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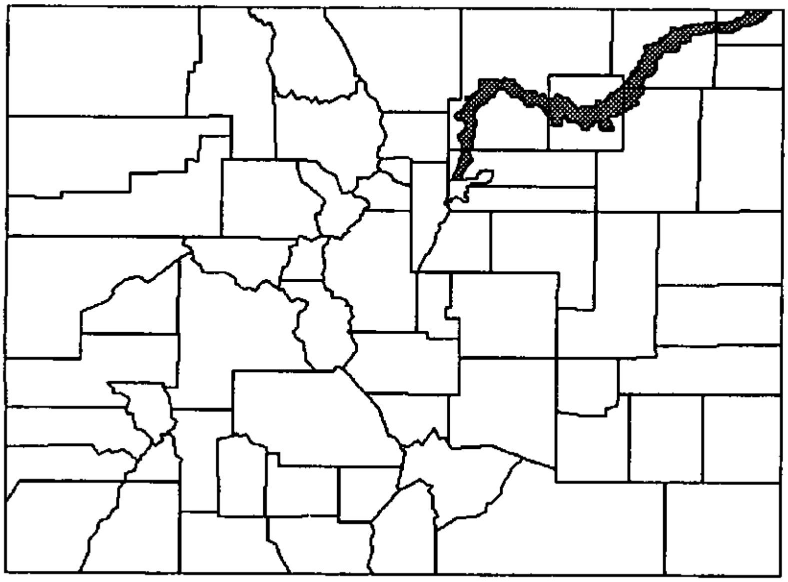
Report to the
Commissioner of Agriculture
Colorado Department of Agriculture



Ground Water Monitoring Activities
South Platte River Alluvial Aquifer
1992-1993

Bradford Austin
Agricultural Chemicals Program
Water Quality Control Division
Colorado Department Of Health

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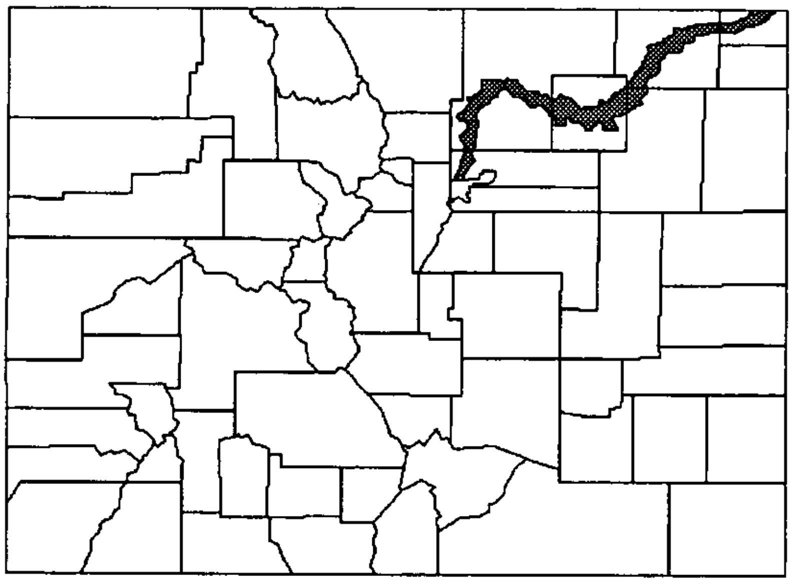

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Executive Summary

The Water Quality Control Division (WQCD) of the Colorado Department of Health (CDH) has responsibility under the Agricultural Chemicals and Ground Water Protection Program (SB 90-126) to conduct monitoring for the presence of commercial fertilizers and pesticides in ground water. This data assists the Commissioner of Agriculture in determining whether agricultural operations are impacting ground water quality. This report describes the monitoring program for groundwater quality in one of Colorado's major agricultural regions, the South Platte River Valley. The Program initially sampled ninety six (96) domestic wells along the river from Denver to Julesburg (Figure 1). Each well was sampled once between June and August, 1992. Well samples were analyzed for basic constituents, dissolved metals, and selected pesticides. The laboratory results and field data from the survey have been entered into the CDH Ground Water Quality Data System. Analysis of the laboratory reports, particularly for the nitrate and pesticide data, indicates that ground water in several areas of the study has been impacted by various agricultural chemicals. The major inorganic contaminant of concern is nitrate. Thirty three percent (33%) of the domestic wells sampled showed nitrate levels in excess of the EPA standard for drinking water (10 mg/L) (Figure 2). The majority of the wells that exceeded the drinking water standard were located in three areas: Brighton to Greeley, western Morgan County, and Sedgwick County (Figure 4). Seven different pesticides were detected, but only one well contained a pesticide at a level higher than the EPA drinking water standard. This pesticide, alachlor, was detected at a level of 3.09 ug/L; the MCL for alachlor is 2.0 ug/L. The only pesticide detected in a significant number of wells was atrazine (Table 2). Of the ninety six (96) wells sampled, nineteen (19) wells showed a trace of atrazine (detectable, but not in measurable quantity) (Figure 5). Seven (7) wells had measurable levels of atrazine, although none of these exceeded the EPA standard for drinking water (Figure 6). Atrazine is a common herbicide used extensively on corn in Colorado, with over one million pounds of active ingredient used per year.

After initial analysis of the data from the screening survey it was decided to do a follow-up sampling for nitrate in Morgan and Sedgwick Counties. Because of the extensive monitoring in the Brighton/Greeley area being conducted by other agencies, this area was not resampled. In Morgan County, the seventeen (17) original wells sampled in 1992 were resampled and seventeen (17) new wells were added. In Sedgwick County, the eight (8) wells sampled in 1992 were resampled and five (5) new wells were added. The resampling indicated little or no change in nitrate levels from one year to the next (Figure 8). The results also confirmed that nitrate levels exceeded the drinking water standard in both areas (Figure 9). This report provides the details of the monitoring effort in the South Platte River alluvial aquifer to the Commissioner of Agriculture. Sections describing the area sampled, the protocol for sampling and analysis, and the results of the analysis are provided.

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LIST OF ACRONYMS USED IN THIS REPORT

CDH	Colorado Department of Health
CSU	Colorado State University
EPA	United States Environmental Protection Agency
GIS	Geographic Information System
MCL	Maximum Contaminate Level
mg/L	Milligrams per Liter (for water equivalent to parts per million)
NWQL	National Water Quality Laboratory
QA	Quality Assurance
QC	Quality Control
SB 90-126	Senate Bill 90-126 of the Colorado General Assembly
ug/L	Micrograms per Liter (for water equivalent to parts per billion)
WQCD	Water Quality Control Division of the Colorado Department of Health

Introduction

The Water Quality Control Division (WQCD) of the Colorado Department of Health (CDH) has responsibility under the Agricultural Chemicals and Ground Water Protection Program (SB 90-126) to conduct monitoring for the presence of commercial fertilizers and pesticides in ground water. The Agricultural Chemicals Program has been established to provide current, scientifically valid, ground water quality data to the Commissioner of Agriculture. Prior to passage of SB 90-126, a lack of data had prevented an accurate assessment of impacts to groundwater quality from agricultural operations. This program will assist the Commissioner of Agriculture in determining to what extent agricultural operations are impacting ground water quality. The program also assists the Commissioner in identifying those aquifers that are vulnerable to contamination. The philosophy adopted is to protect ground water and the environment from impairment or degradation due to the improper use of agricultural chemicals, while allowing for their proper and correct use.

This report has been prepared for the Commissioner of Agriculture to provide a summary of the monitoring work completed in the South Platte alluvial aquifer in 1992-1993. This report details the monitoring work required by SB 90-126, including an evaluation of possible impacts to ground water quality from current and past use of agricultural chemicals in the lower South Platte River Basin (Denver to Julesburg).

The scope of this project involves the collection and laboratory analysis of ground water samples. This monitoring program was planned to meet the objectives necessary for a preliminary determination of the existence of agricultural chemicals in the ground water in a safe, cost effective, and timely manner.

The ground water quality sampling program is intended to fulfill the following objectives:

1. Determine if agricultural chemicals are present in the ground water.
2. Provide data to assist the Commissioner of Agriculture in the identification of potential agricultural management areas.

The factors considered in the choice of the lower South Platte River Basin as a study area are:

1. The South Platte River Basin is a major agricultural area of Colorado.
2. The ground water in the alluvial aquifer within this area is shallow in depth.
3. The area is heavily irrigated by both surface water diversions and ground water pumpage.
4. The soil types are conducive to leaching.
5. The alluvial and shallow bedrock aquifers are utilized for irrigation and domestic water supplies throughout the basin.

6. The Colorado Department of Agriculture and Colorado State University Extension have chosen the South Platte as the site for initial development of Best Management Practices.

Based on the land use and hydrogeologic factors, the potential exists for migration of agricultural chemicals into the ground water in this area. In addition, this area is currently the subject of other scientific research into agricultural impacts to ground water quality.

During the preliminary planning for sampling, CDH contacted interested parties to inform them of the sampling program and SB 90-126, and how we envisioned its implementation. CDH has coordinated closely with federal agencies, county extension agents, conservancy districts, and local health officials in the project area.

Ground Water Monitoring Program

The monitoring program presented in this report focused on groundwater quality monitoring in one of Colorado's major agricultural regions, the South Platte River Valley. A map of the study area and sample locations is provided in Figure 1. The monitoring program included sample collection, laboratory analysis, and data analysis and storage. Upon completion of the full analysis, which will include integration with previous and current studies by other agencies, this sampling program will provide the basis for determining a groundwater quality baseline for this region.

The Ag Chemicals Program of the Water Quality Control Division sampled ninety six (96) domestic wells along the South Platte River from Denver to Julesburg. This sampling program was the first effort to monitor the entire lower South Platte alluvial aquifer to establish the possible impacts and magnitude of agricultural chemical contamination. This region is characterized by intense irrigation agriculture encompassing both surface water diversions and wells for irrigation water supplies. The wells supply surface and center-pivot irrigation systems from the shallow alluvial aquifer along the river.

Wells were selected for sampling based on the following factors: permitted for domestic or household use, located within the valley fill aquifer of the South Platte River or one of its major tributaries, and cooperation of the well owner. The wells were sampled once between June and August, 1992 by Brad Austin and John Colbert of CDH. Field sampling procedures followed the protocol developed by the Ground Water Quality Monitoring Working Group of the Colorado Nonpoint Task Force.

Well samples were analyzed for basic water quality constituents, dissolved metals, and selected pesticides. A list of analytes is presented in Table 1. The basic inorganic analysis was performed by the Soils Laboratory at CSU with all samples split with the Colorado Department of Health Laboratory for nitrate and total dissolved solids for quality control evaluation. Comparison of these split parameters shows consistent results between the two laboratories.

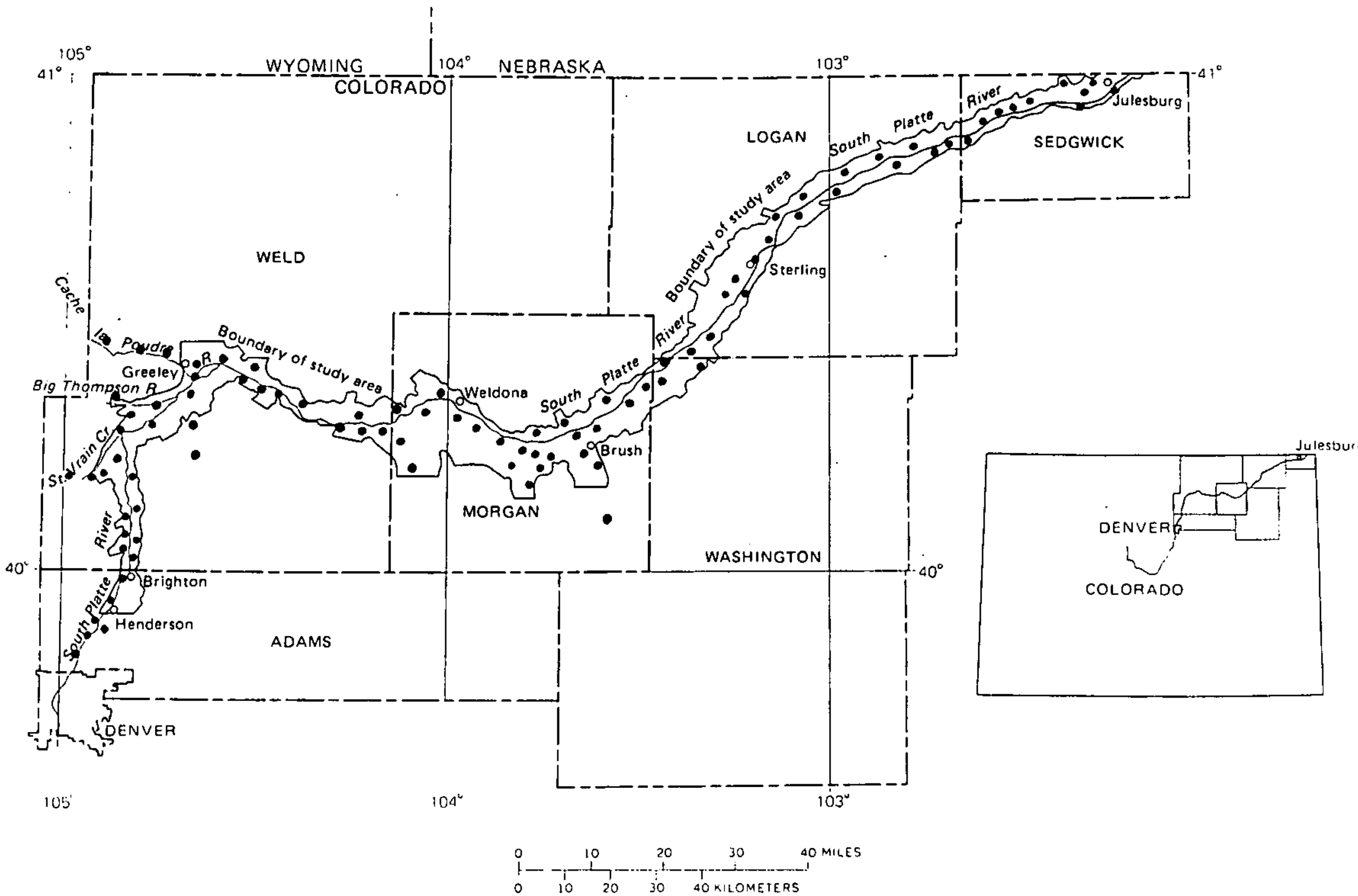


Figure 1 - Study area and sample locations for South Platte alluvial aquifer monitoring program.

Table 1 - List Of Analytes

South Platte River Alluvial Aquifer
Ground Water Monitoring, 1992

BASIC WATER QUALITY CONSTITUENTS	DISSOLVED METALS
Boron	Aluminum
Bicarbonate	Barium
Calcium	Cadmium
Carbonate	Chromium
Chloride	Copper
Magnesium	Iron
Nitrate	Lead
pH	Manganese
Sodium	Nickel
Specific Conductance (TDS)	Molybdenum
Sulfate	Phosphorous, total
Potassium	Zinc
Alkalinity, total	
Solids, Total Dissolved	
Hardness, total	

PESTICIDE COMPOUNDS

Trade Name	Use	Trade Name	Use
Atrazine	Herb	Ambush/Pounce	Insect
Balan	Herb	Diazinon	Insect
Bladex	Herb	Furadan	Insect
Dacthal	Herb	Lannate	Insect
Eptam	Herb	Lorsban	Insect
Evik	Herb	Malathion	Insect
IPC	Herb	Parathion	Insect
Lasso	Herb	Penncap-M	Insect
Lexone/Sencor	Herb	Sevin	Insect
Ro-Neet	Herb	Bayleton	Fungi
Sinbar	Herb	Bravo	Fungi
Sonnalan	Herb	Temik	Nematode
Treflan	Herb		
Velpar	Herb		

In addition to the inorganic constituents, all of the groundwater samples collected were analyzed for selected pesticides. A listing of pesticides was compiled for analysis based on those substances that have recently been, or are currently being utilized in the South Platte Valley according to agricultural officials there. Budget restrictions would not allow testing for all pesticides used in the study area. To reduce the analysis cost, each pesticide was weighted according to its chemical properties of persistence and mobility in the environment, amount of active ingredient used per acre, and the amount of acreage within the study area that pesticide was used on. Pesticides were then selected according to their final score and the ability of the laboratory to detect their presence.

Ground Water Monitoring Results

The results from this sampling program have been entered into the CDH Groundwater Quality Data System, a database specifically designed and maintained by the WQCD to store ground water quality data. Reports may be generated from the database on ground water quality in any area of the state from all data sources available. A complete printout of all water quality data from this survey is provided in Appendix A. A sample report on results, from an analysis done for this survey, is provided in Appendix B.

Analysis of the laboratory results indicates that ground water in portions of the study area has been impacted by nitrates and certain pesticides. The major inorganic contaminant of concern is nitrate. Thirty three (33) of the ninety six (96) domestic wells sampled (35%) showed nitrate levels in excess of the EPA standard for drinking water (10 mg/L) (Figure 2). Fifty five (55) wells (57%) tested positive for nitrate but were below the EPA standard. Only eight (8) wells tested below the detection level of 0.5 mg/L.

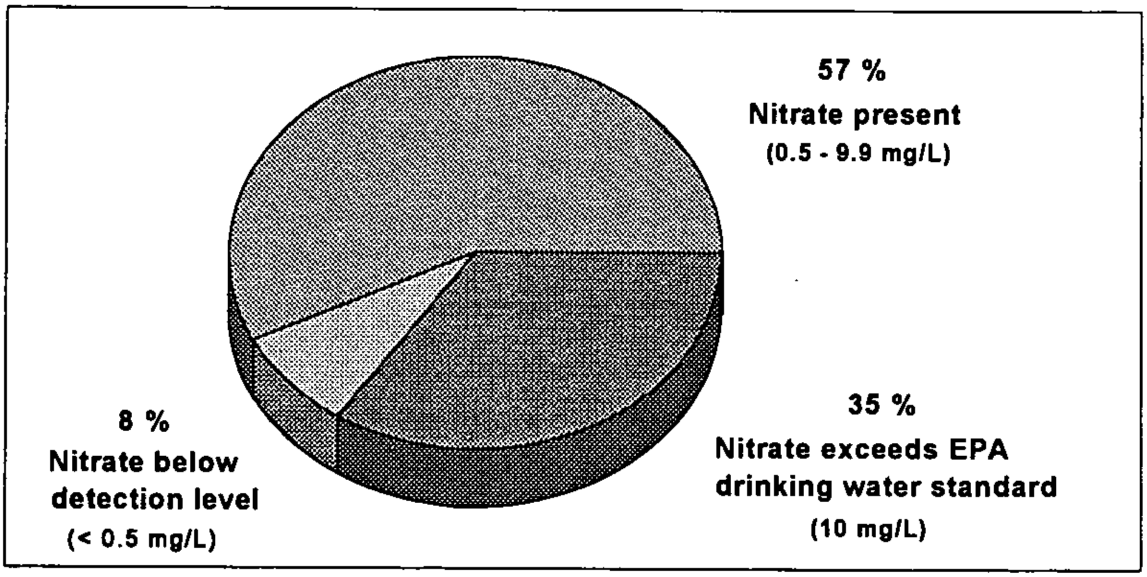


FIGURE 2 - Nitrate levels in domestic wells Pie chart showing distribution of nitrate levels in domestic well survey, South Platte alluvial aquifer, 1992.

