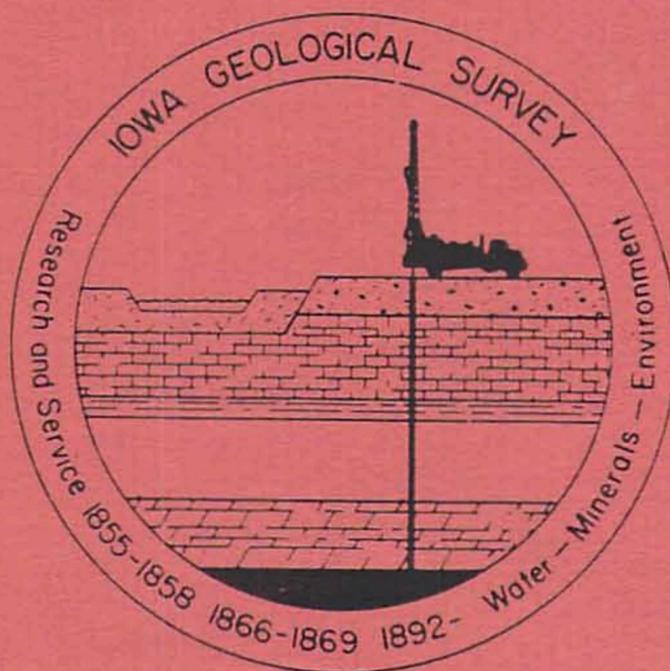


ESTIMATES OF RURAL WELLS IN IOWA

Results from a "Well-Inquiry" conducted
as directed by H.F. 2382 of the 69th
General Assembly of the Iowa Legislature

George R. Hallberg
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This compilation was partially supported by a grant from the
U.S. Environmental Protection Agency, Region VII,
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Abstract

The 1982 Iowa Legislature enacted House File 2382 instructing all assessors to ask each property owner or tenant to provide information about the number and nature of wells on their properties during property re-assessment in 1983 and 1984. The assessors were to provide this information to the Iowa Geological Survey. To implement this program, the Iowa Geological Survey, in cooperation with the Iowa State Association of Assessors and the Iowa Department of Revenue, developed a postal-card, well-inquiry questionnaire. Based on an estimate of the number of rural dwellings 250,000 cards were distributed.

County assessors distributed the cards. To date, approximately 103,000 (41%) of the cards have been returned. A total of 158,320 wells from the various well categories have been reported. The number of wells reported from individual counties ranged from a low of 209 wells to a high of 3,376. An average of 1,580 wells per county was reported, with an average of 1.5 wells per card.

The categories of wells included: household/livestock (and other), irrigation, drainage, and abandoned. A total of 135,464 household/livestock (and other) wells were reported statewide. A comparison of these numbers with census statistics suggests that the well-card inventory constitutes about a 60% sample of the number of active rural wells in the state. This 60% estimate was used to adjust other inventory numbers.

A total of 884 irrigation wells were reported. These reports were compared with irrigation well permits for farm crop use. The total number of irrigation wells reported equalled about 60% of those permitted (from the counties where irrigation wells were reported).

A total of 197 drainage wells were reported from the inventory cards. If the card inventory is accurately estimating about 60% of the wells, as suggested by census and irrigation well data, a total estimate of approximately 328 drainage wells, statewide, is derived. This is less than previous estimates derived by other means. No accurate check on the number of drainage wells presently exists, however.

A total of 21,775 abandoned wells were reported; or an average of one abandoned well for every 6 active wells. Again, if the well cards represent a 60% sample of actual wells, then an estimated 36,300 abandoned wells may occur in Iowa. An average of 217 abandoned wells was reported per county, but reports for individual counties ranged from a low of 15 to a high of 607. The distribution of reported abandoned wells follows a logical pattern. The lowest numbers and percentages of abandoned wells are reported from northeastern Iowa where, historically, reliable productive wells have been easy to develop. The largest numbers and percentages of abandoned wells are reported from south-central Iowa and to some extent northwestern Iowa. These areas, histor-

ically, have been groundwater poor, and many old, shallow wells have been abandoned.

The well card inventory data undoubtedly has some inaccuracies in reporting. However, the large number of responses does provide a reasonable statistical basis for estimating the number of private, rural wells. At best the data can be regarded as a 60% sample from which some first order estimates of the number of various types of rural wells in Iowa can be made. The numbers of drainage and abandoned wells, while substantial, are lower than previous estimates. Thus, collectively, their adverse impact on groundwater quality, while potentially significant, likely is less severe than previously contemplated.

INTRODUCTION

In recent years public awareness and concern about groundwater and groundwater quality has been increasing. The majority of Iowans derive their drinking water from groundwater. The Iowa Legislature, reflecting this concern, has been investigating a variety of legislation dealing with the development and protection of Iowa's groundwater resources.

During the Sixty-Ninth General Assembly in 1982, the Legislature passed an act (House File 2382, quoted below) designed to help identify and inventory private wells. This act reflected the Legislature's concern for the need to understand the number and distribution of existing water wells, abandoned water wells, and wells developed to improve drainage. These abandoned and drainage wells were recognized as potential and likely ways that contaminants might be introduced into the groundwater. The well identification program was envisioned as a method to compile some basic information on the number and distribution of various classes of wells which might be useful for future considerations. The act reads:

Laws of the Sixty-Ninth General Assembly

1982 ACTS, CHAPTER 1085 WELL IDENTIFICATION H.F. 2382

AN ACT relating to the identification of the location of wells.

