formation		
Dolomite	50	290
Shale	50	340
Galena-Platteville limestone and dolomite	340	680
Glenwood dolomite, sandy . . . . .	.10	690
St. Peter formation		
Sandstone, water-bearing . . . . .	.140	830
Shale, weak . . . . .	.10	840
Shakopee dolomite . . . . .	.50	890
Oneota dolomite . . . . .	.150	1040
CAMBRIAN SYSTEM		
Jordan sandy dolomite and Trempealeau dolomite	230	1270
Franconia dolomite and sandstone . . . . .	.120	1390
Galesville (Dresbach) sandstone, water-bearing	160	1550
Eau Claire dolomite, sandy . . . . .	.8	1558

The water level was 252 feet below the ground surface when not pumping and was lowered about 16 feet by pumping at a rate of 65 gallons per minute.

Analysis of Sample Number 70274 from 1558-Foot Well Owned by Public Service Company of Northern Illinois.

Determinations Made.	Pts. per million.	Hypothetical Combinations.		
		Pts. per million.	Grs. per gallon.	
Iron Fe	0.8	Sodium Chloride NaCl	38.0	2.22
Manganese Mn	0.0	Sodium Sulfate Na ₂ SO ₄	118.0	6.88
Silica SiO ₂	8.0	Sodium Carbonate Na ₂ CO ₃	45.6	2.66
Turbidity	0	Ammonium Carbonate (NH ₄) ₂ CO ₃	1.9	0.11
Calcium Ca	57.7	Magnesium Carbonate MgCO ₃	67.9	3.96
Magnesium Mg	19.6	Calcium Carbonate CaCO ₃	144.5	8.43
Ammonium NH ₄	0.7	Iron Oxide Fe ₂ O ₃	1.2	0.07
Sodium Na	73.0	Manganese Oxide MnO	0.0	0.00
Sulfate SO ₄	79.5	Silica SiO ₂	8.0	0.47
Nitrate NO ₃	0.0			
Chloride Cl	23.0	Total	425.1	24.80
Alkalinity (as CaCO ₃)				
Phenolphthalein	0.0			
Methyl Orange	270.0			
Residue	423.0			
Total hardness	225.0			

The water from this well had a residue of 423, a total hardness of 225 and an iron content of 0.8 parts per million as shown by the analysis of sample number 70274, collected February 3, 1932.

This well was never equipped with a pump and is now used as an observation well by the State Water Survey and has been equipped with an automatic water level recorder.

STATION 9 (61) is located south of Joliet on the east side of the DesPlaines River. Water is obtained from a well completed in 1941 by S. B. Geiger and Company of Chicago, Illinois, to a depth of 1508 feet below a ground surface elevation of 515 feet above sea level. The well is located approximately 4700 feet north and 600 feet east of the southwest corner of Section 29, T. 35 N., R. 10 E.

It was drilled 21 inches in diameter to a depth of 498 feet, 13 inches in diameter to a depth of 1325 feet, and 10 inches in diameter to a depth of 1508 feet. It is cased with 12-inch cast iron pipe from 2.75 feet above ground surface to a depth of 493 feet and with 8-inch cast iron pipe between depths of 493 and 1325 feet.

A log of material penetrated, furnished by the State Geological Survey, is as follows:

Formations.	Thickness in feet.	Depth in feet.
PLEISTOCENE SYSTEM		
Glacial drift	2	2
SILURIAN SYSTEM		
Niagaran-Alexandrian dolomite, water-bearing...	143	145
ORDOVICIAN SYSTEM		
Maquoketa formation		
Dolomite	23	168
Shale	78	246
Galena-Platteville dolomite	344	590
St. Peter formation		
Sandstone, water-bearing	142	732
Shale	6	738
Shakopee-Oneota dolomite	252	990
CAMBRIAN SYSTEM		
Jordan-Trempealeau dolomites and sandstone...	214	1204
Franconia sandstone and dolomite	135	1339
Galesville sandstone	141	1480
Eau Claire sandstone and dolomite	29	1509

The water level was at a depth of 160 feet when not pumping and was lowered 172 feet by pumping at a rate of 550 gallons per minute.

The well is equipped with a 10-inch Layne turbine pump consisting of 320 feet of 8-inch column pipe, a 9-stage bowl assembly 7 feet long, and 30 feet of 6-inch suction pipe. The pump is rated at 350 gallons per minute at a speed of 1750 revolutions per minute and is driven by a 75-horsepower, direct-connected electric motor. A small air pipe for determining water levels extends to a depth of 320 feet below the pump base.

The water from the well had a residue of 528, a total hardness of 314, and an iron content of 0.1 parts per million as shown by the analysis of sample number 91246, collected August 8, 1941.

Analysis of Sample Number 91246 from Well 1508 Feet Deep.

Determinations Made.		Hypothetical Combinations.	
	Pts. per million.		Pts. per million. Grs. per gallon.
Turbidity.....	trace	Sodium Nitrate.....	NaNO ₃ 1.7 0.10
Color.....	0	Sodium Chloride.....	NaCl 44.4 2.59
Odor.....	0	Sodium Sulfate.....	Na ₂ SO ₄ 137.1 7.99
Iron.....	Fe	Ammonium Sulfate.....	(NH ₄) ₂ SO ₄ 2.6 0.15
(filtered at well) ..	0.1	Magnesium Sulfate.....	MgSO ₄ 9.6 0.56
(unfiltered).....	0.4	Magnesium Carbonate.....	MgCO ₃ 91.5 5.33
Manganese.....	Mn 0.0	Calcium Carbonate.....	CaCO ₃ 197.7 11.53
Silica.....	SiO ₂ 11.5	Silica.....	SiO ₂ 11.5 0.67
Calcium.....	Ca 78.9		
Magnesium.....	Mg 28.3	Total.....	496.1 28.92
Ammonium.....	NH ₄ 0.7		
Sodium.....	Na 62.3		
Sulfate.....	SO ₄ 102.4		
Nitrate.....	NO ₃ 1.3		
Chloride.....	Cl 27.0		
Alkalinity (as CaCO ₃)			
Phenolphthalein..	0.0		
Methyl Orange...	306.0		
Hardness (as CaCO ₃)	314.0		
Residue.....	528.0		
pH = 7.0			
Free CO ₂ (calc.)....	58.0		

THE RUBEROID COMPANY (17). The plant of the Euberoid Company is located on Theodore Avenue east of Broadway Road.

Water is obtained from a 10-inch well drilled in 1937 by C. W. Varner of Dubuque, Iowa to a depth of 796 feet below a ground surface elevation above sea level of 550 feet at a site about 600 feet north of the center line of Theodore Avenue and 1000 feet east of the center line of Broadway Road or 660 feet north and 220 feet east of the southwest corner of Section 34, T. 36 N., R. 10 E. The well was reported to have been drilled 23 inches in diameter to a depth of 27½ feet, 15 inches in diameter to a depth of 365 feet and 10 inches in diameter to the bottom.

A log of the materials penetrated, furnished by the State Geological Survey, is as follows:

Formations.	Thickness in feet.	Depth in feet.
PLEISTOCENE SYSTEM		
Glacial drift.....	.10	10
SILURIAN, SYSTEM		
Niagaran and Alexandrian dolomites, water-bearing .....	.180	190
ORDOVICIAN SYSTEM		
Maquoketa formation		
Dolomite.....	.50	240
Shale, some dolomite.....	.110	350
Galena-Platteville dolomite.....	.305	655
Glenwood sandstone and dolomite.....	.45	700
St. Peter sandstone, water-bearing.....	.96	796

The well was cased with 15-inch pipe from the ground surface to a depth of 27½ feet and with 10-inch pipe from the ground surface to a depth of 365 feet. It was equipped with an 8-inch Sterling deep-well turbine pump directly connected to a 50-horsepower U. S. Electric Com-

pany electric motor which operates at a full-load speed of 1760 revolutions per minute.

The assembly of the pump consists of 330 feet of 5-inch column pipe, 18 stages of bowls having an over-all length of 9 feet 10 3/16 inches, and 30 feet of 5-inch suction pipe. The unit is rated at 200 gallons per minute against a 469-foot head when operating at 1760 revolutions per minute. A small air pipe for measuring water levels extends to a depth of 340. feet below the pump base.

On February 24, 1937 a production test was conducted on this well by the State Water Survey. The temperature of the water was found to be 69° F., the static water level 206 feet and the pumping water level 309 feet below the ground surface when the production rate was 200 gallons per minute at the end of 12 hours continuous pumping.

The water from this well had a residue of 522, a total hardness of 260.5 and an iron content of 5.3 parts per million as shown by the analysis of sample number 79587, collected February 25, 1937.

Analysis of Sample Number 79587 from 796-Foot Ruberoid Company Well.

Determinations Made.

Hypothetical Combinations.

	Pts. per million.		Pts. per million.	Grs. per gallon.
Iron.....Fe		Sodium Nitrate.....NaNO ₃	0.9	0.05
(filtered).....	0.0	Sodium Chloride.....NaCl	60.8	3.55
(unfiltered).....	5.3	Sodium Sulfate.....Na ₂ SO ₄	167.5	9.76
Manganese...Mn	0.0	Sodium Carbonate.....Na ₂ CO ₃	37.1	2.16
Silica.....SiO ₂	8.0	Ammonium Carbonate...(NH ₄) ₂ CO ₃	2.4	0.14
Turbidity.....	800.0	Magnesium Carbonate...MgCO ₃	94.8	5.53
Odor.....E ₂		Calcium Carbonate.....CaCO ₃	148.0	8.62
Calcium.....Ca	59.1	Silica.....SiO ₂	8.0	0.47
Magnesium Mg	27.4			
Ammonium...NH ₄	0.8	Total.....	519.5	30.28
Sodium.....Na	94.5			
Sulfate.....SO ₄	113.5			
Nitrate.....NO ₃	0.8			
Chloride....Cl	37.0			
Alkalinity (as CaCO ₃)				
Phenolphthalein..	0.0			
Methyl Orange...	298.0			
Residue.....	522.0			
Total hardness	260.5			

When this well was constructed in 1937 it was reported that the St. Peter sandstone was soft and friable. In September 1941 it was reported this formation had caved badly and in attempting to make repairs the J. P. Miller Artesian Well Company of Chicago, Illinois, found that the sandstone caved as rapidly as it could be removed. It may be necessary to case off the St. Peter Sandstone and deepen the well into the Galesville sandstone.

In the latter part of September 1941 static water level was found to be, at a depth of 270 feet and about four weeks later it was observed to be at a depth of 290 feet.

ST. FEANCIS CONVENT (30). The St. Francis Convent is located at 603 Taylor Street.

Water is obtained from an 8-inch well drilled in 1937 by Peter Dittmyer of Joliet, Illinois to a depth of 946 feet below a ground surface

elevation above sea level of 647 feet at a site 470 feet south of the center line of Douglas Street and 300 feet east of the center line of Wilcox Street or 940 feet east and 1860 feet south of the northwest corner of Section 9, T. 35 N., R. 10 E.

The well was reported to have been cased with 8-inch pipe to a depth of 70 feet and with 6 5/8-inch pipe between depths of 200 and 315 feet. The open bore hole is 6 inches in diameter at a depth of 700 feet and 4 1/2 inches in diameter at a depth of 946 feet.

A log of the materials penetrated, furnished by the State Geological Survey, is as follows :

Formations.	Thickness in feet.	Depth in feet.
PLEISTOCENE SYSTEM		
Glacial drift . . . . .	.60	60
SILURIAN SYSTEM		
Niagaran and Alexandrian dolomites, water-bearing . . . . .	.110	170
ORDOVICIAN SYSTEM		
Maquoketa formation		
Dolomite . . . . .	.40	210
Shale and dolomite . . . . .	.100	310
Galena-Platteville dolomites . . . . .	.345	655
Glenwood sandstone and dolomite . . . . .	.15	670
St. Peter sandstone, water-bearing . . . . .	.276	946

The well is equipped with a 6-inch Peerless deep-well turbine pump directly connected to a 25-horsepower electric motor which operates at 1800 revolutions per minute. The pump assembly consisted of 400 feet of 4-inch column pipe, a 33-stage bowl section having an over-all length of 19 feet and 10 feet of 4-inch suction pipe. The pump is rated at 150 gallons per minute. The well was also equipped with a 1/8-inch copper tube for measuring water levels, which extends to a depth of 400

Analysis of Sample Number 91638 from 946-Foot Well.

Determinations Made.		Hypothetical Combinations.		
	Pts. per million.		Pts. per million.	Grs. per gallon.
Turbidity	trace	Sodium Nitrate NaNO ₃	1.7	0.10
Color	0	Sodium Chloride NaCl	78.9	4.60
Odor	0	Sodium Sulfate Na ₂ SO ₄	182.5	10.64
Iron Fe		Sodium Carbonate Na ₂ CO ₃	87.5	5.10
(filtered at well)	0.2	Ammonium Carbonate (NH ₄) ₂ CO ₃	2.9	0.17
(unfiltered)	1.6	Magnesium Carbonate MgCO ₃	71.3	4.16
Manganese Mn	0.2	Calcium Carbonate CaCO ₃	114.1	6.65
Silica SiO ₂	9.8	Silica SiO ₂	9.8	0.57
Calcium Ca	45.5			
Magnesium Mg	20.6	Total	548.7	31.99
Ammonium NH ₄	1.1			
Sodium Na	128.6			
Sulfate SO ₄	123.3			
Nitrate NO ₃	1.3			
Chloride Cl	48.0			
Alkalinity (as CaCO ₃)				
Phenolphthalein	0.0			
Methyl Orange	234.0			
Residue	545.0			
Hardness (as CaCO ₃)	198.5			
pH = 7.4				
Free CO ₂ (calc.)	21.0			

feet below the pump base. The elevation of the pump base is 648.05 feet above sea level or 1 foot above the ground surface.

In August 1941 the static water level was at a depth below the pump base of 352 feet and the pumping water level was 370 feet below the pump base when the discharge was approximately 125 gallons per minute. In 1937 the static water level was at a depth of 324 feet below the pump base.

The water had a temperature of 58° F. and a pH of 7.4. The water had a residue of 545, a total hardness of 198.5, and an iron content of 0.2 parts per million as shown by the analysis of sample number 91638, collected October 23, 1941.

SISTERS OF ST. JOSEPH (9). The property of the Sisters of St. Joseph, which was known as Dellwood Park prior to 1940, is located south of Lockport on the east side of Lockport Road.

When the park was in operation water was obtained from a well 1365 feet deep below a ground surface elevation above sea level of 632 feet. The well was drilled, before 1907, by John Mathews of Joliet, Illinois, at a site approximately 200 feet east and 2000 feet north of the southwest corner of Section 26, T. 36 N., R. 10 E. It was later repaired by the Whitney Well Company.

A-record of material penetrated by the well, furnished by the State Geological Survey, is as follows:

Formations.	Thickness in feet.	Depth in feet.
PLEISTOCENE SYSTEM		
Glacial drift .....	.18	18
SILURIAN AND ORDOVICIAN SYSTEMS		
Niagaran, Alexandrian, Maquoketa and Galena- Platteville formations. ....	.729	747
St. Peter formation.		
Sandstone, water-bearing	263	1010
Shale, blue .....	.11	1021
ORDOVICIAN AND CAMBRIAN SYSTEMS		
Oneota, Jordan, Trempealeau, and Franconia formations. ....	.344	1365

The well is reported to have seven liners of unknown size and length placed at unknown depths. The original diameter at the bottom of the well was 3 3/8 inches but it is now reported that the well has caved at a depth of 900 feet.

It is equipped with a Gould's double-acting deep-well cylinder pump belt-driven by a 10-horsepower electric motor.

In 1941 the well had not been used for several years and its use in the near future was not anticipated.

UNITED STATES WAR DEPARTMENT. BRANDON LOCK AND DAM (58). The Brandon Lock and Dam on the DesPlaines River are located just south of the city of Joliet.

Water is secured from a well located about 1725 feet south and 1275 feet west of the northeast corner of Section 20, T. 35 N., R. 10 E. and thought to have been drilled about 1925 by J. Otis Heflin of Joliet to

a depth of 864 feet below a ground surface elevation of 520 feet above sea level.

The lockmaster reported from memory that the well was cased with 6-inch pipe and that the static water level was at a depth of 90 feet in 1934.

The well is equipped with a 6-inch Aurora turbine pump consisting of 210 feet of 4-inch column pipe, a 13-stage bowl assembly 6½ feet long, and 20 feet of 4½-inch suction pipe. The pump is rated at 40 gallons per minute against a head of 210 feet at a speed of 1750 revolutions per minute.

The water had a residue of 511, a total hardness of 232, and an iron content of 0.1 parts per million as shown by the analysis of sample number 91687, collected October 29, 1941. The sample, collected from a pressure tank, had a temperature of 52° F.

Analysis of Sample Number 91687 from Well 864 Feet Deep.

Determinations Made.		Hypothetical Combinations.		
	Pts. per million.		Pts. per million.	Grs. per gallon.
Turbidity.....	trace	Sodium Nitrate..... NaNO ₃	4.3	0.25
Color.....	0	Sodium Chloride..... NaCl	72.3	4.22
Odor.....	0	Sodium Sulfate..... Na ₂ SO ₄	168.3	9.81
Iron..... Fe		Sodium Carbonate..... Na ₂ CO ₃	31.2	1.82
(filtered at well)...	0.1	Ammonium Carbonate.. (NH ₄) ₂ CO ₃	0.5	0.03
(unfiltered).....	1.4	Magnesium Carbonate.. MgCO ₃	75.5	4.40
Manganese.. Mn	0.0	Calcium Carbonate.... CaCO ₃	11.0	0.64
Silica..... SiO ₂	11.0			
Calcium..... Ca	57.0	Total	506.1	29.50
Magnesium.. Mg	21.7			
Ammonium.. NH ₄	0.1			
Sodium..... Na	97.7			
Sulfate..... SO ₄	113.9			
Nitrate..... NO ₃	3.0			
Chloride.... Cl....	44.0			
Alkalinity (as CaCO ₃)				
Phenolphthalein..	0.0			
Methyl Orange...	262.0			
Residue.....	511.0			
Hardness (as CaCO ₃)	232.0			
pH = 7.3				
Free CO ₂ (calc.)...	25.0			

UNITED STATES WAR DEPARTMENT. MOORINGS (53). A well was drilled in 1936 for the United States War Department at a site at the "Moorings" approximately 200 feet east of the center line of Illinois Street and 80 feet north of the center line of Groghan Street or approximately 1430 feet east and 710 feet north of the southwest corner of Section 16, T. 35 N., R. 10 E.

