Report on Summer/Fall 2009 Nitrate-Nitrogen Monitoring in the Casper Aquifer Protection Area

Acknowledgements

The City of Laramie would like to acknowledge and thank those who cooperated in establishing, and participated in the Casper Aquifer Monitoring Program. Those entities include Albany County, the Wyoming Department of Agriculture Analytical Services Laboratory, and all landowners who voluntarily agreed to have their wells sampled. Without the assistance and participation of these organizations and people, the monitoring program would not be possible.

1.0 Background

In May 2008, the Laramie City Council adopted the updated Casper Aquifer Protection Plan and associated Aquifer Protection Ordinance. The updated Casper Aquifer Protection Plan (CAPP) includes several management goals for implementation within a few years' time, one of which is the implementation of a water quality monitoring program.

While the list of suggested monitoring parameters in the updated CAPP is considerably more exhaustive than what is feasible for the City to implement at this time, it was possible due to the cooperation of the Wyoming Department of Agriculture laboratory to conduct nitrate-nitrogen monitoring on 98 wells and total/fecal coliform testing on nine of those as well.

The results of these analyses are included in the report that follows.

2.0 Site Selection

In July 2009, letters were sent to landowners in the Casper Aquifer Protection Area (CAPA), as provided in a list from obtained from Albany County. These letters asked for the landowners' permission to collect a sample from their well to be tested for nitrate-nitrogen. In the interest of initial establishment of a monitoring network, the Water Resources Specialist collected samples from any site for which permission was granted. Samples were collected from a total of 98 wells, some of which incidentally lie just outside of the designated CAPA but are near enough to boundaries for the data to still be considered useful.

After nitrate-nitrogen results were reviewed, the Water Resources Specialist contacted homeowners for whom well water had tested at or above 5 parts per million (ppm) nitrate-nitrogen and requested permission to collect samples for fecal/total coliform bacteria. Nine of these were tested, and samples were collected and handled according to the Wyoming Department of Agriculture's procedure document, which will be hereby incorporated into the Casper Aquifer Monitoring Plan as a Standard Operating Procedure (SOP).

3.0 Method

The Water Resources Specialist collected and handled samples and data in accordance with the methods outlined in the FY 2009/2010 Casper Aquifer Protection Area Monitoring Plan, in applicable SOPs.

4.0 Results

The results of all nitrate-nitrogen testing are shown in Table 1. Note, due to the desire to protect confidentiality of individual results, sites are assigned a site number according to their general location, and ownership/address information is not shared.

