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STATE OF ILLINOIS

WILLIAM G. STRATTON, *Governor*

TRENDS IN
RESIDENTIAL WATER USE

BY

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H. E. HUDSON, JR.

DEPARTMENT OF REGISTRATION AND EDUCATION

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STATE WATER SURVEY DIVISION

WILLIAM C. ACKERMANN, *Chief*

URBANA, ILLINOIS

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SUMMARY

In addition to the changing number of persons-per-household unit, which has undoubtedly resulted in a changed pattern of water use, and in addition to the increasing proportion of the urban population that has running water service, there are other factors to be considered in future planning of public water-supply systems.

A very important factor is the increasing installation of appliances that cause more water to be used in homes. These include dishwashers, food waste disposers, water heaters, and automatic and conventional washing machines. The installation of these units has been concentrated mainly in the higher-income communities, which are generally the larger communities of Illinois. These communities have frequently displayed large increases in residential water use over the past 15 years in spite of the fact that there was no material increase in the proportion of the population served with running water. It is believed that these water-using devices have not yet come into wide use in the smaller communities in which incomes may be lower. Per capita residential uses have therefore commenced to increase as a result of the installation of these devices in the larger communities, but have not yet been observed in the lower-income communities. Further increases in residential water use in these communities may possibly be expected in the future as a result of this trend.

It is evident that in the larger cities, where the proportion of the population served by public water supply system has steadily approached 100 per cent, the declining number of persons per household indicates an even greater per capita use of water. While the amount of water pumped per service connection over the past several decades has not risen substantially, the actual number of persons per service has continued to decline, so that there has actually been an increase in per capita residential use of water in these cases.

It seems plausible that a method could be devised for estimating water use in communities on a more rational basis than the now-popular 100 gallons-per-capita per day. Such a method might include the adoption of a residential per-capita and/or per-service figure plus a commercial water-use figure on a per-service basis. There appears to be no merit in compiling industrial-use figures on a per-capita basis since they will depend altogether on the types and methods of operation of the particular industries concerned in each community.

Of the nine Illinois communities studied in this report, five of them with less than 10,000 population had an average residential water use of 38 gallons-per-capita per day and 110 gallons-per-service per day.

Four of the communities with populations ranging from 15,000 to 50,000 had an average residential water use of 45 gallons-per-capita and 140 gallons-per-service.

Projecting the residential water-use requirements of these communities to 1970, the graphs indicate that towns of less than 10,000 population may reach water-use demands of as high as 50 gallons-per-capita per day and 155 gallons-per-service per day.

For communities of 15,000 to 50,000 population the residential water-use demands may reach 75 gallons-per-capita per day and 220 gallons-per-service per day.

ACKNOWLEDGMENTS

This report was prepared mainly during the administration of Dr. T. E. Larson, Acting Chief of the State Water Survey Division, and completed following the appointment of William C. Ackermann as Chief, who made helpful comments and suggestions in his review of the manuscript. Acknowledgment is given to Dr. Max Suter, H. F. Smith and Jack Bruin for their counsel and technical advice during the preparation of the report.

The authors take this opportunity to express their appreciation to water works officials of the many municipalities visited in the search for water-use data. In all cases the water records were made available and office assistance given in the collection of data from the records.

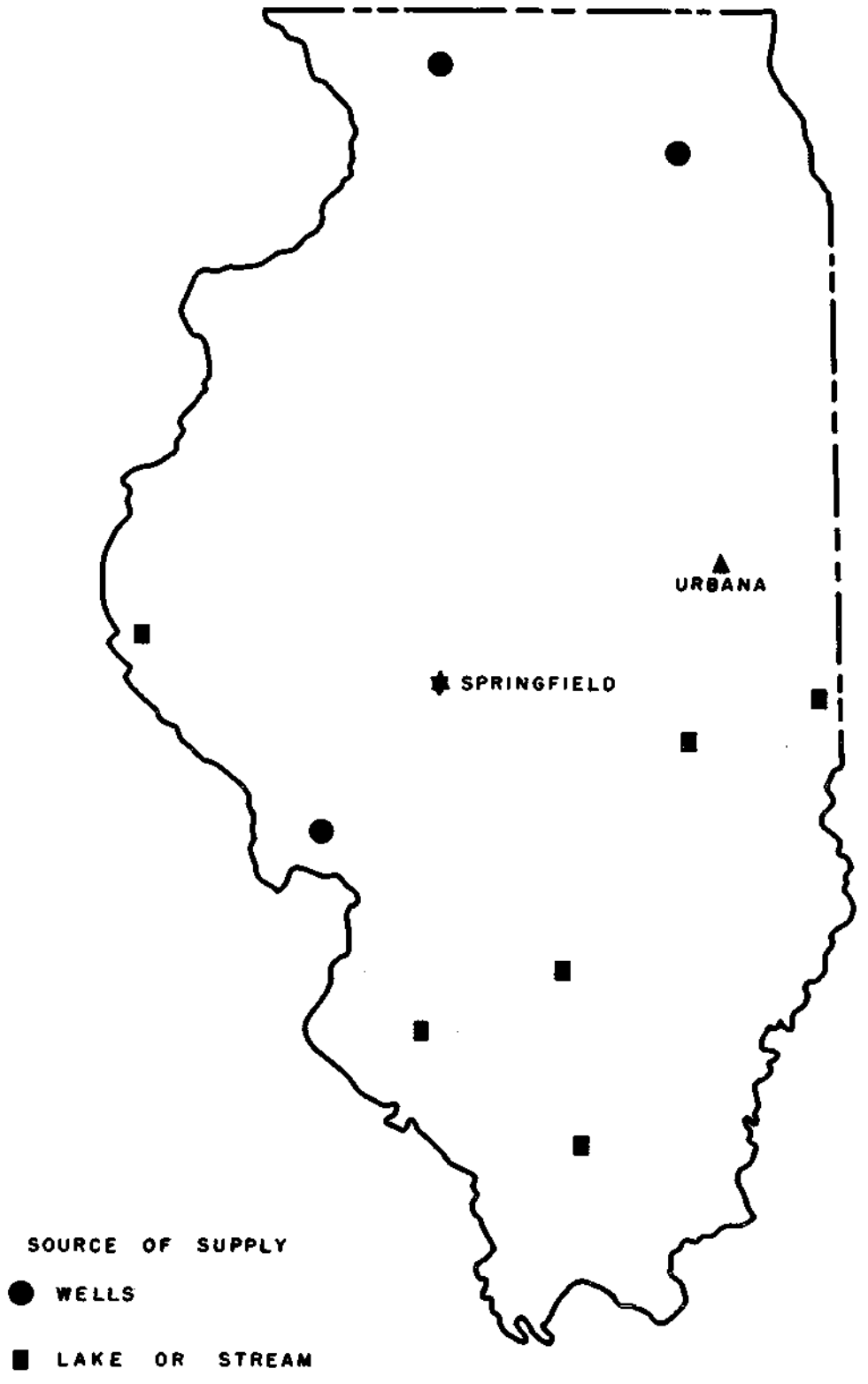

FIGURE 1

TRENDS IN RESIDENTIAL WATER USE

by

Ross Hanson, Associate Engineer, and H. E. Hudson, Jr., formerly Head, Engineering Subdivision

INTRODUCTION

It is common practice to express per capita water consumption for a given community as the quotient of the total pumpage and the census population. This method assumes that all of the water pumped gets to the users, and assumes further that all persons counted in the census are served with water from the system. The resultant figure, called per capita consumption or gallons-per-capita, may at times be completely misleading when the population served differs from the census population or when the total water used differs materially from the total pumpage. The per capita consumption figure obtained in this way is undoubtedly a useful figure, but there is accumulated under its broad cloak a variety of considerations of such importance that each should be evaluated separately.

It is the thesis of this report that water use can be better established on the basis of sales per water-service connection; that the per capita consumption can be expressed as the amount of water sold through residential users divided by the product of the number of services and the number of persons per service connection. Such figures need to be assembled for residential users separate from commercial and industrial users. There appears to be no merit in compiling industrial-use figures on a per capita basis, since they will depend altogether on the types, numbers, and methods of operation of the particular industries concerned in each community.

Data gathered by the Illinois State Water Survey in 1954 indicated that declines in water consumption per service connection were taking place in certain Illinois communities over the period 1920 to 1953. Compared to reports from other parts of the country this indication seemed so unreasonable that further study was initiated. The study showed that changes in per capita consumption had been masked by two factors: (1) the declining number of persons per household, and (2) the increasing proportion of the community population served. The study also indicated that several other factors heretofore omitted from consideration play a role in the estimation of water use in homes served by public water supplies.

For the 1954 study, information was gathered from a number of communities in Illinois that were encountering difficulty with water supply adequacy, presumably due to the drought. A preliminary report on this work was given in a separate publication[1], but the data from the 1954 study were, in some respects, incomplete in extent and in detail, lacking sufficiency for a reasonable analysis. Accordingly, information was sought from other communities selected throughout the State where fairly adequate records were thought to be available. These were later sifted down to the nine communities distributed over the State, as shown in Figure 1, which also indicates the type of source of supply used. Four of the communities relied on groundwater, and five of them on surface water. The communities are identified in the text and in the Appendix by a letter of the alphabet.

Of the 819 public water systems in Illinois in 1955, approximately 7 per cent are privately owned. This study does not cover any of the privately-owned water systems.

There may be some bias in the sampling, for all of the communities finally selected had water supply administrations that had maintained reasonably detailed records in recent years, which indicates that they were probably better operated than the general average. Data for the years 1940 to 1955 were available in most cases, and some earlier records were available.

In the Appendix at the end of this report, each tabulation, under an identification letter, shows the census and physical data collected for each municipality, together with the results obtained from analysis of the data.