Be it enacted by the General Assembly of the State of Iowa:

Section 1. WELL INQUIRY. The assessor in each assessor jurisdiction shall, when reassessing property for the 1983 and 1984 assessment years inquire of each property owner or tenant whether there are wells on the property, whether they are usable or abandoned and whether the wells are used for drainage purposes. The assessor shall provide the information collected on wells to the Iowa geological survey.

Approved April 19, 1982.

This report outlines how this legislation was executed, tabulates the results of the inquiries, and provides an analysis of the results.

The Well Inquiry

The Iowa Geological Survey (IGS), in cooperation with the Iowa State Association of Assessors and the Iowa Department of Revenue, developed a well inquiry questionnaire. To make the distribution procedure easier, and to make it easy for residents to respond, the questionnaire was simplified and put on a postal card. Based on an estimate of the number of rural dwellings and properties, 250,000 cards were printed and proportionately distributed to the county assessors. Urban, incorporated areas with public-water supply systems were not included in the survey. A copy of the postal-card form is shown in figure 1.

The cards were distributed by the county assessors in various ways. In some counties property owners were asked to fill out the cards in the assessor's office or during a field visit by a representative of the assessor's office. In these counties the assessor collected the cards and sent them in bulk to the IGS. In other cases, the cards were distributed to residents with other mailings, and property owners were asked to mail them directly to IGS. The first method provided the best rate-of-return.

An occasional card continues to arrive in the mail. Thus, this report will provide a summary of the information collected as of 15 April 1985. The few cards that may still arrive will not significantly alter the results tabulated in this report.

The cards were received and stored at IGS. Originally, estimates of the number of cards returned were made, but no formal counting was done because staff were not available for this activity. The U.S. Environmental Protection Agency (EPA) became interested in the potential of these data to provide information about the number and distribution of agricultural drainage wells, to supplement other inventories required in the Underground Injection Control Program. A contract with EPA facilitated the hand sorting, counting, and compilation of the data presented in this report.

THE RESULTS

As of April 15, 1985, approximately 103,000 of the 250,000 cards distributed (or 41%) had been returned. A total of 158,320 wells from all categories were reported (Table 1). The vast majority of wells reported (84%) were currently in use and were developed to supply water for household and/or livestock usage. However, a significant number of wells (14%) were reported as abandoned. The remaining categories, irrigation, drainage, and other constituted about 2% of the reported wells (Table 1).

An average of 1,580 wells were reported from each county, although the number varied from a high of 3,376 in Shelby County to a low of 209 in Howard County. Figure 2 graphically summarizes the response and the number of wells reported by county. A complete tabulation by use category for each county is included in Appendix 1.

There was an average of 1.5 wells reported per card; some cards reported no wells, and a few reported as many as 8 to 10 wells on different properties. A few cards contained messages conveying the landowners refusal to submit this information. Some cards were also received where landowners reported other sources of water such as springs or rural-water districts. These cards were not counted in any well category. In the following sections of this report: 1. the basic responses are tabulated; and 2. an analysis of these data is presented to provide a perspective on the utility of the inventory.

Household/Livestock Wells

The Household/Livestock well category constitutes wells actively used for rural-domestic drinking water supplies and/or livestock. A total of 133,158 wells were reported in the household and/or livestock use category. As noted this category constitutes 84% of all the wells reported. The distribution of the response is the same as shown for the total response, in figure 2.

TO THE ADDRESSED PROPERTY OWNER OR TENANT:

WELL INQUIRY

In House File 2382, the Iowa Legislature instructed each assessor jurisdiction to inquire of each property owner or tenant whether there are wells on the property, and whether they are usable, abandoned, or used for agricultural drainage purposes. Each assessor is required to obtain this information when reassessing property for the 1983 and 1984 assessment years and is required to provide the information to the Iowa Geological Survey. Please assist by completing and promptly mailing the attached card. Thank you for your cooperation.

(Tear off and return survey card only)

(Please Type or Print)

COUNTY.....

NAME..... OWNER TENANT

ADDRESS

CITY..... STATE..... ZIP.....

On land controlled by me, I have the following well(s):

Type	Number	In Township	In Section
Household/Livestock
Irrigation
Drainage
Abandoned
Other..... (specify)

DATED:..... SIGNED.....

Figure 1. Sample of well-inquiry postal-card.

Table 1. Total wells reported for Iowa from well-inventory cards returned.

<u>Category</u>	<u>Total</u>	<u>Percentage of Reported Wells</u>
Household/Livestock	133,158	84
Irrigation	884	<1
Drainage	197	0
Abandoned	21,775	14
Other	<u>2,306</u>	<1
Total	158,320	

Irrigation Wells

A total of 884 irrigation wells was reported. Figure 3 shows the distribution of these wells reported by county. The majority are reported from western Iowa, with 65% occurring in the western-border counties.