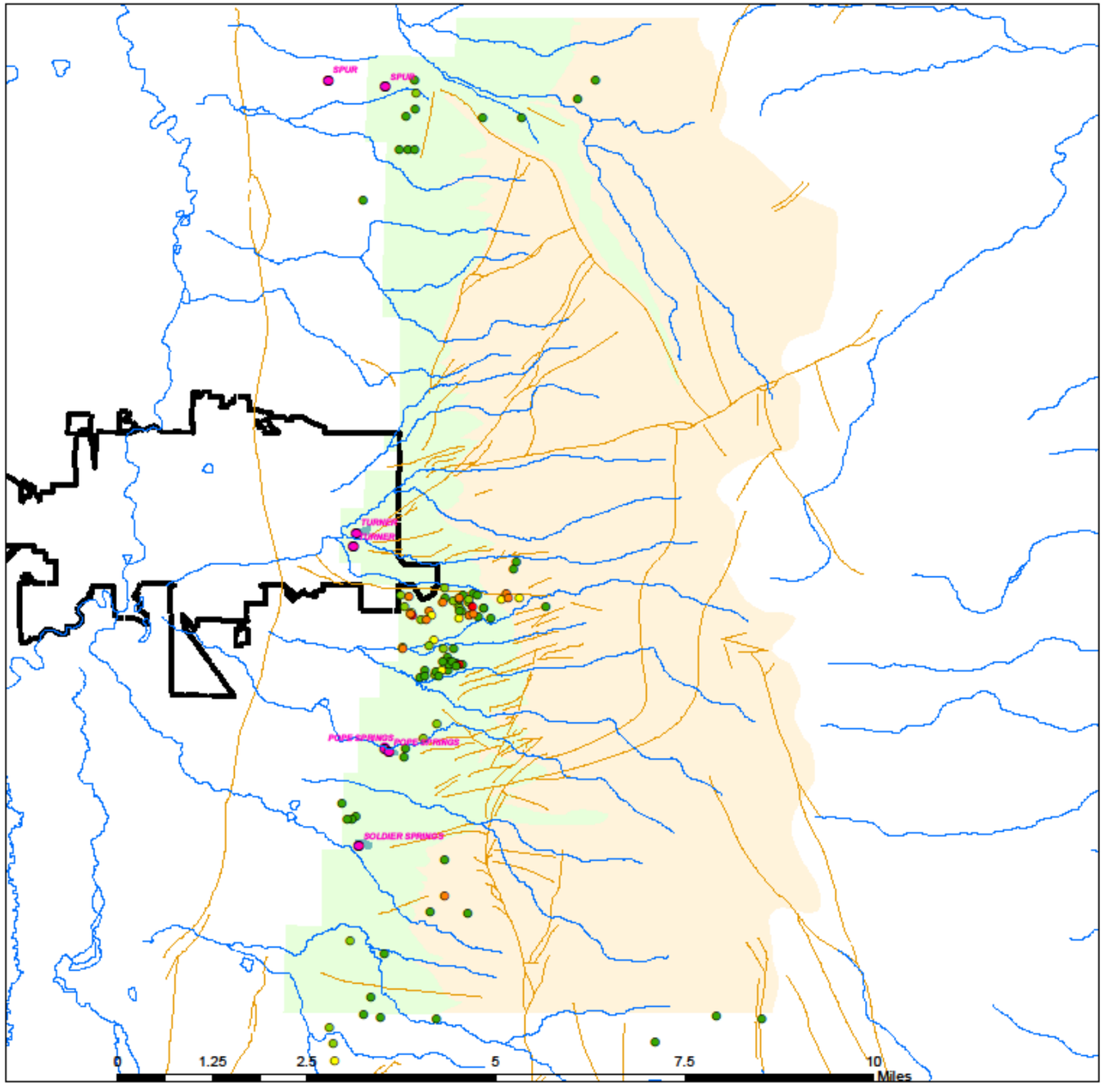
Well #	Sampling Date	NO3-N (ppm)		Well #	Sampling Date	NO3-N (ppm)
EG-1	8/24/2009	1.5		EG-34	9/2/2009	1.2
EG-2	8/24/2009	1.7		EG-34	9/2/2009	1.2
EG-3	8/24/2009	3.1		EG-35	9/2/2009	5.7
EG-4	8/24/2009	2.2		EG-36	9/2/2009	1.6
EG-4	8/24/2009	2.2		EG-37	9/2/2009	6.4
EG-5	8/24/2009	3.3		EG-38	9/2/2009	6.8
EG-6	8/24/2009	5.9		EG-39	9/2/2009	1
EG-7	8/24/2009	1.4		EG-40	9/1/2009	4.6
EG-8	8/24/2009	1.4		EG-40	9/1/2009	4.4
EG-9	8/24/2009	8.4		EG-41	9/1/2009	1.7
EG-10	8/24/2009	1.5		EG-42	9/1/2009	3.9
EG-11	8/24/2009	5.7		EG-43	9/1/2009	8
EG-12	8/25/2009	1.6		EG-44	9/1/2009	3.2
EG-13	8/26/2009	3.1		EG-45	9/1/2009	1.3
EG-14	8/26/2009	1.8		EG-46	9/1/2009	1.4
EG-15	8/26/2009	2.8		EG-47	9/1/2009	1.2
EG-15	8/26/2009	2.7		EG-48	9/1/2009	1.5
EG-16	8/26/2009	3.6		EG-49	9/28/2009	10.3
EG-17	8/26/2009	4.7		EG-50	9/28/2009	1.6
EG-18	8/26/2009	6.9		EG-51	9/28/2009	1.6
EG-19	8/26/2009	2		EG-52	9/28/2009	4.3
EG-20	8/26/2009	3.6		EG-53	9/29/2009	1.5
EG-21	8/26/2009	8.1		EG-54	9/29/2009	4
EG-22	8/26/2009	0.89		EG-54	9/29/2009	4
EG-23	8/26/2009	12.1		EG-55	9/29/2009	6.2
EG-24	8/31/2009	2.7		EG-56	9/29/2009	19
EG-25	8/31/2009	1.6		EG-57	9/29/2009	1.9
EG-25	8/31/2009	1.6		EG-58	9/29/2009	7.4
EG-26	8/31/2009	7.9		EG-59	10/5/2009	5.9
EG-27	8/31/2009	2.7		EG-59	10/5/2009	5.9
EG-28	8/31/2009	2		EG-60	10/5/2009	8.1
EG-29	9/2/2009	1.6		EG-61	10/7/2009	2.2
EG-30	9/2/2009	4.2		EG-62	10/7/2009	1.2
EG-31	9/2/2009	1.3		HJ-1	10/7/2009	1.6
EG-32	9/2/2009	6.3		HJ-1	10/7/2009	1.6
EG-33	9/2/2009	1.9		HJ-2	10/7/2009	0.44
				HJ-3	10/7/2009	0.89

