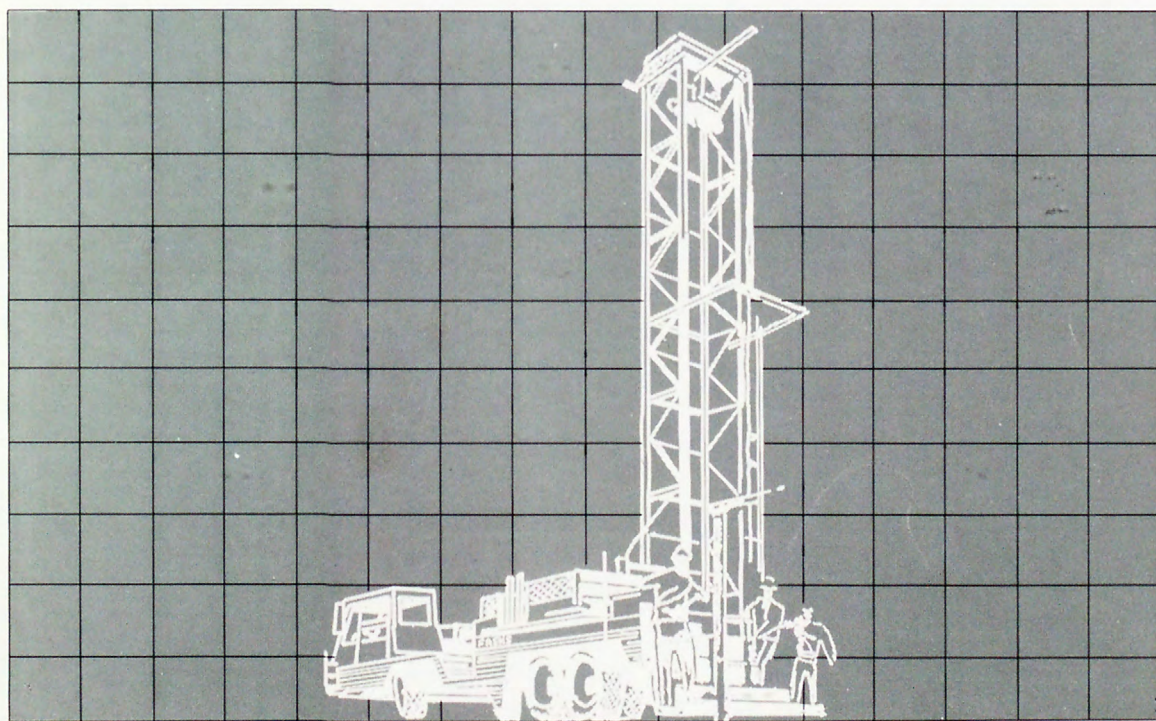


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NATIONAL AND REGIONAL TRENDS IN WATER- WELL DRILLING IN THE UNITED STATES, 1964-84

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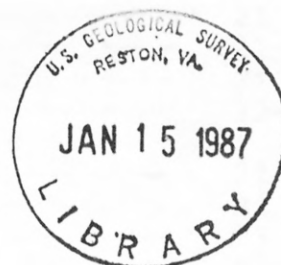
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NATIONAL AND REGIONAL TRENDS IN WATER-WELL DRILLING IN THE
UNITED STATES, 1964-84

By S. M. Hindall and Michael Eberle

U.S. GEOLOGICAL SURVEY

Open-File Report 87-247



Columbus, Ohio

1987

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NATIONAL AND REGIONAL TRENDS IN WATER-WELL
DRILLING IN THE UNITED STATES, 1964-84

By S. M. Hindall and Michael Eberle

ABSTRACT

Information on national and regional water-well drilling activity is important for water-resource planning and management and for water-related equipment marketing. This report describes a study to analyze drilling trends on the basis of data for selected years from 1964 through 1984. The study focused primarily on the years 1964 and 1980-84, but also included data from 1960.

Approximately 397,000 water wells were drilled in the United States in 1984. Seven states--Florida, Texas, New York, Michigan, North Carolina, Virginia, and Ohio--accounted for 39 percent of all the wells drilled in the United States in 1984. Florida led the nation in drilling activity with 45,600 new wells. The 1984 national drilling total was 2.6 percent greater than the total for 1980 (387,000) and 8.5 percent less than the total for 1964 (434,000). However, these moderate differences do not reflect substantial year-to-year fluctuations that may have occurred during that 20-year period.

Qualitative comparisons suggest that drilling activity for a given year is closely related to the number of housing starts for that year. If so, there may have been peaks in drilling activity in 1972 and 1977-78 (corresponding to peaks in housing starts) that are not identified in this study because of a lack of available well-drilling data for those years. Well-drilling data for 1964 and the 1980-84 period probably represent a low to moderate level of drilling activity, and, if compared to earlier data, suggest that there has been no substantial growth or decline in the water-well industry as a whole since the 1940's.

INTRODUCTION

Ground water--the source of about 40 percent of the water used in the United States exclusive of power generation (Heath, 1983, p. v)--has received much attention in recent years as the value of this resource and its vulnerability to contamination became increasingly apparent to the general public. Except for modest supplies derived from developed springs, driven wells, and hand-dug wells still in use in rural areas, virtually all of the ground water produced in the United States today is provided by drilled or bored wells.

Although information on water-well drilling activity may be of interest to the general reader, drilling-trend data is of particular importance in two fields:

1. National and regional water planning--Information on numbers of wells drilled annually provides a means of corroborating estimates of ground-water withdrawal, indicates changing patterns in water use, and highlights potential problems of supply and demand.
2. Water-related equipment marketing--Technical advances during the 20th century have resulted in numerous products to improve water-well yield, reliability, sanitary quality, and ease of delivery to the point of use. Construction of domestic wells, for example, creates markets for water-system components such as well casing and screens; pumps and associated piping, valves, and electrical controls; pressure tanks; and water-treatment equipment. Construction of large public, industrial, and irrigation wells stimulates sales of correspondingly large water-handling machinery. Information on national and regional trends in drilling activity is of obvious value to water-equipment manufacturers and suppliers in analyzing and forecasting changes in their markets.

Despite the need for such information, no summary and interpretation of national and regional drilling data for the United States has been compiled or printed since the U.S. Geological Survey published a national report in 1966 based on data for 1960 and 1964 (Meyer and Wyrick, 1966).

Purpose and Scope

The purpose of this report is to summarize and interpret current trends in national and regional water-well drilling activity by (1) comparing data reported by Meyer and Wyrick (1966) for 1964 with data available for 1980 through 1984, and (2) discussing the possible influences of economic activity, demographic changes, and natural phenomena on well-drilling activity. Special emphasis is given to data from 1964 and 1980-84--years that were initially selected in this study to highlight "long-term" (1964-84) and "recent" (1980-84) trends. For consistency in the discussion of regional trends, the same groupings of contiguous States used by Meyer and Wyrick have been adopted for this report.