Drainage Wells

Drainage wells were developed, in local areas of Iowa, as part of the system of tile-lines and ditches installed to improve the drainage of agricultural land. The wells were designed to inject this agricultural-drainage water into underlying groundwater aquifers instead of discharging the water into main-tiles and/or streams. Today, drainage wells are of concern because they inject surface-runoff water and tile-effluent water, and the agricultural chemicals and bacteria these waters can contain, into aquifers which are used for drinking water. A total of 197 drainage wells were reported from the inventory cards. The distribution of the reports by county is shown on figure 4.

Abandoned Wells

Perhaps the primary reason the well-card inventory was initiated by the Legislature was a concern for the potential, detrimental impact abandoned wells may have on groundwater quality. Improperly abandoned wells may allow seepage-water and surfacewater to enter the well. This would potentially inject contaminants into the groundwater just as a drainage well does, but likely in substantially lower volumes. A total of 21,775 abandoned wells was reported (figure 5). An average of 217 abandoned wells was reported by county ranging from 15 in Franklin County to 607 in Washington County. Although the inventory cards did not inquire about whether or not these wells had been plugged, a surprising number of cards indicated that owners had plugged or

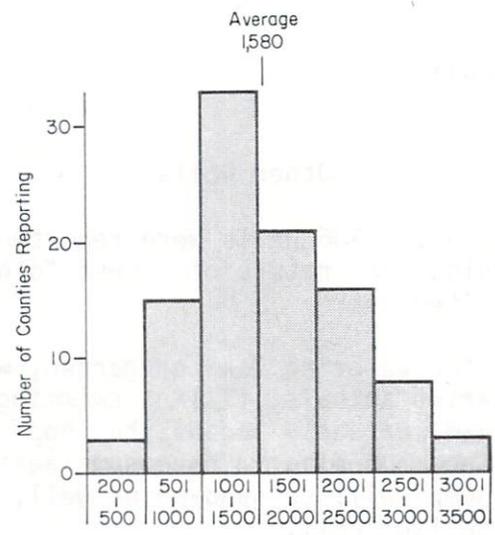
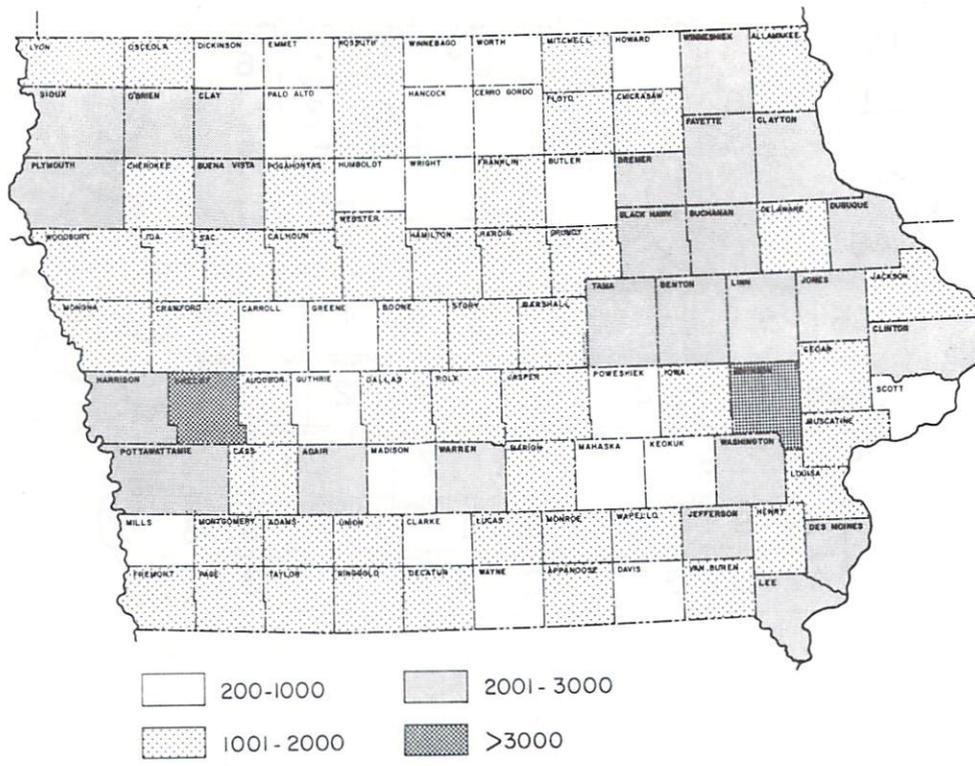


Figure 2. Map (above) and histogram (below) summarizing the total number of wells reported by county. Total reported--158,320.

