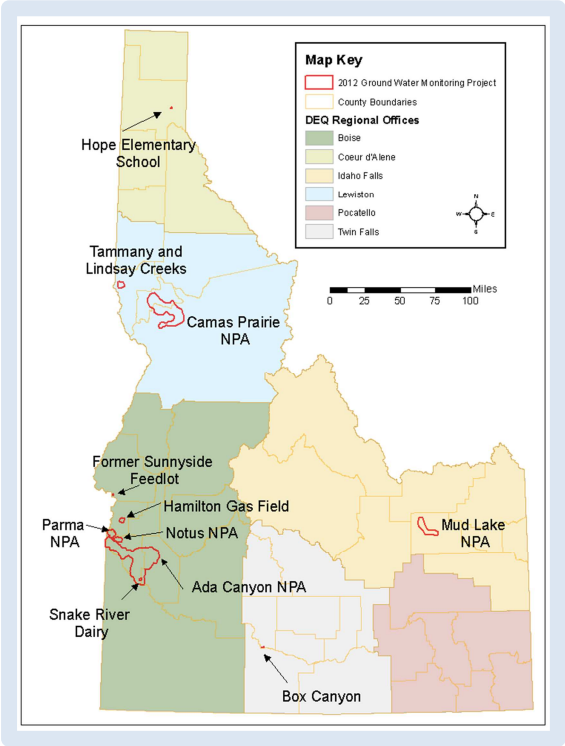
Summary Report for the Idaho Department of Environmental Quality Ground Water Quality Monitoring Projects—2012

Ground Water Quality Technical Report No. 46



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Summary Report for the Idaho Department of Environmental Quality Ground Water Quality Monitoring Projects—2012

July 2014

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Compiled and edited by Jessica J. Atlakson, PG.

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- Rebecca Goehring authored the Notus Nitrate Priority Area Ground Water Monitoring Project, Parma Nitrate Priority Area Ground Water Monitoring Project, Ada/Canyon Nitrate Priority Area Ground Water Monitoring Project, and Hamilton Gas Field Ground Water Monitoring Project summaries (sections 2.1.2, 2.1.3, 2.1.4, and 2.1.6).
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- Gary Stevens authored the Hope Elementary School Ground Water Investigation summary (section 2.2.1).
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Acronyms, Abbreviations, and Symbols

$\delta^{15}N$	ratio of the two stable nitrogen isotopes ^{15}N and ^{14}N
$\delta^{15}N_{NO_3}$ or $\delta^{15}N_{nitrate}$	ratio of the two stable nitrogen isotopes ^{15}N and ^{14}N of the nitrate molecule
$\delta^{18}O$	ratio of the two stable oxygen isotopes ^{18}O and ^{16}O
$\delta^{18}O_{NO_3}$ or $\delta^{18}O_{nitrate}$	ratio of the two stable oxygen isotopes ^{18}O and ^{16}O of the nitrate molecule
$\delta^{2}H$	ratio of the two stable hydrogen isotopes ^{1}H and ^{2}H (deuterium), also denoted as δD
bgs	below ground surface
BMP	best management practice
BTEX	benzene, toluene, ethylbenzene, and xylene
°C	degrees Celsius
$CaCO_3$	calcium carbonate
cm	centimeter
CO_3	carbonate
DEQ	Idaho Department of Environmental Quality
DO	dissolved oxygen
EBSD	Ellisport Bay Sewer District
E. coli	*Escherichia coli*
EPA	United States Environmental Protection Agency
ESRP	Eastern Snake River Plain
FC	fecal coliform
FSP	field sampling plan
IBL	Idaho Bureau of Laboratories
IDAPA	refers to citations of Idaho's administrative rules
HES	Hope Elementary School

IDWR	Idaho Department of Water Resources
ISDA	Idaho State Department of Agriculture
L	liter
m + p – xylene	meta-xylene plus para-xylene
MCL	maximum contaminant level
mg	milligrams
mL	milliliter
MPN	most probable number
NA	not analyzed
NAU	Northern Arizona University
NO_2	nitrite
NO_3	nitrate
NPA	nitrate priority area
NS	not sampled
NSDWR	National Secondary Drinking Water Regulation
NTU	nephelometric turbidity unit
o-phosphate	orthophosphate
o-xylene	orthoxylene
pCi	picocuries
per mil (‰)	parts per thousand
PWS	public water system
QAPP	quality assurance project plan
QA/QC	quality assurance/quality control
TC	total coliform
TDS	total dissolved solids
TKN	total Kjeldahl nitrogen
TMDL	total maximum daily load

TPH	total petroleum hydrocarbons
TPH-D	total petroleum hydrocarbons-diesel
µg	micrograms
UIASL	University of Idaho Analytical Sciences Laboratory
µS	microsiemens

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1 Introduction

Ground water is a key resource in Idaho—providing drinking water to 95% of Idahoans—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 §39-120, "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 §39-120 further directs DEQ, the Idaho Department of Water Resources (IDWR), and the Idaho State Department of Agriculture (ISDA) to conduct ground water quality monitoring and promote public awareness of ground water issues by making results of ground water quality investigations available to the public.

Public water systems (PWSs) are regulated by DEQ under the federal Safe Drinking Water Act and the "Idaho Rules for Public Drinking Water Systems" (IDAPA 58.01.08). These regulations require chemical analysis of drinking water for various contaminants. DEQ ensures that follow-up monitoring is conducted when contaminants of concern are detected in PWSs. The United States Environmental Protection Agency (EPA) has set maximum contaminant levels (MCLs) that are legally enforceable standards that apply to public water systems. These levels are set to protect public health by limiting the amount of contaminants in drinking water. EPA has also set National Secondary Drinking Water Regulations (NSDWRs), which are nonmandatory standards that are established as guidelines to assist public water systems in managing their drinking water for aesthetic considerations such as taste, color, and odor.

DEQ also responds to detections of contaminants of concern that are found by monitoring programs implemented by other entities, such as the Statewide Ambient Ground Water Quality Monitoring Program, 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.

Field measurements taken during follow-up investigations and monitoring projects should be considered estimates and are not used for determining NSDWR standard violations. They are used to monitor well water during purging to ensure water in the wellbore is removed from the well prior to sampling. Field measurements are also used to qualitatively evaluate water quality variability between wells.

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). DEQ has designated 32 areas in the state as having elevated concentrations of nitrate in ground water. These NPAs are ranked based on population, existing water quality, and water quality trends. The criterion for an NPA is that 25% or more of the wells sampled by state agencies within the designated area have nitrate concentrations that exceed 5 mg/L. EPA has established an MCL for nitrate at 10 mg/L. The NPAs are reevaluated and reranked approximately every 5 years. Additional information about

NPA delineation and ranking is available from the *2008 Nitrate Priority Area Delineation and Ranking Process* document (DEQ 2008).

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 improvement plans, also known as ground water quality management plans, that address ground water degradation in NPAs. Ground water quality data are used to evaluate the effectiveness of plan implementation.

The Ground Water Program at DEQ has started to implement regional ground water monitoring using a statistically based approach to determine the monitoring network design. These regional projects have focused in areas designated as NPAs.

This report provides an overview of DEQ's ground water monitoring projects and investigation activities accomplished with public funds during 2012. It does not include results from privately funded activities, including monitoring required by permits, monitoring associated with ongoing environmental remediation projects, monitoring associated with Kootenai County Aquifer Protection District funding, 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 EPA.

2 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 2012. Projects are presented by DEQ regional office and identified in Figure 1.

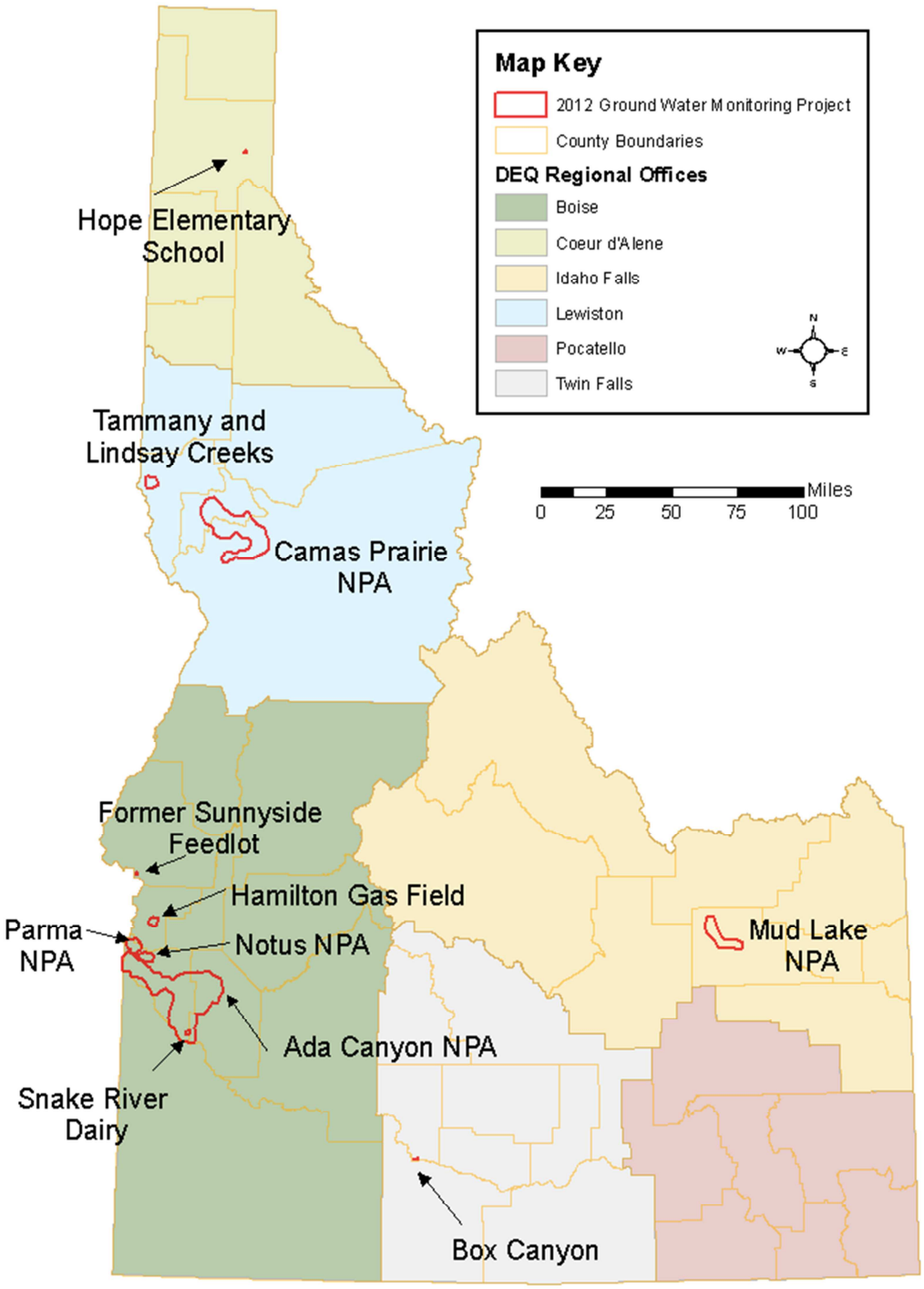


Figure 1. Idaho Department of Environmental Quality's 2012 ground water quality project locations by region.

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 350 contaminants, ranging from nitrate—a widespread ground water contaminant—to emerging contaminants such as personal care products and pharmaceuticals. 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.

2.1 Boise Region

2.1.1 Former Sunnyside Feedlot Follow-Up Monitoring Project

2.1.1.1 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 on a regular basis from 2004 through 2008. The Sunnyside Feedlot consisted of 3,000–4,000 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 2010 and again in May 2012. The purpose of the follow-up project was to evaluate ground water quality in the area, particularly nitrate concentrations, following feedlot closure. The objectives were to provide current ground water quality data, update ground water quality trends, and direct any potential site remediation.

2.1.1.2 Methods and Results

In May 2012, DEQ collected samples from 13 monitoring wells, 5 domestic wells, and 1 irrigation well in and surrounding the former Sunnyside Feedlot (Figure 2). Water quality field parameters—pH, temperature, and specific conductivity—were measured at each site prior to sample collection (Table 1). Dissolved oxygen (DO) was not measured due to a meter calibration error. Samples were collected from each well in accordance with the quality assurance project plan (QAPP) (DEQ 2012a) and field sampling plan (FSP) (DEQ 2012b) 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 during the 2010 sampling event (since the DO probe was malfunctioning during the 2012 sampling) was less than 2 milligrams per liter (mg/L). The results are provided in Table 1.

During the purging process at well 618, an obstruction was encountered while lowering the bailer down the well to extract the water. Due to the obstruction, the well was purged for over an hour; however only 1.5 wellbore volumes were purged, instead of the 3 required by the QAPP and FSP. Due to this deviation from the QAPP and FSP, any analysis conducted with these data includes clarification on when well 618 is included and when it is excluded.

Due to incorrect preservation in the field, the sample from well 608 could not be analyzed for the common ions.

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 well 605 was anomalously large (resulting in an anomalously deep ground water elevation). The depth to ground water at well 605 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 (UIASL) in Moscow, Idaho, for analysis. Nitrogen isotope samples were collected at each sampling location, frozen, and stored at DEQ pending nitrate analysis. Due to budget constraints in 2012, DEQ did not conduct the nitrogen isotope analysis. If money becomes available, DEQ will send all nitrogen isotope samples with nitrate values over 5 mg/L to the University of Arizona in Tucson for analysis.

In addition, 5 wells were sampled for sulfonamide antibiotics and sucralose, and 2 wells were sampled for steroids based on detections of these constituents in the selected wells during previous sampling efforts. These samples were sent to the UIASL for analysis.

Nitrate Sampling

In 2012, the 18 sampled wells had nitrate values ranging from less than 0.05 mg/L to 61 mg/L, with a median value of 17 mg/L (including well 618) or 16 mg/L (excluding well 618) (Figure 2; Table 1); 13 wells (72% including well 618)—or 12 wells (71% excluding well 618)—exceeded EPA's MCL for nitrate of 10 mg/L. Of the wells sampled in 2012, 15 were also sampled in 2010 (DEQ 2013a); 4 of these 15 wells showed a decrease in nitrate concentration, ranging from a decrease of 2 mg/L for wells 607 and 1042 to 8 mg/L in well 616. Nitrate concentrations increased in 11 of the 15 wells (including well 618), ranging from a 0.8 mg/L increase (well 613) to a 27 mg/L increase (well 615). Well 609 also had a significant nitrate increase of 25 mg/L.

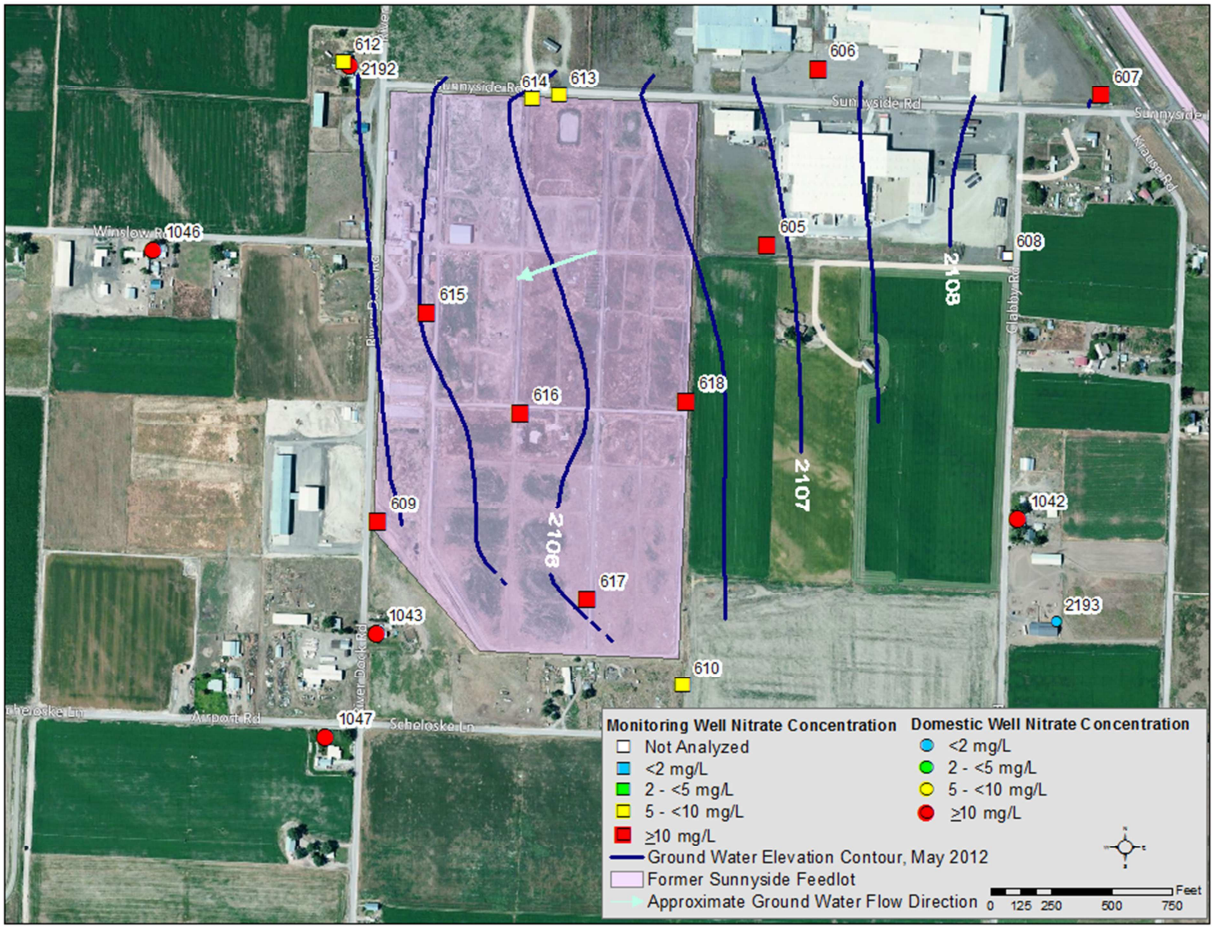


Figure 2. Well locations, DEQ site IDs, and nitrate concentrations (in milligrams per liter)—Former Sunnyside Feedlot Follow-Up Monitoring Project. The ground water elevation for well 605 was not used due to an anomalously deep ground water elevation measurement.

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

DEQ Site ID	Well Depth (feet)	Sample Date	Fluoride	Nitrite	Nitrate	Chloride	Sulfate	Ammonia[a]	Bromide[a]	Ortho-phosphate[a]	Water Temperature[a] (℃)	Specific Conductivity[a] (µS/cm)	pH
			(milligrams per liter)										
605	25	05/22/2012	0.66	<0.05	**19**	26	170	0.22	0.16	<0.1	14.7	1,240	7.36
606	30	05/22/2012	0.59	<0.05	**15**	9.9	83	0.21	<0.10	0.14	15.2	1,050	7.38
607	30	05/22/2012	0.75	<0.05	**18**	32	170	0.23	0.14	0.2	12.1	1,150	7.03
608	30	05/22/2012	QNS[b]	QNS	QNS	QNS	QNS	NA	QNS	QNS	12.2	1,840	7.37
609	25	05/23/2012	0.67	<0.05	**61**	240	*470*	NA	0.32	<0.10	14.5	3,000	7.13
610	40	05/23/2012	0.78	<0.05	8.9	60	*660*	1.7	0.26	<0.10	15.5	2,430	6.94
612	30	05/23/2012	0.68	<0.05	7.6	50	170	NA	0.17	<0.1	13.2	1,250	7.12
613	33	05/22/2012	0.67	0.39	6.8	36	190	0.48	0.16	0.9	12.3	1,140	7.5
614	30	05/21/2012	0.62	<0.05	6.9	40	180	1.1	0.14	<0.1	12.9	1,290	7.54
615	45	05/21/2012	0.97	<0.05	**47**	190	*370*	0.24	0.31	<0.1	15.2	2,470	7.14
616	35	05/22/2012	0.78	<0.05	**10**	110	*410*	1.4	0.3	<0.10	15	2,280	7.14
617	40	05/21/2012	0.89	<0.05	**29**	140	*390*	NA	0.26	<0.1	14.8	2,410	7.13
618[c]	35	05/21/2012	0.73	<0.05	**19**	120	*430*	NA	0.3	0.11	15.5	2,400	7.12
1042	U	05/23/2012	0.67	<0.05	**12**	28	170	NA	0.12	<0.1	13.1	1,370	7.03
1043	U	05/23/2012	0.84	<0.05	**38**	220	*460*	NA	0.3	<0.1	16.6	2,990	6.9
1046	U	05/23/2012	0.7	<0.05	**43**	210	*420*	NA	0.15	<0.1	12.6	2,650	6.76
1047	40	05/23/2012	1.1	<0.05	**19**	120	*680*	0.23	0.37	<0.1	14.1	3,050	7.18
2192	U	05/23/2012	0.65	<0.05	**16**	27	140	NA	0.13	<0.1	13.2	1,110	7.02
2193	U	05/23/2012	0.2	<0.05	<0.05	6.6	<0.2	NA	<0.10	<0.10	17.7	1,070	7.04

Notes: Bolded red numbers indicate EPA's maximum contaminant level was reached or exceeded. Italicized red numbers indicate EPA's National Secondary Drinking Water Regulation (NSDWR) standard was reached or exceeded. The pH did not exceed EPA's NSDWR. However, field measurements should be considered estimates and are not used for determining violations of NSDWR standards.

℃ = degrees Celsius; µS/cm = microsiemens per centimeter; U = unknown; NA = not analyzed

[a] No primary or secondary health standard available.

[b] QNS = quantity not sufficient. The sample for well 608 was incorrectly preserved and laboratory analysis of common ions was not possible.

[c] Due to an obstruction in the wellbore in well 618, only 1.5 wellbore volumes of water were purged prior to sample collection, instead of 3 wellbore volumes as required by the QAPP and FSP.

Nitrogen Isotope Sampling

Due to budget constraints in 2012, DEQ did not submit the nitrogen isotope samples for analysis. If money becomes available, DEQ may send all nitrogen isotope samples with nitrate values over 5 mg/L to the University of Arizona in Tucson for analysis.

Sulfate Sampling

In 2012, the 18 sampled wells had sulfate values ranging from less than 0.2 mg/L to 680 mg/L, with a median value of 280 mg/L (including well 618) or 190 mg/L (excluding well 618) (Table 1); 9 wells (50% including well 618)—or 8 wells (47% excluding well 618)—exceeded EPA's NSDWR standard for sulfate of 250 mg/L. A relationship appears to exist between sulfate and chloride. For wells with sulfate concentrations that exceed 250 mg/L, chloride concentrations range from 60 mg/L to 240 mg/L. For wells with sulfate concentrations less than 250 mg/L, chloride concentrations are less than 50 mg/L.

Antibiotic and Steroid Sampling

Five wells (four monitoring wells and one domestic well) were sampled for the artificial sweetener sucralose and antibiotics, including the compounds sulfathiazole, sulfamerazine, sulfamethizole, sulfamethazine, sulfachloropyridazine, sulfamethoxazole, and sulfadimethoxine (Figure 3; Table 2). None of the wells sampled had a detection of sucralose. The domestic well (2192) had nondetections for the antibiotics. Four monitoring wells (wells 612, 613, 614, and 616) had detections of sulfamethazine, which is primarily used as a veterinary antibacterial drug in food animals (USDL 2011). Three of the four wells with sulfamethazine detections are located within the former feedlot facility; the other well is located downgradient of the northern portion of the former feedlot facility. Three of these wells (613, 614, and 616) were sampled for antibiotics in 2010 (DEQ 2013a). Wells 614 and 616 showed a decrease in the concentration of sulfamethazine from 2010 (0.49 micrograms per liter [µg/L] and 0.40 µg/L, respectively) to 2012 (0.25 µg/L and 0.21 µg/L, respectively). Well 613 showed a slight increase of sulfamethazine from 0.15 µg/L in 2010 to 0.19 µg/L in 2012.

Three monitoring wells (613, 614, and 616) had a detection of sulfamerazine, ranging from 0.11 µg/L to 0.12 µg/L. Sulfamerazine is an antibacterial agent used to treat bronchitis, prostatitis, and urinary tract infections (Drug Bank 2013). The three wells with the sulfamerazine detections are located within the former feedlot facility. These same three wells all had concentrations of sulfamerazine in 2010 of <0.1 µg/L (DEQ 2013a).

Two wells (one domestic and one monitoring well) were sampled for steroids, which included caffeine, cholesterol, coprastan-3-ol, and beta-estradiol (Figure 3; Table 3). The domestic well (1047) 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. In 2010, this same well had a beta-estradiol concentration of <0.05 µg/L.

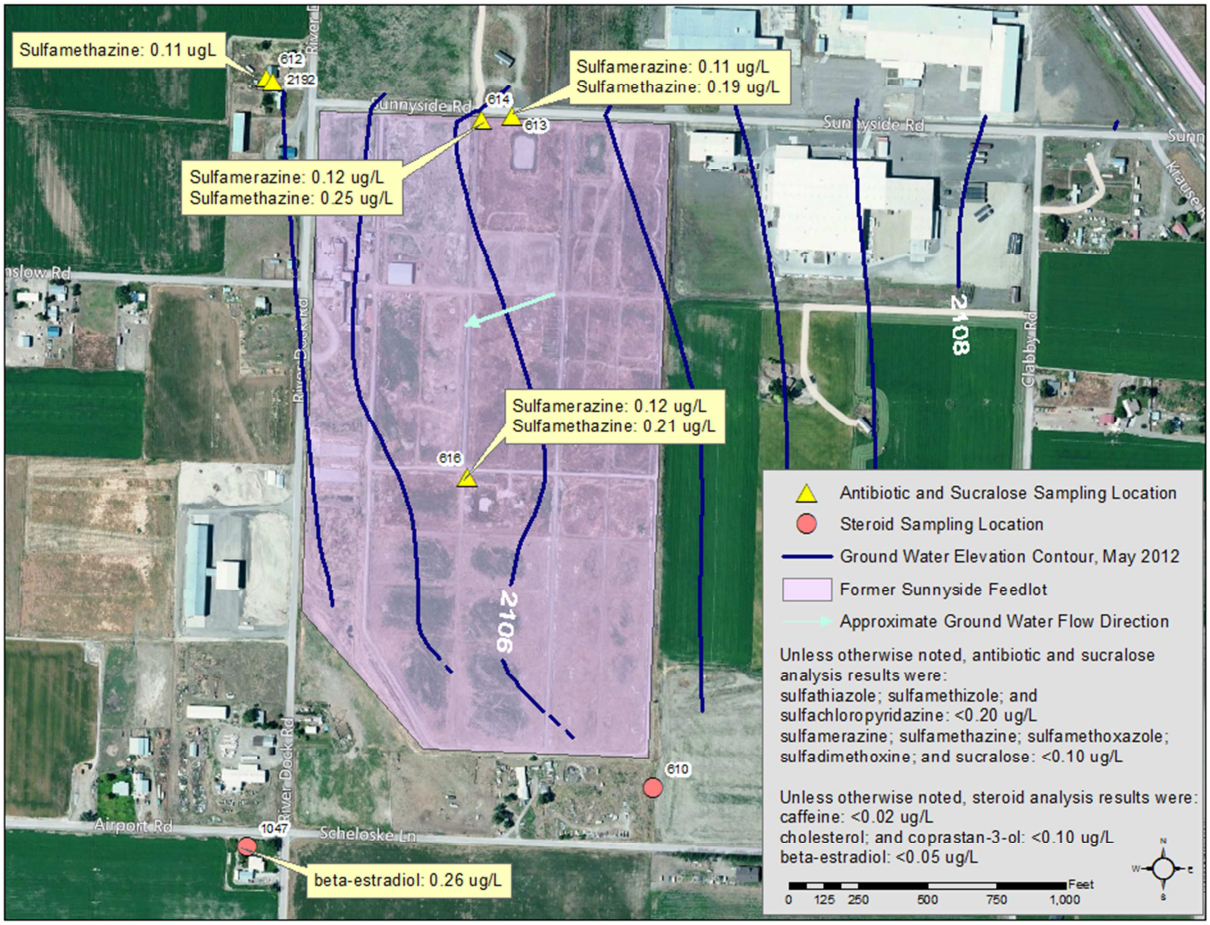


Figure 3. Antibiotic, sucralose, and steroid results—Former Sunnyside Feedlot Follow-Up Monitoring Project.

Table 2. Antibiotic and sucralose results—Former Sunnyside Feedlot Follow-up Monitoring Project.

DEQ Site ID	Well Depth (feet)	Sample Date	Sulfa-thiazole	Sulfa-merazine	Sulfa-methizole	Sulfa-methazine	Sulfachloro-pyridazine	Sulfa-methoxazole	Sulfa-dimethoxine	Sucralose
			(micrograms per liter)							
612	30	05/23/2012	<0.20	<0.10	<0.20	0.11	<0.20	<0.10	<0.10	<0.10
613	33	05/22/2012	<0.20	0.11	<0.20	0.19	<0.20	<0.10	<0.10	<0.10
614	30	05/21/2012	<0.20	0.12	<0.20	0.25	<0.20	<0.10	<0.10	<0.10
616	35	05/22/2012	<0.20	0.12	<0.20	0.21	<0.20	<0.10	<0.10	<0.10
2192	U	05/23/2012	<0.20	<0.10	<0.20	<0.10	<0.20	<0.10	<0.10	<0.10

Note: No primary or secondary health standards available for antibiotics or sucralose.

Table 3. Steroid results—Former Sunnyside Feedlot Follow-Up Monitoring Project.

DEQ Site ID	Well Depth (feet)	Sample Date	Caffeine	Cholesterol	Coprastan-3-ol	beta-estradiol
			(micrograms per liter)			
1047	40	05/23/2012	<0.02	<0.10	<0.10	0.26
610	40	05/23/2012	<0.02	<0.10	<0.10	<0.05

Note: No primary or secondary health standards available for steroids.

2.1.1.3 Conclusions

Out of the 18 wells sampled for this project, nitrate in 13 wells (including well 618) reached or exceeded EPA's MCL; 11 of the 15 wells (including well 618) sampled in both 2010 and 2012 had an increase in nitrate concentration during the 2012 sampling. Out of the 5 wells sampled for antibiotics, 4 contained sulfamethazine and 3 contained sulfamerazine; 2 wells showed a decrease in sulfamethazine from 2010 to 2012 while sulfamerazine was not detected in 2010 (DEQ 2013a). Of the 2 wells sampled for steroids, 1 had a detection of beta-estradiol. Out of the 18 wells sampled for this project, sulfate in 9 wells (including well 618) exceeded EPA's NSDWR.

Six years following the closure of the feedlot, antibiotics continue to be detected within the boundary of the former feedlot, nitrate values are elevated, and the majority of wells sampled for this project had an increasing nitrate concentration when compared to 2010. The water quality data indicate that the former feedlot continues to impact the shallow ground water quality. Sucralose, the artificial sweetener, was analyzed to help indicate if a septic source was contributing to the nitrate concentrations and was not detected in any of the 5 wells analyzed.

2.1.1.4 Recommendations

To evaluate changes in ground water chemistry resulting from the closure of the former feedlot, DEQ recommends that monitoring for anions, ammonia, antibiotics, steroids, and $\delta^{15}N$ continue in order to document the ground water quality trends following removal of manure and the establishment of crops grown at the site. In addition, if DEQ's budget allows, it is recommended that $\delta^{15}N$ samples collected in 2012 be submitted for analysis.

2.1.2 Notus Nitrate Priority Area Ground Water Monitoring Project

2.1.2.1 Purpose

This regional monitoring project was designed to provide the data necessary for evaluating water quality in the Notus NPA. Among the state's 32 NPAs, the Notus NPA is ranked 25, with 1 being the most degraded and 32 the least. Program objectives, design, and well selection processes were identified in the regional network design developed by the Boise Regional Office (DEQ 2011a). Ground water samples were collected from individual private domestic or irrigation wells in accordance with DEQ's *Regional Nitrate Priority Area Ground Water Monitoring Activities Boise Region Quality Assurance Project Plan* (DEQ 2011b). Nitrogen isotope samples and bacteria samples were collected to help determine the source of nitrates in ground water.

To accurately evaluate water quality and determine trends in an area, it is important that data are collected over time from the same wells, the wells monitor the same aquifer zone, and wells are distributed across the area and located in a manner that accurately represents the ground water quality of the area. Monitoring data are used by DEQ during periodic NPA delineation and ranking activities. Data may also be used to identify a local monitoring project to determine potential source(s) and the extent of constituents exceeding a standard (e.g., the MCL). The data are also used to help determine strategies to mitigate ground water quality degradation.

2.1.2.2 Methods and Results

Hydrogeology

DEQ project staff reviewed project area well logs from IDWR's database and determined a blue clay layer is located approximately 25 to 600 feet below ground surface. The clay layer can act as a protective barrier to prevent contaminants generated at the land surface from migrating into deeper aquifers. All wells sampled for this project were completed to 100 feet below ground surface or less, except well 1917. The regional ground water flow direction is to the southwest (Figure 4).

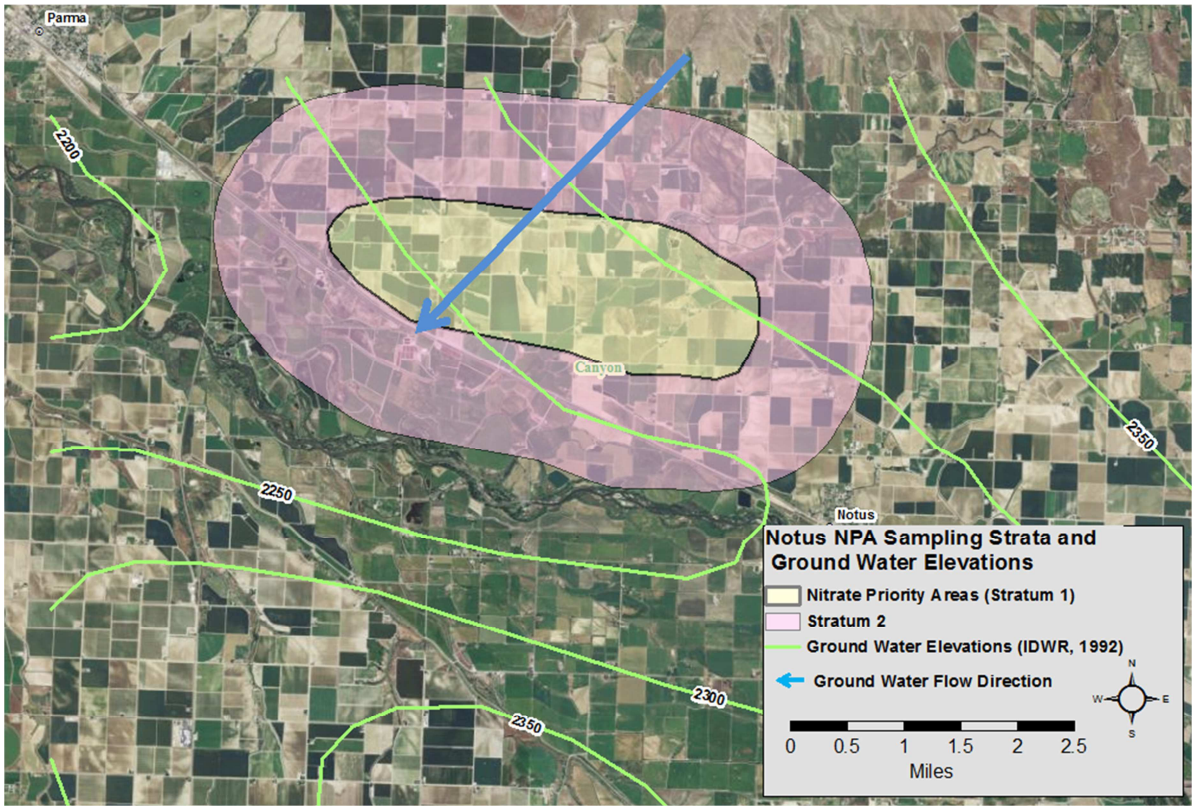


Figure 4. Ground water contours and elevations—Notus Nitrate Priority Area Ground Water Monitoring Project.

Selection Process Design

A statistical process (Steinhorst 2011) was used to determine the number of samples required within the Notus NPA (Stratum 1) and outside the Notus NPA (Stratum 2, a 1-mile buffer around Stratum 1) to ensure the sampling event was statistically valid (Figure 4).

Because the Notus NPA is only 4 square miles, DEQ conducted census sampling—every well that met the sampling criteria (DEQ 2011a) was considered for sampling and permission to sample was pursued. Permission was obtained for 13 wells. However, one of the properties had two untagged wells with no way to determine which well had been selected to sample, so neither well was sampled.

Wells were chosen in accordance with the DEQ regional network design (DEQ 2011a). Preference was given to wells screened solely within the shallow aquifer, which is above the blue lacustrine clay layer that separates the shallow and deep aquifers. All wells sampled for this project were completed to a depth 100 feet or less below ground surface, with the exception of well 1917, which was completed to a depth of 496 feet. Well 1917's log stated the depth was 161 feet; however, the owner stated that the well was redrilled to a depth of 496 feet within the last 5 years. Due to the modification of well 1917, it no longer fits the criteria for the Notus NPA project (DEQ 2011b). This well will be excluded from future sampling rounds.

Samples were collected in April 2012 from each of the 12 wells in accordance with the QAPP (DEQ 2011b) and FSP (DEQ 2012c). Water quality field parameters (pH, temperature, specific conductivity, and DO) were measured at each well prior to sample collection (Table 4).

Table 4. Water quality field parameters—Notus Nitrate Priority Area Ground Water Monitoring Project.