COLLECTION OF DATA

The information sought from each community's water supply operation included the total pumpage, the number of services, and the sales of water to each of the following categories: (1) total, (2) residential, (3) commercial, (4) industrial. In addition, information was sought on sales to water haulers, and on "free" water to municipal offices, parks, playgrounds, drinking fountains, etc. Little information was obtained on sprinkling and air-conditioning loads.

In all cases the communities metered the sales of water to almost all accounts, so that a breakdown of sales into the several categories could be obtained. The available data also made possible the determination of gallons-per-day per service in each of the various categories.

In addition, master-metering of the entire pumpage was considered an important item in order to enable the determination of "unaccounted-for" water, but data on unaccounted-for water were not always available. In some cases estimates were applied for this.

For each community, the census population statistics were available, together with census values for 1940 and 1950 on the number of occupied dwelling units. These figures could be compared with total residential services.

Wherever a substantial proportion of the water-service connections were outside the corporate limits of the community, these were added to those facilities within the corporate limits. In such cases, the total number of services shown for the water system include the services outside the community; and the population, total pumpage, and sales figures also include the number of persons and the quantities of water involved outside the corporate limits. In several instances this was an important factor since several of the systems furnished water to subdivisions outside the corporate limits. Others furnished water to nearby municipalities of considerable size.

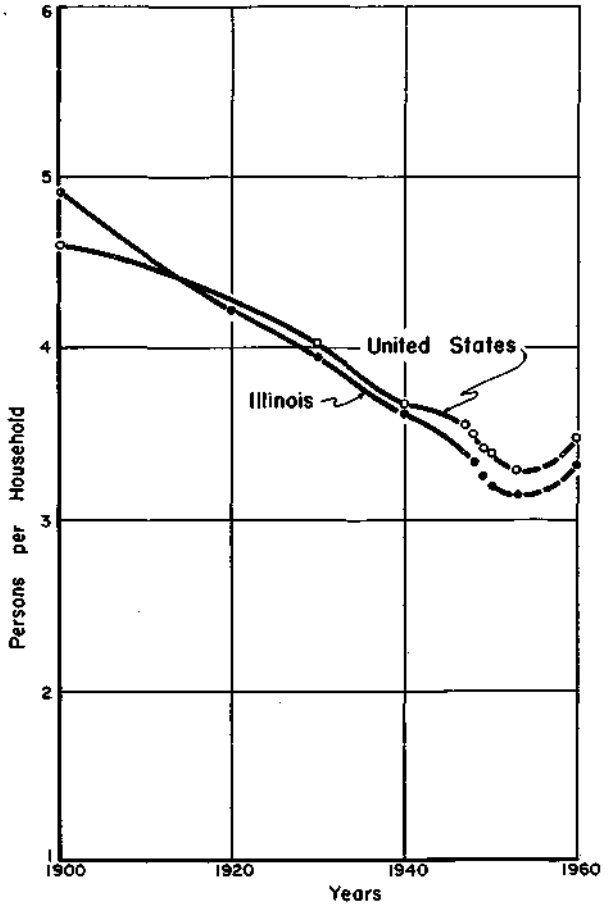

FIGURE 2

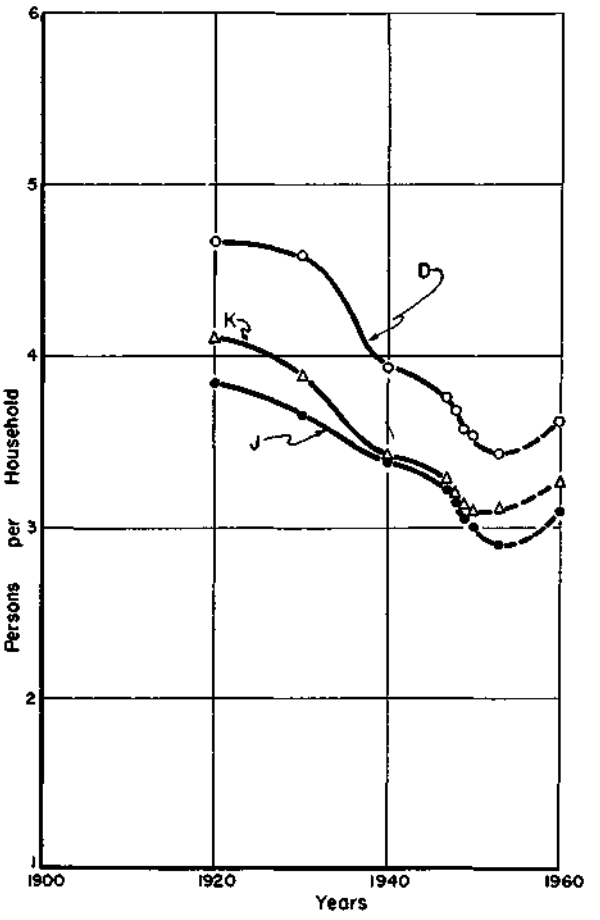

FIGURE 3

Data from census publications from the United States and the State of Illinois proved very useful. Whereas, prior to the 1950 census, dwelling units in unincorporated places outside corporate limits had been classified as "rural"[2] in the 1950 census, dwellings in urban fringe areas were classified as "urban." The census reports gave information on the number of persons per household (size of family), the number of households, trends in population, the relationship between urban and rural populations, the proportion of the urban population served by public water supplies, and the number of dwelling units in the community that had running water inside the household.

POPULATION AND HOUSING

Persons Per Household

The very rapid increase in household formation in the late forties leads to curiosity about the size of family units. Beginning with the 1940 decennial report, the United States Bureau of the Census provided information on the number of persons per household. The values given seem to compare reasonably well

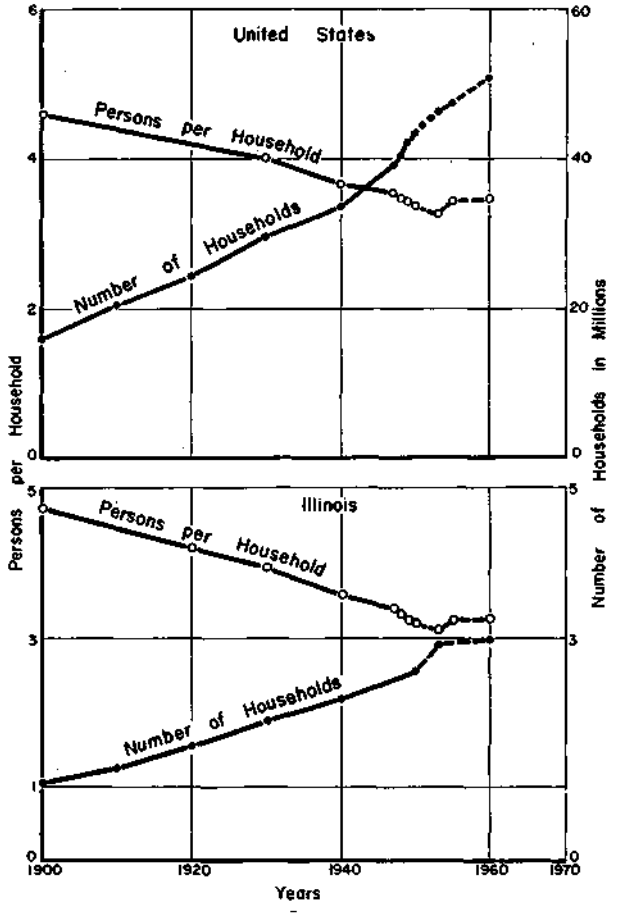

FIGURE 4

with the data available in earlier censuses on persons per family[3] [4].

Figure 2 gives the number of persons per household for the period 1900 to 1960, for the entire nation as enumerated and projected by the Bureau of the Census. The data show a very marked decline in the number of persons per household for the period 1900 to 1953. The greatest rates of change are shown to have occurred in the period after 1946. It will be noted that the number of persons per household in the United States as a whole declined 30 per cent in the period 1900 to 1953. In the corresponding period, the decline in Illinois was 35 per cent.

Data on persons per household were also available through 1950 for the several communities in Illinois which are the basis of this study. The curves for these communities have been prepared from data available in the decennial census reports from 1920 to 1950, and the subsequent projections were drawn from predictions in inter-censal reports of the Bureau of the Census for the State of Illinois. Figure 3 shows the graphs for three of the communities. They reveal trends similar to the national and state trends. Studies of other communities within the State reveal even more marked variation.

Number of Households

One of the biggest problems facing public water-supply systems is furnishing service to new accounts. The Bureau of the Census decennial census reports and certain special inter-censal publications on populations[5] [6] contain pertinent information on trends in the number of households. They reveal that the number of private households in the United States increased at a much more rapid rate

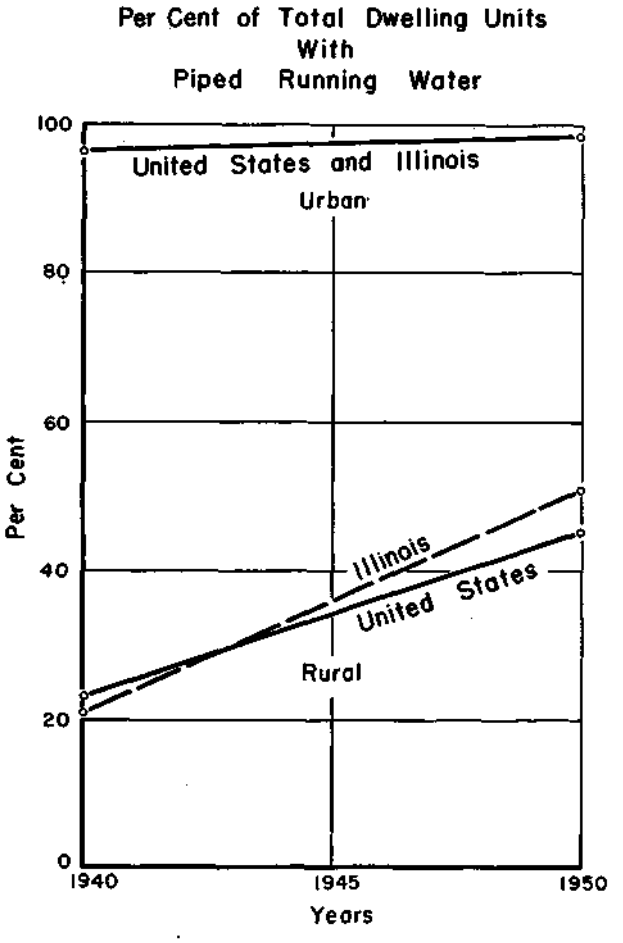

FIGURE 5

than the population from 1940 to 1950 and the average size of household consequently showed a substantial decline[7][8].

