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PESTICIDE RESIDUES IN THE MOXEE AND AHTANUM SURFICIAL AQUIFERS

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Finally, David Nash of the Washington State Department of Health reviewed all results for health implications and wrote health consults that were mailed to well owners explaining these implications.

ABSTRACT

Twenty-seven wells near Yakima, Washington, were sampled in September 1992 for 123 pesticides and nitrate+nitrite-N. Field measurements of water temperature, pH, and specific conductance were also made. Eleven wells were in the Moxee Surficial Aquifer located east of the Yakima River, and sixteen wells were in the Ahtanum Surficial Aquifer located west of the river. Four pesticides were detected in the initial samples; dacthal (DCPAs), atrazine, simazine, and EDB. One or more of these chemicals were detected in eight wells, however, concentrations were at or below the Lifetime or Health Advisory Level allowed by the EPA. Neither dacthal nor EDB was detected in verification samples taken in February 1993. Atrazine was detected in four of the verification samples and simazine in two. One well had a nitrate + nitrite as N concentration greater than the drinking water standard.

INTRODUCTION

In September 1992, I sampled twenty-seven (27) wells near Yakima, Washington, for agricultural pesticides and nitrate + nitrite as N. Eleven wells obtain their water from the Moxee surficial aquifer located beneath an intensive agricultural area just east of Yakima (Figure 1). The remaining 16 wells obtain water from the Ahtanum surficial aquifer. The Ahtanum aquifer is located in the Ahtanum Creek Valley which underlies parts of the city of Yakima (Figure 2).

The primary crop in the Moxee Valley is hops, although grapes and fruit are grown on the surrounding uplands. In places, residential development is replacing farming as the major land use. Farm lands are mostly irrigated by surface water delivered by canal from the Yakima River. Rill irrigation is still practiced on many of the hop fields, although the use of drip irrigation is increasing.

The Ahtanum Valley, although historically farmland, is rapidly becoming urbanized. Residential development is moving westward, upvalley, from Yakima proper. Agriculture is primarily grazing and hay crops, although a few scattered orchards remain. The surrounding highlands are dominated by apple orchards.

Background

Agricultural pesticides are used throughout Washington. They are used extensively on farm lands and are also applied in the urban and forest environment. Population growth and increasing urbanization are placing increasing demands on the ground water resource. At the same time, the effect of pesticide use on the State's ground water quality is largely unknown.

In 1987, the Washington State Legislature asked the Department of Ecology to investigate whether pesticides were contaminating ground water. The resultant project became known as the Washington State Agricultural Chemicals Pilot Study.

Erickson and Norton (1990) investigated ground water at three sites and published the initial results in 1990. Sites were:

1. near Lynden in Whatcom County,
2. near Sunnyside in Yakima County, and
3. near Pasco in Franklin County.

Additional sites have been sampled since this initial work. A portion of the East Naches Aquifer near Gleed was sampled in 1990 (Erickson, 1992) and a portion of the Quincy Surficial Aquifer was sampled in 1991 (Larson and Erickson, 1993). Each study represents a different crop type, climate condition, or aquifer.

