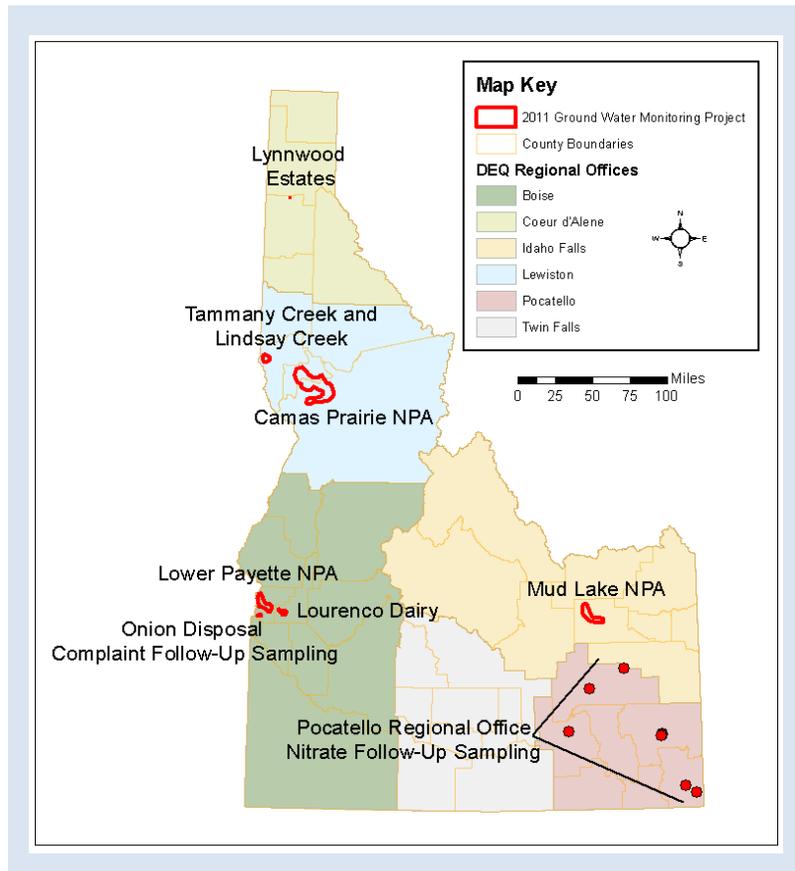


Summary Report for the Idaho Department of Environmental Quality Ground Water Quality Monitoring Projects—2011

Ground Water Quality Technical Report No. 45



State of Idaho
Department of Environmental Quality

November 2013



Printed on recycled paper, DEQ, July 2013, PID 9010,
CA 82017. Costs associated with this publication are
available from the State of Idaho Department of
Environmental Quality in accordance with
Section 60-202, Idaho Code.

Summary Report for the Idaho Department of Environmental Quality Ground Water Quality Monitoring Projects—2011

November 2013



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Acknowledgments

Compiled and edited by Jessica J. Atlakson, PG, and Joanna Hahn.

Thank you to the following people, all of the Idaho Department of Environmental Quality, who assisted with various sections of this annual report:

- Amy Williams reviewed the Source Water Assessments summary (section 2).
- Rebecca Goehring authored the Lourenco Dairy Follow-Up Monitoring Project and Lower Payette Nitrate Priority Area Ground Water Monitoring Project summaries (sections 3.1.1 and 3.1.2).
- Lisa Rowles, PG, authored the Onion Disposal Complaint Follow-Up Sampling summary (section 3.1.3).
- Gary Stevens authored the Lynnwood Estates Arsenic Follow-Up summary (section 3.2.1).
- Flint Hall authored the Mud Lake Nitrate Priority Area Potential Nitrate Source Evaluation summary (section 3.3.1).
- Susan Beattie authored the Camas Prairie Nitrate Priority Area Ground Water Monitoring Project summary (section 3.4.1).
- Brady Johnson authored the Tammany and Lindsay Creeks Ground Water Monitoring Project summary (section 3.4.2).
- John Cardwell reviewed the Camas Prairie Nitrate Priority Area Ground Water Monitoring Project and Tammany and Lindsay Creeks Ground Water Monitoring Project summaries (sections 3.4.1 and 3.4.2).
- Shannon Ansley, PG, reviewed the Health Fair Follow-Up Monitoring summary (section 3.5.1).

Also, thank you to the following Idaho Department of Environmental Quality staff who provided technical and editorial review that improved the quality of this report: Toni Mitchell, PG; Edward Hagan, PG; Erica Shiflet; and Barry Burnell.

Table of Contents

Acronyms, Abbreviations, and Symbols	vii
1 Introduction.....	1
2 Source Water Assessments	2
3 Summary of Ground Water Quality Projects by Region	3
3.1 Boise Region	4
3.1.1 Lourenco Dairy Follow-Up Monitoring Project.....	4
3.1.2 Lower Payette Nitrate Priority Area Ground Water Monitoring Project	14
3.1.3 Onion Disposal Complaint Follow-up Sampling	24
3.2 Coeur d’Alene Region	27
3.2.1 Lynnwood Estates Arsenic Follow-Up.....	27
3.3 Idaho Falls Region.....	32
3.3.1 Mud Lake Nitrate Priority Area Potential Nitrate Source Evaluation	32
3.4 Lewiston Region.....	39
3.4.1 Camas Prairie Nitrate Priority Area Ground Water Monitoring Project	39
3.4.2 Tammany and Lindsay Creeks Ground Water Monitoring Project.....	45
3.5 Pocatello Region.....	54
3.5.1 Pocatello Regional Office Nitrate Follow-Up Sampling.....	54
3.6 Twin Falls Region	59
4 References.....	60

List of Tables

Table 1. ISDA Dairy Bureau nitrate data for Lourenco Dairy.	5
Table 2. Water quality field parameters for the Lourenco Dairy Follow-Up Monitoring project.	8
Table 3. Inorganic results for Lourenco Dairy Follow-Up Monitoring project.....	10
Table 4. Bacteria and nitrogen isotope results for Lourenco Dairy Follow-Up Monitoring project.	11
Table 5. Cation and alkalinity results for Lourenco Dairy Follow-Up Monitoring project.	11
Table 6. Typical $\delta^{15}\text{N}$ values from various nitrogen sources.....	13
Table 7. Water quality field parameter data for Lower Payette Nitrate Priority Area Ground Water Monitoring project.	18
Table 8. Inorganic results for the Lower Payette Nitrate Priority Area Ground Water Monitoring project.	20
Table 9. Water quality field parameter results for Onion Disposal Complain Follow-up Sampling project.	26
Table 10. Results for Onion Disposal Complaint Follow-Up Sampling project.	26
Table 11. Analytical results for Lynnwood Estates Arsenic Follow-Up project.....	31
Table 12. Water quality field parameter data for Mud Lake Nitrate Priority Area Potential Nitrate Source Evaluation project.	35
Table 13. Tritium and major ion results, Mud Lake Nitrate Priority Area Potential Nitrate Source Evaluation project.....	36
Table 14. Nutrient and bacteria results for the Mud Lake Nitrate Priority Area Potential Nitrate Source Evaluation project.	36
Table 15. Stable isotope results for the Mud Lake Nitrate Priority Area Potential Nitrate Source Evaluation project.....	37
Table 16. Water quality field parameter data from Camas Prairie Nitrate Priority Area Ground Water Monitoring project.	42
Table 17. Nitrate and phosphorus results for Camas Prairie Nitrate Priority Area Ground Water Monitoring project, 2011.	43
Table 18. Water quality field parameters for Tammany and Lindsay Creeks Ground Water Monitoring project, 2011.....	49
Table 19. Nitrate results for Tammany and Lindsay Creeks Ground Water Monitoring project, 2011.	50
Table 20. Isotopic data collected in April 2011 from sites within the Tammany and Lindsay Creeks Ground Water Monitoring project.....	52
Table 21. Total phosphorus concentrations in selected sites within the Tammany and Lindsay Creeks Ground Water Monitoring project, December 2011.	53
Table 22. Health fairs and outreach events attended within the Pocatello Regional Office boundaries in 2011.	54
Table 23. Summary of analytical and water quality field parameter results for Pocatello Regional Office Nitrate Follow-Up sampling project.	58

List of Figures

Figure 1. Idaho Department of Environmental Quality’s 2011 ground water quality project locations by region.	3
Figure 2. ISDA Dairy Bureau nitrate data for Lourenco Dairy.	5
Figure 3. Location of Lourenco Dairy within the Emmett North Bench Nitrate Priority Area.....	6
Figure 4. Well sample locations, identification, and nitrate concentrations for Lourenco Dairy Follow-Up Monitoring project.	7
Figure 5. Well AGO1-013 in relation to Lourenco Dairy operation.	12
Figure 6. Well location, project well name, and nitrate concentrations for the Lower Payette Nitrate Priority Area Ground Water Monitoring project. Note: each project well name is preceded with “AGO4-”	16
Figure 7. Well locations, DEQ site identification, and nitrate concentrations for the Onion Disposal Complaint Follow-Up Sampling project.	25
Figure 8. Location of wells LWE 2 and TE 1, labeled with total arsenic concentrations from July 2011 sampling.....	28
Figure 9. Historic arsenic concentrations at LWE 2 and the current arsenic drinking water standard of 10 µg/L.	29
Figure 10. Well locations, project well name, and nitrate concentrations for Mud Lake Nitrate Priority Area Potential Nitrate Source Evaluation project.	33
Figure 11. Ground water elevation and locations of the Mud Lake basin and approximate location of Mud Lake–Market Lake barrier, as indicated by the dashed red lines. Yellow symbols are data points used to create ground water elevation contours. Adapted from Jeffers and Baldwin (2008).	34
Figure 12. General locations of direct seed application in 2011 in the Camas Prairie Nitrate Priority Area.	39
Figure 13. Well locations, project well name, and nitrate concentrations for September 2011 sampling for Camas Prairie Nitrate Priority Area Ground Water Monitoring project... ..	41
Figure 14. Time series plot of historic nitrate data for DEQ1.	44
Figure 15. Time series plot of historic specific conductivity data for DEQ1.	44
Figure 16. Well and spring locations, site identification numbers, and nitrate concentrations for June 2011 sampling of the Tammany and Lindsay Creeks Ground Water Monitoring project.....	47
Figure 17. Location of wells sampled for the Pocatello Regional Office Nitrate Follow-Up sampling project.	55
Figure 18. Well locations, DEQ site identification, and nitrate concentrations for October 2011 for the Pocatello Regional Office nitrate follow-up monitoring in Caribou and Bear Lake Counties.	56
Figure 19. Well locations, DEQ site identification, and nitrate concentrations for October 2011 for the Pocatello Regional Office nitrate follow-up monitoring in Bingham and Power Counties.....	57

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Acronyms, Abbreviations, and Symbols

$\delta^{15}\text{N}$	ratio of the two stable nitrogen isotopes ^{15}N and ^{14}N
$\delta^{18}\text{O}$	ratio of the two stable oxygen isotopes ^{18}O and ^{16}O
$\delta^2\text{H}$	ratio of the two stable hydrogen isotopes ^1H and ^2H (deuterium), also denoted as δD
bgs	below ground surface
BMP	best management practice
CaCO_3	calcium carbonate
cm	centimeter
DEQ	Idaho Department of Environmental Quality
DO	dissolved oxygen
<i>E. coli</i>	<i>Escherichia coli</i>
EPA	United States Environmental Protection Agency
ESRP	Eastern Snake River Plain
FSP	field sampling plan
IDAPA	refers to citations of Idaho's administrative rules
IDWR	Idaho Department of Water Resources
ISDA	Idaho State Department of Agriculture
L	liter
LSCD	Lewis Soil Conservation District
MCL	maximum contaminant level
mg	milligrams
mL	milliliter
MPN	most probable number
NA	not analyzed
NAU	Northern Arizona University

NO ₂ + NO ₃	nitrite plus nitrate
NPA	nitrate priority area
NS	not sampled
pCi	picocuries
per mil (‰)	parts per thousand
PRO	Pocatello Regional Office
PWS	public water system
SWA	source water assessment
TMDL	total maximum daily load
TOC	total organic carbon
QAPP	quality assurance project plan
µg	micrograms
µS	microsiemens
VSMOW	Vienna Standard Mean Ocean Water

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. DEQ also implements the Source Water Protection Program to promote the protection of ground water and surface water that are the sources of drinking water for PWSs.

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

The ground water quality monitoring results can also be used to define and prioritize degraded ground water quality areas, such as nitrate priority areas (NPAs). This prioritization is necessary to effectively allocate resources for water quality improvement strategies. DEQ has worked in coordination with state and federal agencies, as well as stakeholders, to develop ground water quality 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, which are described below.

This report provides the public with an overview of DEQ’s ground water monitoring projects and investigation activities accomplished with public funds during 2011. 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 the United States Environmental Protection Agency (EPA).

2 Source Water Assessments

In 1996, Congress amended the Safe Drinking Water Act to emphasize the protection of surface and ground water sources used for public drinking water (i.e., source water). The amendments require that each state develop a source water assessment (SWA) plan for public drinking water sources, conduct SWAs for all PWSs, and make the assessments available to the public. A PWS is defined by EPA and DEQ as a system for the conveyance of water to the public for human consumption if the system has at least 15 service connections or regularly serves an average of at least 25 individuals at least 60 days per year.

In 1999, the *Idaho Source Water Assessment Plan* (DEQ 1999) was developed in response to the 1996 Safe Drinking Water Act amendments. By May 2003, DEQ completed SWAs for all recognized PWSs. DEQ continues to complete assessments for new PWSs and update completed assessments as new information becomes available. All completed SWAs are available to the public through the *Source Water Assessment Online Database*, which was finalized in March 2011 as an effort to improve efficiency and usability of SWAs. The website can be used to search for PWS sources to view the delineation, susceptibility score, and potential contaminant inventory. In addition, each PWS source has a summary report that is automatically generated after the susceptibility score and delineation have been completed by DEQ. A total of 105 sources were delineated and assessed during 2011. DEQ will continue to create delineations for new PWS sources and will make them available through the interactive website.

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

3 Summary of Ground Water Quality Projects by Region

This section presents data from ground water quality monitoring and investigation projects that were conducted by DEQ in calendar year 2011. Projects are presented by DEQ regional office and identified in Figure 1.

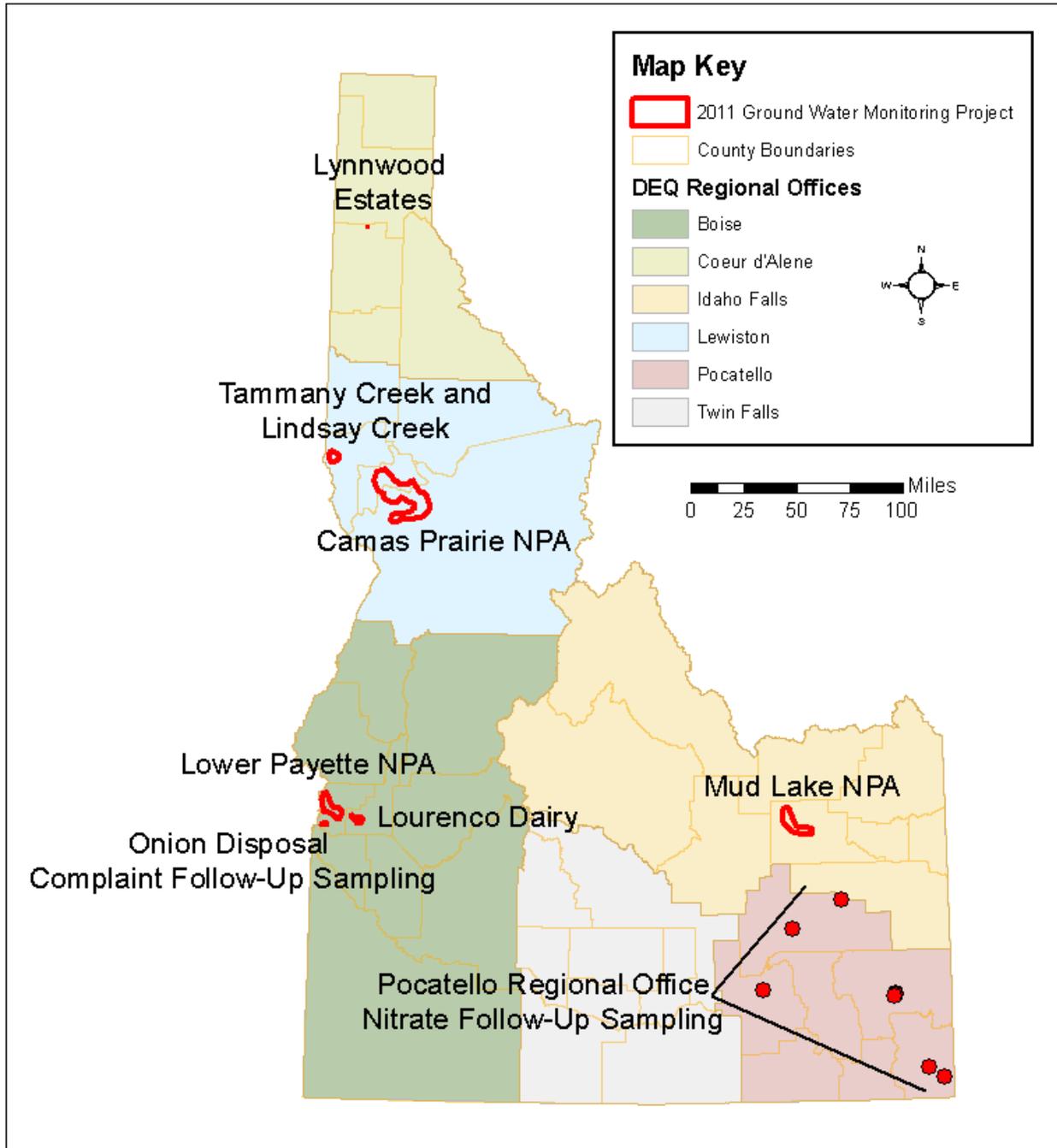


Figure 1. Idaho Department of Environmental Quality's 2011 ground water quality project locations by region.

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.

3.1 Boise Region

3.1.1 Lourenco Dairy Follow-Up Monitoring Project

3.1.1.1 Purpose

The ISDA Dairy Bureau collects ground water samples for nitrate analysis at dairy wells during annual facility inspections. When a sample exceeds the maximum contaminant level (MCL) for nitrate (10 milligrams per liter [mg/L]), ISDA provides the information to DEQ. The ISDA Dairy Bureau data for Lourenco Dairy has been above the MCL since 2004, with the exception of 2009 (Figure 2; Table 1). The trend of the annual ISDA dairy nitrate data was evaluated using a Mann-Kendall statistical analysis, which showed an increasing trend in nitrate concentrations (at 90% confidence level). The Lourenco Dairy is located within the Emmett North Bench NPA (Figure 3). The purpose of this project was to follow up with the elevated nitrate detections and to evaluate the general ground water quality in the area.

In 2008, 32 areas with degraded ground water quality in Idaho were designated by DEQ as having elevated concentrations of nitrate. These NPAs are ranked in order of severity of degradation based on population, existing water quality, and water quality trend. Information about NPA delineation and ranking is available from the *2008 Nitrate Priority Area Delineation and Ranking Process* document (DEQ 2008).

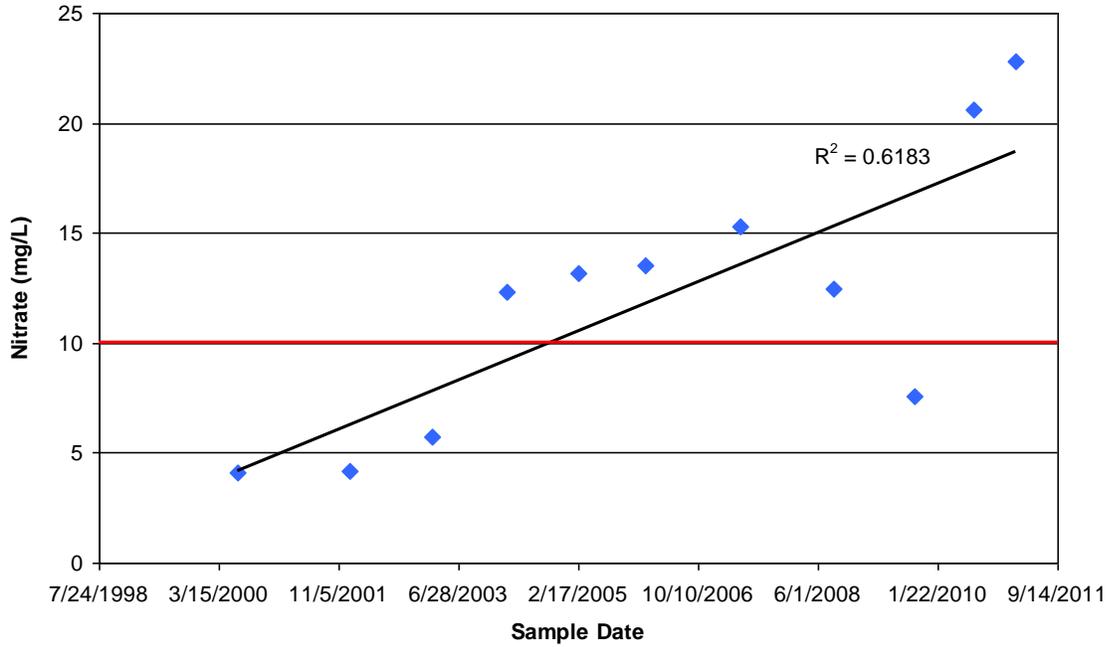


Figure 2. ISDA Dairy Bureau nitrate data for Lourenco Dairy.

