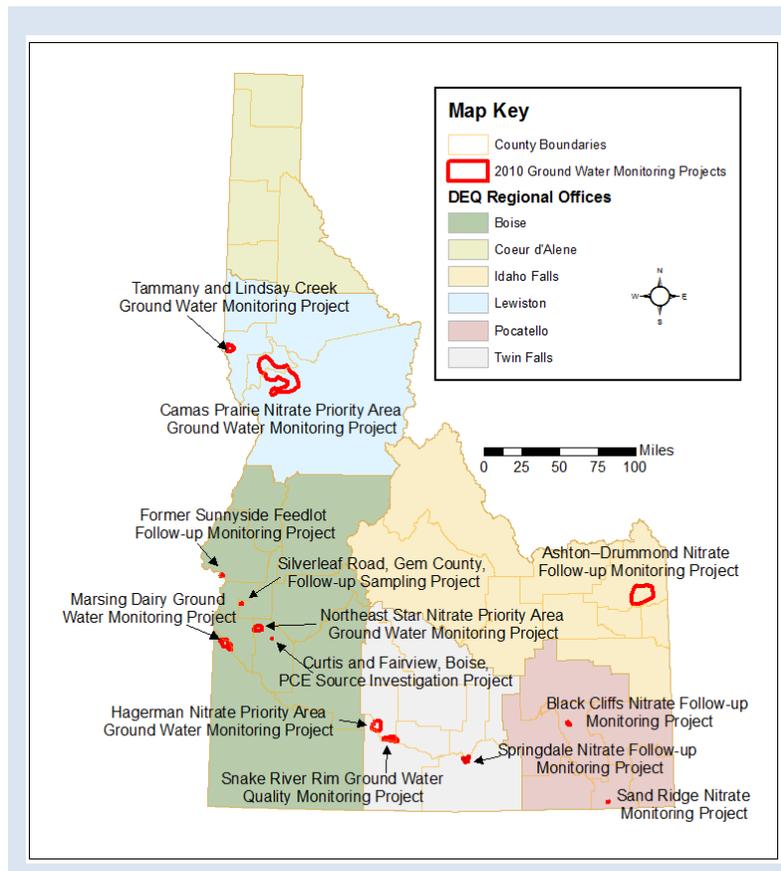


Summary Report for the Idaho Department of Environmental Quality Ground Water Quality Monitoring Projects—2010

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Summary Report for the Idaho Department of Environmental Quality Ground Water Quality Monitoring Projects—2010



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Acronyms, Abbreviations, and Symbols

$\delta^{15}\text{N}$	ratio of the two stable nitrogen isotopes ^{15}N and ^{14}N
$\delta^{18}\text{O}$	ratio of the two oxygen isotopes ^{18}O and ^{16}O
$\delta^2\text{H}$	ratio of the two hydrogen isotopes ^1H and ^2H (deuterium), also denoted as δD
BMP	best management practice
CAFO	confined animal feeding operation
DEQ	Idaho Department of Environmental Quality
DO	dissolved oxygen
<i>E. coli</i>	Escherichia coli
EPA	United States Environmental Protection Agency
GWQMP	ground water quality management plan
IDWR	Idaho Department of Water Resources
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	nondetect
NES	northeast Star
$\text{NO}_2 + \text{NO}_3$ 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
PCE	tetrachlorethylene
PCPP	personal care products and pharmaceuticals

per mil (‰)	parts per thousand
PWS	public water system
QAPP	quality assurance project plan
µg/L	micrograms per liter
µS/cm	microsiemens per centimeter
VOC	volatile organic compound

1. Introduction

Ground water is a key resource in Idaho, providing nearly all the state's drinking water, and 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 code § 39-1, "Environmental Quality—Health" 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.

Idaho code further directs DEQ, Idaho Department of Water Resources (IDWR), and 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 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 Program 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 2010. 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 United States 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.

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. The [DEQ Drinking Water](#) webpage provides more information about the required monitoring at PWSs.

Source water assessments are critical to protect Idaho drinking water sources. The first step of a source water assessment is to delineate the source water assessment area. The delineation process establishes the physical area around a well, spring, or surface water intake that will become the focal point of the source water assessment. The process includes mapping the boundaries of the areas of the aquifer (for ground water sources) or the watershed (for surface water sources) that contribute water to the PWS source. The next step is to conduct the susceptibility analysis to determine the likelihood that the water supply will become contaminated. For each PWS well, spring, or surface water intake, susceptibility to contamination is scored as high, moderate, or low. The susceptibility score takes into account three factors: (1) system construction—construction of the well, spring, or surface water intake being assessed; (2) potential contaminant inventory and land use—potentially significant sources of contamination to the source water and land-use characteristics above the aquifer; and (3) hydrologic sensitivity—hydrologic and geologic conditions surrounding the well, spring, or surface water intake being assessed.

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 2010, DEQ created an [interactive website](#) of source water assessments to improve efficiency and usability. The website can be used to search for PWS sources to view the delineation, susceptibility score, and potential contaminant inventory. In addition, each PWS source has a summary report that is automatically generated after the susceptibility score and delineation have been completed by DEQ. The website was completed in March 2011. DEQ will continue to create source water delineations for new PWS sources and will use the interactive website to produce assessments.

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 2010. Projects are presented by DEQ Regional Offices and identified in Figure 1.

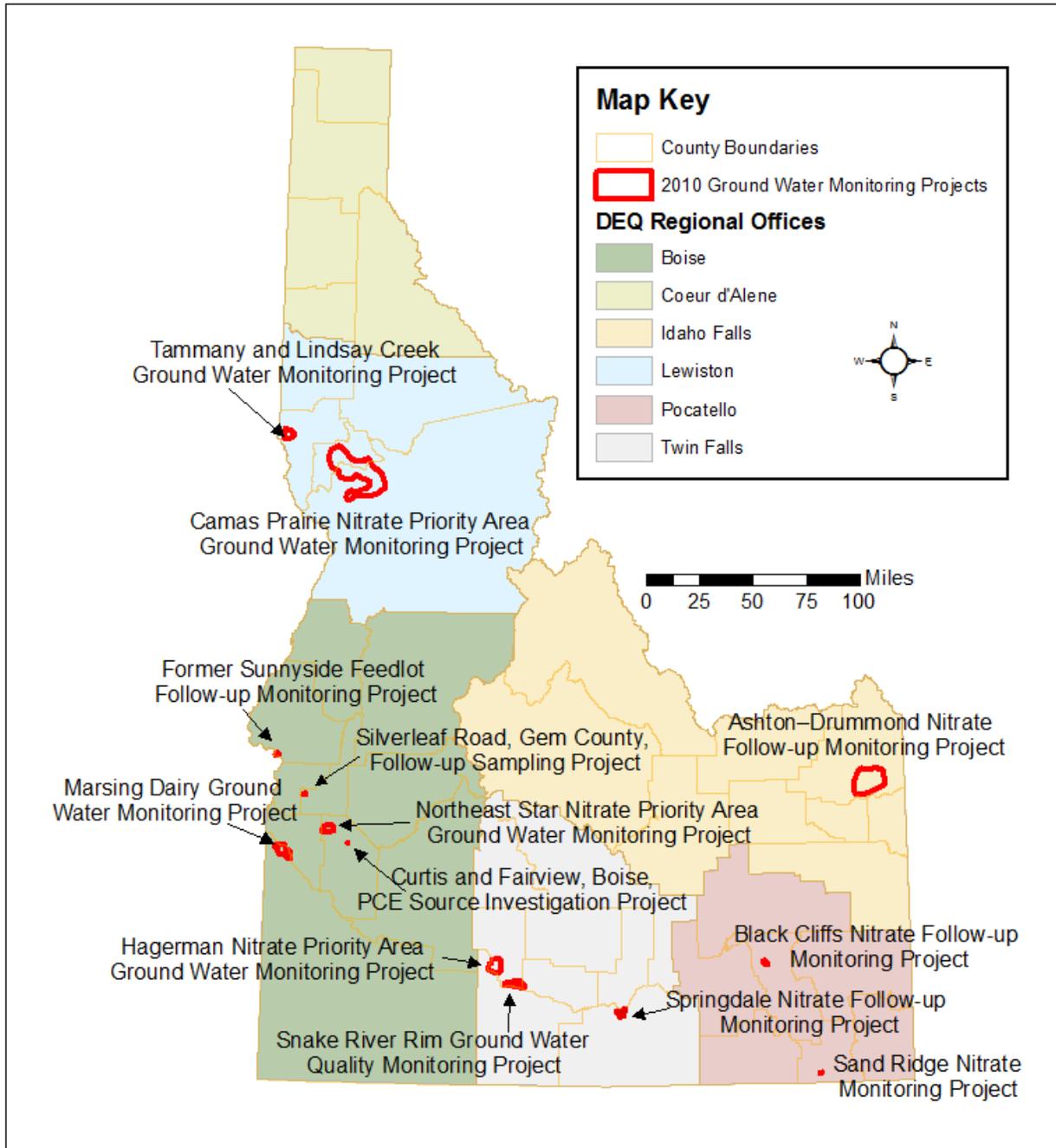


Figure 1. Idaho Department of Environmental Quality's 2010 ground water quality project locations by region.

All ground water quality data contained in this report are available through an [interactive mapping application](#) available on DEQ's website. The application contains ground water quality data that DEQ or its contractors have collected from 1987 to the present. The application can be used to view and download data collected for over 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 Former Sunnyside Feedlot Follow-Up Monitoring Project

3.1.1.1 Purpose

The former Sunnyside Feedlot is located in the eastern portion of the Weiser NPA in Washington County. In 2004, DEQ installed ground water monitoring wells in response to elevated nitrate concentrations detected by ISDA in surrounding domestic wells. DEQ sampled the ground water monitoring wells from 2004 through 2008. The Sunnyside Feedlot consisted of 3,000 to 4,000 head of cattle and ceased operation in early spring 2006. A follow-up ground water quality monitoring project was conducted at and in the vicinity of the former Sunnyside Feedlot in April and May 2010. The purpose of the follow-up project was to evaluate ground water quality in the area, particularly nitrate concentrations, following the closure of the feedlot. The objectives were to provide current ground water quality data, update ground water quality trends, and direct any potential site remediation.

3.1.1.2 Methods and Results

In April and May 2010, DEQ collected samples from 13 monitoring wells and 14 domestic wells in and surrounding the former Sunnyside Feedlot (Figure 2). Water quality field parameters—pH, temperature, specific conductivity, and dissolved oxygen (DO)—were measured at each site prior to sample collection (Table 1). Samples were collected from each well in accordance with the DEQ's quality assurance project plan (QAPP) (DEQ 2006 and DEQ 2010a) and analyzed for fluoride, nitrite, nitrate, chloride, sulfate, bromide, orthophosphate, and nitrogen isotopes. 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 milligrams per liter (mg/L). The results are provided in Table 1. Depth to ground water was collected at the monitoring wells and used to construct ground water elevation contours using a contour modeling software. The contours are shown in Figure 2. The depth to ground water measurement at MW3 was anomalously low (resulting in an anomalously high ground water elevation). The depth to ground water at MW3 was not used in constructing the ground water contours shown in Figure 2. The general ground water flow direction in the project area is from east to west.

All samples, except the nitrogen isotope samples, were submitted to the University of Idaho Analytical Sciences Laboratory in Moscow, Idaho, for analysis. Nitrogen isotope samples were

collected at each sampling location, frozen, and stored at DEQ pending nitrate analysis. After DEQ received the 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 in Tucson, Arizona, for nitrogen isotope analysis.

In addition, 3 wells were sampled for antibiotics and 4 wells were sampled for steroids based on detections of these constituents in the selected wells during previous sampling efforts (Antibiotic and Steroid Sampling section, Table 4 and Table 5). These samples were sent to the University of Idaho Analytical Sciences Laboratory for analysis.

Nitrate Sampling

In 2010, the 27 sampled wells had nitrate values ranging from less than 0.05 mg/L to 36 mg/L, with a median value of 14.5 mg/L (Figure 2 and Table 1). Twenty wells (74%), including 11 domestic wells and 9 monitoring wells, exceeded EPA’s maximum contaminant level (MCL) for nitrate of 10 mg/L.

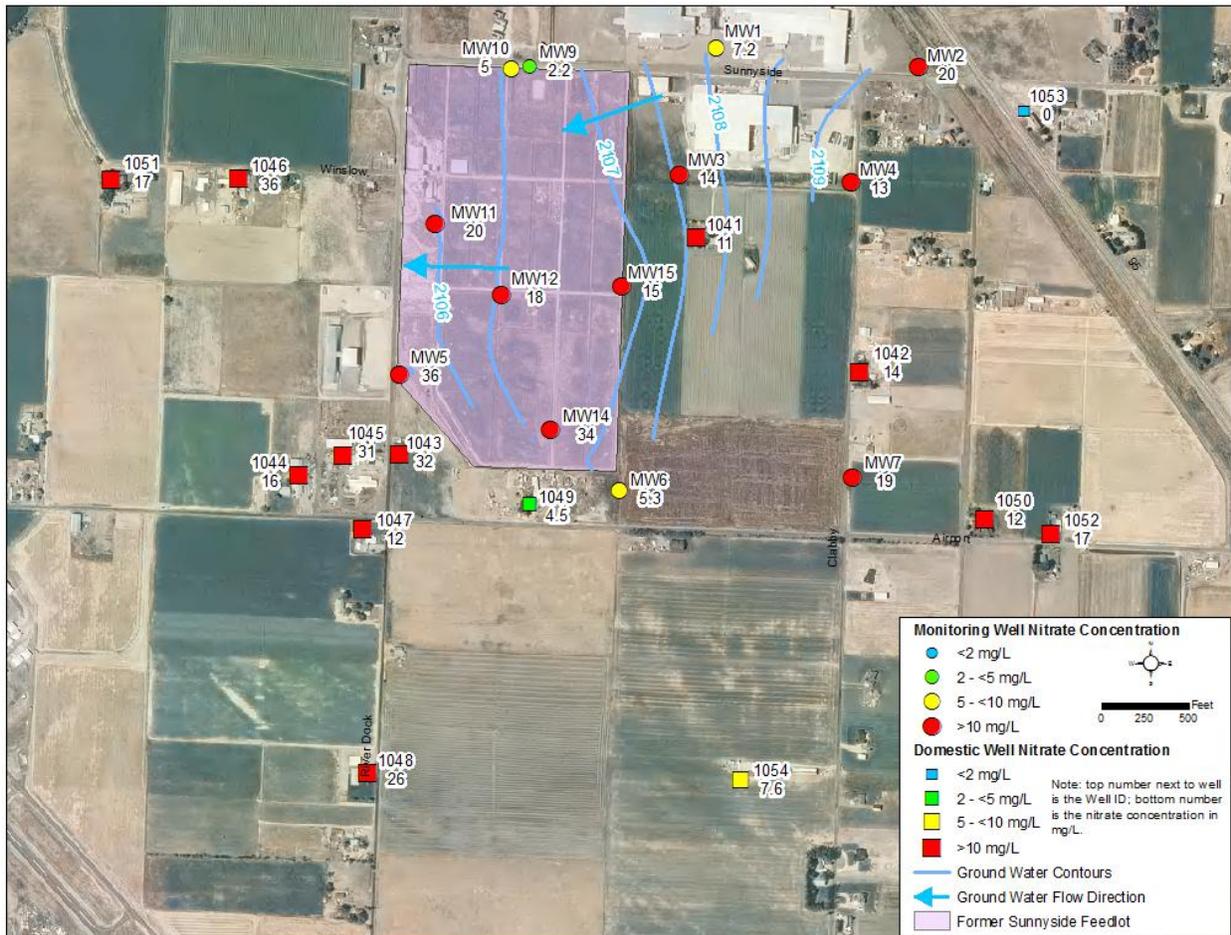


Figure 2. Well locations, well identification, and nitrate concentrations (in milligrams per liter) for Former Sunnyside Feedlot Follow-Up Project in 2010. The ground water elevation for MW3 was not used due to anomalously high ground water elevation measurement.

Table 1. Summary of field parameter and inorganic analytical results for the Former Sunnyside Feedlot Follow-Up Project.

Well ID	Well Depth (feet)	Sample Date	Fluoride (mg/L)	Nitrite (mg/L)	Nitrate (mg/L)	Chloride (mg/L)	Sulfate (mg/L)	Ammonia (mg/L)	Bromide ^a (mg/L)	Ortho-phosphate ^a (mg/L)	Water Temperature ^a (°C)	Specific Conductivity ^a (µS/cm)	Dissolved Oxygen ^a (mg/L)	pH
1041	U	4/26/2010	0.68	<0.05	11	47	210	<0.1	0.16	0.17	13	2,100	1.6	8.8
1042	U	4/28/2010	0.58	<0.05	14	36	230	<0.1	<0.1	<0.1	13	1,600	0.4	7.7
1043	U	4/26/2010	0.96	<0.05	32	190	470	NA	0.32	<0.1	15	2,800	5.8	8.9
1044	47	4/29/2010	1.2	<0.05	16	170	760	<0.1	0.4	<0.1	14	3,500	0	7.5
1045	U	4/29/2010	0.99	<0.05	31	200	530	<0.1	0.34	<0.1	14	3,000	0.1	7.5
1046	U	4/28/2010	0.76	<0.05	36	140	330	NA	0.32	<0.1	13	2,400	2.2	7.6
1047	40	4/29/2010	1.4	<0.05	12	150	950	<0.1	0.46	<0.1	13	3,800	0.1	7.6
1048	45	4/29/2010	1.3	<0.05	26	67	480	NA	0.26	<0.1	12	2,700	3.4	7.8
1049	36	4/28/2010	0.77	<0.05	4.5	120	480	0.25	0.3	<0.1	14	2,600	2.4	7.5
1050	U	4/27/2010	0.72	<0.05	12	18	170	NA	<0.1	0.2	14	150	2.4	7.7
1051	U	4/28/2010	0.77	<0.05	17	130	300	<0.1	0.24	0.12	14	2,800	0.3	7.7
1052	50	4/28/2010	0.78	<0.05	17	25	220	NA	0.1	0.13	15	1,400	2.8	7.8
1053	U	4/28/2010	0.39	<0.05	0	3.3	<0.2	1.7	<0.1	0.12	17	270	0	8.2
1054	35	5/4/2010	0.59	<0.05	7.6	9.6	97	NA	<0.1	0.11	14	1,200	4.7	7.7
MW1	30	4/27/2010	0.59	<0.05	7.2	7	63	<0.1	<0.1	0.12	15	1,100	1.7	7.7
MW2	30	4/27/2010	0.86	<0.05	20	24	160	<0.1	0.14	0.2	12	1,200	1.4	7.8
MW3	25	4/27/2010	0.67	<0.05	14	21	130	<0.1	<0.1	0.11	15	1,300	0.3	7.6
MW4	30	4/27/2010	0.6	<0.05	13	34	200	NA	0.12	<0.1	12	1,800	2.8	7.8
MW5	25	4/27/2010	0.97	<0.05	36	200	420	NA	0.33	<0.1	14	2,900	2	7.4
MW6	40	4/28/2010	0.57	<0.05	5.3	50	370	3.3	0.18	<0.1	16	2,100	0	7.4
MW7	35	5/4/2010	0.89	<0.05	19	34	270	<0.1	0.12	<0.1	14	1,700	4.6	7.7
MW9	33	4/26/2010	0.77	<0.05	2.2	18	96	0.34	<0.1	1.2	14	1,100	0.2	8.8
MW9 ^b	33	5/18/2010	0.75	<0.05	6	26	140	NA	<0.1	0.82	12	920	3.6	7.4
MW10	30	4/27/2010	0.82	<0.05	5	41	150	1.4	0.12	0.33	12	1,300	0.5	7.9
MW11	45	4/26/2010	0.71	<0.05	20	73	210	<0.1	0.18	<0.1	15	1,900	0.4	7.9
MW12	35	4/26/2010	1	<0.05	18	110	420	2.4	0.25	<0.1	16	3,200	0.1	8.6

Well ID	Well Depth (feet)	Sample Date	Fluoride (mg/L)	Nitrite (mg/L)	Nitrate (mg/L)	Chloride (mg/L)	Sulfate (mg/L)	Ammonia (mg/L)	Bromide ^a (mg/L)	Ortho-phosphate ^a (mg/L)	Water Temperature. ^a (°C)	Specific Conductivity ^a (µS/cm)	Dissolved Oxygen ^a (mg/L)	pH
MW14	40	4/26/2010	1.2	<0.05	34	190	<i>470</i>	NA	0.28	<0.1	14	2,900	3.6	8.9
MW15	35	5/4/2010	0.87	<0.2	15	93	<i>320</i>	<0.1	0.2	0.36	NA	NA	NA	NA

Notes: Bolded red numbers indicate the United States Environmental Protection Agency's (EPA's) maximum contaminant level was exceeded; italicized red numbers indicate EPA's Secondary Drinking Water Regulation was exceeded; mg/L = milligrams per liter; °C = degrees Celsius; µS/cm = microsiemens per centimeter; U = unknown; NA = not analyzed.

a. No primary or secondary health standard available.

b. Resampled due to broken antibiotic bottle during shipment.

Nitrogen Isotope Sampling

Nitrogen isotope ratios ($\delta^{15}\text{N}$) 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. 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 2. The $\delta^{15}\text{N}$ results from this project ranged from 5.3 per mil (‰) to 18.1‰ (Table 3). Sixteen wells (64%) had $\delta^{15}\text{N}$ results greater than 9‰, indicating an animal or human waste source. The 9 remaining wells had $\delta^{15}\text{N}$ values ranging from 5.3‰ to 8.9‰, which indicates the source of nitrogen is either from organic nitrogen in the soil or a mixture of fertilizer and waste sources. All wells within and downgradient of the former feedlot facility have $\delta^{15}\text{N}$ values that indicate a waste source (Figure 2 and Figure 3).

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, and plant uptake) that generally increase the $\delta^{15}\text{N}$ values (Kendall and McDonnell 1998). Furthermore, mixing sources with variable nitrogen isotope values along shallow flowpaths makes determining the sources and extent of denitrification 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 animal operations. Typically, this type of land use would result in a majority of wells showing a mixture of nitrogen sources in the ground water. In this project, all of the wells located within and downgradient of the former feedlot have $\delta^{15}\text{N}$ values that indicate a waste source (Figure 2 and Figure 3). This result indicates that the former feedlot is still impacting the shallow ground water in the project area.

Table 2. 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)

Notes: $\delta^{15}\text{N}$ = nitrogen isotope; ‰ = per mil or parts per thousand

Table 3. Nitrogen isotope results for the Former Sunnyside Feedlot Follow-Up Project.

Well ID	Well Depth (feet)	Sample Date	$\delta^{15}\text{N}$ (‰)
1041	U	4/26/2010	10.5
1042	U	4/28/2010	10.7
1043	U	4/26/2010	17.9
1044	47	4/29/2010	16.9
1045	U	4/29/2010	13.8
1046	U	4/28/2010	13.2
1047	40	4/29/2010	16.1
1048	45	4/29/2010	6.5
1050	U	4/27/2010	8
1051	U	4/28/2010	18.1
1052	50	4/28/2010	7.4
1054	35	5/4/2010	6.5
MW1	30	4/27/2010	8.8
MW2	30	4/27/2010	5.3
MW3	25	4/27/2010	6.4
MW4	30	4/27/2010	8.9
MW5	25	4/27/2010	16.1
MW6	40	4/28/2010	12.6
MW7	35	5/4/2010	8.8
MW9	33	4/26/2010	16.6
MW10	30	4/27/2010	15.8
MW11	45	4/26/2010	10.9
MW12	35	4/26/2010	15.8
MW14	40	4/26/2010	13.3
MW15	35	5/4/2010	11.6

Notes: There is no primary or secondary health standard available for nitrogen isotopes; $\delta^{15}\text{N}$ = nitrogen isotope; ‰ = per mil or parts per thousand; U = unknown.

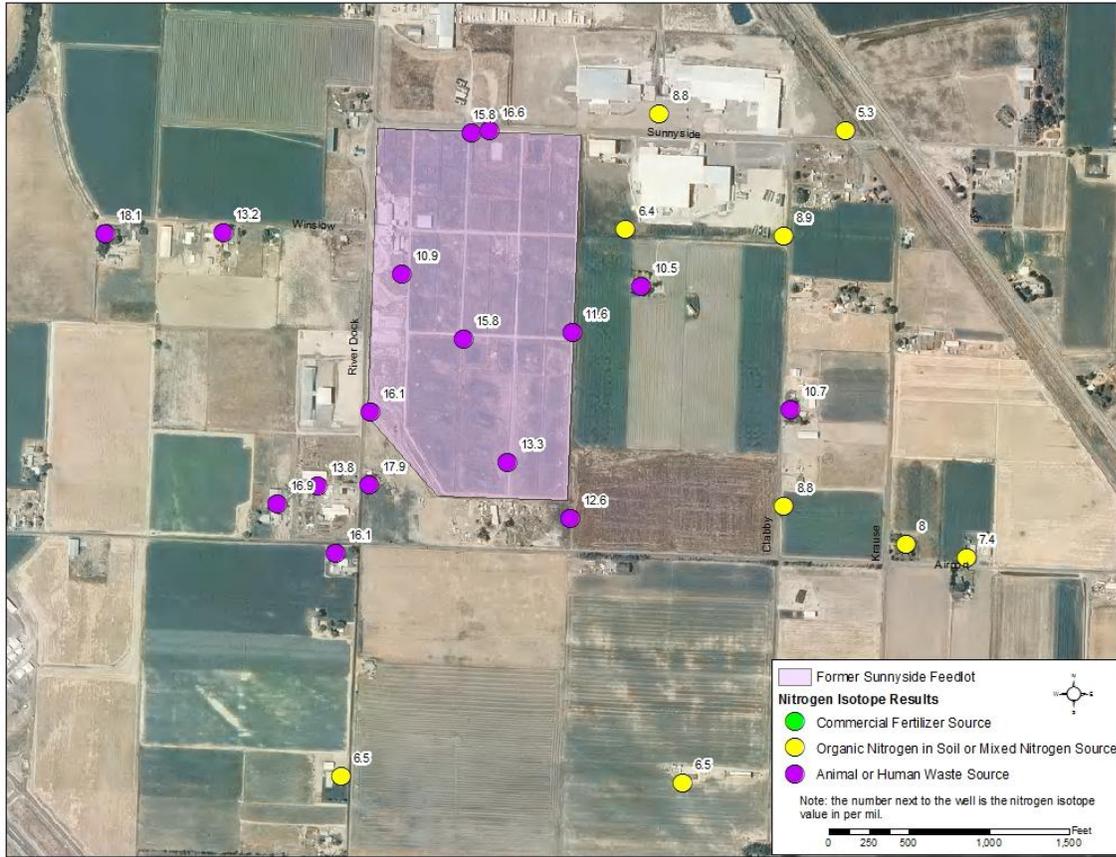


Figure 3. Nitrogen isotope results for the Former Sunnyside Feedlot Follow-Up Project.

