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Occurrence of Soluble Pesticides in Barton Springs, Austin, Texas, in Response to a Rain Event

By B.J. Mahler and P.C. Van Metre

Introduction

Water quality at Barton Springs is a critical issue for the City of Austin and its citizens. Barton Springs, located within sight of downtown Austin highrises, is the fourth largest spring in Texas.

- The major set of spring orifices feeds a 225-meter (m)-long swimming pool enjoyed by over 340,000 people per year—Barton Springs Pool is a significant addition to Austin's quality of life and an important tourist attraction.
- Barton Springs provides a part of Austin's municipal water supply: water from Barton Springs discharges into the Colorado River about 0.6 kilometer (km) upstream of one of Austin's three water supply plants, at times contributing more than 90 percent of flow in this section of the Colorado River (Slade and others, 1986).
- The Barton Springs salamander (*Eurycea sosorum*), listed as an endangered species by the U.S. Fish and Wildlife Service, lives only in Barton Springs and is vulnerable to changes in water quality (U.S. Fish and Wildlife Service, 1997).

U.S. Geological Survey (USGS) personnel sampled Barton Springs and Barton and Williamson Creeks for soluble pesticides during and after a storm event to determine to what degree ongoing urbanization might be affecting water quality at Barton Springs. Numerous pesticides are used in U.S. urban areas, and some of them are frequently detected in streams (Larson and others, 1999) and shallow ground water (Kolpin and others, 1998). At higher concentrations, some pesticides can pose a threat to aquatic life and to human health; thus, regulatory agencies have established drinking water standards, health advisory levels, and standards for the protection of aquatic life. The sampling results presented here are for soluble pesticides in streams and springs in Austin, Texas, during and after 2 days of rainfall in May 2000. Analyses include many of the most widely-used pesticides in U.S. agricultural and urban areas, including the herbicides atrazine, prometon, and simazine, and the insecticides carbaryl and diazinon. Previously, soluble pesticides had been detected at Barton Springs on only two occasions: in 1978, diazinon was detected at a concentration of 0.03 microgram per liter (µg/L), and in 1989, prometon was detected at a concentration of 0.1 µg/L. The diazinon sample was likely collected during baseflow, and the prometon sample was likely collected during stormflow (City of Austin, unpublished data). Since those samples were collected, analytical methods have improved, more compounds can be analyzed, and the amount of developed land in the Barton Springs watershed has increased.

| Hydrology of Barton Springs | Results |

For more information, contact:
Barbara J. Mahler, Research Hydrologist
U.S. Geological Survey
8027 Exchange Drive
Austin, TX 78754

(512) 927-3566 (telephone)
(512) 927-3590 (fax)

or e-mail: Barbara J. Mahler

Hydrology of Barton Springs

Water discharging from Barton Springs comes from the 391-square kilometer (km^2) Barton Springs segment of the Edwards aquifer, which extends southwest of Austin. This segment of the aquifer is fed by rainfall on the watersheds of five creeks (Barton, Williamson, Slaughter, Bear, and Onion Creeks). Water flows eastward via these creeks until they cross onto the recharge zone, where the water infiltrates into the aquifer through sinkholes and fractures in the creekbeds, providing an estimated 85 percent of total recharge (Slade and others, 1986). Rainfall directly on the recharge zone either infiltrates directly into the aquifer through fractures or sinkholes or flows over the surface into a creek and recharges through the creekbed. After very large rainfall events, not all water recharges the aquifer: part of the water in the creeks may flow all the way across the recharge zone and ultimately into the Colorado River.

Barton Springs is actually comprised of four major sets of springs: Main Springs, Eliza Springs, Old Mill Springs, and Upper Barton Springs. The largest set, Main Springs, feeds Barton Springs Pool. Discharge from all the Barton Springs, expressed as volume per time, averages 53 cubic feet per second (ft^3/s) and has varied from a low of 10 ft^3/s to a high of 166 ft^3/s.