The decline in household size occurred despite the high birth rate during the 10-year period. The effects of a high birth rate were more than offset by the effects of the high marriage rate and other factors that tended to increase the number of households[8]. In 1950, about 5.6 per cent of the married couples had not established their own households but were sharing the living quarters of other persons or were living in hotels, rooming houses, or other quasi-households. Corresponding percentages for earlier years were 6.8 per cent in 1940 and 6.1 per cent in 1930[8]. Taking into account low birth rates during the depression years of the 1930s, the increasing average length of life and the growing tendency for older persons to maintain their own households into old age, the Bureau of the Census observed that, "The indicated trend in household and family formation is generally downward for the 1950s"[9]. Extraordinary increases in establishment of new households were observed during the postwar years 1947 to 1950, and those increases brought on many of today's water-service problems. Increases were smaller subsequently and are not expected to be as high in the near future.

The census projections indicate (Figure 4) the number of households in the United States will rise from 45.5 million in April 1952 to 47.7 million in July 1955 and to 50.8 million in July 1960[9]. Subsequent census studies give additional information on rates of establishment of households[10][11].

For Illinois the census projections indicate (Figure 4) the number of households will rise from 2.5 million in 1950 to 2.9 million in 1955 and to 3.0 million in 1960.

Proportion of Population Served

Prior to World War II, many water systems in Illinois were installed on a basis of serving only part of the population within the incorporated limits of the municipality. In some instances, the proportion served ranged from 10 to 25 per cent of the entire population. This has increased rapidly in many small communities, but in some this development is quite incomplete.

In 1940 (Figure 5), of all the urban dwelling units in the United States, 96.0 per cent had

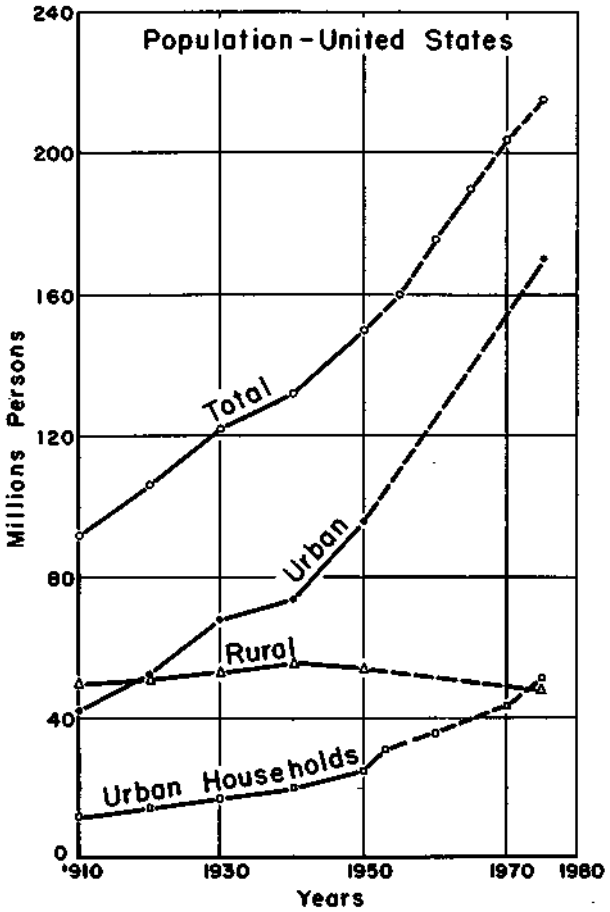

FIGURE 6

running water inside the home; in 1950, the ratio was 97.2 per cent. Most of this rise was due to increases in extension of service in communities less than 10,000 in population. This change is obviously no national problem, but it has caused grave difficulties for many small communities.

For rural homes, the picture is different. In 1940, there were 20.7 per cent of rural homes in Illinois with piped running water, and 22.7 per cent over the entire United States. In 1950, there were 51.2 per cent of Illinois rural homes equipped with piped running water, and 45.5 per cent for the United States. Here is a rapidly changing aspect of the national scene.

Projections of Urban Population and Households

The Bureau of the Census has made illustrative projections of the population of the United States (Figure 6) and of Illinois (Figure 7)[12]. While events of the last two decades

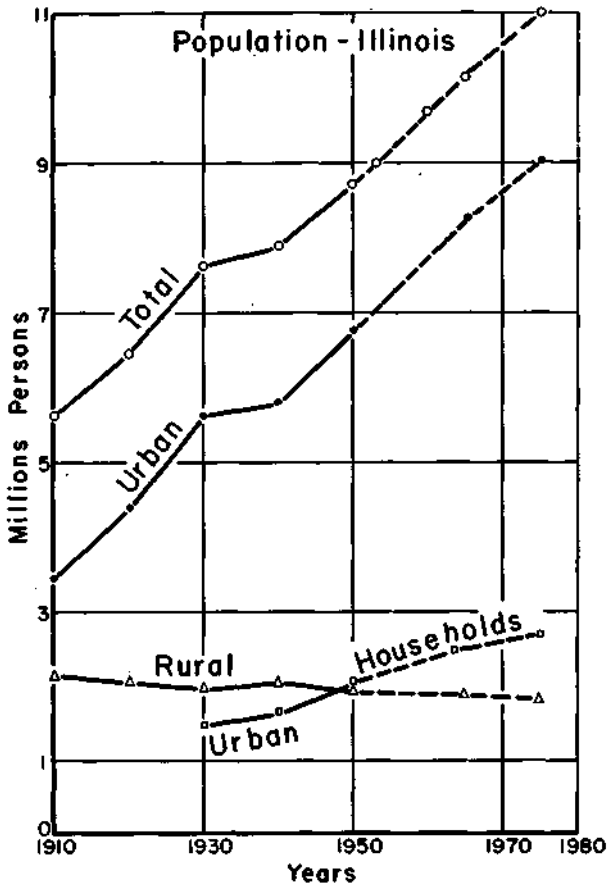

FIGURE 7

have given demographers less confidence in their forecasts than they once had, these projections are still among the best available. Estimates based on several anticipated fertility rates are provided. In addition, projections have been made both by the "component" method and the "ratio" method. The writers have used the highest of these estimates in order to provide assurance that the most demanding situation will receive consideration. Using these data, together with urban and rural total ratios projected by the writers, the urban and rural populations for the United States have been estimated to 1975.

Figures 6 and 7 indicate that an increasing proportion of the population will be living under urban conditions and will expect service from public water-supply systems.

The population forecasts can be combined with estimates of household size to yield forecasts of urban households in the United States and Illinois as shown in Tables 1 and 2 respectively.

TABLE 1

Projections - Persons per Household and Urban Households For United States

Year	Projected Urban Population (millions)	Estimated Persons per Household	Estimated Urban Households (millions)
1960	126.0	3.5	35.0
1970	156.0	3.6	43.4
1975	170.0	3.6	47.2

TABLE 2

For Illinois

Year	Projected Urban Population (millions)	Estimated Persons per Household	Estimated Urban Households (millions)
1960	7.7	3.3	2.3
1970	8.6	3.4	2.5
1975	9.0	3.4	2.6

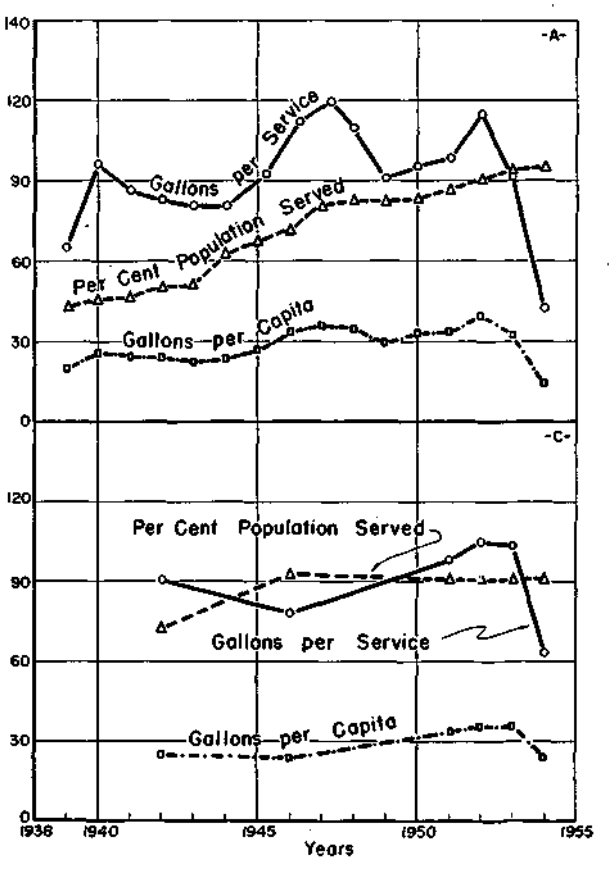

FIGURE 8

These estimates are also shown in Figures 6 and 7 together with census data on urban households for earlier years. The estimates indicate a reduced rate of increase in the number of urban households to be served by public water supplies in the coming two decades, but they also indicate a continuing growth.

