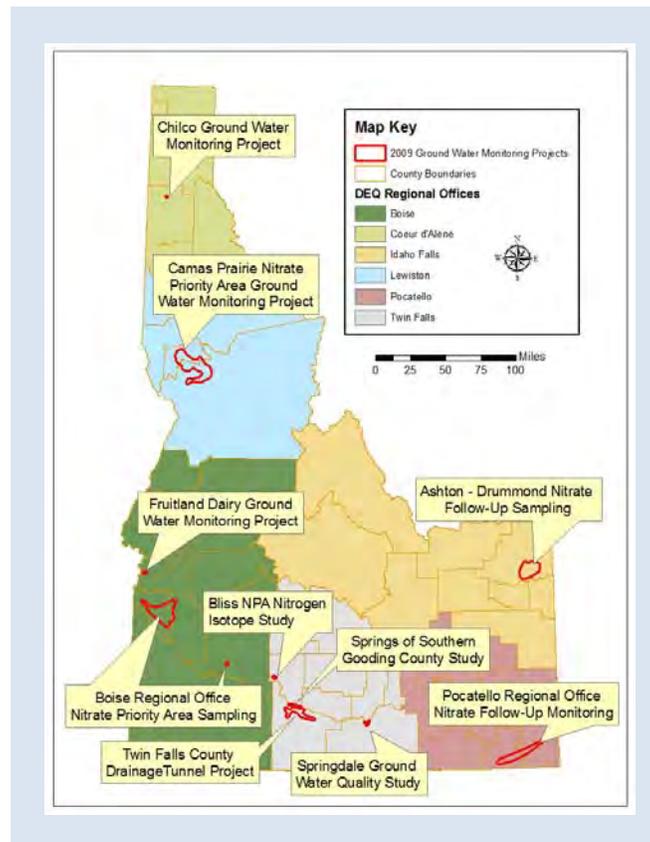


Summary Report for the Idaho Department of Environmental Quality Ground Water Quality Monitoring Projects 2009



Idaho Department of Environmental Quality
March 2011

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List of Acronyms, Abbreviations, and Symbols

$\delta^{15}\text{N}$	the ratio of the two stable nitrogen isotopes ^{15}N and ^{14}N
$\delta^{18}\text{O}$	the ratio of the two oxygen isotopes ^{18}O and ^{16}O
$\delta^2\text{H}$	deuterium, the ratio of the two hydrogen isotopes ^1H and ^2H , also denoted as δD
BMP	best management practice
CAFO	confined animal feeding operation
CaCO_3	calcium carbonate
DEQ	Idaho Department of Environmental Quality
DO	dissolved oxygen
EPA	Environmental Protection Agency
GMWL	global meteoric water line
GWQMP	ground water quality management plan
HCO_3	bicarbonate
IDWR	Idaho Department of Water Resources
IFG	Idaho Forest Group
ISCC	Idaho Soil Conservation Commission
ISDA	Idaho State Department of Agriculture
LSCD	Lewis Soil Conservation District
MCL	maximum contaminant level
mg/L	milligrams per liter
MPN/100 mL	most probable number per 100 milliliters
ND	non detect
ng/L	nanograms per liter
$\text{NO}_2 + \text{NO}_3$ as N	nitrite plus nitrate as nitrogen
NO_3	nitrate
$\text{NO}_3\text{-N}$ or NO_3 as N	nitrate as nitrogen
NPA	nitrate priority area
NS	not sampled
OP	ortho-phosphorous
PCPP	personal care products and pharmaceuticals
per mil (‰)	parts per thousand
PWS	public water system
SCD	Soil Conservation District
SMX	sulfamethoxazole
TDS	total dissolved solids
TKN	total Kjeldahl nitrogen
$\mu\text{g/L}$	micrograms per liter
$\mu\text{S/cm}$	microsiemens per centimeter

1. Introduction

Ground water is a key resource in Idaho, providing nearly all the state's drinking water, and is a critical component of the state's economy. The economic and social vitality of every Idaho community depends on access to a safe and clean ground water supply.

Idaho statute (Title 39, Chapter 1) designates the Idaho Department of Environmental Quality (DEQ) as the primary agency to coordinate and administer ground water quality protection programs for the state. DEQ is also responsible for collecting and analyzing data for ground water quality management purposes.

The statute further directs DEQ, the Idaho Department of Water Resources (IDWR), and the Idaho State Department of Agriculture (ISDA) to conduct ground water quality monitoring and promote public awareness of ground water issues by making results of ground water quality investigations available to the public.

Public water systems (PWSs) are regulated by DEQ under the federal Safe Drinking Water Act and the "Idaho Rules for Public Drinking Water Systems" (IDAPA 58.01.08). These regulations require chemical analysis of drinking water for various contaminants. DEQ ensures that follow-up monitoring is conducted when contaminants of concern are detected in PWSs. DEQ also implements the Source Water Protection Program to promote the protection of drinking water.

In addition, DEQ also responds to detections of contaminants of concern that are found by monitoring programs implemented by other entities, such as the Statewide Ambient Ground Water Quality Monitoring Network, administered by IDWR. Follow-up investigations may develop into a DEQ local or regional monitoring project to assess conditions and identify areas where public health may be threatened. The investigation results can facilitate management decisions that protect the resource and promote public awareness for ground water protection.

The ground water quality monitoring results can also be used to define and prioritize degraded ground water quality areas, such as nitrate priority areas (NPAs). This prioritization is necessary to effectively allocate resources for water quality improvement strategies. DEQ has worked in coordination with state and federal agencies, as well as stakeholders, to develop ground water quality management plans (GWQMPs) that address ground water degradation in NPAs. Ground water quality data are used to evaluate the effectiveness of GWQMP implementation.

This report is intended to provide the public with an overview of DEQ's ground water monitoring projects and investigation activities accomplished with public funds during 2009. It does not include results from privately funded activities, including monitoring required by permits; monitoring associated with ongoing environmental remediation projects; or monitoring associated with PWS requirements. Prior to 2007, ground water quality monitoring activities were included as a chapter in the Integrated Report for surface water, which DEQ submits to the U.S. Environmental Protection Agency (EPA).

2. Source Water Assessments

In 1996, Congress amended the Safe Drinking Water Act (1974) to emphasize the protection of surface and ground water sources used for public drinking water (i.e., source water). The amendments require that each state develop a source water assessment plan for public drinking water sources, conduct assessments of all PWSs, and make the assessments available to the public. In 1999, the [Idaho Source Water Assessment Plan](#) (DEQ 1999) was developed and has since been implemented by DEQ.

A PWS is defined by EPA and DEQ as a system for the conveyance of water to the public for human consumption if the system has at least 15 service connections or regularly serves an average of at least 25 individuals at least 60 days per year. In 2009, Idaho had 1,884 active PWSs that obtained their water from ground water sources (EPA 2009). PWSs with a ground water source account for 96% of all PWSs in the state and serve a combined population of 990,020 people.

DEQ administers the [Safe Drinking Water Act](#) and the “[Idaho Rules for Public Drinking Water Systems](#)” (IDAPA 58.01.08) through the Drinking Water Program. PWS sources (both ground water and surface water) are monitored under this program. The DEQ Ground Water Program may conduct additional monitoring when contaminants of concern are detected in PWSs. Please refer to the [DEQ Drinking Water](#) webpage for more information regarding the required monitoring at PWSs.

Source water assessments are the first step in protecting Idaho drinking water sources. Assessments summarize the likelihood of individual drinking water sources becoming contaminated and serve as the cornerstone of drinking water protection. DEQ completed assessments on all recognized PWSs in May 2003 and continues to complete assessments for new PWSs and update assessments as new information becomes available.

In 2009, DEQ continued to delineate and assess new PWSs in Idaho and develop source water assessment reports. A source water assessment report includes the following elements: (a) source water delineations, (b) potential contaminant inventories, (c) susceptibility analyses, and (d) system summary information. DEQ tracks source water assessment progress based on the state fiscal year, which runs from July 1 through June 30. For fiscal year 2009 (July 1, 2008, through June 30, 2009) 34 source water delineations and 41 source water assessment reports were completed. For fiscal year 2010 (July 1, 2009, through June 30, 2010) 58 source water delineations and 5 source water assessment reports were completed. In fiscal year 2010, a computerized web-based application that automatically generates the source water assessment reports was initiated and should be completed by February 2011.

3. Summary of Ground Water Quality Projects by Region

This section presents data from ground water quality monitoring and investigation projects that were conducted by DEQ in calendar year 2009. Projects are presented by region. Figure 1 identifies project locations and DEQ regions.

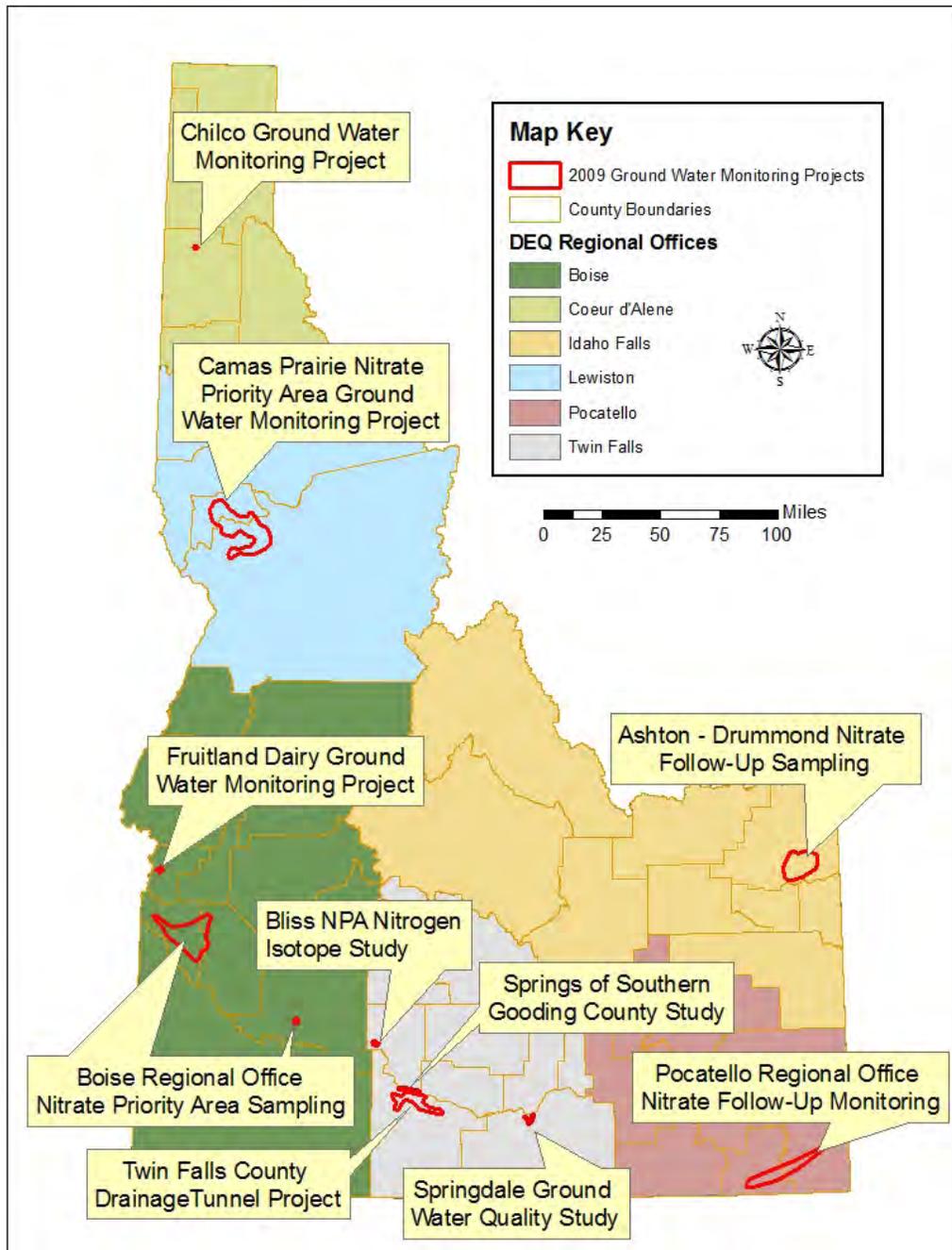


Figure 1. Idaho Department of Environmental Quality’s 2009 ground water quality project locations by region

An [interactive mapping application](#) of DEQ ground water quality data was created in 2009 and is now available on DEQ's website. The application contains ground water quality data that DEQ or its contractors have collected, including all of the data contained within this report. The application can be used to view and download data collected from 1987 to the present for nearly 300 contaminants, ranging from nitrate—a widespread ground water contaminant—to emerging contaminants such as personal care products and pharmaceuticals (PCPPs). The application was developed to help citizens, local officials, researchers, water quality professionals, consultants, and other stakeholders make informed decisions about land-use activities. The application also provides private well owners with an indication of ground water quality conditions in an area when considering treatment options for protecting their family's health.

3.1. Boise Region

3.1.1 Boise Regional Office Nitrate Priority Area Sampling

Purpose

The DEQ Boise Regional Office partnered with the ISDA for collecting and analyzing ground water from domestic wells that are part of ISDA's pesticide monitoring network. DEQ selected 20 wells within ISDA's pesticide monitoring network located in or near NPAs to sample for nitrate, arsenic, and other ions to help better characterize ground water quality.

Methods and Results

In July 2009, ISDA collected samples from 12 wells in or near the Ada Canyon NPA, 3 wells in the NE Star NPA, and 5 wells in or near the Mountain Home NPA (Figure 2 and Figure 3) on behalf of DEQ. ISDA measured water quality field parameters, including pH, temperature, specific conductance, and total dissolved solids (TDS). The samples were collected in conjunction with the ISDA's collection of water samples at the wells for pesticide analysis in accordance with ISDA's quality assurance project plan. DEQ funded analytical costs for the analysis of arsenic, bromide, chloride, fluoride, nitrate, nitrite, ortho-phosphorous (OP), and sulfate for the 20 wells. This section summarizes nitrate and arsenic sampling results since these were the only two contaminants detected at concentrations above EPA's drinking water maximum contaminant level (MCL).

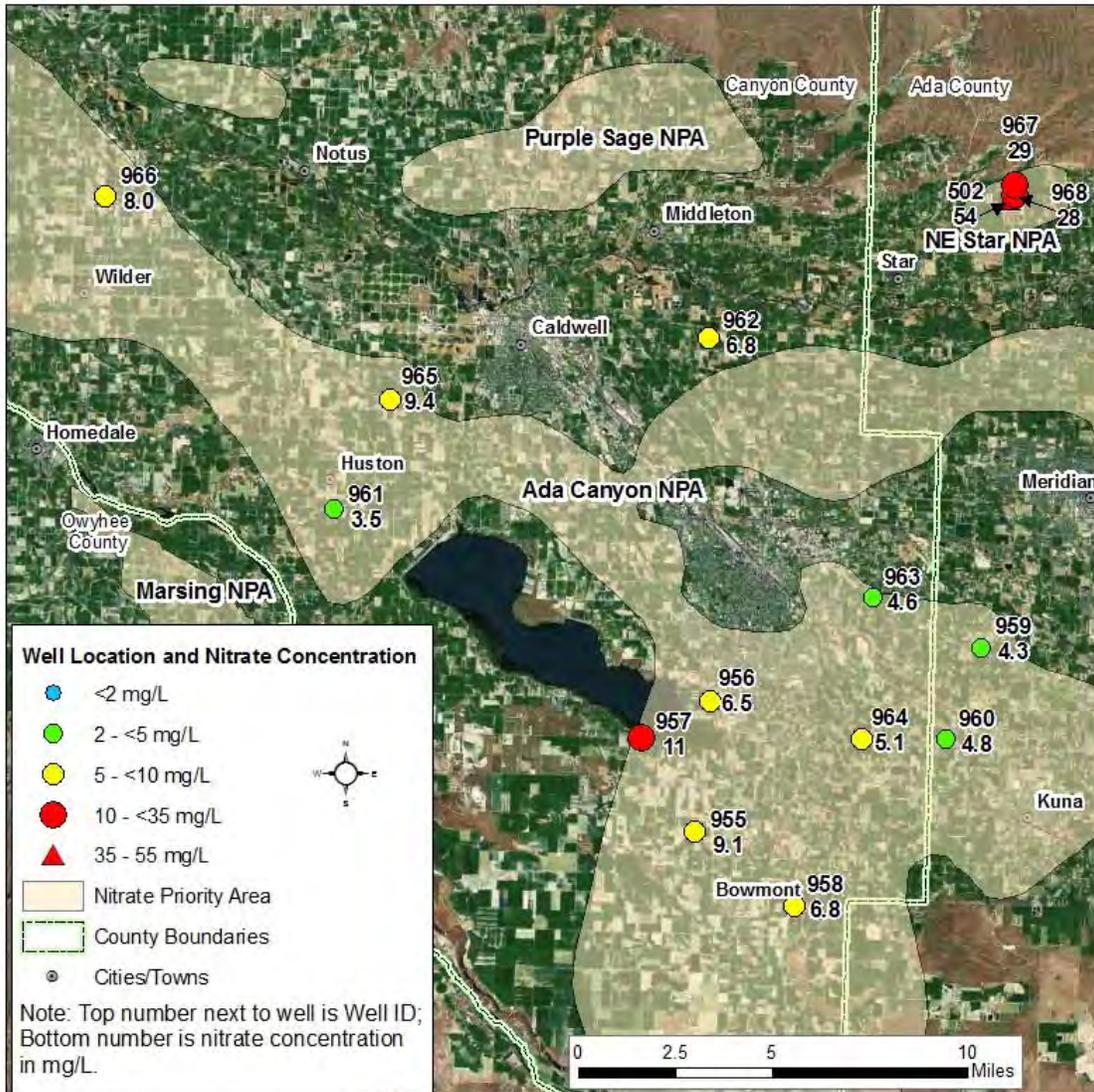


Figure 2. Well location, well ID, and nitrate concentrations (in milligrams per liter) for 2009 sampling in and near the Ada Canyon and NE Star Nitrate Priority Areas
Note: Full extent of nitrate priority areas is not shown.