Antibiotic and Steroid Sampling

Three wells were sampled for antibiotics, including the compounds sulfathiazole, sulfamerazine, sulfamethizole, sulfamethazine, sulfachloropyridazine, sulfamethoxazole, and sulfadimethoxine (Figure 4 and Table 4). All 3 wells had detections of sulfamethazine, which is primarily used as a veterinary antibacterial drug in food animals (USDL 2011), and 1 well had a detection of sulfachloropyridazine, which is a widely used antibiotic in livestock production (Wang et al. 2009). The 3 wells are located within the former feedlot facility. Four wells were sampled for steroids, which included caffeine, cholesterol, coprostan-3-ol, and beta-estradiol (Figure 4 and Table 5). One well had a detection of beta-estradiol, which was commonly used in the former feedlot's operations (Tesch and Owsley 2006). This well is located sidegradient of the former facility and downgradient of an onion dump based on depth to ground water data collected during the sampling event.



Figure 4. Antibiotic and steroid results for Former Sunnyside Feedlot Follow-Up Project, 2010.

Table 4. Antibiotic results for Former Sunnyside Feedlot Follow-up Project, 2010.

Well ID	Well Depth (feet)	Sample Date	Sulfa-thiazole (µg/L)	Sulfa-merazine (µg/L)	Sulfa-methizole (µg/L)	Sulfa-methazine (µg/L)	Sulfachloro-pyridazine (µg/L)	Sulfa-methoxazole (µg/L)	Sulfa-dimethoxine (µg/L)
MW9	33	5/18/2010	<0.2	<0.1	<0.2	0.15	0.60	<0.1	<0.1
MW10	30	4/27/2010	<0.2	<0.1	<0.2	0.49	<0.2	<0.1	<0.1
MW12	35	4/26/2010	<0.2	<0.1	<0.2	0.40	<0.2	<0.1	<0.1

Notes: No primary or secondary health standards available for antibiotics; µg/L = micrograms per liter.

Table 5. Steroid results for Former Sunnyside Feedlot Follow-Up Project, 2010.

Well ID	Well Depth (feet)	Sample Date	Caffeine ($\mu\text{g/L}$)	Cholesterol ($\mu\text{g/L}$)	Copristan-3-ol ($\mu\text{g/L}$)	beta-estradiol ($\mu\text{g/L}$)
1044	47	4/29/2010	<0.02	<0.1	<0.1	<0.05
1047	40	4/29/2010	<0.02	<0.1	<0.1	<0.05
1049	36	4/28/2010	<0.02	<0.1	<0.1	<0.05
MW6	40	4/28/2010	<0.02	<0.1	<0.1	0.99

Notes: No primary or secondary health standards available for steroids; $\mu\text{g/L}$ = micrograms per liter.

3.1.1.3 Conclusions

Out of the 27 wells sampled for this project, nitrate in 20 wells samples exceeded EPA's MCL. Out of the 3 wells sampled for antibiotics, all 3 contained sulfamethazine, and 1 well had a detection of sulfachloropyridazine, both widely used in livestock production (USDL 2011; Wang et al. 2009). Four wells were sampled for steroids; 1 well had a detection of beta-estradiol. Four years following the closure of the feedlot, antibiotics continue to be detected within the boundary of the former feedlot. The $\delta^{15}\text{N}$ results indicated a waste source of nitrogen for all wells located within and downgradient of the former feedlot based on ground water elevation data collected during the sampling event. The water quality data indicate that the former feedlot continues to impact the shallow ground water quality 4 years after the closure of the facility.

3.1.1.4 Recommendations

To evaluate changes in ground water chemistry resulting from the closure of the confined animal feeding operation (CAFO), DEQ recommends that monitoring for anions, ammonia, antibiotics, and $\delta^{15}\text{N}$ continue to document the ground water quality trends following removal of manure and the establishment of crops grown at the site.

3.1.2 Marsing Dairy Ground Water Monitoring Project

3.1.2.1 Purpose

The ISDA Dairy Bureau collects ground water samples for nitrate at dairy wells during annual facility inspections. When a sample exceeds the EPA's MCL for nitrate (10 mg/L), ISDA provides the information to DEQ. Three dairies are located northwest of Marsing, Idaho. The nitrate concentrations from the 2010 ISDA Dairy Bureau sampling at the production wells at two of these dairies were 24.5 mg/L and 56.9 mg/L, exceeding the MCL. In November 2010, DEQ conducted a follow-up ground water monitoring project surrounding the dairies to determine the extent and magnitude of nitrate contamination in ground water.

3.1.2.2 Methods and Results

Using well logs from the IDWR website, and assistance from a local citizen, DEQ selected 30 wells that surround the dairies for monitoring and evaluation (Figure 5). For the wells with available information, the well depths ranged from 30 feet to 164 feet, and the static water level ranged from 1 foot to 35 feet. Within the project area, there are two aquifers: a shallow system composed of coarse-grained sand and gravels and a deeper system composed of black sand (Carlson et al. 2001). The two systems are

separated by a characteristic blue-colored clay. A review of the available well logs of sampled wells indicate the blue clay layer is encountered at various depths throughout the project area, ranging from 3 feet to 92 feet below ground surface. The thickness of the blue clay layer ranges from 12 feet to 71 feet, with an average thickness of 37 feet. The blue clay layer can act as a protective barrier to prevent contaminants generated at the land surface from migrating into deeper aquifers. For all wells sampled with well logs available, the screened interval was located below the blue clay, within the deeper aquifer.

In November 2010, samples were collected from each well in accordance with the DEQ QAPP (DEQ 2010b) and analyzed for nitrate plus nitrite, ammonia, chloride, sulfate, arsenic, total coliform, *Escherichia coli* (*E. coli*) (Table 6), and nitrogen isotopes (Nitrogen Isotope Sampling section, Table 7). Water quality field parameters—pH, temperature, specific conductivity, and DO—were measured at each site prior to sample collection (Table 6). All samples, except the nitrogen isotope samples, were submitted to the Idaho Bureau of Laboratories in Boise, Idaho, for analysis. Nitrogen isotope samples were collected at each sampling location, frozen, and stored at DEQ pending nitrate analysis. After DEQ received the nitrate analysis results, those nitrogen isotope samples from wells with nitrate or ammonia concentrations equal to or greater than 5 mg/L were then sent to the University of Arizona, Tucson, Arizona, for nitrogen isotope analysis.

Nitrite plus Nitrate Sampling

The nitrite plus nitrate values ranged from nondetectable (<0.01 mg/L) to 22 mg/L (Table 6). EPA's MCL of 10 mg/L was exceeded in 1 well. Twenty-three of the 30 wells sampled had nitrite plus nitrate concentrations less than the detection limit of 0.01 mg/L. The spatial distribution of nitrate concentrations is shown in Figure 5. The majority of the wells with nitrite plus nitrate less than the detection limit had DO concentrations less than 2 mg/L. The anoxic conditions would likely result in any nitrogen in the system being in a chemically reduced form, such as ammonia.

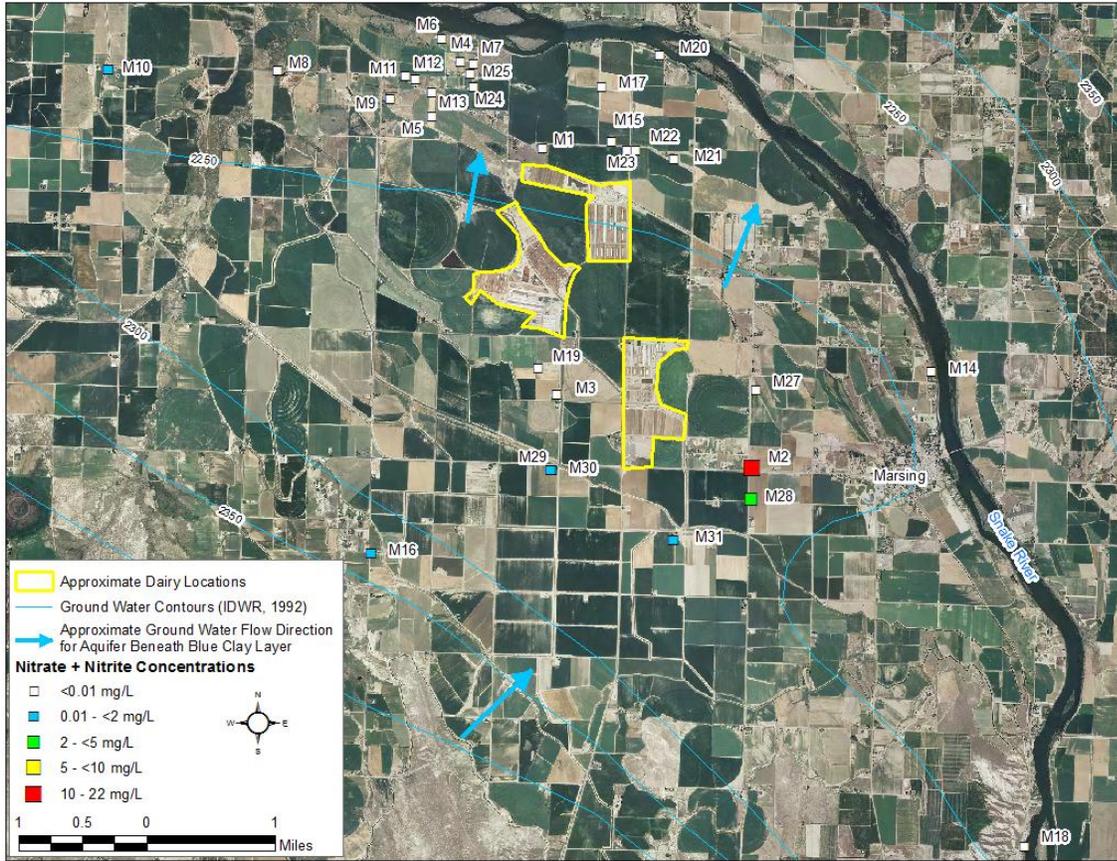


Figure 5. Nitrate plus nitrite concentrations for the Marsing Dairy Ground Water Monitoring Project.

Table 6. Inorganic and field parameter results for the Marsing Dairy Ground Water Monitoring Project.

Well ID	Well Depth (feet)	Sample Date	Nitrite + Nitrate (mg/L)	Ammonia (mg/L)	Arsenic (µg/L)	Chloride (mg/L)	Sulfate (mg/L)	Total Coliform (MPN/100 mL)	<i>E. coli</i> (MPN/100 mL)	Dissolved Oxygen ^a (mg/L)	pH	Specific Conductivity ^a (µS/cm)	Water Temperature ^a (°C)
M1	121	11/8/2010	<0.010	3.8	14	72.6	216	<1	<1	0	8.18	950	17
M2	U	11/9/2010	22	0.04	10	138	858	<1	<1	1.26	7.58	2,260	14.6
M3	164	11/9/2010	<0.010	1.5	8.9	11.5	196	<1	<1	0	8.16	844	15
M4	125	11/8/2010	<0.010	7.5	<5	26.3	197	<1	<1	0	8.42	892	16.5
M5	U	11/8/2010	<0.010	5	<5	21.2	0.986	<1	<1	0	8.53	794	16.7
M6	85	11/8/2010	<0.010	5.5	<5	40.1	99.4	<1	<1	0	8.39	756	15.7
M7	115	11/8/2010	<0.010	6.7	<5	27.2	9.92	<1	<1	0	8.42	665	16.6
M8	80	11/15/2010	<0.010	6.7	5.4	23.4	86.6	<1	<1	0.31	8.35	549	16.1
M9	U	11/15/2010	<0.010	5	<5	34.6	76.5	<1	<1	2.45	8.65	773	18.7
M10	U	11/15/2010	0.2	8	<5	25	101	<1	<1	2.83	8.38	1,090	16.7
M11	U	11/15/2010	<0.010	6	6	33.2	1.87	<1	<1	1.59	8.48	766	16
M12	30	11/8/2010	<0.010	3.9	10	46.2	159	<1	<1	0	7.93	970	14.7
M13	75	11/8/2010	<0.010	3.7	<5	30.2	227	<1	<1	0	8.5	1,000	15.6
M14	U	11/16/2010	<0.010	3	5.1	21.5	3.65	<1	<1	0.36	8.24	980	15.6
M15	135	11/15/2010	<0.010	2.9	<5	44.7	82.6	8.6	<1	3.4	8.24	782	16.7
M16	180	11/9/2010	0.011	7.4	5.9	50.6	602	<1	<1	0	7.74	2,030	16.4
M17	U	11/9/2010	<0.010	4.2	6	20.8	23.8	<1	<1	0	8.34	683	15.6
M18	127	11/16/2010	<0.010	2.9	<5	12	<0.80	<1	<1	0	7.84	759	17.1
M19	100	11/9/2010	<0.010	2.6	<5	69.6	551	<1	<1	0	7.6	1,780	14.2
M20	U	11/15/2010	<0.010	1.5	<5	7.6	<0.80	<1	<1	2	8.43	403	17.5
M21	145	11/9/2010	<0.010	6.2	35	9.78	<0.80	<1	<1	0	8.14	805	16.4
M22	U	11/8/2010	<0.010	4.8	18	17.8	3.41	3	<1	0	8.18	851	15.4
M23	U	11/8/2010	<0.010	1	<5	53.3	79.4	<1	<1	0	8.21	806	15
M24	U	11/8/2010	<0.010	6	<5	28.4	41.9	<1	<1	0	8.29	708	16.7
M25	117	11/8/2010	<0.010	5.5	<5	27.3	39.3	<1	<1	0	8.26	746	16.4
M27	U	11/16/2010	<0.010	7.4	<5	69.8	176	<1	<1	0	7.99	1,210	16.1
M28	U	11/9/2010	4	1.8	<5	47.5	169	10.8	<1	0	7.9	950	15.6

Well ID	Well Depth (feet)	Sample Date	Nitrite + Nitrate (mg/L)	Ammonia (mg/L)	Arsenic ($\mu\text{g/L}$)	Chloride (mg/L)	Sulfate (mg/L)	Total Coliform (MPN/100 mL)	<i>E. coli</i> (MPN/100 mL)	Dissolved Oxygen ^a (mg/L)	pH	Specific Conductivity ^a ($\mu\text{S/cm}$)	Water Temperature ^a ($^{\circ}\text{C}$)
M29	130	11/9/2010	0.39	1.5	20	22.5	<i>350</i>	40.8	<1	0	7.76	1,200	14.7
M30	U	11/9/2010	1.7	1.2	52	19.7	<i>332</i>	40.8	<u>1</u>	3.01	8.07	1,150	13.9
M31	75	11/16/2010	0.013	4.7	<5	129	<i>443</i>	<1	<1	0.72	7.92	1,530	14.6

Notes: Bolded red numbers indicate the United States Environmental Protection Agency's (EPA's) maximum contaminant level was exceeded; italicized red numbers indicate the EPA's Secondary Drinking Water Regulation was exceeded; red underlined numbers indicate Idaho's "Ground Water Quality Standards" (IDAPA 58.01.11.200) were exceeded. U = unknown; mg/L = milligrams per liter; $\mu\text{g/L}$ = micrograms per liter; MPN/100 mL = most probable number per 100 milliliters; $\mu\text{S/cm}$ = microsiemens per centimeter; $^{\circ}\text{C}$ = degrees Celsius.

a. No primary or secondary health standard available.

Sulfate and Specific Conductivity Sampling

There appears to be an association between elevated levels of sulfate and specific conductivity with the detection of nitrate. Five of the 6 wells that exceeded the secondary taste threshold of 250 mg/L for sulfate had a detection of nitrate above the laboratory detection limit. Similarly, 6 of the 8 wells (including the 5 previously mentioned wells with sulfate values exceeding the taste threshold) with specific conductivity greater than 1,000 microsiemens per centimeter ($\mu\text{S}/\text{cm}$) had a detection of nitrate above the laboratory detection limit.

Ammonia Sampling

Ammonia values ranged from 0.04 mg/L to 8 mg/L (Figure 6 and Table 6). EPA has set the taste threshold for ammonia at 30 mg/L. Twenty-three of the 30 wells had ammonia concentrations over 2 mg/L. Concentrations exceeding 2 mg/L are not typical for Idaho ground water (Carlson et al. 2001). Nitrogen found in an anaerobic environment (low DO) typically takes the form of ammonia rather than nitrate or nitrite. The mean ammonia concentration for wells upgradient of the dairies (M16, M28, M29, M30, and M31) was 3.32 mg/L. The mean ammonia concentration for the wells sidegradient of the dairies (M2, M3, M8, M10, M14, M19, and M27) was 4.18 mg/L. The mean ammonia for the downgradient wells (M1, M4, M5, M6, M7, M9, M11, M12, M13, M15, M17, M18, M20, M21, M22, M23, M24, and M25) was 4.56 mg/L. There was a very minor increase of the mean ammonia concentration downgradient of the dairies, however, the sidegradient mean ammonia concentration was similar in concentration to the downgradient mean, indicating a nitrogen source other than, or in addition to, the dairy facilities. Other sources include synthetic fertilizers and manure application on surrounding fields, and septic systems.

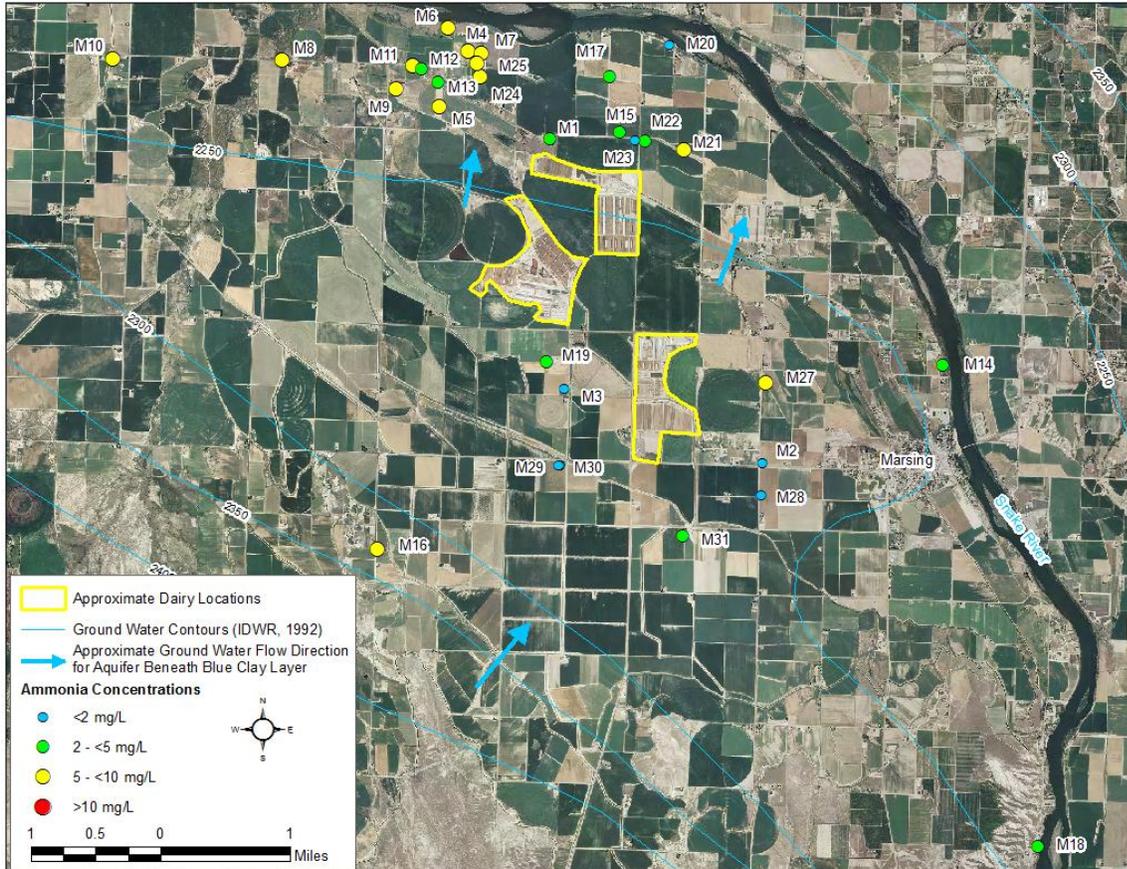


Figure 6. Ammonia concentrations for the Marsing Dairy Ground Water Monitoring Project.

Nitrogen Isotope Sampling

Nitrogen isotope ratios ($\delta^{15}\text{N}$) can be helpful in determining sources of nitrate in the ground water and was completed for all samples with nitrate and ammonia concentrations greater than 5 mg/L. Nitrogen from human or animal waste and fertilizer sources has distinguishable $\delta^{15}\text{N}$ signatures (refer to Table 2 for typical $\delta^{15}\text{N}$ values for various nitrogen sources). The $\delta^{15}\text{N}$ results from this project ranged from -9.9‰ to 13.9‰ (Table 7). Five wells had $\delta^{15}\text{N}$ that ranged from 1.9‰ to 4‰, falling within the commercial fertilizer nitrogen source range (Table 7 and Figure 7). Three wells had $\delta^{15}\text{N}$ results greater than 9‰, indicating an animal or human waste source. Five wells had $\delta^{15}\text{N}$ values ranging from 4.2‰ to 7.4‰, which indicate the nitrogen source is either from organic nitrogen in the soil or a mixture of fertilizer and waste sources. Well M7 had a $\delta^{15}\text{N}$ value of -9.9‰, which could indicate a plant decay nitrogen source (Kendall and McDonnell 1998).

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, and plant uptake) especially in anoxic environments 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 determining the 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 animal operations. It is expected that this type of land use would result in a mixture of nitrogen sources in the ground water, as indicated by the $\delta^{15}\text{N}$ values detected.

Table 7. Nitrogen isotope results for the Marsing Dairy Ground Water Monitoring Project.

Well ID	Well Depth (feet)	Sample Date	$\delta^{15}\text{N}$ (‰)
M2	U	11/9/2010	11
M4	125	11/8/2010	4
M5	U	11/8/2010	5.7
M6	85	11/8/2010	13.9
M7	115	11/8/2010	-9.9
M8	80	11/15/2010	7.4
M9	U	11/15/2010	3.9
M10	U	11/15/2010	5.6
M11	U	11/15/2010	4.2
M16	180	11/9/2010	13.3
M21	145	11/9/2010	1.9
M24	U	11/8/2010	1.9
M25	117	11/8/2010	2.2
M27	U	11/16/2010	5.9

Notes: There is no primary or secondary health standard available for nitrogen isotopes; U = unknown; $\delta^{15}\text{N}$ = nitrogen isotope; ‰ = per mil or parts per thousand.

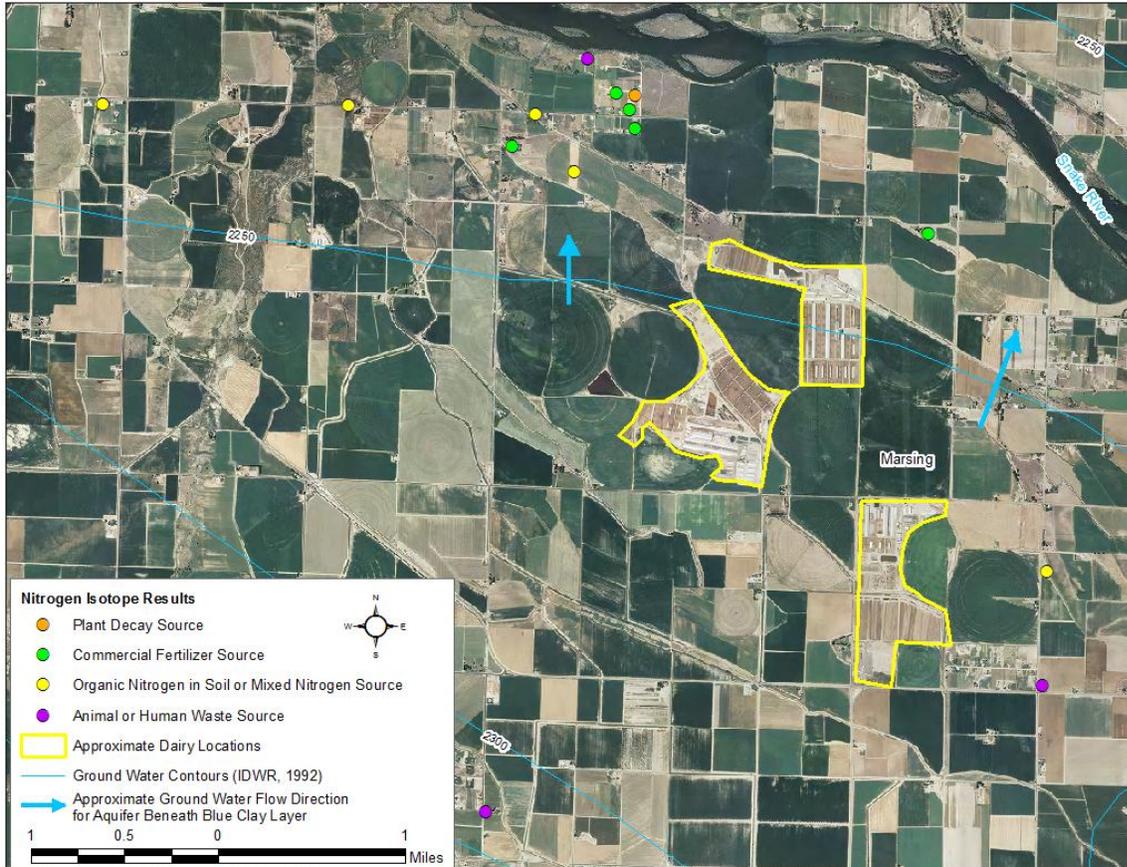


Figure 7. Nitrogen isotope results for the Marsing Dairy Ground Water Monitoring Project.

