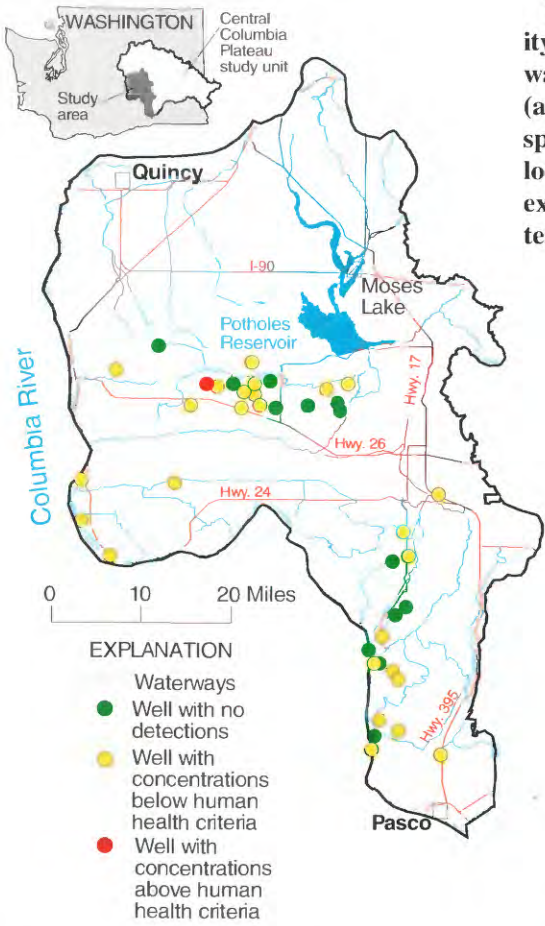
U.S. Department of the Interior
U.S. Geological Survey
Fact Sheet 171-96

Pesticides Found in Ground Water below Orchards in the Quincy and Pasco Basins



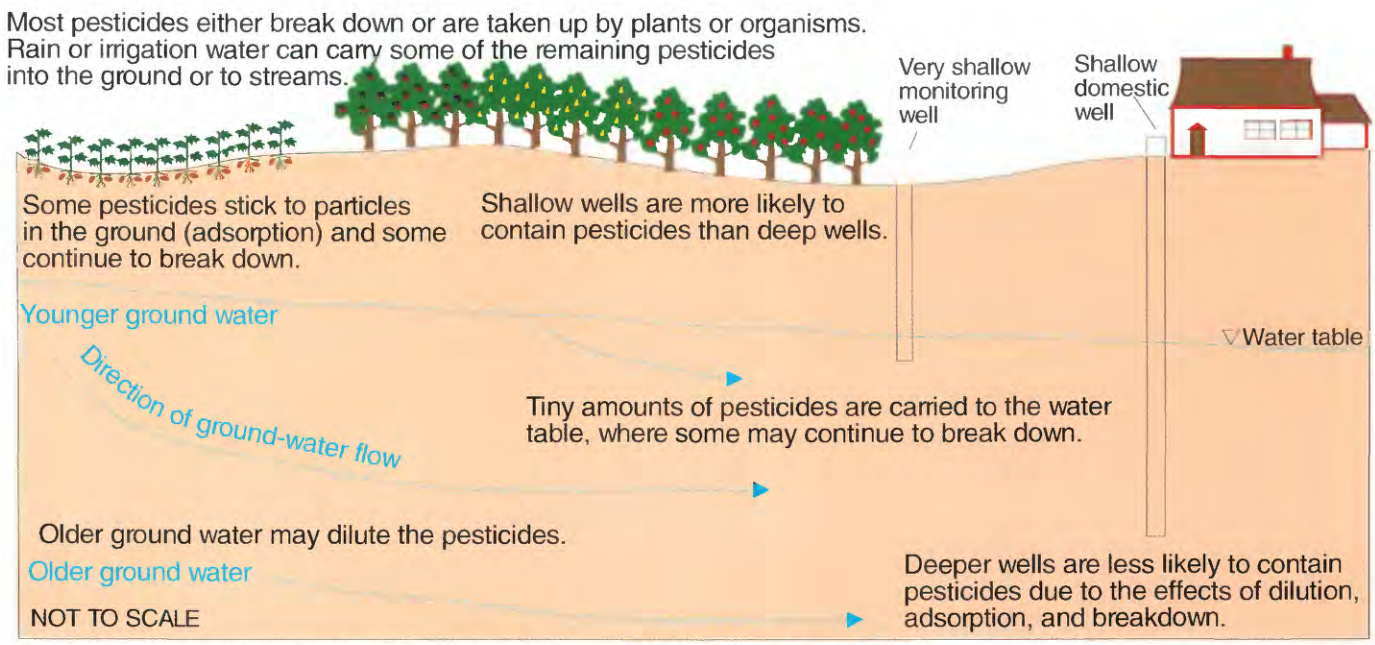
Location of wells sampled for pesticides.