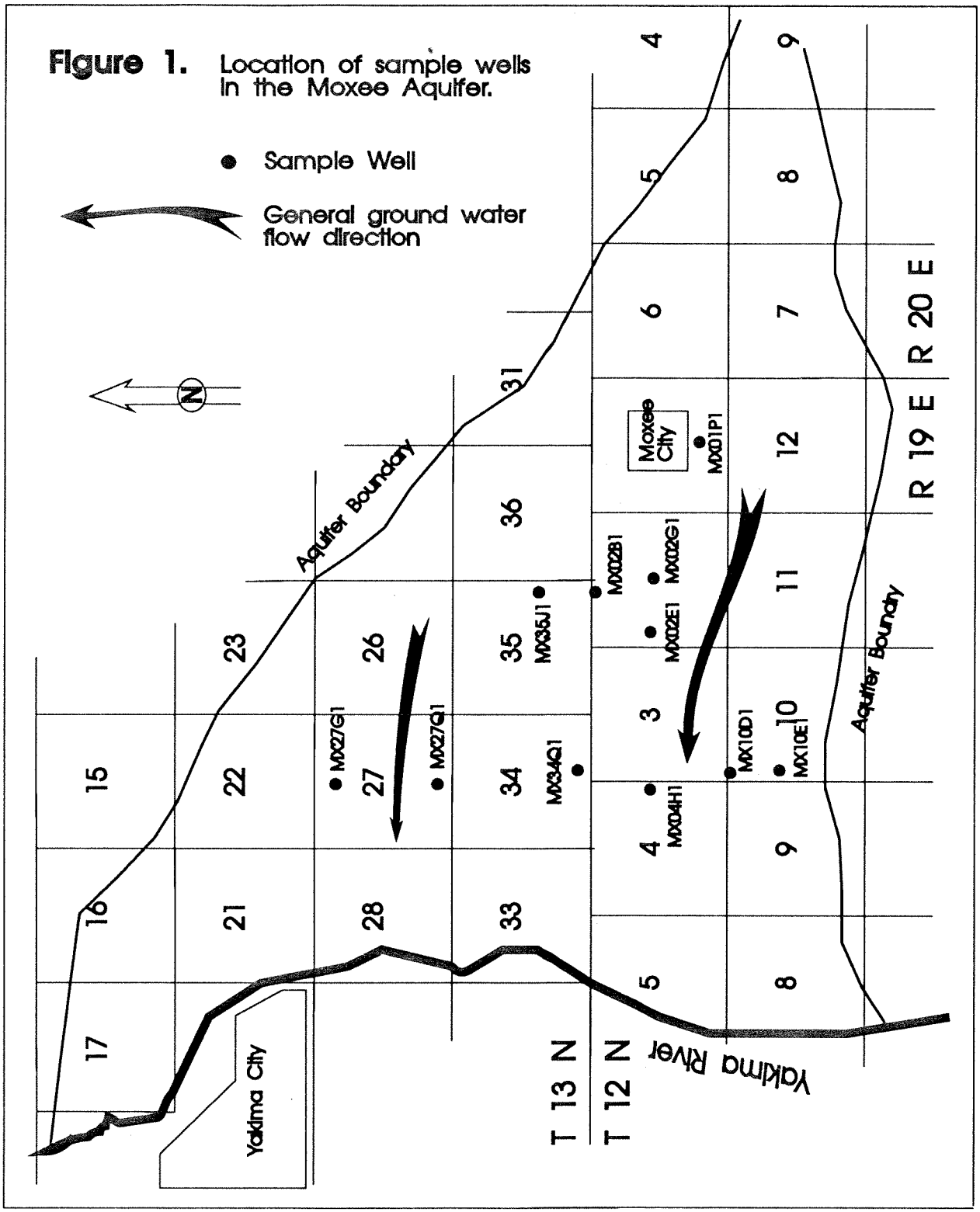
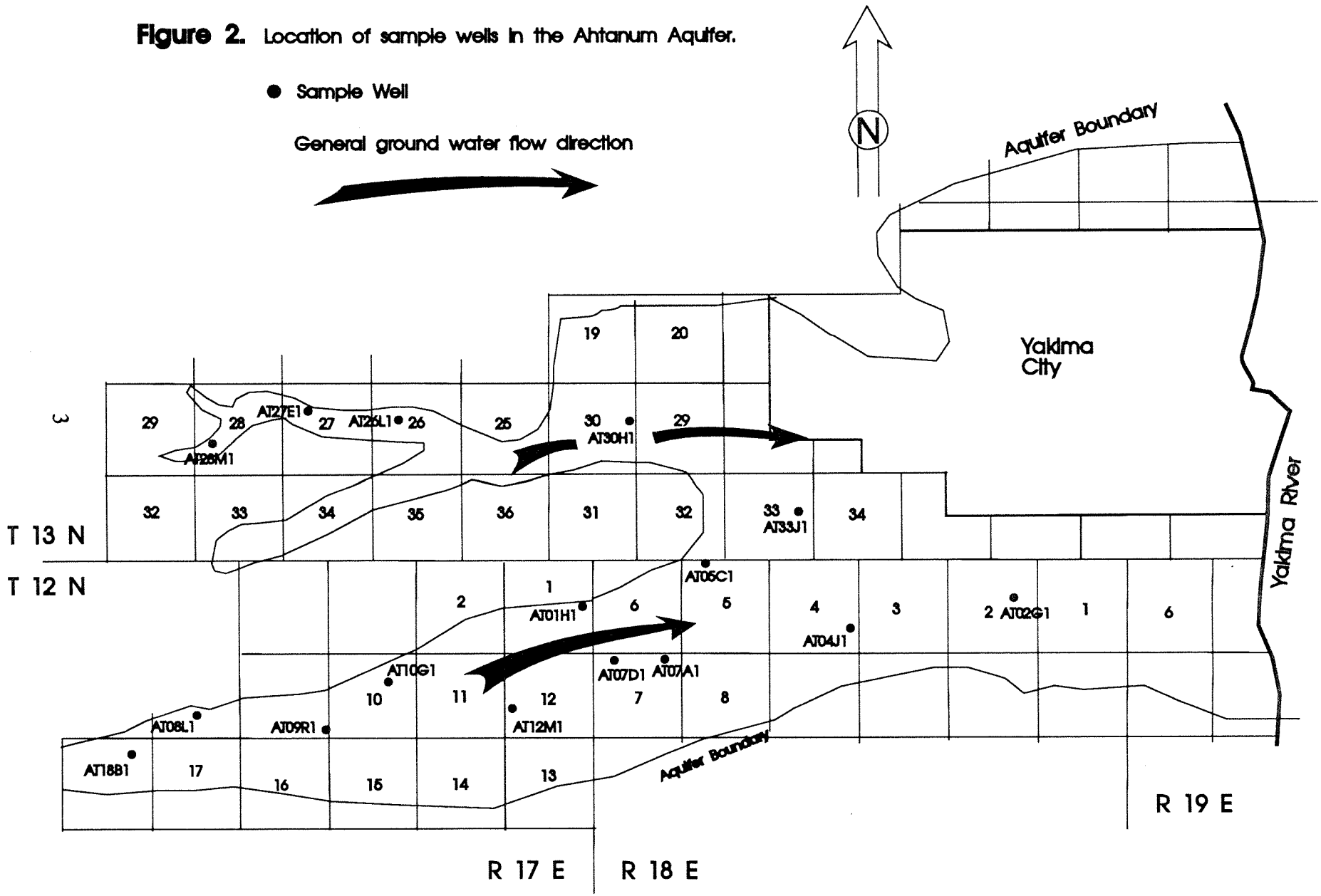


Figure 1. Location of sample wells in the Moxee Aquifer.

Figure 2. Location of sample wells in the Ahtanum Aquifer.



PURPOSE

Sampling of the Moxee and Ahtanum aquifers extends the state-wide monitoring of pesticides. It provides background data on the concentrations of pesticides in ground water in two shallow aquifers where agriculture is interspersed with residential development. The shallow Moxee aquifer is artificially drained by canals, which feed the Yakima River. The aquifer is heavily tapped by shallow domestic wells. The Ahtanum aquifer supports the baseflow of Ahtanum and Wide Hollow Creeks.

AQUIFERS

Both the Moxee and the Ahtanum aquifers are located in the Yakima River Basin. The Moxee Aquifer is situated east of the Yakima River in the Moxee Valley. The Ahtanum Aquifer is located west of the river. The two aquifers are separated from each other by the Yakima River, the major drainage for surficial ground water in the basin.

Moxee Aquifer

The Moxee Aquifer is a 30 square mile aquifer bounded on the north by Yakima Ridge and the south by the Rattlesnake Hills. The aquifer is part of an east-west trending syncline situated between anticlinal ridges. Elevation ranges from 1300 feet near the eastern aquifer boundary to 960 feet at the Yakima River. Ground water movement is generally toward the west with the Yakima River as the downgradient boundary.