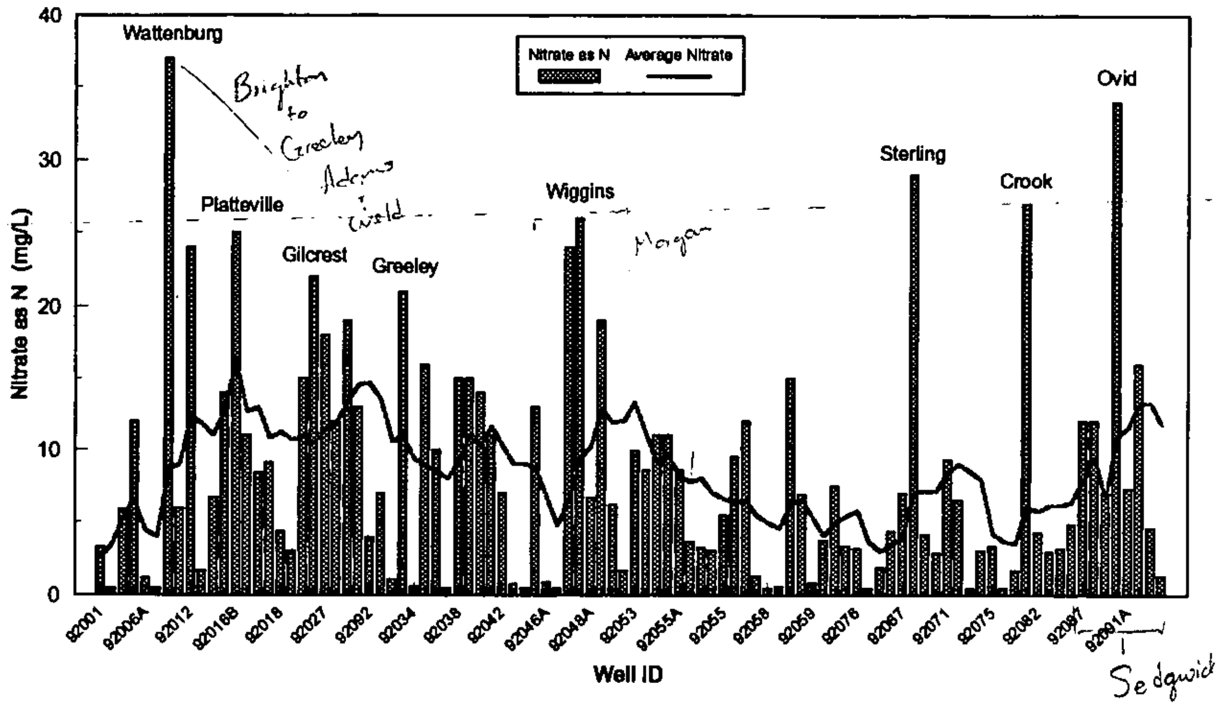


FIGURE 3 - Trend of nitrate levels in domestic wells Graph showing the variation of nitrate levels in domestic wells along the South Platte River from Denver to Julesberg, 1992. Drinking water standard for nitrate is 10.0 mg/L.

Figure 3 is a plot of the nitrate levels as you move downstream along the South Platte River from Denver to Julesburg. Immediately below Denver, in Adams County, levels are well below the standard. Just below Brighton the levels begin to increase and an area from Brighton through Greeley shows several wells above 20 mg/L with the average level consistently above the standard of 10 mg/L. Around Wiggins in western Morgan County, a second area of elevated nitrate appears in the data. Nitrate levels then decrease through eastern Morgan and Logan County with the exception of two isolated wells at Sterling and Crook. As we move into Sedgwick County the nitrate levels once again begin to increase with the overall average rising above the drinking water standard. A map prepared on a geographic information system (GIS) is shown in Figure 4. Areas on the map have been color coded according to the nitrate level measured in the well. White or blank indicates below detection level or no data. Green indicates nitrate present in the sample but below the standard of 10 mg/L. Yellow, orange, and red indicate nitrate levels in the 11-20 mg/L, 21-30 mg/L, and 31-40 mg/L ranges respectively. The elevated nitrate levels (above the EPA drinking water standard) appear in three distinct areas: the Brighton to Greeley reach of the aquifer, an area in western Morgan County around Wiggins, and Sedgwick County.

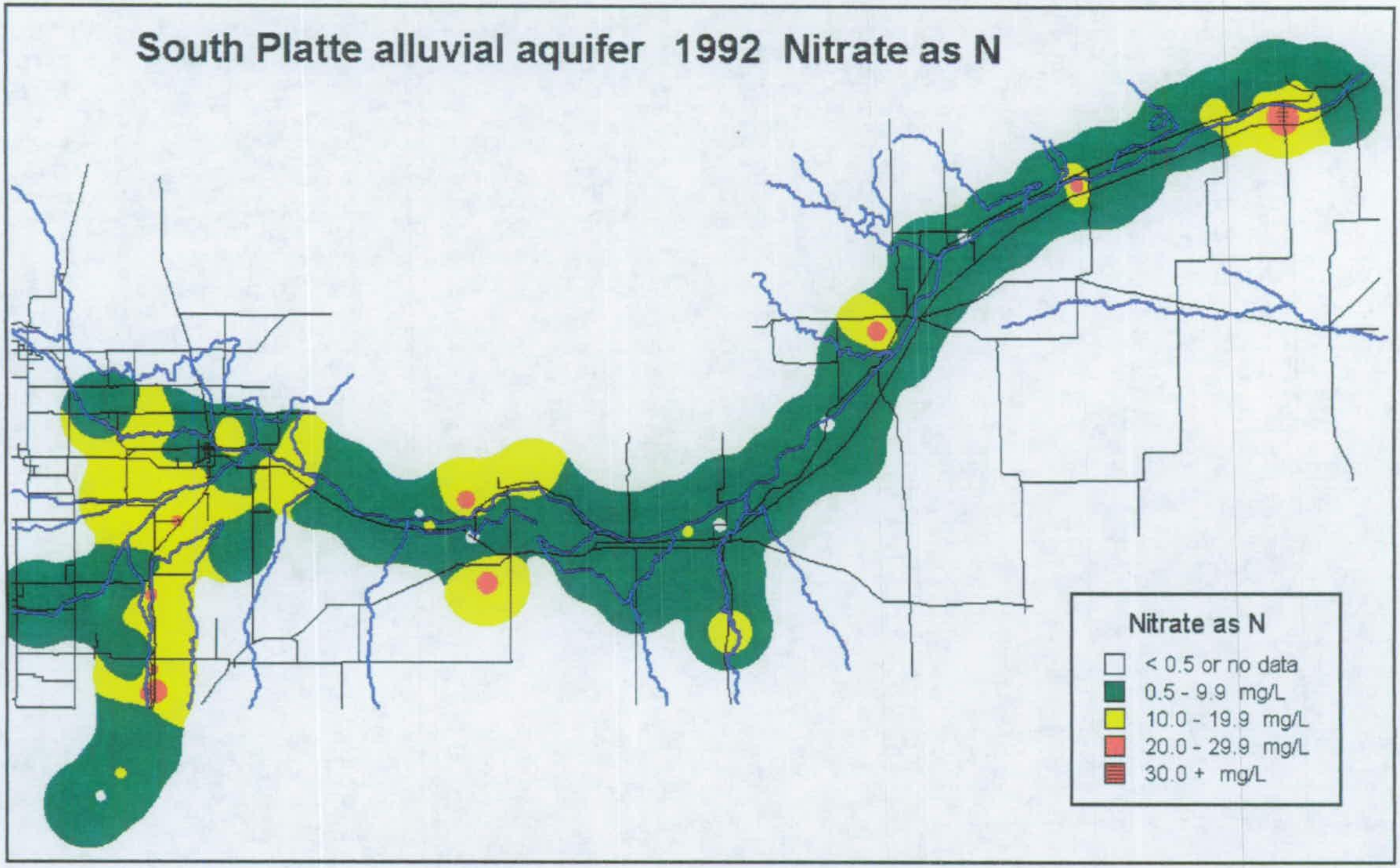


FIGURE 4 - Map of nitrate concentrations, South Platte alluvial aquifer, 1992.

Examination of the pesticide data reveals that seven different pesticides were detected in the South Platte alluvial aquifer. Of the ninety six (96) wells sampled, only one well contained a pesticide at a level higher than the EPA drinking water standard. This pesticide, alachlor, was detected at a level of 3.09 ug/L; the MCL for alachlor is 2.0 ug/L. Several wells had detectable levels of the pesticide atrazine (Table 2). Nineteen (19) wells showed a trace of atrazine (detectable by the lab, but not in measurable quantity), and seven (7) wells had measurable levels of atrazine. None of these atrazine levels exceeded the EPA standard for drinking water of 3.0 ug/L, (Figure 5). The location of all eight (8) pesticide detections above the trace level are plotted in Figure 6.

A GIS map of the atrazine concentrations is shown in Figure 7. Areas on the map have been color coded according to the atrazine level measured in the well. White or blank indicates no data. Green indicates below the detection level of 0.05 ug/L. Yellow areas show atrazine present in the sample at the trace level (0.05 - 0.5 ug/L). Orange and red indicate atrazine levels in the 0.51-1.00 ug/L and 1.01-2.00 ug/L ranges respectively. Due to the widespread nature of the detections of atrazine in the South Platte alluvial aquifer, the occurrence of this pesticide appears to result from non-point sources. Atrazine is a common herbicide used extensively on corn, with over one million pounds of active ingredient used per year in Colorado. Water quality studies in other states and nationally have also detected atrazine as a common pesticide in surface and ground water.

TABLE 2 - Summary of Pesticide Detections and Drinking Water Exposure

		Number of wells					(ug/L)	
Pesticide		Trace	DW	Present	DW		MDL	PQL
Alachlor		1	0	1	0		0.3	2.5
Atrazine		19	9	7	4		0.05	0.5
Benefin		1	0	0			0.03	0.3
DCPA		1	1	0			0.03	0.3
Diazinon		1	0	0			0.2	2
EPTC		1	0	0			0.05	0.5
Hexazinone		1	1	0			0.15	1.5

MDL - Method Detection Level. Lab instrument can detect the presence of a compound at this level.
PQL - Practical Quantification Level. The concentration, at or above which, lab can quantify results.
ug/L - Micrograms per liter. Units of measurement for pesticide concentrations. In water, equivalent to parts per billion.
Trace - Well sample contained a pesticide at a concentration above MDL but below PQL.
Present - Well sample contained a pesticide at or above the PQL.
DW - Number of wells with that pesticide that are a drinking water source.

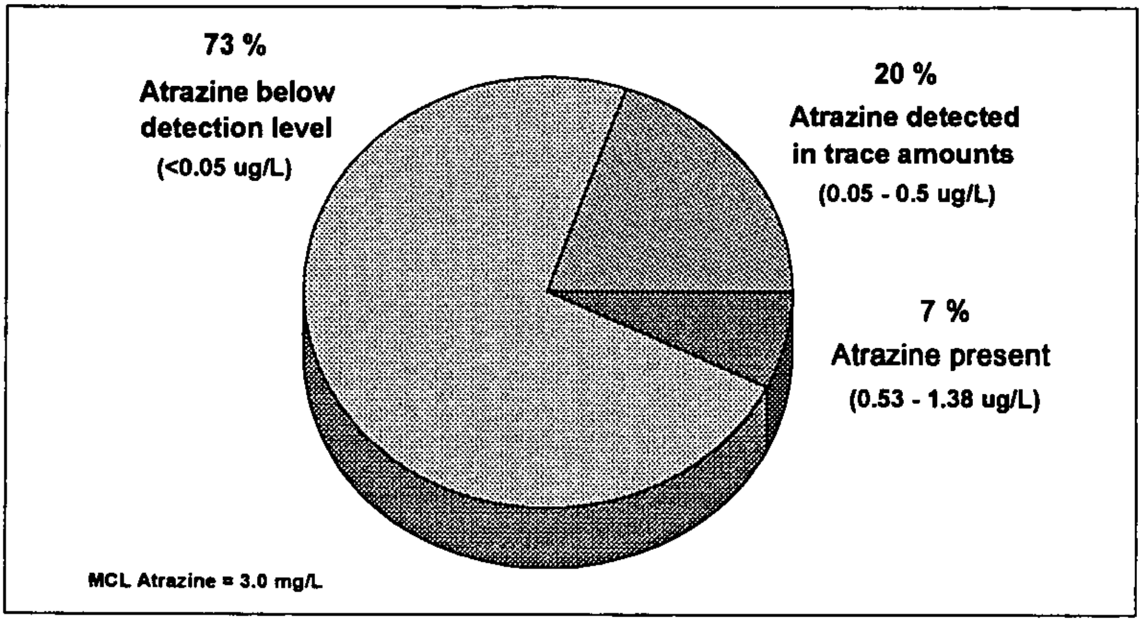


Figure 5 - Atrazine levels in domestic wells Pie chart showing distribution of atrazine levels in domestic well survey, South Platte alluvial aquifer, 1992.

The WQCD intends to include, in the final analysis of the South Platte alluvial aquifer, all available ground water quality data. Results from previous and on-going studies by other agencies in the area will be integrated into this analysis.

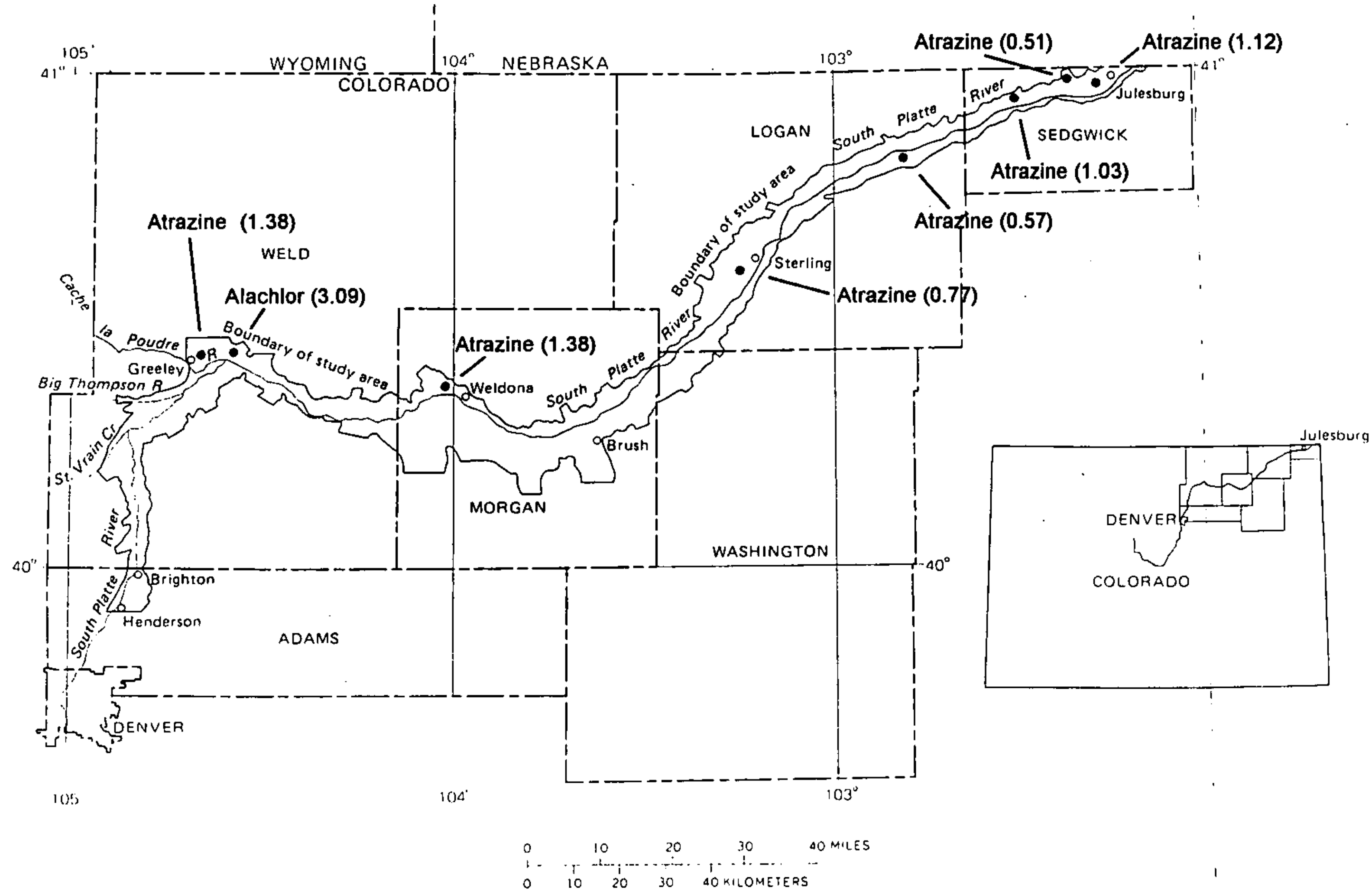


FIGURE 6 - Location of pesticide detections above the trace level. All values given in ug/L.

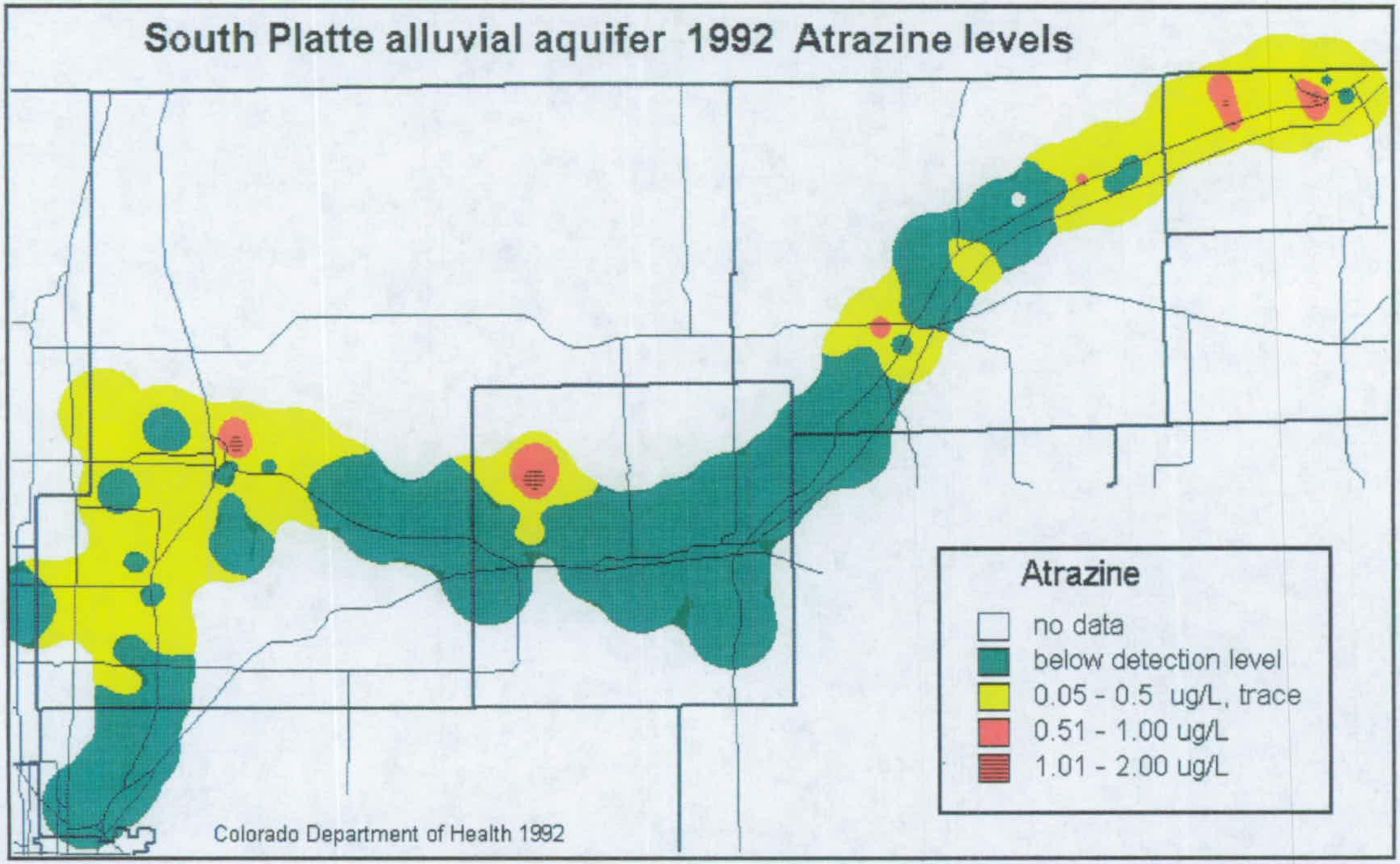


FIGURE 7 - Map of atrazine concentrations, South Platte alluvial aquifer, 1992.