The well was drilled by F. M. Gray, Jr. of Milwaukee, Wisconsin, to a depth of 855 feet below a ground surface elevation above sea level of 539 feet. It is cased with 12-inch pipe to a depth of 12½ feet and with 8-inch pipe from the surface to a depth of 353 feet, below which the bore hole is 8 inches in diameter to the bottom. The 8-inch pipe is sealed in for its full length with cement grout. Water is obtained from the St. Peter sandstone.

A log of the materials penetrated, furnished by the State Geological Survey, is as follows:

Formations.	Thickness in feet.	Depth in feet.
PLEISTOCENE SYSTEM		
Glacial drift	9	9
SILURIAN SYSTEM		
Niagaran and Alexandrian dolomites, shaly at base	116	125
ORDOVICIAN SYSTEM		
Maquoketa formation		
Shale	5	130
Dolomite	30	160
Shale with dolomite layers	85	245
Galena-Platteville dolomites	330	575
Glenwood dolomite sandstone	5	580
St. Peter formation		
Sandstone	138	718
Shale, weak	1	719
Shakopee dolomite	43	762
New Richmond sandstone	20	782
Oneota dolomite	73	855

The well is equipped with a 6-inch Aurora turbine pump consisting of 280 feet of 4-inch column pipe, a 26-stage bowl assembly 12 feet long, and 15 feet of 4½-inch Suction pipe. The pump is driven by a 10-horsepower, direct-connected electric motor and is rated at 40 gallons per minute against a head of 319 feet at a speed of 1750 revolutions per minute.

The well delivered at a rate of 28 gallons per minute with a draw-down of 3.6 feet below a static water level of 202 feet at the end of four hours continuous pumping. The temperature of the water was 56° F.

The water had a residue of 546 and a total hardness of 248.5 parts per million as shown by an analysis of sample number 79758, collected March 23, 1937. The well had just been completed and the iron content of the water was abnormally high at that time.

Analysis of Sample Number 79758 from a Well 855 Feet Deep.

Determinations Made.		Hypothetical Combinations.		
	Pts. per million.		Pts. per million.	Grs. per gallon.
Iron Fe				
(filtered)	0.0	Sodium Nitrate NaNO ₃	0.9	0.05
(unfiltered)	70.0	Sodium Chloride NaCl	102.4	5.96
Manganese Mn	0.0	Sodium Sulfate Na ₂ SO ₄	161.2	9.39
Silica SiO ₂	16.0	Sodium Carbonate Na ₂ CO ₃	3.7	0.21
Turbidity	25.0	Magnesium Carbonate MgCO ₃	76.6	4.47
Odor	Ce ₁	Calcium Carbonate CaCO ₃	157.6	9.18
Calcium Ca	63.0	Silica SiO ₂	16.0	0.93
Magnesium Mg	22.0			
Sodium Na	94.2	Total	518.4	30.19
Sulfate SO ₄	109.2			
Nitrate NO ₃	0.7			
Chloride Cl	62.0			
Alkalinity (as CaCO ₃)				
Phenolphthalein	0.0			
Methyl Orange	252.0			
Residue	546.0			
Total hardness	248.5			

WEBER DAIRY COMPANY (38). The Weber Dairy Company's plant is located at 407 W. Jefferson Street.

Water is obtained from a well located about 150 feet north of the center line of Jefferson Street and 200 feet west of the center line of Center Street, or approximately 700 feet north and 2400 feet east of the southwest corner of Section 9, T. 35 N, R. 10 E.

The well was drilled several years ago by J. Otis Hefiin of Joliet, Illinois, to a depth of 224 feet below a ground surface elevation of 591 feet above sea level and was cased to rock with 8-inch pipe. In 1941 it was deepened by J. A. Kramer of Joliet, Illinois, to a final depth of 855 feet. It is now cased with 6-inch pipe to a depth of 390 feet and has a 6-inch open hole below that depth.

A record of material penetrated, as furnished by Mr. Kramer, is as follows:

Formations.	Thickness in feet.	Depth in feet.
Soil and limestone.	224	224
Shale.	166	390
Limestone.	215	605
St. Peter sandstone.	250	855

The well is equipped with a 6-inch Pomona turbine pump consisting of 350 feet of 4½-inch column pipe, a 34-stage bowl assembly 13 feet long, and 30 feet of 4½-inch suction pipe. The pump is driven by a 15-horsepower electric motor and is rated at 100 gallons per minute against a head of 440 feet at a speed of 1760 revolutions per minute. A small air pipe for determining water level extends to a reported depth of 350 feet below the pump base.

Analysis of Sample Number 91731 from 855-Foot Well.

Determinations Made.		Hypothetical Combinations.		
	Pts. per million.		Pts. per million.	
Turbidity.....	0	Sodium Nitrate..... NaNO ₃	5.9	0.34
Color.....	0	Sodium Chloride..... NaCl	74.1	4.32
Odor.....	0	Sodium Sulfate..... Na ₂ SO ₄	172.0	10.03
Iron..... Fe		Sodium Carbonate..... Na ₂ CO ₃	56.7	3.31
(filtered).....	0.1	Magnesium Carbonate..... MgCO ₃	73.8	4.30
(unfiltered).....	0.4	Calcium Carbonate..... CaCO ₃	119.0	6.94
Manganese..... Mn	0.0	Silica..... SiO ₂	10.5	0.61
Silica..... SiO ₂	10.5			
Calcium..... Ca	47.5	Total.....	512.0	29.85
Magnesium..... Mg	21.3			
Ammonium..... NH ₄	trace			
Sodium..... Na	111.0			
Sulfate..... SO ₄	116.2			
Nitrate..... NO ₃	4.6			
Chloride..... Cl	45.0			
Alkalinity (as CaCO ₃)				
Phenolphthalein..	0.0			
Methyl Orange...	260.0			
Residue.....	557.0			
Hardness (as CaCO ₃)	206.5			
pH = 7.4				
Free CO ₂ (calc.)....	19.0			

The water level was reported to be at a depth of 245 feet when not pumping and was lowered 120 feet by pumping at a rate of 100 gallons per minute.

The temperature of the water is 53° F. The water had a residue of 557, a total hardness of 206.5, and an iron content of 0.4 parts per million as shown by the analysis of sample number 91731, collected October 30, 1941.

WESTERN UNITED GAS AND ELECTRIC COMPANY (12). The plant of the Western United Gas and Electric Company, formerly the Coal Products Manufacturing Company, is located about one mile north of the city of Joliet between Broadway Road and DesPlaines River.

Water is obtained from a well, located approximately 750 feet north and 525 feet west of the southeast corner of Section 28, T. 36 N., R. 10 E., which was drilled in 1919 by F. M. Gray, Jr., of Chicago, Illinois, to a depth of 1505 feet below a ground surface elevation of 562 feet above sea level. The well is cased with 16-inch pipe from the surface to a depth of 16 feet, with 12-inch pipe from the surface to a depth of 100 feet, and with 10-inch pipe from slightly above 100 feet to a depth of 400 feet. The open hole below 400 feet is reported to be 10 inches in diameter to the bottom.

The well is equipped with an air-lift pump consisting of 300 feet of 6-inch eductor pipe, below which is 192 feet of 5-inch eductor pipe, and 492 feet of 2-inch air pipe with a footpiece 4¼ feet in length.

Tests with air-lift pumping equipment during construction of the well showed an inadequate supply of water at depths of 700 and 1100 feet. -At a depth of 1450 feet a yield of 400 gallons per minute was obtained and at the final depth a yield of 400 gallons per minute was obtained with less drawdown. In 1919 static water level was reported to be at a depth of 75 feet. A production test made June 11, 1920 showed a static level of 44 feet and a drawdown of 201 feet when pump-

Analysis of Sample Number 91736 from Well 1505 Feet Deep.

Determinations Made.

Hypothetical Combinations.

	Pts. per million.		Pts. per million.	Grs. per gallon.
Turbidity.....	10	Sodium Nitrate..... NaNO ₃	16.2	0.95
Color.....	0	Sodium Chloride..... NaCl	31.0	1.81
Odor.....	0	Ammonium Chloride..... NH ₄ Cl	1.6	0.09
Iron..... Fe		Magnesium Sulfate..... MgSO ₄	272.1	15.86
(filtered at well)...	0.1	Calcium Sulfate..... CaSO ₄	33.4	1.95
(unfiltered).....	2.8	Calcium Carbonate..... CaCO ₃	268.2	15.63
Manganese.. Mn	0.0	Silica..... SiO ₂	11.3	0.66
Silica..... SiO ₂	11.3			
Calcium..... Ca	117.0	Total.....	633.8	36.95
Magnesium.. Mg	55.0			
Ammonium.. NH ₄	0.6			
Sodium..... Na	16.7			
Sulfate..... SO ₄	240.5			
Nitrate..... NO ₃	12.1			
Chloride.... Cl	20.0			
Alkalinity (as CaCO ₃)				
Phenolphthalein..	0.0			
Methyl Orange...	268.0			
Residue.....	658.0			
Hardness (as CaCO ₃)	518.0			
pH = 8.0				
Free CO ₂ (calc.)....	5			

ing 321 gallons per minute. A test made September 2, 1921 showed a static level of 98 feet and a drawdown of 152 feet when pumping 272 gallons per minute.

The water had a residue of 658, a total hardness of 518, and an iron content of 0.1 parts per million as shown by the analysis of sample number 91736, collected October 31, 1941. The temperature of the water was 57° F.

WILL COUNTY COUET HOUSE (43). The Will County Court House is located at the southwest corner of the intersection of Chicago and Jefferson Streets. Water is obtained from a well located about 110 feet west of the center line of Chicago Street and 125 feet south of the center line of Jefferson Street, or approximately 110 feet west and 175 feet north of the southeast corner of Section 9, T. 35 N., R. 10 E.

This well was drilled several years ago by the Ohio Drilling Company of Massillon, Ohio, and is reported to be 10 inches in diameter at the top and 970 feet deep below a ground surface elevation of 541 feet above sea level. No exact record of construction is available, but the well is reported to be quite crooked.

It is equipped with a 23-stage, 6-inch Peerless turbine pump consisting of 300 feet of 4-inch column pipe, a bowl section 9 feet 8 inches long, and 43 feet of suction pipe. The pump is driven by a direct-connected, 7½-horsepower electric motor and is rated at 40 gallons per minute against a 340-foot head.

The temperature of the water was 59 °F. The water had a residue of 725, a total hardness of 350.5, and a content of iron of 0.1 parts per million as shown by the analysis of sample number 91642, collected October 25, 1941.

Analysis of Sample Number 91642 from Well 970 Feet Deep.

Determinations Made.		Hypothetical Combinations.		
	Pts. per million.		Pts. per million.	Grs. per gallon.
Turbidity.....	5	Sodium Nitrate..... NaNO ₃	1.7	0.10
Color.....	0	Sodium Chloride..... NaCl	123.4	7.19
Odor.....	0	Sodium Sulfate..... Na ₂ SO ₄	224.5	13.09
Iron..... Fe		Ammonium Sulfate..... (NH ₄) ₂ SO ₄	4.0	0.23
(filtered at well)...	0.1	Magnesium Sulfate..... MgSO ₄	48.8	2.85
(unfiltered).....	0.6	Magnesium Carbonate... MgCO ₃	86.4	5.04
Manganese... Mn	0.1	Calcium Carbonate..... CaCO ₃	207.6	12.10
Silica..... SiO ₂	9.5	Silica..... SiO ₂	9.5	0.55
Calcium..... Ca	82.9			
Magnesium... Mg	34.8	Total.....	705.9	41.15
Ammonium... NH ₄	1.0			
Sodium..... Na	121.7			
Sulfate..... SO ₄	193.3			
Nitrate..... NO ₃	1.4			
Chloride..... Cl	75.0			
Alkalinity (as CaCO ₃)				
Phenolphthalein...	0.0			
Methyl Orange...	310.0			
Hardness (as CaCO ₃)	350.5			
Residue.....	725.0			
pH = 7.1				
Free CO ₂ (calc.)	46.0			

ZERO ICE COMPANY. The Cass Street plant of the Zero Ice Company is located at the southeast corner of the intersection of Cass Street and Henderson Avenue. Water is obtained from two wells known as wells numbered 3 and 4. Wells 1 and 2, drilled into limestone, are located at the Michigan Street plant of this company at the southeast corner of the intersection of Van Buren and Michigan Streets.

WELL NUMBER 3 (35) is located 40 feet north of the center line of Cass Street and 325 feet east of the center line of Henderson Avenue, or about 1400 feet north and 135 feet west of the southeast corner of Section 10, T. 35 N., R. 10 E.

It is reported to have been drilled about 1890 to a depth of 1600 feet below a ground surface elevation of 548 feet above sea level. The artesian pressure at that time is said to have been high enough to cause the well to flow at the ground surface. Apparently the well was later plugged back to the 1200-foot level. A report that the well produced salt water has not been verified. In 1931 the well was repaired by J. Otis Heflin of Joliet. At this time it was reamed, and cased with 10-inch pipe to a depth of 400 feet. The bottom of the casing was fitted with a rubber packer and about 20 feet of cement grout was placed around the lower end.

In 1936 the water level was at a depth of 280 feet when not pumping and was lowered 25 feet by pumping with the permanent pump.

The well is equipped with an 8-inch American deep-well turbine pump consisting of 350 feet of 6-inch column pipe, a 14-stage bowl section 7½ feet long, and 20 feet of 5-inch suction pipe. The pump is driven by a direct-connected, 25-horsepower electric motor and is rated at 160 gallons per minute against a head of 360 feet at a speed of 1750 revolutions per minute. A small air pipe for determining water levels terminates at a depth of 350 feet below the pump base.

WELL NUMBER 4 (36) is located 60 feet south of the center line of Cass Street and 290 feet east of the center line of Henderson Avenue, or about 1300 feet north and 175 feet west of the southeast corner of Section 10, T. 35 N., R. 10 E.

It is reported to have been drilled in 1930 by William Felker of New Lenox, Illinois, to a depth of 800 feet below a ground surface elevation of 548 feet above sea level. It is 8 inches in diameter at the bottom in St. Peter sandstone and is cased with 8-inch pipe to a depth of 50 feet. Limestone was encountered at a depth of 12 feet. In 1941 the water level when not pumping was at a depth of 23 feet and, when pumping was at a depth of 120 feet.

The well is equipped with a 9-stage, 6-inch Peerless turbine pump consisting of 120 feet of 4-inch column pipe, a bowl section 3 feet 10 inches long, and 30 feet of 3-inch suction pipe. The pump is driven by a direct-connected, 3-horsepower electric motor and is rated at 25 gallons per minute against a head of 160 feet at a speed of 1760 revolutions per minute. A small air pipe for measuring water levels extends to a depth of 120 feet below the pump base.

KANKAKEE ORDNANCE WORKS

THE KANKAKEE ORDNANCE WORKS is an explosives manufacturing plant covering about 27,000 acres and located between the Kankakee and DesPlaines Rivers and west of the right-of-way of the Alton Railroad Company. Water for most purposes will be obtained from these two rivers but during the summer months as much as 17,000 gallons per minute may be pumped from rock wells. During the ten-month period ending September 30, 1941 eleven wells had been completed or were nearing completion.

WELL NUMBER 1 (75), located approximately 2745 feet west and 50 feet north of the southeast corner of Section 35, T. 34 N., R. 9 E., was completed in 1941 by the Layne Western Company of Chicago, Illinois, to a depth of 1596 feet 10 inches below a ground surface elevation of 539 feet above sea level. It was drilled 171¼ inches in diameter at the bottom and is cased with 12 feet 5 inches of 22-inch pipe, and from the surface with 278 feet 3 inches of 18-inch pipe. The annular space outside the 18-inch pipe, for its full length, is filled with cement grout.

A log of material penetrated, furnished by the State Geological Survey, is as follows:

Formations.	Thickness in feet.	Depth in feet.
PLEISTOCENE SYSTEM		
Glacial drift . . . . .	.10	10
SILURIAN SYSTEM		
Niagaran-Alexandrian dolomite, water-bearing...	128	138
ORDOVICIAN SYSTEM		
Maquoketa formation		
Limestone and dolomite. . . . .	.52	190
Shale and little dolomite. . . . .	.75	265
Galena-Platteville dolomite. . . . .	.350	615
St. Peter sandstone, water-bearing . . . . .	.167	782
Shakopee dolomite. . . . .	.65	847
New Richmond sandstone and dolomite. . . . .	.28	875
Oneota dolomite . . . . .	.193	1068
CAMBRIAN SYSTEM		
Jordan dolomite, sandy. . . . .	.87	1155
Trempealeau dolomite. . . . .	.160	1315
Franconia sandstone and dolomite. . . . .	.125	1440
Galesville sandstone, water-bearing. . . . .	.155	1595
Eau Claire sandstone. . . . .	.2	1597

After drilling had been completed the well was shot in the Galesville sandstone section with one charge of 240 quarts of nitroglycerine.

The well is equipped with an 11-stage, 12-inch Peerless turbine pump consisting of 380 feet of 10-inch column pipe, a bowl section 9 feet in length, and 10 feet of 10-inch suction pipe. The pump is driven by a direct-connected, 200-horsepower electric motor and is rated at 1000 gallons per minute against a head of 570 feet at a speed of 1760 revolutions per minute. A small air pipe for determining water levels terminates at a depth of 380 feet below the pump base.

During the construction of wells 1, 2, and 3 a number of production tests were made by the State Water Survey and the Stone and Webster Engineering Corporation, builders of the plant. The three wells were tested both singly and simultaneously when drilling had reached the base

parts per million as shown by the analysis of sample number 89783, collected February 3, 1941.

