

# Pinedale Anticline Ground Water Data Summary

Data collected by the Sublette County Conservation District  
August 1, 2008 through July 31, 2009

*Plus additions to the report: Pinedale Anticline Ground  
Water Data Summary, August 25, 2008,  
that includes data from July 30, 2008*

Final Annual Report  
To  
Pinedale Anticline Working Group - Water Resource Task Group  
October 15, 2009

*Volume 1 of 5*



Sublette County Conservation District - [www.sublettecountycd.com](http://www.sublettecountycd.com)

Delsa Allen, Ground Water Program Supervisor • [delsa.allen@wy.nacdn.net](mailto:delsa.allen@wy.nacdn.net)

P.O. Box 36 / 1625 W. Pine Street, Pinedale Wyoming

# Table of Contents

Introduction.....	1
Report Objective .....	1
Map 1. PAPA Boundary Within Sublette County .....	2
Map 2. Water Wells Visited vs Sampled.....	3
Methods.....	4
Results.....	4-13
Water Wells Permitted for Domestic and Stock Use.....	5-7
Water Wells Permitted for Miscellaneous Use.....	8
Total Petroleum Hydrocarbon (TPH) Results.....	9-10
Map 3. Water Wells With Past TPH Detections.....	11
Plugged Water Wells .....	12
Map 4. Plugged Water Wells.....	13
Literature Cited.....	14
Appendix A, Tables 1 and 2 .....	(attached separately)
Table 1. Water Well Field and Lab Analysis Data – Domestic and Stock Wells	
Table 2. Water Well Field and Lab Analysis Data – Miscellaneous Wells	
Appendix B.....	(attached separately)
Table 3. Water Well Field and Lab Analysis Data, July 30, 2008	
Appendix C.....	(attached separately)
Table 4. History of Water Wells With Past TPH Detections	

## **Introduction**

The Pinedale Anticline Project Area (PAPA), which is currently undergoing gas exploration development, is located south of Pinedale, WY and north of the Jonah gas field. It is bordered by the Green River to the west and Highway 191 to the east. The Record of Decision (ROD) for the Environmental Impact Statement for the Pinedale Anticline Oil and Gas Exploration and Development Project, Sublette County Wyoming was released in July of 2000. The Conditions of Approval within this ROD states, "...the operators will conduct a survey and a complete water analysis (ex. static water level, alkalinity, salinity, benzene, oil, etc.) of all water wells within a one mile radius of existing and proposed development, and annually monitor and maintain a complete record of water analysis of all new water supply wells drilled in the project area to evaluate the quality of source options in the event some mitigation is required." (section 3, p. 25). See Map 1.

