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Office of Water
Office of Pesticides and
Toxic Substances

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EPA

National Pesticide Survey

Survey Design

The U.S. Environmental Protection Agency (EPA) has completed its five-year National Survey of Pesticides in Drinking Water Wells (NPS). A joint project of EPA's Office of Drinking Water (ODW) and Office of Pesticide Programs (OPP), the Survey was designed to assess the extent and severity of the presence of pesticides and nitrate in drinking water wells nationwide, and the relationship of pesticide use and ground-water vulnerability to the presence of pesticides and nitrate. To achieve these goals, EPA tested water samples from more than 1,300 community water system (CWS) wells and rural domestic wells for the presence of 101 pesticides, 25 pesticide degradates, and nitrate (a total of 127 Survey analytes). EPA also collected detailed information about the wells' characteristics and condition, as well as surrounding circumstances such as nearby pesticide use and agricultural activities.

The focus of the Survey was on the quality of water in drinking water wells before treatment rather than on the quality of drinking water at the tap. The Survey does not provide a representative assessment of the presence of pesticides or nitrate for specific local areas, counties, or States, nor does it assess the presence of pesticides or nitrate in surface or ground water.

This fact sheet describes the key elements of the Survey design, including design tasks, scheduling, questionnaires, and design review. These elements ensure that the design was statistically sound and capable of producing information of a known and useful quality.

Survey Design

The primary task in designing the Survey was to select a sample of wells that would be representative of the nation's drinking water wells. Accomplishing this task involved a complex process of scientific and statistical calculations, as well as budget, policy, and program considerations. The basic elements of the Survey design and the process of choosing wells are described below.

Defining the Population. EPA's first step in survey design was to define carefully the two major categories of wells that it wanted to study. They were community water system wells (managed by public water suppliers) and rural domestic wells.

- Community water systems are defined as systems of piped drinking water with at least 15 connections and/or 25 or more permanent residents of the service area that have at least one working well used to obtain drinking water.

- Rural domestic wells are defined as drinking water wells supplying occupied housing units located in rural areas of the United States, except for wells located on government reservations. Rural households are defined as households located outside of incorporated or unincorporated places with populations of 2,500 or

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more, or located outside of areas designated as urban fringe by the Census Bureau.

With these overall categories of wells defined, EPA next set up a process for selecting wells from those two categories for the Survey.

Determining the Size and Accuracy of the Survey. In order to determine how many wells to visit for data collection, EPA first needed to identify approximately how many drinking water wells exist in the United States. This process was easier for community water systems than for rural domestic wells because a list of all public water systems, with their addresses, is contained in the Federal Reporting Data System (FRDS), which is maintained by EPA. From FRDS, EPA estimated that there were approximately 51,000 CWSs with wells in the United States. EPA did not have a comprehensive list of rural domestic wells to serve as the foundation for well selection, as it did for CWSs. Using data from the Census Bureau for 1980, EPA estimated that there were approximately 13 million rural domestic wells in the country, but the specific owners and addresses of these rural domestic wells were not known.

EPA chose a survey design technique called "stratification" to ensure that survey data would meet its objectives. This technique was used to improve the precision of the estimates by selecting extra wells from areas with substantial agricultural activity and high susceptibility to ground-water pollution (vulnerability). EPA developed criteria for separating the population of CWS wells and rural domestic wells into four categories of pesticide use and three relative ground-water vulnerability measures. This design ensures that the range of variability that exists nationally with respect to the agricultural use of pesticides and ground-water vulnerability is reflected in the sample of wells.

EPA identified five subgroups of wells for which it was interested in obtaining information. These subgroups were community water system wells in counties with relatively high average ground-water vulnerability; rural domestic wells in counties with relatively high average ground-water vulnerability; rural domestic wells in counties with high pesticide use; rural domestic wells in counties with both high pesticide use and relatively high average ground-water vulnerability; and rural domestic wells in "cropped and vulnerable" parts of counties (high pesticide use and relatively high ground-water vulnerability).

