Idaho State Department of Agriculture
Division of Agricultural Resources

Ground Water Quality of Minidoka County Alluvial Aquifer

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Introduction

The Idaho State Department of Agriculture (ISDA) developed the Regional Agricultural Ground Water Quality Monitoring Program to characterize degradation of ground water quality by contaminants leaching from agricultural sources. The ISDA currently is conducting monitoring at twelve regions in Idaho, including a project in southern Minidoka County (Figure 1). The objectives of the program are to: (1) characterize ground water quality, primarily related to nitrate-nitrogen (NO_3-N) and pesticides, (2) determine if legal pesticide use contributes to aquifer degradation, (3) relate data to agricultural land use practices, and (4) provide data to support Best Management Practices (BMP) and/or regulatory decision making and evaluation processes.

The ISDA Minidoka County alluvial aquifer regional monitoring project began in 1997 as a result of previous monitoring by the Idaho Department of Water Resources (IDWR) and the United States Geological Survey (USGS). Twenty-nine wells in the Minidoka County alluvial aquifer were tested for NO_3-N by the USGS from 1991 to 1995. The NO_3-N concentrations ranged from less than 0.05 milligrams per liter (mg/L) to 58 mg/L; the 50th percentile concentration was 7.1 mg/L (Rupert, 1997). To establish this regional monitoring project, the ISDA randomly selected domestic wells in the area and coordinated with homeowners to conduct ground water sampling.

Nutrients, pesticides, and common ions were evaluated during the seven years (1997 through 2003) of ISDA's testing. Laboratory results indicate numerous domestic wells located north of Paul and Rupert have NO_3-N values that suggest some type of land use influences on the ground water. In addition, low level concentrations of various pesticides were detected in numerous wells.

The ISDA is currently working to advise residents and officials of the area on how to minimize further ground water contamination and possible health risks. Ground water monitoring will continue at least through the year 2004 to assist with these efforts.

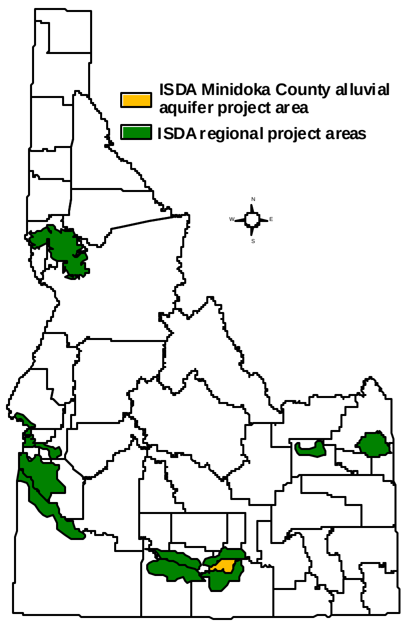

Figure 1. Location of Minidoka County alluvial aquifer project and other regional project areas.

Methods

To establish this project, ISDA statistically assessed IDWR Statewide Program nitrate, chloride, and atrazine monitoring data. ISDA statistically determined that sampling 45 randomly selected domestic wells would provide adequate data to evaluate overall ground water quality underlying the area. All sampling was conducted after a quality assurance project plan (QAPP) was established. Permission was gained from the land owners prior to sampling.

Nutrients and other common ions were evaluated every year since 1997. All sample collections followed established ISDA protocols (on file at ISDA main office) for handling, storage, and shipping. Samples were sent to the University of Idaho Analytical Sciences Laboratory (UIASL) in Moscow, Idaho. UIASL conducted tests for nitrate, nitrite, ammonia, orthophosphorous, chloride, sulfate, bromide, and fluoride using Environmental Protection Agency (EPA) Methods 300.0 and 350.1. Duplicates, splits, and matrix

