Water Quality Monitoring of Springs Used for Fish Production at the Hagerman National Fish Hatchery; Relating Nitrate Levels to Specific Conductance

By the

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Abstract

The springs supplying the Hagerman National Fish Hatchery (Hatchery) originate from the Eastern Snake River Plain Aquifer. Discharge from the Aquifer into the Thousand Springs area has declined considerably since the mid-1900's. Recently, Aquifer recharge efforts have increased emphasis on supplying water to irrigation canals and infiltration ponds outside the irrigation season. Concurrently, changes in agricultural production to nitrogen intense crops have increased the risk of Aquifer contamination. Annual nitrate data collected from 1994-2007 suggest that Hatchery nitrate levels are very close to the chronic exposure limit of 1.0 mg/l suggested for safe fish culture. The Hatchery monitored nitrate and specific conductivity levels of six springs used for fish production during 2008. Nitrate concentrations were correlated with specific conductance so that future nitrate monitoring could be accomplished by measuring specific conductivity. After one year of monthly monitoring, the springs had a mean nitrate level of 0.84 mg/l and mean specific conductivity of 320 µS/cm. There was no significant difference in nitrate concentrations between springs. We found no significant correlation between nitrate values and specific conductivity because of the small range of nitrate values (0.32 mg/l). Due to the water quality characteristics of the Aquifer, a specific conductivity reading of 450 µS/cm or greater would be cause for additional testing of nitrate levels.

Introduction

The water supply for the Hagerman National Fish Hatchery (Hatchery) originates from 17 springs and seeps from the Eastern Snake River Plain Aquifer (Aquifer). The Aquifer consists of Quartnery Age basalt flows up to 5,000 feet thick, with most ground water flow occurring from the upper 300 – 500 feet (IDWR 1999). The Aquifer flows from Yellowstone Hotspot in a west/southwest direction to the Thousand Springs area of the Snake River between Bliss and Box Canyon (Appendix 1). During the latter part of the last century, increased groundwater withdrawals, irrigation efficiencies, and drought have diminished the volume of water stored in the Aquifer and associated spring flows throughout the Thousand Springs Reach. As a result, Aquifer recharge projects have increased. These recharge projects and increased Confined Animal Feeding Operations (CAFO's) in the close vicinity of the Hatchery have increased the potential of Nitrate contamination.

Concurrent to the increase of recharge projects and CAFO's, land use in the Hagerman area has changed from desert sagebrush to irrigated agricultural lands. Application rates of inorganic and animal manure fertilizer in southern Idaho are among the highest in the nation (Entry and Farmer 2001). Previous studies have shown intensive fertilization has led to increased nitrogen and phosphorus concentrations in surface and ground water, changed riparian and aquatic ecosystems, and degraded drinking water.

Eastern Snake River Plain Aquifer

The Snake River has been diverted onto the Eastern Snake River Plain for irrigation since the late 1800's (Johnson et al. 1999). Incidental Aquifer recharge occurred through canal seepage and application of excess water. Aquifer recharge was more than 4 million acre-feet per year in the early 1900's. Incidental recharge rates doubled the natural recharge and increased flows of spring discharges. Between the years 1915 and 1955, the volume of water stored in the Aquifer increased by 15 million acre-feet with an average of 340,000 acre-feet added to the Aquifer annually. This created a dependence of water users on the incidental recharge. Incidental recharge from irrigation diminished as flood irrigation was converted to sprinkler irrigation. In addition, increased groundwater withdrawals have decreased Aquifer recharge. Between the years 1975 and 1995, the average rate of decline in groundwater storage was 350,000 acre-feet/year.

The Idaho Department of Water Resources (IDWR) reported that the Aquifer discharge in the Thousand Springs reach prior to 1912 was less than 4,300 cfs (Idaho Department of Water Resources 1999). Between 1912 and 1950 the Aquifer discharge gradually increased to 6,800 cfs. Since then, the Aquifer has irregularly declined to the current discharge rate of 5,200 cfs into the Snake River (Baldwin et al. 2006).

The Aquifer is divided into two water quality groups based on data collected by Clark and Ott (1996) and the USGS. Water quality is correlated to the discharge location on the Snake River. Upstream springs (those above river km 960) have higher loads of dissolved solids, dissolved nitrogen, total nitrogen, and tritium concentrations compared to downstream springs. The

Hatchery is located in the downstream spring section at River km 938. The following table compares mean values for nutrients and dissolved solids of upstream and downstream springs from Clark and Ott (1996):

	Upstream	Downstream
Dissolved Solids (mg/L)	410	236
Dissolved Nitrates (mg/L)	2.4	0.9
N as Total Nitrogen (mg/L)	2.6	1.0
Tritium (pCi/L)	60	13

The groundwater quality of upstream springs is dependent on the source of water for the springs, direction of groundwater flow, and spatial variations in land and water use of the north side of the Snake River. The upstream springs consist mostly of water from local surface-water recharge in agricultural areas east of the springs. The downstream springs contain some recharge water, but consist mostly of water from the older portions of the aquifer that are recharged from snowmelt and intermontane basin stream charge.

The Aquifer can be further categorized into a regional aquifer and local aquifer based on water chemistry and hydrology, illustrated in Appendix 2 (Baldwin et al. 2006). The local aquifer tends to have higher specific conductance, higher nitrate levels, and shorter ground water flow paths which reduce the dilution of contaminants, compared to the regional aquifer. The local aquifer has a mean specific conductance of 715 µS/cm and a mean nitrate level of 4.27 mg/L, compared to a mean specific conductance of 417 µS/cm and a mean nitrate level of 1.29 mg/L in the regional aquifer. Water in the regional aquifer originates from high elevations or cooler climates, while local aquifer water is mixed with recharge water from a surface source (Baldwin et al. 2006).

Aquifer Recharge

The Aquifer is mostly recharged from irrigation (60%), followed by tributary basin underflows (18%), precipitation (9%), Snake River losses (8%), and tributary and stream losses (5%) (IDWR 1999). The large irrigation influence increased discharge from the Aquifer during the first half of the 1900’s. As irrigation efficacies increased in the second half of the 1900’s, ESRPA recharge decreased.

Artificial recharge of the ESRPA evolved in three stages (Johnson et al. 1999):

Stage 1: incidental recharge from irrigation
Stage 2: intentional recharge using mostly existing facilities
Stage 3: managed recharge using sites designed to meet certain objectives

Stage 1 recharge was largely uncontrolled and occurred form the late 1800’s to about 1985 due to extensive surface water irrigation. Annual incidental recharge has decreased by 580,000 acre-feet since 1970 as groundwater pumping has increased, creating a net annual depletion of 1.8 million acre-feet in 1999.

