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Wyoming Department of Agriculture

Wyoming Department of Environmental Quality

Prepared in cooperation with the Wyoming Department of Agriculture and the Wyoming Department of Environmental Quality, on behalf of the Wyoming Ground-water and Pesticides Strategy Committee

Pesticides in Ground Water of Wyoming, 1995–2006

In 1991, members of local, State, and Federal governments, as well as industry and interest groups, formed the Ground-water and Pesticides Strategy Committee (GPSC) to prepare the State of Wyoming Generic Management Plan for Pesticides in Ground Water. Little existing information was available describing pesticide occurrence in ground water; therefore, statewide baseline ground-water sampling was considered a high priority by the GPSC.

The GPSC identified 20 pesticides and degradates for baseline ground-water sampling (referred to herein as focal pesticides). Sampling focused on the State's most vulnerable ground water (Wyoming Ground-water and Pesticides Strategy Committee, 1999) as determined by Hamerlinck and Arneson (1998; fig. 1). Ground-water vulnerability is based on inherent sensitivity of the hydrogeology (such as a shallow water table or highly permeable aquifer materials) and overlying land use.

Ground-Water Sampling

The U.S. Geological Survey (USGS), in cooperation with the Wyoming Departments of Agriculture and Environmental Quality, on behalf of the GPSC, conducted baseline sampling in Wyoming to characterize the large-scale occurrence of pesticides in ground water. During 1995–2006, sampling was conducted in each county, during which generally two water samples were collected (once in the fall and spring) from each of 296 wells. Five to 28 wells were selected for sampling in each county with site selection focused on areas where the ground water is most vulnerable, shown as areas of high or medium high vulnerability in figure 1.

The order of counties sampled was based on a ranking from the GPSC (fig. 1; Ground-water and Pesticides Strategy Committee, 1999). Most wells selected for this study were either a domestic, monitoring, or stock well. The depths of all wells were between 7 and 200 feet below land surface, with most well depths less than 100 feet. Most (78 percent) wells were completed in unconsolidated aquifers, and 22 percent of wells were completed in consolidated (bedrock) aquifers (Bartos and others, 2009).

Ground-water samples were analyzed for the 20 focal pesticides (table 1), plus as many as 136 additional pesticides (Bartos and others, 2009) using USGS laboratory methods. These highly

