

# Managing Groundwater Contamination In Rural Areas

*Groundwater in many States has become contaminated, raising concerns about risks to human health. Farm chemicals are a major source of contamination. Congress has introduced several bills to protect groundwater, and some States have adopted groundwater protection strategies. Rural areas, relying heavily on private wells, may be at the most risk from contaminated groundwater, yet would likely receive less protection than urban areas under proposed strategies permitting different levels of protection. Programs to protect farm and rural income while meeting water quality goals are likely to receive the most enthusiasm in rural areas.*

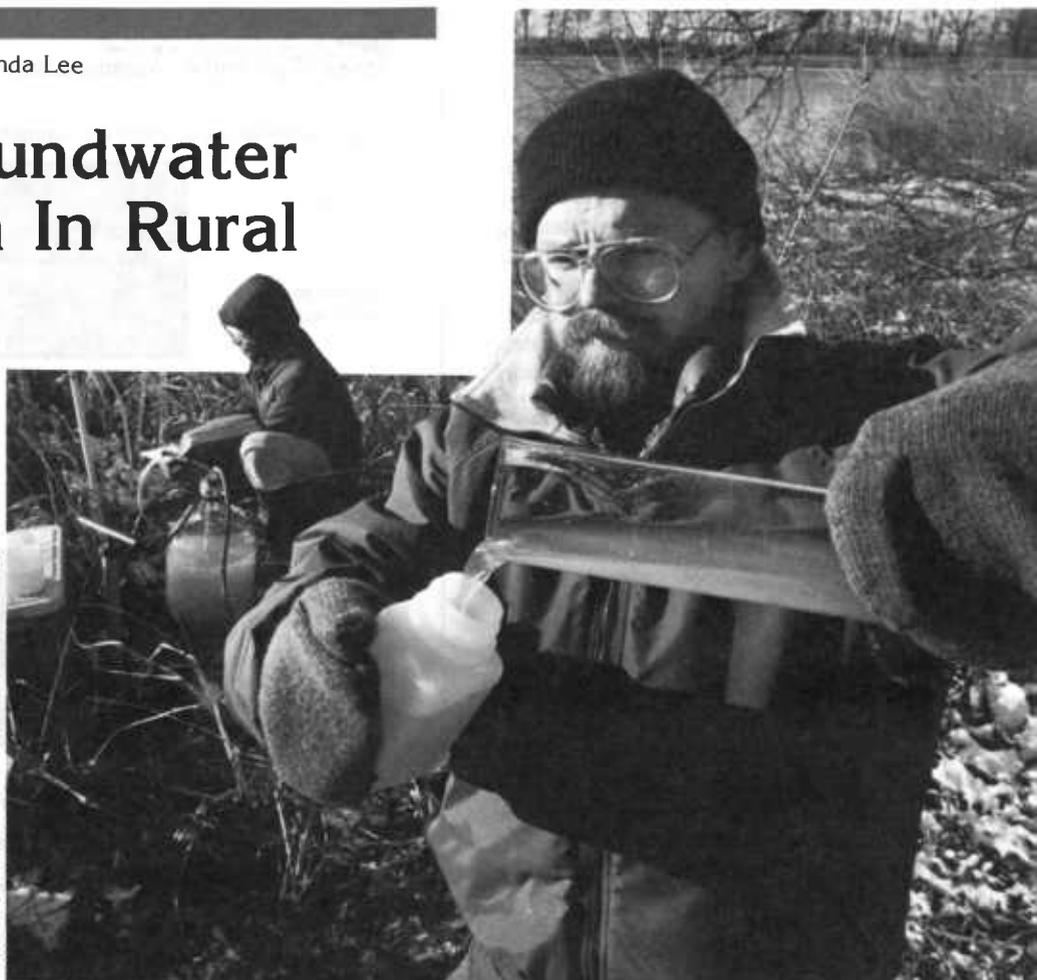
Groundwater contamination from farm use of pesticides and nitrogen fertilizers has been documented in many States, including Florida, Pennsylvania, Wisconsin, California, New York, and Iowa. The Economic Research Service, USDA, estimates that nearly half of all U.S. counties have a potential for groundwater contamination from agricultural chemicals (fig. 1). Nearly three-fourths of those counties are nonmetropolitan, of which nearly nine-tenths have populations under 20,000 (fig. 2).