Stage 2 recharge occurred from 1985 until 1999 through irrigation canals to natural and man-made depressions during high-water times. These sites were chosen by convenience without consideration of where, when, and to what degree of benefits would occur. The recharge potential of the canal system was limited to fewer than 350,000 acre-feet but averaged 40,000 acre-feet depending on the interpretation of hydropower water rights. The state of Idaho provided irrigation companies with a $0.25 per acre-foot compensation for conveyance since 1996. These irrigation companies conveyed an average of 193,000 acre-feet through 1995-1997.

Stage 3 recharge started in 1999 and continues today to relieve water shortages at specific locations and times of year or manage long-term carryover of water from high-water years. Numerical and analytical models have demonstrated that managed recharge within a few miles of the Snake River may provide additional spring discharge during months when water shortages are most acute. However, more distant recharge sites will not increase discharge for decades and the effects will vary among the river reaches. Strategically locating recharge sites is essential to control the impacted spring locations and the carryover in Aquifer storage. Groundwater quality is not expected to be impacted significantly since the managed recharge is similar to existing natural and incidental recharge.

In the late 1990's, the IDWR (1999) compiled a report on the feasibility of a managed recharge of the Aquifer. The recharge would divert excess flow from the Snake River and tributaries to infiltration sites on the Aquifer. Water would be diverted by existing irrigation canals to depressions in the landscape that allow for ponding and infiltration of the water. This would increase ground water levels, and in turn, increase discharge to the Snake River, principally at spring discharge locations in the Thousand Springs and American Falls areas. The majority of the recharge (76-85%) could occur in December, January, and February, followed by 14-23% during May, June, October, and November, and followed by less than 1% during July, August, and September (IDWR 1999).

The effect of artificial recharge on groundwater quality and aquifer storage recovery has been studied in other agricultural regions. Ma and Spalding (1997) examined the agricultural region of the Central Platte in Nebraska. Groundwater levels rose rapidly in response to the recharge, but leveled off as infiltration rates declined. Nitrate concentrations dropped from 20 to 2 mg/l beneath the down gradient of the recharge basins because of nitrate remediation.

Land Use Changes

ESRP land use changed drastically over the past 2 decades (Baldwin et al. 2006). In Gooding County, corn and cattle production increased as potato production decreased. Alfalfa production has remained constant. Corn as a fraction of total acreage increased from 17% in 1981 to 37% in 2005. Milk cows increased from 20,000 in 1986 to 139,000 in January 2006, mostly south of the I-84 corridor. Fertilizer accounted for 46.6% of the nitrogen loading applied to Gooding County, followed by cattle at 42.1%, legume crop plow down at 7.8%, and precipitation at 1.3 %. More than 92 million pounds of nitrogen was applied to Gooding, Lincoln, Minidoka, and Jerome Counties in 2005.

Agricultural Nitrate Contamination of Aquifers

ESRP land uses changes and recharge attempts have increased nitrate contamination risks. Nitrate is a negatively charged ion and moves easily through water. Nitrates enter water from the decomposition of soil organic matter, commercial fertilizer, animal waste, septic and municipal waste water effluent, industrial sources, and precipitation (Baldwin et al. 2006).

Miller 1971, Lorimor et al. 1972, and Boyer and Pasquarell 1996 examined the effect of cattle feedlots on nitrate concentrations in groundwater. Nitrate contamination was generally a geographically localized problem rather than a regional aquifer problem. However, dairy feed lots could be responsible for 70% of the annual nitrate load where there was a direct connection between surface water and groundwater. Irrigation pumping did not significantly change groundwater nitrate levels beneath feedlots.

The Hatchery monitored influent nitrate concentration annually between October and December. Nitrate concentrations ranged from 0.7 – 0.9 ppm (Figure 1). The Hatchery also monitored influent phosphorus as part of the National Pollution Discharge Elimination System. Phosphorus concentrations ranged from 0.12 to 0.16 and varied seasonally (Figure 2). Phosphorus concentrations were higher in July and August.

Nitrates and Fish Culture

Piper et al. (1982) recommended nitrate concentrations between 0 – 3 ppm for trout production. Nitrate exposure causes nonspecific osmoregulatory system failure and problems with embryo development. A maximum chronic exposure level of less than 1.0 ppm is recommended (Wedemeyer 1996). The Hatchery annual mean nitrate concentration was 0.8 ppm from 1994 – 2007 in the mixing chamber (Figure 1).

Objective

As a result of the characteristics of the Aquifer, along with the changing land uses in Gooding County and Aquifer recharge efforts, the Hatchery is concerned with potential nitrate contamination. The previous nitrate monitoring effort was limited to annual grab samples in winter months sent to an accredited laboratory. The Hatchery hypothesized that nitrate levels could vary seasonally as observed during phosphorus monitoring. The objective of this project was to establish a baseline of monthly nitrate levels to examine seasonal variation. Nitrate concentrations were regressed against specific conductivity as done in Baldwin et al. (2006). The specific conductivity regression could provide a more cost effective and efficient method to estimate nitrate concentrations.

Methods

The Hatchery monitored water quality in six springs: Bickle, Riley, Len Lewis, 17, 15, and 13.

Spring Site	Type	Elevation (ft)
Bickle	Open	2,974
Riley	Open	2,972
Spring 17	Covered	3,000
Spring 13	Covered	3,037
Len Lewis	Open	3,028
Spring 15	Open	3,025

Covered springs had steel sheeting coverings over the collection boxes. Open springs were not covered. Spring flows were calculated with various water measurement devices according to Hatchery Standard Operating Procedures.

Specific conductivity, total dissolved solids, and pH was measured monthly with a Hanna Instruments HI 9812 portable meter (accuracy of ± 2% for conductivity and total dissolved solids; resolution of 10 ppm for TDS and 10 µS/cm for conductivity; pH accuracy and resolution of ± 0.1 standard units). The probe was cleaned and calibrated before each monthly sampling period. Water samples were sent to Magic Valley Labs to test nitrate levels using the EPA 300 method from January through August 2008. Water samples were sent to Rangen Aquaculture Research Center to test nitrate levels using EPA 353.3 method from September through December 2008. Water was collected in 1-L bottles and chilled to 4^0C until it reached the lab.