Well #	Sampling Date	NO3-N (ppm)		Well #	Sampling Date	NO3-N (ppm)
LS-1	9/1/2009	1.9		LS-18	9/28/2009	1.8
LS-2	9/1/2009	1.8		LS-19	9/28/2009	1.9
LS-3	9/8/2009	2.2		LS-20	9/28/2009	2.7
LS-4	9/8/2009	3		LS-21	10/7/2009	1.6
LS-5	9/8/2009	4.3		RC-1	9/22/2009	1.5
LS-5	9/8/2009	4.3		RC-2	9/22/2009	1.7
LS-6	9/8/2009	1.6		RC-3	9/22/2009	1.4
LS-7	9/8/2009	1.7		RC-4	9/22/2009	2.1
LS-8	9/8/2009	1.8		RC-4	9/22/2009	2.1
LS-9	9/8/2009	1.6		RC-5	9/22/2009	1.4
LS-10	9/8/2009	1.5		RC-6	9/22/2009	1.5
LS-11	9/8/2009	1.5		RC-7	9/22/2009	1.3
LS-12	9/8/2009	1.3		RC-8	9/23/2009	1.1
LS-13	9/8/2009	1.7		RC-9	9/23/2009	1.5
LS-14	9/8/2009	8.1		RC-10	9/23/2009	1.7
LS-15	9/8/2009	1.5		RC-10	9/23/2009	1.7
LS-16	9/28/2009	2.2		RC-11	9/23/2009	0.91
LS-17	9/28/2009	2.2		RC-12	9/23/2009	1.5

Table 1: Results of nitrate-nitrogen testing on samples collected in the Casper Aquifer Protection Area, summer and fall 2009. Results showing for the same location on the same date are for duplicate samples collected according to the City's QA/QC plan.

Well numbers are assigned as "EG," "HJ," "LS," and "RC" according to the general geographic location of the well – respectively, East Grand, Happy Jack, Laramie South and Roger Canyon. A map depicting well locations and range of nitrate-nitrogen results is given in Figure 1, and a map showing the general areas described above is given in Figure 2.

The results of all total/fecal coliform tests were negative. A map depicting locations of the wells tested for total/fecal coliform is given in Figure 3.



2009 CAPA Nitrate-Nitrogen Monitoring Results

CAPA Wells Monitored 2009
NO3-N (ppm)
- 0-2
- 2-4
- 4-6
- 6-10
- 10-19
- Streams
- City Wellfields
- Faults
- City of Laramie Boundary 2009
- Zone 1 CAPA
- Zone 2 CAPA
- Zone 3 CAPA

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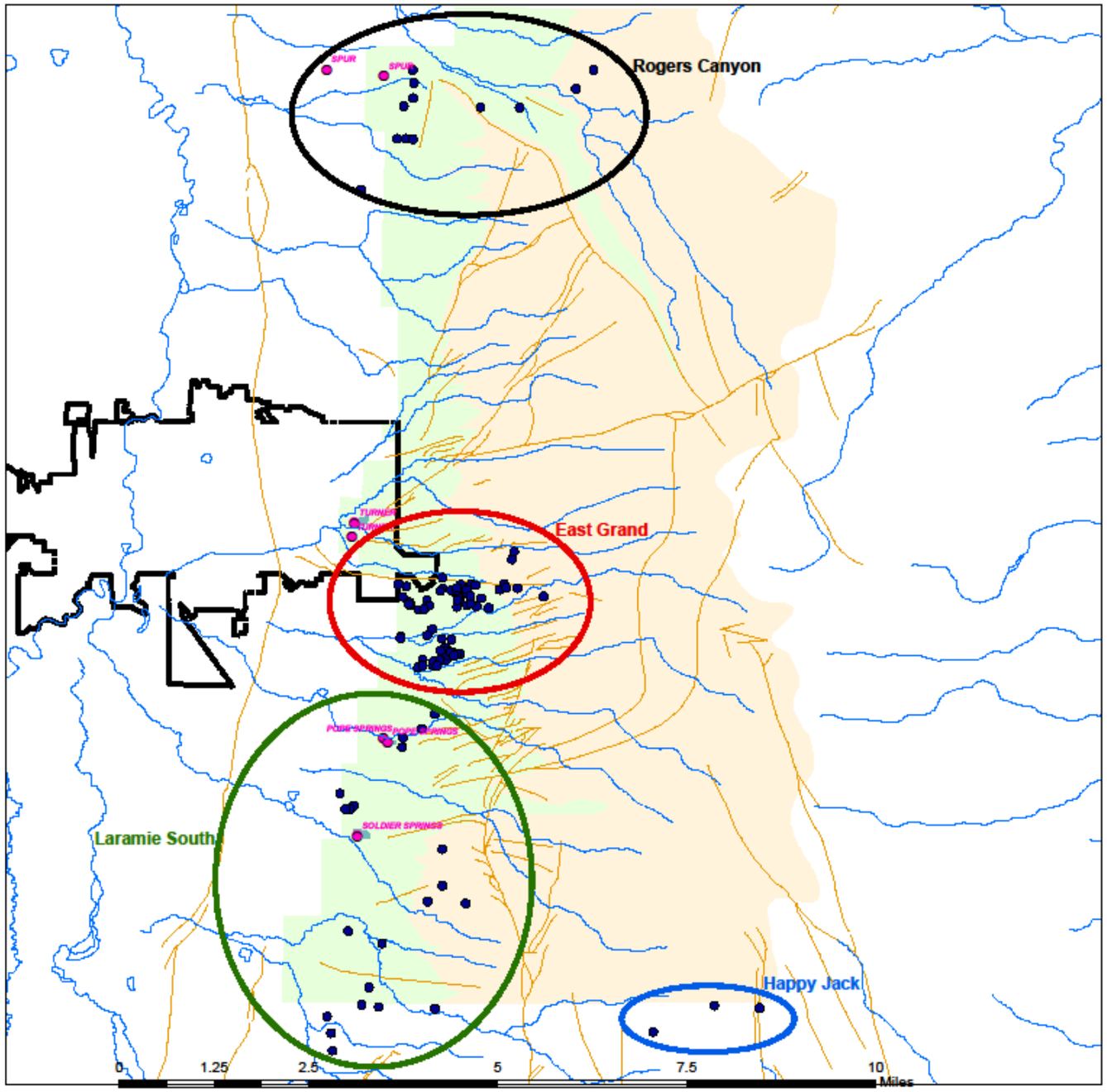
Figure 1: Nitrate-nitrogen results for wells monitored in 2009. [1]