In the potentially contaminated counties, an estimated 50 million people rely on groundwater for their drinking water. Over 19 million of them obtain their water from private wells (fig. 3) which, being shallower than public wells and often not as well built, are more vulnerable to contamination. Nor are they subject to public regulation. The individual well

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**Some States are ahead of Federal action in developing plans for managing polluted groundwater and monitoring groundwater quality. These technicians are taking water samples from a Delaware well for analysis.**

owner is responsible for assuring the quality of the water.

Nonmetro counties contain 45 percent of all the people using private wells in potentially contaminated areas (fig. 1). These include 1.1 million people who reside in completely rural counties. They are the people least likely to be targeted by programs to protect groundwater resources and who most often cannot hook up to public water supplies.

Pesticides affect more regions and people than fertilizers, according to the ERS analysis. Counties with pesticide contamination potential (alone or in combination with nitrates from nitrogen fertilizers) constitute 78 percent of the potentially contaminated counties and include 90 percent of the affected people.

The dimensions of the problem have generated a growing demand for legislation to prevent contamination,

motivated by concerns for public health and by the perception that prevention is usually more cost efficient than cleaning up a contaminated aquifer or treating drinking water.

There is no comprehensive Federal groundwater protection statute, although many legislative proposals have been introduced in Congress. State legislatures are also developing innovative approaches to groundwater quality protection. Although States generally possess better information than does the Federal Government on the location of potentially polluting activities and local hydrogeologic conditions, State budgets may be insufficient to finance a comprehensive groundwater quality control program. Given budget realities, rural areas, because of their low population densities, would receive a lower level of groundwater protection under some suggested solutions than areas more densely populated.

## Environmental Control of Farm Activities Historically Based on Voluntarism

Regulatory (or mandatory), as well as voluntary approaches have been developed in response to specific environmental goals. Goals for protecting a resource such as groundwater fall into three general categories: nondegradation, limited degradation, and differential protection (see box, "Groundwater Lexicon"). Under a differential protection strategy, rural areas would likely be assigned water quality guidelines less stringent than those of more populated localities. In rural areas, monitoring and other costs would be more expensive per capita than in urban areas, and the number of people affected by contamination would be far fewer.

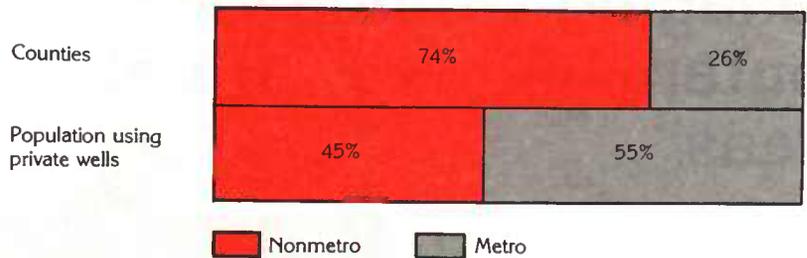
Regulation is the major control strategy used to protect public health and the environment in the United States. The most common regulatory approaches have been ambient water quality standards and design and operating standards for facilities that produce or otherwise handle wastes.

Ambient standards imply limited degradation and are used where environmental quality can be monitored at a reasonable cost. They are sometimes used to apply differential protection. An example of ambient standards is the Safe Drinking Water Act (SDWA), which establishes health-based standards for the quality of water produced by water treatment plants. The SDWA, however, does not protect the quality of water drawn from private wells.