Arsenic Sampling

The arsenic values ranged from nondetectable (<5 micrograms per liter [$\mu\text{g/L}$]) to 52 $\mu\text{g/L}$; 7 wells were equal to or exceeded the EPA's MCL of 10 $\mu\text{g/L}$ for arsenic (Table 6). Elevated arsenic values have been identified in this area in various studies (Boyle et al. 2002; Mitchell 2004). Naturally occurring arsenic has been documented in this area, as well as many other areas in the western Snake River Plain (Neely 2002).

3.1.2.3 Conclusions

Ground water in the deeper black sand aquifer within the study area is being negatively impacted from some type of nitrogen source as evidenced by elevated ammonia concentrations. The $\delta^{15}\text{N}$ results suggest a mixture of sources, including waste, fertilizer, and organic sources including both crop decay (such as legume crop plow down) or geologic deposits. This mixture of nitrogen sources is typical of an agricultural area with a combination of animal facilities and row crops. The source of elevated arsenic concentrations in the ground water is unclear; however, the source is likely naturally occurring in the soils.

3.1.2.4 Recommendations

Producers and agrichemical professionals are encouraged to apply nutrients following the Natural Resources Conservation Service (NRCS) Nutrient Management 590 Standard, and

follow the NRCS Irrigation Water Management 449 Standard for irrigation to minimize nutrient entry into the ground water.

Homeowners are encouraged to properly maintain septic systems to help protect ground water quality.

DEQ should coordinate with the ISDA Dairy Bureau to determine appropriate best management practices (BMPs) for dairies with nitrate concentrations exceeding EPA's MCL to help protect ground water from further degradation.

3.1.3 Northeast Star Nitrate Priority Area Ground Water Monitoring Project

3.1.3.1 Purpose

Thirty-two areas in the state that have been designated by DEQ as having elevated concentrations of nitrate in ground water. These NPAs are ranked based on population, existing water quality, and water quality trends. The northeast Star NPA was ranked 5 in the state (with 1 being the most degraded) and is 1 of only 4 NPAs in the state that have been shown to have an increasing trend in nitrate concentration during the 2008 NPA delineation and ranking process.

Accurate information about water quality and trends requires (1) data collected over time from the same wells, (2) wells that monitor the same aquifer zone (the shallowest water quality is desired), (3) wells distributed across the area, and (4) wells spatially located accurately. This monitoring project was designed to provide the data necessary for evaluating the water quality in the northeast Star NPA and providing data for the next NPA delineation and ranking process in 2012.

3.1.3.2 Methods and Results

Well logs from the IDWR website were reviewed and 20 wells were chosen for the project (Figure 8). The wells were selected based on the well depth (with preference given to wells screened within the shallow aquifer), location (distributed across the area with a goal of selecting 2 wells per square mile), and if the well had been previously sampled.

The well depths ranged from 38 feet to 275 feet; the majority of the wells were less than 100 feet. The static water level ranged from a flowing artesian well to 70 feet below ground surface. Within the project area, there are two aquifers: a shallow system composed of older terrace gravels, younger terrace gravels, and recent finer-grained alluvial deposits; and a deeper system that is thought to be part of the Tertiary Glens Ferry Formation of the Idaho Group (Howarth 1999; Bahr et al. 2000). The two systems are separated by a characteristic blue clay layer that ranges in thickness from 10 feet to 20 feet (Howarth 1999). A review of the available well logs of sampled wells shows that the blue clay layer is located at various depths throughout the project area, ranging from 18 feet to 105 feet below ground surface. The blue clay layer can act as a protective barrier to prevent contaminants generated at the land surface from migrating into deeper aquifers. The ground water flow direction of the shallow aquifer is to the southwest, towards the Boise River; the ground water flow direction of the deep aquifer is unknown but thought to be similar to the shallow aquifer (Howarth 1999).

In October 2010, samples were collected from each well according to the DEQ project plan (DEQ 2010c) and analyzed for nitrate, nitrite, ammonia, fluoride, bromide, orthophosphate, chloride, sulfate, total coliform, *E. coli*, and nitrogen isotopes. The results are provided in Table 8. Water-quality field parameters—pH, temperature, specific conductivity, and DO—were measured at each site (Table 9) prior to sample collection.

All samples, except the total coliform, *E. coli*, and nitrogen isotope samples, were submitted to the University of Idaho Analytical Sciences Laboratory in Moscow, Idaho, for analysis. The total coliform and *E. coli* samples were submitted to the Idaho Bureau of Laboratories in Boise, Idaho. Nitrogen isotope samples were collected at each sampling location, frozen, and stored at DEQ pending nitrate analysis. After DEQ received the 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 in Tucson, Arizona, for nitrogen isotope analysis.

Nitrate Sampling

The nitrate values ranged from nondetectable (<0.05 mg/L) to 40 mg/L (Table 8). EPA's MCL of 10 mg/L for nitrate was exceeded in 4 wells. The mean nitrate concentration was 7.3 mg/L, and the median nitrate concentration was 3.3 mg/L. The spatial distribution of nitrate concentrations is shown in Figure 8.

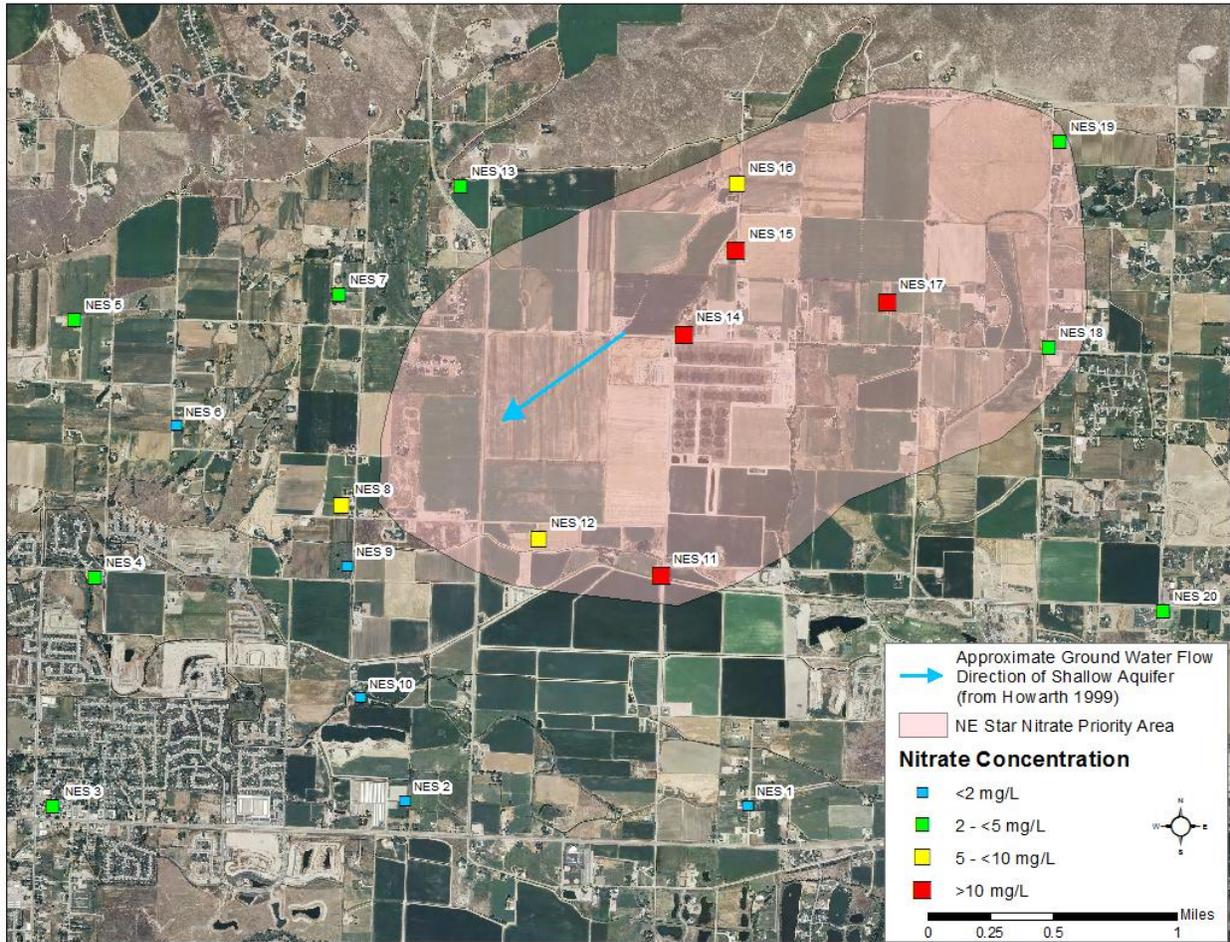


Figure 8. Well locations, well identification, and nitrate concentrations for the Northeast Star Nitrate Priority Area Ground Water Monitoring Project.

Table 8. Inorganic, bacteria, and nitrogen isotope results for the Northeast Star Nitrate Priority Area Ground Water Monitoring Project.

Well ID	Well Depth (feet)	Sample Date	Ammonia (mg/L)	Bromide ^a (mg/L)	Chloride (mg/L)	Fluoride (mg/L)	Nitrate (mg/L)	Nitrite (mg/L)	Sulfate (mg/L)	Ortho-phosphate ^a (mg/L)	Total Coliform (MPN/100 mL)	<i>E. coli</i> (MPN/100 mL)	$\delta^{15}\text{N}^a$ (‰)
NES 1	66	10/25/2010	0.55	<0.1	1.3	0.4	0.092	<0.05	6.4	<0.1	<1	<1	NA
NES 2	65	10/28/2010	0.15	<0.1	1.8	0.33	<0.05	<0.05	2.7	<0.1	<1	<1	NA
NES 3	38	10/25/2010	0.3	<0.1	8.4	0.21	3.3	<0.05	11	<0.1	<1	<1	NA
NES 4	110	10/26/2010	0.51	<0.1	3.4	0.26	2.2	<0.05	9.4	<0.1	<1	<1	NA
NES 5	144	10/25/2010	<0.1	<0.1	4.6	0.19	3.8	<0.05	12	0.19	<1	<1	NA
NES 6	79	10/25/2010	0.24	<0.1	2.8	0.28	1.7	<0.05	6.5	0.2	<1	<1	NA
NES 7	123	10/25/2010	<0.1	<0.1	5.3	0.23	3.2	<0.05	16	<0.1	<1	<1	NA
NES 8	98	10/25/2010	0.49	<0.1	8.3	0.24	8.9	<0.05	14	<0.1	1	<1	4.4
NES 9	102	10/25/2010	0.32	<0.1	6.3	0.4	1.5	<0.05	16	<0.1	<1	<1	NA
NES 10	275	10/25/2010	0.21	<0.1	0.83	0.42	<0.05	<0.05	5.3	<0.1	<1	<1	NA
NES 11	57	10/25/2010	0.14	<0.1	48	0.16	11	<0.05	20	0.11	648.8	<1	16
NES 12	120	10/25/2010	0.24	<0.1	39	0.27	8.5	<0.05	23	<0.1	<1	<1	10.6
NES 13	108	10/25/2010	0.47	<0.1	12	0.35	3.5	<0.05	21	0.16	<1	<1	NA
NES 14	60	10/26/2010	0.36	<0.1	29	<0.15	19	<0.05	34	<0.1	<1	<1	8.2
NES 15	74	10/26/2010	0.17	<0.1	50	<0.15	40	<0.05	53	0.13	<1	<1	8.1
NES 16	85	10/26/2010	<0.1	<0.1	12	0.28	5.2	<0.05	14	0.11	8.6	<1	9.1
NES 17	200	10/26/2010	0.17	<0.1	36	0.35	25	<0.05	24	<0.1	<1	<1	5.5
NES 18	50	10/28/2010	0.28	<0.1	5.6	0.32	3	<0.05	9.8	<0.1	<1	<1	NA
NES 19	60	10/26/2010	0.13	<0.1	7.1	0.29	2.9	<0.05	11	<0.1	19.9	<1	NA
NES 20	71	10/26/2010	0.22	<0.1	7.4	0.38	2.9	<0.05	11	<0.1	<1	<1	NA

Notes: Bolded red numbers indicate the United States Environmental Protection Agency's maximum contaminant level was exceeded; mg/L = milligrams per liter; MPN/100 mL = most probable number per 100 milliliters; $\delta^{15}\text{N}$ = nitrogen isotope; ‰ = per mil or parts per thousand; NA = not analyzed.

a. No primary or secondary health standard available.

Table 9. Water quality field parameters for the Northeast Star Nitrate Priority Area Ground Water Monitoring Project.

Well ID	Well Depth (feet)	Sample Date	Dissolved Oxygen ^a (mg/L)	pH	Specific Conductance ^a (µS/cm)	Water Temperature ^a (°C)
NES 1	66	10/25/2010	1.09	7.33	148	13.8
NES 2	65	10/28/2010	0	7.42	222	12.7
NES 3	38	10/25/2010	0	6.73	248	15.8
NES 4	110	10/26/2010	6.76	6.97	381	14.1
NES 5	144	10/25/2010	8.01	7.41	328	14.8
NES 6	79	10/25/2010	7.69	7.46	288	15
NES 7	123	10/25/2010	4.37	7.57	442	13.8
NES 8	98	10/25/2010	4.66	7.56	544	14.8
NES 9	102	10/25/2010	2.07	7.63	345	17.2
NES 10	275	10/25/2010	0	7.47	142	15.5
NES 11	57	10/25/2010	0	7.5	839	14.2
NES 12	120	10/25/2010	1.52	7.44	708	14.8
NES 13	108	10/25/2010	8.64	7.38	260	14.8
NES 14	60	10/26/2010	4.15	7.31	1,110	13.8
NES 15	74	10/26/2010	4.52	7.1	1,000	13.6
NES 16	85	10/26/2010	5.07	7.48	565	14
NES 17	200	10/26/2010	5.08	7.88	796	13.6
NES 18	50	10/28/2010	4.4	7.62	494	12.9
NES 19	60	10/26/2010	6.55	7.7	634	13.8
NES 20	71	10/26/2010	7.14	7.7	556	13.8

Notes: United States Environmental Protection Agency's Secondary Drinking Water Regulation for pH was not exceeded; mg/L = milligrams per liter; µS/cm = microsiemens per centimeter; °C = degrees Celsius.

a. No primary or secondary health standard available.

Specific Conductance Sampling

There appears to be a relationship between elevated nitrate and specific conductance. The 4 wells with the highest nitrate concentrations (all exceed the MCL) also have the highest specific conductance concentrations (all exceed 750 µS/cm).

Nitrogen Isotope Sampling

Nitrogen from human or animal waste and fertilizer sources has distinguishable $\delta^{15}\text{N}$ signatures (refer to Table 2 for typical $\delta^{15}\text{N}$ values for various nitrogen sources). Wells that had nitrate concentrations greater than 5 mg/L were analyzed for $\delta^{15}\text{N}$. The $\delta^{15}\text{N}$ results from this project ranged from 4.4 ‰ to 16‰ (Table 8). Wells NES 11, NES 12, and NES 16 had $\delta^{15}\text{N}$ results greater than 9‰, indicating an animal or human waste source. In addition to the $\delta^{15}\text{N}$ signature indicating a waste source, wells NES 11 and NES 16 both had total coliform detections (Table

8), which can also indicate a waste source of nitrogen. Wells NES 11 and NES 12 are downgradient from a cattle feedlot with approximately 3,000 head of cattle. The 4 remaining wells had $\delta^{15}\text{N}$ values ranging from 4.4‰ to 8.2‰, which indicates the nitrogen source is either from organic nitrogen in the soil or a mixture of fertilizer and waste sources.

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, and 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 determining the 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 animal operations. It is expected that this type of land use would result in a mixture of nitrogen sources in the ground water, as indicated by the $\delta^{15}\text{N}$ values detected.

3.1.3.3 Conclusions

Ground water within the northeast Star NPA is being negatively impacted from some type of nitrogen source as evidenced by elevated nitrate concentrations. Nitrogen isotope results from 3 wells suggest an animal or human waste nitrogen source impacting the aquifer; while 4 wells had $\delta^{15}\text{N}$ results that indicate that the nitrogen source is either from organic nitrogen in the soil or a mixture of fertilizer and waste sources.

3.1.3.4 Recommendations

The nitrate results from this monitoring project will be used to provide data that are critical for the next NPA delineation and ranking process in 2012.

Additional sampling is recommended in the location of wells NES 11 and 12, which both had $\delta^{15}\text{N}$ results indicating a waste nitrogen source and are located downgradient of a cattle feedlot.

3.1.4 Silverleaf Road, Gem County, Follow-Up Sampling Project

3.1.4.1 Purpose

The Silverleaf Road, Gem County Follow-Up Sampling Project investigated potential sources of elevated nitrate concentrations that had been detected in ground water from a private drinking water well located along Silverleaf Road in Emmett, Idaho (referred to as the impacted well). In early March 2010, nitrate was detected in water from the well at 49.5 mg/L; no ammonia or coliform bacteria were detected. The nitrate concentration exceeded EPA's MCL of 10 mg/L. Southwest District Health requested DEQ's assistance in monitoring the area to see if a nitrogen source could be identified.

The project area is located on the broad river terrace northwest of Emmett (Figure 9). Ground water flows in a southwesterly direction from the foothills to the Payette River. Land use in the project area consists primarily of irrigated agriculture. A CAFO for calves is located directly upgradient (northeast) of the impacted well, and a dairy with less than 100 head of cattle operates 1,000 feet to the east (transgradient) of the well. Sand Hollow Creek generally borders the project area on the east and an irrigation canal that runs along the base of the foothills lies at the

northern edge of the project area (Figure 9). The irrigation canal runs through a large dairy operation in Sand Hollow valley just to the northeast of the study area.

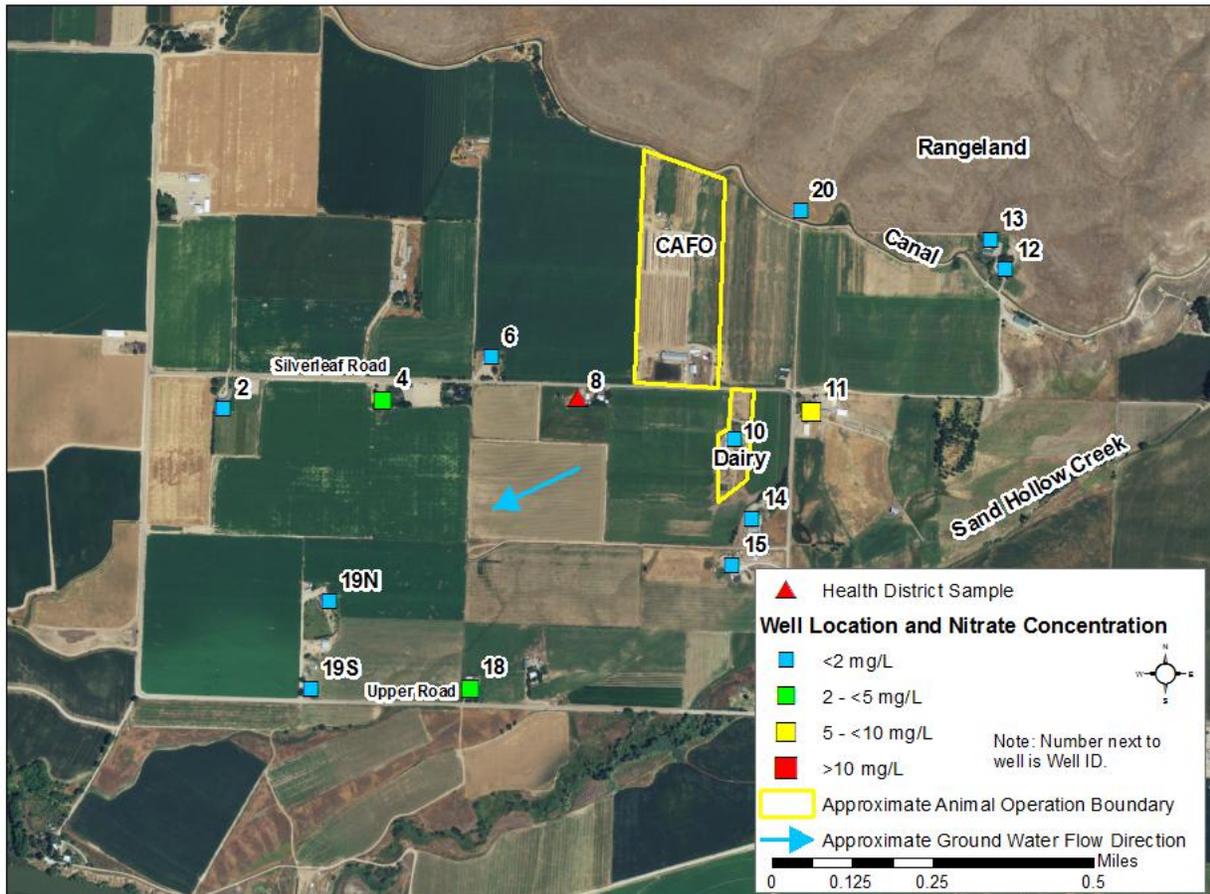


Figure 9. Well locations, well identification, and nitrate concentrations for Silverleaf Road, Gem County, Follow-Up Sampling Project.

3.1.4.2 Methods and Results

DEQ identified all wells within a three-quarter mile radius of the impacted well property to request access to collect samples. Of the 20 possible wells identified around the impacted well, DEQ sampled 13 wells (Figure 9). Well locations included the dairy (well 10), a rangeland watering trough (well 20), a community center (well 6), and the remaining well locations were private residences. Permission to sample the well at the CAFO was not granted, and the initially impacted well (well 8) had been destroyed and could not be resampled. The impacted well (well 8) is located in the middle of the study area (Figure 9).

Well logs for 7 of the 13 wells were obtained from the IDWR database, and the depth and water level of an additional well had been recorded directly by the well owner. Based on the available water-level elevation, lithologic logs, and water-quality field measurements of temperature, pH, specific conductance, and DO, it appears that well 12 pulls water from a confined aquifer, and the other wells pull water from the shallow water table aquifer. Depth to ground water on the broad river terrace, southwest of the foothills, ranges from about 25 feet to 40 feet below ground

surface, and at the base of the foothills, ground water was measured at 113 feet and 141 feet below ground surface (wells 13 and 12, respectively).

The ground water samples were collected on August 9 and 10, 2010, and analyzed for nitrate, ammonia, chloride, sulfate, total coliform, *E. coli*, and arsenic in accordance with the DEQ QAPP (DEQ 2010b). Water quality field parameters—DO, pH, specific conductivity, and temperature—were measured at each well prior to sampling (Table 10). The total coliform, *E. coli*, and arsenic samples were sent to the Idaho Bureau of Laboratories in Boise, Idaho, for analysis. The remaining samples were sent to the University of Idaho Analytical Sciences Laboratory in Moscow, Idaho, for analysis. The results are provided in Table 11 and summarized in the following sections.

Table 10. Water quality field parameters for Silverleaf Road, Gem County, Follow-Up Sampling Project.

Well ID	Well Depth (feet)	Sample Date	Dissolved Oxygen ^a (mg/L)	pH	Specific Conductivity ^a (µS/cm)	Water Temperature ^a (°C)
2	Unknown	8/9/2010	0.11	8.08	490	15.6
4	Unknown	8/9/2010	7.29	7.59	482	15.4
6	Unknown	8/9/2010	0.66	8.04	373	17.7
10	121	8/9/2010	0	8.28	507	16.3
11	Unknown	8/9/2010	8.37	7.57	554	15.6
12	228	8/9/2010	0.02	8.88	229	19.3
13	188.6	8/9/2010	2.59	7.94	459	18.4
14	85	8/9/2010	0.23	7.5	478	16.0
15	106	8/10/2010	1.22	7.68	429	15.4
18	Unknown	8/10/2010	5.33	7.5	435	15.0
19N	106	8/10/2010	0	7.94	496	16.5
19S	Unknown	8/10/2010	10.8	8.47	468	15.4

Notes: Italicized red numbers indicate the United States Environmental Protection Agency's Secondary Drinking Water Regulation was exceeded; mg/L = milligrams per liter; µS/cm = microsiemens per centimeter; °C = degrees Celsius.

a. No primary or secondary health standard available.

Table 11. Analytical data for Silverleaf Road, Gem County, Follow-Up Sampling Project.