DEQ Site ID	Well Depth (feet)	Sample Date	pH	Water Temperature[a] (°C)	Specific Conductivity[a] (µS/cm)	Dissolved Oxygen[a] (mg/L)
1859	100	4/02/2012	7.76	15.8	757	6.98
1860	63	4/10/2012	7.72	14.1	729	8.24
1861	95	4/04/2012	7.43	14.9	699	5.16
1862	60	4/04/2012	7.06	14.4	566	2.90
1863	60	4/04/2012	7.60	14.4	780	5.03
1864	67	4/04/2012	7.56	14.9	845	3.43
1922	41	4/26/2012	7.60	14.2	874	7.02
1865	56	4/04/2012	7.64	13.4	990	4.04
1866	65	4/04/2012	7.60	14.3	790	6.70
1867	50	4/10/2012	7.63	14.3	759	7.33
1918	54	4/26/2012	7.85	15.8	278	1.83
1917	496	4/26/2012	7.80	21.5	346	0.01

Notes: pH was within the range of EPA's National Secondary Drinking Water Regulation (NSDWR) standard (6.5–8.5 pH units). However, field measurements should be considered estimates and are not used for determining violations of NSDWR standards.
mg/L = milligrams per liter; °C = degrees Celsius; µS/cm = microsiemens per centimeter
[a] No primary or secondary health standard available.

Samples collected from each well were analyzed for arsenic; anions (bromide, chloride, fluoride, nitrate, nitrite, orthophosphate, and sulfate); total coliform (TC); *Escherichia coli* (*E. coli)*; and nitrogen isotopes (Table 5; Table 7). Wells with a DO level of less than 2 milligrams per liter (mg/L) as determined by field analysis were also sampled for ammonia as required by the FSP. As a courtesy, the Idaho Bureau of Laboratories (IBL) in Boise analyzed two additional samples for ammonia. Arsenic, TC, and *E. coli* samples were submitted to IBL for analysis. At the time of the Notus NPA project, IBL was engaged in a special project to identify other metals in ground water throughout the state. IBL analyzed all ground water samples for uranium as part of its project and informed DEQ of uranium results only if the results exceeded the uranium MCL of 30 µg/L. Nitrate, nitrite, chloride, sulfate, and ammonia samples were submitted to the UIASL in Moscow for analysis. Nitrogen isotope samples were collected at each sampling location and frozen and stored at DEQ pending nitrate analysis. After DEQ received nitrate analysis results,

those nitrogen isotope samples from wells with nitrate concentrations greater than 5 mg/L were sent to the University of Arizona Environmental Isotope Geosciences Laboratory in Tucson for nitrogen isotope analysis.

Table 5. Inorganic results—Notus Nitrate Priority Area Ground Water Monitoring Project.

DEQ Site ID	Well Depth (feet)	Sample Date	Ammonia[a]	Bromide[a]	Chloride	Fluoride	Nitrate	Nitrite	O-phosphate[a]	Sulfate	Arsenic	Uranium
			(milligrams per liter)								(micrograms per liter)	
1859	100	4/02/2012	NA	0.32	60	<0.15	3.1	<0.05	<0.10	140	7.1	NA
1860	63	4/10/2012	NA	0.10	13	0.36	**11**	<0.05	<0.10	61	**16**	NA
1861	95	4/04/2012	NA	<0.10	11	0.42	2.3	<0.05	<0.10	32	**20**	**39**
1862	60	4/04/2012	NA	<0.10	7.6	0.33	5.2	<0.05	<0.10	31	**12**	NA
1863	60	4/04/2012	NA	0.13	20	0.32	9.9	<0.05	<0.10	75	**22**	NA
1864	67	4/04/2012	NA	0.21	29	0.34	**10**	<0.05	<0.10	110	**12**	NA
1922	41	4/26/2012	NA	0.22	30	0.26	**16**	<0.05	<0.10	98	**23**	NA
1865	56	4/04/2012	NA	0.23	28	0.34	**13**	<0.05	<0.10	120	**21**	NA
1866	65	4/04/2012	NA	0.11	16	0.24	5.3	<0.05	<0.10	61	**21**	NA
1867	50	4/10/2012	NA	0.11	17	0.33	**13**	<0.05	0.10	68	**10**	NA
1918	54	4/26/2012	<0.10	<0.10	14	0.25	0.09	<0.05	<0.10	31	**18**	NA
1917	496	4/26/2012	1.90	<0.10	5.5	1.50	<0.05	<0.05	<0.10	0.29	<2.0	NA

Notes: Bolded red numbers indicate EPA's maximum contaminant level was reached or exceeded. No constituents exceeded EPA's National Secondary Drinking Water Regulation.
NA = not analyzed; O-phosphate = orthophosphate
[a] No primary or secondary health standard available.

Nitrate Sampling

The reported nitrate concentrations ranged from <0.05 mg/L to 16 mg/L; 8 of the 12 wells sampled had nitrate concentration of 5 mg/L or greater (Table 5). The nitrate MCL of 10 mg/L was equaled or exceeded in 5 wells (1860, 1864, 1922, 1865, and 1867). The spatial distribution of nitrate concentrations is shown in Figure 5.

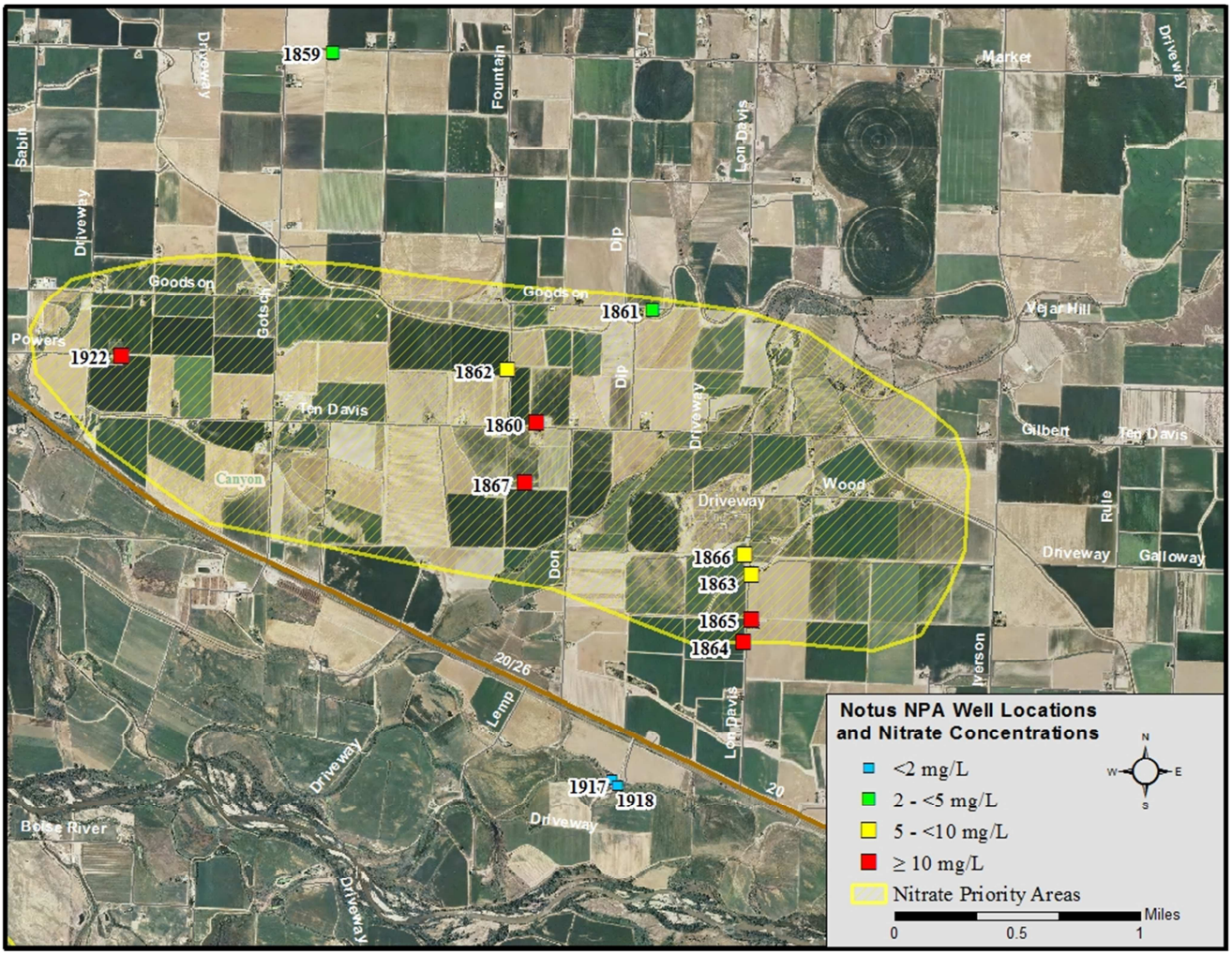


Figure 5. Private domestic drinking water well sample locations and nitrate concentrations—Notus Nitrate Priority Area Ground Water Monitoring Project.

Arsenic Sampling

The reported arsenic concentrations ranged from <2 µg/L to 23 µg/L; 10 of the 12 well samples reached or exceeded the arsenic MCL of 10 µg/L (Table 5).

Chloride Sampling

Reported chloride concentrations ranged from 5.5 mg/L to 60 mg/L (Table 5). EPA set the NSDWR standard for chloride at 250 mg/L, based on aesthetic effects. All reported chloride concentrations were below this standard.

Sulfate Sampling

Reported sulfate concentrations ranged from 0.29 mg/L to 140 mg/L (Table 5). The NSDWR standard for sulfate is 250 mg/L, based on aesthetic effects. All reported sulfate concentrations were below this standard.

Nitrogen Isotope Sampling

Nitrogen isotope ratio, denoted as $\delta^{15}N$, involves analysis to establish the ratio of nitrogen-15 (^{15}N) to nitrogen-14 (^{14}N) in a water sample, which is compared to the ratio in a standard of atmospheric nitrogen. Comparison of the ratios indicates if there is more (positive) or less (negative) ^{15}N in the sample. The values can be helpful in determining the potential sources of nitrate in the ground water. Values for $\delta^{15}N$ analysis are reported in units of per mil (‰), equal to one part per thousand. Nitrogen from human or animal waste and fertilizer sources has distinguishable $\delta^{15}N$ signatures. Typical $\delta^{15}N$ values for various nitrogen sources are listed in Table 6 (Seiler 1996).

Table 6. Typical $\delta^{15}N$ values from various nitrogen sources.

Potential Nitrate Source	$\delta^{15}N$ (‰)
Precipitation	−3
Commercial fertilizer	−4 to +4
Organic nitrogen in soil	+4 to +9
Animal or human waste	Greater than +10

Source: Seiler (1996)
Notes: $\delta^{15}N$ = nitrogen isotope; ‰ = per mil

Nitrogen isotope ratios were determined for all samples with nitrate concentrations equal to or greater than 5 mg/L (Table 5). The $\delta^{15}N$ results from this project ranged from 3.7‰ to 5.2‰ (Table 7). Wells 1862 and 1922 had $\delta^{15}N$ values of 3.9‰ and 3.7‰, respectively, indicating the source of nitrates in the ground water is most likely from commercial fertilizers. Wells 1860, 1863, 1864, 1865, 1866, and 1867 had $\delta^{15}N$ values of 4.1‰ through 5.2‰, indicating the source of nitrates in the ground water is most likely from organic nitrogen in soil (Seiler 1996).

Table 7. Bacteria and nitrogen isotope data—Notus Nitrate Priority Area Ground Water Monitoring Project.

DEQ Site ID	Sample Depth (feet)	Sample Date	Total Coliform (MPN/100 mL)[a]	*E. coli* (MPN/100 mL)	$\delta^{15}N$ (‰)[b]
1859	100	4/02/2012	<1	<1	NA
1860	63	4/10/2012	<1	<1	4.1
1861	95	4/04/2012	<1	<1	NA
1862	60	4/04/2012	<1	<1	3.9
1863	60	4/04/2012	<1	<1	5.1
1864	67	4/04/2012	<1	<1	5.0
1922	41	4/26/2012	38.9	<1	3.7
1865	56	4/04/2012	275.5	<1	4.5
1866	65	4/04/2012	<1	<1	5.2
1867	50	4/10/2012	<1	<1	4.2
1918	54	4/26/2012	<1	<1	NA
1917	496	4/26/2012	<1	<1	NA

Notes: MPN/100 mL = most probable number per 100 milliliters; $\delta^{15}N$ = nitrogen isotope; ‰ = per mil; NA = not analyzed

[a] A ground water quality standard does not exist.

[b] No primary, secondary, or advisory health standards available for isotopes.

TC bacteria are common in the environment (such as soil) and the intestines of animals and are generally not harmful. Fecal coliform (FC) and *E. coli* bacteria are found in greater quantities than TC in animal fecal matter. The presence of FC or *E. coli* along with TC in drinking water provides strong evidence that sewage is present; therefore, a greater potential for pathogenic organisms exists.

The reported TC concentrations ranged from <1 most probable number per 100 milliliters (MPN/100 mL) to 275.5 MPN/100 mL; 2 of the 12 wells sampled were positive for TC (wells 1922 and 1865). The remaining samples had nondetects for TC. All 12 of the samples had no presence of *E. coli* (Table 7).

2.1.2.3 Conclusions

The criterion for NPA designation is that at least 25% of the wells sampled within the area exceed 5 mg/L nitrate (half of the EPA MCL of 10 mg/L). In the Notus project, 8 of the 12 wells sampled had nitrate values of 5 mg/L or greater. The nitrate MCL of 10 mg/L was equaled or exceeded in 5 wells (1860, 1864, 1922, 1865, and 1867). The highest nitrate concentrations detected during the monitoring event were located in a lower lying area between the foothills to the north and the Boise River to the south.

The $\delta^{15}N$ results suggest a mixture of nitrogen sources, including fertilizer and organic sources in the soil. This mixture of nitrogen sources is typical of an agricultural area with a combination of animal facilities and row crops. There does not appear to be one point source that can be considered the major contributor of nitrates to these sampling sites.

Elevated arsenic values have been identified in this area by various studies (Mitchell 2004; Neely 2002). These exceedances may be due to naturally occurring arsenic in the geology of this area,

specifically the granitic sediments found in the valley from the erosion of the Idaho Batholith (Neely 2002).

2.1.2.4 Recommendations

Property owners with private domestic drinking water wells should sample and analyze their well water for bacteria, arsenic, and nitrate on an annual basis. Southwest District Health can also provide property owners with information and guidance. In addition, property owners would benefit from education on using commercial pesticides on their lawns and gardens and education on proper well and septic system maintenance.

Land-use activities near the sites with elevated nitrate concentrations should be evaluated by the appropriate agency to determine if best management practice (BMP) modifications should be implemented or improved to protect ground water quality from further degradation.

DEQ is in the process of assisting Canyon County in developing and implementing ground water quality improvement and drinking water source protection plans. These plans include outreach activities for private well owners and agricultural operators aimed at reducing contamination of source water, including activities to reduce nitrate contamination.

2.1.3 Parma Nitrate Priority Area Ground Water Monitoring Project

2.1.3.1 Purpose

This regional monitoring project was designed to provide the data necessary for evaluating water quality in the Parma NPA. Among the state's 32 NPAs, the Parma NPA is ranked 26, with 1 being the most degraded and 32 the least. Program objectives, design, and well selection processes were identified in the regional network design developed by the Boise Regional Office (DEQ 2011a). Ground water samples were collected from individual private domestic or irrigation wells in accordance with the QAPP (DEQ 2011b). Nitrogen isotope samples and bacteria samples were collected to help determine the source of nitrates in ground water.

To accurately evaluate water quality and determine trends in an area, it is important that data are collected over time from the same wells, the wells monitor the same aquifer zone, and wells are distributed across the area and located in a manner that accurately represents the ground water quality of the area. Monitoring data will be used by DEQ during periodic NPA delineation and ranking activities. Data may also be used to identify a local monitoring project to determine potential sources and the extent of constituents exceeding a standard (e.g., the MCL). Data will also be used to help determine strategies to mitigate ground water quality degradation.

2.1.3.2 Methods and Results

Hydrogeology

Within the project area, the blue clay layer is located approximately 25–355 feet below ground surface and can act as a protective barrier to prevent contaminants generated at the land surface from migrating into deeper aquifers. All wells sampled for this project were completed to less than 150 feet below ground surface. The regional ground water flow direction is generally to the

west, with a southerly component in the southern portion of the project area and a northerly component in the northern portion of the project area (Figure 6).

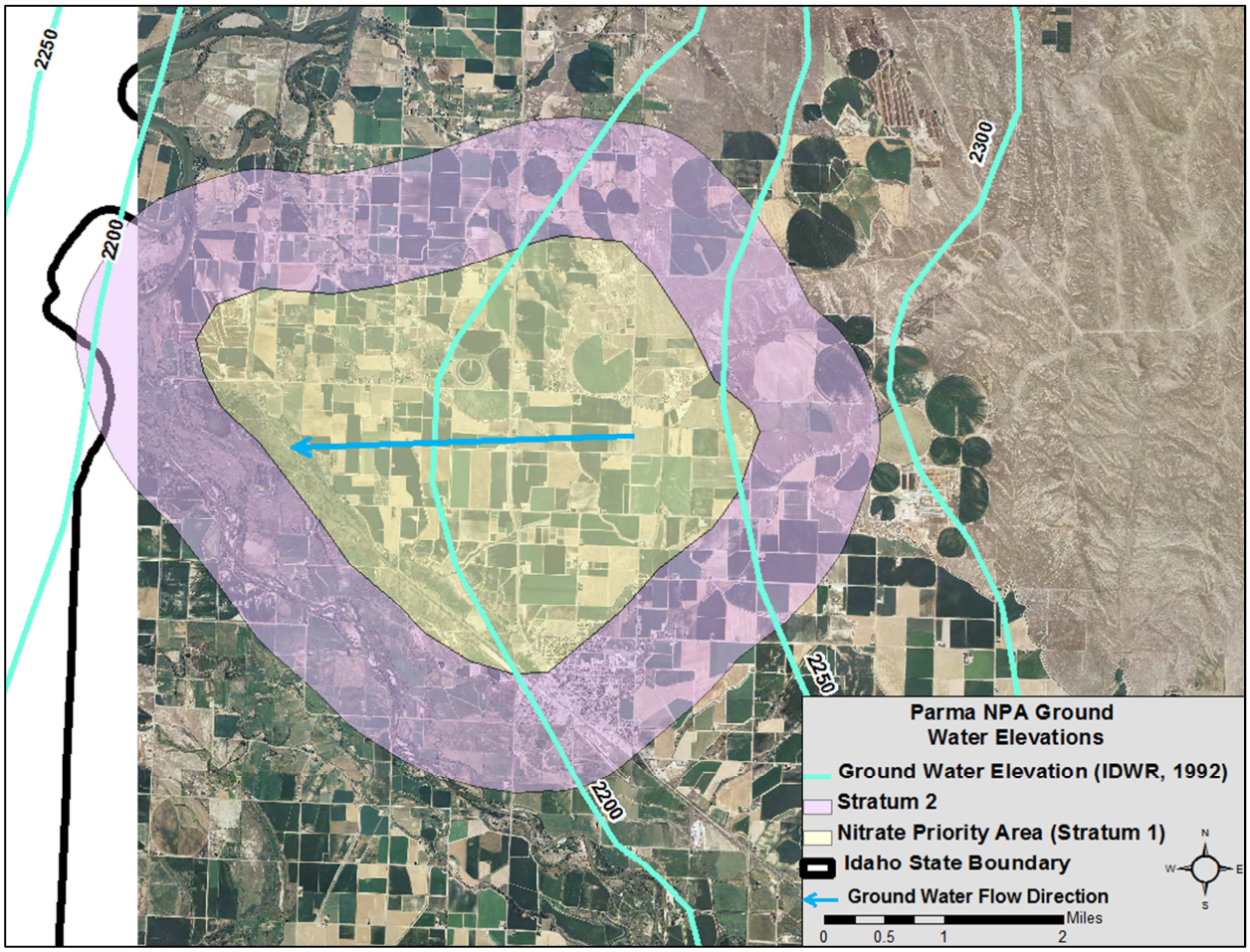


Figure 6. Ground water contours and elevations—Parma Nitrate Priority Area Ground Water Monitoring Project.

Selection Process Design

A statistical process (Steinhorst 2011) was used to determine the number of samples needed within the Parma NPA (Stratum 1) and outside the Parma NPA (Stratum 2, which surrounds Stratum 1 with a 1-mile buffer) to ensure the sampling event was statistically valid (Figure 6).

Because the Parma NPA is small (11 square miles), census sampling was used—every well that met the sampling criteria (DEQ 2011a) was considered for sampling and permission to sample was pursued. Permission was obtained for 19 wells. However, one of the wells could not be located and the owner could not be reached; therefore, only 18 wells were sampled.

Wells were chosen in accordance with the DEQ regional network design (DEQ 2011a). Preference was given to wells screened solely within the shallow aquifer, which is above the blue lacustrine clay layer that separates the shallow and deep aquifers.

Samples were collected in April 2012 from each of the 18 wells in accordance with the QAPP (DEQ 2011b) and FSP (DEQ 2012d). Water quality field parameters (i.e., pH, temperature, specific conductivity, and DO) were measured at each well prior to sample collection (Table 8).

Table 8. Water quality field parameters—Parma Nitrate Priority Area Ground Water Monitoring Project.

DEQ Site ID	Well Depth (feet)	Sample Date	pH	Water Temperature[a] (℃)	Specific Conductivity[a] (µS/cm)	Dissolved Oxygen[a] (mg/L)
1831	69.5	4/03/2012	8.43	15.0	528	3.29
1832	53	4/12/2012	7.58	17.4	336	0.08
1833	60	4/03/2012	*8.57*	14.8	708	5.32
1834	40	4/03/2012	*8.62*	14.8	559	4.03
1835	142	4/03/2012	*9.08*	16.3	295	7.53
1836	103	4/03/2012	*8.51*	13.9	1000	2.63
1837	65	4/02/2012	7.50	14.6	549	1.86
1838	55	4/03/2012	*8.51*	14.6	759	4.96
1839	125	4/03/2012	*8.99*	14.3	349	8.97
1840	47	4/04/2012	7.72	13.8	631	1.68
1841	40	4/03/2012	*8.65*	13.5	732	4.26
1842	55	4/02/2012	7.59	14.5	736	3.22
1843	60	4/02/2012	7.65	14.3	802	3.31
1844	77	4/02/2012	7.24	15.4	724	0.87
1919	85	4/26/2012	7.37	15.7	725	0.70
1921	70	4/26/2012	7.56	15.6	626	5.92
1920	104	4/26/2012	7.58	15.7	642	10.63
1923	58	4/26/2012	7.70	15.9	654	4.68

Notes: Italicized red numbers indicate EPA's National Secondary Drinking Water Regulation (NSDWR) standard was reached or exceeded. However, field measurements should be considered estimates and are not used for determining violations of NSDWR standards. The pH standard is 6.5–8.5 pH units.
mg/L = milligrams per liter; µS/cm = microsiemens per cm;℃ = degrees Celsius
[a] No primary or secondary health standard available.

Samples collected from each well were analyzed for arsenic; anions (bromide, chloride, fluoride, nitrate, nitrite, orthophosphate, and sulfate); TC; *E. coli*; and nitrogen isotopes (Table 9; Table 10). Wells with DO less than 2 mg/L as determined by field analysis were also sampled for ammonia as required by the FSP. Arsenic, TC, and *E. coli* samples were submitted to IBL in Boise for analysis. At the time of the Parma NPA project, IBL was engaged in a special project to identify other metals in ground water throughout the state. IBL analyzed all ground water samples for uranium as part of its project and informed DEQ of uranium results only if the results exceeded the MCL of 30 µg/L. Nitrate, nitrite, chloride, sulfate, and ammonia samples were submitted to the UIASL in Moscow for analysis. Nitrogen isotope samples were collected at each sampling location and frozen and stored at DEQ pending nitrate analysis. After DEQ received nitrate analysis results, those nitrogen isotope samples from wells with nitrate concentrations greater than 5 mg/L were sent to the University of Arizona Environmental Isotope Geosciences Laboratory in Tucson for nitrogen isotope analysis.

Table 9. Inorganic results—Parma Nitrate Priority Area Ground Water Monitoring Project.

DEQ Site ID	Well Depth (feet)	Sample Date	Nitrate	Chloride	Sulfate	Nitrite	Fluoride	Bromide[a]	Ortho-phosphate[a]	Ammonia[a]	Arsenic	Uranium
			(milligrams per liter)								(micrograms per liter)	
1831	69.5	4/03/2012	6.0	9.4	22	<0.05	0.43	<0.10	<0.1	NA	**17**	NA
1832	53	4/02/2012	<0.05	8.0	1.4	<0.05	0.77	<0.10	<0.1	3.2	6.0	NA
1833	60	4/03/2012	7.5	19	42	<0.05	0.20	<0.10	<0.1	NA	**18**	NA
1834	40	4/03/2012	3.7	13	37	<0.05	0.26	<0.10	<0.1	NA	**23**	NA
1835	142	4/03/2012	2.6	15	19	<0.05	0.41	0.12	<0.1	NA	**19**	NA
1836	103	4/03/2012	**13**	35	56	<0.05	<0.15	0.12	<0.1	NA	8.7	NA
1837	65	4/02/2012	4.7	22	48	<0.05	0.31	0.12	<0.1	<0.1	**22**	NA
1838	55	4/03/2012	**12**	27	54	<0.05	0.19	0.11	<0.1	NA	**13**	NA
1839	125	4/03/2012	1.5	14	22	<0.05	0.39	<0.10	<0.1	NA	**16**	NA
1840	47	4/04/2012	<0.05	26	24	<0.05	0.47	0.13	0.1	2.9	<2.0	NA
1841	40	4/03/2012	**10**	26	75	<0.05	0.20	0.13	<0.1	NA	**17**	NA
1842	55	4/02/2012	8.6	31	82	<0.05	0.27	0.16	<0.1	NA	**17**	NA
1843	60	4/02/2012	**16**	34	91	<0.05	0.23	0.18	<0.1	NA	**17**	NA
1844	77	4/02/2012	3.7	46	99	<0.05	<0.15	0.22	<0.1	<0.1	**16**	NA
1919	85	4/26/2012	0.95	28	72	<0.05	0.15	0.16	<0.1	<0.1	**35**	NA
1921	70	4/26/2012	4.8	12	32	<0.05	0.47	<0.10	<0.1	NA	**21**	NA
1920	104	4/26/2012	5.0	26	46	<0.05	0.18	0.15	<0.1	NA	**37**	**44**
1923	58	4/26/2012	3.7	11	29	<0.05	0.24	<0.10	<0.1	NA	**15**	NA

Notes: Bolded red numbers indicate EPA's maximum contaminant level was reached or exceeded. No constituents exceeded EPA's National Secondary Drinking Water Regulation.
NA = not analyzed
[a] No primary or secondary health standard available.

Nitrate Sampling

The reported nitrate concentrations ranged from <0.05 mg/L to 16 mg/L; 8 of the 18 wells sampled had nitrate concentration of 5 mg/L or greater. The nitrate MCL of 10 mg/L was reached or exceeded in 4 wells (1836, 1838, 1841, and 1843). The spatial distribution of nitrate concentrations is shown in Figure 7.

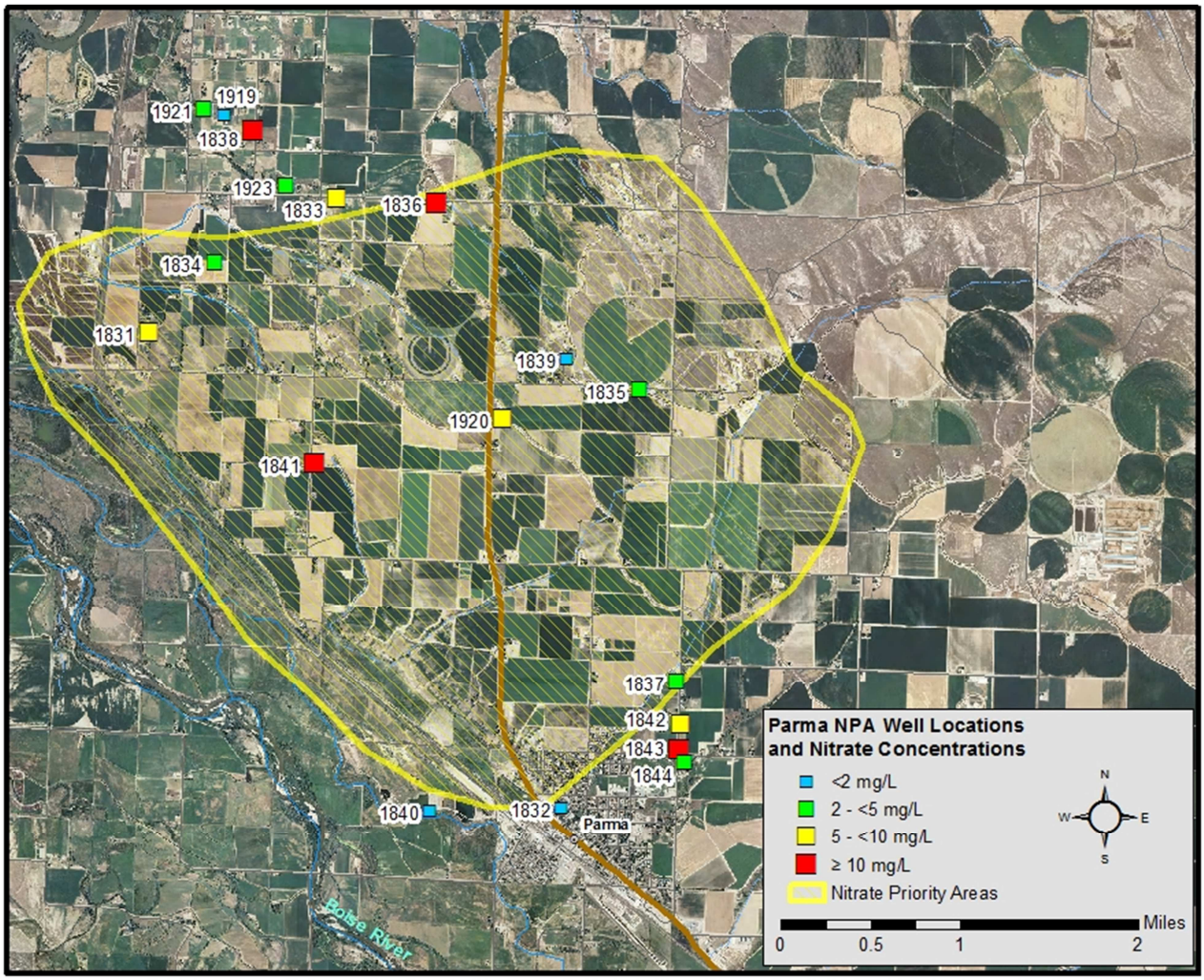


Figure 7. Private domestic drinking water well sample locations and nitrate concentrations—Parma Nitrate Priority Area Ground Water Monitoring Project.

Arsenic Sampling

The reported arsenic concentrations ranged from <2 µg/L to 37 µg/L; 15 of the 18 well samples exceeded the arsenic MCL of 10 µg/L (Table 9).

Chloride Sampling

Reported chloride concentrations ranged from 8.0 mg/L to 46 mg/L. The NSDWR standard for chloride is 250 mg/L, based on aesthetic effects. All reported chloride concentrations were below this standard (Table 9).

Sulfate Sampling

Reported sulfate concentrations ranged from 1.4 mg/L to 99 mg/L. The NSDWR standard for sulfate is 250 mg/L, based on aesthetic effects. All reported sulfate concentrations were below this standard (Table 9).

Nitrogen Isotope Sampling

Nitrogen isotope ratios, denoted as $\delta^{15}N$, can be helpful in determining the potential sources of nitrate in the ground water. Nitrogen isotope ratios were determined for all samples with nitrate concentrations greater than 5 mg/L. Nitrogen from human or animal waste and fertilizer sources has distinguishable $\delta^{15}N$ signatures. Typical $\delta^{15}N$ values for various nitrogen sources are listed in Table 6.

The $\delta^{15}N$ results from this project ranged from 3.0‰ to 9.2‰ (Table 10). Wells 1842 and 1843 had $\delta^{15}N$ values indicating the source of nitrates in the ground water is most likely from commercial fertilizers. Wells 1831, 1833, 1838, and 1841 had $\delta^{15}N$ values of 4.1‰ through 6.8‰, indicating a source of organic nitrogen in soil (Seiler 1996). Well 1836 had a $\delta^{15}N$ value of 9.2‰. Values between 8.0‰ and 10.0‰ fall between the ranges of organic nitrogen in the soil and a waste source of nitrogen.

Bacteria Results

TC bacteria are common in the environment (such as soil) and the intestines of animals and are generally not harmful. FC and *E. coli* bacteria are found in greater quantities than TC in animal fecal matter. The presence of FC or *E. coli* along with TC in drinking water provides strong evidence that sewage is present; therefore, a greater potential for pathogenic organisms exists.

The reported TC concentrations ranged from <1 MPN/100 mL to 195.6 MPN/100 mL; 2 of the 18 wells sampled were positive for TC (1833 and 1836). The remaining samples were negative for TC. All 18 samples were negative for *E. coli* (Table 10).

Table 10. Bacteria and nitrogen isotope data—Parma Nitrate Priority Area Ground Water Monitoring Project.

DEQ Site ID	Well Depth (feet)	Sample Date	Total Coliform[a] (MPN/100 mL)	*E. coli* (MPN/100 mL)	$\delta^{15}N$ (‰)[b]
1831	69.5	4/03/2012	<1	<1	6.8
1832	53	4/02/2012	<1	<1	NA
1833	60	4/03/2012	195.6	<1	6.6
1834	40	4/03/2012	<1	<1	NA
1835	142	4/03/2012	<1	<1	NA
1836	103	4/03/2012	1	<1	9.2
1837	65	4/02/2012	<1	<1	NA
1838	55	4/03/2012	<1	<1	5.8
1839	125	4/03/2012	<1	<1	NA
1840	47	4/04/2012	<1	<1	NA
1841	40	4/03/2012	<1	<1	4.1
1842	55	4/02/2012	<1	<1	3.0
1843	60	4/02/2012	<1	<1	3.2
1844	77	4/02/2012	<1	<1	NA
1919	85	4/26/2012	<1	<1	NA
1921	70	4/26/2012	<1	<1	NA
1920	104	4/26/2012	<1	<1	NA
1923	58	4/26/2012	<1	<1	NA

Notes: MPN/100 mL = most probable number per 100 milliliters; $\delta^{15}N$ = nitrogen isotope; ‰ = per mil; NA = not analyzed

[a] A ground water quality standard does not exist.

[b] No primary, secondary, or advisory health standards available for isotopes.

2.1.3.3 Conclusions

The criterion for NPA designation is that at least 25% of the wells sampled within the area exceed 5 mg/L nitrate (half of the MCL of 10 mg/L). In the Parma project, 8 of the 18 wells sampled had nitrate values of 5 mg/L or greater. The nitrate MCL of 10 mg/L was equaled or exceeded in 4 wells (1836, 1838, 1841, and 1843).

The $\delta^{15}N$ results suggest a mixture of nitrogen sources, including fertilizer and organic sources. There does not appear to be one point source that can be considered the major contributor of nitrates to these sampling sites.

Elevated arsenic values have been identified in this area by various studies (Mitchell 2004; Neely 2002). These exceedances may be due to naturally occurring arsenic in the geology of this area, specifically the granitic sediments found in the valley from the erosion of the Idaho Batholith (Neely 2002)

2.1.3.4 Recommendations

Property owners with private domestic drinking water wells should sample and analyze their well water for bacteria, arsenic, and nitrate on an annual basis. Southwest District Health can also provide property owners with information and guidance. In addition, property owners would

benefit from education on using commercial pesticides on their lawns and gardens and education on proper well and septic system maintenance.

Land-use activities near the sites with elevated nitrate concentrations should be evaluated by the appropriate agency to determine if BMP modifications should be implemented or improved to protect ground water quality from further degradation.

DEQ is in the process of assisting Canyon County in developing and implementing ground water quality improvement and drinking water source protection plans. These plans include outreach activities for private well owners and agricultural operators aimed at reducing contamination of source water, including activities to reduce nitrate contamination.

2.1.4 Ada/Canyon Nitrate Priority Area Ground Water Monitoring Project

2.1.4.1 Purpose

This ground water monitoring project was designed to evaluate the water quality and nitrate concentrations in the Ada/Canyon NPA. In 2008, the Ada/Canyon NPA ranked as the second-most impacted NPA in Idaho. The original number of wells to be sampled in 2012 was 106 wells. Unfortunately, the temperatures dropped in December and the final six wells had to be sampled in fall 2013.

In 2012, DEQ collected ground water samples from 100 domestic or irrigation wells in the Ada/Canyon NPA using procedures outlined in the QAPP (DEQ 2011b). Program objectives, design, and well selection processes are identified in the *Regional Ground Water Monitoring Network Design* (DEQ 2011a). DEQ analyzed the ground water samples for common water quality analytes including nitrate, bacteria, selected metals, phosphate, sulfate, and ammonia to assess the water quality in the project area. Figure 8 shows the Ada/Canyon NPA in the western Ada County and eastern Canyon County area.

