Iowa Statewide Rural Well Water Survey

Increased concern for water quality has substantially increased the research and monitoring of water quality in Iowa. Several water quality monitoring surveys have been conducted in Iowa, including watershed-specific, county-specific, and statewide surveys.

These surveys have greatly clarified the type, concentration, and distribution of contaminants in Iowa water supplies. This publication summarizes preliminary results of the Iowa Statewide Rural Well Water Survey. This survey is unique because it is the first statewide assessment of water quality in rural, private wells.

The Iowa Statewide Rural Well Water Survey was designed and conducted by the Iowa Department of Natural Resources Geological Survey Bureau and the University of Iowa Center for Health Effects of Environmental Contamination.

Systematic sampling of 686 rural wells was conducted during 1988 and 1989. The survey sample was based on rural population density and covered all of Iowa's 99 counties. Water samples were analyzed for coliform bacteria, nitrate, 27 pesticides, several pesticide breakdown products, and various other elements.

The survey also included a questionnaire and site evaluation that determined well characteristics, potential point sources of chemicals, agriculture chemical use and practices, and existing health symptoms or conditions. Preliminary results were released in February 1990; complete analysis of the results is expected within one to two years.

Total Coliform Bacteria Detection in Private Wells

A greater percent of private wells were unsafe because of total coliform bacteria than any other contaminant; 44.6 percent of the private wells tested were considered unsafe (table 1). Coliform bacteria are not a health concern in themselves, but are an indication that other disease-causing microorganisms may be able to enter the water system. For that reason, the presence of coliform bacteria is considered unsafe.

The highest percent of wells considered unsafe due to coliform bacteria were in western and southern Iowa (figure 1). The highest percent of unsafe wells was found in southwest Iowa (66.6 percent), followed by southeast (62.3 percent), northwest (60.1 percent), and central Iowa (58.4 percent). In contrast, the lowest percent of wells that had unsafe bacteria levels was in northeast Iowa where 20.2 percent tested unsafe.

Well depth was a significant factor with respect to contamination from total coliform bacteria. For wells less than 50-feet deep, 71.5 percent con-

Table 1. The Iowa Statewide Rural Well Water Survey: private wells exceeding drinking water standards or guidelines for bacteria, nitrates, and herbicides. Source: Iowa Department of Natural Resources and the University of Iowa, 1990.

Contaminant	Percent of Private Wells Sampled
Total Coliform Bacteria: **unsafe wells**	44.6
Nitrate-Nitrogen: wells **exceeding** 10 ppm	18.3
Herbicides: wells **exceeding** lifetime health advisory levels	1.2

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tained coliform bacteria. Wells deeper than 50 feet were less vulnerable to bacterial contamination — 36.3 percent of these wells were unsafe.

Nitrate-Nitrogen Detection in Private Wells

Nitrate-nitrogen concentrations exceeded the 10 parts per million (ppm) drinking water standard in 18.3 percent of the private wells tested (table 1). The distribution of wells exceeding the drinking water stand ard for nitrate-nitrogen are given in figure 2.

Similar to the distribution of wells with unsafe bacteria levels, the highest percent of wells exceeding the nitrate-nitrogen drinking water standard were in northwest (32.3 percent), southwest (32.2 percent), and southeast Iowa (26.5 percent). The lowest percent of wells exceeding the standard was found in north central Iowa (3.8 percent) followed by east central Iowa (7.0 percent).

Mean nitrate-nitrogen concentrations averaged 6.2 ppm statewide. Both southwest (11.3 ppm) and northwest Iowa (10.9 ppm) had mean nitrate-nitrogen concentrations that exceeded the drinking water standard. The lowest mean nitrate-nitrogen concentration was in north central Iowa (2.5 ppm).

As with bacteria, well depth was an important factor influencing wells exceeding the nitrate-nitrogen drinking water standard. For wells less than 50-feet deep, 35.1 percent exceeded the 10 ppm nitrate-nitrogen standard. In contrast, 12.8 percent of the wells greater than 50-feet deep exceeded the nitrate drinking water standard.

Pesticide Detection in Private Wells

Pesticides were detected in 13.6 percent of the 686 rural, private wells tested in this survey. Nearly all of these detections were herbicides (table 2). Drinking water health advisory levels for commonly used pesticides are listed in table 3.

Herbicide concentrations in this survey were generally less than 1 part per billion (ppb). No active ingredient of any insecticide was detected. However, two breakdown products of the insecticide Furadan were each detected in 0.4 percent of the 686 private wells sampled.

Only 1.2 percent (eight wells) of the 686 wells tested exceeded Environmental Protection Agency (EPA) lifetime health advisory levels for herbicides (table 1). Atrazine exceeded the 3 ppb EPA lifetime health advisory level in 0.7 percent (five wells) of the 686 sampled.

Three wells exceeded lifetime health advisory levels for herbicides other than atrazine. Lasso exceeded the EPA lifetime health advisory level of 0.4 ppb in 0.3 percent (two wells) of those tested. The maximum Lasso concentration detected was 4.76 ppb. A spill of the formulated Lasso near one of these wells likely contributed to the elevated concentration. Treflan exceeded the EPA lifetime health advisory level of 2 ppb in 0.1 percent (one well) of the total wells sampled. Treflan detection in this well was attributed to a past backsiphoning incident.