Analysis of Sample Number 90234 from Well Number 1 Before Shooting.

Determinations Made.		Hypothetical Combinations.	
	Pts. per million.		Pts. per million. Grs. per gallon.
Turbidity.....	30	Sodium Nitrate..... NaNO ₃	1.7 0.10
Color.....	0	Sodium Chloride..... NaCl	145.0 8.45
Odor.....	0	Sodium Sulfate..... Na ₂ SO ₄	198.9 11.60
Iron..... Fe		Ammonium Sulfate.... (NH ₄) ₂ SO ₄	7.9 0.46
(filtered at well) ..	0.2	Magnesium Sulfate.... MgSO ₄	21.1 1.23
(unfiltered).....	0.7	Magnesium Carbonate.. MgCO ₃	87.7 5.11
Manganese.. Mn	0.1	Calcium Carbonate.... CaCO ₃	170.1 9.92
Silica..... SiO ₂	10.0	Silica..... SiO ₂	10.0 0.58
Calcium..... Ca	67.9		
Magnesium.. Mg	29.6	Total.....	642.4 37.45
Ammonium.. NH ₄	2.1		
Sodium..... Na	121.9		
Sulfate..... SO ₄	157.2		
Nitrate..... NO ₃	1.2		
Chloride.... Cl	88.0		
Alkalinity (as CaCO ₃)			
Phenolphthalein..	0.0		
Methyl Orange...	274.0		
Hardness (as CaCO ₃)	292.0		
Residue.....	646.0		
pH = 7.3			
Free CO ₂ (calc.)....	26.0		

After well number 1 had been drilled to the final depth, but before it had been shot, the water level was at a depth of 63 feet when not pumping and was lowered 250 feet by pumping at a rate of 468 gallons per minute. No other wells were being pumped at this time.

Analysis of Sample Number 90434 from Well Number 1 After Shooting.

Determinations Made.		Hypothetical Combinations.	
	Pts. per million.		Pts. per million. Grs. per gallon.
Turbidity.....	trace	Sodium Nitrate..... NaNO ₃	1.7 0.10
Color.....	0	Sodium Chloride..... NaCl	154.9 9.03
Odor.....	0	Sodium Sulfate..... Na ₂ SO ₄	182.5 10.64
Iron..... Fe		Ammonium Sulfate.... (NH ₄) ₂ SO ₄	4.6 0.27
(filtered at well) ..	0.0	Magnesium Sulfate.... MgSO ₄	36.7 2.14
(unfiltered).....	0.2	Magnesium Carbonate.. MgCO ₃	65.8 3.83
Manganese.. Mn	0.1	Calcium Carbonate.... CaCO ₃	180.1 10.50
Silica..... SiO ₂	16.0	Silica..... SiO ₂	16.0 0.93
Calcium..... Ca	72.1		
Magnesium.. Mg	26.3	Total.....	642.3 37.15
Ammonium.. NH ₄	1.3		
Sodium..... Na	122.7		
Sulfate..... SO ₄	155.8		
Nitrate..... NO ₃	1.3		
Chloride.... Cl	94.0		
Alkalinity (as CaCO ₃)			
Phenolphthalein..	- 0.0		
Methyl Orange...	258.0		
Total hardness.....	288.0		
Residue.....	648.0		
pH = 7.2			
Free CO ₂ (by test)..	13.0		
Free CO ₂ (calc.)....	14.0		

The temperature of the water was 60° F. The water had a residue of 646, a total hardness of 292, and a content of iron of 0.2 parts per million as shown by the analysis of sample number 90234, collected March 30, 1941.

After well number 1 had been drilled to its final depth and had been shot the water level was at a depth of 69½ feet when not pumping and was lowered 256 feet by pumping at a rate of 1212 gallons per minute. Wells 2 and 3 were being pumped at the same time.

The temperature of the water was 60° F. The water had a residue of 648, a total hardness of 288 parts per million, and no iron as shown by the analysis of sample number 90434, collected April 27, 1941.

WELL NUMBER 2 (74), located approximately 35 feet east and 80 feet north of the southwest corner of Section 35, T. 34 N., R. 9 E., or 2500 feet west of well number 1, was completed in 1941 by the Layne Western Company of Chicago, Illinois, to a depth of 1611 feet 11 inches below a ground surface elevation of 531.8 feet above sea level. It was drilled 15¼ inches in diameter at the bottom and is cased with 5 feet 8 inches of 22-inch pipe and 277½ feet of 18-inch pipe, the tops of both pipes being 2 feet 1 inch above the ground surface. A 16-inch liner was set between depths of 775½ and 920 feet. The annular space outside the 18-inch pipe was filled with cement grout only through the Maquoketa formation.

A log of material penetrated, furnished by the State Geological Survey, is as follows :

Formations.	Thickness in feet.	Depth in feet.
PLEISTOCENE SYSTEM		
Glacial drift	5	5
SILURIAN SYSTEM		
Niagaran-Alexandrian dolomite, water-bearing...	116	121
ORDOVICIAN SYSTEM		
Maquoketa formation		
Shale	29	150
Limestone	40	190
Shale	74	264
Galena-Platteville dolomite	346	610
St. Peter formation		
Sandstone, water-bearing	185	795
Shale	7	802
Shakopee dolomite	53	855
New Richmond sandstone	20	875
Oneota dolomite	192	1067
CAMBRIAN SYSTEM		
Jordan dolomite, sandy	98	1165
Trempealeau dolomite	135	1300
Franconia sandstone and dolomite	125	1425
Galesville sandstone, water-bearing	160	1585
Eau Claire sandstone and dolomite	27	1612

After drilling had been completed the well was shot with five charges, each consisting of 30 quarts of nitroglycerine, all within the Galesville sandstone section.

The well is equipped with an 11-stage, 12-inch Peerless turbine pump consisting of 380 feet of 10-inch column pipe, a bowl section 9

feet long, and 10 feet of 10-inch suction pipe. The pump is driven by a direct-connected, 200-horsepower electric motor and is rated at 1000 gallons per minute against a head of 570 feet at a speed of 1760 revolutions per minute. A small pipe for determining water levels terminates at a depth of 380 feet below the pump base.

When well number 2 was 280 feet deep and cased only with the 22-inch pipe the water level was at a depth of 10 feet when not pumping and was lowered 19, 39, and 63 feet by pumping at rates of 233, 382, and 470 gallons per minute, respectively. Wells 1 and 3 were being pumped at the same time.

The temperature of the water was 52½° F. The water had a residue of 449, a total hardness of 331, and a content of iron of 1.7 parts per million as shown by the analysis of sample number 89587, collected December 31, 1940.

Analysis of Sample Number 89587 from "Well Number 2 When 280 Feet Deep.
Determinations Made.

	Pts. per million.
Turbidity	225
Color	0
Odor	0
Iron Fe	
(filtered at well)	1.7
(unfiltered)	4.8
Chloride Cl	3.0
Alkalinity (as CaCO ₃)	
Phenolphthalein	0.0
Methyl Orange	354.0
Total hardness (as CaCO ₃)	331.0
Total mineral content	449.0

When well number 2 was 788 feet deep and the 18-inch casing had been installed the water level was at a depth of about 51 feet when not pumping and was lowered to a depth of 288 feet by pumping at a rate

Analysis of Sample Number 89824 from Well Number 2 When 788 Feet Deep.
Determinations Made.

	Pts. per million.	Hypothetical Combinations	Pts. per million.	Grs. per gallon.
Turbidity	5	Sodium Chloride NaCl	112.2	6.54
Color	0	Sodium Sulfate Na ₂ SO ₄	272.0	15.86
Odor	0	Sodium Carbonate Na ₂ CO ₃	33.4	1.95
Iron Fe		Magnesium Carbonate MgCO ₃	86.4	5.04
(filtered)	0.0	Calcium Carbonate CaCO ₃	138.1	8.05
(unfiltered)	0.6	Silica SiO ₂	8.5	0.49
Manganese Mn	0.2			
Silica SiO ₂	8.5	Total	650.6	37.93
Calcium Ca	55.1			
Magnesium Mg	24.9			
Sodium Na	146.7			
Sulfate SO ₄	184.0			
Chloride Cl	68.0			
Alkalinity (as CaCO ₃)				
Phenolphthalein	0.0			
Methyl Orange	272.0			
Hardness (as CaCO ₃)	240.6			
Residue	662.0			

of 146 gallons per minute. Wells 1 and 3 were being pumped at the same time.

The temperature of the water was 58° F. The water had a residue of 662, a total hardness of 240.6 parts per million and no iron as shown by the analysis of sample number 89824, collected February 3, 1941.

After well number 2 had been drilled to the final depth, but before it was shot, the water level was at a depth of 52 feet when not pumping and was lowered 248½ feet by pumping at a rate of 505 gallons per minute. No other wells were being pumped at this time.

The temperature of the water was 60° F. The water had a residue of 655, a total hardness of 281 parts per million and a trace of iron as shown by the analysis of sample number 90230, collected March 26, 1941.

Analysis of Sample Number 90230 from Well Number 2 Before Shooting.

Determinations Made.		Hypothetical Combinations.			
	Pts. per million.		Pts. per million.	Grs. per gallon.	
Turbidity.....	trace	Sodium Nitrate.....	NaNO ₃	1.7	0.10
Color.....	0	Sodium Chloride.....	NaCl	142.1	8.28
Odor.....	0	Sodium Sulfate.....	Na ₂ SO ₄	213.8	12.46
Iron..... Fe		Ammonium Sulfate.....	(NH ₄) ₂ SO ₄	5.3	0.31
(filtered at well) ..	trace	Magnesium Sulfate.....	MgSO ₄	13.2	0.77
(unfiltered).....	0.5	Magnesium Carbonate.....	MgCO ₃	90.6	5.28
Manganese.. Mn	0.06	Calcium Carbonate.....	CaCO ₃	162.6	9.48
Silica..... SiO ₂	11.0	Silica.....	SiO ₂	11.0	0.64
Calcium..... Ca	65.0				
Magnesium.. Mg	28.8	Total.....		640.3	37.32
Ammonium.. NH ₄	1.4				
Sodium..... Na	125.6				
Sulfate..... SO ₄	159.0				
Nitrate..... NO ₃	1.3				
Chloride..... Cl	86.0				
Alkalinity (as CaCO ₃)					
Phenolphthalein..	0.0				
Methyl Orange...	270.0				
Hardness (as CaCO ₃)	281.0				
Residue.....	655.0				
pH = 7.3					
Free CO ₂ (by test)..	13.0				
Free CO ₂ (calc.)....	25.0				

WELL NUMBER 3 (73), located approximately 1965 feet west and 110 feet north of the southeast corner of Section 34, T. 34 N., R. 9 E., or 2000 feet west of well number 2 was completed in 1941 by the Layne Western Company of Chicago, Illinois, to a depth of 1593 feet 5 inches below a ground surface elevation of 528 feet above sea level. It was drilled 15¼ inches in diameter at the bottom and is cased with 16 feet of 22-inch pipe and 299 feet of 18-inch pipe, the tops of both pipes being 2 feet 1 inch above the ground surface. The annular space outside the 18-inch pipe is filled for its full length with cement grout. A 16-inch liner is set between depths of 801 feet 11 inches and 852. feet.

A log of material penetrated, furnished by the State Geological Survey, is as follows:

Formations.	Thickness in feet.	Depth in feet.
PLEISTOCENE SYSTEM		
Glacial drift.....	7	7

Formations.	Thickness in feet.	Depth in feet.
SILURIAN SYSTEM		
Niagaran-Alexandrian dolomite, water-bearing. . .	108	115
ORDOVICIAN SYSTEM		
Maquoketa formation		
Shale. . . . .	.15	130
Limestone and dolomite. . . . .	.50	180
Shale. . . . .	.77	257
Galena-Platteville dolomite.	348	605
G-lenwood sandstone.	5	610
St. Peter formation		
Sandstone, water-bearing. . . . .	.195	805
Shale and chert, caving . . . . .	.13	818
Shakopee dolomite. . . . .	.42	860
New Richmond sandstone. . . . .	.25	885
Oneota dolomite. . . . .	.179	1064
CAMBRIAN SYSTEM		
Jordan dolomite and sandstone. . . . .	.101	1165
Trempealeau dolomite. . . . .	.135	1300
Franconia sandstone and dolomite. . . . .	.120	1420
Galesville sandstone, water-bearing . . . . .	.155	1575
Eau Claire sandstone and dolomite. . . . .	.18	1593

After drilling had been completed the well was shot with five charges, each consisting of 30 quarts of nitroglycerine, all within the Galesville sandstone section.

The well is equipped with an 11-stage, 12-inch Peerless turbine pump consisting of 380 feet of 10-inch column pipe, a bowl section 9 feet long, and 10 feet of 10-inch suction pipe. The pump is driven by a direct-connected, 200-horsepower electric motor and is rated at 1000 gallons per minute against a head of 570 feet at a speed of 1760 revolutions per minute. A small air pipe for determining water levels terminates at a depth of 380 feet below the pump base.

When well number 3 was 255-260 feet deep and cased only with the 22-inch pipe the water level was at a depth of 6½ feet when not pumping and was lowered 74 feet by pumping at a rate of 148 gallons per minute. Wells 1 and 2 were being pumped at the same time.

The temperature of the water was 53° F. The water had a residue of 394, a total hardness of 300, and a content of iron of 0.1 parts per million as shown by the analysis of sample number 89586, collected December 30, 1940.

Analysis of Sample Number 89586 from Well Number 3 When 255-260 Feet Deep.
Determinations Made.

	Pts. per million.
Turbidity. . . . .	.15
Color.	0
Odor.	0
Iron. Fe	
(filtered at well). . . . .	.01
(unfiltered). . . . .	.03
Chloride. Cl	4.0
Alkalinity (as CaCO ₃)	
Phenolphthalein.	0.0
Methyl Orange.	304.0
Total hardness (as CaCO ₃).	300.0
Total mineral content.	394.0

When well number 3 was 809 feet deep and the 18-inch casing had been! installed the water level was at a depth of about 44½ feet when not pumping and was lowered to a depth of 232½ feet by pumping at a rate of 162 gallons per minute. Wells 1 and 2 were being pumped at the same time.

The temperature of the water was 58° F. The water had a residue of 638, a total hardness of 248.5, and a content of iron of 0.7 parts per million as shown by the analysis of sample number 89782, collected February 3, 1941.

Analysis of Sample Number 89782 from Well Number 3 When 809 Feet Deep.
Determinations Made. Hypothetical Combinations.

	Pts. per million.		Pts. per million.	Grs. per gallon.
Turbidity.....	40	Sodium Chloride.....NaCl	110.5	6.44
Color.....	0	Sodium Sulfate.....Na ₂ SO ₄	266.4	15.53
Odor.....	0	Sodium Carbonate.....Na ₂ CO ₃	10.6	0.62
Iron.....Fe		Magnesium Carbonate..MgCO ₃	136.2	7.94
(unfiltered).....	0.7	Calcium Carbonate.....CaCO ₃	86.6	5.05
Manganese..Mn	0.1	Silica.....SiO ₂	9.8	0.57
Silica.....SiO ₂	9.8			
Calcium.....Ca	34.6	Total.....	620.1	36.15
Magnesium..Mg	39.3			
Sodium.....Na	134.3			
Sulfate.....SO ₄	180.0			
Chloride.....Cl	67.0			
Alkalinity (as CaCO ₃)				
Phenolphthalein..	0.0			
Methyl Orange...	258.0			
Hardness (as CaCO ₃)	248.5			
Residue.....	638.0			

After well number 3 had been drilled to the final depth, but before it was shot, the water level was at a depth of 45 feet when not pumping

Analysis of Sample Number 90233 from Well Number 3 Before Shooting.
Determinations Made. Hypothetical Combinations.

	Pts. per million.		Pts. per million.	Grs. per gallon.
Turbidity.....	30	Sodium Nitrate.....NaNO ₃	1.7	0.10
Color.....	0	Sodium Chloride.....NaCl	143.2	8.35
Odor.....	0	Sodium Sulfate.....Na ₂ SO ₄	234.4	13.67
Iron.....Fe		Sodium Carbonate.....Na ₂ CO ₃	10.1	0.59
(filtered at well)..	trace	Ammonium Carbonate..(NH ₄) ₂ CO ₃	4.8	0.28
(unfiltered).....	1.0	Magnesium Carbonate..MgCO ₃	93.6	5.46
Manganese..Mn	0.1	Calcium Carbonate.....CaCO ₃	148.6	8.66
Silica.....SiO ₂	16.0	Silica.....SiO ₂	16.0	0.93
Calcium.....Ca	59.3			
Magnesium..Mg	27.0	Total.....	652.4	38.04
Ammonium..NH ₄	1.9			
Sodium.....Na	137.1			
Sulfate.....SO ₄	158.8			
Nitrate.....NO ₃	1.2			
Chloride.....Cl	87.0			
Alkalinity (as CaCO ₃)				
Phenolphthalein..	0.0			
Methyl Orange...	274.0			
Hardness (as CaCO ₃)	260.0			
Residue.....	644.0			
pH = 7.4				
Free CO ₂ (calc.)....	20.0			

and was lowered 273½ feet by pumping at a rate of 525 gallons per minute. No other wells were being pumped at this time.

The temperature of this water was 59° F. The water had a residue of 644, a total hardness of 260 parts per million and a trace of iron as shown by the analysis of sample number 90233, collected March 28, 1941.

After well number 3 had been shot the water level was at a depth of 50 feet when not pumping and was lowered 246½ feet by pumping at a rate of 974 gallons per minute. Wells 1 and 2 were being pumped at the same time.

The temperature of the water was 60° F. The water had a residue of 657, a total hardness of 265, and a content of iron of 0.1 parts per million as shown by the analysis of sample number 90436, collected April 27, 1941.