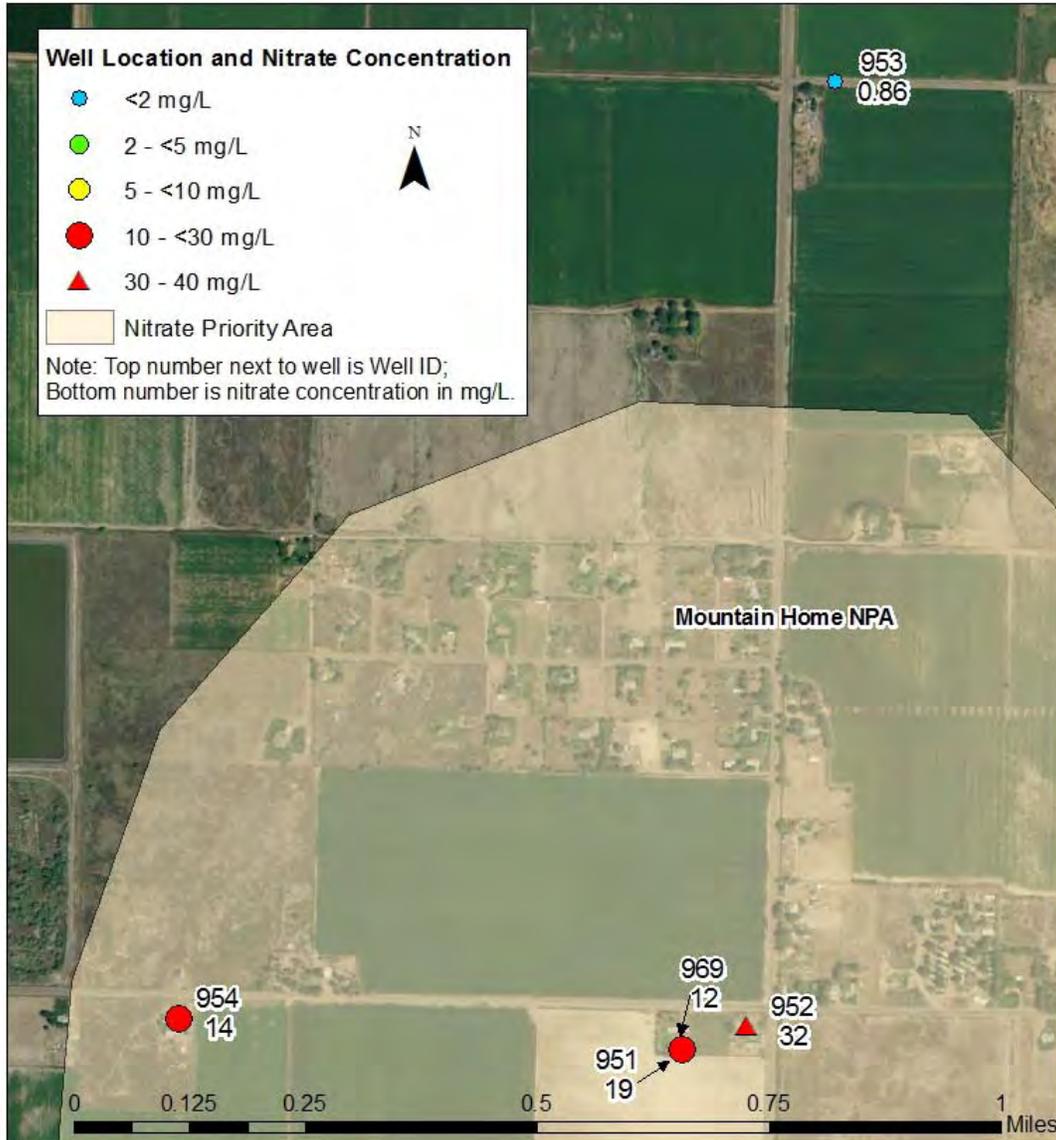


Figure 3. Well location, well ID, and nitrate concentrations (in milligrams per liter) for 2009 sampling in and near the northern portion of the Mountain Home Nitrate Priority Area

Note: Full extent of nitrate priority area is not shown.

Nitrate Sampling

In 2009, the 12 wells sampled in or near the Ada Canyon NPA had nitrate values ranging from 3.5 milligrams per liter (mg/L) to 11 mg/L, with a median value of 6.65 mg/L (Figure 2 and Table 1); 1 well exceeded the EPA's MCL for nitrate of 10 mg/L. The 3 wells sampled in the NE Star NPA ranged from 28 mg/L to 54 mg/L (Figure 2), all exceeding the MCL. The 5 wells sampled in or near the Mountain Home NPA had values ranging from 0.86 mg/L to 32 mg/L, with a median value of 14 mg/L (Figure 3), with 4 wells exceeding the MCL. Table 1 summarizes the laboratory results from samples collected for the Boise Regional Office NPA project.

Table 1. Summary of laboratory analytical results for Boise Regional Office 2009 Nitrate Priority Area project

Well ID	Well Depth (feet)	Nitrate Priority Area	Sample Date	Arsenic (µg/L)	Bromide (mg/L)	Chloride (mg/L)	Fluoride (mg/L)	Nitrate (mg/L)	Nitrite (mg/L)	Ortho-Phosphorus (mg/L)	Sulfate (mg/L)
955		Ada Canyon	7/13/2009	6.3	0.26	30	0.90	9.1	<0.050	<0.10	230
956		Ada Canyon	7/13/2009	13	1.2	150	0.63	6.5	<0.050	<0.10	350
957		Ada Canyon	7/13/2009	20	<0.10	14	0.55	11	<0.050	<0.10	100
958		Ada Canyon	7/13/2009	36	0.12	16	0.68	6.8	<0.050	<0.10	52
959	115	Ada Canyon	7/14/2009	5.6	<0.10	7.3	0.94	4.3	<0.050	<0.10	55
960	125	Ada Canyon	7/14/2009	2.9	<0.10	9.4	0.37	4.8	<0.050	<0.10	74
961	108	Ada Canyon	7/15/2009	3.7	<0.10	4.3	0.19	3.5	<0.050	0.25	8.4
962		Ada Canyon	7/15/2009	1.2	0.17	29	<0.15	6.8	<0.050	<0.1	110
963	48	Ada Canyon	7/14/2009	26	<0.10	4.8	1.0	4.6	<0.050	<0.10	21
964	107	Ada Canyon	7/13/2009	14	<0.10	12	0.61	5.1	<0.050	<0.10	79
965	182	Ada Canyon	7/14/2009	13	0.49	94	0.54	9.4	<0.050	<0.10	210
966		Ada Canyon	7/14/2009	26	0.16	19	0.74	8.0	<0.050	<0.10	140
951	190	Mountain Home	7/22/2009	3.4	0.3	64	0.30	19	<0.050	<0.10	240
952		Mountain Home	7/22/2009	4.1	0.21	57	0.75	32	<0.050	0.11	500
953		Mountain Home	7/22/2009	2.5	<0.10	5.8	0.31	0.86	<0.050	0.20	26
954		Mountain Home	7/22/2009	1.2	0.38	120	0.94	14	<0.050	0.17	270
969		Mountain Home	7/22/2009	1.9	0.43	76	0.20	12	<0.050	<0.10	240
502	150	NE Star	7/23/2009	5.5	<0.10	76	0.22	54	<0.050	0.18	87
967		NE Star	7/23/2009	7.2	<0.10	32	0.22	29	<0.050	0.20	50
968		NE Star	7/23/2009	4.3	<0.10	29	0.22	28	<0.050	0.21	48

Note: Bolded red numbers indicate the U.S. Environmental Protection Agency's maximum contaminant level was exceeded.
 Italicized red numbers indicate the U.S. Environmental Protection Agency's Secondary Drinking Water Regulation was exceeded.
 µg/L = micrograms per liter; mg/L = milligrams per liter

Arsenic Sampling

The 12 wells sampled in or near the Ada Canyon NPA had arsenic values ranging from 1.2 micrograms per liter ($\mu\text{g/L}$) to 36 $\mu\text{g/L}$, with a median value of 13 $\mu\text{g/L}$ (Table 1 and Figure 4); 7 wells exceeded the EPA’s MCL of 10 $\mu\text{g/L}$ for arsenic. The 3 wells sampled in the NE Star NPA had arsenic concentrations ranging from 4.3 $\mu\text{g/L}$ to 7.2 $\mu\text{g/L}$ (Table 1 and Figure 4), all below the MCL for arsenic. The 5 wells sampled in or near the Mountain Home NPA had values ranging from 1.2 $\mu\text{g/L}$ to 4.1 $\mu\text{g/L}$, with a median value of 2.5 $\mu\text{g/L}$ (Table 1), none exceeding the MCL for arsenic.

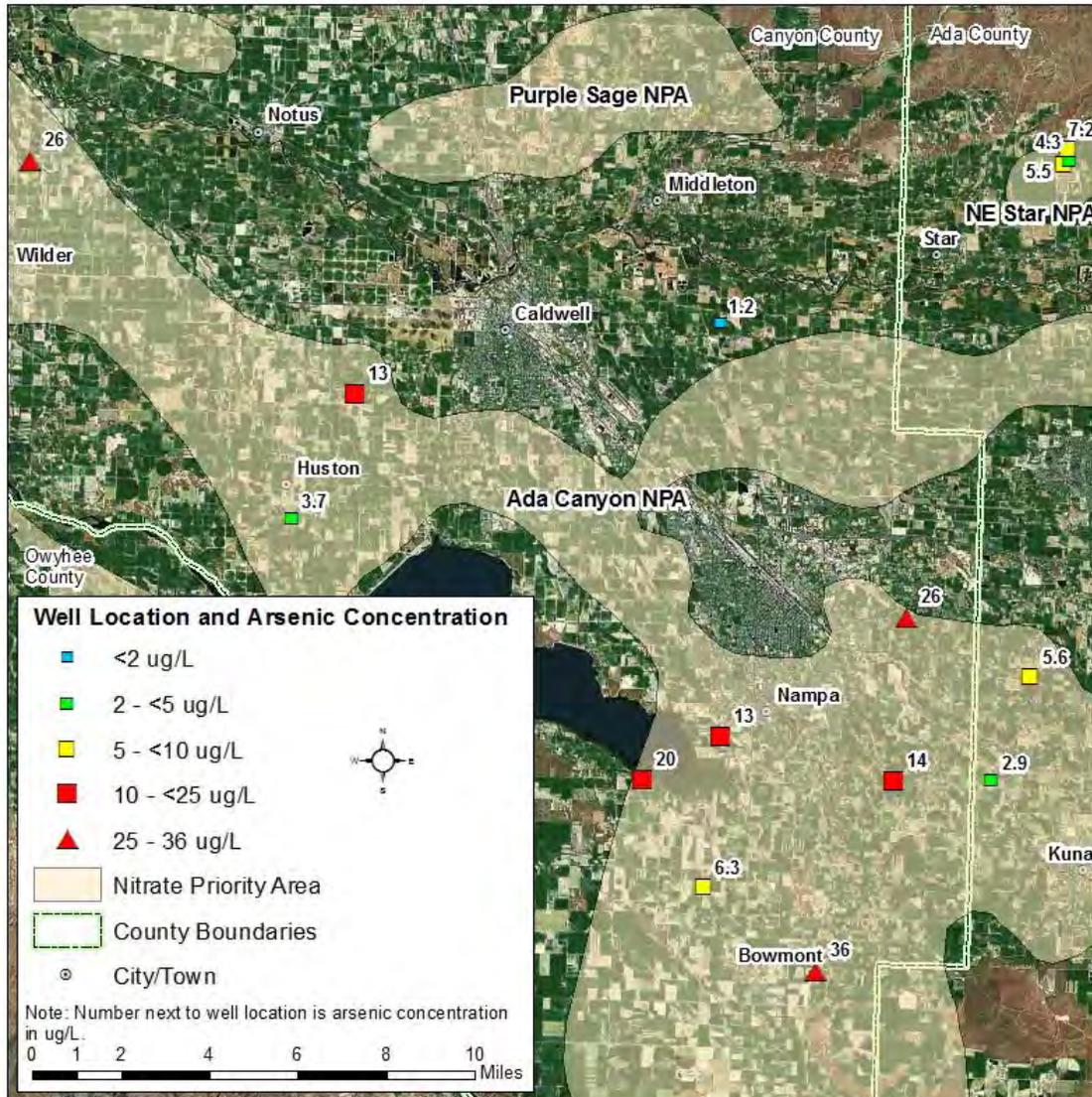


Figure 4. Arsenic concentrations (in micrograms per liter) for 2009 sampling in and near the Ada Canyon and NE Star Nitrate Priority Areas

Note: Full extent of nitrate priority areas is not shown.

Conclusions

Out of the 20 wells sampled for this project, 8 wells exceeded the nitrate MCL (1 in the Ada Canyon NPA, 3 in the NE Star NPA, and 4 in the Mountain Home NPA). For arsenic, 7 wells—all located within the Ada Canyon NPA—exceeded the EPA's MCL of 10 µg/L.

Recommendations

Land-use activities near the elevated nitrate concentrations should be evaluated to determine what potential best management practices (BMPs) could be implemented or improved to protect ground water from further contamination. Domestic well owners are encouraged to test their wells annually for nitrate, especially if a well is located near or in an NPA. Domestic well owners are also encouraged to annually test their wells for arsenic, especially those located within the Canyon County portion of the Ada Canyon NPA.

3.1.2 Fruitland Dairy Ground Water Monitoring Project

Purpose

The ISDA Dairy Bureau collects ground water samples for nitrate at dairy wells during annual facility inspections. When a sample exceeds the MCL for nitrate (10 mg/L), ISDA provides the information to DEQ. The nitrate concentrations from the 2009 ISDA Dairy Bureau sampling at the production wells at the Holm and Van Beek Dairies in Payette County east of Fruitland were 17.1 mg/L and 11.4 mg/L, respectively, exceeding the MCL of 10 mg/L (Figure 5). In November 2009, DEQ conducted a follow-up ground water monitoring project surrounding each dairy to determine the extent and degree of ground water nitrate contamination.

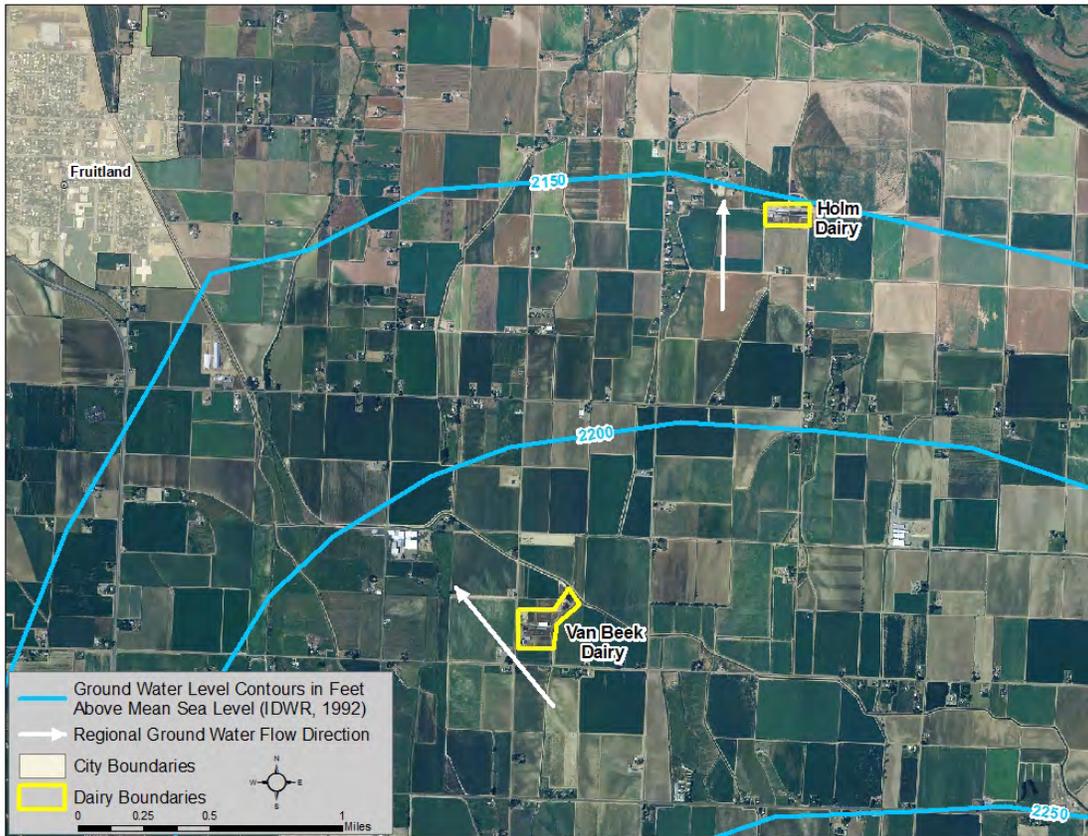


Figure 5. Location of Holm Dairy and Van Beek Dairy

Methods and Results

Using well logs from the IDWR website, DEQ selected 8 wells for monitoring and evaluation surrounding the Holm Dairy and 13 wells surrounding the Van Beek Dairy (Figure 6). Preference was given to wells screened solely within the shallow aquifer, which is above a blue lacustrine clay layer that separates the shallow and deep aquifers. Within the project area, the blue clay layer is located approximately 70 feet below ground surface and can act as a protective barrier to prevent contaminants generated at the land surface from migrating into deeper aquifers. The shallow aquifer wells selected were located hydraulically upgradient, sidegradient, and downgradient of each dairy. Additionally, several wells screened in or beneath the blue clay layer were also selected for sampling to determine if the deeper aquifer has been impacted. All wells sampled for this project were completed to less than 150 feet below ground surface.¹ A drain sample was collected near the Holm Dairy after the surface water flows in the canal ceased (after the irrigation season had ended) (Sample ID 998—Figure 6). Water in the drains is coincident with the shallow water table and considered representative of ground water chemistry.

¹ “Completed” refers to the final depth of the well. In some instances, wells are drilled to a certain depth and if a deeper water producing zone was not found at that depth, the bottom of the well may be sealed to the depth where a shallower water-producing zone was encountered. In this case, the completed depth is less than the drilled depth.