Methods

Four sites (fig. 1) were sampled during and after 2 days of rainfall in May 2000. For this study, 11 samples were collected—8 from Main Springs and 1 sample each from Williamson Creek, Barton Creek, and Eliza Springs. The two creeks sampled are known to contribute recharge to the Barton Springs segment of the Edwards aquifer (Slade and others, 1986).

Rainfall occurred during the early morning hours and late evening hours of May 1 through the early morning hours of May 2; discharge from Barton Springs began to increase about 1 hour after the onset of rainfall (fig. 2). Eight grab samples were collected from Main Springs during May 1-4.

The springs were sampled by filling baked amber glass jars directly from the spring orifice. The Main Springs samples were collected in the fissure upstream from the diving board where most previous water-quality sampling at the spring has taken place. The Eliza Springs sample was collected from one of the openings through the cement "floor" underlying the bottom of the pool.

Creek samples were collected by automated samplers that pump seven discrete samples over the duration of a storm-event hydrograph. A large rainfall will cause flow in Austin area creeks to rapidly change from very low or completely dry to flood conditions. Flow in the creeks typically recedes more slowly, returning to base flow or dry conditions from several hours to days after the rain. A plot of flow versus time for the response of a stream to a storm is known as a storm-event hydrograph. The seven samples are used to create a single flow-weighted composite sample that contains flow-weighted average concentrations of constituents over the duration of the storm flow.

Sample water from the flow-weighted composite sample and from the grab samples collected from the springs was filtered through 0.7-micrometer (μm) glass-fiber filters to remove particles, then passed through a column to concentrate pesticides. The columns were sent to the USGS National Water Quality Laboratory in Denver for analysis of more than 40 pesticides and pesticide metabolites (table 1).

| **Results** | **Back to Introduction** |

Results

Of the more than 40 pesticides analyzed, 5 were detected in Main Springs, 4 in Williamson and Barton Creeks, and 3 in Eliza Springs (table 2) (fig. 3) (fig. 4) (fig. 5) (background information on 5 pesticides). Atrazine and deethylatrazine (DEA), a metabolite of atrazine, were detected in all samples. The insecticide diazinon was the next most frequently detected pesticide, occurring in all the samples except the first two collected from Main Springs. Carbaryl was detected in 8 of the 11 samples; carbaryl was not detected in the first 2 samples from Main Springs or the sample from Eliza Springs. The fifth pesticide detected was simazine, detected in two samples from Main Springs, 39 and 79 hours after the onset of rainfall.

Concentrations of carbaryl and diazinon in the two creeks were about an order of magnitude greater than the largest concentrations in the two springs. In contrast, the atrazine concentrations in Main Springs at 39 to 79 hours after the onset of rainfall were larger than the 0.44 μg/L atrazine concentration in Barton Creek but smaller than the 0.80 μg/L atrazine concentration in Williamson Creek. A similar pattern in concentrations occurred for DEA.

Of the two creeks and two springs sampled, only Main Springs had multiple samples collected, eight over a 79-hour period after the onset of rainfall (figs. 2 and 3). Concentrations varied greatly over the 79 hours. In the first two samples, 8 and 15 hours after the onset of rainfall, only atrazine and DEA were detected; these detections were at low concentrations. Concentrations of all 5 pesticides detected in Main Springs increased until the 39-hour sample. Only atrazine and simazine were still increasing at the last sample collected 79 hours after the onset of rainfall.

None of these pesticide concentrations exceeded maximum contaminant levels, health advisories, or State of Texas aquatic life standards; however, the presence of pesticides in the springs soon after rainfall does indicate the vulnerability of the springs to contaminant infiltration from the surface.

References

Kolpin, D.W., Barbash, J.E., and Gilliom, R.J., 1998, Occurrence of pesticides in shallow ground water of the United States—Initial results from the National Water-Quality Assessment Program: Environmental Science and Technology, v. 32, no. 5, p. 558-566.