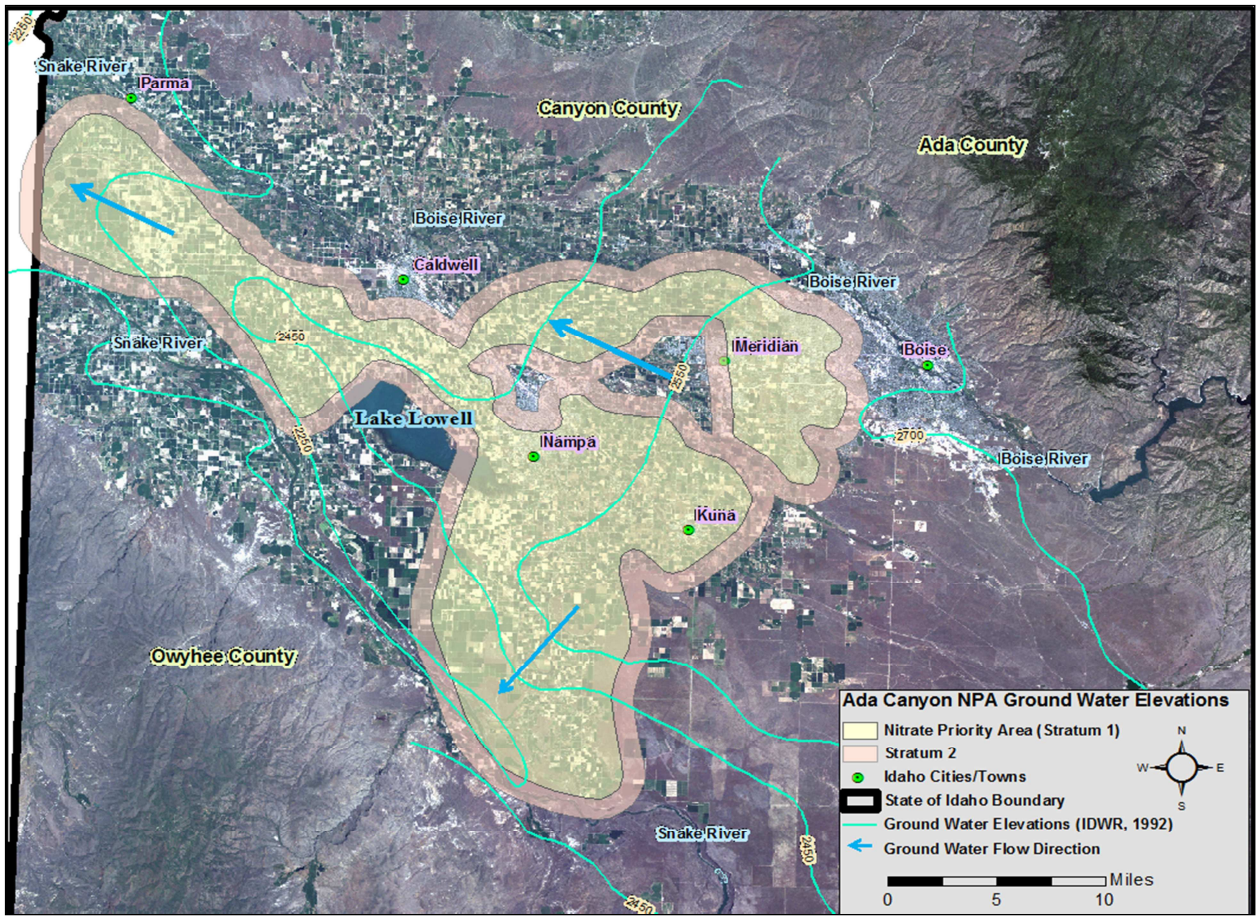


Figure 8. Ada/Canyon Nitrate Priority Area showing Stratum 1, Stratum 2, and general ground water flow directions.

2.1.4.2 Methods and Results

Hydrogeology

Ada and Canyon Counties are located within the western section of the Snake River plain geologic province. The western Snake River plain is a downdropped fault-block basin, with normal (vertical) north-northwest trending faults along the margins of the basin. The basin is filled with rhyolite ash, basalt lava flows, and sediments that eroded off the surrounding hills or were deposited by streams or into lakes. Stream and lake sediments in the basin include volcanic ash, clay, silt, sand, and gravel.

Many wells in the Ada/Canyon NPA produce water from relatively shallow sand and gravel aquifers. A layer of blue clay often underlies these upper aquifers; the clay acts as a barrier to downward ground water movement and separates the shallow aquifers from deeper aquifers located within and below the clay layer (Newton 1991).

For the Ada/Canyon NPA project, DEQ staff reviewed the IDWR well logs of wells in the project area to assess the lithology of the subsurface. The review indicated the blue clay layer is located approximately 25–500 feet below ground surface in the area of the Ada/Canyon NPA. Wells selected for sampling for this project were completed at depths of 450 feet or less.

Selection Process Design

The regional network design was used to calculate a sampling unit size of one section (one square mile). A statistical process, developed for DEQ by Kirk Steinhorst of the University of Idaho, was used to determine the number of samples needed in Stratum 1 (the area of the NPA) and Stratum 2 (a 1-mile wide buffer area surrounding Stratum 1) to ensure the sampling event was statistically valid (Figure 8) (Steinhorst 2011).

It was calculated that 54 wells located in Stratum 1 and 52 wells in Stratum 2 would need to be sampled to meet a 90% statistical confidence level that the estimated mean of nitrate is within 15% of the true mean. The total number of sections in Stratum 1 and the total number of sections in Stratum 2 were randomized separately to determine which sections would be sampled. Wells in each randomized section were chosen in accordance with the regional network design. DEQ reviewed available IDWR well logs for wells in the sections and selected wells to deliver sampling request forms to the well owner. During the selection process, preference was given to wells screened within the shallow aquifer. DEQ received permission to sample 106 wells within the Ada/Canyon NPA.

DEQ collected ground water samples from 100 of the selected wells in September, October, November, and December 2012 in accordance with the QAPP (DEQ 2011b) and the FSP (DEQ 2012e). Six wells were sampled in fall 2013, and one well was sampled in spring 2014. DEQ's field staff measured water quality field parameters of pH, temperature, specific conductance, and DO prior to sample collection (Table 11).

Table 11. Water quality field parameters—Ada/Canyon Nitrate Priority Area Ground Water Monitoring Project.

DEQ Site ID	Well Depth (feet)	Sample Date	pH	Water Temperature[a] (℃)	Specific Conductance[a] (µS/cm)	Dissolved Oxygen[a] (mg/L)
1992	109	09/26/2012	6.98	15.1	872	4.70
1991	100	09/26/2012	6.78	15.2	840	3.40
2052	78	09/05/2012	7.06	14.3	861	4.40
2058	60	09/04/2012	8.08	14.9	843	6.16
2051	66	09/05/2012	7.19	13.6	576	5.85
1972	85	09/18/2012	7.24	15.5	796	10.87
2057	84	09/04/2012	7.85	15.9	647	9.39
2013	71	09/12/2012	7.40	14.2	543	7.20
2054	82	09/05/2012	7.10	14.7	623	6.00
2007	75	09/25/2012	5.97	14.8	657	3.15
1968	78	09/18/2012	7.15	14.1	506	11.19
2056	39	09/04/2012	7.87	15.1	1,120	1.37
2019	131	09/12/2012	7.47	13.9	555	9.00
1960	110	09/19/2012	7.98	17.3	733	2.19
2005	58	09/25/2012	6.02	15.0	622	4.59
1979	120	09/18/2012	7.26	15.1	654	5.95
1975	80	09/18/2012	7.34	14.8	845	10.10
2059	180	09/04/2012	7.55	18.8	585	1.62
1973	80	09/18/2012	7.36	14.4	577	9.55
1956	82	09/11/2012	7.05	14.0	350	2.75
1977	57	09/18/2012	7.14	14.7	521	4.08
1970	115	09/18/2012	7.22	14.8	590	10.99
1969	104	09/19/2012	7.38	15.4	716	8.29
1962	300	09/19/2012	7.83	16.9	768	9.64
2006	98	09/19/2012	5.92	14.0	94	4.93
2049	89	09/05/2012	7.27	15.4	501	3.85
1965	191	09/19/2012	7.92	15.9	310	10.28
2063	41	09/04/2012	7.93	13.8	2,480	0.53
2062	34	09/04/2012	8.20	13.0	760	12.60
2015	80	09/12/2012	7.50	13.3	475	9.48
1971	85	09/18/2012	7.31	15.0	566	10.05
1955	60	09/11/2012	7.32	14.7	479	4.77
1984	80	09/11/2012	7.71	15.1	566	5.97
1961	260	09/19/2012	8.11	21.2	554	7.75
1993	142	09/25/2012	5.84	15.1	569	6.43
2048	83	09/12/2012	7.41	14.6	536	6.90
1964	288	09/19/2012	7.89	14.6	474	9.75
1963	275	09/19/2012	8.27	15.8	358	9.40
1976	83	09/18/2012	7.21	14.9	579	8.30
1966	147	09/19/2012	7.77	16.9	815	9.50

DEQ Site ID	Well Depth (feet)	Sample Date	pH	Water Temperature[a] (℃)	Specific Conductance[a] (µS/cm)	Dissolved Oxygen[a] (mg/L)
1994	81	09/25/2012	6.03	13.5	501	7.52
2068	108	10/11/2012	6.93	15.2	630	9.97
2065	159	10/11/2012	7.07	13.5	454	10.79
1996	200	10/17/2012	7.57	14.2	520	7.90
2038	100	11/06/2012	7.20	15.2	442	0.00
2042	46	11/08/2012	7.77	13.4	664	1.38
2040	80	11/08/2012	8.00	14.3	559	8.67
2070	34	12/06/2012	7.57	10.7	127	2.70
2073	277	12/18/2012	7.49	23.0	999	0.04
2075	60	12/18/2012	7.32	14.4	558	5.44
2074	70	12/18/2012	7.32	13.6	586	5.33
2061	72	09/04/2012	8.19	13.5	854	13.10
1982	38	09/11/2012	7.56	17.8	231	3.59
2020	150	09/12/2012	7.74	14.9	431	8.89
1957	79	09/11/2012	7.50	13.9	816	10.16
2012	142	09/12/2012	7.48	13.9	238	8.40
2003	78	09/26/2012	6.78	14.6	566	2.50
2008	80	09/11/2012	7.54	14.5	251	1.25
2053	98	09/05/2012	6.96	14.6	789	4.91
1981	100	09/11/2012	6.85	13.4	642	4.70
1969	81	09/26/2012	7.18	14.7	587	11.97
1989	94	09/26/2012	6.46	14.8	1,025	5.92
2011	100	09/11/2012	7.63	19.1	419	8.66
2010	90	09/11/2012	7.66	17.1	376	5.04
2014	197	09/12/2012	7.59	15.2	481	9.70
1983	97	09/11/2012	7.75	12.3	434	0.09
2055	72	09/04/2012	7.54	15.7	1,080	0.11
2009	69	09/11/2012	7.61	16.3	649	6.42
2060	44	09/04/2012	7.92	15.8	757	3.54
2018	137	09/12/2012	7.56	14.4	421	8.41
1990	58	09/26/2012	6.91	14.4	1,003	8.59
2050	93	09/05/2012	6.85	15.0	387	8.45
2004	37	09/25/2012	5.83	14.4	553	7.69
2002	440	09/26/2012	7.11	24.5	438	0.01
2016	63	09/12/2012	7.33	13.8	584	9.60
1978	102	09/18/2012	6.90	15.8	552	8.26
1985	62	09/11/2012	7.48	14.4	225	9.97
2046	240	09/12/2012	7.37	15.2	772	5.62
1980	80	09/18/2012	6.73	19.1	1,140	4.68
1974	132	09/18/2012	7.41	13.3	584	7.78
1959	140	09/19/2012	7.97	14.9	297	6.44
1958	134	09/19/2012	7.81	14.5	666	8.96

DEQ Site ID	Well Depth (feet)	Sample Date	pH	Water Temperature[a] (°C)	Specific Conductance[a] (µS/cm)	Dissolved Oxygen[a] (mg/L)
1988	128	09/26/2012	6.88	17.6	327	0.11
1995	190	10/17/2012	7.85	15.0	322	11.40
2000	90	10/17/2012	7.89	14.8	366	10.18
2066	107	10/11/2012	6.51	13.1	670	3.69
1998	70	10/17/2012	7.65	14.8	1,042	0.10
2067	143	10/11/2012	6.90	14.3	540	8.53
1997	80	10/17/2012	7.69	15.7	520	5.98
2001	440	10/17/2012	8.06	22.7	399	0.01
1840	47	04/04/2012	7.72	13.8	631	1.68
1999	201	10/17/2012	7.50	13.7	355	9.30
2045	105	11/06/2012	7.44	15.6	603	8.46
2043	65	11/06/2012	7.63	15.3	593	7.08
2039	70	11/08/2012	7.81	13.9	769	8.17
2041	73	11/08/2012	7.84	15.7	628	0.05
2044	59	11/06/2012	7.47	15.1	235	0.89
2069	155	12/06/2012	7.35	17.0	588	0.00
2071	157	12/06/2012	7.29	14.7	727	7.40
2064	423	10/11/2012	7.79	24.0	393	0.29
2072	105	12/06/2012	7.44	16.0	980	0.04

Notes: Italicized red numbers indicate EPA's National Secondary Drinking Water Regulation (NSDWR) standard was reached or exceeded. However, field measurements should be considered estimates and are not used for determining violations of NSDWR standards. The pH standard is 6.5–8.5 pH units.
mg/L = milligrams per liter; µS/cm = microsiemens per centimeter; °C = degrees Celsius
[a] No primary or secondary health standard available.

The ground water samples were delivered to the analytical laboratories identified in the FSP. The laboratories analyzed the samples for arsenic; anions (bromide, chloride, fluoride, nitrate, nitrite, orthophosphate, and sulfate); and bacteria (TC and *E. coli*). At wells where a DO concentration of less than 2.0 mg/L was measured, samples were collected for ammonia analysis with the following exceptions:

- Sample 2059—The DO remained above 2.0 for the first 15 minutes of the well purge but dropped to 1.37 mg/L at the 20-minute mark when the pressure tank came on during the last reading. Because the DO had remained constant for the first 15 minutes, the field crew determined that it was not necessary to take an ammonia sample.
- Samples 2063 and 2042—Due to a technical error, these two samples were not analyzed for ammonia although the DO was below 2.0.

Arsenic and bacteria samples were submitted to IBL in Boise. Anion and ammonia samples were submitted to the UIASL in Moscow.

During the time period of the Ada/Canyon NPA sampling, the IBL was analyzing ground water samples for uranium for an auxiliary state project and analyzed the Ada/Canyon NPA samples for uranium. The IBL reported uranium concentrations in the DEQ samples only if the concentrations exceeded the MCL of 30 µg/L.

Selected samples were analyzed for nitrogen isotopes by the University of Arizona Environmental Isotope Geosciences Laboratory in Tucson. Samples for nitrogen isotope analysis were collected from all project wells, frozen, and stored at DEQ pending nitrate analysis. If nitrate was detected at a concentration of 5 mg/L or greater in the analysis performed by the UIASL in Moscow, the frozen sample was shipped to the University of Arizona for analysis.

Table 12 presents a summary of the analytical results for nitrate, nitrite, ammonia, orthophosphate, sulfate, uranium, arsenic, bromide, chloride, and fluoride. The analytical results for TC, *E. coli*, and nitrogen isotopes are discussed below.

Table 12. Inorganic results—Ada/Canyon Nitrate Priority Area Ground Water Monitoring Project.

Site ID	Well Depth (feet)	Sample Date	Ammonia[a] (mg/L)	Arsenic (µg/L)	Bromide[a] (mg/L)	Chloride (mg/L)	Fluoride (mg/L)	Nitrate (mg/L)	Nitrite (mg/L)	Ortho-phosphate[a] (mg/L)	Sulfate (mg/L)	Uranium (µg/L)
1992	109	09/26/2012	NA	**31**	0.22	33	0.41	8.7	<0.05	<0.10	120	NA
1991	100	09/26/2012	NA	**67**	0.24	45	0.96	8.4	<0.05	<0.10	130	NA
2052	78	09/05/2012	NA	4.4	<0.10	6.5	0.23	7.8	<0.05	<0.10	52	**58**
2058	60	09/04/2012	NA	**24**	0.12	30	0.49	**13**	<0.05	<0.10	84	NA
2051	66	09/05/2012	NA	4.6	<0.10	11	0.41	5.4	<0.05	0.20	20	NA
1972	85	09/18/2012	NA	**16**	0.12	14	0.37	**11**	<0.05	<0.10	75	NA
2057	84	09/04/2012	NA	**19**	<0.10	12	0.50	4.0	<0.05	<0.10	65	NA
2013	71	09/12/2012	NA	2.1	<0.10	8.1	0.75	4.0	<0.05	<0.10	33	**32**
2054	82	09/05/2012	NA	**13**	<0.10	16	0.64	6.5	<0.05	<0.10	23	NA
2007	75	09/25/2012	NA	**13**	0.10	28	0.34	4.3	<0.05	0.13	40	NA
1968	78	09/18/2012	NA	6.0	<0.10	5.3	0.54	5.1	<0.05	<0.10	29	NA
2056	39	09/04/2012	<0.10	**22**	0.20	37	0.62	**18**	<0.05	<0.10	110	NA
2019	131	09/12/2012	<0.10	5.5	<0.10	6.5	0.75	4.4	<0.05	<0.10	53	NA
1960	110	09/10/2012	NA	7.1	0.17	20	0.28	3.5	<0.05	<0.10	92	NA
2005	58	09/25/2012	NA	3.0	<0.10	8.8	0.33	3.6	<0.05	<0.10	26	**34**
1979	120	09/18/2012	NA	3.5	<0.10	13	<0.15	3.8	<0.05	<0.10	53	NA
1975	80	09/18/2012	NA	**15**	0.11	19	0.63	**15**	<0.05	<0.10	120	NA
2059	180	09/04/2012	NA[b]	**13**	0.13	24	0.43	1.6	<0.05	<0.10	97	NA
1973	80	09/18/2012	NA	**13**	<0.10	14	0.34	6.8	<0.05	<0.10	58	NA
1956	82	09/11/2012	NA	2.6	<0.10	12	0.26	2.6	<0.05	<0.10	38	NA
1977	57	09/18/2012	NA	**16**	<0.10	21	0.20	4.2	<0.05	<0.10	78	NA
1970	115	09/18/2012	NA	**17**	<0.10	8.2	0.62	5.8	<0.05	<0.10	56	NA
1969	104	09/19/2012	NA	**14**	<0.10	13	0.48	8.8	<0.05	<0.10	57	NA
1984	80	09/11/2012	NA	5.0	0.21	28	0.30	8.4	<0.05	<0.10	83	NA
1962	300	09/19/2012	NA	2.8	0.13	18	<0.15	**21**	<0.05	<0.10	73	NA
2006	98	09/25/2012	NA	3.5	0.10	42	0.36	8.6	<0.05	<0.10	39	37
2049	89	09/05/2012	NA	6.0	<0.10	22	0.55	2.9	<0.05	0.11	23	NA
1965	191	09/19/2012	NA	7.0	<0.10	3.8	0.37	1.1	<0.05	<0.10	21	NA

Site ID	Well Depth (feet)	Sample Date	Ammonia[a] (mg/L)	Arsenic (µg/L)	Bromide[a] (mg/L)	Chloride (mg/L)	Fluoride (mg/L)	Nitrate (mg/L)	Nitrite (mg/L)	Ortho-phosphate[a] (mg/L)	Sulfate (mg/L)	Uranium (µg/L)
2063	41	09/04/2012	TD[c]	**31**	1.20	170	0.85	**21**	<0.05	<0.10	*560*	**34**
2062	34	09/04/2012	NA	**26**	<0.10	14	0.49	**18**	<0.05	<0.10	67	NA
2015	80	09/12/2012	NA	**19**	<0.10	3.3	0.73	5.4	<0.05	<0.10	21	NA
1971	85	09/18/2012	NA	**12**	<0.10	11	0.32	7.1	<0.05	<0.10	58	NA
1955	60	09/11/2012	NA	4.4	<0.10	10	0.41	2.5	<0.05	<0.10	49	NA
2017	105	09/12/2012	NA	**21**	<0.10	3.9	0.80	6.1	<0.05	<0.10	25	NA
1961	260	09/19/2012	NA	2.8	0.15	21	0.20	4.2	<0.05	<0.10	78	NA
1993	142	09/25/2012	NA	5.2	<0.10	14	0.42	5.3	<0.05	0.14	31	**59**
2048	83	09/12/2012	NA	3.0	<0.10	5.4	0.70	3.3	<0.05	<0.10	41	NA
1964	288	09/19/2012	NA	**10**	<0.10	4.2	0.46	3.7	<0.05	<0.10	28	NA
1963	275	09/19/2012	NA	5.7	<0.10	15	0.36	2.5	<0.05	<0.10	45	NA
1976	83	09/18/2012	NA	**16**	<0.10	8.8	0.30	3.8	<0.05	<0.10	36	NA
1966	147	09/19/2012	NA	**20**	<0.10	11	0.47	**11**	<0.05	<0.10	66	NA
1994	81	09/25/2012	NA	**18**	<0.10	18	0.45	5.4	<0.05	0.20	17	NA
2068	108	10/11/2012	NA	**17**	<0.10	8.2	0.75	8.5	<0.05	<0.10	68	NA
2065	159	10/11/2012	NA	**20**	<0.10	3.2	0.68	5.1	<0.05	<0.10	25	NA
1996	200	10/17/2012	NA	2.1	<0.10	15	0.61	5.7	<0.05	<0.10	35	NA
2038	100	11/06/2012	<0.10	9.6	<0.10	12	0.64	2.6	<0.05	<0.10	18	NA
2042	46	11/08/2012	TD[c]	**28**	<0.10	7.3	0.56	6.4	<0.05	<0.10	72	NA
2040	80	11/08/2012	NA	**23**	<0.10	7.3	0.55	**11**	<0.05	<0.10	38	NA
2070	34	12/06/2012	NA	3.2	<0.10	1.1	0.29	<0.05	<0.05	<0.10	5.2	NA
2073	277	12/18/2012	<0.10	2.2	1.1	130	0.74	0.35	<0.05	<0.10	*280*	NA
2074	70	12/18/2012	NA	**10**	<0.10	5.1	0.39	5.9	<0.05	<0.10	31	NA
2075	60	12/18/2012	NA	8.2	<0.10	5.8	0.62	4.3	<0.05	<0.10	31	NA
2061	72	09/04/2012	NA	**17**	<0.10	13	0.23	**14**	<0.05	<0.10	45	NA
1982	38	09/11/2012	NA	4.7	<0.10	6.1	0.91	0.31	<0.05	<0.10	8.3	NA
2020	150	09/12/2012	NA	6.9	<0.10	8.8	0.59	1.6	<0.05	<0.10	52	NA
1957	79	09/11/2012	NA	4.5	<0.10	9.8	0.33	9.5	<0.05	<0.10	60	**32**

Site ID	Well Depth (feet)	Sample Date	Ammonia[a] (mg/L)	Arsenic (µg/L)	Bromide[a] (mg/L)	Chloride (mg/L)	Fluoride (mg/L)	Nitrate (mg/L)	Nitrite (mg/L)	Ortho-phosphate[a] (mg/L)	Sulfate (mg/L)	Uranium (µg/L)
1983	97	09/11/2012	<0.10	14	<0.10	2.6	0.28	<0.05	<0.05	<0.10	16	NA
2012	142	09/12/2012	NA	7.8	<0.10	2.7	<0.15	0.92	<0.05	<0.10	19	NA
2003	78	09/26/2012	NA	3.8	0.11	13	0.26	6.0	<0.05	<0.10	51	NA
2008	80	09/11/2012	<0.10	6.4	<0.10	2.3	0.43	0.32	<0.05	<0.10	12	NA
2053	98	09/05/2012	NA	5.1	<0.10	7.8	0.26	8.90	<0.05	<0.10	23	78
1969	81	09/18/2012	NA	17	<0.10	7.2	0.67	6.6	<0.05	<0.10	52	NA
1989	94	09/26/2012	NA	26	0.41	62	0.41	6.1	<0.05	<0.10	240	53
2011	100	09/11/2012	NA	<2.0	0.16	20	0.22	1.9	<0.05	<0.10	58	NA
2010	90	09/11/2012	NA	2.8	0.13	14	1.0	1.1	<0.05	<0.10	45	NA
2014	197	09/12/2012	NA	<2.0	<0.10	10	0.52	3.9	<0.05	<0.10	46	NA
2047	75	09/12/2012	NA	4.0	<0.10	9.8	0.33	3.8	<0.05	0.12	81	76
2055	72	09/04/2012	1.8	30	0.15	37	0.45	<0.05	<0.05	<0.10	120	NA
2009	69	09/11/2012	NA	2.2	0.12	21	<0.15	7.7	<0.05	<0.10	76	NA
2060	44	09/04/2012	NA	14	<0.10	17	0.41	7.9	<0.05	<0.10	66	NA
2018	137	09/12/2012	NA	6.9	<0.10	5.0	0.46	2.8	<0.05	<0.10	29	NA
1990	58	09/26/2012	NA	17	0.23	45	0.46	8.7	<0.05	<0.10	98	NA
2050	93	09/05/2012	NA	3.2	<0.10	13	0.27	3.6	<0.05	<0.10	14	NA
2004	37	09/25/2012	NA	2.9	<0.10	23	0.20	1.9	<0.05	0.19	90	NA
2002	440	09/26/2012	<0.10	4.6	<0.10	15	1.30	<0.05	<0.05	<0.10	65	NA
2016	63	09/12/2012	NA	25	<0.10	8.4	0.82	5.1	<0.05	<0.10	69	NA
1978	102	09/18/2012	NA	<2.0	<0.10	10	<0.15	9.3	<0.05	<0.10	47	NA
1985	62	09/11/2012	NA	5.2	<0.10	2.6	0.64	1.4	<0.05	<0.10	8.3	NA
2046	240	09/12/2012	NA	<2.0	0.14	25	<0.15	4.4	<0.05	<0.10	67	73
1980	80	09/18/2012	NA	<2.0	0.38	44	0.26	5.1	<0.05	<0.10	170	35
1974	132	09/18/2012	NA	4.3	0.17	18	0.25	4.0	<0.05	<0.10	87	NA
1959	140	09/19/2012	NA	6.9	<0.10	3.0	0.51	1.1	<0.05	<0.10	18	NA
1958	134	09/19/2012	NA	4.0	<0.10	7.0	0.73	4.3	<0.05	<0.10	59	NA
1988	128	09/26/2012	0.49	4.9	<0.10	6.4	0.58	0.13	<0.05	<0.10	20	NA

Site ID	Well Depth (feet)	Sample Date	Ammonia[a] (mg/L)	Arsenic (µg/L)	Bromide[a] (mg/L)	Chloride (mg/L)	Fluoride (mg/L)	Nitrate (mg/L)	Nitrite (mg/L)	Ortho-phosphate[a] (mg/L)	Sulfate (mg/L)	Uranium (µg/L)
1995	190	10/17/2012	NA	**19**	<0.10	2.1	0.79	1.4	<0.05	<0.10	17	NA
2000	90	10/17/2012	NA	**12**	<0.10	3.7	0.55	2.9	<0.05	<0.10	11	NA
2066	107	10/11/2012	NA	2.7	<0.10	19	0.38	**12**	<0.05	<0.10	31	NA
1998	70	10/17/2012	1.3	<2.0	0.49	91	0.29	<0.05	<0.05	<0.10	*290*	NA
2064	423	10/11/2012	<0.10	<2.0	<0.10	13	0.90	<0.05	<0.05	<0.10	46	NA
2067	143	10/11/2012	NA	**15**	<0.10	7.7	0.72	5.5	<0.05	<0.10	22	NA
1997	80	10/17/2012	NA	3.3	<0.10	12	0.35	7.5	<0.05	<0.10	51	NA
2001	440	10/17/2012	<0.10	7.9	<0.10	12	0.73	<0.05	<0.05	<0.10	65	NA
1840	47	04/04/2012	2.9	<2.0	0.13	26	0.47	<0.05	<0.05	<0.10	24	NA
1999	201	10/17/2012	NA	**16**	<0.10	2.6	0.60	2.6	<0.05	<0.10	14	NA
2045	105	11/06/2012	NA	**24**	<0.10	25	0.64	7.4	<0.05	<0.10	83	NA
2043	65	11/06/2012	NA	2.4	0.40	21	<0.15	4.9	<0.05	<0.10	110	NA
2039	70	11/08/2012	NA	**26**	<0.10	13	0.52	4.6	<0.05	<0.10	53	NA
2041	73	11/08/2012	<0.10	**14**	<0.10	13	0.66	0.14	<0.05	<0.10	57	NA
2044	59	11/06/2012	<0.10	<2.0	<0.10	8.5	0.23	0.61	<0.05	<0.10	29	NA
2069	155	12/06/2012	0.93	7.4	0.25	27	0.40	<0.05	<0.05	<0.10	93	NA
2071	157	12/06/2012	NA	3.3	0.13	32	0.25	6.2	<0.05	<0.10	110	NA
2072	105	12/06/2012	2.3	7.5	0.15	23	0.67	<0.05	<0.05	<0.10	100	NA

Notes: Bolded red numbers indicate the maximum contaminant level was reached or exceeded. Italicized red numbers indicate EPA's National Secondary Drinking Water Regulation was exceeded.
mg/L = milligrams per liter; µg/L = micrograms per liter; NA = not available
[a] No primary or secondary health standard available.
[b] Dissolved oxygen remained above 2.0 until the pressure tank came on during the last reading.
[c] TD = technical difficulties. Sample not analyzed for ammonia although the DO was below 2.0.

Nitrate Results

Nitrate concentrations detected in the ground water samples collected from the 100 wells in the Ada/Canyon NPA ranged from <0.05 mg/L to 21 mg/L. Nitrate concentrations exceeded 5 mg/L in 47 of the 100 wells, and nitrate concentrations at 11 wells equaled or exceeded the MCL of 10 mg/L (2058, 1972, 2056, 1975, 1962, 2063, 2062, 1966, 2040, 2061, and 2066). Figure 9 shows a map of the nitrate concentrations in the entire Ada/Canyon NPA. Figure 10 through Figure 12 show larger-scale maps of the nitrate concentrations in the eastern, western, and southern areas of the NPA.

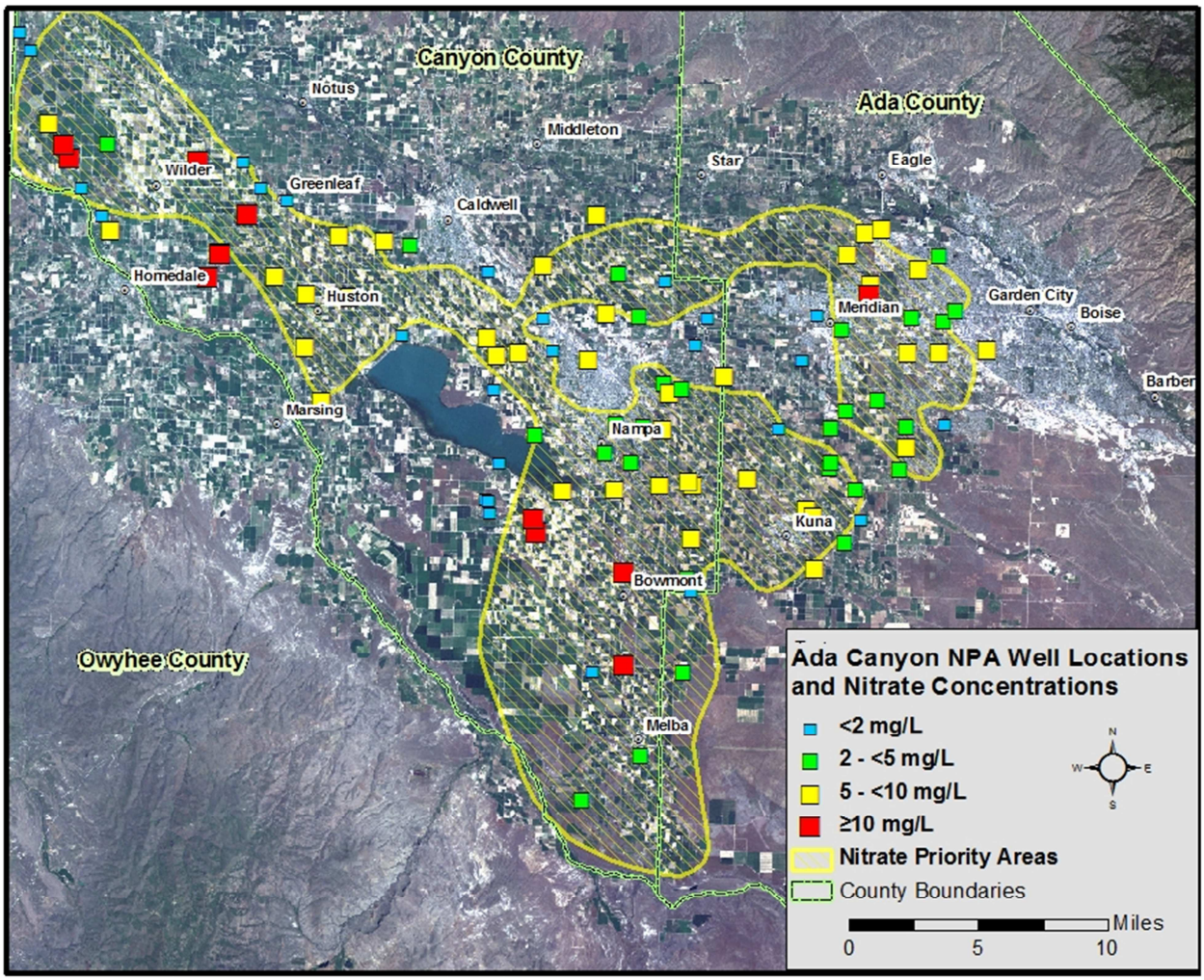


Figure 9. Well locations and nitrate concentrations—Ada/Canyon Nitrate Priority Area.

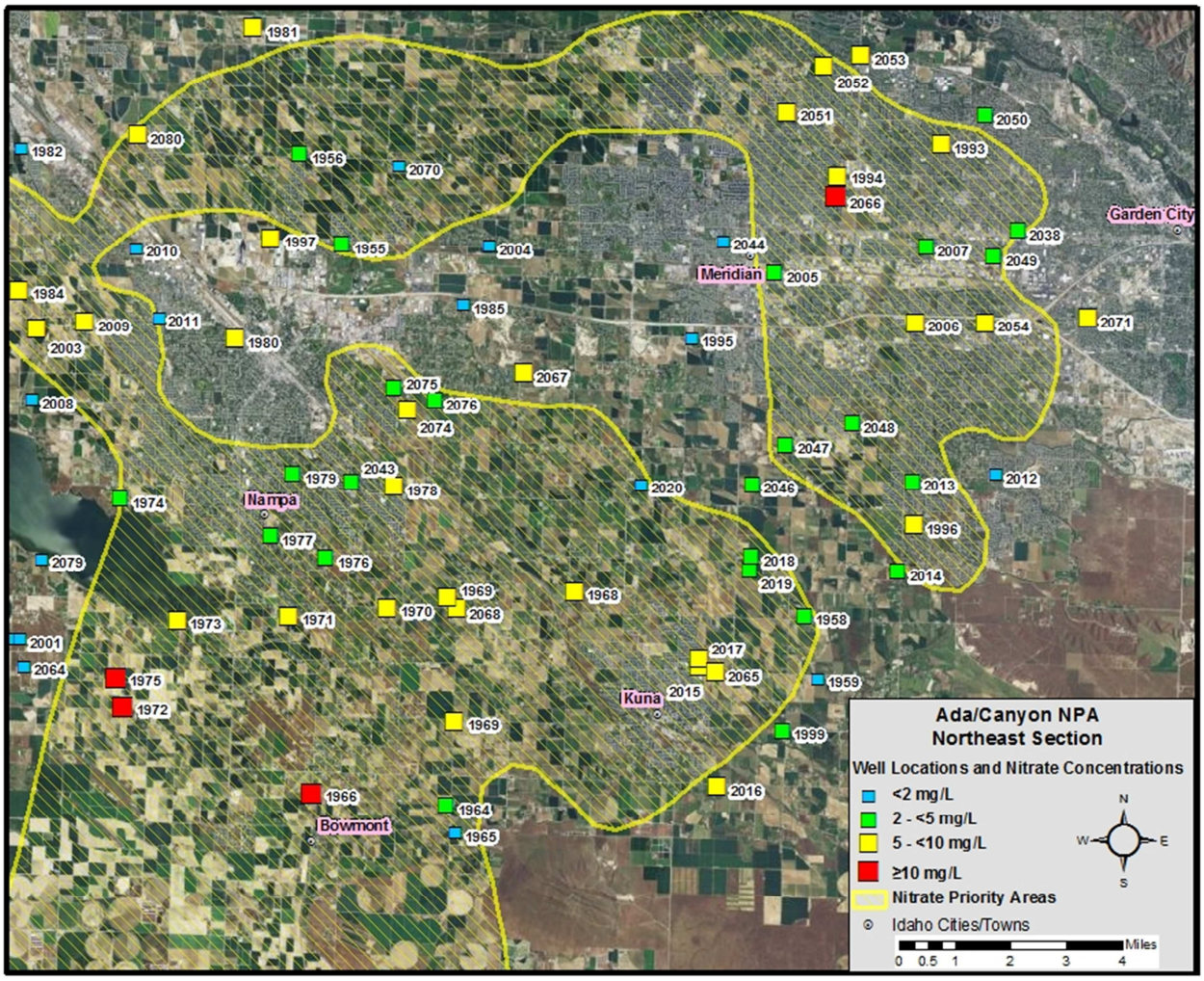


Figure 10. Well locations, well numbers, and nitrate concentrations—eastern Ada/Canyon Nitrate Priority Area.