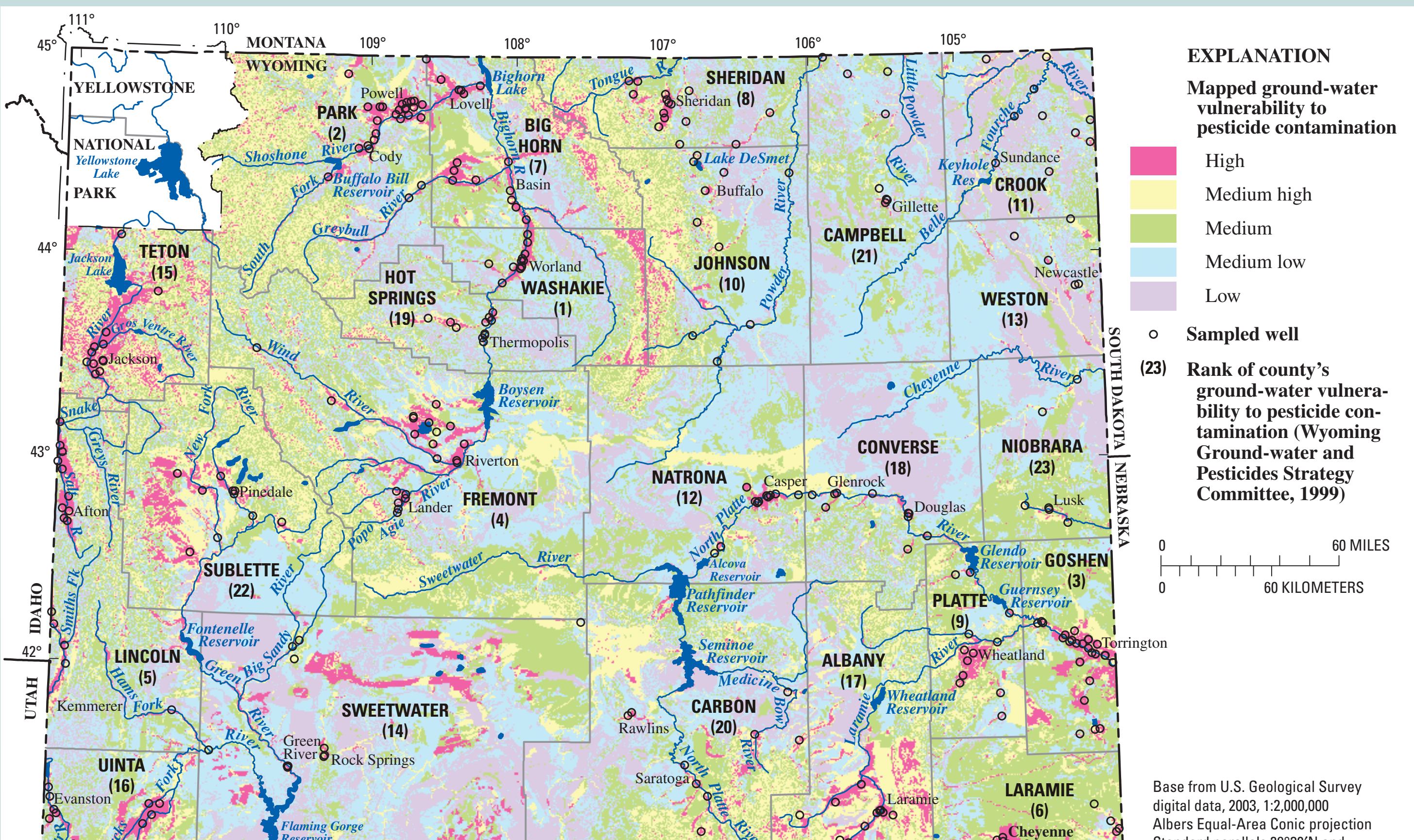

Figure 1. Aquifer vulnerability mapped across the State of Wyoming was based on hydrogeologic features and land use (Hamerlinck and Arneson, 1998). Two hundred and ninety-six wells were sampled to evaluate the presence of pesticides in Wyoming's most vulnerable aquifers.

Table 1. Focal pesticides and nonfocal pesticides, as determined by the Wyoming Ground-water Pesticides Strategy Committee (1999), detected in Wyoming ground water, 1995–2006 (compiled from Bartos and others, 2009).

[Compounds in **bold type** were detected at concentrations greater than the CSAL. CSAL, compound-specific assessment level; µg/L, micrograms per liter; --, not applicable; NA, not assigned; USEPA, U.S. Environmental Protection Agency]