[1] Locations shown in Figures 1 through 6 are not precise at the scale shown.



General Monitoring Areas for
2009 CAPA Monitoring

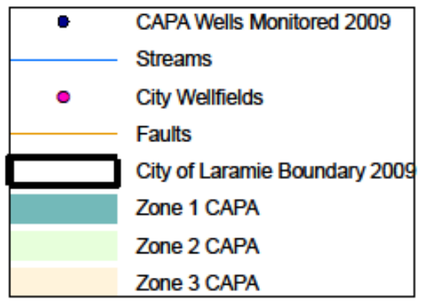
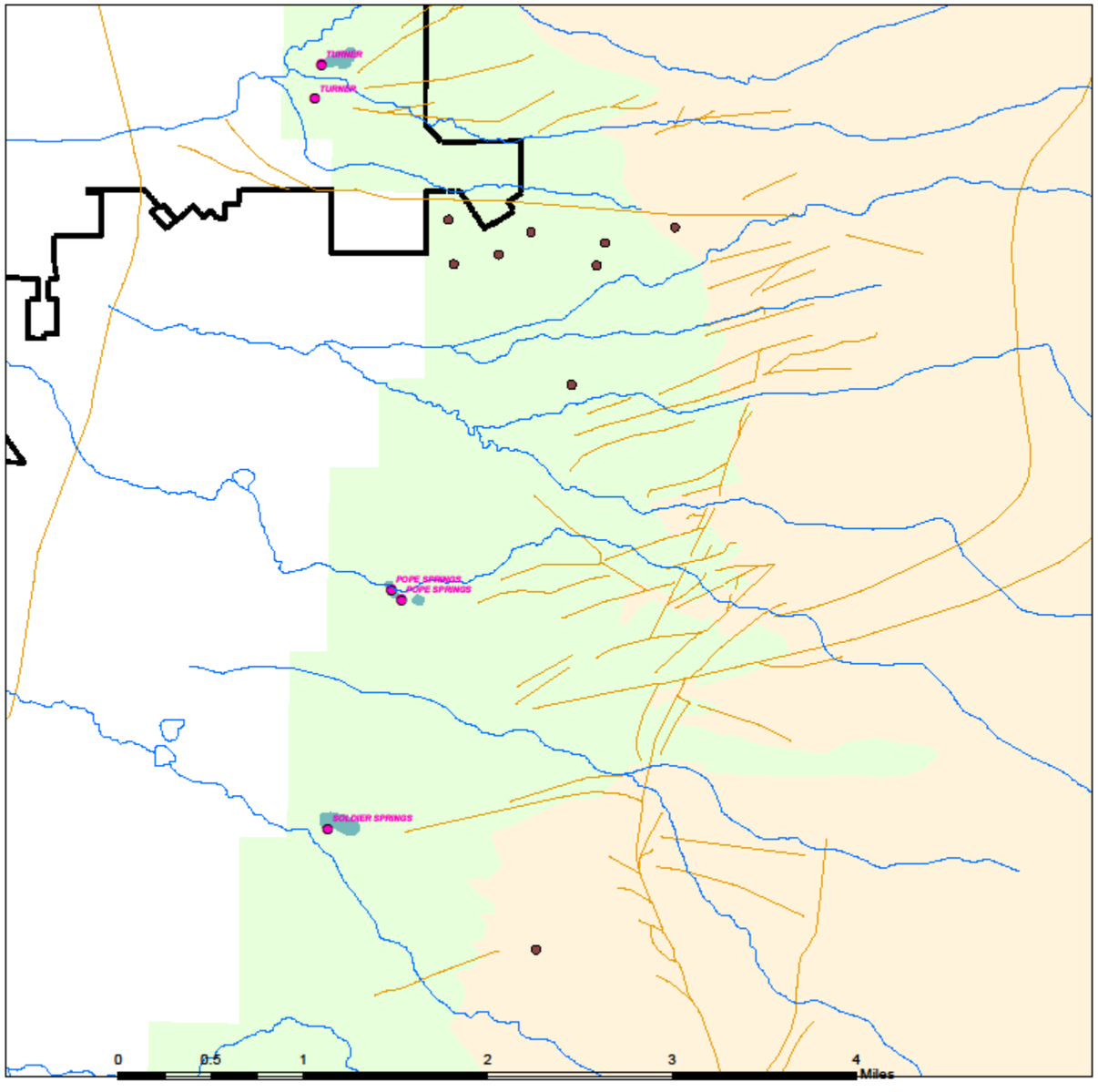