Analysis of Sample Number 90436 from Well Number 3 After Shooting.			
Determinations Made.		Hypothetical Combinations.	
	Pts. per million.		
		Pts. per million.	Grs. per gallon.
Turbidity.....	trace	Sodium Nitrate..... NaNO ₃	0.9 0.05
Color.....	0	Sodium Chloride..... NaCl	163.1 9.51
Odor.....	0	Sodium Sulfate..... Na ₂ SO ₄	202.4 11.80
Iron..... Fe		Ammonium Sulfate..... (NH ₄) ₂ SO ₄	4.6 0.27
(filtered at well)...	0.1	Magnesium Sulfate..... MgSO ₄	18.7 1.09
(unfiltered).....	0.6	Magnesium Carbonate.. MgCO ₃	74.7 4.36
Manganese... Mn	0.0	Calcium Carbonate..... CaCO ₃	161.6 9.42
Silica..... SiO ₂	12.0	Silica..... SiO ₂	12.0 0.70
Calcium..... Ca	64.7		
Magnesium... Mg	25.3	Total.....	638.0 37.20
Ammonium... NH ₄	1.3		
Sodium..... Na	130.1		
Sulfate..... SO ₄	155.5		
Nitrate..... NO ₃	0.9		
Chloride.... Cl	99.0		
Alkalinity (as CaCO ₃)			
Phenolphthalein...	0.0		
Methyl Orange...	250.0		
Hardness (as CaCO ₃)	265.0		
Residue.....	657.0		
pH = 7.2			
Free CO ₂ (by test)...	11.0		
Free CO ₂ (calc.)....	29.5		

The tests showed that each of these three wells has a wide circle of influence and that pumping any one well would cause a water level recession of several feet in the other wells.

WELL NUMBER 4 (72), located 1230 feet east and 100 feet north of the southwest corner of Section 34, T. 34 N., R. 9 E., or about 2000 feet west of well number 3, was being drilled in 1941 by the Layne Western Company of Chicago, Illinois, to a depth of about 1600 feet. It is to be 17¼ inches in diameter at the bottom and is cased with 22-inch pipe from 2 feet above the surface to a depth of 9 feet, and with 18-inch pipe from 2 feet above the surface to a depth of 273 feet. The annular space outside the 18-inch pipe was filled for its entire length with cement grout.

It was drilled 15¼ inches in diameter at the bottom and is cased with 25 feet 5 inches of 22-inch pipe from 2 feet 1½ inches above the ground surface and with 300 feet 2 inches of 18-inch pipe from 3 feet 1½ inches above the ground surface. The annular space outside the 18-inch pipe for its entire length is filled with cement grout. A 16-inch liner is set between depths of 876 feet 3 inches and 1010 feet 9 inches.

A log of material penetrated, furnished by the State Geological Survey, is as follows:

Formations.	Thickness in feet.	Depth in feet.
PLEISTOCENE SYSTEM		
Glacial drift	25	25
SILURIAN SYSTEM		
Niagaran series		
Joliet dolomite	15	40
Osgood dolomite	30	70
Alexandrian series		
Kankakee dolomite	42	112
Edgewood siltstone	43	155
ORDOVICIAN SYSTEM		
Maquoketa formation		
Shale	15	170
Dolomite	45	215
Shale	80	295
Galena-Platteville dolomite	365	660
St. Peter formation		
Sandstone, water-bearing	240	900
Shale and dolomite fragments	109	1009
Oneota dolomite	101	1110
CAMBRIAN SYSTEM		
Jordan sandy dolomite	90	1200
Trempealeau dolomite	150	1350
Franconia sandstone and dolomite	125	1475
Galesville sandstone, water-bearing	175	1650
Eau Claire dolomitic sandstone	3	1653

After drilling had been completed the well was shot with two charges, each consisting of 100 quarts of nitroglycerine, within the Galesville sandstone.

The well is equipped with a 12-stage, 12-inch Peerless turbine pump consisting of 500 feet of 10-inch column pipe, a bowl section 10 feet long, and 10 feet of 10-inch suction pipe. The pump is driven by a direct-connected, 250-horsepower electric motor and is rated at 1100 gallons per minute against a head of 690 feet at a speed of 1760 revolutions per minute. A small air pipe for measuring water levels terminates at a depth of 514 feet below the pump base.

After well number 6 had been completed and shot the water level was at a depth of 139 feet when not pumping and was lowered 112 feet by pumping at a rate of 1165 gallons per minute. No other nearby wells were being pumped at this time.

The temperature of the water was 60° F. The water had a residue of 689, a hardness of 267.5, and a content of iron of 0.1 parts per million as shown by the analysis of sample number 91245, collected August 8, 1941.

Analysis of Sample Number 91245 from Well Number 6.

Determinations Made.

Hypothetical Combinations.

	Pts. per million.		Pts. per million.	Grs. per gallon.	
Turbidity.....	5	Sodium Nitrate.....	NaNO ₃	1.7	0.10
Color.....	0	Sodium Chloride.....	NaCl	143.2	8.35
Odor.....	0	Sodium Sulfate.....	Na ₂ SO ₄	236.5	13.79
Iron..... Fe		Sodium Carbonate.....	Na ₂ CO ₃	6.4	0.37
(filtered at well)..	0.1	Ammonium Carbonate.....	(NH ₄) ₂ CO ₃	2.4	0.14
(unfiltered).....	0.2	Magnesium Carbonate.....	MgCO ₃	84.3	4.91
Manganese..... Mn	0.0	Calcium Carbonate.....	CaCO ₃	169.1	9.86
Silica..... SiO ₂	11.5	Silica.....	SiO ₂	11.5	0.67
Calcium..... Ca	67.0				
Magnesium..... Mg	24.4	Total.....		655.1	38.19
Ammonium..... NH ₄	1.0				
Sodium..... Na	138.2				
Sulfate..... SO ₄	160.2				
Nitrate..... NO ₃	1.1				
Chloride..... Cl	87.0				
Alkalinity (as CaCO ₃)					
Phenolphthalein..	0.0				
Methyl Orange...	276.0				
Hardness (as CaCO ₃)	267.5				
Residue.....	689.0				
pH = 7.2					
Free CO ₂ (calc.)....	32.0				

WELL NUMBER 7 (69), located 2403 feet south and 2744 feet west of the northeast corner of Section 36, T. 34 N., R. 9 E., was drilled by the Layne Northwest Company of Milwaukee, Wisconsin, to a depth of 1649 feet below a ground surface elevation of 601 feet above sea level. It was drilled 15¼ inches in diameter at the bottom and is cased with 22-inch pipe from the surface to a depth of 54 feet and with 18-inch pipe from the surface to a depth of 326 feet 8 inches. The annular space outside the 18-inch pipe is filled for its full length with cement grout. A 16-inch liner is set between depths of 930 and 992 feet.

A log of material penetrated, furnished by the State Geological Survey, is as follows:

Formations.	Thickness in feet.	Depth in feet.
PLEISTOCENE SYSTEM		
Glacial drift	50	50
SILURIAN SYSTEM		
Niagaran-Alexandrian dolomite, water-bearing...	140	190
ORDOVICIAN SYSTEM		
Maquoketa formation		
Shale	10	200
Dolomite	40	240
Shale	85	325
Galena-Platteville limestone and dolomite	355	680
Glenwood sandstone	5	685
St. Peter formation		
Sandstone, water-bearing	265	950
Shale	7	957
Oneota dolomite	178	1135

Formations.	Thickness in feet.	Depth in feet.
CAMBRIAN SYSTEM		
Jordan dolomite and sandstone	85	1220
Trempealeau dolomite	140	1360
Franconia sandstone and dolomite	130	1490
Galesville sandstone, water-bearing	150	1640
Eau Claire sandstone	15	1655

After drilling had been completed the well was shot with three charges, each consisting of 60 quarts of nitroglycerine, all within the section of the Galesville sandstone.

The well is equipped with a 12-stage, 12-inch Peerless turbine pump consisting of 530 feet of 10-inch column pipe, a bowl section 10 feet long, and 10 feet of 10-inch suction pipe. The pump is driven by a direct-connected, 250-horsepower electric motor and is rated at 1100 gallons per minute against a head of 690 feet at a speed of 1760 revolutions per minute. The air pipe for determining water levels extends to a depth of 530 feet.

After well number 7 had been completed and shot the water level was at a depth of 137 feet when not pumping and was lowered 182 feet by pumping at a rate of 1045 gallons per minute for 90 hours. Wells 8 and 9 were being pumped at the same time.

The temperature of the water was 60-61° F. The water had a residue of 688, a total hardness of 298.5 and a content of iron of 0.1 parts per million as shown by the analysis of sample number 91158, collected July 27, 1941.

Analysis of Sample Number 91158 from Well Number 7.

Determinations Made.		Hypothetical Combinations.	
	Pts. per million.		Pts. per million.
Turbidity	trace	Sodium Nitrate NaNO ₃	1.7
Color	0	Sodium Chloride NaCl	173.0
Odor	0	Sodium Sulfate Na ₂ SO ₄	172.6
Iron Fe		Ammonium Sulfate (NH ₄) ₂ SO ₄	4.0
(filtered at well)	0.1	Magnesium Sulfate MgSO ₄	21.1
(unfiltered)	0.2	Magnesium Carbonate MgCO ₃	72.5
Manganese Mn	0.0	Calcium Carbonate CaCO ₃	192.2
Silica SiO ₂	11.5	Silica SiO ₂	11.5
Calcium Ca	76.9		
Magnesium Mg	25.2	Total	648.6
Ammonium NH ₄	1.2		38.01
Sodium Na	124.4		
Sulfate SO ₄	136.4		
Nitrate NO ₃	1.2		
Chloride Cl	105.0		
Alkalinity (as CaCO ₃)			
Phenolphthalein	0.0		
Methyl Orange	278.0		
Hardness (as CaCO ₃)	298.5		
Residue	688.0		
pH = 7.2			
Free CO ₂ (calc.)	32.0		

WELL NUMBER 8 (68), located 87 feet north and 2744 feet west of the northeast corner of Section 25, T. 34 N., R. 9 E., was completed in 1941 by the Layne Northwest Company of Milwaukee, Wisconsin, to

a depth of 1639 feet below a ground surface elevation of 606 feet above sea level. It was drilled 17¼ inches in diameter at the bottom and is cased with 22-inch pipe from the surface to a depth of 561/3 feet and with 18-inch pipe from the surface to a depth of 331½ feet. The annular space outside the 18-inch pipe, for its full length, is filled with cement grout.

A log of material penetrated, furnished by the State Geological Survey, is as follows: .

Formations.	Thickness in feet.	Depth in feet.
PLEISTOCENE SYSTEM		
Glacial drift	54	54
SILURIAN SYSTEM		
Niagaran-Alexandrian dolomite, water-bearing...	129	183
ORDOVICIAN SYSTEM		
Maquoketa formation		
Shale	17	200
Dolomite and limestone	44	244
Shale	81	325
Galena-Platteville dolomite	350	675
Glenwood sandstone	5	680
St. Peter formation		
Sandstone, water-bearing	170	850
Shale	3	853
Shakopee dolomite	42	895
New Richmond sandstone	12	907
Oneota dolomite	168	1075
CAMBRIAN SYSTEM		
Jordan dolomite, sandy	105	1180
Trempealeau dolomite	164	1344
Franconia sandstone and dolomite	126	1470
Galesville sandstone, water-bearing	150	1620
Eau Claire dolomite	7	1627

After drilling had been completed the well was shot with one charge of 180 quarts of nitroglycerine, within the section of the Galesville sandstone.

The well is equipped with a 12-stage, 12-inch Peerless turbine pump consisting of 530 feet of 10-inch column pipe, a bowl section 10 feet long, and 10 feet of 10-inch suction pipe. The pump is driven by a direct-connected, 250-horsepower electric motor and is rated at 1100 gallons per minute against a head of 690 feet at a speed of 1760 revolutions per minute. A small pipe for determining water levels terminates at a depth of 530 feet below the pump base.

After well number 8 had been completed and shot, the water level was at a depth of 136 feet when not pumping and was lowered 67 feet by pumping at a rate of 823 gallons per minute for 13 hours. No other nearby wells were being pumped at this time. Three days later this well was tested for 90 hours while wells 7 and 9 were being pumped. At this time the water level was at a depth of 139½ feet when not pumping and was lowered 149 feet by pumping at a rate of 963 gallons per minute. At the end of 90 hours pumping the water level was still receding.

The temperature of the water was 60° F. The water had a residue of 650, a total hardness of 241, and a content of iron of 0.1 parts per million as shown by the analysis of sample number 91159, collected July 27, 1941.

Analysis of Sample Number 91159 from Well Number 8.

Determinations Made.		Hypothetical Combinations.	
	Pts. per million.		Pts. per million. Grs. per gallon.
Turbidity.....	trace	Sodium Nitrate..... NaNO ₃	1.7 0.10
Color.....	0	Sodium Chloride..... NaCl	116.9 6.82
Odor.....	0	Sodium Sulfate..... Na ₂ SO ₄	214.5 12.51
Iron..... Fe		Sodium Carbonate..... Na ₂ CO ₃	36.0 2.10
(filtered at well)...	0.1	Ammonium Carbonate.. (NH ₄) ₂ CO ₃	2.9 0.17
(unfiltered).....	0.1	Magnesium Carbonate.. MgCO ₃	81.8 4.77
Manganese... Mn	0.0	Calcium Carbonate.... CaCO ₃	144.1 8.40
Silica..... SiO ₂	13.0	Silica..... SiO ₂	13.0 0.76
Calcium..... Ca	57.6		
Magnesium... Mg	23.6	Total.....	610.9 35.63
Ammonium... NH ₄	1.1		
Sodium..... Na	131.6		
Sulfate..... SO ₄	145.2		
Nitrate..... NO ₃	1.4		
Chloride.... Cl	71.0		
Alkalinity (as CaCO ₃)			
Phenolphthalein..	0.0		
Methyl Orange...	278.0		
Hardness (as CaCO ₃)	241.0		
Residue.....	650.0		
pH = 7.2			
Free CO ₂ (calc.)....	32.0		

WELL NUMBER 9 (67), located 2587 feet north and 2745 feet west of the southeast corner of Section 25, T. 34 N., R. 9 E., was completed in 1941 by the Layne Western Company of Chicago, Illinois, to a depth of 1602 feet below a ground surface elevation of 589 feet above sea level. It was drilled 17¼ inches in diameter at the bottom and is cased with 22-inch pipe from the surface to a depth of 38 feet and with 18-inch pipe from the surface to a depth of 310 feet. The annular space outside the 18-inch pipe is filled for its full length with cement grout.

A log of material penetrated, furnished by the State Geological Survey, is as follows:

Formations.	Thickness in feet.	Depth in feet.
PLEISTOCENE SYSTEM		
Glacial drift.....	38	38
SILURIAN SYSTEM		
Niagaran-Alexandrian dolomite, water-bearing...	102	140
ORDOVICIAN SYSTEM		
Maquoketa formation		
Shale.....	40	180
Dolomite and limestone.....	55	235
Shale.....	71	306
Galena-Platteville limestone and dolomite.....	344	650
Glenwood sandstone.....	5	655
St. Peter sandstone.....	153	808
Shakopee dolomite.....	67	875
New Richmond sandstone.....	12	887
Oneota dolomite.....	198	1085
CAMBRIAN SYSTEM		
Jordan dolomite, sandy.....	100	1185
Trempealeau dolomite.....	154	1339
Franconia sandstone and dolomite.....	126	1465
Galesville sandstone, water-bearing.....	130	1595
Eau Claire sandstone.....	8	1603

After drilling had been completed the well was shot with one charge of 180 quarts of nitroglycerine, in the section of the Galesville sandstone.

The well is equipped with a 12-stage, 12-inch Peerless turbine pump consisting of 530 feet of 10-inch column pipe, a bowl section 10 feet long, and 10 feet of 10-inch suction pipe. The pump is driven by a direct-connected, 250-horsepower electric motor and is rated at 1100 gallons per minute against a head of 690 feet at a speed of 1760 revolutions per minute. A small air pipe for determining water levels terminates at a depth of 535 feet below the pump base.

After well number 9 had been completed the water level was at a depth of 121 feet when not pumping and was lowered 218½ feet by pumping at a rate of 760 gallons per minute. Wells 7 and 8 were being pumped at the same time.

The temperature of the water was 61° F. The water had a residue of 582, a total hardness of 280.5, and a content of iron of 0.1 parts per million as shown by the analysis of sample number 91160, collected July 27, 1941.

Analysis of Sample Number 91160 from Well Number 9.

Determinations Made.		Hypothetical Combinations.	
	Pts. per million.		
		Pts. per million.	Grs. per gallon.
Turbidity.....	trace	Sodium Nitrate.....NaNO ₃	0.9 0.05
Color.....	0	Sodium Chloride.....NaCl.....	80.7 4.70
Odor.....	0	Sodium Sulfate.....Na ₂ SO ₄	184.7 10.77
Iron.....Fe		Ammonium Sulfate.....(NH ₄) ₂ SO ₄	2.6 0.15
(filtered at well)...	0.1	Magnesium Sulfate....MgSO ₄	3.0 0.17
(unfiltered).....	0.1	Magnesium Carbonate..MgCO ₃	83.9 4.89
Manganese...Mn	0.0	Calcium Carbonate....CaCO ₃	178.6 10.41
Silica.....SiO ₂	12.5	Silica.....SiO ₂	12.5 0.73
Calcium....Ca	71.6		
Magnesium..Mg	24.8	Total.....	546.9 31.87
Ammonium..NH ₄	0.8		
Sodium....Na	91.8		
Sulfate....SO ₄	129.2		
Nitrate....NO ₃	0.9		
Chloride....Cl	49.0		
Alkalinity (as CaCO ₃)			
Phenolphthalein..	0.0		
Methyl Orange...	278.0		
Hardness (as CaCO ₃)	280.5		
Residue.....	582.0		
pH = 7.1			
Free CO ₂ (calc.)....	41.0		

Seven days after the end of the 90-hour test of wells 7, 8 and 9 the water levels were 22½, 21½, and 17 feet, respectively, below the water levels prevailing before the test.

WELL NUMBER 10 (66), located 151 feet south and 2745 feet west of the northeast corner of Section 25, T. 34 N., R. 9 E., was completed in 1941 by Joseph Egerer of Milwaukee, Wisconsin, to a depth of 1569 feet below a ground surface elevation of 591 feet above sea level. It was drilled 17¼ inches in diameter at the bottom and is cased with 41½ feet of 22-inch pipe, 103 feet of 20-inch pipe and 302½ feet of 18-inch pipe, the tops of all pipes being 1 foot 10 inches above ground

level. The annular space outside the 18-inch pipe for its entire length is filled with cement grout.