Table 1. ISDA Dairy Bureau nitrate data for Lourenco Dairy.

Sample Date	Nitrate (milligrams/liter)
06/20/2000	4.13
12/28/2001	4.17
02/14/2003	5.77
02/24/2004	12.3
02/17/2005	13.2
01/20/2006	13.5
05/07/2007	15.3
08/21/2008	12.5
09/24/2009	7.6
07/20/2010	20.6
02/17/2011	22.8

Note: Bolded red numbers indicate EPA's maximum contaminant level was exceeded.

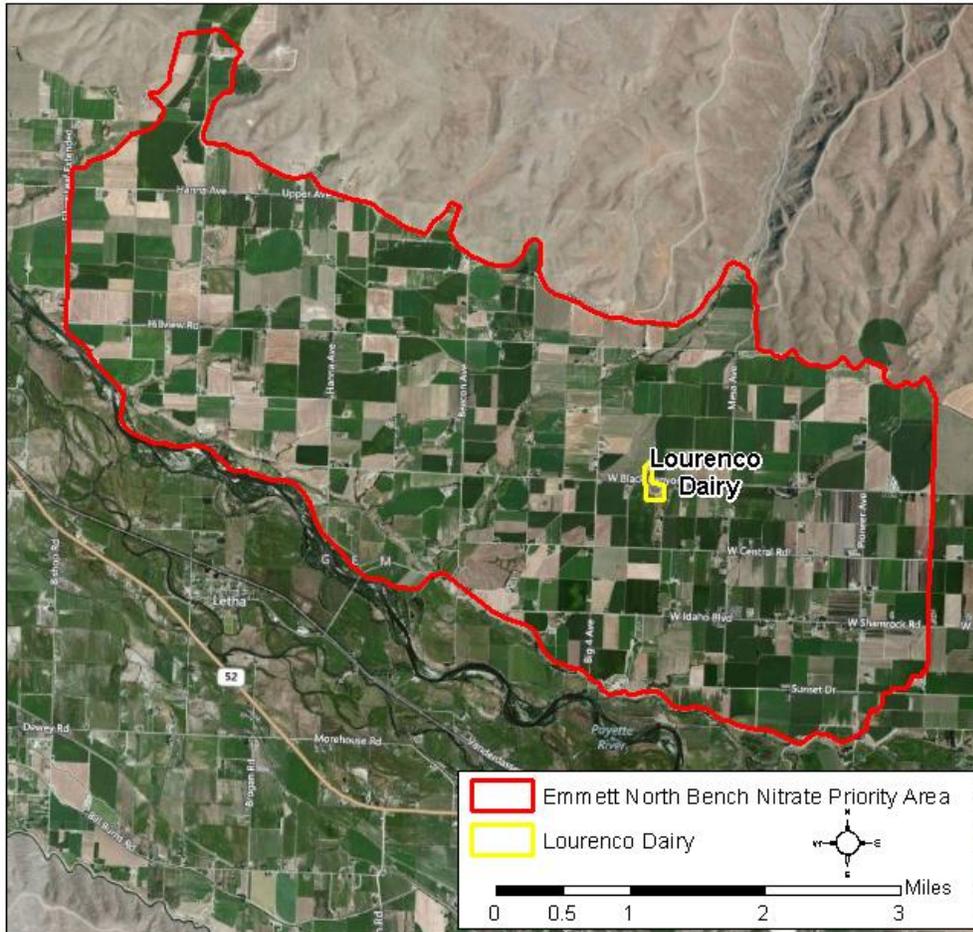


Figure 3. Location of Lourenco Dairy within the Emmett North Bench Nitrate Priority Area.

ISDA also collects nitrogen isotope samples every 5 years from dairy production wells with previous nitrate concentrations greater than 5 mg/L. Nitrogen isotope ratios ($\delta^{15}\text{N}$) can be helpful in determining sources of nitrate in the ground water, as nitrogen from human or animal waste and fertilizer sources has distinguishable $\delta^{15}\text{N}$ signatures. The ISDA nitrogen isotope data indicate the ground water in the Lourenco Dairy production well changed from an organic nitrogen in the soil source in 2005 to an organic (waste) source in 2010. Nitrogen isotope results are further discussed in section 3.1.1.2.

Based on the ISDA monitoring results, DEQ conducted a follow-up ground water monitoring project in May and June 2011 surrounding the Lourenco Dairy to determine the extent and degree of ground water contamination. Due to an elevated nitrate concentration detected in a private domestic well during this event, another monitoring event was conducted in September 2011 for that well.

3.1.1.2 Methods and Results

Using well driller's logs from the IDWR website, DEQ selected 17 wells to monitor and evaluate ground water quality surrounding the Lourenco Dairy (Figure 4). Preference was given to wells screened solely within the shallow aquifer, which is above a blue lacustrine clay layer that

separates the shallow and deep aquifers. Within the project area, the blue clay layer is located approximately 60–100 feet below ground surface (bgs) and can act as a protective barrier to prevent contaminants generated at the land surface from migrating down into deeper aquifers. The wells selected were located hydraulically upgradient, sidegradient, and downgradient of the dairy. Ground water flow is approximately to the south-southwest in the project area (Figure 4). All wells sampled for this project were completed to less than 110 feet bgs. Water quality field parameters (pH, temperature, specific conductivity, and dissolved oxygen [DO]) were measured at each site (Table 2) prior to sample collection.

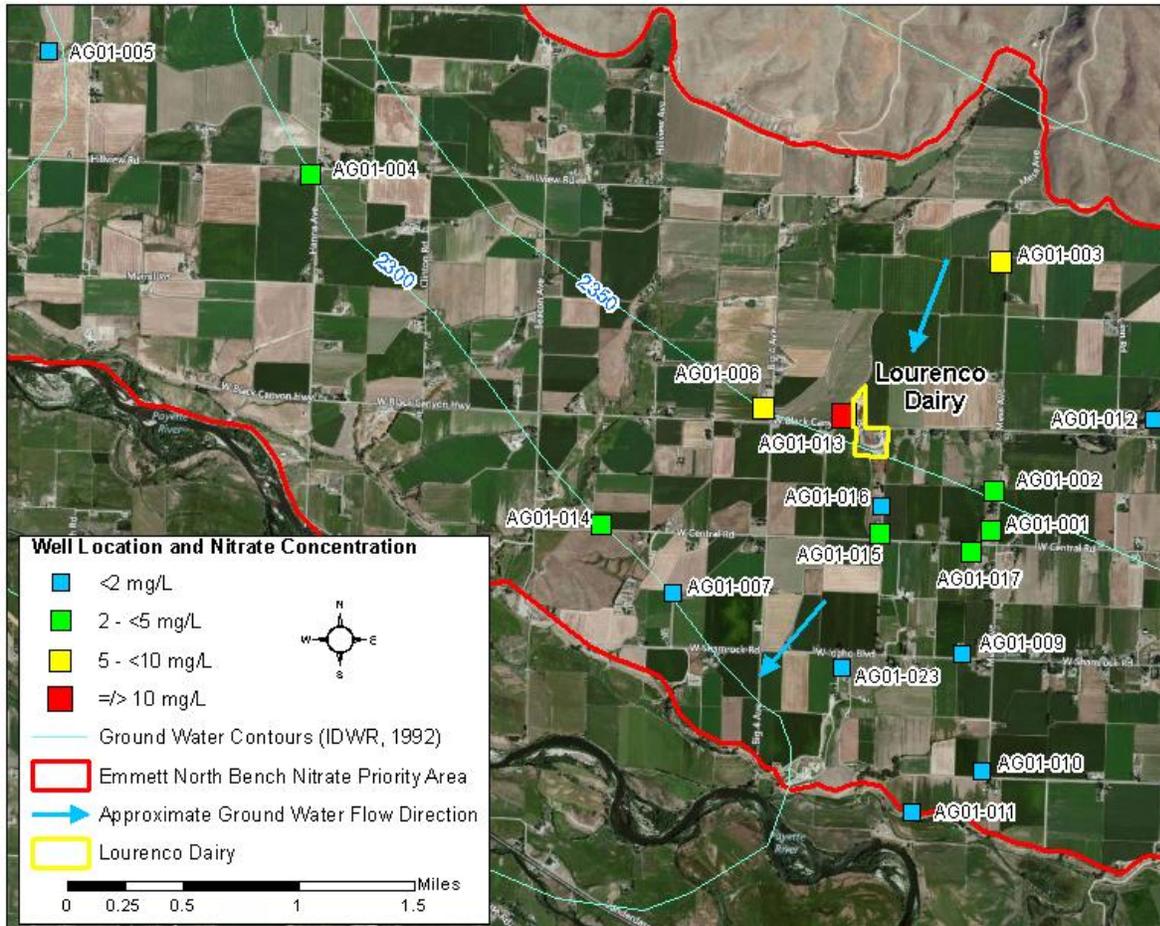


Figure 4. Well sample locations, identification, and nitrate concentrations for Lourenco Dairy Follow-Up Monitoring project.

Table 2. Water quality field parameters for the Lourenco Dairy Follow-Up Monitoring project.

Project Well Name	DEQ Site ID	Well Depth (feet)	Sample Date	pH	Water Temperature ^a (°C)	Specific Conductivity ^a (µS/cm)	Dissolved Oxygen ^a (mg/L)
AGO1-001	1284	75	05/26/2011	7.24	15.5	271	7.01
AGO1-002	1285	100	05/26/2011	7.42	14.6	512	7.72
AGO1-003	1286	65	05/26/2011	7.8	14.8	464	8.7
AGO1-004	1287	82	05/26/2011	7.44	14.5	491	7.61
AGO1-005	1288	100	05/26/2011	8.11	15	371	0
AGO1-006	1289	54	06/01/2011	7.51	14.5	651	7.93
AGO1-007	1290	95	06/01/2011	8.4	15.5	582	0
AGO1-009	1291	100	06/01/2011	7.29	14.4	529	0
AGO1-010	1292	76	06/01/2011	7.46	14	745	5.6
AGO1-011	1293	106	05/26/2011	7.33	15.1	540	0.55
AGO1-012	1294	80	05/26/2011	6.91	18.3	157	2.49
AGO1-013	1295	70	06/01/2011	7.59	14	950	5.49
AGO1-013	1295	70	09/21/2011	7.42	14.1	723	7.42
AGO1-014	1296	43	06/02/2011	7.28	14	523	6.85
AGO1-015	1297	65	06/01/2011	7.48	13.9	650	7.48
AGO1-016	1298	60	06/02/2011	7.8	14.5	723	0
AGO1-017	1299	53	06/02/2011	7.71	14.5	443	9.92
AGO1-023	1300	78	06/02/2011	6.82	14.5	387	0.09

Notes: pH did not violate EPA's Secondary Drinking Water Regulation; °C = degrees Celsius; µS/cm = microsiemens per centimeter; mg/L = milligrams per liter.

^a No primary or secondary health standard available.

Samples were collected from each well in accordance with DEQ's quality assurance project plan (QAPP) (DEQ 2010a) and the Lourenco field sampling plan (FSP) (DEQ 2011a). Samples were analyzed for anions (nitrate, nitrite, chloride, sulfate, bromide, fluoride, and ortho-phosphate); ammonia; arsenic; total coliform; *Escherichia coli* (*E. coli*); nitrogen isotopes; and sulfonamide antibiotics (sulfathiazole, sulfamerazine, sulfamethizole, sulfamethazine, sulfachloropyridazine, sulfamethoxazole, and sulfadimethoxine). Arsenic, total coliform, and *E. coli* samples were submitted to the Idaho State Bureau of Laboratories in Boise, Idaho, for analysis (Table 3 and Table 4). The anion, ammonia, and sulfonamide antibiotics samples were submitted to the University of Idaho Analytical Sciences Laboratory in Moscow, Idaho, for analysis (Table 3).

After receiving the May/June 2011 results, additional sampling for well AGO1-013 was conducted on September 21, 2011, in accordance with DEQ's QAPP (DEQ 2010a) and the Lourenco FSP addendum (DEQ 2011b). The sample was analyzed for anions (nitrate, nitrite, chloride, sulfate, bromide, fluoride, and ortho-phosphate); cations (calcium, magnesium, potassium, and sodium); alkalinity; ammonia; total coliform; *E. coli*; and nitrogen isotopes (Table 3 through Table 5). Total coliform and *E. coli* samples were submitted to the Idaho State Bureau of Laboratories in Boise, Idaho, for analysis (Table 4). Anions, cations, and ammonia

samples were submitted to the University of Idaho Analytical Sciences Laboratory in Moscow, Idaho, for analysis (Table 3 and Table 5).

Nitrogen isotope samples were collected during both sampling events at each sampling location and frozen and stored at DEQ pending nitrate analysis. After DEQ received nitrate analysis results, those nitrogen isotope samples from wells with nitrate concentrations equal to or greater than 5 mg/L were then sent to the University of Arizona Environmental Isotope Geosciences Laboratory in Tucson, Arizona, for nitrogen isotope analysis. Nitrogen isotope results are shown in Table 4.

Table 3. Inorganic results for Lourenco Dairy Follow-Up Monitoring project.

Project Well Name	DEQ Site ID	Well Depth (feet)	Sample Date	Nitrate	Chloride	Sulfate	Nitrite	Fluoride	Bromide ^a	Ortho-phosphate ^a	Ammonia	Arsenic (micrograms/liter)
				(milligrams per liter)								
AGO1-001	1284	75	05/26/2011	2.6	2	6.2	<0.050	0.72	<0.1	0.21	<0.1	9.4
AGO1-002	1285	100	05/26/2011	3.2	4.9	13	<0.050	0.5	<0.1	<0.1	<0.1	21
AGO1-003	1286	65	05/26/2011	5.1	3.5	18	<0.050	0.38	<0.1	<0.1	0.26	5.4
AGO1-004	1287	82	05/26/2011	2	1.6	6.6	<0.050	0.38	<0.1	<0.1	<0.1	16
AGO1-005	1288	100	05/26/2011	0.05	11	34	<0.050	0.2	<0.1	<0.1	0.27	5.5
AGO1-006	1289	54	06/01/2011	5.1	3.6	14	<0.050	0.41	<0.1	<0.1	0.62	10
AGO1-007	1290	95	06/01/2011	0.05	12	64	<0.050	<0.15	0.12	<0.1	0.8	<5
AGO1-009	1291	100	06/01/2011	0.058	2.2	25	<0.050	0.5	<0.1	<0.1	0.38	5
AGO1-010	1292	76	06/01/2011	1.5	1.8	13	<0.050	0.62	<0.1	<0.1	0.17	<5
AGO1-011	1293	106	05/26/2011	0.05	2.6	37	<0.050	0.26	<0.1	<0.1	0.31	<5
AGO1-012	1294	80	05/26/2011	0.88	1.4	2.4	<0.050	<0.15	<0.1	0.31	0.92	<5
AGO1-013	1295	70	06/01/2011	17	16	35	<0.050	0.26	<0.1	<0.1	0.38	7.7
AGO1-013	1295	70	09/21/2011	13	12	26	<0.050	0.33	<0.1	<0.1	0.44	NA
AGO1-014	1296	43	06/02/2011	3.9	3.1	16	<0.050	0.53	<0.1	<0.1	1.1	9
AGO1-015	1297	65	06/01/2011	2.1	6.1	47	<0.050	0.33	<0.1	<0.1	0.97	<5
AGO1-016	1298	60	06/02/2011	0.13	10	69	<0.050	0.26	0.1	<0.1	0.64	<5
AGO1-017	1299	53	06/02/2011	3.2	2.9	7.5	<0.050	0.98	<0.1	<0.1	0.84	18
AGO1-023	1300	78	06/02/2011	0.05	2	22	<0.050	<0.15	<0.1	<0.1	0.83	<5

Notes: Bolded red numbers indicate EPA's maximum contaminant level was exceeded; No constituents exceeded EPA's Secondary Drinking Water Regulation; NA = not analyzed.

^a No primary or secondary health standard available.

Table 4. Bacteria and nitrogen isotope results for Lourenco Dairy Follow-Up Monitoring project.

Project Well Name	DEQ Site ID	Well Depth (feet)	Sample Date	Total Coliform (MPN/100 mL) ^a	<i>E. coli</i> (MPN/100 mL)	$\delta^{15}\text{N}$ (‰) ^a
AGO1-001	1284	75	05/26/2011	<1	<1	NA
AGO1-002	1285	100	05/26/2011	<1	<1	NA
AGO1-003	1286	65	05/26/2011	<1	<1	5.2
AGO1-004	1287	82	05/26/2011	<1	<1	NA
AGO1-005	1288	100	05/26/2011	<1	<1	NA
AGO1-006	1289	54	06/01/2011	<1	<1	5.7
AGO1-007	1290	95	06/01/2011	<1	<1	NA
AGO1-009	1291	100	06/01/2011	2	<1	NA
AGO1-010	1292	76	06/01/2011	9.6	<1	NA
AGO1-011	1293	106	05/26/2011	<1	<1	NA
AGO1-012	1294	80	05/26/2011	<1	<1	NA
AGO1-013	1295	70	06/01/2011	<1	<1	9.5
AGO1-013	1295	70	09/21/2011	<1	<1	10.2
AGO1-014	1296	43	06/02/2011	<1	<1	NA
AGO1-015	1297	65	06/01/2011	<1	<1	NA
AGO1-016	1298	60	06/02/2011	7.5	<1	NA
AGO1-017	1299	53	06/02/2011	<1	<1	NA
AGO1-023	1300	78	06/02/2011	<1	<1	NA

Notes: Idaho's "Ground Water Quality Standards" (IDAPA 58.01.11.200) was not exceeded for *E. coli*; MPN/100 mL = most probable number per 100 milliliters; $\delta^{15}\text{N}$ = nitrogen isotope; ‰ = per mil; NA = not analyzed.

^a No primary or secondary health standard available.

Table 5. Cation and alkalinity results for Lourenco Dairy Follow-Up Monitoring project.

Project Well Name	DEQ Site ID	Well Depth (feet)	Sample Date	Calcium ^a	Magnesium ^a	Potassium ^a	Sodium	Alkalinity ^a (as CaCO ₃)
				(milligrams per liter)				
AGO1-013	1295	70	09/21/2011	54	16	5.6	96	310

Notes: Italicized red numbers indicate EPA's Drinking Water Advisory Taste Threshold was exceeded; CaCO₃ = calcium carbonate.

^a No primary or secondary health standard available.

Nitrate Results

The nitrate values ranged from 0.05 mg/L to 17 mg/L. The nitrate MCL of 10 mg/L was exceeded in one well (AGO1-013). The spatial distribution of nitrate concentrations is shown in Figure 4. The highest nitrate concentration detected during the May/June 2011 monitoring event (AGO1-013) is located down- and sidegradient of the Lourenco Dairy property, north of Black Canyon Highway (Figure 5). Additional sampling in September 2011 at AGO1-013 found a nitrate concentration of 13 mg/L, with the duplicate sample nitrate concentration of 14 mg/L.