Figure 2: General monitoring areas in 2009.[1]



2009 CAPA Wells
Monitored for Coliform

CAPA Wells Monitored (coliform) 2009
Streams
City Wellfields
Faults
City of Laramie Boundary 2009
Zone 1 CAPA
Zone 2 CAPA
Zone 3 CAPA

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Figure 3: Locations of wells monitored for fecal/total coliform in 2009. [1]

As can be observed in Figure 1, the area with the highest concentrations of nitrate-nitrogen were found in the East Grand area, including the areas immediately east of City limits off of Grand Avenue. (Neighborhood streets are not included on the maps so as to prevent identification of any particular sampling point with a particular property, as most participating landowners wished to have individual results kept confidential.) There were a few outlying elevated nitrate-nitrogen levels in the Laramie South area, but none in the Roger Canyon or Happy Jack areas.

In the East Grand area, 29% of wells sampled had a nitrate-nitrogen level above 5 mg/L, and this area contained all three wells in the monitoring area with results above the 10 mg/L drinking water standard. Outside of the East Grand area, only one well (in the Laramie South area) had a nitrate-nitrogen level above 5 mg/L. The averages for each area were as follows:

- East Grand: 3.9 ppm
- Laramie South: 2.3 ppm
- Happy Jack: 0.98 ppm
- Rogers Canyon: 1.5 ppm

Total/fecal coliform results on all wells tested were negative.

It is possible to qualitatively assess potential contamination without relying solely on water quality results. Using spatial information on septic system locations, and Wyoming State Engineer's Office records on well depths and completion dates, we can draw some preliminary conclusions about contamination. The figures that follow summarize this information. It should be noted that static water levels used for this mapping are the levels that are included in the State Engineer's Office records and likely represent the level at the time of drilling, *not* at present. Static water levels were not measured as part of the 2009 monitoring in the CAPA.