Follow-up Sampling

The follow-up sampling program was conducted in May, 1993, to resample a portion of the original South Platte study area. Analysis of the nitrate data had indicated three areas where nitrate levels exceeded the drinking water standard of 10.0 mg/L. These three areas were the Brighton to Greeley reach of the aquifer, an area in western Morgan County around Wiggins, and Sedgwick County. The Platteville-Gilcrest-Greeley area has been monitored in recent years by two other agencies, the North Front Range Water Quality Authority (NFRWQA), and the Central Colorado Water Conservancy District (CCWCD). The U. S. Geological Survey (USGS) is currently monitoring the area under the National Water Quality Assessment (NAWQA) program. Since these other studies will eventually be incorporated into the final analysis, it was determined best to spend our limited resources on the other two areas where less work had been done. The follow-up sampling program consisted of resampling a majority of the original wells in Morgan and Sedgwick Counties, plus adding additional wells to improve the sampling density. In all, forty seven (47) wells were sampled for nitrate. The resampling program was designed to determine if the contamination originally detected was a widespread non-point source occurrence or only a coincidence of randomly selecting a few wells with high nitrate levels. The 1993 results confirmed that nitrate levels exceeded the drinking water standard in both counties. In Morgan County, thirteen of thirty four (38%) of the wells had nitrate levels in excess of the EPA drinking water standard of 10 mg/L, with only two wells (5%) showing no nitrate. In Sedgwick County, five of thirteen (38%) of the wells had nitrate levels in excess of the EPA drinking water standard of 10 mg/L. All Sedgwick County wells had some level of nitrate present. The resampling also indicated little or no change in nitrate levels from one year to the next in those wells that had been sampled both years (Figure 8).

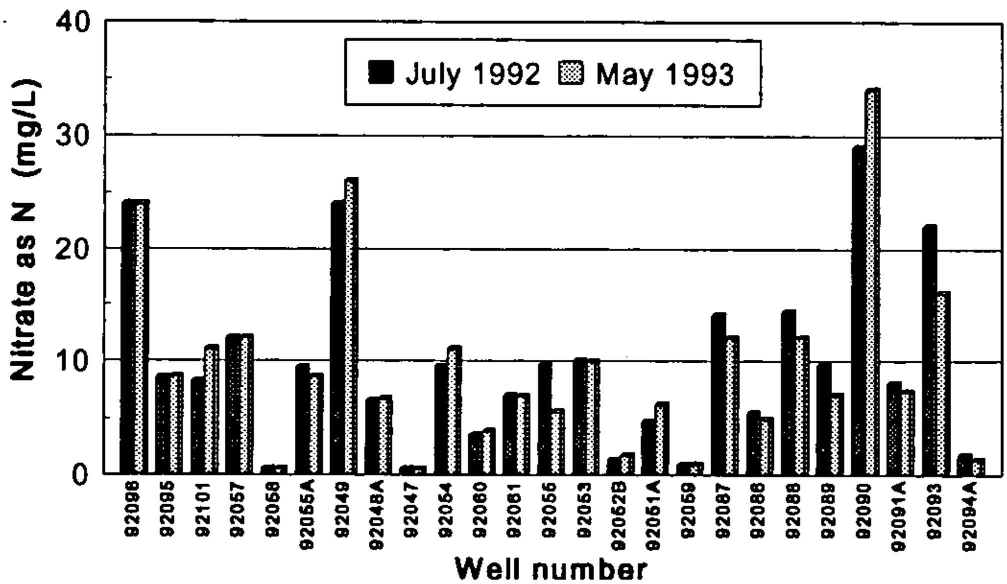


FIGURE 8 - Comparison of nitrate levels 1992-1993. Chart showing variation of nitrate levels from 1992 to 1993 in Morgan and Sedgwick Counties, South Platte River alluvial aquifer.

A revised GIS map of the nitrate concentrations (Figure 9) was prepared to include the results of the additional nitrate data obtained in 1993. Areas on the map have been color coded according to the nitrate level measured in the well. White or blank indicates below detection level or no data. Green indicates nitrate present in the sample at or above the detection level of 0.5 mg/L, but below the EPA drinking water standard of 10 mg/L. Yellow, red , and dark red indicate nitrate levels in the 10-19 mg/L, 20-29 mg/L, and 30 + mg/L ranges respectively.

In Morgan County, an additional seventeen (17) wells were added to the seventeen (17) wells sampled in 1992. With double the original well density, the elevated nitrate area first observed around Wiggins has now expanded. The 1993 resampling confirms that an area of elevated nitrate levels exists in western Morgan County.

In Sedgwick County, an additional five (5) wells were added to the eight (8) wells sampled in 1992. Again the additional sample points slightly expanded and confirmed an area of elevated nitrate levels centered about Ovid.

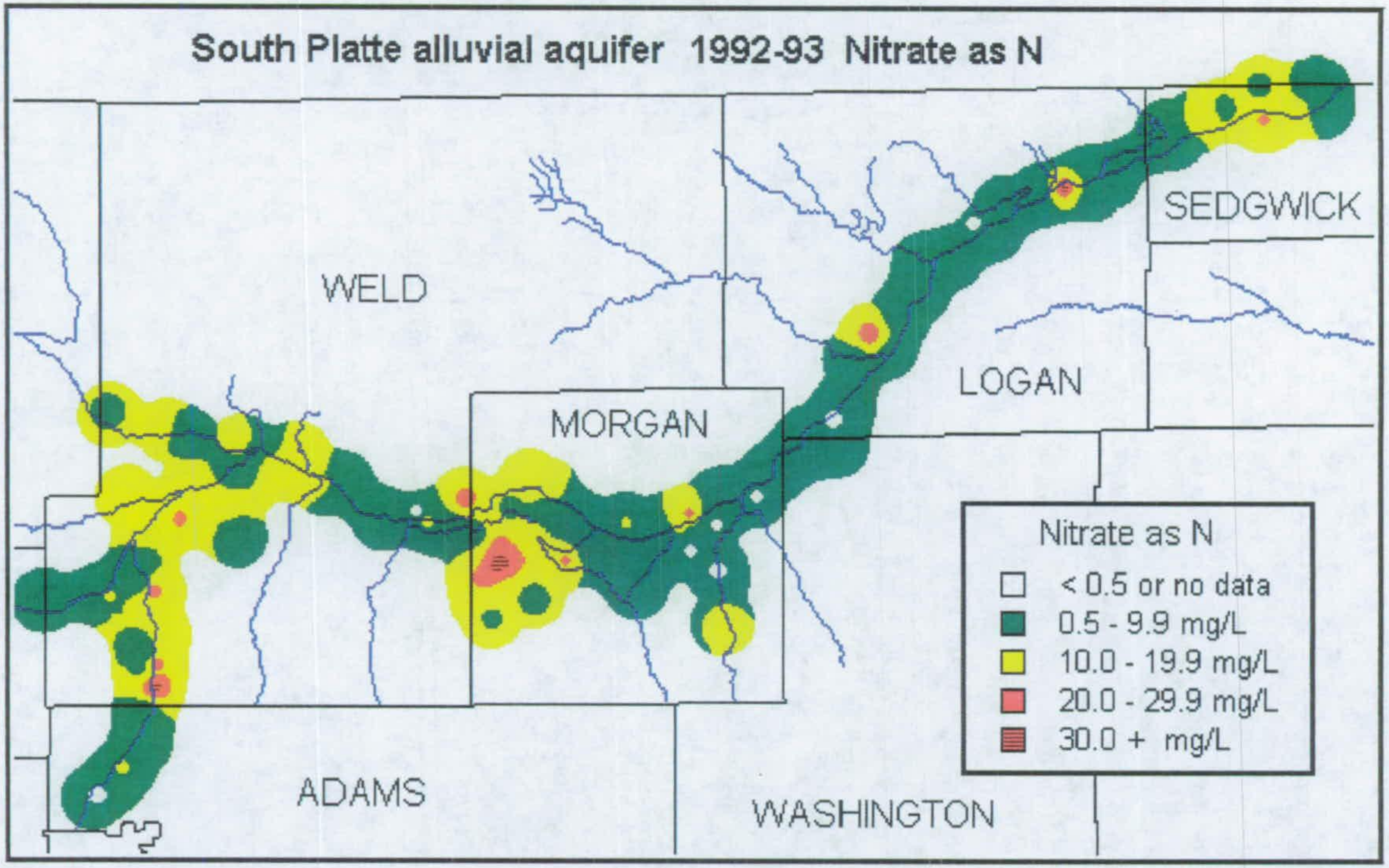


Figure 9 - Map of nitrate concentrations, South Platte alluvial aquifer, 1992 and 1993 data.

Sampling Area Description And Characteristics

Sampling Area Location and Description

The sampling area includes the South Platte River valley from the northern part of Denver County, to the Colorado - Nebraska border in Sedgwick County. The area is approximately 200 miles in length and occupies about 950 square miles.

Agricultural History and Water Use in the Area

The agricultural economy of the South Platte river basin is based on irrigated and dry land farming, and livestock production. The principal irrigated crops are corn, alfalfa, dry beans, sugar beets, potatoes, and garden variety vegetables. Small grains, chiefly wheat, are the principal dry land farm crops. The livestock consists mostly of beef and dairy cattle although some hogs, sheep and poultry are raised.

Several large canals for diverting water for irrigation were constructed in the late 1800's. Water for irrigation is also diverted from several reservoirs built around 1900. Because shortages of surface water occur during years of low runoff and the timing of runoff does not coincide with irrigation requirements, irrigation wells have been drilled in the valley to supplement the surface-water supply. In some areas groundwater pumped from wells is the sole supply for irrigation.

Many of the towns and some industries in the area also obtain water from wells. Although nearly all the large-capacity wells are in the valleys, small-capacity domestic and stock wells have been constructed both in the valleys and on the uplands since early settlement of the region. The upland areas that are without adequate surface or groundwater supplies for irrigation total about 400,000 acres and are used largely for dry land farming and for grazing.

The principal industries in the area are related to the processing of agricultural products; they include sugar-beet processing plants, canneries, alfalfa mills, vegetable warehouses, and creameries. A few plants produce construction materials and fertilizers. Deposits of sand and gravel are exploited for the fabrication of concrete products and building roads.

Geology

The rocks that crop out in the lower South Platte River Valley are sedimentary and range in age from Late Cretaceous to Recent. The oldest rocks, which are of Late Cretaceous age, are the Pierre shale, the Fox Hills sandstone, and the Laramie formation. Most of the major valleys contain Quaternary deposits of alluvium, terrace deposits, and dune sand.

The alluvium in the South Platte River valley was deposited in a channel eroded into the underlying bedrock and consists mainly of heterogeneous mixtures of clay, sand, and gravel, or lenses of these materials. Pebbles, cobbles, and boulders occur as erratics. The particles generally are well rounded to subrounded and range from well sorted to poorly sorted. Extensive lenses of clay are present within the alluvium. These clay lenses are most prevalent in the tributary valleys and probably represent shallow-lake deposits. The lenses of silt, sand, and gravel were deposited by braided streams as they aggraded their channels. The materials in the South Platte River valley generally are coarser than those in the tributary valleys and contain fewer clay lenses. The thickness of the alluvium ranges from less than a foot to more than 290 feet in some areas.

Alluvium is present in the South Platte River valley both as Pleistocene and recent terrace deposits and as recent flood-plain deposits. Terrace deposits form the major portion of the alluvium in the South Platte River valley and its tributaries. In the area covered by this study, the terraces are present throughout the South Platte river valley on both sides of the river and in all the major tributary valleys.

Dune sand covers a large part of the area included in this study. It consists predominantly of very fine to medium sand and includes some coarse sand, but it also contains some silt and clay. The thickness of the dune-sand deposits ranges from less than 1 foot to more than 100 feet; where the dunes are actively migrating the thickness may differ considerably in a few years.

Hydrogeology

The alluvium contains the major available supply of ground water in the area covered by this study. Throughout the South Platte River valley and its tributary valleys, these deposits form an almost continuous unconfined aquifer that is in hydraulic connection with the South Platte River. Because of its high permeability, the alluvium yields large quantities of water to wells in many parts of the area. Most of the irrigation wells obtain their entire yield from the alluvium. Supplemented by water supplied through trans-mountain diversions, the river and alluvial aquifer supply nearly all of the water used in the area.

In general the areas of dune-sand deposits are good infiltration areas for recharge to the underlying alluvial material. However, the few wells in dune-sand areas yield only small quantities of water. In areas where small saturated thickness of dune sand is underlain by impervious material, a few wells have been drilled through the sand into the impervious material, thus providing a small reservoir for the accumulation of water.

Hydrology

In the South Platte River valley, surface water and ground water are two components of one hydraulic system. The valley-fill aquifer is recharged by precipitation, applied irrigation water, and leakage from canals and reservoirs. Recharge to the aquifer from irrigated land is from 45 to 50 percent of the applied irrigation water and precipitation. Ground water withdrawals lower the water table and tend to reduce flow towards the river and, locally, under heavy pumpage, may temporarily lower the water table sufficiently to reverse the ground water gradient and cause water to flow from the stream to the aquifer.

The surface water supply has been augmented by diversions to the South Platte River drainage basin from the Colorado River and Laramie River basins. Ground water return flows that augment the flow of the river are the direct result of recharge from applied irrigation water. Prior to the practice of diverting surface water for irrigation, ground water levels were not high enough to maintain river flow throughout the year for the length of the river. In some areas the sand and gravel did not contain any water at all. With the application of surface water for irrigation, water began percolating into the alluvium beneath the fields and the water table rose. As a result of consumptive losses, due to evaporation and evapotranspiration, recharged ground water is higher in dissolved solids than the applied irrigation water. This creates a general increase in dissolved solids concentration in a down-gradient and down-valley direction within the alluvial aquifer.

A long term water budget of streamflow shows the South Platte River to be a gaining stream as a large part of the ground water recharge ultimately seeps into the river. Therefore the trend in surface water quality is an increase in dissolved solids concentrations in the river in a down-valley direction.

Irrigation Practices

With the exception of dry land wheat, most crops in the area are irrigated. The main crops grown in the study area and their irrigated acreage is:

1.	Corn	396,000
2.	Hay	203,000
3.	Dry Beans	71,000
4.	Sugar Beets	38,950
5.	Wheat	32,500
6.	Barley	27,500
7.	Oats	8,000
8.	Sorghum Grain	1,800

The data for irrigated acreage in the study area by crop were based on 1989 agricultural statistics data from the Colorado Department of Agriculture.

Meteorology

Based on U.S. Weather Bureau data, the climatic regime of the surrounding area would be classified as semi-arid. Mean annual precipitation in the area ranges from approximately 14 inches to 16 inches per year. Over 75 percent of the precipitation occurs during the period of April through September. Based on published information from the Colorado State Engineer's Office, the 100 year 24 hour precipitation event is approximately 4.5 inches and the 10 year 24 hour precipitation event is 3 inches. Normal annual Class A pan evaporation for this area is approximately 65 inches to 70 inches per year with the majority occurring during the May through October period. The general prevailing wind direction pattern is from the north and northeast.

Field Operations

Scheduling

All wells were scheduled for sampling by Water Quality personnel during the early summer of 1992. The exact dates for sampling were subject to laboratory schedules, sample holding times, well owner availability, and travel times.

Monitoring Well Selection

The rationale used in selecting wells for this monitoring project are listed below.

1. Low flow, shallow depth wells; in general, wells permitted or used for domestic purposes;
2. Completed within the South Platte Alluvial Aquifer;
3. Location generally down gradient with respect to agricultural activities;
4. Depth to ground water less than 150 feet, generally less than 75 feet;
5. Well currently in use or at least has a working pump installed;
6. Direction of ground water flow;
7. Wellhead and casing in good physical condition and availability of completion information documentation;
8. Wellhead area free of point sources of contamination;
9. Well owner consent to participate in the monitoring program;

The ground water contaminants that may be encountered in the area include nitrates, high levels of total dissolved solids, dissolved metals, and pesticides.

Key Personnel

The sampling survey was conducted by:

Brad Austin, Ground Water Geologist and Program Manager
John Colbert, Physical Sciences Tech

Site Access and Logistics

Access to the sampling sites and scheduling with land owners will be the responsibility of the field personnel. Consent for access to the property and for sampling the well will have been received prior to site entry.

Quality Assurance / Quality Control

SAMPLE COLLECTION METHODS

All samples were collected in accordance with the Non-Point Source Task Force protocol for sampling of ground water. Samples were collected from existing wells via outside hydrants or whatever means available prior to any type of treatment (i.e. water softener). Prior to purging the well for sampling purposes, the water level was measured and recorded to the nearest +/- 0.01 foot when access to the wellhead was possible. As a rule of thumb, three times the volume of water in the well casing plus any volume contained within the associated piping was purged prior to sampling. Rather than attempt to calculate these volumes, a determination of when fresh formation water has reached the point of sampling was verified by measuring pH, conductivity and temperature. A field portable instrument for measuring pH, conductivity and temperature was used for this purpose at each well site. For each well, the pH, conductivity and temperature were measured at periodic intervals (approximately every 5 minutes) while the well was being purged. Water samples were collected when solution chemistry of the ground water had stabilized such that three consecutive readings were within 5 % . It can be reasonably assumed that a stabilization in the values of these parameters indicates that the casing and piping have been purged and fresh formation water had reached the sampling point.

Negative bias (loss of constituent) is of significant concern in sampling for volatile compounds. Therefore great care was taken in sample collection to minimize degassing by operating the sampling port at a low volume. Samples for volatile constituents and those samples which require field filtration were collected first. Samples for nitrate and inorganic analysis were collected next. Water samples for dissolved metals analysis were filtered in the field with a 0.45 micron size filter.

In addition, the sampling team collected quality assurance samples consisting of field blanks, periodic duplicate samples, and spiked samples. Field blanks were utilized for field QA/QC performance and subjected to all conditions to which the samples were exposed. Duplicate and spiked samples were prepared for lab calibration checks.

The following types of samples were provided for quality assurance:

1. Field Blank

   A blank ground water sample was periodically collected to check field decontamination procedures. The blank was prepared by pouring laboratory supplied deionized water through decontaminated sampling equipment following the collection of possible contaminated samples.

2. Duplicates

   Random duplicate groundwater samples were collected to compare laboratory analysis procedures as well as sample collection procedure.

3. Splits

For one day in Weld County, the USGS traveled with the sampling crew to observe our sampling methods. Splits were provided to the USGS during this time and independently analyzed by their lab. This provided yet another quality check on the sampling and lab analysis.

4. Spikes

Up to five pesticide spiked samples were submitted to the organic laboratories for lab QA/QC. These spiked samples were prepared in duplicate in accordance with instructions provided by the manufacture of the spiking kits.

Ground water samples were protected from undue exposure to light during handling, storage, and transport. Samples were stored on ice to prevent temperature extremes and transported to the CDH, NWQL, or CSU laboratory and analyzed within the recommended holding periods. Documentation of actual sample storage and treatment were handled as part of the chain of custody procedures.

Decontamination Procedures

Wells were sampled to minimize the potential for cross contamination. Decontamination procedures were adhered to between each sampling event. All common sampling equipment was decontaminated prior to and between all sampling events by washing with a nonphosphate detergent and triple rinsing with deionized water. Since pesticides were the constituents of most concern due to the low levels detectable, no sampling equipment was common between wells for the pesticide sampling.

Control of Contaminated Materials

The sampling team disposed of all wastes produced during the investigation in accordance with Federal and State regulations. Disposable sampling equipment was bagged, removed from the site, and disposed of as a non-hazardous material.