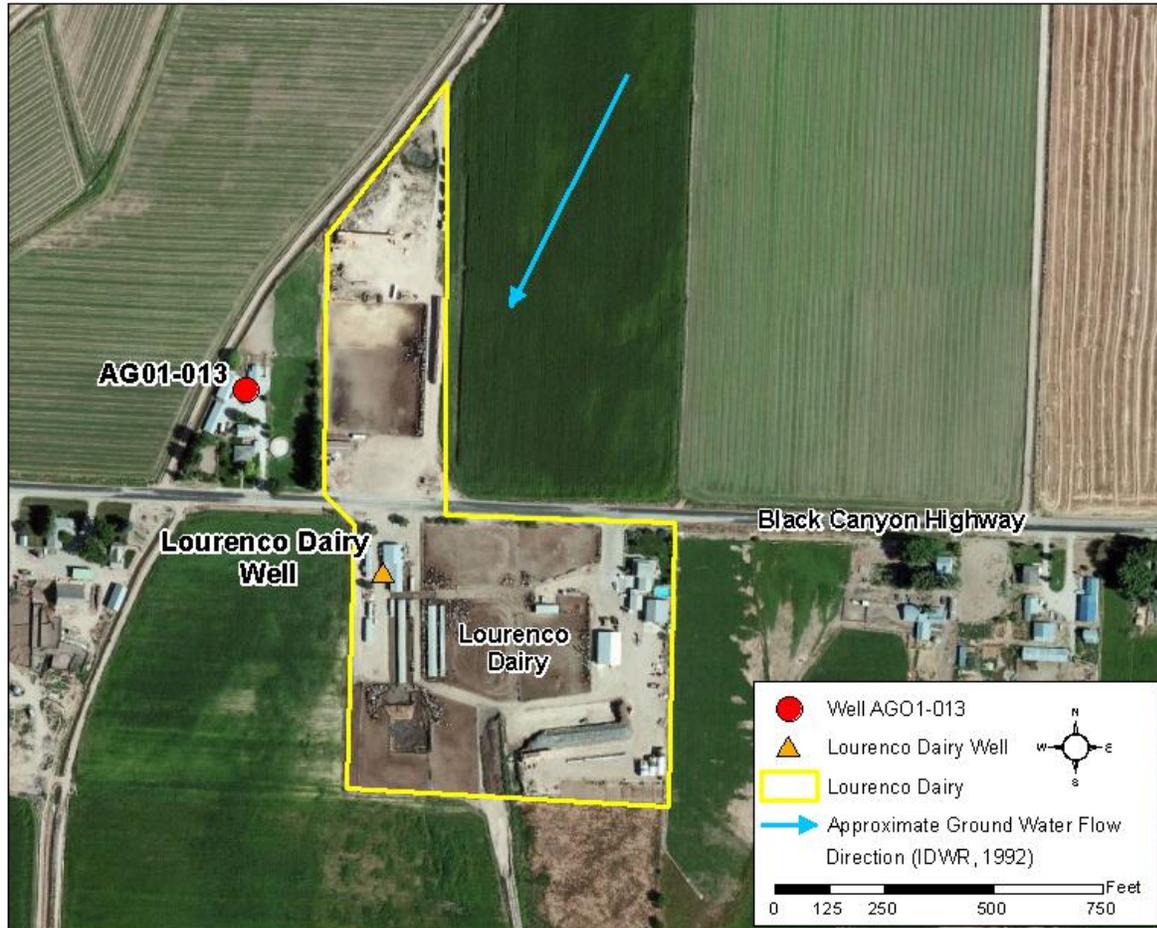


Figure 5. Well AGO1-013 in relation to Lourenco Dairy operation.

Arsenic Results

The arsenic values ranged from nondetectable (<5 micrograms per liter [$\mu\text{g/L}$]) to 21 $\mu\text{g/L}$; four well samples exceeded the arsenic MCL of 10 $\mu\text{g/L}$ (AGO1-002, AGO1-004, AGO1-006, and AGO1-017). 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 and many other areas in the western Snake River Plain (Baldwin and Wicherski 1994; Parlman 1982; Neely 2002).

Chloride Results

Chloride values ranged from 1.4 mg/L to 16 mg/L. The EPA National Secondary Drinking Water Regulations standard for chloride is 250 mg/L, based on aesthetic effects. All chloride concentrations were below the standard.

Bacteria Results

Total coliform was detected in 3 wells, ranging from 2 MPN/100 mL to 9.6 MPN/100 mL. *E. coli* was not detected in any of the wells.

Sulfonamide Antibiotic Results

Samples were analyzed for seven sulfonamide antibiotics: sulfathiazole, sulfamerazine, sulfamethizole, sulfamethazine, sulfachloropyridazine, sulfamethoxazole, and sulfadimethoxine. All ground water samples were below detection limits for the sulfonamide antibiotics tested.

Nitrogen Isotope Results

Nitrogen isotope ratios ($\delta^{15}\text{N}$) can be helpful in determining sources of nitrate in the ground water and were completed for all samples with nitrate concentrations greater than 5 mg/L (Table 4). Nitrogen from human or animal waste and fertilizer sources has distinguishable $\delta^{15}\text{N}$ signatures. Typical $\delta^{15}\text{N}$ values for various nitrogen sources are listed in Table 6. The $\delta^{15}\text{N}$ results from this project ranged from 5.2 per mil (‰) to 9.5‰ during the May and June sampling event. Wells AGO1-003 and AGO1-006 had $\delta^{15}\text{N}$ results of 5.2‰ and 5.7‰, respectively, indicating the source of nitrogen is from inorganic nitrogen in the soil. Well AGO1-013 had a $\delta^{15}\text{N}$ value of 9.5‰, falling between the signatures for organic nitrogen in the soil or organic waste nitrogen source. Follow-up sampling at well AGO1-013 in September 2011 indicated an $\delta^{15}\text{N}$ value of 10.2‰, indicating a waste source. The property owner of well AGO1-013 indicated that the septic tank is located off the northeast corner of the house; the septic cleanout port is located in the driveway on the east side of the house, both downgradient of well AGO-013. The property owner did not know where the drainfield is located.

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

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

Potential Nitrate Source	$\delta^{15}\text{N}$ (‰)
Precipitation	-3
Commercial fertilizer	-4 to +4
Organic nitrogen in soil	+4 to +8
Animal or human waste	Greater than +10

Source: Heaton (1986)

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

3.1.1.3 Conclusions

Based on elevated nitrate concentrations in the Lourenco Dairy production well, DEQ conducted this project to determine the extent and degree of contamination in the area around the dairy. Of the 17 wells sampled for this project, only 1 exceeded the nitrate MCL (AGO1-013). Based on the elevated nitrate concentrations at AGO1-013, DEQ conducted confirmation sampling of this well on September 21, 2011. Nitrate was detected at 13 mg/L (14 mg/L for the duplicate sample). The follow-up sampling nitrogen isotope value was 10.2‰, with the duplicate result of 10.1‰, confirming the organic (waste) source signature.

DEQ collected ground water samples upgradient, downgradient, and sidegradient in proximity to this dairy. Based on this data, it appears that elevated nitrate is relatively localized to the area immediately around the dairy and to the west and northeast of the main dairy facility.

A review of historic Google Earth aerial photographs indicates the dairy expanded its operations to the north of Black Canyon Highway during the first half of 2005. Irrigated cropland on the property immediately adjacent to and east of the AGO1-013 sample location was converted to cattle storage and feed facilities in 2005 or 2006. This expanded area is upgradient of well AGO1-013 and generally crossgradient from the dairy production well. Regional ground water generally flows in a southwesterly direction. However, the local ground water flow direction is unknown.

Shallow ground water within the study area is being negatively impacted from land-use practices as evidenced by elevated nitrate concentrations. The nitrate concentrations have exceeded the MCL of 10 mg/L at well AGO1-013 and at the Lourenco Dairy production well. The most recent nitrogen isotope signature indicates an organic (waste) source for both wells. The Lourenco Dairy houses cattle on property upgradient of well AGO1-013 and the dairy production well. These data suggest that waste generated by the dairy may be contributing to the nitrate concentrations in the shallow ground water exceeding the ground water quality standard of 10 mg/L. The high specific conductivity value and elevated chloride concentrations in well AGO1-013 (with respect to surrounding wells) also support this suggestion. Additional water quality parameters were not available for the dairy production well.

The source of elevated arsenic concentrations in the ground water is unclear; however, the source is likely naturally occurring in the soils as noted by previous studies within the area (Baldwin and Wicherski 1994; Parlman 1982; Neely 2002).

3.1.1.4 Recommendations

DEQ recommends that property owners with private domestic drinking water wells sample their wells on an annual basis. DEQ suggests wells be analyzed for bacteria, arsenic, and nitrate. The Southwest District Health Department can also provide property owners with information and guidance.

DEQ should work with the ISDA Dairy Bureau to further evaluate land-use activities near the elevated nitrate concentrations (AGO1-013 and the dairy production well) and determine appropriate modifications of best management practices (BMPs) that could be implemented or improved to protect ground water quality from further degradation.

3.1.2 Lower Payette Nitrate Priority Area Ground Water Monitoring Project

3.1.2.1 Purpose

Among the state's 32 NPAs, the Lower Payette NPA is ranked 11, with 1 being the most degraded and 32 the least. 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.

This regional monitoring project was designed to provide the data necessary for evaluating water quality in the Lower Payette NPA. Ground water samples were collected from individual private domestic or irrigation wells. Program objectives, design, and well selection processes were identified in the Boise Regional Office's *Regional Ground Water Monitoring Network Design* (DEQ 2011c), hereafter referred to as the Regional Network Design. The monitoring results will be used by DEQ in future 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 health standard.

Sampling Process Design

The number of wells to sample was chosen in accordance with the statistical process specified in the Regional Network Design. The process determined that for the Lower Payette NPA, 50 wells located in Stratum 1 (within the boundaries of the NPA identified in 2008) and 25 wells located in Stratum 2 (a 1-mile area around Stratum 1) would be sampled to meet a 90% statistical confidence level that the estimated mean is within 15% of the true mean. The Regional Network Design protocol also determined that the size of each sampling unit would be a quarter section of a Township/Range/Section within the project area.

The total number of quarter sections located within in Stratum 1 and Stratum 2 were randomized separately to determine which quarter sections would be sampled. Figure 6 shows the distribution of sample sites.

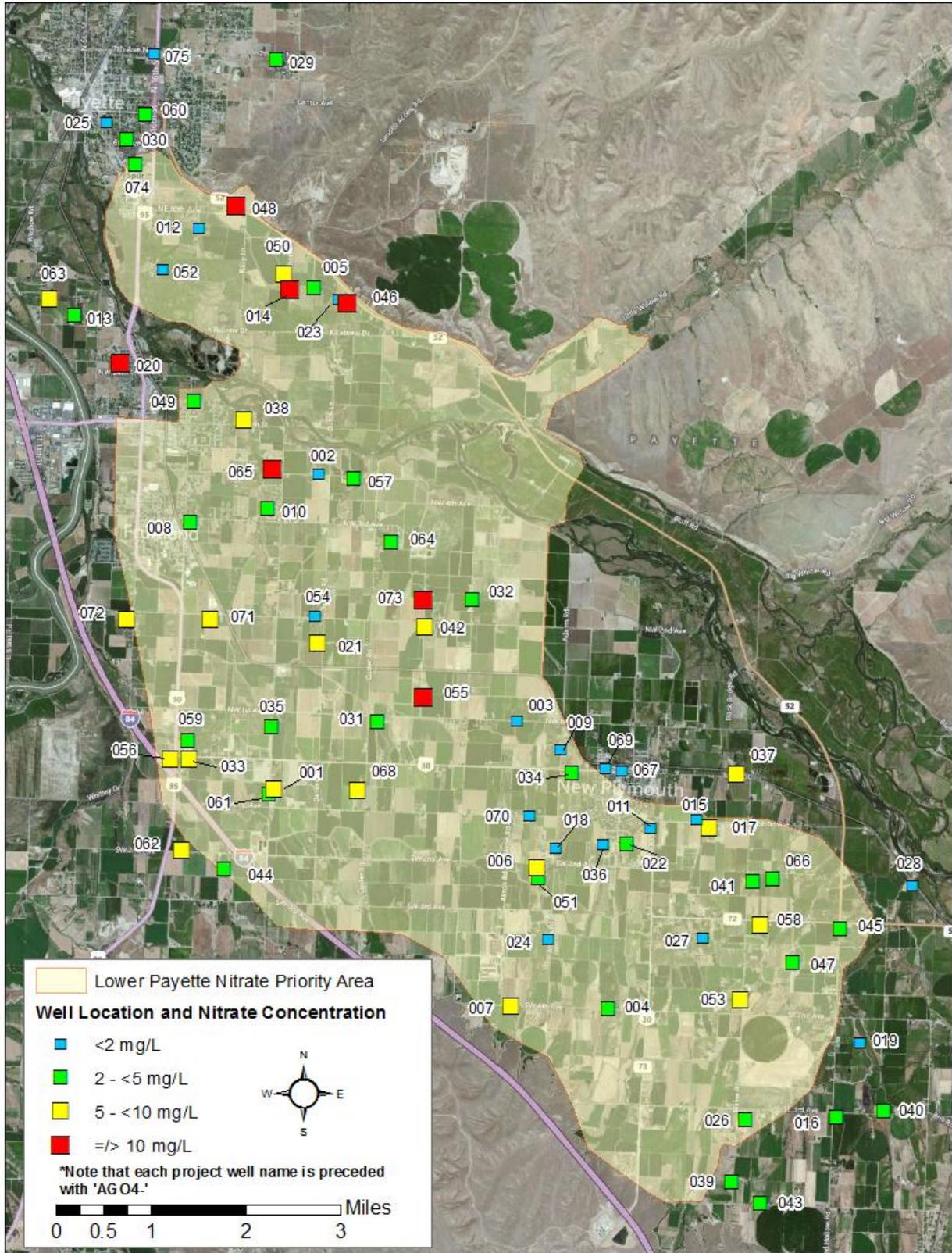


Figure 6. Well location, project well name, and nitrate concentrations for the Lower Payette Nitrate Priority Area Ground Water Monitoring project. Note: each project well name is preceded with "AGO4-".

3.1.2.2 Methods and Results

Samples were collected in October and November 2011 from each well in accordance with the QAPP (DEQ 2011d) and FSP (DEQ 2011e). Water quality field parameters (pH, temperature, specific conductivity, and DO) were measured at each site prior to sample collection (Table 7).

Samples were analyzed for anions (nitrate, nitrite, chloride, sulfate, bromide, fluoride, and ortho-phosphate); arsenic; total coliform; and *E. coli*. All wells had a nondetect result for *E. coli* (<1 MPN/100 mL). Wells with DO less than 2 mg/L as determined by field analysis were also sampled for ammonia. Wells with nitrate concentrations greater than 5 mg/L were also analyzed for nitrogen isotopes. Arsenic, total coliform, and *E. coli* samples were submitted to the Idaho State Bureau of Laboratories for analysis. Anion samples were submitted to the University of Idaho Analytical Sciences Laboratory. Nitrogen isotope samples were collected at each sampling location and frozen and stored at DEQ pending nitrate analysis. When the nitrate analytical results were received, the nitrogen isotope samples from wells with nitrate concentrations greater than 5 mg/L were sent to the University of Arizona Environmental Isotope Geosciences Laboratory for nitrogen isotope analysis.

Nitrate Results

The nitrate values ranged from <0.05 mg/L to 61 mg/L; 25 of the 75 wells had nitrate values of 5 mg/L or greater, and 7 wells reached or exceeded the nitrate MCL of 10 mg/L (wells AGO4-014, AGO4-020, AGO4-046, AGO4-048, AGO4-055, AGO4-065, and AGO4-073) (Figure 6; Table 8). The highest nitrate concentration detected during the monitoring event (well AGO4-048) was north of Highway 52 in Payette.

Arsenic Results

The arsenic values ranged from <2 µg/L to 42 µg/L; 46 of the 75 wells equaled or exceeded the arsenic MCL of 10 µg/L (Table 8). 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 the western Snake River Plain (Baldwin and Wicherski 1994; Parlman 1982; Neely 2002). Baldwin and Wicherski (1994) also noted that arsenic-based pesticides were used on fruit orchards in part of the project area until the 1940s; however, their study did not conclude if elevated arsenic in the area was naturally occurring or a result of historic pesticide use.

Chloride Results

Chloride values ranged from 0.19 mg/L to 210 mg/L. EPA's National Secondary Drinking Water Regulations standard for chloride is 250 mg/L, based on aesthetic effects. All chloride concentrations are below this standard (Table 8).

Sulfate Results

Sulfate values ranged from 3.1 mg/L to 1,100 mg/L. The highest sulfate concentration detected during the monitoring event (well AGO4-048) was north of Highway 52 in Payette. EPA's National Secondary Drinking Water Regulations standard for sulfate is 250 mg/L, based on

aesthetic effects. Well AGO4-048 exceeded the secondary standard for sulfate; this same well also had the highest nitrate concentration (Table 8).

Table 7. Water quality field parameter data for Lower Payette Nitrate Priority Area Ground Water Monitoring project.

Project Well Name	DEQ Site ID	Well Depth (feet)	Sample Date	pH	Water Temperature ^a (°C)	Specific Conductivity ^a (µS/cm)	Dissolved Oxygen ^a (mg/L)
AGO4-001	1320	60	10/27/2011	9.54	14	741	5.2
AGO4-002	1379	72	10/25/2011	9.96	14.8	253	0
AGO4-003	1338	46	10/26/2011	9.2	14.4	354	0.11
AGO4-004	1324	52	10/27/2011	9.42	15.1	683	9.83
AGO4-005	1380	70	10/24/2011	8.73	16.7	428	5.62
AGO4-006	1360	60	11/03/2011	9.3	14	748	7.58
AGO4-007	1325	78	10/27/2011	9.13	15.7	497	9.01
AGO4-008	1335	60	10/26/2011	9.23	14.3	513	2.89
AGO4-009	1359	40	11/03/2011	9.41	14.9	261	1.17
AGO4-010	1330	40	10/26/2011	9.35	14.6	805	7.52
AGO4-011	1367	80	11/03/2011	9.39	14.1	437	5.7
AGO4-012	1381	15	10/24/2011	8.43	15.6	431	0
AGO4-013	1382	29	10/25/2011	8.94	14.3	550	6.5
AGO4-014	1383	45	10/24/2011	8.41	14.5	752	5.1
AGO4-015	1366	55	11/03/2011	9.29	14.5	475	3.83
AGO4-016	1349	98	11/07/2011	9.45	15	533	9.58
AGO4-017	1365	43	11/03/2011	9.03	13.8	567	7.56
AGO4-018	1364	40	11/03/2011	9.32	15.3	201	0.26
AGO4-019	1348	58	11/07/2011	9.23	15.4	527	8.14
AGO4-020	1384	55	10/25/2011	8.88	15	97	4.89
AGO4-021	1339	45	10/26/2011	9.48	14.2	639	2.6
AGO4-022	1363	50	11/03/2011	9.28	14.2	525	5.11
AGO4-023	1385	25	10/24/2011	8.95	13.7	290	0
AGO4-024	1323	65	10/27/2011	9.47	14	632	8.31
AGO4-025	1386	26	10/24/2011	8.45	17.1	526	0
AGO4-026	1350	95	11/07/2011	9.57	15.5	462	7.6
AGO4-027	1346	60	11/07/2011	9.35	14.3	605	10.16
AGO4-028	1344	35	11/07/2011	9.09	14.2	326	3.61
AGO4-029	1837	130	10/24/2011	8.62	15.9	741	4.1
AGO4-030	1334	30	10/26/2011	8.88	16.8	642	0.48
AGO4-031	1336	69	10/26/2011	9.36	13.5	684	4.86
AGO4-032	1388	36	10/25/2011	9.27	12.7	606	3.54
AGO4-033	1328	52	10/26/2011	9.55	14.7	775	5.96
AGO4-034	1362	57	11/03/2011	9.28	12.9	576	3.6
AGO4-035	1340	58	10/26/2011	9.62	15.5	424	6.7
AGO4-036	1361	64	11/03/2011	9.72	14.7	453	2.28
AGO4-037	1343	37	11/07/2011	9.18	12.9	659	7.64
AGO4-038	1402	53	10/25/2011	9.27	14.3	793	6.62

Project Well Name	DEQ Site ID	Well Depth (feet)	Sample Date	pH	Water Temperature ^a (°C)	Specific Conductivity ^a (µS/cm)	Dissolved Oxygen ^a (mg/L)
AGO4-039	1351	85	11/07/2011	<i>9.09</i>	15.3	795	9.29
AGO4-040	1356	80	11/07/2011	<i>9.26</i>	14.3	513	10.01
AGO4-041	1345	63	11/07/2011	<i>9.26</i>	15.3	467	6.61
AGO4-042	1389	44	10/25/2011	<i>9.14</i>	13.5	845	3.85
AGO4-043	1352	100	11/07/2011	<i>9.43</i>	15.2	721	7.31
AGO4-044	1331	57	10/27/2011	<i>9.23</i>	15	636	9.53
AGO4-045	1355	55	11/07/2011	<i>9.15</i>	14.1	516	5.53
AGO4-046	1390	100	10/24/2011	<i>8.76</i>	14.5	1280	0
AGO4-047	1368	75	11/15/2011	8.47	16.3	332	5.57
AGO4-048	1391	100	10/24/2011	<i>8.53</i>	17.4	3270	3.89
AGO4-049	1392	6	10/25/2011	<i>9.12</i>	15.6	598	6.38
AGO4-050	1393	40	10/24/2011	<i>8.52</i>	14.7	801	7
AGO4-051	1322	68	10/27/2011	<i>9.17</i>	15	768	4.15
AGO4-052	1394	18	10/25/2011	8.08	14.6	188	0
AGO4-053	1347	80	11/07/2011	<i>9.44</i>	15.5	695	8.55
AGO4-054	1329	33	10/26/2011	<i>9.29</i>	14.2	659	0
AGO4-055	1337	38	10/26/2011	<i>9.18</i>	14.3	698	2.7
AGO4-056	1326	53	10/26/2011	<i>9.47</i>	14.7	723	5.92
AGO4-057	1395	50	10/25/2011	<i>9.36</i>	15.7	587	2.89
AGO4-058	1342	75	11/07/2011	<i>9.36</i>	16.2	615	6.57
AGO4-059	1327	58	10/26/2011	<i>9.37</i>	15	681	5.68
AGO4-060	1396	25	10/24/2011	7.2	16.6	0.512	1.6
AGO4-061	1332	68	10/27/2011	<i>9.42</i>	13.7	593	5.95
AGO4-062	1333	57	10/27/2011	<i>9.24</i>	14.1	95	7.31
AGO4-063	1397	37	10/24/2011	8.5	13.9	534	10.74
AGO4-064	1398	56	10/25/2011	<i>9.15</i>	14	668	7.01
AGO4-065	1370	40	11/15/2011	<i>9.27</i>	14	1060	7.31
AGO4-066	1369	60	11/15/2011	<i>9.15</i>	15	383	7.09
AGO4-067	1353	39	11/07/2011	<i>9.35</i>	15.4	344	0.49
AGO4-068	1354	45	11/07/2011	<i>9.12</i>	14.1	608	7.13
AGO4-069	1357	40	11/03/2011	<i>9.23</i>	15.7	305	2.31
AGO4-070	1358	33	11/03/2011	<i>9.37</i>	15.3	287	7.09
AGO4-071	1321	60	10/27/2011	<i>9.26</i>	13.8	701	2.96
AGO4-072	1341	61	10/26/2011	<i>9.56</i>	14.07	643	9.64
AGO4-073	1399	36	10/25/2011	<i>9.08</i>	13.2	825	8.18
AGO4-074	1400	36	10/24/2011	8.17	15	749	0.46
AGO4-075	1401	45	10/24/2011	8.44	16	372	0

Notes: Red italics indicate violation of EPA's Secondary Drinking Water Regulation; °C = degrees Celsius; µS/cm = microsiemens per centimeter; mg/L = milligrams per liter.