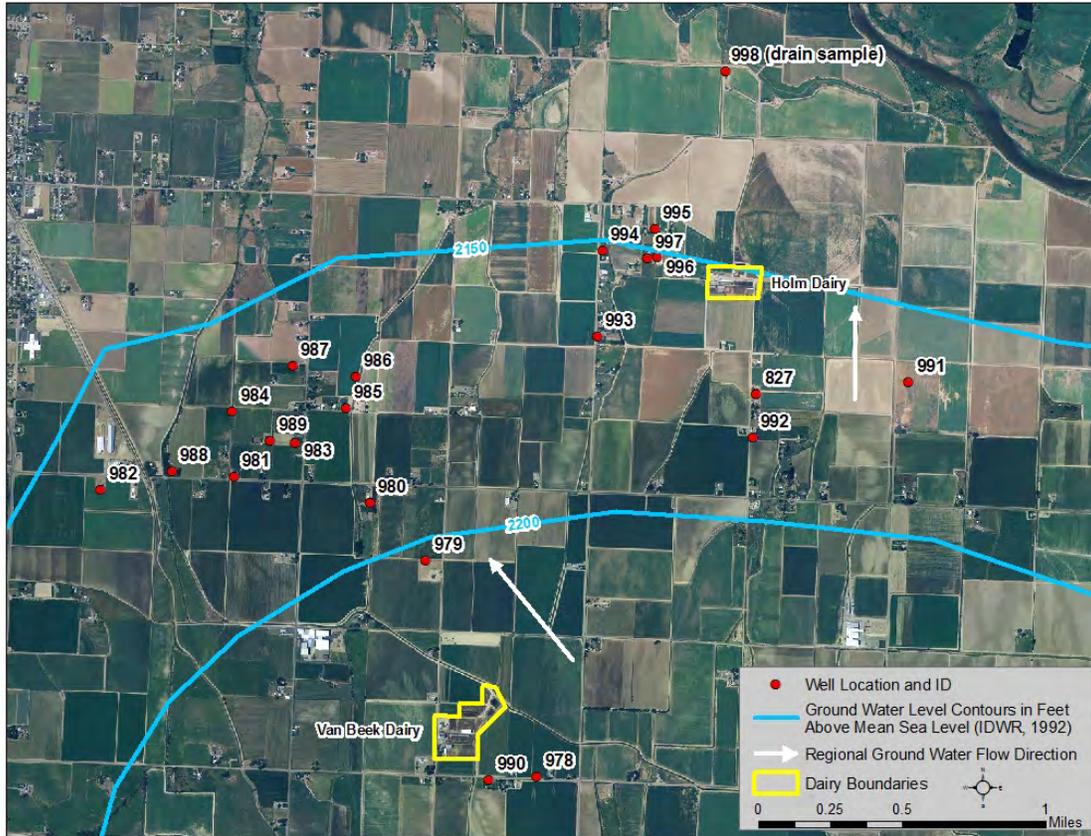


Figure 6. Domestic well and drain sample locations with Well IDs for Fruitland Dairy Ground Water Monitoring Project

Of the total 22 sample locations, 13 represent shallow ground water (12 wells and 1 drain); 7 represent the deeper ground water with screens below or within the blue clay layer; and 2 represent ground water mixed from both aquifers because they are screened both above and below or within the blue clay layer.

Water quality field parameters—pH, temperature, specific conductivity, and dissolved oxygen (DO)—were measured at each site (Table 2) prior to sample collection.

Table 2. Water quality field parameters for the Fruitland Dairy Ground Water Monitoring Project

Well ID	Well Depth (feet)	Sample Date	pH	Temperature (°C)	Specific Conductivity ($\mu\text{S}/\text{cm}$) ^a	Dissolved Oxygen (mg/L) ^b
<i>Shallow wells</i>						
827	40	11/17/2009	8.66	13.4	97	0
978	61	11/16/2009	8.81	13.6	92	5.93
979	45	11/16/2009	7.83	14.0	634	2.41
981	38	11/16/2009	8.32	13.6	787	2.20
982	60	11/16/2009	7.30	13.8	693	2.14
984	45	11/16/2009	7.96	14.7	692	2.57
985	35	11/16/2009	8.31	13.6	741	3.64
988	50	11/16/2009	8.18	13.0	683	1.06
989	51	11/16/2009	6.78	13.9	738	2.83
990	65	11/17/2009	8.11	13.5	719	3.63
995	56	11/18/2009	8.41	13.0	506	0
997	56	11/18/2009	8.45	14.9	691	7.35
998 (drain)	10	11/18/2009	7.47	10.9	751	11.56
<i>Deep wells</i>						
980	120	11/16/2009	8.46	14.5	752	0.02
983	105	11/16/2009	6.64	13.9	300	0.11
986	123	11/17/2009	7.92	14.6	305	0
991	137	11/17/2009	8.58	15.3	302	0
992	92	11/17/2009	8.85	13.9	682	0
994	120	11/17/2009	8.93	15.0	286	0
996	120	11/18/2009	8.20	15.5	244	0
<i>Mixed wells</i>						
987	150	11/17/2009	8.26	14.0	460	0
993	82	11/17/2009	8.62	13.4	788	6.08

^a $\mu\text{S}/\text{cm}$ = microsiemens per centimeter^b mg/L = milligrams per liter

Samples were collected from each well in accordance with the DEQ's quality assurance project plan (DEQ 2009b) and analyzed for nitrate, nitrite, chloride, sulfate, arsenic, total coliform, *E. coli*, total Kjeldahl nitrogen (TKN), and nitrogen isotopes (Table 3 and Table 4). Since ammonia is typically found only in anoxic conditions, the well was sampled for ammonia only if the DO reading at the well was less than 2 mg/L. All samples, with the exception of the nitrogen isotope samples, were submitted to the Idaho State Bureau of Laboratories for analysis. Nitrogen isotope samples were collected at each sampling location and frozen and stored at DEQ pending nitrate analysis. After DEQ received nitrate analysis results, those nitrogen isotope samples from wells with nitrate concentrations equal to or greater than 5 mg/L were then sent to the University of Arizona for nitrogen isotope analysis.

Table 3. Inorganic results for the Fruitland Dairy Ground Water Monitoring Project

Well ID	Well Depth (feet)	Sample Date	Nitrate (mg/L)	Nitrite (mg/L)	Ammonia (mg/L)	Total Kjeldahl Nitrogen (mg/L)	Arsenic (µg/L)	Chloride (mg/L)	Sulfate (mg/L)
<i>Shallow wells</i>									
827	40	11/17/2009	<0.01	<0.01	0.81	0.76	5.2	54.7	110
978	61	11/16/2009	13	<0.01	NS	<0.1	31	17.4	45.4
979	45	11/16/2009	7.6	<0.01	NS	<0.1	35	8.41	47.5
981	38	11/16/2009	11	<0.01	NS	<0.1	36	10.6	37.0
982	60	11/16/2009	9.2	<0.01	NS	0.11	44	9.55	39.2
984	45	11/16/2009	4.8	<0.01	NS	0.14	38	5.57	19.5
985	35	11/16/2009	15	<0.01	NS	0.13	27	16.8	35.0
988	50	11/16/2009	8.8	<0.01	<0.01	0.18	37	8.98	34.9
989	51	11/16/2009	12	<0.01	NS	0.13	33	11.2	30.6
990	65	11/17/2009	7.2	<0.01	NS	0.21	20	16.2	53.1
995	56	11/18/2009	<0.01	<0.01	3.6	4.0	<0.005	18.0	47.5
997	56	11/18/2009	6.7	<0.01	NS	0	22	5.47	41.2
998 (drain)	10	11/18/2009	7.8	NS	NS	0.19	18	19.1	65.7
<i>Deep wells</i>									
980	120	11/16/2009	<0.01	<0.01	1.0	1.1	22	68.9	120
983	105	11/16/2009	<0.01	<0.01	0.5	0.53	22	8.79	28.8
986	123	11/17/2009	<0.01	<0.01	1.7	1.9	19	11.0	22.9
991	137	11/17/2009	<0.01	<0.01	4.8	5.0	<0.005	2.6	<0.8
992	92	11/17/2009	<0.01	<0.01	1.1	1.2	5.9	74.1	70.2
994	120	11/17/2009	<0.01	<0.01	3.6	3.9	<0.005	8.2	0.60
996	120	11/18/2009	<0.01	<0.01	3.6	3.9	<0.005	3.42	8.03
<i>Mixed wells</i>									
987	150	11/17/2009	<0.01	<0.01	3.5	3.9	<0.005	11.6	36.2
993	82	11/17/2009	17	<0.01	NS	<0.1	29	10.4	64.8

Note: Bolded red numbers indicate the U.S. Environmental Protection Agency's maximum contaminant level was exceeded.
 mg/L = milligrams per liter; µg/L = micrograms per liter
 NS = not sampled

Nitrate Sampling

The nitrate values ranged from non-detectable (<0.01 mg/L) to 17 mg/L. EPA's MCL of 10 mg/L was exceeded in 5 wells. The median value for all 22 samples was 5.75 mg/L. However, when the sample locations are grouped by the depth of the screened interval (shallow, deep, and mixed), there is a notable difference in nitrate concentrations between the shallow and deep aquifer systems. The 13 samples collected from wells in the shallow aquifer had nitrate concentrations ranging from non-detectable to 15 mg/L, with a median concentration of 7.8 mg/L. Nitrate was not detected in any of the 7 samples collected from wells in the deep aquifer. The deep wells had low DO (<2 mg/L) (Table 2), indicating any nitrogen in the system would be in the form of ammonia or TKN. TKN values ranged from 0.53 to 5 mg/L for the deep wells. The 2 mixed wells (screened in both the shallow and deep aquifers) varied in nitrate concentration; nitrate was not detected in well 987, but well 993 had a concentration of 17 mg/L, which is the highest nitrate concentration detected in this study (Table 3). Poor well construction—such as screening in multiple aquifers, as in the case of well 993—is likely providing a conduit for land-use related contaminants to reach the deep aquifer.

The spatial distribution of nitrate concentrations is shown in Figure 7. The median concentration for the shallow aquifer wells upgradient of the Holm and Van Beek Dairies (wells 827, 978, and 990) was 7.2 mg/L. The median concentration of shallow aquifer wells sidegradient of the dairies (wells 995 and 997) was 3.35 mg/L, and the median nitrate concentration of shallow aquifer wells downgradient of the dairies (wells 979, 981, 982, 984, 985, 988, 989, and 998) was 9 mg/L. There is a slight increase between nitrate concentrations upgradient and downgradient of the dairies in the shallow aquifer. However, the large difference between the upgradient and sidegradient nitrate concentrations indicates that land uses other than the dairies are adding nitrogen into the shallow aquifer system.

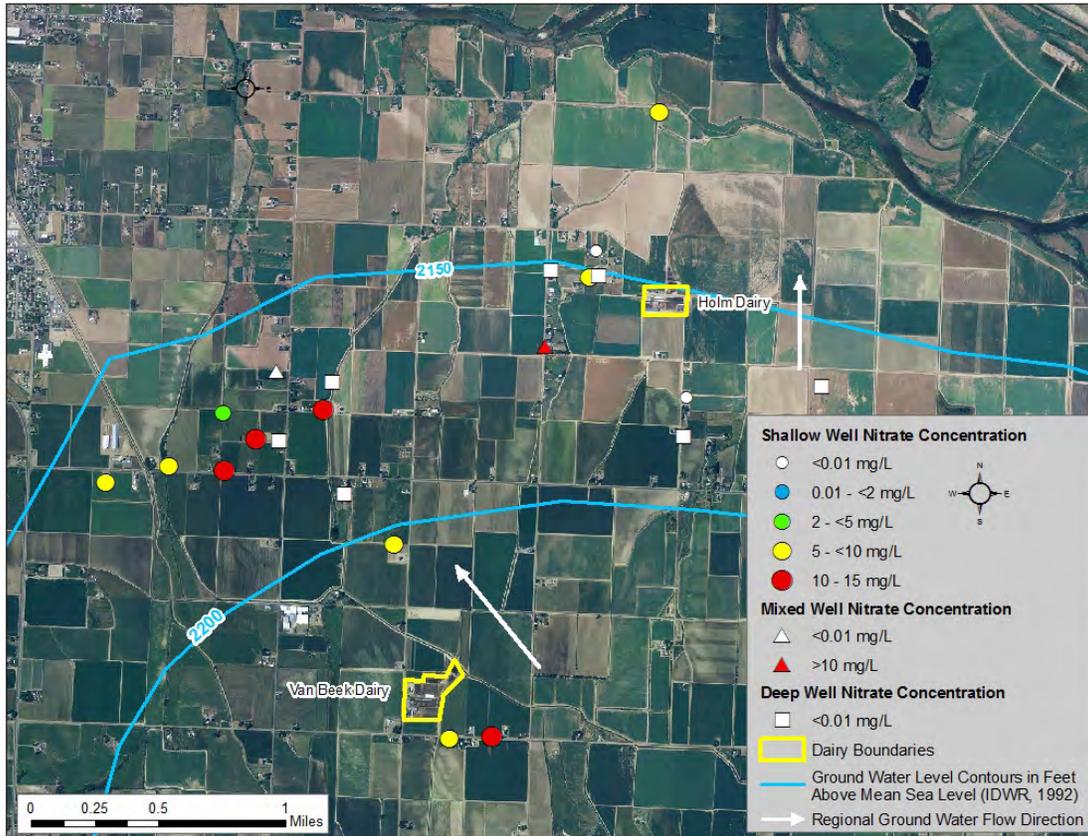


Figure 7. Nitrate concentrations for the Fruitland Dairy Ground Water Monitoring Project

Arsenic Sampling

The arsenic values ranged from non-detectable (<0.005 $\mu\text{g/L}$) to 44 $\mu\text{g/L}$; 14 wells and 1 drain sample exceeded the EPA's MCL of 10 $\mu\text{g/L}$ for arsenic. Elevated arsenic values have been identified in this area in various studies (Wicherski 2000; Mitchell 2004). Naturally occurring arsenic has been documented in this area, as well as many other areas in the western Snake River Plain (Baldwin and Wicherski 1994; Parlman 1982; Neely 2002).

Chloride Sampling

Chloride values ranged from 2.6 mg/L to 74.1 mg/L. The EPA has set the National Secondary Drinking Water Regulations standard for chloride at 250 mg/L, based on aesthetic effects. Baldwin and Wicherski (1994) determined the chloride background level for ground water in the area ranged from 10 mg/L to 15 mg/L; 8 wells exceeded the background level for chloride, indicating that the ground water has been impacted by human activities.

Nitrogen Isotope Sampling

Nitrogen isotope ratios, denoted as $\delta^{15}\text{N}$, can be helpful in determining sources of nitrate in the ground water and was completed for all samples with nitrate concentrations greater than 5 mg/L (Table 4).

Table 4. Bacteria and nitrogen isotope data for Fruitland Dairy Ground Water Monitoring Project

Well ID	Well Depth (feet)	Sample Date	Total Coliform (MPN/100 mL) ^a	<i>E. coli</i> (MPN/100 mL)	$\delta^{15}\text{N}$ (‰) ^b
<i>Shallow wells</i>					
827	40	11/17/2009	<1	<1	NS ^c
978	61	11/16/2009	<1	<1	5.1
979	45	11/16/2009	<1	<1	4.5
981	38	11/16/2009	<1	<1	4.7
982	60	11/16/2009	<1	<1	3.9
984	45	11/16/2009	<1	<1	NS
985	35	11/16/2009	<1	<1	5.0
988	50	11/16/2009	<1	<1	5.2
989	51	11/16/2009	<1	<1	4.4
990	65	11/17/2009	<1	<1	5.1
995	56	11/18/2009	<1	<1	NS
997	56	11/18/2009	2.0	<1	5.4
998 (drain)	10	11/18/2009	NS	NS	NS
<i>Deep wells</i>					
980	120	11/16/2009	<1	<1	NS
983	105	11/16/2009	<1	<1	NS
986	123	11/17/2009	1.0	<1	NS
991	137	11/17/2009	<1	<1	NS
992	92	11/17/2009	<1	<1	NS
994	120	11/17/2009	2.0	<1	NS
996	120	11/18/2009	<1	<1	NS
<i>Mixed wells</i>					
987	150	11/17/2009	<1	<1	NS
993	82	11/17/2009	6.3	<1	2.9

^a MPN/100 mL—most probable number per 100 milliliters

^b ‰—per mil

^c NS—not sampled

Nitrogen from human or animal waste and fertilizer sources has distinguishable $\delta^{15}\text{N}$ signatures. Typical $\delta^{15}\text{N}$ values for various nitrogen sources are listed in Table 5. The $\delta^{15}\text{N}$ results from this project ranged from 2.9 per mil (‰) to 5.4‰. Wells 982 and 993 had $\delta^{15}\text{N}$ results less than 4‰, indicating commercial fertilizer as the nitrogen source (Figure 8) in the 2 wells. The 8 remaining wells had $\delta^{15}\text{N}$ values ranging from 4.4‰ to 5.4‰, which indicates the source of nitrogen is either from organic nitrogen in the soil or a mixture of fertilizer and waste sources.

However, use of nitrogen isotopes alone should not be used as the only analysis to determine nitrogen sources. Nitrogen isotope values in ground water can be complicated by several reactions (e.g., ammonia volatilization, nitrification, denitrification, plant uptake) that generally increase the $\delta^{15}\text{N}$ values (Kendall and McDonnell 1998). Furthermore, mixing of sources with variable nitrogen isotope values along shallow flowpaths makes determination of sources and extent of denitrification very difficult for intermediate $\delta^{15}\text{N}$ values (Kendall and McDonnell 1998). The land-use in the project area

is predominately agricultural, including both crop fields and dairies. It is expected that this type of land-use would result in a mixture of sources of nitrogen in the ground water, as indicated by the $\delta^{15}\text{N}$ values detected.