Two of the most difficult design questions were determining how many wells to include in the Survey and determining the level of precision that would be sought for the NPS national estimates. These two questions were connected, because greater precision is usually obtained by collecting more data. Resolving these questions would have been simpler if the Survey designers had known in advance what proportion of wells in the nation contained pesticides, but answering that question was one of the purposes of the Survey. Although many State studies have been conducted for specific pesticides, no reliable national estimates of well water contamination existed. EPA evaluated alternative precision requirements and costs for collecting data from different numbers of wells to determine the Survey size that would meet EPA's requirements and budget.

The Survey designers ultimately selected wells for data collection so that the Survey provided a 90 percent probability of detecting the presence of pesticides in the CWS wells sampled, assuming 0.5 percent of all community water system wells in the country contained pesticides. The rural domestic well Survey design was structured with different probabilities of detection for the several subgroups of interest, with the greatest emphasis placed on the cropped and vulnerable subcounty areas, where EPA was interested in obtaining very precise estimates of pesticide occurrence. EPA assumed that 1 percent of rural domestic wells in these areas would contain

pesticides and designed the Survey to have about a 97 percent probability of detection in "cropped and vulnerable" areas if the assumption proved accurate. EPA concluded that sampling approximately 1,300 wells (564 public wells and 734 private wells) would meet the Survey's accuracy specifications and provide a representative national assessment of the number of wells containing pesticides.