Atrazine, the most commonly detected herbicide in this survey, was found in 4.4 percent of the private wells sampled (table 2). Atrazine and/or its breakdown products were detected in a total of 8 percent of the private wells tested.

The distribution of the percent of wells with atrazine detections is shown in figure 3. Northwest Iowa had the highest percent (14.6 percent) of wells with atrazine detections; southeast Iowa had the lowest (6.2 percent). Atrazine detections in other areas were similar, ranging from 7.1 to 8.8 percent.

Several other herbicides were detected in the survey, but none were detected in more than 2 percent of the wells (table 2). The distribution of pesticide detections is shown in figure 4. The lowest percent of wells with

Table 2. Summary of pesticide detections for the 1990 Statewide Rural Well Water Survey. Source: Iowa Department of Natural Resources and the University of Iowa, 1990.

Pesticide	Private Wells with Detections	Average Concentration	Private Wells Exceeding EPA Lifetime Health Advisory Level
	(% of total)	(ppb)	(% of total)
atrazine	4.4	0.90	0.7
deethyl-atrazine[a]	3.5	0.54	-
deisopropyl-atrazine[a]	3.4	0.68	-
Sencor	1.9	0.16	0
Prowl	1.7	0.19	0
Dual	1.5	0.92	0
Bladex	1.2	0.30	0
Lasso	1.2	0.67	0.3
hydroxy-alachlor[a]	0.4	0.91	-
Tordon	0.6	0.39	0
2,4-D	0.6	0.20	0
DCPA	0.4	0.02	0
Ramrod	0.4	0.11	0
Treflan	0.4	5.65	0.1
Furadan	0		
hydroxy-carbofuran[a]	0. 4	0. 38	-
keto-carbofuran[a]	0. 4	0. 03	-
All others	0		

[a]Environmental breakdown products

pesticide detections was in southeast Iowa (9.3 percent) followed by northeast Iowa (10.9 percent). The highest percent of wells with pesticide detections was in northwest Iowa (22 percent). In contrast to both bacteria and nitrate results, well depth was not a significant factor with respect to pesticide detections, at least when comparing wells less or more than 50 feet in depth.

There are many factors that can influence the movement of pesticides below the root zone. However, one characteristic sets atrazine apart from other herbicides commonly used for weed management in corn. It degrades at a slower rate — a characteristic that has both advantages and disadvantages.

As a benefit, atrazine remains active longer and can control many weeds throughout the season. At the same time, the slower degradation rate of atrazine increases the chance that it may move below the root zone into the lower soil profile.

Preliminary conclusions

The results of this survey should be interpreted with caution, as the survey was conducted during two of the driest years on record. Results may have been considerably different during years with average or above average precipitation.

Secondly, the results are preliminary. Much of the information collected during the survey, which will help interpret the results, is being analyzed.

However, some conclusions can be made. On a regional basis, the Iowa Statewide Rural Well Water Survey indicates wells in western and southern Iowa are the most vulnerable to contamination, primarily because of the dependence on shallow groundwater in these areas.

The high percent of wells with coliform bacteria is related to the large proportion of shallow wells used by rural Iowans. Coliform bacteria is common in the water from shallow wells. Many of these wells are open to the top of the water table, which makes them susceptible to contamination.

The total coliform data may suggest other problems with well location, construction, and/or placement. These factors also may contribute to the nitrate and pesticide detections in rural wells. There is not a good correlation, however, between total coliform occurrence and nitrate and pesticide detections. Additional analysis will help define these relationships.

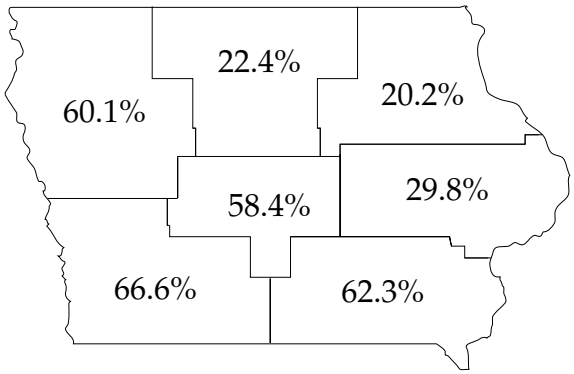

Figure 1. Percent of private wells with unsafe levels of total coliform bacteria. Statewide average: 44.6 percent.

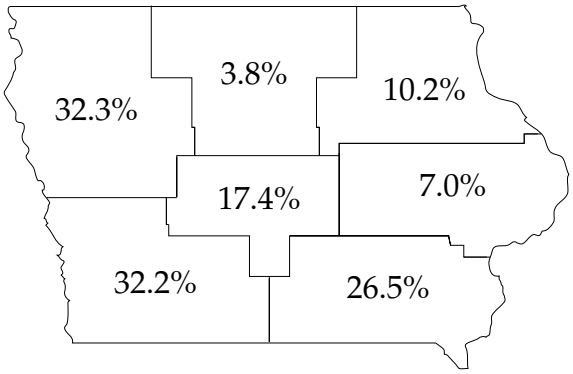

Figure 2. Percent of private wells with detection of nitrate-nitrogen exceeding 10 parts per million. Statewide average: 18.3 percent.