To investigate the potential effects of agricultural chemicals on the quality of shallow ground water beneath fruit orchards, we collected ground-water samples during 1994-95 from 40 wells--18 shallow domestic wells (averaging 151 feet deep) and 22 monitoring wells (shallow wells drilled specifically for this study averaging 40 feet deep). Areas with potential local sources of pesticides, such as chemical mixing or storage sites, were excluded. This study was conducted as part of the Central Columbia Plateau National Water Quality Assessment (NAWQA) Program.

Highlights

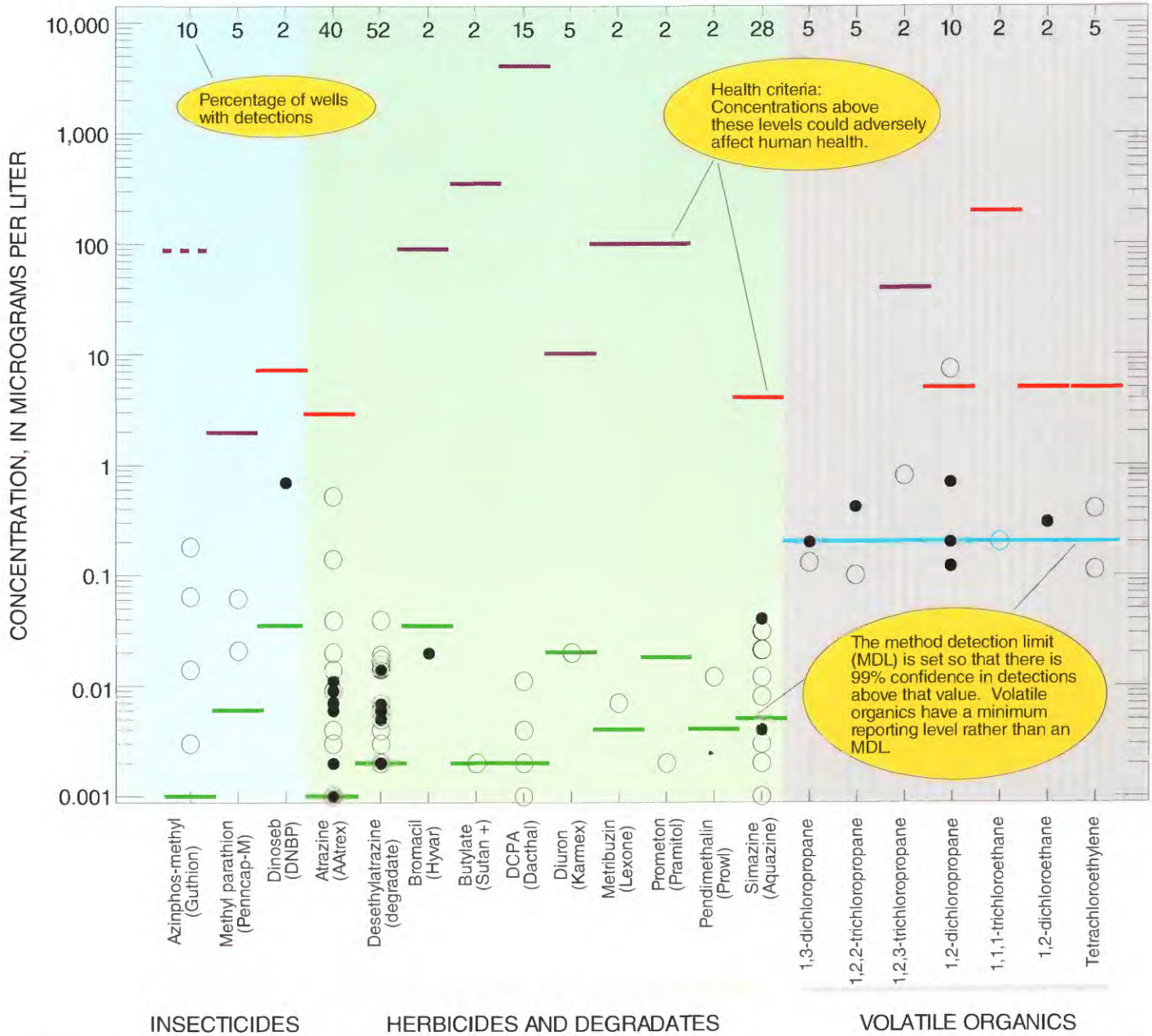
- Water from 68% of 40 wells had detectable concentrations of 20 different pesticides and volatile organic compounds out of 144 compounds analyzed for.
- Of the 16 detected compounds with existing human health criteria for drinking water, only 1,2-dichloropropane exceeded its criterion and in only one well.
- More pesticides were detected in water from shallow monitoring wells than in water from shallow domestic wells.
- Most of the pesticides detected (except the insecticides), are not used extensively on orchards in this study area. However, they all have been used on either the orchards or the surrounding cropland.
- Almost half of the wells sampled had detectable concentrations of more than one pesticide.