Well ID	Well Depth (feet)	Sample Date	Total Coliform (MPN/100 mL)	Nitrate (mg/L)	Ammonia (mg/L)	Chloride (mg/L)	Sulfate (mg/L)	Arsenic (mg/L)
Impacted Well								
8	Unknown	3/8/2010	Absent	49.5	NS	NS	NS	NS
8	Unknown	3/22/2010	NS	38.3	NS	NS	NS	NS
8	Unknown	3/30/2010	Absent	43	<0.01	NS	NS	NS
Upgradient								
20	Unknown	8/10/2010	34.5	<0.05	<0.1	4.8	25	<0.005
Transgradient to the East								
12	228	8/9/2010	<1	<0.05	0.15	4.4	<0.2	<0.005
13	188	8/9/2010	86.5	<0.05	<0.1	7.5	31	<0.005
10	121	8/10/2010	78.5	<0.05	<0.1	8.7	33	<0.005
11	Unknown	8/10/2010	80.9	7.6	<0.1	7.4	18	<0.005
14	85	8/10/2010	<1	0.36	<0.1	4.6	23	<0.005
15	105	8/10/2010	<1	1.7	0.12	5	21	<0.005
Downgradient								
18	Unknown	8/10/2010	<1	4.2	<0.1	3.9	12	<0.005
19N	106	8/10/2010	<1	<0.05	<0.1	8.4	38	<0.005
19S	Unknown	8/10/2010	<1	<0.05	0.17	12	49	<0.005
Transgradient to the West								
2	60	8/10/2010	<1	<0.05	<0.1	13	47	<0.005
4	86	8/10/2010	<1	3.2	<0.1	3.4	13	<0.005
6	Unknown	8/10/2010	<1	<0.05	<0.1	3.7	19	<0.005

Notes: Bolded red numbers indicate the United States Environmental Protection Agency's maximum contaminant level was exceeded; MPN/100 mL = most probable number per 100 milliliters; mg/L = milligrams per liter; NS = not sampled.

Nitrate Sampling

Nitrate was detected in 5 of the 13 wells; only 3 wells had detections above 2 mg/L; and none of the concentrations exceeded the drinking water standard of 10 mg/L (Figure 9 and Table 11). Besides the impacted well, nitrate concentrations ranged from 0.36 mg/L to 7.6 mg/L. Well 11, located east of the impacted well, had a nitrate concentration of 7.6 mg/L.

Ammonia Sampling

Ammonia was detected in only 3 of the 13 samples (Table 11). All detections occurred in the easternmost edge of the study area (Figure 10). There is no drinking water standard for ammonia; the EPA taste threshold is 30 mg/L; and the concentrations detected were all less than 0.2 mg/L.

Bacteria Sampling

Total coliform was the only analyte detected in the study area at significantly elevated concentrations. It was detected at concentrations ranging from 34.5 MPN/100 mL to 86.5 MPN/100 mL in the 4 northeastern most samples of the study area (Figure 10). *E. coli* was not detected in any of the wells.

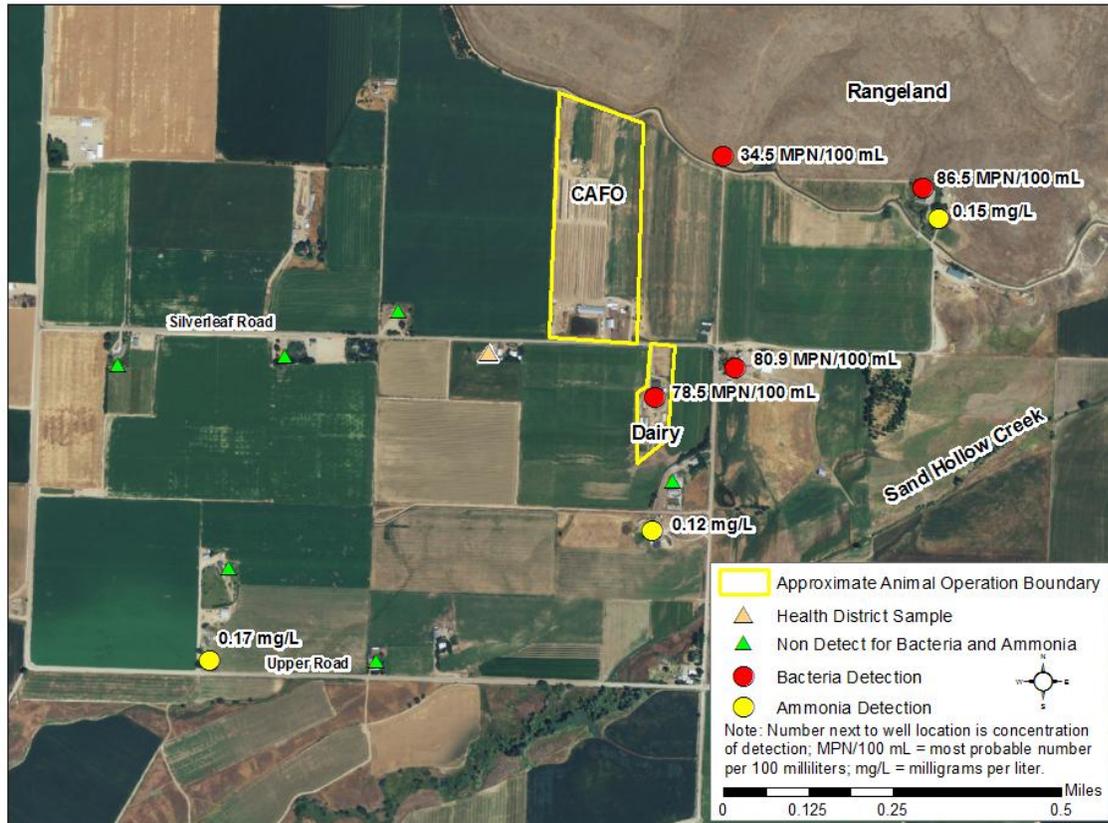


Figure 10. Ammonia and bacteria detections for the Silverleaf Road, Gem County, Follow-Up Sampling Project.

Sulfate and Chloride Sampling

The sulfate and chloride concentrations show a generally linear pattern (as chloride concentrations increase, so does sulfate). The only marked exception to this pattern is the water sampled from well 12, which is thought to come from a separate aquifer based on the available water-level elevation, lithologic logs, and water quality field parameters.

Arsenic Sampling

Arsenic was not detected above the laboratory detection limit of 0.005 mg/L in any of the samples.

3.1.4.3 Conclusions

The study's findings are summarized below:

- The source of the elevated nitrate at the impacted well was not identified by the study. No samples were collected at the upgradient CAFO, and nitrate was not detected in the wells downgradient of the impacted well.
- Except for nitrate in 1 well located west of the impacted well and ammonia in 1 well located downgradient (southwest) of the impacted well, the elevated concentrations of nitrate, ammonia, and total coliform bacteria detected in ground water are only present along the eastern and northern portions of the study area, east of the impacted well.
- The source of the coliform in the northeastern portion of the study area could potentially be from infiltration from the irrigation canal that runs along the base of the foothills and adjacent to a dairy operation located upgradient to and northeast of the study area.

3.1.4.4 Recommendations

Because the only well with nitrate concentrations over the MCL was located downgradient of the CAFO lagoon, it is recommended that to help determine if the CAFO is contributing to elevated nitrate in the ground water, additional monitoring should be attempted at the facility and coordination with ISDA should be initiated.

3.1.5 Curtis and Fairview, Boise, Tetrachloroethylene Source Investigation Project

3.1.5.1 Purpose

Tetrachloroethylene, also known as perchloroethylene (PCE), was detected in samples of ground water from a PWS well located northwest of the intersection of Curtis and Fairview in Boise, Idaho, starting in 2007. The concentrations generally increased through time; the most recent sample collected from the PWS well during testing (September 2010) was 7.8 µg/L. The EPA MCL for PCE is 5 µg/L.

To help identify the source of the PCE in the PWS well, DEQ researched the locations of additional wells in the area that could be sampled. No monitoring wells on commercial properties were identified in the area, but DEQ identified 13 residential parcels near and upgradient of the supply well that are not connected to a PWS. DEQ contacted the 13 property owners and received permission to sample 4 wells.

All 4 wells were located on the western side of the impacted supply well. Three of the wells were thought to be screened in the shallow aquifer above a characteristic blue-colored clay layer that separates the shallow and deep aquifers; the fourth well, according to the property owner, was thought to be approximately 1,000 feet deep (Figure 11). Ground water flows in a northerly and northwesterly direction in the region.



Figure 11. Well locations for Curtis and Fairview, Boise, PCE Source Investigation Project.

3.1.5.2 Methods and Results

Ground water samples were collected from the 4 wells by DEQ staff on June 21, 2010. The samples were collected in laboratory-supplied sample bottles and analyzed for volatile organic compounds (VOCs) in accordance with EPA method 8260 by ESC in Mount Juliet, Tennessee. The analytical report on the samples indicated that a few VOCs were present at very low concentrations in all of the samples. Although the laboratory quality assurance/quality control appeared to be acceptable, laboratory contamination was suspected. DEQ resampled the wells on July 21, 2010, using sample bottles supplied by two laboratories. One set of samples was shipped to the original laboratory (ESC), and the second set of samples was shipped to Anatek Laboratories in Moscow, Idaho. The samples were analyzed for VOCs in accordance with EPA method 524, a drinking water analytical method that has a lower detection limit than EPA method 8260.

Low concentrations of various VOCs were detected in the samples from ESC, but only chloroform was detected in 1 sample analyzed by Anatek. In the sample collected from the deep well, 0.77 $\mu\text{g/L}$ chloroform was detected by Anatek (EPA's MCL for chloroform is 80 $\mu\text{g/L}$).

DEQ was notified after the second set of samples was analyzed that the sample bottles stored in Boise at an ESC Laboratories distribution location were contaminated. The contaminated bottles resulted in detectable constituents in the ground water samples analyzed by ESC.

3.1.5.3 Conclusions

- No PCE is present in ground water collected from the 4 domestic wells located west of the PCE-contaminated public drinking water well.
- The source of the PCE in ground water is located to the south, southeast, or east of the supply well. The PCE source has not been identified.

3.1.5.4 Recommendations

To assist with identifying the source of PCE in the PWS well, DEQ is currently investigating the possible sources of PCE within a one-half mile to the east and south of the PWS well.

3.2 Coeur d'Alene Region

No ground water quality projects were conducted using public monies in the Coeur d'Alene region in 2010.

3.3 Idaho Falls Region

3.3.1 Ashton–Drummond Nitrate Follow-Up Monitoring Project

3.3.1.1 Purpose

In 2009, private well owners were invited to bring water samples for nitrate screening to a public meeting. DEQ then conducted a follow-up ground water monitoring project by sampling private wells within the Ashton–Drummond NPA that had nitrate concentrations approaching or exceeding EPA's MCL of 10 mg/L during the 2009 public meeting. The Ashton–Drummond NPA is located within Fremont and Teton Counties in eastern Idaho (Figure 12). During the project, a nitrate test strip was used as a screening tool to estimate the nitrate value prior to laboratory analysis. Two wells had nitrate test strip values and analytical laboratory nitrate values that did not agree. The screening result for well Ashton09-01 suggested a nitrate concentration that exceeded 10 mg/L, where the laboratory nitrate result indicated 8.2 mg/L. The screening result for well Ashton09-06 indicated 10 mg/L, where the laboratory analysis yielded 29 mg/L. These two wells were sampled in 2010 as a follow up to determine if the test strip or analytical laboratory values were accurate.

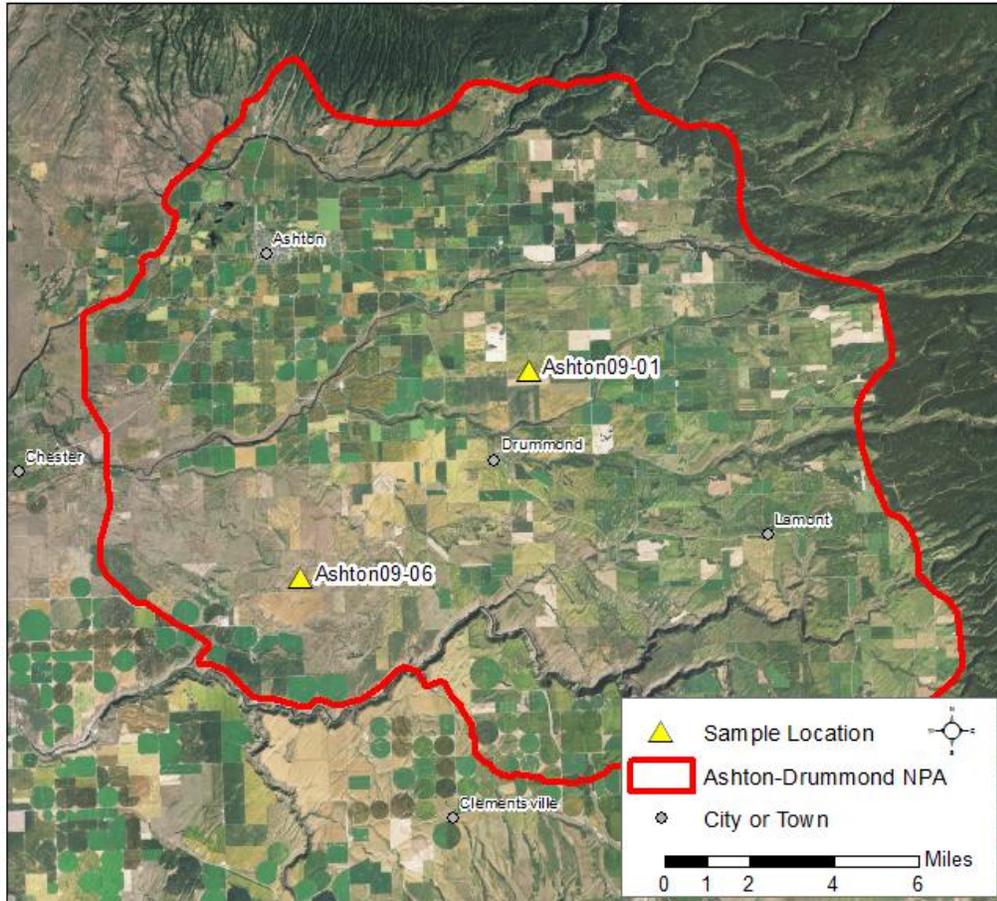


Figure 12. Sampling locations for Ashton–Drummond Nitrate Follow-Up Monitoring Project.

3.3.1.2 Methods and Results

Wells Ashton09-01 and 06 were sampled in June 2010. Water quality field parameters—DO, pH, specific conductivity, and temperature—were measured at each site (Table 12) prior to sample collection. Samples were collected for tritium, nutrients, and stable isotopes of hydrogen, nitrogen, and oxygen (Table 13), as well as major ions (Table 14). Wells were sampled according to the QAPP (DEQ 2009).

Nitrate Sampling

The 2010 nitrate test strip for well Ashton09-01 indicated a nitrate concentration of 5–10 mg/L, which agreed with the laboratory analysis results of 7.9 mg/L (Table 13). The 2010 nitrate test strip for well Ashton09-06 indicated a nitrate concentration of >10 mg/L, which was consistent with the 23 mg/L result from the laboratory. Both wells had 2010 nitrate test strip values and nitrate laboratory values consistent with laboratory nitrate values from the 2009 sampling. The results indicate that the test strip values for these two wells in 2009 were incorrect or were read incorrectly.

Table 12. Water quality field parameter results for Ashton–Drummond Nitrate Follow-Up Monitoring Project.

Well ID	Well Depth (feet)	Sample Date	Dissolved Oxygen ^a (mg/L)	pH	Specific Conductivity ^a (µS/cm)	Water Temperature ^a (°C)
Ashton09-01	240	6/15/2010	6.61	7.7	475	9.51
Ashton09-06	Unknown	6/15/2010	8.24	7.14	698	10.71

Notes: pH results did not violate the United States Environmental Protection Agency's Secondary Drinking Water Regulation; mg/L = milligrams per liter; µS/cm = microsiemens per centimeter; °C = degrees Celsius.

a. No primary or secondary health standard available.

Table 13. Tritium, nutrient, and stable isotope results for Ashton-Drummond Nitrate Follow-Up Monitoring Project.

Well ID	Well Depth (feet)	Sample Date	Tritium (pCi/L)	Nutrient Concentration (mg/L)			Ratio (‰)		
				Nitrate Test Strip	Total NO ₂ + NO ₃ as N ^a	Total Phosphorus ^b as P	δ ² H ^b	δ ¹⁵ N ^b	δ ¹⁸ O ^b
Ashton09-01	240	6/15/2010	20	5–10	7.9	0.070	-135	5	-18.1
Ashton09-06	Unknown	6/15/2010	28	>10	23	0.068	-131	8.8	-17.8

Notes: Bolded red numbers indicate the United States Environmental Protection Agency's maximum contaminant level was exceeded; mg/L = milligrams per liter; ‰ = per mil or parts per thousand; pCi/L = picocuries per liter; δ²H = deuterium; δ¹⁵N = nitrogen isotope; δ¹⁸O = oxygen isotope.

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

b. No primary or secondary health standard available.

Table 14. Major ion results for Ashton–Drummond Nitrate Follow-Up Monitoring Project.

Well ID	Well Depth (feet)	Sample Date	Major Ion Concentration (milligrams per liter)								
			Total Calcium ^a	Total Magnesium ^a	Total Sodium	Total Potassium ^a	Total Chloride	Total Sulfate	Total Fluoride	Total Alkalinity ^a (as CaCO ₃)	Total Dissolved Solids
Ashton 09-01	240	6/15/2010	61	20	12	2.2	5.47	10.5	0.583	210	310
Ashton 09-06	Unknown	6/15/2010	90	28	12	3.0	14.6	19.8	0.228	239	460

Notes: No primary, secondary, or advisory health standards were exceeded; CaCO₃ = calcium carbonate.

a. No primary or secondary health standard available.

3.3.1.3 Conclusions

While nitrate test strips can be a helpful indicator of the general nitrate concentration, the resampling of the 2 wells shows that the test strips can give misleading information, either due to problems with the test strip or due to measurement or interpretation error. The laboratory nitrate results from 2009 were confirmed by the resampling in 2010. Additional conclusions are outlined in the Ashton-Drummond technical report for this project including the 2009 and 2010 data (DEQ 2011a).

3.3.1.4 Recommendations

Test strip results that indicate a drinking water well has nitrate concentrations over 10 mg/L should have a follow-up laboratory analysis conducted to determine the nitrate concentration.

Additional recommendations are outlined in the full technical report for this project including the 2009 and 2010 data by DEQ (2011a).

For more information, the Ashton-Drummond technical report (DEQ 2011a) summarizes data collected for this project from 2009 through 2010 at <http://www.deq.idaho.gov/media/805650-ashton-drummond-npa-study-43.pdf>.

3.4 Lewiston Region

3.4.1 Camas Prairie Nitrate Priority Area Ground Water Monitoring Project

This section summarizes the 2010 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 of EPA's 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.

3.4.1.1 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. As part of the plan, approximately \$1 million of Clean Water Act Section 319 grant funds have been expended on the Camas Prairie for installing agricultural ground water protection BMPs. Long-term ground water monitoring is being conducted in the Camas Prairie to determine the GWQMP's effectiveness for improving ground water quality. The seasonal nitrate trends of the Camas Prairie ambient ground water network are being tracked to determine if ambient nitrate concentrations increase or decrease.

3.4.1.2 Methods and Results

DEQ initiated the Camas Prairie ground water monitoring program in 2005 to establish an ambient ground water monitoring well network. In addition to the wells monitored by DEQ, more wells were identified and sampled by the Lewis Soil Conservation District (LSCD) and

ISDA. Since 2006, DEQ has employed a well network of 25 wells for quarterly sampling (Figure 13).

Nitrate concentrations from sampled wells were compared seasonally for several years to identify wells with nitrate concentrations that had similar seasonal trends and wells that provided results considered to be anomalies. Wells with anomalous data were addressed to resolve isolated or localized situations and dropped from the ambient network. Routine quarterly sampling has continued for the selected Camas Prairie network wells. During March, June, September, and December 2010 sampling was conducted, including nitrate analysis, in accordance with the QAPP (DEQ 2005) (Table 15 and Table 16). Water quality field parameters—pH, temperature, specific conductance, and DO—were measured prior to sample collection.

Nitrate results from the 2010 quarterly sampling are presented in Table 16. The most elevated nitrate concentration detected was in well DEQ 48 with 19 mg/L during the March 2010 sampling event. Well DEQ 48 had the highest nitrate concentration during all 4 sampling events. In 2010, the same 5 wells exceeded the MCL of 10 mg/L for nitrate in March and September; 7 wells exceeded the MCL in June; and 6 wells exceeded the MCL in December. The percentage of wells in this project with nitrate concentrations exceeding 5 mg/L ranged from 52% during the December sampling to 57% during the September sampling. The data confirm that the area meets the criteria of an NPA, in that 25% or more of the wells have nitrate concentrations that exceed 5 mg/L, or half of the MCL. The quarterly sampling indicates that this project area is consistently impacted by elevated nitrate concentrations in the ground water.

Tracking trends in ambient nitrate ground water concentration due to changes in land uses or source controls will be accomplished by comparing seasonal trends over multiple years. This comparison will also assist with determining the effects of seasonal variability that occurs under conditions such as 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. Multiple year seasonal trend analysis of ambient nitrate concentrations has not been conducted. Additional data and data compilation are needed prior to conducting such analyses. Data and resources are anticipated to be available to complete the analysis phase of the project in the future.

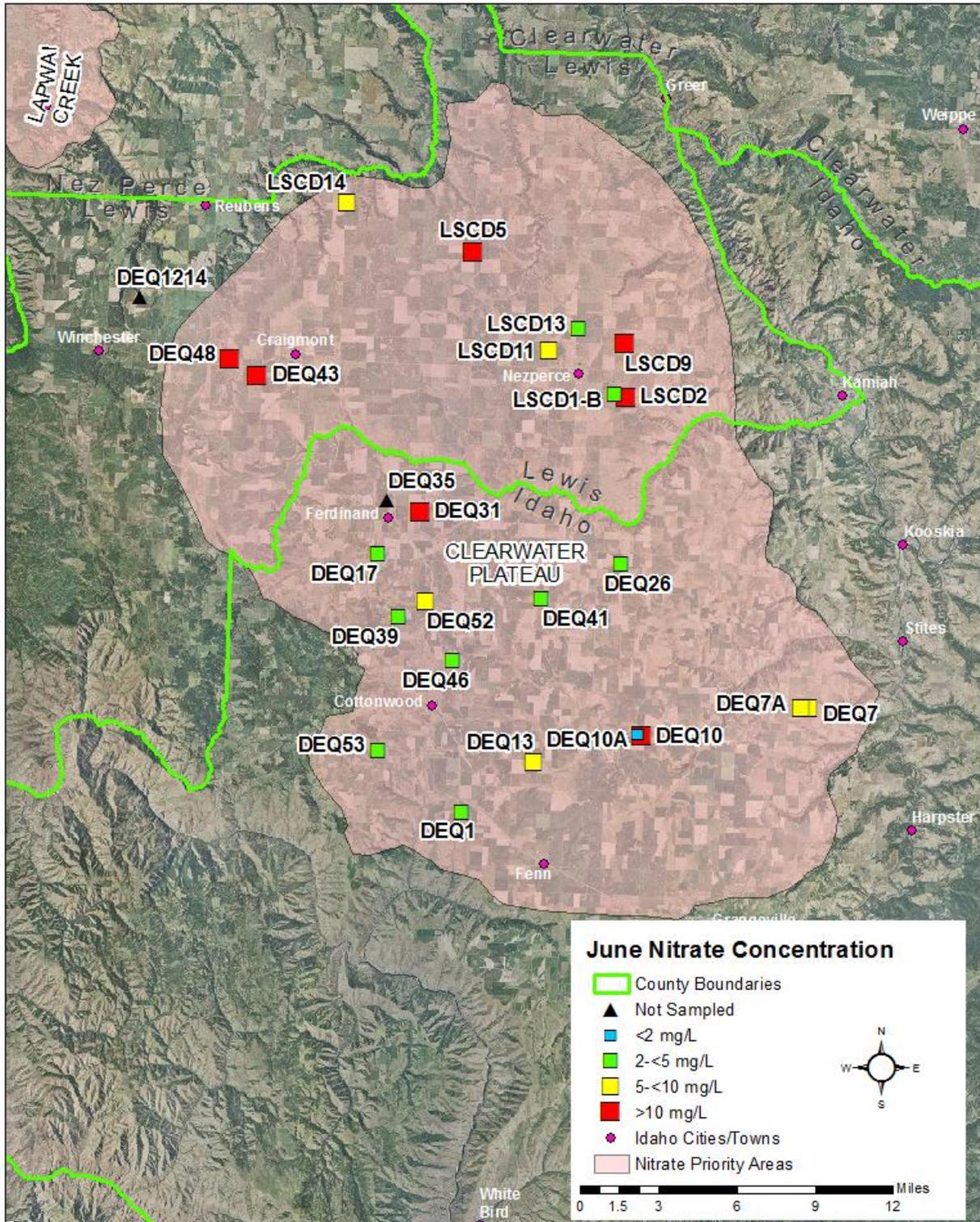


Figure 13. Well locations, well identification, and nitrate concentrations for June 2010 sampling for Camas Prairie Nitrate Priority Area Ground Water Monitoring Project.

Table 15. Water quality field parameter data from Camas Prairie Nitrate Priority Area Ground Water Monitoring Project.