After drilling had been completed the well was shot with one charge of 180 quarts of nitroglycerine, in the section of the Galesville sandstone.

The well is equipped with a 12-stage, 12-inch Peerless turbine pump consisting of 510 feet of 10-inch column pipe, a bowl section 10 feet long, and 10 feet of 10-inch suction pipe. The pump is driven by a direct-connected, 250-horsepower electric motor and is rated at 1100 gallons per minute against a head of 690 feet at a speed of 1760 revolutions per minute. A small air pipe for determining water levels terminates at a depth of 510 feet below the pump base.

After well number 10 had been completed the water level was at a depth of 198 feet when not pumping and was lowered 150 feet by pumping at a rate of 880 gallons per minute. No other nearby well was being pumped at this time.

The temperature of the water was $59\frac{1}{2}^{\circ}\text{F}$. The water had a residue of 610, a total hardness of 263, and an iron content of 0.2 parts per million as shown by the analysis of sample number 91817, collected November 16, 1941.

Analysis of Sample Number 71817 from Well Number 10.

Determinations Made.		Hypothetical Combinations.	
	Pts. per million.		
			Pts. per million. Grs. per gallon.
Turbidity.....	trace	Sodium Nitrate.....	NaNO ₃ 2.6 0.15
Color.....	0	Sodium Chloride.....	NaCl 125.0 7.29
Odor.....	0	Sodium Sulfate.....	Na ₂ SO ₄ 202.5 11.81
Iron..... Fe		Sodium Carbonate.....	Na ₂ CO ₃ 4.2 0.24
(filtered at well)...	0.2	Ammonium Carbonate.,	(NH ₄) ₂ CO ₃ 9.6 0.56
(unfiltered).....	0.5	Magnesium Carbonate.,	MgCO ₃ 85.2 4.97
Manganese.. Mn	0.0	Calcium Carbonate....	CaCO ₃ 153.1 8.93
Silica..... SiO ₂	10.5	Silica.....	SiO ₂ 10.5 0.61
Calcium.... Ca	61.2		
Magnesium.. Mg	24.6	Total.....	592.7 34.56
Ammonium.. NH ₄	3.7		
Sodium.... Na	117.3		
Sulfate.... SO ₄	137.0		
Nitrate.... NO ₃	1.7		
Chloride... Cl	76.0		
Alkalinity (as CaCO ₃)			
Phenolphthalein..	0.0		
Methyl Orange...	268.0		
Residue.....	610.0		
Hardness (as CaCO ₃)	263.0		
pH = 7.3			
Free CO ₂ (calc.)....	25.0		

WELL NUMBER 2A (74A), is located 8 feet west of well number 2, or approximately 27 feet east and 80 feet north of the southwest corner of Section 35, T. 34 N., R. 9 E. It was completed in 1941 by the Layne Western Company of Chicago, Illinois, to a depth of 100 feet below a ground surface elevation of 532 feet above sea level. It is $25\frac{1}{4}$ inches in diameter at the bottom and is cased to rock at a depth of $8\frac{1}{2}$ feet with 26-inch pipe.

The well is equipped with an 11-stage, 8-inch Peerless turbine pump consisting of 80 feet of 5-inch column pipe, a bowl section 7 feet long,

and 10 feet of 5-inch suction pipe. The pump is driven by a direct-connected, 25-horsepower electric motor and is rated at 225 gallons per minute against a head of 300 feet at a speed of 1760 revolutions per minute. A small pipe- for determining water levels terminates at a depth of 80 feet below the pump base.

After well number 2A had been completed the water level was at a depth of 8½ feet when not pumping and was lowered 43 and 67½ feet by pumping at rates of 195 and 200 gallons per minute, respectively.

The yield of this well was much lower than that of well number 2 when it was but 280 feet deep although they are only 8 feet apart. It is thought that the cementing operations at well number 2 filled some of the crevices in the Silurian dolomite, thereby reducing the yield of that formation.

The water had a residue of 427, a total hardness of 350 parts per million and no iron as shown by the analysis of sample number 90630, collected May 22, 1941.

Analysis of Sample Number 90630 from Well Number 2A.

Determinations Made.		Hypothetical Combinations.			
	Pts. per million.		Pts. per million.	Grs. per gallon.	
Turbidity.....	60	Sodium Nitrate.....	NaNO ₃	3.4	0.20
Color.....	0	Sodium Chloride.....	NaCl	6.4	0.37
Odor.....	0	Sodium Sulfate.....	Na ₂ SO ₄	44.8	2.61
Iron..... Fe		Ammonium Sulfate.....	(NH ₄) ₂ SO ₄	0.7	0.04
(filtered).....	0.0	Magnesium Sulfate.....	MgSO ₄	43.8	2.55
(unfiltered).....	0.9	Magnesium Carbonate..	MgCO ₃	105.4	6.14
Manganese.. Mn	0.0	Calcium Carbonate.....	CaCO ₃	189.2	10.03
Silica..... SiO ₂	13.5	Silica.....	SiO ₂	13.5	0.79
Calcium..... Ca	75.6				
Magnesium.. Mg	40.4	Total.....		407.2	22.73
Ammonium.. NH ₄	0.2				
Sodium..... Na	17.9				
Sulfate..... SO ₄	66.0				
Nitrate..... NO ₃	2.2				
Chloride.... Cl	4.0				
Alkalinity (as CaCO ₃)					
Phenolphthalein..	0.0				
Methyl Orange...	314.0				
Residue.....	427.0				
Total hardness.....	350.0				
pH = 7.2					
Free CO ₂ (calc.)....	37.1				

LOCKPORT

LOCKPORT CITY WELLS. WELL NUMBER 1 (1). The public water supply for Lockport was first obtained from a well, number 1, drilled by the J. P. Miller Artesian Well Company of Chicago, Illinois, in 1895 at a site 70 feet east of the center line of Ames Street and 70 feet north of the center line of Tenth, Street or approximately 625 feet east and 2620 feet north of the southwest corner of Section 23, T. 36 N., R. 10 E. to a depth of 1922 feet below a ground surface elevation of 563 feet.

The log of this well, furnished by the State Geological Survey, is as follows:

Formations.	Thickness in feet.	Depth in feet.
PLEISTOCENE SYSTEM		
Glacial drift	3	3
SILURIAN SYSTEM		
Niagaran & Alexandrian dolomites	200	203
ORDOVICIAN SYSTEM		
Maquoketa shale	87	290
Galena-Platteville dolomite	340	630
St. Peter formation		
Sandstone, water-bearing	230	860
Shale and chert, caving	60	920
ORDOVICIAN AND CAMBRIAN SYSTEMS		
Oneota-Trempealeau dolomites	280	1200
CAMBRIAN SYSTEM		
Franconia dolomite	110	1310
Galesville (Dresbach) sandstone, water-bearing	165	1475
Eau Claire shale and marl	375	1850
Mt. Simon sandstone, water-bearing	72	1922

Because of salt water the well was plugged back to a depth of 1650 feet.

The well was reported to have been drilled 10 inches in diameter to a depth of 78½ feet, 8 inches in diameter to a depth of 325 feet, 7 inches in diameter to a depth of 860 feet, 6 inches in diameter to a depth of 1210 feet, and 5 inches in diameter to a depth of 1922 feet.

Ten-inch casing was set from the surface to a depth of 51 feet and 70 feet of 6-inch liner placed through the caving material below 860 feet.

When first completed and placed in service the well had a free flow of 275 gallons per minute at the top of the casing which was 2 feet above ground level. By 1904 the pressure and rate of flow had diminished to such an extent that an air-lift pump was installed. It was reported in 1915 that the static or non-pumping water level had

Analysis of Sample Number 48280 from 1650-Foot City Well.

Determenations Made.		Hypothetical Combinations.	
	Pts. per million.		Pts. per million. Grs. per gallon.
Iron Fe	0.0	Potassium Nitrate KNO ₃	11.5 0.67
Manganese Mn	0.0	Potassium Chloride KCl	31.7 1.85
Silica SiO ₂	15.6	Sodium Chloride NaCl	574.1 33.57
Non-volatile	1.6	Ammonium Chloride NH ₄ Cl	1.2 0.07
Alumina Al ₂ O ₃	4.0	Magnesium Chloride MgCl ₂	232.3 13.58
Calcium Ca	158.3	Calcium Chloride CaCl	35.6 2.08
Magnesium Mg	59.4	Calcium Sulfate CaSO ₄	227.4 13.29
Ammonium NH ₄	0.4	Calcium Carbonate CaCO ₃	196.0 11.47
Potassium K	21.1	Silica SiO ₂	15.6 0.91
Sodium Na	225.9	Non-volatile	1.6 0.10
Sulfate SO ₄	160.6	Alumina Al ₂ O ₃	4.0 0.23
Nitrate NO ₃	7.1		
Chloride Cl	560.0	Total	1331.0 77.82
Alkalinity (as CaCO ₃)			
Phenolphthalein	0.0		
Methyl Orange	234.0		
Residue	1458.0		
Hardness	629.3		

receded to 6 feet below the top of the casing. During that year the well was producing from 100,000 to 140,000 gallons per day.

In 1915 the water from this well had a mineral content of 1162.4, a total hardness of 560 and an iron content of 0.1 parts per million as shown by the analysis of sample number 30866, collected July 2, 1915.

In 1920 it became necessary to install larger air pumping equipment and to lower the foot-piece on the air pipe to a depth of 300 feet. In 1922 when pumping at a rate of 140 gallons per minute a drawdown of 159 feet below a non-pumping level of 11 feet took place at the end of 4 hours of continued pumping. The well recovered to within 2 feet of the original non-pumping level in 1½ hours.

In 1922 the water had a residue of 1458, and a total hardness of 629.3 parts per million without iron as shown by the analysis of sample number 48280, collected September 28, 1922.

In 1924 the static water level was 40 feet below the top of the well. The well was abandoned about 1928 and plugged in 1940.

WELL NUMBER 2 (2). In 1927 well number 2 was completed by the J. P. Miller Artesian Well Company of Chicago, Illinois, at a site 180 feet south of the center line of Ninth Street and 165 feet west of the center line of State Street or approximately 1650 feet east and 2420 feet north of the southwest corner of Section 23, T. 36 N., R. 10 E. to a depth of 1475 feet below a ground surface elevation of 587.5 feet above sea level.

A log of the formations penetrated, supplied by the State Geological Survey, is as follows:

Formations.	Thickness in feet.	Depth in feet.
PLEISTOCENE SYSTEM		
Glacial drift	7	7
SILURIAN SYSTEM		
Niagaran and Alexandrian dolomites, water-bearing	253	260
ORDOVICIAN SYSTEM		
Maquoketa formation		
Dolomite	35	295
Shale	65	360
Galena-Platteville dolomite	280	640
Glenwood sandy dolomite	10	650
St. Peter formation		
Sandstone, water-bearing	190	840
Sandstone, shale and chert	50	890
ORDOVICIAN AND CAMBRIAN SYSTEMS		
Oneota, Jordan and Trempealeau dolomites and sandstone	310	1200
CAMBRIAN SYSTEM		
Franconia sandstone and dolomite	110	1310
Galesville (Dresbach) sandstone, water-bearing	118	1428
Eau Claire sandstone	47	1475

The well was drilled 25 inches in diameter to a depth of 9 feet, 19 inches in diameter to a depth of 364 feet 10 inches, 15¼ inches in diameter to a depth of 406 feet 3 inches, 12 inches in diameter to a depth of 913 feet 5 inches, and 10 inches in diameter to the bottom at 1472 feet. It was cased with 24-inch O. D. pipe from the surface to

a depth of 9 feet, with 16-inch O. D. pipe from the surface to a depth of 364 feet 10 inches, and with 10-inch pipe between depths of 843 feet and 913 feet 5 inches. The water level was reported on April 4, 1927 as 273/4 feet below the floor level. At this time water from the Silurian dolomite was entering the well.

The well was originally equipped with a Keystone Driller Company two-stroke deep-well pump consisting of 230 feet 2 inches of 8-inch drop pipe, a 73/4-inch cylinder having a length of 7 feet 1 inch, and 19 feet 10 inches of suction pipe below which was a strainer 2 feet long. This assembly placed the bottom of the suction pipe at a depth of 257 feet 1 inch. On April 3, 1928 it was reported that an additional 90 feet of drop pipe and pump rods had been installed. It is reported that the depth of the well was measured on April 1, 1928 and found to be 1428 feet 10 inches.

The pump was connected by a chain belt to an electric motor and operated at a speed of 30 revolutions per minute with an 18-inch stroke and discharged at a rate of 210 gallons per minute. Pumping water level was 296 feet below the pump room floor at the end of 8½ hours operation. Water temperature at the end of the pumping period was 53° F.

In June 1928 the Whitney Well Company made repairs to the well for the purpose of shutting out gasoline pollution which apparently came from a nearby refinery. The repair consisted of placing 55 feet of 12-inch casing inside the 16-inch casing with the bottom at the bottom of the 151,4-inch hole or at a depth of 406¼ feet. The annular space between the 12-inch and 16-inch casings was closed with a lead seal.

On June 28, 1928, after the well had been quiet since May 16, the water level was found to be 205 feet 5 inches below the pump house floor or 203 feet 9 inches below the top of the casing. The floor level was 20 inches above the top of the casing.

The water had a residue of 668, a total hardness of 436, and an iron content of 0.4 parts per million as shown by the analysis of sample number 61785, collected May 14, 1928.

Analysis of Sample Number 61785 from Lookport Well Number 2.

Determinations Made.		Hypothetical Combinations.	
	Pts. per million.		Pts. per million.
Iron..... Fe	0.4	Sodium Nitrate..... NaNO ₃	0.5
Manganese.. Mn	0.0	Sodium Chloride..... NaCl	107.2
Turbidity.....	5	Sodium Sulfate..... Na ₂ SO ₄	55.6
Silica..... SiO ₂	10.0	Ammonium Sulfate..... (NH ₄) ₂ SO ₄	1.1
Calcium.... Ca	104.3	Magnesium Sulfate.... MgSO ₄	143.1
Magnesium.. Mg	42.9	Magnesium Carbonate.. MgCO ₃	48.6
Ammonium.. NH ₄	0.3	Calcium Carbonate.... CaCO ₃	260.6
Sodium..... Na	60.3	Silica..... SiO ₂	10.0
Sulfate..... SO ₄	152.7	Iron Oxide..... Fe ₂ O ₃	0.6
Nitrate..... NO ₃	0.4	Manganese Oxide..... MnO	0.0
Chloride.... Cl	65.0		
Alkalinity (as CaCO ₃)		Total.....	627.3
Phenolphthalein..	0.0		
Methyl Orange...	318.0		
Residue.....	668.0		
Total hardness....	436.0		36.68

The well was equipped, in 1929, with a Peerless deep-well turbine pump. In 1935 the bowls were lowered 20 feet and in 1938 the assembly consisted of 320 feet of 8-inch column pipe, 16 stages of 12-inch bowls having an over-all length of 10 feet, and 30 feet of 8-inch suction pipe. The small air pipe for determining water levels terminated at the top of the bowl assembly at a depth of 320 feet. In 1935 water level, when not pumping, was reported at a depth of 207 feet and the drawdown was 90 feet when pumping at a rate of 375 gallons per minute. In 1940 the distance to water when not pumping was reported as 220 feet below the pumping station floor.

In 1940 the water from well number 2 had a residue of 537, a total hardness of 272 and an iron content of 0.1 parts per million as shown by the analysis of sample number 89524, collected December 16, 1940. In October 1941 the temperature of the water was 57° F.

Analysis of Sample Number 89524 from Lockport Well Number 2.

Determinations Made.		Hypothetical Combinations.	
	Pts. per million.		Pts. per million. Grs. per gallon.
Turbidity.....	0	Sodium Nitrate..... NaNO ₃	7.7 0.45
Color.....	0	Sodium Chloride..... NaCl	132.2 7.71
Odor.....	0	Sodium Sulfate..... Na ₂ SO ₄	115.8 6.75
Iron..... Fe		Ammonium Sulfate..... (NH ₄) ₂ SO ₄	2.6 0.15
(filtered).....	0.1	Magnesium Sulfate..... MgSO ₄	2.4 0.14
(unfiltered).....	0.1	Magnesium Carbonate.. MgCO ₃	72.0 4.20
Manganese.. Mn	0.0	Calcium Carbonate.... CaCO ₃	184.5 10.76
Silica..... SiO ₂	11.5	Silica..... SiO ₂	11.5 0.67
Calcium.... Ca	73.8		
Magnesium.. Mg	21.3	Total.....	528.7 30.83
Ammonium.. NH ₄	0.6		
Sodium..... Na	91.5		
Sulfate..... SO ₄	82.1		
Nitrate..... NO ₃	5.8		
Chloride.... Cl	80.0		
Alkalinity (as CaCO ₃)			
Phenolphthalein..	0.0		
Methyl Orange...	270.0		
Residue.....	537.0		
Total hardness.....	272.0		

WELL NUMBER 3 (4). Well number 3 was completed for the city in 1940 by S. B. Geiger and Company of Chicago, Illinois, at a site on block 109 at 14th Street and Division Street, approximately 2500 feet east and 50 feet north of the southwest corner of Section 23, T. 36 N., R. 10 E., to a depth of 1571 feet below a ground surface elevation above sea level of 661.5 feet. It is cased with 14-inch O. D. pipe from the surface to a depth of 442 feet, with 10-inch pipe between depths of 1111 feet and 1290 feet, and with 8-inch pipe between depths of 1284 feet and 1364 feet.