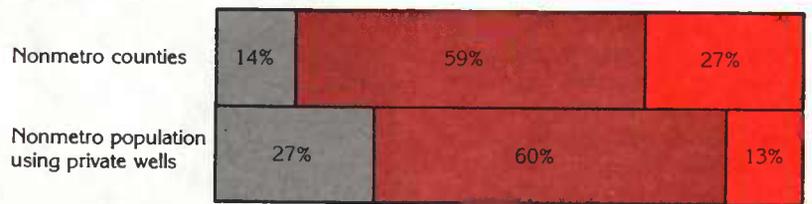
Where monitoring is unreliable, excessively expensive, or technically infeasible, design standards have been used to control pollution. The Resource Conservation and Recovery Act, for example, establishes design and operating standards for hazardous waste facilities and the Clean Water Act establishes design and operating standards for wastewater treatment plants. For a firm to receive an operating permit, standards reflecting appropriate pollution-handling technology must be met. Design standards can be applied in response to any of the three major groundwater protection goals.

Figure 1  
Areas of potential contamination

Three-fourths of the counties are nonmetro



Semirural counties contain three-fifths of nonmetro people reliant on private wells



- Urban (population of 20,000 or more living in an urban place)
- Semirural (population of 2,500-20,000 living in an urban place)
- Rural (no population in an urban place)

(Urban place = place with 2,500 or more population.)

Sources: Nielsen and Lee, and data from the Agriculture and Rural Economy Division, Economic Research Service. 1983 definitions of metro and nonmetro.

## Groundwater Lexicon

**Adsorption**—Adherence of molecules to the surface of the solids or liquids with which they are in contact.

**Ambient water quality standards**—Criteria that specify an acceptable level of pollution.

**Differential protection**—A policy under which water resources are given differing levels of protection, depending on the resource's use and value.

**Leaching**—Passing through or out of by percolation. Agricultural chemicals leach when they move downward beyond the root zone with the flow of water. Chemical and environmental factors affect leaching.

**Limited degradation**—A policy that allows specified levels of contaminants in water. Water resources may be equally protected or receive differential protection.

**Nondegradation**—A policy that protects a water resource at its current level of quality.

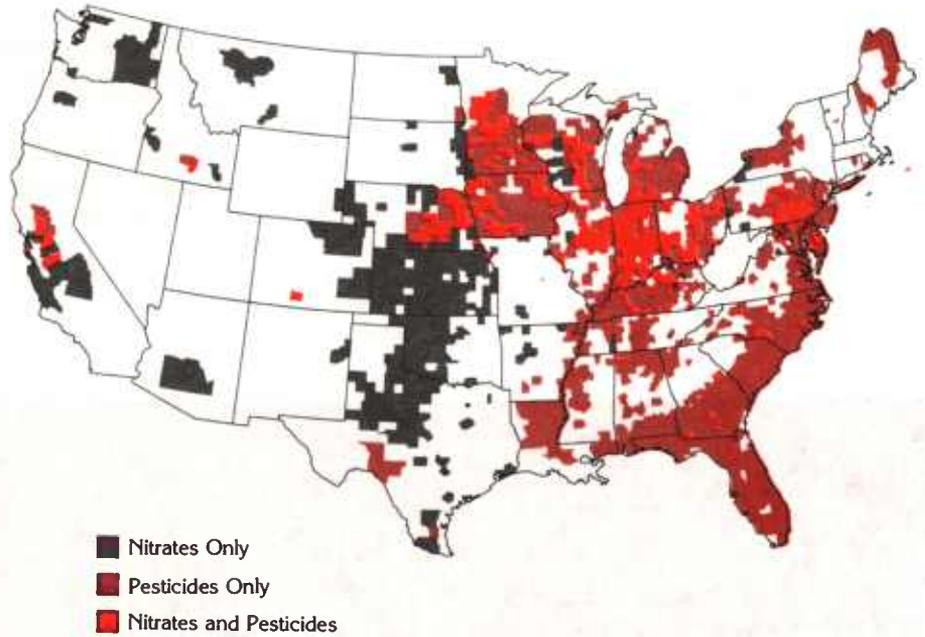
**Persistence**—A substance's "lasting power" or stability, usually measured in half-life, the time it takes for half of the substance to be degraded or transformed.