Common name	Trade name	Type of pesticide (Meister, 2002)	Number of detections (using CSAL)/number of samples (CSAL noted in parentheses, in µg/L)	Median concentration of two or more detections, or value if only one detection, greater than CSAL (µg/L)	USEPA standard or health advisory (µg/L)
Focal pesticides[1] from Wyoming Ground-water and Pesticides Strategy Committee (1999)					
Alachlor	Lasso, Alanex, Shroad	Herbicide	0/589 (0.05)	--	[2]2
Aldicarb	Temik	Insecticide	0/577 (NA)	--	[2,3]3
Aldicarb sulfone	Aldicarb degradate, Standek, Aldoxycarb	Insecticide	6/569 (0.11)	0.24	[2,3]2
Aldicarb sulfoxide	Aldicarb degradate	--	6/571 (0.14)	.47	[2,3]4
Atrazine	Aatrex, Atranex	Herbicide	160/578 (0.004)	.010	[2]3
Bromacil	Hyvar X	Herbicide	18/574 (0.06)	.52	[4]70
Clopyralid	Stinger, Lontrel	Herbicide	3/567 (0.26)	22	([7])
Cyanazine	Bladex	Herbicide	2/535 (0.013)	.074	[4]1
2,4–D	Dacamine, Weed-B-Gon	Herbicide	[5]1/580 (0.15)	13.8	[2]70
DCPA	Dacthal	Herbicide	[5]1/587 (0.004)	.004	[4]70
Dicamba	Banvel, Banex	Herbicide	[5]1/575 (0.13)	1.1	[4]4,000
cis- and *trans-*1,3-Dichloropropene	Telone	Nematicide	0/570 (NA)	--	[6]40
Difenzoquat	Avenge	Herbicide	No analytical method available	--	([7])
Hexazinone	Buckshot, Pronone, Velpar	Herbicide	[5]1/46 (0.05)	.06	[4]400
Metolachlor	Bicep, Dual	Herbicide	5/534 (0.009)	.024	[4]700
Metribuzin	Lexone, Sencor	Herbicide	0/589 (0.05)	--	[4]70
Metsulfuron	Ally, Escort	Herbicide	0/142 (0.07)	--	([7])
Picloram	Tordon	Herbicide	36/569 (0.06)	.35	[2]500
Simazine	Princep, Primatol, Aquazine	Herbicide	4/589 (0.05)	.08	[2]4
Tebuthiuron	Graslan, Spike	Herbicide	65/589 (0.01)	.05	[4]500
Nonfocal pesticides detected above applicable CSAL[1]					
Bentazon	Basagram, Bentazone	Herbicide	2/578 (0.06)	0.36	[4]200
Bromoxynil	Agristar, Brominal, Buctril	Herbicide	[5]1/580 (0.07)	.22	([7])
Carbofuran	Furadan, Futura	Insecticide	2/587 (0.02)	.032	[2]40
2,4–D methyl ester	--	Herbicide	[5]1/140 (0.009)	.74	([7])
Deethylatrazine	Atrazine degradate	--	25/591 (0.05)	.21	([7])
Deisopropylatrazine	Atrazine/cyanazine/simazine degradate	--	2/217 (0.05)	.12	([7])
Diazinon	Basudin, Spectracide, Knoxout	Insecticide, nematicide	[5]1/587 (0.008)	.016	[4]1
3,4-Dichloroaniline	Propanil degradate	--	[5]1/21 (0.004)	.007	([7])
Dichlorprop	Weedone, Polymone	Herbicide	[5]1/583 (0.06)	.07	([7])
Diuron	Durashield, Karmex	Herbicide	5/585 (0.06)	.11	[6]200
Fipronil sulfide	Fipronil degradate	--	2/154 (0.006)	.007	([7])
Flumetsulam	Broadstrike, Python	Herbicide	2/142 (0.06)	.07	([7])
Hydroxyatrazine	Atrazine degradate	--	[5]1/141 (0.016)	.02	([7])
Imidacloprid	Admire, Provado	Insecticide	2/141 (0.02)	.03	([7])
Oryzalin	Surflan	Herbicide	[5]1/520 (0.31)	.63	([7])
Prometon	Pramitol, Gesafram	Herbicide	74/549 (0.05)	.11	[4]100
Triallate	Far-Go, Avadex BW	Herbicide	[5]1/541 (0.003)	.005	([7])
Triclopyr	Garlon	Herbicide	2/584 (0.36)	10.1	([7])

[1]For a list of all pesticides analyzed for during the study, see Bartos and others, 2009, table 1.

[2]MCL, USEPA Maximum Contaminant Level (U.S. Environmental Protection Agency, 2006).

[3]The MCL for any combination of two or more of these three chemicals (aldicarb, aldicarb sulfoxide, and aldicarb sulfone) should not exceed 7 µg/L because of similar mode of action.