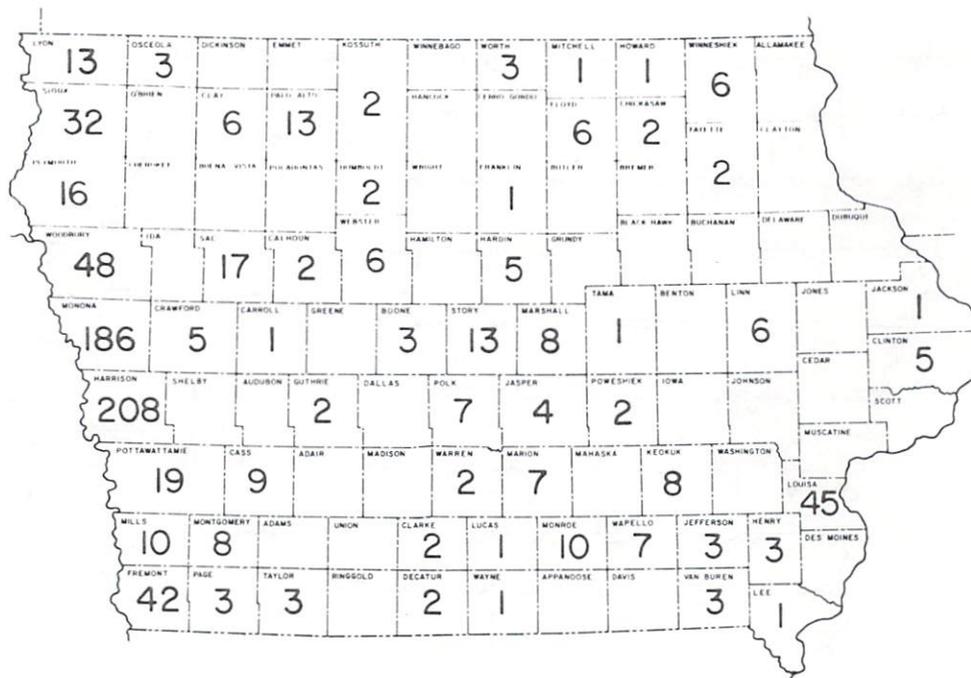


Figure 3. Number of irrigation wells reported by county. Total reported--884.

filled their abandoned wells.

Other Wells

In the "other" category 2,306 wells were reported. On many cards people made annotations regarding the nature of these "other" wells. The comments typically included such items as:

1. Well only used for watering lawn or garden, washing car or machinery, watering animals, filling swimming pool, etc.
2. Well at homestead currently vacant, but hope to rent out; or no cattle at farm now but plan to have some again.
3. Have old hand pump well, or sand-point well, used for emergencies; or have an 'artesian' well.

All the written comments indicated that the "other" wells would typically fall under the household and/or livestock well category. The "other" category constitutes less than 2% of the household/livestock total, and thus for analysis of these results the other wells were added to the Household/livestock category for an estimate of rural farm and domestic wells. Together these categories total 135,464 wells.

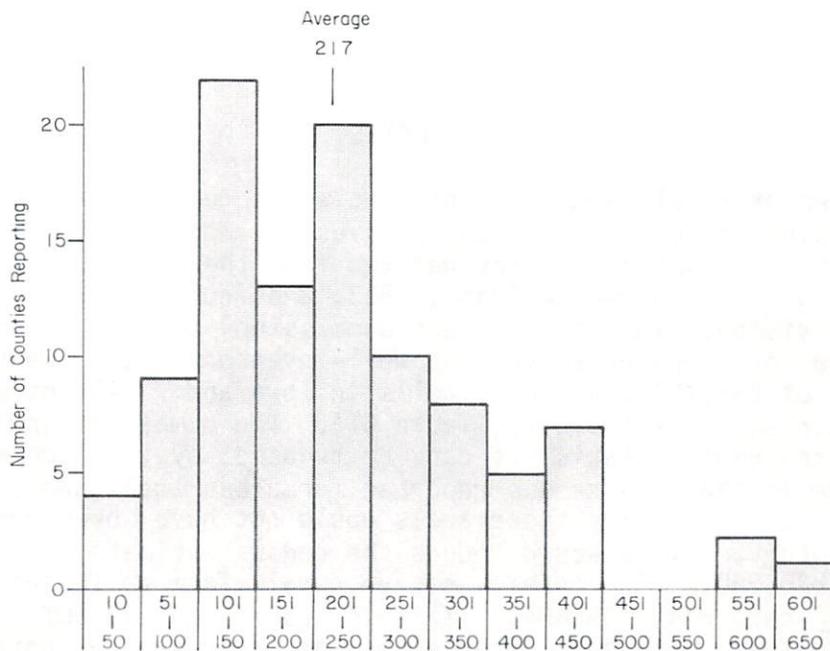
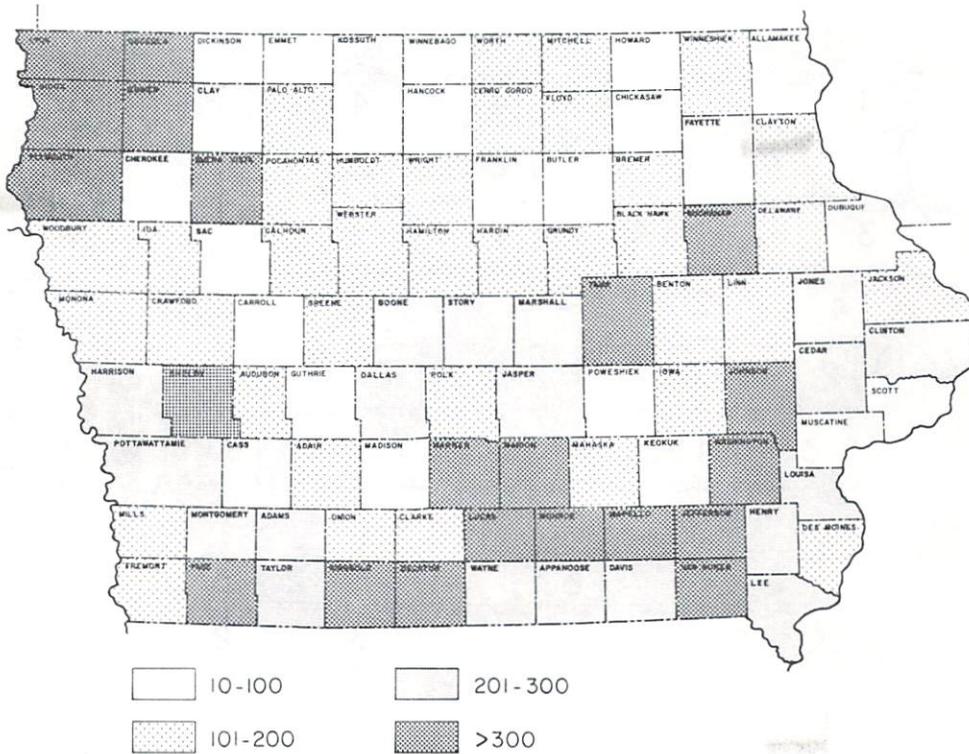