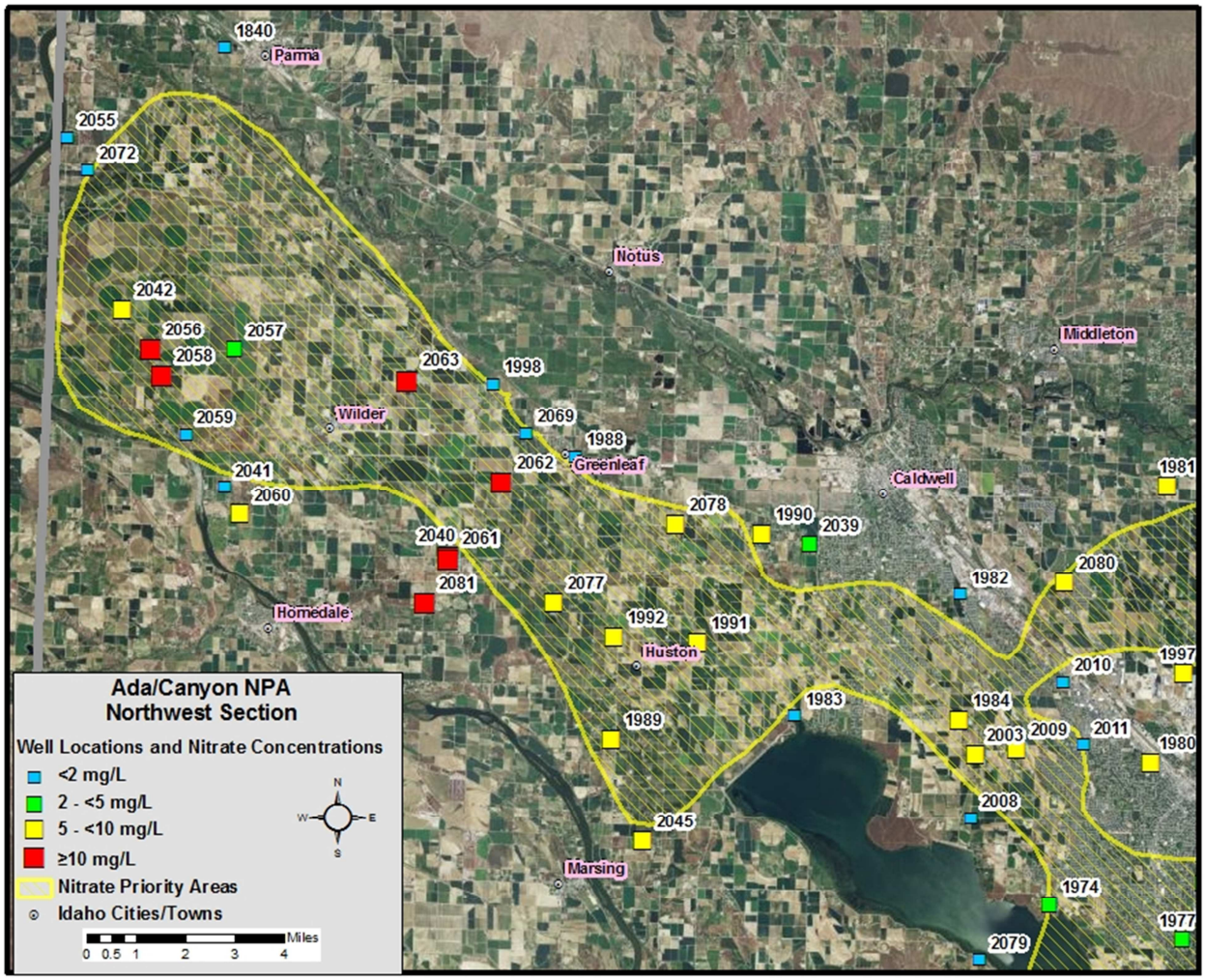


Figure 11. Well locations, well numbers, and nitrate concentrations—western Ada/Canyon Nitrate Priority Area.

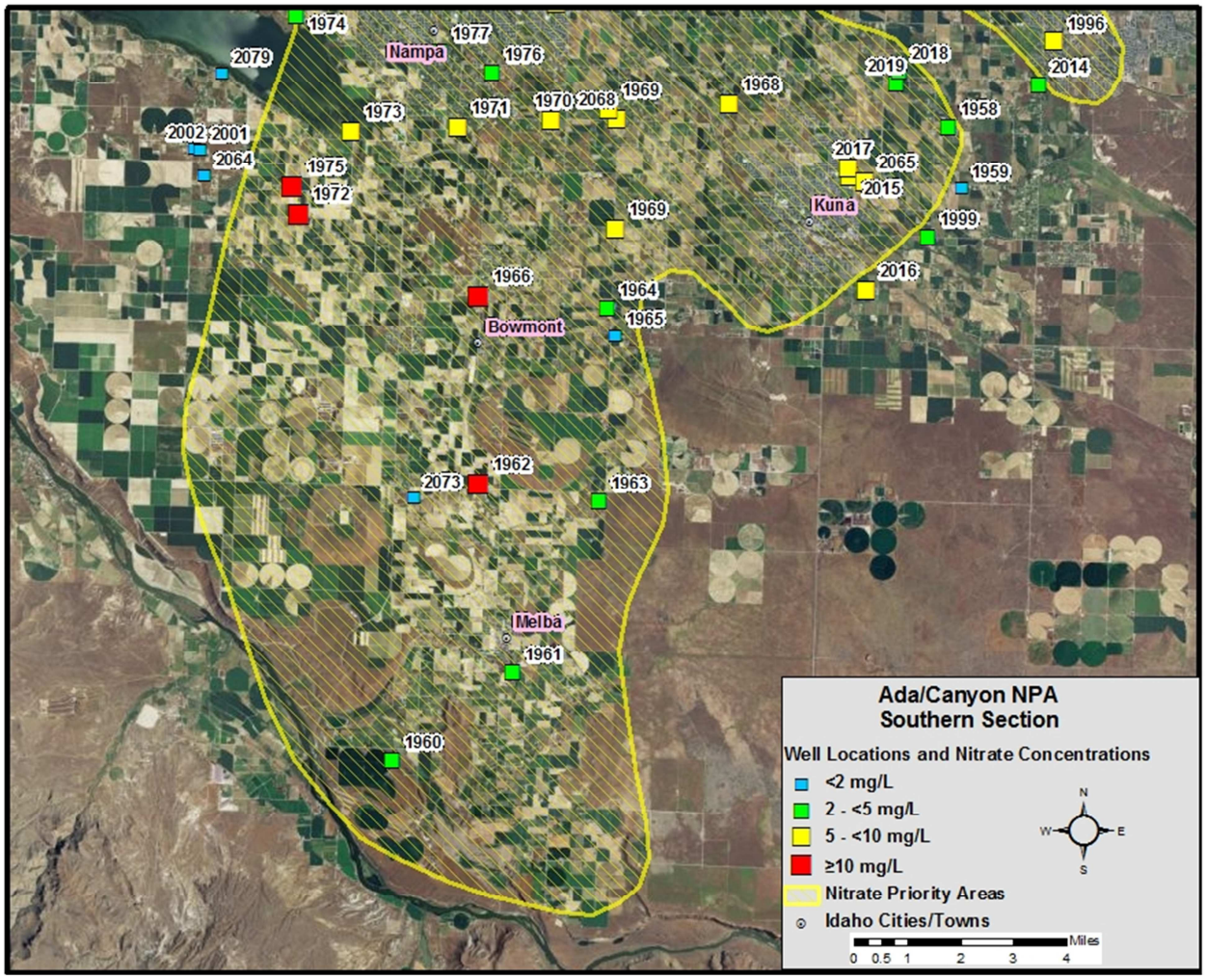


Figure 12. Well locations, well numbers, and nitrate concentrations—southern Ada/Canyon Nitrate Priority Area.

Arsenic Results

Arsenic concentrations detected in the ground water samples collected in the Ada/Canyon NPA ranged from not detected (less than 2 µg/L) to 67 µg/L (Table 12). The drinking water MCL for arsenic is 10 µg/L, and 43 of the 100 samples equaled or exceeded the MCL.

Chloride Results

Detections of chloride in the ground water samples ranged from 1.1 mg/L to 170 mg/L (Table 12). The NSDWR standard for chloride is 250 mg/L, based on aesthetic effects. All reported chloride concentrations were below this standard (Table 12).

Ammonia Results

Ammonia in ground water is often associated with impacts from sewage systems, livestock wastes, or nitrogen fertilizers; 22 ground water samples with DO concentrations less than 2 mg/L were analyzed for ammonia. Concentrations of ammonia detected in the ground water samples

ranged from not detected (less than 0.10 mg/L) to 2.90 mg/L (Table 12). There is no MCL or NSDWR standard for ammonia in ground water.

Sulfate Results

Concentrations of sulfate detected in the Ada/Canyon NPA ground water samples ranged from 5.2 mg/L to 560 mg/L. The NSDWR standard for sulfate is 250 mg/L, based on aesthetic effects. Three of the ground water samples exceeded the standard for sulfate.

Nitrogen Isotope Sampling

Nitrogen isotope ratio analysis was performed on all samples with nitrate detected at concentrations equal to or greater than 5 mg/L. A total of 45 samples were submitted for analysis. The $\delta^{15}N$ values for the Ada/Canyon NPA ground water samples ranged from 1.3‰ to 8.9‰ (Table 13). Samples from 13 wells had $\delta^{15}N$ values ranging from +1.3‰ to +4.0‰, and 32 samples had $\delta^{15}N$ values ranging from 4.1‰ to 9.0‰. As shown in Table 6, $\delta^{15}N$ values of -4 to +4 indicate commercial fertilizer as the typical nitrate source, and $\delta^{15}N$ values of +4 to +9 indicate organic nitrogen in soil or a mixed nitrogen source as the typical nitrate source.

Table 13. Bacteria and nitrogen isotope data—Ada/Canyon Nitrate Priority Area Ground Water Monitoring Project.

Site ID	Sample Depth (feet)	Sample Date	Total Coliform[a] (MPN/100 mL)	*E. coli* (MPN/100 mL)	$\delta^{15}N$[b] (‰)
1992	109	09/26/2012	<1	<1	5.0
1991	100	09/26/2012	<1	<1	5.0
2052	78	09/05/2012	<1	<1	7.5
2058	60	09/04/2012	1.0	<1	3.7
2051	66	09/05/2012	<1	<1	6.6
1972	85	09/18/2012	<1	<1	3.3
2057	84	09/04/2012	<1	<1	NA
2013	71	09/12/2012	<1	<1	NA
2054	82	09/05/2012	<1	<1	7.7
2007	75	09/25/2012	<1	<1	NA
1968	78	09/18/2012	<1	<1	5.3
2056	39	09/04/2012	<1	<1	3.6
2019	131	09/12/2012	<1	<1	NA
1960	110	09/19/2012	<1	<1	NA
2005	58	09/25/2012	<1	<1	NA
1979	120	09/18/2012	<1	<1	NA
1975	80	09/18/2012	<1	<1	3.0
2059	180	09/04/2012	<1	<1	NA
1973	80	09/18/2012	<1	<1	5.5
1956	82	09/11/2012	<1	<1	NA
1970	115	09/18/2012	8.6	<1	5.0
1969	104	09/19/2012	1.0	<1	6.5
1984	80	09/11/2012	<1	<1	3.6
1962	300	09/19/2012	2.0	<1	3.1
2006	98	09/19/2012	<1	<1	8.3
2049	89	09/05/2012	<1	<1	NA
1965	191	09/19/2012	<1	<1	NA
2063	41	09/04/2012	<1	<1	7.7
2062	34	09/04/2012	<1	<1	1.7
2015	80	09/12/2012	<1	<1	4.6
1971	85	09/18/2012	<1	<1	5.0
1955	60	09/11/2012	<1	<1	NA
2017	105	09/12/2012	<1	<1	4.9
1961	260	09/19/2012	<1	<1	NA
2048	83	09/12/2012	<1	<1	NA
1977	57	09/18/2012	<1	<1	NA
1964	288	09/19/2012	<1	<1	NA
1963	275	09/19/2012	<1	<1	NA
1976	83	09/18/2012	<1	<1	NA
1966	147	09/19/2012	<1	<1	2.7

Site ID	Sample Depth (feet)	Sample Date	Total Coliform[a] (MPN/100 mL)	*E. coli* (MPN/100 mL)	$\delta^{15}N$[b] (‰)
1994	81	09/25/2012	30.5	<1	7.3
2068	108	10/11/2012	<1	<1	5.5
2065	159	10/11/2012	<1	<1	4.4
1996	200	10/17/2012	<1	<1	8.2
2038	100	11/06/2012	<1	<1	NA
2042	46	11/08/2012	<1	<1	8.9
2040	80	11/08/2012	<1	<1	3.5
2070	34	12/06/2012	<1	<1	NA
2073	277	12/18/2012	<1	<1	NA
2075	60	12/18/2012	34.5	<1	NA
2074	70	12/18/2012	<1	<1	6.3
2061	72	09/04/2012	<1	<1	1.3
1982	38	09/11/2012	<1	<1	NA
2020	150	09/12/2012	<1	<1	NA
1983	97	09/11/2012	<1	<1	NA
2012	142	09/12/2012	<1	<1	NA
2003	78	09/26/2012	<1	<1	5.4
2008	80	09/11/2012	<1	<1	NA
2053	98	09/05/2012	8.6	<1	6.1
1969	81	09/26/2012	<1	<1	5.1
1989	94	09/26/2012	<1	<1	7.8
2011	100	09/11/2012	<1	<1	NA
2010	90	09/11/2012	<1	<1	NA
2014	197	09/12/2012	<1	<1	NA
2047	75	09/12/2012	<1	<1	NA
2055	72	09/04/2012	<1	<1	NA
2009	69	09/11/2012	1.0	<1	5.9
2060	44	09/04/2012	<1	<1	4.0
2018	137	09/12/2012	<1	<1	NA
1990	58	09/26/2012	<1	<1	4.1
2050	93	09/05/2012	<1	<1	NA
1957	79	09/11/2012	<1	<1	4.7
2004	37	09/25/2012	12.0	<1	NA
2002	440	09/26/2012	<1	<1	NA
2016	63	09/12/2012	1.0	<1	6.1
1978	102	09/18/2012	<1	<1	3.3
1985	62	09/11/2012	<1	<1	NA
2046	240	09/12/2012	<1	<1	NA
1980	80	09/18/2012	<1	<1	7.6
1974	132	09/18/2012	<1	<1	NA

Site ID	Sample Depth (feet)	Sample Date	Total Coliform[a] (MPN/100 mL)	*E. coli* (MPN/100 mL)	$\delta^{15}N$[b] (‰)
1959	140	09/19/2012	<1	<1	NA
1958	134	09/19/2012	<1	<1	NA
1988	128	09/26/2012	<1	<1	NA
1995	190	10/17/2012	<1	<1	NA
2000	90	10/17/2012	<1	<1	NA
2066	107	10/11/2012	<1	<1	6.0
1998	70	10/17/2012	7.5	<1	NA
2064	423	10/11/2012	<1	<1	NA
2067	143	10/11/2012	5.2	<1	4.8
1997	80	10/17/2012	<1	<1	3.7
2001	440	10/17/2012	<1	<1	NA
2045	105	11/06/2012	2.0	<1	7.2
2043	65	11/06/2012	<1	<1	NA
1840	47	04/04/2012	<1	<1	NA
1999	201	10/17/2012	<1	<1	NA
2039	70	11/08/2012	<1	<1	NA
2041	73	11/08/2012	<1	<1	NA
2044	59	11/06/2012	<1	<1	NA
2069	155	12/06/2012	<1	<1	NA
2071	157	12/06/2012	<1	<1	7.3
2072	105	12/06/2012	<1	<1	NA
1993	142	9/25/2012	<1	<1	7.8

Note: MPN/100 mL = most probable number per 100 milliliters; ‰ = per mil; NA = not analyzed
[a] A ground water quality standard does not exist.
[b] No primary, secondary, or advisory health standards available for isotopes.

Bacteria Results

Coliform bacteria include bacteria that are common in the environment (e.g., soil and ground water affected by surface water) and in the waste of warm-blooded animals. Analysis for TC bacteria is used as an indicator of the sanitary conditions of a water supply and potential impacts from human or animal waste. *E. coli* is a member of the coliform group, and detections of *E. coli* in ground water is an indication of potential contamination by animal or human waste. TC numbers greater than one indicate potential impacts to ground water from surface water or other surface sources and can be the result of surface water leakage into a well or around a well casing. *E. coli* numbers greater than one indicate a human or animal waste impact to ground water.

Of the Ada/Canyon NPA ground water samples, 13 reported positive results for the TC testing, with values ranging from 1 to 34.5 MPN/100 mL. None of the 100 ground water samples tested positive for *E. coli* (Table 13).

2.1.4.3 Conclusions

DEQ conducted a ground water monitoring project in the Ada/Canyon NPA to assess nitrate concentrations and evaluate ground water quality. The Ada/Canyon NPA has been identified as an area of nitrate impact to ground water based on ground water sampling performed by various state agencies. The Ada/Canyon NPA ground water monitoring project included using regional network design to calculate the size of the sampling unit for the NPA; using a statistical model developed for DEQ nitrate sampling projects to determine the number of samples needed to be statistically valid; reviewing IDWR well logs to identify wells likely sourced in shallow ground water; selecting potential wells to be sampled; contacting well owners for approval to collect water samples; collecting samples using procedures outlined in the FSP; and conducting laboratory analyses of the collected samples.

Nitrate was detected at a concentration of 5 mg/L or greater in 47% of the samples. Nitrate was detected at a concentration equal to or greater than the MCL of 10 mg/L in 11 samples (11%). The results of the nitrate isotope analyses indicated the nitrate source for the majority of samples with nitrate concentrations of 5 mg/L or greater was from fertilizer or a mixed source (organic source and/or fertilizer). The results of the nitrate isotope analyses indicated that the elevated nitrate concentrations were not from a human or animal waste source. A review of the well locations and concentrations of nitrate in the ground water samples does not indicate a point source for the nitrate.

Coliform bacteria were detected in 13 of the ground water samples collected for the Ada/Canyon NPA project, indicating the wells had potential impacts from surface water or other surface sources. However, *E. coli* was not detected in any of the ground water samples, indicating ground water at the sampled wells had not been impacted by human or animal wastes.

Arsenic was detected at a concentration equal to or greater than the MCL of 10 µg/L in approximately 43% of the ground water samples collected from the Ada/Canyon NPA. Previous studies (Mitchell 2004; Neely 2002) have identified elevated arsenic values in this area and in other areas of the western Snake River Plain (Baldwin and Wicherski 1994; Neely 2002). The elevated concentrations of arsenic in ground water may be due to naturally occurring arsenic in the granitic sediments found in the area of the Ada/Canyon NPA.

2.1.4.4 Recommendations

The ground water quality data for the Ada/Canyon NPA identified significant, apparent nonpoint source nitrate impacts to ground water in the study area. The data also indicate that the source of the nitrate is likely from a mixed source of naturally occurring nitrate and fertilizer. The most effective action that can be taken is public education, including outreach education directed at property owners on the appropriate use of commercial fertilizers and pesticides on their lawns and gardens, and education on proper maintenance of wells and septic systems.

DEQ recommends that property owners with private domestic drinking water wells sample their wells—prior to any water treatment system and as close to the well as possible—on an annual basis for bacteria, arsenic, and nitrate. Southwest District Health and the Central District Health Department can provide property owners with information and guidance.

DEQ should work with the ISDA to further evaluate land-use activities near wells with elevated nitrate concentrations and evaluate any existing BMPs or whether implementation of new BMPs should be made to protect ground water quality.

DEQ is currently assisting Ada and Canyon Counties in developing and implementing ground water quality improvement and drinking water source protection plans. These plans include outreach activities for private well owners and agricultural operators aimed at reducing source water contamination, including activities to reduce nitrate contamination.

2.1.5 Snake River Dairy Ground Water Monitoring Project

2.1.5.1 Purpose

The ISDA Dairy Bureau collects ground water samples from dairy wells for nitrate analysis during annual facility inspections. When the nitrate concentration exceeds the MCL of 10 mg/L, ISDA provides the information to DEQ. DEQ's review of ISDA data for the Snake River Dairy LLC (Snake River Dairy; ISDA Dairy Number DY16010902) identified multiple nitrate concentrations exceeding 10 mg/L since 1999. Figure 13 shows a summary of ISDA sample analyses for the Snake River Dairy well. In 2012, DEQ conducted a monitoring project to assess ground water quality in the area downgradient of the Snake River Dairy and evaluate potential impacts of the dairy on ground water quality.

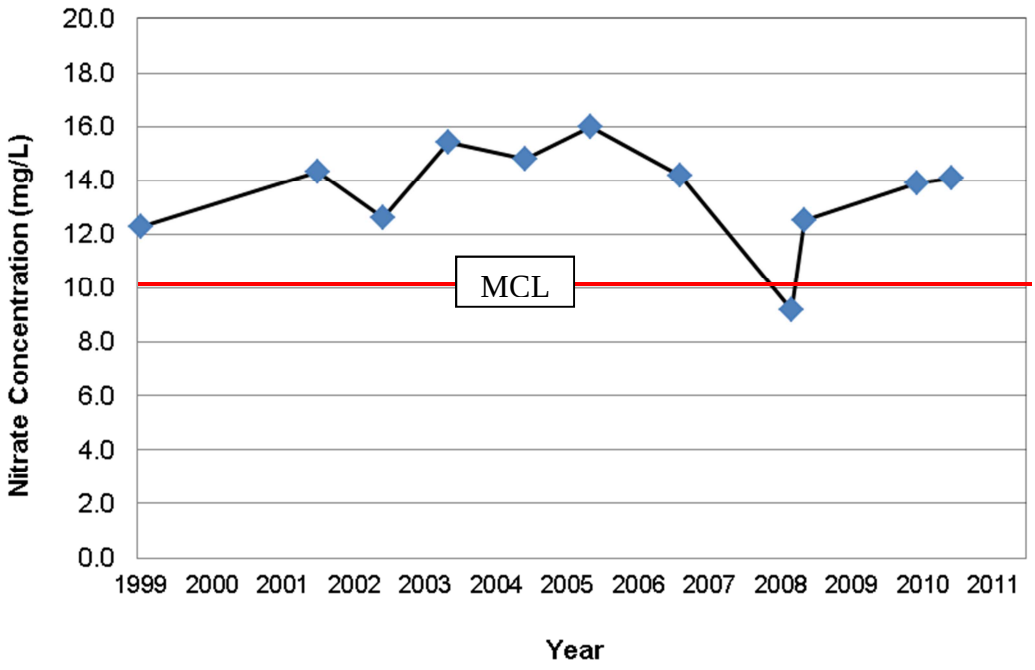


Figure 13. Idaho State Department of Agriculture nitrate data for the Snake River Dairy well.

The Snake River Dairy is located approximately 2 miles southeast of Melba, Idaho, and is approximately 4 miles northeast of the Snake River. Land use surrounding the dairy is generally agricultural, with undeveloped rangeland located to the east. Ground water in the Melba area has been mapped by the IDWR (1992) as flowing in a general southwest direction toward the Snake

River. Figure 14 shows the location of the dairy properties, ground water elevation contours, and ground water flow direction.

2.1.5.2 Methods and Results

DEQ used the IDWR's online database to identify well logs for water wells near the Snake River Dairy. The dairy's well is reported to be approximately 250 feet deep, and well logs in the area that listed both well addresses and well depths of approximately 300 feet or less were plotted on a map. DEQ selected potential wells for sampling based on their distribution adjacent to or downgradient of the dairy. The well owners were contacted, and DEQ received written permission to collect samples from 12 domestic wells located to the west or southwest (downgradient) of the dairy properties and from 1 well northeast (upgradient) of the dairy properties. Figure 14 shows the locations of the sampled wells.

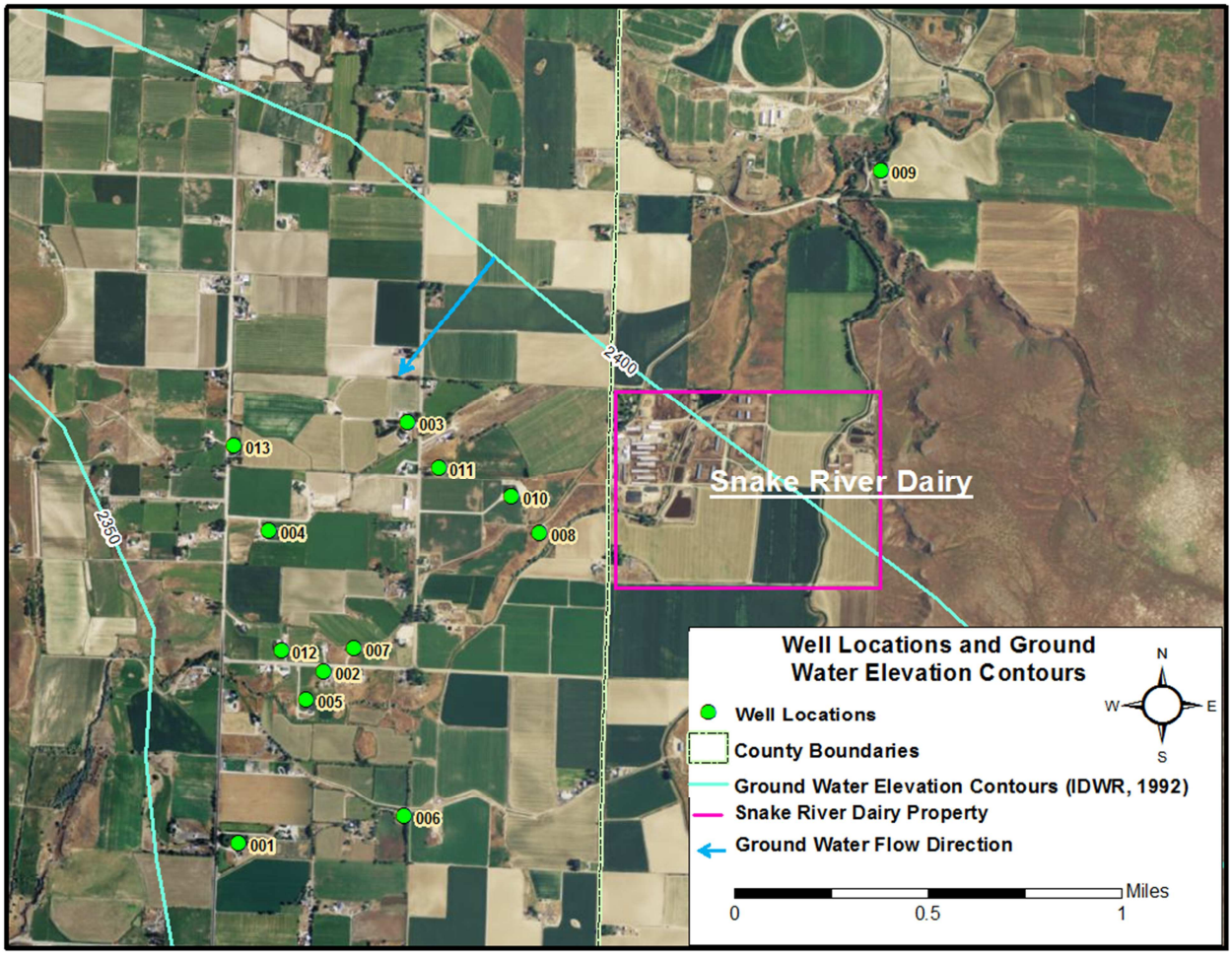


Figure 14. Location of the Snake River Dairy, sampled wells, ground water elevation contours, and general ground water flow direction.

Based on the well drillers' observations and their lithologic descriptions reported in the logs, the geology of the project area appears to consist of layers of solid volcanic rock (basalt/lava) and broken/fractured volcanic rock; a few well logs reported layers of interbedded clay and sand. Ground water was generally reported as being found in broken/fractured rock layers at depths

ranging from 80 to 230 feet below the surface, with water levels in the majority of the wells reported at depths ranging from 90 to 130 feet.

The monitoring project activities were conducted following the procedures outlined in the FSP (DEQ 2012f), health and safety plan (DEQ 2012g), and QAPP (DEQ 2012h). From March 12–15, 2012, DEQ collected ground water samples from 13 wells. DEQ also collected two duplicate samples and one blank sample for quality assurance/quality control (QA/QC) purposes as outlined in the FSP (DEQ 2012f).

Prior to sample collection, the wells were pumped for 15 or more minutes, and field parameters (pH, temperature, specific conductance, DO, and turbidity) were measured in the discharge water at approximately 5-minute intervals. Stabilization of pH, temperature, and specific conductance (consecutive measurements within specified limits) indicates stagnant water in the well has been removed and fresh ground water is being sampled. In a deviation from the FSP, DEQ collected water samples from the following wells after two consecutive measurements with stabilized field parameter values, not three as outlined in the FSP: project wells 001, 004, 005, 006, 009, 010, 011, and 012.

Samples were submitted to the UIASL in Moscow for analysis of anions (nitrate, nitrite, chloride, sulfate, fluoride, bromide, and orthophosphate). Samples were submitted to the IBL in Boise for analysis of arsenic, *E. coli*, and TC. Nitrogen isotope samples were collected at each sampling location and frozen and stored at DEQ pending nitrate analysis. After DEQ received nitrate analysis results, those nitrogen isotope samples from wells with nitrate concentrations greater than 5 mg/L were sent to the University of Arizona Environmental Isotope Geosciences Laboratory in Tucson for nitrogen isotope analysis. A review of the QA/QC objectives for the project indicated the objectives were met with the exception of the anion analysis of the blank sample. The analytical laboratory added an incorrect preservative acid to the blank sample, and the sample was not analyzed.

Nitrate Sampling

Nitrate was detected in 11 of the 13 domestic water samples at concentrations ranging from 1.1 mg/L to 12 mg/L. Nitrate concentrations in 2 wells (002 and 005) equaled or exceeded the MCL of 10 mg/L, and nitrate was not detected (<0.05 mg/L) in 2 wells (010 and 011) (Figure 15; Table 14).

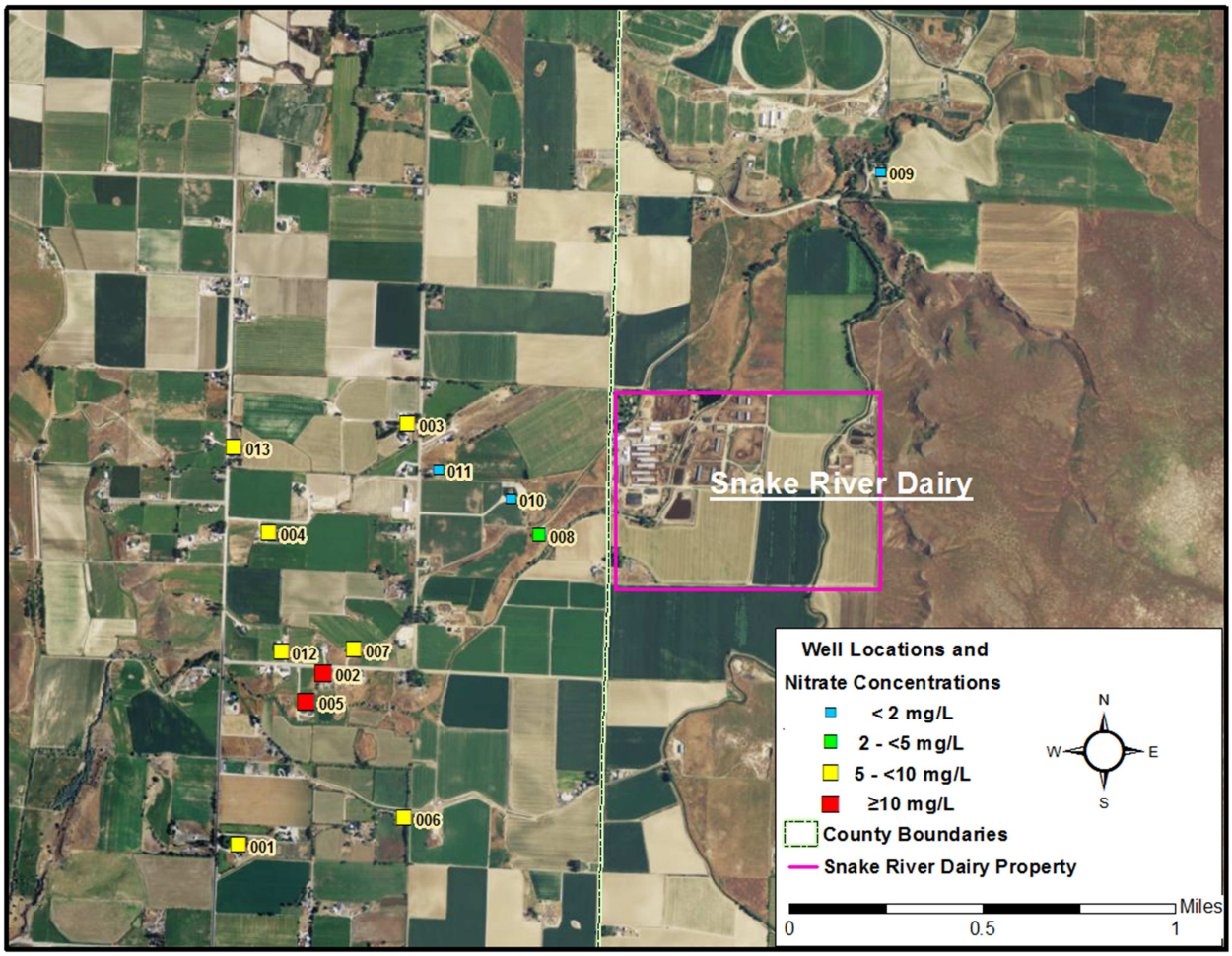


Figure 15. Well location and nitrate concentrations—Snake River Dairy Ground Water Monitoring Project.

Table 14. Analytical results—Snake River Dairy Ground Water Monitoring Project.

DEQ Site ID	Project Well Name	Well Depth (feet)	Date Sampled	Nitrate	Fluoride	Chloride	Nitrite	Bromide	o-Phosphate	Sulfate	Arsenic	T. Coliform	E. coli	$\delta^{15}N$
				(milligrams per liter)							(µg/L)	(MPN/100 mL)		(‰)
1638	001	115	3/13/2012	7.4	0.54	5.3	<0.05	<0.1	<0.1	17	**11**	<1	<1	3.2
1639	002	158	3/13/2012	**12**	0.47	11	<0.05	<0.1	<0.1	50	8.9	<1	<1	3.1
1640	003	170	3/12/2012	6.7	0.30	9.6	<0.05	<0.1	<0.1	46	**14**	<1	<1	6.2
1641	004	188	3/13/2012	6.0	0.75	7.9	<0.05	<0.1	<0.1	29	8.3	<1	<1	3.6
1642	005	136	3/12/2012	**12**	0.45	13	<0.05	<0.1	<0.1	60	9.3	<1	<1	3.0
1643	006	150	3/13/2012	5.3	0.61	25	<0.05	0.12	<0.1	110	**58**	**6.3**	<1	3.0
1644	007	232	3/12/2012	8.4	0.47	14	<0.05	<0.1	<0.1	77	**12**	<1	<1	3.2
1645	008	248	3/15/2012	3.7	0.28	5.9	<0.05	<0.1	<0.1	18	<2.0	<1	<1	NA
1646	009	298	3/15/2012	1.1	0.26	4.1	<0.05	<0.1	<0.1	36	3.0	<1	<1	NA
1647	010	270	3/12/2012	<0.05	0.26	11	<0.05	<0.1	<0.1	33	4.7	<1	<1	NA
1649	011	186	3/13/2012	<0.05	0.26	10	<0.05	<0.1	<0.1	47	7.9	<1	<1	NA
1650	012	172	3/12/2012	9.8	0.45	7.7	<0.05	<0.1	<0.1	32	8.7	<1	<1	3.5
1648	013	141	3/13/2012	7.4	0.47	8.2	<0.05	<0.1	<0.1	48	**12**	<1	<1	3.3

Notes: Bolded red numbers indicate the maximum contaminant level was reached or exceeded. No constituents exceeded EPA's National Secondary Drinking Water Regulation.

O-phosphate = orthophosphate; µg/L = micrograms per liter; MPN/100 mL = most probable number per 100 milliliters; ‰ = permil; NA = not analyzed

[a] No primary or secondary health standard available.

[b] A ground water quality standard does not exist.

[c] No primary, secondary, or advisory health standards available for isotopes.

Arsenic Sampling

Arsenic was detected in 12 of the 13 domestic water samples at concentrations ranging from 3.0 µg/L to 58 µg/L. Arsenic concentrations in 5 wells (001, 003, 006, 007, and 0013) equaled or exceeded the MCL of 10 µg/L (Table 14).

Elevated arsenic concentrations have been identified in southwest Idaho (Baldwin and Wicherski 1994; Neely 2002) and may be sourced from naturally occurring arsenic in the sediments found in the valley and other areas in the western Snake River plain (Neely 2002; Mitchell 2004; Parliman 1982).

Nitrogen Isotope Sampling

Nitrate was detected in 9 wells at concentrations greater than 5.0 mg/L, and these samples were submitted for nitrogen isotope ratio analyses ($\delta^{15}N$). The $\delta^{15}N$ values for the 9 wells ranged from 3.0‰ to 6.2‰. The $\delta^{15}N$ values for 8 of the nitrate-impacted wells downgradient of the Snake River Dairy indicate the nitrate source appears to be commercial fertilizer, with $\delta^{15}N$ values at 1 well indicating a source of organic nitrogen in soil or a mixed nitrogen source.