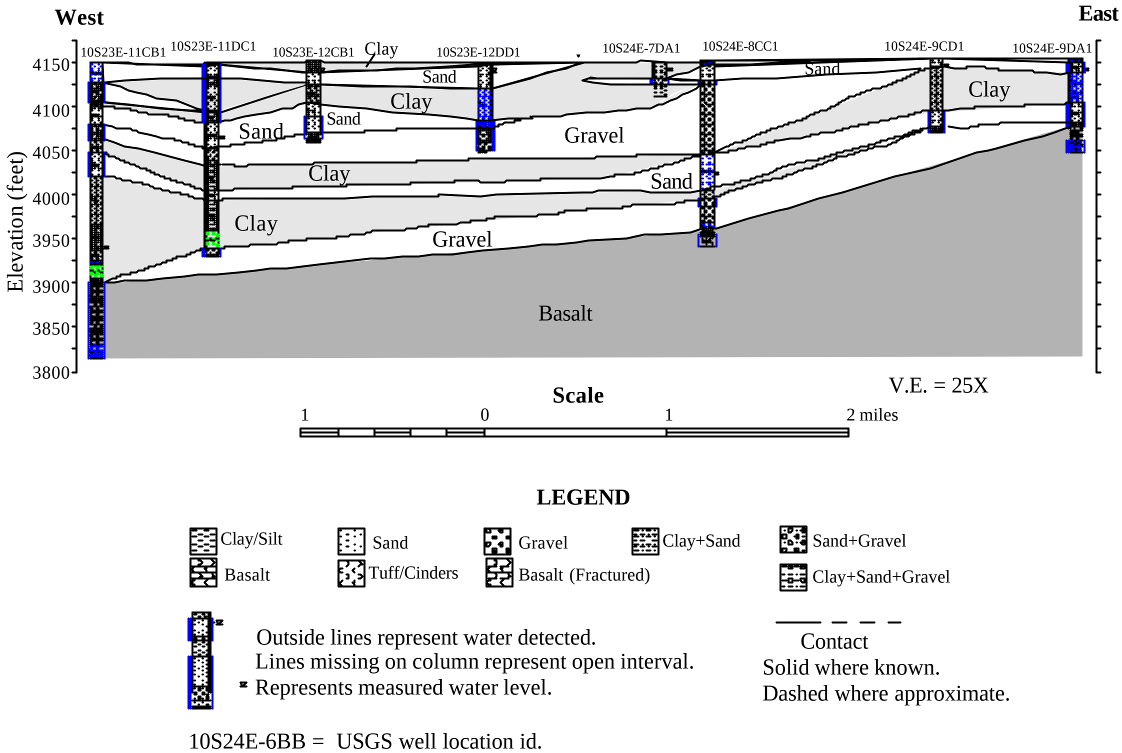

Figure 2. Geologic cross section based on well drillers' reports from Minidoka Alluvial Aquifer project area. Cross section line is displayed on Figure 4 (after Carlson, 1999).

spikes/matrix spike duplicates were collected and submitted as a part of the QAPP.

In 1997, samples were sent to the Washington Department of Ecology (WDOE) Laboratory in Manchester, Washington. Testing for pesticides was accomplished utilizing EPA Methods 1618 and SW8150 with very low detection limits. In 1999 and 2001, samples were sent to the UIASL in Moscow, Idaho for pesticide analysis. Samples were tested for various pesticides utilizing EPA Methods 507, 508, 515.1, and 531.1.

In 2000, samples were collected from selected wells following ISDA protocols for nitrogen isotope analysis. Samples were frozen and shipped via Federal Express one-day service to the ^{15}N Analysis Service, Department of Natural Resources and Earth Sciences, University of Illinois Champaign-Urbana. In 2001 and 2002, samples were collected from selected wells for nitrogen and oxygen isotope analysis, following ISDA protocols. The samples were frozen and shipped via Federal Express one-day service to North Carolina State University Stable Isotope Laboratory.

Description of Project Area

The Minidoka County alluvial aquifer regional monitoring project encompasses an approximately 16 mile wide and 10 mile long area of irrigated agricultural land adjacent to the Snake River. The main source of irrigation is provided by surface water diverted from the Snake River (Rupert, 1997). Local irrigation systems vary from the typical and historic practice of flood irrigation to more modern techniques of sprinkler irrigation. Major crops in the area include potatoes, sugar beets, wheat, barley, corn and beans (Mitchell, 1998).

Potential sources for NO_3-N leaching to ground water in the project area include applied nitrogen-based fertilizers, septic systems, cattle manure, legume crops, and nitrogen mineralization. A study of the Magic Valley Region conducted by Rupert (1997) calculated that 93% of the total NO_3-N input into the regional system is supplied by cattle manure (29%), fertilizer (45%), and legume crops (19%). He also concluded that domestic septic systems had minimal NO_3-N input (less than 1%) and precipitation provided 7% of the NO_3-N input.

Hydrogeology

The top soil in the project area can be classified into two basic types. The soil north of the Snake River and south of Paul and Rupert is somewhat poorly drained loamy sands to clay loams on low alluvial terraces (Hansen, 1975). The soil north of Paul and Rupert is well drained sands to silty clay loams on low alluvial terraces (Hansen, 1975).

Figure 2 shows the alluvial aquifer is perched on top of clay layers, which separates the shallow alluvial aquifer from the deeper regional basalt aquifer (Rupert, 1997).