Figure 5. Map (above) and histogram (below) summarizing the number of abandoned wells reported by county. Total reported--21,775.

number of people per rural farm-domestic well reported. The results are summarized on figure 6. The arithmetic average (or mean) for the 99 counties was 11 people/well; the median was 8 people/well. In contrast, comparison of various census statistics suggests average ratios of 2.5 to 3.3 people per well or water supply connection for Iowa, which again indicates that the well-card data is only recording a portion of the wells in the state. The higher ratios, shown on figure 6, reflect counties with proportionately low returns on the inventory. Thus, the larger the ratio shown for an individual county the less complete the sample is from that county.

As noted, the median county ratio was 8 people/well. The ratio from the state totals (1,205,576 people/135,464 wells) is about 9. The difference between these ratios and the census data ratio of about 3, suggests that the well-card data only represents about a 40% sample. These figures require further adjustment. The values used above for the 'rural' populations are too large because the census rural population data include people in smaller towns and suburbs who are, in part, served by public water supplies, and would not have been included in the well-card inventory. Approximately 2,175,000 Iowans are served by some form of public water supply, leaving approximately 739,000 rural Iowans to be served by individual water supplies, i.e., rural household wells. The ratio of these revised rural population figures to the number of rural-farm wells reported by the well-inventory cards is slightly over 5. A comparison with the census data ratio of 3, again suggests that the well-card inventory approximates a 60% sample. Data in this report for individual counties must be viewed with these considerations. Estimates of the actual number of wells in a given class for each county could be made by adjusting for these sampling problems. However, such county estimates were not made for this report and if they are made they must be used with caution.

Irrigation Wells

The number of irrigation wells reported was compared with the number of irrigation well permits for crop use. Generally the number of wells reported from this inventory was less than the number of permits issued, but in a few counties the number of reported wells exceeded the number permitted. However, there was general agreement in the trend of the number of permitted wells and the number of reported wells. Exact comparisons are difficult because some permits include multiple wells, some of which have not been drilled, but this may also reveal some unpermitted irrigation wells. Overall the total number of irrigation wells reported equals about 60% of those permitted from the counties where irrigation wells were reported.

Drainage Wells

A total of 197 drainage wells was reported on the inventory cards. If the card inventory is accurately reporting about 60% of the wells, as suggested by the census and irrigation well data, a total estimate of approximately 328 drainage wells is derived. This is less than half of a previous estimate of 690 derived by Musterman and others (1981). However, Iowa Geological Survey staff have always considered the estimate of 690 to be too high. The two counties reporting the highest numbers of drainage wells (Floyd--21, Humboldt--34) are the two counties with known concentrations of drainage wells.