Bacteria Results

Coliform bacteria include bacteria that are found in the environment (soil and ground water affected by surface water) and in the waste of warm-blooded animals. Analysis for TC bacteria is used as a general evaluation of the sanitary conditions of a water supply. TC bacteria numbers equal to or greater than 1 MPN (most probable number of colonies per 100 milliliters of sample) indicate potential impacts to ground water from surface water or other surface sources and are often the result of surface water leakage into a well casing.

E. coli is a member of the coliform group, and detections of *E. coli* in a ground water sample is an indication of potential contamination by animal or human waste. *E.coli* numbers equal to or greater than 1 MPN indicate likely human or animal waste impact to ground water.

Of the 13 ground water samples analyzed during the Snake River Dairy project, one sample tested positive for TC bacteria with an MPN of 1. None of the ground water samples tested positive for *E. coli* bacteria (Table 14).

2.1.5.3 Conclusions

DEQ assessed ground water quality at water wells downgradient of the Snake River Dairy following detections of elevated nitrate concentrations in annual ground water samples collected at the dairy by the ISDA. The project included preparing an FSP, reviewing IDWR well logs for wells located in the immediate dairy area, selecting potential wells to be sampled, contacting well owners for approval to collect water samples, sampling, and conducting laboratory analyses of the water samples. Based on DEQ's review of the locations of the sampled wells and the analytical and isotopic data for the water samples, it does not appear that animal waste at the Snake River Dairy is the source of nitrate impacts to ground water downgradient of the dairy.

2.1.5.4 Recommendations

Land-use activities near the water wells with nitrate concentrations near or exceeding 10 mg/L should be evaluated to assess what potential BMPs for fertilizer use could be implemented or improved to protect ground water from future contamination. Well owners are encouraged to test their wells annually for nitrate and arsenic.

2.1.6 Hamilton Gas Field Ground Water Monitoring Project

2.1.6.1 Purpose

Production quantities of gas have been discovered in southwestern Idaho. Two gas fields have been identified in Payette County: the Hamilton Field underlies the area surrounding the town of New Plymouth, while the Willow Field underlies the foothills northeast of New Plymouth. The effects of gas field development on the environment in Idaho is unknown, and a baseline ground water study in the Hamilton Field area was performed to document ground water quality information prior to proposed gas production activities. Gas field development includes, but is not limited to, the drilling of gas wells and drilling-related activities, treatment of gas wells to increase production (e.g., hydraulic fracturing), and gas production and other production-related activities.

The Hamilton Gas Field Ground Water Monitoring Project was designed to provide baseline ground water quality data in the area surrounding six gas wells that have been permitted by the Idaho Department of Lands prior to production. Five of the six wells have already been drilled. A ground water monitoring network was created from selected residential wells and municipal wells from the New Plymouth Public Water System (PWS) to document existing ground water quality near the six gas wells.

2.1.6.2 Methods and Results

The six permitted Hamilton Gas Field wells were plotted on a map, and DEQ hand-delivered sampling permission request forms to owners of developed properties with drinking water wells located within a 0.25-mile radius of the gas wells. DEQ also reviewed the locations of the City of New Plymouth's PWS wells to identify wells with source water critical recharge zones located near the gas wells. DEQ received permission to collect samples from 12 residential wells and 4 of the City of New Plymouth's wells. Figure 16 shows the locations of the gas wells, residential wells, and PWS wells.

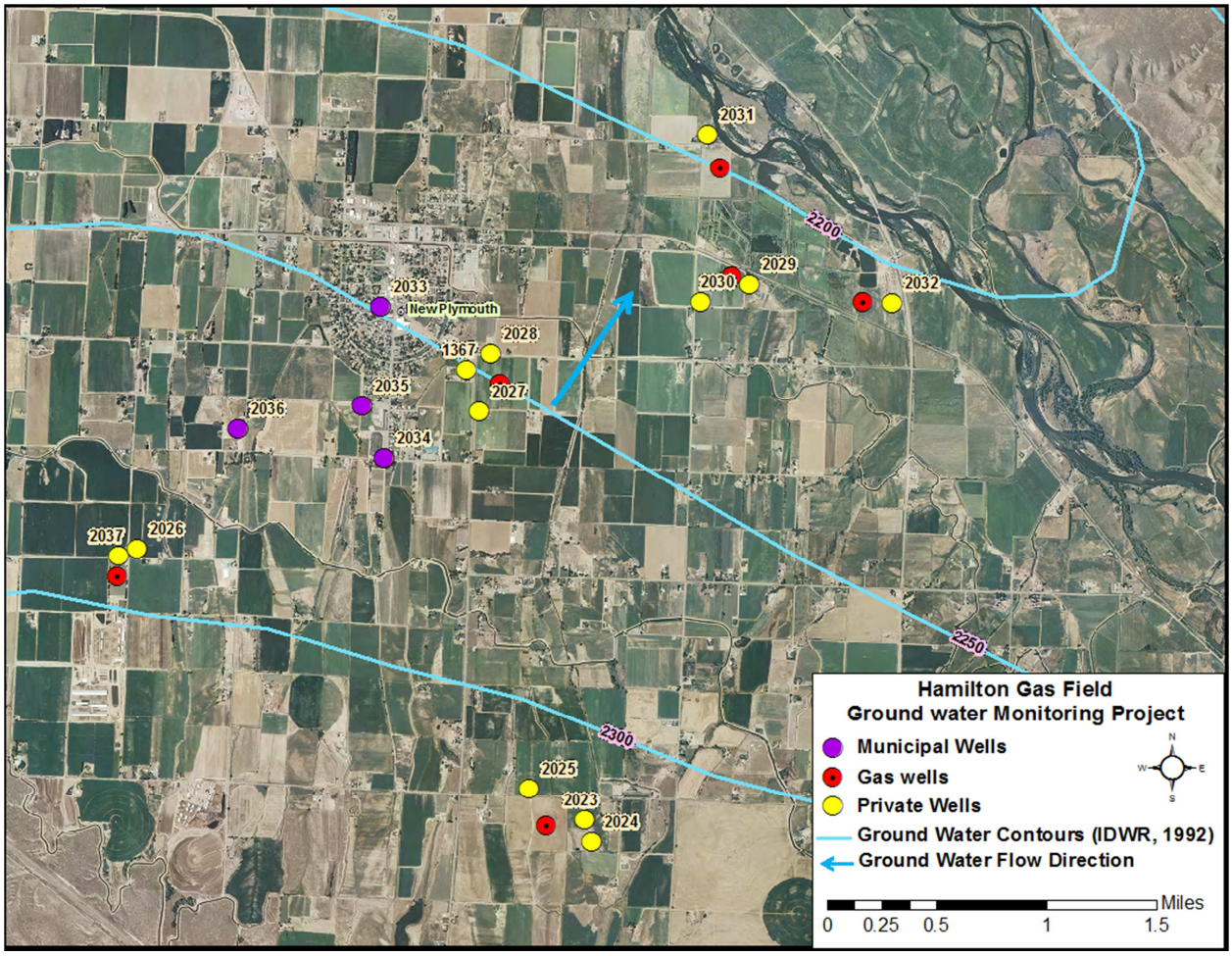


Figure 16. Location of Hamilton Gas Fields production wells, sampling network wells (private and municipal), and DEQ site IDs—Hamilton Gas Field Ground Water Monitoring Project.

DEQ reviewed the IDWR online database to identify well drillers' reports for the wells selected for the network. Reports for 4 of the residential wells and the 4 PWS wells were identified.

On November 13 and 14, 2012, DEQ collected water samples from the domestic and PWS wells using procedures outlined in the QAPP (DEQ 2012i) and FSP (DEQ 2012j). Water quality field parameters (pH, temperature, specific conductivity, and DO) were measured at each well prior to sample collection (Table 15).

The water samples were delivered to four analytical laboratories using procedures outlined in the FSP. The UIASL in Moscow analyzed the samples for common ions (fluoride, nitrite, nitrate, chloride, sulfate, bromide, and orthophosphate) (Table 16); total dissolved solids (TDS) and alkalinity (Table 17); metals (arsenic, barium, boron, cadmium, calcium, chromium, cobalt, copper, iron, lead, magnesium, manganese, molybdenum, nickel, potassium, selenium, sodium, uranium, vanadium, and zinc) (Table 18; Table 19); dissolved methane; benzene, toluene, ethylbenzene, and xylenes (BTEX); and for total petroleum hydrocarbons - diesel range organics (TPH-D) (Table 20). The UIASL subcontracted the dissolved methane analysis to Accutest Laboratories in Wheat Ridge, Colorado, and the BTEX and TPH-D analysis to Anatek Labs, Inc., in Moscow, Idaho. IBL in Boise, Idaho, analyzed the samples for TC and *E. coli* (Table 17).

Table 15. Water quality field parameters—Hamilton Gas Field Ground Water Monitoring Project.

DEQ Site ID	Well Depth (feet)	Sample Date	pH	Water Temperature[a] (℃)	Specific Conductivity[a] (µS/cm)	Dissolved Oxygen[a] (mg/L)
1367	Unknown	11/13/2012	*8.90*	14.1	447	0.20
2023	129	11/13/2012	*8.65*	15.4	814	6.47
2024	145	11/13/2012	*8.67*	15.5	794	7.34
2025	Unknown	11/14/2012	7.51	15.7	694	7.04
2026	150	11/14/2012	*8.73*	16.0	270	0.00
2027	Unknown	11/13/2012	*8.85*	14.4	473	5.23
2028	Unknown	11/13/2012	*8.77*	14.0	596	5.37
2029	Unknown	11/14/2012	7.79	16.3	491	5.70
2030	Unknown	11/14/2012	7.74	15.5	475	4.13
2031	Unknown	11/14/2012	*8.32*	15.5	194	0.00
2032	Unknown	11/14/2012	*9.41*	14.0	192	0.00
2033	78	11/13/2012	*8.99*	14.3	558	5.81
2034	100	11/13/2012	*9.05*	14.4	485	4.47
2035	80	11/13/2012	*9.02*	13.8	600	6.50
2036	216	11/13/2012	*10.29*	16.1	152	3.88
2037	101	11/14/2012	7.72	15.0	713	3.83

Notes: Italicized red numbers indicate EPA's National Secondary Drinking Water Regulation (NSDWR) standard was reached or exceeded. However, field measurements should be considered estimates and are not used for determining violations of NSDWR standards. The pH standard is 6.5-8.5 pH units.
mg/L = milligrams per liter; µS/cm = microsiemens per centimeter; ℃ = degrees Celsius
[a] No primary or secondary health standard available.

Table 16. Common ion results—Hamilton Gas Field Ground Water Monitoring Project.

DEQ Site ID	Well Depth (feet)	Sample Date	Bromide[a]	Chloride	Fluoride	Nitrite	Nitrate	O-phosphate[a]	Sulfate
			(milligrams per liter)						
1367	Unknown	11/13/2012	0.12	28	0.27	<0.05	0.37	<0.10	49
2023	129	11/13/2012	0.17	28	0.25	<0.05	4.7	<0.10	76
2024	145	11/13/2012	0.14	22	0.29	<0.05	4.5	0.18	66
2025	Unknown	11/14/2012	0.21	36	0.24	<0.05	2.0	<0.10	73
2026	150	11/14/2012	0.28	53	0.19	<0.05	<0.05	<0.10	84
2027	Unknown	11/13/2012	<0.10	7.2	0.49	<0.05	3.7	<0.10	10
2028	Unknown	11/13/2012	<0.10	7.0	0.42	<0.05	6.4	<0.10	31
2029	Unknown	11/14/2012	<0.10	2.2	0.60	<0.05	0.97	0.11	5.6
2030	Unknown	11/14/2012	<0.10	4.5	0.56	<0.05	2.3	<0.10	10
2031	Unknown	11/14/2012	<0.10	1.5	0.55	<0.05	<0.05	<0.10	<0.20
2032	Unknown	11/14/2012	<0.10	3.3	0.36	<0.05	<0.05	<0.10	8.3
2033	78	11/13/2012	<0.10	11	0.36	<0.05	3.3	<0.10	31
2034	100	11/13/2012	<0.10	6.1	0.42	<0.05	2.4	<0.10	19
2035	80	11/13/2012	<0.10	17	0.33	<0.05	2.6	0.10	41
2036	216	11/13/2012	<0.10	2.0	0.36	<0.05	<0.05	<0.10	5.7
2037	101	11/14/2012	0.23	37	0.42	<0.05	1.6	<0.10	86

Notes: EPA's maximum contaminant level and National Secondary Drinking Water Regulation standards were not exceeded.
O-phosphate = orthophosphate.
[a] No primary or secondary health standard available.

Table 17. Bacteria, total dissolved solids, and alkalinity results—Hamilton Gas Field Ground Water Monitoring Project.

DEQ Site ID	Well Depth (feet)	Sample Date	Total Coliform (MPN/100 mL)[a]	*E. coli* (MPN/100 mL)	Total Dissolved Solids (mg/L)	Alkalinity[b] (as $CaCO_3$) (mg/L)
1367	Unknown	11/13/2012	<1	<1	290	150
2023	129	11/13/2012	<1	<1	*530*	350
2024	145	11/13/2012	<1	<1	*520*	350
2025	Unknown	11/14/2012	<1	<1	440	250
2026	150	11/14/2012	<1	<1	350	130
2027	Unknown	11/13/2012	<1	<1	280	240
2028	Unknown	11/13/2012	<1	<1	370	280
2029	Unknown	11/14/2012	<1	<1	310	270
2030	Unknown	11/14/2012	<1	<1	360	240
2031	Unknown	11/14/2012	<1	<1	140	110
2032	Unknown	11/14/2012	<1	<1	120	93
2033	78	11/13/2012	<1	<1	290	260
2034	100	11/13/2012	<1	<1	320	260
2035	80	11/13/2012	<1	<1	410	270
2036	216	11/13/2012	<1	<1	100	80
2037	101	11/14/2012	<1	<1	490	230

Notes: Italicized red numbers indicate EPA's National Secondary Drinking Water Regulation (NSDWR) standard was reached or exceeded. However, field measurements should be considered estimates and are not used for determining violations of NSDWR standards.
MPN/100 mL = most probable number per 100 milliliters; mg/L = milligrams per liter; $CaCO_3$ = calcium carbonate
[a] A ground water quality standard does not exist.
[b] No primary or secondary health standard available.

Table 18. Metals results—Hamilton Gas Field Ground Water Monitoring Project.

DEQ Site ID	Well Depth (feet)	Sample Date	Arsenic	Cadmium	Chromium	Lead[a]	Nickel[a]	Selenium	Uranium
			(micrograms per liter)						
1367	Unknown	11/13/2012	6.6	<0.10	<0.50	<3.0	<2.5	0.16	5.7
2023	129	11/13/2012	7.9	0.12	0.65	<3.0	<2.5	1.1	**32**
2024	145	11/13/2012	8.0	<0.10	0.57	<3.0	<2.5	0.94	26
2025	Unknown	11/14/2012	5.7	0.19	0.84	<3.0	<2.5	1.6	29
2026	150	11/14/2012	3.2	<0.10	<0.50	<3.0	<2.5	<0.10	<0.25
2027	Unknown	11/13/2012	**15**	<0.10	<0.50	<3.0	<2.5	0.17	4.4
2028	Unknown	11/13/2012	**18**	0.32	0.56	<3.0	<2.5	0.36	8.1
2029	Unknown	11/14/2012	**11**	<0.10	<0.50	<3.0	<2.5	<0.10	6.3
2030	Unknown	11/14/2012	**11**	<0.10	<0.50	<3.0	<2.5	0.18	5.2
2031	Unknown	11/14/2012	<0.10	0.13	<0.50	<3.0	<2.5	<0.10	<0.25
2032	Unknown	11/14/2012	0.73	<0.10	<0.50	<3.0	<2.5	<0.10	<0.25
2033	78	11/13/2012	8.9	0.16	0.50	<3.0	<2.5	0.36	7.6
2034	100	11/13/2012	**12**	<0.10	<0.50	<3.0	<2.5	0.31	7.2
2035	80	11/13/2012	8.8	<0.10	<0.50	<3.0	<2.5	0.60	10
2036	216	11/13/2012	1.4	<0.10	<0.50	<3.0	<2.5	<0.10	<0.25
2037	101	11/14/2012	6.9	<0.10	<0.50	<3.0	<2.5	2.2	15

Notes: Bolded red numbers indicate EPA's maximum contaminant level was reached or exceeded. No constituents exceeded EPA's National Secondary Drinking Water Regulation.

[a] No primary or secondary health standard available.

Table 19. Additional metals results—Hamilton Gas Field Ground Water Monitoring Project.

DEQ Site ID	Well Depth (feet)	Sample Date	Barium	Boron[a]	Calcium[a]	Cobalt[a]	Copper	Iron	Magnesium[a]	Manganese	Molybdenum[a]	Potassium[a]	Sodium[a]	Vanadium[a]	Zinc
			(milligrams per liter)												
1367	U	11/13/2012	0.086	0.22	53	<0.05	<0.02	<0.02	8.4	*0.10*	<0.10	2.0	29	<0.02	0.056
2023	129	11/13/2012	0.070	0.28	85	<0.05	<0.02	0.10	17	<0.005	<0.10	3.2	86	<0.02	0.024
2024	145	11/13/2012	0.067	0.32	74	<0.05	<0.02	0.087	15	<0.005	<0.10	3.2	87	<0.02	0.024
2025	U	11/14/2012	0.13	0.23	85	<0.05	<0.02	0.076	16	<0.005	<0.10	3.4	46	<0.02	0.045
2026	150	11/14/2012	0.099	0.20	80	<0.05	<0.02	*2.9*	3.9	*0.41*	<0.10	3.1	38	<0.02	0.029
2027	U	11/13/2012	0.063	0.34	54	<0.05	<0.02	<0.02	20	<0.005	<0.10	2.8	20	0.042	0.026
2028	U	11/13/2012	0.073	0.29	67	<0.05	<0.02	<0.02	21	<0.005	<0.10	2.3	34	0.042	0.038
2029	U	11/14/2012	0.054	0.28	52	<0.05	<0.02	<0.02	21	<0.005	<0.10	2.4	27	0.044	0.030
2030	U	11/14/2012	0.066	0.29	53	<0.05	<0.02	<0.02	20	<0.005	<0.10	1.8	25	0.043	0.032
2031	U	11/14/2012	0.025	0.21	10	<0.05	<0.02	0.024	2.8	*0.13*	<0.10	2.3	30	<0.02	0.024
2032	U	11/14/2012	0.024	0.26	7.1	<0.05	<0.02	*0.56*	0.79	0.038	<0.10	0.83	36	<0.02	0.018
2033	78	11/13/2012	0.053	0.28	52	<0.05	<0.02	0.021	12	<0.005	<0.10	2.8	60	0.02	0.027
2034	100	11/13/2012	0.044	0.26	50	<0.05	<0.02	<0.02	16	<0.005	<0.10	3.3	37	0.043	0.025
2035	80	11/13/2012	0.065	0.26	66	<0.05	<0.02	0.026	15	<0.005	<0.10	4.3	51	0.02	0.029
2036	216	11/13/2012	<0.010	0.19	6.7	<0.05	<0.02	<0.02	0.16	0.014	<0.10	0.72	30	<0.02	0.024
2037	101	11/14/2012	0.065	0.36	69	<0.05	<0.02	0.089	11	0.0060	<0.10	2.6	80	<0.02	0.028

Notes: No constituents exceeded EPA's maximum contaminant level. Italicized red numbers indicate EPA's National Secondary Drinking Water Regulation standard was reached or exceeded.
U = unknown
[a] No primary or secondary health standard available.

Table 20. Hydrocarbon results—Hamilton Gas Field Ground Water Monitoring Project.

DEQ Site ID	Well Depth (feet)	Sample Date	Benzene	Toluene	Ethylbenzene	m+p-xylene	O-xylene	TPH-Diesel[a]	Methane[a]
			(micrograms per liter)						(mg/L)
1367	Unknown	11/13/2012	<0.50	<0.50	<0.50	<1.00	<0.50	<0.10	<0.0008
2023	129	11/13/2012	<0.50	<0.50	<0.50	<1.00	<0.50	<0.10	<0.0008
2024	145	11/13/2012	<0.50	<0.50	<0.50	<1.00	<0.50	<0.10	<0.0008
2025	Unknown	11/14/2012	<0.50	<0.50	<0.50	<1.00	<0.50	<0.10	<0.0008
2026	150	11/14/2012	<0.50	0.77	<0.50	<1.00	<0.50	<0.10	<0.0008
2027	Unknown	11/13/2012	<0.50	<0.50	<0.50	<1.00	<0.50	<0.10	<0.0008
2028	Unknown	11/13/2012	<0.50	<0.50	<0.50	<1.00	<0.50	<0.10	<0.0008
2029	Unknown	11/14/2012	<0.50	<0.50	<0.50	<1.00	<0.50	<0.10	<0.0008
2030	Unknown	11/14/2012	<0.50	<0.50	<0.50	<1.00	<0.50	<0.10	<0.0008
2031	Unknown	11/14/2012	<0.50	<0.50	<0.50	<1.00	<0.50	<0.10	0.0876
2032	Unknown	11/14/2012	<0.50	<0.50	<0.50	<1.00	<0.50	<0.10	<0.0008
2033	78	11/13/2012	<0.50	<0.50	<0.50	<1.00	<0.50	<0.10	<0.0008
2034	100	11/13/2012	<0.50	<0.50	<0.50	<1.00	<0.50	<0.10	<0.0008
2035	80	11/13/2012	<0.50	<0.50	<0.50	<1.00	<0.50	<0.10	<0.0008
2036	216	11/13/2012	<0.50	<0.50	<0.50	<1.00	<0.50	<0.10	0.00205
2037	101	11/14/2012	<0.50	<0.50	<0.50	<1.00	<0.50	<0.10	<0.0008

Notes: EPA's maximum contaminant level or National Secondary Drinking Water Regulation standards were not exceeded.
m + p – xylene = meta-xylene plus para-xylene; O-xylene = orthoxylene; TPH = total petroleum hydrocarbons; mg/L = milligrams per liter
[a] No primary or secondary health standard available.

Arsenic Sampling

The arsenic concentrations ranged from nondetectable (<0.1 µg/L) to 18 µg/L; 5 wells exceeded the arsenic MCL of 10 µg/L (Table 18; Figure 17). Elevated arsenic values have been identified in this area by various studies (Baldwin and Wicherski 1994; Neely 2002; Mitchell 2004). Elevated arsenic values were also found in this area when samples were collected by DEQ for the Lower Payette NPA in 2011 (DEQ 2013b). These exceedances may be due to naturally occurring arsenic in the granitic sediments found in the lower Payette River valley (Neely 2002).

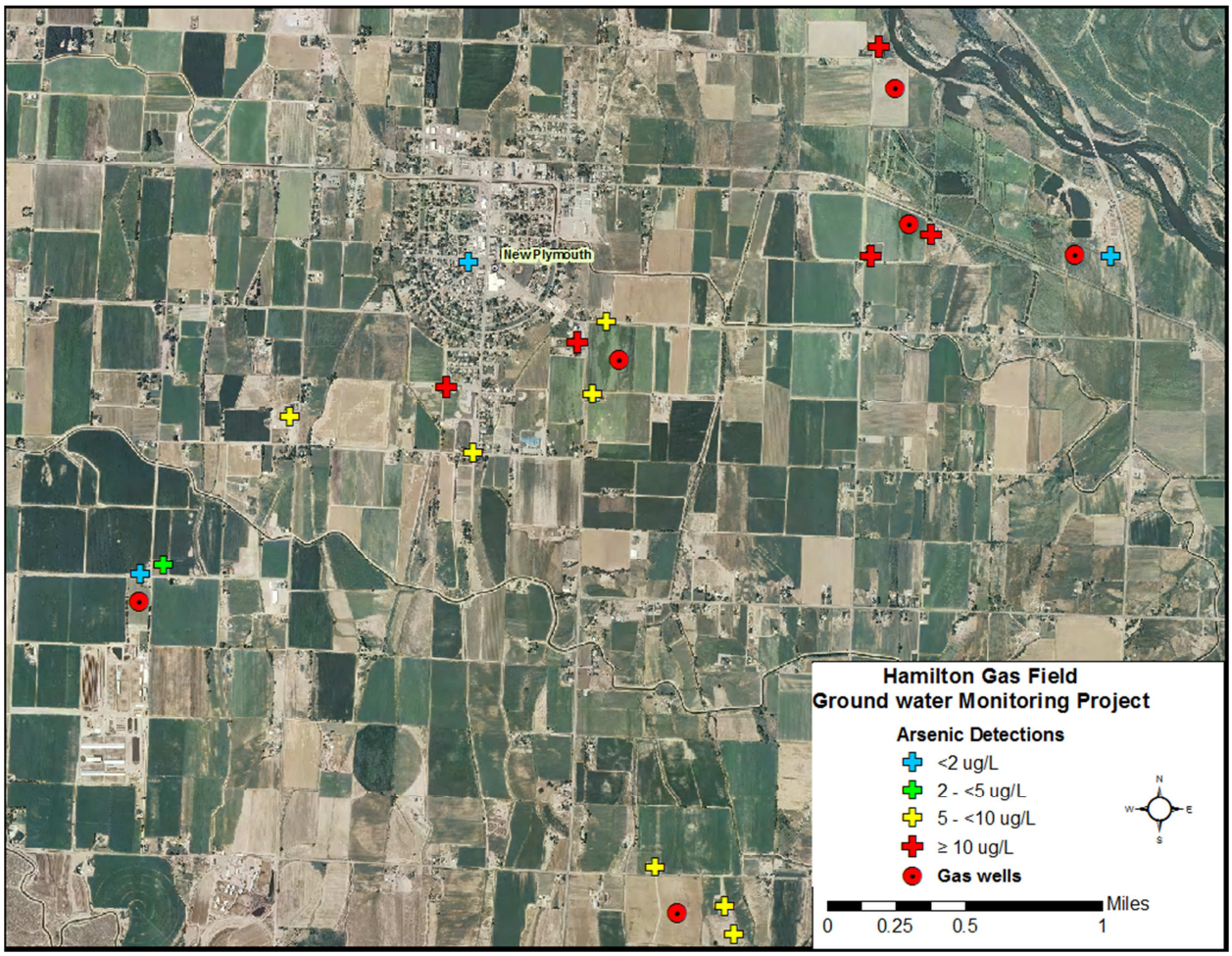


Figure 17. Arsenic detections—Hamilton Gas Field Ground Water Monitoring Project.

Uranium Sampling

The uranium concentrations ranged from nondetectable (<0.25 µg/L) to 32 µg/L; 1 well exceeded the uranium MCL of 30 µg/L (2023). The three highest uranium concentrations occurred in the southern portion of the project area (Figure 18).

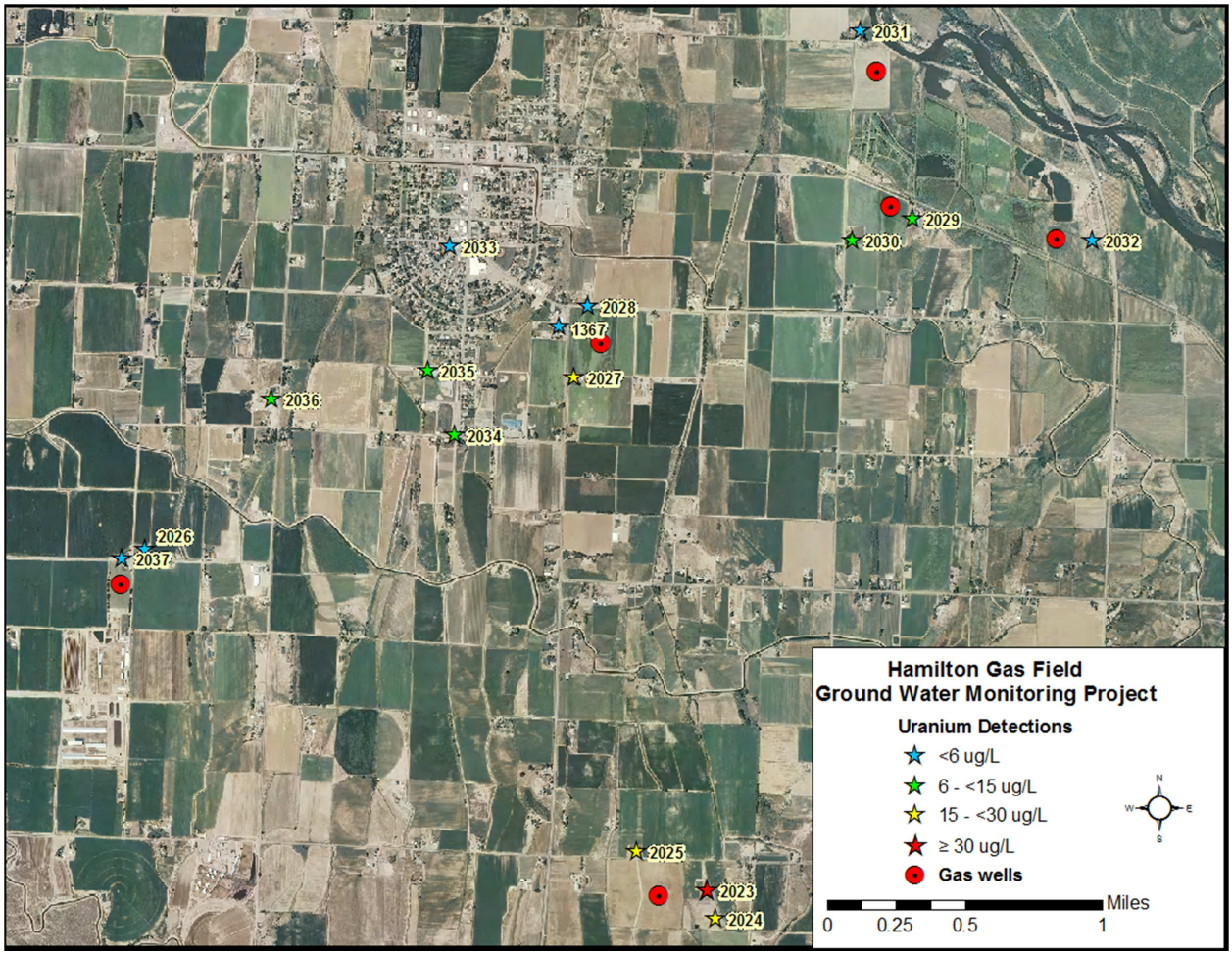


Figure 18. Uranium detections—Hamilton Gas Field Ground Water Monitoring Project.

Hydrocarbon Sampling

Benzene, ethylbenzene, xylene, and diesel were not detected in any of the wells that were sampled. Toluene was found at a concentration of 0.77 µg/L in 1 well (2026) and not detected in the other 15 wells (Table 20; Figure 19). The MCL for toluene is 1,000 µg/L. Methane was found in 2 wells at 0.0876 mg/L and 0.00205 mg/L (wells 2031 and 2036, respectively) and not detected in the other 14 wells (Table 20; Figure 19). An MCL for methane does not exist. The hazard with methane in water is when dissolved methane moves from ground water into the atmosphere, it can potentially ignite, or if it accumulates in a confined space, it can explode. The United States Department of the Interior, Office of Surface Mining (Eltschlager et al. 2001), advises well owners with dissolved methane levels greater than 28 mg/L to immediately remove any potential ignition sources and vent the gas away from any confined spaces.

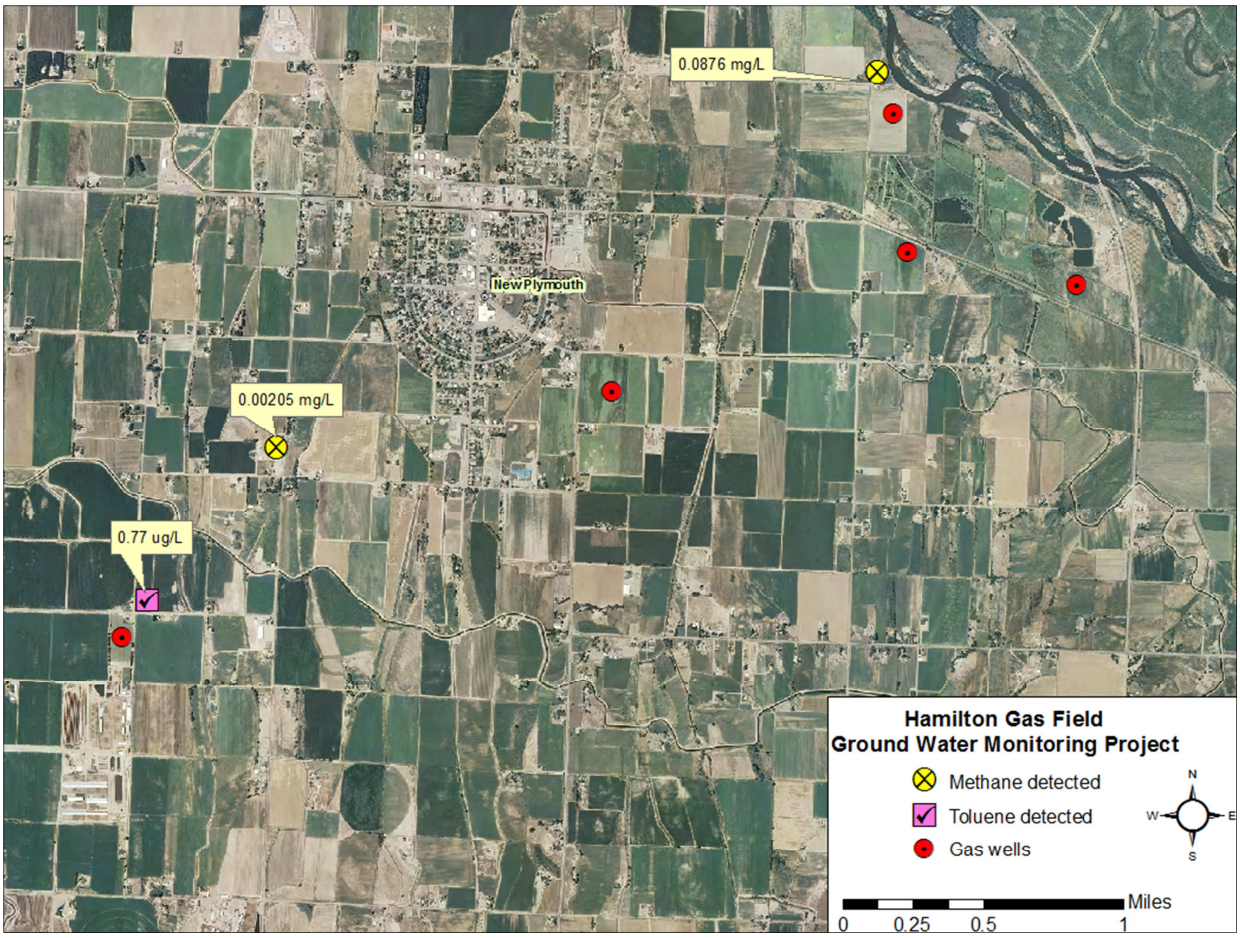


Figure 19. Toluene and methane detections—Hamilton Gas Field Ground Water Monitoring Project.

2.1.6.3 Conclusions

The Hamilton Gas Field Ground Water Monitoring Project was designed to provide background ground water quality data in the area surrounding 6 gas wells permitted by the Idaho Department of Lands. Ground water samples from 6 of the 16 wells contained elements in excess of safe drinking water MCLs. Water samples from 5 wells contained arsenic concentrations at or above the arsenic MCL of 10 µg/L. A water sample from 1 well contained a uranium concentration above the uranium MCL of 30 µg/L. Both the arsenic and uranium appear to be associated with naturally occurring geologic deposits present in the aquifer.

Methane concentrations of 0.0876 mg/L and 0.00205 mg/L were detected in samples from 2 of the 16 wells sampled. The suggested action level for methane is 28 mg/L. Toluene was detected in samples from one well at a concentration of 0.77 mg/L. The toluene MCL is 1,000 µg/L.

2.1.6.4 Recommendations

Additional ground water quality monitoring should be conducted to evaluate seasonal and annual variations in ground water quality. Ground water quality monitoring also should be conducted

during different phases of natural gas production to assess potential impacts on ground water quality.

2.2 Coeur d'Alene Region

2.2.1 Hope Elementary School Ground Water Investigation

2.2.1.1 Purpose

Hope Elementary School (HES) is located in northern Idaho approximately 3 miles southeast of Hope, Idaho (Figure 20). The school is adjacent to the Denton Slough of Lake Pend Oreille on the Hope Peninsula. The water system for HES is comprised of a single well located immediately adjacent to the school. The HES has had an increasing trend in nitrate-nitrogen (nitrate) concentrations from their drinking water well (Figure 21). There have been concerns regarding potential water quality impacts to the HES well from the Ellisport Bay Sewer District (EBSD) wastewater reuse site located immediately west of the school.