Table 5. Typical $\delta^{15}\text{N}$ values from various nitrogen sources

Potential Nitrate Source	$\delta^{15}\text{N}$ (‰)
Precipitation	-3
Commercial fertilizer	-4 to +4
Organic nitrogen in soil or mixed nitrogen source	+4 to +9
Animal or human waste	Greater than +9

Source: Seiler 1996

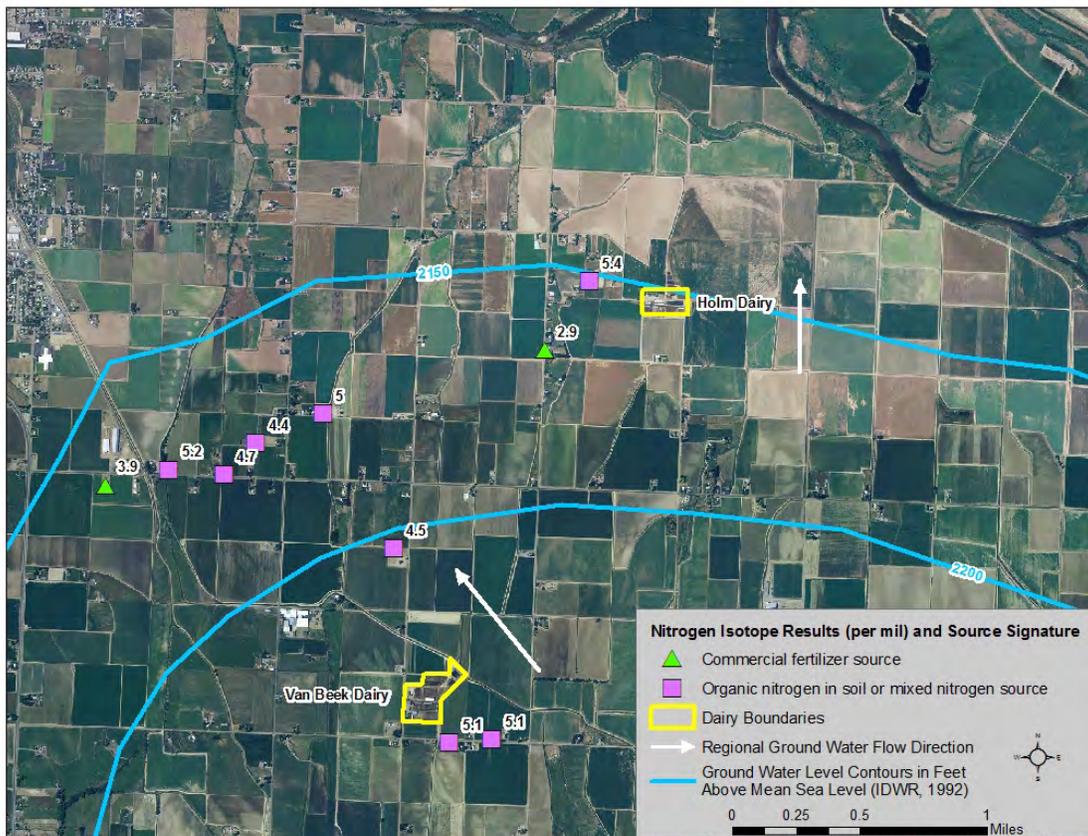


Figure 8. $\delta^{15}\text{N}$ results for the Fruitland Dairy Ground Water Monitoring Project

The inorganic compounds and $\delta^{15}\text{N}$ data suggest the dairies are contributing nitrogen to the ground water in the shallow aquifer; however, the $\delta^{15}\text{N}$ results indicate fertilizers and other nitrogen sources are also contributing. Nitrogen in the shallow aquifer is primarily in the form of nitrate. In the deeper aquifer, the nitrogen is in the form of ammonia or TKN due to the low DO. The nitrogen in the deeper aquifer could originate from the decaying lake bed sediments that compose the deep aquifer.

Conclusions

Shallow ground water within the study area is being negatively impacted from land-use practices as evidenced by elevated nitrate and chloride concentrations. The source of

elevated arsenic concentrations in the ground water is unclear; however, the source is likely naturally occurring in the soils.

The range of $\delta^{15}\text{N}$ values observed in the study area indicates the sources of nitrogen in the shallow ground water include commercial fertilizer, organic nitrogen in soil, or a mixed source of fertilizer and waste. Wells 982 and 993 have $\delta^{15}\text{N}$ results that are consistent with commercial fertilizer as the source of nitrogen.

Wells screened in multiple aquifers have the potential to provide a conduit for surface contaminants to reach the deeper aquifer, as seen in well 993.

Recommendations

Several wells had negligible detections of nitrate and elevated levels of ammonia and TKN (wells 987, 991, 994, 995, and 996). To gain better understanding of the source(s) of nitrogen in these wells, DEQ recommends conducting $\delta^{15}\text{N}$ analysis on the ammonia or TKN compound for the samples collected that were frozen after the sampling.

DEQ will work to investigate funding sources to improve well construction in wells screened in multiple aquifers and provide well owners with assistance in selecting BMPs to protect their wellheads.

In addition, DEQ will work with the ISDA Dairy Bureau to determine appropriate BMPs for dairies with nitrate concentrations exceeding the EPA's MCL (such as the Van Beek and Holm Dairies) to help protect shallow ground water from further contamination.

3.2. Coeur d'Alene Region

3.2.1 Chilco Area of the Spokane Valley–Rathdrum Prairie Aquifer Ground Water Monitoring Project

Chilco is a rural community located approximately 15 miles north of Coeur d'Alene, Idaho, along Highway 95. DEQ conducted a ground water study from 2006 through 2009 in the Chilco area to assess the overall quality of the Chilco Channel aquifer and evaluate the potential sources of contamination that may have contributed to the bacteria detected in a drinking water well.

Well DEQ 529, formerly a PWS until approximately 2006, has had problems with turbidity, total coliform, and *E. coli* contamination. In October 2004, a photo was taken illustrating a cracked casing that was exposed at ground level (DEQ 2005b). During December 2005, residents reported having cloudy drinking water following heavy rainstorms. As a result, DEQ conducted a study in 2006 to determine if the source of bacteria was the result of overland flow entering the well via the cracked casing, or if local land-use activities were impacting ground water quality. Possible sources of contamination to the aquifer include septic tank effluent, runoff from road de-icers, infiltration of surface water from Chilco Lake, wood milling activities, and agriculture activities.

This section of the report summarizes ground water data collected during 2009 monitoring. For analysis of all data collected for this project, please see the technical report by Lee (2010).

Purpose

The objectives of this study were as follows:

1. Evaluate ground water quality and flow direction within the Chilco Channel.
2. Identify whether inorganic chemical constituents are increasing or decreasing in the aquifer within the study area and determine the possible source(s) of these constituents.
3. Determine the possible source(s) of bacteria in well DEQ 529.

Methods and Results

In an effort to identify site-specific seasonal flow directions, ground water flow direction was calculated for both summer and winter using water levels. The ground water flow direction in the vicinity of well DEQ 529 appears to be consistently in a westerly direction, with very little seasonal variation. DEQ's findings are consistent with those of Graham and Buchanan (1994).

Ground water samples have been collected from as many as 9 different domestic wells on a quarterly or monthly basis since 2006, with 13 sampling events occurring between September 2006 and May 2009. The completed depth of the wells sampled ranged from 4 feet to 158 feet below ground surface, with water levels ranging from 65 feet to 90 feet below ground surface. The project area encompasses approximately 2 square miles and includes an approximately 175-acre mill and log yard that formerly belonged to Louisiana Pacific. The mill and log yard are now owned by Idaho Forest Group (IFG). Since surface water from Chilco Lake is applied to log decks at the IFG mill site during the second half of the summer, the lake water was sampled, as were two locations where runoff water from the log decks ponded.

During 2009, 5 wells and 1 surface water body (2 sample sites at Chilco Lake—Sample Site ID DEQ 677) were sampled in February and May in the vicinity of the mill (Figure 9). Ground water samples were collected prior to any filtration system and in accordance with ASTM D4448-01 and D6089-97, *Standard Guide for Sampling Ground-water Monitoring Wells* and *Standard Guide for Documenting a Ground-water Sampling Event* (ASTM International 2007, 2010). Samples were collected when the water quality field parameters (temperature, pH, specific conductivity, and DO) of purged water had stabilized (Table 6). The surface water sample from Chilco Lake (DEQ 677) was a composite of multiple grab samples and was collected at the base of the dam or at the base of a waterfall located at the rim rock, depending on accessibility.

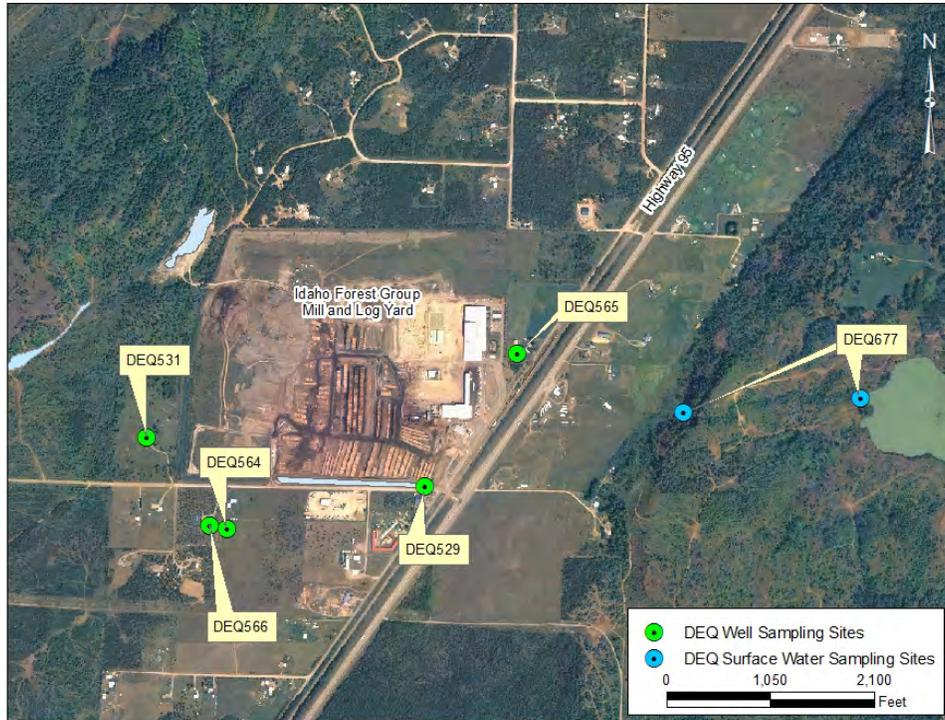


Figure 9. Sample location map of Chilco project, 2009

Table 6. Water quality field parameter results for Chilco project (2009)

Site ID	Well Depth (feet)	Sample Date	Water Temperature (°C)	Specific Conductivity (µS/cm)	pH	Dissolved Oxygen (mg/L)
529	107	2/5/2009	8.6	307	6.61	8.65
531		2/5/2009	8.2	567	6.83	8.09
564	158	2/5/2009	7.9	525	6.87	5.22
565	120	2/5/2009	8.0	281	7.19	12.55
566	105	2/5/2009	8.1	506	6.73	6.82
531		5/20/2009	8.9	480	6.22	0.55
564	158	5/20/2009	9.0	575	5.97	0.55
565	120	5/20/2009	8.4	294	6.38	0.56
566	105	5/20/2009	9.0	555	5.92	0.55
677	surface water	5/20/2009	8.1	56	7.05	0.57

Note: Blank cells indicate data not available.

µS/cm = microsiemens per centimeter; mg/L = milligrams per liter

Water samples were analyzed in the lab for a range of constituents, including the following: total coliform, *E. coli*, deuterium isotope ($\delta^2\text{H}$), oxygen isotope ($\delta^{18}\text{O}$), tannin and lignin, chloride, fluoride, nitrite plus nitrate as nitrogen, sulfate, TDS, alkalinity, bicarbonate, calcium, carbonate, magnesium, potassium, and sodium (Table 7, Table 8, and Table 9). The analytical approach was modified throughout the investigation in an attempt to optimize project objectives. Therefore, not all constituents were analyzed in all wells during each sampling event.

Bacteria Sampling

Total coliform bacteria were detected in the Chilco Lake surface water sample (DEQ 677) at 290 MPN/100 mL (most probable number per 100 milliliters) in February and 870 MPN/100 mL in May (Table 7). Bacteria were not detected in any other samples taken during 2009, except for DEQ 529, with a concentration of 15 MPN/100 mL of total coliform in May.

Tannin and Lignin Sampling

Tannin and lignin, compounds specifically related to the decomposition of pine trees, were analyzed during the February sampling event. Tannin and lignin were not detected in any of the wells that were analyzed for these compounds (Table 7).

Table 7. Bacteria, isotope, and tannin and lignin results for Chilco project (2009)

Site ID	Sample Date	Total Coliform (MPN/100 mL)	<i>E. coli</i> (MPN/100 mL)	$\delta^2\text{H}$ (‰)	$\delta^{18}\text{O}$ (‰)	Tannin and Lignin (mg/L)
529	2/5/2009	<1	<1	-107	-14.4	<0.1
531	2/5/2009	<1	<1	-108	-14.4	<0.1
564	2/5/2009	<1	<1	-109	-14.7	<0.1
565	2/5/2009	<1	<1	-106	-14.5	
566	2/5/2009	<1	<1	-108	-14.8	<0.1
677	2/5/2009	290	4	-105	-13.8	<0.1
529	5/20/2009	15	<1			
531	5/20/2009	<1	<1	-109	-14.9	
564	5/20/2009	<1	<1	-108	-14.8	
565	5/20/2009	<1	<1	-108	-14.7	
566	5/20/2009	<1	<1	-110	-14.7	
677	5/20/2009	870	440	-114	-15.5	

Note: Blank cells indicate no data available.

MPN/100 mL = most probably number per 100 milliliters; ‰ = per mil; mg/L = milligrams per liter

Chloride Sampling

As shown in Table 8, chloride concentrations ranged from 2.17 mg/L (DEQ 677 in February) to 18 mg/L (DEQ 566 in May). DEQ 565 showed variability in chloride concentrations, increasing from 9.09 mg/L in February to 17.2 mg/L during the May sampling event. Variability of chloride concentrations is seen in the 2006–2009 data for DEQ 565, as well as DEQ 529, as documented in Lee (2010).

Nitrate Sampling

As shown in Table 8, Nitrate concentrations ranged from 0.05 mg/L (DEQ 677 in May) to 1.74 mg/L (DEQ 565 in February and May). None of the samples exceeded the nitrate MCL of 10 mg/L.

Table 8. Laboratory results for Chilco project (2009)

Site ID	Sample Date	Chloride (mg/L)	Fluoride (mg/L)	Nitrite plus Nitrate as N (mg/L)	Sulfate (mg/L)	Total Dissolved Solids (mg/L)
529	2/5/2009	11.7	<0.100	1.37	6.01	178
531	2/5/2009	8.76	<0.100	0.783	9.52	316
564	2/5/2009	14.5	<0.100	1.21	9.68	310
565	2/5/2009	9.09	0.449	1.74	6.03	164
566	2/5/2009	14.2	0.236	1.21	8.87	290
677	2/5/2009	2.17	<0.100	0.18	1.60	56
529	5/20/2009	14.7		1.00	5.30	180
531	5/20/2009	6.67		1.05	7.09	288
564	5/20/2009	17.3		1.10	9.69	380
565	5/20/2009	17.2		1.74	5.83	184
566	5/20/2009	18.0		1.13	8.86	348
677	5/20/2009	5.40		0.05	0.66	66

Note: Blank cells indicate no data available.
mg/L = milligrams per liter

Additional major ions were analyzed during the May sampling event (Table 9). DEQ 564 shows an elevated sodium concentration of 136 mg/L and minor concentrations of calcium, magnesium, and potassium at 1.71 mg/L, 0.299 mg/L, and 0.84 mg/L, respectively, in comparison with other Chilco project site data. These differences are thought to be the result of water softener effluent discharge into a septic drainfield located approximately 250 feet upgradient of DEQ 564.

Table 9. Major ion laboratory results for Chilco project during May 2009 sampling event

Site ID	Sample Date	Alkalinity (mg/L as CaCO ₃) ^a	Bicarbonate (mg/L as HCO ₃) ^b	Calcium (mg/L)	Carbonate (mg/L)	Magnesium (mg/L)	Potassium (mg/L)	Sodium (mg/L)
529	5/20/2009	134	134	45.8	<1	7.17	3.03	3.54
531	5/20/2009	255	25	86.3	<1	10.5	3.85	3.37
564	5/20/2009	290	290	1.71	<1.0	0.299	0.84	136
565	5/20/2009	121	121	43.8	<1	7.24	2.47	3.14
566	5/20/2009	280	280	97.7	<1.0	13.5	4.36	4.98
677	5/20/2009	19.3	19.3	5.34	<1	1.87	1.34	2.34

Note: mg/L = milligrams per liter

^a CaCO₃—calcium carbonate

^b HCO₃—bicarbonate

Conclusions

The ground water flow direction in the vicinity of DEQ 529 appears to be in a consistent westerly direction, with very little seasonal variation.

Potential contaminant sources within the study area include the IFG mill site, septic systems, road de-icers, Chilco Lake, fertilizers, animal waste, well construction, and historic land use.

Nitrate and chloride appear to impact each well in the study area to varying degrees based upon the concentration trends. Both nitrate and chloride concentrations in the ground water have consistently increased within the project area since 1993, based upon sample results at DEQ 531 and DEQ 565 as documented by Lee (2010) and Graham and Buchanan (1994).

Analytical results suggest that log deck runoff from the IFG mill site influences the ground water chemistry, but the influence is not quantified in this study. Sample points upgradient of the IFG mill site are needed to determine potential impacts to the aquifer due to the mill site.

DEQ 529 was the only well that had a total coliform detection in 2009. Total coliform and *E. coli* bacteria were detected in the surface water from Chilco Lake (DEQ 677). Possible sources of bacteria in ground water include upgradient septic tanks, surface water discharge from Chilco Lake, or both. Chilco Lake drains directly into the aquifer at a point approximately 0.5 miles northeast of DEQ 529. Surface water applied to the log decks from Chilco Lake may also be a source of bacteria.

The distance from potential contaminant sources to the sample sites appears to influence the sampling results. DEQ 565 is located approximately 120 feet downgradient of a septic tank, and sample results show variability and higher concentrations for chloride in 2009. Lee (2010) also documented variability in the nitrate concentration for DEQ 565 from 2006 through 2009 sampling events.

A crack in the well casing of DEQ 529 poses a great risk as a contamination pathway. An attempt by local residents to fix the problem by packing dirt around the casing did not appear to eliminate the problem. Ground water flow direction at this well is westerly, so it appears that ground water contamination in this well is not originating from the mill, but rather from an easterly to northeasterly source, possibly Chilco Lake. A well sample taken by Graham and Buchanan (1994) approximately 600 feet east (upgradient) of DEQ 529 contained bacteria, indicating that a persistent bacteria source has been present before many of the upgradient residences (and septic tanks). The bacteria source in DEQ 529 is likely from Chilco Lake.