Laboratory Analyses

All water samples were analyzed for selected pesticides currently used in the area, basic inorganic minerals including nitrate, and dissolved metals. Table 3 provides a listing of the laboratories used, the chemicals analyzed by each, and their detection limits. All collected samples (classified as environmental samples) were transported to the designated laboratory as medium hazard and analyzed accordingly. EPA analytical methods for each parameter group were as follows:

pesticides	extraction: GC/ECD
metals	ICP / GFAA
inorganics	varies with analyte

Table 3 - Laboratories, Methods and Detection Levels

Colorado Department of Health Organic Laboratory - Pesticide Compounds

Pesticide Trade Name	Pesticide Common Name	Pesticide Use	Chemical Type	EPA Method	PQL (ug/L)
Lasso	Alachlor	Herb	OrganoCL	507	2.0
Atrazine	Atrazine	Herb	Triazine	507	0.5
Balan	Benefin	Herb	OrganoFL	508	0.3
Bravo	Chlorothalonil	Fungi	Nitrile	508	0.25
Lorsban	Chlorpyrifos	Insect	OrganoPH	8140	0.5
Bladex	Cyanazine	Herb	Triazine	507	2.5
Dacthal	DCPA	Herb	OrganoCL	508	0.3
Diazinon	Diazinon	Insect	OrganoPH	507/8140	2.0
Eptam	EPTC	Herb	Carbamate	507	0.5
Sonnalan	Ethalfluralin	Herb	OrganoFL	508	0.3
Velpar	Hexazinone	Herb	Triazine	507	1.5
Penncap-M	Parathion methyl	Insect	OrganoPH	8140	0.5
Ambush/Pounce	Permethrin	Insect	OrganoCL	508	2.5
Treflan	Trifluralin	Herb	OrganoFL	508	2.5
	Anzinphos methyl	Insect	OrganoPH	507/8140	2.5
	Endosulfan I	Insect		508	0.1
	Endosulfan II	Insect		508	0.1
	4,4-DDD	Insect	OrganoCL	508	0.1
	4,4-DDE	Insect	OrganoCL	508	0.1
	4,4-DDT	Insect	OrganoCL	508	0.1
	Aldrin	Insect		508	0.75
	Dieldrin	Insect	OrganoCL	508	0.1
	Endrin	Insect	OrganoCL	508	0.1
	Heptachlor	Insect	OrganoCL	508	0.05
	Heptachlor epoxide	Insect	OrganoCL	508	0.05
	Lindane	Insect	OrganoCL	508	0.05
	Methoxychlor	Insect	OrganoCL	508	0.5

CDH Inorganic Laboratory - Analysis

Chemical Compound	Method	Lowest Reportable Concentration (mg/L)
Nitrate	Technicon	0.5
Solids, Total Dissolved	Gravimetric	10.0

Table 3, continued - Laboratories, Methods and Detection Levels

U. S. Geological Survey National Water Quality Laboratory - Pesticide Compounds

Pesticide Trade Name	Pesticide Common Name	Pesticide Use	Chemical Type	EPA Method	PQL (ug/L)
Temik	Aldicarb	Insect	Carbamate	531.1	1.0
	Aldicarb sulfone		Carbamate	531.1	2.0
	Aldicarb sulfoxide		Carbamate	531.1	2.0
Baygon	Propoxur	Insect	Carbamate	531.1	1.0
Sevin	Carbaryl	Insect	Carbamate	531.1	2.0
Furadan	Carbofuran	Insect	Carbamate	531.1	1.5
	3-Hydroxycarbofuran		Carbamate	531.1	2.0
	Methiocarb	Insect	Carbamate	531.1	4.0
Lannate	Methomyl	Insect	Carbamate	531.1	0.5
	Oxamyl	Insect	Carbamate	531.1	2.0

Colorado State University Soils Laboratory - Minerals and Dissolved Metals Analysis

Basic Water Quality Parameters	Method	Reporting Limit (mg/L)
Boron	EPA 200.0	0.01
Bicarbonate	APHA 2320B	0.1
Calcium	EPA 200.0	0.1
Carbonate	APHA 2320B	0.1
Chloride	EPA 300.0	0.1
Magnesium	EPA 200.0	0.1
Nitrate	EPA 300.0	0.1
pH	EPA 150.1	0.1 pH unit
Sodium	EPA 200.0	0.1
Specific conductance (TDS)	EPA 120.1	1.0 uS/cm
Sulfate	EPA 300.0	0.1
Potassium	EPA 200.0	0.1
Alkalinity, total	Titration	1.0
Solids, Total Dissolved	Gravimetric	10.0
Hardness, total	Calculation	1.0
Dissolved Metals		
Aluminum	EPA 200.0	0.1
Barium	EPA 200.0	0.01
Cadmium	EPA 200.0	0.01
Chromium	EPA 200.0	0.01
Copper	EPA 200.0	0.01
Iron	EPA 200.0	0.01
Lead	EPA 200.0	0.05
Manganese	EPA 200.0	0.01
Nickel	EPA 200.0	0.01
Molybdenum	EPA 200.0	0.01
Phosphorous, total	EPA 200.0	0.1
Zinc	EPA 200.0	0.01

Sample bottles were provided by the lab and were part of the quality control program. All samples were handled and preserved in accordance with the requirements of the laboratory used for that analysis. Calibration and operation of all monitoring equipment followed the instrument manufacturer's instructions.

CHAIN OF CUSTODY

All samples were handled in accordance with standard laboratory chain of custody protocol after collection and identification.

Appendix A

	A	B	C	D	E	F	G	H	I	J	K	L
1	COUNTY	WELL_NO	PH	CONDUCT	CA	MG	NA	K	CO3	HCO3	SO4	CL
2												
3	ADAMS	SP92-01	6.2	2040	181.4	22.9	286.7	6.6	<0.1	371.10	677.4	76.3
4	ADAMS	SP92-02A	6.7	1317.0	115.2	24.6	127.4	5.5	<0.1	359.70	189.1	114.7
5	ADAMS	SP92-03	6.7	855.0	97.7	16.3	90.4	0.0	<0.1	271.10	110.1	52.6
6	ADAMS	SP92-04	7.6	1282.0	117.4	29.9	100.3	1.5	<0.1	361.40	185.7	84.2
7	ADAMS	SP92-06A	6.3	672.0	27.7	4.4	104.2	2.5	<0.1	310.50	36.0	24.4
8	ADAMS	SP92-08	6.7	1428.0	132.4	30.3	192.2	0.9	<0.1	295.40	369.0	84.6
9	WELD	SP92-10	6.4	1403.0	83.1	19.7	98.9	13.4	<0.1	227.80	200.8	90.8
10	WELD	SP92-11	6.3	1608.0	132.9	42.4	138.3	6.8	<0.1	436.20	422.9	66.2
11	WELD	SP92-12	6.6	1725.0	142.5	41.3	192.7	2.1	<0.1	402.70	279.8	128.7
12	WELD	SP92-13	7.6	1816.0	144.5	49.5	201.9	1.1	<0.1	493.00	444.6	92.4
13	WELD	SP92-14A	6.4	1376.0	89.0	26.9	142.9	10.3	<0.1	334.50	232.2	92.3
14	WELD	SP92-16B	6.4	1551.0	131.8	34.9	143.6	5.9	<0.1	401.80	245.4	101.8
15	WELD	SP92-17	6.5	1423.0	100.9	44.5	129.9	3.6	<0.1	440.30	342.0	42.1
16	WELD	SP92-18	7.0	1044.0	79.9	19.7	105.0	4.1	<0.1	250.40	186.4	70.4
17	WELD	SP92-20B	6.5	1121.0	108.2	26.5	84.4	4.8	<0.1	349.80	182.9	53.2
18	WELD	SP92-21	5.9	1150.0	83.9	21.5	105.7	5.7	<0.1	285.60	203.0	89.5
19	WELD	SP92-22B	7.9	1631.0	134.1	34.4	147.1	4.4	<0.1	354.50	276.2	138.6
20	WELD	SP92-23	7.0	1570.0	134.5	30.8	110.6	8.3	<0.1	312.80	263.5	119.4
21	WELD	SP92-26B	6.6	1747.0	152.0	76.5	101.6	4.0	<0.1	382.60	998.4	49.3
22	WELD	SP92-27	7.7	1571.0	135.3	38.0	128.2	3.0	<0.1	310.90	324.0	115.9
23	WELD	SP92-28A	6.7	1257.0	173.9	54.9	169.4	5.9	<0.1	430.70	295.4	121.9
24	WELD	SP92-29	8.3	1274.0	92.8	37.8	102.1	12.2	<0.1	262.90	296.6	70.7
25	WELD	SP92-30	6.6	1221.0	78.2	70.2	74.1	2.5	<0.1	369.20	344.9	12.3
26	WELD	SP92-31	7.0	1784.0	183.2	70.9	95.9	4.4	<0.1	390.30	629.6	32.1
27	WELD	SP92-33A	8.0	2050.0	172.1	92.2	125.7	1.3	<0.1	433.20	626.6	33.1
28	WELD	SP92-34	7.8	1306.0	121.2	49.5	86.4	2.4	<0.1	293.00	439.8	24.5
29	WELD	SP92-35	7.8	1333.0	206.9	63.2	142.7	8.8	<0.1	393.30	602.7	33.3
30	WELD	SP92-36B	6.6	1688.0	142.0	65.4	198.6	-0.5	<0.1	409.80	411.9	97.7
31	WELD	SP92-37	6.3	2210.0	237.7	94.7	157.9	24.1	<0.1	741.70	640.1	93.9
32	WELD	SP92-38	6.7	1742.0	142.5	60.1	131.4	8.0	<0.1	388.60	504.5	85.9
33	WELD	SP92-39	6.7	2180.0	209.7	77.0	154.0	11.7	<0.1	471.60	798.8	77.3

	A	B	C	D	E	F	G	H	I	J	K	L
34	WELD	SP92-40	6.6	2100.0	216.5	80.3	218.6	0.9	<0.1	406.50	744.5	119.3
35	WELD	SP92-41	6.6	2490.0	227.6	76.5	308.6	2.1	<0.1	443.20	872.6	185.2
36	WELD	SP92-42	6.6	1254.0	118.7	45.6	114.3	0.8	<0.1	274.20	386.4	57.0
37	WELD	SP92-43	7.0	1192.0	69.8	49.7	190.6	17.1	<0.1	434.60	406.5	57.3
38	WELD	SP92-44A	6.9	942.0	79.1	39.6	159.7	7.8	<0.1	336.10	340.2	48.5
39	WELD	SP92-45	6.7	1239.0	145.6	55.2	162.0	15.6	<0.1	476.70	422.6	55.8
40	WELD	SP92-46A	6.9	939.0	108.2	40.8	141.3	9.7	<0.1	463.70	284.1	70.8
41	MORGAN	SP92-47	7.0	1331.0	128.3	29.1	116.9	6.7	<0.1	311.80	375.1	79.9
42	MORGAN	SP92-48A	6.9	1530.0	184.4	30.1	107.6	6.0	<0.1	337.80	482.5	76.3
43	MORGAN	SP92-49	6.9	3380.0	222.1	103.7	368.7	13.8	<0.1	310.70	1227.6	127.7
44	MORGAN	SP92-50	7.1	1939.0	168.7	65.9	167.2	7.4	<0.1	285.80	634.9	90.8
45	MORGAN	SP92-51A	7.0	1610.0	217.0	30.0	115.3	6.9	<0.1	256.70	548.5	63.2
46	MORGAN	SP92-52B	7.4	1390.0	172.1	25.3	110.6	5.3	<0.1	268.50	530.3	62.6
47	MORGAN	SP92-53	7.5	1578.0	263.2	37.5	166.9	9.5	<0.1	339.50	539.2	79.1
48	MORGAN	SP92-54	6.9	1649.0	261.6	37.7	139.8	6.9	<0.1	337.00	509.2	61.9
49	MORGAN	SP92-55	7.4	2290.0	330.5	80.0	260.6	15.8	<0.1	382.30	958.3	122.6
50	MORGAN	SP92-56	6.9	2240.0	323.6	79.8	239.3	16.7	<0.1	460.10	870.3	105.1
51	MORGAN	SP92-57	8.2	2450.0	291.6	80.1	250.8	13.2	<0.1	470.60	1033.3	117.6
52	MORGAN	SP92-58	7.1	2840.0	281.6	71.5	187.7	10.4	<0.1	447.90	1328.4	162.5
53	MORGAN	SP92-59	6.9	2080.0	297.5	56.8	200.1	10.5	<0.1	377.80	673.8	80.0
54	MORGAN	SP92-60	8.2	1550.0	142.3	51.4	122.2	32.1	<0.1	296.80	522.6	71.9
55	MORGAN	SP92-61	6.9	2365.0	290.4	85.3	218.1	15.3	<0.1	381.50	1038.4	113.7
56	WASHINGTON	SP92-62	7.0	3200.0	237.9	105.6	247.1	43.2	<0.1	471.20	876.6	68.7
57	WASHINGTON	SP92-63	7.7	2020.0	184.8	60.9	145.8	33.2	<0.1	432.40	610.6	52.4
58	LOGAN	SP92-64	6.8	1483.0	107.8	37.7	127.4	34.3	<0.1	216.40	471.6	50.2
59	LOGAN	SP92-65	6.9	1643.0	131.2	50.2	116.5	32.9	<0.1	255.50	567.7	39.0
60	LOGAN	SP92-66	7.0	1810.0	159.9	43.1	107.6	22.1	<0.1	320.60	568.4	64.7
61	LOGAN	SP92-67	8.1	2280.0	207.5	51.1	148.2	20.8	<0.1	405.20	657.0	75.7
62	LOGAN	SP92-68	7.3	2419.0	239.3	64.0	223.5	37.5	<0.1	388.60	743.8	108.5
63	LOGAN	SP92-69	7.3	2620.0	243.3	71.6	255.8	15.4	<0.1	356.80	1042.5	134.6
64	LOGAN	SP92-70	6.5	3070.0	224.5	72.6	297.6	43.9	<0.1	390.90	1148.3	91.0
65	LOGAN	SP92-71	7.1	2480.0	190.4	89.6	261.2	34.4	<0.1	368.70	796.8	88.9
66	LOGAN	SP92-72	7.9	1744.0	173.8	46.0	135.2	14.4	<0.1	307.40	526.8	75.5

	A	B	C	D	E	F	G	H	I	J	K	L
67	LOGAN	SP92-73	7.2	2147.0	27.2	11.5	425.0	3.6	<0.1	692.00	21.0	311.0
68	LOGAN	SP92-74	6.4	1431.0	156.0	30.7	100.9	11.5	<0.1	237.80	454.2	52.8
69	LOGAN	SP92-75	6.4	2630.0	232.7	58.2	260.5	25.6	<0.1	365.90	948.2	138.5
70	WASHINGTON	SP92-76	6.3	181.0	35.6	2.4	4.9	5.4	<0.1	81.60	7.2	5.3
71	LOGAN	SP92-75A	7.1	1589.0	11.7	3.2	333.6	2.8	<0.1	656.20	9.8	162.5
72	LOGAN	SP92-79	6.4	1765.0	132.7	33.8	131.4	6.8	<0.1	243.60	646.3	82.9
73	LOGAN	SP92-81	6.6	897.0	143.5	24.2	22.6	5.7	<0.1	201.40	136.6	34.2
74	LOGAN	SP92-82	6.7	2336.0	229.0	77.2	342.1	13.0	<0.1	343.70	1295.4	154.2
75	LOGAN	SP92-83	6.6	327.0	48.8	6.1	7.2	5.3	<0.1	156.50	12.4	14.5
76	LOGAN	SP92-84	6.4	330.0	63.3	11.2	14.1	11.1	<0.1	153.70	25.9	15.0
77	SEDGWICK	SP92-86	7.0	2100.0	225.3	43.0	161.4	20.9	<0.1	233.60	632.5	101.1
78	SEDGWICK	SP92-87	7.5	2240.0	234.0	46.1	171.4	20.4	<0.1	304.60	648.2	88.2
79	SEDGWICK	SP92-88	6.6	2420.0	231.7	49.3	150.0	16.4	<0.1	267.90	630.9	87.4
80	SEDGWICK	SP92-89	7.3	2480.0	233.0	46.0	180.6	30.0	<0.1	375.80	610.9	72.9
81	SEDGWICK	SP92-90	7.6	2260.0	183.4	36.0	152.3	10.2	<0.1	336.40	114.6	280.7
82	WELD	SP92-91	6.5	1099.0	96.4	39.4	170.9	4.9	<0.1	425.20	237.1	85.6
83	WELD	SP92-92	6.9	1620.0	121.0	44.8	132.9	6.4	<0.1	396.70	316.8	118.9
84	SEDGWICK	SP92-93	7.4	2150.0	229.4	49.9	193.8	32.5	<0.1	337.00	604.6	79.1
85	MORGAN	SP92-94	7.9	1533.0	198.2	58.7	155.8	16.7	<0.1	456.60	380.3	82.9
86	MORGAN	SP92-95	6.3	2570.0	336.9	53.1	205.5	17.0	<0.1	435.40	831.3	100.5
87	MORGAN	SP92-96	6.8	952.0	141.5	43.9	124.0	8.2	<0.1	394.60	365.4	50.6
88	MORGAN	SP92-97	6.8	2560.0	337.4	109.7	187.0	7.3	<0.1	650.70	1150.9	100.5
89	MORGAN	SP92-98	6.7	2380.0	328.3	90.6	173.9	7.7	<0.1	394.40	929.3	70.9
90	MORGAN	SP92-99	7.7	1649.0	179.4	49.4	134.1	9.9	<0.1	412.00	574.9	77.7
91	WELD	SP92-12A	6.4	1506.0	135.2	36.3	151.8	2.7	<0.1	391.70	361.2	110.8
92	MORGAN	SP92-100	6.7	2530.0	320.4	88.8	179.5	15.8	<0.1	446.30	995.3	102.7
93	MORGAN	SP92-101	6.9	2070.0	318.9	41.6	160.7	6.9	<0.1	421.10	746.1	71.1
94	MORGAN	SP92-102	6.7	2050.0	303.4	68.3	149.6	10.8	<0.1	370.00	889.5	90.0
95	SEDGWICK	SP92-91A	6.5	1580.0	148.2	32.4	100.9	18.9	<0.1	225.30	504.4	77.1
96	SEDGWICK	SP92-92A	7.0	1050.0	108.5	13.9	50.4	-0.5	<0.1	204.70	278.3	40.4
97	SEDGWICK	SP92-94A	7.0	431.0	32.3	4.4	71.9	-0.5	<0.1	188.70	27.7	16.2
98	MORGAN	SP92-55A	7.0	2360.0	260.8	93.7	227.0	11.1	<0.1	384.30	948.7	124.2

	M	N	O	P	Q	R	S	T	U	V	W	X
1	NO3	B	TOT_ALK	CACO3	P	AL	FE	MN	CU	ZN	NI	MO
2												
3	19.3	0.15			<0.1	<0.1	0.32	0.02	<0.01	0.01	<0.01	<0.01
4	<0.1	0.26			0.8	<0.1	0.39	1.94	<0.01	0.02	0.01	<0.01
5	25.8	0.19			<0.1	<0.1	0.07	0.01	0.03	0.34	<0.01	<0.01
6	50.9	0.23			0.1	0.1	0.04	0.01	<0.01	0.01	<0.01	<0.01
7	5.9	0.08			<0.1	<0.1	0.21	0.03	0.01	0.23	0.01	<0.01
8	3.9	0.30			<0.1	<0.1	0.12	1.88	<0.01	0.03	<0.01	<0.01
9	166.3	0.29			0.1	0.1	0.10	0.03	0.50	0.12	0.02	<0.01
10	23.3	0.30			0.2	0.2	<.01	0.01	0.02	0.02	0.02	0.02
11	112.9	0.43			0.1	<0.1	0.09	0.01	0.02	0.02	0.01	<0.01
12	26.5	0.31			0.1	<0.1	0.16	0.01	0.01	0.02	0.01	<0.01
13	65.2	0.42			0.7	0.1	<0.01	0.01	0.01	0.04	0.01	0.02
14	108.7	0.39			0.2	0.0	<0.01	0.01	0.05	0.04	0.01	0.01
15	39.6	0.26			0.2	0.1	<0.01	0.05	0.02	0.06	0.02	0.03
16	17.5	0.30			0.1	<0.1	<0.01	0.02	0.02	0.02	0.01	0.02
17	47.6	0.22			0.1	0.1	<0.01	0.01	0.01	0.01	0.01	0.01
18	13.9	0.29			0.1	0.1	<0.01	0.01	0.01	0.01	0.01	0.01
19	64.8	0.21			0.1	<0.1	0.09	0.01	<0.01	0.02	0.01	<0.01
20	99.9	0.31			0.2	<0.1	0.07	0.01	0.01	0.03	0.01	<0.01
21	79.6	0.34			0.2	0.1	0.36	0.01	0.01	0.09	0.02	0.01
22	82.1	0.23			0.1	<0.1	0.05	0.01	<0.01	0.02	<0.01	<0.01
23	83.6	0.34			0.2	<0.1	0.10	0.02	0.01	0.02	0.02	0.01
24	33.6	0.21			0.5	<0.1	0.05	0.02	<0.01	0.07	<0.01	0.01
25	42.2	0.22			0.2	0.1	0.04	0.01	0.01	0.02	0.02	0.02
26	48.8	0.21			0.2	<0.1	0.07	0.01	0.01	0.02	0.02	0.01
27	59.5	0.22			0.3	<0.1	0.07	0.01	<0.01	0.02	0.02	0.01
28	16.9	0.10			0.1	<0.1	0.09	0.10	<0.01	<0.01	0.01	<0.01
29	82.3	0.23			0.2	<0.1	<0.01	0.01	<0.01	0.02	0.01	<0.01
30	2.9	0.38			0.2	<0.1	0.25	0.04	0.06	0.08	<0.01	<0.01
31	<0.1	0.27			0.2	<0.1	10.80	2.69	<0.01	<0.01	<0.01	<0.01
32	58.7	0.29			0.1	<0.1	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
33	55.7	0.31			0.2	<0.1	2.40	<0.01	<0.01	<0.01	<0.01	<0.01