^a No primary or secondary health standard available.

Table 8. Inorganic results for the Lower Payette Nitrate Priority Area Ground Water Monitoring project.

Project Well Name ^a	DEQ Site ID	Well Depth (feet)	Sample Date	Nitrate (mg/L)	$\delta^{15}\text{N}^a$ (‰)	Nitrite (mg/L)	Chloride (mg/L)	Sulfate (mg/L)	Fluoride (mg/L)	Bromide ^b (mg/L)	Ortho-phosphate ^b (mg/L)	Ammonia (mg/L)	Arsenic ($\mu\text{g/L}$)	Total Coliform ^b (MPN/100 mL)
001	1320	60	10/27/11	6.1	4.6	<0.05	22	60	0.43	<0.1	<0.1	NS	17	<1
002	1379	72	10/25/11	<0.05	NA	<0.05	3.1	5.1	0.62	<0.1	<0.1	1.8	<2	2
003	1338	46	10/26/11	0.22	NA	<0.05	11	32	0.42	<0.1	<0.1	1.5	20	<1
004	1324	52	10/27/11	2.9	NA	<0.05	25	72	0.67	0.16	<0.1	NS	20	<1
005	1380	70	10/24/11	3.1	NA	<0.05	2.1	12	0.45	<0.1	0.19	NS	7.1	<1
006	1360	60	11/03/11	5.4	4.4	<0.05	12	40	0.41	<0.1	<0.1	NS	14	<1
007	1325	78	10/27/11	8.4	8.1	<0.05	9.1	22	0.34	<0.1	<0.1	NS	6.0	<1
008	1335	60	10/26/11	2.4	NA	<0.05	8.5	39	0.47	0.13	0.15	NS	34	<1
009	1359	40	11/03/11	1.2	NA	<0.05	4.0	7.1	0.57	<0.1	<0.1	1.8	14	<1
010	1330	40	10/26/11	3.7	NA	<0.05	5.4	19	0.29	<0.1	<0.1	NS	20	<1
011	1367	80	11/03/11	0.34	NA	<0.05	25	49	0.17	0.12	<0.1	NS	7.2	<1
012	1381	15	10/24/11	0.16	NA	0.053	18	42	0.39	<0.1	0.26	2.0	7.3	365.4
013	1382	29	10/25/11	4.4	NA	<0.05	3.0	9.1	0.54	<0.1	0.25	NS	14	<1
014	1383	45	10/24/11	10	0.5	<0.05	4.8	18	0.16	<0.1	<0.1	NS	4.0	<1
015	1366	55	11/03/11	<0.05	NA	<0.05	36	59	0.18	0.14	<0.1	NS	7.1	<1
016	1349	98	11/07/11	2.1	NA	<0.05	13	50	0.3	<0.1	<0.1	NS	8.2	<1
017	1365	43	11/03/11	5.8	3.8	<0.05	4.2	19	0.34	<0.1	<0.1	NS	15	<1
018	1364	40	11/03/11	0.57	NA	<0.05	4.0	9.4	0.45	<0.1	<0.1	1.1	24	<1
019	1348	58	11/07/11	1.7	NA	<0.05	3.0	11	0.45	<0.1	<0.1	NS	12	<1
020	1384	55	10/25/11	13	6.7	<0.05	13	25	0.18	<0.1	<0.1	NS	11	<1
021	1339	45	10/26/11	8.8	4.8	<0.05	8.8	47	0.61	<0.1	<0.1	NS	30	<1
022	1363	50	11/03/11	4.8	NA	<0.05	7.9	27	0.49	<0.1	<0.1	NS	16	<1
023	1385	25	10/24/11	0.53	NA	<0.05	3.2	15	0.48	<0.1	0.27	1.2	7.8	<1
024	1323	65	10/27/11	1.9	NA	<0.05	9.5	38	0.53	<0.1	<0.1	NS	17	<1
025	1386	26	10/24/11	0.16	NA	<0.05	18	42	0.23	<0.1	0.26	2.0	2.4	<1
026	1350	95	11/07/11	3.5	NA	<0.05	7.0	22	0.48	<0.1	<0.1	NS	21	<1
027	1346	60	11/07/11	1.8	NA	<0.05	5.9	3.1	0.24	<0.1	<0.1	NS	12	<1
028	1344	35	11/07/11	<0.05	NA	<0.05	1.6	3.5	0.35	<0.1	<0.1	NS	3.4	<1
029	1837	130	10/24/11	3.7	NA	<0.05	60	110	<0.15	0.26	<0.1	NS	2.2	<1
030	1334	30	10/26/11	2.3	NA	<0.05	27	59	0.45	0.13	0.15	1.2	5.0	1
031	1336	69	10/26/11	2.9	NA	<0.05	36	88	<0.15	0.19	<0.1	NS	6.7	2

Project Well Name ^a	DEQ Site ID	Well Depth (feet)	Sample Date	Nitrate (mg/L)	$\delta^{15}\text{N}^a$ (‰)	Nitrite (mg/L)	Chloride (mg/L)	Sulfate (mg/L)	Fluoride (mg/L)	Bromide ^b (mg/L)	Ortho-phosphate ^b (mg/L)	Ammonia (mg/L)	Arsenic ($\mu\text{g/L}$)	Total Coliform ^b (MPN/100 mL)
032	1388	36	10/25/11	4.1	NA	<0.05	7.2	35	0.49	<0.1	<0.1	NS	10	<1
033	1328	52	10/26/11	9.2	3.94	<0.05	13	41	0.49	<0.1	<0.1	NS	36	<1
034	1362	57	11/03/11	4.9	NA	<0.05	7.2	23	0.36	<0.1	<0.1	NS	16	<1
035	1340	58	10/26/11	2.8	NA	<0.05	5.1	15	0.4	<0.1	<0.1	NS	12	<1
036	1361	64	11/03/11	<0.05	NA	<0.05	25	53	<0.15	0.11	<0.1	NS	5.0	<1
037	1343	37	11/07/11	7.5	5.1	<0.05	4.9	47	0.44	<0.1	<0.1	NS	9.1	<1
038	1402	53	10/25/11	9.2	2.82	<0.05	9.3	33	0.32	<0.1	0.14	NS	16	<1
039	1351	85	11/07/11	2.8	NA	<0.05	40	67	0.22	0.32	<0.1	NS	9.2	<1
040	1356	80	11/07/11	2.9	NA	<0.05	12	50	0.44	<0.1	<0.1	NS	7.4	<1
041	1345	63	11/07/11	2.5	NA	<0.05	2.4	5.9	0.24	<0.1	<0.1	NS	12	1
042	1389	44	10/25/11	9.6	3.72	<0.05	16	95	0.24	<0.1	<0.1	NS	18	<1
043	1352	100	11/07/11	2.5	NA	<0.05	9.5	38	0.38	<0.1	<0.1	NS	4.5	<1
044	1331	57	10/27/11	3.3	NA	<0.05	22	68	0.88	<0.1	<0.1	NS	17	<1
045	1355	55	11/07/11	3.2	NA	<0.05	0.19	7.8	0.19	<0.1	<0.1	NS	11	<1
046	1390	100	10/24/11	49	11.51	<0.05	53	75	0.55	0.23	<0.1	1.8	21	1
047	1368	75	11/15/11	4.6	NA	<0.05	4.9	11	0.23	<0.1	<0.1	NS	8.8	<1
048	1391	100	10/24/11	61	9.2	<0.05	210	1100	0.7	1.1	<0.1	NS	19	<1
049	1392	6	10/25/11	4.3	NA	<0.05	12	19	0.32	<0.1	0.11	NS	19	16.9
050	1393	40	10/24/11	7.4	5.4	<0.05	7	62	0.17	<0.1	<0.1	NS	4.8	<1
051	1322	68	10/27/11	2.3	NA	<0.05	31	83	0.36	0.19	<0.1	NS	9	<1
052	1394	18	10/25/11	<0.05	NA	<0.05	1.8	9.5	0.51	<0.1	<0.1	1.9	<2.0	3.1
053	1347	80	11/07/11	5.0	NA	<0.05	6.6	27	0.41	<0.1	<0.1	NS	13	<1
054	1329	33	10/26/11	0.98	NA	<0.05	2.9	10	0.32	<0.1	<0.1	1.4	26	<1
055	1337	38	10/26/11	10	6.9	<0.05	9.1	43	0.27	<0.1	<0.1	NS	10	8.4
056	1326	53	10/26/11	7.3	4.6	<0.05	19	43	0.49	<0.1	<0.1	NS	10	4.1
057	1395	50	10/25/11	2.5	NA	<0.05	4.4	26	0.49	<0.1	<0.1	NS	18	<1
058	1342	75	11/07/11	9.5	8.6	<0.05	12	16	<0.15	<0.1	<0.1	NS	5.7	<1
059	1327	58	10/26/11	3.8	NA	<0.05	5.8	15	0.25	<0.1	<0.1	NS	19	<1
060	1396	25	10/24/11	2.1	NA	<0.05	21	27	0.39	<0.1	0.3	1.9	6.1	4.1
061	1332	68	10/27/11	2.9	NA	<0.05	9.6	31	0.5	<0.1	<0.1	NS	21	<1
062	1333	57	10/27/11	9.1	6.6	<0.05	32	93	0.61	0.18	<0.1	NS	33	<1
063	1397	37	10/24/11	6.7	4.6	<0.05	2.8	9.5	0.46	<0.1	<0.1	NS	9	7.5

Project Well Name ^a	DEQ Site ID	Well Depth (feet)	Sample Date	Nitrate (mg/L)	$\delta^{15}\text{N}^a$ (‰)	Nitrite (mg/L)	Chloride (mg/L)	Sulfate (mg/L)	Fluoride (mg/L)	Bromide ^b (mg/L)	Ortho-phosphate ^b (mg/L)	Ammonia (mg/L)	Arsenic ($\mu\text{g/L}$)	Total Coliform ^b (MPN/100 mL)
064	1398	56	10/25/11	3.8	NA	<0.05	4.6	29	0.45	<0.1	<0.1	NS	19	<1
065	1370	40	11/15/11	20	4.0	<0.05	15	100	0.41	0.16	<0.1	NS	31	<1
066	1369	60	11/15/11	3.2	NA	<0.05	6.5	8.0	0.37	<0.1	<0.1	NS	9.9	2
067	1353	39	11/07/11	1.3	NA	<0.05	6.2	15	0.44	<0.1	<0.1	1.2	12	14.8
068	1354	45	11/07/11	7.7	4.8	<0.05	7.4	38	0.62	<0.1	<0.1	NS	27	<1
069	1357	40	11/03/11	0.91	NA	<0.05	4.6	11	0.48	<0.1	<0.1	NS	13	<1
070	1358	33	11/03/11	0.73	NA	<0.05	2.3	7.2	0.83	<0.1	<0.1	NS	17	19.7
071	1321	60	10/27/11	9.7	4.1	<0.05	8.6	43	0.64	<0.1	0.12	NS	42	<1
072	1341	61	10/26/11	6.1	4.7	<0.05	6.6	22	0.51	<0.1	<0.1	NS	39	<1
073	1399	36	10/25/11	17	3.6	<0.05	14	48	0.39	<0.1	<0.1	NS	12	<1
074	1400	36	10/24/11	4.9	NA	0.18	46	140	0.37	0.19	<0.1	2.0	3.9	<1
075	1401	45	10/24/11	0.054	NA	<0.05	5.2	44	0.27	<0.1	<0.1	1.9	3.8	<1

Notes: Bolded red numbers indicate EPA's maximum contaminant level was exceeded; italicized red numbers indicate EPA's Secondary Drinking Water Regulation was exceeded; mg/L = milligrams per liter; $\delta^{15}\text{N}$ = nitrogen isotope; ‰ = per mil. $\mu\text{g/L}$ = micrograms per liter; MPN/100 mL = most probable number per 100 milliliters; NA = not analyzed; NS = not sampled.

^a Each project well name is preceded with 'AGO4-'.

^b No primary or secondary health standard available.

Nitrogen Isotope Results

Nitrogen isotope ratios ($\delta^{15}\text{N}$) can be helpful in determining sources of nitrate in ground water and were completed for all samples with nitrate concentrations greater than 5 mg/L (Table 8). Nitrogen from human or animal waste and fertilizer sources has distinguishable $\delta^{15}\text{N}$ signatures (refer to Table 6, page 11, for typical $\delta^{15}\text{N}$ values for various nitrogen sources). DEQ analyzed 24 wells for $\delta^{15}\text{N}$: 7 had $\delta^{15}\text{N}$ values indicating a fertilizer source of nitrogen (wells AGO4-014, AGO4-017, AGO4-033, AGO4-038, AGO4-042, AGO4-065, and AGO4-073); 1 had a $\delta^{15}\text{N}$ value suggesting a waste source of nitrogen (well AGO4-046, located in the northern portion of the project area); 3 had $\delta^{15}\text{N}$ values between the organic nitrogen in the soil and waste source (AGO4-007, AGO4-048, and AGO4-058) and the remaining 13 wells had $\delta^{15}\text{N}$ values suggesting an organic nitrogen in the soil source (Table 8 and Figure 6).

Nitrogen isotopes can be used in conjunction with other water quality data and land use information to better determine sources of nitrogen in ground water. However, nitrogen isotope values in ground water can be complicated by several reactions (e.g., ammonia volatilization, nitrification, denitrification, and plant uptake) (Kendall and McDonnell 1998). Mixing of sources with variable nitrogen isotope values along shallow flowpaths makes determining the sources and extent of denitrification very difficult for intermediate $\delta^{15}\text{N}$ values (Kendall and McDonnell 1998). The land use in the project area is predominately agricultural, including both crop fields and animal operations. This type of land use would likely result in a mixture of nitrogen sources in the ground water, as indicated by the $\delta^{15}\text{N}$ values detected.

3.1.2.3 Conclusions

NPAs are designated when at least 25% of the wells sampled contain nitrate concentrations equal to or greater than 5 mg/L. In this project, 25 of the 75 wells sampled (33%) had nitrate values of 5 mg/L or greater. This result is consistent with the NPA criteria. The nitrate MCL of 10 mg/L was exceeded in 7 wells.

The highest nitrate concentration detected during the monitoring event (61 mg/L) was north of Highway 52 in Payette (well AGO4-048). The second highest nitrate concentration detected (49 mg/L) was south of Highway 52 in Payette (well AGO4-046). Well AGO4-046 had a nitrogen isotope value that suggested a waste nitrogen source; AGO4-048 had a nitrogen isotope value that was between an organic nitrogen in the soil source and a waste source. The high chloride and sulfate concentrations at well AGO4-048 indicate that the source of nitrate could be waste.

The source of elevated arsenic concentrations in the ground water is unclear; however, potential sources may include naturally occurring arsenic or a remnant from historical pesticide use (Baldwin and Wicherski 1994; Parlman 1982; Neely 2002).

3.1.2.4 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. The Southwest District Health Department can also provide property owners with information and guidance. In addition, property owners would benefit from education on the use of 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.

The *Payette County Ground Water Quality Improvement and Drinking Water Source Protection Plan* is available at <http://www.deq.idaho.gov/media/856951-payette-county-ground-wq-improvement-dw-source-protection-plan-0612.pdf>. This plan includes implementation activities for private well owners and agricultural operators designed to reduce source water contamination from nitrate and other contaminants.

3.1.3 Onion Disposal Complaint Follow-up Sampling

3.1.3.1 Purpose

The purpose of this project was to investigate potential impacts to ground water quality from a 69-acre onion disposal site (“onion dump”) north of Parma in Payette County. The investigation was prompted by a complaint from a homeowner located directly downgradient of the onion dump who stated his water is often brown and cloudy and smells like onions. The homeowner showed DEQ staff samples of brown water and brown staining on the side of the house where the lawn sprinkler had watered the house. According to local residents, discoloration and odors in the water are intermittent. At the time of sampling, the water was clear and odor-free.

3.1.3.2 Methods and Results

DEQ requested permission to sample all domestic wells located west (downgradient) of the onion dump; DEQ obtained permission to sample five downgradient wells. In addition, DEQ identified two wells east (upgradient) of the onion dump and permission was granted for sampling at both wells. DEQ sampled a total of seven wells on April 28, 2011, in accordance with the *Parma Onion Dump Investigation Project Plan* (DEQ 2011f) and *Quality Assurance Project Plan- Ground Water Quality Monitoring* (DEQ 2009) (Figure 7). Prior to collecting the samples at each well, field parameters (pH, temperature, specific conductance, and DO) were measured.

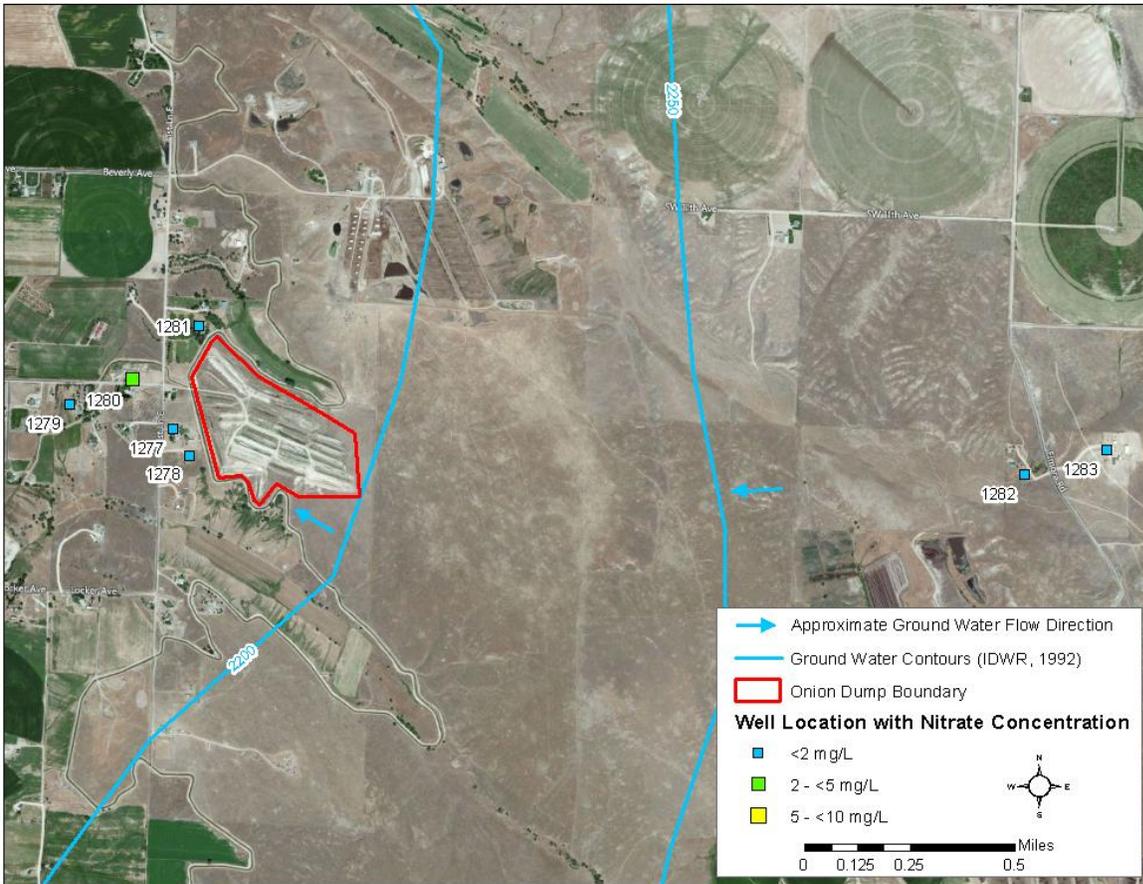


Figure 7. Well locations, DEQ site identification, and nitrate concentrations for the Onion Disposal Complaint Follow-Up Sampling project.