The Moxee is a water table aquifer composed of alluvial sediments, stream channel deposits, and glacial outwash deposits. Aquifer thickness is at least 80 feet, but probably no more than 100 feet in most places. The depth to the water table is as little as five feet. The Moxee Aquifer is underlain by several distinct confined aquifers of the Yakima Basalts (Kirk and Mackie, 1993). Recharge is from precipitation, irrigation, leakage from irrigation canals, and runoff from the surrounding hills. Although at times the Moxee may recharge the deeper aquifers, most wells tapping the confined aquifers have greater hydraulic heads than the Moxee. Thus the deeper ground water flow is generally upward, especially in the lower Moxee Valley. Hydraulic conductivity of the Moxee aquifer varies from 4 to 800 feet/day, increasing downgradient (U.S. Corps of Engineers, 1978; Cearlock, *et al.*, 1975).

Wastewater canals drain the Moxee Valley to maintain unsaturated soil conditions for crop growth. The shallow aquifer is the primary source of surface water in the valley, draining into the waste canals and wetlands along the Yakima River. The aquifer is also heavily used for domestic purposes.

Ahtanum Aquifer

The 57 square mile Ahtanum aquifer is bounded on the north by Cowiche Mountain and on the south by Ahtanum Ridge. The aquifer pinches out up-valley below Sedge Ridge where

Ahtanum Ridge converges with Cowiche Mountain. Elevation ranges from about 1700 feet near the western aquifer boundary to 960 feet at the Yakima River. Ground water moves generally east, downvalley, toward the Yakima River. The city of Yakima is located over this aquifer. Like other unconfined aquifers in the Yakima River basin, the Ahtanum is underlain by several distinct confined aquifers. Recharge occurs via precipitation, irrigation, leakage from streams, runoff from the surrounding hills, and upward seepage from the underlying confined aquifers.

The Ahtanum Aquifer is composed of alluvial sediments, stream channel deposits, and glacial outwash deposits. Unsorted to sorted alluvial gravel, sand, and silt - 30 feet thick - overlies cemented basalt gravel up to 400 feet in thickness (Foxworthy, 1959). Water bearing layers within the cemented gravel are semi-confined, and wells penetrating these layers are often flowing. The unconsolidated alluvium is very productive and well yields between 100-400 gpm are common. The water table is generally less than 10 feet, and often less than 5 feet, below land surface. Transmissivity is relatively high, ranging from 30,000 to 90,000 gpd/ft (Cearlock, *et al.*, 1975; Twiss, 1943)

Soils

Major soils are silt loams formed on terraces or flood plains (SCS, 1985). They are deep to very deep, well-drained (or artificially drained) with moderate permeability. Moisture holding capacity is high, and soils at lower elevations have a high water table unless drained. Typical soil series include the Warden silt loam, Umapine silt loam, and the Esquatzel silt loam. Soils are suitable for a wide variety of crops which include asparagus, corn, grain, grapes, hops, mint, peas, some tree fruit, and grasses and legumes for hay, pasture, and seed. Annual precipitation is six to nine inches, and most crops require irrigation; drip, furrow, and sprinkler are common.

METHODS

To select appropriate wells for sampling, I searched the well log files located at Ecology's Central Region Office. I selected well logs based on a shallow depth, a high water table, and a representative location within the aquifer. Once an adequate number of well logs were selected, I visited each well to assess its possible use.

Final well selection was controlled by:

1. source of the water- either the surficial Moxee or Ahtanum Aquifer,
2. location of the well with respect to aquifer boundaries and wells already selected,
3. availability of well construction information,
4. ease of collecting a representative water sample, and
5. the owner's permission to sample.

Moxee Wells

I selected 11 wells for sampling the Moxee Aquifer: nine domestic and two irrigation. Most domestic wells are also used for limited crop or garden irrigation. I selected wells near the downgradient end of the aquifer, between Moxee City and the Yakima River. I located the wells on two lines across the valley, roughly normal to the general ground water flow direction. The location of the wells with respect to aquifer boundaries is shown in Figure 1.

Wells ranged from 38 to 80 feet deep and averaged 60 feet. The depth to ground water averaged about 10 feet, ranging from four to 25 feet. The total depth and depth to water for the individual wells in the Moxee Aquifer is presented in Appendix A1.

Ahtanum Wells

I sampled 16 wells in the Ahtanum Aquifer: 13 domestic and three irrigation wells. Most wells were located west of downtown Yakima in the residential and farming portion of the Ahtanum Valley. Four wells were also located within the Wide Hollow Creek valley, which is separated from the main Ahtanum Creek valley by a low ridge. Figure 2 shows the location of Ahtanum wells with respect to aquifer boundaries.

Sample wells ranged from 20 to 152 feet deep. The deeper wells were selected when no other wells were available. The depth to ground water ranged from 0 to 21 feet. The total depth and depth to water for the wells is presented in Appendix A2. Well AT26L1, in the Wide Hollow Creek Valley, had a water level near the land surface (recorded as 0 feet). This well, drilled 100 feet into cemented gravel, was flowing when constructed. The water pressure has since declined. This was the second deepest well in the study and water from this well may not represent the surficial aquifer.

Sampling

The ground water sampling was not tied to any specific pesticide application, but was intended to detect residual pesticides from historical use.

Initial sampling occurred in late September and early October 1992. Detected pesticides were verified by a second round of sampling in late February 1993. Only wells with detected pesticides were included in the verification sampling.

Sampling Procedures

I purged all wells before sampling until the temperature, pH, and specific conductance had stabilized and at least three casing volumes of water had been removed. I used an Orion meter for pH and temperature measurement, and a YSI meter for specific conductance. I purged and sampled the wells from existing faucets located as close to the well as possible and before any pressure tanks where feasible. The water level was measured in wells that were not sealed.

Analytes Tested

Ground water was analyzed for 123 pesticides and pesticide breakdown products and for nitrate + nitrite as N. Most of the pesticides were derived from the Environmental Protection Agency's (EPA) list of leachable pesticides which have properties conducive to migration through soil to ground water (Cohen, 1985). Target pesticides, test methods, and quantitation limits are presented in Appendix B.