Sampling was conducted monthly during 2008. A regression analysis was performed with specific conductivity on the X axis as the independent variable and nitrate concentration on the Y axis as the dependent variable as shown in the example in Appendix 3. An ANOVA test was performed on the regression analysis to determine if a significant dependence of nitrate concentrations on specific conductivity values existed. Mean nitrate levels among the springs were compared by ANOVA to determine significant differences ($p < 0.05$). Nitrate concentration variations were also compared to season and spring flows.

Results

The first water sample was taken January 14, followed by monthly sampling through December 12. Mean nitrate levels were 0.84 ± 0.07 mg/L with a range of 0.66 to 0.98 mg/L. Mean specific conductivity levels were 321 ± 19 µS/cm with a range of 280 to 370 µS/cm. The regression analysis is illustrated in Figure 3.

The regression analysis of nitrate and specific conductivity had a R^2 value of 0.0621; therefore, 93.79% of the variation was not explained by the regression. The ANOVA test found nitrate concentrations were not dependent on specific conductivity ($F = 4.635$ and $F_{significant} = 0.0348$).

There was no significant difference ($p = 0.237$) in mean nitrate levels among springs. However, mean levels did vary slightly throughout the year as illustrated in Figure 4 and Figure 5.

Mean nitrate levels increased as flow increased. The R^2 value for this test was 0.4796; therefore 52.04% of the variation was not explained by the regression (Figure 6).

Mean nitrate levels were highest from September through February ranging from 0.85 to 0.92 mg/L. Mean nitrate concentrations ranged from 0.75 to 0.81 mg/L from March through August. Total flow for the springs measured averaged 54.4 cfs from March through August compared to 57.2 cfs through the rest of the year.

Discussion

Mean nitrate and specific conductance levels observed at the Hatchery were consistent with those measured by Clark and Ott (1996) and Baldwin et al. (2006) for the reach of Snake River that the Hatchery is located. The nitrate and specific conductance levels indicate the Hatchery water originates from the regional portion of the ESRPA. Since this portion of the aquifer is recharged from higher elevations in cooler climates, it is less likely to be influenced by surface water recharge efforts.

There was no significant difference of mean nitrate values between spring locations. Although the springs are located at varying elevations, the seeps and fissures that feed those springs probably originated from the same pool in the aquifer.

Mean nitrate levels were highest in the winter when total flow was highest, and decreased throughout the spring and summer as total flow decreased. It appears that as flow from the springs increase, so do mean nitrate concentrations.

Future nitrate monitoring willl occur at the head box of the steelhead raceways since there was no significant difference in nitrate levels among springs.

Specific conductance was not significantly correlated with nitrate levels as suggested by Baldwin (personal communication 2007). The lack of correlation was influenced by the limited nitrate concentration range (0.7 and 1.0 ppm). However the nitrate concentrations did fit into the regression of Clark and Ott (1996) data (Appendix 3). In the future, specific conductance may be monitored to track changes in nitrates. Specific conductance values above 450 µS/cm may be cause for additional nitrate testing.

Although the Hatchery appears to be largely influenced by the regional portion of the ESRPA, changes in land use practices and recharge efforts may still influence the Hatchery's water supply. The Hatchery's average nitrate concentration of 0.8 ppm is very close to the recommended concentration limit of 1.0 ppm for chronic exposure recommended by Wedemeyer (1996). In the near future, the Hatchery will continue monthly nitrate sampling to establish a longer baseline. If conditions in the aquifer and land use stabilize, the Hatchery may utilize specific conductivity as a more economical and efficient surrogate to nitrate monitoring.

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Figures

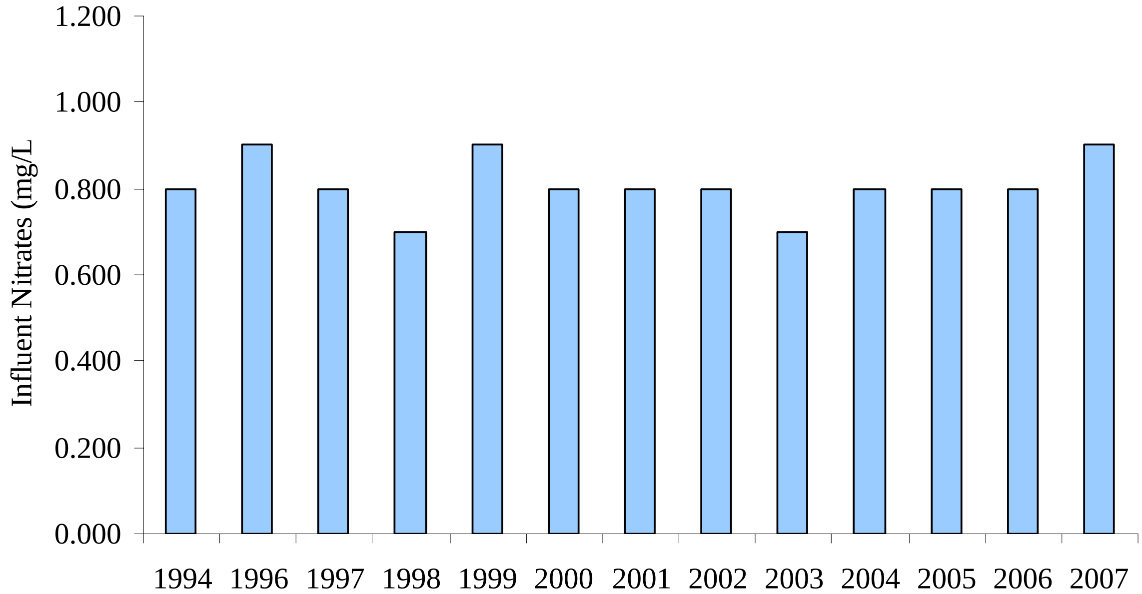


Figure 1. Annual Influent Nitrate Concentrations at the Hagerman National Fish Hatchery, 1994, 1996-2007.