	M	N	O	P	Q	R	S	T	U	V	W	X
34	66.5	0.34			0.2	<0.1	1.00	<0.01	<0.01	<0.01	<0.01	<0.01
35	53.2	0.47			0.1	<0.1	3.60	<0.01	<0.01	<0.01	<0.01	<0.01
36	28.9	0.23			<0.1	<0.1	5.00	<0.01	0.03	<0.01	<0.01	<0.01
37	3.0	0.40			1.0	<0.1	<0.01	0.02	0.08	0.01	0.02	<0.01
38	<0.1	0.35			0.2	<0.1	<0.01	0.26	<0.01	0.06	0.01	<0.01
39	47.9	0.33			0.2	<0.1	<0.01	0.02	<0.01	0.01	0.01	<0.01
40	3.4	0.31			0.1	<0.1	<0.01	0.01	<0.01	0.01	0.01	<0.01
41	<0.1	0.32			0.1	<0.1	0.05	0.03	0.04	0.06	0.02	<0.01
42	32.3	0.22			0.1	<0.1	0.09	0.06	<0.01	0.03	0.01	<0.01
43	93.9	0.52			0.3	0.1	0.07	0.02	<0.01	0.05	0.03	<0.01
44	82.0	0.29			0.2	<0.1	0.05	0.01	<0.01	0.02	0.01	<0.01
45	24.4	0.12			<0.1	<0.1	0.06	0.96	0.02	0.01	<0.01	<0.01
46	7.1	0.18			<0.1	<0.1	0.04	0.91	0.01	0.01	<0.01	<0.01
47	45.3	0.21			<0.1	<0.1	0.13	1.19	0.01	0.02	<0.01	<0.01
48	50.3	0.20			<0.1	<0.1	0.06	1.02	<0.01	0.02	0.01	<0.01
49	20.6	0.41	313	1154	0.1	<0.1	2.34	0.08	<0.01	0.03	0.01	<0.01
50	43.9	0.43	377	1136	0.1	<0.1	0.06	0.55	<0.01	0.01	0.01	<0.01
51	49.4	0.37	386	1057	0.2	<0.1	0.14	1.16	0.02	0.03	0.03	0.01
52	<0.1	0.23	367	997	0.2	0.1	0.34	1.79	0.01	0.02	0.01	<0.01
53	<0.1	0.21	310	976	0.2	0.8	0.20	0.83	0.02	0.04	0.01	<0.01
54	14.4	0.27	243	566	0.2	<0.1	0.22	0.15	0.03	0.07	0.02	0.04
55	26.7	0.38	313	1075	0.2	<0.1	0.22	0.06	0.03	0.02	0.05	<0.01
56	18.7	0.37	386	1028	0.3	<0.1	0.10	0.63	0.02	0.02	0.02	<0.01
57	15.5	0.23	354	711	0.2	<0.1	0.34	0.29	0.02	0.05	0.01	<0.01
58	<0.1	0.33	177	424	0.2	<0.1	0.10	0.16	0.01	0.01	<0.01	<0.01
59	7.5	0.26	209	534	0.2	<0.1	0.07	0.60	<0.01	0.02	0.01	0.02
60	17.4	0.20	263	576	0.1	<0.1	0.03	0.02	<0.01	0.02	0.01	<0.01
61	35.6	0.25	332	728	0.2	<0.1	0.12	0.02	0.01	0.02	0.01	<0.01
62	123.6	0.35			0.2	<0.1	0.06	0.02	<0.01	0.03	0.01	<0.01
63	<0.1	0.37			0.2	0.1	0.19	0.03	0.02	0.03	0.01	<0.01
64	20.9	0.42	320	859	0.2	<0.1	0.21	0.02	<0.01	0.02	0.01	<0.01
65	39.0	0.41	302	843	0.3	3.6	0.09	0.02	<0.01	0.02	0.01	0.09
66	25.4	0.21			0.2	<0.1	0.05	0.01	<0.01	0.01	0.01	<0.01

	M	N	O	P	Q	R	S	T	U	V	W	X
67	<0.1	1.76			<0.1	<0.1	0.97	0.01	<0.01	0.45	<0.01	0.02
68	12.6	0.14			0.1	<0.1	0.04	0.09	<0.01	0.02	0.01	<0.01
69	14.4	0.39			0.2	<0.1	0.09	0.56	<0.01	0.01	0.01	<0.01
70	12.4	0.01			0.1	0.1	0.04	0.01	<0.01	0.02	0.01	<0.01
71	<0.1	1.63			0.1	<0.1	0.07	0.01	<0.01	0.06	<0.01	<0.01
72	9.5	0.24			0.1	<0.1	0.05	0.01	0.01	0.03	<0.01	0.01
73	119.9	0.05			0.1	<0.1	0.07	<0.01	<0.01	0.02	<0.01	<0.01
74	22.8	0.44			0.2	0.1	0.07	0.80	<0.01	0.01	0.03	<0.01
75	11.2	0.02			<0.1	<0.1	0.02	<0.01	<0.01	0.03	<0.01	<0.01
76	13.6	0.04			0.1	<0.1	0.03	<0.01	<0.01	0.01	<0.01	<0.01
77	19.1	0.31			0.2	<0.1	0.12	0.06	0.01	0.03	0.02	<0.01
78	42.8	0.33			0.2	<0.1	0.09	0.03	<0.01	0.01	0.01	<0.01
79	39.5	0.31			0.2	<0.1	0.12	0.03	0.01	0.03	0.02	<0.01
80	20.0	0.34			0.2	<0.1	0.22	0.03	0.02	0.06	0.02	<0.01
81	112.0	0.38			0.2	<0.1	0.06	0.01	0.01	0.05	0.02	<0.01
82	48.1	0.27			0.1	<0.1	<0.01	<0.01	<0.01	0.01	<0.01	<0.01
83	18.7	0.34			0.1	<0.1	0.07	0.01	<0.01	0.01	0.01	<0.01
84	63.2	0.32			0.1	<0.1	0.22	0.01	<0.01	0.03	<0.01	<0.01
85	17.5	0.34			0.1	<0.1	<0.01	0.12	<0.01	0.01	<0.01	<0.01
86	<0.1	0.28			0.1	<0.1	0.08	0.07	<0.01	<0.01	<0.01	<0.01
87	106.5	0.22			0.2	<0.1	0.14	0.03	0.03	0.05	0.02	0.05
88	<0.1	0.38			0.3	<0.1	0.07	0.22	<0.01	<0.01	<0.01	<0.01
89	57.6	0.31			0.1	<0.1	0.07	<0.01	<0.01	0.04	<0.01	<0.01
90	16.1	0.21			0.1	<0.1	<0.01	0.10	<0.01	0.04	<0.01	<0.01
91	11.2	0.30			0.2	<0.1	0.08	0.01	0.21	0.05	0.01	<0.01
92	<0.1	0.23			0.1	<0.1	0.02	0.11	<0.01	<0.01	<0.01	<0.01
93	45.1	0.15			<0.1	<0.1	<0.01	0.41	<0.01	<0.01	<0.01	<0.01
94	<0.1	0.14			0.2	<0.1	0.06	0.02	0.01	0.04	0.01	<0.01
95	32.8	0.22			0.2	<0.1	0.06	0.01	0.01	0.01	0.02	<0.01
96	19.3	0.09			0.1	0.2	0.05	<0.01	0.01	0.01	<0.01	<0.01
97	6.6	0.14			<0.1	<0.1	0.08	<0.01	<0.01	0.01	<0.01	<0.01
98	35.9	0.41	315	1036	0.2	<0.1	0.48	0.02	0.02	0.06	0.02	<0.01

	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI
1	CD	CR	BA	PB	NITRATE_N	TDS	ALACHLOR	ALDRIN	ATRAZINE	ANZIPHOS	BENEFIN
2											
3	<0.01	0.01	0.03	<0.05	3.30	1450.0	ND	ND	ND	ND	ND
4	<0.01	0.01	0.09	<0.05	<0.05	810.0	ND	ND	ND	ND	ND
5	0.05	0.01	0.04	<0.05	5.90	540.0	ND	ND	ND	ND	ND
6	<0.01	0.01	0.03	<0.05	12.00	840.0	ND	ND	ND	ND	ND
7	0.04	0.02	0.19	<0.05	1.20	370.0	ND	ND	ND	ND	ND
8	<0.01	0.02	0.11	<0.05	0.54	970.0	ND	ND	ND	ND	ND
9	0.02	0.06	0.12	0.16	37.00	970.0	ND	ND	ND	ND	ND
10	<0.01	0.04	0.03	0.07	6.00	1210.0	ND	ND	TRACE	ND	ND
11	0.01	0.02	0.07	<0.05	24.00	1880.0	ND	ND	ND	ND	ND
12	<0.01	0.02	0.04	0.06	6.70	1390.0	ND	ND	ND	ND	ND
13	<0.01	0.03	0.05	<0.05	14.00	910.0	ND	ND	TRACE	ND	ND
14	<0.01	0.02	0.08	<0.05	25.00	1080.0	ND	ND	ND	ND	ND
15	0.01	0.05	0.06	0.19	8.40	1010.0	ND	ND	TRACE	ND	ND
16	<0.01	0.02	0.08	<0.05	4.40	690.0	ND	ND	TRACE	ND	ND
17	<0.01	0.03	0.08	<0.05	11.00	770.0	ND	ND	TRACE	ND	ND
18	<0.01	0.03	0.08	0.07	3.10	740.0	ND	ND	ND	ND	ND
19	<0.01	0.02	0.06	<0.05	15.00	1090.0	ND	ND	TRACE	ND	ND
20	<0.01	0.03	0.05	<0.05	22.00	1080.0	ND	ND	TRACE	ND	ND
21	<0.01	0.04	0.04	0.05	12.00	1380.0	ND	ND	ND	ND	ND
22	<0.01	0.02	0.08	<0.05	18.00	1080.0	ND	ND	TRACE	ND	ND
23	0.01	0.04	0.08	0.13	19.00	1140.0	ND	ND	TRACE	ND	ND
24	<0.01	0.01	0.07	<0.05	7.00	840.0	ND	ND	ND	ND	ND
25	<0.01	0.03	0.03	<0.05	9.10	890.0	ND	ND	ND	ND	ND
26	<0.01	0.03	0.02	<0.05	10.00	1400.0	ND	ND	TRACE	ND	ND
27	<0.01	0.03	0.02	<0.05	16.00	1620.0	TRACE	ND	ND	ND	ND
28	0.01	0.02	0.03	<0.05	0.60	1000.0	ND	ND	ND	ND	ND
29	<0.01	0.03	0.03	<0.05	21.00	1620.0	ND	ND	1.38	ND	ND
30	<0.01	<0.01	0.08	<0.05	1.10	1220.0	ND	ND	ND	ND	ND
31	<0.01	<0.01	0.06	<0.05	<0.05	1710.0	3.0	ND	TRACE	ND	TRACE
32	<0.01	0.02	0.08	0.14	15.00	1320.0	ND	ND	ND	ND	ND
33	<0.01	<0.01	0.02	<0.05	14.00	1820.0	ND	ND	TRACE	ND	ND

	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI
34	<0.01	<0.01	0.03	<0.05	15.00	1690.0	ND	ND	TRACE	ND	ND
35	<0.01	<0.01	0.02	<0.05	11.00	1900.0	ND	ND	ND	ND	ND
36	<0.01	<0.01	0.02	<0.05	7.00	920.0	ND	ND	ND	ND	ND
37	<0.01	0.02	0.02	<0.05	0.78	1240.0	ND	ND	ND	ND	ND
38	<0.01	0.02	0.05	<0.05	<0.05	1030.0	ND	ND	ND	ND	ND
39	<0.01	0.03	0.04	<0.05	13.00	1390.0	ND	ND	ND	ND	ND
40	<0.01	0.02	0.03	<0.05	0.90	910.0	ND	ND	ND	ND	ND
41	0.01	0.04	0.08	0.13	<0.05	990.0	ND	ND	ND	ND	ND
42	<0.01	0.02	0.05	0.02	6.70	1160.0	ND	ND	ND	ND	ND
43	<0.01	0.04	0.03	0.03	26.00	2950.0	ND	ND	ND	ND	ND
44	<0.01	0.03	0.02	<0.05	19.00	1520.0	ND	ND	1.38	ND	ND
45	<0.01	0.02	0.04	<0.05	6.20	1320.0	ND	ND	ND	ND	ND
46	<0.01	0.01	0.03	<0.05	1.70	1120.0	ND	ND	ND	ND	ND
47	<0.01	0.03	0.03	<0.05	9.90	1310.0	ND	ND	ND	ND	ND
48	<0.01	0.03	0.03	<0.05	11.00	1320.0	ND	ND	ND	ND	ND
49	<0.01	0.03	0.02	<0.05	5.50	2020.0	ND	ND	ND	ND	ND
50	<0.01	0.03	<0.01	<0.05	9.50	1940.0	ND	ND	ND	ND	ND
51	0.01	0.06	0.05	0.07	12.00	2230.0	ND	ND	ND	ND	ND
52	<0.01	0.04	0.02	<0.05	<0.05	2780.0	ND	ND	ND	ND	ND
53	<0.01	0.03	0.05	<0.05	0.86	1800.0	ND	ND	ND	ND	ND
54	0.01	0.04	0.04	<0.05	3.80	1240.0	ND	ND	ND	ND	ND
55	<0.01	0.03	0.03	<0.05	6.90	2180.0	ND	ND	ND	ND	ND
56	<0.01	0.05	0.02	<0.05	7.50	2860.0	ND	ND	ND	ND	ND
57	<0.01	0.03	0.04	<0.05	3.40	1570.0	ND	ND	ND	ND	ND
58	<0.01	0.02	0.03	<0.05	<0.05	1060.0	ND	ND	ND	ND	ND
59	<0.01	0.02	0.02	<0.05	1.90	1250.0	ND	ND	ND	ND	ND
60	<0.01	0.03	0.03	<0.05	4.40	1390.0	ND	ND	ND	ND	ND
61	<0.01	0.03	0.02	<0.05	7.00	1810.0	ND	ND	ND	ND	ND
62	<0.01	0.02	0.02	<0.05	29.00	1930.0	ND	ND	0.77	ND	ND
63	<0.01	0.04	0.03	<0.05	4.20	2300.0	ND	ND	ND	ND	ND
64	<0.01	0.04	0.02	<0.05	2.90	2570.0	ND	ND	ND	ND	ND
65	<0.01	0.03	0.03	<0.05	9.30	2010.0	ND	ND	ND	ND	ND
66	<0.01	0.02	0.03	<0.05	6.50	1300.0	ND	ND	TRACE	ND	ND

	Y	Z	AA	AB	AC	AD	AE	AF	AG	AH	AI
67	<0.01	<0.01	0.25	<0.05	<0.05	1260.0	ND	ND	ND	ND	ND
68	<0.01	0.02	0.03	<0.05	3.10	1080.0	ND	ND	ND	ND	ND
69	<0.01	0.02	0.02	<0.05	3.40	2150.0	ND	ND	ND	ND	ND
70	<0.01	0.01	0.15	<0.05	3.20	150.0	ND	ND	ND	ND	ND
71	<0.01	<0.01	0.06	<0.05	<0.05	950.0	ND	ND	ND	ND	ND
72	<0.01	0.02	0.02	<0.05	1.70	1320.0	ND	ND	ND	ND	ND
73	<0.01	0.01	0.04	<0.05	27.00	670.0	ND	ND	0.57	ND	ND
74	<0.01	0.03	0.01	<0.05	4.30	2730.0	ND	ND	TRACE	ND	ND
75	<0.01	<0.01	0.31	<0.05	3.00	1290.0	ND	ND	ND	ND	ND
76	<0.01	0.01	0.22	<0.05	3.20	230.0	ND	ND	ND	ND	ND
77	<0.01	0.04	0.03	<0.05	4.90	1600.0	ND	ND	TRACE	ND	ND
78	<0.01	0.04	0.03	<0.05	12.00	1800.0	ND	ND	TRACE	ND	ND
79	<0.01	0.04	0.02	0.01	12.00	1970.0	ND	ND	1.03	ND	ND
80	<0.01	0.04	0.03	<0.05	7.00	1970.0	ND	ND	TRACE	ND	ND
81	<0.01	0.04	0.10	<0.05	34.00	1490.0	ND	ND	TRACE	ND	ND
82	<0.01	0.02	0.05	<0.05	13.00	1020.0	ND	ND	ND	ND	ND
83	<0.01	0.02	0.04	<0.05	4.00	1100.0	ND	ND	ND	ND	ND
84	<0.01	<0.01	0.03	<0.05	16.00	1650.0	ND	ND	1.12	ND	ND
85	<0.01	0.02	0.03	<0.05	3.30	1170.0	ND	ND	ND	ND	ND
86	<0.01	0.04	0.04	0.02	8.60	2240.0	ND	ND	ND	ND	ND
87	0.02	0.06	0.09	0.19	24.00	1130.0	ND	ND	ND	ND	ND
88	<0.01	<0.01	<0.01	<0.05	0.61	2490.0	ND	ND	ND	ND	ND
89	<0.01	<0.01	<0.01	<0.05	15.00	2200.0	ND	ND	ND	ND	ND
90	<0.01	<0.01	<0.01	<0.05	3.10	1290.0	ND	ND	ND	ND	ND
91	<0.01	0.01	0.06	<0.05	1.70	980.0	ND	ND	ND	ND	ND
92	<0.01	<0.01	<0.01	<0.05	3.70	2380.0	ND	ND	ND	ND	ND
93	<0.01	<0.01	<0.01	<0.05	11.00	1760.0	ND	ND	ND	ND	ND
94	<0.01	0.04	0.02	<0.05	1.30	1840.0	ND	ND	ND	ND	ND
95	0.01	0.03	0.02	0.01	7.30	1170.0	ND	ND	0.51	ND	ND
96	<0.01	<0.01	0.04	<0.05	4.60	760.0	ND	ND	ND	ND	ND
97	<0.01	<0.01	0.05	<0.05	1.30	300.0	ND	ND	ND	ND	ND
98	<0.01	0.04	0.02	<0.05	8.60	2110.0	ND	ND	ND	ND	ND

	AJ	AK	AL	AM	AN	AO	AP	AQ	AR	AS	AT
1	CHLOROTH	CHLORPYRIF	CYANAZINE	DCPA	DDE	DDD	DDT	DIAZINON	DIELDRIN	ENDO_I	ENDO_II
2											
3	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
4	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
5	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
6	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
7	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
8	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
9	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
10	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
11	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
12	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
13	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
14	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
15	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
16	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
17	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
18	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
19	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
20	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
21	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
22	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
23	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
24	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
25	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
26	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
27	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
28	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
29	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
30	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
31	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
32	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
33	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