With the exception of carbamates, samples were analyzed by the Ecology/EPA Manchester Laboratory. Carbamates were analyzed by Water, Food and Research Laboratory in Tigard, Oregon, a contract lab.

Quality Assurance

The quality of the results is generally good. However, carbamate samples collected before October 16, 1992, were not analyzed within the 28 day known stability period for these analyses. The qualitative and quantitative accuracy, validity, and usefulness of data from Water, Food and Research Laboratory were independently reviewed by Stuart Magoon of the Ecology/EPA Manchester Laboratory. A description of the quality assurance review and its results for samples analyzed by the Manchester Lab and the contract lab are included as Appendix C.

RESULTS

In the initial sampling, one or more pesticides were detected in eight of the 27 study wells, and possibly identified in one other. The pesticides detected were **dacthal** (DCPAs), **atrazine**, **simazine**, and 1,2 dibromoethane (**EDB**). The concentrations of detected pesticides are presented in Table 1, including both the results of the initial and the verification sampling.

Dacthal is a preemergence herbicide used to control various annual grasses in turf, ornamentals, and food crops. Atrazine is a selective triazine herbicide used before or just after the crop emerges. Simazine is also a selective triazine herbicide applied before the crop emerges. EDB is a soil fumigant used to control nematodes (root worms) in potatoes, strawberries, and other row crops.

Table 1. Concentrations of pesticides detected in Moxee and Ahtanum ground water (μg/L). Concentrations of initial samples are followed by those of the verification sample.

Site ID	DCPAs	Simazine	Atrazine	EDB
Moxee Surficial Aquifer				
MX02B1	NJ			
MX27Q1	0.55			
MX35J1			0.02J/0.01J	
Ahtanum Surficial Aquifer				
AT01H1		0.023J/0.06J	0.056J/0.04J	
AT02G1	0.080/*			
AT05C1		0.002J/0.03J	0.006J/0.05J	
AT28M1				0.050/*
AT30H1				0.040/*
AT33J1		0.008J/*	0.011J/0.02J	
AT33J1 Dup		0.002J	0.007J	

* = Not detected.
NJ= There was evidence the analyte was present, but no estimate of value.
J = The analyte was positively identified. The associated value is an estimate.
Dup = Field duplicate sample.

Dacthal

Dacthal (DCPAs) was initially detected in two wells, one in the Moxee and one in the Ahtanum aquifer. Concentrations were 0.55 and 0.08 μg/L respectively. During verification sampling, the Moxee well was out of commission and was not re-sampled. Dacthal was not detected in the verification sample from the Ahtanum well.

Atrazine

Atrazine was initially detected in four wells, one in the Moxee and three in the Ahtanum Aquifer. Atrazine was positively identified in all four samples. But since concentrations were so low, only an estimate of the concentration was possible. Estimates ranged from 0.006 to 0.056 μg/L. Atrazine was also detected in the verification samples. Again, since concentrations were so low, only estimated concentrations were possible. Estimates ranged from 0.01 to 0.05 μg/L.

Simazine

Simazine was positively identified in three of the four wells in which atrazine was detected. Simazine was not detected in the Moxee Aquifer well in which atrazine was detected. Like atrazine, concentrations in both initial and verification samples were low and could only be estimated. Estimated concentrations for initial samples ranged from 0.002 to 0.023 μg/L. Estimates for verification samples ranged from 0.03 to 0.06 μg/L.

EDB

EDB was detected in the initial samples from two wells in the Ahtanum Aquifer at concentrations of 0.040 and 0.050 μg/L. EDB was not detected in the verification samples from these wells. I do not know why EDB was initially detected but not detected during verification, quantitation limits for both analyses were 0.02 μg/L. EDB is volatile, and the detection anomaly may be related to volatilization into the air during sample collection. It may also result from seasonal variation. Mayer, *et al.*, (1991) have shown that EDB concentrations in shallow ground water may be diluted (decreased) by precipitation events.

Nitrate + Nitrite as N

Nitrate + nitrite as N was detected in 26 of the 27 wells sampled (Table 2). Concentrations in the Moxee Aquifer ranged from <0.01 to 11.90 mg/L and averaged 3.61 mg/L. Concentrations in the Ahtanum Aquifer ranged from 0.41 to 5.19 mg/L and averaged 2.03 mg/L. The concentration of nitrate + nitrite in one well in the Moxee Aquifer (11.90 mg/L) exceeded the 10.0 mg/L drinking water standard for nitrate-N. This was an irrigation well located near the field under irrigation. No pesticides were detected in this well.

Table 2. Concentrations of nitrate + nitrite as N in Moxee and Ahtanum ground water (mg/L).

Site ID	Value
Moxee Surficial Aquifer	
MX01P1	11.90
MX02B1	1.24
MX02E1	4.11
MX02G1	1.45
MX04H1	2.73
MX10D1	1.28
MX10E1	<0.01
MX27G1	5.46
MX27Q1	2.16
MX34Q1	4.28
MX35J1	5.04
Ahtanum Surficial Aquifer	
AT01H1	3.73
AT02G1	1.87
AT04J1	0.45
AT05C1	1.30
AT07A1	0.49
AT07D1	2.07
AT08L1	1.00
AT09R1	2.51
AT10G1	0.86
AT12M1	1.30
AT18B1	0.41
AT26L1	2.80
AT27E1	5.19
AT28M1	2.41
AT30H1	2.39/2.41D
AT33J1	3.66/3.72D

D = Duplicate field samples.

Health Concerns

Dacthal (DCPAs) was detected in two of the 27 study wells, but was not detected in the verification sample. The Environmental Protection Agency (EPA) has set a Lifetime Health Advisory level (a concentration that is considered protective of non-cancer health effects) for dacthal at 3,500 μg/L. Dacthal is not classified by the EPA as a cancer causing chemical. The concentrations detected in the Moxee and Ahtanum aquifers were 10,000 times less than the advisory level.

The EPA has set the Maximum Contaminant Level (MCL) for EDB (a possible carcinogen) in public drinking water systems at 0.050 μg/L. The ground water standard for EDB is 0.001 μg/L, 50 times lower than the MCL. The lab detected EDB at concentrations near the MCL. However, the EPA cancelled most agricultural uses of EDB in 1983 and 1984. Because the concentrations of EDB were low and the detections were not verified, EDB does not appear to be a widespread problem.