Larson, S.J, Gilliom, R.J., and Capel, P.D., 1999, Pesticides in streams of the United States—Initial results from the National Water-Quality Assessment Program: U.S. Geological Survey Water-Resources Investigations Report 98-4222, 99 p.

Slade, R.M. Jr., Dorsey, M.E., and Stewart, S.L., 1986, Hydrology and water quality of the Edwards aquifer associated with Barton Springs in the Austin area, Texas: U.S. Geological Survey Water-Resources Investigations Report 86-4036, 117 p.

U.S. Fish and Wildlife Service, 1997, Endangered and threatened wildlife and plants—Final rule to list the Barton Springs salamander as endangered: Federal Register, v. 62, no. 83, p. 23,377-23,392.

| **Back to Introduction** |

Atrazine

Atrazine is a broad-leaf, pre-emergence herbicide, widely used in agriculture and used to a lesser extent in urban areas. The maximum contaminant level (MCL; the legally allowable concentration of a toxic chemical allowed in public water supply systems) for atrazine is 3.0 µg/L. Trade names of this product include G-30027, Aatrex, Aktikon, Alazine, Atred, Atranex, Atrataf, Atratol, Azinotox, Crisazina, Farmco Atrazine, Gesaprim, Giffex 4L, Malermais, Primatol, Simazat, and Zeaphos.

Deethylatrazine

Deethylatrazine is a breakdown product of atrazine.

Simazine

Simazine is used as a pre-emergence herbicide for control of broad-leaved and grassy weeds. Its major use is on corn, but it is also used on a variety of deep-rooted crops such as artichokes, asparagus, berry crops, broad beans, citrus, etc., and on non-crop areas such as farm ponds and fish hatcheries. The MCL for simazine is 4.0 µg/L. Trade names of this product include Aquazine, Cekusan, Cekusima, Framed, G-27692, Gesatop, Primatol, Princep, Simadex, Simanex, Tanzine, and Totazina.

Carbaryl

Carbaryl is an insecticide used on citrus, fruit, cotton, forests, lawns, nuts, ornamentals, shade trees, and other crops, as well as on poultry, livestock, and pets. There is no MCL for carbaryl, but it has an EPA lifetime health-advisory (HA) of 700 µg/L. Product names include Carbamine, Denapon, Dicarbam, Hexavin, Karbaspray, Nac, Ravyon, Septene, Sevin, Tercyl, Tricarnam, and Union Carbide 7744.

Diazinon

Diazinon is an insecticide used on home gardens and farms to control a wide variety of sucking and leaf-eating insects. It is used on rice, fruit trees, sugarcane, corn, tobacco, potatoes, and horticultural plants. It is an ingredient in pest strips and is used to control fleas and ticks. There is no MCL for diazinon, but it has an EPA lifetime HA of 0.6 µg/L. Trade names of this product include Knox Out, Spectracide, and Basudin.

The information on the pesticides detected in Barton Springs was summarized from the following links:

Acrobat Reader is needed to read this PDF file. You may download Acrobat Reader here if you do not have it.

Users with visual disabilities can visit this site for conversion tools and information to help make PDF files accessible.

http://www.epa.gov/ost/drinking/standards/dwstandards.pdf http://www.epa.gov/OGWDW/dwh/c-soc.html

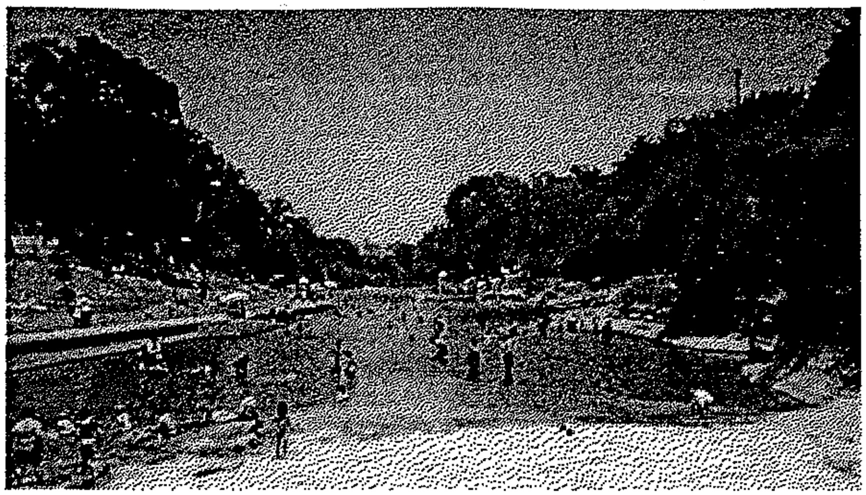
http://pmep.cce.cornell.edu/profiles/extoxnet

