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AGRICULTURAL CHEMICALS PILOT STUDY
YAKIMA COUNTY STUDY AREA

SAMPLING AND ANALYSIS PLAN

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INTRODUCTION

The use of agricultural chemicals in Washington State is widespread. However, the effects of these chemicals on the state's ground water quality is unknown. As of 1986, 17 pesticides have been found in the ground water of 23 states as the result of agricultural uses (Cohen *et al.*, 1986). Ethylene Dibromide (EDB), a soil fumigant used to control nematodes, has been found in drinking water wells in Skagit, Thurston, and Whatcom Counties (DSHS, 1985).

The 1987 Washington State Legislature authorized the Department of Ecology to conduct a study to investigate the effects of current uses of agricultural chemicals on ground water quality in Washington. The agricultural chemical pilot study is a first step toward defining these effects. The primary objective of the pilot study is to provide information on the presence and concentration of pesticides in ground water in three agricultural areas that, because of their hydrogeologic setting, are considered susceptible to ground water contamination. Secondary objectives of the pilot study are to identify potential indicator parameters for pesticide contamination and to correlate, where possible, site conditions and pesticide usage with any observed ground water contamination. Three study areas, located in Whatcom, Franklin, and Yakima Counties were selected statewide based on the following characteristics:

1. Presence of irrigated agriculture

2. Variety of crop types

3. Shallow ground water (less than 50 feet)

4. Unconfined aquifer with porous media flow

5. Permeable, well-drained surficial soils

6. Available well information and an adequate number of shallow wells for sampling

To allow hydrogeologic characterization and a sufficient density of wells to define ground water quality, relatively small study areas were chosen ranging from about five to 30 square miles.

A separate sampling and analysis plan is being prepared for each area. This sampling and analysis plan describes the Yakima County study area location, hydrogeologic conditions, agricultural practices, and sampling procedures.

LOCATION AND SITE CONDITIONS

Location

The Yakima County study area shown in Figure 1 is located in the southeastern portion of the county about three miles southwest of Sunnyside. It consists of Sections 3-5, 8-10, 15-17; the northern half of Section 23; and the western halves of Sections 2, 11, and 14, of Township 9 North, Range 22 East, an area of about 9 1/2 square miles.