This report is intended only as general review of data readily available at the time of study (1986). These data are of uneven quality and of limited detail--for example, the data cannot be used to distinguish between uses of wells (such as for homes, for irrigation, for industry, or for public-supply systems). The

data are annual data, some of which are from widely separated years. Increases or decreases from one year to the next should not be interpreted as steady because significant annual fluctuations may have occurred in the intervening years. Exhaustive data collection and quantitative statistical analysis were beyond the scope of this investigation.

Sources of Data

The 1980-84 data presented in this report were compiled for the U.S. Geological Survey by the National Water Well Association (NWWA)--a trade and professional organization for the water-well industry. NWWA maintains a State-by-State data file on water-well drilling in the United States. This file had its beginnings with an NWWA survey of the water-well industry in 1981 and now is being updated annually.

The primary sources of information from which NWWA estimates numbers of wells drilled annually are State agencies responsible for archiving drillers' logs and well-completion reports and for certifying or licensing drilling contractors and pump installers. Secondary data sources used by NWWA include State boards of health; State water-well associations; national trade organizations for related water industries; periodic surveys of NWWA members or readers of water-well industry magazines and newsletters; personal contacts with suppliers, manufacturers and drillers; State and county agricultural extension agents; and reports on the construction industries by the U.S. Bureau of the Census and the Internal Revenue Service. Most of the data obtained from secondary sources are anecdotal or fragmentary but are useful in many cases for corroborating or supplementing data from the primary sources.

The estimates provided by NWWA for total wells drilled annually in each of the 50 States can be ranked into three levels of accuracy. At the highest level, State-agency officials believe that reporting requirements, and compliance with those requirements, are good enough to provide reasonably accurate numbers of wells drilled; thus, for these States, primary-source data were used as is. At the next level, the State-agency officials were able to estimate the total number of wells drilled from incomplete information available to them; for these States, primary-source data were corroborated or adjusted on the basis of secondary-source data. At the lowest level, State-agency officials had little or no information available on the number of wells drilled annually; hence, NWWA made estimates solely on the basis of secondary data sources. Approximately 85 percent of the 1980-84 data presented in this report were partially estimated by the source organization or NWWA staff. Of that 85 percent, NWWA believes that about 30 percent of the numbers are based entirely on secondary sources.

Most State agencies do not keep records of the types of wells (domestic, irrigation, industrial, and public supply) drilled annually; therefore, it was impossible to analyze primary-source data for trends by well-use type. Secondary-source data also were insufficient for analysis by well-use type.

The Water-Well Industry in the United States in 1984

Recent estimates from diverse sources indicate that approximately 8,000 water-well drilling contractors operated approximately 20,000 drilling rigs in the United States in 1984, as compared with 9,500 contractors operating 27,000 rigs in 1964 (National Water Well Association, 1983, sections V and VI). Although some of the apparent decline in numbers of firms and drill rigs may be a result of differences in estimation methods, the economic recession of the mid-1970's may well have forced several hundred drilling firms out of business because of the pronounced decrease in housing construction (U.S. Bureau of the Census, 1986, p. 724-5). Subsequent peaks in drilling activity are more likely the result of increased amounts of work by surviving firms rather than entrance of new firms into the industry, and it is reasonable to assume that the water-well-contractor workforce as a whole has indeed declined somewhat (K. B. McCray, National Water Well Association, oral commun., 1986).

In 1984, these firms drilled an estimated 397,000 wells. The estimated average cost per well to customers was \$2,600 (Water Well Journal, 1985, p. 48), making the total annual water-well drilling business in excess of \$1 billion that year.

The small-business character of the industry has made estimates of water-well drilling activity difficult to obtain in past years. Although 10 percent of the industry (in 1980) consisted of large firms whose drilling-services sales exceeded \$1 million, most water-well drilling firms were small businesses, many of which were family owned. Only about 37 percent of the firms in business in 1983 were corporations; 54 percent were sole proprietorships and 9 percent were partnerships (Water Well Journal, 1985, p. 48). The average number of employees per firm was 6.4 in 1980 (McCray, 1982, p. 73).

Acknowledgments

The authors wish to express their appreciation to Kevin B. McCray of the National Water Well Association for his advice and technical assistance in planning, providing data for, and reviewing this report. Gerald Meyer, Staff Scientist for the U.S. Geological Survey's Water Resources Division, served as an advisor for this publication.

TRENDS IN WATER-WELL DRILLING

National Trends

Figure 1 and table 1 show the number of wells drilled, by State, in 1984. In general, most wells are drilled in States that have abundant ground-water supplies and large populations. Seven States account for 39 percent of all the wells drilled in 1984. Drilling was most intensive in Florida, where more than 45,600 wells accounted for 11 percent of the United States total in 1984. In declining order, the other six States with the largest annual totals for 1984 were Texas, New York, Michigan, North Carolina, Virginia, and Ohio. Six of these seven States also were the leaders in drilling activity in 1964.

In terms of the number of wells drilled per unit of population (fig. 2), more than 3.0 wells were drilled per 1,000 people in 1984 in Alaska, Delaware, Florida, Maine, Michigan, Montana, New Hampshire, Vermont, Virginia, and Wyoming. The United States average in 1984 was 1.7 wells drilled per 1,000 people, as compared with 2.3 wells drilled per 1,000 people in 1964. The fewer new wells per unit of population in 1964 than in 1984 may be attributable to a reported increase in the number of people and the percentage of the total population served by community or public water-supply systems. In 1980, for example, public water supplies served about 186 million people or 81 percent of the population; in 1960, public systems served 136 million people or 75 percent of the population (Solley and others, 1983, p. 10; MacKichan and Kammerer, 1961, p. 7; U.S. Bureau of the Census, 1986, p. 5).

The number of wells drilled annually in the United States from 1980 through 1984 ranged from 336,000 (in 1982) to 397,000 (in 1984) and averaged 370,000. The national total of wells drilled in 1984 was 8.5 percent less than the national total in 1964. National totals decreased from 1980-82, then increased from 1982-84; overall, 2.6 percent more wells were drilled in 1984 than in 1980 (table 1).

There are considerable differences in total wells drilled in 1964 and 1984 in several States. Totals in 1984 were greater by at least 80 percent than totals in 1964 for Alaska, Arizona, Louisiana, Maine, New Jersey, Rhode Island, Vermont, and Washington. Totals in 1984 were at least 39 percent less than totals in 1964 for Hawaii, Iowa, Kentucky, Mississippi, Nebraska, North Dakota, South Dakota, and West Virginia. Totals in 1984 were at least 36 percent greater than totals in 1980 for Delaware, Maine, New Hampshire, New Jersey, North Carolina, Rhode Island, and Virginia, whereas totals in 1984 were at least 23 percent less than totals in 1980 for Hawaii, Idaho, Iowa, Michigan, Montana, Oregon, Pennsylvania, South Carolina, and South Dakota.