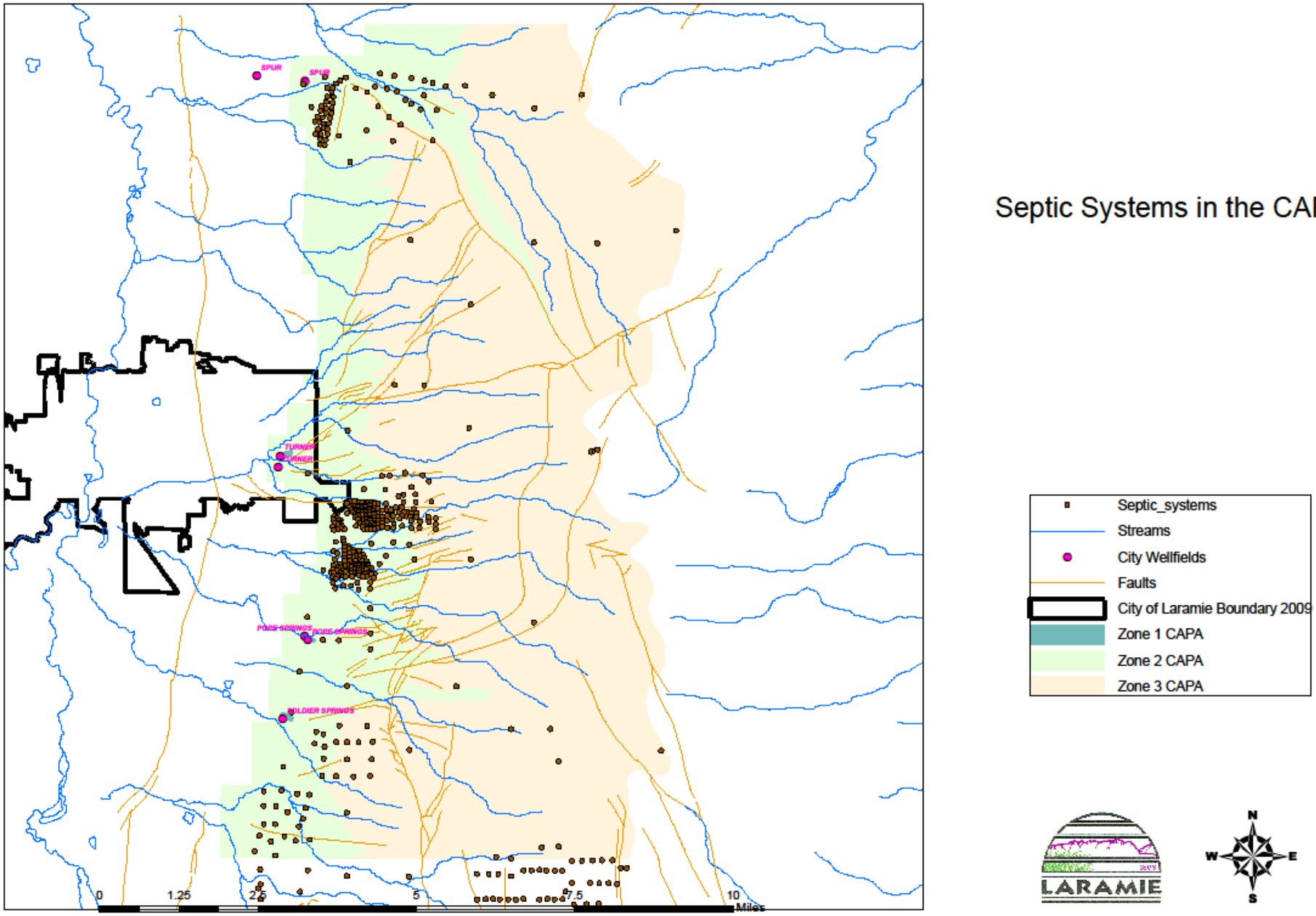


Figure 4: Locations of septic systems in the Casper Aquifer Protection Area and vicinity. [1]