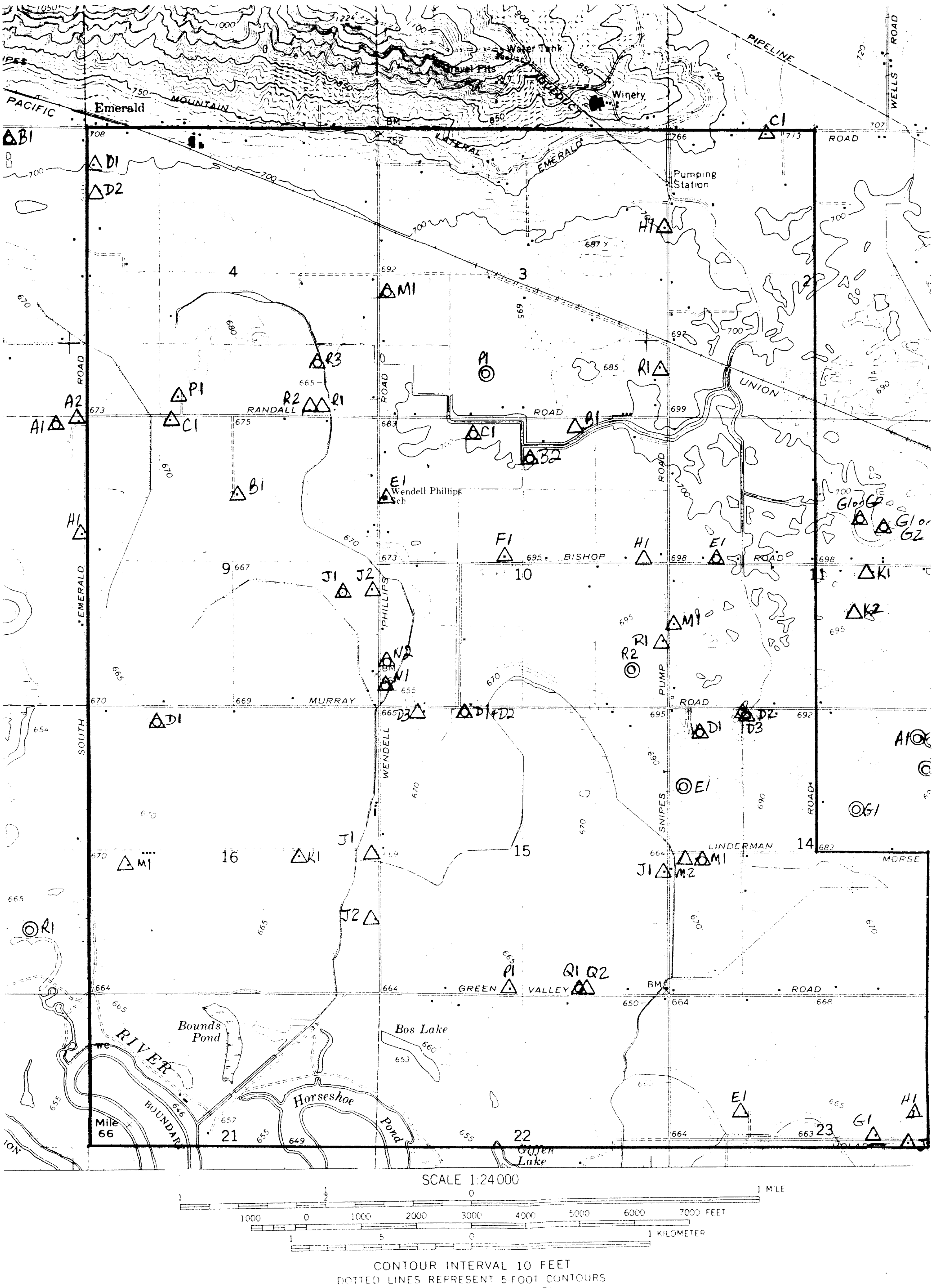
Geology

The Yakima Valley lies within the Columbia Plateau, a major physiographic province formed by repeated extrusions of lava between six to 17.5 million years ago. The thickness of the volcanic sequence, the Columbia River Basalt Group, may exceed 15,000 feet locally. Tectonic warping combined with fluvial and lacustrine processes have resulted in the deposition of sedimentary deposits on the the Columbia River Basalt Group. The thickness of sedimentary deposits is about 200 feet in the Sunnyside area (Drost and Whiteman, 1986).

Five geologic units have been identified in the study area: alluvium, loess deposits, catastrophic flood slack-water sediments, Tertiary fluvial deposits (Ringold Formation), and basaltic flows with sedimentary interbeds of the Columbia River Basalt Group (Campbell, 1977 and 1979). The Columbia River Basalt Group underlies the entire area and crops out at Snipes Mountain. At Snipes Mountain it consists of the Saddle Mountain Basalt unit, the uppermost basalt unit of the Columbia River Basalt Group, and sedimentary interbeds of the Ellensburg Formation. The Ringold Formation, also designated as the upper Ellensburg Formation (Campbell, 1977), consists of Tertiary fluvial sediments with some lacustrine deposits and uncomformably overlies the Columbia River Basalt Group. The lithology of the Ringold has not been defined in detail near Sunnyside but commonly consists of three units: an upper well-bedded silt and sand unit; a well-sorted, variably cemented sand and gravel; and a lower silt-clay unit which is usually blue but can be green, brown, or tan (Geoscience Research Consultants, 1978). The upper unit of the Ringold Formation crops out at Peanut Hump east of the study area. Loess deposits, consisting of silt and fine sand derived from glacial meltwater plains during the Pleistocene Epoch, occur in the northeast portion of the study area. Catastrophic flood slack-water sediments consisting predominately of sand and gravel, underlie portions of the the upper terrace that occupies the northeastern half of the study area. Alluvium, consisting of silt, sand, and gravel, underlies the modern floodplain of the Yakima River and lower terrace in the south western portion of the study area.