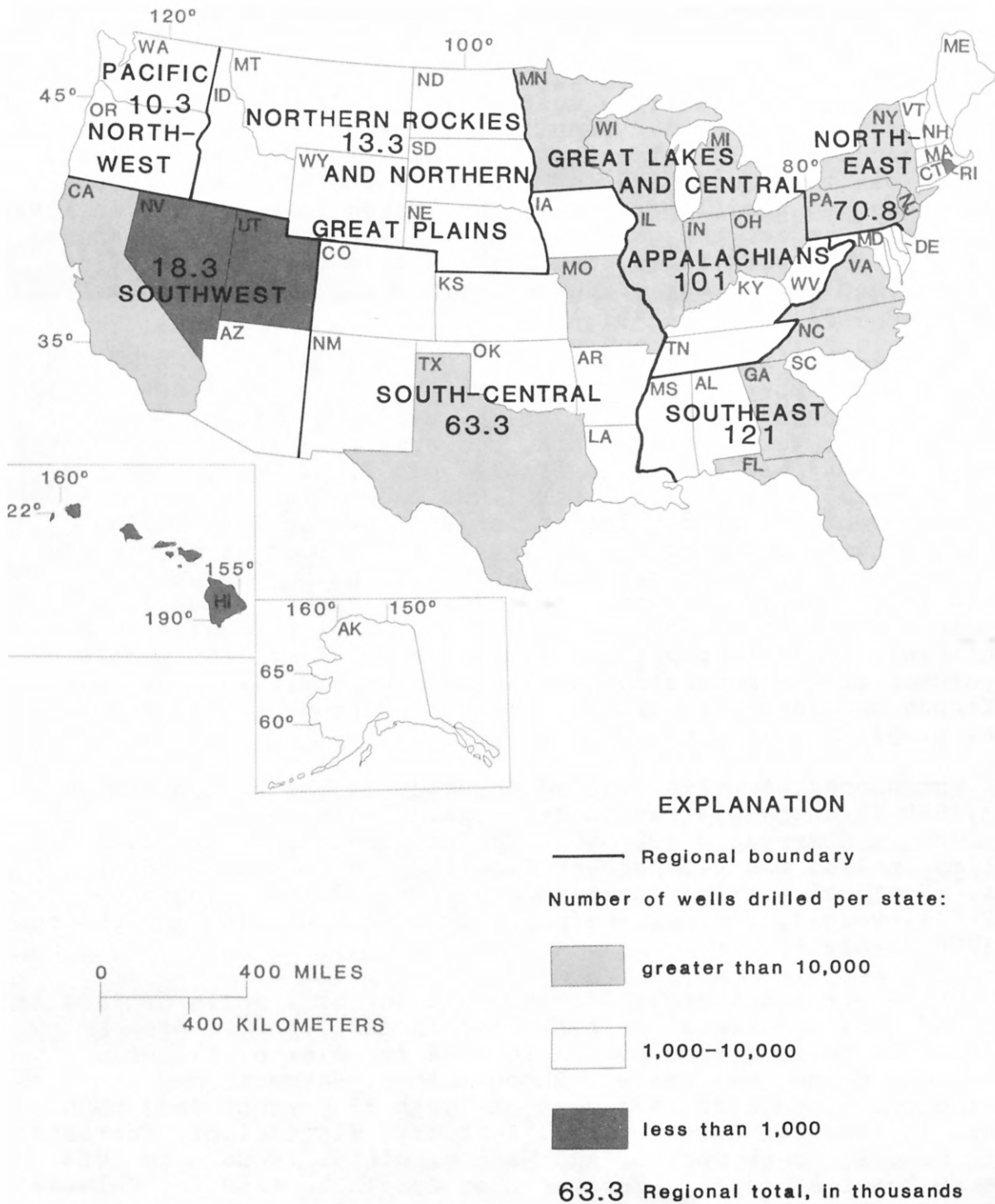


Figure 1.—Number of water wells drilled in the United States, by State and region, 1984.

Table 1.--Estimated number of water wells drilled in the United States, by State, 1960, 1964, and 1980-84

[Data for 1960 and 1964 from Meyer and Wyrick (1966). Data for 1980-84 based mainly on data supplied by State water agencies, modified and supplemented by other data available to the National Water Well Association. Columns may not add to totals because of independent rounding. NC, no change; ND, no data available.]

State	Estimated number of wells drilled ¹							Percent of total drilled in 1984	Percentage change ² between annual totals		
	1960	1964	1980	1981	1982	1983	1984		1960 and 1964	1964 and 1980	1980 and 1984
Alabama-----	4,000	4,500	5,960	6,420	5,920	5,570	6,260	1.6	+13	+ 39	+5
Alaska-----	726	1,000	2,440	2,400	2,400	2,800	2,700	.68	+38	+170	+11
Arizona-----	1,400	1,520	2,190	2,220	2,380	2,710	2,760	.7	+8.6	+82	+26
Arkansas-----	5,000	5,000	4,010	5,910	2,750	3,320	4,200	1.1	NC	-16	+5
California-----	9,100	10,000	17,100	15,900	11,300	11,000	14,300	3.6	+10	+43	-16
Colorado-----	3,100	5,910	4,910	4,570	4,390	4,360	4,060	1.0	+91	-31	-17
Connecticut-----	6,500	6,500	5,470	5,410	4,500	5,140	5,780	1.5	NC	-11	+6
Delaware-----	3,800	3,440	2,000	2,680	2,290	2,700	3,100	.78	-9.5	-10	+55
District of Columbia-	12	12	ND	0	0	0	ND	ND	NC	ND	ND
Florida-----	33,900	55,000	40,200	40,500	38,900	43,200	45,600	11	+62	-17	+13
Georgia-----	10,500	10,000	11,000	13,400	10,100	10,800	12,200	3.1	- 4.8	+22	+11
Hawaii-----	17	21	11	11	7	7	2	<0.1	+24	-90	-82
Idaho-----	1,400	1,400	2,880	1,470	2,400	1,590	1,630	.35	NC	+16	-43
Illinois-----	21,000	19,500	14,000	12,200	13,400	13,600	15,300	3.9	-7.1	-22	+9.3
Indiana-----	17,700	15,000	9,670	8,180	9,700	9,180	10,300	2.6	-15	-31	+6.5
Iowa-----	9,000	15,000	5,890	6,850	4,120	3,780	3,140	.79	+67	-79	-47
Kansas-----	4,700	5,500	4,530	5,050	3,380	3,420	3,910	1.0	+17	-29	-14
Kentucky-----	9,880	9,620	5,060	5,100	4,800	5,440	5,740	1.4	-2.6	-40	+13
Louisiana-----	974	2,620	6,050	6,830	6,580	5,180	5,560	1.4	+170	+110	-8.1
Maine-----	1,500	1,700	2,860	2,570	2,440	3,470	3,900	1.0	+13	+130	+36
Maryland-----	4,020	6,900	7,200	8,000	6,700	8,800	8,300	2.1	+72	+20	+15
Massachusetts-----	8,000	9,000	6,330	6,270	5,370	6,820	7,670	1.9	+12	-15	+21
Michigan-----	25,000	25,000	24,000	20,000	16,000	17,000	18,500	4.7	NC	-26	-23
Minnesota-----	13,000	9,000	14,400	10,500	10,800	11,100	12,500	3.1	-31	+39	-13
Mississippi-----	5,300	5,900	2,670	3,550	2,540	2,400	2,640	.66	+11	-55	-1