How do pesticides get into wells?



Pesticide movement in the subsurface and relative proximity of wells to the orchards.

What compounds did we find?



Concentrations of pesticides detected in wells near orchards. Trade names are for descriptive purposes only and their use does not imply endorsement by the U.S. Government.

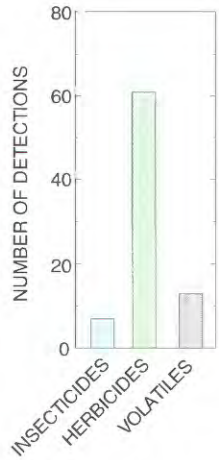
EXPLANATION

- Monitoring wells (22 wells)
- Domestic wells (18 wells)
- Method detection limit
- Minimum reporting level
- Maximum contaminant level (MCL)
- Health advisory level (HAL)
- Suggested no adverse response level (SNARL)

The MCL is the maximum level of a contaminant allowed in public drinking water. The HAL is a non-enforceable guideline which is the concentration that is not expected to result in any known or anticipated health effect in an average life-span (a 70-kilogram adult drinking 2 liters of water per day for 70 years). The U.S. Environmental Protection Agency (1996) sets the MCL and HAL; the SNARL is comparable to the HAL but is set by the National Academy of Sciences (Nowell and Resek, 1994).

Insecticides

All of the insecticides detected are used primarily on orchards in this study area. Three insecticides were detected; one or more were in samples from 5 of the 40 wells. **Azinphos-methyl** and **methyl parathion** rank first and seventh in amount of active ingredient applied to orchards in this study area (Anderson and Gianessi, 1995); both are also used on row crops but in much smaller quantities. **Dinoseb** is a dormant fruit spray that was banned from use in the U.S. in 1988; it was detected at 10% of its MCL of 7 micrograms per liter (µg/L).



Number of detections for each pesticide category.

Herbicides

Herbicides were more frequently detected than other pesticides despite being applied to orchards at lower rates (except simazine, which ranks 12th among synthetic pesticides applied to orchards, and diuron, which ranks 29th). In this study area, herbicides are applied in much greater amounts to surrounding row crops (for example, potatoes and corn); another potential source of herbicides is applications to rights-of-way for transportation, canals, and power transmission. Additionally, some of these herbicides may have been applied before the orchards were planted. Orchards in the study area increased from 4,300 to 30,500 acres between 1974 and 1991 (Bureau of Reclamation, 1974, 1991), and in most cases they replaced irrigated row crops. Ground water moves slowly enough that these pesticides could be left over from previous crops, as evidenced by the presence of compounds that have been banned for many years.