Hydrogeology

For conceptual purposes, four major aquifer systems have been identified regionally within the Columbia Plateau: three within the Columbia River Basalt Group and one



EXPLANATION

C1 Well ID Number

Well Location

△ Log available, location verified

△ No log available, location verified

◎ Log available, location unverified

—— Study Area Boundary

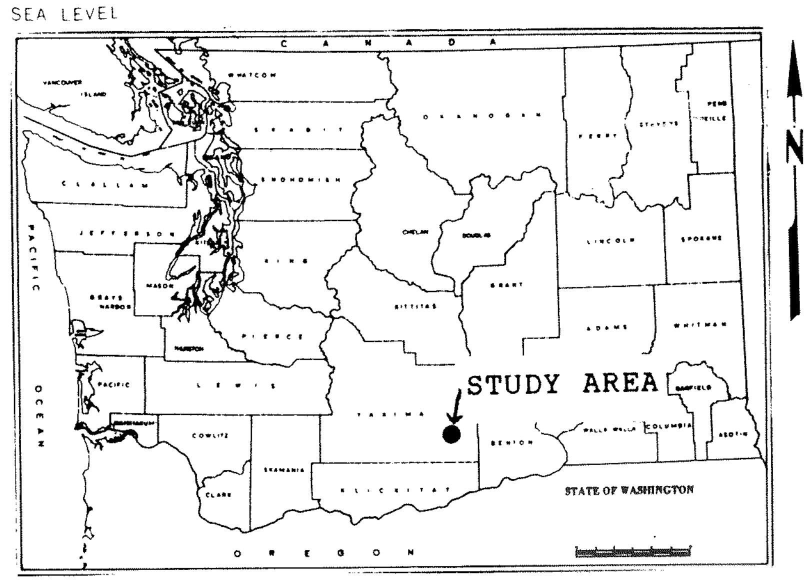


FIGURE 1

STUDY AREA AND WELL LOCATION MAP

within the overlying sedimentary deposits (Bauer *et al.*, 1985). The aquifer within the uppermost portions of the sedimentary deposits is the target aquifer for the pilot study. It consists of alluvium, catastrophic flood deposits, loess deposits, and the Ringold Formation. Hydraulic properties of the target aquifer are expected to vary widely because of the heterogeneity of the units that comprise it. The hydrostratigraphy of the target aquifer will be defined as part of the pilot study to the extent possible using existing information, primarily published geologic reports and well log lithologic descriptions. In nearby Toppenish Creek basin the sedimentary deposits have been divided into two hydrogeologic units: young valley fill and old valley fill (USGS, 1975 and Skrivan, 1987). A similar subdivision may be appropriate for this area.

The regional ground water flow direction in the sedimentary deposits is toward the Yakima River. In the Sunnyside area, flow is thought to be toward the south and southeast (Bauer *et al.*, 1985) or southeast and south-southeast (Kinnison and Sceva, 1963). Insufficient data exist to define the local ground water flow pattern. Water levels will be measured at sampling wells and will be used to better define the ground water flow direction. Because the target aquifer is shallow and unconfined the flow patterns will be influenced seasonally by pumping and irrigation.

<u>Ground Water Use</u>

A well inventory consisting of a compilation of well logs on-file at the Ecology Central Regional Office files and a reconnaissance survey conducted July 20 through 22, 1988, identified about 80 wells in the vicinity. The locations of the wells are shown in Figure 1. Because all water use in the area is supplied by wells, many more wells are known to exist in the area that were not identified in the inventory. Most of the wells are used for irrigation or domestic water use.

<u>Soils</u>

The soils consist predominately of Quincy-Hezel and Umapine-Wenas series (Lenfesty and Reedy, 1985). Quincy-Hezel soils are very deep, somewhat excessively drained, and occur in the northeast half of the study area. The southwest half is dominated by Umapine-Wenas soil series which is very deep, somewhat poorly drained, and artificially drained and associated with the modern flood plain of the Yakima River. The soils are generally sandy and permeable.

<u>Ground Water Quality</u>

Ground water in the sedimentary deposits is calcium bicarbonate type and ground water in the basalt is calcium-sodium bicarbonate (Turney, 1986).

Nitrate can be an indicator of agricultural effects on ground water quality. Turney reported that concentrations of nitrate-N of ground water in the sedimentary deposits commonly ranged from 1 to 5 mg/L in the Lower Yakima River basin. Turney also reported an elevated concentration of manganese (300 ug/L) in the study area.