Table 1.--Estimated number of water wells drilled in the United States, by State, 1960, 1964, and 1980-84--Continued

State	Estimated number of wells drilled ¹							Percent of total drilled in 1984	Percentage change ² between annual totals		
	1960	1964	1980	1981	1982	1983	1984		1960 and 1964	1964 and 1980	1980 and 1984
Missouri-----	6,380	9,990	10,900	8,530	7,830	10,200	11,500	2.9	+57	+15	+5.5
Montana-----	1,900	2,000	3,580	6,410	6,260	2,360	2,560	.64	+5.3	+28	-28
Nebraska-----	5,510	6,000	4,500	5,940	3,470	3,260	3,660	.92	+8.9	-39	-19
Nevada-----	824	825	775	765	503	639	718	.18	NC	-13	-7.4
New Hampshire-----	3,600	4,400	3,050	4,190	2,630	5,210	5,860	1.5	+22	+33	+92
New Jersey-----	3,800	3,440	8,620	8,540	8,580	10,900	13,100	3.3	-9.5	+280	+52
New Mexico-----	2,290	3,150	2,750	2,880	3,370	3,430	3,110	.78	+38	-1.3	+13
New York-----	25,000	25,000	16,800	17,000	15,600	17,800	20,000	5.0	NC	-20	+19
North Carolina-----	20,000	25,000	10,500	12,000	13,500	15,900	17,100	4.3	+25	-32	+63
North Dakota-----	4,200	3,760	1,710	2,190	1,450	1,480	1,450	.36	-10	-61	-15
Ohio-----	17,100	18,600	16,700	14,300	14,200	14,000	15,700	4.0	+8.8	-160	-6.0
Oklahoma-----	4,400	5,000	7,980	7,630	6,500	5,870	6,590	1.8	+14	+32	-17
Oregon-----	3,500	4,500	7,500	6,620	3,800	3,550	3,530	.89	+29	-22	-53
Pennsylvania-----	13,500	16,200	15,600	12,400	9,620	8,140	10,800	2.7	+20	-33	-31
Rhode Island-----	200	250	319	240	206	387	548	.14	+25	+120	+72
South Carolina-----	5,300	5,400	11,400	5,340	4,640	7,780	8,740	2.2	+1.9	+62	-23
South Dakota-----	6,080	5,430	2,210	1,820	1,590	1,330	1,500	.38	-11	-72	-32
Tennessee-----	10,000	8,000	7,080	7,130	6,710	7,600	8,020	2.0	-20	NC	+13
Texas-----	19,000	25,000	16,200	17,700	21,700	17,700	21,200	5.3	+32	-15	+31
Utah-----	630	650	630	547	507	488	548	.14	+3.2	-16	-13
Vermont-----	1,240	1,460	3,100	2,280	1,900	2,330	3,050	.77	+18	+110	-1.6
Virginia-----	8,500	10,000	10,900	8,830	9,060	15,300	16,900	4.3	+18	+69	+55
Washington-----	1,400	1,700	5,040	4,290	3,550	4,320	4,030	1.0	+21	+137	-20
West Virginia-----	5,500	5,900	3,280	3,510	2,730	2,580	2,900	.73	+7.3	-51	-12
Wisconsin-----	11,000	12,000	11,600	9,900	9,590	10,400	11,700	2.9	+9.1	-2.5	+86
Wyoming-----	1,000	1,000	3,010	3,680	2,970	2,500	2,520	.6	NC	+152	-16
Total	381,000	434,000	387,000	371,000	336,000	359,000	397,000	100	+14	-8.5	+2.6

¹Numbers rounded to three significant figures.²Numbers rounded to two significant figures.



Figure 2.--Number of water wells drilled per 1,000 people, by State and region, 1984.

Because of the lack of continuous, reliable, and consistent data on water-well drilling activity for most of this century, it has been difficult to relate drilling trends to the condition of the nation or to specific national events with any certainty. It generally is believed, however, that the water-well industry responds to the same national circumstances as the rest of the construction industry. Factors that appear to be most influential on water-well drilling activity were considered in this study in an effort to explain the significance of these trends. These factors fall into the categories of natural phenomena such as droughts and earthquakes, population change, and housing starts.

Drought is the most obvious and most common natural phenomenon that influences well-drilling activity. During periods of below-normal precipitation, water levels in surficial aquifers may decline to the point where shallow wells begin to go dry. Water-level declines due to drought generally spur drilling of domestic wells; shallow wells are deepened or replacement wells are drilled to deeper water-bearing zones that are more resistant to the effects of below-normal precipitation.

Prolonged drought also can stimulate drilling of irrigation, industrial, and municipal wells. Because regional ground-water reservoirs generally are depleted more slowly than surface-water reservoirs, farmers and municipal and industrial water managers may supplement or replace their surface-water supplies with ground water after experiencing service interruptions caused by severe drought.

Droughts of greater or less severity occur in one place or another almost every year. Some of the more notable droughts in the United States from 1964 through 1984 occurred in the Northeast in the mid-1960's, in the Southwest in the early 1970's, and in the Northern Rockies and Great Plains in the late 1970's and early 1980's (Karl and Knight, 1985). The last major drought that affected a large part of the Nation during this period occurred from 1976 through 1977, and was felt in the Southwest, Pacific Northwest, Northern Rockies and Northern Great Plains, and Great Lakes and Central Appalachians regions. Unfortunately, most of these droughts occurred between 1964 and 1980--a period for which very little drilling data are available. No conclusions could be drawn, and, until drilling data are available for a sufficient number of consecutive years to bracket a significant drought, a meaningful assessment of the effects of drought on drilling trends will not be feasible.