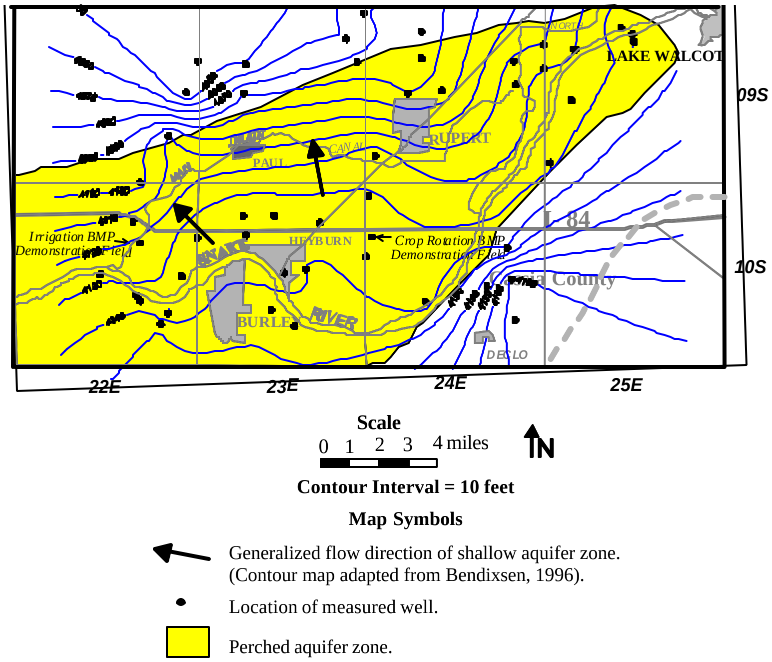

Figure 3. Contour map of the shallow alluvial ground water system in southern Minidoka County. Map shows generalized direction of ground water flow and extent of perched aquifer zone (after Carlson, 1999).

Water elevation contouring of the deep system suggests an area of mixing at the northern most extent of the shallow system. The majority of the alluvial aquifer is composed of sands and gravels deposited by streams and the Snake River (Rupert, 1997). The aquifer is recharged mainly from infiltration of irrigation water, with some shallow wells going dry after the end of the irrigation season (Rupert, 1997). Based on well driller's reports from domestic wells in the project area, typical depth to ground water is less than 100 feet and is as little as 4 feet below land surface in some areas.

Figure 2 indicates that unconsolidated deposits of sand and gravel extend to a depth of 200 to 250 feet below land surface and are underlain by basalt. In addition, the geologic cross section suggests that the unconsolidated deposits and basalt are fairly continuous laterally with a very slight dip to the west.

Data collected from the area suggests a relatively low gradient for the shallow system with direction of ground water flow to the north (Rupert, 1997; Mitchell, 1998) (Figure 3). However, in a study done by the USGS, water flow direction of the shallow system was determined to be south towards the Snake River (Mitchell, 1998).

Results

Sampling results of the first seven years indicate NO_3-N and pesticide impacts have occurred to the shallow alluvial aquifer. Results are summarized and presented in the following sections.

Nitrate

Table 1 presents statistics for 36 wells that have been sampled every year (1997 to 2003). Approximately 45 wells have been sampled per year; however, only wells that have been sampled consistently every year are used for the statistics.

In 2003, the maximum NO_3-N concentration for the 36 wells consistently sampled was 8.8 mg/L, which was the lowest value during the past seven sampling years. The median NO_3-N concentration has fluctuated between 4.6 mg/L in 2000 to 3.2 mg/L in 2002. In 2003, the median NO_3-N concentration was 3.4 mg/L for the 36 wells used for the statistics. In general, median NO_3-N concentrations have declined over the period of this study.

A total of 44 wells were sampled in 2003. One of these wells had NO_3-N concentrations above 10 mg/L and was

Table 1. Nitrate results for Minidoka County Alluvial Aquifer regional project, 1997-2003.[1]

Concentration Range (mg/L)	1997 36 Wells	1998 36 Wells	1999 36 Wells	2000 36 Wells	2001 36 Wells	2002 36 Wells	2003 36 Wells
<Laboratory Detection Limit	0	0	0	0	0	2 (5.6%)	0
Laboratory Detection Limit to < 2.0	8 (22.2%)	7 (19.4%)	9 (25%)	8 (22.2%)	10 (27.8%)	10 (27.8%)	11 (30.6%)
2.0 to <5.0	12 (33.3%)	16 (44.4%)	16 (44.4%)	11 (30.6%)	13 (36.1%)	13 (36.1%)	15 (41.7%)
5.0 to <10.0	14 (38.8%)	11 (30.6%)	10 (27.8%)	15 (41.7%)	13 (36.1%)	10 (27.8%)	10 (27.8%)
>10.0	2 (5.6%)	2 (5.6%)	1 (2.8%)	2 (5.6%)	0	1 (2.8%)	0
Mean Value	4.7 mg/L	4.7 mg/L	4.2 mg/L	5.0 mg/L	4.2 mg/L	4.5 mg/L	3.6 mg/L
Median Value	4.3 mg/L	4.5 mg/L	3.8 mg/L	4.6 mg/L	3.6 mg/L	3.2 mg/L	3.4 mg/L
Maximum Value	11.4 mg/L	12.9 mg/L	10 mg/L	10.1 mg/L	9.8 mg/L	11 mg/L	8.8 mg/L

[1]The 36 wells used in table 1 were sampled consistently for all seven sampling years. Approximately 45 wells were sampled per year; however, only wells that have been sampled every year were used in this table.