	AJ	AK	AL	AM	AN	AO	AP	AQ	AR	AS	AT
34	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
35	ND	ND	ND	ND	ND	ND	ND	0.1	ND	ND	ND
36	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
37	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
38	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
39	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
40	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
41	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
42	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
43	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
44	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
45	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
46	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
47	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
48	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
49	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
50	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
51	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
52	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
53	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
54	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
55	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
56	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
57	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
58	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
59	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
60	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
61	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
62	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
63	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
64	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
65	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
66	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

	AJ	AK	AL	AM	AN	AO	AP	AQ	AR	AS	AT
67	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
68	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
69	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
70	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
71	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
72	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
73	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
74	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
75	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
76	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
77	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
78	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
79	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
80	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
81	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
82	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
83	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
84	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
85	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
86	ND	ND	ND	TRACE	ND	ND	ND	ND	ND	ND	ND
87	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
88	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
89	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
90	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
91	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
92	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
93	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
94	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
95	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
96	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
97	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND
98	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND	ND

	AU	AV	AW	AX	AY	AZ	BA	BB	BC
1	ENDRIN	EPTC	ETHALFLU	HEPTACH	HEPTACH_E	HEXAZINONE	LINDANE	METHOXYC	M_PARATHIO
2									
3	ND	ND	ND	ND	ND	ND	ND	ND	ND
4	ND	ND	ND	ND	ND	ND	ND	ND	ND
5	ND	ND	ND	ND	ND	ND	ND	ND	ND
6	ND	ND	ND	ND	ND	ND	ND	ND	ND
7	ND	ND	ND	ND	ND	ND	ND	ND	ND
8	ND	ND	ND	ND	ND	ND	ND	ND	ND
9	ND	ND	ND	ND	ND	ND	ND	ND	ND
10	ND	ND	ND	ND	ND	ND	ND	ND	ND
11	ND	ND	ND	ND	ND	ND	ND	ND	ND
12	ND	ND	ND	ND	ND	ND	ND	ND	ND
13	ND	ND	ND	ND	ND	ND	ND	ND	ND
14	ND	ND	ND	ND	ND	ND	ND	ND	ND
15	ND	ND	ND	ND	ND	ND	ND	ND	ND
16	ND	ND	ND	ND	ND	TRACE	ND	ND	ND
17	ND	ND	ND	ND	ND	ND	ND	ND	ND
18	ND	ND	ND	ND	ND	ND	ND	ND	ND
19	ND	ND	ND	ND	ND	ND	ND	ND	ND
20	ND	ND	ND	ND	ND	ND	ND	ND	ND
21	ND	ND	ND	ND	ND	ND	ND	ND	ND
22	ND	ND	ND	ND	ND	ND	ND	ND	ND
23	ND	ND	ND	ND	ND	ND	ND	ND	ND
24	ND	ND	ND	ND	ND	ND	ND	ND	ND
25	ND	ND	ND	ND	ND	ND	ND	ND	ND
26	ND	ND	ND	ND	ND	ND	ND	ND	ND
27	ND	ND	ND	ND	ND	ND	ND	ND	ND
28	ND	ND	ND	ND	ND	ND	ND	ND	ND
29	ND	ND	ND	ND	ND	ND	ND	ND	ND
30	ND	ND	ND	ND	ND	ND	ND	ND	ND
31	ND	TRACE	ND	ND	ND	ND	ND	ND	ND
32	ND	ND	ND	ND	ND	ND	ND	ND	ND
33	ND	ND	ND	ND	ND	ND	ND	ND	ND

	AU	AV	AW	AX	AY	AZ	BA	BB	BC
34	ND	ND	ND	ND	ND	ND	ND	ND	ND
35	ND	ND	ND	ND	ND	ND	ND	ND	ND
36	ND	ND	ND	ND	ND	ND	ND	ND	ND
37	ND	ND	ND	ND	ND	ND	ND	ND	ND
38	ND	ND	ND	ND	ND	ND	ND	ND	ND
39	ND	ND	ND	ND	ND	ND	ND	ND	ND
40	ND	ND	ND	ND	ND	ND	ND	ND	ND
41	ND	ND	ND	ND	ND	ND	ND	ND	ND
42	ND	ND	ND	ND	ND	ND	ND	ND	ND
43	ND	ND	ND	ND	ND	ND	ND	ND	ND
44	ND	ND	ND	ND	ND	ND	ND	ND	ND
45	ND	ND	ND	ND	ND	ND	ND	ND	ND
46	ND	ND	ND	ND	ND	ND	ND	ND	ND
47	ND	ND	ND	ND	ND	ND	ND	ND	ND
48	ND	ND	ND	ND	ND	ND	ND	ND	ND
49	ND	ND	ND	ND	ND	ND	ND	ND	ND
50	ND	ND	ND	ND	ND	ND	ND	ND	ND
51	ND	ND	ND	ND	ND	ND	ND	ND	ND
52	ND	ND	ND	ND	ND	ND	ND	ND	ND
53	ND	ND	ND	ND	ND	ND	ND	ND	ND
54	ND	ND	ND	ND	ND	ND	ND	ND	ND
55	ND	ND	ND	ND	ND	ND	ND	ND	ND
56	ND	ND	ND	ND	ND	ND	ND	ND	ND
57	ND	ND	ND	ND	ND	ND	ND	ND	ND
58	ND	ND	ND	ND	ND	ND	ND	ND	ND
59	ND	ND	ND	ND	ND	ND	ND	ND	ND
60	ND	ND	ND	ND	ND	ND	ND	ND	ND
61	ND	ND	ND	ND	ND	ND	ND	ND	ND
62	ND	ND	ND	ND	ND	ND	ND	ND	ND
63	ND	ND	ND	ND	ND	ND	ND	ND	ND
64	ND	ND	ND	ND	ND	ND	ND	ND	ND
65	ND	ND	ND	ND	ND	ND	ND	ND	ND
66	ND	ND	ND	ND	ND	ND	ND	ND	ND

	AU	AV	AW	AX	AY	AZ	BA	BB	BC
67	ND	ND	ND	ND	ND	ND	ND	ND	ND
68	ND	ND	ND	ND	ND	ND	ND	ND	ND
69	ND	ND	ND	ND	ND	ND	ND	ND	ND
70	ND	ND	ND	ND	ND	ND	ND	ND	ND
71	ND	ND	ND	ND	ND	ND	ND	ND	ND
72	ND	ND	ND	ND	ND	ND	ND	ND	ND
73	ND	ND	ND	ND	ND	ND	ND	ND	ND
74	ND	ND	ND	ND	ND	ND	ND	ND	ND
75	ND	ND	ND	ND	ND	ND	ND	ND	ND
76	ND	ND	ND	ND	ND	ND	ND	ND	ND
77	ND	ND	ND	ND	ND	ND	ND	ND	ND
78	ND	ND	ND	ND	ND	ND	ND	ND	ND
79	ND	ND	ND	ND	ND	ND	ND	ND	ND
80	ND	ND	ND	ND	ND	ND	ND	ND	ND
81	ND	ND	ND	ND	ND	ND	ND	ND	ND
82	ND	ND	ND	ND	ND	ND	ND	ND	ND
83	ND	ND	ND	ND	ND	ND	ND	ND	ND
84	ND	ND	ND	ND	ND	ND	ND	ND	ND
85	ND	ND	ND	ND	ND	ND	ND	ND	ND
86	ND	ND	ND	ND	ND	ND	ND	ND	ND
87	ND	ND	ND	ND	ND	ND	ND	ND	ND
88	ND	ND	ND	ND	ND	ND	ND	ND	ND
89	ND	ND	ND	ND	ND	ND	ND	ND	ND
90	ND	ND	ND	ND	ND	ND	ND	ND	ND
91	ND	ND	ND	ND	ND	ND	ND	ND	ND
92	ND	ND	ND	ND	ND	ND	ND	ND	ND
93	ND	ND	ND	ND	ND	ND	ND	ND	ND
94	ND	ND	ND	ND	ND	ND	ND	ND	ND
95	ND	ND	ND	ND	ND	ND	ND	ND	ND
96	ND	ND	ND	ND	ND	ND	ND	ND	ND
97	ND	ND	ND	ND	ND	ND	ND	ND	ND
98	ND	ND	ND	ND	ND	ND	ND	ND	ND

	BD	BE	BF	BG	BH	BI	BJ	BK	BL
1	PEMETHRIN	TRIFLURALI	ALDI_SX	ALDI_SO	OXAMYL	METHOMYL	CARBO_3_O	ALDICARB	BAYGON
2									
3	ND	ND	<2.0	<2.0	<2.0	<0.5	<2.0	<1.0	<1.0
4	ND	ND	<2.0	<2.0	<2.0	<0.5	<2.0	<1.0	<1.0
5	ND	ND	<2.0	<2.0	<2.0	<0.5	<2.0	<1.0	<1.0
6	ND	ND	<2.0	<2.0	<2.0	<0.5	<2.0	<1.0	<1.0
7	ND	ND	<2.0	<2.0	<2.0	<0.5	<2.0	<1.0	<1.0
8	ND	ND	<2.0	<2.0	<2.0	<0.5	<2.0	<1.0	<1.0
9	ND	ND	<2.0	<2.0	<2.0	<0.5	<2.0	<1.0	<1.0
10	ND	ND	<2.0	<2.0	<2.0	<0.5	<2.0	<1.0	<1.0
11	ND	ND	<2.0	<2.0	<2.0	<0.5	<2.0	<1.0	<1.0
12	ND	ND	<2.0	<2.0	<2.0	<0.5	<2.0	<1.0	<1.0
13	ND	ND	<2.0	<2.0	<2.0	<0.5	<2.0	<1.0	<1.0
14	ND	ND	<2.0	<2.0	<2.0	<0.5	<2.0	<1.0	<1.0
15	ND	ND	<2.0	<2.0	<2.0	<0.5	<2.0	<1.0	<1.0
16	ND	ND	<2.0	<2.0	<2.0	<0.5	<2.0	<1.0	<1.0
17	ND	ND	<2.0	<2.0	<2.0	<0.5	<2.0	<1.0	<1.0
18	ND	ND	<2.0	<2.0	<2.0	<0.5	<2.0	<1.0	<1.0
19	ND	ND	<2.0	<2.0	<2.0	<0.5	<2.0	<1.0	<1.0
20	ND	ND	<2.0	<2.0	<2.0	<0.5	<2.0	<1.0	<1.0
21	ND	ND	<2.0	<2.0	<2.0	<0.5	<2.0	<1.0	<1.0
22	ND	ND	<2.0	<2.0	<2.0	<0.5	<2.0	<1.0	<1.0
23	ND	ND	<2.0	<2.0	<2.0	<0.5	<2.0	<1.0	<1.0
24	ND	ND	<2.0	<2.0	<2.0	<0.5	<2.0	<1.0	<1.0
25	ND	ND	<2.0	<2.0	<2.0	<0.5	<2.0	<1.0	<1.0
26	ND	ND	<2.0	<2.0	<2.0	<0.5	<2.0	<1.0	<1.0
27	ND	ND	<2.0	<2.0	<2.0	<0.5	<2.0	<1.0	<1.0
28	ND	ND	<2.0	<2.0	<2.0	<0.5	<2.0	<1.0	<1.0
29	ND	ND	<2.0	<2.0	<2.0	<0.5	<2.0	<1.0	<1.0
30	ND	ND	<2.0	<2.0	<2.0	<0.5	<2.0	<1.0	<1.0
31	ND	ND	<2.0	<2.0	<2.0	<0.5	<2.0	<1.0	<1.0
32	ND	ND	<2.0	<2.0	<2.0	<0.5	<2.0	<1.0	<1.0
33	ND	ND	<2.0	<2.0	<2.0	<0.5	<2.0	<1.0	<1.0

	BD	BE	BF	BG	BH	BI	BJ	BK	BL
34	ND	ND	<2.0	<2.0	<2.0	<0.5	<2.0	<1.0	<1.0
35	ND	ND	<2.0	<2.0	<2.0	<0.5	<2.0	<1.0	<1.0
36	ND	ND	<2.0	<2.0	<2.0	<0.5	<2.0	<1.0	<1.0
37	ND	ND	<2.0	<2.0	<2.0	<0.5	<2.0	<1.0	<1.0
38	ND	ND	<2.0	<2.0	<2.0	<0.5	<2.0	<1.0	<1.0
39	ND	ND	<2.0	<2.0	<2.0	<0.5	<2.0	<1.0	<1.0
40	ND	ND	<2.0	<2.0	<2.0	<0.5	<2.0	<1.0	<1.0
41	ND	ND	<2.0	<2.0	<2.0	<0.5	<2.0	<1.0	<1.0
42	ND	ND	<2.0	<2.0	<2.0	<0.5	<2.0	<1.0	<1.0
43	ND	ND	<2.0	<2.0	<2.0	<0.5	<2.0	<1.0	<1.0
44	ND	ND	<2.0	<2.0	<2.0	<0.5	<2.0	<1.0	<1.0
45	ND	ND	<2.0	<2.0	<2.0	<0.5	<2.0	<1.0	<1.0
46	ND	ND	<2.0	<2.0	<2.0	<0.5	<2.0	<1.0	<1.0
47	ND	ND	<2.0	<2.0	<2.0	<0.5	<2.0	<1.0	<1.0
48	ND	ND	<2.0	<2.0	<2.0	<0.5	<2.0	<1.0	<1.0
49	ND	ND	<2.0	<2.0	<2.0	<0.5	<2.0	<1.0	<1.0
50	ND	ND	<2.0	<2.0	<2.0	<0.5	<2.0	<1.0	<1.0
51	ND	ND	<2.0	<2.0	<2.0	<0.5	<2.0	<1.0	<1.0
52	ND	ND	<2.0	<2.0	<2.0	<0.5	<2.0	<1.0	<1.0
53	ND	ND	<2.0	<2.0	<2.0	<0.5	<2.0	<1.0	<1.0
54	ND	ND	<2.0	<2.0	<2.0	<0.5	<2.0	<1.0	<1.0
55	ND	ND	<2.0	<2.0	<2.0	<0.5	<2.0	<1.0	<1.0
56	ND	ND	<2.0	<2.0	<2.0	<0.5	<2.0	<1.0	<1.0
57	ND	ND	<2.0	<2.0	<2.0	<0.5	<2.0	<1.0	<1.0
58	ND	ND	<2.0	<2.0	<2.0	<0.5	<2.0	<1.0	<1.0
59	ND	ND	<2.0	<2.0	<2.0	<0.5	<2.0	<1.0	<1.0
60	ND	ND	<2.0	<2.0	<2.0	<0.5	<2.0	<1.0	<1.0
61	ND	ND	<2.0	<2.0	<2.0	<0.5	<2.0	<1.0	<1.0
62	ND	ND	<2.0	<2.0	<2.0	<0.5	<2.0	<1.0	<1.0
63	ND	ND	<2.0	<2.0	<2.0	<0.5	<2.0	<1.0	<1.0
64	ND	ND	<2.0	<2.0	<2.0	<0.5	<2.0	<1.0	<1.0
65	ND	ND	<2.0	<2.0	<2.0	<0.5	<2.0	<1.0	<1.0
66	ND	ND	<2.0	<2.0	<2.0	<0.5	<2.0	<1.0	<1.0

	BD	BE	BF	BG	BH	BI	BJ	BK	BL
67	ND	ND	<2.0	<2.0	<2.0	<0.5	<2.0	<1.0	<1.0
68	ND	ND	<2.0	<2.0	<2.0	<0.5	<2.0	<1.0	<1.0
69	ND	ND	<2.0	<2.0	<2.0	<0.5	<2.0	<1.0	<1.0
70	ND	ND	<2.0	<2.0	<2.0	<0.5	<2.0	<1.0	<1.0
71	ND	ND	<2.0	<2.0	<2.0	<0.5	<2.0	<1.0	<1.0
72	ND	ND	<2.0	<2.0	<2.0	<0.5	<2.0	<1.0	<1.0
73	ND	ND	<2.0	<2.0	<2.0	<0.5	<2.0	<1.0	<1.0
74	ND	ND	<2.0	<2.0	<2.0	<0.5	<2.0	<1.0	<1.0
75	ND	ND	<2.0	<2.0	<2.0	<0.5	<2.0	<1.0	<1.0
76	ND	ND	<2.0	<2.0	<2.0	<0.5	<2.0	<1.0	<1.0
77	ND	ND	<2.0	<2.0	<2.0	<0.5	<2.0	<1.0	<1.0
78	ND	ND	<2.0	<2.0	<2.0	<0.5	<2.0	<1.0	<1.0
79	ND	ND	<2.0	<2.0	<2.0	<0.5	<2.0	<1.0	<1.0
80	ND	ND	<2.0	<2.0	<2.0	<0.5	<2.0	<1.0	<1.0
81	ND	ND	<2.0	<2.0	<2.0	<0.5	<2.0	<1.0	<1.0
82	ND	ND	<2.0	<2.0	<2.0	<0.5	<2.0	<1.0	<1.0
83	ND	ND	<2.0	<2.0	<2.0	<0.5	<2.0	<1.0	<1.0
84	ND	ND	<2.0	<2.0	<2.0	<0.5	<2.0	<1.0	<1.0
85	ND	ND	<2.0	<2.0	<2.0	<0.5	<2.0	<1.0	<1.0
86	ND	ND	<2.0	<2.0	<2.0	<0.5	<2.0	<1.0	<1.0
87	ND	ND	<2.0	<2.0	<2.0	<0.5	<2.0	<1.0	<1.0
88	ND	ND	<2.0	<2.0	<2.0	<0.5	<2.0	<1.0	<1.0
89	ND	ND	<2.0	<2.0	<2.0	<0.5	<2.0	<1.0	<1.0
90	ND	ND	<2.0	<2.0	<2.0	<0.5	<2.0	<1.0	<1.0
91	ND	ND	<2.0	<2.0	<2.0	<0.5	<2.0	<1.0	<1.0
92	ND	ND	<2.0	<2.0	<2.0	<0.5	<2.0	<1.0	<1.0
93	ND	ND	<2.0	<2.0	<2.0	<0.5	<2.0	<1.0	<1.0
94	ND	ND	<2.0	<2.0	<2.0	<0.5	<2.0	<1.0	<1.0
95	ND	ND	<2.0	<2.0	<2.0	<0.5	<2.0	<1.0	<1.0
96	ND	ND	<2.0	<2.0	<2.0	<0.5	<2.0	<1.0	<1.0
97	ND	ND	<2.0	<2.0	<2.0	<0.5	<2.0	<1.0	<1.0
98	ND	ND	<2.0	<2.0	<2.0	<0.5	<2.0	<1.0	<1.0

	Summary Statistics South Platte 1992							
	pH	Conduct.	TDS-CSU	Tot-Alk	Ca	Mg	Na	K
Mean	6.95833333	1736.92708	1830.76471	310	179.389583	49.09375	159.694792	11.478125
Standard Error	0.05282931	63.9795219	#N/A	#N/A	10.2923808	2.55696538	7.572836	1.03903338
Median	6.9	1646	1882	313	164.3	45.8	147.65	8.1
Mode	7	2050	#N/A	313	142.5	4.4	127.4	-0.5
Standard Deviation	0.51761938	626.86873	441.190652	59.4527123	100.844325	25.0530419	74.1983364	10.1804064
Variance	0.26792982	392964.405	194649.191	3534.625	10169.5778	627.654908	5505.39313	103.640674
Kurtosis	-0.0169662	0.0733952	-1.0858559	0.30411854	13.0273323	-0.4036146	1.73793929	1.4981478
Skewness	0.75287727	0.02360806	-0.3932259	-0.7845216	2.40556581	0.33344127	0.90962853	1.39013259
Range	2.4	3199	1448	209	779.3	107.3	420.1	44.4
Minimum	5.9	181	1045	177	11.7	2.4	4.9	-0.5
Maximum	8.3	3380	2493	386	791	109.7	425	43.9
Sum	668	166745	31123	5270	17221.4	4713	15330.7	1101.9
Count	96	96	17	17	96	96	96	96