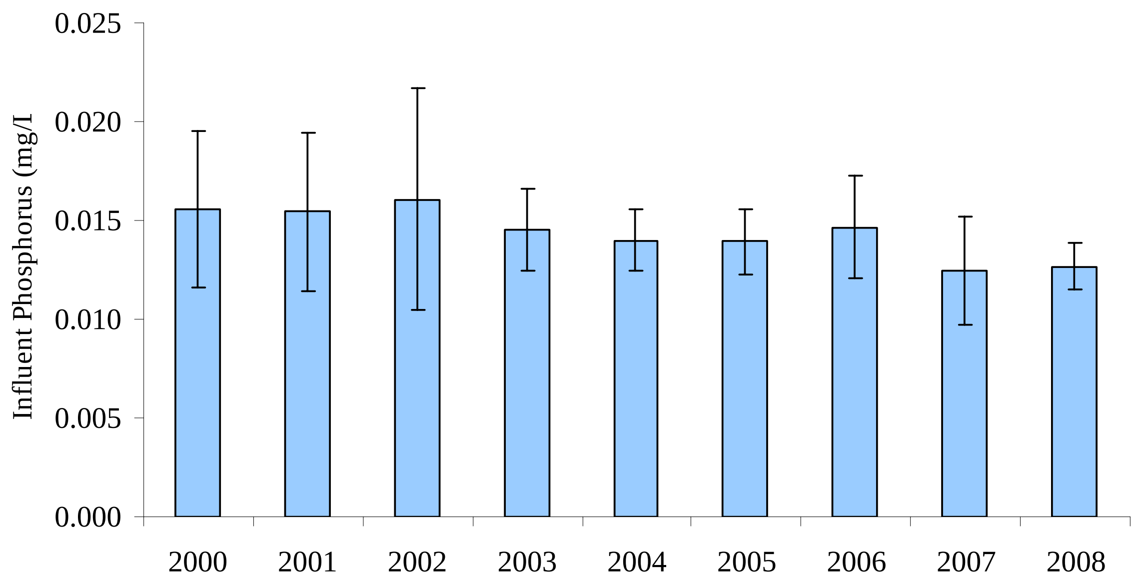


Figure 2. Mean Monthly Influent Phosphorus Concentrations from 2000-2008 at the Hagerman National Fish Hatchery.

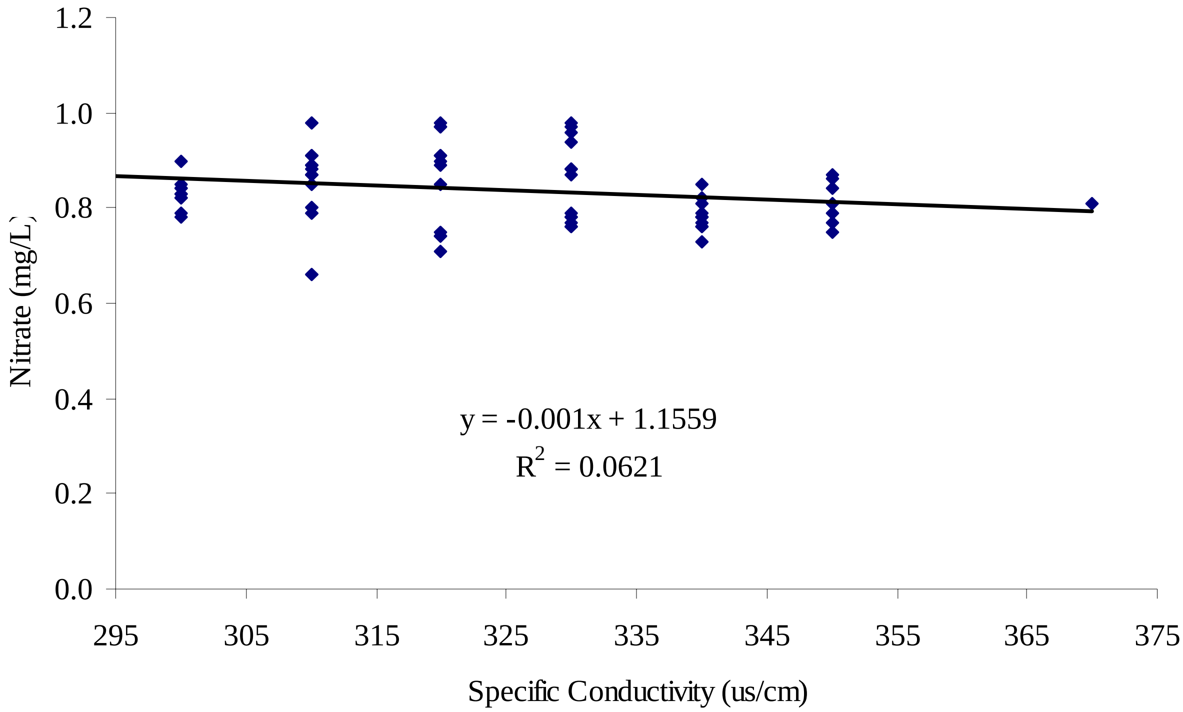


Figure 3. Specific Conductivity vs Nitrate Levels for Springs at the Hagerman National Fish Hatchery 2008.