**Water solubility**—The amount of a substance that will dissolve in water under specific circumstances.

### Identifying Areas of Potential Contamination

The potentially contaminated counties were identified by synthesizing several data sources. This approach was necessary because there is currently no national database on the broad range of agricultural chemicals capable of reaching groundwater. Counties with groundwater potentially contaminated by pesticides were estimated by combining data on specific pesticide application rates with a rating of each county's physical vulnerability to groundwater contamination (which takes into account such factors as rainfall and depth to groundwater). Counties potentially contaminated by nitrates from nitrogen fertilizers, on the other hand, were inferred primarily from historical data on nitrate levels in groundwater provided by the U.S. Geological Survey.

Figure 2  
Areas of potential groundwater contamination from agricultural chemicals



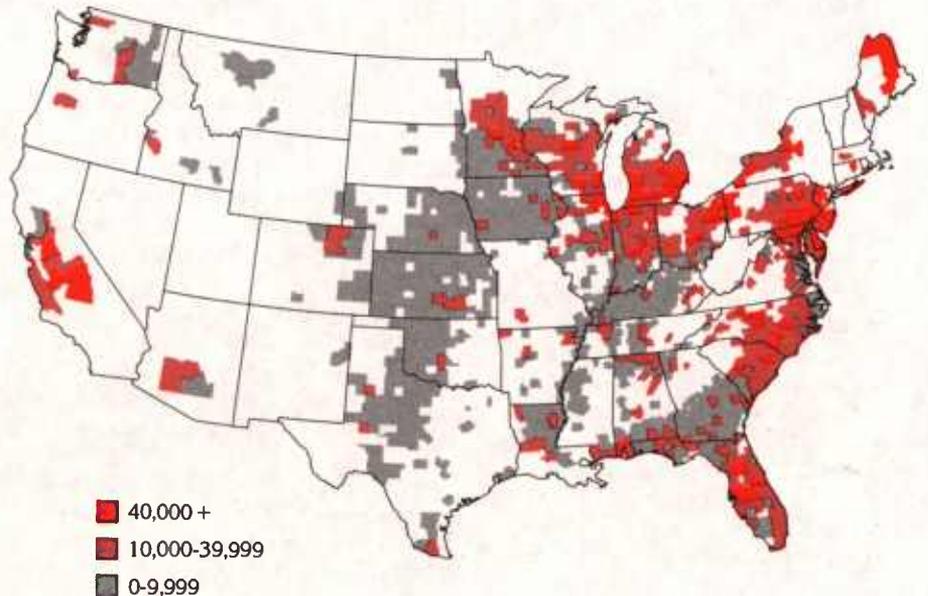
Data used to develop this map are reliable at a regional level. Individual counties should be evaluated with additional local data.

In contrast to the pollution control measures imposed on nonagricultural industries, mandatory ambient standards or design regulations have not been used for controlling agricultural pollution. Although agriculture has been identified as a major source of water pollution, only voluntary policy instruments to enhance water quality have been designed, to avoid interfering too much with individual farmer's activities.

Two examples of Federal legislation using a voluntary approach to reduce agricultural pollution and protect water quality are the Rural Clean Water Program (RCWP), an experimental program consisting of 21 projects nationwide, and the Conservation Reserve Program (CRP). Both programs provide farmers with financial incentives to participate.

The RCWP (PL 95-217) authorizes the use of cost-sharing subsidies to persuade participating farmers to adopt "best management practices" (BMP's) to conserve soil and to protect environmental quality. BMP's (such as terraces, sediment basins, conservation tillage, and contour plowing) are conceptually similar to the design and operating standards used for other

Figure 3  
Distribution of population using private wells in potentially contaminated areas



industries. The CRP, authorized by the 1985 Food Security Act, is a voluntary land retirement program. Owners and operators of "highly erodible" cropland may submit bids for enrollment of their eligible acreage.

In most RCWP projects, BMP's are not used to protect groundwater quality. Likewise, farmland cannot be enrolled in the CRP on the basis of potential groundwater contamination. However, both BMP's and CRP retirement for groundwater protection are being considered by Congress and may appear in the 1990 farm legislation.

A mandatory policy option being considered to protect groundwater is the pesticide registration process (a type of design standard.) In 1972, Congress amended the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) to require new health and safety standards. Under these provisions, pesticide manufacturers are required to provide test data for the new standards. If the test data indicate that the pesticide does not meet health or safety standards, the Environmental Protection Agency conducts a special review to weigh the benefits of using the pesticide against its possible health and environmental effects.