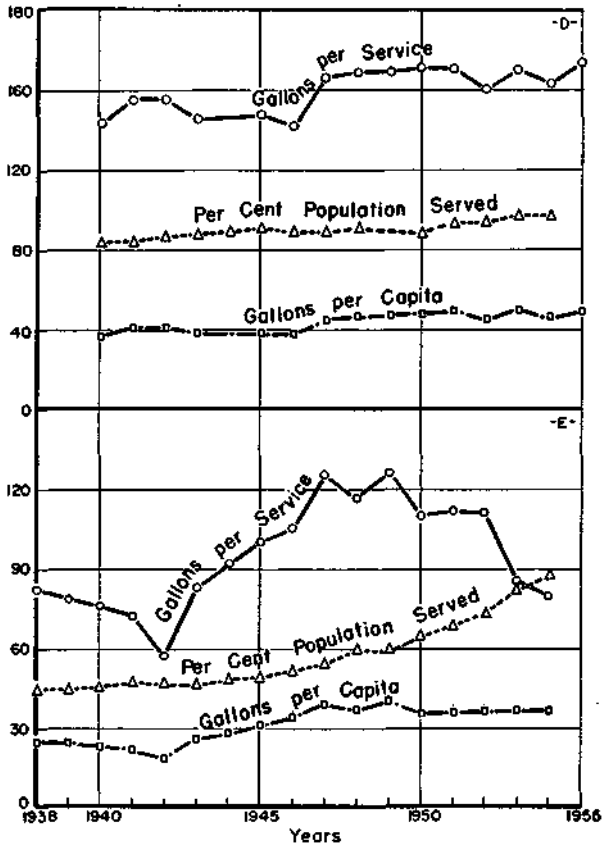

FIGURE 9

RESIDENTIAL WATER USE

Water-Use Data in Some Illinois Communities

The Bureau of the Census data and the water-use data collected from each community are tabulated on the data sheets. Appendix A, C, D, E, F, G, H, I and J include calculations of residential daily use in gallons-per-service and gallons-per-capita. A brief description of the water use in each community follows.

A and C

Figure 8 shows the results of the analysis of residential water-use data collected at two Illinois municipalities as tabulated in Appendix A and C. A and C, with populations 1600 and 5600, respectively, receive water from impounding reservoirs. At A, there were slight overall increases in gallons-per-capita and gallons-per-service from the earliest records to 1952, in which year restrictions in water use were initiated due to the drought. The per cent of population served showed a gradual increase from 46 per cent of the population in 1939 to 93 per cent in 1954.

Town C showed slight increases in gallons-per-capita and gallons-per-service from 1942 to 1953. In 1953 restrictions were initiated. The per cent of population served increased sharply from 1942 to 1946 and then remained fairly level at 91 per cent to 1954. This town, a thriving coal mining community prior to 1930, suffered a population loss of 35 per cent from 1920 to 1950 because of the mines being worked out. In 1920 the number of persons per household was 4.67 or 10 per cent higher than for Illinois and the United States, but in 1950 the average was about 2.9 or 12 per cent below the Illinois and United States' averages.

Contrary to the general experience in towns where the water-use restrictions have been lifted, the residents of C discovered they could get along with the water shortage. When the reservoir began spilling over, they were not inclined to return to the basis of pre-drought use of water and the water department, with increased expenses, became plagued with an unanticipated shortage in revenue.

D and E

Figure 9 shows the results of the analysis of residential water-use data collected for municipalities D and E, (Appendix D and E), having populations at 5100 and 5700, respectively.

Town D, a residential and industrial community, receives its water supply from deep rock wells and furnishes considerable water to an adjoining municipality. The neighbor town is supplied from one meter and therefore is not included in the data on the graphs in Figure 9.

This municipal supply was installed about 1896 and by 1940 about 85 per cent of the population was being served and by 1954 about 98 per cent was using city water; and correspondingly a steady normal increase is shown in the gallons-per-service and gallons-per-capita. From 1940 to 1954 the total pumpage demand increased 160 per cent (Appendix D) and the residential consumption increased 140 per cent. Total sales increased 190 per cent. A breakdown of the total pumpage in 1940 and 1954 is shown in Table 3.

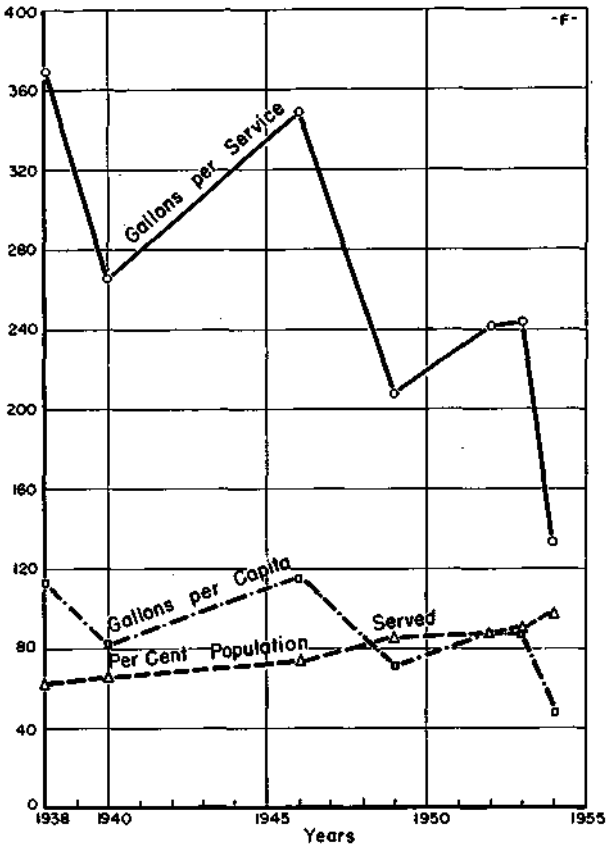

FIGURE 10

TABLE 3

Year	Total Pumpage	Per cent of Total Pumpage: Residential Sales	Commercial Sales	Industrial Sales	Unaccounted-for Losses
	mgd	%	%	%	%
1940	0.386	34	17	18	31
1954	1.062	24	17	35	24

Restrictions were not instituted in D.

Town E is located in a prosperous agricultural area with water supply from wells and springs. The curves for residential use show gallons-per-capita and gallons-per-service comparable to those of other Illinois towns in the same population bracket. In 1952 to 1953, a noticeable decline in gallons-per-service occurred at the same time with a gradual increase inper cent of population served. However, as high as 27 per cent of the pumpage is lost through leaks in corroded water mains. In November 1953 a consulting engineer was retained and in 1954 the losses through leaks were reduced to 18 per cent. Subsequent losses were apparently not considered serious enough to warrant repair.

F, G, and I

Figure 10 shows the water-use data analysis for F, a town of 9500 population largely composed of retired farm folks with its water supply obtained from a surface reservoir. In the early 1930s, when the customers were charged on a flat-rate basis, a record of 2.25 million gallons was pumped for one day and the annual average rate of pumping was 1.5 million gallons per day. Eight months after meters had been installed on all the services the summer peak was 0.6 mgd and the January-July average was 0.46 mgd, a drop of 66 per cent. By 1946 there was another runaway in residential water use, with an average in July of 1.1 mgd. Thereafter rates were increased 20 per cent. Again the pumpage dropped to 0.6 mgd, 45 per cent below the July 1946 average. In December 1953, full restrictions 'were instituted because the reservoir was depleted, not only due to the drought but also because customers were allowing water to drip to waste to prevent freezing of water pipes.

A breakdown of the total pumpage for 1940, 1946 and 1953 (before restrictions were imposed due to water shortage) is shown in Table 4.

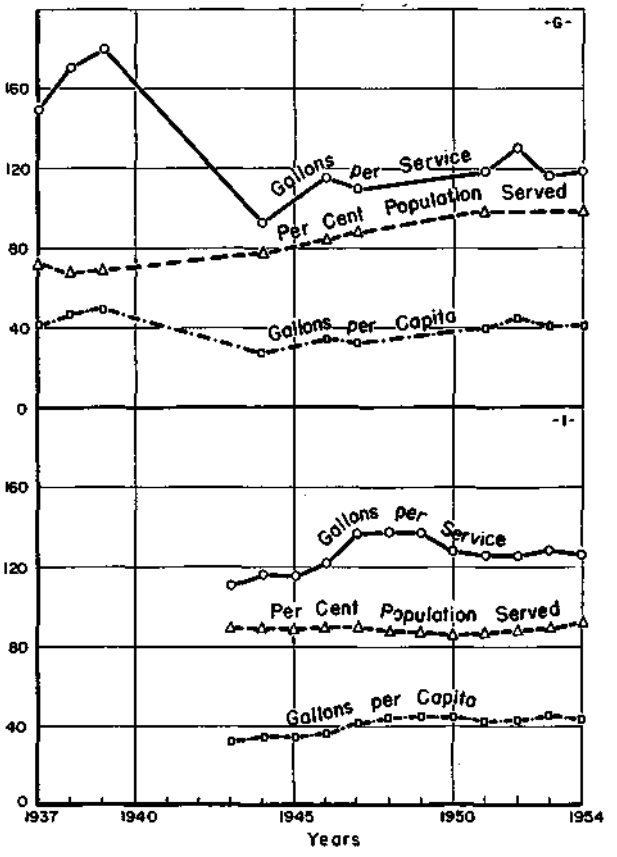

FIGURE 11

TABLE 4

Year	Total Pumpage mgd	Per cent of Total Pumpage: Residential Sales %	Commercial Sales %	Industrial Sales %
1940	0.72	71	4	25
1946	1.03	80	3	17
1953	0.80	91	4	5