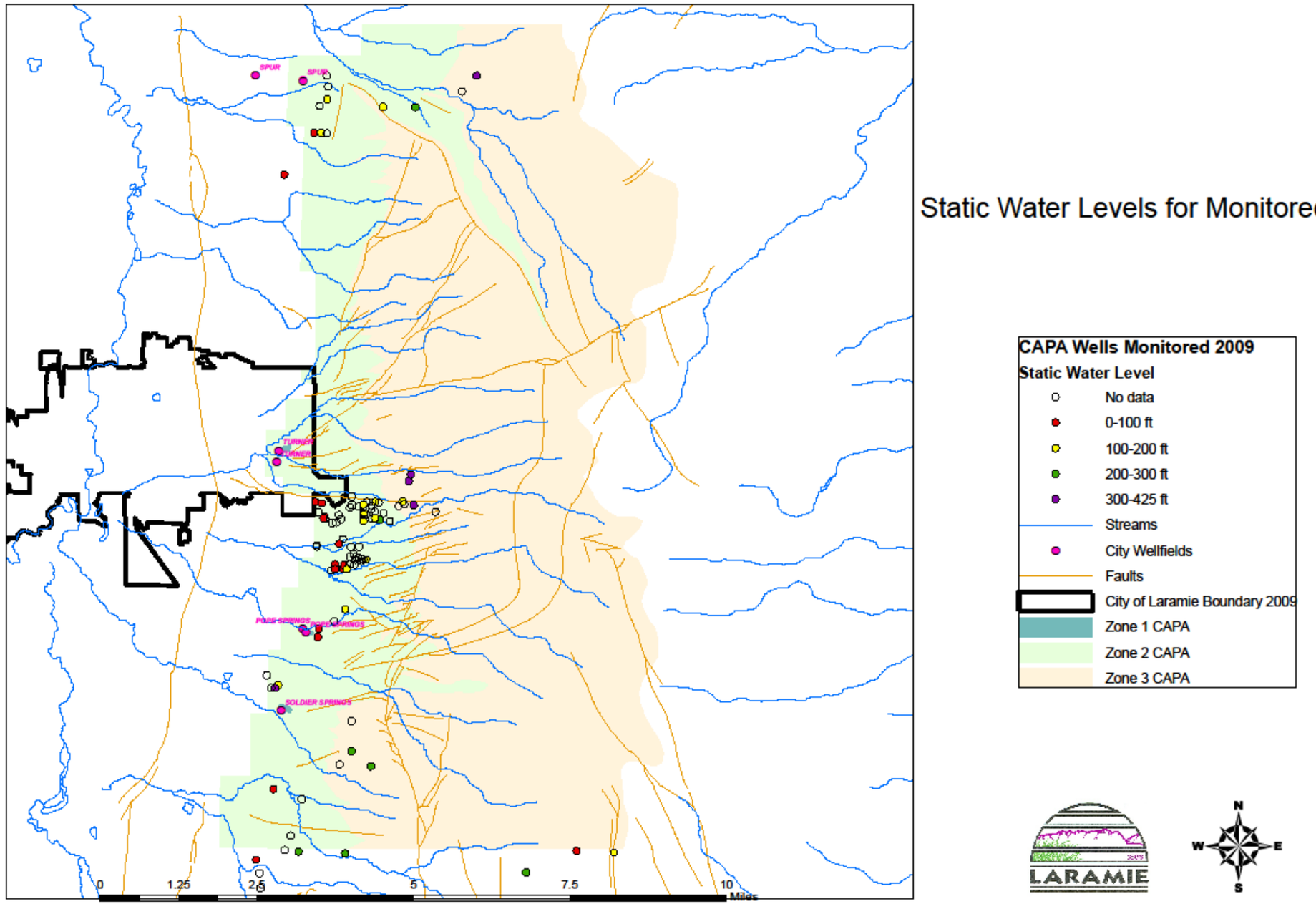
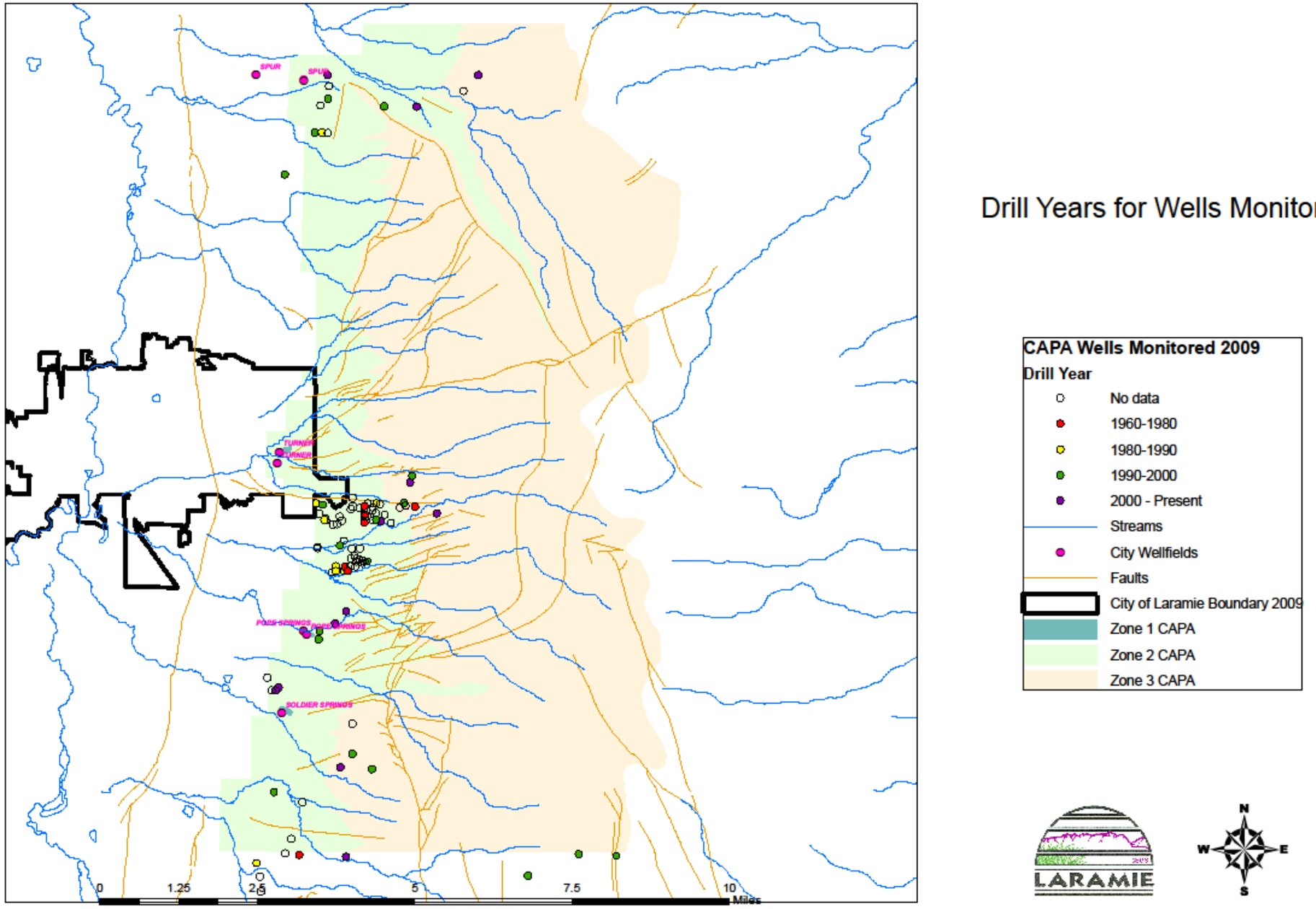