## States Develop Innovative Approaches to Groundwater Protection

Various States have, since 1980, developed management plans for coping with groundwater contamination. The plans and strategies vary according to the nature of the pollution, population density, settlement patterns, the pattern of economic growth, and the physical dimensions of the groundwater resource.

A 1984 survey of all 50 States undertaken by the EPA found that 16 had adopted nondegradation goals, 16 had adopted limited degradation goals, and

### Groundwater Contamination From Agricultural Chemicals:

#### *Its Causes...*

There is no one factor that determines whether or not a particular agricultural chemical will eventually enter the groundwater. Chemical characteristics including high water solubility, low adsorption, and high persistence mean an increased likelihood of leaching (see box "Groundwater Lexicon"). Nitrates and certain pesticides, including some of the most common such as alachlor, atrazine, butylate, and metolachlor, have been found in groundwater and traced to agricultural activities.

Even a "leacher," however, will not necessarily reach groundwater under all conditions. Certain hydrogeological characteristics of an area such as soil type, depth to groundwater, and amount of rainfall, are also important factors. Agricultural practices such as the method and timing of chemical application, tillage technique, and irrigation practices, also play a role. Unfortunately, much remains to be learned about how specific agricultural practices affect the leaching of chemicals. It appears, however, that some practices that reduce erosion (such as reduced tillage) actually increase the potential for leaching.

#### *...Its Effects...*

The primary potential effects of agricultural chemicals in groundwater are human health risks. Other potential effects include livestock health problems from nitrate ingestion, crop losses from fertilizer salts leached to groundwater and concentrated in irrigation water, and damage to vegetation, waterfowl, and aquatic life in surface waters fed by groundwater. No instances of these other effects, however, have been documented.

Very high concentrations of nitrates in drinking water can cause infant methemoglobinemia, which can be fatal at very young ages. Reported instances of death from this disorder are rare, although the true incidence is unknown. A 1986 infant death in South Dakota was tentatively linked to fertilizer applications. While the link between nitrate consumption and cancer has been investigated, no firm conclusions have been reached.

The risk from drinking water containing pesticide residues, though much studied, remains little understood. Since all pesticides are designed to be toxic to certain forms of life, and because few are completely selective in their actions, most could harm human health, depending on their concentrations. Evidence indicates that some chemicals which have been found in groundwater could cause harmful effects. Examples include EDB and

DBCP, which appear to cause genetic mutations and reproductive disorders, alachlor, EDB, and DBCP, which are suspected carcinogens, and atrazine, cyanazine, simazine, 2,4-D, 2,4,5-T, and 2,4,5-TP (Silvex), which have been linked to central nervous system disorders.

#### *...And Its Costs*

Individuals must weigh the perceived risks from drinking contaminated water with the costs of reducing those risks. Just obtaining information on the water's quality, however, is not costless. Monitoring wells for nitrates can cost up to \$28. Testing for just a few pesticides can cost \$100-\$300. The cost is essentially the same for an individual well owner as for a public system well, where the cost is spread out over a network of users.

If the levels of chemicals in the water are thought to be risky, the individual may adopt a remedial strategy, which also can be expensive. Water treatment units installed to reduce the level of contaminants can cost from \$25-\$800, depending on the type of unit, its effectiveness and capacity, and other factors. Most require periodic maintenance. Drilling a new well or hooking up to a public system require much larger outlays, and may not be feasible at any cost. Finally, drinking bottled water can cost an average family \$7-\$15 per week, in addition to the cost and inconvenience of transporting the water.

12 had adopted differential protection goals for protecting groundwater quality. Although these categories represent different levels of "acceptable" contamination, they are not necessarily mutually exclusive, and some States have more than one goal. For example, where a nondegradation policy is in force, waivers may be granted for specific activities that cannot be reasonably expected to achieve that goal. In total, 29 States had adopted and 21 had not adopted groundwater protection strategies.