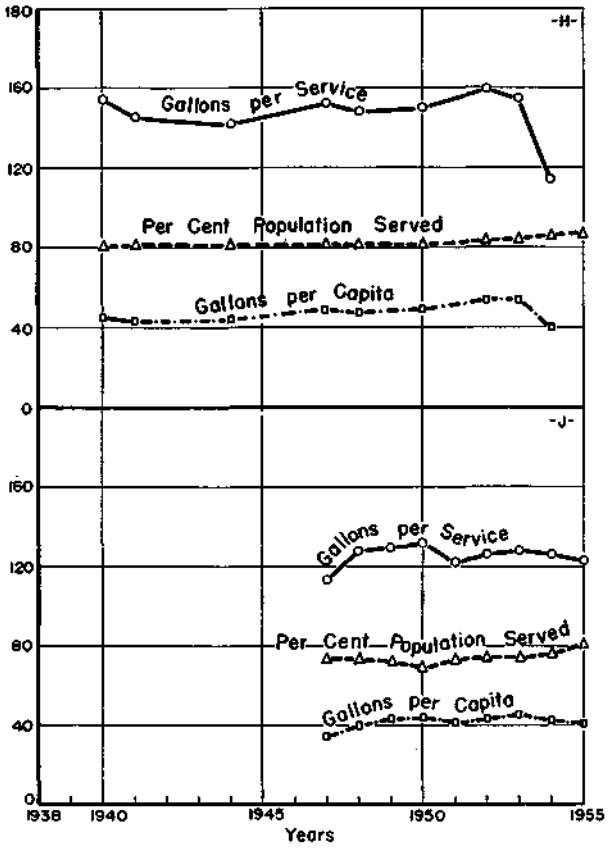

FIGURE 12

Apparently all water was charged to consumers, as no "unaccounted-for losses" were reported. About 1948 to 1950 the railroads changed form steam to diesel power, thus explaining the large reduction in industrial sale of water by the municipality.

Figure 11 shows the results of the analysis of water-use data for G and I.

G has a population of 14,000 and receives its water supply from artificial lakes. It is a railroad center and is located in the midst of a large area of coal mines, oil and gas fields.

Following 1938 and until 1944 when meters were installed on practically all services, the gallons-per-service dropped rapidly although there was a' steady increase in the pumpage and in the number of services (Appendix G). Since 1944, the pumpage and number of services have continued to climb but the gallons-per-service and per-capita have increased only slightly.

A breakdown of the total pumpage and per cent of sales is shown in Table 5.

TABLE 5

Year	Total Pumpage mgd	Per cent of Total Pumpage: Residential Sales %	Commercial Sales %	Industrial Sales %	Unaccounted-for Losses %
1937	1.15	38	5	55	2
1939	1.58	35	20	39	6
1944	1.94	20	21	57	2
1953	2.24	27	21	32	20

The gradual decline in residential consumption to 1939 was accompanied by an increase in commercial consumption and decrease in industrial. This was followed by a further decline in residential consumption accompanied by a leveling-off of commercial and an increase to an all-time high in industrial (railroads) use during the war years. By 1953 the railroads had changed over to steam power and the industrial consumption reached an all-time low. Unaccounted-for losses mounted due to leaks in an old wooden stave pipe line. G supplies water to four small neighboring com. munities.

I, a manufacturing town, has a population of 23,000 which has remained approximately the same for the past twenty years after a normal growth during previous years. The water supply, obtained from an unconsolidated material and also shallow rock wells, has been adequate. Many of the industries have their own supplies for boiler purposes.

A breakdown of the total pumpage and per cent of sales is shown in Table 6.

TABLE 6

Year	Total Pumpage mgd	Per cent of Total Pumpage: Residential Sales %	Commercial Sales %	Industrial Sales %	Free (Public Use) %	Unaccounted-for Losses %
1943	1.60	41	15	19	15	10
1947	2.03	41	15	24	12	8
1950	1.97	42	15	23	12	8
1953	2.18	41	15	30	8	6

Appendix I shows the residential and commercial water-consumption increase to be about 50 per cent over the period. The commercial consumption gained about 100 per cent, due to increased use of city water in preference to their own supplies. "Free" (or public use) water and unaccounted-for losses remained at the same levels during the period.

No restrictions on water use were imposed during the 1952 to 1955 period of water shortages elsewhere in the State.

H and J

Figure 12 shows the results of the analysis of the residential water-use data for H and J, towns of 18,000 and 41,000 population, respectively, and both with considerable commercial and industrial water use. H obtains water from a surface reservoir supplemented by a limited groundwater supply.

The reservoir supply was depleted about 1953 and full dependence was placed on the groundwater supply. However, this became inadequate, even with the construction of additional shallow wells, and restrictions, started partially in 1951, were rigidly enforced. The desperate situation brought about plans for laying a seven-mile pipe line from a stream. Before the pipe was laid, the rains came.

A breakdown of the total pumpage and per cent of sales taken from Appendix H, is shown in Table 7.

TABLE 7

Year	Total Pumpage	Per cent of Total Pumpage: Residential Sales	Commercial Sales	Industrial Sales	Unaccounted-for Losses
	mgd	%	%	%	%
1940	1.48	40	7	40	13
1944	1.72	35	12	41	12
1948	2.46	28	17	40	15
1953	2.25	35	19	33	13

J obtains its water supply from the Mississippi River. Since 1946, due to improved accounting, the water records are quite complete (Appendix J). A breakdown of the total pumpage and per cent of sales is shown in Table 8.

TABLE 8

Year	Total Pumpage	Per cent of Total Pumpage: Residential Sales	Commercial Sales	Industrial Sales	Unaccounted-for Losses
	mgd	%	%	%	%
1947	3.63	29	29	23	19
1949	3.82	33	33	20	14
1951	3.42	36	36	19	9
1955	4.33	32	32	23	13

This community has always been and continues to be in a good position as to its current water supply and management problems, however, obsolescence of the plant and mains due to short term planning is weakening the entire water works structure.

Public Reaction to Restrictions in Some Illinois Communities

When a municipally-owned groundwater system encounters a water shortage due to a failing supply, it frequently becomes necessary to impose restrictions. When such restrictions as prohibition of lawn sprinkling and washing of cars do not meet the emergency, it becomes necessary to shut off water use for allnight periods and later on for intermittent periods in daytime "while the tank is being filled." When such extreme measures are necessary, the customers generally become inured to the unsatisfactory operation and gradually develop a tolerant attitude toward the water works officials.

The officials of a municipally-owned surface water system may find it difficult, as a drought period becomes extended, to convince the customers that the capacity of their lake is becoming critically low; that the broad water surface of the lake which they see may be only a very few feet above the bed of the lake.

In one of the communities studied but not discussed herein, city officials instituted restrictions during 1953, prohibiting the washing of cars and the sprinkling of lawns. A reduction in residential use of approximately 26 per cent ensued. These restrictions had to be continued through 1954, and by the end of that year, it was found that the water revenue had declined so severely that the water system was running into debt at a rapid rate. Officials thereupon reported this fact to the community and recommended'a substantial increase in water rates to rectify the financial situation. The response of the citizenry was to elect new officials who, by drastic curtailment of both essential and nonessential expenditures, managed to bring the water department books into a current operating balance.

Water-Using Appliances in the Home

The most serious likelihood of increased residential use of water may result from the installation of water-using appliances in the home.

Table 9 shows the extent of water-using appliances installed in homes during the years 1949 to 1955 inclusive, as given by Electrical Merchandising magazine for Illinois and for the United States. Installations prior to 1949 are not known.

Residential Water Use - Effective Family Buying Income

An earlier study by the Water Survey[13] indicated residential water-use in 1948 to be related to the family income of the community.

Sales Management magazine's "Survey of Buying Power" of May 1956 gives data on the effective net family income buying power for all communities over 10,000 population. Table 10 gives data from this magazine for the Illinois communities discussed herein. Because three of the communities A, C, and D are less than 10,000 population, the county average was used.

TABLE 9

Electric Water-Using Appliances in United States and Illinois Homes

	Index of Saturation December 31, 1955*							
	Millions Wired Homes With				Per cent Wired Homes With			
	Millions Wired Homes	Dish Washers	Food Waste Disposers	Water Heaters	Wash-** ers	Dish Washers	Food Waste Disposers	Water Heaters	Wash-** ers
United States	46.0	1.84	2.55	7.50	38.70	4.0	5.6	16.3	84.1
Illinois	2.0	0.042	0.062	0.093	0.994		3.2	4.8	51.0

* For years 1949-1955 inclusive.

** Includes automatic and conventional types.

The data indicate that, while the market had been fairly well saturated with home washing machines, comparatively few dishwashers, food waste disposers and electric water heaters had been installed. A continuing trend toward increased installation of automatic and conventional washing machines can be expected. Only electric water heater sales are shown in the data. No information has been made available on gas water heater sales.

It may also be assumed that nearly all the newer water-using devices have been installed in higher-income urban centers. Therefore large increases in water use in small communities can be expected, and the small saturation indices for dishwashers and food waste disposers point toward considerable increases in per capita use in the larger communities. It is reasonable to assume that there may be a trend towards the air-cooled home air conditioner in preference to the water-cooled type.