http://www.scorecard.org/chemical-profiles/

http://water.wr.usgs.gov/pnsp/use92

Additional information can be found on these sites.

| Back to Introduction |



Barton Springs Pool.

Table 1. Pesticides and minimum reporting levels

Pesticides and minimum reporting levels (in µg/L), USGS National Water Quality Laboratory					
Acetochlor	0.002	Disulfoton	0.017	Phorate	0.002
Alachlor	.002	EPTC	.002	*p,p'*-DDE	.006
Atrazine	.001	Ethalfluralin	.004	Prometon	.018
Azinphos-methyl	.001	Ethoprophos	.003	Propachlor	.007
Benfluralin	.002	Fonofos	.003	Propanil	.004
Butylate	.002	Lindane	.004	Propargite	.013
Carbaryl	.003	Linuron	.002	Propyzamide	.003
Carbofuran	.003	Malathion	.005	Simazine	.005
cis-Permethrin	.005	Metolachlor	.002	Tebuthiuron	.010
Chlorpyrifos	.004	Metribuzin	.004	Terbacil	.007
Cyanazine	.004	Molinate	.004	Terbufos	.013
Dacthal	.002	Napropamide	.003	Thiobencarb	.002
Deethylatrazine	.002	Parathion	.004	Tri-allate	0.001
Diazinon	.002	Parathion-methyl	.006	Trifluralin	.002
Dieldrin	.001	Pebulate	.004	alpha-HCH	.002
2,6-Diethylaniline	.003	Pendimethalin	.004		

Table 2. Concentrations of pesticides detected in Barton Springs (Main and Eliza Springs) and Barton and Williamson Creeks, May 1-4, 2000

Site	Date	Time	Pesticide concentrations (micrograms per liter; e, estimated value[1]; <, non-detection)				
			Atrazine	Deethyl-atrazine	Carbaryl	Diazanon	Simazine
Main Springs	5/1/00	1055	0.0075	e0.0079	<0.003	<0.002	<0.005
	5/1/00	1820	78	e.0093	<.003	<.002	<.005
	5/1/00	2305		e.013	e.0065	.0089	<.005
	5/2/00	1145		e.025	e.011	.021	<.005
	5/2/00	1420		e.023	e.0090	.024	<.005
	5/2/00	1812		e.033	e.012	.028	.0069
	5/3/00	1240		e.025	e.013	.019	<.01
	5/4/00	1015		e.024	e.0066	.0075	.011
Eliza Springs	5/2/00	1855	6	e.013	<.003	.0051	<.005
Barton Creek	5/2/00	[2]0135		e.0097	e.30	.18	<.005
Williamson Creek	5/1/00	[2]0400		e.031	e.47	.26	<.005

[1] An estimated value is a confirmed detection that is less than the long-term method detection limit.
[2] Sample is a flow event composite; time is first sample collection time.