An innovative approach to controlling groundwater degradation is the Safe Drinking Water and Toxic Enforcement Act of 1986 (Proposition 65) passed by referendum in California. This initiative makes it unlawful for any person in the course of doing business to knowingly discharge a chemical known to the State to cause cancer or reproductive toxicity into any source of drinking water. For such chemicals, the act embodies a nondegradation goal that gives equal protection to all resources. Among the unusual features of this initiative is the "bounty hunter" provision, which allows individuals to file suit against alleged violators of the law and share 25 percent of any fines. While considerable disagreement exists concerning the interpretation of several of the law's provisions, a number of other States are considering a similar approach to controlling groundwater quality.

In 1987, Iowa passed a comprehensive groundwater protection bill with a nondegradation intent that relies more on education and demonstration than on regulation. It establishes groundwater protection funds for various pollution sources. For example, the Agricultural Management Account receives funds from a pesticide dealer fee, a pesticide registration fee, and a tax on nitrogen fertilizer. With the funds gathered by these fees, the State will establish a sustainable agricultural research center, test rural drinking water wells for contamination, demonstrate alternatives to agricultural drainage wells, and develop a database on health effects from exposure to agricultural chemicals. Other accounts are established for household hazardous waste, storage tank management, and solid waste. Other States are considering similar approaches for managing their own groundwater contamination problems.

### Various Factors Influence Demand for State Groundwater Policies

Using the EPA data and voting data on the California referendum and the Iowa bill, we examined the relationship between groundwater policies and various economic, environmental, and demographic factors. This analysis (table 1) compares decisions by individuals (the referendum), representatives (the Iowa bill), and States (the EPA data).

We found that groundwater policies are associated with States that have high per capita incomes, high percentages of the population completing high school, low percentages of the population living in rural areas, and low percentages of the population living on farms. One possible explanation for these results is that environmental regulations can result in increased production costs, the loss of jobs, and an increase in prices. Rural areas that face limited employment opportunities are probably more sensitive to possible plant closings than are urban areas where employment opportunities are greater. Likewise, farmers and others in the agricultural economy are likely to be wary of regulations that could raise farm production costs.

The relationships found across all States are also found in California and Iowa. In California, counties with high per capita incomes, high percentages of the population completing high school, low proportions of the population living in nonmetropolitan areas, and low proportions of the labor force working in agriculture were more likely to vote for California's Proposition 65. In Iowa, representatives from districts with high per capita incomes and representatives from districts with low proportions of the labor force employed in agriculture were more likely to vote for the groundwater protection bill. Again, the implication is that the costs of controlling groundwater contamination in rural and agricultural areas is higher than in other areas and that legislation to protect groundwater is less popular in areas where jobs and incomes are likely to be adversely affected.

We also found that groundwater policies are associated with States that had experienced some groundwater contamination from pesticides. Of all the chemicals we tested for association (nitrates, volatile organic chemicals,

**Table 1—Economic, and environmental factors are correlated with the demand for groundwater policies**

Variables	California	Iowa	All States
<i>(Correlation coefficient)</i>			
Pesticides			
in groundwater	—	—	0.34
Level of income	0.25	0.19	.30
Rural	.22	—	.24
Level of education	.69	—	.27
Importance of agriculture	-.80	-.27	-.24

The numbers in the table are correlation coefficients, which indicate the direction and strength of the relationship between variables. The larger the number, the greater the correlation. A perfect relationship) and no correlation gives a coefficient of zero. Only relationships at the 0.10 level, indicating that the observed relationship could occur purely by chance only 1 time out of 10, are presented in the table.

synthetic organic chemicals, fluorides, arsenic, salt, metals, and radioactive materials), only nitrates and pesticides were significant. This suggests that the public perceives contamination from agricultural chemicals as different from other chemicals, and as a significant threat to public health and the environment.

### Proposed Federal Legislation Draws on Variety of Strategies

Groundwater quality legislation considered in the 100th Congress took one or more of the historical approaches described above (table 2). The policy option with the largest consequences for farmers was probably proposed legislation based on ambient water quality standards. Two sorts of ambient quality standards, reflecting differences in groundwater quality protection goals, were offered.