The samples were analyzed for total nitrate (as nitrogen), ammonia (as nitrogen), chloride, sulfate, total dissolved solids, total coliform bacteria, and *E. coli* bacteria at the Idaho State Bureau of Laboratories in Boise, Idaho. Samples were not quantified for odor and color as planned because the water samples were clear and no odors were observed during sampling activities.

A sample from the original complainant's well (well 1) was also analyzed for arsenic because a water treatment salesman told him that the arsenic in the water was significantly elevated (Table 10). Analysis for arsenic was not part of the original project plan.

Table 9. Water quality field parameter results for Onion Disposal Complain Follow-up Sampling project.

Project Well Name	DEQ Site ID	Well Depth (feet)	Sample Date	pH	Water Temperature ^a (°C)	Specific Conductivity ^a (µS/cm)	Dissolved Oxygen ^a (mg/L)
1	1277	200	4/28/2011	6.77	18.0	613	0.83
2	1278	187	4/28/2011	7.91	19.0	249	7.43
3	1279	180	4/28/2011	8.39	18.5	347	0
4	1280	Unknown	4/28/2011	8.34	16.2	420	10.64
5	1281	300+	4/28/2011	8.25	20.6	185	0
6	1282	150	4/28/2011	8.38	18.1	209	0.81
7	1283	323	4/28/2011	8.19	18.1	200	0

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

^a No primary or secondary health standard available.

Table 10. Results for Onion Disposal Complaint Follow-Up Sampling project.

Project Well Name	DEQ Site ID	Well Depth (feet)	Sample Date	Nitrate	Ammonia	Chloride	Sulfate	Total Dissolved Solids	Arsenic (micrograms/liter)	Total Coliform ^a	<i>E. Coli</i>
				(milligrams per liter)				(MPN/100 mL)			
Downgradient Wells											
1	1277	200	04/28/2011	<0.3	<0.01	7.86	6.8	410	38	<1	<1
2	1278	187	04/28/2011	0.516	<0.01	3.46	13.7	210	NA	<1	<1
3	1279	180	04/28/2011	<0.3	0.022	6.91	25.5	260	NA	<1	<1
4	1280	Unknown	04/28/2011	4.25	<0.01	13.9	27	300	NA	<1	<1
5	1281	300+	04/28/2011	<0.3	0.094	2.56	7.44	160	NA	<1	<1
Upgradient Wells											
6	1282	150	04/28/2011	<0.3	<0.01	3.08	8.56	170	NA	<1	<1
7	1283	323	04/28/2011	<0.3	<0.01	3.08	8.37	160	NA	<1	<1

Notes: Bolded red numbers indicate EPA's maximum contaminant level was exceeded; No EPA's secondary standards were exceeded; MPN/100 mL = most probable number per 100 milliliters; NA = not analyzed.

^a No primary or secondary health standard available.

Arsenic was detected in the sample collected from well 1 at a concentration of 38 µg/L; the MCL for arsenic is 10 µg/L. Although the other wells in the study were not analyzed for arsenic, it is possible that the arsenic in the water at well 1 is related to the low pH (6.77) present in that well (Table 9). Acidic conditions can cause dissolution of natural arsenic from the soil. The remaining wells had pH values that ranged from 7.91 to 8.39 (Table 9).

3.1.3.3 Conclusions

No evidence was found that the onion dump was contributing nitrogen or other analyzed constituents to ground water in concentrations exceeding any health standards.

3.1.3.4 Recommendations

Although it is unlikely that the water downgradient of the onion dump will contain inorganic or organic constituents that exceed primary drinking water standards, the secondary standards of color and odor could be exceeded during the intermittent times when the water appears impacted. Residents downgradient of the onion dump were asked to contact DEQ when their water contains significant suspended sediment and odor. DEQ will try to sample the wells during that period of time or provide guidance on how residents can collect a sample themselves.

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

3.2 Coeur d'Alene Region

3.2.1 Lynnwood Estates Arsenic Follow-Up

3.2.1.1 Purpose

This project analyzed arsenic concentrations in the ground water from the well that services the Lynnwood Estates Water Company area, identified potential sources of arsenic in the vicinity, and helped distinguish if activities in the area may be contributing to or causing the elevated arsenic in the Lynnwood Estates drinking water. The Lynnwood Estates Water Company services approximately 43 people and is located approximately 1 mile northeast of Athol, Idaho. The ground water flow direction is most likely to the south-southeast (USGS 2007).

The Lynnwood Estates PWS consists of one well (LWE 2) (Figure 8). Well LWE 2 was completed on November 3, 1994, to a depth of 394 feet bgs. The stratigraphy described in the well driller's report is generally alternating units of coarse sand and gravel and coarse sand. Depth to water from land surface in LWE 2 is 324 feet bgs.

Another well in the immediate vicinity is the Trinity Estates well (TE 1) (Figure 8). Well TE 1 was completed on August 29, 2006, to a depth of 382 feet bgs. The stratigraphy described in the well driller's report is generally alternating units of coarse sand and gravel and finer sand and clay units. Depth to water from land surface in well TE 1 is 305 feet bgs.



Figure 8. Location of wells LWE 2 and TE 1, labeled with total arsenic concentrations from July 2011 sampling.

Historic arsenic concentrations in well LWE 2 are shown in Figure 9. The arsenic concentrations from well LWE 2 vary between 0 $\mu\text{g/L}$ and 91 $\mu\text{g/L}$ from approximately 1998 to present (Figure 9). The arsenic concentration has reached or exceeded the current MCL of 10 $\mu\text{g/L}$ in over 75% of the water quality samples obtained since 1998. The MCL for arsenic changed from 50 $\mu\text{g/L}$ to 10 $\mu\text{g/L}$ in 2006.

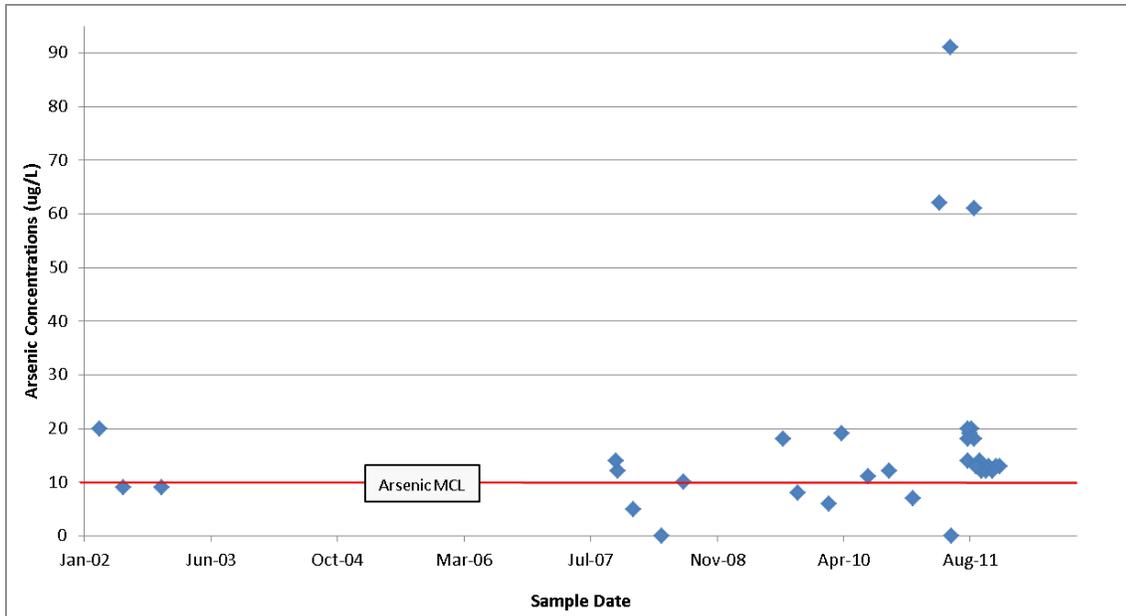


Figure 9. Historic arsenic concentrations at LWE 2 and the current arsenic drinking water standard of 10 µg/L.

3.2.1.2 Methods and Results

The goal of ground water sampling and analysis in the area of well LWE 2 is to determine the potential for anthropogenic contributions to the elevated arsenic in the well. This project was attempted with chemical analysis in conjunction with knowledge of the land use and contribution rate of the contaminants of concern at the potential sources. Two water wells, LWE 2 and TE 1, were sampled during a single sampling event on July 15, 2011. The wells were sampled for total organic carbon (TOC); biological oxygen demand; fats, oils, and greases; total iron; sulfide; sulfate; arsenite; and arsenate. The samples were sent to Anatek Labs, Inc., in Moscow, Idaho, for analysis. The analytical results are shown in Table 11.

The potential sources of arsenic in the area that could affect ground water quality include both naturally occurring and anthropogenic sources. Arsenic does occur in the ground water and glacial flood deposit aquifers of Kootenai County and is most likely derived from the geology associated with the granitic/gneissic parent material. A second potential source may be activities on adjacent property. Area residents have complained about activities that include illegal dumping, livestock (swine) operations, and operation of a slaughterhouse. On inspection, DEQ found approximately 500 stockpiled empty 55-gallon drums labeled for cooking oil on the adjacent property.

The release of significant quantities of used cooking oil and migration to the aquifer can cause geochemical conditions that may result in reductive dissolution of metal oxides/hydroxides (usually iron) that have sorbed arsenic, resulting in elevated dissolved arsenic concentrations. Swine operations and slaughterhouse operations may contribute to elevated arsenic in well LWE 2 in two ways: (1) the use of organoarsenic feed additives and (2) contribution of dissolved organic material to the underlying aquifer. The use of organoarsenic feed additives can result in elevated arsenic concentrations in swine waste. Storage and disposal of swine waste on the property could result in contributions of arsenic to the underlying aquifer. In addition, the storage

and disposal of swine waste or slaughterhouse waste could also contribute TOC to the aquifer that creates similar geochemical conditions as the used cooking oil with increased concentrations of dissolved arsenic.

Well LWE 2 is a PWS subject to required water quality testing. The nitrate concentration from the regulated monitoring has historically been below detection limits, which likely precludes swine waste as the source. Swine waste can have nitrate concentrations of 10–20 mg/L. Given the proximity of the well to activities on the adjacent property, these low concentrations make it unlikely that the well is being impacted by swine waste. Slaughterhouse waste can contribute TOC to the aquifer and in turn cause reductive dissolution of sorbed arsenic. However, the sampled wells had TOC values less than the detection limit (Table 11), which further indicates that swine waste is not contributing to the elevated arsenic at well LWE 2.

Table 11. Analytical results for Lynnwood Estates Arsenic Follow-Up project.

Project Well Name	DEQ Site ID	Well Depth (feet)	Date	Total Iron	Sulfate	Sulfide	Total Organic Carbon	Biological Oxygen Demand	Fats, Oils, and Greases	Arsenic		
										Total Arsenic	Arsenite (III)	Arsenate (V)
							(milligrams/liter)					
							(microgram/liter)					
LWE 2	2190	470	07/15/2011	0.261	28.9	<1.0	<1.00	<2.0	<1	10.6	<3	10.6
TE 1	2191	382	07/15/2011	<0.060	27.5	<1.0	<1.00	<2.0	<1	<3	<3	<3

Notes: Bolded red numbers indicate EPA's maximum contaminant level was exceeded.

3.2.1.3 Conclusions

The analytical results from the ground water sampling of wells LWE 2 and TE 1 indicate that elevated arsenic concentrations are from naturally occurring sources.

The TOC; biological oxygen demand; fats, oils, and greases; and sulfide concentrations in wells LWE 2 and TE 1 were below detection limits. Sulfate concentrations were similar in the two wells. These analytical results indicate a well-oxygenated system with little or no influence from potential activities on the adjacent site. An interview with the owner and site observations did not support any current swine onsite or slaughterhouse operations. The arsenic speciation results for well LWE 2 indicated that the arsenate (V) was dominant, with arsenite (III) concentrations below detection levels. The elevated arsenate in LWE 2 occurred in conjunction with elevated iron concentrations (relative to TE 1). The arsenic and iron concentrations from the ground water sample obtained from TE 1 were below detection limits. The elevated arsenate and iron concentrations in LWE 2 are most likely from oxidative dissolution of arsenic-containing minerals in the aquifer material such as pyrite or other iron sulfides.

3.2.1.4 Recommendations

Due to the nature of natural conditions leading to arsenic contamination, the Lynnwood Estate PWS should investigate treatment options. In addition, private well owners in the area are encouraged to analyze their well water for arsenic.

3.3 Idaho Falls Region

3.3.1 Mud Lake Nitrate Priority Area Potential Nitrate Source Evaluation

3.3.1.1 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 towards 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.

Sites were selected from those with existing monitoring results showing elevated nitrates. PWS wells, ISDA dairy monitoring sites, and IDWR Statewide Monitoring Network Program sites were reviewed. DEQ received permission to sample seven sites in 2011 (Figure 10).

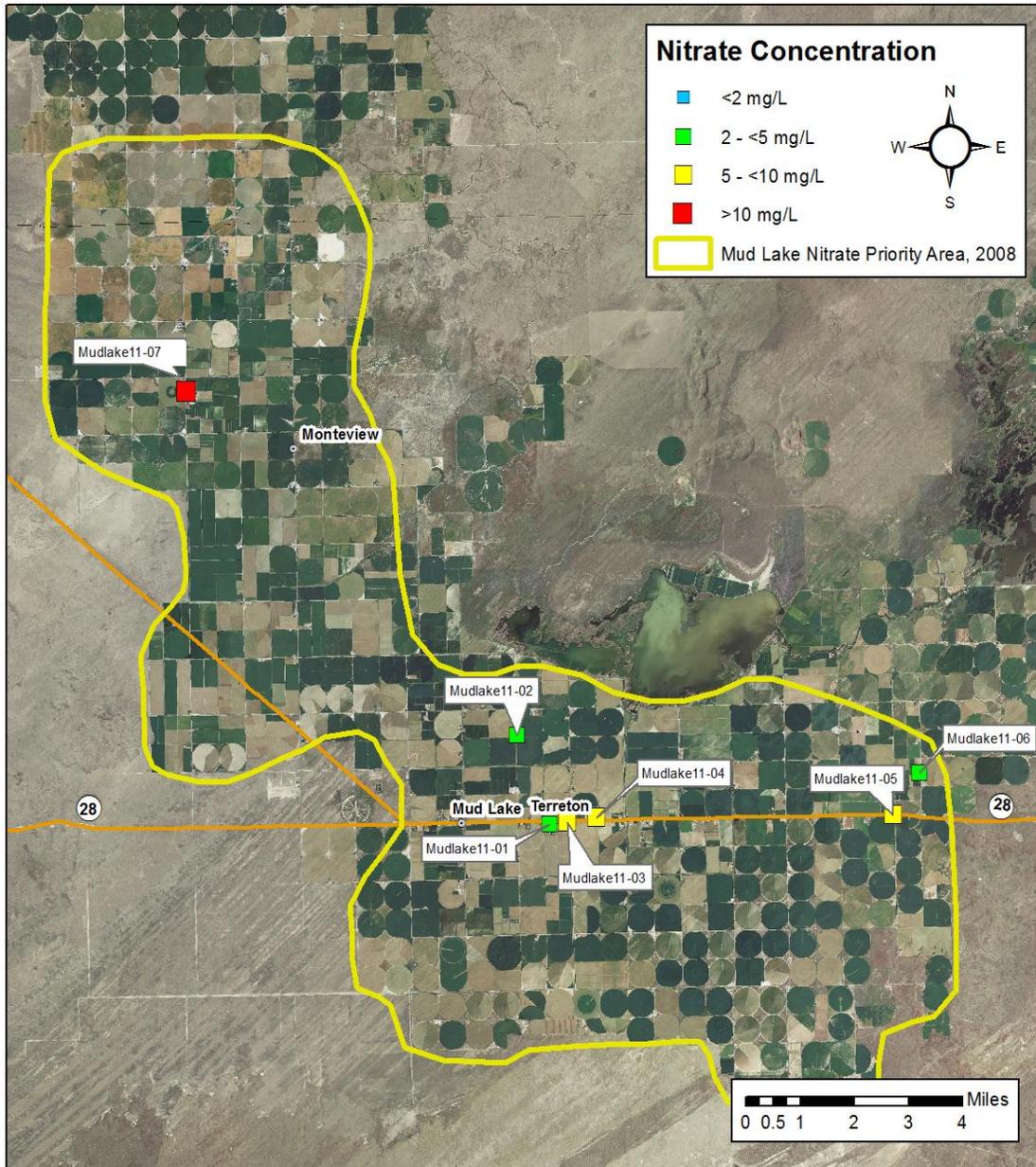


Figure 10. Well locations, project well name, and nitrate concentrations for Mud Lake Nitrate Priority Area Potential Nitrate Source Evaluation project.

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 portion 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 11). Regional ground water flow is to the south and west (Jeffers and Baldwin 2008).

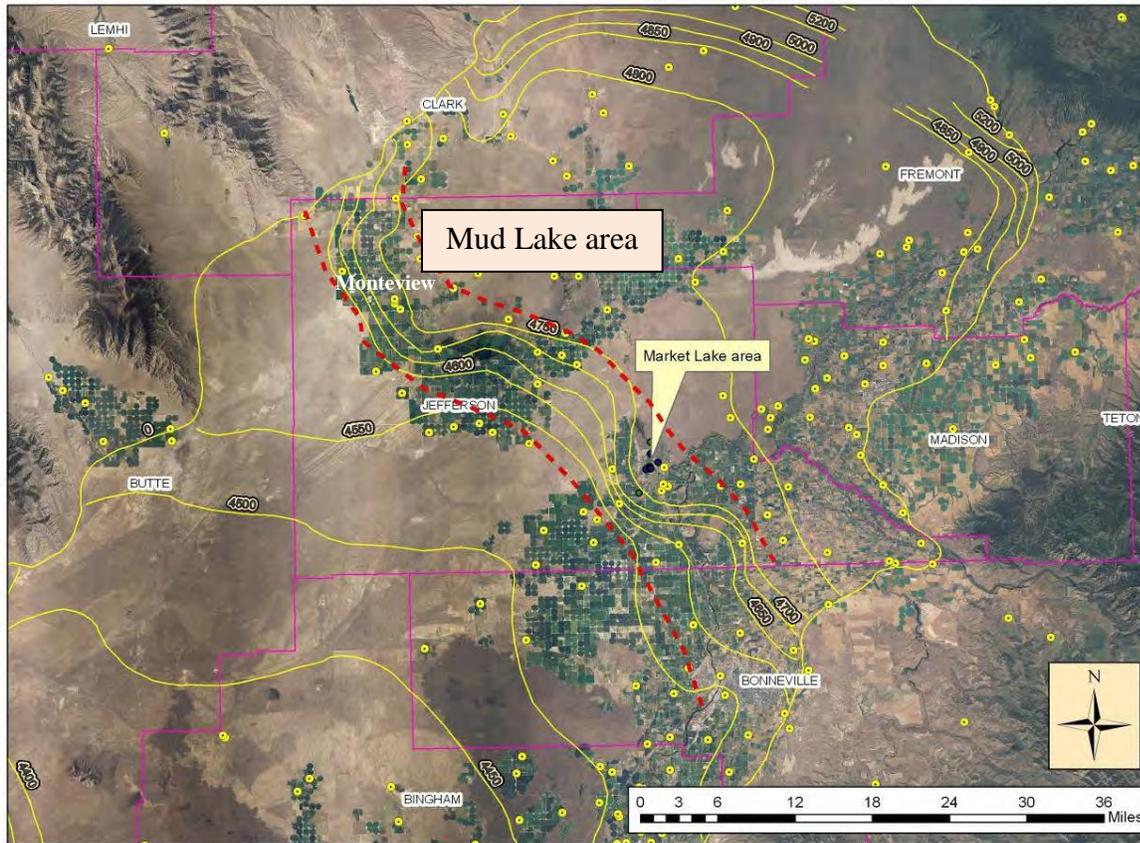


Figure 11. Ground water elevation and locations of the Mud Lake basin and approximate location of Mud Lake–Market Lake barrier, as indicated by the dashed red lines. Yellow symbols are data points used to create ground water elevation contours. Adapted from Jeffers and Baldwin (2008).