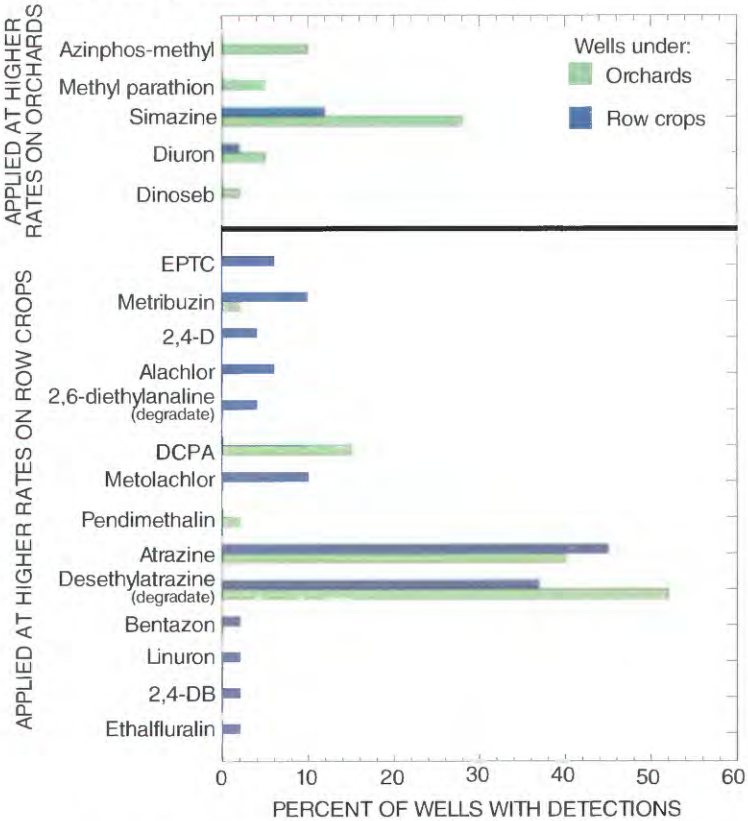
Herbicides are typically more water soluble than other pesticides (Smith and others, 1988), giving them a greater potential to leach into ground water. **Triazine compounds** in particular have been shown to leach into ground water; three triazines were among the most commonly detected compounds in the study (40% of the wells had detections of **atrazine**, 52% had **desethylatrazine,** a degradate of atrazine, and 28% had **simazine**). Of these, **atrazine** was at the highest concentration (0.5 µg/L) and closest to its MCL of 3 µg/L.

Volatile organics

Almost 70% of the volatile organic compounds (VOCs) detected were used on row crops prior to the early 1980s; they included the only compound we detected at a concentration above a drinking water standard: **1,2-dichloropropane** exceeded its MCL (5 µg/L) in one well and was also the most frequently detected VOC. The chlorinated propanes such as 1,2-dichloropropane are discontinued soil fumigants or their manufacturing by-products; they are not believed to be associated with orchards but have likely migrated beneath orchards or were applied before the orchards were planted. The rest of the VOCs we detected have been used in a variety of ways including the fumigation of stored grain.

Are all these pesticides used on orchards?

No, only the three insecticides and the herbicides simazine and diuron can clearly be associated with orchards; most of the herbicides and volatile organic compounds probably migrated beneath the orchards from surrounding crops or were applied before the orchard was planted.



Frequency of detection of selected pesticides used on orchards and row crops in the study area.

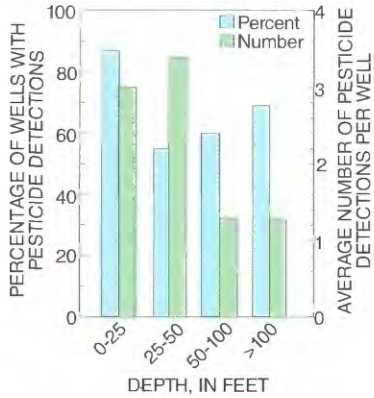
In the chart above, detected compounds are grouped by whether they are applied at higher rates on orchards or row crops, and are listed from highest to lowest usage rate within each group. (The degradates desethylatrazine and 2,6-diethylanaline are listed below their parent compound.) The darker bars reflect data from a similar study on row crops (Roberts and Jones, 1996).

The chart shows that the five compounds that are applied at higher rates on orchards were detected more frequently in wells near orchards. Similarly, 11 of the 14 detected compounds applied at higher rates on row crops were detected more frequently in wells near row crops. However, usage rate is not an ideal guide in determining detection frequency. Within each group, the pesticides used at the highest rates were not detected most frequently, and other pesticides applied at similar or higher rates are not shown on the chart because they were not detected at all.

Shallow wells are more contaminated

Shallow wells are generally more susceptible than deeper wells to contamination by chemicals applied at the land surface, mainly because of the short distance between the land surface and the well. Therefore, there is less opportunity for the chemicals to break down by natural means, adsorb to minerals and organic matter in the ground, or be diluted by uncontaminated water from canals and other sources.

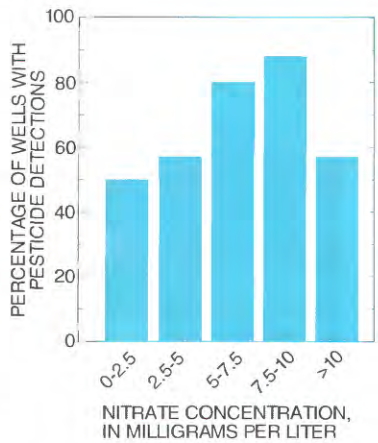
The shallowest wells in this study had the highest rate and number of pesticide detections (see graph); however, the effect of well depth is not very pronounced because the study focused exclusively on shallow ground water.