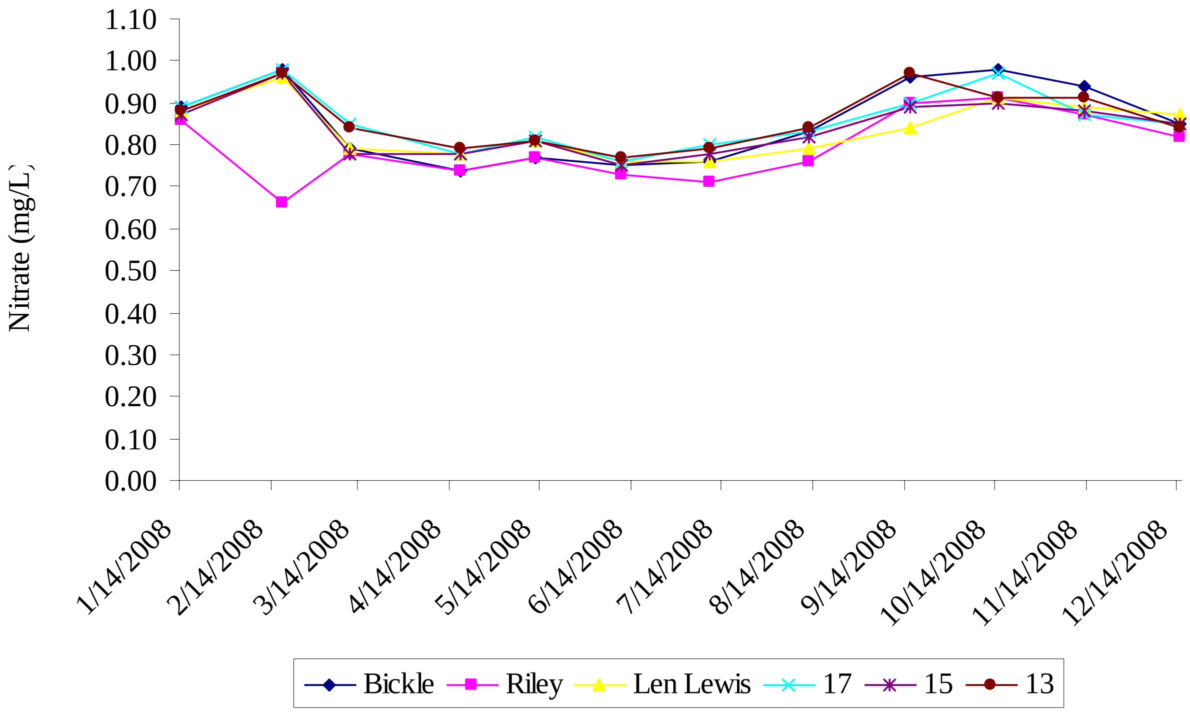


Figure 4. Monthly Nitrate Levels of Springs at the Hagerman National Fish Hatchery, 2008.

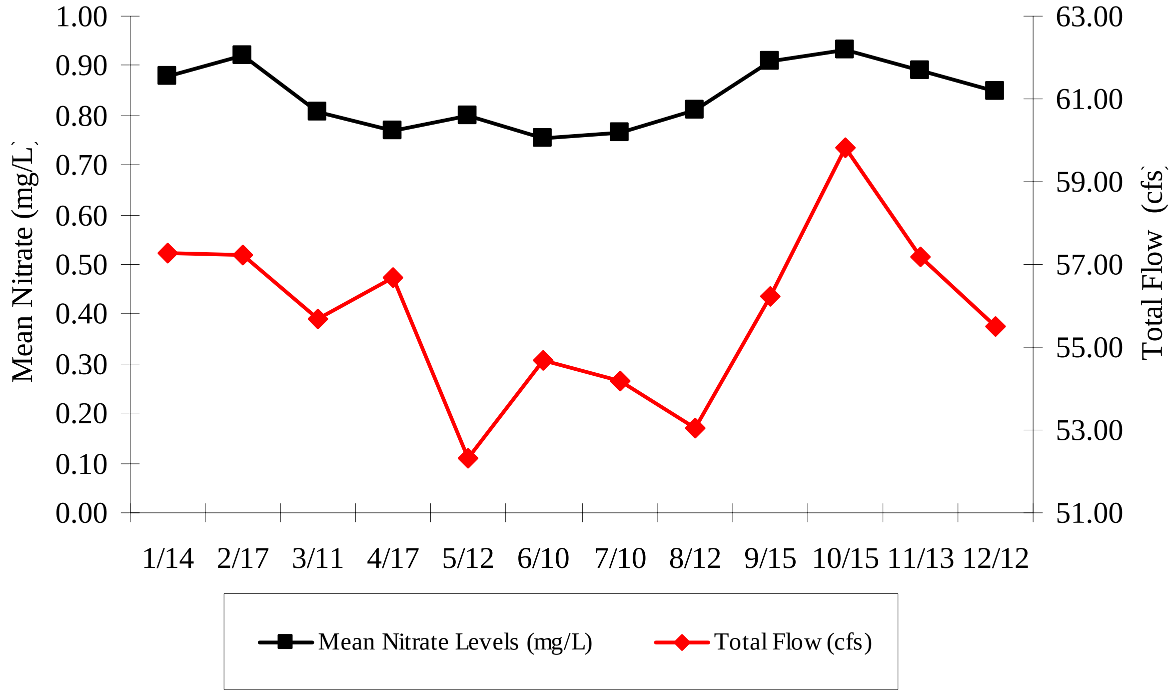


Figure 5. Mean Nitrate and Total Flow in Bickle, Riley, Len Lewis, 15, 17, and 13 Springs at the Hagerman National Fish Hatchery, 2008.