Earthquake is another natural phenomenon (although relatively uncommon except in the western part of the United States) that can affect the rate of well drilling, especially replacement wells for those that are destroyed or are rendered useless by an earthquake. Meyer and Wyrick (1966), for example, discuss how the Alaskan earthquake of March 1964 boosted water-well drilling in that State by 38 percent. From 1964 through 1984, 41 earthquakes in the conterminous United States had magnitudes of 5.5 or more on the

Richter scale (National Oceanic and Atmospheric Administration-National Geophysical Data Center, written commun., 1986). All these earthquakes occurred in the West, and most were in southern California and Nevada. No evidence exists to link increased drilling activity to any of these earthquakes, although it is possible that some replacement wells were drilled as a result of earthquake damage to wells or sudden, permanent drops in water levels.

Water use in the United States has increased as the population has increased, presumably because of a corresponding increase in water demand. For example, comparisons of 1950 and 1980 data (MacKichan, 1951, p. 6-7; Solley and others, 1983, p. 10-14; and U.S. Bureau of the Census, 1986, p. 5) show that (1) population increased 50 percent, (2) ground-water use by public ("municipal") water supplies increased 230 percent, and (3) rural domestic and livestock ground-water use increased 50 percent.

Some of these increases in ground-water use most likely reflect greater production from existing wells, in part because of changing lifestyles (and associated higher per capita water demands) and, in part, because of improvements in well pumps during the period. Although it is reasonable to assume that an increasing United States population has had a strong influence on the number of wells in operation, the influence of population growth on the number of wells drilled annually is much less clear. The data examined in this study suggest that annual change in population for a given year was not a major influence on drilling activity for that year. Data presented below for annual changes in population (U.S. Bureau of the Census, 1986, p. 5) and national totals of wells drilled annually from 1980 through 1984 show little relation with regard to percentage change from year to year.

	Year				
	1980	1981	1982	1983	1984
Population:					
Annual increase, in thousands-----	1,979	2,996	2,280	2,201	2,135
Percentage change from previous year-----	--	+51	-24	-3	-3
Wells drilled:					
Number drilled annually, in thousands-----	387	371	336	359	397
Percentage change from previous year-----	--	-4	-9	+7	+10

Although general economic indicators such as the gross national product may reflect the availability of capital for development of new ground-water supplies (industrial, irrigation, and public supplies in particular), the number of private housing starts appears to be the economic indicator most closely tied to

total number of wells drilled annually. The relation between private housing starts and total wells drilled annually is by no means direct, inasmuch as private housing data pertain to many single-unit and multiunit structures located within the service areas of public-water supplies. However, new single-family dwellings account for the majority of new domestic water wells drilled, and domestic water wells currently account for 80 to 90 percent of all wells drilled (National Water Well Association, 1983, p. II/6). Furthermore, housing starts and shipments of individual water systems (well pumps and accessories) show similar patterns for the years 1961 through 1980 (McCray, 1981). Sales of individual water systems are themselves indicators of well-drilling activity.

Private-housing starts in the United States remained relatively constant through the 1960's at about 1.3 million to 1.5 million per year, but increased dramatically in the early 1970's and peaked at about 2.4 million in 1972. This peak was followed by a steep decline in the mid-1970's and another increase in the late 1970's. Private-housing starts declined during the early 1980's to a low of around 1.1 million (in 1981), but increased to about 1.75 million by 1984.

Qualitative comparisons of housing-start data with drilling data for 1960, 1964, and 1980-84 (fig. 3) show considerable similarity of trends, especially in the 1980-84 period. It is unfortunate that reliable drilling data do not exist for the period 1965-79 to shed light on the strength of this relation. Nevertheless, this comparison suggests that:

1. Water-well drilling activity in the United States fluctuates substantially from year to year.
2. The documented changes in drilling activity between 1960 and 1964 and between 1964 and 1984 listed in table 1 should not be interpreted as periods of steady increase or decline. It is indeed possible that significant fluctuations occurred during these periods for which few, if any, national and regional drilling statistics are available.
3. Two significant peaks of drilling activity may have occurred around 1972 and during 1977-78. These years represent the peaks in housing starts between 1964 and 1980 (fig. 3). If drilling is as closely tied to housing starts as the part of the graph from 1980 through 1984 suggests, annual totals higher than any reported herein would have been likely. It also should be noted that the 1977-78 housing-start peak follows the 1976-77 drought mentioned earlier, which could have further stimulated drilling activity at that time. For these reasons, data for 1960, 1964, and 1980-84 probably represent low to moderate levels of drilling activity.