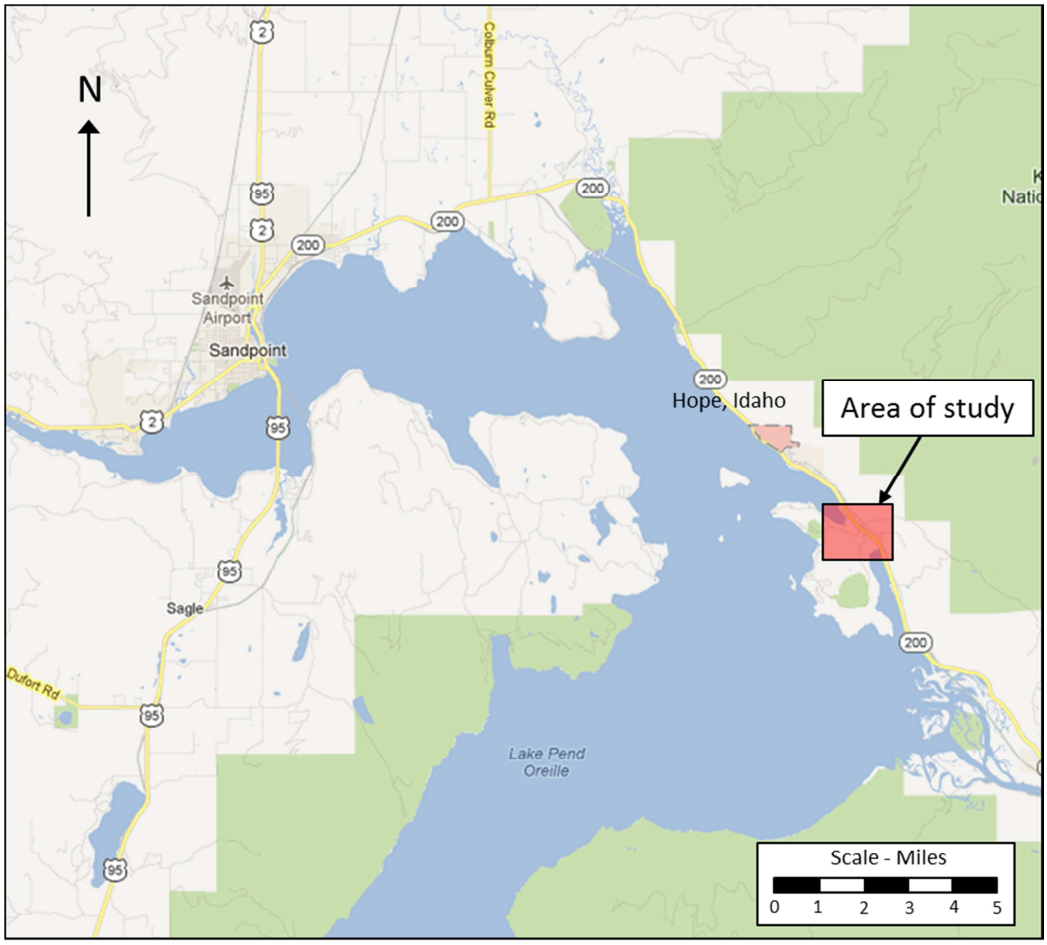


Figure 20. Vicinity map of Hope, Idaho, and the study area.

DEQ initiated a ground water investigation to study the cause of elevated nitrate concentrations at HES. The purpose of the investigation was to identify any activities in the area that may be

contributing to or causing the elevated nitrate in the HES drinking water well. Determining the source or sources may allow alternatives to treatment that can reduce or eliminate the introduction of excess nitrogen to the ground water.

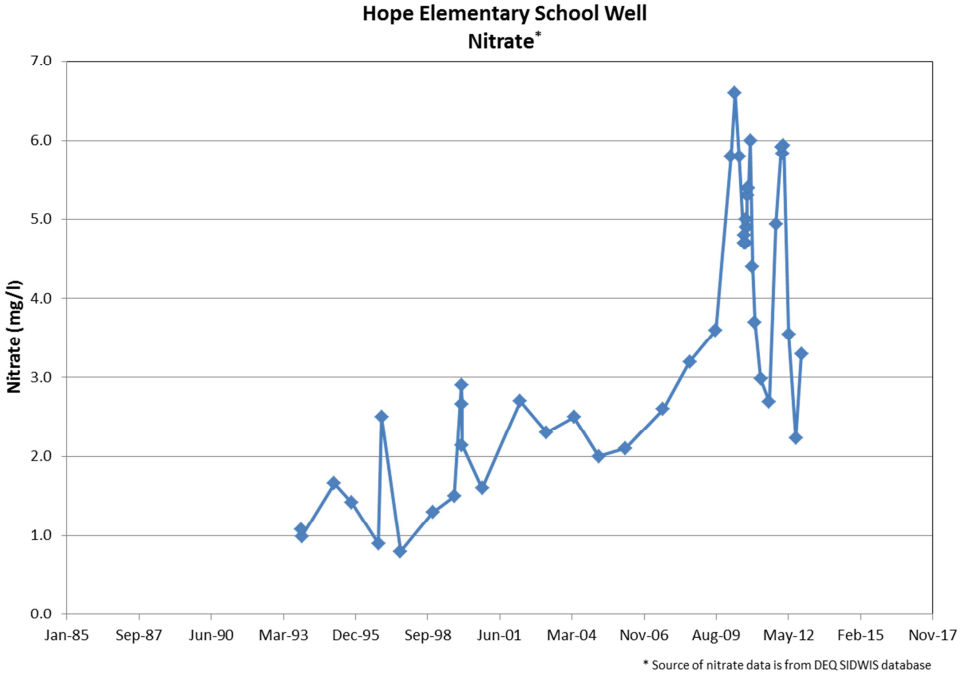


Figure 21. Historic nitrate concentrations in the Hope Elementary School well.

The lithology described in well logs of the study area indicates that bedrock underlies the majority of the Hope Peninsula and adjacent mainland areas. The EBSD reuse site is located on the Hope Peninsula with subsurface conditions described as approximately 12 to 20 feet of unconsolidated material over bedrock. The school and associated well are located in a small area of unconsolidated sediments, bordered by Ellisport Bay to the north and Denton Slough to the south that joins the bedrock of the peninsula and the mainland. The unconsolidated materials consist of an upper unit of clay with sand, gravel, and cobbles and is underlain by a water-bearing sand and gravel. The well logs indicate a brown clay unit below the sand and gravel.

The HES well (Well #1 in Figure 22) was completed on August 4, 1987, to a depth of 132 feet below ground surface (bgs). The stratigraphy described in the well driller's report is generally clay with sand, gravel, and cobbles to 95 feet bgs and sand and gravel below the clay unit to the depth of the well. The well is screened in the lower sand and gravel unit. Depth to water from land surface in the HES well is 92 feet bgs.

The regional ground water elevations within the study area range from approximately 2,100 to 2,065 feet above mean sea level. The depth to ground water in the project area ranges between 1 and 92 feet bgs. Ground water flow direction within the unconsolidated sediments between the bedrock of the Hope Peninsula and the mainland is northwest to southeast (Figure 22). The shallow ground water flow in the area of the EBSD wastewater reuse facility, most likely migrates horizontally to the northeast following the local topography (Figure 22).

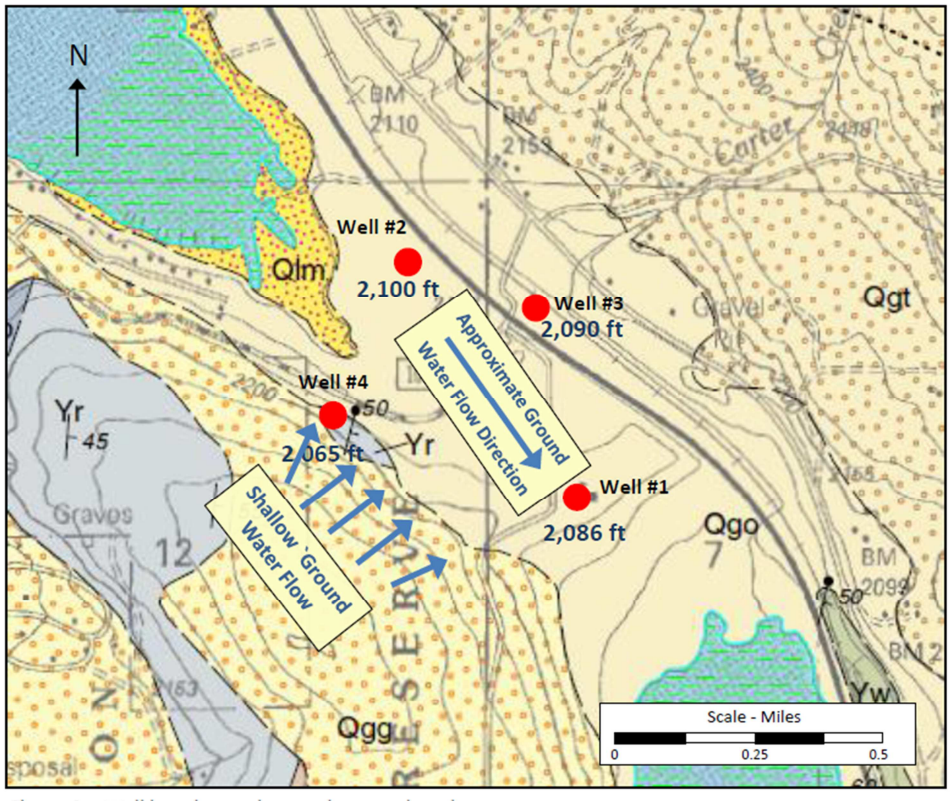


Figure 22. Ground water flow direction and geologic cross section well locations.

Potential Nitrate Sources and Sampling

The HES well is located in an area with multiple potential nitrogen sources, including (1) the HES septic drainfield, (2) an adjacent agriculture field, (3) the EBSD wastewater reuse site, and (4) Denton Slough of Lake Pend Oreille (Figure 23). The goal of the water sampling and analysis in the area of the HES is to determine the potential nitrogen sources that may be responsible for the elevated nitrate concentration found in the school's well. Two sampling events were completed during April and May 2012. A separate sampling event for ammonia and total Kjeldahl nitrogen (TKN) was conducted in July 2012. Water samples were obtained from the two EBSD lagoons, HES well, and Denton Slough. The HES septic drainfield was not sampled as part of this study because it has been abandoned and is no longer in use.



Figure 23. Potential nitrogen sources near the Hope Elementary School well.

2.2.1.2 Conclusions

Four potential nitrogen sources were investigated: HES septic drainfield, agricultural field, EBSD storage lagoons, and Denton Slough. A spreadsheet tool developed by the Idaho Department of Environmental Quality for wastewater reuse sites to determine the quantity of leachate that will migrate past the root zone and the concentration of nitrogen in the leachate was applied to the conditions at the agricultural field. The model indicates that leachate will migrate past the root zone of the agricultural field with rates that range between 0.0 and 3.8 inches per month with an average nitrogen concentration of 0.6 mg/L. The HES septic drainfield does not appear to be a source of nitrogen due to the subsurface conditions of the underlying soils and hydrogeology along with evidence from historical nitrate levels in the HES well relative to EBSD site operations and history. Water samples obtained from the Denton Slough do not have any significant concentrations of nitrogen compounds.

Lagoon #1 has significant nitrogen content in the form of ammonia and TKN (15.9 mg/L and 19.2 mg/L, respectively) and has past and recent documented leakage of treated wastewater. The oxidation of ammonia and TKN in lagoon #1 water could result in a source water with

significant nitrate concentrations. The recent seepage test in lagoon #1 indicates leakage in excess of allowable rates. DEQ inspection reports have also documented concern with the density of vegetation around the trees causing the irrigated water to disperse over a much smaller area and increase the hydraulic loading rates over a given area. Based on the available data, the elevated nitrate concentrations exhibited in the HES well water are consistent with leakage from EBSD lagoon #1 and/or seasonal hydraulic overloading on the irrigation site causing water to move past the root zone and into the ground water.

2.2.1.3 Recommendations

DEQ continues to work with stakeholders and interested parties to evaluate the ground water conditions.

2.3 Idaho Falls Region

2.3.1 Mud Lake Nitrate Priority Area Potential Nitrate Source Evaluation

2.3.1.1 Purpose

The Mud Lake NPA includes 127 square miles of Jefferson County and is ranked the 28th most degraded area (out of 32) in the 2008 statewide NPA rankings. It is the second largest and second-highest ranked NPA for the Idaho Falls region.

Samples were collected to evaluate the potential sources of nitrates to ground water in the area. An understanding of potential sources specific to the Mud Lake NPA is critical to directing resources and education toward appropriate BMPs and to help determine what community resources or potential regulatory responses are needed to prevent further ground water quality degradation. Accurate information regarding spatial and temporal water quality trends is also critical to interagency decision making. This study is intended to be a “first look” at the region, helping to identify criteria that should be considered when developing a regional monitoring network. This project is a continuation of the investigation into seven wells that were sampled in 2011 (DEQ 2013b).

Sites were selected from wells with existing monitoring results showing elevated nitrates. PWS wells, ISDA dairy and pesticide monitoring sites, and IDWR Statewide Monitoring Network Program sites were reviewed. DEQ received permission to sample five wells in 2012 (Figure 24).

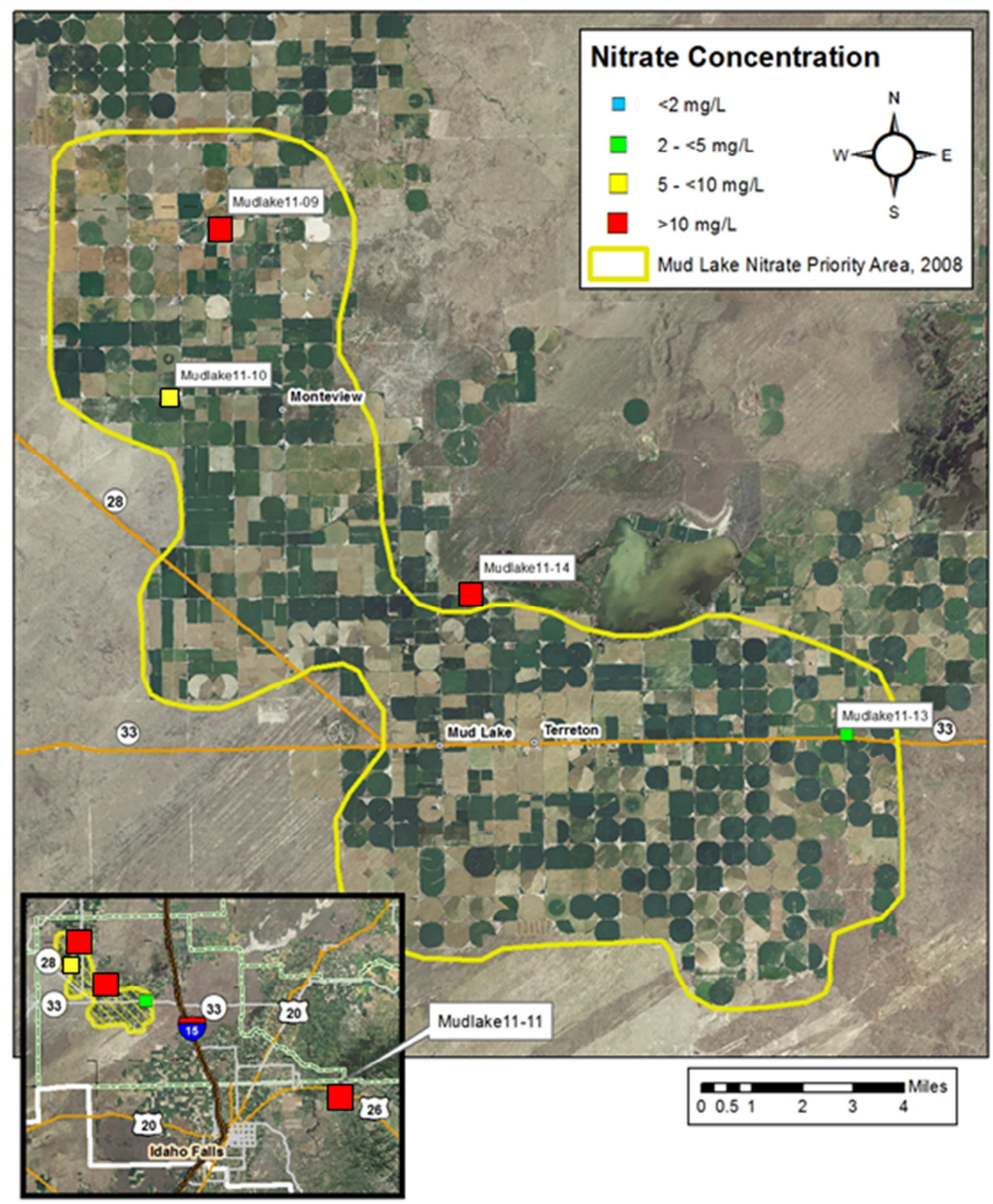


Figure 24. Well locations, project well name, and nitrate concentrations—Mud Lake Nitrate Priority Area Potential Nitrate Source Evaluation.

Mud Lake is a closed basin along the northern portion of the eastern Snake River plain (ESRP). The basin, along with the related Big Lost River trough, forms the terminus of surface water drainages for the northern and northwestern portions of the ESRP. The area is characterized by basaltic volcanism and deposition of eolian, fluvial, and lacustrine sediments concurrent with subsidence over the past few million years (Gianniny et al. 2002; Spinazola 1994). The Mud

Lake basin is separated by a low divide from the Big Lost River trough. Climate fluctuations since the Pleistocene resulted in formation of several lakes and lake complexes in the area; the current Mud Lake is a remnant of these lakes (Gianniny et al. 2002). During times of greater discharge, Mud Lake combined with the terminal lakes of the Big Lost River basin to form Lake Terreton. Sediments tend to thin to the south against the more predominant basalts along the ESRP axial volcanic zone (Spinazola 1994) (Figure 25). Regional ground water flow is to the south and west (Jeffers and Baldwin 2008).

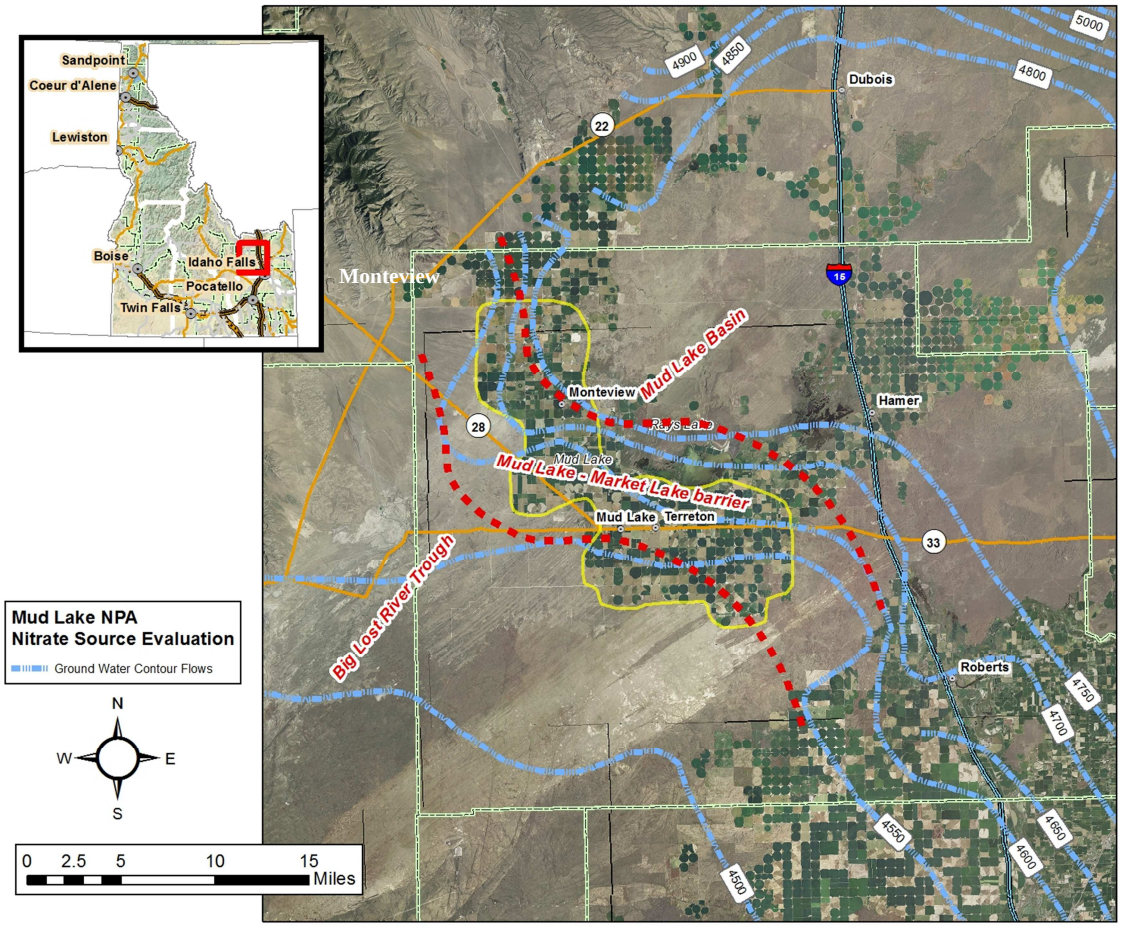


Figure 25. Ground water elevation (IDWR 1992) and locations of the Mud Lake basin and approximate location of Mud Lake–Market Lake barrier, as indicated by the dashed red lines.

Based on review of area well logs, the surficial sediments consisting primarily of sands and clays can vary from just a few feet to more than 100 feet thick. These sandy clayey layers are commonly separated by fractured basalt. Well logs from the region also tend to show a characteristic grey or blue clay at depth that is likely related to large Yellowstone rhyolitic eruptions. This clay layer is present in some wells at about 300 feet deep in the central portion of the study area and is occasionally present in wells from Monteview-Mud Lake to Roberts. Depth to ground water ranges from tens of feet in the northern portions of the study area to 250 feet or more in the southern margin. Logs suggest that a shallow, surficial aquifer is present in some areas, particularly in the northern portion of the region, as well as a deeper aquifer throughout most of the area.

Work summarized by Spinazola (1994) identifies as much as 450 feet of sediment in this central part of the basin. These sediments constitute a band of lower permeability that reaches from Monteview to Roberts. More permeable basalts intercalated with these sediments result in locally confined aquifer conditions. Regionally, this band of sediments results in what other authors have described as the Mud Lake–Market Lake barrier (Figure 25). North and east of this barrier, ground water gradients are low (5–10 feet per mile); at the barrier, gradients are much higher (30–60 feet per mile) (Crosthwaite 1973; Jeffers and Baldwin 2008). Camas Creek, Rays Lake, and areas to the north and east are areas of ground water discharge, while areas to the south and west are recharge areas.

Average annual precipitation for the Mud Lake area is 8.79 inches, with May and June having the largest monthly totals at 1.3 and 1.22 inches, respectively. Average annual high and low temperatures are 58.5°F and 26.7°F, with the average minimums above freezing from May–September (WRCC 2012).

2.3.1.2 Methods and Results

Five wells were sampled in June and July 2012 following the QAPP and FSP (DEQ 2011c; Hall 2011). Water quality field parameter data were collected prior to sampling (Table 21). Samples were sent to IBL in Boise for analysis of calcium, magnesium, sodium, potassium, chloride, sulfate, alkalinity, nitrate plus nitrite, and ammonia. Samples were sent to Idaho State University in Pocatello for tritium analysis. Samples were sent to IAS Environmental in Pocatello for TC and *E. coli* analysis. After receiving the major ion chemistry and nutrient results, samples for nitrogen isotope, oxygen isotope, and deuterium were sent to the University of Arizona and samples for nitrogen isotope on the nitrate molecule and oxygen isotope on the nitrate molecule were sent to University of Waterloo and Northern Arizona University for analysis. Analysis of the stable nitrogen and oxygen isotopes for nitrates ($\delta^{15}N_{nitrate}$, $\delta^{18}O_{nitrate}$) can provide information about the history of the nitrogen in the environment.

Results for major ion chemistry and tritium are presented in Table 22; nitrate and bacteria results are presented in Table 23. Major ion chemistry provides a picture of the overall relative character of ground water, including mixing between ground water from different sources and changes in ground water chemistry from inputs such as dissolution of the aquifer matrix, infiltration, and impacts from sources of contamination.

Table 21. Water quality field parameters—Mud Lake Nitrate Priority Area Potential Nitrate Source Evaluation.

Project Well Name	DEQ Site ID	Well Depth (feet)	Sample Date	Water Temp.[a] (˚C)	Specific Conductivity[a] (µS/cm)	pH	Dissolved Oxygen[a] (mg/L)	Air Temp. (˚C)
Mudlake11-09	2224	40	6/27/2012	10.3	1105	7.00	CE	23
Mudlake11-10	2225	165	6/27/2012	10.6	1105	7.11	CE	23
Mudlake11-11	2228	350	6/29/2012	13.6	2810	7.43	CE	30
Mudlake11-13	2227	250	7/12/2012	13.5	642	7.31	6.75	26
Mudlake11-14	2226	U	7/12/2012	12.4	1610	7.67	3.15	28

Notes: pH was within the range of EPA's National Secondary Drinking Water (NSDWR) standard (6.5–8.5 pH units). However, field measurements should be considered estimates and are not used for determining violations of NSDWR standards.
℃ = degrees Celsius; µS/cm = microsiemens per centimeter; mg/L = milligrams per liter; Temp. = temperature; CE = calibration error of field meter and measurement was not quantifiable; U = unknown
[a] No primary or secondary health standard available.

Table 22. Tritium and major ion results—Mud Lake Nitrate Priority Area Potential Nitrate Source Evaluation.

Project Well Name	DEQ Site ID	Well Depth (feet)	Sample Date	Tritium[a] (pCi/L)	Major Ion Concentration (milligrams per liter)						
					Calcium[a]	Magnesium[a]	Sodium[a]	Potassium[a]	Chloride	Sulfate	Alkalinity[a] (as $CaCO_3$)
Mudlake11-09	2224	40	6/27/2012	4	120	30	75	5.6	80.6	87.7	349
Mudlake11-10	2225	165	6/27/2012	2	86	26	120	5.8	72.6	87.1	385
Mudlake11-11	2228	350	6/29/2012	3	200	190	96	12	*461*	*626*	235
Mudlake11-13	2227	250	7/12/2012	6	77	19	42	4.6	13.9	20.6	331
Mudlake11-14	2226	U	7/12/2012	3	81	47	280	9.7	*340*	135	345

Notes: Italicized red numbers indicate EPA's National Secondary Drinking Water Regulation was reached or exceeded.
pCi/L = picocuries per liter; $CaCO_3$ = calcium carbonate; U = unknown
[a] No primary or secondary health standard available.

Table 23. Nutrient and bacteria results—Mud Lake Nitrate Priority Area Potential Nitrate Source Evaluation.

Project Well Name	DEQ Site ID	Well Depth (feet)	Sample Date	Nutrient Concentration (milligrams/liter)		Bacteria (colonies/100 milliliter)	
				Total $NO_2 + NO_3$ as Nitrogen	Total Ammonia as Nitrogen	Total Coliform[a]	*E. coli*
Mudlake11-09	2224	40	6/27/2012	**14**	<0.01	<1.0	<1.0
Mudlake11-10	2225	165	6/27/2012	9.4	<0.01	<1.0	<1.0
Mudlake11-11	2228	350	6/29/2012	**31**	<0.01	<1.0	<1.0
Mudlake11-13	2227	250	7/12/2012	3.2	<0.01	<1.0	<1.0
Mudlake11-14	2226	U	7/12/2012	**26**	0.051	1.0	**3.1**

Notes: Bolded red numbers indicate EPA's maximum contaminant level or Idaho Ground Water Quality standards were reached or exceeded.
$NO_2 + NO_3$ = nitrite plus nitrate
[a] A ground water quality standard does not exist.

Nitrate Sampling

Figure 24 presents the distribution of nitrate concentrations for the Mud Lake study area. Three wells (11-09, 11-11, and 11-14) exceeded the MCL for nitrate (Table 23). There appears to be a relationship of increasing sulfate and chloride along flow paths with increasing nitrate (Figure 26). This relationship is especially pronounced in the nitrate versus chloride relationship.

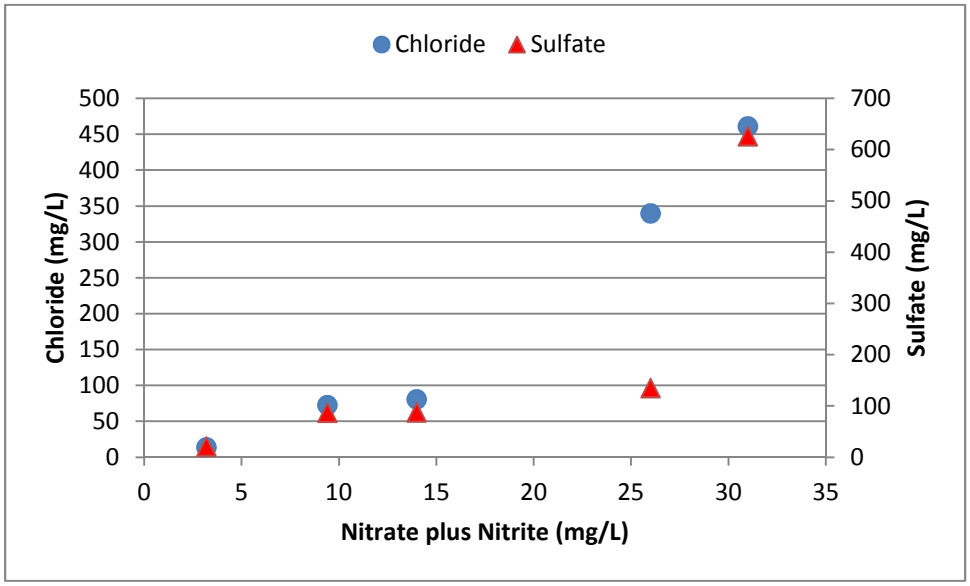


Figure 26. Nitrate versus chloride and nitrate versus sulfate plot—Mud Lake Nitrate Priority Area Potential Nitrate Source Evaluation.

Stable Isotope Sampling

Stable isotope measurements can provide insight to the history of the nitrate and potential sources and processes that may be at work modifying both the observed nitrate concentration and the isotopic signature. Stable isotope results for this project are displayed in Table 24. $\delta^{18}O$ / $\delta^{2}H$ relationships for Mud Lake area sites reflect ESRP ground water with a trend characteristic of water that has been evaporated. This finding suggests that recharge for the region is likely related to local precipitation and irrigated agricultural lands (Wood and Low 1988; Cecil et al. 2005).

Table 24. Stable isotope results—Mud Lake Nitrate Priority Area Potential Nitrate Source Evaluation.

Project Well Name	DEQ Site ID	Well Depth (feet)	Sample Date	$\delta^{18}O$	$\delta^{2}H$	$\delta^{15}N$	NAU		Waterloo	
							$\delta^{15}N_{nitrate}$	$\delta^{18}O_{nitrate}$	$\delta^{15}N_{nitrate}$	$\delta^{18}O_{nitrate}$
Mudlake11-09	2224	40	6/27/2012	-16.9	-130	7.5	7.38	-7.99	7.92	-4.48
Mudlake11-10	2225	165	6/27/2012	-17.1	-131	4.8	5.08	-7.31	5.49	-5.22
Mudlake11-11	2228	350	6/29/2012	-17.8	-136	6.5	6.11	-8.91	7.00	-4.09
Mudlake11-13	2227	250	7/12/2012	-17.3	-130	6.6	6.39	-8.13	7.39	-4.18
Mudlake11-14	2226	U	7/12/2012	-16.9	-130	9.6	10.61	-3.49	10.91	3.11

Notes: No primary, secondary, or advisory health standards available for isotopes.
NAU = Northern Arizona University; $\delta^{18}O$ = oxygen isotope; $\delta^{2}H$ = deuterium; $\delta^{15}N$ = nitrogen isotope; $\delta^{15}N_{nitrate}$ = nitrogen isotope of nitrate molecule; $\delta^{18}O_{nitrate}$ = oxygen isotope of nitrate molecule.

$\delta^{15}N$ results can provide some insight relating nitrate concentrations and primary nitrogen sources for sample sites. Stable $\delta^{15}N$ measurements are presented as per mil relative to nitrogen in air. Nitrogen from human or animal waste and fertilizer sources has distinguishable $\delta^{15}N$ signatures. Typical $\delta^{15}N$ values for various nitrogen sources are listed in Table 6. One well (11-14) had a $\delta^{15}N$ value in between an organic nitrogen in the soil source and a waste source. The remaining four wells sampled for this project had $\delta^{15}N$ values that indicate an organic soil nitrogen source.

Analysis of the stable nitrogen and oxygen isotopes for nitrates ($\delta^{15}N_{nitrate}$, $\delta^{18}O_{nitrate}$) can provide information about the history of the nitrogen in the environment. Results are presented as per mil relative to air for $\delta^{15}N_{nitrate}$ and relative to the Vienna Standard Mean Ocean Water for $\delta^{18}O_{nitrate}$. Observed nitrogen isotopic ratios and nitrate concentrations can be modified by both chemical and biological processes in the environment. The $\delta^{15}N_{nitrate}$ and $\delta^{18}O_{nitrate}$ signature for nitrates in ground water can help in understanding whether processes of nitrification or denitrification are likely occurring and can explain the observed $\delta^{15}N_{nitrate}$ and $\delta^{18}O_{nitrate}$ results (Kendall et al. 2007).

DEQ collected duplicate samples for all sites; for each site, a sample was sent to both the University of Waterloo Environmental Isotope Laboratory and Northern Arizona University's Colorado Plateau Stable Isotope Laboratory (NAU). Waterloo and NAU use different methods for $\delta^{15}N_{nitrate}$ and $\delta^{18}O_{nitrate}$ analysis. University of Waterloo uses the AgCl, $AgNO_3$-based methods. NAU uses a current industry standard denitrifying bacteria method.

All sites could have been modified by nitrification processes; however, more information and review is needed to fully interpret these results. A comparison of the Waterloo and NAU results indicates some small differences that will be assessed when the balance of data is received.

2.3.1.3 Conclusions

Preliminary review suggests that nitrates in ground water for most sites sampled are likely from mixed or organic nitrate sources in the soil.

A combination of tools is being used to understand the potential sources of nitrates in the ground water in the Mud Lake NPA. The combination of major ion chemistry and plots of specific indicators versus nitrate concentrations and other combinations of chemical and isotopic results appear to be valuable in identifying relationships specific to local ground water. A partial list of tools include the following:

- Major ion chemistry plots
- Spatial plot of nitrate concentrations
- $\delta^{18}O$ versus $\delta^{2}H$
- Nitrate plus nitrite versus $\delta^{15}N$
- $\delta^{15}N_{nitrate}$ versus $\delta^{18}O_{nitrate}$

2.3.1.4 Recommendations

Additional wells were sampled in the Mud Lake NPA in 2011 (DEQ 2013b). Analysis of both 2011 and 2012 data using the tools referenced above will be conducted to better understand the

potential nitrate sources. DEQ will also present recommendations regarding a suggested set of plots and comparisons to employ to identify potential sources for the elevated nitrates.

2.4 Lewiston Region

2.4.1 Camas Prairie Nitrate Priority Area Ground Water Monitoring Project

This section summarizes the 2012 sampling results from an ongoing ground water quality evaluation of nitrate concentrations in the Camas Prairie, north of Grangeville, Idaho. A DEQ investigation (Bentz 1998) found that 24 of 55 wells sampled (44%) had nitrate concentrations that exceeded 5 mg/L (i.e., half the MCL of 10 mg/L). The maximum nitrate concentration reported in the 1998 study was 77.1 mg/L. That value was later determined to be from a point source near the wellhead and the site has not been sampled in subsequent years. The Camas Prairie is one of Idaho's 32 NPAs, based in part on the 1998 nitrate investigation results.

2.4.1.1 Purpose

DEQ initiated the Camas Prairie ground water monitoring program in August 2005 as part of a regional ambient ground water monitoring network. To address elevated nitrate concentrations in the Camas Prairie NPA, a ground water quality management plan 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 through 2011 for implementing agricultural ground water protection BMPs, such as direct seed practices. Direct seed practices allow for crop planting with minimal soil disturbance, which may contribute to reduced nitrogen mobility when combined with other BMPs.

Long-term ground water monitoring is being conducted to determine the plan's effectiveness on improving ground water quality. Nitrate concentration data will be periodically evaluated to determine if ambient concentrations increase or decrease. This evaluation will include seasonal and overall trend assessment.

2.4.1.2 Methods and Results

Since 2006, DEQ has conducted routine quarterly sampling from the Camas Prairie network of 23 wells and 2 springs. In addition to the sites monitored by DEQ, wells were identified and sampled by the Lewis Soil Conservation District and the ISDA. Nitrate concentrations from sampled sites were compared seasonally for several years to identify wells with nitrate concentrations with similar seasonal trends and well results considered to be anomalies. Wells with reported results that were considered to be anomalies were addressed to identify and resolve isolated or localized situations and dropped from the ambient monitoring network.

During the 2012 calendar year, ambient sampling in accordance with the QAPP (DEQ 2005) was conducted in March, June, September, and December. Data were collected from 23 wells and 1 spring (Figure 27). Water quality field parameters of water temperature, specific conductance, and DO were measured prior to sample collection for nitrates (Table 25).

Samples collected in March, September, and December were also analyzed for total phosphorus to characterize total phosphorus concentrations in the Camas Prairie ground water and determine if the potential exists to use total phosphorus to augment current efforts in assessing the region's ground water quality.