Recommendations

Based on 2009 monitoring results, in addition to data collected from 2006 through 2008, the following recommendations are made (from Lee 2010):

- Identify the location of all septic tanks in the area.
- Identify wells to sample north of the IFG mill site and east of Highway 95 in the vicinity of Chilco Lake's outlet.
- Measure water levels in as many area wells as possible, on a monthly basis, to better define seasonal fluctuations, especially east of Highway 95.
- Delineate the perimeter of the log deck runoff at the IFG mill site during each sampling event to determine if changes in recharge area and volume affect downgradient sample results.
- Properly abandon or repair DEQ 529 to prevent potential surface-related contamination from entering the aquifer.

- Extract a DNA sample from bacteria in ground water and surface water to determine the origins of bacterial contamination.
- Evaluate historic land uses, especially those related to waste disposal.

For more information, please see the full technical report by Lee (2010) at http://www.deq.idaho.gov/water/data_reports/ground_water/chilco_41.pdf.

3.3. Idaho Falls Region

3.3.1 Ashton–Drummond Nitrate Follow-Up Sampling

Purpose

The intent of this project was to provide follow-up response to private wells owners within the Ashton–Drummond NPA who had nitrate concentrations detected in their drinking water that approached or exceeded the EPA’s 10 mg/L MCL during a 2009 public meeting. The Ashton–Drummond NPA is located within Fremont and Teton Counties in eastern Idaho (Figure 10).

This project had three objectives:

- Resample sites from previous sampling or nitrate screening efforts with nitrate concentrations that approached or exceeded the MCL of 10 mg/L for nitrite plus nitrate as nitrogen ($\text{NO}_2 + \text{NO}_3$ as N—referred to as nitrate throughout section 3.3).
- Identify potential sources for elevated nitrate concentrations.
- Provide feedback to the private well owners to help address nitrate contamination in their wells.

Methods and Results

A public meeting was held at the Ashton Community Center on October 17, 2009. Private well owners were invited to participate in the sampling and join the Ashton–Drummond NPA Advisory and Planning teams. All volunteered sites were screened using nitrate test strips. DEQ selected 16 wells that exceeded 8 mg/L of nitrate for sampling (Figure 10). The wells were sampled according to the quality assurance project plan (DEQ 2009a) for major ions, nutrients, stable isotopes, bacteria, and tritium during November and December 2009.

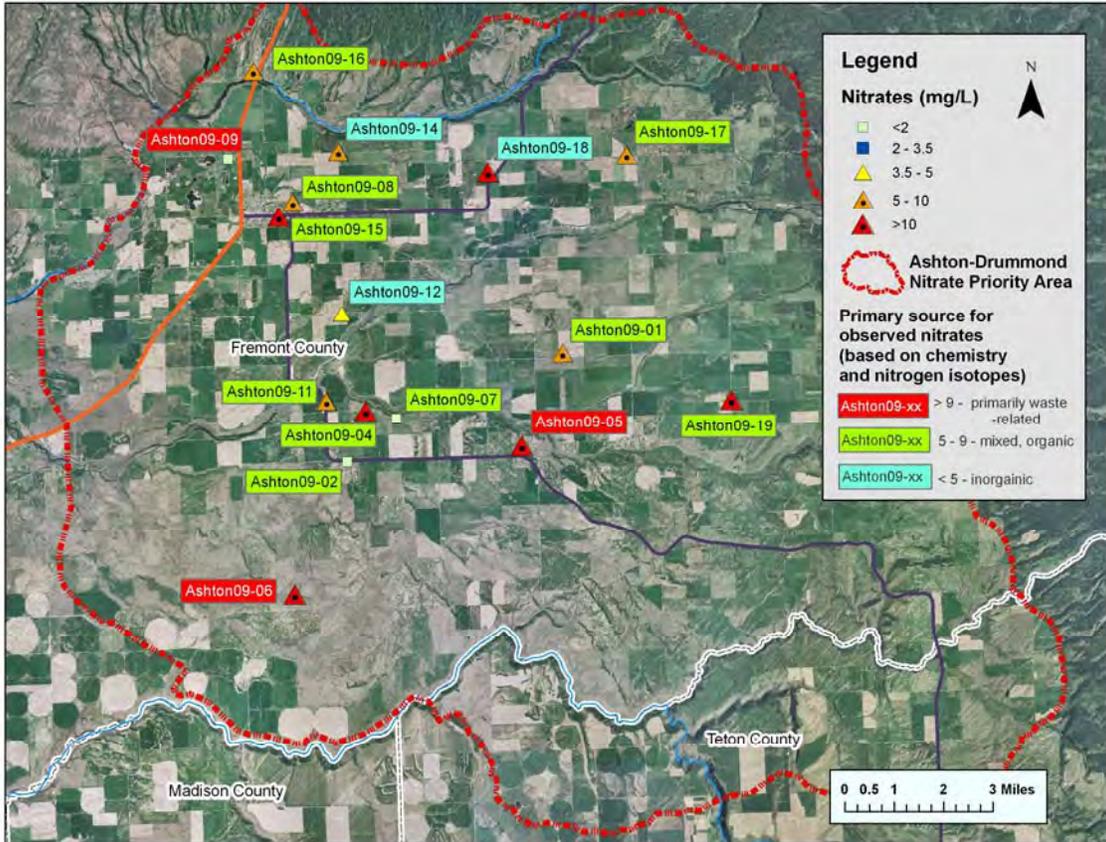


Figure 10. Sampling location, nitrate concentration, and nitrogen isotope signatures for Ashton–Drummond nitrate follow-up sampling project

Water quality field parameters, including DO, pH, specific conductivity, and temperature were measured at each site (Table 10) prior to sample collection.

Table 10. Water quality field parameter results for Ashton–Drummond nitrate follow-up sampling project

Well ID	Well Depth (feet)	Sample Date	Dissolved Oxygen (mg/L)	pH	Specific Conductivity ($\mu\text{S}/\text{cm}$)	Temperature ($^{\circ}\text{C}$)
09-01	240	11/2/2009	7.17	8.26	522	10.19
09-02		11/2/2009	7.87	8.25	624	9.58
09-04	200	11/2/2009	9.90	8.21	540	10.82
09-05	310	11/9/2009	3.58	7.95	900	10.69
09-06		11/9/2009	9.82	8.03	805	9.53
09-07	160	11/9/2009	9.04	8.14	381	11.12
09-08	70	11/9/2009	5.32	8.09	742	10.42
09-09	102	11/9/2009	0.63	8.14	860	9.44
09-11	365	11/17/2009		7.09		12.0
09-12	190	11/17/2009		7.56	384	12.5
09-14		11/17/2009		7.92	438	12.8
09-15	105	11/17/2009		7.39	501	13.2
09-16	300	11/17/2009		7.10	265	12.8
09-17		11/17/2009		7.58	703	10.1
09-18	400	11/18/2009		8.06	472	11.4
09-19	560	12/1/2009		7.81	529	10.6

Note: Blank cells indicate data not available.

mg/L = milligrams per liter; $\mu\text{S}/\text{cm}$ = microsiemens per centimeter

Bacteria Sampling

Total coliform bacteria were present at 4 sites (Table 11). The sites with bacteria detections were older wells with either an overgrown well pit area, an open wellhead, or a poorly sealed well.

Table 11. Nutrient, bacteria, and stable isotope results for Ashton-Drummond nitrate follow-up sampling

Well ID	Sample Date	Nutrient Concentration (mg/L)			Colonies/mL		Ratio (‰)		
		Nitrate Test Strip	Total NO ₂ + NO ₃ as N ^a	Total Phosphorus as P	Total Coliform	<i>E. coli</i>	δ ² H	δ ¹⁵ N	δ ¹⁸ O
09-01	11/2/2009	>10	8.2	0.071	ND	ND	-134	6.6	-18.4
09-02	11/2/2009	<2	1.9	0.064	13.4	ND	-126	7.6	-17.1
09-04	11/2/2009	10	12	0.052	ND	ND	-131	8.5	-17.8
09-05	11/9/2009	>10	30	0.063	ND	ND	-131	9.5	-17.8
09-06	11/9/2009	10	29	0.069	ND	ND	-134	9.1	-17.9
09-07	11/9/2009	2–5	1.8	0.110	11	ND	-130	6.6	-17.7
09-08	11/9/2009	10	7.4	0.066	ND	ND	-125	7.1	-17.2
09-09	11/9/2009	<2	0.28	0.020	3.1	ND	-128	12.5	-17.5
09-11	11/17/2009	5–10	7.4	0.056	ND	ND	-127	6.5	-17.3
09-12	11/17/2009	5–10	4.1	0.140	ND	ND	-128	5.0	-17.4
09-14	11/17/2009	10	9.6	0.072	2	ND	-128	4.8	-17.4
09-15	11/17/2009	10	11	0.057	ND	ND	-128	7.0	-17.5
09-16	11/17/2009	5–10	8.1	0.072	ND	ND	-131	5.6	-17.6
09-17	11/17/2009	10	10	0.100	ND	ND	-127	6.3	-17.5
09-18	11/18/2009	10	11	0.074	ND	ND	-130	5.0	-17.7
09-19	12/1/2009	>10	13	0.082	ND	ND	-133	6.0	-18.0

Note: Bolded red numbers indicate the U.S. Environmental Protection Agency's maximum contaminant level was exceeded.

mg/L = milligrams per liter; mL = milliliters; ‰ = per mil; ND = non-detectable

^a NO₂ + NO₃ as N—nitrite plus nitrate as nitrogen

Nitrate Sampling

Nitrate concentrations ranged from 0.28 to 30 mg/L, with a median of 8.9 mg/L (Table 11 and Figure 10). Samples from 6 wells had concentrations that exceeded the MCL of 10 mg/L for nitrate. For 2 sites (09-01 and 09-06), the test strip screening differed significantly from the laboratory nitrate results. The sites were resampled in June 2010, confirming the laboratory results.

Stable Isotope Sampling

Nitrogen-isotope (δ¹⁵N) results ranged from 4.8‰ to 12.5‰ (Table 11). Based on research by Kendall and McDonnell (1998), the typical δ¹⁵N range for inorganic sources, such as fertilizer, is -5‰ to +5‰; 3 wells had δ¹⁵N results that indicate a fertilizer source of nitrogen (09-12, 09-14, and 09-18—Figure 10). Another 3 wells (09-05, 09-06, and 09-09—Figure 10) had δ¹⁵N results that indicate an animal or human waste nitrogen source as described by Seiler (1996) (see Table 5). The remaining 10 sites had δ¹⁵N results indicating mixed or organic nitrogen sources (Figure 10).

Stable oxygen/deuterium isotope results compared with the local meteoric water line (Cecil et al. 2005) suggest that the ground water for the Ashton–Drummond region is consistent with a winter precipitation source and lacks an evaporative signature common for water recharged from lower elevations along the eastern Snake River Plain (Table 11 and Figure 11).

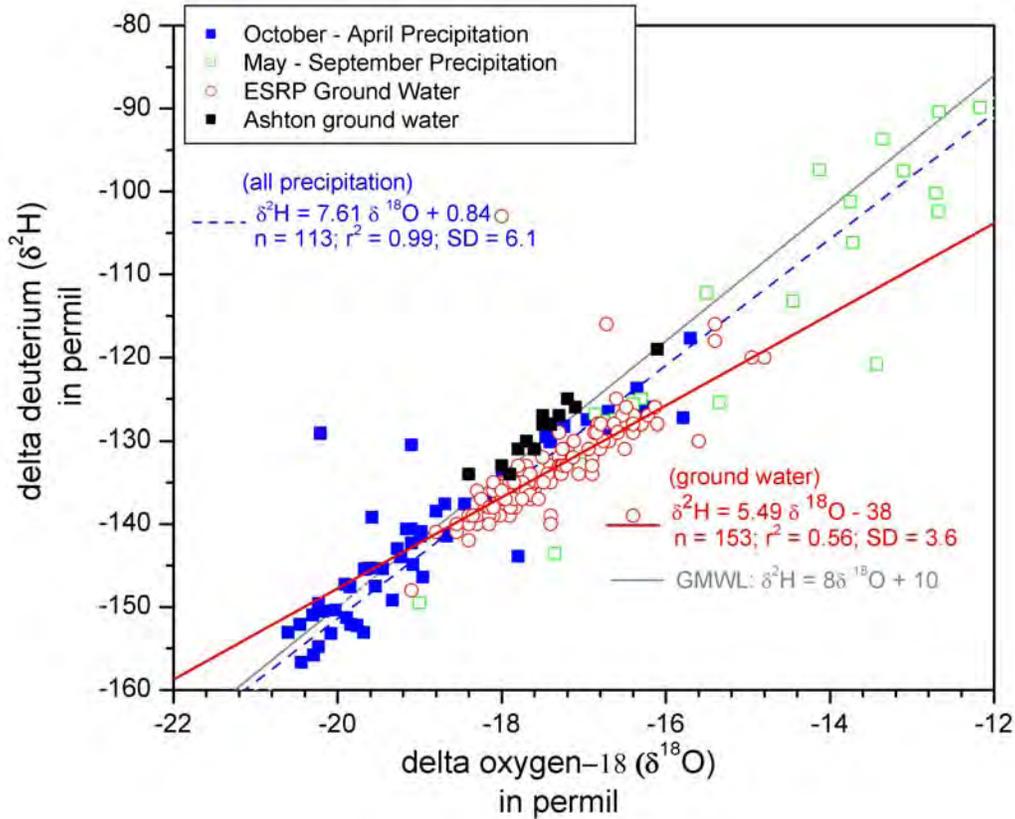


Figure 11. Stable oxygen/deuterium ratios for the 2009 Ashton–Drummond nitrate follow-up sampling project compared with local seasonal precipitation and the eastern Snake River Plain ground water

Note: GMWL = global meteoric water line; ESRP = eastern Snake River Plain; SD = standard deviation

Major Ions Sampling

The analytical results of the major ions sampled in 2009 suggest concentrations typical for the eastern Snake River Plain aquifer with little overall chemical variation among sites (Table 12). As suggested by Welhan and Poulson (2009), a characteristic chloride-to-sulfate relationship for natural ground water was apparent. Sulfate and chloride concentrations seem to be diagnostic in interpreting possible nitrate sources (Figure 12). Welhan (2009) suggests that waste-related nitrogen sources tend to have elevated chloride relative to sulfate, and for fertilizer sources where the fertilizer is in the form of ammonium sulfate, sulfate would be elevated relative to chloride. Mixed or natural sources would tend to have a consistent ratio characteristic of natural ground water for the area.

Table 12. Major ion results for Ashton–Drummond nitrate follow-up sampling

Well ID	Sample Date	Major Ion Concentration (milligrams per liter)								
		Total Calcium	Total Magnesium	Total Sodium	Total Potassium	Total Chloride	Total Sulfate	Total Fluoride	Total Alkalinity (as CaCO ₃) ^a	Total Dissolved Solids
09-01	11/2/2009	58	20	12	2.1	5.00	10.6	0.691	211	290
09-02	11/2/2009	43	44	12	1.2	2.79	6.02	0.843	302	310
09-04	11/2/2009	52	26	10	1.3	9.68	13.5	0.578	199	320
09-05	11/9/2009	87	45	13	3.2	9.69	89.8	0.457	228	550
09-06	11/9/2009	94	30	13	3.2	17.2	21.8	0.377	241	470
09-07	11/9/2009	42	16	6.1	1.7	1.94	3.86	0.470	176	200
09-08	11/9/2009	61	32	36	2.4	31.7	17.4	0.774	272	410
09-09	11/9/2009	90	21	44	5.9	78.5	17.2	1.51	306	540
09-11	11/17/2009	71	41	22	2.4	9.84	10.7	0.815	364	350
09-12	11/17/2009	48	10	19	1.9	9.79	16.0	1.27	169	300
09-14	11/17/2009	56	15	16	1.4	12.0	16.4	0.440	177	350
09-15	11/17/2009	61	17	22	3.8	14.9	22.3	1.02	194	380
09-16	11/17/2009	27	9.5	12	2.5	4.58	5.50	0.577	100	230
09-17	11/17/2009	87	32	17	2.4	6.82	30.3	0.304	307	460
09-18	11/18/2009	64	26	8.0	1.5	4.69	12.7	0.280	222	360
09-19	12/1/2009	72	25	6.4	1.4	1.73	25.4	0.360	228	360

^a CaCO₃—calcium carbonate

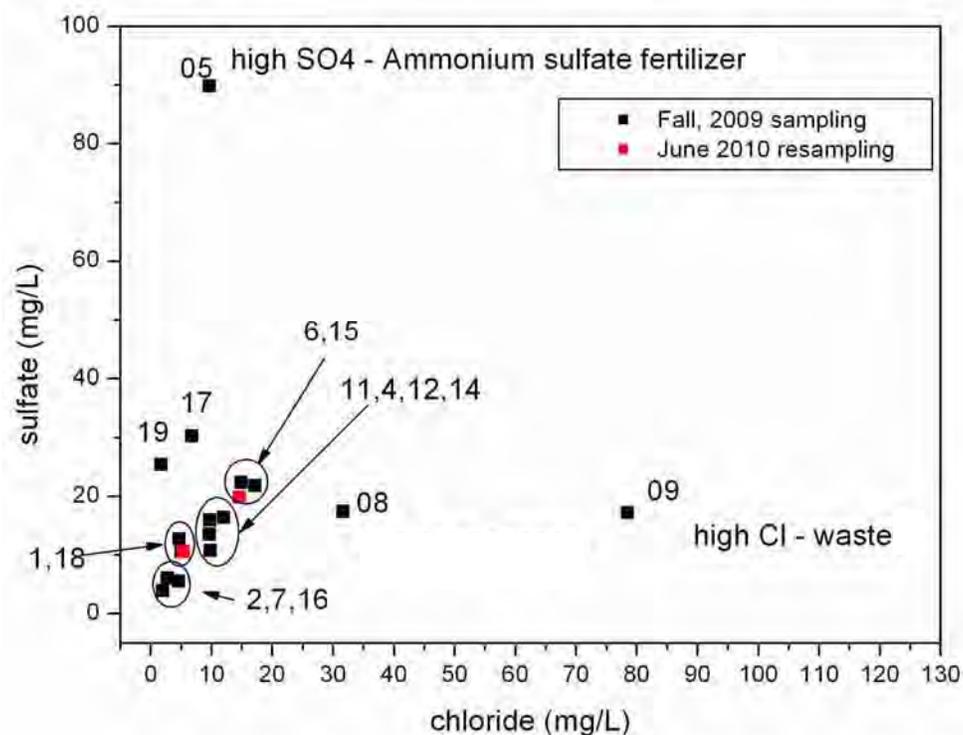


Figure 12. Chloride (Cl) and sulfate (SO₄) concentrations, and well IDs for the Ashton–Drummond nitrate follow-up sampling project, 2009

Conclusions

Individual sample results were provided to the well owners with an interpretation of potential nitrate sources based on observations found during sampling and recommendations for protection specific to each well. Brochures and other information related to nitrates in ground water, septic systems, and wellhead maintenance were also included. At least one well owner called for more specific recommendations.