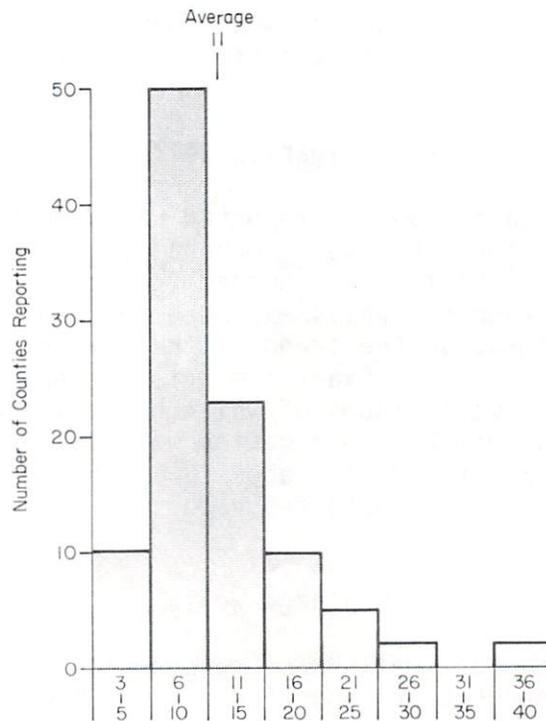
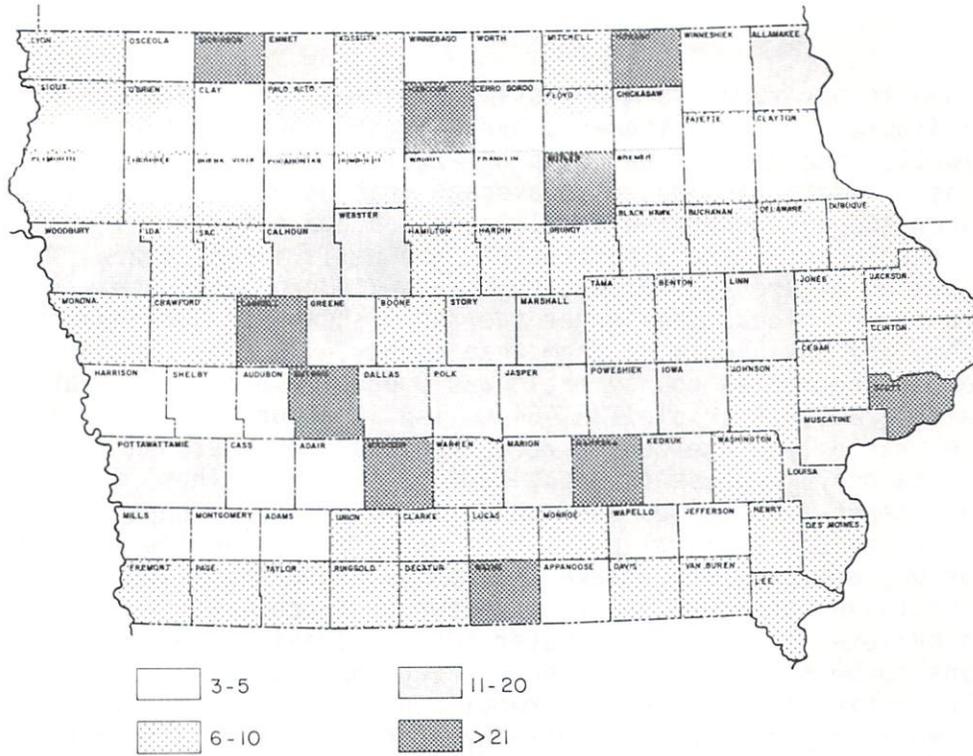


Figure 6. Map (above) and histogram (below) summarizing the ratio of number of people (rural population) per rural farm-domestic well reported. See text for derivation.

In Floyd County approximately 36 drainage wells have been reported from other surveys. However, a few of these are not actually drainage wells; two are actually sinkholes and one is likely a main tile inlet. Also, in Floyd and Fayette counties the county installed drainage wells many years ago (at least one each) to help with road drainage. Based on the reports from Floyd County, again, approximately 60% of the known private drainage wells were reported.

In Humboldt County approximately 44 drainage wells are known from current work (Baker and Austin, 1984). The thirty-four reported constitute 77% of the known sites, suggesting a reasonable sample. In both Floyd and Humboldt counties even a review on a township basis reveals similar trends.

There clearly is some error in the estimates of drainage wells. Only 4 drainage wells are reported from Pocahontas County, but many more are known or suspected. Also, there was an apparent misunderstanding with the 'drainage' category; a number of well cards reported tile-drainage under the drainage well category. Where clearly noted these cards were not included in the tally, but they provide a likely reason for the reports of small numbers (1-4) of drainage wells from counties where drainage wells are unlikely to occur.

Abandoned Wells

A total of 21,775 abandoned wells were reported (figure 5). Again, if the well card inventory is an accurate 60% sample, then approximately 36,300 abandoned wells may be estimated to occur in Iowa. Figure 7 summarizes the number of abandoned wells, calculated as a percentage of the number of active farm and rural domestic wells reported (Household/Livestock plus Other categories). On this basis there is an average of 16% abandoned wells, or 1 abandoned well for every 6 active wells reported in the state.

Both figures 5 and 7 show logical distributions by county. The lowest numbers (figure 5) and percentages (figure 7) of abandoned wells are reported from northeastern Iowa, where reliable productive wells, of relatively shallow depth (and hence, relatively low cost) historically have been easy to develop. Many wells in this area have been in service for over 50 years. The same factors which have made groundwater readily available in this area, however, are now contributing to growing problems with water quality.

In contrast, the largest numbers and percentages of abandoned wells are reported from south-central Iowa and to some extent northwestern Iowa. These areas, historically, have been deficient in groundwater supplies, either because of poor natural quality or because of the considerable depth (and hence, cost) to a reliable source. In these regions very shallow hand-dug or drilled wells have commonly dried up or become contaminated, and have been replaced. Also, the development of rural water districts in these areas have contributed to the number of abandoned wells.

A comparison was made between the change in rural populations (1960 to 1980) and the number of abandoned wells, to evaluate if there was a relationship between rural population decline and abandoned wells reported. There was no apparent relationship. Although the number of abandoned wells reported (and estimated) is substantial, it is still less than previous conjectural estimates. This is a positive note, in terms of the potential adverse impacts on groundwater quality.