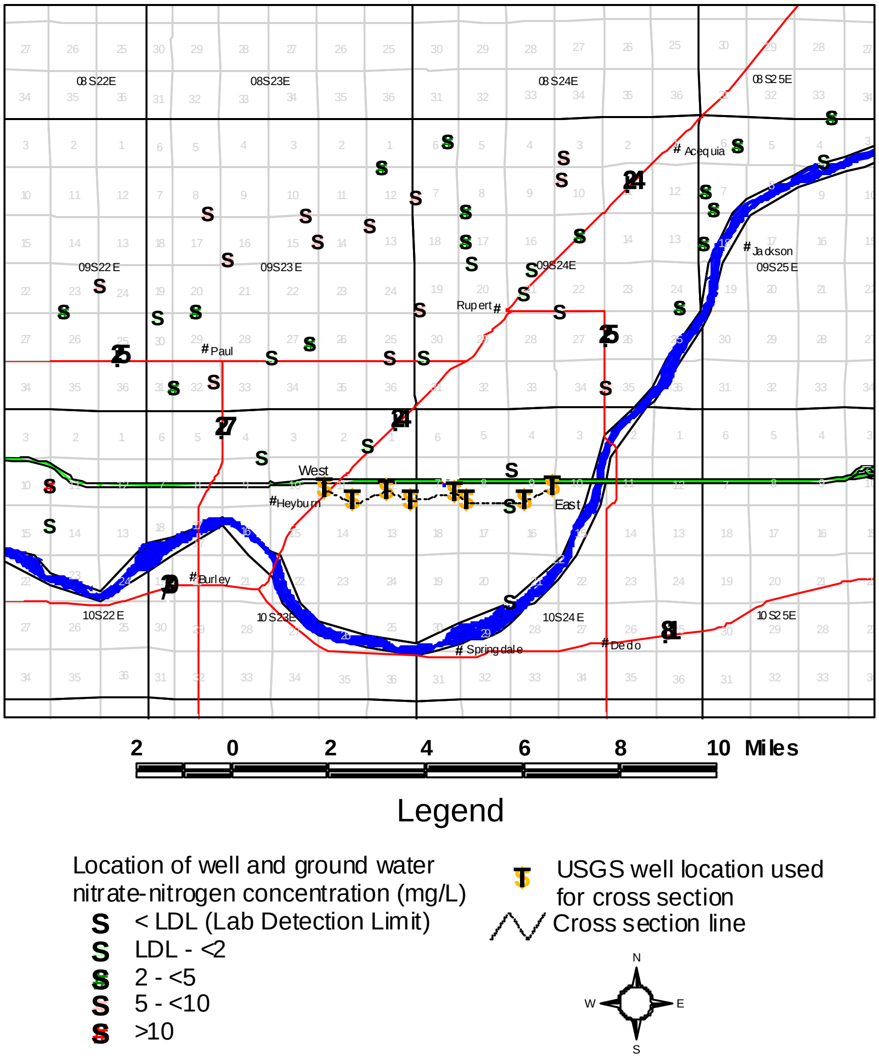

Figure 4. Location of wells sampled by ISDA in Minidoka County and geologic cross section line. Colors represent NO_3-N concentration measured in ground water from each well during ISDA 2003 sampling.

located west of Heyburn (Figure 4). The detection over the EPA Maximum Contaminant Level (MCL) of 10 mg/L for NO_3-N is of concern because of potential health risks.

Pesticides

Samples were collected in 1997 and sent to the WDOE Laboratory in Manchester, Washington. Testing for pesticides was accomplished utilizing EPA Methods 1618 and SW8150 with very low detection limits. In 1999 and 2001, samples were sent to the University of Idaho Analytical Sciences Laboratory (UIASL) in Moscow, Idaho for pesticide analysis. Samples were tested for various pesticides utilizing EPA Methods 507, 508, 515.1, and 531.1.

Forty-three wells were sampled for pesticides in 1997, the results are shown in Table 2. Analysis of samples detected the presence of atrazine, desethyl atrazine, simazine, bromacil, prometon, metribuzin, propazine, desisopropyl prometon, diuron, desisopropyl atrazine, alachlor, benzene, EPTC, hexazinone, and triallate, in order from most to least frequently detected. There were a total of 125 positive pesticide detections in 36 wells during 1997. All of the detections were below any EPA health standards, except one

Table 2. Pesticide results for Minidoka County alluvial aquifer regional project, 1997.