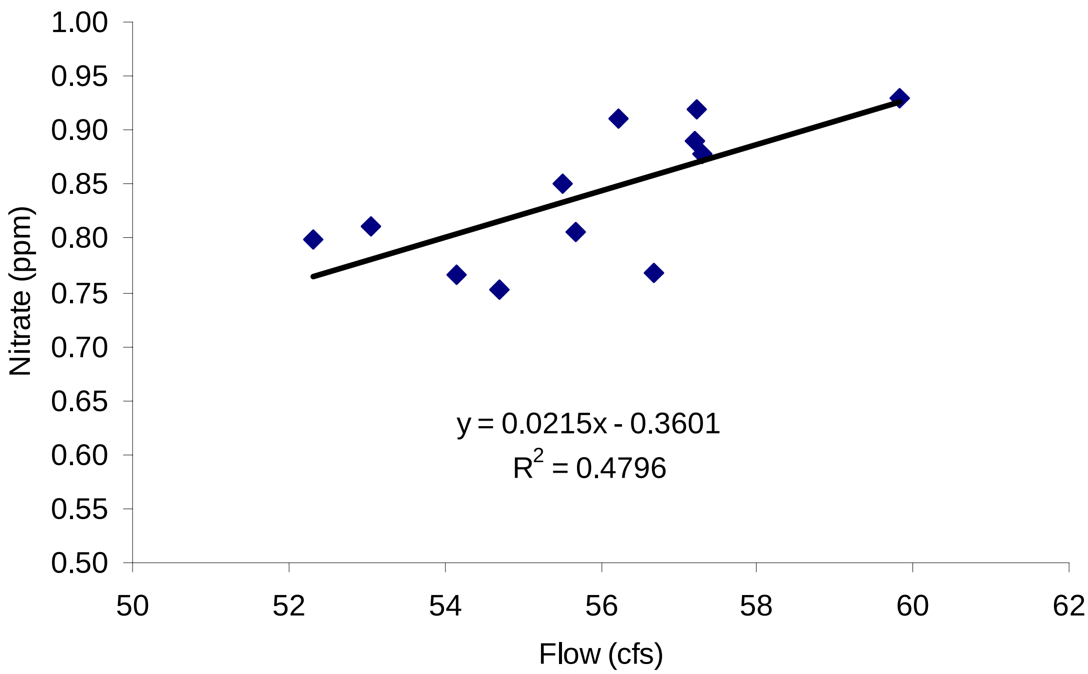
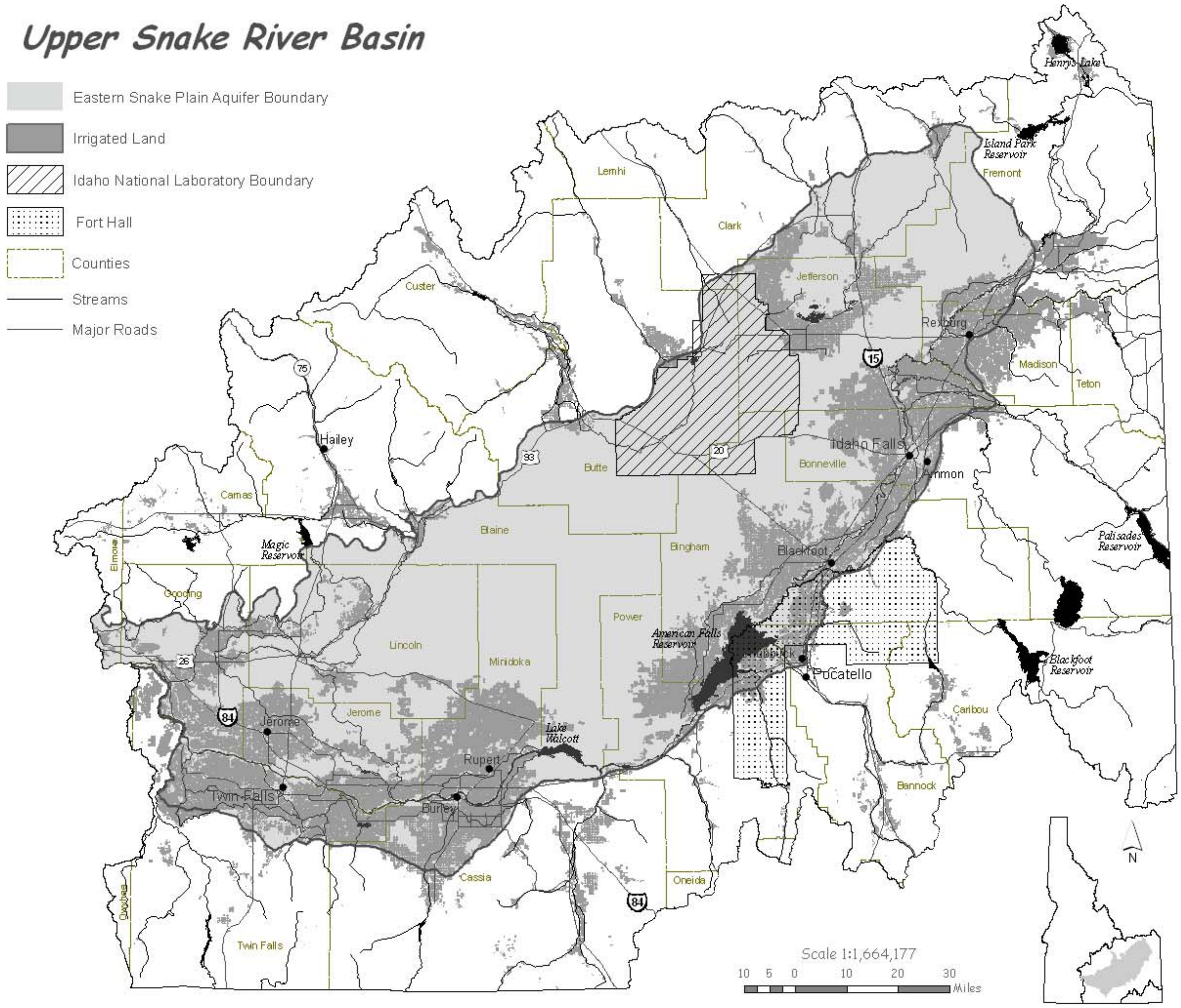


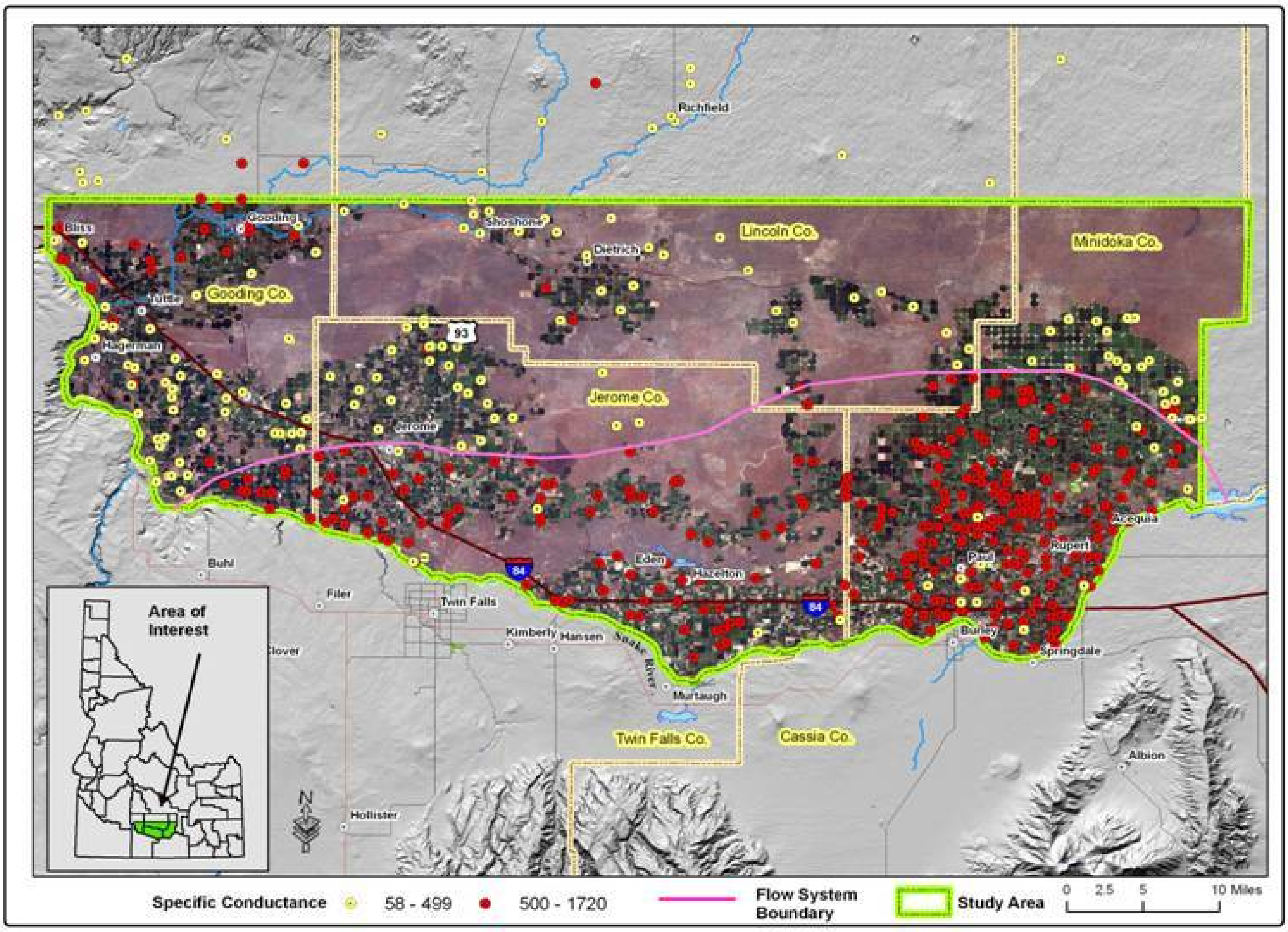
Figure 6. Mean Nitrate Levels vs Flow for Springs Bickle, Riley, Len Lewis, 15, 17, and 13 at the Hagerman National Fish Hatchery, 2008.