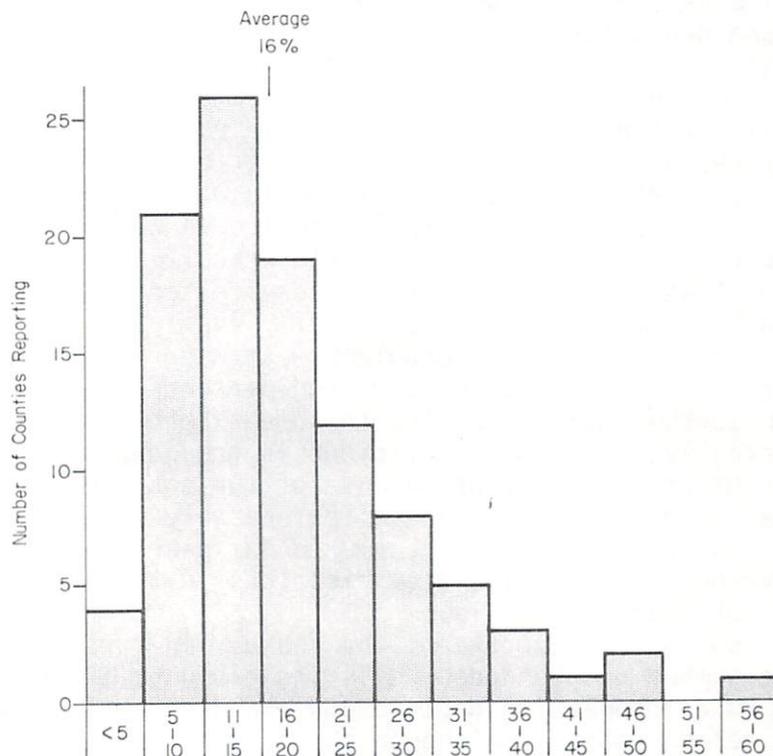
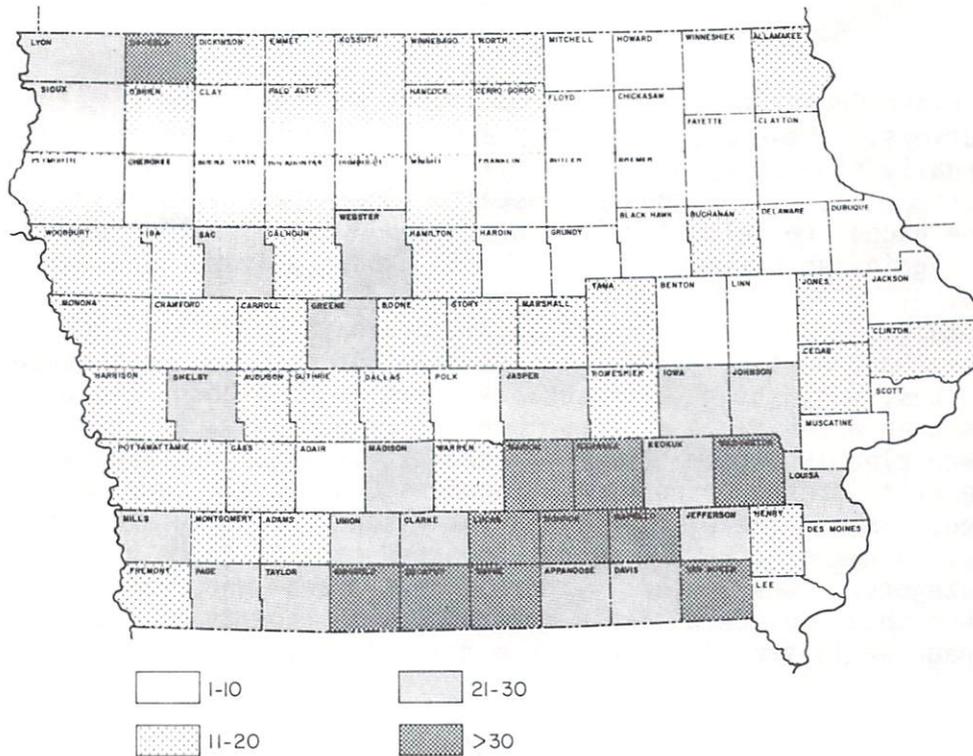


Figure 7. Map (above) and histogram (below) summarizing the distribution of abandoned wells reported; calculated as a percentage of the number of active farm or rural domestic wells reported.

CONCLUSIONS

The postal-card inventory of wells conducted in 1983 and 1984 was not an ideal process for gathering information, but with the cooperative nature of Iowa's citizens it did produce a large, independent source of data about the number of rural wells. These data can be evaluated and interpreted as part of our information base for resource evaluation. Approximately 60% of the rural population responded by answering and returning the cards. Based on the returned cards and assuming a constant 60% reporting of all well categories, the potential threat to groundwater from drainage wells and abandoned wells, while potentially significant, is less than estimated by previous methods. Further, the geographic distribution of drainage and abandoned wells has been clarified, allowing for more informed resource planning efforts throughout Iowa. Research controls for this inventory were minimal, and consequently the data must be used cautiously, particularly when reviewing data for individual counties.

REFERENCES CITED

- Baker, J. L., and Austin, T.A., 1984, Impact of agricultural drainage wells on groundwater quality; *Completion Report Project 2450, ISU-ERI-Ames-85183*, Iowa State University, Ames, IA, 238 p.
- Musterman, J. L., Fisher, R. A., and Drake L., Underground Injection Control in Iowa, project termination: Office of Drinking Water, Environmental Protection Agency, Department of Environmental Engineering, University of Iowa.
- U.S. Commerce Dept., 1983, Bureau of the Census, 1980 Census of Population and Housing: U. S. Gov't. Printing Office, Washington, D.C.

APPENDIX I.