[4]LHA, USEPA Lifetime Health Advisory Level (U.S. Environmental Protection Agency, 2006).

[5]If a compound was only detected once, that value rather than a median is presented.

[6]RSD4, USEPA Risk-Specific Dose at 10^{-4} Cancer Risk (U.S. Environmental Protection Agency, 2006).

[7]At the time of publication, a standard or health advisory had not been established by the USEPA.

sensitive methods often have analytical reporting limits 100 to 1,000 times lower than State and Federal drinking-water standards and guidelines for protecting water quality or routine pesticide monitoring of public drinking-water supplies. All concentrations of pesticides detected during the study were less than State and Federal standards and guidelines. Detections, therefore, do not necessarily indicate a concern to human health but rather help identify the environmental presence of pesticides and track their occurrence over time.

Data Analysis

Results of baseline ground-water sampling were analyzed to describe pesticide occurrence (Bartos and others, 2009). Although the data were collected over a 12-year period, the data were not conducive to trend analyses, because most sites were only sampled during a 1-year period.

Most pesticide detections were at low levels—concentrations that approach laboratory analytical capabilities. When comparing detections of the same pesticide over time, all sample detections were recensored to a single reporting level (noted as the CSAL, compound-specific assessment level). In order to compare different compounds to each other, pesticide detections were again recensored to a common assessment level (CAL) of 0.07 microgram per liter (µg/L).

A screening-level assessment of the possible significance of detected compounds to human health was done and was based on a comparison of measured concentrations to available human-health benchmarks. Concentrations of regulated compounds were compared to U.S. Environmental Protection Agency (USEPA) Maximum Contaminant Levels (MCLs). Concentrations of some unregulated compounds were compared to USEPA Lifetime Health Advisory Levels (LHAs) or toxicity information, if available. Sixteen of the detected compounds listed in table 1 do not have human-health benchmarks or adequate toxicity information for evaluating results in a human-health context.

Pesticide Detections—Statewide

Descriptions of pesticide detections are useful for understanding the nature of pesticides in ground water throughout the State and are as follows:

- No pesticide concentrations exceeded USEPA drinking-water standards or health-advisory levels (available for 18 of 32 detected pesticides; table 1).
- One or more pesticides were detected at concentrations greater than the CAL (0.07 µg/L) in water from about 23 percent of wells sampled in the State.
- Most detected pesticides (81 percent) were classified as herbicides or herbicide degradates.
- Thirty-two different pesticides were detected at concentrations greater than applicable CSALs.
- A greater number of pesticides were detected at concentrations greater than the CSAL during the fall (28 different compounds) compared to the spring (21 different compounds).

Pesticide Detections—Geographic Area

The State was divided into eight different regional geographic areas by Bartos and others (2009), on the basis of regional areas having similar natural characteristics (geography, physical features,