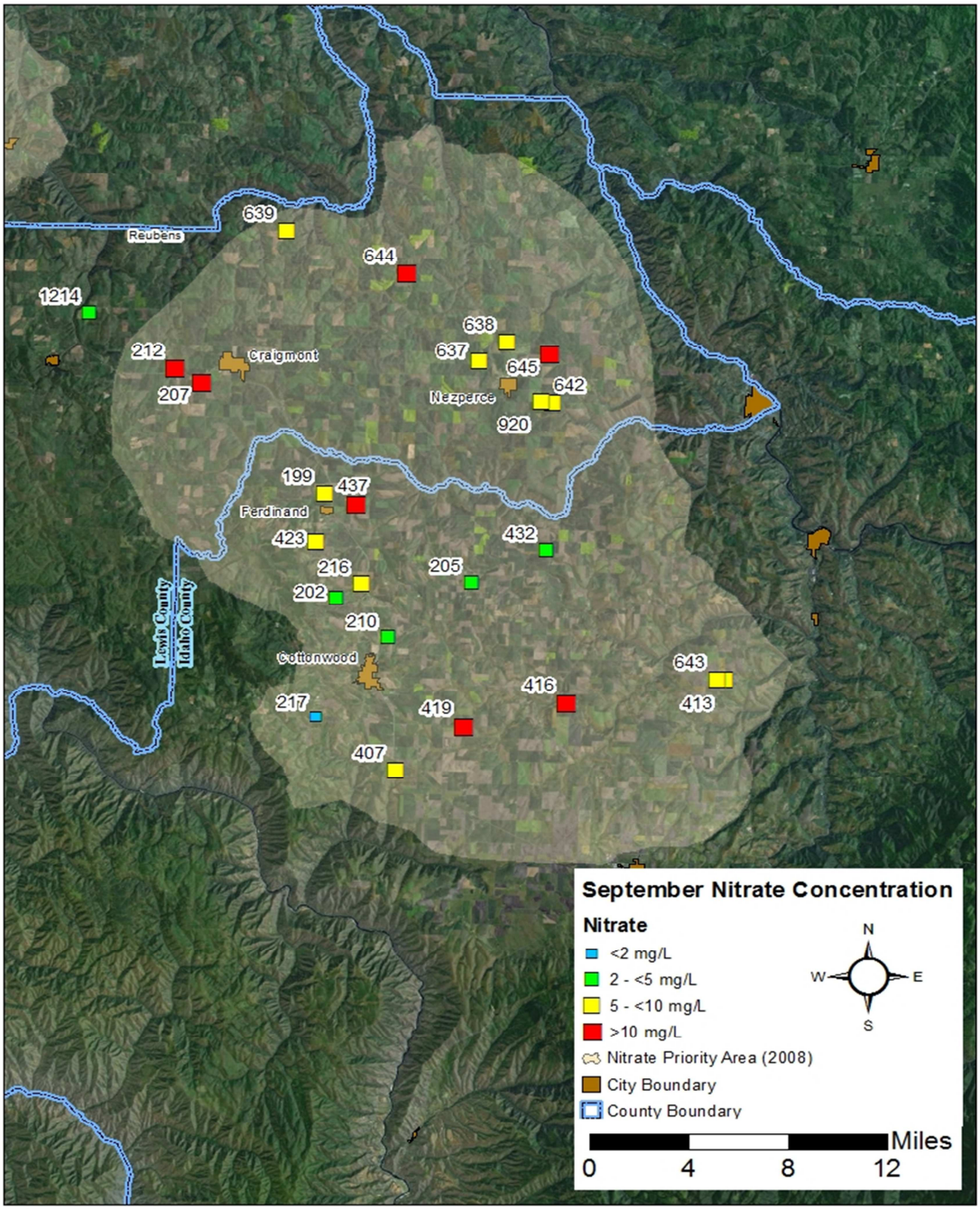


Figure 27. Well locations, site identification, and nitrate concentrations for September 2012 sampling—Camas Prairie Nitrate Priority Area Ground Water Monitoring Project.

Table 25. Water quality field parameters—Camas Prairie Nitrate Priority Area Ground Water Monitoring Project.

DEQ Site ID	Well Depth (feet)	March 2012			June 2012			September 2012			December 2012		
		Spec. Cond. (µs/cm)	Water Temp. (℃)	DO (mg/L)	Spec. Cond. (µs/cm)	Water Temp. (℃)	DO (mg/L)	Spec. Cond. (µs/cm)	Water Temp. (℃)	DO (mg/L)	Spec. Cond. (µs/cm)	Water Temp. (℃)	DO (mg/L)
199	140	457	8.2	10.05	NS	NS	NS	461	11.9	9.74	463	9.7	9.74
202	400	228	9	7.8	251	11.6	8.43	267	12.1	8.11	227	9.5	7.55
205	327	575	10.8	0.41	586	12.0	0.34	593	12.7	0.66	535	12.7	0.66
207	85	433	9.6	3.76	443	9.9	3.90	433	10.7	3.91	445	9.5	3.74
210	500	345	11.7	3.3	342	15.3	2.27	341	15.0	1.79	332	12.5	2.37
212	400	416	8.6	7.66	421	10.8	7.29	415	13.4	7.54	406	9.6	7.70
216	80	564	11.9	7.13	589	11.8	7.15	576	12.9	6.95	574	12.0	6.98
217	500	239	5.3	6.48	250	13.5	5.60	255	15.5	2.60	247	7.0	6.01
407	375	366	5.1	8.71	359	13.7	6.64	396	15.8	8.03	377	7.2	8.67
413	260	425	4.1	14.1	432	13.5	10.45	413	17.9	11.44	397	5.9	10.64
416	187	427	10.8	8.88	452	11.0	8.76	442	11.3	8.91	438	10.9	8.43
419	250	664	8.5	6.09	451	12.6	7.06	626	12.1	6.16	538	8.0	6.94
423	500	240	8.5	8.0	239	10.6	8.45	265	11.8	7.69	243	8.9	7.84
432	135	361	10.7	3.53	373	11.2	3.72	363	11.2	3.33	353	10.7	3.05
437	28	NS	NS	NS	521	8.9	7.64	522	11.5	7.01	504	7.0	7.25
637	396	413	9.7	10.84	429	11.4	12.78	407	11.9	11.87	394	10.6	9.84
638	90	420	7.7	10.37	429	11.0	9.93	434	11.2	9.09	420	8.7	9.63
639	85	628	9.1	7.71	639	10.4	7.67	633	10.4	7.37	619	8.6	7.48
642	65	641	10.6	9.88	621	11.4	10.19	497	10.9	9.47	553	10.7	9.03
643	145	362	4.5	9.07	377	13.0	2.28	440	17.7	8.25	379	6.4	9.36
644	402	505	8.3	8.98	524	113	9.02	503	11.7	8.81	5.06	7.2	9.72
645	165	644	10.2	8.43	665	11.4	7.47	629	11.6	6.71	643	10.1	8.06
920	300	443	5.8	9.32	450	12.2	8.82	451	13.6	7.99	436	8.0	8.68
1214	Spring	NS	NS	NS	316	9.7	4.39	311	10.6	3.29	313	9.3	4.25

Notes: No primary or secondary health standard available for listed water quality field parameters.
Spec. Cond. = specific conductivity; µS/cm= microsiemens per centimeter; Temp. = temperature; ℃ = deg rees Celsius; DO = dissolved oxygen; mg/L = milligrams per liter; NS = not sampled.

Nitrate Sampling

The highest reported nitrate concentration of 17.6 mg/L was collected from site 212 during the September sampling event. Site 212 had the highest reported nitrate concentration during all four sampling events, with an annual average of 17.25 mg/L. In all, 9 of the 24 sampled Camas Prairie sites reported nitrate concentrations exceeding the EPA ground water MCL at least once during the 2012 sampling year (Table 26). Overall, there was little variation in median and mean nitrate concentrations (from 0 to 7.8%) at each site between sampling events in 2012.

Table 26. Nitrate results—Camas Prairie Nitrate Priority Area Ground Water Monitoring Project.

DEQ Site ID	Well Depth (feet)	Nitrate Concentration (milligrams per liter)			
		March 2012	June 2012	September 2012	December 2012
199	140	8.19	NS	8.29	8.76
202	400	3.50	4.21	4.99	3.83
205	327	4.24	4.59	4.76	4.13
207	85	**12.2**	**11.8**	**12.7**	**13.5**
210	500	4.00	3.70	3.58	3.69
212	400	**17.4**	**16.9**	**17.6**	**17.1**
216	80	9.48	9.53	9.40	**10.6**
217	500	2.71	2.67	1.97	2.64
407	375	3.49	1.16	6.89	9.47
413	260	6.14	5.95	5.86	5.79
416	187	**15.2**	**16.9**	**16.3**	**16.4**
419	250	**11.9**	8.66	**16.9**	**13.2**
423	500	3.56	4.29	6.90	4.65
432	135	4.61	2.98	4.14	4.51
437	28	NS	**10.3**	**10.1**	9.93
637	396	5.69	7.07	6.12	5.48
638	90	5.15	5.34	5.30	5.41
639	85	5.35	5.56	5.48	5.43
642	65	**13.0**	**12.9**	7.70	**10.3**
643	145	6.09	5.17	7.78	6.89
644	402	**11.8**	**11.7**	**10.8**	**11.4**
645	165	**13.5**	**13.4**	**13.8**	**15.0**
920	300	6.40	6.39	6.34	6.10
1214	Spring	4.22	4.33	4.43	4.24

Notes: Bolded red numbers indicate EPA's maximum contaminant level was reached or exceeded.
NS = not sampled

Phosphorus Sampling

The reported laboratory results for total phosphorus concentrations range from 0.0202 mg/L to 0.142 mg/L. The highest reported concentration for each sampling event was reported for samples collected from site 639. The lowest reported concentrations were from site 407 in March and from site 205 in September and December (Table 27). Variability between mean and median concentrations at each site was greater than the variability for reported nitrate concentrations,

ranging from 0 to 16.9%. Two sites had the greatest variability, with 10.2% at site 212 and 16.9% at site 423.

Because of the variation between mean and median total phosphorus concentrations, seasonal variability may be meaningful. Of the 24 sampled sites, 11 (46%) reported the lowest total phosphorus concentrations in March and 12 (50%) reported the highest concentrations in December.

Table 27. Phosphorus results—Camas Prairie Nitrate Priority Area Ground Water Monitoring Project.

DEQ Site ID	Well Depth (feet)	Total Phosphorus[a] Concentration (milligrams per liter)		
		March 2012	September 2012	December 2012
199	140	0.0657	0.0654	0.0674
202	400	0.047	0.0448	0.0514
205	327	0.029	0.0216	0.0317
207	85	0.0683	0.0627	0.0697
210	500	0.0861	0.0716	0.0772
212	400	0.101	0.0831	0.0786
216	80	0.0805	0.078	0.0784
217	500	0.0552	0.0599	0.0701
407	375	0.0202	0.0253	0.0318
413	260	0.0542	0.0593	0.0684
416	187	0.0314	0.037	0.0429
419	250	0.0642	0.0706	0.0728
423	500	0.04	0.0414	0.0408
432	135	0.0423	0.0446	0.0543
437	28	NS	0.0845	0.0465
637	396	0.0727	0.0753	0.0751
638	90	0.0718	0.0661	0.0752
639	85	0.142	0.125	0.132
642	65	0.0356	0.0782	0.0543
643	145	0.0561	0.0369	0.0459
644	402	0.0685	0.0722	0.079
645	165	0.0395	0.038	0.0386
920	300	0.0926	0.0911	0.0921
1214	Spring	0.0597	0.0638	0.054

Note: NS = not sampled.
[a] No primary or secondary health standard available.

2.4.1.3 Conclusions

Sample results show that ground water in the Camas Prairie contains elevated nitrate concentrations. At some locations, reported nitrate concentrations equal or exceed the EPA MCL of 10 mg/L. Based on the large aerial extent of degraded ground water, commercial fertilizer, livestock manure, and septic discharge are potential sources of elevated nitrate concentrations reported in project area ground water.

The temporal variability between ground water nitrate concentrations at various wells in the area may indicate nitrate leaching rates, sources of nitrogen, and ground water hydrology are not uniform throughout the year. Total phosphorus concentrations reflect more seasonal variability. This variation can be due to changes in cropping patterns and fertilizer application, variation in nutrient uptake by crops due to growing season conditions, or variations in leaching rates related to the amount and timing of precipitation available to mobilize nutrients below the crop root zone.

2.4.1.4 Recommendations

Annual variability reported for individual wells makes it difficult to detect improvements in ground water quality in the project area as BMPs are implemented because concentration changes may be within the range of historic concentrations reported for individual wells. Therefore, this project will attempt in the future to compare changes in seasonal trends of the network over multiple years to identify changes in ambient conditions.

In addition to assessing nitrate concentrations over time, evaluating total phosphorus concentration trends may be helpful in determining the effectiveness of BMPs over time. Continued investigation of total phosphorus concentrations in the region's ground water is recommended.

Tracking changes in ambient nitrate concentrations relative to changes in land use or source controls could be accomplished by comparing changes in seasonal trends over multiple years to minimize the effects of seasonal variability that occur under the conditions mentioned above. Multiple year seasonal trend analysis of ambient nitrate concentrations has not been conducted. Additional data and data compilation is needed prior to conducting such analyses. Data and resources are anticipated to be available for the analysis phase of the project in the future.

Ground water conditions can be represented in spring water. Monitoring spring water when ground water provides the only source of water to a stream can also be used to determine ground water nitrogen loads to surface water. This information may be useful in determining if and where ground water nitrogen contribution to surface water exists in the drainage basin and to focus BMP implementation efforts. For more information, see Baldwin et al. (2008), which summarizes data collected for this project from 2005 through 2007.

2.4.2 Tammany and Lindsay Creeks Ground Water Monitoring Project

2.4.2.1 Purpose

The Lindsay Creek NPA was designated in 2008 using ground water quality data from IDWR, ISDA, United States Geological Survey, and DEQ. The NPA encompasses the Lindsay and Tammany Creek watersheds. The 2007 Lindsay Creek total maximum daily load (TMDL) determined that ground water base flow is a nitrogen contributor to Lindsay Creek and requires a reduction in nitrogen loading (DEQ 2007a). The goal of this project is to create an ambient ground water quality monitoring network to complete a 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 ground water sampling has shown elevated nitrate concentrations in the Tammany Creek area. 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 28). 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 (DEQ 2010a).

2.4.2.2 Methods and Results

For this project, DEQ sampled 13 wells and 5 springs quarterly during March, June, September, and December 2012. Water-quality field parameters—temperature, specific conductivity, and DO—were measured in the field prior to sample collection (Table 28). Samples were collected quarterly for nitrate (Table 29) and sent to Anatek Labs in Moscow, Idaho, for analysis. Samples were also collected (Table 30) and sent to Anatek Labs for phosphorus analysis in March, September, and December 2012. DEQ is collecting data to develop an ambient ground water quality monitoring network of approximately 25 sites for quarterly sampling. Nitrate concentrations from sampled wells will be analyzed to determine if seasonal or spatial trends exist in the monitoring network in addition to monitoring long-term regional changes. Anomalous nitrate concentrations will be addressed as isolated or localized situations and dropped from the ambient network, if needed.

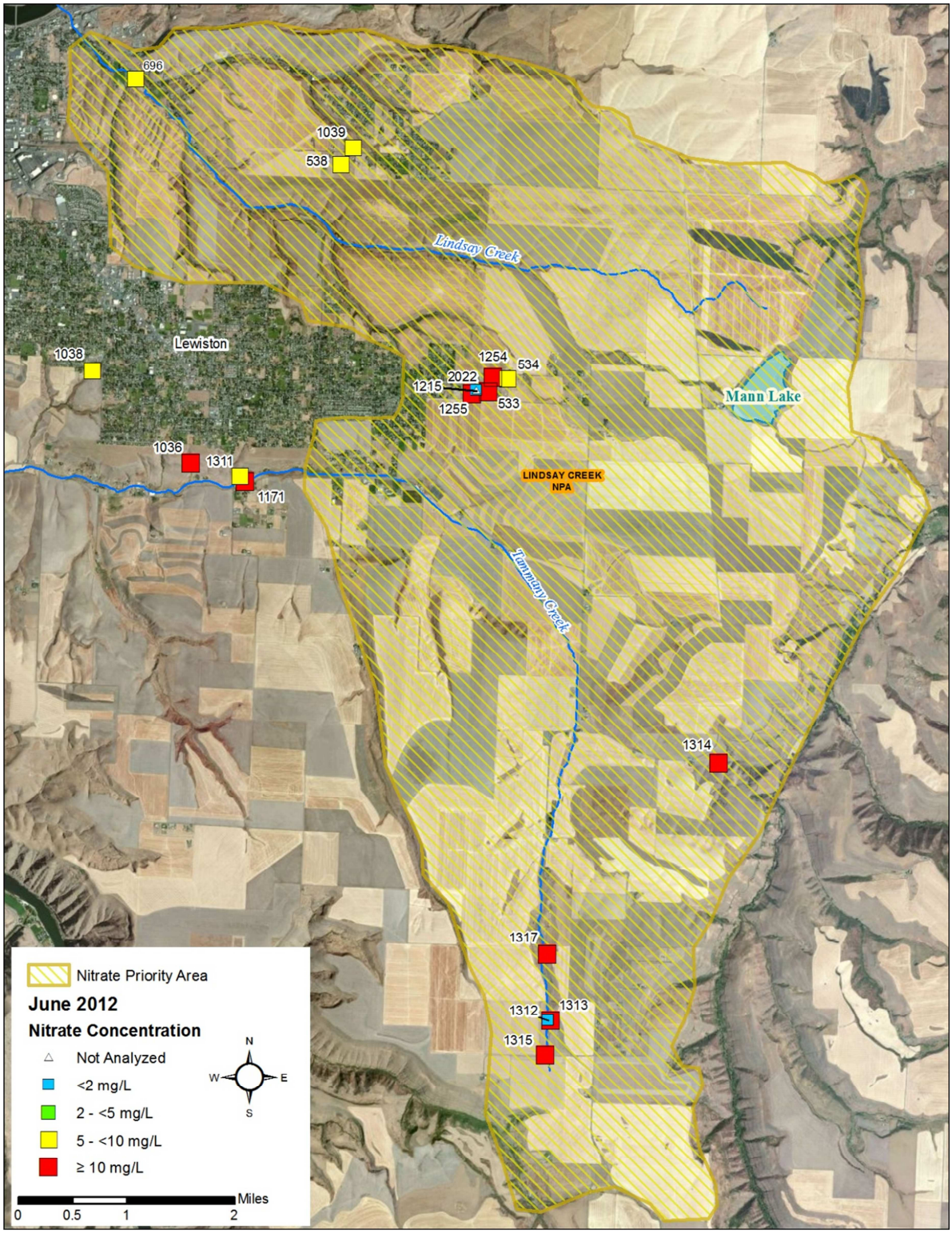


Figure 28. Well and spring locations, DEQ site IDs, and nitrate concentrations for June 2012 sampling—Tammany and Lindsay Creeks Ground Water Monitoring Project.

Table 28. Water quality field parameters—Tammany and Lindsay Creeks Ground Water Monitoring Project.

DEQ Site ID	Well Depth (feet)	March 2012			June 2012			September 2012			December 2012		
		Specific Cond. (µS/cm)	Water Temp. (℃)	DO (mg/L)	Specific Cond. (µS/cm)	Water Temp. (℃)	DO (mg/L)	Specific Cond. (µS/cm)	Water Temp. (℃)	DO (mg/L)	Specific Cond. (µS/cm)	Water Temp. (℃)	DO (mg/L)
533	225	861	10.5	9.86	805	14.7	9.54	803	15.1	10.15	811	11.8	9.84
534	205	720	12.2	10.05	720	13.9	9.87	713	13.6	9.83	NA	NA	NA
538	228	1222	13.8	2.22	777	14.0	9.62	869	14.5	8.80	2276	13.6	7.97
696	295	NA	NA	NA	1106	11.4	3.87	1036	14.2	4.16	1021	11.8	3.79
1036	134	940	13.8	8.21	935	16.6	8.33	842	16.8	8.50	906	7.9	8.81
1038	150	1273	12.3	9.73	1273	12.9	9.80	1225	13.4	9.72	1248	11.2	9.89
1039	235	1200	11.0	9.59	864	14.9	8.56	881	15.4	8.37	1091	12.9	9.13
1171	Spring	1196	9.9	11.04	1222	15.3	9.07	1187	16.9	8.87	1145	6.4	10.94
1215	Spring	814	8.4	5.75	NA	NA	NA	NA	NA	NA	NA	NA	NA
1254	205	975	13.6	9.83	1021	14.2	9.58	NA	NA	NA	1045	12.5	9.70
1255	197	911	14.1	8.55	899	15.2	8.33	897	14.8	7.66	892	13.7	8.82
1311	200	1409	11.1	8.61	1296	16.4	7.67	1296	18.8	6.02	1298	8.7	9.52
1312	Spring	244	11.1	7.88	210.1	16.6	7.58	219	19.1	7.58	213.8	14.5	7.81
1313	1025	606	8.4	8.94	647	14.2	9.20	630	15.1	7.99	NA	NA	NA
1314	Spring	592	7.5	9.17	572	13.4	7.98	NA	NA	NA	560	8.6	9.32
1315	Spring	598	10.7	6.68	596	12.7	9.21	592	12.1	9.45	580	7.8	9.65
1317	476	533	11.7	9.78	593	12.3	9.21	575	13.5	8.93	593	10.2	10.16
2022	800	NA	NA	NA	227	15.5	1.14	NA	NA	NA	224	11.5	6.16

Notes: No primary or secondary health standard available for listed water quality field parameters.
Spec. Cond. = specific conductivity; µS/cm= microsiemens per centimeter; Temp. = temperature; ℃ = deg rees Celsius; DO = dissolved oxygen; mg/L = milligrams per liter; NA = not analyzed

Nitrate Sampling

Nitrate results from the 2012 quarterly sampling are presented in Table 29. The highest nitrate concentration was observed at site 1314 (19.4 mg/L) during the December 2012 sampling event. Overall, 13 of the 18 sample sites in the Tammany/Lindsay Creek project area had nitrate concentrations that equaled or exceeded the MCL of 10 mg/L during at least one quarter, and 10 sites had average nitrate concentrations over 10 mg/L for 2012. Only sites 1312 and 2022 (depths of 1,025 and 800 feet, respectively) had average concentrations less than 5 mg/L for the year. A histogram of all nitrate samples in the project area for 2012 is shown in Figure 29. Mann-Whitney analyses of synoptic sampling data show no significant differences ($\alpha = 0.10$) between any of the quarterly sampling events in 2012.

Table 29. Nitrate results—Tammany and Lindsay Creeks Ground Water Monitoring Project.

DEQ Site ID	Well depth (feet)	Nitrate Concentration (milligrams per liter)			
		March 2012	June 2012	September 2012	December 2012
533	225	**14.6**	**10.1**	**11.1**	**11.9**
534	205	9.51	9.92	**10.3**	NA
538	228	3.61	6.07	6.14	**13.7**
696	295	NA	8.14	6.91	5.73
1036	134	9.87	**10.8**	7.05	**10.0**
1038	150	7.30	7.65	7.96	7.97
1039	235	8.19	6.8	6.84	8.63
1171	Spring	**12.4**	**11.5**	**11.8**	**11.8**
1215	205	**11.2**	NA	NA	NA
1254	197	**14.2**	**15.8**	NA	**15.0**
1255	200	**14.9**	**14.7**	**13.3**	**15.1**
1311	Spring	**12.9**	9.99	9.09	**12.2**
1312	1025	1.28	0.35	0.31	0.33
1313	Spring	**12.7**	**12.8**	**13.3**	NA
1314	Spring	**17.3**	**17.1**	NA	**19.4**
1315	476	**15.2**	**14.3**	**14.0**	**13.7**
1317	Spring	**12.9**	**15.9**	**15.8**	**15.5**
2022	800	NA	<0.1	NA	<0.1

Note: Bolded red numbers indicate EPA's maximum contaminant level was reached or exceeded.
NA = not analyzed

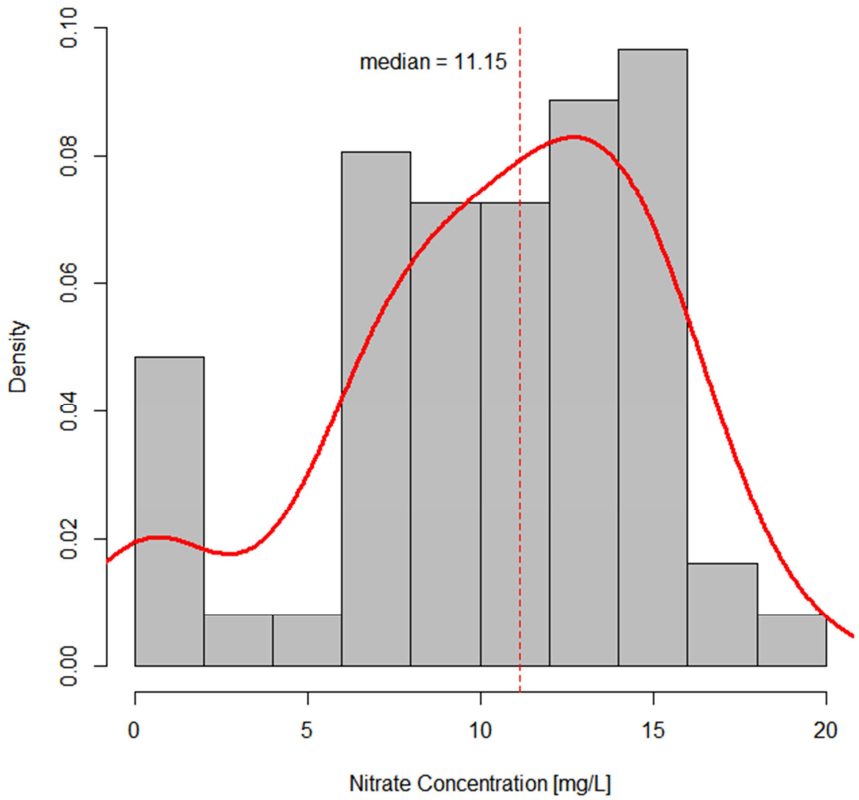


Figure 29. Histogram of nitrate concentrations and estimated kernal density distribution of all nitrate samples (n = 62, bandwidth = 2)—Tammany/Lindsay Creek project area, 2012. The median nitrate concentration value exceeds the MCL of 10 mg/L.

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 assist in determining the effects of seasonal variability that occur due to changes in cropping patterns and fertilizer application, variation in nitrogen uptake by crops due to growing season conditions, and variations in leaching rates related to the amount and timing of precipitation available to mobilize nitrogen below the crop root zone. Multiple year seasonal trend analysis of ambient nitrate concentrations has not yet been conducted because additional data and compilation are needed prior to conducting such analyses. Data and resources are anticipated to be available to complete the trend analysis phase of the project in the future.

Phosphorus Sampling

Samples for total phosphorous were also collected during the March, September, and December sampling events (Table 30) to determine if total phosphorus could be used to supplement current efforts in monitoring regional ground water quality. For all sample sites in 2012, concentrations ranged from <0.01 mg/L to 0.3330 mg/L with a median value of 0.0319 mg/L. Seasonally, median values increased slightly over the year from 0.0306 mg/L in March to 0.0396 mg/L in December.

Table 30. Total phosphorus concentrations—selected sites within the Tammany and Lindsay Creeks Ground Water Monitoring Project.

DEQ Site ID	Well depth (feet)	Phosphorus[a] Concentration (milligrams per liter)		
		March 2012	September 2012	December 2012
533	225	0.0415	0.0406	0.0302
534	205	0.0373	0.0256	NA
538	228	0.0279	0.0319	0.0618
696	295	NA	0.2280	0.21
1036	134	0.0291	0.0346	0.0278
1038	150	0.0819	0.0815	0.0848
1039	235	0.0301	0.0376	0.0396
1171	Spring	0.0280	<0.01	0.0396
1215	Spring	0.0206	NA	NA
1254	205	0.0310	NA	0.0254
1255	197	0.0227	0.0195	0.0272
1311	200	0.0590	<0.01	0.0174
1312	Spring	0.0606	<0.01	0.0132
1313	1025	0.0250	0.0145	NA
1314	Spring	0.3330	NA	0.0897
1315	Spring	0.0264	0.0462	0.0485
1317	476	0.0530	0.0484	0.0529
2022	800	NA	NA	0.0232

Note: NA = not analyzed
[a] No primary or secondary health standard available.

2.4.2.3 Conclusions

Sample results show that ground water in the Tammany and Lindsay Creek project area has elevated nitrate concentrations, with the majority of sample locations exceeding EPA's MCL of 10 mg/L in at least one quarter of the year. Wells available to include in an ambient network are limited, and springs shown to be representative of ground water conditions may continue to be enlisted into the monitoring network to satisfy data needs. Currently, not enough phosphorus data are available to determine seasonal or spatial trends in concentration.

2.4.2.4 Recommendations

Continued monitoring of available wells and springs is recommended to establish an ambient ground water quality network to track multiple year and seasonal trends, specifically for nitrate, in the project area. Outlier tests and common ion chemistry should be used to determine if samples are representative of ambient conditions and could be used to monitor long-term trends in ground water quality, once sufficient data are collected. Any wells yielding sample concentrations or other parameters inconsistent with the ambient conditions should be considered anomalies and dropped from the monitoring network. Multiple year trend analysis should be completed to quantify long-term trends in nitrate concentration. Continued investigation of total phosphorus concentration in the region's ground water is also recommended.

To address the ground water degradation, 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 Nez Perce County Soil and Water Conservation District has proposed funding the plan through the Clean Water Act section 319 grant program. The NPA management plan and applications for funding should continue in order to assist with ground water protection efforts and projects to reduce nitrogen loading.

2.5 Pocatello Region

No ground water quality projects were conducted using public funds in the Pocatello region in 2012.

2.6 Twin Falls Region

2.6.1 Box Canyon Follow-Up Sampling Project

2.6.1.1 Purpose

In spring 2012, an investigation was initiated following a complaint made to ISDA by a local resident and dairy operator in southern Gooding County, Idaho. The complaint involved an odor emanating from a private well in the area neighboring a complex of seven dairies known as the Box Canyon Complex. ISDA requested assistance from DEQ staff after samples collected by ISDA showed that nitrate concentrations exceeded EPA's MCL (Marv Patton, personal communication, 2012). Concern over elevated ammonia concentrations was also expressed due to the strong odor detected. The area also supports aquaculture facilities owned by Clear Springs Foods, Inc., including the Snake River Farms site.

The sampling area lies in the ESRP in the Clear Lakes spring system of southern Gooding County, Idaho, just north of the Snake River and south of Interstate I-84 (Figure 30). The wells and springs at Snake River Farm represented the nearest convenient potentially downgradient site from the complaint well. In 2009, DEQ conducted a study at this site because of elevated nitrate levels detected in springs supplying water to Snake River Farms (Schorzman et al. 2009).

The purpose of this 2012 investigation was to follow up on the complaint to determine the nature and extent of the reported contamination, determine if the contamination was a chronic or a temporary problem, identify possible sources, and recommend solutions.

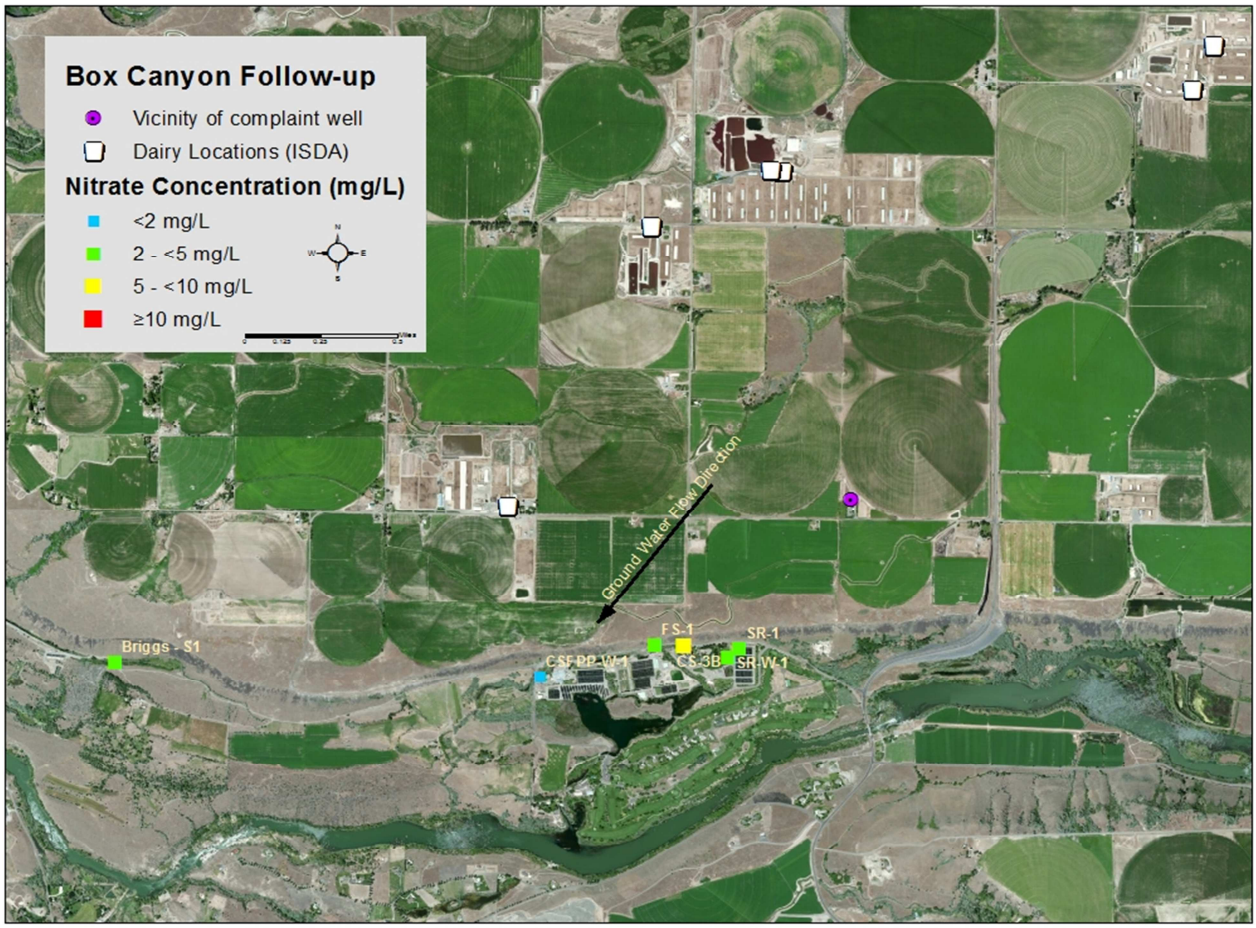


Figure 30. Location, project well name, and nitrate concentrations for springs and wells sampled for the Box Canyon Follow-Up Sampling Project.

2.6.1.2 Methods and Results

The ESRP is a northeast-southwest trending structural feature dominated by successive Quaternary-age basalt flows of the Snake River Group. The cumulative basalt units range from 300 to 400 feet thick along the Snake River, with individual flows approximately 20 feet thick (Whitehead 1992). The advancing basalt flows, causing the ancestral Snake River to shift course, resulted in highly porous pillow basalt zones and show evidence of rapid vertical ground water movement (Gillerman and Schiappa 1994).

Ground water in the ESRP aquifer generally moves from northeast to southwest. A previous study (Schorzman et al. 2009) suggested that the complex geology in the Snake River plain includes zones of high transmissivity that could potentially channelize water with high nitrate concentrations toward spring discharge outlets eventually leading to the Snake River Farm facility. Delineation of two ground water flow systems—one regional and one local—was described previously by Baldwin et al. (2006). The project area is located within the local flow system delineated by Baldwin et al. (2006), which has high transmissivity and greater susceptibility to contamination.

Six sampling sites were chosen based on downgradient proximity to the reported contamination. Four springs and two wells in the Snake River Farms aquaculture facility were sampled due to their accessibility and location downgradient of the complaint well and because concern was expressed that facility water may be adversely affected. One spring site, Briggs-S1, was located about a mile west of the main Snake River Farm complex (Figure 30). Samples were taken at the six sites on May 7, 2012, in accordance with two previously completed QAPPs for this study area (DEQ 2007b; DEQ 2010b).

Field parameters of temperature, pH, specific conductivity, DO, and turbidity were recorded on site (Table 31). Laboratory samples were analyzed at IBL in Boise for chloride; sulfate; major ions (calcium, magnesium, potassium, sodium); and alkalinity to define the current geochemistry and for ammonia, nitrate, TC, and *E. coli*. In addition, water samples were drawn for sulfonamide antibiotics and sent to the UIASL in Moscow for analysis.

A summary of the analytical results is shown in Table 32 and Table 33. No EPA National Primary or Secondary Drinking Water Regulation standards were equaled or exceeded. Three spring samples tested positive for TC, but no detectable *E. coli* were found in those samples. The Briggs-S1 spring sample was taken below the outlet some 300 feet from a pond with abundant floral growth, which explains why TC was as high as 866.4 mg/L. Nitrate concentration was highest in CS-3B at 5.6 mg/L. Spatial distribution of nitrate levels is shown in Figure 30.

No detectable results for sulfonamide antibiotics or sucralose were found in any of the samples based on a reporting limit ranging from 0.10 µg/L to 0.20 µg/L (Table 33).

Table 31. Water quality field parameters—Box Canyon Follow-Up Sampling Project.

DEQ Site ID	Project Well Name	Well Depth (feet)	Sample Date	Temp.[a] (°C)	pH	Specific Conductivity[a] (µS/cm)	Dissolved Oxygen[a] (mg/L)	Turbidity[a] (NTU)
847	SR-1	Spring	5/7/2012	14.32	7.54	606	9.96	0.0
2099	SR-W1	140	5/7/2012	15.87	7.54	616.8	8.22	1.1
852	CS-3B	Spring	5/7/2012	14.27	7.60	728.8	9.73	0.0
2101	FS-1	Spring	5/7/2012	14.43	7.60	558.4	9.86	0.0
2100	CSFPP-W1	432	5/7/2012	17.49	8.26	356.5	9.37	7.8
843	Briggs-S1	Spring	5/7/2012	14.82	7.75	446.2	10.41	0.0

Notes: pH was within the range of EPA's National Secondary Drinking Water Regulation (NSDWR) standard (6.5–8.5 pH units). However, field measurements should be considered estimates and are not used for determining violations of NSDWR standards.
mg/L = milligrams per liter; µS/cm = microsiemens per centimeter; °C = degrees Celsius; Temp. = temper ature; NTU = nephelometric turbidity unit
[a] No primary or secondary health standard available.