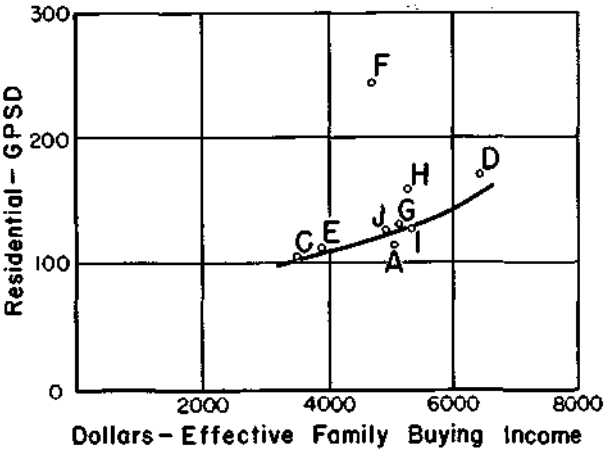

FIGURE 13

Also shown in Table 10 are the gallons-per-service per day and the gallons-per-capita per day as taken from the data sheets in the

TABLE 10

Effective Family Buying Income - Residential Water Use

Community	Family Buying Income (dollars)	Residential Gallons-Per-Service (gpd)	Residential Gallons-Per-Capita (gpd)
A*	5035	116	34
C*	3517	105	36
D*	6412	171	46
E	3958	112	36
F	4743	244	87
G	5179	131	45
H	5250	160	55
I	5325	129	45
J	4941	128	45

* County average

Appendix. Figure 13 is a graphical relationship of residential daily use per service and net effective family buying income. Gallons-per-service are used in the graph because this figure more closely represents the use per family. (Incidentally, in plotting gallons-per-capita and net family income, a similar straight line correlation is produced.) In this graph the data for F are not given weight because of the poor record of residential water use by this community (Appendix F). The data for H are lightly considered because the record of the number of services for that community was occasionally interpolated. The data for D were given strong consideration because the water records (Appendix D) were well-kept and the water use per capita as well as per service is keeping pace with the higher family income of this community.

The communities used in this report are none of those used in the earlier[13] study, but the correlation between residential water use and family buying income corresponds very well.

Projections of Residential Water Use in Illinois Communities

The data from 9 Illinois towns in which the water records were found to be fairly comprehensive have been assembled in two groups. Group one is composed of 4 towns in the population range of 15,000 to 50,000. In group two are 5 towns having populations of less than 10,000. By inspection of the per-capita graphs for the individual towns, it was seen that the residential consumption in 1952 for the towns in group one averaged about 48 gallons-per-capita. For the group two towns the residential consumption in 1952 averaged 35 gallons-per-capita.

Figure 14 has been prepared from the weighted averages for residential consumption of gallons-per-capita and gallons-per-service for group one. Figure 15 shows the weighted averages of gallons-per-capita and gallons-per-service for group two. The data for both groups were plotted for 1951 and prior years, as the 1952 to 1954 records reflected the effect of the restrictions instituted during the drought.

In designing the projections for residential gallons-per-capita, Figure 14, consideration has been given to the slope of the curve for the period just prior to 1952 when homes in cities of this size were being equipped with water-using appliances. A saturation of less than 50 per cent had been reached by 1956, and this was considered a good reason for extending the maximum projection at this same slope to 1970. The minimum projection has been extended with very little increase in slope from 1952 to 1970.

For group two, Figure 15, consideration was given to the fact that up to 1952, a negligible number of homes, in towns of this population range were equipped with water-using appliances. However, by 1956, the economic status of these towns was improved and the net family buying income was up. Giving consideration to these factors, the maximum projection to 1970 was designed on the same slope as for the towns in group one.

The gallons-per-service graphs represent the family use of water and a fairly close check of the projections is observed when multiplying any point on the gallons-per-capita curve by the Bureau of the Census' estimated average of 3.03 persons per family.

There is need to consider other factors in future planning. One of these other factors is the availability of public sewer service, which in many small communities did not become available until after 1930, and which undoubtedly stimulated the increasing installation of water-borne waste disposal methods.

It seems obvious that both per-capita and per-service demands will rise in these communities. Conservative planning dictates the necessity of estimating future trends generously. Although maximum, medium and minimum estimates are plotted, it is recommended that the maximum projections be used.

Because these projections are based on residential consumption only, they are not apt to be greatly influenced by changes in the commercial and industrial life of a community.

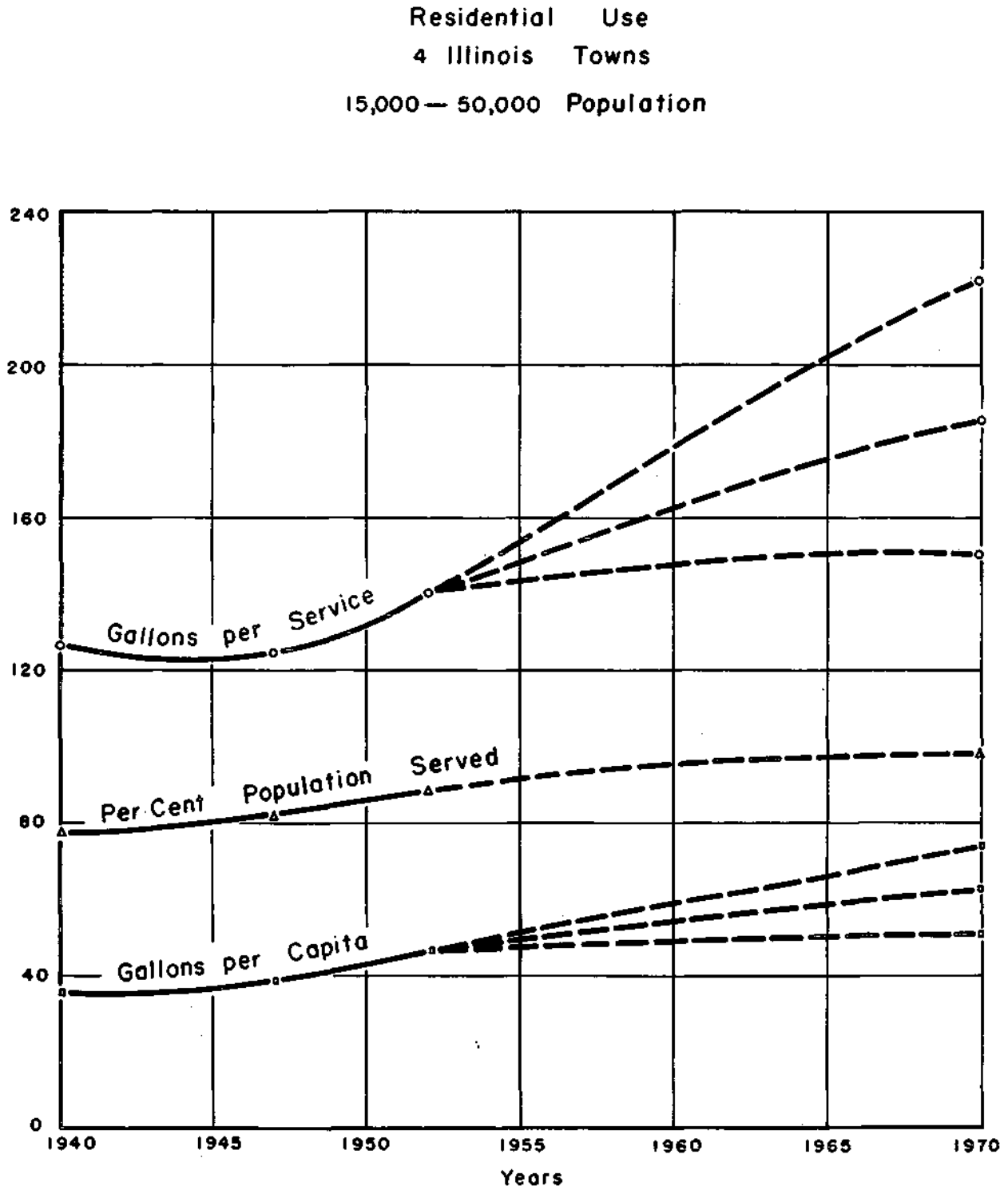
Residential Use
4 Illinois Towns
15,000 — 50,000 Population
240
200
160
120
80
40
0
Gallons per Service
Per Cent Population Served
Gallons per Capita
1940
1945
1950
1955
1960
1965
1970
Years

FIGURE 14.

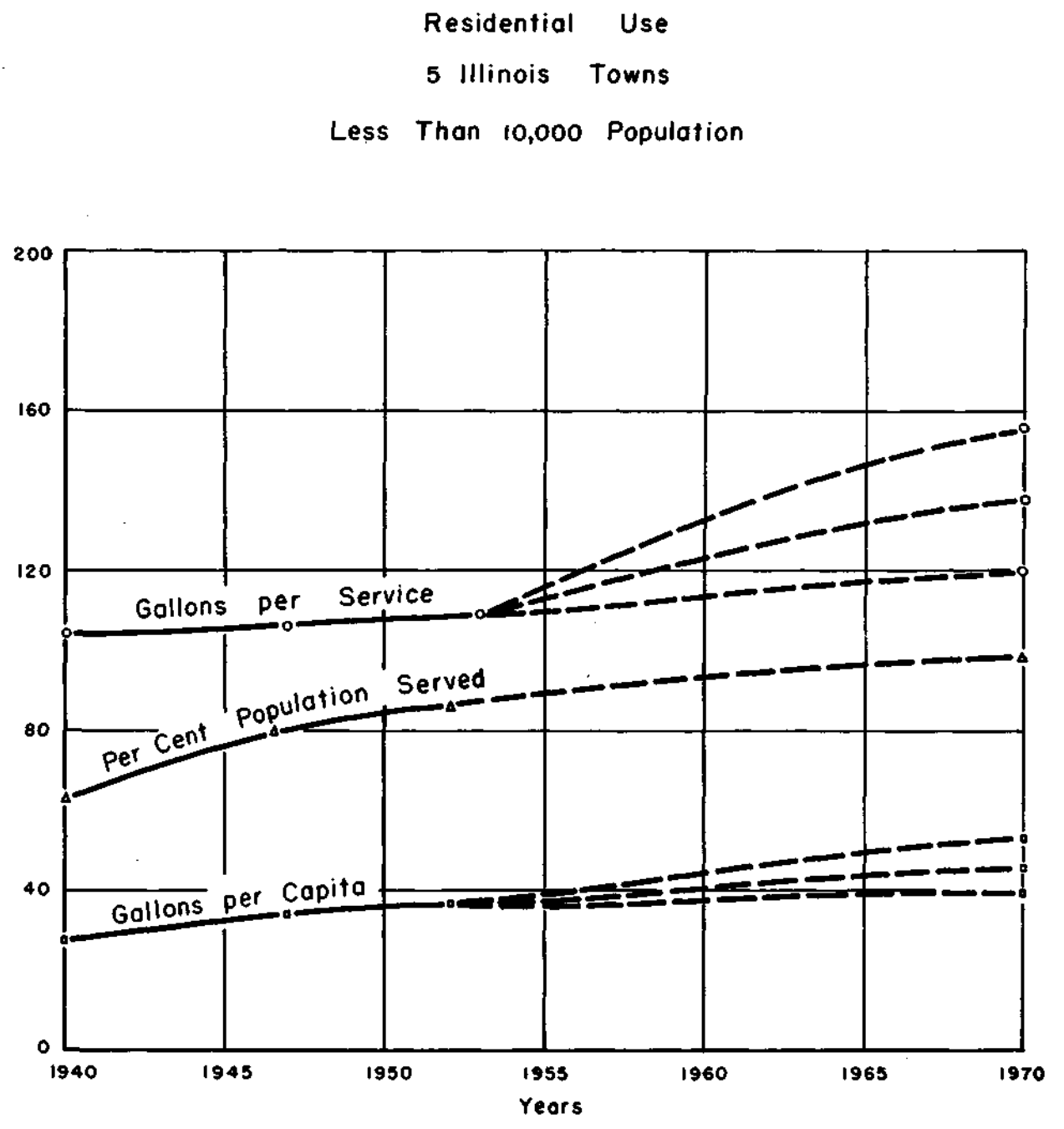
Residential Use
5 Illinois Towns
Less Than 10,000 Population
200
160
120
80
40
0
Gallons per Service
Per Cent Population Served
Gallons per Capita
1940
1945
1950
1955
1960
1965
1970
Years