	Summary Statistics South Platte 1992								
		CaCO3	CO3	HCO3	SO4	Cl	NO3	NO3-N	B
Mean		866.941176	0.09	361.826042	529.5375	85.7135417	35.9552083	4.31111111	0.304375
Standard Error		#N/A	3.8221E-10	10.901678	32.3393598	4.79241397	3.55950971	#N/A	0.02329578
Median		976	0.09	368.95	506.85	79.95	24.9	4	0.29
Mode		#N/A	0.09	388.6	#N/A	76.3	<0.1	#N/A	0.23
Standard Deviation		233.628303	3.7448E-09	106.814194	316.859721	46.9558754	34.8759301	2.8558906	0.22825107
Variance		54582.1838	1.4024E-17	11409.2721	100400.083	2204.85424	1216.3305	8.15611111	0.05209855
Kurtosis		-1.0558598	-2.0430108	2.37663765	-0.3341508	7.24547123	1.52288433	0.01304126	28.3737158
Skewness		-0.5869351	1.01594352	0.70107538	0.45055509	1.89805214	1.29024114	0.3930205	4.7801713
Range		730	0	660.1	1321.2	305.7	166.4	9.1	1.75
Minimum		424	0.09	81.6	7.2	5.3	<0.1	<0.1	0.01
Maximum		1154	0.09	741.7	1328.4	311	166.3	9	1.76
Sum		14738	8.64	34735.3	50835.6	8228.5	3451.7	38.8	29.22
Count		17	96	96	96	96	96	9	96

	Summary Statistics South Platte 1992							
	P	Al	Fe	Mn	Cu	Zn	Ni	Mo
Mean	0.17885417	0.13666667	0.36123229	0.21738333	0.02140521	0.03655104	0.01298542	0.01231667
Standard Error	0.0141823	0.03724141	0.1311574	0.04908075	0.00554797	0.00619161	0.00064928	0.00101445
Median	0.2	<0.1	0.07	0.02	<0.01	0.02	0.01	<0.01
Mode	0.2	<0.1	<0.01	0.01	<0.01	0.02	0.01	<0.01
Standard Deviation	0.13895755	0.36488979	1.28507483	0.48089113	0.05435874	0.0606651	0.00636166	<0.0139571
Variance	0.0193092	0.13314456	1.65141731	0.23125628	0.00295487	0.00368025	4.0471E-05	9.8795E-05
Kurtosis	17.686001	88.0253022	48.2164308	10.1162514	65.9237716	29.3406702	11.8317393	41.8696725
Skewness	3.81415124	9.254395	6.51356927	3.07472274	7.79803507	5.10857642	2.92332027	6.02746505
Range	0.91	3.6	10.7901	2.6801	0.4901	0.4401	0.0401	0.0801
Minimum	<0.1	0	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Maximum	1	3.6	10.8	2.69	0.5	0.45	0.05	0.09
Sum	17.17	13.12	34.6783	20.8688	2.0549	3.5089	1.2466	1.1824
Count	96	96	96	96	96	96	96	96

Summary Statistics South Platte 1992

	Cd	Cr	Ba	Pb		NITRATE N	TDS-CDH
Mean	0.01085	0.02508646	0.05051458	0.01851146		8.69877083	1417.70833
Standard Error	0.00053716	0.00135119	0.00501448	0.00398049		0.82456706	60.2404683
Median	<0.01	0.02	0.03	<0.05		6.7	1305
Mode	<0.01	0.02	0.03	<0.05		<0.5	1080
Standard Deviation	0.00526306	0.01323888	0.04913169	0.03900069		8.07907418	590.233636
Variance	2.77E-05	0.00017527	0.00241392	0.00152105		65.2714396	348375.746
Kurtosis	41.9909064	-0.211546	11.3604211	9.91682975		1.6377024	0.03736653
Skewness	6.35867917	0.62905603	3.06102524	3.2268905		1.35424356	0.48446355
Range	0.0401	0.0501	0.3001	0.1851		36.501	2800
Minimum	<0.01	<0.01	<0.01	<0.05		<0.5	150
Maximum	0.05	0.06	0.31	0.19		37	2950
Sum	1.0416	2.4083	4.8494	1.7771		835.082	136100
Count	96	96	96	96		96	96

	A	B	C	D	E	F
101	COUNTY	WELL_NO	PH	CONDUCT	NITRATE_N	
102						
103	MORGAN	SP93-96	6.1	1513.0	24	
104	MORGAN	SP93-01	6.7	1149.0	19	
105	MORGAN	SP93-02	6.8	916.0	4.8	
106	MORGAN	SP93-03	6.7	2.4	41	
107	MORGAN	SP93-04	6.5	1637.0	7.5	
108	MORGAN	SP93-95	6.9	275.0	8.5	
109	MORGAN	SP93-05	6.5	2190.0	3.9	
110	MORGAN	SP93-101	6.6	2030.0	8.2	
111	MORGAN	SP93-07	6.6	2150.0	23	
112	MORGAN	SP93-08	6.7	1701.0	18	
113	MORGAN	SP93-09	6.8	1624.0	11	
114	MORGAN	SP93-57	6.7	260.0	12	
115	MORGAN	SP93-58	6.8	3.0	<0.5	
116	MORGAN	SP93-55A	7.0	2.6	9.4	
117	MORGAN	SP93-49	7.2	3.3	24	
118	MORGAN	SP93-48A	7.2	1586.0	6.5	
119	MORGAN	SP93-47	7.3	1392.0	<0.5	
120	MORGAN	SP93-54	7.1	1670.0	9.5	
121	MORGAN	SP93-11	7.2	2.7	12	
122	MORGAN	SP93-12	7.0	2.3	4.4	
123	MORGAN	SP93-13	6.4	3.1	16	
124	MORGAN	SP93-14	6.5	823.0	7.7	
125	MORGAN	SP93-15	6.6	3.2	23	
126	MORGAN	SP93-60	6.5	1667.0	3.5	
127	MORGAN	SP93-16	6.7	1433.0	5.1	
128	MORGAN	SP93-61	6.5	2.5	7.0	
129	MORGAN	SP93-55	6.7	2.8	9.6	
130	MORGAN	SP93-53	6.5	1759.0	10	
131	MORGAN	SP93-52B	6.5	1478.0	1.3	
132	MORGAN	SP93-51A	6.5	1708.0	4.7	
133	MORGAN	SP93-17	6.8	1855.0	4.4	
134	MORGAN	SP93-59	6.5	2.1	0.8	
135	SEDGWICK	SP93-87	6.4	2.3	14	

	A	B	C	D	E	F
136	SEDGWICK	SP93-86	6.5	2.0	5.4	
137	SEDGWICK	SP93-18	6.5	2.0	3.1	
138	MORGAN	SP93-19	7.2	1.7	4.4	
139	MORGAN	SP93-20	7.1	2.5	15.7	
140	SEDGWICK	SP93-88	7.0	2.4	14.3	
141	SEDGWICK	SP93-89	6.9	2.4	9.6	
142	SEDGWICK	SP93-21	7.0	2.2	16.1	
143	SEDGWICK	SP93-90	6.9	2.8	29	
144	SEDGWICK	SP93-22	7.2	459.0	7.0	
145	SEDGWICK	SP93-91A	7.1	1265.0	8.0	
146	SEDGWICK	SP93-93	7.0	2.1	22	
147	SEDGWICK	SP93-94A	7.6	411.0	1.7	
148	SEDGWICK	SP93-23	6.9	2.0	9.5	
149	SEDGWICK	SP93-25	6.9	1429.0	9.7	

Appendix B

STATE OF COLORADO

COLORADO DEPARTMENT OF HEALTH
Dedicated to protecting and improving the health and environment of the people of Colorado
4300 Cherry Creek Dr. S.
Denver, Colorado 80222-1530
Phone: (303) 692-2000

Laboratory Building
4210 E. 11th Avenue
Denver, Colorado 80220-3716
(303) 691-4700

Roy Romer
Governor
Patricia A. Nolan, MD, MPH
Executive Director

Water Quality Control Division
Agricultural Chemicals Program
Mail Code: WQCD-GWPS-B2

January 27, 1993

[redacted]

RE: Well water sample taken at [redacted]

Dear Mr. / Ms. [redacted]

Thank you for your cooperation in our study of the quality of ground water in the South Platte River Valley. The laboratory analysis of water from your domestic well is finally in and we are pleased to present you with the results. We apologize for the delay as the laboratory analysis took much longer than expected.

Enclosed you should find:

1. A print out of the laboratory results for your well with three columns of data. The left column lists the chemicals that were tested for. The center column lists the results for your well. The right column lists the maximum recommended level for that chemical in drinking water.
2. A pamphlet that describes the program responsible for this study.
3. If the nitrate level in your well was above the recommended level for drinking water, a "Service in Action" information sheet, on nitrates in ground water, will be included.
4. If the pesticide atrazine was present in any amount in your well, an EPA Advisory on atrazine will be included.

Sincerely yours,

Bradford Austin
Program Manager
(303) 692-3572

Laboratory Test Results for Well Water Sample

[redacted] Date sampled - 06/23/92
[redacted] Well number - 92012
Well address - [redacted]

Below you will see listed the test results from your well. The column on the left list the chemicals that were tested for. The center column list the results for your well. The column on the right list the maximum recommended level for that chemical in drinking water. If you have any questions about these results please call us at 692-3572 or 692-3576.

Basic chemicals:	Results (mg/L)		MCL for drinking water (mg/L)
Boron	0.43		*
Bicarbonate	402.70		*
Calcium	142.5		*
Carbonate	<0.1		*
Chloride	128.7		250.0
Magnesium	41.3		*
Nitrate	112.9		45.0
Nitrate as N	24.00		10.0
pH	6.6		6.5 - 8.5
Sodium	192.7		*
Specific Conductance	1725.0	umhos/cm	*
Sulfate	279.8		250
Potassium	2.1		*
Total Alkalinity			*
Total Dissolved Solids	1880.0		*
Total Hardness			*

Dissolved metals:	Results: (mg/L)	
Aluminum	<0.1	*
Barium	0.07	1.0
Cadmium	0.01	0.01
Chromium	0.02	0.05
Copper	0.02	1.0
Iron	0.09	0.3
Lead	<0.05	0.05
Manganese	0.01	0.05
Nickel	0.01	*
Molybdenum	<0.01	*
Phosphorous	0.1	*
Zinc	0.02	5.0

Well number - 92012 Date sampled - 06/23/92
Well address - [redacted]

Results for Pesticides:

Trade Name:	Common Name:	Results (ug/L)	MCL (ug/L)
Lasso	Alachlor	ND	2.0
Aldrin	Aldrin	ND	*
Atrazine	Atrazine	ND	3.0
Azinphos Meth	Azinphos Meth	ND	*
Balan	Benefin	ND	*
Bravo	Chlorothalonil	ND	2.0
Lorsban	Chlorpyrifos	ND	*
Bladex	Cyanazine	ND	10.0
Dacthal	DCPA	ND	*
TDE	DDD	ND	*
DDE	DDE	ND	*
DDT	DDT	ND	*
Diazinon	Diazinon	ND	0.6
Dieldrin	Dieldrin	ND	0.002
Thiodan	Endosulfan 1	ND	*
Thiodan	Endosulfan 2	ND	*
Endrin	Endrin	ND	0.3
Eptam	EPTC	ND	*
Sonnalan	Ethalfluralin	ND	*
Heptachlor	Heptachlor	ND	0.4
Heptachlor epox.	Heptachlor epox.	ND	0.2
Velpar	Hexazinone	ND	200
Lindane	Lindane	ND	0.2
Methoxychlor	Methoxychlor	ND	40
Penncap M	Methyl Parathion	ND	*
Pounce	Permethrin	ND	*
Treflan	Trifluralin	ND	*
Temik	Aldicarb Sulfoxide	<2.0	4.0
Aldoxycarb	Aldicarb Sulfone	<2.0	2.0
Oxamyl	Oxamyl	<2.0	0.2
Methomyl	Methomyl	<0.5	200
Carbofuran	3-OH-Carbofuran	<2.0	40
Temik	Aldicarb	<1.0	3.0
Propoxur	Baygon	<1.0	3.0
Carbofuran	Carbofuran	<1.5	40
Carbaryl	Carbaryl	<2.0	700
Methiocarb	Methiocarb	<4.0	*

** Key to notations **

TRACE - Detected by lab, but too low to measure accurately
MCL - Maximum recommended level for drinking water
ND - Not detected
(mg/L) - Miligrams per Liter or parts per million
(ug/L) - Micrograms per Liter or parts per billion
< - If present, amount is LESS than lab can measure
* - EPA health advisory or MCL not known for this chemical

FUNDING

Funding for the program is provided by a twenty dollar fee assessed to the manufacturer or formulator of each pesticide product registered in the state each year and a fee of fifty cents on each ton of commercial fertilizer sold in the state of Colorado.

FYI

Further information can be obtained by contacting the following:

Lead Agency/Rules and Regulations
Mitchell Yergert
Colorado Department of Agriculture
(303) 239-4140

Education and Training
Reagan Waskom
CSU Cooperative Extension
(303) 491-6103

Groundwater Monitoring
Brad Austin
Colorado Department of Health
(303) 692-3572

This fact sheet was prepared by the
Colorado Department of Agriculture
Division of Plant Industry
700 Kipling St., Suite 4000
Lakewood, CO 80215-5894
(303) 239-4140

COLORADO DEPARTMENTOF AGRICULTURE
Division of Plant Industry
700 Kipling St., Suite 4000 - Lakewood, CO 80215-5894
(303)239-4140

AGRICULTURAL CHEMICALS AND GROUNDWATER PROTECTION

GOAL...
"To protect groundwater and the environment from impairment or degradation due to the improper use of agricultural chemicals while allowing for their proper and correct use..."

Taken from SB 90-126

Steven W. Horn, Commissioner

Roy Romer, Governor

THE COLORADO LEGISLATURE

During the 1990 legislative session the Colorado Legislature passed Senate Bill 90-126, the Agricultural Chemicals and Groundwater Protection Act. In this Amendment to the Colorado Water Quality Control Act, the general assembly declared that the public policy of this state is "to protect groundwater and the environment from impairment or degradation due to the improper use of agricultural chemicals while allowing for their proper and correct use." The emphasis is to improve the management of agricultural chemicals to prevent, minimize, and mitigate their presence in groundwater.

The Act emphasizes a voluntary approach, using education and training, to achieve the goal. Should voluntary efforts fail to address groundwater contamination from agricultural chemicals, the law sets forth a series of actions first by the Commissioner of Agriculture and then finally by the Water Quality Control Commission.

The Act defines agricultural chemicals as all pesticides and commercial fertilizers used in both urban and rural settings. The Colorado Department of Agriculture, the lead agency, the Colorado Department of Health, and Colorado State University Cooperative Extension are cooperating agencies in the implementation of this program.

ADVISORY COMMITTEE

The Colorado Agricultural Commission appointed an advisory committee to assist in the implementation of this program. The committee consists of seventeen individuals from the public, producers, green industry, agricultural chemical suppliers, commercial applicators and the Water Quality Control Commission. Members are appointed for a three year term with one-third of the terms expiring each year.

EDUCATION AND TRAINING

Education and training of agricultural chemical applicators to insure proper and correct use of pesticides and fertilizers is the key to the program. The program is geared to all users of pesticides and fertilizers including commercial applicators, urban homeowners, farmers, golf course superintendents and the general public. Colorado State University Cooperative Extension provides the education and training component. A variety of educational methods are used to reach these groups with information on agricultural chemical use and groundwater protection.

One major component of the program is the development of best management practices (BMPs) for agricultural chemical use. Research based guidance principles and BMPs are being developed by CSU in cooperation with the Soil Conservation Service and other agricultural groups. Localized BMPs will be developed at the user level with extensive local input.

GROUNDWATER MONITORING

The Colorado Department of Health is conducting a groundwater monitoring program to determine the presence of agricultural chemicals in the groundwater. The water sampling is performed by the Department of Health's Water Quality Control Division in close coordination with extension agents, water conservancy districts, and local officials.

Wells sampled are analyzed for selected pesticides and basic inorganic parameters including nitrate. The pesticides are selected based on the frequency of use in the area and the physical properties of the pesticide. The groundwater monitoring program provides a basis for determining a groundwater quality baseline upon which to gauge trends in groundwater quality. The results are entered in the CDH groundwater quality data base.

RULES AND REGULATIONS FOR BULK STORAGE AND MIXING AND LOADING AREAS

The Commissioner of Agriculture is required to "promulgate rules and regulations for bulk storage facilities and mixing and loading areas where at least fifty-five thousand pounds of finished product of agricultural chemicals are handled each year; except that any such rule and regulation shall include a three-year phase-in period for any persons subject to such rules and regulation." The purpose of these rules and regulations is to prevent spills and leaks that may occur during the storage or mixing/loading of agricultural chemicals from contaminating groundwater. The rules and regulations will establish performance standards for the construction and operation of: secondary containment of bulk liquid pesticide and fertilizer storage facilities; pesticide and fertilizer mixing/loading areas; and bulk dry pesticide and fertilizer storage.

The process for the development of the rules and regulations provides for extensive public input. A subcommittee including members of the advisory committee develops a draft of potential rules and regulations. The advisory committee reviews and revises the subcommittee's draft. With the advisory committee's approval this draft is presented at public meetings of professional organizations, industry groups, and interested parties throughout the state to receive input.

Following this presentation of the rules, the draft is revised, as necessary, and formal hearings held in preparation of adoption of the rules and regulations. This process allows two opportunities, the public meetings and the formal hearings, for the public to affect the content of these regulations. It is anticipated adoption of the regulations occurs in early 1994.

service in ACTION

Colorado State University Cooperative Extension

no. .517

Nitrates in drinking water

[1]J.R. Self and R.M. Waskom

Quick Facts

Nitrate is a colorless, odorless, and tasteless compound that is present in some groundwater in Colorado.

Nitrate can be expressed as either NO_3 (nitrate) or NO_3-N (nitrate-nitrogen). Nitrate levels above the EPA Maximum Contaminant Level of 10mg/l NO_3- N or 45 mg/1 NO_3 may cause methemoglobinemia in infants.

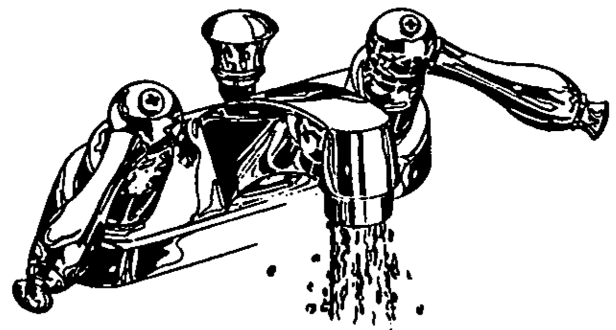
Proper management of fertilizers, manures, and other nitrogen sources can minimize contamination of drinking water supplies.

Nitrate (NO_3) is a naturally occurring form of nitrogen found in soil. Nitrogen is essential to all life, and most crop plants require large quantities to sustain high yields. The formation of nitrates is an integral part of the nitrogen cycle in our environment. In moderate amounts, nitrate is a harmless constituent of food and water. Plants use nitrates from the soil to satisfy nutrient requirements and may accumulate nitrate in their leaves and stems. Due to its high solubility, nitrate also can leach into groundwater. If humans or animals ingest water high in nitrate, it may cause *methemoglobinemia*, an illness especially found in infants.

Nitrates form when fertilizers, decaying plants, manures, or other organic residues are broken down by micro-organisms. Usually plants take these nitrates up, but sometimes rain or irrigation water can leach them into groundwater. Although nitrate occurs naturally in some groundwater, higher levels are thought to be the result of human activities in most cases.