Table 32. Common ion and bacteria analytical results—Box Canyon Follow-Up Sampling Project.

DEQ Site ID	Project Well Name	Well Depth (feet)	Sample Date	Calcium[a]	Magnesium[a]	Potassium[a]	Sodium[a]	Chloride	Sulfate	Ammonia	Nitrate	Alkalinity[a]	Total Coliform[b]	*E. coli*
				(milligrams per liter)									(MPN/100 mL)	
847	SR-1	Spring	5/07/2012	54	24	4.7	31	51.0	58.4	<0.010	2.6	171	58.3	<1
2099	SR-W1	140	5/07/2012	62	21	5.9	30	45.6	61.4	<0.010	2.0	185	<1	<1
852	CS-3B	Spring	5/07/2012	62	31	5.2	39	63.3	69.9	<0.010	5.6	198	7.3	<1
2101	FS-1	Spring	5/07/2012	51	22	4.5	29	46.0	54.2	<0.010	2.2	160	<1	<1
2100	CSFPP-W1	432	5/07/2012	22	0.85	7.1	50	14.3	30.5	0.070	<0.010	121	<1	<1
843	Briggs-S1	Spring	5/07/2012	40	18	3.8	22	29.1	41.6	0.013	1.7	141	866.4	<1

Notes: EPA's maximum contaminant level or National Secondary Drinking Water Regulation standards were not reached or exceeded.
MPN/100 mL = most probable number per 100 milliliters
[a] No primary or secondary health standard available.
[b] A ground water quality standard does not exist.

Table 33. Sulfonamide antibiotics and sucralose analytical results—Box Canyon Follow-Up Sampling Project.

DEQ Site ID	Project Well Name	Well Depth (feet)	Sample Date	Sulfathiazole	Sulfamerazine	Sulfamethizole	Sulfamethazine	Sulfachloropyridazine	Sulfamethoxazole	Sulfadimethoxine	Sucralose
				(micrograms per liter)							
847	SR-1	Spring	5/07/2012	<0.20	<0.10	<0.20	<0.10	<0.20	<0.10	<0.10	<0.10
2099	SR-W1	140	5/07/2012	<0.20	<0.10	<0.20	<0.10	<0.20	<0.10	<0.10	<0.10
852	CS-3B	Spring	5/07/2012	<0.20	<0.10	<0.20	<0.10	<0.20	<0.10	<0.10	<0.10
2101	FS-1	Spring	5/07/2012	<0.20	<0.10	<0.20	<0.10	<0.20	<0.10	<0.10	<0.10
2100	CSFPP-W1	432	5/07/2012	<0.20	<0.10	<0.20	<0.10	<0.20	<0.10	<0.10	<0.10
843	Briggs-S1	Spring	5/07/2012	<0.20	<0.10	<0.20	<0.10	<0.20	<0.10	<0.10	<0.10

Note: No primary or secondary health standard available for sulfonamide antibiotics or sucralose.

2.6.1.3 Conclusions

In a previous study, seasonal trends in the Snake River Farm springs showed highest nitrate concentrations in the fall and lowest in the spring and early summer from April to June (Schorzman et al. 2009). The nitrate concentration detected in CS-3B (5.6 mg/L) could be a potential indication that the elevated nitrate concentrations detected within the complaint well also affected the downgradient springs. However, all other samples had nitrate concentrations 2.6 mg/L or less; 2 mg/L is generally considered background level (DEQ 2008). No further complaints of odor or nitrate contamination were received. It is possible that an unintended discharge due to poor wellhead protection practices (or via an unprotected well) occurred causing the ammonia odor and localized contamination. However, the dynamics of the local versus regional ground water flow systems may have played a part in the nonelevated nitrate concentrations detected in this sampling event.

Baldwin et al. (2006) used specific conductance and nitrate to delineate the regional and local flow systems of the ESPA in this region. Based on their analysis, the local flow system had conductance values in excess of 500 µS/cm and an average nitrate concentration of 3.6 mg/L, while the regional flow system was less than 500 µS/cm and had an average nitrate concentration of 1.29 mg/L. Baldwin et al. (2006) developed a division line that ran generally east and west dividing the area into a northern (regional flow) and southern (local flow) portion. The Box Canyon Dairy Complex is located just north of the flow division line delineated by Baldwin et al. (2006) and would therefore be part of the regional flow system. If introduced to ground water at the Box Canyon Dairy Complex, contaminated water may never reach the springs at Snake River Farm. Ground water in the regional system also travels more slowly. However, Baldwin et al. (2006) also noted that the springs at Snake River Farm exhibited characteristics of both flow systems over the course of the year dependent on irrigation, and the division line is difficult to pinpoint.

No detectable sulfonamide antibiotics were found in any of the samples. Schorzman et al. (2009) found traces of sulfamethoxazole in several springs at Snake River Farm but at levels ranging from 0.0012 µg/L to 0.0092 µg/L, which are far below the detection limits used in this study (0.10 µg/L–0.20 µg/L).

2.6.1.4 Recommendations

If the contaminated wells were a result of an unprotected well or human error at the dairy, BMPs for wellhead protection need to be addressed. ISDA has the authority to inspect dairies for BMP implementation to protect water quality. A single backflow incident or flooding of wastewater in the vicinity of the complaint well could have caused a localized problem.

Without a complete understanding of the complex flow regimes in this region of the ESRP, it is difficult to predict ground water flow paths. A comprehensive dye tracer testing program combined with water quality monitoring would shed more light on the fate of pollutants as they enter the ground water system in this region. At a minimum, a regional trend monitoring program for nitrate and coliform is recommended.

3 DEQ Cooperative Projects

This section presents data from special ground water quality monitoring and investigation projects that were conducted jointly by DEQ and other state agencies in calendar year 2012.

3.1 DEQ–ISDA Nitrate and Common Ions Ground Water Monitoring Project

3.1.1 Purpose

The ISDA Ground Water Program has developed a ground water monitoring network across the state of Idaho to assess the impacts of pesticide use on ground water quality. DEQ partnered with ISDA to pay for analysis of common ions, specifically nitrate, to help assess ground water quality across the state. By using ISDA's existing network and planned sampling activities, the common ion ground water quality data were collected for only the analytical costs. The data will help identify areas of concern and potential health threats associated with degraded ground water quality. Additionally, the information will be used to augment data from PWSs, the IDWR Statewide Ambient Ground Water Quality Monitoring Program, and local-scale monitoring projects to be used in the NPA ranking process.

3.1.2 Methods and Results

ISDA collected 109 samples from domestic wells across the state following its EPA-approved QAPP (Figure 31 through Figure 35). Samples were submitted to the UIASL in Moscow for analysis of fluoride, chloride, nitrite, bromide, nitrate, orthophosphate, and sulfate. Samples collected in Owyhee County were also analyzed for ammonia due to the anaerobic nature of the aquifer in the area. The analytical results are shown in Table 34.

3.1.2.1 Nitrate Sampling

Nitrate concentrations for this project ranged from nondetect (<0.050 mg/L) to 50 mg/L. Out of the 109 samples collected for nitrate analysis, 24 samples (22%) equaled or exceeded the EPA MCL of 10 mg/L for nitrate. At least 1 well exceeded the MCL in each of the project areas, except in Kootenai (Figure 31) and Owyhee Counties (Figure 33). In total, 83 samples (76%) were at or greater than 2 mg/L, indicating some type of nonnaturally occurring nitrogen source; 2 mg/L is generally considered background level (DEQ 2008).

Well locations and nitrate concentrations are shown in Figure 31 through Figure 35.

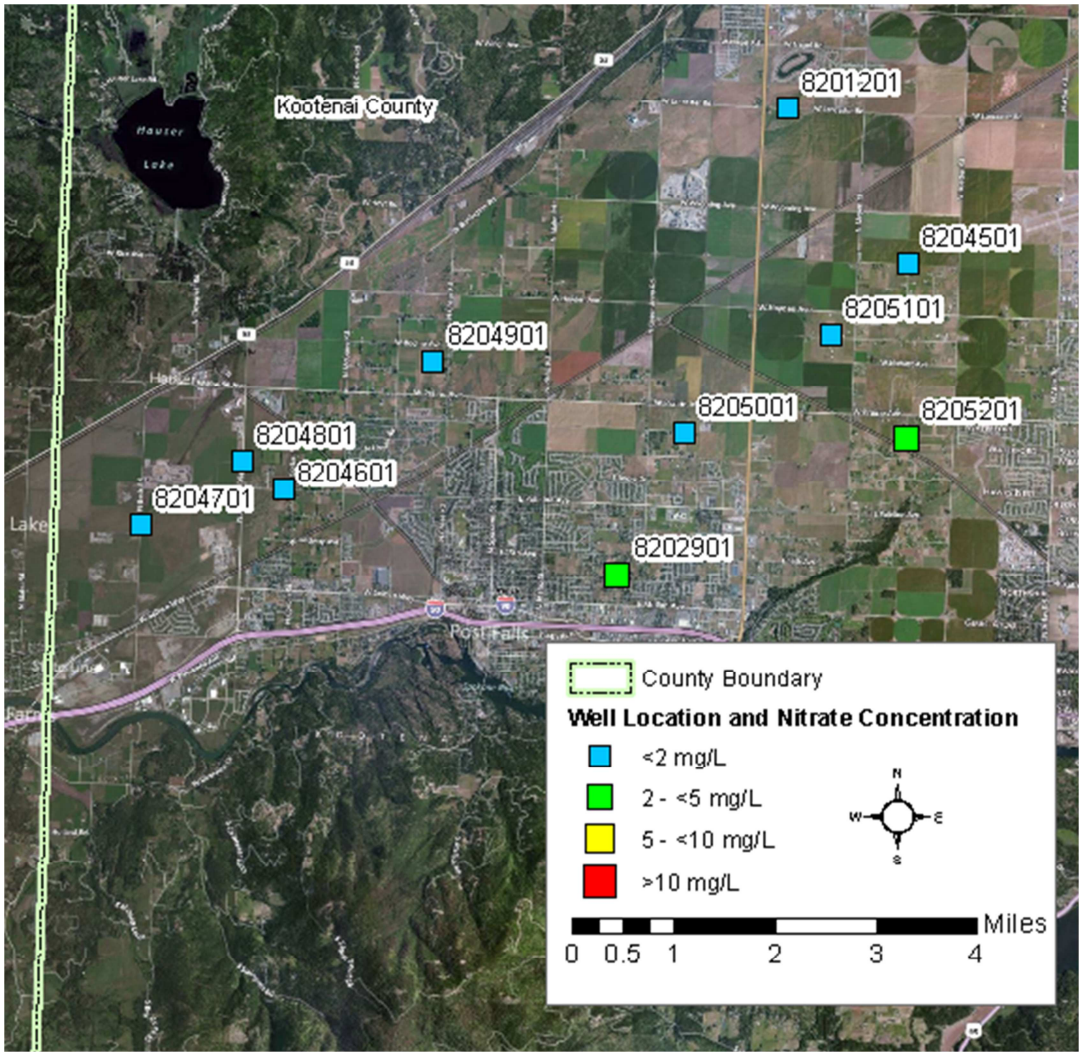


Figure 31. Well location, ISDA well ID, and nitrate results in Kootenai County—DEQ–ISDA Nitrate and Common Ions Ground Water Monitoring Project.

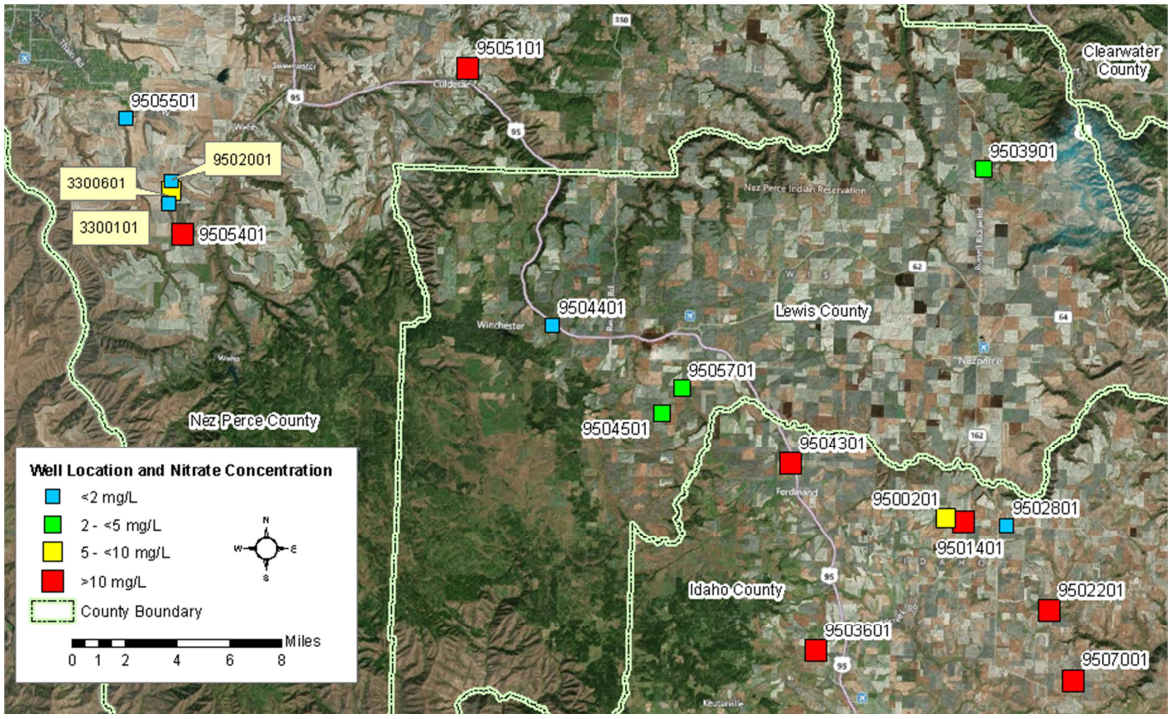


Figure 32. Well location, ISDA well ID, and nitrate results in Nez Perce, Lewis, and Idaho Counties—DEQ–ISDA Nitrate and Common Ions Ground Water Monitoring Project.

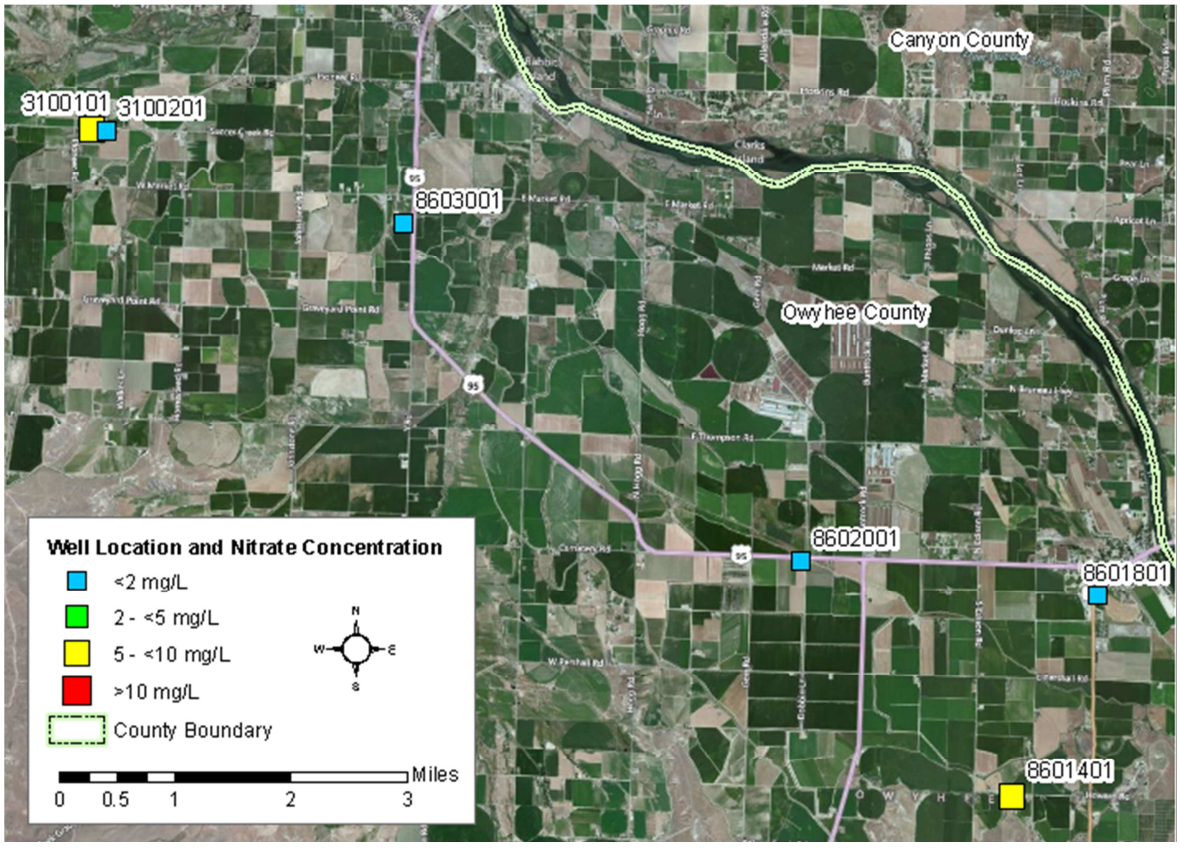


Figure 33. Well location, ISDA well ID, and nitrate results in Owyhee County—DEQ–ISDA Nitrate and Common Ions Ground Water Monitoring Project.

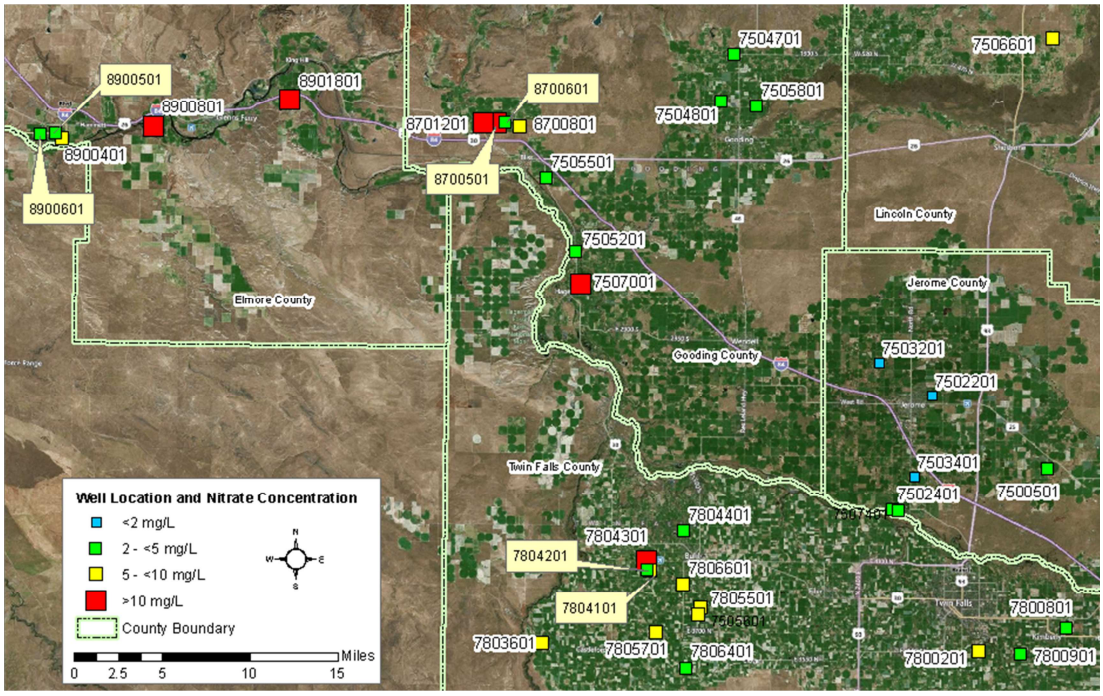


Figure 34. Well location, ISDA well ID, and nitrate results in Elmore, Gooding, Twin Falls, Lincoln, and Jerome Counties—DEQ–ISDA Nitrate and Common Ions Ground Water Monitoring Project.

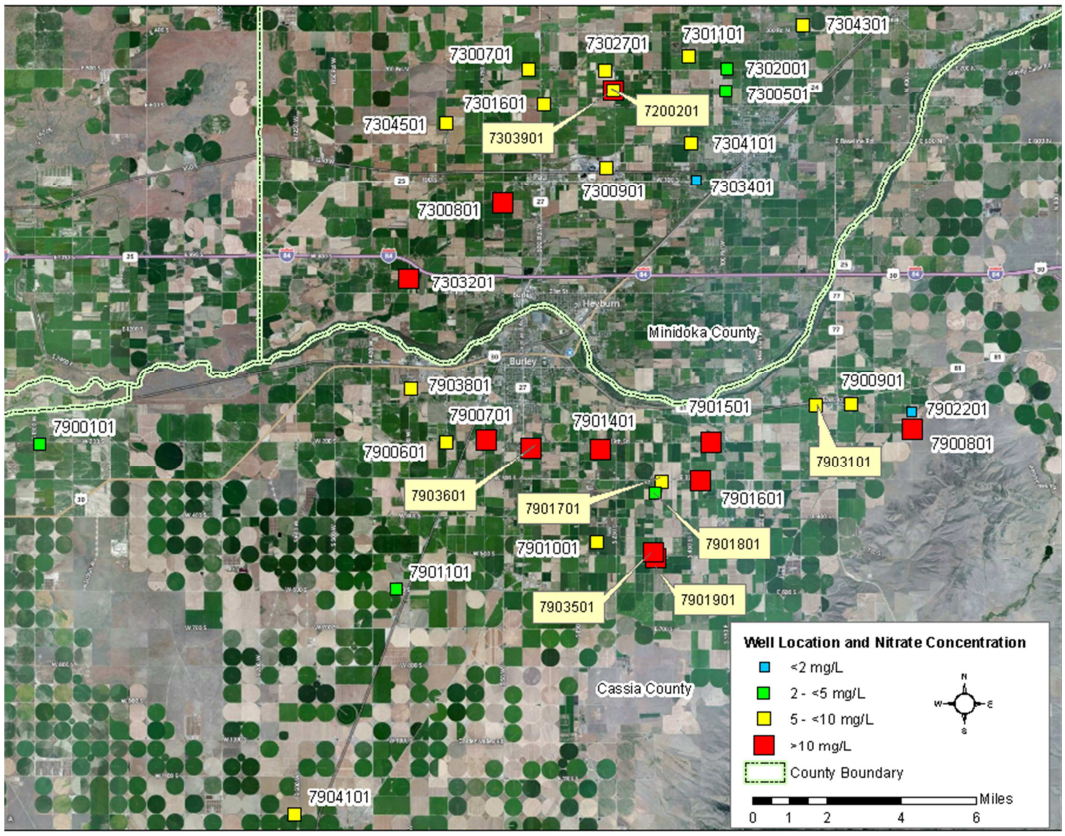


Figure 35. Well location, ISDA well ID, and nitrate results in Minidoka and Cassia Counties—DEQ–ISDA Nitrate and Common Ions Ground Water Monitoring Project.

Table 34. Analytical results—DEQ–ISDA Nitrate and Common Ions Ground Water Monitoring Project.

ISDA Well ID	Well Depth (feet)	Sample Date	Fluoride	Chloride	Nitrite	Bromide[a]	Nitrate	Ortho-phosphate[a]	Sulfate	Ammonia[a]
			(milligrams per liter)							
3100101	Unknown	09/19/2012	2.5	42	<0.050	0.22	4.7	<0.10	*970*	NA
3100101	Unknown	12/17/2012	2.5	37	<0.050	0.17	5.1	<0.10	*1100*	<0.10
3100201	Unknown	09/19/2012	1.1	120	<0.050	0.40	0.31	0.16	*600*	NA
3100201	Unknown	12/17/2012	1.0	130	<0.050	0.49	0.27	<0.10	*580*	6.3
3300101	Unknown	08/22/2012	0.37	24	<0.050	0.38	1.6	<0.10	22	NA
3300601	Unknown	08/22/2012	0.65	15	0.19	0.25	9.8	0.12	51	NA
7300201	Unknown	08/08/2012	0.28	40	<0.050	<0.10	6.3	<0.10	74	NA
7300501	40	08/08/2012	0.21	33	<0.050	<0.10	2.1	<0.10	47	NA
7300701	Unknown	08/09/2012	0.17	39	<0.050	<0.10	8.5	<0.10	82	NA
7300801	170	08/08/2012	0.77	63	<0.050	<0.10	**12**	<0.10	150	NA
7300901	167	08/16/2012	0.89	36	<0.050	<0.10	5.2	0.13	86	NA
7301101	160	08/08/2012	0.16	28	<0.050	<0.10	6.0	<0.10	54	NA
7301601	125	08/09/2012	0.24	43	<0.050	<0.10	6.8	<0.10	77	NA
7302001	125	08/08/2012	0.19	29	<0.050	<0.10	2.9	<0.10	49	NA
7302701	Unknown	08/09/2012	0.17	41	<0.050	<0.10	6.7	<0.10	71	NA
7303201	100	08/09/2012	0.69	*480*	<0.050	0.70	**36**	<0.10	*420*	NA
7303401	33	08/08/2012	0.75	36	<0.050	<0.10	0.24	<0.10	93	NA
7303901	Unknown	08/08/2012	0.58	30	<0.050	<0.10	**12**	<0.10	55	NA
7304101	Unknown	08/08/2012	0.23	31	<0.050	<0.10	9.8	<0.10	64	NA
7304301	Unknown	08/08/2012	0.56	22	<0.050	<0.10	5.4	<0.10	48	NA
7304501	Unknown	08/09/2012	0.30	50	<0.050	<0.10	9.8	<0.10	110	NA
7500501	Unknown	07/18/2012	0.25	26	<0.050	<0.10	2.2	<0.10	53	NA
7502201	Unknown	07/18/2012	0.52	31	<0.050	<0.10	0.99	<0.10	42	NA
7502401	200	07/17/2012	0.41	42	<0.050	<0.10	3.6	<0.10	63	NA
7503201	31	07/18/2012	0.57	17	<0.050	<0.10	0.72	<0.10	32	NA
7503401	483	07/18/2012	0.58	21	<0.050	<0.10	0.70	<0.10	33	NA
7504701	Unknown	07/19/2012	0.68	25	<0.050	<0.10	2.7	<0.10	59	NA
7504801	Unknown	07/19/2012	0.44	27	<0.050	<0.10	2.6	<0.10	57	NA

ISDA Well ID	Well Depth (feet)	Sample Date	Fluoride	Chloride	Nitrite	Bromide[a]	Nitrate	Ortho-phosphate[a]	Sulfate	Ammonia[a]
			(milligrams per liter)							
7505201	Unknown	07/17/2012	0.47	29	<0.050	<0.10	2.4	<0.10	63	NA
7505501	198	07/17/2012	0.50	24	<0.050	<0.10	3.6	<0.10	51	NA
7505801	168	07/19/2012	0.40	28	<0.050	<0.10	2.3	0.11	57	NA
7506601	Unknown	07/19/2012	0.32	14	<0.050	<0.10	5.6	<0.10	29	NA
7507001	Unknown	07/17/2012	0.47	30	<0.050	<0.10	**11**	<0.10	85	NA
7507401	205	07/17/2012	0.46	39	<0.050	<0.10	3.2	<0.10	60	NA
7800201	Unknown	08/15/2012	0.86	34	<0.050	<0.10	5.1	<0.10	140	NA
7800801	Unknown	08/16/2012	0.40	27	<0.050	<0.10	4.0	<0.10	62	NA
7800901	Unknown	08/16/2012	0.39	45	<0.050	<0.10	4.3	<0.10	140	NA
7803601	Unknown	08/15/2012	0.65	38	<0.050	<0.10	6.9	<0.10	120	NA
7804101	Unknown	08/14/2012	1.1	32	<0.050	<0.10	4.4	<0.10	68	NA
7804201	Unknown	08/14/2012	1.0	37	<0.050	<0.10	5.4	<0.10	74	NA
7804301	Unknown	08/14/2012	0.95	43	<0.050	<0.10	**12**	<0.10	96	NA
7804401	Unknown	08/15/2012	0.84	38	<0.050	<0.10	2.6	<0.10	74	NA
7805501	Unknown	08/15/2012	1.0	33	<0.050	<0.10	7.1	<0.10	74	NA
7805601	180	08/15/2012	0.98	37	<0.050	<0.10	6.4	<0.10	88	NA
7805701	Unknown	08/15/2012	1.0	53	<0.050	<0.10	6.2	<0.10	87	NA
7806401	Unknown	08/15/2012	0.87	28	<0.050	<0.10	3.2	<0.10	60	NA
7806601	Unknown	08/15/2012	1.3	43	<0.050	<0.10	7.7	<0.10	92	NA
7900101	Unknown	08/02/2012	0.26	77	<0.050	0.29	4.2	<0.10	110	NA
7900601	Unknown	08/02/2012	<0.15	42	<0.050	<0.10	9.0	<0.10	79	NA
7900701	Unknown	08/02/2012	<0.15	49	<0.050	<0.10	**12**	<0.10	78	NA
7900801	Unknown	08/07/2012	<0.15	39	<0.050	<0.10	**11**	<0.10	67	NA
7900901	185	08/01/2012	0.19	34	<0.050	<0.10	5.9	<0.10	63	NA
7901001	Unknown	08/01/2012	0.26	35	<0.050	<0.10	8.2	<0.10	67	NA
7901101	425	08/02/2012	<0.15	51	<0.050	0.12	3.6	<0.10	45	NA
7901401	58	08/07/2012	<0.15	49	<0.050	<0.10	**17**	<0.10	71	NA
7901501	80	07/31/2012	0.32	34	<0.050	<0.10	**10**	<0.10	83	NA
7901601	Unknown	07/31/2012	<0.15	34	<0.050	<0.10	**13**	<0.10	88	NA

ISDA Well ID	Well Depth (feet)	Sample Date	Fluoride	Chloride	Nitrite	Bromide[a]	Nitrate	Ortho-phosphate[a]	Sulfate	Ammonia[a]
			(milligrams per liter)							
7901701	230	07/31/2012	0.27	27	<0.050	<0.10	6.6	<0.10	65	NA
7901801	51	07/31/2012	0.41	23	<0.050	<0.10	4.9	<0.10	45	NA
7901901	61	08/01/2012	<0.15	38	<0.050	<0.10	**13**	<0.10	72	NA
7902201	56	08/01/2012	1.7	31	<0.050	<0.10	1.6	0.13	60	NA
7902201	56	08/07/2012	1.7	32	<0.050	<0.10	1.6	0.17	59	NA
7903201	Unknown	08/01/2012	0.47	44	<0.050	<0.10	9.3	<0.10	74	NA
7903501	68	08/01/2012	<0.15	33	<0.050	<0.10	**11**	<0.10	66	NA
7903601	Unknown	08/07/2012	<0.15	45	<0.050	<0.10	**10**	<0.10	67	NA
7903801	42	08/02/2012	0.32	37	<0.050	<0.10	8.3	<0.10	77	NA
7904101	425	08/02/2012	0.16	36	<0.050	0.11	5.2	<0.10	35	NA
8201201	Unknown	09/25/2012	<0.15	1.6	<0.050	<0.10	1.9	<0.10	11	NA
8202901	Unknown	09/25/2012	<0.15	6.9	<0.050	<0.10	3.4	<0.10	12	NA
8204501	303	09/25/2012	<0.15	1.4	<0.050	<0.10	1.5	<0.10	19	NA
8204601	Unknown	09/25/2012	<0.15	2.8	<0.050	<0.10	1.4	<0.10	14	NA
8204701	Unknown	09/25/2012	<0.15	1.8	<0.050	<0.10	1.3	<0.10	16	NA
8204801	178	09/25/2012	<0.15	1.5	<0.050	<0.10	0.74	<0.10	17	NA
8204901	218	09/25/2012	<0.15	5.2	<0.050	<0.10	1.4	<0.10	8.2	NA
8205001	Unknown	09/25/2012	<0.15	1.1	<0.050	<0.10	0.87	<0.10	17	NA
8205101	300	09/25/2012	<0.15	1.1	<0.050	<0.10	1.7	<0.10	19	NA
8205201	302	09/25/2012	<0.15	3.1	<0.050	<0.10	2.6	<0.10	8.3	NA
8601401	Unknown	09/19/2012	0.42	130	<0.050	0.58	8.5	<0.10	*350*	NA
8601401	Unknown	12/17/2012	0.46	130	<0.050	0.54	8.2	<0.10	*340*	<0.10
8601801	Unknown	09/19/2012	1.8	30	<0.050	0.13	<0.050	<0.10	15	NA
8601801	Unknown	12/17/2012	1.7	21	<0.050	<0.10	<0.050	<0.10	5.6	5.3
8602001	Unknown	09/19/2012	1.0	83	<0.050	0.32	6.1	<0.10	*710*	NA
8602001	Unknown	12/17/2012	0.55	15	<0.050	<0.10	0.063	<0.10	*300*	1.4
8603001	Unknown	09/19/2012	0.59	39	<0.050		<0.050	<0.10	*320*	NA
8603001	Unknown	12/17/2012	0.55	40	<0.050	0.19	<0.050	<0.10	*320*	9.5
8700501	Unknown	07/11/2012	0.53	49	<0.050	<0.10	**15**	<0.10	78	NA

ISDA Well ID	Well Depth (feet)	Sample Date	Fluoride	Chloride	Nitrite	Bromide[a]	Nitrate	Ortho-phosphate[a]	Sulfate	Ammonia[a]
			(milligrams per liter)							
8700601	Unknown	07/11/2012	0.53	15	<0.050	<0.10	2.5	<0.10	37	NA
8700801	Unknown	07/11/2012	0.47	41	<0.050	<0.10	9.0	<0.10	90	NA
8701201	Unknown	07/11/2012	0.52	68	<0.050	0.31	**11**	<0.10	170	NA
8900401	Unknown	07/10/2012	0.58	50	<0.050	0.13	7.2	<0.10	110	NA
8900501	81	07/10/2012	0.65	48	<0.050	0.22	3.1	<0.10	79	NA
8900601	Unknown	07/10/2012	0.60	41	<0.050	<0.10	3.5	<0.10	94	NA
8900801	106	07/10/2012	0.71	130	<0.050	0.32	**50**	<0.10	*290*	NA
8901801	Unknown	07/10/2012	0.38	51	<0.050	0.10	**10**	<0.10	160	NA
9500201	Unknown	08/20/2012	0.89	4.5	<0.050	<0.10	6.0	<0.10	18	NA
9501401	Unknown	08/20/2012	0.53	46	<0.050	0.27	**41**	<0.10	48	NA
9502001	Unknown	08/22/2012	0.33	6.5	<0.050	0.12	0.36	<0.10	20	NA
9502201	Unknown	08/20/2012	0.31	6.2	<0.050	0.14	**11**	<0.10	27	NA
9502801	Unknown	08/20/2012	0.74	3.9	<0.050	<0.10	0.16	<0.10	19	NA
9503601	Unknown	08/21/2012	0.41	13	<0.050	<0.10	**10**	<0.10	28	NA
9503901	Unknown	08/21/2012	0.48	1.0	<0.050	<0.10	2.7	<0.10	6.6	NA
9504301	Unknown	08/21/2012	0.80	15	<0.050	0.18	**24**	<0.10	54	NA
9504401	Unknown	08/21/2012	0.38	0.49	<0.050	<0.10	0.067	<0.10	2.9	NA
9504501	Unknown	08/21/2012	0.36	0.61	<0.050	<0.10	2.0	<0.10	8.9	NA
9505101	Unknown	08/21/2012	0.31	10	<0.050	0.19	**11**	0.16	18	NA
9505401	Unknown	08/22/2012	0.65	7.4	<0.050	0.16	**13**	<0.10	31	NA
9505501	Unknown	08/22/2012	0.35	7.3	<0.050	0.14	<0.050	<0.10	24	NA
9505701	Unknown	08/21/2012	0.54	2.3	<0.050	<0.10	2.8	<0.10	9.5	NA
9507001	Unknown	08/20/2012	0.70	14	<0.050	0.27	**17**	<0.10	31	NA

Notes: Bolded red numbers indicate EPA's maximum contaminant level was reached or exceeded. Italicized red numbers indicate EPA's National Secondary Drinking Water Regulation standard was reached or exceeded.
NA = not analyzed
[a] No primary or secondary health standard available.

3.1.3 Conclusions

The cooperative project between ISDA and DEQ resulted in common ion ground water data that helped assess ground water quality across the state. By using the existing ISDA ground water monitoring network and its planned sampling, DEQ was able to obtain additional water quality data with only analytical costs. Out of the 109 samples collected for nitrate analysis, 24 samples (22%) equaled or exceeded the EPA MCL of 10 mg/L for nitrate. The nitrate and other common ion results indicate degradation of ground water quality across the state. These data will be helpful in the next NPA determination and ranking process conducted by DEQ and the Ground Water Monitoring Technical Committee.

3.1.4 Recommendations

This project was a good example of a cooperative project between state agencies in Idaho saving time and money by using existing ground water monitoring networks and sampling schedules. DEQ and ISDA continued this cooperative approach during ISDA Ground Water Program sampling scheduling in 2013, adding additional constituents to help with further identifying degraded ground water across the state. ISDA and DEQ should continue these cooperative efforts to increase program efficiency and protect ground water quality in the state of Idaho.

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