Selecting Wells for the Survey. Because the exact number and location of rural domestic wells was unknown, EPA chose a survey design composed of several steps (stages) for those wells. The design began with a sampling of counties, and then characterized pesticide use and ground-water vulnerability for subcounty areas. This eventually allowed small enough geographic areas to be delineated to enable the sampling of individual rural domestic wells. This procedure was not needed for community water system wells, because their number and location were known.

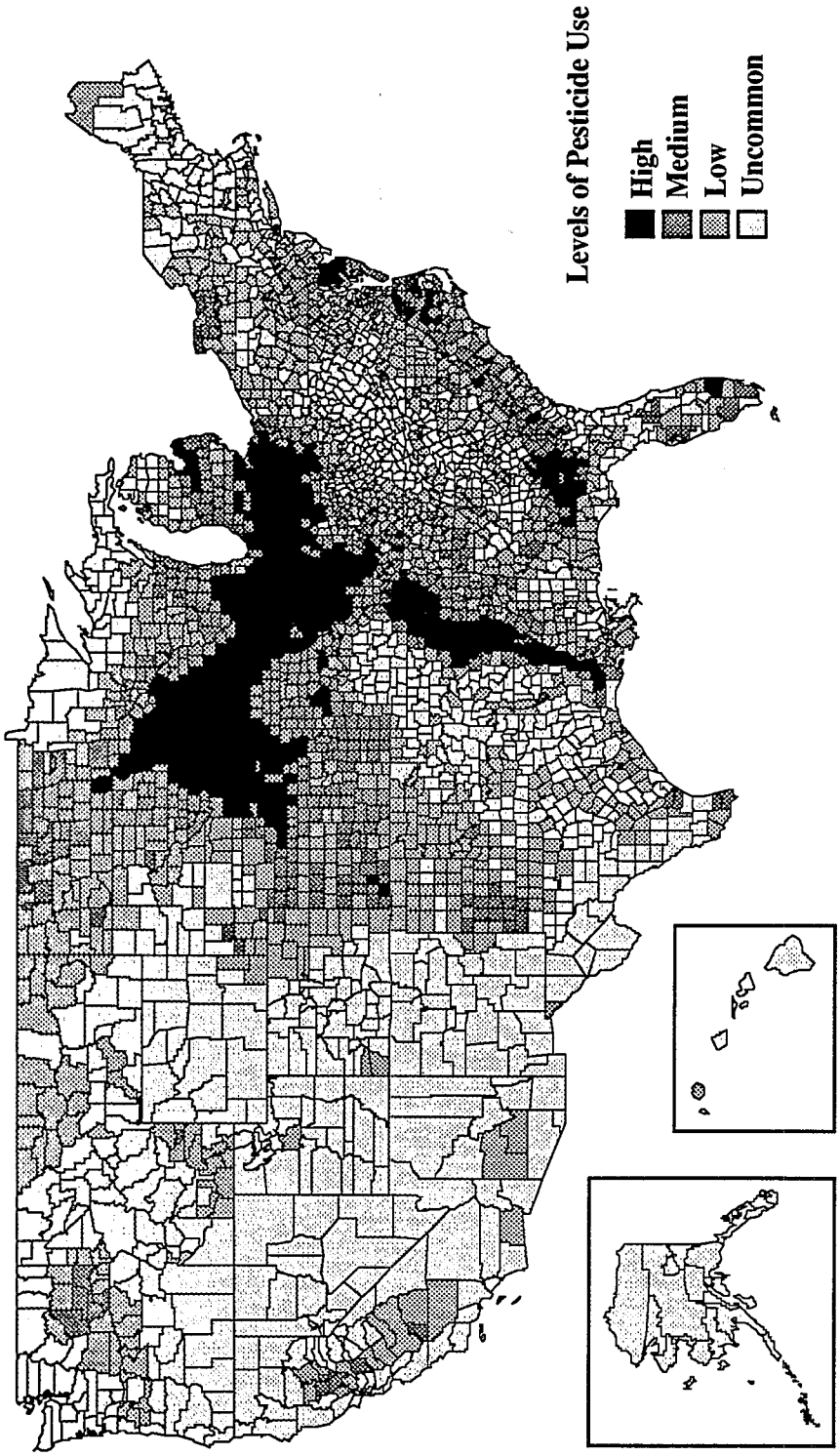
The first step in well selection was common to both CWS wells and rural domestic wells. Each of the 3,137 counties or county equivalents in the U.S. was characterized according to pesticide use and ground-water vulnerability to ensure that the variability in agricultural pesticide use and ground-water vulnerability was reflected in the Survey. EPA used data on agricultural pesticide use obtained from a marketing research source and information on the proportion of the county area that was in agricultural production to rank agricultural pesticide use for each county as high, medium, low, or uncommon. Ground-water vulnerability of each county was estimated using a numerical classification system called Agricultural DRASTIC, which assesses seven factors: (depth of water, recharge, aquifer media, soil media, topography, impact of unsaturated zone, conductivity of the aquifer). The model was modified for the Survey to evaluate the vulnerability of aquifers to pesticide and nitrate contamination, and one of the subsidiary purposes of the Survey was to assess the effectiveness of the DRASTIC classification. Each area was evaluated and received a score of high, moderate, or low, based on information obtained from U.S. Geological Survey maps, U.S. Department of Agriculture soil survey maps and other resources from State agencies, associations, and universities. The following two maps show the national characterization of pesticide use and ground-water vulnerability by county.