A summary of sample sites, nitrate concentrations, and potential nitrate sources is presented in Figure 10; 3 sites show what appears to be a waste related source. Nitrate concentration, nitrogen-isotopic ratio, and water chemistry may instead be indicative of denitrification for 1 of these sites (Ashton 09-05), which also had the highest nitrate result of 30 mg/L. Of the total sample sites, 3 showed a signature suggestive of a primarily inorganic source. Most sites showed a mixed or organic nitrate source.

Recharge from spring snowmelt is likely a significant contributing factor to the migration of nitrates infiltrating through the soil into the aquifer. Fertilizer application that limits nitrate excess in the soil at the end of the growing season and prior to the spring melt may reduce migration of nitrates from agricultural sources.

Recommendations

Residents within the Ashton–Drummond NPA are aware of elevated nitrates in the region and are receptive to learning ways to reduce the impacts to ground water quality. The biggest improvement could be made by encouraging local partnership/ownership of

education in at least three areas: wellhead and septic system maintenance, climate- and soil condition–tuned nutrient management, and land-use planning.

The Fremont County Soil and Water Conservation District and the Yellowstone Soil Conservation District (SCD) should be encouraged to partner with the City of Ashton and local residents and groups interested in local water quality, such as the Henrys Fork Foundation and Friends of the Teton River, for education efforts.

3.4. Lewiston Region

3.4.1 Camas Prairie Nitrate Priority Area Ground Water Monitoring Project

This section summarizes the 2009 sampling results from an ongoing ground water quality evaluation for nitrate (initiated in August 2005) conducted on the Camas Prairie, north of Grangeville, Idaho. An investigation conducted by DEQ (Bentz 1998) found that 24 of 55 wells sampled (44%) had nitrate concentrations that exceeded 5 mg/L, one-half the MCL of 10 mg/L. The maximum nitrate concentration in the 1998 study was 77.1 mg/L. The Camas Prairie is included as one of Idaho's 32 NPAs, based in part on the 1998 nitrate results.

Purpose

To address elevated nitrate concentrations in the Camas Prairie NPA, a GWQMP was developed (DEQ and ISCC 2008). The plan encourages implementation of voluntary BMPs to reduce nitrate concentrations in ground water. Continued ground water monitoring is being conducted in the Camas Prairie to determine BMP effectiveness on improving ground water quality compared to baseline nitrate concentrations that were established at the beginning of this project in 2005.

Methods and Results

DEQ initiated a long-term ground water monitoring program in 2005 to establish baseline conditions as well as to compare findings with 1998 sampling results. In addition to the wells selected for monitoring by DEQ, additional wells were identified and sampled by the Lewis Soil Conservation District (LSCD) in August 2005 and quarterly by DEQ since 2006. DEQ sampled 25 wells quarterly for the Camas Prairie project during February, May, September, and December 2009 (Figure 13) for nitrate. All sampling was conducted in accordance with the quality assurance project plan (DEQ 2005a). Water quality field parameters—pH, temperature, specific conductance, and DO—were measured prior to sample collection.

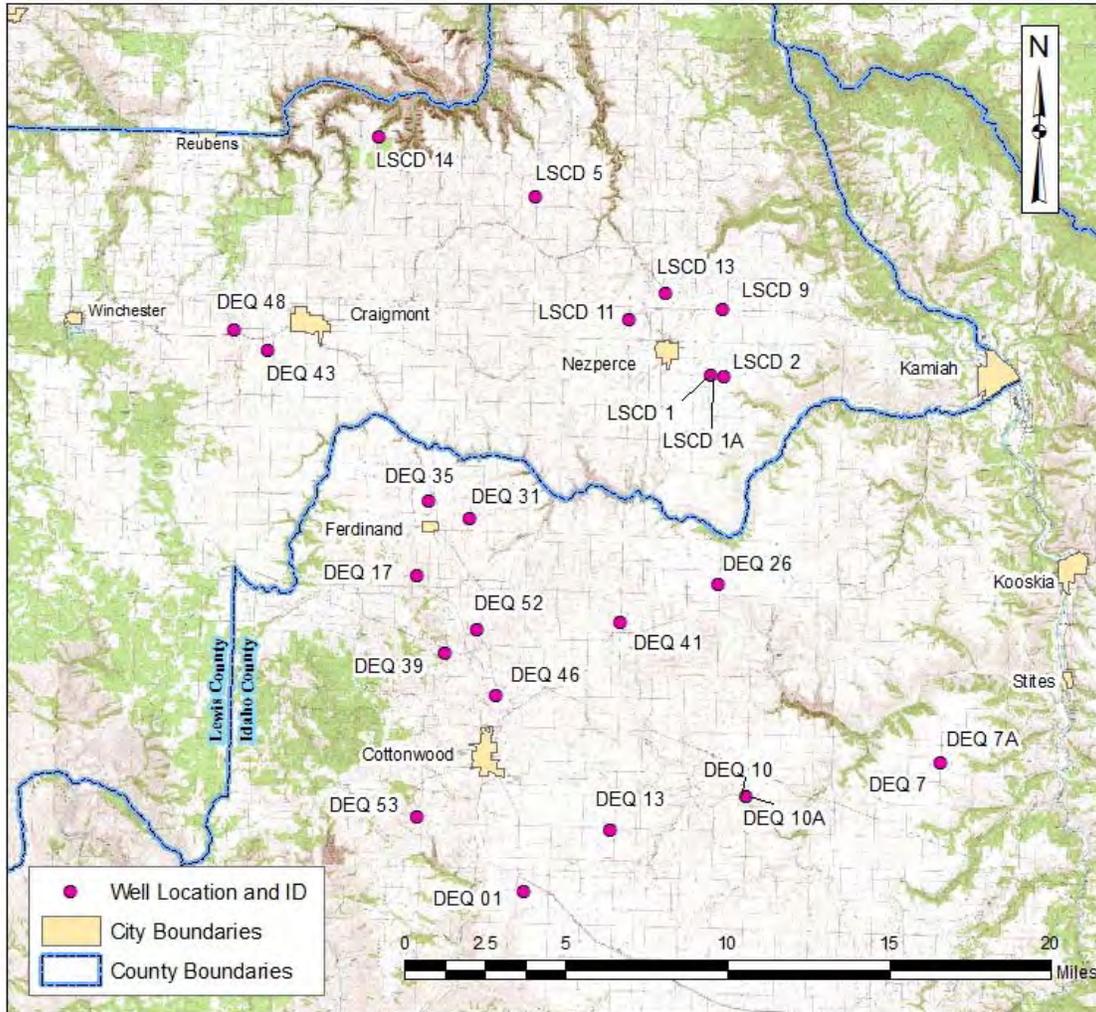


Figure 13. Well locations and IDs for Camas Prairie project

Nitrate results from the 2009 quarterly sampling are presented in Table 13. The highest nitrate concentration detected was in well DEQ 48 at 21.4 mg/L during the December 2009 sampling event. Well DEQ 48 also had the highest nitrate concentration in the February and May sampling events, with concentrations of 18.4 mg/L and 17.9 mg/L, respectively. In September 2009, well LSCD 9 had the highest nitrate concentration at 19.9 mg/L. In 2009, 6 wells exceeded the MCL of 10 mg/L for nitrate in February, 7 wells exceeded in May, 8 wells exceeded in September, and 4 wells in December.

When comparing the 18 wells that were sampled every quarter of 2009 (some wells were not sampled every quarter due to various reasons, such as dry wells during the summer and frozen pipes during the winter), the mean nitrate values showed minimal variation, ranging from 6.39 mg/L in May to 7.99 mg/L in September. The median values for the 18 wells showed a slightly larger variation, ranging from 4.48 mg/L in May to 6.5 mg/L in September.

Table 13. Nitrate results for Camas Prairie project, 2009

Well ID	Nitrate Concentration (milligrams per liter)			
	February 2009	May 2009	September 2009	December 2009
DEQ 01	0.913	1.88	2.08	1.07
DEQ 7	6.06	NS ^a	6.69	NS
DEQ 7A	8.73	5.81	9.44	6.99
DEQ 10	14.9	15.2	15.7	17.5
DEQ 10A	<0.1	<0.1	<0.1	<0.1
DEQ 13	9.19	10.0	11.5	11.3
DEQ 17	2.63	3.13	10.0	6.06
DEQ 26	4.30	4.06	4.65	4.95
DEQ 31	NS	11.1	10.8	NS
DEQ 35	9.32	11.7	NS	NS
DEQ 39	3.26	4.18	4.19	4.09
DEQ 41	4.64	4.46	6.22	5.08
DEQ 43	10.5	10.2	12.6	4.70
DEQ 46	3.75	3.39	5.85	5.32
DEQ 48	18.4	17.9	19.6	21.4
DEQ 52	13.1	9.71	10.8	2.24
DEQ 53	2.13	2.84	1.85	2.74
LSCD 1	5.13	NS	NS	4.92
LSCD 1B	NS	3.06	2.51	NS
LSCD 2	9.13	0.675	6.79	7.74
LSCD 5	11.1	11.2	11.8	13.6
LSCD 9	12.6	14.5	19.9	NS
LSCD 11	4.20	5.12	5.50	NS
LSCD 13	4.62	4.50	4.82	5.39
LSCD 14	4.98	5.87	5.97	6.01

Note: Bolded red numbers indicate the U.S. Environmental Protection Agency's maximum contaminant level was exceeded.

Shaded rows indicate wells with variable nitrate concentrations.

^a NS = not sampled.

Overall, there was very little variation in median and mean nitrate concentrations between sampling events. However, highly variable nitrate concentrations were observed in individual wells between sampling events (i.e., wells DEQ 17, DEQ 43, DEQ 52, LSCD 2, and LSCD 9—see highlighted rows in Table 13). The variability in annual ground water nitrate concentrations at various wells in the area indicates that nitrate leaching rates and/or the sources of nitrogen have not been constant over the years evaluated. This variation is probably due to changes in cropping patterns and fertilizer application, variation in nitrogen uptake by crops due to growing season conditions, and variations in leaching rates related to the amount and timing of precipitation that is available to mobilize nitrogen below the crop root zone.

Conclusions

Sample results show that ground water in the Camas Prairie contains elevated nitrate. In some locations, nitrate concentrations exceed the MCL of 10 mg/L. Based on the large

aerial extent of degraded ground water, agricultural activities are most likely the source of nitrate contamination.

There has been a large range in nitrate concentrations since the project began in 2005 (Baldwin et al. 2008). The variability may make it difficult to detect improvements in ground water quality in the study area as BMPs are implemented because the concentration changes will likely fall within the range of concentrations already measured in individual wells.

Recommendations

One method that could improve the usability of the data set would be to establish ground water and surface water connectivity by conducting monitoring at surface water locations that are representative of ground water discharge. All ground water in the study area discharges to surface water. If surface water samples are collected during base flow conditions when ground water provides the only source of water to the stream, the surface water samples will be representative of ground water. Discharge and water quality samples collected during the same sampling event at several locations along the same drainage can also be used to calculate nitrogen loads. This information may be useful in determining if and where areas of larger nitrogen contribution exist in the drainage basin and focusing BMP implementation efforts.

In addition, nitrogen isotope analysis could help identify sources of nitrogen and establish seasonal variations.

For more information, please see the technical report by Baldwin et al. (2008) that summarizes data collected for this project from 2005 through 2007 at http://www.deq.idaho.gov/water/data_reports/ground_water/camas_prairie_29.pdf.

3.5. Pocatello Region

3.5.1 Pocatello Regional Office Nitrate Follow-Up Monitoring

Purpose

In 2009, the DEQ Pocatello Regional Office participated in eight local health fairs and events across the region (Table 14). DEQ offered free nitrate analysis using test strips to local residents who provided water samples from their private domestic wells to determine the approximate nitrate concentrations. Well owners with nitrate concentrations over the MCL of 10 mg/L were offered additional information and follow-up monitoring.

Table 14. Local health fairs within the Pocatello Regional Office boundaries during which the office offered free nitrate analysis using test strips

Event	Date
Bear Lake Memorial Hospital Senior Fair	April 2, 2009
Franklin Medical Center Health Fair	April 18, 2009
Oneida County Hospital Health Fair	April 22, 2009
Community Environmental Fair—Pocatello	April 25, 2009
Caribou Memorial Hospital Health Fair	April 30, 2009
Eastern Idaho State Fair	September 8–9, 2009
Bear Lake Memorial Hospital Health Fair	September 12, 2009
Lamb Weston Employee Health Fair	November 11, 2009

Methods and Results

Based on the test strip results for nitrate taken at the health fairs, the DEQ Pocatello Regional Office collected reconnaissance ground water samples from 2 wells in Franklin County on May 5 and 1 well in Bear Lake County on April 8 for laboratory analysis of nitrate and total coliform bacteria (Figure 14). Water quality field parameters—temperature, pH, and specific conductivity—were collected prior to the sampling.

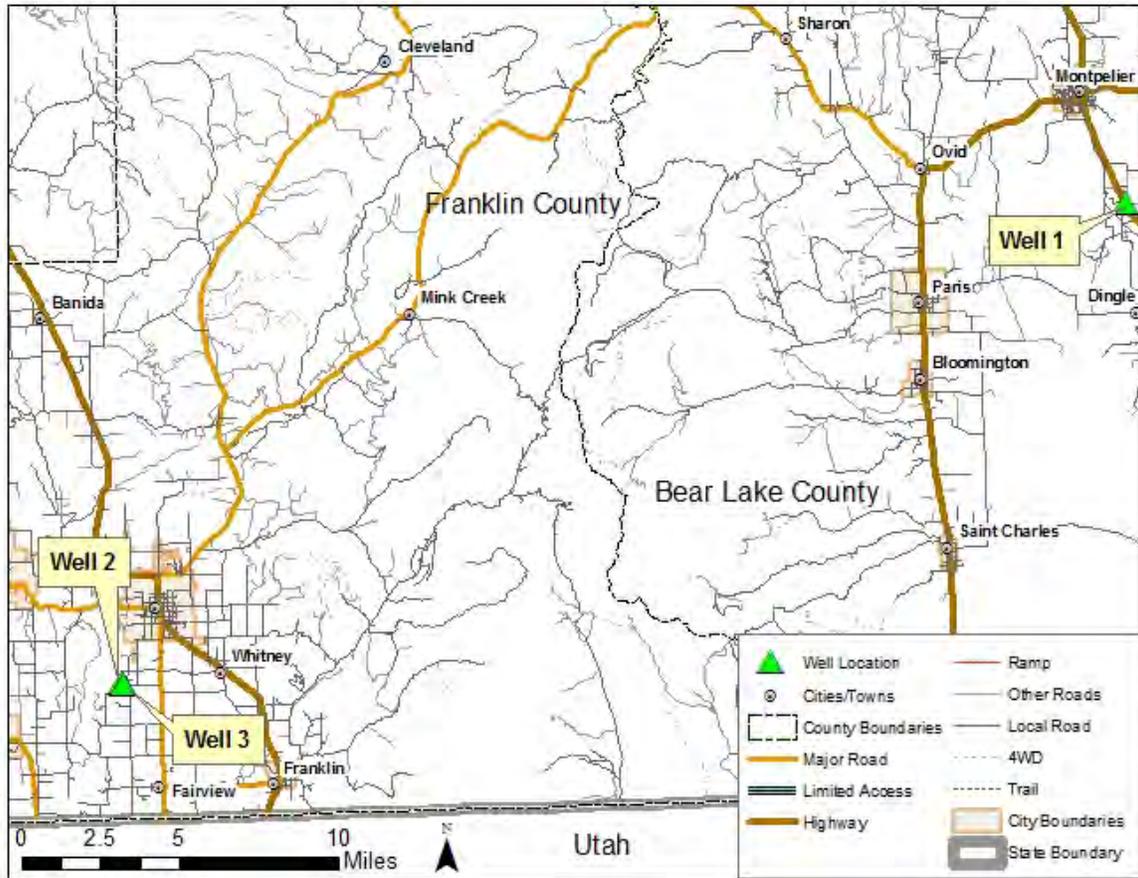


Figure 14. Location of wells sampled for the Pocatello Regional Office nitrate follow-up monitoring

The laboratory analysis confirmed that the nitrate concentrations in the 3 wells were over the MCL of 10 mg/L, validating the test strip results. The nitrate concentrations ranged from 18.6 mg/L to 28.6 mg/L (Table 15). Total coliform was not detected in any of the wells.

Table 15. Pocatello Regional Office nitrate follow-up monitoring data

Well ID	Sample Date	Nitrate (mg/L)	Nitrate Result from Test Strip (mg/L)	Total Coliform (MPN/100 mL) ^a
Well 1	4/8/2009	18.6	20–50	Absent
Well 2	5/5/2009	26.9	10–20	Absent
Well 3	5/5/2009	28.6	10–20	Absent

Note: Bolded red numbers indicate the U.S. Environmental Protection Agency's maximum contaminant level was exceeded.
mg/L = milligrams per liter

^a MPN/100 mL = most probable number per 100 milliliters

Conclusions

The follow-up sampling confirmed the test strip results in that the nitrate concentration exceeded the MCL in all 3 wells. Follow-up sampling also confirmed the validity of using nitrate test strips as a reliable and inexpensive screening tool for nitrate.

Recommendations

Further investigation in the areas surrounding the wells, including nitrate and $\delta^{15}\text{N}$ analyses, will be helpful in determining the source and extent of nitrate contamination. Sampling of wells screened in the shallow aquifer is planned by DEQ in the Sand Ridge Subdivision, where wells 2 and 3 are located.