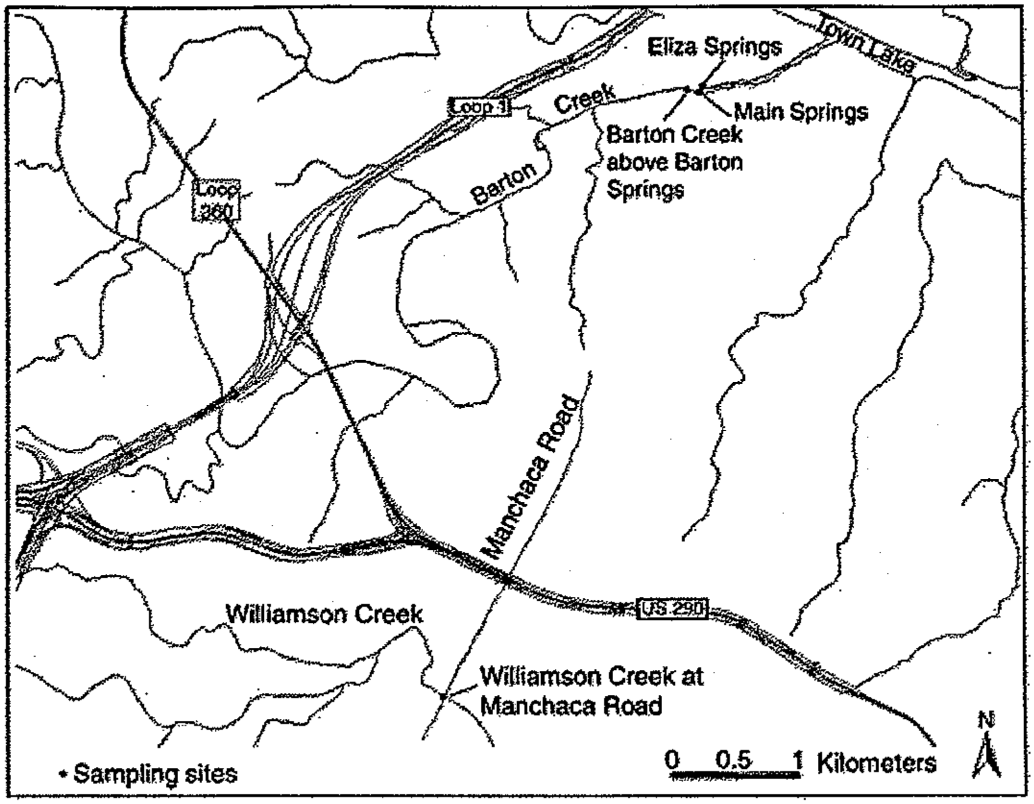


Figure 1. Sampling sites.