Exhibit 1 shows the resulting table of 12 strata for pesticide use and relative ground-water vulnerability and the number of U.S. counties ranked within each stratum.

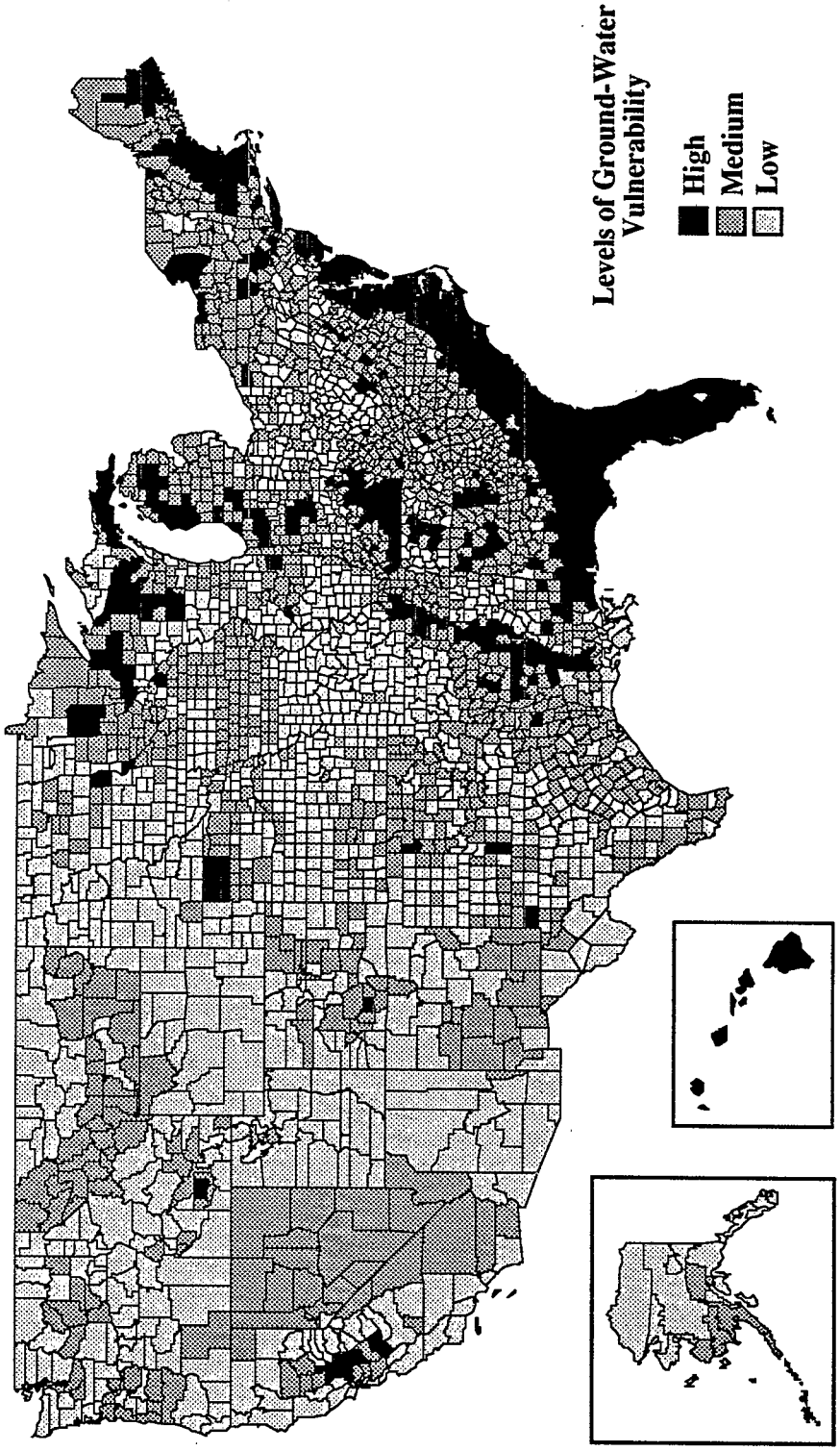
Exhibit 1: Strata for NPS Survey Design

Strata	Pesticide Use	Ground-Water Vulnerability (as estimated by DRASTIC)	Number of Counties
1	High	High	106
2	High	Moderate	234
3	High	Low	129
4	Moderate	High	110
5	Moderate	Moderate	204
6	Moderate	Low	267
7	Low	High	193
8	Low	Moderate	375
9	Low	Low	404
10	Uncommon	High	186
11	Uncommon	Moderate	513
12	Uncommon	Low	416
			3,137

First-Stage Characterization of Pesticide Use by County for the United States



First-Stage Characterization of Relative Ground-Water Vulnerability by County for the United States



The selection of the final sample of CWSs and domestic wells and the later stages of stratification in the selection process are described below.

Community Water Systems. After the first stage of stratification, EPA randomly selected approximately 7,000 CWSs from the total population of eligible systems contained in FRDS. The selection process, though random, was designed to sample a slightly larger proportion of those CWSs in the high ground-water vulnerability stratum because EPA wanted to ensure that estimates for areas sensitive to contamination achieved greater precision in the Survey. For the second stage of stratification, EPA contacted the systems by telephone to determine their operating status, confirm the number of wells, and obtain cooperation for sampling. Based on the results of this screening process, EPA selected eligible systems in about 390 counties distributed throughout all 50 States. EPA gathered water samples from 566 community water system wells. At those community water systems chosen for sampling that had more than one eligible well, the actual well to be sampled was chosen randomly. CWSs with large numbers of eligible wells could be chosen for sampling more than once, but a different well was sampled each time the CWS was included. Wells were sampled from all twelve strata.