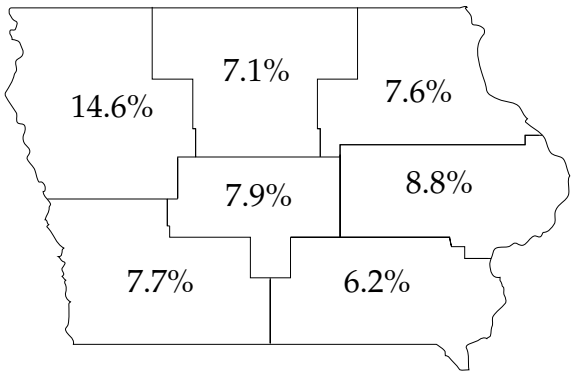

Figure 3. Percent of private wells with detections of atrazine and/or atrazine breakdown products. Statewide average: 8.0 percent.

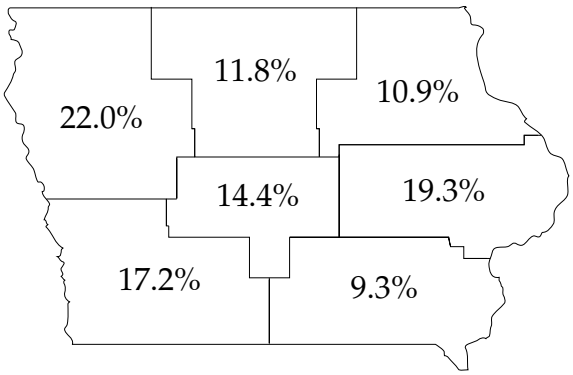

Figure 4. Percent of private wells with detections of pesticide and/or pesticide breakdown products. Statewide average: 13.6 percent.

This survey shows there is a poor correlation between the regional variation in the percent of rural wells with atrazine detection and the regional variation in atrazine use.

For example, northwest Iowa had the highest percent of wells with atrazine detection. However, in the past, northwest Iowa has had one of the lowest percent of corn acres treated with atrazine, as well as a relatively low application rate per acre. This suggests that factors in addition to the atrazine application rate and the number of acres treated with atrazine contribute to its detection in well water.

However, conclusions drawn at the regional level are general. Analysis of results from specific well sites is still necessary.

For atrazine and other pesticides, well depth, construction and placement, the proximity of application to the well, and the proximity of mixing and loading to the well, may be important factors influencing pesticide movement into well water.

Table 3. Environmental Protection Agency drinking water health advisory levels for commonly used herbicides and insecticides in Iowa.

Common Name	Trade Name	EPA Health Advisory Level[a] 10 Day (ppb)	Lifetime (ppb)
Herbicides:			
acifluorfen	Blazer/Tackle	2,000	--
alachlor	Lasso	100	--
atrazine	AAtrex	100	3
bentazon	Basagran	300	20
butylate	Genate/Sutan	2,000	350
cyanazine	Bladex	100	1
2,4-D	many	300	70
DCPA	Dacthal	80,000	4,000
dicamba	Banvel	300	200
glyphosate	Roundup	20,000	700
metolachlor	Dual	2,000	100
metribuzin	Lexone/Sencor	5,000	200
propachlor	Ramrod	500	90
simazine	Aquazine/Princep	500	4
trifluralin	Treflan	80	5
Insecticides:			
carbaryl	Sevin	1,000	700
carbofuran	Furadan	50	40
fonofos	Dyfonate	20	10
terbufos	Counter	5	0.9

[a]Source: U.S. EPA Office of Water, April 1992

Additional information

Additional information on factors influencing pesticide movement to groundwater and surface water, as well as best management practices that minimize pesticide losses, can be found in extension publication Pm-1394, *Pesticide Use and Water Quality in Iowa*. Other related publications include Pm-1389, *Chemical Alternatives to Atrazine In Corn Weed Management Programs*; Pm-1390, *Atrazine Management Rules for Iowa*; Pm-1393, *Banding Herbicides for Row Crop Weed Management*; Pm-1395, *The Iowa Public Water Supply Survey*.

These publications are available at county extension offices in Iowa or from Extension Publications Distribution, 112 Printing and Publications Building, Iowa State University, Ames, Iowa 50011; (515) 294-5247.

Additional information concerning the Iowa Statewide Rural Well Water Survey is available from the Iowa Department of Natural Resources, Wallace State Office Building, Des Moines, Iowa 50319; or call the Groundwater Hotline, 1-800-532-1114.

Reference

Hallberg, G.R. and Kross, B.C. 1990. Iowa Statewide Rural Well Water Survey — Summary of Results. Iowa Department of Natural Resources Geological Survey Bureau and University of Iowa Center for Health Effects of Environmental Contamination. Iowa City, IA, 52242.

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