The MCL for atrazine in drinking water is 3.0 μg/L and the MCL for simazine is 4.0 μg/L. Detected atrazine concentrations were less than 1.9 percent of the MCL and simazine detections were less than 0.6 percent of the MCL. Because wells with detected atrazine or simazine were several miles apart, the source of the pesticide contamination is probably near each well. Wells ranged from 21 to 60 feet deep and the depth to water was only 7 to 11 feet at these sites.

Table 3. Field measurements of temperature (T-°C), pH (standard units), and specific conductance (SC-μmhos/cm).

Site ID	T	pH	SC
Moxee Surficial Aquifer			
MX01P1	14.0	7.2	650
MX02B1	13.0	7.0	570
MX02E1	14.5	7.3	710
MX02G1	14.5	6.7	720
MX04H1	14.0	6.6	370
MX10D1	14.2	7.1	322
MX10E1	14.5	7.2	315
MX27G1	15.0	6.5	570
MX27Q1	13.3	7.6	347
MX34Q1	14.0	6.8	370
MX35J1	13.5	6.8	520
Ahtanum Surficial Aquifer			
AT01H1	14.8	7.1	460
AT02G1	13.3	7.4	222
AT04J1	16.3	7.0	261
AT05C1	13.4	7.2	272
AT07A1	12.0	7.5	156
AT07D1	12.4	7.1	250
AT08L1	11.9	7.4	104
AT09R1	14.1	7.3	202
AT10G1	13.7	7.2	199
AT12M1	13.6	7.5	208
AT18B1	13.8	8.0	255
AT26L1	13.0	7.5	370
AT27E1	14.4	7.2	510
AT28M1	13.3	7.0	308
AT30H1	12.8	7.8	423
AT33J1	13.5	7.3	372

The standard for public drinking-water systems for nitrate as N is 10.0 mg/L (WSDH, 1992). This concentration was exceeded in one irrigation well in the Moxee Aquifer. The average concentration of the remaining wells was less than one-half of the standard.

Field Measurements

The water temperature, pH, and specific conductance of study wells are shown in Table 3. The average temperature of the Moxee Aquifer was 14.0° C, slightly warmer than the 13.5°C average temperature of the Ahtanum Aquifer. The average pH of the Moxee was 7.0 and that of the Ahtanum, 7.3. Average specific conductances were 497 and 286 μmhos/cm for the Moxee and Ahtanum Aquifers, respectively.

Two domestic wells in the Moxee Aquifer exceeded the MCL (700 μmhos/cm) for specific conductance of public drinking water. These wells are located near the center of the study area about one-mile west of Moxee City. The next greatest specific conductance values (570 and 650 μmhos/cm) were from wells in the same vicinity. A specific conductance contour map constructed from the eleven wells (Figure 3) shows that conductance is greatest near the center of the study area and decreases down-gradient toward the Yakima River.

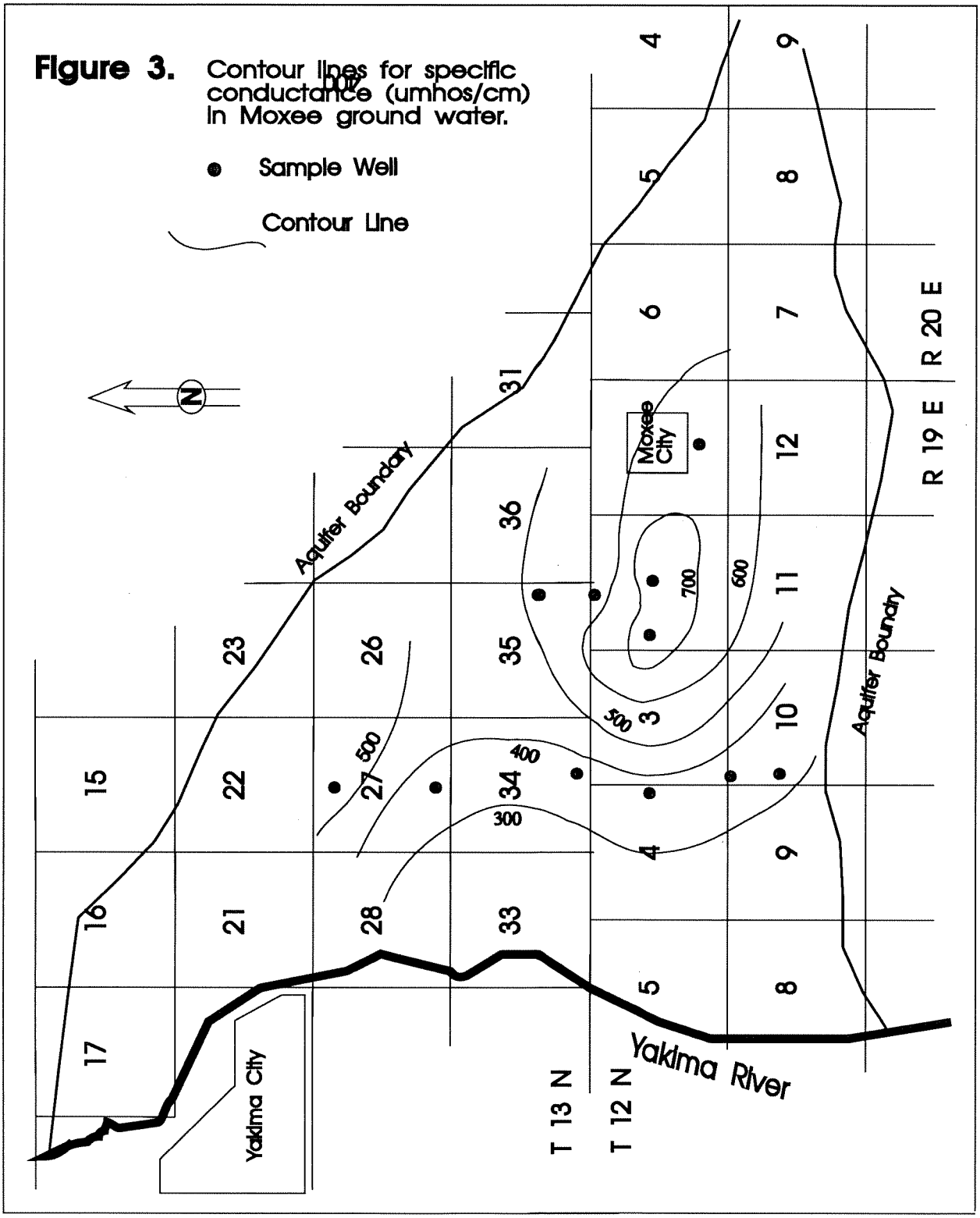


Figure 3. Contour lines for specific conductance (umhos/cm) in Moxee ground water.