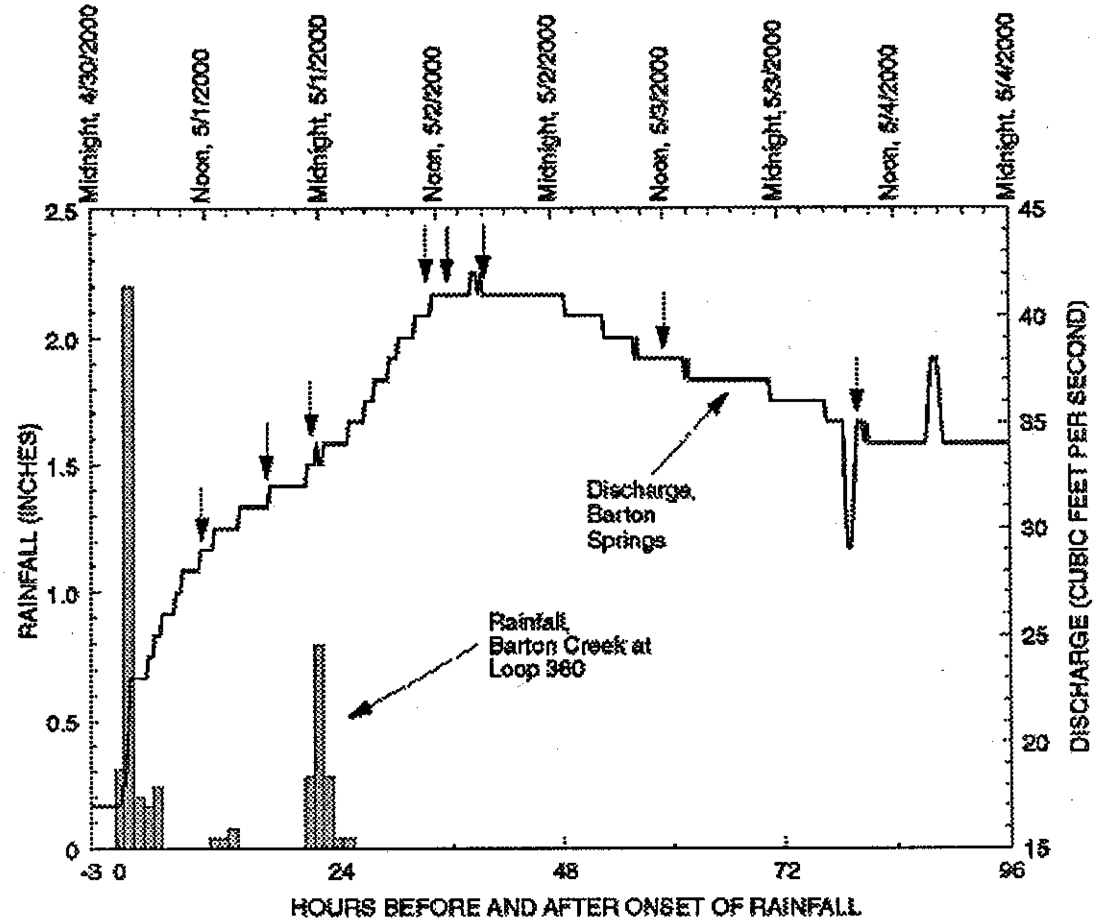


Figure 2. Rainfall recorded at Barton Creek at Loop 360 and discharge at Barton Springs for May 1-4. The onset of rainfall was determined to be 3 a.m., May 1. The blue arrows indicate times that grab samples were collected from Main Springs.

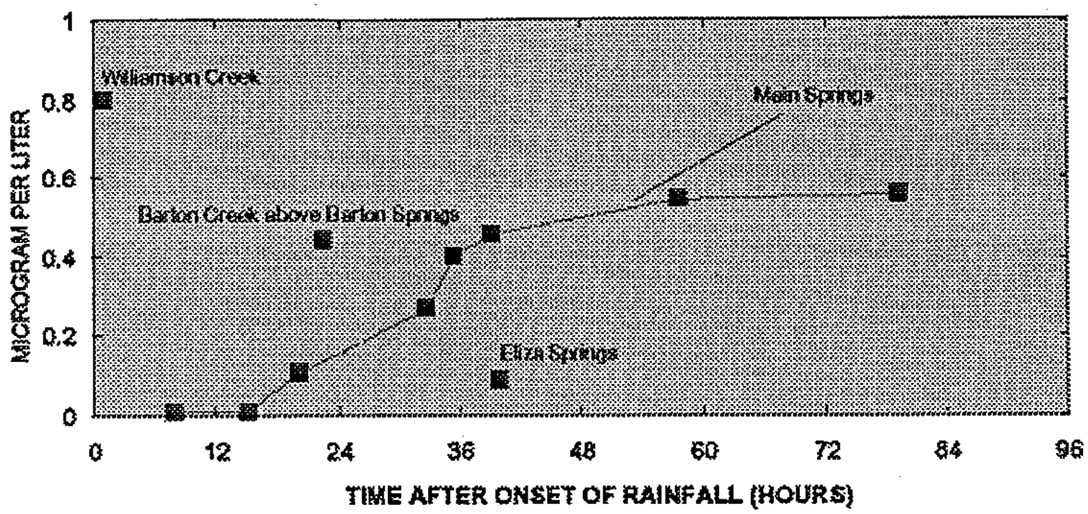


Figure 3. Occurrence of atrazine in response to May 1, 2000, rain event.