Well ID	Well Depth (feet)	March 2010		June 2010				September 2010				December 2010			
		Spec. Cond. ^a (µs/cm)	Water Temp. ^a (°C)	Spec. Cond. ^a (µs/cm)	Water Temp. ^a (°C)	DO ^a (mg/L)	pH	Spec. Cond. ^a (µs/cm)	Water Temp. ^a (°C)	DO ^a (mg/L)	pH	Spec. Cond. ^a (µs/cm)	Water Temp. ^a (°C)	DO ^a (mg/L)	pH
DEQ1	375	355	5.7	360	12.8	9.66	8.73	344	15.5	7.01	8.84	338	5.3	10.35	8.08
DEQ7	260	439	5.7	391	11.7	0.17	7.53	427	15.0	NS	7.51	352	4.9	11.08	7.62
DEQ7A	145	452	9.9	445	12.4	12.43	8.15	428	14.3	12.66	7.67	427	4.3	16.35	8.09
DEQ10	187	439	10.9	430	11.3	0.18	7.63	417	11.4	10.01	7.48	423	10.6	10.25	7.52
DEQ10A	Spring	425	11.7	422	12.2	0.17	8.76	410	11.9	0.30	8.70	NS	NS	NS	NS
DEQ13	250	479	8.3	480	11.3	0.18	7.81	482	11.2	8.62	8.23	468	9.6	7.34	7.74
DEQ17	500	252	8.9	237	10.5	NS	7.64	235	11.8	8.37	8.01	228	10.3	9.07	7.52
DEQ26	135	369	10.8	360	11.0	4.50	7.90	351	11.2	3.86	7.84	350	10.7	4.26	7.89
DEQ31	28	NS	NS	550	9.5	NS	7.81	519	11.5	7.88	8.12	NS	NS	NS	NS
DEQ35	340	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	459	9.9	11.33	8.06
DEQ39	400	263	10.7	245	11.6	0.18	7.75	231	11.7	7.90	8.11	242	10.6	8.79	7.63
DEQ41	327	583	10.9	580	12.0	0.20	8.10	NS	NS	NS	NS	540	10.8	0.39	8.06
DEQ43	85	438	9.6	540	10.2	0.08	7.83	438	10.3	4.70	7.93	415	9.6	5.25	7.82
DEQ46	500	322	13	345	14.0	0.15	7.94	301	14.2	2.53	8.34	338	12.0	3.47	7.83
DEQ48	400	438	8.4	446	10.5	0.21	8.21	420	13.1	7.96	8.49	424	9.1	9.28	8.27
DEQ52	80	589	11.5	800	11.6	0.18	7.91	NS	NS	NS	NS	NS	NS	NS	NS
DEQ53	500	175	5.7	212	12.5	7.68	8.93	214	14.6	4.26	8.32	223	5.9	6.09	7.78
DEQ1214	Spring	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	313	9.1	4.95	7.24
LSCD1-B	300	460	6.2	440	11.0	8.70	8.20	423	13.1	8.01	8.13	429	6.0	11.63	8.85
LSCD2	65	545	11.1	620	11.0	7.80	7.90	486	11.3	10.89	8.00	593	10.8	10.72	8.05
LSCD5	402	531	9.6	530	11.0	11.30	7.70	503	11.8	10.94	8.15	490	10.4	10.24	8.03
LSCD9	165	651	10.8	630	11.0	10.30	7.90	653	11.6	9.41	7.90	647	11.3	10.82	8.15
LSCD11	396	419	9.8	410	11.0	15.20	7.70	386	11.8	10.60	8.22	NS	NS	NS	NS

Well ID	Well Depth (feet)	March 2010		June 2010				September 2010				December 2010			
		Spec. Cond. ^a (µS/cm)	Water Temp. ^a (°C)	Spec. Cond. ^a (µS/cm)	Water Temp. ^a (°C)	DO ^a (mg/L)	pH	Spec. Cond. ^a (µS/cm)	Water Temp. ^a (°C)	DO ^a (mg/L)	pH	Spec. Cond. ^a (µS/cm)	Water Temp. ^a (°C)	DO ^a (mg/L)	pH
LSCD13	90	403	10	400	10.0	11.10	7.70	398	10.7	10.54	7.97	409	9.8	11.64	7.84
LSCD14	85	630	8.7	640	10.0	8.40	7.60	608	10.9	10.99	8.19	604	9.1	9.09	7.83

Notes: Italicized red numbers indicate the United States Environmental Protection Agency's Secondary Drinking Water Regulation was exceeded; Spec. Cond. = specific conductivity; µS/cm = microsiemens per centimeter; Temp. = temperature; °C = degrees Celsius; DO = dissolved oxygen; mg/L = milligrams per liter; NS = not sampled.

a. No primary or secondary health standard available.

Table 16. Nitrate results for Camas Prairie Nitrate Priority Area Ground Water Monitoring Project, 2010.

Well ID	Well Depth (feet)	Nitrate Concentration (milligrams per liter)			
		March 2010	June 2010	September 2010	December 2010
DEQ1	375	0.905	3.57	1.05	1.07
DEQ7	260	8.39	7.06	7.64	7.58
DEQ7A	145	5.72	5.62	5.68	6.00
DEQ10	187	15.40	14.70	14.50	16.20
DEQ10A	Spring	<0.10	<0.10	<0.10	NS
DEQ13	250	8.73	9.08	9.12	8.35
DEQ17	500	3.37	3.07	2.55	2.39
DEQ26	135	4.53	4.49	4.11	4.52
DEQ31	28	NS	15.80	9.92	NS
DEQ35	340	NS	NS	NS	7.53
DEQ39	400	3.51	3.54	3.32	3.73
DEQ41	327	4.59	4.82	NS	4.32
DEQ43	85	11.30	14.60	11.70	12.70
DEQ46	500	4.62	3.92	3.61	4.17
DEQ48	400	19.00	18.50	16.80	18.90
DEQ52	80	9.78	9.47	NS	NS
DEQ53	500	2.38	2.47	1.89	2.45
DEQ1214	Spring	NS	NS	NS	4.03
LSCD1-B	300	8.00	4.54	3.99	4.71
LSCD2	65	4.60	14.50	6.42	10.20
LSCD5	402	11.90	10.30	10.70	11.90
LSCD9	165	13.20	12.80	14.30	15.30
LSCD11	396	5.68	5.55	5.25	NS
LSCD13	90	4.71	4.83	4.54	4.85
LSCD14	85	5.33	5.57	5.06	5.16

Notes: Bolded red numbers indicate the United States Environmental Protection Agency's maximum contaminant level was exceeded; NS = not sampled.

3.4.1.3 Conclusions

Sample results show that ground water in the Camas Prairie contains elevated nitrate. In some locations, nitrate concentrations exceed EPA's MCL of 10 mg/L. Nitrogen isotope analysis conducted in previous years indicate that both inorganic and organic nitrogen are contributing to the elevated concentrations. Based on the large aerial extent of degraded ground water, commercial fertilizer, livestock manure, and septic systems are likely sources of elevated nitrate concentrations found in project area ground water.

The annual variability found in individual wells makes it difficult to detect improvements in ground water quality in the study area as BMPs are implemented because the concentration changes may fall within the range of concentrations already measured in individual wells. Instead this project will attempt to compare changes in seasonal trends of the network over multiple years to identify changes in ambient conditions.

3.4.1.4 Recommendations

Ground water conditions can be represented in spring water. Monitoring spring water when ground water provides the only source of water to the stream can also be used to determine ground water nitrogen loads to surface water. This information may be useful in determining if and where areas of larger nitrogen contribution exist in the drainage basin and in focusing BMP implementation efforts.

For more information, the Camas Prairie technical report (Baldwin et al. 2008) summarizes data collected for this project from 2005 through 2007 at http://www.deq.idaho.gov/media/470730-water_data_reports_ground_water_camasa_prairie_29.pdf.

3.4.2 Tammany and Lindsay Creeks Ground Water Monitoring Project

3.4.2.1 Purpose

The Lindsay Creek NPA was designated in 2008 using ground water data from IDWR and DEQ. The 2007 Lindsay Creek total maximum daily load (TMDL) determined that the ground water base flow is a nitrogen contributor to Lindsay Creek and requires a load reduction. The goal of this project is to create an ambient ground water quality monitoring network for multiple year seasonal trend analysis to detect changes as a result of the Lindsay Creek NPA and also extend ground water quality monitoring to include the aquifer within the Tammany Creek watershed area. Limited sampling has shown elevated nitrate concentrations can be found in Tammany Creek area wells. Tammany Creek is located on the south side of Lewiston, Idaho, and the watershed has similar spring-fed nutrient load characteristics as the Lindsay Creek watershed on the north side of Lewiston (Figure 14). The ground water in this watershed may also be a potential source of excess nutrients to Tammany Creek. Tammany Creek is currently impaired by nutrients and has an approved nutrient TMDL.

3.4.2.2 Methods and Results

DEQ sampled 15 wells quarterly for the Tammany and Lindsay Creeks project during March, June, September, and December 2010 (Figure 14). Water-quality field parameters—temperature, specific conductivity, pH, and DO—were measured in the field (Table 17). Samples were collected quarterly for nitrate (Table 18). In addition, 9 wells were sampled for deuterium and oxygen isotopes during the June 2010 sampling event. DEQ is collecting data to develop an ambient ground water quality monitoring network of approximately 25 wells for quarterly sampling. Nitrate concentrations from sampled wells will be compared seasonally for several years to distinguish wells with nitrate concentrations that have similar seasonal trends and wells that provide results considered to be anomalies when compared to surrounding wells. Wells considered to have anomalous nitrate data will be addressed as isolated or localized situations and dropped from the ambient network.

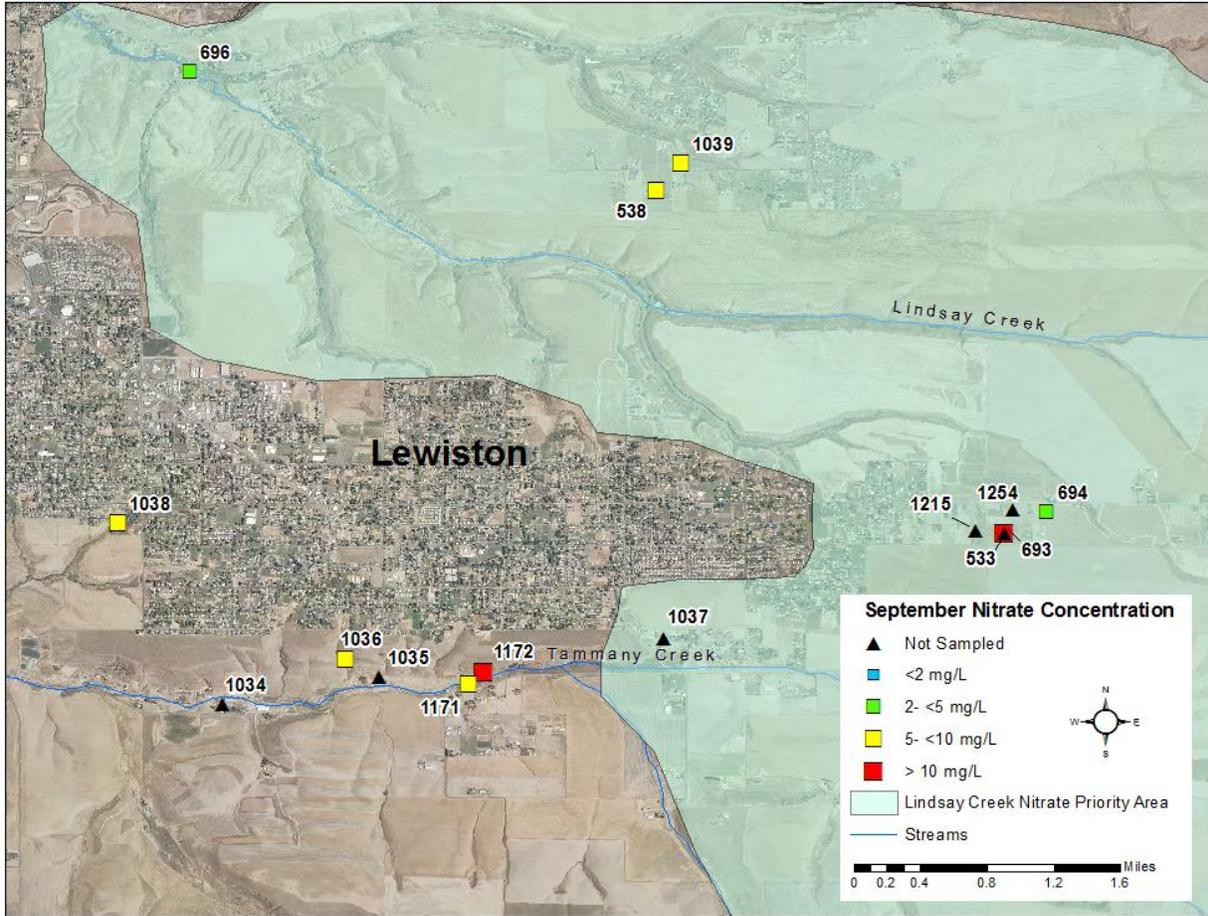


Figure 14. Well locations, well identification, and nitrate concentrations for September 2010 sampling of the Tammany and Lindsay Creeks Ground Water Monitoring Project.

Table 17. Water quality field parameters for Tammany and Lindsay Creeks Ground Water Monitoring Project.

Well ID	Well Depth (feet)	March 2010				June 2010				September 2010				December 2010			
		DO ^a (mg/L)	pH	Spec. Cond. ^a (µS/cm)	Water Temp. ^a (°C)	DO ^a (mg/L)	pH	Spec. Cond. ^a (µS/cm)	Water Temp. ^a (°C)	DO ^a (mg/L)	pH	Spec. Cond. ^a (µS/cm)	Water Temp. ^a (°C)	DO ^a (mg/L)	pH	Spec. Cond. ^a (µS/cm)	Water Temp. ^a (°C)
533	225	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	11.10	<i>8.55</i>	778	10.6
538	228	NS	NS	NS	NS	NS	NS	NS	NS	11.12	<i>9.29</i>	700	14.8	11.79	<i>8.54</i>	586	13.6
693	Unknown	10.04	<i>8.62</i>	715	11.1	NT	<i>8.64</i>	820	15.5	10.24	<i>8.79</i>	710	16.4	NS	NS	NS	NS
694	Unknown	NS	NS	NS	NS	NT	<i>8.94</i>	710	13.5	NT	<i>9.20</i>	670	14.0	NS	NS	NS	NS
696	Unknown	8.06	8.23	1,030	11.22	NT	7.79	1,130	12.9	4.34	8.17	1,070	14.8	4.78	7.68	1,070	13.7
1034	Unknown	5.22	8.47	587	14.1	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
1035	Unknown	1.62	<i>8.62</i>	687	15.8	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
1036	134	8.66	8.26	826	12.8	NT	8.11	940	18.4	9.70	<i>8.82</i>	850	18.3	10.05	8.20	852	12.8
1037	Unknown	1.57	<i>9.14</i>	226	12.6	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS
1038	150	10.39	<i>8.64</i>	1,320	11.2	NT	<i>8.64</i>	1,340	13.1	10.74	<i>9.12</i>	1,250	13.7	11.61	8.50	1,310	12.0
1039	235	10.03	<i>8.58</i>	1,010	11.5	NT	8.37	950	14.9	9.32	<i>8.64</i>	850	15.2	10.84	8.28	1,040	12.5
1171	Spring	NS	NS	NS	NS	NS	NS	NS	NS	4.57	8.24	1,300	17.7	NS	NS	NS	NS
1172	Unknown	NS	NS	NS	NS	NS	NS	NS	NS	8.25	<i>9.82</i>	1,220	19.1	13.77	<i>9.36</i>	1,210	5.3
1215	205	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	2.28	8.47	447	9.1
1254	197	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	8.52	7.35	1,080	15.8

Notes: Italicized red numbers indicate the United States Environmental Protection Agency's Secondary Drinking Water Regulation was exceeded; DO = dissolved oxygen; mg/L = milligrams per liter; Spec. Cond. = specific conductivity; µS/cm = microsiemens per centimeter; Temp. = temperature; °C = degrees Celsius; NS = not sampled; NT = not tested.

a. No primary or secondary health standard available.

Table 18. Nitrate results for Tammany and Lindsay Creeks Ground Water Monitoring Project, 2010.

Well ID	Well Depth (feet)	Nitrate Concentration (milligrams per liter)			
		March 2010	June 2010	September 2010	December 2010
533	225	NS	NS	NS	13.70
538	228	NS	NS	5.62	5.20
693	Unknown	11.80	5.39	10.30	NS
694	Unknown	NS	10.10	4.21	NS
696	295	5.48	4.70	4.87	5.33
1034	Unknown	0.10	NS	NS	NS
1035	Unknown	0.10	NS	NS	NS
1036	134	9.04	9.92	8.98	8.99
1037	Unknown	0.10	NS	NS	NS
1038	150	6.74	7.40	6.92	6.85
1039	235	6.40	6.54	6.12	6.82
1171	Spring	NS	NS	7.75	NS
1172	Unknown	NS	NS	10.50	10.00
1215	205	NS	NS	NS	4.16
1254	197	NS	NS	NS	19.30

Notes: Bolded red numbers indicate the United States Environmental Protection Agency's maximum contaminant level was exceeded; NS = not sampled.

Nitrate results from the 2010 quarterly sampling are presented in Table 18. The highest nitrate concentration detected was in well 1254 at 19.3 mg/L during the December 2010 sampling event. Well 1254 was not sampled during the other three quarters of 2010. One well exceeded EPA's nitrate MCL in March and June (wells 693 and 694, respectively); 2 wells exceeded the MCL in September (wells 693 and 1172), and 3 wells exceeded the MCL in December (wells 533, 1172, and 1254).

Tracking trends in ambient nitrate ground water concentration due to changes in land uses or source controls will be accomplished by comparing seasonal trends over multiple years. This comparison will also assist with determining the effects of seasonal variability that occur under the conditions such as 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. Multiple year seasonal trend analysis of ambient nitrate concentrations has not been conducted. Additional data and data compilation are needed prior to conducting such analyses. Data and resources are anticipated to be available to complete the analysis phase of the project in the future.

Deuterium ($\delta^2\text{H}$) and oxygen ($\delta^{18}\text{O}$) isotopes were collected during the June sampling event for 9 wells. The results are shown in Table 19. Samples were collected to assist in analyzing well characteristics and selecting a long-term well network for multiple year nitrate concentration trend analysis. As is shown in Table 17, Table 18, and Table 19, wells 1034 and 1037 specific

conductivity, nitrate concentrations, and isotope ratios are not similar with the remaining network wells sampled and may not be good candidates for tracking ambient trends in the impacted aquifer.

Table 19. Deuterium and oxygen isotope results for Tammany and Lindsay Creeks Ground Water Monitoring Project, 2010.

Well ID	Well Depth (feet)	Sample Date	$\delta^2\text{H}$ (‰)	$\delta^{18}\text{O}$ (‰)
693	Unknown	6/9/2010	-111	-14.6
694	Unknown	6/10/2010	-113	-14.5
696	Unknown	6/10/2010	-107	-13.6
1034	Unknown	6/9/2010	-126	-16.3
1035	Unknown	6/9/2010	-119	-15.1
1036	Unknown	6/9/2010	-105	-13.1
1037	Unknown	6/10/2010	-120	-15.8
1038	Unknown	6/9/2010	-103	-13.2
1039	Unknown	6/10/2010	-114	-14.7

Notes: There is no primary or secondary health standard available for nitrogen or oxygen isotopes; $\delta^2\text{H}$ = deuterium; $\delta^{18}\text{O}$ = oxygen isotope; ‰ = per mil or parts per thousand.

3.4.2.3 Conclusions

Sample results show that ground water in the Tammany and Lindsay Creeks project area contains elevated nitrate. In some locations, nitrate concentrations exceed the EPA's MCL of 10 mg/L. Wells available to include in an ambient network are limited. Springs shown to be representative of ground water conditions may be enlisted into the monitoring network to satisfy data needs.

3.4.2.4 Recommendations

Continued monitoring of available wells and springs is recommended to establish an ambient ground water quality network to track multiple year seasonal trends, specifically for nitrate, in the project area. DEQ is drafting an NPA management plan with the assistance of the Lindsay and Tammany Creeks Watershed Advisory Group. The management plan will be a component of the Lindsay Creek TMDL Implementation Plan. The NPA management plan and applications for funding should be continued to assist with ground water protection efforts.

3.5 Pocatello Region

3.5.1 Black Cliffs Nitrate Follow-Up Monitoring Project

3.5.1.1 Purpose

In 2010, the DEQ Pocatello Regional Office conducted a nitrate ground water investigation in the Black Cliffs area as a follow up to a DEQ study conducted in 1990 that found nitrate ground water concentrations as high as 20.6 mg/L (Winter et al. 1994) in private wells. The Black Cliffs

area is located approximately 4 miles southeast of Idaho State University, north of Interstate 15, and about a one-half mile from the Portneuf River in Bannock County. The study area includes a mobile home park, the site of initial detections of high nitrate in 1980 and 1990, and surrounding residential and industrial development along the South 5th Avenue corridor to the Portneuf Gap. The hydrogeologic system in this study area, called the Eastern Aquifer, is composed mainly of fine-grained silt with extremely slow moving ground water relative to the regional valley aquifer (Figure 15). The Eastern Aquifer, separated from the highly permeable valley aquifer by the Portneuf Basalt, is contaminated with inorganic salts of chloride, sulfate, and nitrate, some in very high concentrations (Welhan et al. 1996). Pocatello municipal wells in the southern valley are affected by this contamination.

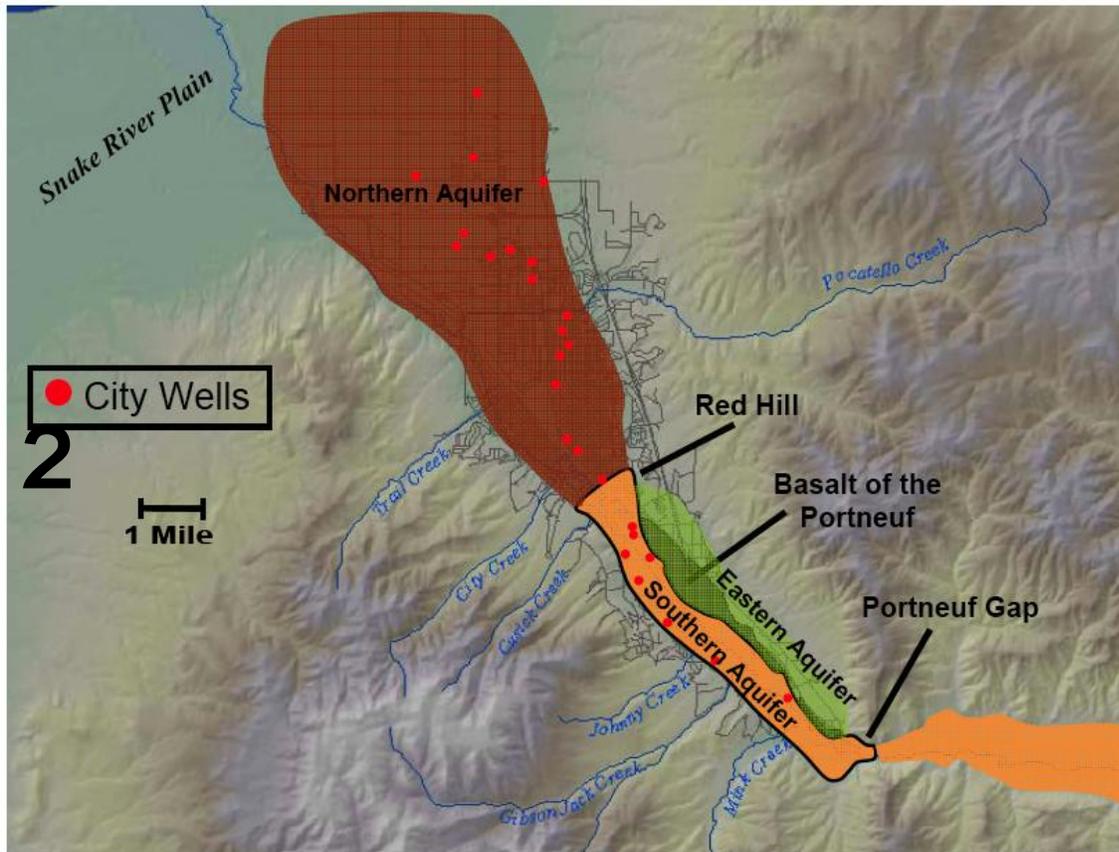


Figure 15. Lower Portneuf Valley aquifer system and location of the Eastern Aquifer (Welhan et al. 1996).

3.5.1.2 Methods and Results

Fifteen private wells were sampled in June 2010 for the Black Cliffs project (Figure 16) following the DEQ QAPP (DEQ 2010d). Of these 15 wells, 7 wells were sampled during the 1980 and 1990 sampling events, providing a long-term picture of nitrate contamination (Figure 17).