CONCLUSIONS

1. Four pesticides were detected in ground water from the Moxee and Ahtanum Surficial Aquifers: **dacthal (DCPAs)**, **atrazine**, **simazine**, and **EDB**. However, only the presence of atrazine and simazine was confirmed by the verification sampling.

2. None of these pesticides were detected above concentrations established by the EPA for health protection. One detection of EDB was at the maximum contaminant level.

3. Although the two EDB detections exceeded state ground water standards, widespread impairment of water use due to pesticides was not found.

4. One sample, collected from an irrigation well in the Moxee Aquifer, had a nitrate + nitrite as N concentration exceeding the 10.0 mg/L drinking water standard. The average nitrate+nitrite as N concentration in the Moxee Aquifer was 3.61 mg/L and in the Ahtanum Aquifer, 2.03 mg/L.

5. Specific conductance near the center of the Moxee Aquifer exceeded the 700 μmhos/cm secondary drinking water standard.

REFERENCES

Cearlock, D.B., C.R. Cole, H.P. Foute, and R.W. Wallsace, 1975. Mathematical Ground-water Model of the Ahtanum-Moxee Subbasins,Yakima County, Washington. Battelle Pacific Northwest Laboratories, Richland, WA, 36 pp. with Appendices.

Cohen, S., 1985. Revised List of Analytes for the National Pesticide Survey. Memorandum to Herb Brass, August 2, 1985.

Erickson, D.R. and D. Norton, 1990. Washington State Agricultural Chemicals Pilot Study, Final Report. Washington State Department of Ecology Report 90-46, 76 pp.

Erickson, D.R., 1992. Gleed Agricultural Chemicals Ground Water Quality Assessment. Washington State Department of Ecology Report, 16 pp. with Appendices.

Foxworthy, B.L., 1959. Geology and Ground-water Resources of the Ahtanum Valley, Yakima County, Washington. U.S. Geological Survey Open File Report, 201 p.

Kirk, T.K. and T.L. Mackie, 1993. Black Rock-Moxee Valley Groundwater Study. Washington State Department of Ecology, Water Resources Program Open File Report OFTR 93-1, 80 pp.

Larson, A.G. and D.R. Erickson, 1993. Quincy Agricultural Chemicals Ground Water Quality Assessment. Washington State Department of Ecology Report, 14 pp. with Appendices.

Mayer, J.L.,T.E. Lacher, N.R. Elkins, and C.J. Thorn, 1991. Temporal Variation of Ethylene Dibromide in an Unconfined Aquifer, Whatcom County, Washington, USA: A Twenty-Seven Month Study. Bull. Environ. Contam. Toxicol. 47:368-373.

SCS, 1985. Soil Survey of Yakima County Area, Washington. USDA Soil Conservation Service, 345 pp. with plates.

Twiss, S.N., 1943. Report on Ground Water in Ahtanum Valley, Yakima County, Washington. U.S. Soil Conservation Service, Region 7, 10 pp.

U.S. Corps of Engineers, 1978. Yakima Valley Regional Water Management Study, Vol IV Geology and Ground Water. Seattle District, 46 pp. with Appendices.

WSDH, 1992. Drinking Water Regulations. Washington State Department of Health, Division of Drinking Water, p. 40.

APPENDICES

Appendix A1. Moxee surficial aquifer sample wells.			
Site ID	Water Use	Well Depth (ft.)	Depth to Water (ft.)
MX01P1	Irrigation	80	10
MX02B1	Irrigation	70	9
MX02E1	Domestic	60	14
MX02G1	Domestic	42	U
MX04H1	Domestic	70	11
MX10D1	Domestic	60	8
MX10E1	Domestic	60	9
MX27G1	Domestic	65	25
MX27Q1	Domestic	60	5
MX34Q1	Domestic	42	8
MX35J1	Domestic	38	4
U = Not measured, well sealed.			

Appendix A2. Ahtanum surficial aquifer sample wells.			
Site ID	Water Use	Well Depth (ft.)	Depth to Water (ft.)
AT01H1	Domestic	30	11
AT02G1	Domestic	79	20
AT04J1	Irrigation	20	11
AT05C1	Domestic	60	9
AT07A1	Irrigation	54	14
AT07D1	Domestic	20	U
AT08L1	Domestic	80	U
AT09R1	Domestic	20	8
AT10G1	Domestic	20	9
AT12M1	Domestic	55	14
AT18B1	Domestic	152	19
AT26L1	Domestic	100	0
AT27E1	Irrigation	40	U
AT28M1	Domestic	87	21
AT30H1	Domestic	28	8
AT33J1	Domestic	21	7
U = Not measured, well sealed.			

Appendix B. List of pesticides, quantitation limit (ug/L), and laboratory method.