FIGURE 15

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APPENDIX

A

Year	Population	Occupied dwelling units	Persons per household	Services				Consumption									Piped running water		Residential	
				Total	Residential	Commercial	Industrial	Population served	Per cent of total population served	Total pumpage	Residential	Commercial	Industrial	Total sales	Free	Losses unaccounted for	Per cent of pumpage	in dwelling units	per cent of total dwelling units	Gallons per capita	Gallons per service
		no.	no.	no.	no.	no.	no.		%	mgd	mgd	mgd	mgd	mgd	mgd	mgd	%	no.	%	gpd	gpd
1930	1630		3.74																		
1939				232	200			714	43	0.023	0.013	0.01								20	65
1940	1657		3.56	240	208			761	46	0.03	0.02	0.01								26	97
1941				251	219			772	47	0.030	0.019	0.01				0.001				25	87
1942				272	240	32		835	51	0.030	0.02	0.01								24	83
1943				287	248			855	52	0.030	0.02	0.01								23	81
1944				348	309			1050	63	0.035	0.025	0.01								24	81
1945				373	334	39		1124	68	0.041	0.031	0.01								27	93
1946				407	362			1200	72	0.053	0.041	0.01				0.002				34	113
1947				445	400			1318	79	0.059	0.048	0.011								36	120
1948				480	435			4370	83	0.06	0.048	0.011				0.001				35	110
1949				501	456			1364	83	0.052	0.041	0.010				0.001				30	91
1950	1652	566	2.92	527	482	45		1408	85	0.057	0.046	0.011						482	82.8	33	96
1951				556	504			1460	88	0.062	0.05	0.012								34	99
1952				578	526	52		1511	91	0.075	0.061	0.014								40	116
1953				593	540	53		1545	93	0.065	0.051	0.014								33	95
1954				609	556	53		1580	96	0.036	0.024	0.012								15	43

C

Year	Population	Occupied dwelling units	Persons per household	Services				Consumption								Piped running water		Residential	
				Total	Residential	Commercial	Industrial	Population served	Per cent of total population served	Total pumpage	Residential	Commercial	Industrial	Total sales	Free	Losses unaccounted for	Per cent of pumpage	in dwelling units	per cent of total dwelling units	Gallons per capita	Gallons per service
		no.	no.	no.	no.	no.	no.		%	mgd	mgd	mgd	mgd	mgd	mgd	mgd	%	no.	%	gpd	gpd
1930	5955	1455	4.08																		
1940	5418	1551	3.49	1140																	
1941				1140																	
1942				1151	1111	34	6	3800	73	0.13	0.10	0.02	0.01	0.13				1177	75.4	26	91
1943				1199																	
1944				1312																	
1945				1411																	
1946				1444	1406	32	6	4620	93	0.14	0.11	0.02	0.01	0.14						24	78
1947				1469																	
1948				1462																	
1949				1479																	
1950	4605	1520	2.94	1480														1440	92.5		
1951				1472	1429	35	8	4175	91	0.17	0.14	0.02	0.01	0.17						34	98
1952				1471	1428	35	8	4160	91	0.18	0.15	0.02	0.01	0.18						36	105
1953				1492	1449	35	8	4150	91	0.18	0.15	0.01	0.01	0.17						36	104
1954				1482	1436	38	8	4130	91	0.12	0.09	0.02	0.01	0.12						24	63

D

Year	Population	Occupied dwelling units	Persons per household	Services				Population served	Per cent of total population served	Consumption								Piped running water		Residential	
				Total	Residential	Commercial	Industrial			Total pumpage	Residential	Commercial	Industrial	Total sales	Free	Losses unaccounted for	Per cent of pumpage	in dwelling units	per cent of total dwelling units	Gallons per capita	Gallons per service
		no.	no.	no.	no.	no.	no.		%	mgd	mgd	mgd	mgd	mgd	mgd	mgd	%	no.	%	gpd	gpd
1940	4101	1041	3.94	1000				3380	83	0.386	0.123	0.067	0.070	0.260	0.03	0.096	24	1061	99.4	36	143
1941			3.91	1047				3540	84	0.512	0.140	0.086	0.125	0.351	0.03	0.131	26			40	155
1942			3.88	1094				3700	86	0.565	0.148	0.091	0.280	0.519	0.04	0.006	1			40	155
1943			3.85	1141				3850	87	0.830	0.147	0.093	0.572	0.812	0.012	0.006	1-			38	146
1944			3.83	1188				4000	89	1.020					0.04	0.005	1-				
1945				1234	1094	126	14	4170	91	1.095	0.160	0.138	0.584	0.882	0.04	0.178	16			38	147
1946				1242	1097	130	15	4140	88	0.818	0.155	0.115	0.232	0.502	0.04	0.176	22			38	142
1947				1286	1118	150	17	4210	88	0.820	0.185	0.114	0.295	0.594	0.06	0.166	20			44	166
1948				1363	1207	139	17	4450	91	0.910	0.203	0.103	0.406	0.712	0.06	0.138	15			46	168
1949										0.923	0.208	0.122	0.409	0.740	0.06	0.123	13			47	168
1950	5139	1455	3.53	1461	1273	171	17	4500	88	1.030	0.218	0.163	0.409	0.790	0.07	0.170	16	1543	99.5	48	171
1951				1558	1373	170	15	4800	93	1.242	0.235	0.154	0.622	1.010	0.07	0.160	13			49	171
1952				1589	1397	176	16	4850	94	1.015	0.223	0.144	0.447	0.815	0.07	0.130	13			46	160
1953				1651	1458	171	22	5010	98	0.846	0.248	0.161	0.262	0.672	0.08	0.094	11			50	171
1954				1786	1566	197	23	5500		1.062	0.255	0.185	0.369	0.808	0.07	0.184	17			46	163
1955				1809	1684	202	23	6025		1.039	0.294	0.167	0.284	0.744	0.08	0.215	21			49	174

E

Year	Population	Occupied dwelling units	Persons per household	Services					Consumption							Piped running water		Residential	
				Total	Residential	Commercial	Industrial	Population served	Per cent of total population served	Total pumpage	Residential	Commercial	Industrial	Total sales	Free	Losses unaccounted for	Per cent of pumpage	in dwelling units	per cent of total dwelling units	Gallons per capita	Gallons per service
		no.	no.	no.	no.	no.	no.		%	mgd	mgd	mgd	mgd	mgd	mgd	mgd	%	no.	%	gpd	gpd
1930	4309	1228	3.51																		
1938				763	612	151		2020	44	0.17	0.05	0.05	0.03	0.13		0.04	23			25	82
1939				770	634	136		2075	44	0.16	0.05	0.05	0.03	0.13		0.03	19			24	79
1940	4809	1470	3.27	793	657	136		2145	45	0.15	0.05	0.05	0.03	0.13		0.02	13	778	52.0	23	76
1941				829	700	129		2290	47	0.16	0.05	0.05	0.03	0.13		0.03	19			22	72
1942				850	700	150		2285	46	0.18	0.04	0.04	0.03	0.11		0.07	39			18	57
1943				870	720	150		2340	46	0.19	0.06	0.05	0.03	0.14		0.05	26			26	83
1945				963	800	163		2580	49	0.23	0.08	0.05	0.03	0.16		0.07	30			31	100
1946				1039	859	180		2765	51	0.22	0.09	0.05	0.03	0.17		0.05	23			33	105
1947				1151	960	191		3075	54	0.24	0.12	0.05	0.03	0.20		0.04	17			39	125
1948				1235	1035	200		3300	58	0.27	0.12	0.05	0.03	0.20		0.07	26			36	116
1949				1238	1033	205		3270	58	0.25	0.13	0.06	0.03	0.22		0.03	12			40	126
1950	5792	1841	3.14	1393	1183	210		3720	64	0.27	0.13	0.06	0.03	0.22		0.05	19	1339	71.0	35	110
1951				1465	1250	215		3900	68	0.29	0.14	0.06	0.03	0.23		0.06	21			36	112
1952				1576	1358	218		4200	73	0.32	0.15	0.06	0.03	0.24		0.08	25			36	111
1953				1756	1526	230		4730	82	0.30	0.13	0.06	0.03	0.22		0.08	27			37	85
1954				1855	1620	235		5010	87	0.28	0.13	0.07	0.03	0.23		0.05	18			36	80