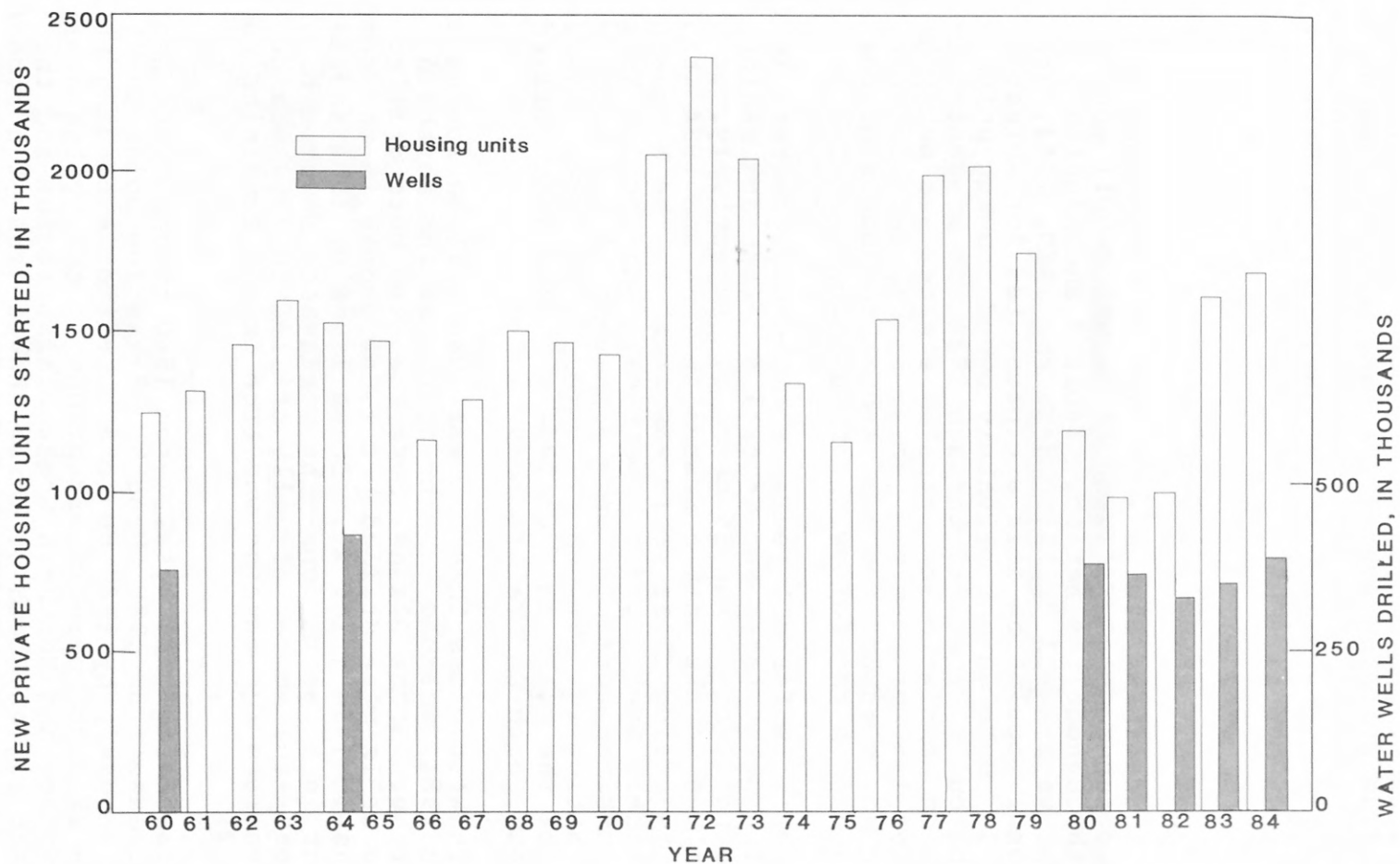


Figure 3.—Number of new private housing units started and number of water wells drilled (1960; 1964; 1980–84) (data from U.S. Bureau of the Census, 1980, p. 787, and 1986, p. 725).

Assuming that Picton's estimates (1956) are comparable to those reported herein, it appears that well-drilling activity has fluctuated about a long-term average of approximately 400,000 wells per year since the mid-1940's (fig. 4). This corroborates anecdotal data from drilling contractors and water-equipment manufacturers and suppliers that the water-well industry is neither growing nor declining overall (K. B. McCray, National Water Well Association, oral commun., 1986).

Regional Trends

Grouping of adjoining States with similar conditions or activities reveals substantial differences in water-well construction activity throughout the nation. Table 2 and figures 5 and 6 present regional water-well drilling data for 1960, 1964, and 1980-84. Regional population data are presented for selected years in table 3. Data on new privately owned housing units authorized to be built from 1980 through 1984 are presented in table 4. (Data on housing units actually started are not available by State for 1980 or previous years; hence, data for new private housing units authorized are used as the basis of comparison in table 4 and in the following discussion.)

Drilling activity for all years reported was greatest in the Southeast and the Great Lakes and Central Appalachians regions, with a combined total of 57 and 55 percent, respectively, of the total wells drilled in the United States in 1964 and 1984 (table 2). Drilling activity during these years was least in the Northern Rockies and Northern Great Plains, Southwest, and Pacific Northwest regions, with combined totals of only 9 percent of the total wells drilled in the Nation for 1964 and 11 percent for 1984. The remaining 34 percent of the wells in both 1964 and 1984 were drilled in the Northeast and South-Central regions.

In the Southwest, less than one well was drilled for each 1,000 people in 1984, whereas, in the Southeast and Northern Rockies and Northern Great Plains, more than two were drilled. From one to two wells were drilled per 1,000 people in the remaining four regions in 1984 (fig. 2). Comparisons of 1964 and 1984 totals show that in three regions--the Northeast, Southwest, and Pacific Northwest--the number of wells drilled in 1984 was greater than in 1964, whereas the reverse was true in the remaining four regions (table 2).

Comparisons of regional totals from 1980 through 1984 generally show a decrease from 1980 through 1981, a low point in 1982 or 1983, and a recovery by 1984 to totals near or exceeding totals for 1980 (table 2). The primary exceptions to this pattern are the Northern Rockies and Northern Great Plains region and the Pacific Northwest region, both of which showed less of a recovery than the other regions from 1983 through 1984.