ANALYTE	DETECT	METHOD
1,2-Dibromo-3-Chloropropane (Dbcp)	0.02	EPA 504
1,2-Dichloropropane	1	EPA 846
2,4,5-T	0.014	EPA 615
2,4,5-Tb	0.014	EPA 615
2,4,5-Tp (Silvex)	0.014	EPA 615
2,4-D	0.027	EPA 615
2,4-Db	0.058	EPA 615
3,5-Dichlorobenzoic	0.027	EPA 615
4-Nitrophenol	0.027	EPA 615
5-Hydroxydicamba	0.021	EPA 615
Abate (Temephos)	0.75	EPA 1618
Acifluorfen (Blazer)	0.027	EPA 615
Alachlor	0.2	EPA 1618
Aldicarb	1	EPA 531.1
Aldicarb Sulfone	1	EPA 531.1
Aldicarb Sulfoxide	2	EPA 531.1
Ametryn	0.084	EPA 1618
Atraton (Atron, Atratone)	0.25	EPA 1618
Atrazine	0.04	EPA 1618
Atrazine	0.08	EPA 1618
Azinphos (Guthion)	0.15	EPA 1618
Baygon (Propoxur)	1	EPA 531.1
Benefin	0.13	EPA 1618
Bentazon	0.11	EPA 615
Bolstar (Sulprofos)	0.058	EPA 1618
Bromacil	0.5	EPA 1618
Bromoxynil	0.014	EPA 615
Butachlor	0.29	EPA 1618
Butifos (Def)	0.12	EPA 1618
Butylate	0.13	EPA 1618
CIPC (Chlorpropham)	0.42	EPA 1618
Carbaryl	2	EPA 531.1
Carbofuran	2	EPA 531.1
Carbophenothion	0.083	EPA 1618
Carboxin	0.92	EPA 1618
Chloramben	0.021	EPA 615
Chlorothalonil (Daconil)	0.2	EPA 1618
Chlorpropham	0.42	EPA 1618
Chlorpyrifos	0.058	EPA 1618
Cis-1,3-Dichloropropene	1	EPA 846
Coumaphos	0.1	EPA 1618
Cyanazine	0.1	NPS 4
Cycloate	0.13	EPA 1618
Dacthal (DCPA)	0.014	EPA 615
Dalapon (Dpa)	0.18	EPA 615
Demeton-O	0.05	EPA 1618
Demeton-S	0.058	EPA 1618
Diazinon	0.066	EPA 1618
Dicamba	0.014	EPA 615
Dichlobenil	0.1	EPA 1618
Dichloroprop	0.027	EPA 615

ANALYTE	DETECT	METHOD
Dichlorvos (Ddvp)	0.066	EPA 1618
Diethyl Fumarate	0.25	EPA 1618
Dimethoate	0.066	EPA 1618
Dinoseb	0.017	EPA 615
Dioxathion	0.14	EPA 1618
Diphenamid	0.25	EPA 1618
Disulfoton (Di-Syston)	0.05	EPA 1618
Diuron	0.1	NPS 4
EDB (Ethylene Dibromide)	0.02	EPA 504
Epn	0.084	EPA 1618
Eptam (EPTC)	0.13	EPA 1618
Ethalfluralin (Sonalan)	0.13	EPA 1618
Ethion	0.058	EPA 1618
Ethoprop	0.066	EPA 1618
Ethyl Azinphos (Ethyl Guthion)	0.13	EPA 1618
Fenamiphos	0.12	EPA 1618
Fenarimol	0.25	EPA 1618
Fenitrothion	0.058	EPA 1618
Fensulfothion	0.083	EPA 1618
Fenthion	0.058	EPA 1618
Fluridone	0.67	EPA 1618
Fonofos	0.05	EPA 1618
Hexazinone	0.13	EPA 1618
Imidan	0.091	EPA 1618
Ioxynil	0.014	EPA 615
Malathion	0.066	EPA 1618
Mcpa	1.7	EPA 615
Mcpp	3.1	EPA 615
Methiocarb	3	EPA 531.1
Methomyl	1	EPA 531.1
Methyl Chlorpyrifos	0.058	EPA 1618
Methyl Paraoxon	0.15	EPA 1618
Methyl Parathion	0.058	EPA 1618
Metolachlor	0.25	EPA 1618
Metribuzin	0.084	EPA 1618
Mevinphos	0.083	EPA 1618
Mgk 264	0.59	EPA 1618
Molinate (Ordram)	0.22	EPA 1618
Monocrotophos	0.58	EPA 1618
Napropamide	0.25	EPA 1618
Norflurazon	0.13	EPA 1618
Oxamyl (Vydate)	2	EPA 531.1
Oxyfluorfen (Goal)	0.22	EPA 1618
Parathion	0.066	EPA 1618
Pebulate (S-Propyl butylethylthiocarbamate)	0.2	EPA 1618
Pendimethalin (Prowl)	0.13	EPA 1618
Pentachlorophenol	0.004	EPA 615
Phorate	0.058	EPA 1618
Phosphamidan	0.2	EPA 1618
Picloram	0.021	EPA 615
Prometon (Pramitol 5p)	0.084	EPA 1618
Prometryn (Caparol, Gesagard, Primatol Q)	0.084	EPA 1618

ANALYTE	DETECT	METHOD
Pronamide (Kerb)	0.25	EPA 1618
Propachlor (Ramrod)	0.17	EPA 1618
Propazine	0.084	EPA 1618
Propetamphos	0.17	EPA 1618
Ronnel	0.058	EPA 1618
Simazine	0.08	EPA 1618
Simazine	0.04	EPA 1618
Sulfotepp (Tetraethyl Dithiopyrophosphate)	0.05	EPA 1618
Tebuthiuron	0.084	EPA 1618
Terbacil	0.42	EPA 1618
Terbutryn (Igran)	0.084	EPA 1618
Tetrachlorvinphos (Gardona, Striofos)	0.17	EPA 1618
Tetraethyl Pyrophosphate	0.058	EPA 1618
Trans-1,3-Dichloropropene	1	EPA 846
Treflan (Trifluraline)	0.13	EPA 1618
Triadimefon	0.22	EPA 1618
Triallate	0.22	EPA 1618
Tributylphosphorotrithioite(Folex),(Merphos)	0.13	EPA 1618
Vernolate	0.13	EPA 1618
Xylene	1	EPA 846

Appendix C. Quality Assurance

Analyses were conducted by the Ecology/EPA Manchester Laboratory except for Carbamates which were analyzed by Water, Food and Research Laboratory (WFRL). The qualitative and quantitative accuracy, validity, and usefulness of data from WFRL were reviewed by Stuart Magoon of Manchester Laboratory. Laboratory quality control (QC) followed standard Manchester guidelines and included laboratory blanks, surrogate spikes, and pesticide matrix spikes. The relative percent difference (RPD) was used to estimate analytical precision. The RPD is the ratio of the difference and the mean of duplicate (or replicate) samples expressed as a percentage.