Pesticide Detects	Number of Detects	Range (µg/L)	Mean Value of Detects (µg/L)	Median Value of Detects (µg/L)	Health Standard (µg/L)
Alachlor	1	0.042	0.042	0.042	2 (MCL)[1]
Atrazine	31	0.001 - 0.680	0.048	0.013	3 (MCL)[1]
Benzene	1	0.32	0.32	0.32	5 (MCL)[1]
Bromacil	10	0.004 - 3.10	0.44	0.08	100 (RfD)[2]
Desethyl Atrazine	28	0.002 - 0.27	0.02	0.007	35 (RfD)[2]
Desisopropyl Atrazine	2	0.006 - 0.086	0.046	0.046	35 (RfD)[2]
Desisopropyl Prometon	3	0.011 - 0.050	0.029	0.027	100 (Lifetime)[3]
Diuron	3	0.020 - 9.20	3.157	0.25	9 (RfD)[2]
EPTC	1	0.038	0.038	0.038	25 (RfD)[2]
Hexazinone	1	0.003	0.003	0.003	200 (RfD)[2]
Metribuzin	5	0.001 - 0.007	0.004	0.004	13 (RfD)[2]
Prometon	9	0.001 - 0.490	0.086	0.016	15 (RfD)[2]
Propazine	4	0.003 - 0.100	0.029	0.006	20 (RfD)[2]
Simazine	21	0.001 - 0.430	0.037	0.012	4 (MCL)[1]
Triallate	1	0.027	0.027	0.027	13 (RfD)[2]

[1]MCL-EPA Maximum Contaminate Level
[2]RfD-EPA Reference Dose for 10 kg Child
[3]Lifetime-EPA Maximum daily dose

detection of diuron. The EPA daily reference dose for a 10 kg child is 9.0 micrograms/liter (µg/L). One well had a diuron concentration of 9.2 µg/L. However, the health standard was not exceeded in subsequent sampling in 1999 and 2001.

Forty-three wells were tested for pesticides in 1999, the results are shown in Table 3. The pesticides positively detected were atrazine, simazine, prometon, bentazon, bromacil, cycloate, dacthal (DCPA), diuron, and propazine, in order from most to least frequently detected. There were a total of 50 positive pesticide detections in 29 wells during 1999. One well had a concentration of cycloate over the EPA health standard of 0.17 µg/L (Table 3). However, the pesticide was not detected in subsequent sampling in 2001. A potential reason for fewer pesticide detections in 1999 versus 1997 is the higher environmental detection limits utilized by the UIASL as compared to WDOE Laboratory.

Forty-four wells were tested for pesticides in 2001, the results are shown in Table 4. The pesticides detected were desethyl atrazine, atrazine, bromacil, simazine, dacthal (DCPA), desisopropyl atrazine, diuron, hexazinone, metolachlor, and prometon, in order from most to least frequently detected. There were a total of 41 positive pesticide detections in 23 wells during 2001. All detections were below any EPA health standards.

Nitrogen and Oxygen Isotopes

Overview

The ratio of the common nitrogen isotope ^{14}N to its less abundant counterpart ^{15}N relative to a known standard (denoted d^{15}N) can be useful in determining sources of NO_3-N. Common sources of NO_3-N in ground water are applied commercial fertilizers, animal or human waste, precipitation, and organic nitrogen within the soil. Each of these NO_3-N source categories has a potentially distinguishable nitrogen isotopic signature. Typical d^{15}N

Table 3. Pesticide results for Minidoka County alluvial aquifer regional project, 1999.

Pesticide Detects	Number of Detects	Range (µg/L)	Mean Value of Detects (µg/L)	Median Value of Detects (µg/L)	Health Standard (µg/L)
Atrazine	22	0.029 - 0.23	0.053	0.044	3 (MCL)[1]
Bentazon	2	1.10 - 2.90	2.0	2.0	300 (RfD)[2]
Bromacil	1	4.90	4.90	4.90	100 (RfD)[2]
Cycloate	1	0.36	0.36	0.36	0.17 (RfD)[2]
Dacthal (DCPA)	1	0.25	0.25	0.25	70 (Lifetime)[3]
Diuron	1	1.40	1.40	1.40	9 (RfD)[2]
Prometon	4	0.060 - 0.130	0.081	0.066	15 (RfD)[2]
Propazine	1	0.027	0.027	0.027	20 (RfD)[2]
Simazine	17	0.021 - 0.810	0.115	0.05	4 (MCL)[1]

[1]MCL-EPA Maximum Contaminate Level
[2]RfD-EPA Reference Dose for 10 kg Child
[3]Lifetime-EPA Maximum daily dose

Table 4. Pesticide results for Minidoka County alluvial aquifer regional project, 2001.