AGRICULTURE

Types of Agriculture

Crops grown within the study area are varied and will be defined in greater detail as a part of the pilot study. Major crops consist of hops, grapes, alfalfa, wheat, and some corn. Stone fruit orchards occur at the northern margin. Because of the low precipitation all agricultural areas are irrigated. Most of the crops are irrigated using sprinklers or rills.

Pesticide Usage

Detailed information on pesticide usage in the area is limited. A list of pesticides that are used in Yakima County is shown in Table 1. This list is based on a survey of county WSU Cooperative Extension agents (EPA, 1986). The core pesticides for the survey came from the EPA list of leachable pesticides (Cohen, 1985) which consists of about 60 pesticides with properties conducive to migration through soils to ground water. Thirty-four of the EPA leachable pesticides are registered in Washington State.

SAMPLING PROCEDURES

General

Two sampling events are planned: initial sampling and verification sampling. Initial sampling will be conducted the first two weeks of October. Verification sampling will be conducted only at those wells that show positive finds for pesticides during the initial sampling. For planning purposes it is estimated that verification sampling will occur in January 1989 and will be needed at 20 percent of the wells.

Sample Locations

Twenty-seven wells have been selected for initial sampling. The wells are listed in Table 2 and locations are shown on Figure 2. Criteria for well selection were as follows:

1. An adequate spatial distribution to represent the ground water quality for the study area

2. Proximity to agriculture practices

3. Wells with known well construction and stratigraphic logs

4. Previously reported contamination

Minor changes to this list

Table 1. Leachable Pesticides Registered in Washington and Used in Yakima County.

Common Name	Brand Name	Lifetime Drinking Water Health Advisory (ug/L)	WSU Cooperative Extension*	Cancer Risk** (ug/L)
Alachlor	Lasso	Prob. Human Carc.	X	0.15 to 1.5
Aldicarb + Metabs.	Temik	10	X	
Ametryne	Evik	60		
Atrazine	Aattrex	2.5	X	
Baygon	Propoxure	3		
Bentazon	Basagran	17.5	X	
Bromacil	--	80		
Butylate	Sutan	50	X	
Carbofuran	Furadan	36	X	
Carboxin	Vitavax	700	X	
Chloramben	Amiben	105	X	
Cyanazine	Bladex	9		
Cycloate	Ro-Neet	None		
Dacthal	Dacthal/DCPA	3500	X	
Dalapon	Dowpon-M	560		
Dicamba	Banvel	9	X	
Dichloropropane	Telone	Poss. Human Carc.		0.56
Dinoseb	Dinitro	7	X	
Diphenamide	Enide	200		
Disulfoton	Di-Syston	0.3	X	
Diuron	Karmex	14	X	
Fenamiphos	Nemacur	1.8		
Hexazinone	Velpar	210		
Maleichydrazide	--	3500		
Methomyl	Lannate, Nudrin	175	X	
Metolachlor	Dual	10	X	
Metribuzin	Lexone, Sencor	175	X	
Oxamyl	Vydate	175	X	
Picloram	Tordon	490	X	
Prometon	Pramitol	100		
Pronamide	Kerb	52	X	
Propazine	Milocep	14		
Propham	Chemhoe	120	X	
Simazine	Princep	35	X	
Tebuthiuron	--	35		
Terbacil	Sinbar	90	X	
Other Pesticides of Concern:				
EDB		Prob. Human Carc.		0.0005
DBCP	Nemafume	Prob. Human Carc.		0.025
2,4-D		70		

*U.S. EPA (1986)

**Lifetime exposure via drinking water for one additional cancer death per million people.

Table 2. Proposed Sample Locations.