In addition to laboratory QC samples, field quality assurance (QA) samples were also tested. Field QA samples consisted of duplicates, replicates, and a transport blank. Duplicate samples consisted of identical samples submitted to the laboratory with different sample identifications. A replicate sample was obtained from the same well using identical sampling procedures but sampled at a different time. A transport blank consisted of organic-free water in unopened sample bottles that were carried during the sampling event.

No pesticides or nitrate-nitrite-N were detected in the transport blank. However, because of the preponderance of below quantitation limit results, duplicate and replicate samples were not useful in determining precision of the analyses, except for nitrate-nitrite as N.

In general, the quality of the results are good. Specific comments on each laboratory method follow:

Chlorinated herbicides by EPA Method 615: All sample extraction and analysis holding times were met. One compound, 4-nitrophenol, was detected in a laboratory blank, but not in the duplicate blank or in the remaining lab blanks. Nitrophenol was not detected in any sample. Surrogate recoveries for 2,4,6-tribromophenol ranged from 55% to 116%. No recovery limits have been established for this method. Matrix spikes recoveries ranged from 51% to 133%. The relative percent differences (RPD) ranged from 3% to 18%.

DCPA (dacthal) was analyzed in one follow-up sample. The surrogate spike recoveries for this sample and a laboratory blank were 82% and 112%, respectively; within acceptable QC limits. No matrix spikes were analyzed with this sample.

Volatile organics by EPA SW 846 Method 8240: All samples were analyzed within the recommended 14 day holding time. However, the matrix spikes were analyzed one day over the holding time. No pesticides were detected in the laboratory blanks, although low levels of the common laboratory solvents acetone and methylene chloride were found. Surrogate recoveries for p-Bromofluorobenzene; 1,2-dichloroethane-d4; 1,2 dichlorobenzene-d4; and D8-toluene were within acceptable limits, ranging from 92% to 115%. Matrix spikes were within acceptable limits for both percent recovery and RPD. Percent recovery for pesticides ranged from 89% to 98% except for cis-1,3-dichloropropene with 45% recovery. A duplicate cis-1,3-dichloropropene had 93% recovery.

Ethylene dibromide(EDB) and dibromochloropropane (DBCP) by EPA Method 504: All samples were extracted and analyzed within the recommended holding times. No target compounds were detected in the laboratory blanks. Surrogate recoveries for methylated dalapon ranged from 61% to 95%. No recovery limits have been established for this method. No matrix spikes were analyzed with these samples due to an oversight at the laboratory.

EDB and DCPA were also analyzed in two follow-up samples. These samples were also extracted and analyzed within the recommended holding time. Neither analyte was found in laboratory blanks. The surrogate recoveries ranged from 99% to 104% and the matrix spike recovery for EDB was 100% and for DBCP, 110%. The RPD for both compounds was 0%.

Nitrogen containing pesticides by EPA Method 1618: All samples were extracted within seven days and extracts were analyzed within the recommended holding time. No target analytes were detected in laboratory blanks. The organo-phosphorous, triphenyl phosphate (TPP) was used as the surrogate compound. No specific nitrogen containing pesticide surrogates were available for this analysis. Matrix spike recoveries for the eight nitrogen containing compounds spiked, ranged from 57% to 85% and the RPD from 1.5% to 69%. No recommended recovery limits or RPD have been established for this method. Hexazinone recoveries (33% and 16%) were significantly lower than the other nitrogen pesticides. However, no hexazinone was detected in any sample.

Simazine and atrazine were also analyzed in three follow-up samples. These samples were completed within the recommended holding time. Neither analyte was detected in laboratory blanks. Surrogate recovery for dimethylnitrobenzene ranged from 52% to 73%. No dimethylnitrobenzene recovery limits have been set for this method. No matrix spikes were analyzed with these samples.

Urea pesticides by NPS-4 Method: All samples were extracted within seven days and extracts were analyzed within the recommended holding time. No target analytes were detected in laboratory blanks. Surrogate recoveries for carbazole ranged from 90% to 140%. No carbazole recovery limits have been established for this method. Both the target compounds, diuron and cyanazine, were used in the matrix spikes. Recovery ranged from 101% to 133%. RPD for both diuron and cyanazine was 16%. No recommended recovery limits or RPD have been established for this method.

Organo-phosphorous pesticides by EPA 1618 Method: All samples were extracted within seven days and extracts were analyzed within the recommended holding time. No target analytes were detected in the laboratory blanks. Surrogate recovery for triphenyl phosphate (TPP) ranged from 56% to 167%. No recommended recovery limits have been established for this method. Matrix spike recoveries for nine organo-phosphorous pesticide compounds spiked, ranged from 85% to 110% and the RPD ranged from 7% to 15%. No recommended recovery limits or RPD have been established for this method.

Carbamates by EPA Method 531.1: Only carbamate samples collected on October 16, 1992, were analyzed within the known stability period of 28 days from collection. All other

samples were analyzed after 28 days from collection. Carbamate stability beyond 28 days from collection is not known. Aldicarb sulfoxide, methomyl, and carbaryl are the most susceptible to degradation. None of these compounds were detected, but all results for these three analytes were qualified with an estimated quantitation limit due to the extended holding times and the fact that stability of these compounds beyond 28 days is not known. No target analytes were detected in laboratory blanks. Surrogate recovery for BDMC ranged from 97% to 110% and matrix spike recovery ranged from 50% to 197%. There are no quality control limits established for recovery or precision for this method.

Nitrate-nitrite as nitrogen by EPA Method 353.2: All samples were analyzed within recognized holding times. No laboratory blank was analyzed, but the analyte was not detected in the transfer blank. The RPD of a field and a laboratory duplicate was 1% and 0%, respectively.