Pesticide Detects	Number of Detects	Range (µg/L)	Mean Value of Detects (µg/L)	Median Value of Detects (µg/L)	Health Standard (µg/L)
Atrazine	10	0.028 - 0.33	0.08	0.041	3 (MCL)[1]
Bromacil	5	0.11 - 0.44	0.22	0.18	100 (RfD)[2]
Dacthal (DCPA)	4	0.39 - 4.20	1.90	1.5	70 (Lifetime)[3]
Desethyl Atrazine	12	0.026 - 0.55	0.080	0.35	35 (RfD)[2]
Desisopropyl Atrazine	1	0.28	0.28	0.28	35 (MCL)[1]
Diuron	1	0.50	0.50	0.50	9 (RfD)[2]
Hexazinone	1	0.17	0.17	0.17	200 (RfD)[2]
Metolachlor	1	0.099	0.099	0.099	100 (HAL)[4]
Prometon	1	0.65	0.65	0.65	15 (RfD)[2]
Simazine	5	0.027 - 0.40	0.13	0.081	4 (MCL)[1]

[1]MCL-EPA Maximum Contaminate Level
[2]RfD-EPA Reference Dose for 10 kg Child
[3]Lifetime-EPA Maximum daily dose
[4]HAL-EPA Health Advisory Limit

Table 5. 2000 through 2002 $d^{15}N$ and $d^{18}O_{NO_3}$ results for selected wells.

Well ID	2000 Data		2001 Data			2002 Data		
	NO_3-N (mg/L)	$d^{15}N$ ($^0/_{00}$)	NO_3-N (mg/L)	$d^{15}N$ ($^0/_{00}$)	$d^{18}O_{NO_3}$ ($^0/_{00}$)	NO_3-N (mg/L)	$d^{15}N$ ($^0/_{00}$)	$d^{18}O_{NO_3}$ ($^0/_{00}$)
7300201	9.32	NT[1]	8.64	NT[1]	NT[1]	8.3	5.491	6.485
7300601	5.62	NT[1]	5.06	NT[1]	NT[1]	4.3	8.552	1.483
7300701	10.1	NT[1]	9.6	6.118	5.160	8.1	6.304	3.429
7300901	7.97	NT[1]	7.25	11.872	3.443	7.4	15.586	5.684
7301101	7.06	NT[1]	6.68	NT[1]	NT[1]	6.5	4.614	1.960
7301601	9.39	4.81	8.51	NT[1]	NT[1]	8.1	6.870	1.232
7301801	5.78	NT[1]	5.35	NT[1]	NT[1]	4.7	6.284	1.918
7302601	NT[1]	NT[1]	18.9	NT[1]	NT[1]	12	5.179	3.303
7302701	9.8	8.68	9.15	10.397	2.197	9.8	5.665	0.215
7302801	10.1	8.42	9.76	NT[1]	NT[1]	7.9	3.209	0.695
7303101	3.02	NT[1]	3.08	10.797	10.711	3	NT[1]	NT[1]
7303201	24.1	12.28	23.7	NT[1]	NT[1]	33	9.511	3.731
7303901	8.32	NT[1]	7.16	NT[1]	NT[1]	5.4	4.032	2.721
7304101	9.53	8.12	7.85	NT[1]	NT[1]	8	6.331	3.588
7304301	7.2	4.45	5.67	NT[1]	NT[1]	11	4.799	3.051
7304501	7.32	NT[1]	5.86	NT[1]	NT[1]	5.5	12.512	3.141

[1]NT - Not tested

ranges for fertilizer is –5 per mil ($^0/_{00}$) to +5 per mil ($^0/_{00}$), while typical waste sources have ranges greater than 10$^0/_{00}$ (Kendall and McDonnell, 1998). Nitrogen isotope values between 5$^0/_{00}$ and 10$^0/_{00}$ are generally believed to indicate an organic or mixed source (Kendall and McDonnell, 1998).

Use of nitrogen isotopes as the sole means to determine NO_3-N sources should be done with great care. Nitrogen isotope values in ground water can be complicated by several reactions (e.g., ammonia volatilization, nitrification, denitrification, plant uptake, etc.) that can modify the $d^{15}N$ values (Kendall and McDonnell, 1998). Furthermore, mixing of sources along shallow flowpaths makes determination of sources and extent of denitrification very difficult (Kendall and McDonnell, 1998).

^{18}Oxygen (^{18}O) fractionization of the nitrate molecule together with $d^{15}N$ can be used to trace the effects of denitrification (Clark and Fritz, 1997). Denitrification results in enrichment of both $d^{15}N$ and $d^{18}O_{NO_3}$. By analyzing both $d^{15}N$ and $d^{18}O_{NO_3}$, denitrification effects can be distinguished from mixing sources since the ratio of enrichment in $d^{15}N$ to $d^{18}O_{NO_3}$ is about 2:1 (Kendall et. al, 1995).

Findings

In 2000 through 2002, ISDA conducted $d^{15}N$ testing as a possible indicator of source(s) of NO_3-N in the ground water. Six wells were tested in 2000, four wells were tested in 2001, and 15 wells were tested in 2002 (Table 5). Wells chosen for $d^{15}N$ testing had elevated NO_3-N concentrations in previous monitoring rounds. Table 5 presents the $d^{15}N$ results along with NO_3-N concentrations.