Domestic Wells. EPA did not have a comprehensive list of domestic wells to serve as the basis for well selection, as it did for CWS wells. EPA used additional data to select domestic wells for the Survey. In the 90 counties in 38 States that EPA selected as areas for domestic well sampling in the first stage of stratification, a more detailed assessment of ground-water vulnerability was conducted that resulted in development of subcounty DRASTIC maps for each of these counties. Additional information on cropping intensity (a surrogate measure for agricultural pesticide use) was also collected and combined with the subcounty DRASTIC maps to delineate areas with varying degrees of ground-water vulnerability to pesticide contamination (second-stage stratification). These areas were used to select a slightly larger proportion of wells in the cropped and vulnerable parts of counties during the final stage of well selection. During this last stage, EPA conducted telephone interviews with well owners within each of the 90 counties to determine the eligibility of potentially participating households and obtain their cooperation. Based on the results of the subcounty scores and telephone interviews, EPA gathered water samples from 783 rural domestic drinking water wells for the Survey. Wells were sampled from all twelve strata.

Scheduling

EPA prepared a sampling schedule that provided for well water samples to be taken from both community water system wells and rural domestic wells during all seasons and pesticide application cycles. EPA's scheduling approach minimized the effect on NPS findings of weather conditions and pesticide applications in any particular season. To accomplish this, sampling at the selected community water systems and rural domestic wells in each stratum was randomly assigned to two week time periods across the data collection period (April 1988 to February 1990).

Questionnaires

During the well selection and actual sampling, EPA used questionnaires designed for the Survey to collect detailed information on individual wells, water systems, agricultural and non-agricultural pesticide use, and on geologic characteristics in the surrounding areas. The questionnaires proved to be very valuable in gathering important information from CWS owners and operators, domestic well owners, county agricultural extension agents, and farmers. The questionnaire data, together with the results of the water quality analyses, provide the basis for exploring the relationships between pesticide use, ground-water vulnerability, and the probability of contamination of drinking water wells. The analysis of these relationships will be provided in the Survey Phase II report, expected Spring 1991.

Design Review

A subpanel of EPA's Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) Scientific Advisory Panel (SAP) reviewed the design of the Survey in 1985 and again in 1987. The SAP subpanel made recommendations on several aspects of the design, including the type and complexity of data needed to carry out stratification, the proposed method for selecting CWSs, and the potential problem of seasonal variations influencing the presence of contaminants in the wells. EPA made appropriate changes to the Survey design to incorporate the subpanel's recommendations.

Survey Design Implemented

EPA conducted sampling of CWS wells and rural domestic wells nationally from April 1988 to February 1990. Laboratory analysis was completed in May 1990. EPA's Phase I Report on the Survey findings was released in Fall 1990. A Phase II Report, including the relational analysis of results, is scheduled for release in Spring 1991.

Where to Go for More Information

This fact sheet is part of a series of NPS outreach materials, fact sheets and reports. The following additional fact sheets are available through EPA's Public Information Center (401 M Street SW, Washington DC 20460, 202-382-2080):

Project Summary	***Analytical Methods***	***Survey Analytes***
Summary Results		***Glossary***
Fact Sheet for each detected analyte	***How EPA Will Use The NPS Results***	***Quality Assurance/ Quality Control***

Additional information on the Survey and on pesticides in general can be obtained from the following sources:

U.S. EPA Safe Drinking Water Hotline 1-800-426-4791 (In Washington, DC -- 382-5533) Monday-Friday, 8:30 am to 4:30 pm Eastern Time	Information on regulation of pesticides in drinking water
National Pesticide Telecommunications Network 1-800-858-7378 24 hours a day	Information on health effects and safe handling of pesticides
U.S. EPA Office of Pesticide Programs (OPP) Docket 401 M Street, SW Room NEG004 Washington, DC 20460 (202) 382-3587	Background documents for Survey (available for review)
National Technical Information Service (NTIS) 5285 Port Royal Road Springfield, VA 22161 (703) 487-4650	Copies of the NPS Phase I Report (available 1991) and NPS Phase II Report (when available)

If you are concerned about the presence of pesticides and nitrate in your private water well, contact you local or State health department. Other experts in your State environmental agency or agriculture and health department may also be helpful to you. If you receive your drinking water from a community water system and have questions about your water quality, contact your local community water system owner/operator or the State water supply agency.