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 Montevieu–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. Driller’s 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 Montevieu 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 11). 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 and 26.7 degrees Fahrenheit, with the average minimums above freezing May–September (WRCC 2012).

3.3.1.2 Methods and Results

Seven wells were sampled in December 2011 following the QAPP and FSP (DEQ 2011g; Hall 2011). Water quality field parameter data were collected prior to sampling (Table 12). Samples were sent to the Idaho Bureau of Laboratories in Boise, Idaho, for analysis of calcium, magnesium, sodium, potassium, chloride, sulfate, alkalinity, nitrate plus nitrite, and ammonia. Samples were sent to Idaho State University in Pocatello, Idaho, for tritium analysis. Samples were sent to IAS Environmental in Pocatello, Idaho, for total coliform 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 ($\delta^{15}\text{N}_{\text{nitrate}}$, $\delta^{18}\text{O}_{\text{nitrate}}$) can provide information about the history of the nitrogen in the environment.

Results for major ion chemistry and tritium are presented in Table 13; nitrate and bacteria results are presented in Table 14. 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 12. Water quality field parameter data for Mud Lake Nitrate Priority Area Potential Nitrate Source Evaluation project.

Project Well Name	DEQ Site ID	Well Depth (feet)	Sample Date	Water Temp. ^a (°C)	Specific Conductivity ^a (µS/cm)	pH	Air Temp. (°C)
Mudlake11-01	1787	320	12/14/2011	11.9	667	7.3	-5
Mudlake11-02	1788	300	12/14/2011	8.4	719	7.3	-5
Mudlake11-03	1789	320	12/14/2011	10.7	693	7.3	-4
Mudlake11-04	1790	285	12/14/2011	9.9	753	7.2	-1
Mudlake11-05	1791	137	12/21/2011	9.9	745	7.3	-3
Mudlake11-06	1792	Unknown	12/21/2011	10.5	604	7.2	-2
Mudlake11-07	1793	170	12/21/2011	8.9	875	7.1	-2

Notes: pH met EPA's Secondary Drinking Water Regulation requirements; °C = degrees Celsius; µS/cm = microsiemens per centimeter; Temp. = Temperature.

^a No primary or secondary health standard available.

Table 13. Tritium and major ion results, Mud Lake Nitrate Priority Area Potential Nitrate Source Evaluation project.

Project Well Name	DEQ Site ID	Well Depth (feet)	Sample Date	Tritium ^a (pCi/L)	Major Ion Concentration (milligrams/liter)						
					Calcium ^a	Magnesium ^a	Sodium	Potassium ^a	Chloride	Sulfate	Alkalinity ^a (as CaCO ₃)
Mudlake11-01	1787	320	12/14/2011	20	60	24	43	5	42.2	39.2	252
Mudlake11-02	1788	300	12/14/2011	19	69	22	55	5.2	31.3	35.5	300
Mudlake11-03	1789	320	12/14/2011	21	66	26	45	5.2	45.6	38.4	265
Mudlake11-04	1790	285	12/14/2011	13	69	27	51	5.3	55.6	37.3	269
Mudlake11-05	1791	137	12/21/2011	12	74	19	52	4.3	25.3	25	305
Mudlake11-06	1792	Unknown	12/21/2011	11	68	19	30	3.5	16.8	19	273
Mudlake11-07	1793	170	12/21/2011	8	85	26	61	5.4	34.2	38.4	339

Notes: EPA's Secondary Drinking Water Regulation was not exceeded for chloride or sulfate; italicized numbers indicate that EPA's health-based advisory value for individuals on a 500 mg/day restricted sodium diet were exceeded; pCi/L = picocuries per liter; CaCO₃ = calcium carbonate.

^a No primary or secondary health standard available.

Table 14. Nutrient and bacteria results for the Mud Lake Nitrate Priority Area Potential Nitrate Source Evaluation project.

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	<i>E. coli</i>
Mudlake11-01	1787	320	12/14/2011	4.9	<0.01	<1.0	<1.0
Mudlake11-02	1788	300	12/14/2011	4.4	<0.01	<1.0	<1.0
Mudlake11-03	1789	320	12/14/2011	5.2	0.014	<1.0	<1.0
Mudlake11-04	1790	285	12/14/2011	5.6	<0.01	<1.0	<1.0
Mudlake11-05	1791	137	12/21/2011	7.1	<0.01	<1.0	<1.0
Mudlake11-06	1792	Unknown	12/21/2011	4.2	0.011	<1.0	<1.0
Mudlake11-07	1793	170	12/21/2011	10	0.01	<1.0	<1.0

Notes: Bolded red numbers indicate EPA's maximum contaminant level was exceeded; NO₂ + NO₃ = nitrite plus nitrate.

^a No primary or secondary health standard available.

Nitrate Results

Figure 10 presents the distribution of nitrate concentrations for the Mud Lake study area. One well (11-07) exceeded the MCL for nitrate.

Stable Isotope Results

Stable isotope measurements can provide insight to the history of the nitrate and potential sources and the 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 15. The stable isotopes oxygen-18 ($\delta^{18}\text{O}$) and deuterium ($\delta^2\text{H}$) can shed light on the history of the water that is potentially carrying nitrates to the ground water. Stable oxygen-18 and deuterium isotope measurements are reported as a ratio relative to the Vienna Standard Mean Ocean Water (VSMOW) standard, which defines the isotopic composition of freshwater. Combined with the water chemistry information, supporting information related to hydrogeology, and land use and agricultural practices, stable isotopes can help identify likely sources of contamination and point decision makers to potential BMPs. Oxygen/deuterium 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 15. Stable isotope results for the Mud Lake Nitrate Priority Area Potential Nitrate Source Evaluation project.

Project Well Name	DEQ Site ID	Well Depth (feet)	Sample Date	Stable Isotopes (‰)							
				$\delta^{18}\text{O}$	$\delta^2\text{H}$	$\delta^{15}\text{N}$	NAU		Waterloo		
							$\delta^{15}\text{N}_{\text{nitrate}}$	$\delta^{18}\text{O}_{\text{nitrate}}$	$\delta^{15}\text{N}_{\text{nitrate}}$	$\delta^{18}\text{O}_{\text{nitrate}}$	
Mudlake11-01	1787	320	12/14/2011	-15.3	-120	6.5	6.10	-5.18	6.81	-3.79	
Mudlake11-02	1788	300	12/14/2011	-15.9	-123	6.0	5.51	-5.23	5.88	-3.68	
Mudlake11-03	1789	320	12/14/2011	-15.5	-122	6.2	6.22	-5.13	6.65	Lost ^a	
Mudlake11-04	1790	285	12/14/2011	-15.8	-123	6.7	6.87	-5.23	7.30	-3.86	
Mudlake11-05	1791	137	12/21/2011	-17.1	-128	6.7	6.56	-6.60	7.04	-3.45	
Mudlake11-06	1792	Unknown	12/21/2011	-17.1	-129	4.7	4.78	-6.45	5.36	-4.19	
Mudlake11-07	1793	170	12/21/2011	-17	-130	8.1	7.04	-9.41	8.68	-4.40	

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

^a Sample lost in processing.

Stable nitrogen-15 isotope ($\delta^{15}\text{N}$) results can provide some insight relating nitrate concentrations and primary nitrogen sources for sample sites. Stable nitrogen-15 measurements are presented as per mil relative to nitrogen in air. Nitrogen from human or animal waste and fertilizer sources has distinguishable $\delta^{15}\text{N}$ signatures. Typical $\delta^{15}\text{N}$ values for various nitrogen sources are listed in Table 6, page 11. One well (11-07) had a $\delta^{15}\text{N}$ value in between an organic nitrogen in the soil source and a waste source. The remaining six wells sampled for this project have $\delta^{15}\text{N}$ values that indicate an organic nitrogen in the soil source.

Analysis of the stable nitrogen and oxygen isotopes for nitrates ($\delta^{15}\text{N}_{\text{nitrate}}$, $\delta^{18}\text{O}_{\text{nitrate}}$) can provide information about the history of the nitrogen in the environment. Results are presented as per mil relative to air for nitrogen-15 of nitrate and relative to VSMOW for oxygen-18 of nitrate. Observed nitrogen isotopic ratios and nitrate concentrations can be modified by both chemical and biological processes in the environment. The nitrogen-15 and oxygen-18 of 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 $\delta^{15}\text{N}_{\text{nitrate}}$ and $\delta^{18}\text{O}_{\text{nitrate}}$ 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 $\delta^{15}\text{N}_{\text{nitrate}}$ and $\delta^{18}\text{O}_{\text{nitrate}}$ analysis. University of Waterloo uses the AgCl, AgNO₃-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 complete interpretation of 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.

3.3.1.3 Conclusions

Preliminary review of results 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
- Oxygen-18 versus deuterium
- Nitrate plus nitrite versus nitrogen-15
- Nitrogen-15 of nitrate versus oxygen-18 of nitrate

3.3.1.4 Recommendations

Additional wells were sampled in the Mud Lake NPA in 2012. As these data are received and reviewed, additional tools and plots will be used 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.

3.4 Lewiston Region

3.4.1 Camas Prairie Nitrate Priority Area Ground Water Monitoring Project

This section summarizes the 2011 sampling results from an ongoing ground water quality evaluation for nitrate concentrations on the Camas Prairie, north of Grangeville, Idaho. A DEQ study (Bentz 1998) found that 24 of 55 wells sampled (44%) had nitrate concentrations that exceeded 5 mg/L, one-half the MCL of 10 mg/L. The maximum nitrate concentration reported in the 1998 study was 77.1 mg/L. The Camas Prairie is one of Idaho's 32 NPAs, based in part on the 1998 nitrate investigation results.

3.4.1.1 Purpose

To address elevated nitrate concentrations in the Camas Prairie NPA, a ground water quality management plan (Plan) was developed (DEQ and ISCC 2008). The Plan encourages implementation of voluntary BMPs to reduce nitrate concentrations in ground water.

DEQ initiated the Camas Prairie ground water monitoring program in August 2005 to establish an ambient ground water monitoring network. Long-term ground water monitoring is being conducted to determine the Plan's effectiveness on improving ground water quality. Seasonal nitrate trends in Camas Prairie wells are being tracked to determine if ambient concentrations fluctuate seasonally.

As part of the Plan, approximately \$1 million of Clean Water Act §319 grant funds have been expended on the Camas Prairie for implementation of agricultural ground water protection BMPs, such as direct seed practices (Figure 12). Direct seed applications allow for crop planting with minimal soil disturbance, which may contribute to reduced nitrogen mobility when combined with other BMPs.

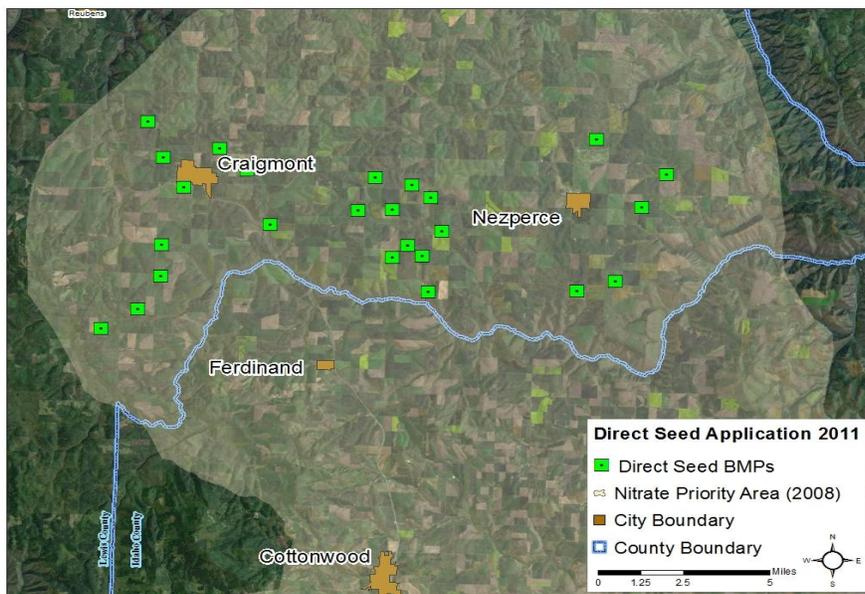


Figure 12. General locations of direct seed application in 2011 in the Camas Prairie Nitrate Priority Area.

3.4.1.2 Methods and Results

In addition to the wells monitored by DEQ, wells were also identified and sampled by the Lewis Soil Conservation District (LSCD) and ISDA. Nitrate concentrations from sampled sites were compared seasonally for several years to identify wells with nitrate concentrations that had similar seasonal trends and wells with results considered to be anomalies. Wells with apparent anomalies were addressed to resolve isolated or localized situations and dropped from the ambient network.

Since 2006, DEQ has conducted routine quarterly sampling from a Camas Prairie network of 23 wells and 2 springs (Figure 13). During the 2011 calendar year, sampling in accordance with the QAPP (DEQ 2005) was conducted in March, June, September, and December. Water quality field parameters of temperature, specific conductance, DO, and pH (June only) were measured prior to sample collection (Table 16). Samples were collected for nitrate plus nitrite and sent to Anatek Labs in Moscow, Idaho, for analysis.

Samples collected in December were also analyzed for total phosphorus by Anatek Labs to characterize total phosphorus concentrations in the region's ground water and determine if the potential exists to use total phosphorus to augment current efforts in monitoring the region's ground water quality. The laboratory results reported from that effort range from 0.0224 mg/L to 0.134 mg/L (Table 17).

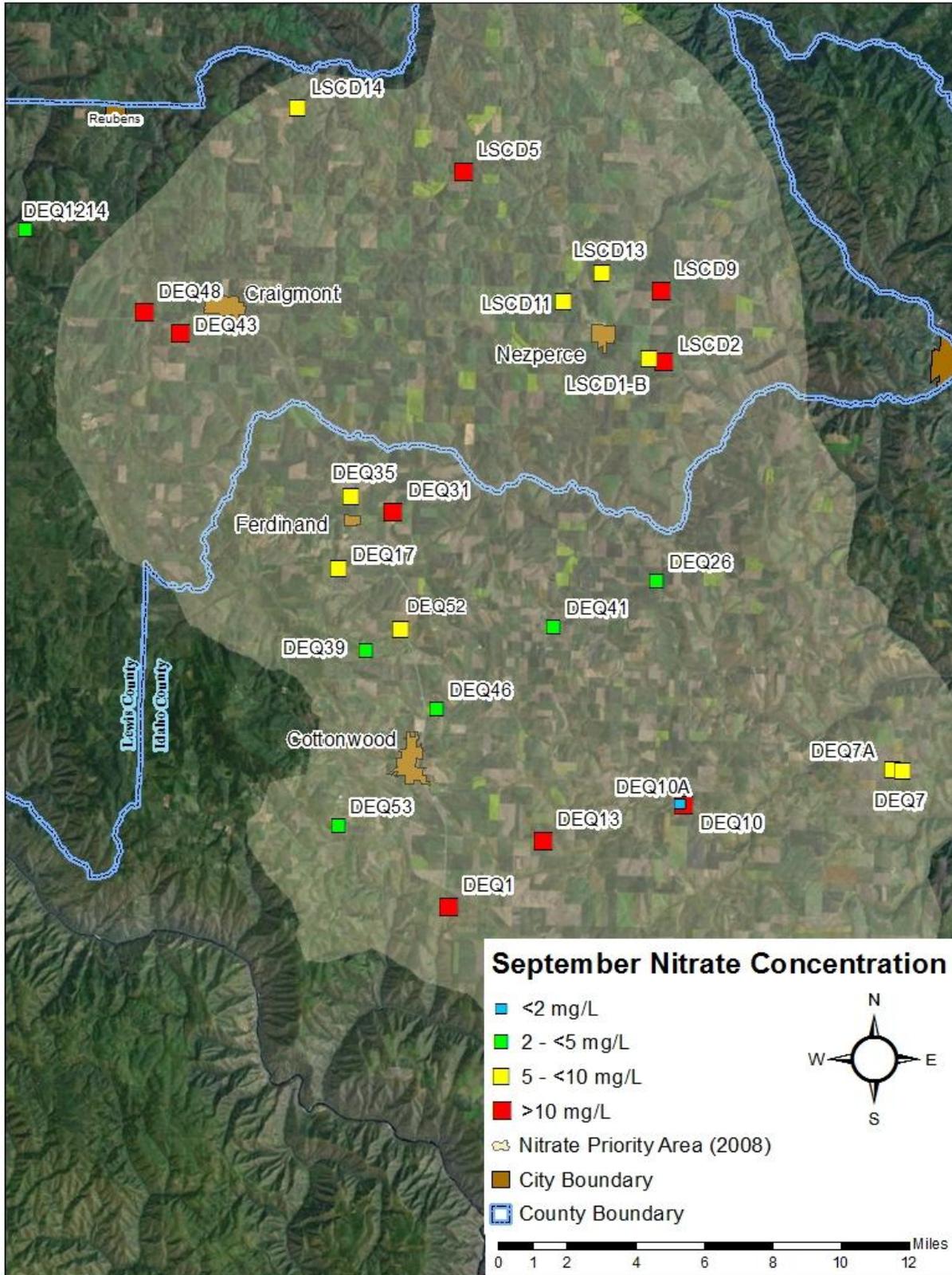


Figure 13. Well locations, project well name, and nitrate concentrations for September 2011 sampling for Camas Prairie Nitrate Priority Area Ground Water Monitoring project.

Table 16. Water quality field parameter data from Camas Prairie Nitrate Priority Area Ground Water Monitoring project.

Project Well Name	DEQ Site ID	Well Depth (feet)	March 2011			June 2011				September 2011			December 2011		
			Spec. Cond. ^a (µS/cm)	Water Temp. ^a (°C)	DO ^a (mg/L)	Spec. Cond. ^a (µS/cm)	Water Temp. ^a (°C)	DO ^a (mg/L)	pH	Spec. Cond. ^a (µS/cm)	Water Temp. ^a (°C)	DO ^a (mg/L)	Spec. Cond. ^a (µS/cm)	Water Temp. ^a (°C)	DO ^a (mg/L)
DEQ1	407	375	321.8	5.2	9.24	374	12.1	7.41	8.31	494	17.5	8.00	384	5.1	9.15
DEQ7	413	260	NS	NS	NS	355	12.9	5.27	7.11	433	18.7	6.48	424	4.3	14.3
DEQ7A	643	145	374.1	9.9	13.22	417	12.4	15	7.9	418	14.3	13.07	NS	NS	NS
DEQ10	416	187	348	10.8	8.1	402	11.4	8.9	7.24	417	12.0	8.55	440	10.9	9.27
DEQ10A	417	Spring	NS	NS	NS	422	12.5	2.4	8.5	410	13.1	3.1	NS	NS	NS
DEQ13	419	250	407.01	8.9	6.17	512	11.2	7.52	7.64	570	11.7	6.36	664	6.0	7.83
DEQ17	423	500	210.43	9.5	7.06	228	10.9	8.03	7.64	265	11.6	7.96	244	7.8	8.39
DEQ26	432	135	306	10.6	3.49	349	11.3	3.94	7.83	357	11.5	3.3	362	10.6	3.68
DEQ31	437	28	NS	NS	NS	505	10.5	9.99	8.29	575	10.2	7.44	NS	NS	NS
DEQ35	199	340	420.5	9.8	9.32	NS	NS	NS	NS	480	10.9	9.67	462	9.4	10.61
DEQ39	202	400	NS	NS	NS	319	11.7	9.85	7.76	257	12.8	8.37	244	9.3	8.27
DEQ41	205	327	500.7	10.7	0.44	570	11.6	0.15	8.00	593	12	0.49	561	10.8	0.46
DEQ43	207	85	370.8	9.6	3.99	510	10.1	3.93	7.98	371	10.1	3.8	350	9.5	4.23
DEQ46	210	500	304.7	11.4	3.5	355	13.8	5.23	7.72	340	14.6	1.87	344	12.3	3.61
DEQ48	212	400	386.7	8.1	7.89	421	10.9	7.82	8.2	412	13.6	7.2	410	9.2	8.06
DEQ52	216	80	522.6	11.1	7.14	550	11.8	7.59	7.72	568	11.6	6.93	571	10.9	7.73
DEQ53	217	500	202.2	4.6	6.31	235	12.7	8.12	8.09	243	16.6	3.35	241	5.5	6.21
DEQ1214	1214	Spring	NS	NS	NS	NS	NS	NS	NS	318	9.1	3.31	NS	NS	NS
LSCD1-B	920	300	388.8	4.4	9.45	436	10.9	9.48	8.05	442	15.5	7.79	444	6.3	9.89
LSCD2	642	65	626.4	10.6	8.46	684	11.1	12.17	7.85	486	11.8	10.05	610	10.8	11.08
LSCD5	644	402	452.2	8.3	9.19	510	11.4	10.42	8.09	523	14	8.49	516	9.3	11.18
LSCD9	645	165	630.6	10.3	7.87	667	11.3	10.25	7.99	627	11.7	6.19	660	7.5	9.44
LSCD11	637	396	350.7	10.1	9.23	414	11.6	14.19	7.94	425	12.9	10.09	421	9.9	12.18
LSCD13	638	90	346.9	9.6	9.18	404	10.5	11.88	8.11	423	11.3	9.69	423	7.6	10.86
LSCD14	639	85	554.7	9.3	7.87	624	10.6	7.99	8.02	626	11.9	7.27	630	8.6	7.93

Notes: EPA's Secondary Drinking Water Regulation was not violated for pH; Spec. Cond. = specific conductivity; µS/cm= microsiemens per centimeter; Temp. = temperature; °C = degrees Celsius; DO = dissolved oxygen; mg/L = milligrams per liter; NS = not sampled.