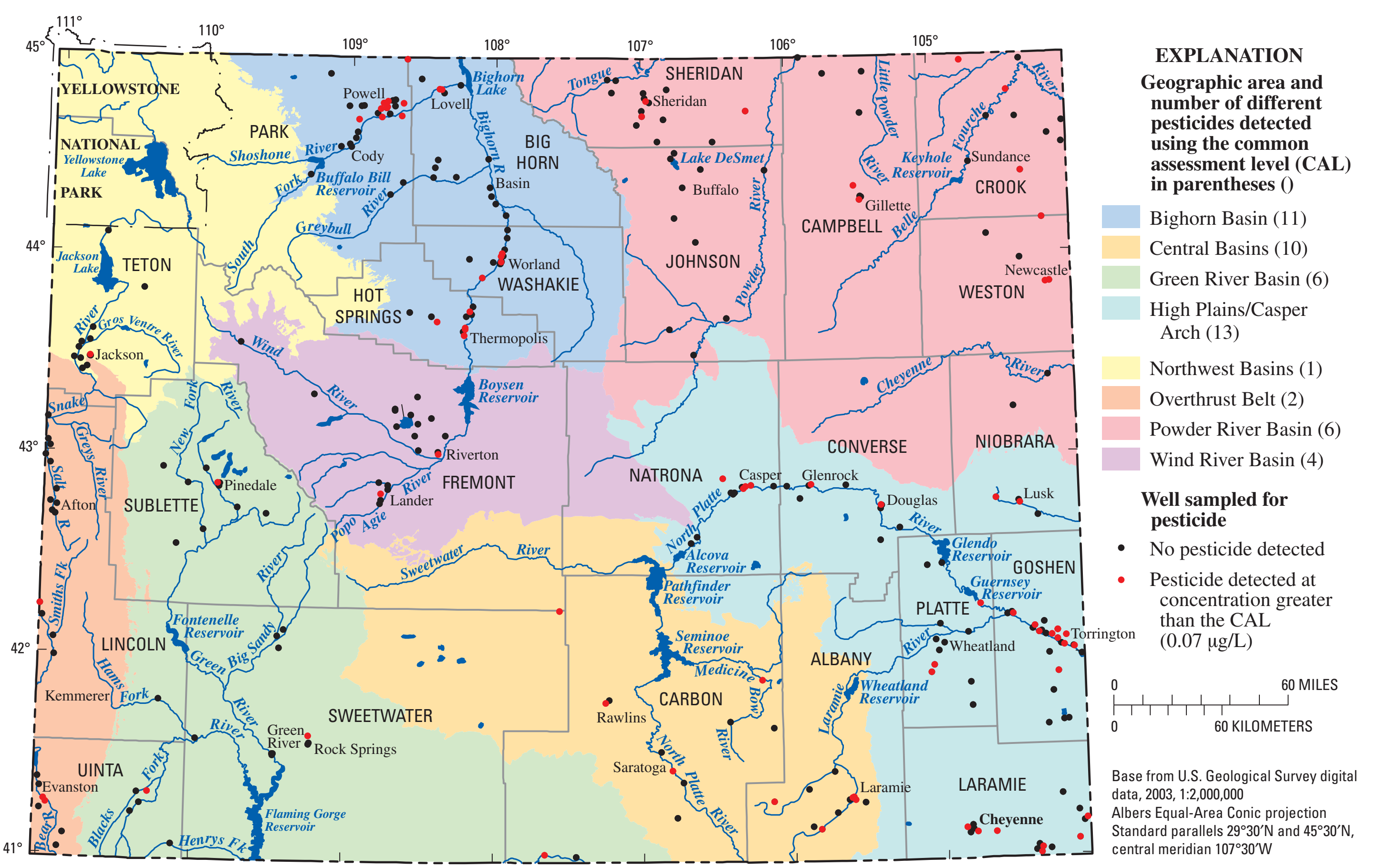

Figure 2. One or more pesticides were detected at concentrations greater than the CAL (0.07 µg/L) in water from 23 percent of the wells sampled during 1995–2006. The largest percentage of pesticide detections was in ground water from the High Plains/Casper Arch geographic area.

hydrology, and geology) and land use (fig. 2). Evaluation of pesticide occurrence in relation to geographic areas showed that:

- The largest percentages of pesticide detections were in water from the High Plains/Casper Arch and Bighorn Basin geographic areas, where 40 and 26 percent, respectively, of all detections occurred at concentrations greater than the CAL (fig. 3).
- The number of different pesticides detected at concentrations greater than the CAL was largest in water from the High Plains/Casper Arch, Bighorn Basin, and Central Basins geographic areas (fig. 2).
- Prometon (a nonagricultural pesticide) was the only pesticide detected in all eight geographic areas.