A log of the formations penetrated, furnished by the State Geological Survey, is as follows:

Formations.	Thickness in feet.	Depth in feet.
PLEISTOCENE SYSTEM		
Glacial drift.....	.60	60
SILURIAN SYSTEM		
Niagaran and Alexandrian dolomites.....	.190	250

Formations.	Thickness in feet.	Depth in feet.
ORDOVICIAN SYSTEM		
Maquoketa formation		
Shale and dolomite.....	85	335
Shale.....	80	415
Galena-Platteville dolomites.....	323	738
St. Peter sandstone, water-bearing.....	382	1120
CAMBRIAN SYSTEM		
Trempealeau dolomite.....	170	1290
Franconia sandstone and shale.....	115	1405
Galesville (Dresbach) sandstone, water-bearing..	164	1569
Eau Claire dolomite.....	2	1571

The well is equipped with a 10-inch Peerless deep-well turbine pump consisting of 500 feet of 7-inch column pipe, 14 bowls having an over-all length of 9 feet, and 20 feet of 6-inch suction pipe. The pump is directly connected to a 75-horsepower U. S. Electric Company electric motor and operates at a speed of 1750 revolutions per minute. A small pipe for measuring water levels was installed with its lower end at a depth of 500 feet below the pump base. The pump is rated at 325 gallons per minute against a head of 560 feet at 1760 revolutions per minute.

The well delivered at the end of 24 hours at the rate of 340 gallons per minute with a drawdown of 127 feet below a static water level of 322 feet and at a rate of 450 gallons per minute with a drawdown of 177 feet at the end of 24 hours pumping. The temperature of the water was 59° F. No effect on water level in well number 2, which is approximately 2500 feet away, was observed.

The water had a residue of 487 and a total hardness of 219.5 parts per million without iron as shown, by analysis of sample number 89776, collected at the end of 96 hours pumping on January 28, 1941.

Analysis of Sample Number 89776 from Lockport Well Number 3.

Determinations Made.		Hypothetical Combinations.		
	Pts. per million.		Pts. per million.	Grs. per gallon.
Turbidity.....	trace	Sodium Nitrate..... NaNO ₃	0.9	0.05
Color.....	0	Sodium Chloride..... NaCl	56.1	3.27
Odor.....	0	Sodium Sulfate..... Na ₂ SO ₄	132.8	7.74
Iron..... Fe		Sodium Carbonate..... Na ₂ CO ₃	66.3	3.86
(filtered).....	0.0	Ammonium Carbonate..... (NH ₄) ₂ CO ₃	1.9	0.11
(unfiltered).....	0.3	Magnesium Carbonate..... MgCO ₃	59.1	3.45
Manganese.. Mn	0.0	Calcium Carbonate.... CaCO ₃	149.6	8.72
Silica..... SiO ₂	10.5	Silica..... SiO ₂	10.5	0.61
Calcium.... Ca	59.8			
Magnesium.. Mg	17.0	Total.....	477.2	27.81
Ammonium.. NH ₄	0.8			
Sodium..... Na	94.1			
Sulfate..... SO ₄	90.1			
Nitrate..... NO ₃	0.9			
Chloride.... Cl	34.0			
Alkalinity (as CaCO ₃)				
Phenolphthalein..	0.0			
Methyl Orange...	284.0			
Hardness (as CaCO ₃)	219.5			
Residue.....	487.0			

NORTHERN ILLINOIS CEREAL COMPANY (3). The plant of the Northern Illinois Cereal Company is located at Commerce and Tenth Streets, Lockport.

A 6-inch well was drilled about 1880 to a reported depth of 875 feet below a ground surface elevation above, sea level of 583 feet at a site 120 feet south of the center line of Tenth Street and 60 feet west of the center line of Commerce Street, or 2200 feet north and 1350 feet east of the southwest corner of Section 23, T. 36 N., R. 10 E.

The well was cased with 6-inch pipe to rock which was reported as found at a depth of about 50 feet.

The well was originally equipped with an air-lift pump with the bottom of the air pipe at a depth of 200 feet. In 1922 it was reported that the static water level was 16 feet below the ground surface and that when in operation the water level was lowered far enough to permit free air to escape.

The well was equipped in October 10, 1940 with a 4-inch Pomona deep-well turbine pump consisting of 255 feet of 3-inch column pipe and a 17-stage bowl section having an over-all length of 8 feet, and 20 feet of 3-inch suction pipe. The pump is directly connected to a 7.5-horsepower Westinghouse Electric Company electric motor which operates at a full-load speed of 3440 revolutions per minute. This pumping unit is rated at 50 gallons per minute against a head of 300 feet.

The well is also equipped with a 1/8-inch copper air pipe for determining water levels, the bottom end of which extends to a depth of 255 feet below the pump base.

The water had a residue of 778, a total hardness of 554, and an iron content of 0.1 parts per million as shown by the analysis of sample number 91733, collected October 24, 1941. The water temperature was 59° F. and the pH 7.0 on this date.

Analysis of Sample Number 91733 from 875-Foot Well.

Determinations Made.		Hypothetical Combinations.	
	Pts. per million.		Pts. per million. Gra. per gallon.
Turbidity.....	trace	Sodium Nitrate.....NaNO ₃	8.5 0.49
Color.....	0	Sodium Chloride.....NaCl	123.9 7.22
Odor.....	0	Sodium Sulfate.....Na ₂ SO ₄	37.6 2.19
Iron.....Fe		Magnesium Sulfate....MgSO ₄	207.7 12.11
(filtered at well)...	0.1	Magnesium Carbonate..MgCO ₃	59.4 3.46
(unfiltered).....	0.1	Calcium Carbonate....CaCO ₃	311.7 18.17
Manganese..Mn	0.0	Silica.....SiO ₂	12.5 0.73
Silica.....SiO ₂	12.5		
Calcium....Ca	124.6	Total.....	761.3 44.37
Magnesium..Mg	59.1		
Ammonium..NH ₄	trace		
Sodium....Na	63.4		
Sulfate....SO ₄	191.0		
Nitrate....NO ₃	6.0		
Chloride....Cl	75.0		
Alkalinity (as CaCO ₃)			
Phenolphthalein..	0.0		
Methyl Orange...	382.0		
Residue.....	778.0		
Hardness (as CaCO ₃)	554.0		
pH = 7.0			
Free CO ₂ (calc.)....	71.0		

SANITARY DISTRICT OF CHICAGO POWER PLANT (11).

A well for the power plant of the Sanitary District of Chicago was completed in 1935 by C. W. Varner of Dubuque, Iowa, at a site 8 feet west of the west end of the Lockport Hydroelectric Power Station of the Sanitary District of Chicago or about 800 feet east and 800 feet north of the southwest corner of Section 27, T. 36 N., R. 10 E. It was finished at a depth of 852 feet below a pump base elevation of 547.5 feet above sea level.

The well was drilled 8 inches in diameter to a depth of 377 feet, and 5½ inches in diameter for the remaining 475 feet. It was cased with 377 feet of 6-inch extra heavy wrought iron pipe secured in place with cement grout in the annular space outside the casing.

A log of the formations penetrated, furnished by the State Geological Survey, is as follows:

Formations.	Thickness in feet.	Depth in feet.
SILURIAN SYSTEM		
Niagaran-Alexandrian dolomites, water-bearing.	220	220
ORDOVICIAN SYSTEM		
Maquoketa formation		
Shale and dolomite	60	280
Shale	60	340
Galena-Platteville limestone and dolomites	320	660
Glenwood sandstone and dolomite	50	710
St. Peter sandstone, water-bearing	142	852

The well is equipped with a 4-inch A. D. Cook deep-well turbine pump consisting of 210 feet of 3-inch column pipe, a 13-stage bowl section having an over-all length of 6 feet, and 14 feet of 3¼-inch O. D. suction pipe. The pump is directly connected to a U. S. Electric Company electric motor and on test a production of 60 gallons per minute was obtained with a drawdown of 11 feet below a non-pumping level

Analysis of Sample Number 86429 from 852-Foot Well.

Determinations Made.		Hypothetical Combinations.		
	Pts. per million.		Pts. per million.	Gras. per gallon.
Iron..... Fe		Sodium Nitrate..... NaNO ₃	1.7	0.10
(filtered).....	0.0	Sodium Chloride..... NaCl	52.5	3.06
(unfiltered).....	2.1	Sodium Sulfate..... Na ₂ SO ₄	139.2	8.13
Manganese.. Mn	0.0	Sodium Carbonate..... Na ₂ CO ₃	70.5	4.11
Silica..... SiO ₂	9.5	Ammonium Carbonate.. (NH ₄) ₂ CO ₃	2.4	0.14
Turbidity.....	12.0	Magnesium Carbonate.. MgCO ₃	64.9	3.78
Color.....	0.0	Calcium Carbonate.... CaCO ₃	124.0	7.23
Odor.....	0.0	Silica..... SiO ₂	9.5	0.55
Magnesium.. Mg	18.8			
Calcium.... Ca	49.5	Total.....	464.7	27.10
Ammonium.. NH ₄	0.8			
Sodium..... Na	96.9			
Sulfate..... SO ₄	94.2			
Nitrate..... NO ₃	0.9			
Chloride.... Cl	32.0			
Alkalinity (as CaCO ₃)				
Phenolphthalein..	0.0			
Methyl Orange...	270.0			
Residue.....	465.0			
Total hardness.....	201.0			

of 185 feet. The pump operates at a speed of 3450 revolutions per minute.

The water had a residue of 465, a total hardness of 201, and an iron content of 2.1 parts per million as shown by the analysis of sample number 86429, collected September 28, 1939.

UNITED STATES WAR DEPARTMENT. LOCKPORT LOCK AND DAM (10). A lock and dam of the United States War Department are located on the Chicago Drainage Canal south of Lockport, Illinois. Water is obtained from a well in the basement of the Administration Building located approximately 1000 feet north and 1700 feet east of the southwest corner of Section 27, T. 36 N., R. 10 E. The well was drilled in 1932 by William Cater of Chicago, Illinois, to a depth of 815 feet below a ground surface elevation of 585 feet above sea level.

The well is reported to be cased with 8-inch pipe from the surface to a depth of 43 feet and with 6-inch pipe from the surface to a depth of 417½ feet.

The driller's log of material penetrated is as follows:

Formation's.	Thickness in feet.	Depth in feet.
Pill	43	43
Dolomite	232	275
Shale	78	353
Dolomite	328	681
Sandstone	134	815

The well is equipped with a Fairbanks-Morse deep-well pump with the cylinder attached to 297 feet of drop pipe. The pump delivers about 7 gallons per minute and is driven by a 3-horsepower electric motor.

It is reported that in 1933 the static water level was at a depth of

Analysis of Sample Number 86430 from Well 815 Feet Deep.

Determinations Made.		Hypothetical Combinations.	
	Pts. per million.		Pts. per million.
Iron Fe		Sodium Nitrate NaNO ₃	1.7
(filtered)	0.1	Sodium Chloride NaCl	56.0
(unfiltered)	3.0	Sodium Sulfate Na ₂ SO ₄	137.0
Manganese Mn	0.0	Sodium Carbonate Na ₂ CO ₃	73.2
Silica SiO ₂	8.0	Magnesium Carbonate MgCO ₃	82.5
Turbidity	18.0	Calcium Carbonate CaCO ₃	107.0
Color	0.0	Silica SiO ₂	8.0
Odor	0.0		
Calcium Ca	42.7	Total	465.4
Magnesium Mg	23.8		27.16
Ammonium NH ₄	0.7		
Sodium Na	99.0		
Sulfate SO ₄	92.6		
Nitrate NO ₃	1.0		
Chloride Cl	34.0		
Alkalinity (as CaCO ₃)			
Phenolphthalein	0.0		
Methyl Orange	274.0		
Residue	468.0		
Total hardness	205.0		
pH = 7.3			
Free CO ₂ (calc.)	16.0		

237 feet and the pumping level at a depth of 290 feet when pumping at an unknown rate.

The water had a residue of 468, a total hardness of 205, and an iron content of 3.0 parts per million as shown by the analysis of sample number 86430, collected October 2, 1939.

MINOOKA

MINOOKA VILLAGE WELLS. Minooka is located in the north-eastern part of Grundy County four miles north of Illinois River. A public water supply was installed by the village in 1886.

WELL NUMBER 1 (65). Water was obtained from a well located 35 feet south of the center line of Mondamon Street and 250 feet west of the center line of Wabena Street, or 250 feet west of the center of Section 1, T. 34 N., R. 8 E. The well was drilled in 1886 to a depth of 2100 feet below a ground surface elevation of 610 feet above sea level. When completed the flow at the ground surface was 100 gallons per minute and the pressure with no flow was equal to a 90-foot head. Water flowed into the mains without pumping. In 1919 the free flow had decreased to 32 gallons per minute 4½ feet above the ground surface and in 1938 to about 4 gallons per minute. In 1941 the flow stopped entirely.

In 1938 the temperature of the water was 62½° F. The water had a mineral content of 1802, a total hardness of 302, and an iron content of 0.3 parts per million as shown by the analysis of sample number 31633, collected September 25, 1915.

Analysis of Sample Number 31633 from 2100-Foot Well.

Determinations Made.		Hypothetical Combinations.		
	Pts. per million.		Grs. per gallon.	
Iron.....Fe	0.3	Potassium Chloride.....KCl	56.4	3.29
Manganese..Mn	0.0	Sodium Chloride.....NaCl	1421.2	82.90
Silica.....SiO ₂	10.4	Ammonium Chloride....NH ₄ Cl	1.2	0.07
Nonvolatile.....	4.0	Magnesium Chloride....MgCl	28.5	1.66
Alumina....Al ₂ O ₃	trace	Magnesium Sulfate....MgSO ₄	51.7	3.00
Calcium....Ca	88.6	Magnesium Carbonate..MgCO ₃	7.6	0.44
Magnesium..Mg	19.9	Calcium Carbonate....CaCO ₃	221.1	12.89
Ammonium..NH ₄	0.41	Iron Carbonate.....FeCO ₃	0.6	0.03
Potassium...K	29.6	Alumina.....Al ₂ O ₃	trace	trace
Sodium.....Na	560.0	Silica.....SiO ₂	10.4	0.61
Sulfate.....SO ₄	41.3	Nonvolatile.....	4.0	0.23
Chloride....Cl	910.0			
		Total.....	1802.7	105.12

WELL NUMBER 2 (64). Since 1906 water for the public supply has been obtained from a well located 200 feet north of the center line of Mondamon Street and 100 feet west of the center line of Wabena Street or about 250 feet north and 100 feet west of the center of Section 1, T. 34 N., R. 8 E. The well was drilled in 1906 by John Mathews of Joliet, Illinois, to a depth of 621 feet below a ground surface elevation of 612 feet above sea level. It is thought to be cased with 12-inch pipe to a depth of 124 feet and to be 10 inches in diameter to a depth of 265

feet, 8 inches in diameter to a depth of 368 feet, and 6 inches in diameter to a depth of 621 feet.

An incomplete record of material penetrated shows 124 feet of glacial drift followed by 71 feet of soapstone, with the well being finished in the St. Peter sandstone.

Because of the receding water level and decreased production the well was shot between depths of 497 and 594 feet with 150 quarts of nitroglycerine and cleaned by W. J. Neely of Batavia, Illinois in 1941. A record of the ensuing change in production is not available.

The well is equipped with an American 2-stroke deep-well cylinder pump, the assembly of which consists of 167 feet of 5-inch drop pipe, a cylinder having an 18-inch stroke and $4\frac{3}{4}$ inches inside diameter, and 30 feet of 5-inch suction pipe. The pump operates at a speed of $25\frac{1}{2}$ revolutions per minute and is driven by a 10-horsepower electric motor.

The depth to water when not pumping was reported to be 60 feet in 1913, 75 feet in 1917, 78 feet in 1919, 84 feet in 1923, 92 feet in 1938, 106 feet in April 1941, and 95 feet in July 1941. In 1938 the drawdown was 29 feet when pumping at an average rate of about 80 gallons per minute.

The temperature of the water is about 54° F. The water had a residue of 731, a total hardness of 169, and an iron content of 0.4 parts per million as shown by the analysis of sample number 53083, collected January 16, 1925. The odor of hydrogen sulfide is noticeable at the well.

Analysis of Sample Number 53083 from 621-Foot Well.

Determinations Made.		Hypothetical Combinations.	
	Pts. per million.		Pts. per million. Grs. per gallon.
Iron.....Fe	0.4	Potassium Nitrate.....KNO ₃	0.9 0.05
Manganese...Mn	0.0	Potassium Chloride....KCl	54.1 3.17
Silica.....SiO ₂	9.8	Sodium Chloride.....NaCl	397.7 23.26
Nonvolatile.....	0.2	Sodium Sulfate.....Na ₂ SO ₄	30.6 1.79
Alumina....Al ₂ O ₃	4.0	Sodium Carbonate.....Na ₂ CO ₃	92.8 5.43
Calcium....Ca	41.3	Ammonium Carbonate..(NH ₄) ₂ CO ₃	4.1 0.24
Magnesium..Mg	16.0	Magnesium Carbonate..MgCO ₃	55.5 3.24
Ammonium..NH ₄	1.5	Calcium Carbonate....CaCO ₃	103.1 6.03
Sodium....Na	206.8	Iron Oxide.....Fe ₂ O ₃	0.6 0.04
Potassium...K	28.7	Alumina.....Al ₂ O ₃	4.0 0.24
Sulfate....SO ₄	20.6	Silica.....SiO ₂	9.8 0.57
Nitrate....NO ₃	0.5	Nonvolatile.....	0.2 0.01
Chloride....Cl	267.0		
Alkalinity (as CaCO ₃)		Total.....	753.4 44.07
Phenolphthalein..	0.0		
Methyl Orange...	252.0		
Residue.....	731.0		
Total hardness.....	169.0		

MORRIS

MORRIS CITY WELLS. WELL NUMBER 1 (90). The public water supply of Morris, Illinois was installed in 1894 when a 6-inch well, number 1, was drilled into the St. Peter sandstone to a depth of 650 feet below a ground surface elevation above sea level of 522 feet, at a site 115 feet west of the center line of Wauponsee Street and 150 feet south of the center line of Main Street or 1030 feet west and 200 feet north

of the southeast corner of Section 4, T. 33 N., R. 7 E. The 6-inch casing is reported to extend to rock at an approximate depth of 40 feet.

When first completed water rose to above the ground level but in 1906 the water level when not pumping was reported as 35 feet below the ground surface, in 1913 as 59 feet and in 1927 as 90 feet.