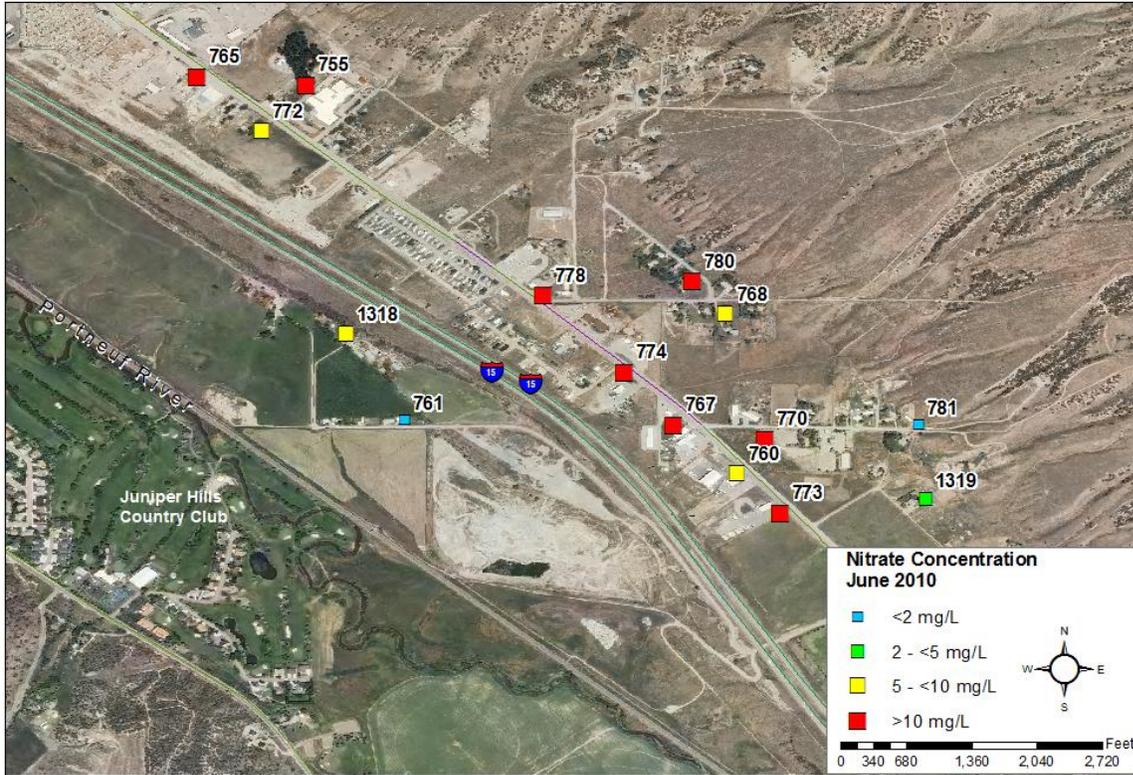


Figure 16. Well locations and nitrate concentrations for the Black Cliffs Nitrate Follow-Up Monitoring Project.

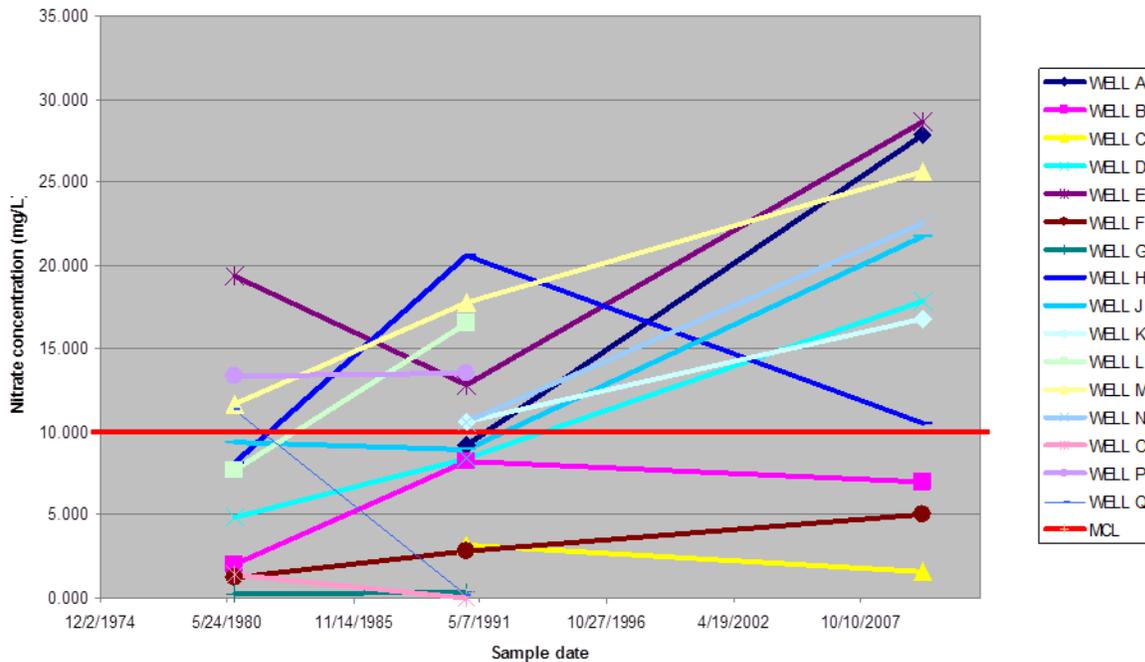


Figure 17. Nitrate concentrations in private wells from 1980 to 2010, Black Cliffs area.

For the June 2010 event, samples were analyzed for total coliform, *E. coli*, nitrate, and nitrite. The samples were submitted to IAS EnviroChem in Pocatello, Idaho, for analysis. Water-quality field parameters—temperature and specific conductivity—were measured prior to sample collection.

2010 Nitrate Sampling

The nitrate values for samples collected in 2010 ranged from nondetectable (<1 mg/L) to 27.82 mg/L (Table 20). EPA's MCL of 10 mg/L was exceeded in 8 wells (53%). The mean nitrate concentration was 13.36 mg/L, and the median nitrate concentration was 10.48 mg/L. The spatial distribution of nitrate concentrations is shown in Figure 16.

Additional Sampling

Nitrite analysis resulted in nondetectable (<0.1 mg/L) for all of the wells (Table 20). Total coliform was detected in 2 wells located at the southern portion of the project area (wells 773 and 1319), while *E. coli* was not detected in any wells (Table 20).

Table 20. Black Cliffs Nitrate Follow-Up Monitoring Project data.

Well ID	Well Depth (feet)	Sample Date	Total Coliform (MPN/100 mL)	<i>E. coli</i> (MPN/100 mL)	Nitrate (mg/L)	Nitrite (mg/L)	Specific Conductivity ^a (µS/cm)	Water Temperature ^a (°C)
755	Unknown	6/7/2010	Absent	Absent	27.82	<0.1	1,760	14.9
760	Unknown	6/7/2010	Absent	Absent	6.96	<0.1	793	14.3
761	69.25	6/8/2010	Absent	Absent	1.55	<0.1	557	11.2
765	Unknown	6/7/2010	Absent	Absent	17.87	<0.1	1,680	14.6
767	Unknown	6/7/2010	Absent	Absent	26.68	<0.1	3,000	14.5
768	400	6/8/2010	Absent	Absent	5.05	<0.1	722	13.6
770	Unknown	6/8/2010	Absent	Absent	10.48	<0.1	852	13.5
772	Unknown	6/7/2010	Absent	Absent	9.02	<0.1	2,360	13.3
773	Unknown	6/7/2010	Present	Absent	21.74	<0.1	1,510	15.7
774	Unknown	6/7/2010	Absent	Absent	16.79	<0.1	1,860	14.2
778	Unknown	6/8/2010	Absent	Absent	25.57	<0.1	1,790	14.3
780	Unknown	6/8/2010	Absent	Absent	22.53	<0.1	1,660	13.1
781	Unknown	6/7/2010	Absent	Absent	<1.0	<0.1	584	16.2
1318	Unknown	6/8/2010	Absent	Absent	5.11	<0.1	901	12.2
1319	Unknown	6/7/2010	Present	Absent	2.73	<0.1	683	15.5

Notes: Bolded red numbers indicate the United States Environmental Protection Agency's maximum contaminant level was exceeded; MPN/100 mL = most probable number per 100 milliliters; mg/L = milligrams per liter; µS/cm = microsiemens per centimeter; °C = degrees Celsius.

a. No primary or secondary health standard available.

3.5.1.3 Conclusions

The high percentage of wells that exceeded the EPA's MCL for nitrate, and the median and mean nitrate concentration also exceeding the MCL, are indicators that the source of nitrate

contamination is still present. Local land-use activities and chemical signatures suggest that septic systems are the source of nitrogen in the ground water.

Data from this project were used to create the Black Cliffs NPA, which was added to the 2008 NPAs. The Black Cliffs NPA will be considered for ranking during the 2012 statewide NPA evaluation and ranking.

3.5.1.4 Recommendations

Further investigation in the project area, including PCPP and $\delta^{15}\text{N}$ ground water analyses, will be helpful in determining the source and extent of nitrate contamination.

Data from this project will be used during the 2012 statewide NPA evaluation and ranking process. The ranking process will be used to prioritize the implementation of protective management strategies or corrective action measures within the NPAs.

Land-use activities near the elevated nitrate concentrations should be examined to determine what potential BMPs could be used to protect the ground water from further contamination, including educating homeowners on proper septic system maintenance or evaluating the potential to develop a municipal sewer system in the area. Well owners in this area are encouraged to test their wells annually for nitrate.

3.5.2 Sand Ridge Subdivision Nitrate Monitoring Project

3.5.2.1 Purpose

In 2009, elevated nitrate concentrations were detected in ground water samples from 2 private wells in the Sand Ridge Subdivision south of Preston, Idaho, as a result of free nitrate testing using test strips offered at a local health fair. DEQ personnel followed up with the residents after the health fair and collected samples for laboratory analysis in May 2009. The nitrate concentrations from the laboratory analysis for the May 2009 sampling were 26.9 mg/L and 28.6 mg/L, both as $\text{NO}_3\text{-N}$. In June 2010, DEQ initiated a subdivision-wide sampling project to determine the areal extent of potential nitrate contamination in private wells and one spring-fed water source. The objectives included the following:

- Collecting and analyzing ground water samples for nitrate and nitrite, both as nitrogen, concentrations, as well as total coliform and *E. coli*, as appropriate
- Compiling any additional data, if available
- Researching the agricultural and industrial history of the area to determine potential sources
- Establishing baseline data that can be used to evaluate current conditions and future trends

3.5.2.2 Methods and Results

Nineteen private wells and 1 spring in the subdivision were sampled in June 2010 (Figure 18). All samples were analyzed for total coliform, *E. coli*, nitrate, and nitrite. Samples were submitted to IAS EnviroChem in Pocatello, Idaho, for analysis. Water quality field parameters—

temperature and specific conductivity—were measured prior to sample collection following the project QAPP and sampling plan (DEQ 2010e).

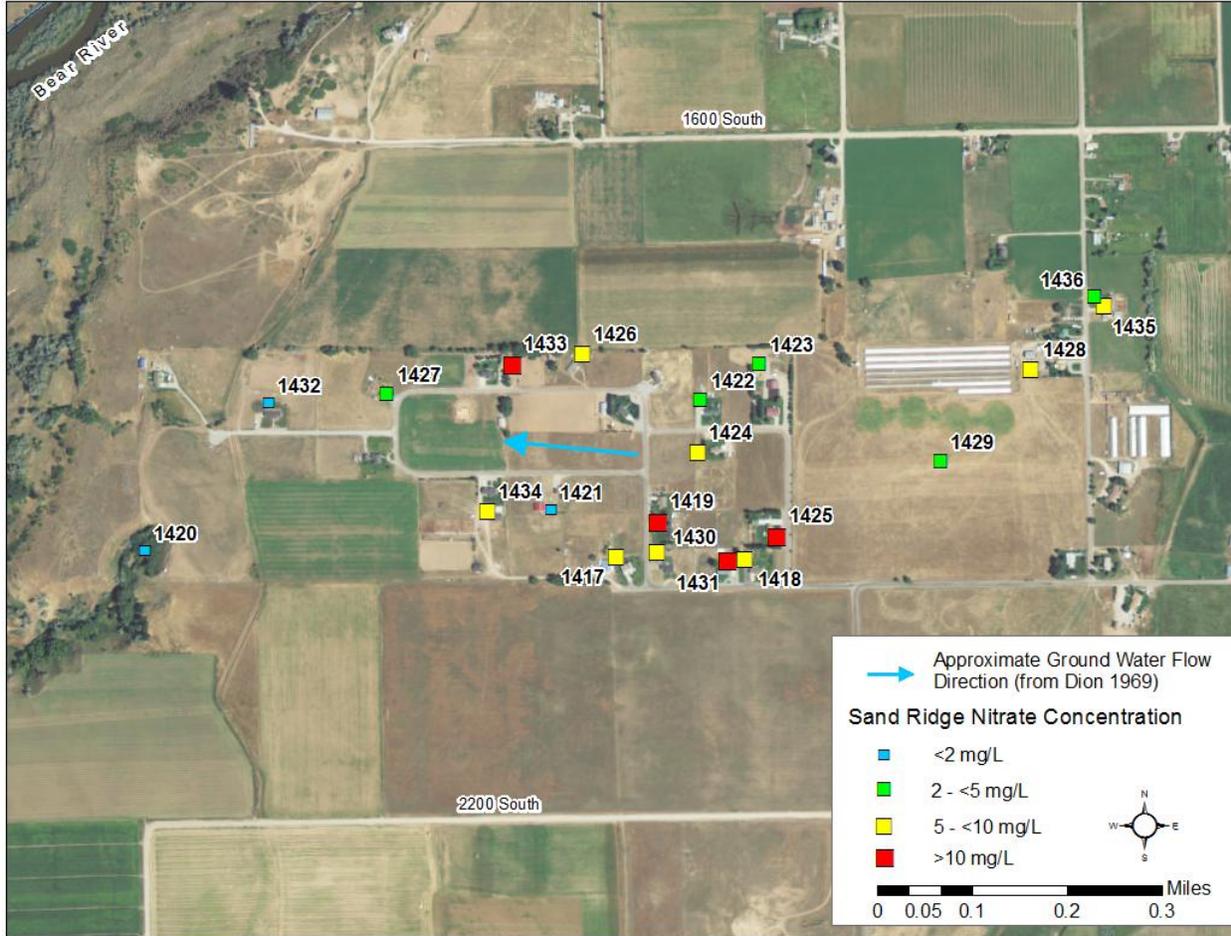


Figure 18. Well and spring locations, well and spring identification, and nitrate concentrations for Sand Ridge Subdivision Nitrate Monitoring Project.

2010 Nitrate Sampling

Nitrate values ranged from nondetectable (<1 mg/L) to 27.75 mg/L (Table 21). EPA’s MCL of 10 mg/L was exceeded in 4 wells (20%), while 12 wells (60%) exceeded 5 mg/L. The mean nitrate concentration was 8.14 mg/L, and the median nitrate concentration was 7.29 mg/L. The spatial distribution of nitrate concentrations is shown in Figure 18.

Table 21. Bacteria, nutrient, and field water quality data for Sand Ridge Subdivision Nitrate Monitoring Project.

Well ID	Well Depth (feet)	Sample Date	Total Coliform (MPN/100 mL)	<i>E. coli</i> (MPN/100 mL)	Nitrate (mg/L)	Nitrite (mg/L)	Specific Conductivity ^a (µS/cm)	Water Temperature ^a (°C)
1417	40	6/16/2010	Absent	Absent	6.95	<0.10	442	12.9
1418	100	6/15/2010	Absent	Absent	9.91	<0.10	452	13.3
1419	67	6/16/2010	Absent	Absent	27.75	<0.10	574	12.2
1420	Spring	6/16/2010	Present	Absent	<1.00	<0.10	320	14.3
1421	73	6/15/2010	Present	Absent	<1.00	<0.10	354	13.5
1422	45	6/23/2010	Absent	Absent	2.00	<0.10	487	12.4
1423	64	6/15/2010	Absent	Absent	3.69	<0.10	777	12.8
1424	45	6/16/2010	Absent	Absent	5.08	<0.10	601	12.5
1425	U	6/16/2010	Absent	Absent	13.06	<0.10	536	13.1
1426	U	6/16/2010	Absent	Absent	7.62	<0.10	469	13.2
1427	40	6/23/2010	Absent	Absent	2.50	<0.10	392	14.8
1428	U	6/15/2010	Absent	Absent	9.00	<0.10	579	11.5
1429	45	6/15/2010	Absent	Absent	4.29	<0.10	578	13.5
1430	55	6/15/2010	Absent	Absent	9.94	<0.10	468	13.3
1431	U	6/15/2010	Absent	Absent	17.43	<0.10	500	13.3
1432	U	6/16/2010	Absent	Absent	<1.00	<0.10	300	13.7
1433	45	6/23/2010	Absent	Absent	21.64	<0.10	430	12.7
1434	U	6/23/2010	Absent	Absent	9.04	<0.10	468	13.6
1435	U	6/15/2010	Absent	Absent	7.79	<0.10	634	12.0
1436	U	6/15/2010	Absent	Absent	3.68	<0.10	639	11.3

Notes: Bolded red numbers indicate the United States Environmental Protection Agency's maximum contaminant level was exceeded; MPN/100 mL = most probable number per 100 milliliters; mg/L = milligrams per liter; µS/cm = microsiemens per centimeter; °C = degrees Celsius; U = unknown.

a. No primary or secondary health standard available.

Additional Sampling

Nitrite analysis resulted in nondetectable (<0.1 mg/L) for all wells and 1 spring (Table 21). Total coliform was detected in 1 well and 1 spring, located at the southwest and southcentral portions of the project area (spring 1420 and well 1421, respectively). *E. coli* was not present in any samples (Table 21).

3.5.2.3 Conclusions

Ground water nitrate concentrations that exceeded the EPA MCL generally occurred in the central portion of the project area. The elevated median and mean nitrate concentrations, as well as the high percentage of wells that exceed 5 mg/L, are indicators that the ground water is being impacted by a nitrogen source.

The subdivision is built on sand and silt material left behind by the Bonneville floods and subsequent aerial deposition of silt and clay. Homes occupy lots ranging from less than 1 to approximately 5 acres; each lot having its own well and septic system. All wells completed in the subdivision are very shallow, ranging from 40 feet to 73 feet deep.

During the sampling event, DEQ learned of a historical septic failure at one of the residences. This event was documented by the local health district. Although the failed septic was replaced, the lot immediately adjacent to the property contained the highest nitrate values in ground water (well 1419). In addition, DEQ learned that the land occupied by the subdivision was once the site of a large mink farm. Farm building footprints are visible in aerial photography immediately adjacent to the subdivision, and some residents mentioned that mink jawbones and tags were observed in excavations for home construction. A nearby active mink farm owner, whose well was also sampled as part of this project (well 1428), identified the subdivision property as once part of his family's mink farm started by his grandfather. Another potential nitrogen source was identified as a barnyard on the northern edge of the subdivision; the well located in the middle of the barnyard (well 1433) had a nitrate concentration that exceeded EPA's MCL.

3.5.2.4 Recommendations

The Sand Ridge Subdivision project is located within the Preston NPA, and the high percentage of wells that exceed 5 mg/L for nitrate confirms the NPA designation for this area. Data from this project will be used during the 2012 statewide NPA evaluation and ranking process. The ranking process will be used to prioritize the implementation of protective management strategies or corrective action measures within the NPAs.

Further investigation in the project area, including PCPP and $\delta^{15}\text{N}$ ground water analyses, will be helpful in determining the source and extent of nitrate contamination.

Subdivision residents have organized and appealed for help from the Franklin County commissioners and nearby PWSs to allow a water connection to the subdivision. In addition to the nitrate contamination, water levels in residential wells have declined significantly since canal water immediately adjacent to the subdivision was piped due to heavy infiltration loss along this sandy stretch of canal. The two closest PWSs have not allowed additional connections to their systems outside of their current service areas.

Well owners are encouraged to test their wells annually for nitrate and bacteria.

3.6 Twin Falls Region

3.6.1 Springdale Nitrate Follow-Up Monitoring Project

3.6.1.1 Purpose

The Cassia County NPA was first delineated by DEQ in 2002 (Figure 19). NPAs were reevaluated and the Cassia County NPA was redesignated in 2008. The mean nitrate concentration of the wells used in the designation was 6.3 mg/L. This NPA extends over approximately 300 square miles of Cassia County, south of the Snake River, and encompasses the cities of Burley and Springdale, Idaho. Ground water in the eastern part of the NPA, south of

the community of Springdale, has higher mean nitrate concentrations than the area as a whole. This Springdale subarea is the focus of this study. Possible sources of nitrate in this area include septic tank effluent and agricultural practices, including crop fertilization and CAFOs.

The goal of this project was to conduct follow-up monitoring of domestic wells within the NPA that exhibited elevated nitrate based on previous studies. DEQ increased the sample suite to further identify sources of nitrate to shallow ground water. DEQ analyzed a variety of parameters to help determine the main sources of ground water contamination within the Springdale study area and also to determine if nitrate concentrations were increasing in the area. Another goal of this project was to complete an interlaboratory comparison of nitrogen isotope analyses and introduce using oxygen isotope analyses to determine sources of nitrate. Sampling was conducted in March 2010 with the help of the Idaho Soil and Water Conservation Commission.

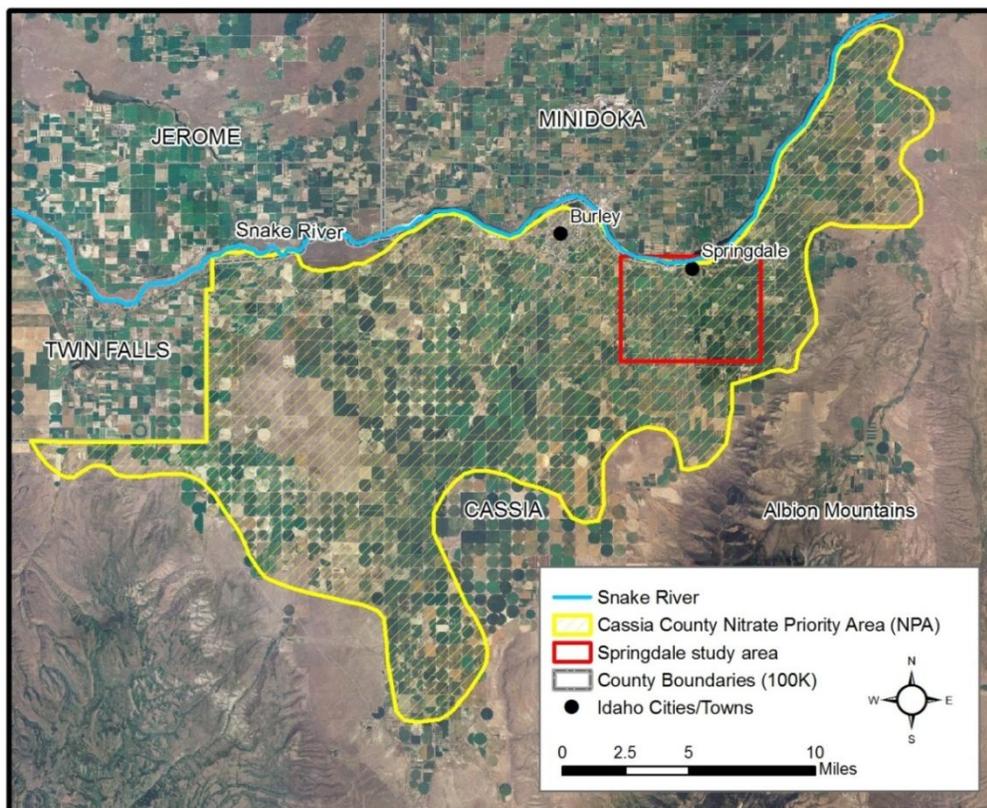


Figure 19. Location of Springdale and Cassia County nitrate priority area.

3.6.1.2 Methods and Results

The community of Springdale lies at the northern edge of an alluvial fan (Oakley Fan) that is situated between the Albion Mountain Range to the south and Snake River to the north. The major aquifer in the Springdale area important to this study is the shallow alluvial aquifer. The aquifer is overlain by sandy soils that allow dissolved constituents of concern to reach the aquifer through infiltrating surface runoff.

The shallow unconfined aquifer in the Springdale area is coincident with areas underlain by alluvial deposits (i.e., Burley Lake beds and Bonneville Flood deposits). Based on well logs in

the Springdale area, the average depth to ground water in the shallow alluvial system is less than 50 feet below ground surface. Based on data from the IDWR, the general direction of ground water flow inferred from potentiometric water-level measurements from the alluvial aquifer is generally from the southeast to the northwest in the study area.

A sampling network consisting of 19 domestic wells was established in the Springdale area to evaluate nitrate impacts to ground water. Additional wells were added to the sample suite from previous studies (Schorzman and Baldwin 2009). Wells were selected that are drilled into and draw water from the upper alluvial aquifer. A majority of the wells have well logs available from the IDWR.

Field parameters—pH, water temperature, DO, and specific conductance—were collected at each well. The following parameters were analyzed at the Idaho Bureau of Laboratories in Boise, Idaho: nitrate, chloride, sulfate, and total dissolved solids. Samples that exhibited DO concentrations less than 2 mg/L were also analyzed for ammonia. Bacteria (including total coliform and *E. coli*) were analyzed at Magic Valley Laboratories in Twin Falls, Idaho. Nitrate analysis results are shown in Figure 20 and Table 22. Samples with nitrate concentrations greater than 5 mg/L were also analyzed for the stable isotope of nitrogen ($\delta^{15}\text{N}$) at the University of Arizona in Tucson, Arizona. For the interlaboratory comparison of nitrogen isotope analyses techniques, splits of 5 samples were also sent to the University of Waterloo in Waterloo, Ontario, Canada, for analyses. Samples were collected following the project QAPP (DEQ 2008a)

Inorganic Chemistry Sampling

Nitrate concentrations exceeded the EPA's MCL of 10 mg/L, and total dissolved solids exceeded the secondary drinking water standard of 500 mg/L in 17 of the 19 wells sampled during the March 2010 sampling event (Table 22). These results are consistent with previous ground water quality studies in the Springdale area (Tesch et al. 2003; Carlson et al. 2005; Schorzman and Baldwin 2009; DEQ 2011b). The spatial distribution of nitrate is displayed in Figure 20. Six sites had nitrate concentrations that were equal to or greater than 20 mg/L—double the MCL for nitrate. These results, along with data from previous studies, have shown that the nitrate is significantly increasing in the shallow aquifer (Tesch et al. 2003; Carlson et al. 2005; Schorzman and Baldwin 2009).