^a No primary or secondary health standard available.

Nitrate Results

The highest reported nitrate concentration of 17.8 mg/L was from well DEQ48 during the December 2011 sampling event. Well DEQ48 had the highest reported nitrate concentration during all four sampling events, with an annual average of 17.34 mg/L. In all, 9 of the 25 Camas Prairie sites (36%) reported nitrate concentrations in excess of the 10 mg/L MCL at least once during the 2011 sampling year (Table 17). Overall, little variation existed in median and mean nitrate concentrations between sampling events in 2011, ranging from a low of 5.33 mg/L for the median and 7.64 mg/L for the mean (March) to a high of 7.14 mg/L for the median (September) and 8.4 mg/L for the mean (December).

Table 17. Nitrate and phosphorus results for Camas Prairie Nitrate Priority Area Ground Water Monitoring project, 2011.

Project Well Name	DEQ Site ID	Well Depth (feet)	Nitrate Concentration (milligrams/liter)				Total Phosphorus ^a (milligrams/liter)
			March 2011	June 2011	September 2011	December 2011	December 2011
DEQ1	407	375	4.94	1.64	15.0	4.61	0.0224
DEQ7	413	260	NA	5.59	8.09	6.11	0.0413
DEQ7A	643	145	5.41	6.19	5.85	NA	NA
DEQ10	416	187	14.0	15.8	14.6	16.5	0.0488
DEQ10A	417	Spring	NA	<0.1	<0.1	NA	NS
DEQ13	419	250	7.52	10.6	13.2	17.6	0.0528
DEQ17	423	500	1.92	1.89	7.14	3.77	0.0478
DEQ26	432	135	4.30	4.68	4.24	4.48	0.0731
DEQ31	437	28	NA	10.2	13.3	NA	NA
DEQ35	199	340	7.35	NA	8.88	8.08	0.0699
DEQ39	202	400	NA	6.51	4.73	4.02	0.0388
DEQ41	205	327	4.15	4.67	4.85	4.38	0.0271
DEQ43	207	Unknown	10.4	10.6	10.8	9.44	0.0406
DEQ46	210	500	3.71	5.03	3.75	3.90	0.0902
DEQ48	212	400	17.2	17.4	17.3	17.8	0.0642
DEQ52	216	80	8.97	8.88	9.38	9.45	0.0883
DEQ53	217	500	2.48	3.28	2.31	2.62	0.0694
DEQ1214	1214	Spring	NA	NA	4.39	NA	NA
LSCD1-B	920	300	4.75	6.23	6.23	6.58	0.0541
LSCD2	642	65	14.1	17.2	10.1	12.9	0.0526
LSCD5	644	402	10.7	10.5	11.6	11.2	0.0793
LSCD9	645	Unknown	16.2	15.6	12.2	15.2	0.0398
LSCD11	637	396	5.25	7.08	7.03	6.67	0.0908
LSCD13	638	90	4.49	4.79	5.12	5.51	0.0784
LSCD14	639	85	5.03	6.50	5.80	5.27	0.134

Notes: Bolded red numbers indicate EPA's maximum contaminant level was exceeded; NA=not analyzed.

^a No primary or secondary health standard available.

The variability between quarterly ground water nitrate concentrations at various wells (i.e., DEQ1, DEQ17) in the area may indicate that nitrate leaching rates, nitrogen sources, and ground water hydrology have not been uniform over the year. This variation can be due to changes in cropping patterns and fertilizer application, variation in nitrogen uptake by crops due to growing season conditions, or variations in leaching rates related to the amount and timing of precipitation available to mobilize nitrogen below the crop root zone.

The anomalously elevated nitrate concentration of DEQ1 in September 2011 was investigated in more detail. All historic nitrate data for this well were plotted (Figure 14). Nitrate concentrations have been variable during the sampling of DEQ1, with detections over 10 mg/L occurring in August 2005, February 2006, and most recently in September 2011.

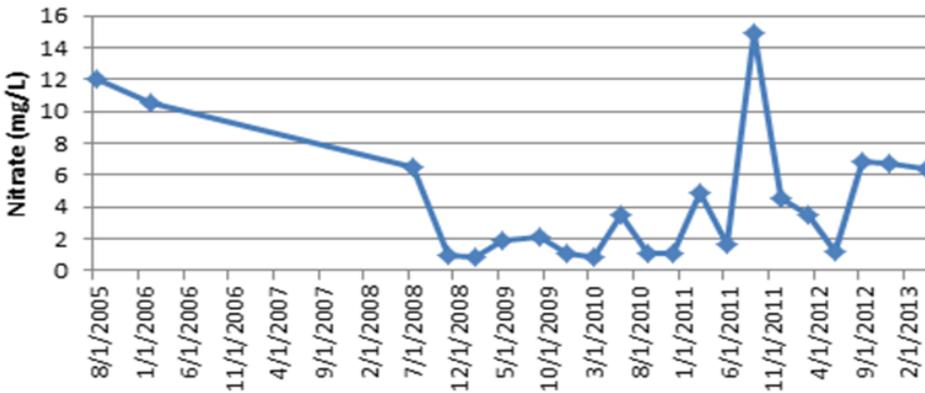


Figure 14. Time series plot of historic nitrate data for DEQ1.

An elevated specific conductivity value (Figure 15) was measured in DEQ1 during September 2011. The variability of the historic nitrate data for DEQ1, coupled with the elevated specific conductivity concentration in September 2011, suggest that the elevated nitrate detection of 15.0 mg/L in September 2011 is a viable value.

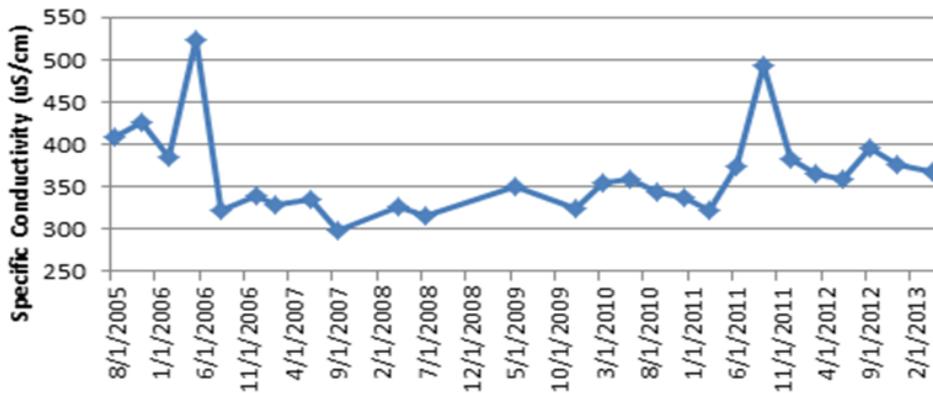


Figure 15. Time series plot of historic specific conductivity data for DEQ1.

Tracking changes in ambient nitrate concentrations relative to changes in land use or source controls will 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.

3.4.1.3 Conclusions

Sample results show that ground water in the Camas Prairie contains elevated nitrate concentrations. At some locations, reported nitrate concentrations exceed the EPA MCL of 10 mg/L. Nitrogen isotope data collected in the project area indicate that both inorganic and organic nitrogen contribute to the elevated concentrations (Baldwin et al. 2008). 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.

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 to compare changes in seasonal trends of the network over multiple years to identify changes in ambient conditions.

3.4.1.4 Recommendations

Ground water conditions can be represented in spring water. Monitoring spring water when ground water provides the only source of water to 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. In addition, spring water can be a good sampling location in project areas where few or no shallow wells are available for sampling. It is recommended that additional springs are sought for sampling to enhance the monitoring network.

Continued investigation of total phosphorus concentrations in the region's ground water is recommended. Monitoring total phosphorus trends may be helpful in determining the effectiveness of BMPs over time.

For more information, see Baldwin et al. (2008), which summarizes data collected for this project from 2005 through 2007 (available at http://www.deq.idaho.gov/media/470730-_water_data_reports_ground_water_camás_prairie_29.pdf).

3.4.2 Tammany and Lindsay Creeks Ground Water Monitoring Project

3.4.2.1 Purpose

The Lindsay Creek NPA was designated in 2008 using ground water quality results from IDWR, ISDA, the United States Geological Survey, PWSs, and DEQ. The NPA encompasses the Lindsay Creek watershed and parts of the Tammany Creek watershed. 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 2007). The goal of this project is to create an ambient ground water quality monitoring network for a multiple year seasonal trend analysis to detect changes in the Lindsay Creek NPA and also extend ground water quality monitoring to include the aquifer within the Tammany Creek watershed. Limited

ground water sampling has shown elevated nitrate concentrations in the Tammany Creek area. Tammany Creek is located south of Lewiston, Idaho, and the watershed has similar spring-fed nutrient load characteristics as the Lindsay Creek watershed north of Lewiston (Figure 16). 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 2010b).

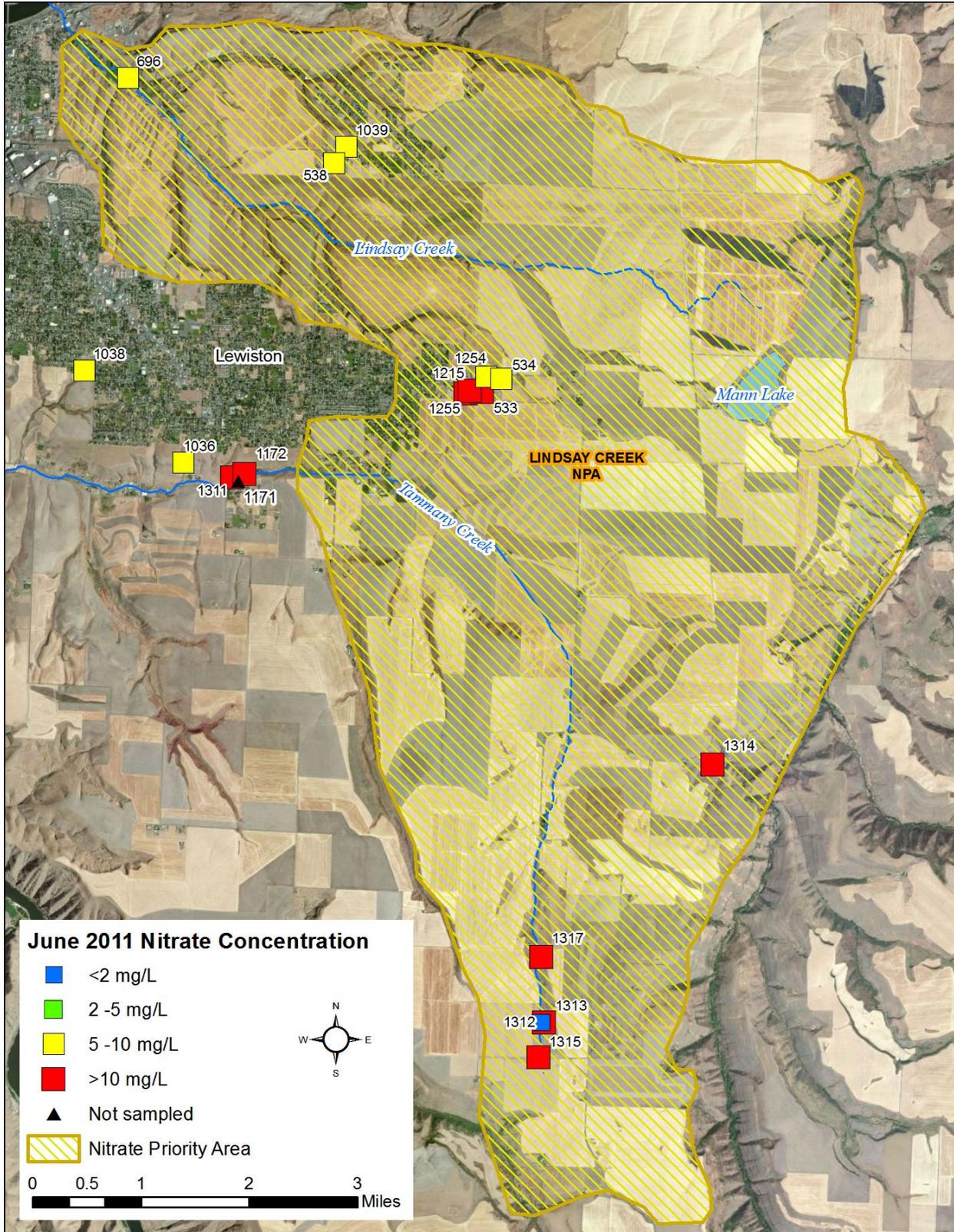


Figure 16. Well and spring locations, site identification numbers, and nitrate concentrations for June 2011 sampling of the Tammany and Lindsay Creeks Ground Water Monitoring project.

3.4.2.2 *Methods and Results*

DEQ sampled 12 wells and 6 springs quarterly for the Tammany and Lindsay Creeks project during March, June, September, and December 2011. Water-quality field parameters—temperature, specific conductivity, DO, and pH (June only)—were measured in the field prior to sample collection (Table 18). Samples were collected quarterly for nitrate (Table 19) and sent to Anatek Labs in Moscow, Idaho, for analysis. 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 and to monitor long-term regional changes. Anomalous nitrate concentrations will be addressed as isolated or localized situations and dropped from the ambient network, if needed.

Table 18. Water quality field parameters for Tammany and Lindsay Creeks Ground Water Monitoring project, 2011.

DEQ Site ID	Well Depth (feet)	March 2011			June 2011				September 2011			December 2011		
		Specific Cond. ^a (µS/cm)	Water Temp. ^a (°C)	DO ^a (mg/L)	Specific Cond. ^a (µS/cm)	Water Temp. ^a (°C)	DO ^a (mg/L)	pH	Specific Cond. ^a (µS/cm)	Water Temp. ^a (°C)	DO ^a (mg/L)	Specific Cond. ^a (µS/cm)	Water Temp. ^a (°C)	DO ^a (mg/L)
533	225	756.11	10.9	9.73	787	15.2	8.91	8.28	731	15.4	10.56	807	10.2	10.08
534	205	NS	NS	NS	700	13.8	9.06	<i>8.71</i>	724	13.9	8.79	728	12.6	10.26
538	228	891.72	10.8	5.71	783	14.4	10.06	8.49	777	15.1	9.6	1752	13	8.06
696	295	963.12	11.2	4.53	1140	12.4	6.38	8	1056	14.3	3.79	NS	NS	NS
1036	134	773.38	11.7	8.42	828	16.6	8.96	8.21	829	17.1	8.31	897	10.9	8.71
1038	150	1149.4	11.5	9.97	1420	13.7	9.44	<i>8.51</i>	1255	13.2	9.74	1347	11.9	10.06
1039	235	919.2	11.9	9.38	826	15.3	9.2	8.27	878	15.8	8.52	1181	11.9	9.85
1171	Spring	NS	NS	NS	NS	NS	NS	NS	NS	NS	NS	1220	5	12.55
1172	Spring	NS	NS	NS	1210	19.1	9.02	<i>8.89</i>	1221	16.9	8.89	NS	NS	NS
1215	205	732.55	7.4	6.47	807	14.7	8.17	8.09	226	18.8	7.76	835	8.6	6.8
1254	197	926.6	14.4	6.84	933	16.2	6.35	8.07	792	17.5	5.74	972	12.8	10.14
1255	200	NS	NS	NS	844	14.8	9.28	8.1	894	15.1	8.33	906	13.7	8.95
1311	Spring	NS	NS	NS	1140	16.5	9.01	7.85	1302	19.2	6.58	1268	7.3	11.06
1312	1025	184.71	13.4	7.85	197	18	8.18	<i>8.7</i>	202.4	19.5	7.37	195.5	10.5	8.47
1313	Spring	NS	NS	NS	624	14.2	8.04	7.54	617	16.4	7.32	603	6.9	10.6
1314	Spring	NS	NS	NS	572	14	7.85	6.97	576	18.4	8.2	570	5.9	10.63
1315	476	495.14	6	10.01	570	13.7	10.32	8.22	600	11.7	10.34	612	5.3	11.1
1317	Spring	NS	NS	NS	593	12.2	10.72	7.98	590	12.1	9.23	597	11.2	10.45

Notes: Italicized red numbers indicate EPA's secondary drinking water regulation for pH was exceeded; Spec. Cond. = specific conductivity; µS/cm= microsiemens per centimeter; Temp. = temperature; °C = degrees Celsius; DO = dissolved oxygen; mg/L = milligrams per liter; NS = not sampled.

^a No primary or secondary health standard available.

Table 19. Nitrate results for Tammany and Lindsay Creeks Ground Water Monitoring project, 2011.

DEQ Site ID	Well Depth (feet)	Nitrate concentration (milligrams per liter)			
		March 2011	June 2011	September 2011	December 2011
533	225	13.1	11.9	10.3	13.6
534	205	NS	9.30	9.69	9.89
538	228	5.01	6.75	6.32	10.8
696	295	6.72	9.06	6.73	NS
1036	134	7.74	9.57	7.93	9.16
1038	150	6.54	8.37	8.19	7.93
1039	235	6.65	6.84	7.02	8.27
1171	Spring	8.94	NS	NS	11.8
1172	Spring	NS	11.4	12.7	NS
1215	205	10.8	11.8	NS ^a	11.5
1254	197	17.9	9.40	9.08	15.3
1255	200	NS	14.5	14.9	15.4
1311	Spring	NS	12.4	9.34	10.3
1312	1025	0.35	0.35	0.34	0.40
1313	Spring	8.36	10.7	12.7	15.7
1314	Spring	NS	15.7	19.0	19.0
1315	476	15.2	17.7	19.1	16.4
1317	Spring	10.8	19.6	16.6	15.5

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

^a Well was not operational at the time of sampling.

Nitrate Results

Nitrate results from the 2011 quarterly sampling are presented in Table 19. The highest nitrate concentration was observed at site 1317 (19.60 mg/L) during the June 2011 sampling event, and 12 of the 18 sample sites in the Tammany/Lindsay Creek project area had nitrate concentrations exceeding the MCL of 10 mg/L during at least one quarter.

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

Stable Isotope Results

Deuterium ($\delta^2\text{H}$), nitrogen ($\delta^{15}\text{N}$), and oxygen ($\delta^{18}\text{O}$) isotope samples were collected in April 2011 from 15 of the sites to assist in analyzing water quality characteristics and determining a suitable long-term monitoring well network for nitrate concentrations. The samples were sent to the University of Idaho in Moscow, Idaho, for analysis. The resulting data are shown in Table 20.

Nitrogen isotope ratios can be helpful in determining sources of nitrate in ground water. Nitrogen from human or animal waste and fertilizer sources has distinguishable $\delta^{15}\text{N}$ signatures (refer to Table 6, page 11, for typical $\delta^{15}\text{N}$ values for various nitrogen sources). Out of the 15 sites analyzed, 1 spring (site 1317) had a $\delta^{15}\text{N}$ value that indicated a fertilizer source of nitrogen. This spring is located at the southern portion of the project area near Tammany Creek (Figure 16). Results indicated a waste source of nitrogen in 1 well (site 696). This well is located in the northwest portion of the project area (Figure 16). Five sites had $\delta^{15}\text{N}$ values in between an organic nitrogen in the soil source and a waste source (sites 1036, 1038, 1172, 1311, and 1314). The remaining 8 sites had $\delta^{15}\text{N}$ values that suggested a mixed source of nitrogen and are located throughout the project area.