The first equipment installed was an air-lift pump in which the 6-inch casing was used as the eductor pipe. A test was made in 1914 at which time a yield of 140 gallons per minute or 200,000 gallons per day was obtained. Several years later the air-lift pump was replaced by a two-stroke deep-well cylinder pump with 200 feet of drop pipe which operated with an 18-inch stroke at a speed of 29 to 30 revolutions per minute. In 1927 it was reported this pump discharged at a rate of 110 gallons per minute but was not operated regularly. The well has not been used since 1939.

WELL NUMBER 2 (91). In about 1902 a second well, number 2, was drilled by A. K. Wallen of Morris, Illinois, through the St. Peter sandstone to a depth of 728 feet below a ground surface elevation above sea level of 522 feet at a site 155 feet west of the center line of Wauponsee Street and 150 feet south of the center line of Main Street, or 1070 feet west and 200 feet north of the southeast corner of Section 4, T. 33 N., R. 7 E. The 10-inch casing was reported to extend from the surface to rock at an approximate depth of 40 feet. A 10-inch open bore extends to the bottom. Records are not available regarding water levels when this well was completed but in 1906 the water level when not pumping was reported as 35 feet below ground surface and in 1913 as 59 feet.

The first equipment installed was an air-lift pump but this was removed in 1911 and replaced by an electric motor-powered Keystone Driller deep-well cylinder pump, the cylinder being placed at the end of 225 feet of drop pipe. With this equipment the yield was at a rate of 190 gallons per minute or 275,000 gallons per day. In 1922 this well was operated with an air-lift pump and a delivery of 325 gallons per minute was obtained. When wells numbered 1 and 2 were operated together the combined discharge was 428 gallons per minute.

Analysis of Sample Number 58503 from Well Number 2 at Morris.

Determinations Made.		Hypothetical Combinations.	
	Pts. per million.		Pts. per million. Grs. per gallon.
Iron.....Fe	0.0	Sodium Nitrate.....NaNO ₃	1.1 0.06
Manganese..Mn	0.0	Sodium Chloride.....NaCl	56.1 3.28
Silica.....SiO ₂	8.0	Sodium Sulfate.....Na ₂ SO ₄	90.7 5.30
Calcium.....Ca	62.2	Sodium Carbonate.....Na ₂ CO ₃	8.6 0.50
Magnesium..Mg	32.2	Ammonium Carbonate..(NH ₄) ₂ CO ₃	0.2 0.01
Ammonium..NH ₄	0.1	Magnesium Carbonate..MgCO ₃	111.7 6.53
Sodium.....Na	55.4	Calcium Carbonate....CaCO ₃	155.2 9.08
Sulfate.....SO ₄	61.3	Silica.....SiO ₂	8.0 0.47
Nitrate.....NO ₃	0.8	Iron Oxide.....Fe ₂ O ₃	0.0 0.00
Chloride....Cl	34.0	Manganese Oxide.....MnO	0.0 0.00
Alkalinity (as CaCO ₃)			
Phenolphthalein..	0.0	Total.....	431.6 25.23
Methyl Orange...	296.0		
Residue.....	440.0		
Total hardness.....	288.0		

Well number 2 has not been used since 1938. The water from well number 2 had a residue of 440 and a hardness of 288 parts per million with no iron as shown by the analysis of sample number 58503, collected March 2, 1927.

WELL NUMBER 3 (92). In 1915 a third well, number 3, was drilled by Wm. Cater of Chicago, Illinois, into the St. Peter sandstone, to a reported depth of 720 feet below a ground surface elevation of 522 feet above sea level, at a site 130 feet west of the center line of Wauponsee Street and 55 feet south of the center line of Main Street or 1045 feet west and 295 feet north of the southeast corner of Section 4, T. 33 N., R. 7 E.

A log of the materials penetrated, furnished by the State Geological Survey, is as follows:

Formations.	Thickness in feet.	Depth in feet.
PLEISTOCENE SYSTEM		
Glacial till	50	50
PENNSYLVANIAN SYSTEM		
Shale, coal, some sandstone.	89	139
ORDOVICIAN SYSTEM		
Galena-Platteville limestone and dolomites.	191	330
Glenwood dolomite, sandy.	5	335
St. Peter sandstone, water-bearing.	385	720

The well was cased with 20-inch O. D. pipe to rock and with 16-inch O. D. pipe to the St. Peter sandstone. It was equipped with an American 15-inch deep-well turbine pump consisting of 190 feet of column pipe, a 6-stage bowl section and 40 feet of suction pipe. This unit was directly connected to a 37½-horsepower electric motor and in 1922 discharged 400 gallons per minute with a drawdown of 71 feet below a non-pumping level of 94 feet.

In 1925 the pump was lowered by adding 73 feet of column, also additional stages were added to make a bowl section 12 feet long. A 20-foot length of suction pipe completed the assembly. A small air pipe for determining water levels was installed with its bottom at a depth of 263 feet.

A report dated January 24, 1927 gave the following data on water levels in well number 3.

Year	Depth below pump base		Discharge rate g.p.m.
	Non-pumping	Pumping	
1915. . . . .	.60	160	400
1922 . . . . .	.94	.....	.....
1924. . . . .	.105	265	400
1927. . . . .	.133	295	200

The well was deepened and shot by the Layne Western Company of Chicago, Illinois in 1940-41. It had filled to a depth of 702½ feet and was cleaned out to the actual original depth of 725 feet. Then a production test was made on December 14, 1940 which showed a static level of 8 feet and a drawdown of 165 feet when pumping 170 gallons per minute. The well was then deepened 15 inches in diameter to a depth of 779 feet and 12 inches in diameter to a depth of 865 feet. A 12-inch perforated liner was set between depths of 734 and 779 feet, and the well was shot in the St. Peter sandstone section.

The material penetrated between depths of 725 and 865 feet was described by the driller as sandstone, limestone, and shale.

After the repair work was completed the water level was at a reported depth of 8 feet when not pumping and was lowered 161 feet by pumping at the rate of 600 gallons per minute. On December 4, 1941 the static level was at a depth of 96 feet after the pump had not operated for a few hours.

The well is now equipped with a 12-inch Layne turbine pump consisting of 200 feet of 8-inch column pipe, a 3-stage bowl assembly 4 feet long, and 30 feet of 8-inch suction pipe. The pump is driven by a 50-horsepower, direct-connected electric motor. A small air pipe for determining water levels terminates at a reported depth of 234 feet below the pump base.

The temperature of the water was 56° F.

The water from well number 3 had a residue of 380 and a hardness of 310 parts per million without iron as shown by the analysis of sample number 58500, collected March 1, 1927.

Analysis of Sample Number 58500 from Well Number 3 at Morris.

Determinations Made.		Hypothetical Combinations.	
	Pts. per million.		Pts. per million. Grs. per gallon.
Iron.....Fe	0.0	Sodium Nitrate.....NaNO ₃	0.5 0.03
Manganese...Mn	0.0	Sodium Chloride.....NaCl	33.0 1.93
Silica.....SiO ₂	10.0	Sodium Sulfate.....Na ₂ SO ₄	62.7 3.67
Calcium.....Ca	66.5	Ammonium Sulfate....(NH ₄) ₂ SO ₄	0.2 0.01
Magnesium...Mg	35.1	Magnesium Sulfate....MgSO ₄	2.3 0.14
Ammonium...NH ₄	0.05	Magnesium Carbonate..MgCO ₃	119.9 7.01
Sodium.....Na	33.4	Calcium Carbonate....CaCO ₃	166.0 9.71
Sulfate.....SO ₄	44.4	Silica.....SiO ₂	10.0 0.58
Nitrate.....NO ₃	0.4	Iron Oxide.....Fe ₂ O ₃	0.0 0.00
Chloride.....Cl	20.0	Manganese Oxide.....MnO	0.0 0.00
Alkalinity (as CaCO ₃)			
Phenolphthalein..	0.0	Total.....	394.6 23.08
Methyl Orange...	308.0		
Residue.....	380.0		
Total hardness.....	310.0		

WELL NUMBER 4 (93). Number 4 well was completed in 1938 by Milaeger and Smyth to a depth of 1501 feet below a ground surface elevation above sea level of 518 feet at a site 55 feet south of the center line of AVashington Street and 65 feet east of the center line of Nettle Street or 1800 feet west and 55 feet south of the northeast corner of Section 9, T. 33 N., R. 7 E.

A log of the material penetrated, furnished by the State Geological Survey, is as follows:

Formations.	Thickness in feet.	Depth in feet.
PLEISTOCENE SYSTEM		
Glacial till.....	50	50
PENNSYLVANIAN SYSTEM		
Shale, some sandstone at base.....	85	135
ORDOVICIAN SYSTEM		
Galena-Platteville limestone and dolomite.....	180	315
Glenwood dolomite and sandstone.....	10	325
St. Peter sandstone, water-bearing.....	578	903
Oneota chert.....	12	915

Formations.	Thickness in feet.	Depth in feet.
CAMBRIAN SYSTEM		
Jordan sandstone and dolomite.	55	970
Trempealeau dolomite.	150	1120
Pranconia dolomite and sandstone.	145	1265
Galesville (Dresbach) sandstone, water-bearing.	190	1455
Eau Claire shale.	46	1501

This well is cased with 19-inch O. D. pipe from the surface to a depth of 90 feet and with 16-inch O. D. pipe from the surface to a depth of 915 feet. Below the 16-inch casing the diameter of the open bore hole is 15 inches.

The well was equipped with a Layne 12-inch deep-well turbine pump consisting of 80 feet of 8-inch column, a 5-stage bowl section having an over-all length of 5 feet, and 30 feet of 8-inch suction pipe. The pump is driven by a 50-horsepower electric motor and is rated at 700 gallons per minute against a head of 104 feet at a speed of 1750 revolutions per minute. A small air pipe for determining water levels was installed with its bottom at a depth of 110 feet below the pump base. On test the well produced at a rate of 450 gallons per minute with a drawdown of 90 feet below a static water level of 16 feet.

The water had a residue of 426, a total hardness of 282, and a content of iron of 0.1 parts per million as shown by the analysis of sample number 84153, collected August 25, 1938.

Analysis of Sample Number 84153 from Well Number 4 at Morris.

Determinations Made.		Hypothetical Combinations.		
	Pts. per million.		Pts. per million.	Grs. per gallon.
Iron. Fe		Sodium Chloride. NaCl	62.5	3.64
(filtered).	trace	Sodium Sulfate. Na ₂ SO ₄	47.6	2.78
(unfiltered).	0.1	Sodium Carbonate. Na ₂ CO ₃	15.9	0.93
Manganese. Mn	0.0	Ammonium Carbonate. (NH ₄) ₂ CO ₃	2.9	0.17
Silica. SiO ₂	11.0	Magnesium Carbonate. MgCO ₃	98.0	5.71
Turbidity.	5.0	Calcium Carbonate. CaCO ₃	166.0	9.68
Color.	0.0	Silica. SiO ₂	11.0	0.64
Odor.	Ch-2			
Calcium. Ca	66.5	Total.	403.9	23.55
Magnesium. Mg	28.2			
Ammonium. NH ₄	1.0			
Sodium. Na	47.0			
Sulfate. SO ₄	32.3			
Nitrate. NO ₃	trace			
Chloride. Cl	38.0			
Alkalinity (as CaCO ₃)				
Phenolphthalein.	0.0			
Methyl Orange.	300.0			
Residue.	426.0			
Total hardness.	282.0			

GEBHARD BREWERY (94). A well was drilled for the Gebhard Brewery, at Morris, Illinois, in about 1919 by S. B. Geiger of Chicago to a depth of 632 feet below a ground surface elevation of 504 feet above sea level at a site 50 feet north of the center line of Washington Street and 575 feet west of the center line of Nettle Street or 20 feet north and 2460 feet west of the southeast corner of Section 4, T. 33 N., R. 7 E.

The well penetrates the St. Peter sandstone and is reported to be cased with 12-inch pipe to rock at a depth of about 50 feet. The well was finished as a 12-inch hole.

The most recent occupant of the property was the Morris Milling Company, but the property has not been operated since 1939.

The well has not been used for some years except when it furnished the water supply for the C. C. C. Camp. It was reported that when work was being done on the city well number 3 in 1939 and 1940 the well overflowed at an elevation above sea level of 505 feet.

ILLINOIS CLAY PRODUCTS COMPANY (89). The plant of the Illinois Clay Products Company is located in Grundy County about 7½ miles east of Morris. Water is obtained from a well located approximately 440 feet south and 1700 feet east of the northwest corner of Section 11, T. 33 N., R. 8 E.

The well was drilled in 1924 by the Sewell Well Company of St. Louis, Missouri, to a depth of 502 feet below a ground surface elevation of 507 feet above sea level. It is reported to be cased with 6-inch pipe from the surface to a depth of 161 feet and with 4½-inch pipe from the surface to a depth of 448½ feet.

The well is equipped with a 4-inch Fairbanks-Morse turbine pump consisting of 50 feet of 3-inch column pipe, a 6-stage bowl assembly 3 feet long, and 10 feet of 3-inch suction pipe. The pump is driven by a 3-horsepower direct-connected electric motor and is rated at 70 gallons per minute against a head of 88 feet at a speed of 3450 revolutions per minute.

For several years after the completion of the well the non-pumping level was above the ground surface but in 1941 it was reported to be 10 feet below the surface.

Analysis of Sample Number 91737 from Well 502 Feet Deep.

Determinations Made.		Hypothetical Combinations.	
	Pts. per million.		Pts. per million. Grs. per gallon.
Turbidity.....	10	Sodium Nitrate..... NaNO ₃	2.6 0.15
Color.....	0	Sodium Chloride..... NaCl	149.0 8.69
Odor.....	0	Sodium Sulfate..... Na ₂ SO ₄	224.0 13.06
Iron..... Fe		Sodium Carbonate..... Na ₂ CO ₃	31.3 1.82
(filtered).....	0.1	Ammonium Carbonate..... (NH ₄) ₂ CO ₃	0.5 0.03
(unfiltered).....	0.8	Magnesium Carbonate..... MgCO ₃	88.2 5.14
Manganese..... Mn...	0.0	Calcium Carbonate..... CaCO ₃	135.6 7.91
Silica..... SiO ₂	12.0	Silica..... SiO ₂	12.0 0.70
Calcium..... Ca	54.2		
Magnesium..... Mg	25.4	Total.....	643.2 37.40
Ammonium..... NH ₄	0.2		
Sodium..... Na	145.5		
Sulfate..... SO ₄	151.0		
Nitrate..... NO ₃	1.7		
Chloride..... Cl	91.0		
Alkalinity (as CaCO ₃)			
Phenolphthalein...	0.0		
Methyl Orange...	270.0		
Residue.....	637.0		
Hardness (as CaCO ₃)	240.0		

The water had a residue of 637, a total hardness of 240 and an iron content of 0.8 parts per million as shown by the analysis of sample number 91737, collected October 28, 1941. The temperature of the water was 54° F.

ROCKDALE

ROCKDALE. VILLAGE WELL (54). The village of Eockdale is located in the northern part of Will County near the southwestern limits of the city of Joliet, Illinois.

Water for the public supply is obtained from a well drilled in 1914-15 by the Ohio Drilling Company of Massillon, Ohio, at a site 1200 feet east and 1000 feet south of the northwest corner, Section 20, T. 35 N., R. 10 E. The well is 10 inches in diameter at the top and 660 feet deep below a ground surface elevation of 553 feet above sea level.

A log of the materials penetrated, furnished by the State Geological Survey, is as follows:

Formations.	Thickness in feet.	Depth in feet.
PLEISTOCENE SYSTEM		
Glacial drift	5	5
SILURIAN AND ORDOVICIAN SYSTEMS		
Niagaran and Alexandrian dolomites, and Ma- quoketa formation	245	250
ORDOVICIAN SYSTEM		
Galena-Platteville dolomite	335	585
Glenwood dolomite, sandy . . . . .	.10	595
St. Peter sandstone, water-bearing . . . . .	.65	660

In 1937 an 8-inch Peerless turbine pump was installed, the assembly of which consisted of 190 feet of 5-inch column pipe, an 11-stage bowl assembly having an over-all length of 7 feet and 35 feet of 5-inch suction pipe. The pump is driven by a 20-horsepower electric motor operating

Analysis of Sample Number 83848 from Village Well.

Determinations Made.		Hypothetical Combinations.		
	Pts. per million.			
Iron. Fe		Sodium Nitrate. NaNO ₃	6.8	0.40
(filtered)	0.0	Sodium Sulfate. Na ₂ SO ₄	85.4	4.98
(unfiltered)	0.16	Magnesium Sulfate. MgSO ₄	72.9	4.25
Manganese. Mn	0.0	Magnesium Carbonate. MgCO ₃	138.6	8.08
Silica. SiO ₂	17.5	Calcium Carbonate. CaCO ₃	212.0	12.36
Turbidity	2.0	Silica. SiO ₂	17.5	1.02
Color	0.0			
Odor.	0.0	Total	533.2	31.09
Calcium. Ca	84.6			
Magnesium. Mg	54.8			
Ammonium. NH ₄	trace			
Sodium. Na	29.4			
Sulfate. SO ₄	115.4			
Nitrate. NO ₃	4.8			
Chloride. Cl	0.0			
Alkalinity (as CaCO ₃)				
Phenolphthalein.	20.0			
Methyl Orange.	376.0			
Residue.	563.0			
Total hardness.	436.5			

at 1800 revolutions per minute. In July 1938 the static water level was reported as 50 feet. The daily pumping time is about 10 hours. No record is available of the total yield of the well but the pump is rated at 150 gallons per minute when pumping against a 333-foot head. A small air pipe for determining water levels terminates at a depth of 190 feet below the pump base.

The temperature of the water is 54° F.

The water from this well had a residue of 563, a total hardness of 436.5, and an iron content of 0.16 parts per million as shown by analysis of sample number 83848, collected July 13, 1938.

AMERICAN CAN COMPANY (5.6). The plant of the American Can Company is located on Moen Avenue, Rockdale, Illinois.