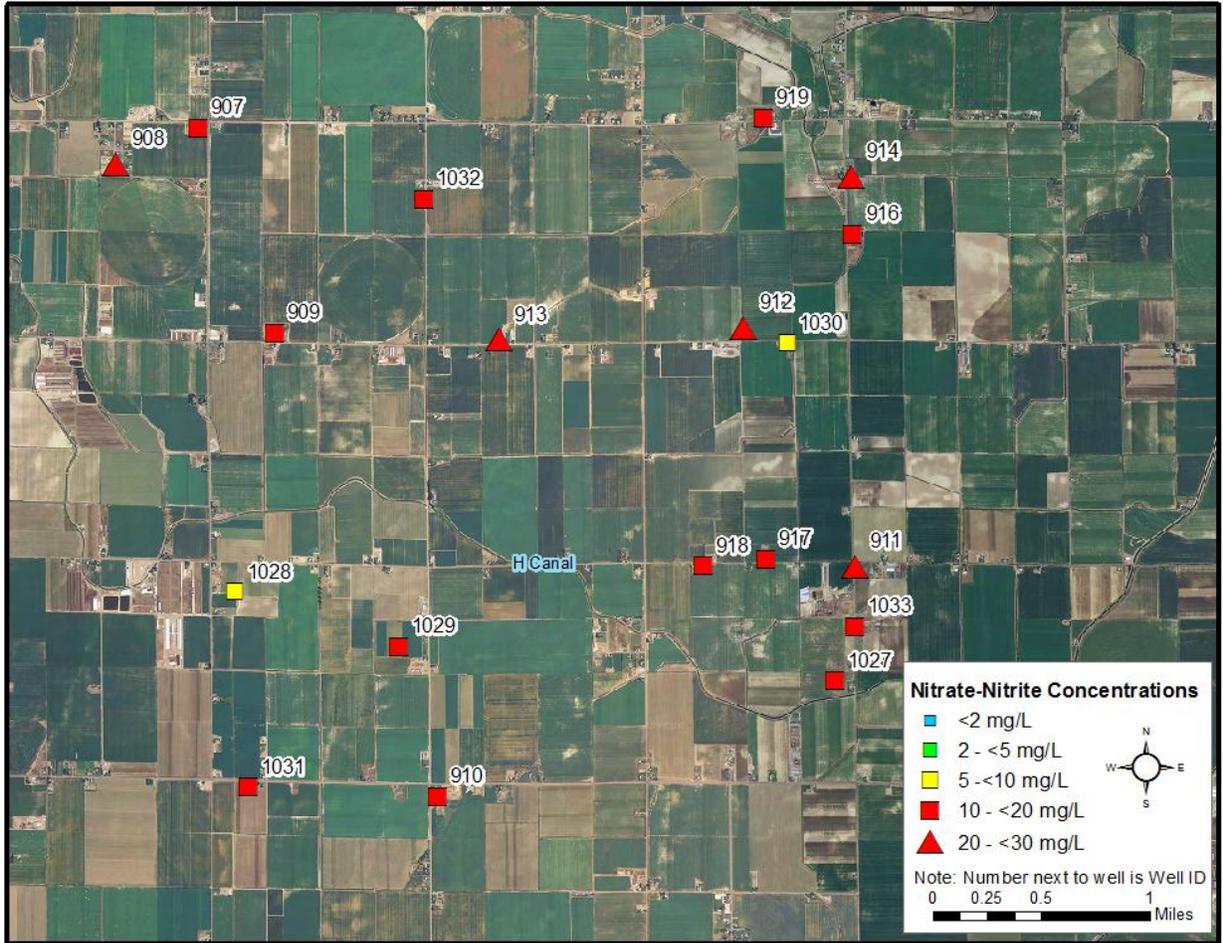


Figure 20. Well locations, well identification, and nitrate concentrations from March 2010 Springdale sampling event.

Table 22. Well depths, field parameters, and inorganic chemistry results for March 2010 Springdale sampling event.

Well ID	Well Depth (feet)	Sample Date	Field Parameters				Inorganic nutrients				
			pH	Specific Conductivity ^a (µS/cm)	Water Temp. ^a (°C)	Dissolved Oxygen ^a (mg/L)	Chloride (mg/L)	Sulfate (mg/L)	Total Dissolved Solids (mg/L)	Nitrate + Nitrite (N) (mg/L)	Ammonia (mg/L)
907	U	3/30/2010	7.9	799	12.1	3.19	39	65.4	560	18	NA
908	70	3/30/2010	7.8	950	12.9	3.25	47.4	66.8	640	20	NA
909	72	3/30/2010	8	684	13.6	3.85	33	53.4	490	11	NA
910	61	3/30/2010	8	910	11.8	8.18	35	67.4	590	13	NA
911	155	3/30/2010	7.9	1,330	12.5	1.67	85.5	113	900	25	<0.10
912	195	3/31/2010	8	1,060	11.4	1.91	49	99.3	710	20	<0.10
913	70	3/30/2010	8.9	970	11.7	8.28	46.4	107	650	21	NA
914	U	3/31/2010	7.9	1,200	12.1	5.41	73.2	117	780	20	NA
916	46	3/31/2010	8	858	12	4.05	40	87.5	600	10	NA
917	25	3/31/2010	8.2	806	12.2	4.16	36.3	72.5	560	12	NA
918	21	3/31/2010	7.9	900	12	5.80	40.5	88.4	630	16	NA
919	80	3/30/2010	8.1	850	12.9	7.14	36.2	82.6	600	11	NA
1033	40	3/30/2010	7.7	980	11	4.38	45.4	73.2	640	19	NA
1027	U	3/30/2010	8.1	1,180	12.4	1.43	69.4	89.4	770	20	<0.10
1030	U	3/31/2010	8.2	806	10.9	0.99	35.5	84	570	8	<0.10
1028	230	3/31/2010	8.1	700	13	9.80	48.1	62.8	480	7.2	NA
1029	U	3/31/2010	7.8	900	13	6.20	39.5	55.3	590	13	NA
1031	61	3/31/2010	8.1	740	12	9.40	32.9	71.2	510	13	NA
1032	U	3/31/2010	8	820	12	7.60	33.2	81.6	570	12	NA

Notes: Bolded red numbers indicate the United States Environmental Protection Agency's (EPA's) maximum contaminant level was exceeded; italicized red numbers indicate the EPA's Secondary Drinking Water Regulation was exceeded; µS/cm = microsiemens per centimeter; Temp = temperature; °C = degrees Celsius; mg/L = milligrams per liter; U = unknown; NA = not analyzed.

a. No primary or secondary health standard available.

No sites exceeded the secondary drinking water regulation for chloride (250 mg/L); however, some wells had comparatively higher concentrations (Figure 21). Because the chloride and nitrate data are correlated, the source of the elevated nitrate and chloride could also be related. Chloride sources include natural chloride from geologic units, septic tank effluent, or CAFO effluent. While the chloride sources could be from naturally occurring sedimentary units, the nitrogen isotope values ($\delta^{15}\text{N} > 9\text{‰}$) of these sites indicate that the additional chloride sources could be from human or animal waste. Additional data collection would be necessary to determine if the chloride source is from animal or human waste contamination.

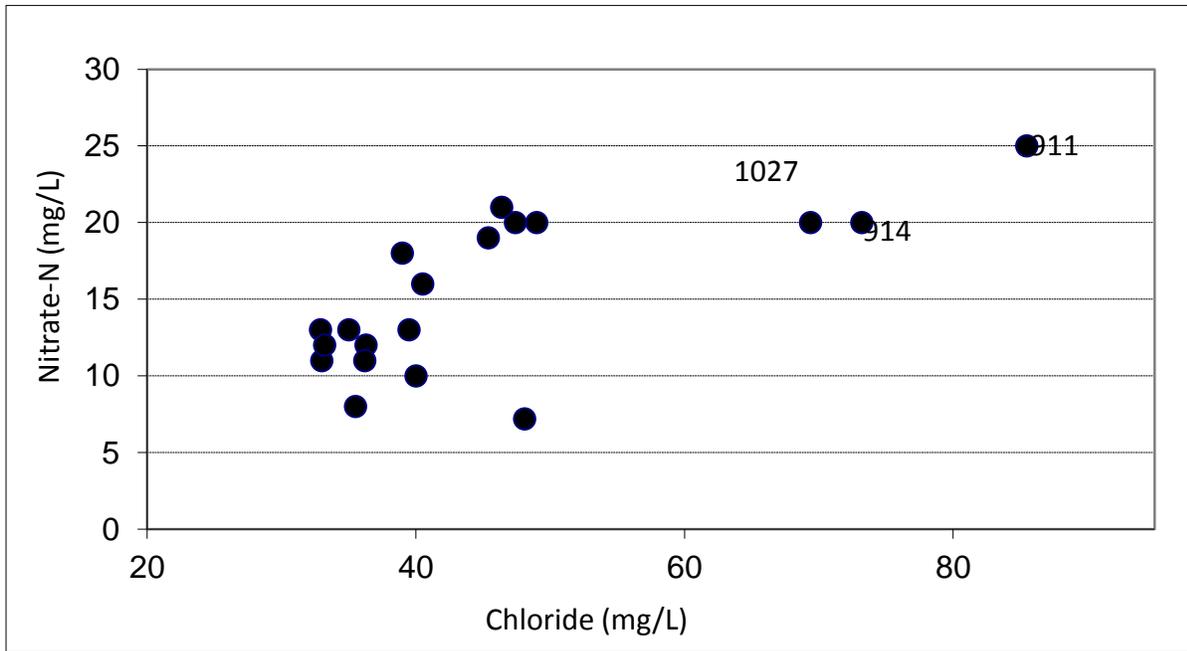


Figure 21. Nitrate versus chloride values for Springdale sample sites, in milligrams per liter.

Nitrate Isotope Sampling

All of the samples collected from Springdale had nitrate as nitrogen concentrations that exceeded 5 mg/L; therefore, all of the samples were sent to the University of Arizona for nitrogen isotope analyses. Five select samples were sent to the University of Waterloo for analytical technique comparison. The nitrogen isotope values ranged from 2.6‰ to 11.05‰ from both laboratories. Five wells had nitrogen isotope values consistent with sources from commercial or inorganic fertilizer. Two samples had nitrogen isotope values consistent with sources from animal and or human waste. A majority of the samples (12) had nitrogen isotope values consistent with mixed organic nitrogen sources (Table 23).

Table 23. Nitrogen and oxygen isotope data from March 2010 Springdale sampling event.

Well ID	$\delta^{15}\text{N}$ (‰) University of Arizona	$\delta^{15}\text{N}$ (‰) University of Waterloo	$\delta^{18}\text{O}$ (‰) University of Waterloo	Source of Nitrogen ^a
1031	2.6	NS	NS	Commercial or inorganic fertilizer
919	3.1	NS	NS	
913	3.4	NS	NS	
1028	3.8	NS	NS	
1032	3.8	NS	NS	
918	4.2	NS	NS	
916	4.6	NS	NS	Organic nitrogen in soil or mixed nitrogen source
910	5.3	NS	NS	
917	5.8	NS	NS	
912	6.2	6.69	7.76	
1030	6.3	NS	NS	
907	6.5	NS	NS	
914	6.7	7.04	0.94	
1029	7.3	NS	NS	
1033	7.6	NS	NS	
909	8.1	NS	NS	
1027	8.3	7.6	5.93	Animal or human waste source
911	9.1	9.65	9.52	
908	9.8	11.05	4.63	

Notes: No primary or secondary health standard available for nitrogen or oxygen isotopes; NS = not sampled; $\delta^{15}\text{N}$ = nitrogen isotope; $\delta^{18}\text{O}$ = oxygen isotope; ‰ = per mil or parts per thousand.

a. Based on Seiler (1996). The data have been sorted based on results from the University of Arizona in Tucson, Arizona.

To compare the accuracy of two isotope sample preparation techniques, DEQ sent splits of 5 samples from this sampling event to the University of Arizona in Tucson, Arizona, and University of Waterloo in Waterloo, Ontario, Canada, for analyses. The University of Arizona uses an evaporative sample preparation technique to isolate the $\delta^{15}\text{N}$ for analysis using mass spectrometry. The University of Waterloo uses a chemical separation technique to isolate the $\delta^{15}\text{N}$ for mass spectrometry analysis. The analytical precision of the analytical technique used by the University of Waterloo was 0.2‰; while the analytical precision of the analytical technique used by the University of Arizona was 0.3‰. The correlation between the laboratories analyses had an R^2 value of 0.86, suggesting that both techniques yield similar nitrogen isotope values for interpretation (Table 23 and Figure 22). Both techniques from the two laboratories were consistent with the range of nitrogen sources from each sample analyzed based on Seiler (1996).

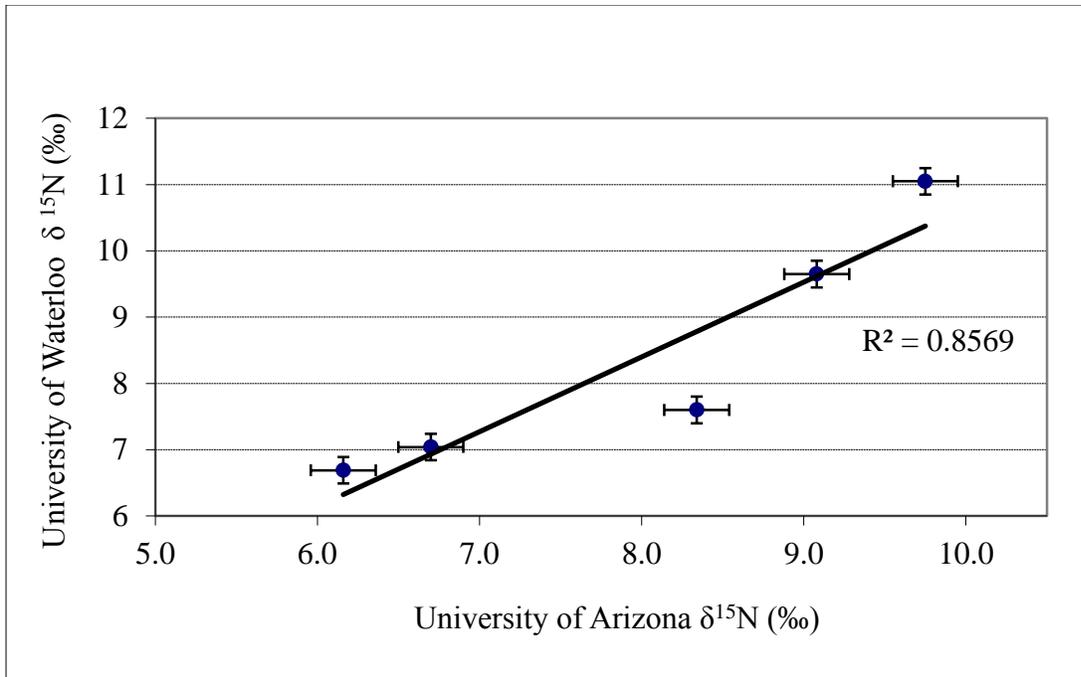


Figure 22. Nitrogen isotope comparison between the University of Arizona and University of Waterloo.

To successfully interpret nitrogen isotopes as a tracer for nitrogen sources, it is important to determine if denitrification is occurring in ground water. To determine if denitrification was occurring in the shallow ground water in Springdale, the oxygen ($\delta^{18}\text{O}$) of the nitrate molecule from 5 split samples were also analyzed (Table 23). Denitrification is the chemical or biological reduction of nitrate to nitrogen gas, which requires the presence of reducing conditions in ground water (low DO). If denitrification is occurring, the ground water becomes isotopically enriched, and this correlates with low nitrate concentrations (Kendall and McDonnell 1998). However, neither of these conditions is present in the samples collected for Springdale. Due to lack of data, it was impractical to interpret the nitrate and oxygen isotope data given the lack of supporting evidence (i.e., low DO in shallow ground water). Additional samples are needed, including samples collected on a regular basis and along ground water flowpaths, to determine if denitrification is a significant process that reduces nitrate concentrations in the shallow ground water. This exercise did, however, show that using the nitrogen isotopes for tracing nitrogen sources is appropriate, given that denitrification is not likely occurring.

Bacteria Sampling

Samples were analyzed for bacteria including total coliform and *E. coli* (Table 24). Two sample sites, wells 913 and 918, had total coliform detections in the ground water. The sample results were not positive for containing *E. coli* bacteria as part of the total coliform count. Follow-up sampling was not conducted at either of the wells that tested positive for total coliform. The lack of bacteria detection in the majority of the sampled sites suggests that, in general, surface water and surficial bacteria sources are not impacting the upper alluvial aquifer and this selected suite of wells.

Table 24. Bacteria results for March 2010 Springdale sampling event.

Well ID	Well Depth (feet)	Sample Date	Total Coliform MPN/100 mL	<i>E. coli</i> MPN/100 mL
907	Unknown	3/30/2010	<1	<1
908	70	3/30/2010	<1	<1
909	72	3/30/2010	<1	<1
910	61	3/30/2010	<1	<1
911	155	3/30/2010	<1	<1
912	195	3/31/2010	<1	<1
913	70	3/30/2010	4	<1
914	Unknown	3/31/2010	<1	<1
916	46	3/31/2010	<1	<1
917	25	3/31/2010	<1	<1
918	21	3/31/2010	3	<1
919	80	3/30/2010	<1	<1
1033	40	3/30/2010	<1	<1
1027	Unknown	3/30/2010	<1	<1
1030	Unknown	3/31/2010	<1	<1
1028	230	3/31/2010	<1	<1
1029	Unknown	3/31/2010	<1	<1
1031	61	3/31/2010	<1	<1
1032	Unknown	3/31/2010	<1	<1

Notes: Ground water quality standard for *E. coli* was not exceeded; MPN/100 mL = most probable number per 100 milliliters.

3.6.1.3 Conclusions

The nitrate concentrations appear to be highly dependent on the local land-use practices in proximity to each well. Nearly 90% of the wells sampled had nitrate concentrations greater than the MCL. Due to the slow ground water velocity and land-use practices, nitrate is potentially accumulating in the shallow ground water (Schorzman and Baldwin 2009). Major sources of nitrate include commercial fertilizer application, dairy and feedlot practices, and localized septic tank effluent.

Five well locations had nitrogen isotope data consistent with a commercial or inorganic fertilizer source (wells 913, 919, 1028, 1031, and 1032) likely related to localized fertilizer-based land-use activities. Two sites had nitrogen isotope values consistent with animal and human waste contributions to ground water (wells 908 and 911) from the analysis of nitrogen isotopes in the study area. Combined with elevated nitrate and chloride concentrations, these two sites are potentially being impacted by on-site or upgradient septic tank effluent.

Using the University of Arizona for nitrogen isotope analysis is reasonable given the good correlation between their analytical techniques and the techniques of the University of Waterloo.

Based on field conditions (DO concentrations) and initial oxygen isotope data, denitrification is not likely occurring, allowing for interpretation of nitrogen isotopes as tracers for nitrogen sources.

3.6.1.4 Recommendations

Additional sampling events could be performed to analyze ground water for the following constituents: nitrate, chloride, sulfate, total dissolved solids, nitrogen and oxygen isotopes, and PCPPs in selected wells (based on detections in 2008 and 2009). Time-integrated sampling of the oxygen isotopes that comprises the nitrate compound (NO_3), along with the nitrogen isotope signature, may be useful in further fingerprinting the wells impacted by commercial fertilizer application, and/or animal or human waste sources.

Due to the proximity of the city of Burley and PWSs that supply drinking water to thousands of local residents, a review of the ground water chemistry to assess the susceptibility of these wells to contamination could be beneficial.

Employing BMPs will ensure that the impact of potential sources of nitrate in the area are minimized. Educating the citizens of Springdale about the quality of ground water in their area and how they can protect their domestic drinking water wells may be beneficial.

3.6.2 Hagerman Nitrate Priority Area Ground Water Monitoring Project

3.6.2.1 Purpose

DEQ identified the Hagerman NPA in 2008. This NPA was delineated using nitrate concentrations from 8 wells with a mean nitrate concentration of 9.92 mg/L. The Hagerman NPA encompasses the town of Hagerman and covers approximately 2 square miles of southwestern Gooding County, east of the Snake River and south of Billingsley Creek (Figure 23). This NPA is ranked eighth out of 32 NPA's delineated in 2008 (DEQ 2008b).

The purpose of this study is to provide a greater sampling resolution for a higher statistical confidence when reevaluating this NPA in the future. The project will also provide a better understanding of the nitrate concentrations and sources of nitrate in the area. Ground water samples were collected from domestic wells inside and within a 1 mile radius of the currently delineated NPA. This study focused on domestic wells completed in the uppermost unconfined aquifer to an approximate depth of 200 feet below ground surface to capture the potential contamination from land-use practices both locally and hydraulically upgradient of the NPA.

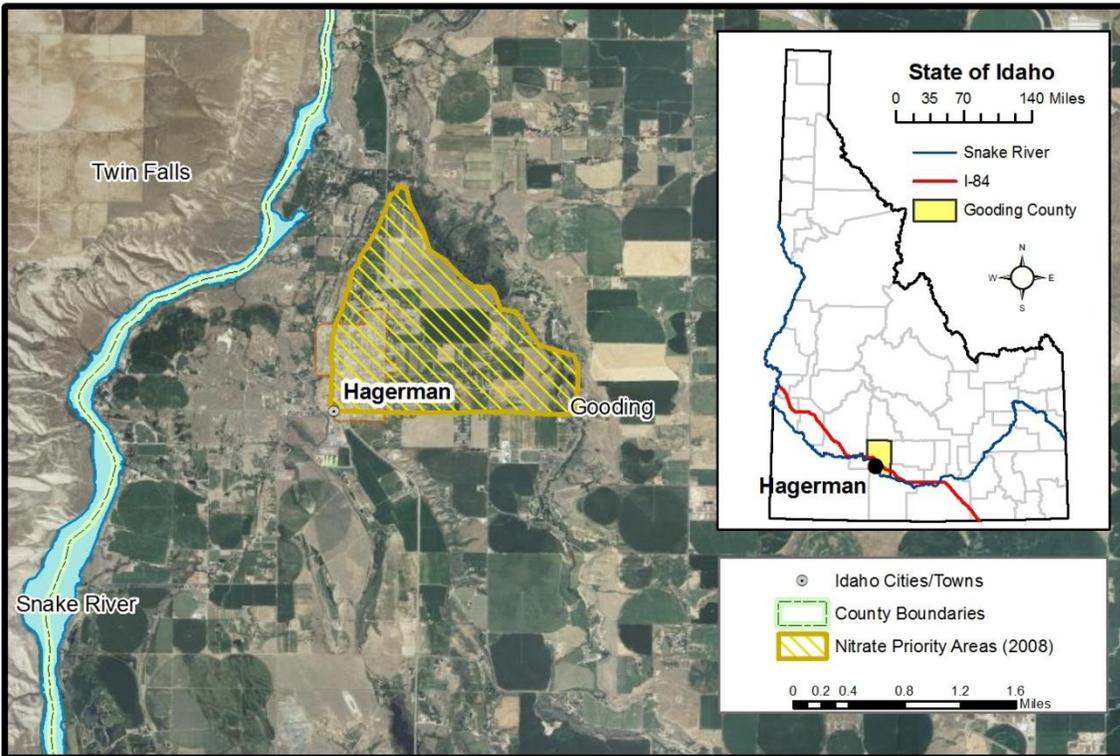


Figure 23. Hagerman nitrate priority area in southern Gooding County.

3.6.2.2 Methods and Results

The Hagerman area is located in southwestern Gooding County (Figure 23). The area, also called the Thousand Springs Valley, is where hundreds of ground water-fed springs emanate from contacts between successive basalt flows. The uppermost volcanic unit within the study area is Quaternary age basalt flows of the Snake River Group (Baldwin et al. 2000). The basalt flows are interbedded with deposits of clay, silt, sand, and gravel deposited by Lake Idaho and more recently by the Lake Bonneville flood.

The Hagerman area lies on the western edge of the Eastern Snake River Plain aquifer. Wells were selected that were completed in the basalt units in the area, ranging in depth from 103 feet to 250 feet below ground surface. The depth to water ranges from 48 feet to 176 feet below ground surface for the wells selected for this study. Ground water flows from east to west toward the Snake River (Figure 24).

The predominant land uses in the Hagerman area are agriculture, dairy and livestock operations, and aquaculture. Aquaculture facilities capture and use the ground water-fed springs for their operations and eventually discharge that water to the Snake River. Previous DEQ studies have shown that land-use practices hydraulically upgradient of the springs are negatively impacting the quality of spring-fed discharge (Baldwin et al. 2000; Schorzman et al. 2009).

During the July 2010 sampling event, DEQ collected samples from 17 domestic wells. Two additional sites were added and sampled in August 2010. Samples were analyzed for field parameters—pH, temperature, specific conductivity, and DO—in the field. Samples were taken to

the Idaho Bureau of Laboratories in Boise, Idaho, to analyze the inorganic chemicals (nitrate, sulfate, chloride, and total dissolved solids). One sample from the August sampling event was analyzed at Magic Valley Laboratories in Twin Falls, Idaho. Four samples were sent to the University of Arizona in Tucson, Arizona, for nitrogen isotope analysis because the nitrate concentration was greater than 5 mg/L, according to sample collection techniques described in the QAPP (DEQ 2010f).