Pesticide Detections—Hydrogeology

The frequency of pesticide detection was examined in relation to hydrogeology. This involved assessing the aquifer type, water level and well depth, well type, and soil characteristics. A notable outcome of this analysis was:

- The percentage of wells with at least one pesticide detected was larger for wells completed in unconsolidated aquifers than in bedrock aquifers regardless of assessment level.

Pesticide Detections—Land Use

Land use was mapped within a 500-meter radius of each sampled well and classified into one of four predominant land-use categories (agricultural, urban, rangeland/undeveloped, and mixed) so that pesticide detections in ground water could be examined in relation to overlying land use. The following information was noted in regard to land use:

- Pesticides were detected most frequently in water from wells located in areas classified as predominantly urban (59.6 percent) and agricultural (38.9 percent; fig. 4).
- Pesticides were detected least frequently in water from wells located in areas classified as predominantly rangeland/undeveloped, as only 16.5 percent of the water samples from these wells had a pesticide detection.

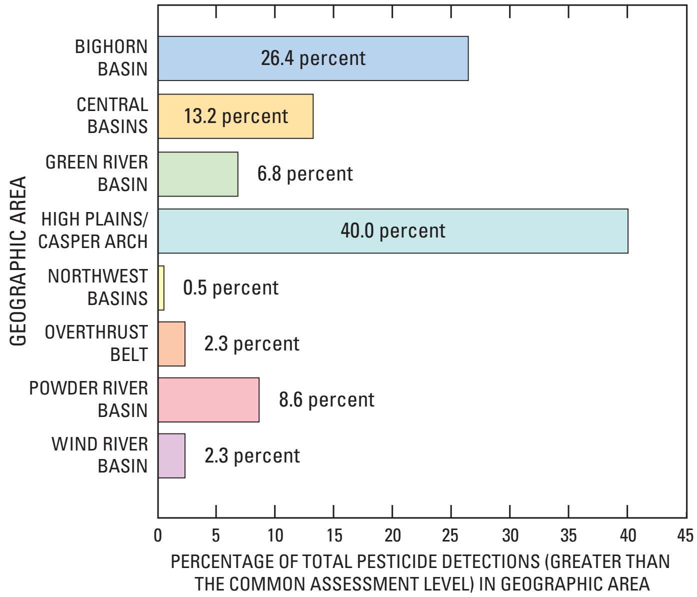

Figure 3. Forty percent of all pesticide detections in Wyoming were in the High Plains/Casper Arch geographic area.

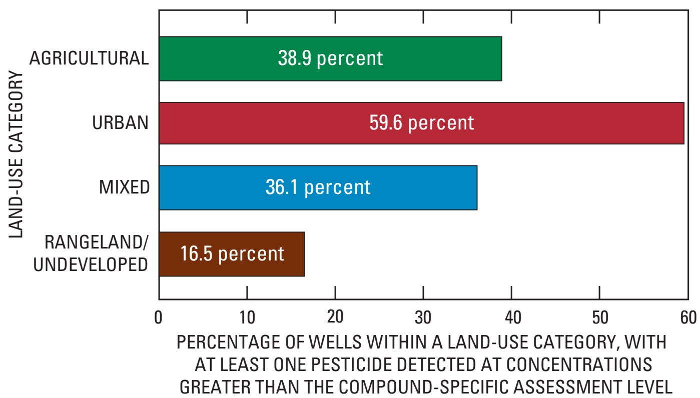

Figure 4. Urban land use has the highest percentage of wells with at least one pesticide detected. Agricultural, mixed, and rangeland/undeveloped land uses had fewer wells with at least one pesticide detection.

Future of Ground-Water Monitoring Program

The completion of baseline ground-water quality sampling and the analysis of that data have provided the State with an opportunity to move forward with monitoring Wyoming's ground water. Information gained from this effort is helping to refine and guide a new, more focused ground-water monitoring program, with the ultimate goal of protecting Wyoming's ground water while allowing responsible use of pesticides to continue (Wyoming Ground-water and Pesticides Strategy Committee, oral commun., 2008).

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