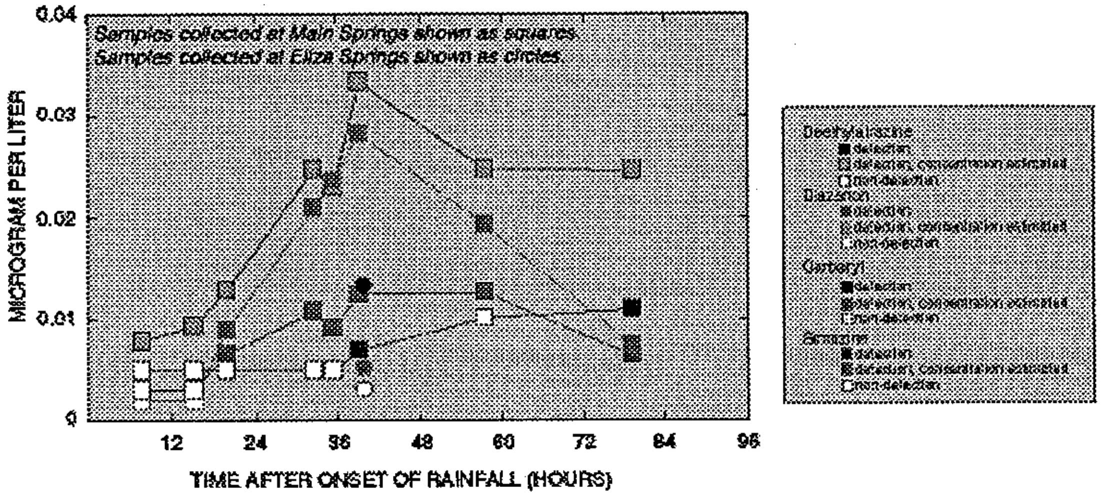


Figure 4. Occurrence of pesticides in Barton Springs (Main Springs and Eliza Springs) in response to May 1, 2000, rain event.

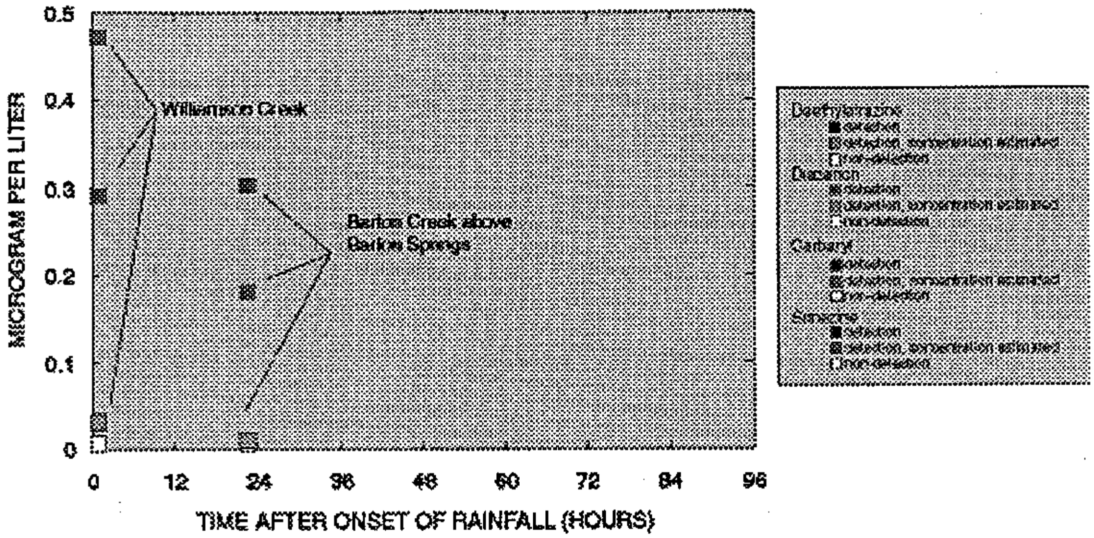


Figure 5. Occurrence of pesticides in Barton and Williamson Creeks in response to May 1, 2000, rain event.