Well Identification	Well Elev. LSD (ft.)	MP Elev. (ft.)	DTW (ft.)	Date	Water Elev. (ft.)	Casing Diameter (inches)	Hole Depth (ft.)	Screened Interval (LSD, ft.)	Well Use*	Log**	Remarks
03H1	700	701			701	6	110	110	D		
03M1	692	693	20	10/30/78	673	6	90	90	D	D	
04D2	690	692				6	75	75	D		
04P1	675	671				1.25	20	20	D		Sand point
04R2	675	674				1.25	47	47	D		Sand point
04R3	672	670				30	11	11	I	D	
08A2	673	674				6	65	65	D		
09B1	680	676				1.25			D		Sand point
09J2	667					1.25			D		Sand point
10B2	700	701	27	05/27/86	674	6	95	92	D	D	
10E1	695	696				6	110-120	110-120	D		
10F1	695	688				1.25			D		Sand point
10H1	695	691				1.25			D		Sand point
10N1	667	667	9	04/03/81	659	6	67	65	D	D	
10R1	695	690					100-120	100-120	D		
14D1	690	691	22	04/24/79	669	6	105	100	D	D	
14D2	692	693	27	05/21/81	666	6	110	110	D	D	
14M1	680	682			682	6	96	90	D	D	Remove cartridge from filter
15D1	695	695	20	01/27/77	675	6	92	90	D	D	
15P1	665					1.25			D,S		Sand point
15Q2	665					1.25			D		New well to be hooked up
16D1	670	671	13	08/12/77	658	8	117	117	I	D	
16J1	669	670				6	107-108	107-108	D		
16J2	665					6			D,S		Contact for log
16M1	670	670				6			D		
23E1	665					6	150	150	D		
23H1	666	666				6			D		Water levels by CRO