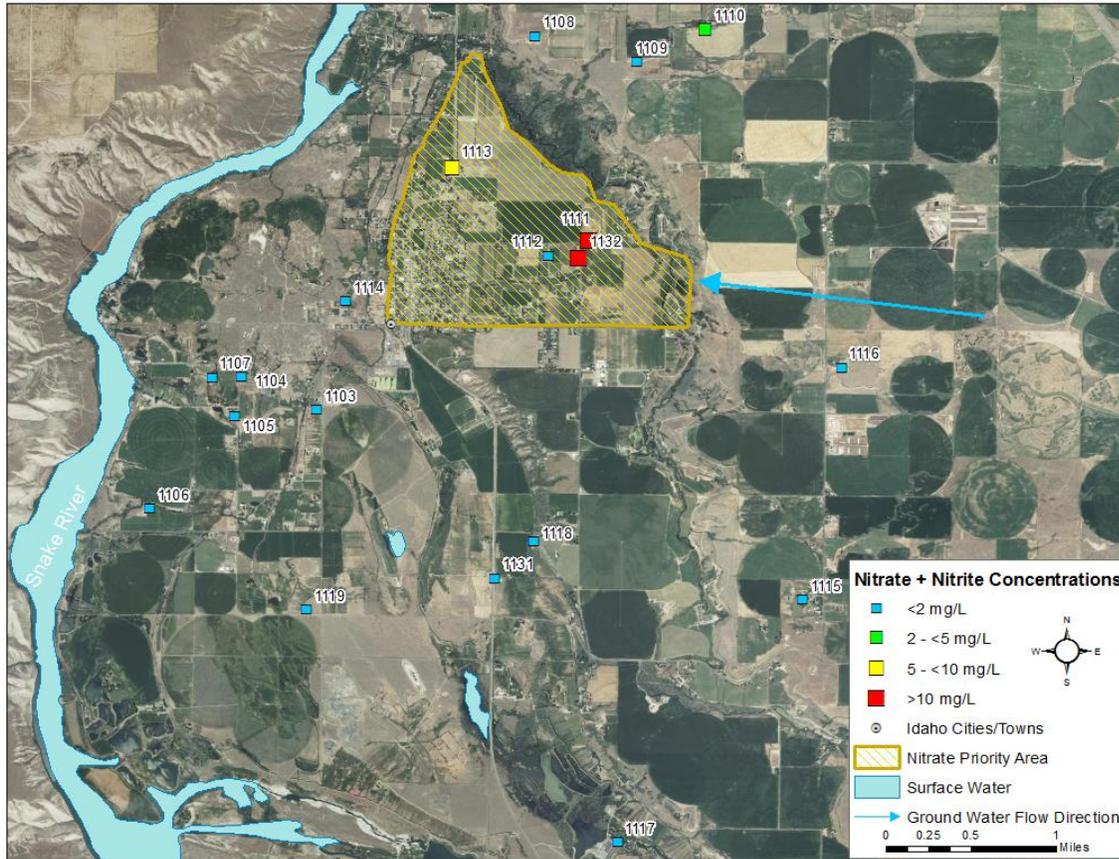


Figure 24. Well locations, well identification, and nitrate concentrations for July and August 2010 Hagerman sampling events. The arrow shows the direction of ground water flow.

Inorganic Chemistry Results

Nitrate concentration results can be seen in Figure 24 and Table 25. Two sites, wells 1111 and 1132, had nitrate values that exceeded EPA's MCL of 10 mg/L. One site, well 1113, had an elevated nitrate concentration at 7.5 mg/L. The remainder of the sites had nitrate values below 5 mg/L. These data along with historic data (Carlson and Atlakson 2006; ISDA Project 910 data) show that the sites, wells 1111, 1113, and 1132, have had elevated nitrate detections over time.

Chloride and sulfate were elevated in several samples; however, these results were well below any primary or secondary health standards established by EPA. Three sites had elevated chloride relative to the remainder of the data, wells 1106, 1113, and 1132. Two of those sites, wells 1113 and 1132, had elevated nitrate, indicating a similar contaminant source. Wells with elevated nitrate detections were drilled to similar depths (however, no data exist for the depth of well 1132) and along the path of ground water flow.

Table 25. Chemistry results from Hagerman July and August sampling events.

Well ID	Date Sampled	Well Depth (feet)	pH	Specific Conductivity ^a (µS/cm)	Water Temperature ^a (°C)	Dissolved Oxygen ^a (mg/L)	Chloride (mg/L)	Sulfate (mg/L)	Total Dissolved Solids (mg/L)	Nitrate + Nitrite (N) (mg/L)	δ ¹⁵ N ^a (‰)
1103	7/12/2010	109	7.41	341	16.2	9.27	11.4	24.4	220	1	NA
1104	7/12/2010	140	7.5	344	15.7	0	11.4	24.4	210	1	NA
1105	7/12/2010	145	8.09	363	19.8	0	12.2	26.3	210	0.9	NA
1106	7/12/2010	201	9.14	413	16.6	0	22.5	1.06	260	0.01	NA
1107	7/12/2010	103	8.42	401	15.1	0	12.4	26.2	240	1.2	NA
1108	7/12/2010	105	9.01	389	16.7	1.03	13.1	28.5	240	1.6	NA
1109	7/12/2010	140	8.84	479	16.21	0	16.6	33.7	290	1.6	NA
1110	7/12/2010	143	8.89	510	16.2	0	18	33.9	310	2.5	NA
1111 ^b	7/13/2010	205	8.22	1,030	15.6	7.34	12.8	31	410	0.63 ^d	11.41
1111 ^b	8/26/2010	205	7.8	885	15.1	6.07	NA	NA	NA	12	9.96
1111 ^c	8/26/2010	205	7.8	885	15.1	6.07	NA	NA	NA	12.1	NA
1112	7/13/2010	205	9.31	349	17.4	10.28	11.8	25.6	210	1.2	NA
1113	7/13/2010	210	8.64	765	15.4	8.78	24.5	44.1	450	7.5	8.59
1114	7/13/2010	125	8.83	351	16.3	9.48	11.6	24.9	210	1.1	NA
1116	7/13/2010	230	8.94	355	16.6	0	12.3	26.1	220	1.3	NA
1115	7/13/2010	U	8.98	409	16	0	14.2	29.8	240	1.7	NA
1117	7/13/2010	250	9.27	323	16.8	0	11.1	24.1	200	0.82	NA
1118	7/13/2010	120	9.13	327	16	9.19	10.9	23.8	200	1	NA
1119	7/13/2010	155	8.77	483	17.8	10.31	16.7	30.1	290	1.8	NA
1131	8/26/2010	U	9.26	221	16.5	0	10.3	25	150	0.065	NA
1132	8/26/2010	U	8.08	1,090	15.3	5.1	23.2	77	720	11	4.16
1132 ^c	8/26/2010	U	8.08	1,090	15.3	5.1	NA	NA	NA	11.2	NA

Notes: Bolded red numbers indicate the United States Environmental Protection Agency's (EPA's) maximum contaminant level was exceeded; italicized red numbers indicate the EPA's Secondary Drinking Water Regulation was exceeded; µS/cm = microsiemens per centimeter; °C = degrees Celsius; mg/L = milligrams per liter; δ¹⁵N = nitrogen isotope; ‰ = per mil or parts per thousand; U = unknown; NA = not analyzed.

a. No primary or secondary health standard available.

b. Analysis conducted at Idaho Bureau of Laboratories, Boise, Idaho.

c. Analysis conducted at Magic Valley Laboratory, Twin Falls, Idaho.

d. Likely erroneous result based on HydroLab measurement, nitrogen isotope data, previous data, and follow-up sampling in August 2010.

Nitrate Isotope Sampling

Only 4 samples (from 3 sites) were submitted for nitrogen isotope analysis at the University of Arizona (Table 25). Field equipment (see HydroLab discussion below) estimated that the sample from well 1111 collected on July 13, 2010, had an approximate nitrate concentration above 10 mg/L; however, the Idaho Bureau of Laboratories results came back with nitrate as less than 1 mg/L. After confirming their original nitrate concentration analysis, this sample was submitted for isotope analyses. After resampling well 1111 on August 26, 2010, and confirming the site had elevated nitrate (NO₃-N was 12 mg/L from Idaho Bureau of Laboratories; and 12.1 mg/L from Magic Valley Laboratory), this sample was also submitted for isotope analyses. Well 1111, tested for both sampling events, yielded nitrogen isotope results consistent with a nitrogen source of animal or human waste, or greater than 9‰ (Seiler 1996). Well 1113 had elevated nitrate at 7.5 mg/L and yielded a nitrogen isotope value of 8.59‰, which is near the upper range of a mixed organic nitrogen source signature and animal or human waste. Well 1132 had nitrate concentrations from both laboratories that were above the nitrate MCL and yielded a nitrogen isotope signature of 4.16‰, which is very close to the signature from inorganic or synthetic fertilizer (Seiler 1996).

HydroLab Field Meter

DEQ used a MS5 series HydroLab probe instrument to evaluate the accuracy of nitrate measurements between the field instrument and laboratory derived measurements. The HydroLab measures temperature, pH, and specific conductivity. The nitrate concentrations are determined using an empirical relationship between specific conductivity and nitrate. The field instrument and laboratory derived data are comparable with an R² value of 0.98 (Figure 25). These results suggest that the HydroLab is a useful instrument for estimating nitrate concentration from the specific conductivity of the sample.

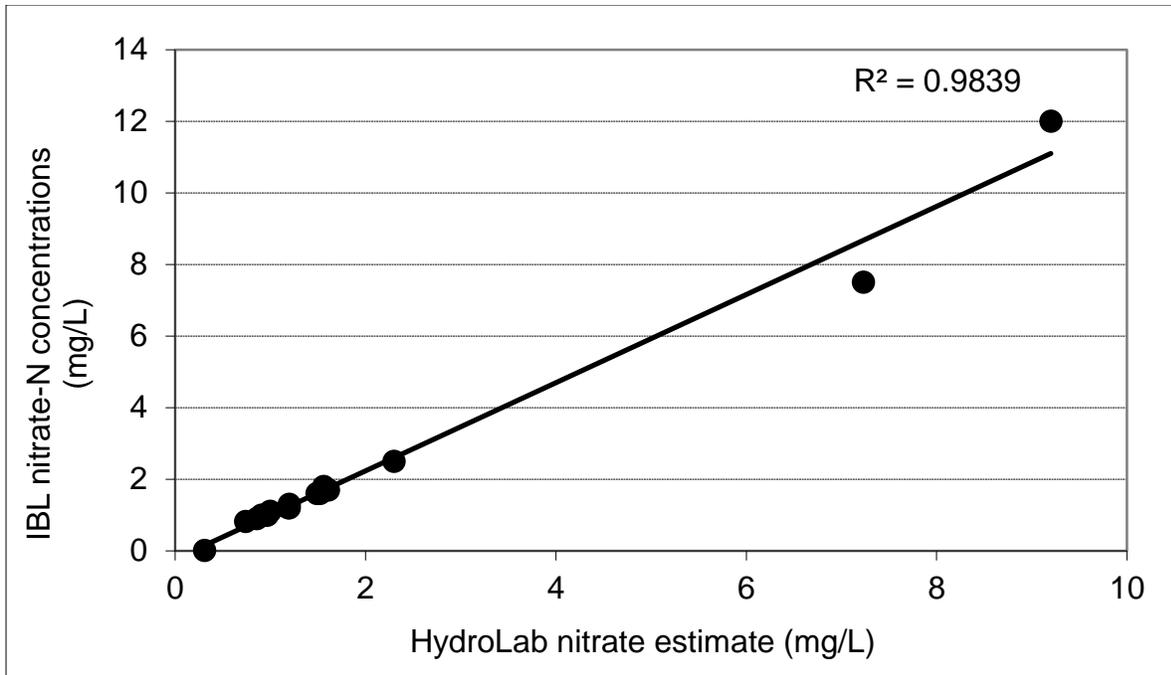


Figure 25. HydroLab field probe nitrate estimate and Idaho Bureau of Laboratories nitrate concentration comparison. The original concentration of well 1111 was not included in this comparison due to laboratory result discrepancy.

3.6.2.3 Conclusions

Samples collected within and surrounding the Hagerman NPA, coupled with historical data (Carlson and Atkinson 2006; ISDA project 910) suggest that elevated nitrate is impacting a limited number of wells from localized nitrate sources. The data collected do not support an area-wide nitrate contamination problem. Two sites, wells 1111 and 1113, exhibit elevated nitrate concentrations along with nitrogen isotope signatures consistent with impacts from animal or human waste nitrogen sources. One site, well 1132, had elevated nitrate along with a nitrogen isotope signature consistent with mixed nitrogen sources, with potential impacts from inorganic or synthetic nitrogen fertilizer. Additional evidence for inorganic or synthetic nitrogen fertilizer source is the increased chloride and sulfate concentrations compared to nearby wells.

While the highest nitrate concentrations of the wells sampled were located within the currently defined Hagerman NPA, the localized nature of the elevated concentrations suggest addressing these local sources of nitrate could mitigate the risk to these and nearby wells. Additionally, more data are needed to determine if an increasing trend in nitrate exists in the currently defined NPA as well as defining future NPAs. The number of wells used to define an NPA should be consistent with statistical significance in determining a nitrate trend.

The HydroLab field instrument, showing good correlation with laboratory nitrate results, indicates this tool is helpful for estimating nitrate concentrations in the field based on specific conductivity measurements. Depending on the project's goals, this instrument should be used as a screening tool, and samples should be sent to the laboratory for analysis using quality control and assurance methods approved by the sampling team.

3.6.2.4 Recommendations

Additional sampling is recommended in Hagerman to provide enough data to establish trends in nitrate concentrations over time. Also, the 2 wells with elevated nitrate should be investigated further. Employing BMPs will ensure that the potential overapplication of commercial and animal fertilizers is minimized. Public outreach may be beneficial to educate the citizens of Hagerman about the quality of ground water in their area and how they can protect their domestic drinking water wells.

3.6.3 Snake River Rim Ground Water Quality Monitoring Project

3.6.3.1 Purpose

DEQ has conducted several investigations to evaluate changes in water quality over time from springs that discharge from the Eastern Snake River Plain aquifer (Figure 26) in southern Gooding County (Baldwin et al. 2000; Baldwin et al. 2006; Schorzman et al. 2009). The primary contaminant of concern for these evaluations was nitrate ($\text{NO}_3\text{-N}$). The purpose of this study was to evaluate the upgradient water quality from domestic wells on the rim of the Snake River gorge. Prior to the use by aquaculture facilities, the ground water is used for drinking water.

Concerns about ground water quality based on nitrate detections determined during ISDA's annual dairy well monitoring, the analytical results from the Clear Springs Foods, Inc. and previous DEQ's studies prompted this additional monitoring event to evaluate a connection between land-use practices and the elevated nitrate concentrations. This project is a continuation of previous work to determine sources of nitrate and phosphorus in the springs by analyzing ground water from domestic wells upgradient of the springs.



Figure 26. Snake River Rim Ground Water Monitoring Project area location.

Previous DEQ studies have shown that land-use practices hydraulically upgradient of the springs are negatively impacting the quality of spring-fed discharge. Results from the previous DEQ studies have also identified a distinction between a regional and local aquifer flow system as shown by the *flow system line* in Figure 27 (Schorzman et al. 2009).

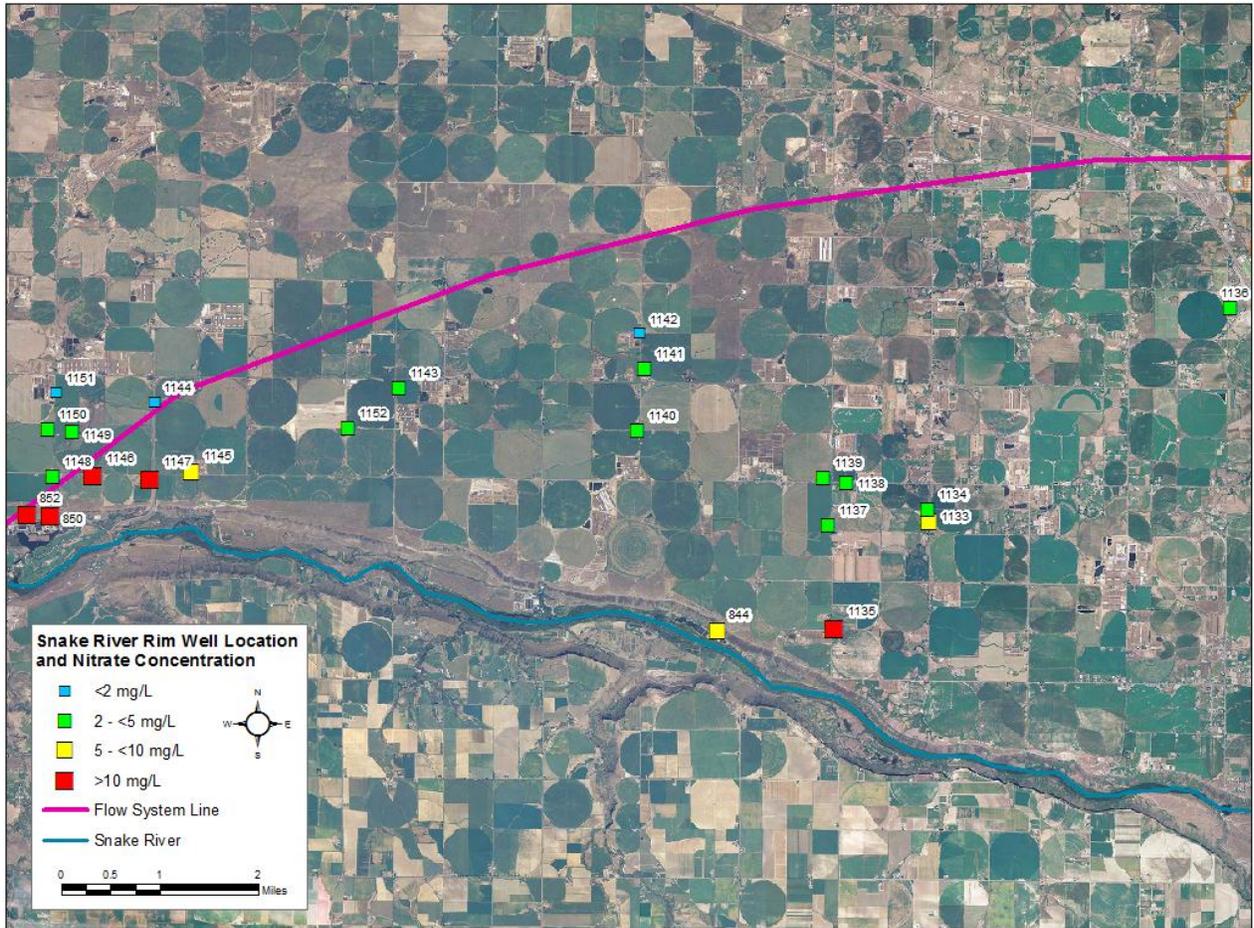


Figure 27. Snake River Rim Ground Water Monitoring Project nitrate plus nitrite concentrations.

The study area is located in southern Gooding and Jerome Counties in the Thousand Springs area, where hundreds of springs discharge into the Snake River. The springs emanate from a volcanic talus slope, which represents the contact between two successive basalt flows. The spring discharge chemistry is a *snapshot* of the highly localized quality of the ground water of the Eastern Snake River Plain aquifer. Recharge that occurs via percolation can transport nitrogen to the regional aquifer, which in turn, migrates laterally to the discharge sites at these springs.

The chemical variability among springs observed at the Clear Springs Food, Inc. facility suggests that the complex geology underlying the Snake River Plain has created zones of high transmissivity that potentially channelize water with high nitrate concentrations toward spring discharge outlets north of the Snake River. These channels of high transmissivity are considered to be directly related to the emplacement of the Snake River Group, where paleoriver channels were buried by advancing basalt flows.

In October 2010, DEQ sampled springs and domestic wells hydraulically upgradient of the flow system divide (Figure 27). The sampling locations of the wells are selected by two major criteria: (1) wells that are screened and drawing water from the contact zone between the two successive basalt flows that feed water to spring discharge; and (2) wells that are located along the theoretical flowpaths of the spring discharge. The intention with this sampling network is to

identify if domestic wells are exhibiting the same elevated nitrate and phosphorus concentrations as in the spring discharge.

3.6.3.2 Methods and Results

Historically the highest nitrate concentrations have been observed in the study area during the fall, therefore, the sampling event was scheduled to coincide with expected high nitrate concentrations. Sampling was conducted during October 2010 in accordance with the sampling plan (DEQ 2010g). Samples were collected from 3 spring locations, 2 at Snake River Farms, and 1 at Crystal Springs. Samples from 20 domestic wells were collected after gaining permission from each well owner. Water-quality field parameters—pH, specific conductivity, temperature, and DO—were collected from each domestic well and spring location. Inorganic chemicals including nitrate and total phosphorus were analyzed at the Idaho Bureau of Laboratories in Boise, Idaho.

Nitrate plus Nitrite Sampling

Nitrate plus nitrite concentrations ranged from 1.6 mg/L to 23 mg/L in domestic wells. If concentrations of nitrate plus nitrite were greater than 5 mg/L, the samples were sent to the University of Arizona for nitrogen isotope analyses. Three sites had nitrate plus nitrite above the MCL of 10 mg/L. Two spring locations at Snake River Farms were above the nitrate plus nitrite MCL. Historic data provided by Clear Springs Foods are consistent with concentrations determined by this sampling event. Samples north of the flow system line (Figure 27) within the regional flow system were generally less than 5 mg/L, while nitrate plus nitrite concentrations in the wells and springs in the local flow system (south of the flow system line) were generally higher.

Nitrogen Isotope Sampling

Nitrogen isotope ratios ($\delta^{15}\text{N}$) 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. Nitrogen from human or animal waste and fertilizer sources has distinguishable $\delta^{15}\text{N}$ signatures (refer to Table 2 for typical $\delta^{15}\text{N}$ values for various nitrogen sources). Ground water samples from 9 wells were analyzed for $\delta^{15}\text{N}$. Results from this project ranged from 6.8‰ to 8.9‰ (Table 26), which all fall within the range of an organic or mixed sources of nitrogen.

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, and plant uptake) especially in anoxic environments 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 determining the 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 animal operations. It is expected that this type of land use would result in a mixture of nitrogen sources in the ground water, as indicated by the $\delta^{15}\text{N}$ values detected.

Table 26. Sample results for Snake River Rim Ground Water Monitoring Project including field parameters, inorganic chemicals, and nitrogen isotope values.

Well ID	Well Depth (feet)	Sample Date	pH	Specific Conductivity ^a (μS/cm)	Water Temperature ^a (°C)	DO ^a (mg/L)	Phosphorus ^a (mg/L)	Nitrate + Nitrite (mg/L)	δ ¹⁵ N ^a (‰)
1133	280	10/13/2010	7.78	741	15.1	9.22	0.037	5.9	7.2
1134	275	10/13/2010	8.03	702	16.5	9.38	0.042	4.8	NA
1135	225	10/13/2010	8.12	803	15.3	9.15	0.034	12	8.9
1136	360	10/13/2010	8.3	639	15.4	9.08	0.028	2.7	NA
1137	230	10/13/2010	8.15	682	14.9	8.87	0.038	4.9	8.2
1138	180	10/13/2010	8.3	672	15.6	7.54	0.032	3.8	NA
1139	203	10/13/2010	8.29	662	15.4	8.98	0.028	3.8	NA
1140	170	10/13/2010	8.62	621	14.5	8.9	0.03	3	NA
1141	120	10/13/2010	8.72	566	15	9.32	0.021	2	NA
1142	175	10/13/2010	8.82	528	15	9.22	0.018	1.8	NA
1143	126	10/14/2010	7.86	557	15.4	8.98	0.025	2.6	NA
1144	98	10/14/2010	8.18	470	14.9	9.39	0.028	1.8	NA
1145	130	10/14/2010	8.15	805	15.7	8.35	0.02	9.4	8.0
1146	80	10/14/2010	8	1,120	15.8	9.47	0.078	20	6.9
1147	140	10/14/2010	7.96	1,250	15.2	9.67	0.11	23	6.8
1148	155	10/14/2010	7.93	617	15	9.39	0.024	3.6	NA
1149	105	10/14/2010	8.04	514	15	9.02	0.032	2	NA
1150	110	10/14/2010	8.07	505	15	9.34	0.035	2	NA
1151	103	10/14/2010	8.15	441	14.9	9.28	0.023	1.6	NA
1152	165	10/15/2010	8.16	619	14.8	9.53	0.023	3.5	NA
850	U	10/15/2010	8.12	1,040	14.6	10.26	0.072	16	7.3

Well ID	Well Depth (feet)	Sample Date	pH	Specific Conductivity ^a (μS/cm)	Water Temperature ^a (°C)	DO ^a (mg/L)	Phosphorus ^a (mg/L)	Nitrate + Nitrite (mg/L)	δ ¹⁵ N ^a (‰)
852	U	10/15/2010	8.6	1,060	14.6	10.02	0.083	16	7.1
844	U	10/14/2010	8.37	789	14.9	10.07	0.038	6.8	7.2

Notes: Bolded red numbers indicate the United States Environmental Protection Agency's (EPA's) maximum contaminant level was exceeded; italicized red numbers indicate the EPA's Secondary Drinking Water Regulation was exceeded; μS/cm = microsiemens per centimeter; °C = degrees Celsius; DO = dissolved oxygen; mg/L = milligrams per liter; δ¹⁵N = nitrogen isotope; ‰ = per mil or parts per thousand; U = unknown; NA = not analyzed.

a. No primary or secondary health standard available.

3.6.3.3 Conclusions

Ground water samples collected within the local flow system had elevated nitrate plus nitrite concentrations, with 5 samples exceeding the nitrate plus nitrite MCL. The 5 samples with nitrate plus nitrite concentrations above the MCL also came from wells with the highest specific conductivity values. Ground water samples collected in the regional flow system had nitrate plus nitrite concentrations less than 5 mg/L. Local land uses appear to be adding nitrogen into the ground water and impacting the local ground water flow system.

3.6.3.4 Recommendations

Further analysis of project data should be done by plotting the specific conductivity results with the nitrate plus nitrite concentrations. If a relationship does exist, specific conductivity could be used as a surrogate for nitrate in this project area. In addition, a portion of the wells sampled for this project should be considered for inclusion in a regional monitoring network to track trends over time.

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