The six water samples collected in 2000 were sent to the University of Illinois ^{15}N Analysis Service for $d^{15}N$ analysis. Results of $d^{15}N$ testing returned values that ranged from 4.45$^0/_{00}$ to 12.28$^0/_{00}$ (Table 5). One well had $d^{15}N$ values that suggested an animal or human waste source and was located southwest of Paul. Two wells had $d^{15}N$ values that suggested a fertilizer source; one was located north of Paul and the other was located northeast of Rupert. The remaining three wells had values that suggested a mixed or inorganic source of NO_3-N.

The four water samples collected in 2001 were sent to University of North Carolina State University (NCSU) Stable Isotope Laboratory for $d^{15}N$ analysis. The NCSU Stable Isotope Laboratory was used in order to perform both $d^{15}N$ and $d^{18}O_{NO_3}$ testing to evaluate for the effects of denitrification. Results of $d^{15}N$ testing returned values that ranged from 6.118$^0/_{00}$ to 11.872$^0/_{00}$ (Table 5). Three wells had values that suggested an animal or human waste source; two were located between Paul and Rupert, and the other was located east of Rupert. The remaining well had a value that suggested a mixed or inorganic source of NO_3-N.

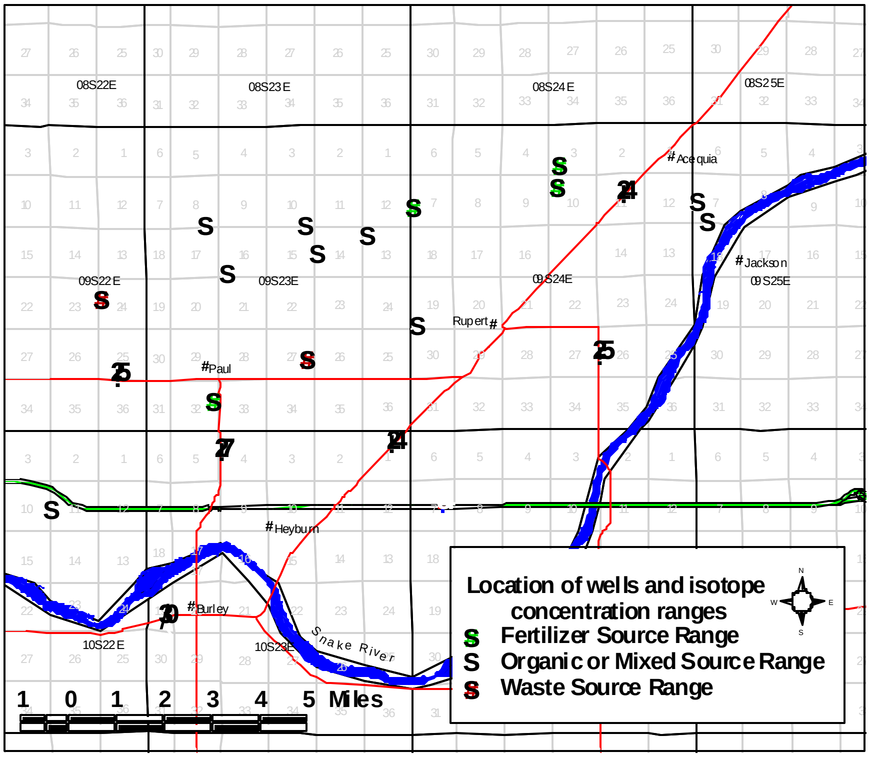

Figure 5. Location of wells sampled by ISDA in Minidoka County, 2002 for nitrogen isotope analysis. Colors represent possible sources of nitrate-nitrogen in ground water from each well based on $d^{15}N$ testing.

The 15 water samples collected in 2002 were sent to the NCSU Stable Isotope Laboratory for $d^{15}N$ analysis. Results of the $d^{15}N$ testing returned values that ranged from $3.209^0/_{00}$ to $15.586^0/_{00}$ (Table 5). Figure 5 shows the location of the wells sampled and the corresponding $d^{15}N$ value. Four wells had values that were within the fertilizer range for $d^{15}N$, three of these wells were located north of Rupert, one was located south of Paul. Two wells had values that suggested an animal or human waste source; one was located between Paul and Rupert while the other was located northwest of Paul. The remaining nine wells had $d^{15}N$ values that indicated an organic or mixed source of NO_3-N.