Appendix 1. The Eastern Snake River Plain Aquifer boundary, southeast Idaho.



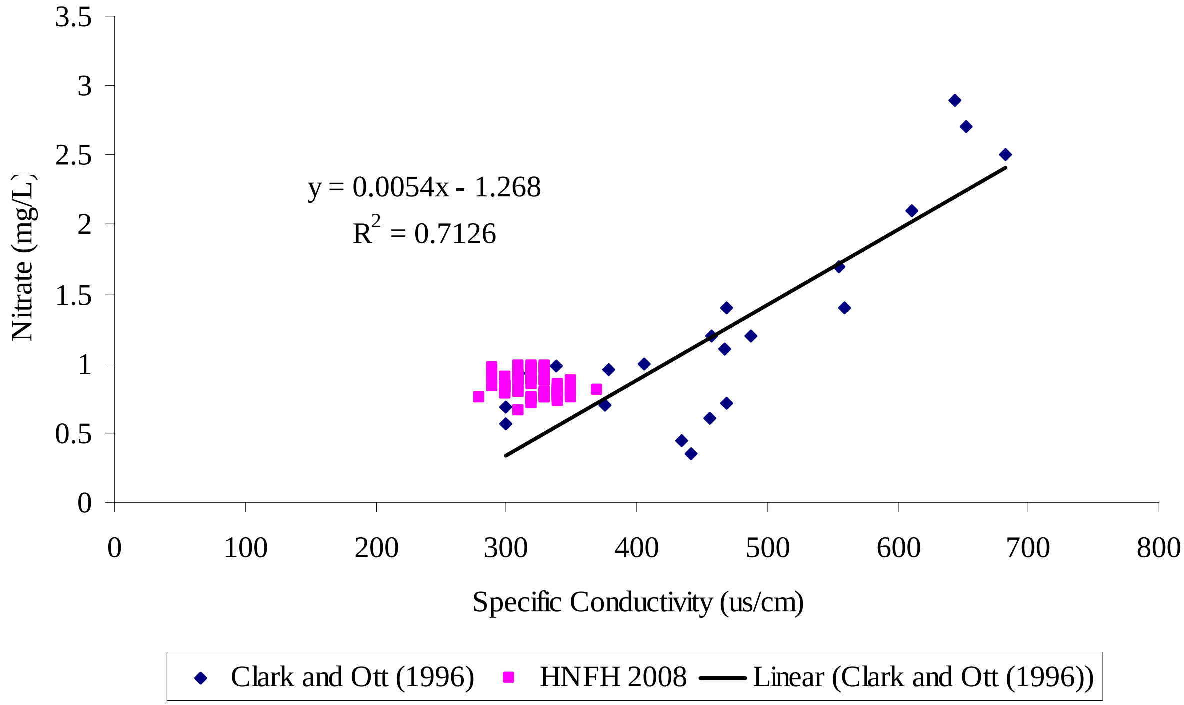
Source: Idaho Department of Water Resources (2008).

Appendix 2. Delineation of the regional and local aquifer in the Thousand Springs Reach of the ESRPA. Those areas north of the pink line are part of the regional aquifer, where as those south of the pink line are part of the local aquifer.



Source: Baldwin et al. (2006)

Appendix 3. Regression of Nitrate vs Specific Conductivity measured from reaches of the Middle Snake River by Clark and Ott (1996) and at the Hagerman National Fish Hatchery (HNFH), 2008**.**



Appendix 4. Conductivity, Nitrate, Flow, pH, Temperature (Temp), Dissolved Oxygen (DO) and Total Dissolved Solids (TDS) from Bickle, Riley, Len Lewis Springs, and Springs 13, 15, 17, Hagerman National Fish Hatchery, 2008.

Spring	Date	Time	Conductivity (us/cm)	Nitrate EPA 300 (ppm)	Flow (cfs)	pH	Temp (C)	DO (ppm)	TDS (ppm)
Bickle	1/14/2008	8:20	310	0.89	15.76	8.4	14.1	8.56	150
Bickle	2/17/2008	14:46	320	0.98	15.76	8.3	n/a	n/a	160
Bickle	3/11/2008	8:34	350	0.79	14.74	8.1	14.7	8.71	160
Bickle	4/17/2008	11:32	320	0.74	15.76	8.3	14.9	9.50	180
Bickle	5/12/2008	10:35	330	0.77	14.74	8.1	15.4	9.53	160
Bickle	6/10/2008	7:32	320	0.75	15.25	7.6	14.9	8.10	160
Bickle	7/10/2008	10:07	340	0.76	14.74	7.9	15.4	9.19	160
Bickle	8/12/2008	8:20	300	0.83	14.24	7.8	15.0	8.35	140
Bickle	9/15/2008	10:03	290	0.96	15.76	7.9	15.1	8.97	140
Bickle	10/15/2008	11:20	310	0.98	16.27	7.8	15.0	8.82	150
Bickle	11/13/2008	10:12	330	0.94	15.76	7.5	15.0	8.44	160
Bickle	12/15/2008	14:38	320	0.85	14.74	8.0	14.5	8.32	150
Riley	1/14/2008	8:30	350	0.86	4.88	8.4	13.4	8.50	170
Riley	2/17/2008	14:51	310	0.66	5.09	8.4	n/a	n/a	150
Riley	3/11/2008	8:40	340	0.78	4.67	8.2	13.8	8.59	170
Riley	4/17/2008	11:32	320	0.74	4.67	8.3	14.9	9.50	160
Riley	5/12/2008	10:44	350	0.77	4.47	8.1	14.6	8.92	170
Riley	6/10/2008	7:37	340	0.73	4.67	7.9	15.0	7.92	170
Riley	7/10/2008	10:12	320	0.71	4.88	7.9	15.4	9.03	160
Riley	8/12/2008	8:25	280	0.76	4.67	7.8	14.8	7.82	130
Riley	9/15/2008	10:12	290	0.90	4.67	7.9	14.7	8.48	140
Riley	10/15/2008	11:25	310	0.91	5.09	7.9	14.4	8.48	150
Riley	11/13/2008	10:20	310	0.87	5.09	7.8	14.6	8.01	150
Riley	12/15/2008	14:44	300	0.82	4.67	8.2	13.2	8.45	150