Legislation (S.20) proposed by Senator Daniel Moynihan (NY) would require States to develop their own management strategies and set their own ambient groundwater standards. While technical information supporting the standards would be provided by the Federal Government, States would be permitted to have different water quality standards depending on "the use of the water and the threat to human health and the environment" (a differential protection approach). In particular, States would be allowed to have standards less stringent for uses such as "agriculture, waste

disposal, industrial processes, and mining.”

The differential protection goal is also part of EPA's Proposed Pesticide Strategy for Agricultural Chemicals in Groundwater: “The Agency will use a differential protection approach to protect the ground-water resource. With this approach, the Agency will focus protection efforts on ground waters that are current or potential sources of drinking water or that are vital to fragile ecosystems.”

In contrast to the differential protection approach, S. 2091 (proposed by Senator Dave Durenberger, MN) would provide equal protection for all groundwater regardless of its relative use and value. This bill reflects concern that a differential protection goal would not adequately protect groundwater quality for rural America.

Another approach before Congress was to amend the FIFRA legislation to change pesticide registration requirements. Some proposals, none of which were included in the amendments recently signed into law, gave special attention to pesticides that leach to groundwater. The most stringent example of this approach was provided by S. 1419 (also proposed by Senator Durenberger). Under this approach, pesticides that are potential leachers would require health-based standards to be developed by EPA for residues in groundwater similar to the standard-setting process in the SDWA. Regulatory responses, such as restricting chemical use in specific locations, would be triggered by EPA and the States if ambient levels exceed the standard. If a pesticide is determined to be a leacher, the registrant would be required to develop BMP's that would be effective in preventing groundwater contamination.

A third approach considered in Congress was to allow land contributing to groundwater contamination to be eligible for enrollment in the CRP. Several bills in the Senate and House proposed this option.

In the end, the 100th Congress adjourned without passing groundwater legislation.

### Implications

Many rural areas potentially face groundwater contamination from

**Table 2—Critical aspects of major groundwater quality bills affecting agriculture and rural areas**

Sponsor and bill	Nondegradation	Differential protection	BMP	Pesticide restriction	Ambient standard	Land-use control
Moynihan (S. 20)		X			X	
Durenberger (S. 1419)	X		X		X	X
Durenberger (S. 2091)	X		X	X	X	
de la Garza (H.R. 2463)		X		X	X	
Oberstar (H.R. 3174)	X		X	X	X	
Nunn (S. 1521)						X
Hatcher (H.R. 3357)						X
Dole (S. 2045)						X
Roberts (H.R. 4137)						X

agricultural chemicals. Our analysis suggests that national groundwater quality standards would affect some rural areas more than others, because not all areas have the same potential for contamination and because standards would vary under differential protection strategies. Also, standards would not be popular among farmers and rural inhabitants. Strategies that would protect farm income while meeting water quality goals, such as BMP's or extension of the Conservation Reserve, would receive more support from the agricultural industry and many rural localities.

Agricultural chemicals are just one of the threats to the Nation's groundwater. States and the Federal Government must grapple with the best way to develop programs that protect the quality of this water and therefore the public health while at the same time protect jobs and economic opportunity. This problem is particularly acute in rural areas where economic opportunities are limited and the evidence of groundwater contamination is increasing. **FOP**

### For Additional Reading...

Committee on Ground Water Quality Protection. “Ground Water Quality Protection—State and Local Strategies.” Washington, DC: National Academy Press, 1986.

Elizabeth G. Nielsen and Linda K. Lee, *The Magnitude and Costs of Groundwater Contamination from Agricultural Chemicals—A National Perspective*, AER-576, U.S. Dept. Agr., Econ. Res. Serv., 1987.

Ruth Patrick, Emily Ford, and John Quarles, *Groundwater Contamination in the United States*, second edition, Philadelphia: University of Pennsylvania Press, 1987.

U.S. Environmental Protection Agency, *Overview of State Ground-Water Program Summaries*, 1985.

U.S. General Accounting Office, *Groundwater Quality—State Activities to Guard Against Contaminants*, 1988.

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