Figure 5: Static water levels of monitored wells (as indicated in State Engineer's Office records). [1]



Drill Years for Wells Monitored

CAPA Wells Monitored 2009

Drill Year

- No data
- 1960-1980
- 1980-1990
- 1990-2000
- 2000 - Present
- Streams
- City Wellfields
- Faults
- City of Laramie Boundary 2009
- Zone 1 CAPA
- Zone 2 CAPA
- Zone 3 CAPA

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Figure 6: Years in which wells monitored were drilled, as provided by the State Engineer's Office. [1]

It is clear from Figure 4 that the area with the highest nitrate-nitrogen levels in groundwater samples corresponds to the area with the greatest density of septic systems. The Albany County Water and Wastewater Engineer has cited a compounding problem as being that many systems originally installed in this area were put in too deep, as much as 10 feet underground, which would contribute to a system's improper function. Improperly functioning systems are cited by the United States Environmental Protection Agency as a leading cause of groundwater contamination[2].

To partially demonstrate the potential effects of septic system density on nitrate-nitrogen concentrations in the aquifer, all of the nitrate-nitrogen levels above the 10 mg/L drinking water standard were located in the area with greatest septic system density. Two of these three wells had 35 and 42, respectively, septic systems within 1000 feet of them (the third of these three could not be analyzed in this way because the septic system spatial information available is not totally complete and data are missing for the particular area in which it is located). Conversely, all of the lowest three nitrate-nitrogen readings were in an area of lower septic system density; all three of these wells had only three septic systems within 1000 feet.

While total/fecal coliform tests were negative, it should be noted that the limited number of samples on which the analysis was performed is insufficient to draw an overall conclusion about the source(s) of contamination in the area. Because most wells are relatively deep, and the depth to water is correspondingly deep, any contaminant entering the aquifer may have encountered natural processes along its flowpath that altered its makeup or removed part of the contamination.

It is worth noting that spatial data are not currently available for livestock corrals or for lawn fertilizer use; livestock and lawn fertilizer are other potential sources of nitrate contamination. Because these data are not currently available, no similar comparisons can be made between elevated nitrate-nitrogen concentrations and their proximity to these potential sources.

There was no significant correlation between the age of the well and nitrate-nitrogen concentration, or between the static water level and nitrate-nitrogen concentration. However, it is also worth noting that at this time, the data available for drilling dates and static water levels are incomplete, as current land ownership records do not, in many cases, coincide with records in the State Engineer's Office. Because these data are incomplete, analysis including this information only covers about half of the sampled wells. Continuing efforts will be made to reconcile the records with the State Engineer's Office so that more meaningful analyses may be performed.

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[2] United States Environmental Protection Agency. *EPA Guidelines for Management of Onsite/Decentralized Wastewater Systems.* Document EPA-832-F-00-012, July 2000.

5.0 Conclusions and Recommendations

The sampling conducted during the summer and fall of 2009 can be considered a success. With approximately 500 possible participants, nearly 20% voluntarily participated in the program and landowners in the area have continued to express an interest in participating in future monitoring efforts.

Data indicate that nitrate-nitrogen levels are most elevated in the East Grand area, and analyses indicate that this could be linked to the high density of septic systems in these subdivisions. However, other potential sources of nitrate contamination could not be evaluated in the same manner as septic system density since spatial information is not available. Therefore, it is recommended that efforts be made to collect spatial information on other potential sources of nitrate.

Additionally, it is recommended that monitoring not only continue for nitrate-nitrogen on a biannual basis, including follow-up testing for total/fecal coliform, but that additional monitoring be conducted for caffeine and/or nitrogen isotopes to further evaluate the sources of contamination.

It is noted that while nitrate-nitrogen levels were observed to be elevated in the “East Grand” area in *private* wells, the City wells do not at this time show corresponding elevated levels of nitrate-nitrogen.

The monitoring conducted in 2009 touched only on one contaminant of concern for the aquifer protection area: nitrate. While this is certainly an important contaminant to continue monitoring, other contaminants such as those associated with lawn care, and petroleum products and other hazardous materials that may enter the system through spills and accidents on Interstate 80, should also be monitored in the coming years.

Appendix

Albany County has established design and construction standards for small wastewater systems. These standards are available for download from the County's website at http://www.co.albany.wy.us/Departments/Planning/tabid/59/Default.aspx.

The State of Wyoming has established water well construction standards. These standards are available for download from the Wyoming Department of Environmental Quality's website at http://deq.state.wy.us/wqd/groundwater/index.asp.

Additional City water resources information is available on the City's website at http://www.ci.laramie.wy.us/cityservices/communitydevelopment/outreach/index.html.