Total number of wells reported from inventory cards, by county.

Number of Wells Reported, By Category

COUNTY	HOUSEHOLD/ LIVESTOCK	IRRIGATION	DRAINAGE WELL	ABANDONED	OTHER	COUNTY TOTAL
Adair	2401	9	5	153	58	2626
Adams	1405			245	72	1722
Allamakee	921			100	29	1050
Appanoose	1008	4	3	308	45	1368
Audubon	1389			167	171	1727
Benton	2032	12	1	149	6	2200
Black Hawk	2777	4		141	16	2938
Boone	1653	3		227	21	1904
Bremer	1967	4		167	7	2145
Buchanan	2092	4		330	16	2442
Buena Vista	2005	4		323	52	2384
Butler	812		2	65	3	882
Calhoun	968	2	1	192	22	1185
Carroll	552	1	1	101	11	666
Cass	1668	9		222	29	1928
Cedar	1632			288	22	1942
Cerro Gordo	896			119	17	1032
Cherokee	1037			295	15	1347
Chickasaw	1066	2	1	87	11	1167
Clarke	678	2		148	6	834
Clay	2172	6		227	12	2417
Clayton	2041			182	4	2227
Clinton	1862	5		227	3	2097
Crawford	1350	5	1	195	21	1572
Dallas	1672			250	7	1929

Number of Wells Reported, By Category

COUNTY	HOUSEHOLD/ LIVESTOCK	IRRIGATION	DRAINAGE WELL	ABANDONED	OTHER	COUNTY TOTAL
Davis	795			210	5	1010
Decatur	968	2		358	28	1356
Delaware	1660			111	13	1784
Des Moines	2008			162	49	2219
Dickinson	427			76	10	513
Dubuque	2725	1		27		2753
Emmet	436			76	11	523
Fayette	2049	2	1	214	27	2293
Floyd	1596	6	21	168	14	1805
Franklin	1574	1		15	44	1634
Fremont	1098	42		186	10	1336
Greene	541			134	12	687
Grundy	1413		3	137	20	1573
Guthrie	544	2		82	7	635
Hamilton	1063			188	9	1260
Hancock	433		2	64	6	505
Hardin	1688	5		133	7	1833
Harrison	2379	208	3	278	18	2886
Henry	1303	3	11	232	50	1599
Howard	184	1	1	20	3	209
Humboldt	863	2	34	122	7	1028
Ida	1006			199	25	1230
Iowa	920			201	24	1145
Jackson	1729	1	2	149	18	1899
Jasper	1045	4	2	287	18	1356
Jefferson	1832	3	3	447	14	2299

Number of Wells Reported, By Category

COUNTY	HOUSEHOLD/ LIVESTOCK	IRRIGATION	DRAINAGE WELL	ABANDONED	OTHER	COUNTY TOTAL
Johnson	2613		1	553		3167
Jones	1885		1	229	36	2151
Keokuk	765	8	3	229	7	1012
Kossuth	1497	2	4	227	23	1753
Lee	2456	1		227	37	2721
Linn	2534	6	2	162	20	2724
Louisa	972	45	2	223	28	1270
Lucas	925	1	1	334	4	1265
Lyon	1458	13	1	408	26	1906
Madison	287			82	5	374
Mahaska	301			121	15	437
Marion	947	7	2	417	37	1410
Marshall	1225	8	7	234	32	1506
Mills	704	10	1	177	20	912
Mitchell	888	1	4	157	29	1079
Monona	1073	186	2	147	16	1424
Monroe	850	10	5	432	51	1348
Montgomery	1436	8		292	12	1748
Muscatine	915	14		53	96	1078
O'Brien	1782		7	374	11	2174
Osceola	1150	3		407	61	1621
Page	1150	3		317	16	1486
Palo Alto	841	13		141	13	1008
Plymouth	2596	16	3	314	27	2956
Pocahontas	996		4	146	16	1162

Number of Wells Reported, By Category

COUNTY	HOUSEHOLD/ LIVESTOCK	IRRIGATION	DRAINAGE WELL	ABANDONED	OTHER	COUNTY TOTAL
Polk	1687	7	1	120	12	1827
Pottawattamie	1792	19		285	24	2120
Poweshiek	725	2	2	89	4	822
Ringgold	893			354	31	1278
Sac	1138	17	2	270	19	1446
Scott	981			47	5	1033
Shelby	2775		1	588	12	3376
Sioux	1745	32	2	402	49	2230
Story	1543	13	1	280	32	1869
Tama	1760	1	3	312	39	2115
Taylor	1181	3		260	7	1451
Union	893		3	201	9	1106
Van Buren	1001	3	2	388	60	1454
Wapello	893	7	2	312	49	1263
Warren	2382	2	3	440	64	2891
Washington	1697		7	607		2311
Wayne	359	1		231	22	613
Webster	953	6	3	207	26	1195
Winnebago	714		4	103	4	825
Winneshiek	2805	6	1	207	17	3036
Woodbury	1059	48	4	207	13	1331
Worth	718	3	1	114	19	855
Wright	804		7	138	22	971
COUNTY TOTALS	133,103	884	197	21,759	2,304	158,247
In-State No Location	33			10	1	44
Out-of-State No Location	22			6	1	29
STATE TOTALS	133,158	884	197	21,775	2,306	158,320