Four water samples were collected in 2001 and 15 water samples were collected in 2002 and sent to the NCSU Stable Isotope Laboratory for $d^{18}O_{NO_3}$ analysis. Results of the $d^{18}O_{NO_3}$ returned values that ranged from $2.197^0/_{00}$ to $10.711^0/_{00}$ in 2001 and $0.215^0/_{00}$ to $6.485^0/_{00}$ in 2002 (Table 5). Nitrogen and oxygen isotope data were used to complete a linear regression analysis. Prior to the analysis, a significance level of 0.05 was selected for a statistical F test. The data did not pass a significance level of 0.05, and had a coefficient of determination (R^2) of 0.1757 for the 2002 isotope data. The ratio of enrichment of $d^{15}N$ to $d^{18}O_{NO_3}$ does not show any significant correlation. The process of denitrification is thought to enrich $d^{15}N$ and $d^{18}O_{NO_3}$ by 2:1 (Kendall et. al, 1995). The $d^{15}N$ and $d^{18}O_{NO_3}$ data do not indicate isotope enrichment due to the denitrification process. Waste from animal operations and septic tanks in the project area could be a source of $d^{15}N$ values greater than $10^0/_{00}$ detected within the wells.

Conclusions

Ground water within the Minidoka County alluvial aquifer is being impacted from NO_3-N and pesticides. The median NO_3-N concentration for the statistically assessed wells for 2003 was 3.4 mg/L. One well had a NO_3-N concentration over the EPA MCL of 10 mg/L. Areas of elevated NO_3-N concentrations that are of concern are located north of Paul and Rupert. However, median nitrate concentrations in ground water from 1997 to 2003 indicate a declining trend in NO_3-N levels.

The number of pesticide detections has declined since the beginning of the project. Although concentrations of pesticide detections were generally low, there is concern about multiple pesticide detections per well. Health risks associated with consuming low level concentrations of multiple pesticide compounds is poorly understood.

Agricultural practices likely contribute to the NO_3-N and pesticide concentrations in the ground water of this project area. Testing results indicate NO_3-N and pesticide impacts to the Minidoka County alluvial aquifer are widespread. This is common in agricultural areas that have high agrichemical input and mostly furrow irrigation overlying a shallow alluvial aquifer. Leaching of applied commercial fertilizers, legume crops, and waste are probably major causes of NO_3-N entering the ground water.

Recommendations

To determine if current farming practices are contributing to ground water degradation and to locate other potential contaminant sources, the ISDA recommends continued and more intensive monitoring in the project area.

Testing should include, but not be limited to:

- Continued ground water monitoring for nutrients, common ions, and pesticides.
- Isotope testing to determine possible NO_3-N sources and relative ages of ground water.

- Soil sampling and soil pore water sampling.
- Analysis of farm practices in the project area, including nutrient and pesticide applications, irrigation practices, and agricultural best management practices (BMP).

The ISDA further recommends that measures to reduce NO_3-N and pesticide impacts on ground water be addressed and implemented. The ISDA recommends that:

- Growers and agrichemical professionals conduct nutrient, pesticide, and irrigation water management evaluations.
- Producers follow the Idaho Agricultural Pollution Abatement Plan and Natural Resources Conservation Service Nutrient Management Standard.
- Producers and agrichemical dealers evaluate their storage, mixing, loading, rinsing, containment, and disposal practices.
- Homeowners assess lawn and garden practices, especially near wellheads.
- Local residents assess animal waste management practices.
- State and local agencies assess impacts from private septic systems.
- Home and garden retail stores establish outreach programs to illustrate proper application and management of nutrients and pesticides.
- Responsible parties assess current pesticide application practices to non-crop areas (such as roadsides, railroad areas, etc.).

The ISDA recommends that the Minidoka Soil and Water Conservation District lead a response process to create a plan of action to address these ground water contamination issues. The soil and water conservation district should work with local agrichemical professionals, landowners, and agencies to implement this process and seek funding to support these efforts. The ISDA will support these local partners in seeking funding and implementing a comprehensive program.

References

Bendixsen, S., 1996. Burley-Rupert area-Idaho Department of Water Resources Poster, Boise, Idaho 83706.

Clark, I., and P. Fritz, 1997. Environmental Isotopes in Hydrogeology. Lewis Publishers, New York, NY, 290 pp.

Carlson, Rick A., 1999. Geostatistical assessment and hydrogeologic implications of agricultural best management practices to reduce nonpoint source nitrate pollution southern Minidoka County, Idaho. Masters Thesis, Boise State University, Boise, Idaho 83725, pp. 177.

Hansen, Harold L., 1975. Soil survey of Minidoka area, Idaho, parts of Minidoka, Blaine, and Lincoln counties. United States Department of Agriculture, Soil Conservation Service, Map 1.

Kendall, C., and McDonnell, J.J., 1998. Isotope tracers in catchment hydrology. Elsevier Science B.V., Amsterdam, pp. 519-576.

Mitchell, John C., 1998. Waste disposal wells as a factor in nitrate levels in ground water, A&B Irrigation District, Minidoka County, Idaho. Idaho Department of Water Resources, 2 p.

Rupert, M.G., 1997. Nitrate (NO_2+NO_3-N) in ground water of the upper Snake River Basin, Idaho and Western Wyoming, 1991-95. U.S. Geological Survey, pp. 8-30.