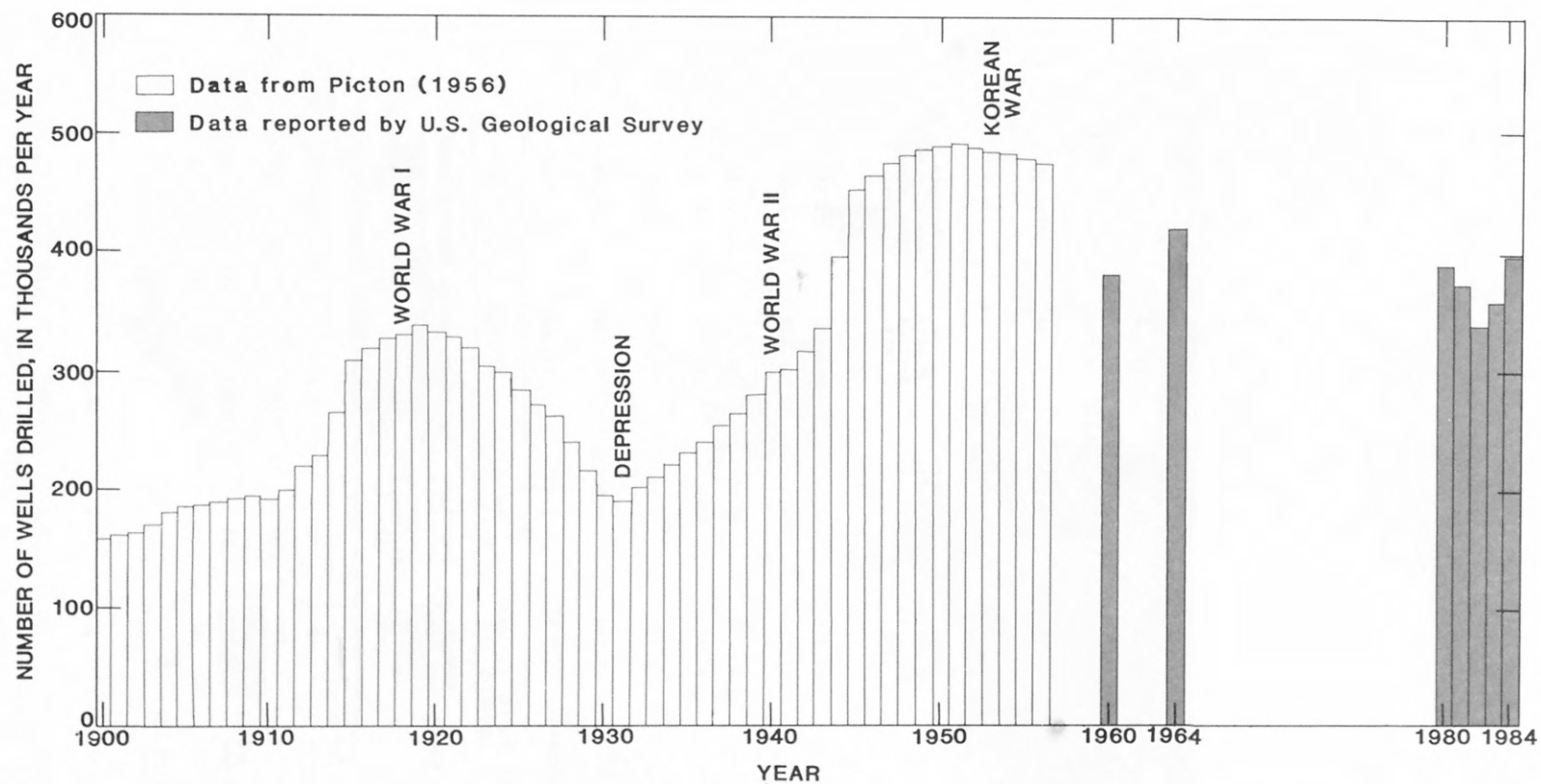


Figure 4.--Number of water wells drilled in the United States from 1900 through 1984 and relation to major events in United States history (adapted from Picton, 1956, and Meyer and Wyrick, 1966).

Table 2.--Regional trends in water-well construction in the United States, 1960, 1964, and 1980-84

[Data for 1960 and 1964 from Meyer and Wyrick (1966). Data for 1980 through 1984 based mainly on data supplied by State water agencies, modified and supplemented by other data available to the National Water Well Association. Columns may not add to totals because of independent rounding. NC, no change.]

Region	Number of wells drilled, 1960	Number of wells drilled, 1964	Number of wells drilled, 1980	Number of wells drilled, 1981	
Northeast (includes D.C.)-----	63,300	68,000	62,100	60,600	
Southeast-----	95,300	126,000	102,000	106,000	
Great Lakes and Central Appalachians----	130,000	123,000	106,000	95,300	
South-Central-----	54,800	77,200	63,200	62,100	
Northern Rockies and Northern Great Plains---	20,100	19,600	17,900	16,700	
Southwest (includes Hawaii)-----	12,000	13,000	20,700	17,700	
Pacific Northwest (includes Alaska)-----	5,620	7,200	15,000	11,400	
Totals-----	381,000	434,000	387,000	370,000	
Region	Number of wells drilled, 1982	Number of wells drilled, 1983	Number of wells drilled, 1984	Average annual total, 1980 through 1984	
Northeast (includes D.C.)-----	50,800	60,200	70,800	60,900	
Southeast-----	93,600	112,000	121,000	107,000	
Great Lakes and Central Appalachians----	87,900	90,900	101,000	96,200	
South-Central-----	60,600	57,300	63,300	61,300	
Northern Rockies and Northern Great Plains---	18,100	12,500	13,300	15,700	
Southwest (includes Hawaii)-----	15,100	14,800	18,300	17,300	
Pacific Northwest (includes Alaska)-----	9,750	8,670	10,300	11,000	
Totals-----	336,000	359,000	397,000	370,000	
	Percentage of total wells drilled, 1964	Percentage of total wells drilled, 1984	Percentage change between annual totals		
			1960 and 1964	1964 and 1984	1980 and 1984
Northeast (includes D.C.)-----	16	18	+7.4	+4.1	+14
Southeast-----	29	30	+32	-3.9	+19
Great Lakes and Central Appalachians----	28	25	-5.4	-18	-4.7
South-Central-----	18	16	+41	-18	NC
Northern Rockies and Northern Great Plains---	4.5	3.3	-2.5	-32	-26
Southwest (includes Hawaii)-----	3.0	4.6	+8.3	+41	-12
Pacific Northwest (includes Alaska)-----	1.7	2.6	+28	+43	-31
Totals-----	100	100	+14	-8.5	+2.6



Figure 5.--Regional changes in water-well drilling activity from 1964 to 1984.



Figure 6.--Regional changes in water-well drilling activity from 1980 to 1984.

Table 3.--Regional trends in population in the United States, 1964, 1980, and 1984

[Data from U.S. Bureau of the Census: 1966, p. 11; and 1986, p. 12]

Region	Total population			Percent- age change between 1964 and 1984	Percent- age change between 1980 and 1984
	1964 (thousands)	1980 (thousands)	1984 (thousands)		
Northeast (includes D.C.)-----	47,844	49,774	50,351	5.2	1.2
Southeast-----	31,352	40,786	43,464	38.6	6.6
Great Lakes and Central Appalachians----	50,082	55,952	56,156	12.1	0.4
South-Central-----	30,688	38,134	41,056	33.8	7.7
Northern Rockies and Northern Great Plains---	4,550	5,115	5,334	17.2	4.3
Southwest (includes Hawaii)-----	21,727	29,612	32,277	48.6	9.0
Pacific Northwest (includes Alaska)-----	5,098	7,167	7,523	47.6	5.0
Total-----	191,341	226,540	236,161	23.4	4.2

Table 4.--Regional trends in new private housing units authorized in the United States, 1980-84

[Data from U.S. Bureau of the Census, 1984, p. 726; and 1986, p. 724]

Region	<u>New private housing units authorized, in thousands</u>					Average annual total, 1980-84
	1980	1981	1982	1983	1984	
Northeast (includes D.C.)-----	120.6	110.8	107.0	164.3	201.2	140.8
Southeast-----	352.3	293.6	262.4	462.5	503.7	374.9
Great Lakes and Central Appalachians----	178.7	124.1	117.5	175.7	202.8	159.8
South-Central-----	245.9	236.1	322.3	462.0	365.4	326.3
Northern Rockies and Northern Great Plains---	24.8	16.9	15.0	22.4	20.9	20.0
Southwest (includes Hawaii)-----	213.7	162.9	142.8	271.4	342.7	226.7
Pacific Northwest (includes Alaska)-----	54.5	41.8	33.3	47.0	44.9	44.3
Total-----	1,190.5	985.5	1,000.5	1,605.2	1,681.6	1,292.7

Northeast Region

The number of wells drilled in the Northeast region in 1984 was 4 percent more than in 1964 and 14 percent more than in 1980 (figs. 5 and 6). Annual totals of wells drilled for the 1980-84 period ranged from 50,800 (in 1982) to 70,800 (in 1984) and averaged 60,900 (table 2). This region ranked third behind the Southeast and the Great Lakes and Central Appalachians regions in number of wells drilled in 1984. Drilling activity corresponds closely to the number of new private housing units authorized in the region (table 4). A recovery of well-drilling and housing-construction activity occurred in 1983 and 1984 despite the recession of early 1980's, which was particularly severe in the industrial Northeast. Population growth of this region was well below the national average. It is possible that population shifts from large cities to adjacent suburban areas stimulated the domestic-well market during this period and accounted for that increase.