*D=Domestic I=Irrigation S=Stock
**D=Driller's Log

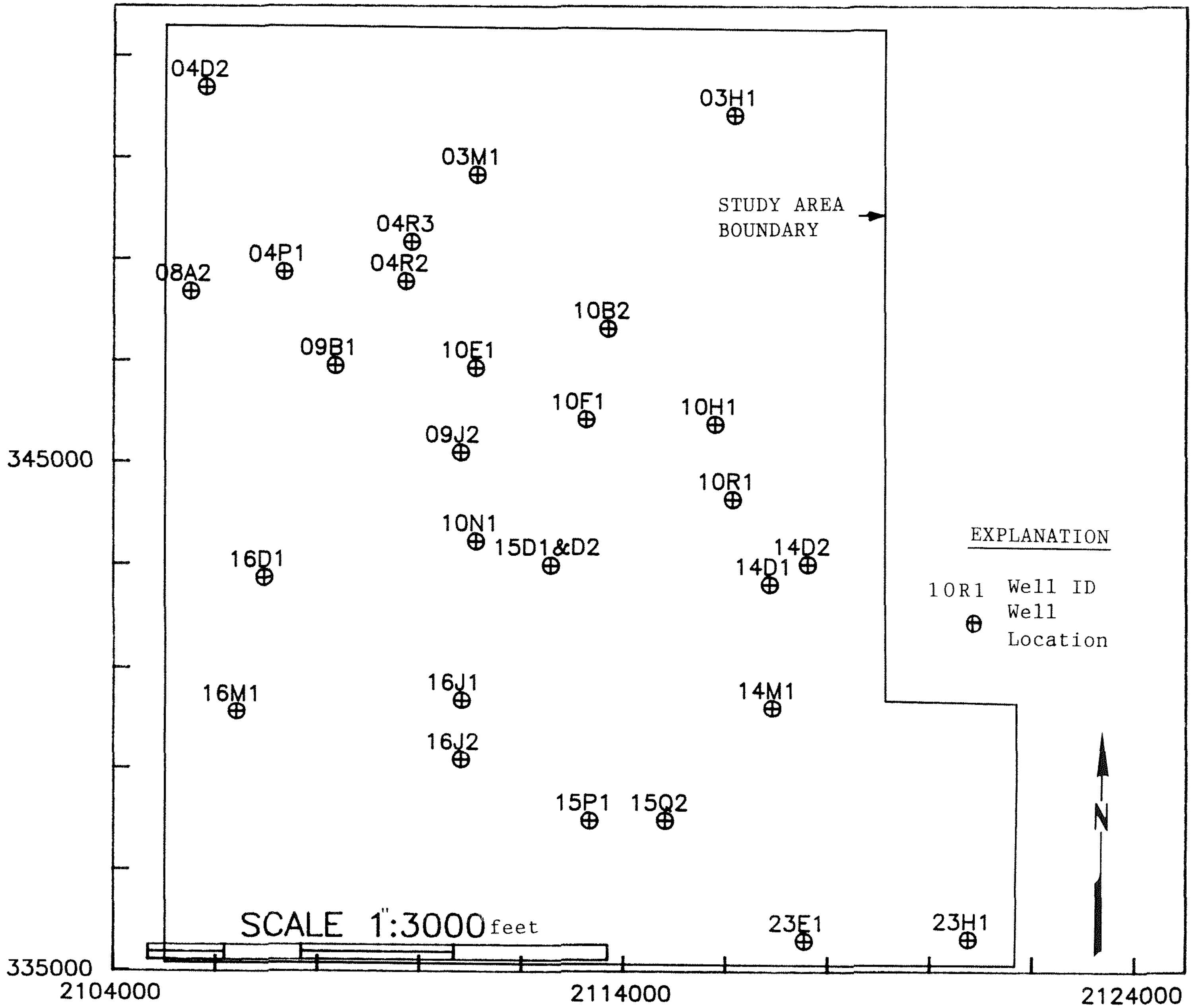


FIGURE 2. PROPOSED SAMPLE LOCATIONS

5. Shallow completion interval

6. Well diameter

7. Ease of access

8. Well age

Contact with well owners will occur as described in the Notification Plan prepared for this project. Owners will be notified in writing two weeks prior to sampling. A phone call requesting permission to sample will follow and, if the well owner is agreeable, a sampling time will be arranged. Access may not be possible for some of these wells and consequently substitutions will be necessary. These decisions will be made in the field as necessary using a list of backup wells that has been prepared. When possible, the owners of back-up wells will be contacted a day or two before the sampling to arrange for a convenient sampling time.

Parameters

Target pesticides, analytical methods, and associated costs are listed in Table 3. Pesticide analyses will be conducted by Montgomery Laboratories of Pasadena, California.

Non-pesticide parameters to be tested are listed in Table 4. This information will be used to characterize the general ground water quality (major anions and cations) and to identify potential indicator parameters for pesticide contamination (e.g., nitrate, total organic halides, total organic carbon, and selected metals). These parameters will be analyzed at the Ecology/EPA Region Laboratory in Manchester, Washington.

The cost of pesticide and non-pesticide analyses is estimated to be $36,800 and $8,200, respectively. Total cost of analytical services is estimated to be $45,000.

Sampling Protocols

Because the samples will be obtained from existing private and public wells, sampling procedures will require modification to accommodate the well owners and the well head appurtenances. Whenever possible, the following protocols will be used.

1. Water levels will be obtained prior to and during sampling.

2. The wells will be pumped until indicator parameters of temperature, specific conductance and pH have stabilized. A minimum of three casing volumes will be purged from the well prior to sampling.

3. Samples will be obtained as close to the well head as possible before the water enters pressure tanks or undergoes treatment.

Table 3. Pesticide Analytes, Analytical Methods, Reporting Limits, and Costs.

Analyte	Analytical Method *	Reporting Limit(ug/L)	Unit Cost	Initial Sampling No. of Wells	Cost
Alachlor	NPS Method 1	1.0	$200	27	$ 5400
Ametryne		0.26			
Atrazine		0.24			
Bromacil		2.2			
Carboxin		1.0			
Cycloate		0.4			
Diphenamide		0.4			
Disulfoton		0.15			
Disulfoton Sulfone		0.2			
Disulfoton Sulfoxide		0.35			
Fenamiphos		0.3			
Hexazinone		0.3			
Metolachlor		1.5			
Metribuzin		0.4			
Prometon		0.3			
Pronamide		1.3			
Propazine		0.2			
Simazine		0.8			
Tebuthiuron		0.5			
Terbacil		3.5			
Bentazon	NPS Method 3	0.5	$250	27	$ 6750
Chloramben		0.5			
Dalapon		5.0			
Dicamba		0.2			
Dinoseb		2.5			
Picloram		1.0			
2,4,D					
Aldicarb	NPS Method 5 &	1.0	$75	27	$ 2025
Aldicarb Sulfone	EPA Method 531	2.0			
Aldicarb Sulfoxide		2.0			
Baygon	NPS Method 4 &	1.0	$100	27	$ 2700
Carbofuran	EPA Method 632	1.0			
Diuron		1.0			
Methomyl		1.0			
Oxamyl		1.0			
Propham		1.0			
Cyanazine		5.0 (tentative)			
Ethylene Dibromide	EPA Method 504	0.01	$150	27	$ 4050
Dibromochloropropane	(Modified)	0.01			
Dichloropropane	EPA Method 601	0.2	$125	27	$ 3375
				Subtotal =	$24300
				QA/QC Samples (20%) =	$ 4860
				Verification Sampling (20%) =	$ 5832
				QA Deliverables (5%) =	$ 1750
				Total =	$36750