Appendix 4 cont. Conductivity, Nitrate, Flow, pH, Temperature (Temp), Dissolved Oxygen (DO) and Total Dissolved Solids (TDS) from Bickle, Riley, Len Lewis Springs, and Springs 13, 15, 17, Hagerman National Fish Hatchery, 2008.

Spring	Date	Time	Conductivity (us/cm)	Nitrate EPA 300 (ppm)	Flow (cfs)	pH	Temp (C)	DO (ppm)	TDS (ppm)
17	1/14/2008	9:05	310	0.89	3.01	8.3	14.9	8.55	150
17	2/17/2008	14:37	330	0.98	2.81	8.0	n/a	n/a	160
17	3/11/2008	8:17	340	0.85	2.62	8.2	15.0	8.85	160
17	4/17/2008	11:55	340	0.78	2.78	8.2	15.0	8.41	160
17	5/12/2008	10:28	340	0.82	2.79	7.9	14.9	8.43	170
17	6/10/2008	8:08	330	0.76	2.66	8.0	14.9	8.35	170
17	7/10/2008	10:33	310	0.80	2.79	7.8	15.1	8.30	150
17	8/12/2008	9:11	300	0.83	2.60	7.8	15.0	8.39	140
17	9/15/2008	10:49	300	0.90	2.63	7.8	15.1	8.40	140
17	10/15/2008	11:49	320	0.97	2.95	7.9	15.1	8.38	150
17	11/13/2008	10:56	350	0.87	2.93	7.9	15.0	8.22	160
17	12/15/2008	15:09	310	0.85	2.68	8.0	14.9	7.83	170
Len Lewis	1/14/2008	8:45	330	0.88	25.15	8.2	14.8	8.29	160
Len Lewis	2/17/2008	15:02	330	0.96	25.00	8.3	n/a	n/a	160
Len Lewis	3/11/2008	8:53	340	0.79	25.30	8.1	14.9	8.43	170
Len Lewis	4/17/2008	11:39	300	0.78	25.23	8.0	15.1	8.46	150
Len Lewis	5/12/2008	10:52	370	0.81	22.26	8.0	15.0	8.09	180
Len Lewis	6/10/2008	7:47	340	0.76	24.35	7.8	14.6	7.92	160
Len Lewis	7/10/2008	10:22	330	0.76	24.15	7.9	15.5	8.73	160
Len Lewis	8/12/2008	8:39	300	0.79	24.72	7.8	15.1	7.99	150
Len Lewis	9/15/2008	10:25	290	0.84	24.67	7.7	15.5	8.93	140
Len Lewis	10/15/2008	11:32	320	0.91	25.87	7.7	15.2	8.13	150
Len Lewis	11/13/2008	10:28	320	0.89	25.05	7.9	15.0	8.14	150
Len Lewis	12/15/2008	14:56	310	0.87	25.24	7.8	14.8	7.75	160

Appendix 4 cont. Conductivity, Nitrate, Flow, pH, Temperature (Temp), Dissolved Oxygen (DO) and Total Dissolved Solids (TDS) from Bickle, Riley, Len Lewis Springs, and Springs 13, 15, 17, Hagerman National Fish Hatchery, 2008.

Spring	Date	Time	Conductivity (us/cm)	Nitrate EPA 300 (ppm)	Flow (cfs)	pH	Temp (C)	DO (ppm)	TDS (ppm)
15	1/14/2008	8:35	330	0.87	3.75	8.2	14.9	8.19	160
15	2/17/2008	15:05	320	0.97	3.83	8.3	n/a	n/a	160
15	3/11/2008	9:00	330	0.78	3.60	8.0	15.0	8.29	160
15	4/17/2008	11:44	340	0.78	3.60	8.0	15.0	8.12	160
15	5/12/2008	10:58	350	0.81	3.52	7.9	15.0	8.04	170
15	6/10/2008	7:54	350	0.75	3.52	7.9	14.9	7.78	180
15	7/10/2008	10:29	330	0.78	3.45	7.8	15.0	7.83	160
15	8/12/2008	8:34	300	0.82	3.60	7.8	15.1	7.80	140
15	9/15/2008	10:31	290	0.89	3.75	7.7	15.3	7.76	140
15	10/15/2008	11:38	320	0.90	4.08	7.7	15.2	7.82	160
15	11/13/2008	10:33	310	0.88	3.83	7.7	15.1	7.76	150
15	12/15/2008	14:52	300	0.85	3.83	7.7	15.0	7.48	140
13	1/14/2008	8:55	330	0.88	4.74	8.2	15.0	8.61	160
13	2/17/2008	15:08	330	0.97	4.74	8.2	n/a	n/a	160
13	3/11/2008	9:07	350	0.84	4.74	8.0	15.0	8.34	170
13	4/17/2008	11:48	330	0.79	4.64	8.0	15.0	8.36	160
13	5/12/2008	11:04	340	0.81	4.54	7.9	15.0	8.14	170
13	6/10/2008	7:58	340	0.77	4.25	7.7	14.9	7.93	160
13	7/10/2008	10:43	310	0.79	4.15	7.7	15.0	7.77	150
13	8/12/2008	8:46	300	0.84	3.23	7.7	15.1	7.83	150
13	9/15/2008	10:40	290	0.97	4.74	7.7	15.2	7.87	140
13	10/15/2008	11:42	320	0.91	5.56	7.6	15.2	7.86	150
13	11/13/2008	10:40	310	0.91	4.54	7.8	15.0	7.74	150
13	12/15/2008	15:02	300	0.84	4.35	7.7	15.0	7.43	140