Land-use activities near the elevated nitrate concentrations should be examined to determine what potential BMPs could be utilized to protect the ground water from further contamination. Well owners in these areas are encouraged to test their wells annually for nitrate.

3.6. Twin Falls Region

3.6.1 Twin Falls County Drainage Tunnel Project

During the early 1900s, 46 drainage tunnels were constructed through the basalt layers in Twin Falls County to drain excess water from flood-irrigated agricultural fields. The tunnels typically discharge into Snake River tributaries, such as Rock Creek, Cedar Draw, and Deep Creek. Since the drain tunnels were constructed, many land-use changes have occurred directly above and adjacent to the tunnels, such as conversion from flood irrigation to sprinkler irrigation and from agricultural to urban and suburban land uses.

Purpose

This project was designed to characterize the relationship between land-use practices above the tunnels and the water quality within the tunnels. In addition, the project was designed to determine if the presence of the tunnels has an effect on the surrounding ground water. The project was funded by DEQ.

Methods and Results

Water samples were collected by the Balanced Rock SCD between August and November 2009. Samples from 45 drain tunnels were collected at the mouth of each tunnel. In addition, ground water samples were collected at 63 domestic wells in the immediate vicinity of drain tunnels. All samples were submitted to a laboratory for nitrate analysis. This section focuses on the ground water samples from the domestic wells. Tollefson (2009) provides information regarding the drain tunnel monitoring.

A total of 63 ground water samples were collected. The mean nitrate concentration was 4.51 mg/L with a standard deviation of 2.23 mg/L. The concentrations ranged from non-detectable (<0.30 mg/L) to 9.32 mg/L. None of the ground water samples exceed the EPA's MCL for nitrate. However, some areas had elevated nitrate concentrations above 5 mg/L near Buhl and west of Filer (Figure 15). For comparison, the drain tunnel samples ranged from non-detectable (<0.30 mg/L) to 13.5 mg/L, with 2 wells exceeding the EPA's MCL for nitrate. For more information about the drain tunnel results, please see Tollefson (2009).

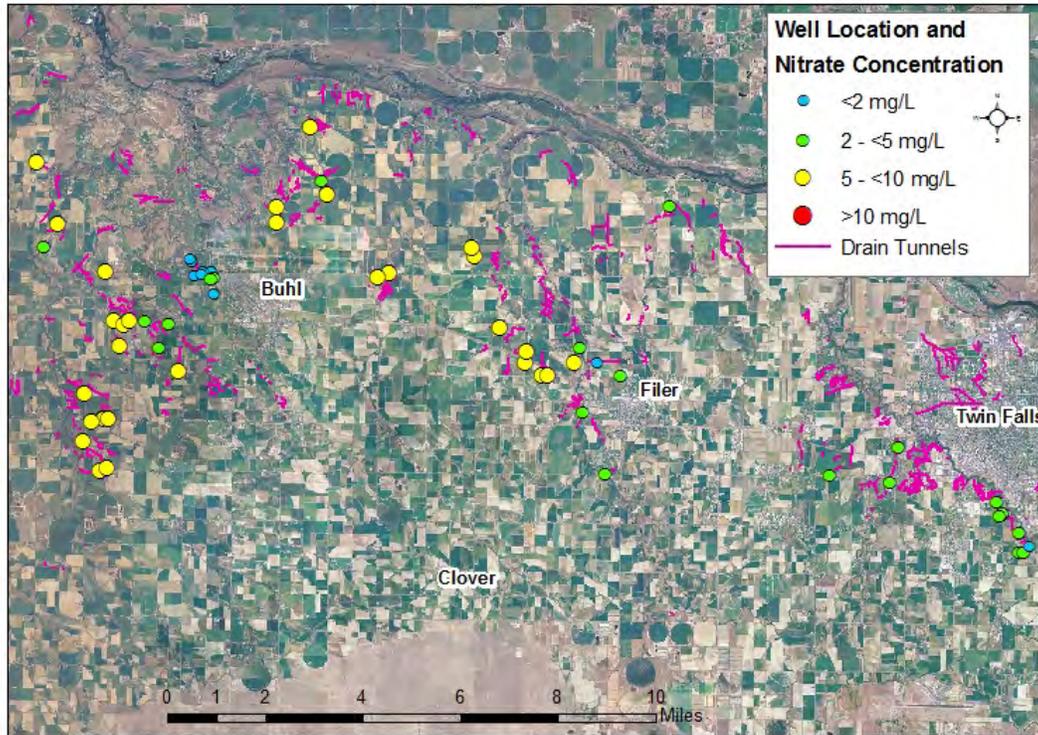


Figure 15. Sample well locations and nitrate concentrations for Twin Falls County drainage tunnel project

Conclusions

None of the wells sampled in this project exceeded the MCL for nitrate; however, areas with elevated nitrate concentrations were identified around Buhl and west of Filer.

Ground water samples were collected to determine if water in the drain tunnels was influencing ground water. However, due to variability that was unaccounted for in the sampling—such as well depth, well casing depth, water levels, and ground water flow directions—it was not possible to determine if a potential relationship exists between the water quality in the tunnels and the ground water quality in the surrounding wells.

Water samples collected from the drain tunnels showed a difference in nitrate concentrations related to different land uses. Mean nitrate concentrations in drain tunnel water samples were significantly higher for agricultural land-use areas as compared to urban/residential land-use areas (Tollefson 2009). For complete analysis of the drain tunnel data, please refer to Tollefson (2009).

Recommendations

DEQ recommends the well identification tag number be recorded to reference with well logs available through IDWR for future sampling events. The additional well log information (e.g., well depth, casing depth) will help clarify the relationship that the tunnels may have on the drinking water quality of surrounding wells.

3.6.2 Springs of Southern Gooding County Study

In 2007, through the National Pollutant Discharge Elimination System monitoring program, Clear Springs Foods, Inc., (Snake River Farms facility) detected elevated nitrate concentrations (greater than 5 mg/L) in springs supplying water to their facility. In an effort to identify possible increasing trends in nitrate at the springs and an attempt to locate the possible source of this elevated nitrate, DEQ began monitoring water chemistry at springs near the facility. In 2009, 2 springs were sampled to help determine possible sources of nitrogen.

Purpose

The purpose of this project was to gain a better understanding of the quality of ground water-fed springs supplying water to Clear Springs Foods' Snake River Farms facility (Snake River Fish Hatchery—Figure 16). To determine if nitrate concentrations were increasing significantly at the facility, DEQ developed and implemented a sampling strategy in 2007. The following section summarizes data collected for the springs near the Snake River Farms facility in 2009.

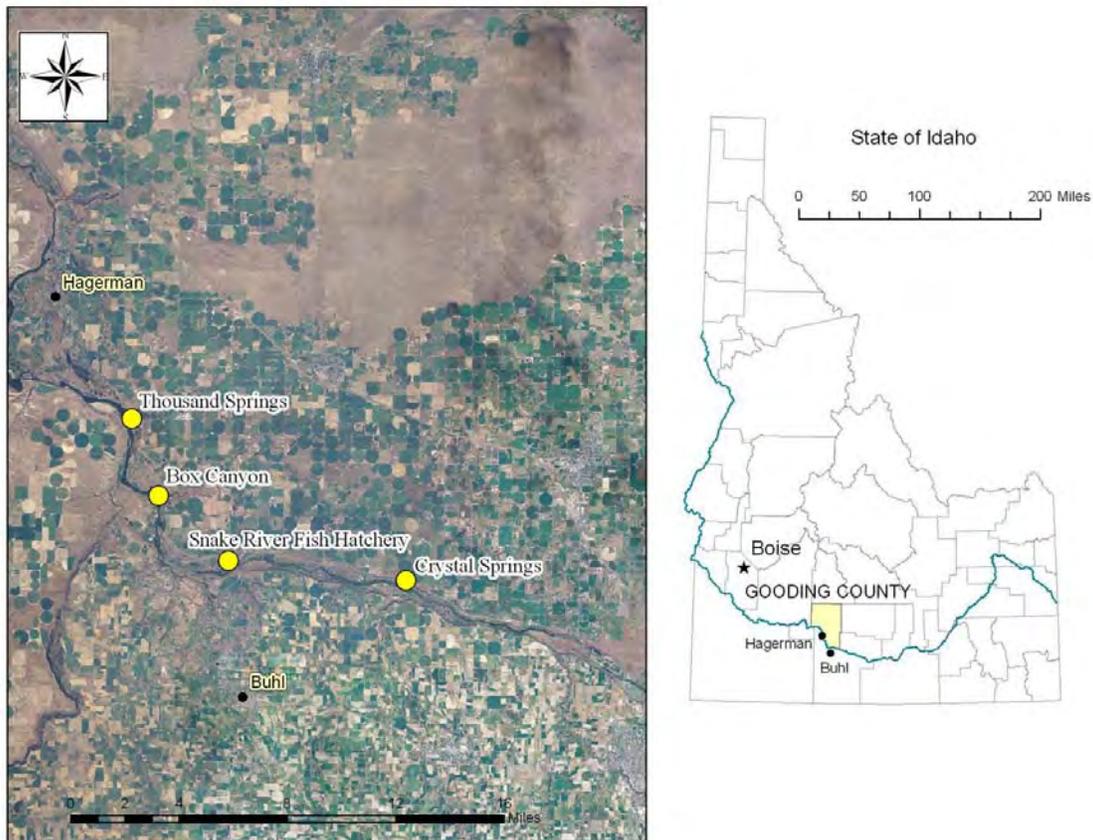


Figure 16. Location of Clear Springs Foods' Snake River Farms facility (denoted by Snake River Fish Hatchery)

Methods and Results

As a follow up to the 2007 and 2008 sampling, two springs were sampled in 2009 in accordance with the quality assurance project plan (DEQ 2007). Spring R & D #3 was sampled in January and February 2009, and Spring SR-1 was sampled in February 2009 (Figure 17). Water quality field parameters were measured at the springs for temperature, pH, specific conductivity, and DO (Table 16). Samples for nitrate were collected and submitted for laboratory analysis.



Figure 17. Locations of springs in the vicinity of the Snake River Farms facility, including R & D #3 and SR-1, which were sampled in 2009

The highest nitrate concentration of 6.8 mg/L was detected during the January 2009 sampling at R & D #3 (Table 16). During the February 2009 sampling, the nitrate concentration was 2.5 mg/L at SR-1 and 5.9 mg/L at R & D #3, which are located approximately 1,000 feet apart (Table 16 and Figure 17).

Table 16. Water quality field and lab nitrate results collected in 2009 for R & D #3 and SR-1 springs

Sample ID	Sample Date	Temperature (°C)	pH	Specific Conductivity (µS/cm)	Dissolved Oxygen (mg/L)	Nitrate (mg/L)
R & D #3	1/21/2009	14.0	7.20	671	10.10	6.8
R & D #3	2/4/2009	14.4	8.67	676	11.16	5.9
SR-1	2/4/2009	14.3	8.97	588	11.17	2.5

Note: µS/cm = microsiemens per centimeter; mg/L = milligrams per liter

Conclusions

Nitrate concentrations in spring discharge are highly variable within short lateral distances (see complete analysis in Schorzman et al. 2009). At the sampled springs, nitrate loading from land uses hydraulically upgradient from the Snake River Farms facility is the source of these areas of higher nitrate concentrations.

The water chemistry data, including nitrate and water quality field parameters, do not provide direct evidence of a source for the increasing nitrate concentrations. The amount of nitrogen (pounds) that flows through the Snake River Farms facility is significantly higher than the amount produced by the residential septic tanks located upgradient of the facility (see complete analysis in Schorzman et al. 2009). Therefore, the source of nitrogen is likely from agricultural practices, including crop fertilization and confined animal feeding operations (CAFOs).

Recommendations

DEQ recommends the continued monitoring of the springs in southern Gooding County for nitrate concentrations. It would be useful to analyze nitrogen isotope ratios in spring discharge on a seasonal basis to identify potential temporal variations in nitrate sources to the springs. Analysis of oxygen and deuterium isotopes would also be useful because this isotopic ratio system exhibits seasonal variation and can help determine the ground water provenance.

To determine the source of elevated nitrate at the Snake River Farms facility, DEQ recommends conducting a hydrologic tracer test. Tracer tests can be used as a tool to determine hydrogeologic parameters by introducing a known volume of tracer (i.e., rhodamine, fluorescein, xenon) and measuring the occurrence of the tracer at the discharge point. It would be useful to use tracer tests to determine the sources of constituents of concern to springs and aquaculture facilities. Using BMPs to reduce or avoid over-application of fertilizer (both animal and commercial) is necessary to control the amount of nitrogen reaching the aquifer and springs in southern Gooding County.

For more information, please see the full technical report by Schorzman et al. (2009) that summarizes project data collected in 2007 and 2008 at http://www.deq.idaho.gov/water/data_reports/ground_water/southern_gooding_county_nitrate_38.pdf.

3.6.3 Springdale Ground Water Quality Study

The Cassia County NPA was delineated using nitrate concentrations from 384 wells. The mean nitrate concentration of these wells was 6.34 mg/L. The NPA extends over approximately 300 square miles of Cassia County and encompasses the cities of Burley and Springdale. Ground water in the eastern part of the NPA, south of Springdale, has higher mean nitrate concentrations than the area as a whole. For 112 wells south of Springdale used for the NPA delineation process, the mean nitrate concentration was 8.15 mg/L. This area is referred to as the Springdale study area and is the focus of this study (Figure 18).

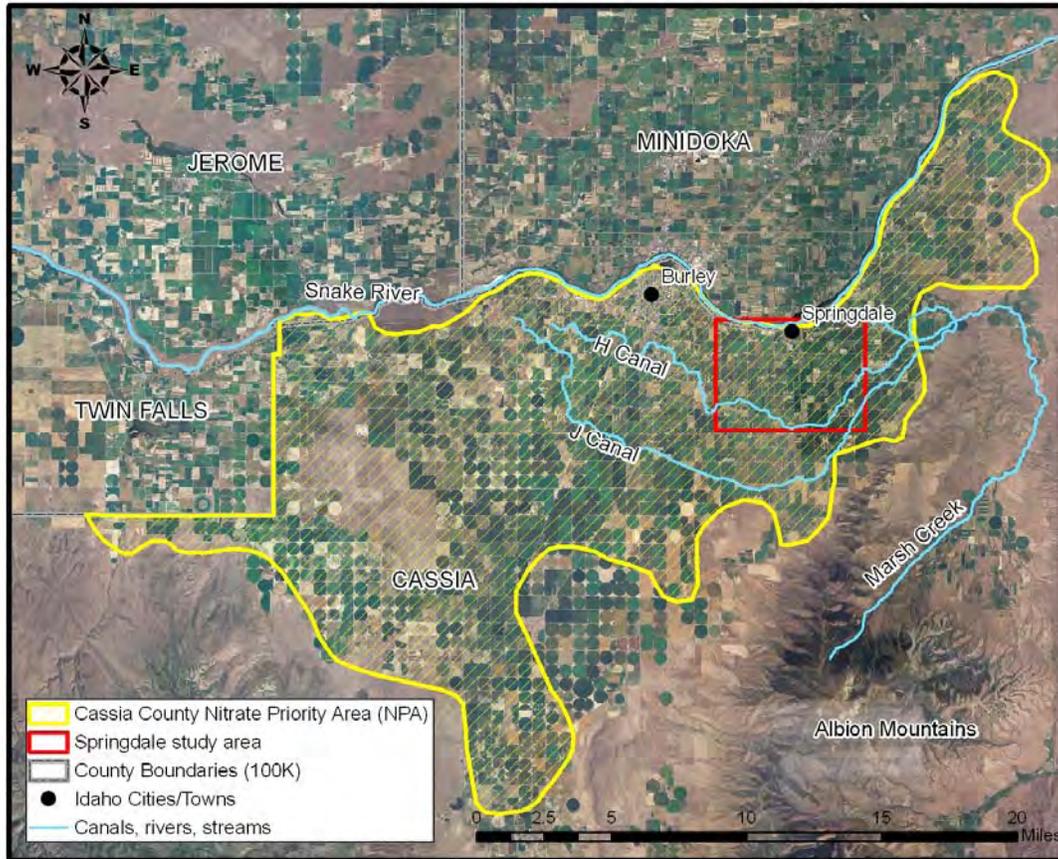


Figure 18. Springdale study area

Purpose

A GWQMP has been developed for the Cassia County NPA (DEQ 2004). The plan calls for continued efforts to monitor ground water within the NPA to determine the effectiveness of BMPs to improve ground water quality. The goal of this sampling project is to determine sources of nitrate and the relative contribution of each source within the Springdale study area (and also within the NPA as a whole). Possible sources of nitrate in this area include agricultural practices, CAFOs, and septic tanks. Analysis of a variety of parameters and constituents can help determine the main sources of nitrate within the Springdale study area.

In October 2008, 10 wells and 2 surface water sites were sampled for this project. Follow-up monitoring occurred in April 2009 and included 13 wells, 2 surface water sites, and 2 drain sites. The following section summarizes data collected in April 2009. For analysis of the 2008 and 2009 data, refer to Schorzman and Baldwin (2009).

Methods and Results

In April 2009, 13 domestic wells, 2 surface water sites, and 2 drain sites were sampled in order to evaluate nitrate impacts to ground water (Figure 19). Water quality field parameters (pH, water temperature, DO, and specific conductance) were measured at each site. Ground water samples were collected in accordance with the quality assurance

project plan (DEQ 2008) and analyzed for the following inorganic chemicals: nitrate, chloride, and sulfate. In addition, the ground water samples were analyzed for PCPPs and TDS. This summary only includes data from the domestic wells. For information regarding the surface water and drain sites, please refer to Schorzman and Baldwin (2009).

Nitrate concentrations exceeded the MCL of 10 mg/L in 11 of 13 wells sampled (Table 17 and Figure 19); 12 of the 13 wells exceed the federal secondary drinking water standard of 500 mg/L for TDS.