Percentage of wells with pesticide detections and number of detections by depth category.

The nitrate connection

The presence of nitrate in well water is another indicator of the potential for pesticide contamination because fertilizers (the primary source of nitrate) and pesticides are typically applied to the same areas. Nitrate in drinking water above certain levels can be a health concern, and is relatively inexpensive to analyze for. In this study, wells with higher nitrate concentrations generally had greater rates of pesticide detections (see chart).

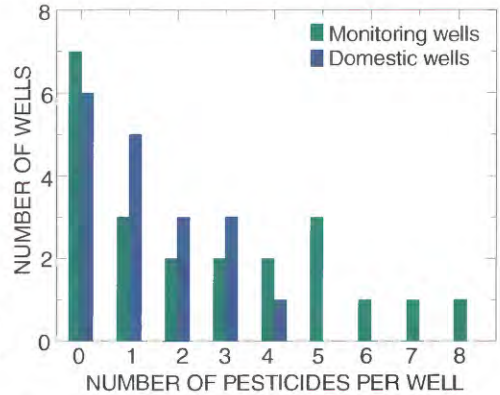


Percentage of wells with pesticide detections by nitrate concentration category.

Multiple pesticides detected in many wells

Multiple pesticides were detected in about half of the 40 wells sampled. No domestic well had more than four pesticides per well, whereas monitoring wells had up to eight pesticides per well.

Health effects of multiple pesticides in drinking water are not well known; however, just as the effectiveness of pesticides may change (increase ***or*** decrease) when mixed together for agricultural use, the effect on humans may change when pesticides are present in combinations. Currently, health criteria are set only for individual compounds. The U.S. Environmental Protection Agency (USEPA) is considering establishing health criteria for combinations of triazine pesticides, as well as for their individual breakdown products (USEPA, 1994). Recent studies (Kolpin and others, 1996), report that breakdown products of some common herbicides, including triazines, are detected as frequently as or more frequently than the parent pesticide.



Number of wells with multiple pesticide detections.

REFERENCES

Anderson, J.E., and Gianessi, L.P., 1995, Pesticide use in the Central Columbia Plateau: National Center for Food and Agricultural Policy, [100] p.

Bureau of Reclamation, 1974 and 1991, Crop Production Report, unpaginated.

Kolpin, D.W., Thurman, E.M., and Goolsby, D.A., 1996, Occurrence of selected pesticides and their metabolites in near-surface aquifers of the midwestern United States: Environmental Science & Technology, v.30, no.1, p. 335-340.

Nowell, L.H., and Resek, E.A., 1994, Summary of national standards and guidelines for pesticides in water, bed sediment, and aquatic organisms and their application to water-quality assessments: U.S. Geological Survey Open-File Report 94-44, 115 p.

Roberts, L.M., and Jones, J.L., 1996, Agricultural pesticides found in ground water of the Quincy and Pasco Basins: U.S. Geological Survey Fact Sheet 240-95, 2 p.

Smith, J.A., Witkowski, P.J., and Fussillo, T.V., 1988, Man-made organic compounds in the surface waters of the United States--a review of current understanding: U.S. Geological Survey Circular 1007, 92 p.

U.S. Environmental Protection Agency, November 23,1994, Atrazine, simazine, cyanazine; notice of initiation of special review: Federal Register, v.59, p. 60412-60443.

U.S. Environmental Protection Agency, February 1996, Drinking water regulations and health advisories: EPA 822-R-96-001, 14 p.

U.S. DEPARTMENT OF THE INTERIOR
U.S. GEOLOGICAL SURVEY
National Water Quality Assessment Program

prepared by
Lonna M. Roberts
and
Joseph L. Jones

For further information contact:
Project Chief
Central Columbia Plateau NAWQA
1201 Pacific Ave., Suite 600
Tacoma, WA 98402
(206) 593-6510 email: nawqa_ccpt_wa@usgs.gov
World Wide Web: http://wwwdwatcm.wr.usgs.gov/ccpt.nawqa.html

The National Water Quality Assessment (NAWQA) Program of the U.S. Geological Survey is designed to describe current water-quality conditions for a large part of the Nation's ground and surface water, to describe how water quality is changing over time, and to improve our understanding of the natural and human factors that affect water quality. These goals are being achieved through investigations of 60 of the Nation's most important river basins and aquifer systems, referred to as study units.

July 1996

☆ U.S. GOVERNMENT PRINTING OFFICE: 1996 - 774-398 / 20006 REGION NO. 8