Southeast Region

The Southeast was the most active region in the nation for 1960, 1964, and 1980-84 in terms of total numbers of wells drilled. Annual totals of wells drilled for the 1980-84 period ranged from 93,600 (in 1982) to 121,000 (in 1984) and averaged 107,000 (table 2). The 121,000 wells drilled in this region in 1984 was 30 percent of the United States total, and the average of about 2.8 wells drilled in 1984 for each 1,000 people is also the largest of all the regions (fig. 2). Although the total number of wells in 1984 was 4 percent less than the number of wells drilled in 1964, the 1984 total was 19 percent greater than the total for 1980. The shift in population from the North to the "Sunbelt" and the availability and dependence on ground water in the Southeast accounts for this recent drilling activity. In the 1980-84 period alone, the population of this region increased by 6.6 percent compared to a 4.2-percent increase nationally (table 3).

Great Lakes and Central Appalachians Region

The number of wells drilled in the Great Lakes and Central Appalachians region in 1984 was 18 percent less than in 1964 and 4.7 percent less than in 1980 (table 2). Annual totals of wells drilled for the 1980-84 period ranged from 87,900 (in 1982) to 106,000 (in 1984) and averaged 96,200. The region was particularly hard hit during the recent recession in both the agricultural and industrial sectors. Regional economic problems are further reflected in a 0.4-percent population growth for the 1980-84 period--the lowest of all the regions--and a fourth-place regional rank in new private housing units authorized despite a first-place regional rank in population (tables 3 and 4).

South-Central Region

The number of wells drilled in the South-Central region was 18 percent less in 1984 than in 1964, but was virtually the same in 1984 and 1980 (figs. 5 and 6). Annual totals of wells drilled for the 1980-84 period ranged from 57,300 (in 1983) to 63,300 (in 1984) and averaged 61,300 (table 2). In 1984, these 63,000 wells amounted to about 1.5 wells per 1,000 individuals (fig. 2). The unusually stable drilling activity with respect to other regions for 1980-84 can be at least partly attributed to unusual stability in the number of new private housing units authorized in this region during that period (table 4); in fact, this was the only region for which 1982 was not the worst year for housing activity from 1980 through 1984.

Northern Rockies and Northern Great Plains Region

The number of wells drilled in the Northern Rockies and Northern Great Plains region in 1984 was 32 percent less than in 1964 (fig. 5) and 26 percent less than in 1980 (fig. 6). Annual totals of wells drilled for the 1980-84 period ranged from 12,500 (in 1983) to 18,100 (in 1982) and averaged 15,700 (table 2). Although the number of wells drilled in the region in 1984 was small--only 13,300 or 3.3 percent of the United States total--the 2.5 wells drilled per 1,000 people was the second highest of the regional averages. This particular region, as well as the South-Central region, experienced an agricultural economic recession over several years, which is reflected by 16 percent fewer new private housing units authorized in 1984 than in 1980 (table 4). The drought of the early 1980's in the region was neither severe enough nor long enough to have any discernable effect on the number of wells drilled.

Southwest Region

The Southwest region had the fewest wells drilled per 1,000 people of any region in the United States in 1984 (about 0.6). The total number of wells drilled in 1984 was 41 percent greater than in 1964, but was 11 percent less than in 1980. Annual totals of wells drilled for the 1980-84 period ranged from 14,800 (in 1983) to 20,700 (in 1980) and averaged 17,300 (table 2). This region experienced the largest population increase and in terms of percentage and the third largest increase in terms of number of people of all regions from 1980 through 1984; however, available well-drilling data did not reflect these increases, nor did drilling activity correlate particularly well with new private housing units authorized. It is possible that peaks in drilling activity that are not reflected by available data occurred in this region in the 1970's.

Pacific Northwest

The Pacific Northwest, which includes Alaska, had the fewest wells drilled in 1984 with slightly more than 10,000, only 2.6 percent of the United States total (table 2). The region also experienced the greatest variability in annual drilling activity. The total number of wells drilled in the Pacific Northwest in 1984 was 43 percent greater than in 1964, but was 31 percent less than in 1980. Annual totals of wells drilled for the 1980-84 period ranged from 8,670 (in 1983) to 15,000 (in 1980) and averaged 11,000 (table 2).

SUMMARY AND CONCLUSIONS

Water-well drilling activity in the United States did not appear to increase or decrease significantly from the mid-1940's through the mid-1980's. The average annual total of new wells drilled during that period probably was about 400,000. The national total of wells drilled in 1984 was 8.5 percent less than the total for 1964, but was 2.6 percent greater than the total for 1980. The number of wells drilled nationally per 1,000 individuals was 2.3 in 1964 and 1.7 in 1984, possibly because of an increase in the percentage of the total population served by public water-supply systems between 1964 and 1984.

Seven States--Florida, Texas, New York, Michigan, North Carolina, Virginia, and Ohio--accounted for 39 percent of all the wells drilled in the United States in 1984. Florida led the nation in well-drilling activity with 45,600 wells. Drilling activity in the Southeast region dominated the nation in 1984 with a total of 121,000 wells, which represents 30 percent of the national total. The Southwest region had the fewest wells drilled per 1,000 individuals in 1984 (about 0.6), whereas the Northern Rockies and Northern Great Plains region had the most (about 2.8).

Data compiled for this study indicate that well-drilling activity in the United States is cyclic in nature and more closely follows patterns of economic activity--particularly housing starts--than patterns of population changes. Data are insufficient to indicate the effects of drought.

The apparent relation between housing starts and totals of wells drilled from 1980 through 1984 suggests that there may have been peaks in drilling activity in 1972 and during 1977-78 that are not represented by available drilling data. If this is true, then the annual totals reported for 1960, 1964, and 1980-84 may be misleading as indicators of "trends" for the period 1960-84. Rather, these totals more likely reflect low to moderate levels of drilling activity during a period of considerable fluctuation.

Because the National Water Well Association intends to collect State-by-State drilling data annually, the outlook is good that a data base of current, reliable, and comparable drilling-activity data will be available in 5 to 10 years to permit the relations among annual well totals, economic indicators, and perhaps even regional precipitation patterns, to be explored in greater detail. If so, the significance of future trends in water well drilling, and the significance of outside factors on drilling activity, will be increasingly apparent and meaningful to water planners, water users, and the water-well industry itself.

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