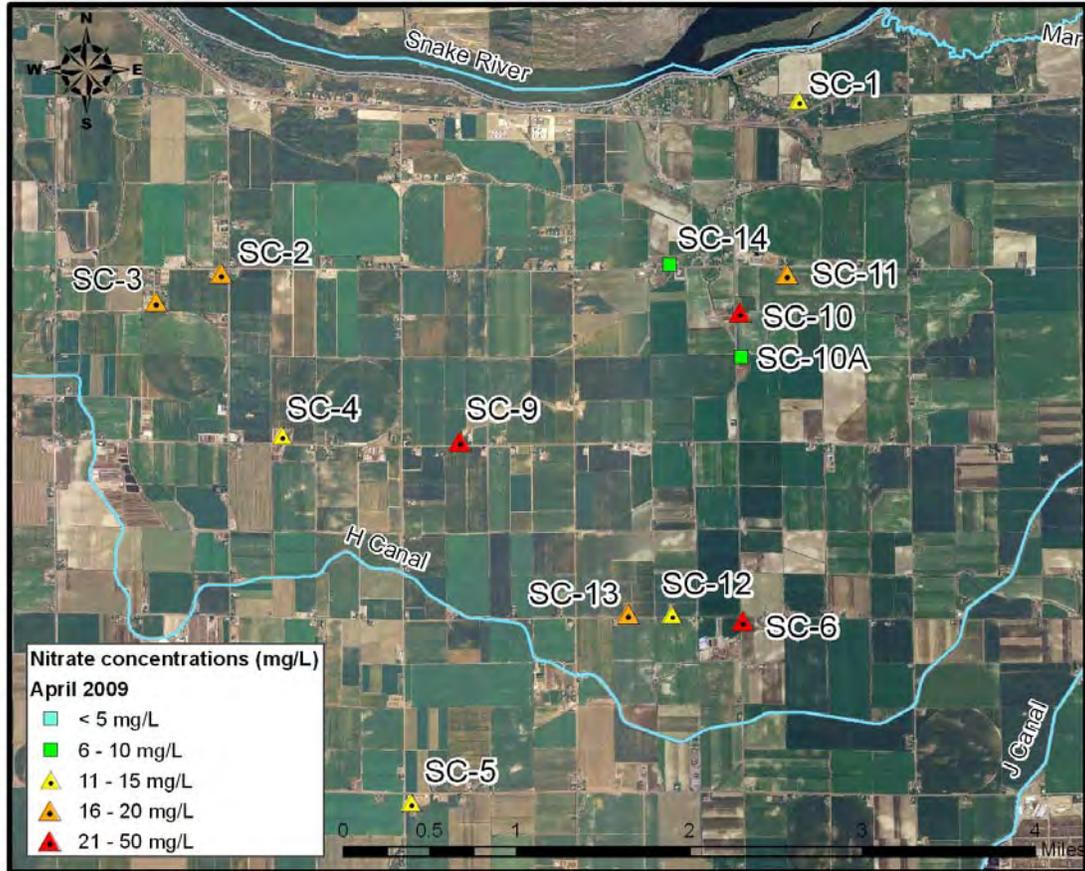


Figure 19. Well locations, IDs and nitrate concentration for the April 2009 Springdale ground water quality study

From the Springdale study area, 10 of the 13 nitrogen isotope ratio results (Table 17) fall within the range of organic nitrogen in soil or a mixed nitrogen source signature, which may be from the mixing of water from more than one source. (Refer to Table 5 for typical $\delta^{15}\text{N}$ values for various nitrogen sources.) In addition, 2 wells (SC-9 and SC-14) had nitrogen isotope values indicating a commercial fertilizer nitrogen source signature. The nitrogen isotope ratio value for SC-3 indicates an animal or human waste source of nitrogen.

Table 17. Inorganic compound and $\delta^{15}\text{N}$ analyses for ground water samples collected in April 2009 in the Springdale study area

Sample ID	Chloride (mg/L)	Sulfate (mg/L)	Nitrate + Nitrite (mg/L)	Total Dissolved Solids (mg/L)	$\delta^{15}\text{N}$ (‰)
SC-1	43.1	83.2	11	<i>520</i>	5.1
SC-2	41.8	72.6	17	<i>590</i>	6.4
SC-3	50.9	74.0	20	<i>640</i>	9.9
SC-4	43.1	65.8	11	480	8.7
SC-5	37.4	76.3	13	<i>540</i>	4.7
SC-6	77.3	119	25	<i>860</i>	8.5
SC-9	50.7	124	21	<i>640</i>	3.4
SC-10	81.3	131	21	<i>730</i>	6.8
SC-10A	42.9	95.0	9.8	<i>530</i>	5.2
SC-11	46.5	97.2	17	<i>620</i>	5.7
SC-12	37.2	78.2	14	<i>540</i>	5.1
SC-13	46.6	104	17	<i>630</i>	4.4
SC-14	37.6	86.9	10	<i>540</i>	3.6

Note: Bolded red numbers indicate the U.S. Environmental Protection Agency's maximum contaminant level was exceeded.

Italicized red numbers indicate the U.S. Environmental Protection Agency's Secondary Drinking Water Regulation was exceeded.

mg/L = milligrams per liter; ‰ = per mil

The 2009 results for the PCPP analyses are presented in Table 18. Sulfamethoxazole (SMX) is a member of the sulfonamide family of antimicrobials used mainly for veterinary practices (Lee et al. 2007). SMX was detected in samples from wells SC-3, SC-4, SC-5, SC-6, SC-10, SC-10A, SC-11, SC-12, and SC-14. Throughout the Springdale study area, SMX was detected in highly variable concentrations, with no apparent relationship to well depth. Wells SC-6 and SC-10 had elevated SMX concentrations compared to the other wells in the Springdale study area. The human anti-seizure drug carbamazepine was detected in the well SC-10A sample at a concentration of 1.4 nanograms per liter (ng/L). The animal antibiotic sulfadimethoxine was detected in the well SC-6 sample at 1.4 ng/L. The human antibiotic trimethoprim was detected in the well SC-14 sample at 8.4 ng/L. Caffeine, found in caffeinated beverages, was detected in wells SC-2, SC-6, and SC-14 ranging from 6.8 ng/L to 27 ng/L. The analgesic acetaminophen was not detected in any of the well samples.

Table 18. Personal care products and pharmaceutical analyses for samples collected in April 2009 in the Springdale study area

Sample ID	Caffeine (ng/L)	Sulfamethoxazole (ng/L)	Sulfadimethoxine (ng/L)	Carbamazepine (ng/L)	Trimethoprim (ng/L)	Acetaminophen (ng/L)
SC-1	ND	ND	ND	ND	ND	ND
SC-2	27	ND	ND	ND	ND	ND
SC-3	ND	1.7	ND	ND	ND	ND
SC-4	ND	3.6	ND	ND	ND	ND
SC-5	ND	1.1	ND	ND	ND	ND
SC-6	6.8	19	1.4	ND	ND	ND
SC-9	ND	ND	ND	ND	ND	ND
SC-10	ND	36	ND	ND	ND	ND
SC-10A	ND	4	ND	1.4	ND	ND
SC-11	ND	1.2	ND	ND	ND	ND
SC-12	ND	2.3	ND	ND	ND	ND
SC-13	ND	ND	ND	ND	ND	ND
SC-14	11	1.2	ND	ND	8.4	ND

Note: ng/L = nanograms per liter; ND = non-detectable

Conclusions

Shallow ground water in the Springdale study area is being negatively impacted from land-use practices as evidenced by elevated nitrate, TDS, and PCPP concentrations. Analytical results indicate the local land-use practices in northern Cassia County influence the concentrations of these constituents of concern in domestic wells and surface water.

The range of nitrogen isotope values observed in the Springdale study area indicates a mixture of nitrogen from commercial fertilizer, animal or human waste, and organic nitrogen in soil. The nitrogen isotope value for SC-3 indicates an animal or human waste source. The nitrogen isotope values for SC-9 and SC-14 indicate a commercial fertilizer nitrogen source signature.

The water quality field parameters and concentrations of inorganic compounds, isotopes, and PCPPs together suggest that an area-wide land use-related contamination problem exists independent of well depth or construction. The measurements and analytical results also suggest that well construction and on-site land-use practices are important factors determining the water quality at individual well locations.

The persistence of PCPPs detected in some of the wells suggests that pathways exist between human and animal waste sources and ground water. A wide variety of PCPPs were detected in the April 2009 sampling event. The fact that PCPPs were found throughout the study area suggests there is an area-wide persistence of PCPPs in northern Cassia County.

Recommendations

Due to current data gaps, DEQ recommends additional samples of these wells to analyze ground water for the following constituents: nitrate, chloride, sulfate, TDS, nitrogen and oxygen isotopes, and PCPPs in selected wells to determine trends as well as seasonality

effects. Measuring the isotopic signature of the oxygen that comprises the nitrate (NO_3) compound, along with the nitrogen isotope signature, will be useful in further fingerprinting the wells impacted by commercial fertilizer application and/or animal or human waste sources.

The additional data will be analyzed to identify sources of nitrogen and develop a GWQMP specifically for the Springdale study area. Employing BMPs will help reduce or avoid the potential over-application of commercial and animal fertilizers. Public outreach would be beneficial to educate the citizens of Springdale about the quality of ground water in their area and how they can protect their domestic drinking water wells.

For more information, please see the full technical report by Schorzman and Baldwin (2009) at

http://www.deq.idaho.gov/water/data_reports/ground_water/springdale_nitrate_39.pdf.

3.6.4 Bliss Nitrate Priority Area Nitrogen Isotope Comparison Study

Purpose

During 2009, the Gooding SCD sampled monitoring wells and domestic wells monthly in the Bliss NPA for various constituents, including nitrogen isotope ($\delta^{15}\text{N}$), to help determine the source of nitrogen to the ground water. In April and July 2009, DEQ collected split samples from two monitoring wells within the Bliss NPA for $\delta^{15}\text{N}$ analysis. DEQ sent half of the split samples to the University of Waterloo Environmental Isotope Laboratory, which is a well-established stable isotope laboratory that uses chemical separation techniques to isolate the nitrate for sample preparation. The Gooding SCD sent the other half of the split samples to the University of Arizona Environmental Isotope Laboratory, which uses an evaporative sample preparation method to measure the $\delta^{15}\text{N}$ on the salt residue. The purpose of the split samples was to compare the accuracy of the two $\delta^{15}\text{N}$ analysis methods.

Methods and Results

During April 2009, DEQ and the Gooding SCD jointly sampled MW 1 and MW 2 within the Bliss NPA (Figure 20). The wells were purged using a submersible pump until the water quality field parameters stabilized. A sample was collected at each monitoring well for $\delta^{15}\text{N}$ analysis and split into two sample bottles. The Gooding SCD sent one $\delta^{15}\text{N}$ sample to the University of Arizona and DEQ sent the other split $\delta^{15}\text{N}$ sample to the University of Waterloo. During July 2009, DEQ and the Gooding SCD jointly sampled MW 1 and MW 2 again using the same protocols and sampling techniques as described above, only the wells were purged using a bailer instead of a submersible pump. All samples were collected in accordance to the quality assurance project plan (Gooding SCD 2009).

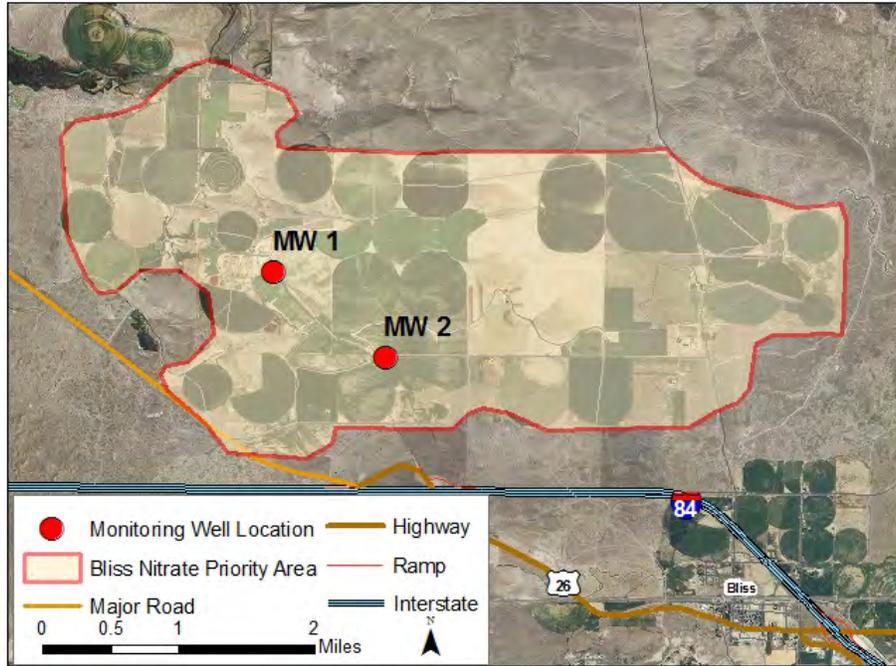


Figure 20. Location of monitoring wells sampled within the Bliss Nitrate Priority Area

The $\delta^{15}\text{N}$ results ranged from 3.1‰ (University of Arizona, April MW 2 sample) to 14.1‰ (University of Arizona, July MW 1 sample) (Table 19). Results of $\delta^{15}\text{N}$ analysis for MW 1 indicated a mixed or organic source of nitrogen during the April sampling event. (Refer to Table 5 for typical $\delta^{15}\text{N}$ values for various nitrogen sources.) During the July sampling event for MW 1, the $\delta^{15}\text{N}$ analysis from the University of Arizona strongly suggested a waste source of nitrogen, while the University of Waterloo's $\delta^{15}\text{N}$ analysis suggested a mixed or organic source. All $\delta^{15}\text{N}$ results for MW 2 indicate a fertilizer source of nitrogen, except the April results from the University of Waterloo. However, the cutoff for a fertilizer source according to Seiler (1996) is 4‰; with a sample result of 4.05‰, it is possible that the $\delta^{15}\text{N}$ result does fall within the fertilizer source range due to a laboratory sample precision of $\pm 0.2\%$.

Table 19. $\delta^{15}\text{N}$ split sample results from University of Waterloo and University of Arizona

Well ID	Sample Date	$\delta^{15}\text{N}$ (‰) ^a	
		University of Waterloo	University of Arizona
MW 1	4/15/2009	7.4	8.7
MW 2	4/15/2009	4.05	3.1
MW 1	7/16/2009	8.81	14.1
MW 2	7/16/2009	3.68	3.3

^a ‰ = per mil

The $\delta^{15}\text{N}$ results were plotted from each laboratory (Figure 21). The R^2 value of 0.95 indicates a high correlation between the two labs. However, there is a difference as noted with the MW 1 July sample that fell into two different nitrogen source ranges.

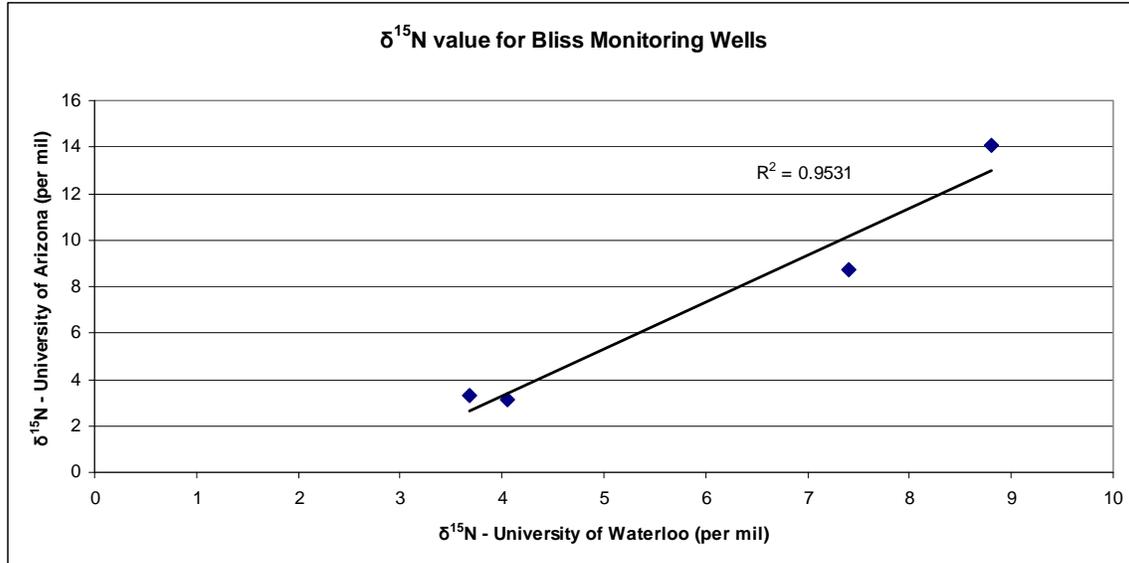


Figure 21. $\delta^{15}\text{N}$ analysis results from University of Waterloo and University of Arizona

Conclusions

Results from $\delta^{15}\text{N}$ analysis from three samples for MW 1 indicated a mixture of nitrogen sources; while one sample in July for MW 1 indicated a waste source. The MW 2 $\delta^{15}\text{N}$ analysis consistently suggested a fertilizer source of nitrogen, with the possible exception of the April University of Waterloo result of 4.05‰. However, analysis of nitrogen isotopes alone should not be used as the only method to determine nitrogen sources. Nitrogen isotope values in ground water can be complicated by several reactions (e.g., ammonia volatilization, nitrification, denitrification, plant uptake) that generally increase the $\delta^{15}\text{N}$ values (Kendall and McDonnell 1998). Furthermore, mixing of sources with variable nitrogen isotope values along shallow flowpaths makes determination of sources and extent of denitrification very difficult for intermediate $\delta^{15}\text{N}$ values (Kendall and McDonnell 1998).

Nitrogen isotope results from the University of Waterloo and University of Arizona $\delta^{15}\text{N}$ analyses show a strong correlation. One sample (MW 1—July sampling) did not fall within the same nitrogen source range according to Seiler (1996). However, the remaining samples were within the same range when taking laboratory analytical precision into consideration.

Recommendations

The $\delta^{15}\text{N}$ results indicate that both waste and fertilizer application are impacting the ground water in the Bliss NPA. The Gooding SCD is encouraged to work with local landowners to implement appropriate BMPs.

The interlaboratory comparison of $\delta^{15}\text{N}$ analysis showed a strong correlation between the nitrogen isotope results generated by the University of Waterloo and University of Arizona. From this small sample population, results indicate that using the University of Arizona for $\delta^{15}\text{N}$ analyses is suitable.

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