*NPS Method 1-Determination of N and P-containing pesticides in groundwater by GC with N-Detector

NPS Method 3-Determination of chlorinated acids in groundwater by GC with Electron Capture Detector

NPS Method 4-Determination of pesticides in groundwater by HPLC with a UV Detector

NPS Method 5-Measurement of N-Methyl Carbomoyloximes and N-Methyl Carbamates in groundwater by Direct Aqueous Injection HPLC with Post Column Derivatization

Table 4. Non-Pesticide Parameters, Analytical Methods, Detection Levels, and Costs

Parameter	Method of Analysis*	Detection Limit	Location	Number of Samples Sept	Number of Samples Jan	Unit Cost	Cost
Water Level	Olympic Well Probe	0.05 foot	Field	NA	NA	NA	NA
pH			Field	NA	NA	NA	NA
Spec. Cond.	Beckman RC-15C Cond. Br.	Field	NA	NA	NA	NA	
Temperature	Precision Thermometer		Field	NA	NA	NA	NA
Total Diss. Solids	EPA #160.1		Manchester	27	5	$ 8	$ 256
Nitrate/Nitrite	EPA #353.2	0.01 mg/L	Manchester	27	5	$ 12	$ 384
Total Phosphate	EPA #365.1	0.01 mg/L	Manchester	27	5	$ 15	$ 480
Potassium	ICAP	0.01 mg/L	Manchester	27	5	$ 12	$ 384
Major Cations							
Sodium	ICAP	0.01 mg/L	Manchester	6		$ 12	$ 72
Calcium	ICAP	0.01 mg/L	Manchester	6		$ 12	$ 72
Magnesium	ICAP	0.01 mg/L	Manchester	6		$ 12	$ 72
Major Anions							
Chloride	EPA #300.0	0.1 mg/L	Manchester	6		$ 18	$ 108
Carbonate	Std Methods #406C	1 mg/L	Manchester	6		$ 14	$ 84
Bicarbonate	Std Methods #406C	1 mg/L	Manchester	6		$ 14	$ 84
Sulfate	EPA #300.0	0.1 mg/L	Manchester	6		$ 18	$ 108
Iron (Total)		0.01 mg/L	Manchester	6		$ 12	$ 72
Manganese (Total)		0.01 mg/L	Manchester	6		$ 12	$ 72
T. Recov. Metals	206.2, 213.2, 220.2,	Pb,Cu,Zn - 5 ug/L	Manchester	6		$135	$ 810
(As, Cd, Cu, Pb,	239.2, 245.2, 249.2,	Se, As - 1 ug/L	Manchester				
Hg, Ni, Se, Zn)	270.2, 289.2	Cd, As - 0.2 ug/L	Manchester				
		Hg - 0.05 ug/L	Manchester				
T. Organic Halides	EPA #450.1	5 ug/L	Manchester	27	5	$100	$3200
T. Organic Carbon	Std Methods #505	0.1 mg/L	Manchester	27	5	$ 35	$1120
						Subtotal =	$7378
						QC (10%) =	$ 740
						Total =	$8118

*Huntamer (1986)

4. Samples will be stored on ice ($4^{0}C$) and will be shipped to the testing laboratory within 48 hours of collection.

5. In addition to method blanks and standard EPA contract laboratory instrument calibration requirements, quality assurance procedures will include analysis of the following sample types: field replicates, transport blanks, transfer blanks, reference samples and laboratory duplicates and spikes. A target level of 20 percent for replication, precision and accuracy will be used for this study.

   NOTE: All pesticide analytical data will be subject to an independent quality assurance review. Ecology and Environment, Inc. of Seattle will be conducting the review.

6. All samples will be properly labeled and sample integrity will be maintained.

7. Sampling order will be from up-gradient wells to down-gradient wells; i.e., north to south based on the assumption that the potential for ground water to be contaminated increases in the down-gradient direction across the study area.

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