F

Year	Population	Persons per household	Persons per O.D.U.	Services				Population served	Per cent of total population served	Consumption								Piped running water		Residential	
				Total	Residential	Commercial	Industrial			Total pumpage	Residential	Commercial	Industrial	Total sales	Free	Losses unaccounted for	Per cent of pumpage	in dwelling units	per cent of total dwelling units	Gallons per capita	Gallons per service
		no.	no.	no.	no.	no.	no.		%	mgd	mgd	mgd	mgd	mgd	mgd	mgd	%	no.	%	gpd	gpd
1930	8781	2552	3.44																		
1938				1800	1783	15	2	5800	63	0.88	0.66	0.04	0.18							114	370
1940	9281	2893	3.21	1940	1923	15	2	6160	66	0.72	0.51	0.03	0.18					1961	66.0	83	266
1946				2360	2343	15	2	7040	75	1.03	0.82	0.03	0.18							116	350
1949				2800	2783	15	2	8060	85	0.79	0.58	0.03	0.18							72	208
1950	9460	3314	2.85				2											2610	79.0		
1952				2900	2883	15	2	8090	86	0.77	0.70	0.03	0.04							87	242
1953				3000	2983	15	2	8360	89	0.80	0.73	0.03	0.04							87	244
1954				3300	3283	15	2	9200	97	0.51	0.44	0.03	0.04							48	134

G

Year	Population	Occupied dwelling units	Persons per household	Services				Population served	Per cent of total population served	Consumption							Piped running water		Residential	
				Total	Residential	Commercial	Industrial			Total pumpage *	Residential	Commercial	Industrial	Total sales *	Free	Losses unaccounted for	Per cent of pumpage	in dwelling units	per cent of total dwelling units	Gallons per capita	Gallons per service
		no.	no.	no.	no.	no.	no.		%	mgd	mgd	mgd	mgd	mgd	mgd	mgd	%	no.	%	gpd	gpd
1930	12583	3502	3.61																		
1937				3165	2900			10300	73	1.15	0.43	0.06	0.62	1.14		0.01	1			42	150
1938				3270	3000			10600	68	1.41	0.51	0.19	0.67	1.40		0.01	1			47	171
1939				3374	3150			11000	69	1.58	0.55	0.32	0.61	1.56		0.02	1			50	175
1940	16343	4718	3.50															4012	84.2		
1944			3.3	3895	3624	265		11975	78	1.94	0.34	0.41	1.05	1.93		0.01	1			28	93
1946			3.2	4145	3873	266		12400	84	1.93	0.45	0.50	0.86	1.92		0.01	1			36	116
1947				4324	4051	267		12750	88	2.08	0.45	0.60	0.87	2.05		0.03	2			35	111
1950	13863	4609	3.00															4546	95.0		
1951				4851	4563	282		13700	99	2.23	0.54	0.45	0.83	1.98		0.25	11			40	119
1952				5003	4732	269		14200	99	2.15	0.62	0.45	0.62	1.87		0.28	13			45	131
1953				5162	4780	376		14350	99	2.24	0.56	0.46	0.59	1.83		0.41	18			41	117
1954					4800			14400	99	2.10	0.57	0.45	0.46	1.66		0.44	21			41	119

* Total pumpage and total sales includes small towns but number of meters and dwelling units for small towns are not known.

Gallons per capita and gallons per service are computed for G only.

H

Year	Population	Occupied dwelling units	Persons per household	Services				Population served	Per cent of total population served	Consumption							Losses unaccounted for	Per cent of pumpage	Piped running water		Residential	
				Total	Residential	Commercial	Industrial			Total pumpage	Residential	Commercial	Industrial	Total sales	Free				in dwelling units	per cent of total dwelling units	Gallons per capita	Gallons per service
		no.	no.	no.	no.	no.	no.		%	mgd	mgd	mgd	mgd	mgd	mgd	mgd	%	no.	%	gpd	gpd
1930	14631	3854	3.80																			
1936				3700																		
1940	15827	4648	3.41	4100	3821	275	4	13050	82	1.48	0.59	0.10	0.59	1.28		0.20	13	3596	75.5	45	155
1941				4200	3921	275	4	13200	82	1.47	0.57	0.10	0.60	1.27		0.20	14			43	146
1942																						
1943																						
1944				4500	4220	275	5	13700	82	1.72	0.60	0.22	0.70	1.52		0.20	12			44	142
1945						275	5															
1946																						
1947				4800	4520	275	5	14050	82	2.42	0.69	0.43	0.98	2.10		0.32	13			49	153
1948				4900	4620	275	5	14250	82	2.46	0.69	0.43	0.98	2.10		0.36	15			48	149
1949																						
1950	17547	5712	3.00	5100	4795	300	5	14300	82	2.28	0.72	0.43	0.95	2.10		0.18	8	5450	94.0	50	151
1951																						
1952				5300	4995	300	5	14675	84	2.36	0.80	0.43	0.78	2.01		0.35	15			55	160
1953				5400	5095	300	5	14900	85	2.25	0.80	0.43	0.73	1.96		0.29	13			54	156
1954				5500	5195	300	5	15200	87	1.52	0.60	0.31	0.29	1.20		0.32	21			40	116
1955				5600	5295	300	5	15475	88													

Year	Population	Occupied dwelling units	Persons per household	Services							Consumption								Piped running water		Residential	
				Total	Residential	Commercial	Industrial	Population served	Per cent of total population served	Total pumpage	Residential	Commercial	Industrial	Total sales	Free	Losses unaccounted for	Per cent of pumpage	in dwelling units	per cent of total dwelling units	Gallons per capita	Gallons per service
		no.	no.	no.	no.	no.	no.		%	mgd	mgd	mgd	mgd	mgd	mgd	mgd	%	no.	%	gpd	gpd
1940	22366	6622	3.48							1.43								6443	97.2		
1941				6398	5828	570				1.50											
1942				6446	5876	570				1.64											
1943				6458	5888	570		19900	89	1.60	0.66	0.24	0.30	1.20	0.24	0.16	10			33	111
1944				6520	5950	570		20000	89	1.71	0.69	0.25	0.37	1.31	0.24	0.16	9			35	116
1945				6567	5967	570		19850	89	1.70	0.69	0.25	0.36	1.30	0.24	0.15	9			35	116
1946				6622	6052	570		20000	89	1.81	0.74	0.28	0.39	1.41	0.24	0.16	9			37	122
1947				6711	6141	570		20200	90	2.03	0.84	0.31	0.48	1.63	0.24	0.16	8			42	137
1948				6813	6243	570		19750	88	2.13	0.86	0.31	0.51	1.68	0.27	0.18	8			44	138
1949				6923	6353	570		19350	87	2.17	0.87	0.32	0.58	1.77	0.24	0.16	7			45	137
1950	22467	7092	3.00	7015	6445	570		19250	86	1.97	0.83	0.30	0.46	1.59	0.23	0.15	8	7042	98.0	45	128
1951				7076	6516	570		19500	87	1.98	0.82	0.30	0.51	1.63	0.23	0.15	8			42	126
1952				7254	6684	570		19700	88	1.93	0.84	0.31	0.50	1.65	0.23	0.15	8			43	126
1953				7446	6874	572		19900	89	2.18	0.89	0.33	0.65	1.87	0.13	0.08	4			45	129
1954				7524	6952	572		20550	92	2.07	0.88	0.33	0.59	1.80	0.17	0.10	5			43	126
1955										2.52											

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Year	Population	Occupied dwelling units	Persons per household	Services.						Consumption								Piped running water		Residential	
				Total	Residential	Commercial	Industrial	Population served	Per cent of total population served	Total pumpage	Residential	Commercial	Industrial	Total sales	Free	Losses unaccounted for	Per cent of pumpage	in dwelling units	per cent of total dwelling units	Gallons per capita	Gallons per service
		no.	no.	no.	no.	no.	no.		%	mgd	mgd	mgd	mgd	mgd	mgd	mgd	%	no.	%	gpc	gpd
1930	39241	10756	3.65																		
1939																					
1940	40469	11974	3.38	9973						3.40								11944	97.4		
1942				10078						2.72											
1943				9989						2.79											
1944				10069						3.03											
1945				10102						3.06											
1947				10361	9379	904	78	30200	73	3.63	1.07	1.06	0.82	2.95		0.68	19			35	114
1948				10517	9535	904	78	30000	73	3.77	1.22	1.21	0.82	3.25		0.52	14			40	128
1949				10714	9732	904	78	29600	72	3.82	1.26	1.25	0.76	3.27		0.55	14			43	130
1950	41450	13557	3.00	10955	9773	904	78	29300	70	3.58	1.29	1.29	0.70	3.28		0.30	8	13327	98.5	44	132
1951				11272	10290	904	78	30500	74	3.42	1.25	1.25	0.63	3.13		0.29	9			41	122
1952				11495	10513	904	78	30900	74	3.82	1.32	1.31	0.70	3.33		0.49	13			43	126
1953				11534	10552	904	78	30700	74	3.90	1.37	1.36	0.76	3.49		0.41	10			45	128
1954				11807	10825	904	78	32250	77	4.00	1.36	1.35	0.88	3.59		0.41	10			42	126
1955				12137	11155	904	78	34000	81	4.33	1.37	1.38	1.00	3.75		0.58	13			41	123

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Urbana

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