Water is obtained from a well originally drilled in 1921 by S. B. Geiger and Company of Chicago, Illinois, to a depth of 1372 feet below a ground surface elevation above sea level of 559 feet, at a site 275 feet south of the center line of Moen Avenue and 150 feet west of the center line of Stryker Avenue or 1550 feet south and 150 feet west of the northeast corner of Section 19, T. 35 N., R. 10 E.

The well was reported to have been drilled 16 inches in diameter to a depth of 260 feet, 12 inches in diameter to a depth of 345 feet, 11 inches in diameter to a depth of 600 feet, 10 inches in diameter to a depth of 777 feet, and 8 inches in diameter to the bottom.

A log of material penetrated, furnished by the State Geological Survey, is as follows:

Formations.	Thickness in feet.	Depth in feet.
PLEISTOCENE SYSTEM .		
Glacial drift . . . . .	.12	12
SILURIAN SYSTEM		
Niagaran and Alexandrian dolomite. . . . .	.123	135
ORDOVICIAN SYSTEM		
Maquoketa shale and dolomite . . . . .	.110	245
Galena-Platteville dolomite. . . . .	.325	570
Glenwood shaly sandstone. . . . .	.30	600
St. Peter formation		
Sandstone, water-bearing . . . . .	.145	745
Shale, weak, caving . . . . .	.15	760
Prairie du Chien dolomite. . . . .	.240	1000
CAMBRIAN SYSTEM		
Jordan shale and dolomite. . . . .	.40	1040
Trempealeau dolomite. . . . .	.175	1215
Franconia formation		
Shale . . . . .	.5	1220
Dolomitic sandstone. . . . .	.25	1245
Sandy dolomite. . . . .	.75	1320
Dolomitic sandstone. . . . .	.30	1350
Galesville (Dresbach) sandstone (to bottom). . . . .	.22	1372

The well was cased with 10-inch pipe to a depth of 238 feet.

In 1934 the well was repaired by pulling the old casing as well as removing 160 feet of 8-inch drop pipe and pump barrel which had been lost in the well several years previously and reaming the well to a diameter of 12½ inches to a depth of 353 feet. At this depth a bridge was constructed and 12 feet of concrete poured, into which was seated 347

feet of 10-inch casing. The lower 220 feet of the casing had welded joints while the upper 127 feet had screwed joints. Ten feet of 14-inch drive pipe was placed around the 10-inch casing at the top.

Upon completion of the repair a Sterling deep-well turbine pump, number S411, was installed. The assembly of this unit consisted of 340 feet of 6-inch column pipe, an 11-stage bowl section having an outside diameter of 9½ inches and an over-all length of 61/3 feet, and 20 feet of 6-inch suction pipe. The pump was directly connected to a 50-horsepower electric motor, the operating speed of which was 1735 revolutions per minute.

When the well was completed in 1921 static or non-pumping water level was reported as 94 feet below the ground surface but in 1934 when the new pump was installed static level was reported as 171 feet. No facilities were available for measuring water levels in 1941.

On November 24, 1934 the pump delivered 11,966 gallons per hour against a head of 171 feet. This is at a rate of about 200 gallons per minute.

The water had a residue of 624, a total hardness of 381, and a content of iron of 0.1 parts per million as shown by the analysis of sample number 91471, collected September 24, 1941.

Analysis of Sample Number 91471 from Well 1372 Feet Deep.

Determinations Made.		Hypothetical Combinations.	
	Pts. per million.		
Turbidity.....	0	Sodium Nitrate..... NaNO ₃	7.7 0.45
Color.....	0	Sodium Chloride..... NaCl	44.4 2.59
Odor.....	0	Sodium Sulfate..... Na ₂ SO ₄	167.6 9.77
Iron..... Fe		Magnesium Sulfate..... MgSO ₄	58.4 3.40
(unfiltered).....	0.1	Magnesium Carbonate... MgCO ₃	87.3 5.09
(filtered).....	0.1	Calcium Carbonate..... CaCO ₃	228.7 13.33
Manganese.. Mn	0.0	Silica..... SiO ₂	12.5 0.73
Silica..... SiO ₂	12.5		
Chloride..... Cl	27.0	Total.....	606.6 35.36
Calcium..... Ca	91.4		
Magnesium.. Mg	37.0		
Ammonium.. NH ₄	trace		
Sodium..... Na	73.8		
Sulfate..... SO ₄	159.8		
Nitrate..... NO ₃	5.8		
Alkalinity (as CaCO ₃)			
Phenolphthaleim..	0.0		
Methyl Orange...	332.0		
Hardness (as CaCO ₃)	381.0		
Residue.....	624.0		

AMERICAN STEEL AND WIRE COMPANY. ROCKDALE PLANT (57). The Rockdale plant of the American Steel and Wire Company is located north of Mound Road, or Railroad Street, and about 1500 feet west of Brandon Road.

Water is obtained from a well drilled in 1919 by W. H. Gray & Bros. of Chicago, Illinois, to a depth of 950 feet below a ground surface elevation of 547 feet above sea level at a site 600 feet north of the center line of Mound Road and 1500 feet west of the center line of Brandon Road, or about 1500 feet south and 2100 feet east of the northwest corner of Section 20, T. 35 N., R. 10 E.

The well was reported by the drillers to have been cased with 12-inch pipe to the top of the bedrock and with 6-inch pipe between depths of 768 and 850 feet where sandy shale was encountered. The bore hole was drilled 10 inches in diameter from the top of the rock to a depth of 267 feet, 8 inches in diameter to a depth of 850 feet, and 6 inches in diameter to a depth of 950 feet. The owner's records show that in 1924 a 6-inch pipe was installed from the surface to a depth of 97 feet 10 inches.

The following is a log of the materials penetrated by this well taken from a blue print of a drawing of the well dated July 10, 1919 and supplied by the company.

Formations.	Thickness in feet.	Depth in feet.
Gravel . . . . .	.15	15
Limestone . . . . .	.170	185
Shale . . . . .	.82	267
Limestone . . . . .	.338	605
St. Peter sandstone . . . . .	.215	820
Sandy shale, caving . . . . .	.30	850
Limestone and shale . . . . .	.80	930
Sandy shale, caving . . . . .	.20	950

The driller's log is essentially the same except that it shows sandy shale between depths of 700 and 850 feet.

The well is equipped with an air-lift pump consisting of 474 feet of 3-inch eductor pipe and 453 feet of 1-inch air pipe. At the present time the yield of the well is about 20,000 gallons per day.

There is no convenient means of determining the depth to water levels; however in 1922 the non-pumping water level was 96 feet below the ground surface, in 1924 it was 135 feet below the surface, and in 1941 it was 210 feet below the surface.

Analysis of Sample Number 91641 from 950-Foot Well.

Determinations Made.		Hypothetical Combinations.		
	Pts. per million.		Pts. per million.	Grs. per gallon.
Turbidity	0	Sodium Nitrate NaNO ₃	6.0	0.35
Color	0	Sodium Chloride NaCl	72.5	4.22
Odor	0	Sodium Sulfate Na ₂ SO ₄	184.0	10.73
Iron Fe		Sodium Carbonate Na ₂ CO ₃	39.2	2.28
(filtered at well) . .	0.1	Magnesium Carbonate MgCO ₃	85.6	4.99
(unfiltered)	0.1	Calcium Carbonate CaCO ₃	137.6	8.02
Manganese . . Mn	0.1	Silica SiO ₂	10.0	0.58
Silica SiO ₂	10.0			
Calcium Ca	54.9	Total	534.9	31.17
Magnesium . . Mg	24.7			
Ammonium . . NH ₄	trace			
Sodium Na	106.7			
Sulfate SO ₄	124.2			
Nitrate NO ₃	4.6			
Chloride Cl	44.0			
Alkalinity (as CaCO ₃)				
Phenolphthalein . .	0.0			
Methyl Orange . . .	276.0			
Residue	536.0			
Hardness (as CaCO ₃)	239.0			
pH = 7.8				
Free CO ₂ (calc.) . . .	8.0			

The water had a residue of 536, a total hardness of 239 and a content of iron of 0.1 parts per million as shown by the analysis of sample number 91641, collected October 25, 1941. A water temperature of 55° F. and a pH of 7.8 was observed on this date.

JOYCE 7-UP BOTTLING COMPANY (52). The plant of the Joyce 7-Up Bottling Company is located southwest of the city of Joliet, Illinois in Troy Township. It is about three-fourths of a mile south of U. S. Highway No. 52 on the east side of the Elgin, Joliet and Eastern Railway Company right-of-way.

Water is obtained from an 8-inch well drilled in 1940 by Peter W. Dittmyer of Joliet, Illinois, to a depth of 724 feet below a ground surface elevation above sea level of 627 feet, at a site approximately 1200 feet north and 150 feet west of the southeast corner of Section 13, T. 35 N., R. 9 E.

The well is cased with 8-inch pipe to a depth of 61 feet and is an 8-inch open hole to the bottom.

The log of materials penetrated, furnished by Mr. Dittmyer, is as follows:

Formations.	Thickness in feet.	Depth in feet.
Glacial drift	61	61
Niagaran dolomite	164	225
Maquoketa shale	79	304
Galena-Platteville dolomite	331	635
St. Peter sandstone	85	720
Limestone	4	724

The well is equipped with a Peerless turbine pump direct-connected to a 15-horsepower electric motor. The assembly of the pump consists

Analysis of Sample Number 91640 from 720-Foot Well.

Determinations Made.		Hypothetical Combinations.	
	Pts. per million.		
Turbidity	0	Sodium Nitrate..... NaNO ₃	1.7 0.10
Color	0	Sodium Chloride..... NaCl	13.4 0.78
Odor	0	Magnesium Sulfate.... MgSO ₄	143.3 8.35
Iron..... Fe		Magnesium Carbonate.. MgCO ₃	70.4 4.10
(filtered at well) ..	0.1	Calcium Carbonate.... CaCO ₃	248.7 14.50
(unfiltered).....	0.4	Silica..... SiO ₂	17.5 1.02
Manganese... Mn	0.1		
Silica..... SiO ₂	17.5	Total.....	495.0 28.85
Calcium..... Ca	99.5		
Magnesium... Mg	49.2		
Ammonium... NH ₄	trace		
Sodium..... Na	5.8		
Sulfate..... SO ₄	114.2		
Nitrate..... NO ₃	1.1		
Chloride.... Cl	8.0		
Alkalinity (as CaCO ₃)			
Phenolphthalein..	0.0		
Methyl Orange...	332.0		
Residue.....	516.0		
Hardness (as CaCO ₃)	451.0		
pH = 7.1			
Free CO ₂ (calc.)...	49.0		

of 200 feet of 5-inch column pipe, a 9-stage, 8-inch bowl assembly 6 feet long, and 30 feet of 5-inch suction pipe. The pump is rated at 150 gallons per minute, against a head of 272 feet. When pumping at a rate of 200 gallons per minute the water level in the well was reported to have been lowered 76 feet below a non-pumping level of 44 feet. In 1941 the well was equipped with a small air pipe for determining water levels, the bottom end of which terminated at a depth of 200 feet below the pump base.

The water had a residue of 516, a total hardness of 451, and a content of iron of 0.1 parts per million as shown by the analysis of sample number 91640, collected October 24, 1941. The temperature of the water was 53½° F.

WILMINGTON

WILMINGTON. CITY WELLS. Wilmington is located in the southwestern part of Will County on the Kankakee River.

A public water supply was installed by the city about 1892. Water was pumped directly from Kankakee River and was used principally for sprinkling and for extinguishing fires.

WELL NUMBER 1 (86). In 1918 the water supply was obtained from a well 710 feet deep drilled by J. W. Hensley and Company of Indianapolis, Indiana in 1917. It is cased into limestone with 21 feet of 12-inch pipe sealed in place with cement. Below the 12-inch casing is 189 feet of 10-inch casing. The elevation of the ground surface at the well site is 545 feet above sea level.

A record of the formations penetrated, furnished by the State Geological Survey, is as follows:

Formations.	Thickness in feet.	Depth in feet.
PLEISTOCENE SYSTEM		
Glacial drift	15	15
ORDOVICIAN SYSTEM		
Maquoketa formation		
Limestone	80	95
Shale with some limestone	45?	140?
Galena-Platteville limestone and dolomite	365	505
Glenwood dolomitic sandstone	20	525
St. Peter sandstone, water-bearing	165	690
Shakopee dolomite	20	710

The well was first equipped with an air-lift pump which was used until 1937 when a new well was put in service. Use of the old well was then discontinued until 1940 when it was equipped with an 8-inch Pomona turbine pump consisting of 200 feet of 6-inch column pipe, a 17-stage bowl assembly 9 feet long, and 30 feet of 6-inch suction pipe. The pump is driven by a 40-horsepower direct-connected electric motor and is rated at 300 gallons per minute against a head of 318 feet at a speed of 1760 revolutions per minute. A small air line for determining water levels extends to a depth of 200 feet below the pump base.

The water level in the well when it was completed was 17 feet below the ground surface. The yield was 250 gallons per minute. Conditions were reported to be the same in 1923 .

The water had a residue of 1167 and a total hardness of 420 parts per million as shown by the analysis of sample number 43291, collected June 21, 1920.

Analysis of Sample Number 43291 from Wilmington City Well Number 1.
Determinations Made. Hypothetical Combinations.

	Pts. per million.		Pts. per million.	Grs. per gallon.
Iron.....Fe	trace	Sodium Nitrate.....NaNO ₃	7.3	0.43
Silica.....SiO ₂	8.0	Sodium Chloride.....NaCl	453.3	26.50
Alumina.....Al ₂ O ₃	0.4	Sodium Sulfate.....Na ₂ SO ₄	187.5	10.96
Calcium.....Ca	103.5	Ammonium Sulfate.....(NH ₄) ₂ SO ₄	0.1	0.01
Magnesium...Mg	39.2	Magnesium Sulfate.....MgSO ₄	193.7	11.33
Sodium.....Na	241.6	Calcium Sulfate.....CaSO ₄	6.1	0.36
Ammonium...NH ₄	0.0	Calcium Carbonate.....CaCO ₃	253.9	14.84
Sulfate.....SO ₄	236.1	Alumina.....Al ₂ O ₃	0.4	0.02
Nitrate.....NO ₃	5.3	Silica.....SiO ₂	8.0	0.47
Nitrite.....NO ₂	0.0			
Chloride....Cl	275.0	Total.....	1110.3	64.92
Alkalinity				
Methyl Orange... 242.0				
Residue..... 1167.0				
Hardness (as CaCO ₃) 420.0				

WELL NUMBER 2 (85). In 1936 a new well known as number 2 was drilled by C. W. Varner of Dubuque, Iowa, at a site about 75 feet easterly of the old well. It is located about 1200 feet north and 1375 feet east of the southwest corner of Section 25, T. 33 N., R. 9 E. The surface elevation of the well site is 545 feet above sea level. The well is 1566 feet deep and 10 inches in diameter at the bottom. It is cased with 12½-inch pipe to a depth of 23 feet and with 10-inch pipe from the surface to a depth of 218 feet.

A log of material penetrated, furnished by the State Geological Survey, is as follows:

Formations.	Thickness in feet.	Depth in feet.
PLEISTOCENE SYSTEM		
Glacial drift.....	20	20
ORDOVICIAN SYSTEM		
Maquoketa formation		
Limestone, dolomitic.....	70	90
Shale, some limestone.....	50	140
Galena-Platteville limestone and dolomite.....	365	505
Glenwood dolomitic sandstone.....	20	525
St. Peter formation		
Sandstone, water-bearing.....	150	675
Shale, weak.....	5	680
Shakopee dolomite, thin shale at 726'.....	70	750
New Richmond sandstone, some dolomite.....	15	765
Oneota dolomite.....	195	960
CAMBRIAN SYSTEM		
Jordan dolomite and sandstone.....	80	1040
Trempealeau dolomite.....	225	1265
Franconia dolomite and sandstone.....	135	1400
Galesville (Dresbach) sandstone, water-bearing..	166	1566

The well is equipped with a 7-stage, 10-inch Peerless turbine pump having 100 feet of 7-inch column pipe, a bowl assembly 6¼ feet long, and 35 feet of suction pipe. The pump is driven by a 40-horsepower

electric motor and is rated at 500 gallons per minute against a head of 228 feet. In 1938 the pumping rate indicated by a Republic Flow Meter was 560 gallons per minute. A small air pipe for determining water levels extends to a depth of 100 feet below the pump base.

In 1936 the water level was at a depth of 59 feet when not pumping and was lowered 6½ feet by pumping at a rate of 485 gallons per minute. In 1940 the non-pumping level was 67 feet below the pump base.

Water from well number 2 had a residue of 1161, a total hardness of 428 and an iron content of 1.06 parts per million as shown by the analysis of sample number 83455, collected May 3, 1938.

Analysis of Sample Number 83455 from Wilmington City Well Number 2.				
Determinations Made.		Hypothetical Combinations.		
	Pts. per million.			
		Pts. per million.	Grs. per gallon.	
Iron.....Fe		Sodium Nitrate.....NaNO ₃	0.7	0.04
(filtered).....	0.12	Sodium Chloride.....NaCl	460.0	26.82
(unfiltered).....	1.06	Sodium Sulfate.....Na ₂ SO ₄	201.0	11.72
Manganese...Mn	0.0	Magnesium Sulfate....MgSO ₄	196.5	11.46
Silica.....SiO ₂	10.0	Calcium Sulfate.....CaSO ₄	28.6	1.67
Turbidity.....	8	Iron Oxide.....Fe ₂ O ₃	0.2	0.01
Color.....	0	Calcium Carbonate....CaCO ₃	245.0	14.28
Odor.....	0	Silica.....SiO ₂	10.0	0.58
Calcium.....Ca	106.0			
Magnesium...Mg	39.6	Total.....	1142.0	66.58
Ammonium...NH ₄	trace			
Sodium.....Na	247.5			
Sulfate.....SO ₄	312.0			
Nitrate.....NO ₃	5.1			
Chloride....Cl	279.0			
Alkalinity (as CaCO ₃)				
Phenolphthalein..	0.0			
Methyl Orange...	244.0			
Residue.....	1161.0			
Total hardness.....	428.0			