Common Sources of Nitrate

- Fertilizers and manure
- Animal feedlots
- Municipal wastewater and sludge
- Septic systems
- N-fixation from atmosphere by legumes, bacteria and lightning



Health Effect of Nitrates

Humans

High nitrate levels in water can cause *methemoglobinemia* or blue baby syndrome, a condition especially found in infants under six months. The stomach acid of an infant is not as strong as older children and adults, which causes an increase in bacteria that can readily convert nitrate to nitrite (NO_2). Therefore, do not let infants consume drinking water that exceeds 10 mg/l NO_3-N (this includes formula preparation). Nitrite is absorbed in the blood, and hemoglobin (the oxygen carrying component of blood) is converted to methemoglobin. Methemoglobin does not carry oxygen efficiently. This results in reduced oxygen supply to vital tissues such as the brain. Methemoglobin in infant blood cannot change back to hemoglobin, which normally occurs in adults. Severe methemoglobinemia can result in brain damage and death.

Pregnant women, adults with reduced stomach acidity, and individuals deficient in the enzyme that changes methemoglobin back to normal hemoglobin are all susceptible to nitrite-induced methemoglobinemia. The most obvious symptom of methemoglobinemia is a bluish color of the skin, particularly around the eyes and mouth. Other symptoms include headache, dizziness, weakness or difficulty in breathing. Take babies with the above symptoms to the hospital emergency room immediately. If recognized in time, methemoglobinemia is treated easily with an injection of methylene blue.

Healthy adults can consume fairly large amounts of nitrate with few known health effects. In fact, most of the nitrate we consume is from our diet, particularly from raw or cooked vegetables. This nitrate is readily absorbed and excreted in the urine. However, prolonged intake of high levels of nitrate are linked to gastric problems due to the formations of nitrosamines. N-nitrosamine compounds have been shown to cause cancer in test animals, but studies of humans exposed to high levels of nitrate or nitrite have not provided convincing evidence of an increased risk of cancer.

Animals

Although there is no enforceable drinking water standard for livestock, do not allow animals to drink water with more than 100 mg/l NO_3-N. This is especially true of young animals that are affected by nitrates in the same manner as human babies. Older animals may tolerate levels as high as 200 mg/l NO_3-N.

Ruminant animals (cattle, sheep) are susceptible to nitrate poisoning since bacteria present in the rumen converts nitrate to nitrite. Non-ruminant animals (swine, chickens) rapidly eliminate nitrate in their urine. Horses are monogastric, but their large cecum acts much like a rumen making them more susceptible to nitrate poisoning than other monogastric animals.

It is difficult to determine the toxicity of nitrate in animals since it depends on the rate that the substance is consumed. A few hundred milligrams of nitrate may cause poisoning if consumed in a few hours. But, spread over a whole day, 1,000 mg nitrate may cause no signs of toxicity. Common symptoms include abdominal pain, diarrhea, muscular weakness, or poor coordination. Affected animals will have blood that is a chocolate-brown color. If the problem is diagnosed in time, they can fully recover with a treatment of methylene blue. Pregnant animals may abort within a few days.

Nitrate also exists in animal feeds and fodder. Drought stressed forage plants commonly have high nitrate levels. These feeds can have an additive effect when consumed with high nitrate drinking water.

The Drinking Water Standard

Reports of methemoglobinemia are extremely rare. Clinical infant methemoglobinemia was first recognized in 1945, and about 2000 cases were reported in North America and Europe by 1971. Fatality rates during that time were reported to be approximately 7 percent to 8 percent. From 1960 to 1972, however, only one death from blue baby syndrome was documented.

Methemoglobinemia has not been reported to occur where water contains less than 10 mg/l of NO_3-N. This level has been adopted by the U.S. Environmental Protection Agency as the standard in the Primary Drinking Water Regulations, chiefly to protect young infants.

Nitrate values are commonly reported as either nitrate (NO_3) or as nitrate-nitrogen (NO_3-N). The maximum contaminant level (MCL) in drinking water as nitrate (NO_3) is 45 mg/l, whereas the MCL as NO_3-N is 10 mg/l. The MCL is the highest level of NO_3 or NO_3-N that is allowable in drinking water by the U.S. Environmental Protection Agency (EPA). These figures also may be reported in ppm (parts per million), which is equivalent to mg/l. Be sure you know which value is reported for your water sample.

Protecting Your Drinking Water

The 1990 EPA National Survey of Drinking Water Wells found that approximately 57 percent of the private wells tested contained detectable levels of nitrates. However, only 2.4 percent exceeded the EPA maximum contaminant level. In Colorado, nitrate contamination above the MCL occurs relatively infrequently, and mainly in agricultural areas overlying vulnerable aquifers.

Protecting your drinking water supply from contamination is important for health and to protect property values and minimize potential liability. High nitrate levels often are associated with poorly constructed or improperly located wells. Locate new wells uphill and at least 100 feet away from feedlots, septic systems, barnyards, and chemical storage facilities. Properly seal or cap abandoned wells.

Manage non-point sources of water pollution (fields, lawns) to limit the loss of excess water and plant nutrients. Match fertilizer and irrigation applications to precise crop uptake needs in order to minimize groundwater contamination.

Best Management Practices for Fertilizer Use

Careful fertilizer management can reduce nitrate leaching to groundwater. Consider the following practices in planning your fertilizer program:

1. Use soil and water analysis to determine exact nitrogen needs of crop (see Service in Action no. .500, *Soil sampling—the key to a quality fertilizer recommendation*).
2. Set a realistic yield goal for each field. Take the five-year average production of your field and add 5 percent to get an attainable yield goal.
3. Credit all sources of nitrogen available to the crop, including manures, water, organic matter, legumes, and residual subsoil nitrate.
4. Split nitrogen fertilizer into as many separate applications as feasible (see .514, *Nitrogen and irrigation management—keys to profitable yields and water quality*.)

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Water Quality Analysis

Nitrate is a tasteless, colorless, and odorless compound that you cannot detect unless your water is chemically analyzed. If you drink water from a private well, get a qualified laboratory to test it yearly. The local health department or Cooperative Extension county office usually can supply the name of an approved testing laboratory in your area.

Sample water for nitrate testing at the well site or at a tap inside the house. Place samples in clean, 4 to 16-ounce plastic containers. Send the sample to a laboratory immediately. If you refrigerate the sample prior to sending, it will help the sample remain intact until it reaches a laboratory. Do not freeze the sample.

Laboratory results will be compared to the MCL, and recommendations for treatment should be considered if nitrate levels exceed 10 mg/l NO_3-N. Be aware that nitrate levels in groundwater may vary seasonally. If your water tests high or borderline high, it is a good practice to retest your water every three to six months.

Purification of Contaminated Water

While it may be technically possible to remediate contaminated groundwater in some cases, it can be difficult, expensive and not totally effective to remove nitrates from water. For this reason, prevention is the best way to ensure clean water.

Water treatments include distillation, reverse osmosis, ion exchange, or blending. **Distillation** boils the water, catches the resulting steam, and condenses the steam on a cold surface (a condenser). Nitrates and other minerals remain behind in the boiling tank.

Reverse osmosis forces water under pressure through a membrane that filters out minerals and nitrate. One-half to two- thirds of the water remains behind the membrane as rejected water. Higher yield systems use water pressures of 150 psi.

Ion-exchange, takes another substance, such as chloride, and trades places with nitrate. An ion exchange unit is filled with special resin beads that are charged with chloride. As water passes over the beads, the resin takes up nitrate in exchange for chloride. As more water passes over the resin, all the chloride is exchanged for nitrate. The resin is recharged by backwashing with sodium chloride solution. The backwash solution, which is high in nitrate, must be disposed of properly.

Blending is another method used to reduce nitrates in drinking water. Contaminated water can be mixed with clean water from another source to lower overall nitrate concentration. Blended water is not safe for infants, but is acceptable for livestock and healthy adults.

Charcoal filters and water softeners do not adequately remove nitrates from water. Boiling nitrate contaminated water does not make it safe to drink, and actually increases the concentration of nitrates. Drilling a new well to deeper water with less nitrate may be a feasible remedy in certain areas. In many cases, the most effective alternative is to utilize bottled water for drinking and cooking.

References

Additional information on water quality can be obtained from the following Service in Action sheets, published by Colorado State University Cooperative Extension:

Follett, R. H., and J. R. Self. 1989. *Domestic water quality criteria.* Service in Action .513.

Hallaway, J. 1983. *Drinking water treatment devices: filters.* Service in Action 9.728.

Hallaway, J. 1983. *Drinking water treatment devices: distillers.* Service in Action 9.729.

Kendall, P. 1991. *Drinking water quality and health.* Service in Action 9.307.

Ludwick, A. E. and P. N. Soltanpour. 1979. *Soil sampling-the key to a quality fertilizer recommendation.* Service in Action .500.

Soltanpour, P. N., I. Broner, and R. H. Follett. 1990. *Nitrogen and irrigation management-keys to profitable yields and water quality.* Service in Action .514.

Soltanpour, P. N. and W. L. Raley. *Evaluation of drinking water quality for livestock.* 1989. Service in Action 4.908.

Stanton, T. L. 1983. *Nitrate poisoning in livestock.* Service in Action 1.610.

Glossary

Blue baby syndrome: A disease that affects the oxygen carrying capacity of infant's blood, usually resulting from the consumption of high levels of NO_3. Also known as methemoglobinemia.

Contaminant: Any physical, chemical, biological, or radiological substance that degrades water quality.

Groundwater: Water that saturates subsurface formations or aquifers.

Leaching: The downward movement of dissolved or suspended minerals, fertilizers, agriculturaal chemicals, or other substances through the soil profile.

Maximum Contaminant Level (MCL): The highest amount of a specific contaminant allowed by the EPA in public drinking water supplies. These are health-based standards that by law must be set as close to the "no-risk" level as feasible.

Nitrate (NO_3): An important plant nutrient that is soluble in water and may cause health problems if consumed in large amounts.

Nitrate-nitrogen (NO_3-N): -Relates to the actual nitrogen in nitrate. Multiply NO_3-N values by 4.4 to convert to nitrate.

Non-point Source Pollution: Water contamination from diffuse sources such as agricultural fields, urban runoff, or large contruction sites.

Parts per million (ppm): A unit of proportion used to describe the concentration of a chemical in water. Equivalent to mg/L.

Additional information on the Survey and on pesticides in general can be obtained from the following sources:

U.S. EPA Safe Drinking Water Hotline 1-800-426-4791 (In Washington, DC (202) 382-5533) Monday-Friday, 8:30 am to 4:30 pm Eastern Time	Information on regulation of pesticides in drinking water
National Pesticide Telecommunications Network 1-800-858-7378 24 hours a day	Information on health effects and safe handling of pesticides
U.S. EPA Office of Pesticide Programs (OPP) Docket 401 M Street, SW Room NEG004 Washington, DC 20460 (202) 382-3587	Background documents for Survey (available for review)
National Technical Information Service (NTIS) 5285 Port Royal Road Springfield, VA 22161 (703) 487-4650	Copies of the NPS Phase I Report (available 1991) and NPS Phase II Report (when available)

If you are concerned about the presence of pesticides and nitrate in your private water well, contact your local or State health department. Other experts in your State environmental agency or agriculture and health departments may also be helpful to you. If you receive your drinking water from a community water system and have questions about your water quality, contact your local community water system owner/operator or the State water supply agency.

Bibliography

Meister Publications. Farm Chemicals Handbook. Ohio: Meister Publications, 1990.

U.S. Environmental Protection Agency. Drinking Water Health Advisory: Pesticides. Michigan: Lewis Publishers, 1989.

U.S. Environmental Protection Agency. Drinking Water Regulations and Health Advisories, April, 1990.

U.S. Environmental Protection Agency. Health Advisory Summaries, January 1989.

U.S. Environmental Protection Agency. Pesticides in Drinking Water Wells, September 1989.

Weed Science Society of America. Herbicide Handbook of the Weed Science Society of America. 5th ed. Illinois: Weed Science Society of America, 1983.

Worthing, Charles R., ed. The Pesticide Manual. 8th ed. Thornton Heath: The British Crop Protection Council, 1987.

United States Environmental Protection Agency

Office of Water
Office of Pesticides and Toxic Substances

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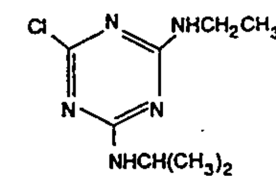
EPA

National Pesticide Survey

Atrazine



Atrazine

The U.S. Environmental Protection Agency (EPA) has completed its five-year National Survey of Pesticides in Drinking Water Wells (NPS), a study of the presence of 127 pesticides, pesticide degradates, and nitrate in community water system (CWS) wells and rural domestic drinking water wells. Atrazine was one of the pesticides detected in the Survey. This fact sheet provides a description of atrazine, its potential health effects, a summary of the concentrations of atrazine found by the NPS in wells, and guidance on both treating and preventing well contamination.

What is Atrazine?

Atrazine is the common name of an herbicide which is a member of the chemical family of triazines. Atrazine was registered for use in the late 1950s. It has been sold under the trade names of Atrazine, AAtrex, Atratol, Gesaprim, and Zeaphos. Atrazine is also a component of other herbicides such as Bicep, Bullet, Extrazine, Lariat, Marksman, Prozine, and Sutazine. Atrazine is used to control many annual broadleaf weeds and certain grasses in corn, sorghum, sugarcane, macadamias, and subtropical tree fruits such as guavas and pineapples. It is also used for general weed control on non-cropped industrial land, selective weed control in conifer restoration and Christmas tree plantations, and non-selective control of vegetation or fallow land.

How Does Atrazine Behave in Soil and Ground Water?

The behavior of a pesticide after it is released to the environment is dependent upon its movement in air, water, and soil as well as the rate at which it is transformed or broken down. Pesticides applied to crops or the soil surface may volatilize (vaporize) to the atmosphere, be carried off by surface runoff, be carried to ground water through leaching, or remain in the soil through adsorption (adherence) to soil particles and undergo little movement in air or water. Pesticides may be transformed by reaction with water, microorganisms, and exposure to sunlight. The likelihood that atrazine will migrate into ground water is influenced by its tendency to be transported (move) from soil to air and water and to be transformed by these various processes, as well as by the characteristics of the site, such as soil type, moisture, temperature, and depth to ground water. Atrazine has a high potential to be transported, and a low potential to be transformed.

How Does Atrazine Get into Ground Water?

Atrazine migration into ground water could result from the presence of atrazine in the soil due to agricultural and other applications of atrazine on cropped and non-cropped land. Atrazine could also reach ground water from direct entry into a well through accidental chemical spills or improper storage near a well.

Findings of the National Pesticide Survey

Based on the results of the NPS, EPA estimates that atrazine is present, at or above the analytical detection level of 0.12 $\mu g/L$ used in the Survey, in about 1,570 (1.7%) CWS wells and 70,800 (0.7%) rural domestic wells nationwide. Considering the precision of the Survey, EPA estimates that the number of CWS wells with detectable levels of atrazine could be as low as 420 or as high as 2,710, and the number of rural domestic wells could be as low as 13,300 or as high as 214,000. Atrazine is measured in micrograms per liter ($\mu g/L$) which is equivalent to parts per billion (ppb). The maximum concentration of atrazine detected was 0.92 $\mu g/L$ in CWS wells sampled by the Survey and 7.0 $\mu g/L$ in rural domestic wells sampled by the Survey. The median concentration of detectable atrazine was 0.26 $\mu g/L$ in CWS wells, and 0.29 $\mu g/L$ in rural domestic wells.

Atrazine was sometimes detected at concentrations above EPA's proposed Maximum Contaminant Level (MCL) and drinking water Lifetime Health Advisory Level (HAL) of 3 $\mu g/L$ in rural domestic wells. Other studies have also indicated atrazine concentrations above the HAL. EPA notified well owners and operators within 24 hours when detections were above the Health Advisory Level.

What Health Effects Might be Caused by Atrazine in Drinking Water?

Non-Cancer Effects: EPA has set a Lifetime Health Advisory Level for atrazine in drinking water at 3 $\mu g/L$. EPA believes that water containing atrazine at or below this level is acceptable for drinking every day over the course of one's lifetime, and does not pose health concerns. A Lifetime HAL represents the concentration of a contaminant in water that may be consumed over an average human lifetime without causing adverse health effects. Lifetime HALs are based on health effects that were found in animals given high doses of the pesticides in laboratory studies. This level includes a margin of safety. Consuming atrazine, however, at high levels well above the Lifetime Health Advisory Level over a long period of time has been shown to result in adverse health effects in animal studies, including tremors, changes in organ weights, and damage to the liver and heart.

Cancer Risk: EPA has not officially classified the carcinogenicity (cancer-causing) potential of atrazine. There is limited or uncertain information indicating that atrazine causes cancer in animals receiving high doses of the chemical over the course of their lifetimes. Because atrazine in drinking water may possibly increase the risk of cancer in humans, the Lifetime Health Advisory Level includes an additional margin of safety.

Standard: EPA sets enforceable standards for public water systems, called MCLs. These regulatory standards set achievable levels of drinking water quality to protect human health. The proposed MCL for atrazine is 3 $\mu g/L$ (proposed as of May 22, 1989).

How is Water Treated to Remove Contaminants?

Atrazine can be detected in drinking water by a laboratory using an EPA method such as #507. If atrazine is detected in well water and confirmed by retesting to be above 3 $\mu g/L$, State or County health officials should be consulted. They may advise periodic retesting to get an accurate overall picture of the water quality because changes in seasonal precipitation and changes in pesticide use can cause variations in the amount of chemicals found in water wells. They also may advise using an alternative drinking water supply (bottled water is an example of a temporary alternative), treating the water, or drilling a new or deeper well. If you receive your well water from a community water system, and have concerns about the quality of your water, contact your State public water supply agency. Public water suppliers are required to notify customers if the drinking water that they deliver contains a contaminant that exceeds its MCL.

You may also be able to treat your well water to remove pesticides and other contaminants. Treatment technologies that can remove atrazine from water include granular and powder activated carbon adsorption. Other technologies such as ion exchange, reverse osmosis, ozone oxidation, and ultraviolet irradiation are in the experimental stages for this pesticide and are not necessarily appropriate or available in every situation. Certain treatment methods are more suitable for large community water systems than for individual domestic wells. State or County health officials should be able to provide advice on the best approach to follow.

How Can Water Contamination be Prevented?

Several steps may be taken to prevent pesticides or nitrate from entering wells, such as eliminating direct entry through the well wall, drilling a new well, or modifying or reducing pesticide and fertilizer use.

Eliminate Direct Entry Through the Well Wall

If pesticides or nitrate are present in well water, they may be entering the ground water through the well itself rather than through the soil. If the well is old or poorly constructed or if there are visible cracks in the well casing, obtain expert advice on whether or not improvements can be made to the well. In addition, investigate simple methods of capping the well or sealing it at the surface to prevent entry. Do not conduct any mixing activities near the well if you use well water to mix pesticides because a spill could lead to direct contamination of the well.

Drill a New Well

If the soil surrounding the well is the source of contamination, drilling a new or deeper well may make sense if water can be drawn from a deeper, uncontaminated aquifer. Unfortunately, it often is difficult to know the quality of the ground water without drilling or extensive testing. Seek expert advice before you drill.

Learn More about Pesticide Use

If you use pesticides, whether for agricultural or home lawn and garden purposes, you should consider attending training courses given by your State or County agriculture department on how to reduce activities that can contaminate ground water. You may find that you can eliminate or lessen the frequency or quantity of your pesticide usage by choosing alternative methods of pest control.

Why was the National Pesticide Survey Conducted?

EPA conducted this Survey to determine the frequency and concentration of pesticides, pesticide degradates, and nitrate in drinking water wells nationwide and to examine the relationship between the presence of pesticides in drinking water wells and patterns of pesticide use and ground-water vulnerability. The Survey sampled 566 community water system wells and 783 rural domestic wells for 127 pesticides, pesticide degradates, and nitrate. The wells were selected as a representative statistical sample to provide nationwide estimates of the presence of pesticides and nitrate in drinking water wells, and are not meant to provide an assessment of pesticide contamination at the local, County, or State level.

Where to Go for More Information

This fact sheet is part of a series of NPS outreach materials, fact sheets and reports. The following additional fact sheets are available through EPA's Public Information Center (401 M Street SW, Washington, DC 20460, (202) 382-2080):

Survey Design	*Analytical Methods*	*Project Summary*
Survey Analytes	*Summary Results*	*Glossary*
Quality Assurance/ Quality Control	*Fact Sheet for each detected analyte*	*How EPA Will Use The NPS Results*