Nitrogen isotopes can be used in conjunction with other water quality data and land use information to better determine sources of nitrogen in ground water. However, nitrogen isotope values in ground water can be complicated by several reactions (e.g., ammonia volatilization, nitrification, denitrification, and plant uptake) (Kendall and McDonnell 1998). Mixing of sources with variable nitrogen isotope values along shallow flowpaths makes determining the sources and extent of denitrification very difficult for intermediate $\delta^{15}\text{N}$ values (Kendall and McDonnell 1998). The land use in the project area is predominately agricultural, with some residential areas around Lewiston. This type of land use would likely result in a mixture of nitrogen sources in the ground water, as indicated by the $\delta^{15}\text{N}$ values detected.

Table 20. Isotopic data collected in April 2011 from sites within the Tammany and Lindsay Creeks Ground Water Monitoring project.

DEQ Site ID	Sample Date	Well Depth (feet)	Values in per mil (‰)		
			Deuterium ($\delta^2\text{H}$)	Nitrogen ($\delta^{15}\text{N}$)	Oxygen ($\delta^{18}\text{O}$)
533	04/14/2011	225	-112.55	6.84	-14.11
538	04/14/2011	228	-112.23	7.26	-14.07
696	04/14/2011	295	-108.12	12.33	-13.8
1036	04/14/2011	134	-105.79	8.79	-12.89
1038	04/14/2011	150	-104.83	9.45	-13.55
1039	04/14/2011	235	-117.11	6.94	-14.68
1172	04/14/2011	Spring	-107.06	8.45	-13.26
1215	04/15/2011	205	-115.32	5.87	-15.45
1254	04/15/2011	197	-114.2	6.6	-14.45
1255	04/15/2011	200	-115.56	7.51	-14.8
1311	04/14/2011	Spring	-109.62	9.21	-13.53
1312	04/14/2011	1,025	-112.98	6.05	-14.83
1314	04/14/2011	Spring	-109.11	8.1	-13.88
1315	04/14/2011	476	-112.09	5.86	-14.23
1317	04/14/2011	Spring	-105.95	1.68	-13.62

Note: There is no primary or secondary health standard available for nitrogen, oxygen, or deuterium isotopes.

Phosphorus Results

Samples collected in December 2011 (Table 21) were also analyzed for total phosphorus to determine if total phosphorus could be used to augment current efforts in monitoring regional ground water quality. The samples were sent to Anatek Labs for analysis. The phosphorus values ranged from 0.0109 mg/L (site 1311) to 0.106 mg/L (site 1314).

Table 21. Total phosphorus concentrations in selected sites within the Tammany and Lindsay Creeks Ground Water Monitoring project, December 2011.

DEQ Site ID	Sample Date	Well Depth (feet)	Phosphorus (milligrams per liter)
533	12/20/2011	225	0.049
534	12/20/2011	205	0.0294
538	12/12/2011	228	0.05389
1036	12/12/2011	134	0.0299
1038	12/14/2011	150	0.0817
1039	12/12/2011	235	0.0796
1171	12/12/2011	Spring	0.0203
1215	12/20/2011	205	0.0176
1254	12/20/2011	197	0.0364
1255	12/20/2011	200	0.0244
1311	12/12/2011	Spring	0.0109
1312	12/12/2011	1025	0.0286
1313	12/12/2011	Spring	0.0215
1314	12/12/2011	Spring	0.106
1315	12/12/2011	476	0.0463
1317	12/12/2011	Spring	0.0678

Note: There is no primary or secondary health standard available for phosphorous.

3.4.2.3 Conclusions

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

Nitrogen isotope results indicated that the source of nitrogen to one spring was a fertilizer source, while three sites indicated a waste source of nitrogen and the remaining sites a mixed source. This finding is typical in areas with mixed land use.

3.4.2.4 Recommendations

Continued monitoring of available wells and springs is recommended to establish an ambient ground water quality network to track multiple year seasonal trends, specifically for nitrate, in the project area. Continued investigation of total phosphorus concentration in the region's ground water is also recommended.

DEQ is drafting an NPA management plan with the assistance of the Lindsay and Tammany Creeks Watershed Advisory Group to address the ground water degradation. The management plan will be a component of the Lindsay Creek TMDL implementation plan.

3.5 Pocatello Region

3.5.1 Pocatello Regional Office Nitrate Follow-Up Sampling

3.5.1.1 Purpose

In 2011, the DEQ Pocatello Regional Office (PRO) participated in ten local health fairs and outreach events across the region (Table 22). Using test strips, DEQ offered free nitrate analyses for private well owners who provided water samples from their domestic wells to determine the approximate nitrate concentrations. Well owners with nitrate concentrations over the MCL of 10 mg/L were offered additional information and follow-up monitoring.

In addition, PRO distributed approximately 2,000 nitrate brochures containing a free nitrate test strip throughout the region at over thirty locations such as grocery stores, convenience stores, health district offices, and schools. These brochures allow private well owners to test their own drinking water. From this effort, PRO received many phone calls and requests for information about a positive nitrate result with the test strip. Well owners with nitrate concentrations over the MCL of 10 mg/L were offered additional information and follow-up monitoring.

Table 22. Health fairs and outreach events attended within the Pocatello Regional Office boundaries in 2011.

Event	Date
Aberdeen Middle School Health Fair	January 18, 2011
Bear Lake Memorial Hospital Senior Fair	April 7, 2011
Franklin Medical Center Health Fair	April 16, 2011
Oneida County Hospital Health Fair	April 21, 2011
Portneuf Valley Environmental Fair—Pocatello	April 23, 2011
Caribou Memorial Hospital Health Fair	April 28, 2011
Idaho State University Women and Children's Fair	May 13, 2011
Eastern Idaho State Fair	September 6–7, 2011
Lamb Weston Employee Health Fair	November 3, 2011
Rockland Elementary Health Fair	November 9, 2011

3.5.1.2 Methods and Results

Based on the nitrate test strip results at the health fairs and from residents who self-tested with the free nitrate test strip, PRO collected follow-up reconnaissance ground water samples from eight private wells in Bingham, Power, Caribou, and Bear Lake Counties for nitrate, total coliform, and *E. coli* bacteria (Figure 17). These samples were sent to Intermountain Analytical Services in Pocatello, Idaho, for analysis. Water quality field parameters—temperature, pH, and specific conductivity—were collected prior to the sampling.

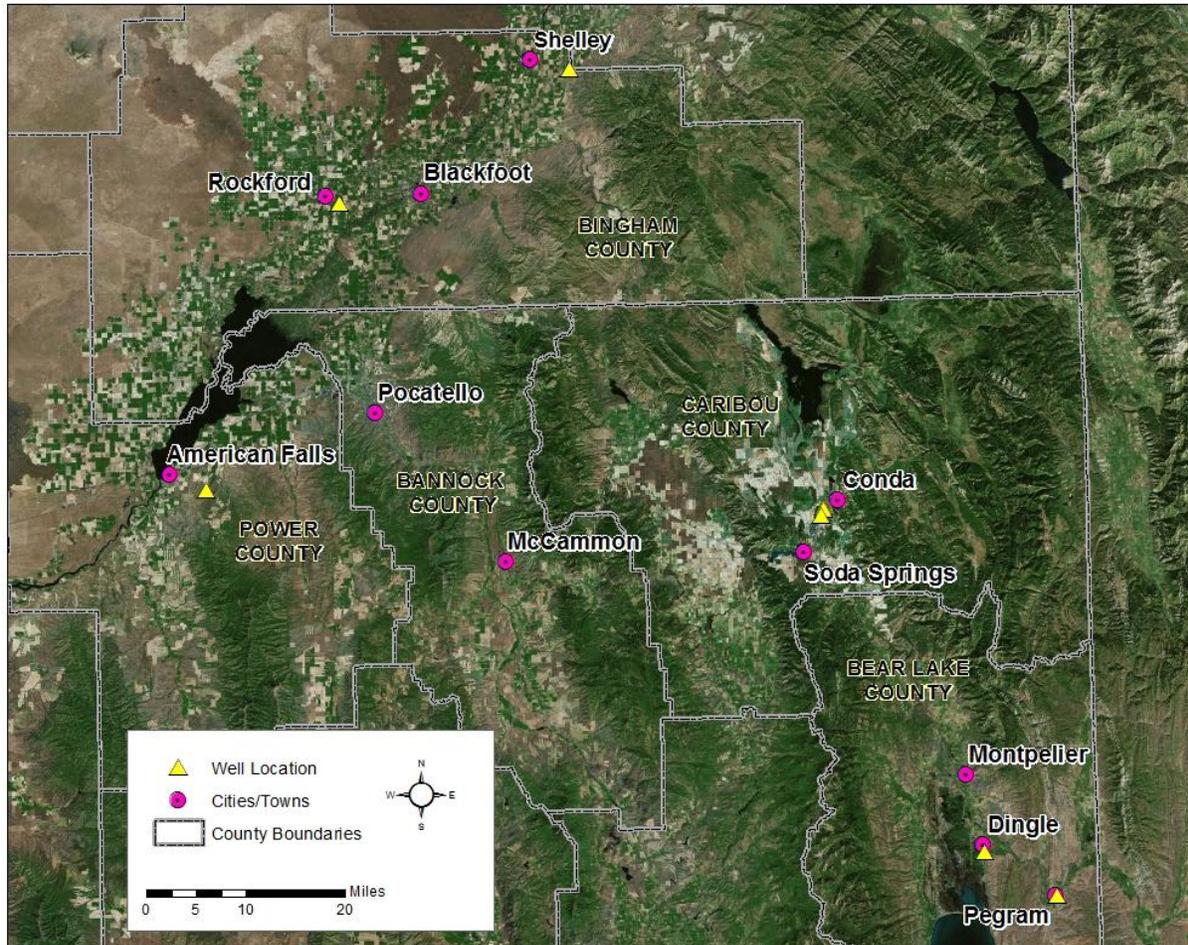


Figure 17. Location of wells sampled for the Pocatello Regional Office Nitrate Follow-Up sampling project.

Nitrate concentration results can be seen in Figure 18, Figure 19, and Table 23. The laboratory analysis confirmed that nitrate concentrations in two of eight wells were over the MCL of 10 mg/L. The nitrate concentrations ranged from <1 mg/L to 19.16 mg/L. Seven of the eight wells were analyzed for total coliform and *E. coli*. The results indicate that total coliform and *E. coli* were not present in samples from the seven wells (Table 23).

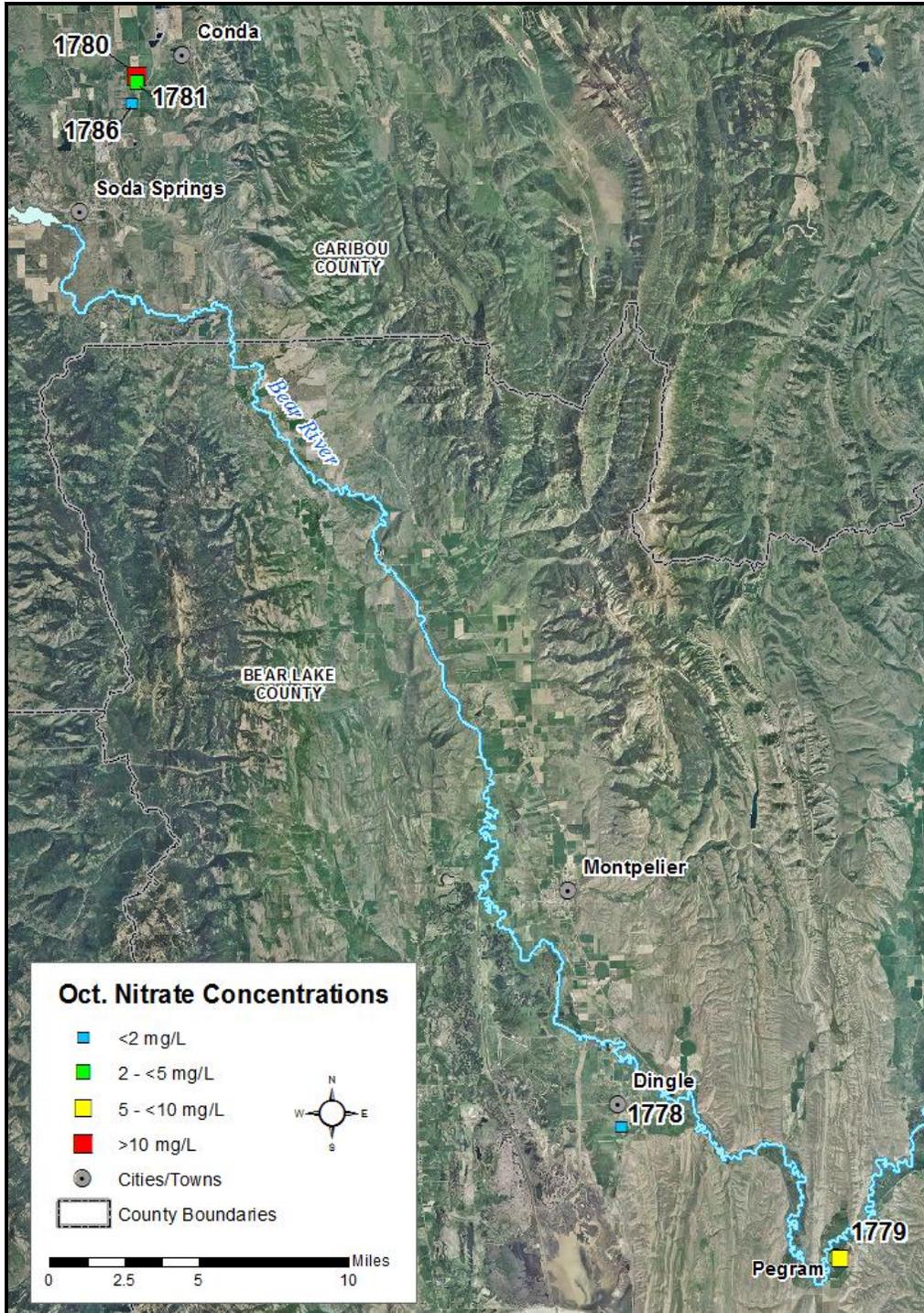


Figure 18. Well locations, DEQ site identification, and nitrate concentrations for October 2011 for the Pocatello Regional Office nitrate follow-up monitoring in Caribou and Bear Lake Counties.

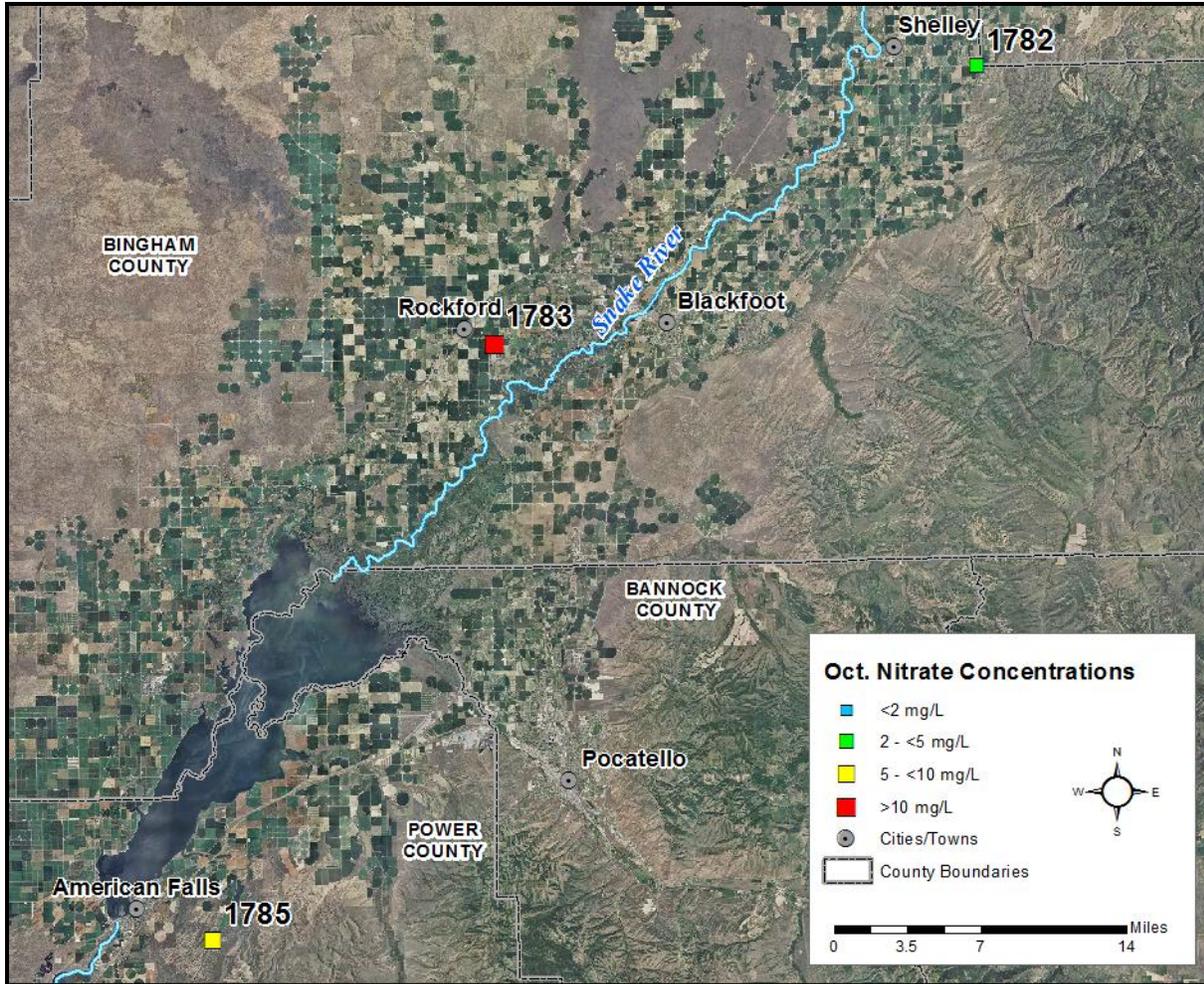


Figure 19. Well locations, DEQ site identification, and nitrate concentrations for October 2011 for the Pocatello Regional Office nitrate follow-up monitoring in Bingham and Power Counties.

Table 23. Summary of analytical and water quality field parameter results for Pocatello Regional Office Nitrate Follow-Up sampling project.

DEQ Site ID	Well Depth (feet)	Sample Date	Nitrate (mg/L)	Nitrite (mg/L)	Total Coliform ^a (#/100 mL)	<i>E. coli</i> (MPN/100 mL)	pH	Specific Conductivity ^a (µS/cm)	Water Temperature ^a (°C)
1778	Unknown	10/04/2011	<1	<0.1	absent	absent	7.06	699	11.7
1779	Unknown	10/04/2011	5.27	<0.1	absent	absent	7.07	1270	10.1
1780	Unknown	10/05/2011	10.94	<0.1	absent	absent	7.15	791	8.5
1781	Unknown	10/05/2011	3.56	NS	absent	absent	6.79	1120	9.3
1782	Unknown	10/06/2011	2.81	<0.1	absent	absent	7.02	687	12
1783	Unknown	10/06/2011	19.16	<0.1	absent	absent	7.11	1280	10.5
1785	Unknown	10/06/2011	6.16	<0.1	absent	absent	7.44	645	12.5
1786	Unknown	10/05/2011	1.13	<0.1	NS	NS	6.92	755	9.6

Notes: Bolded red numbers indicate EPA's maximum contaminant level was exceeded; #/100 mL = number of colonies per 100 milliliters; MPN/100 mL = most probable number per 100 milliliters; mg/L = milligrams per liter; NS = not sampled; µS/cm = microsiemens per centimeter; °C = degrees Celsius.

^a No primary or secondary health standard available.

3.5.1.3 Conclusions

The follow-up sampling confirmed the test strip results in two wells where nitrate concentrations exceeded the MCL. Only 2 of the 8 follow-up samples (25%) had nitrate values over 10 mg/L. The test strip results are not available for all wells. However, the apparent disagreement between test strip results and analytical results with follow-up sampling suggests additional controls regarding usage of test strips should be investigated to avoid unnecessary sampling.

3.5.1.4 Recommendations

Further investigation in the areas surrounding the wells, including nitrate and $\delta^{15}\text{N}$ analyses, will be helpful in determining the source and extent of nitrate contamination in the two wells that exceeded the MCL.

Laboratory results showing low concentrations of nitrate from wells with nitrate test strip values over 10 mg/L indicate that controls need to be put into place when interpreting the test strip results.

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

3.6 Twin Falls Region

No ground water quality projects were conducted using public funds in the Twin Falls region in 2011.

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