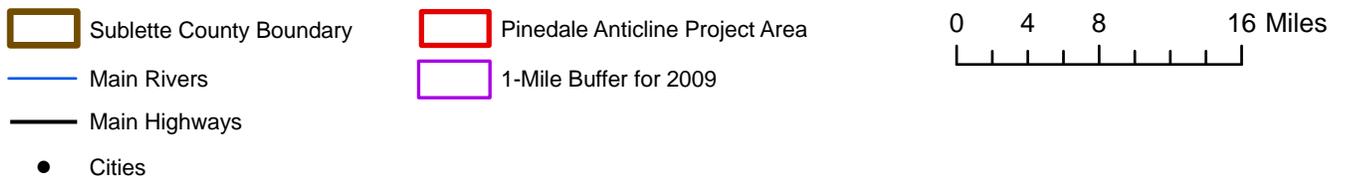
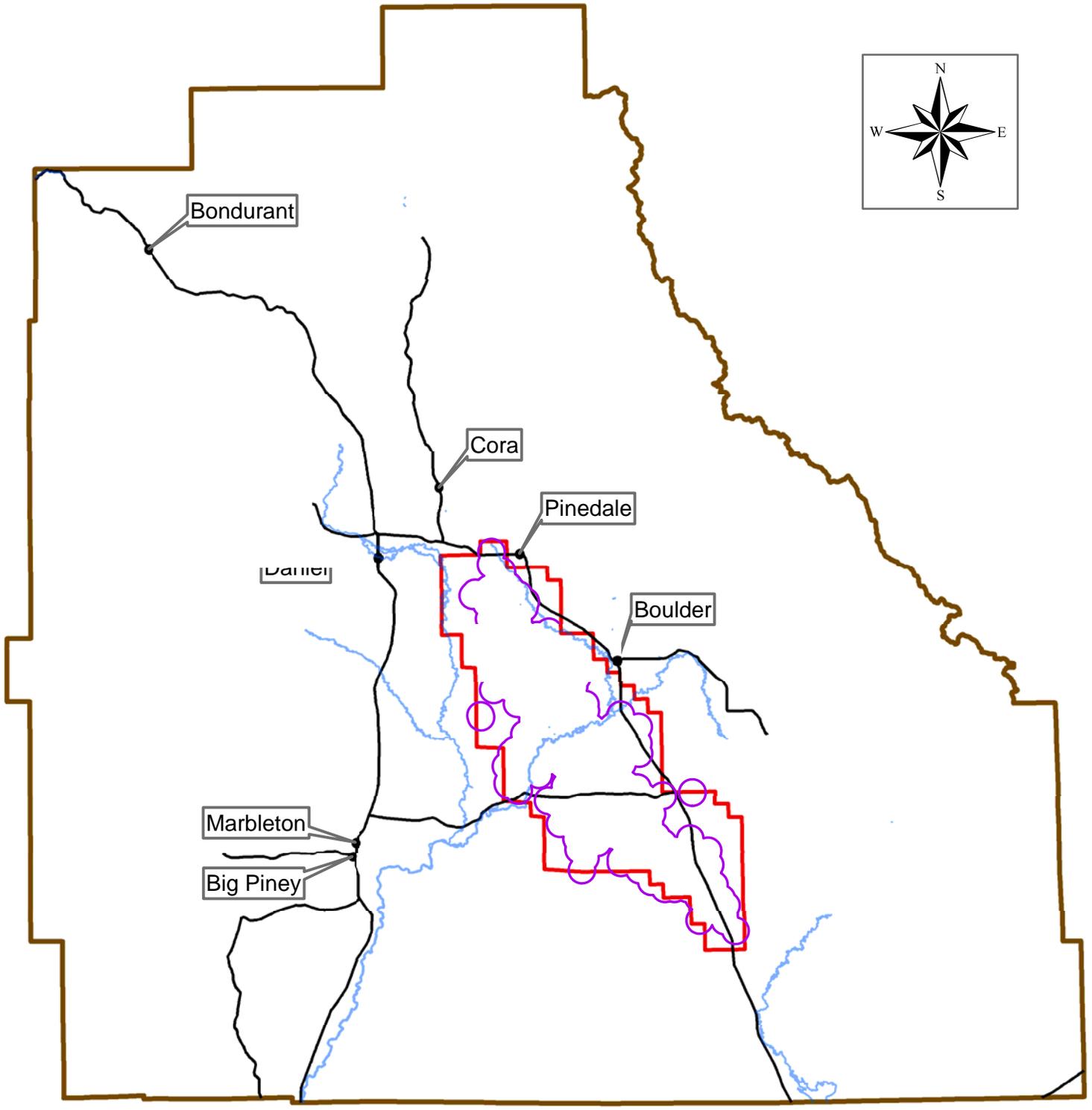
The Sublette County Conservation District (SCCD) was selected to perform the above requirements. The ground water monitoring program was developed in 2001 and ground water sampling began in 2004. Sampling from August 1, 2008 through July 31, 2009 concluded the 5<sup>th</sup> year of monitoring. As of July 31, 2009, the SCCD has collected 1212 ground water samples from water wells within one mile of an existing or proposed gas well within the PAPA.

## **Report Objective**

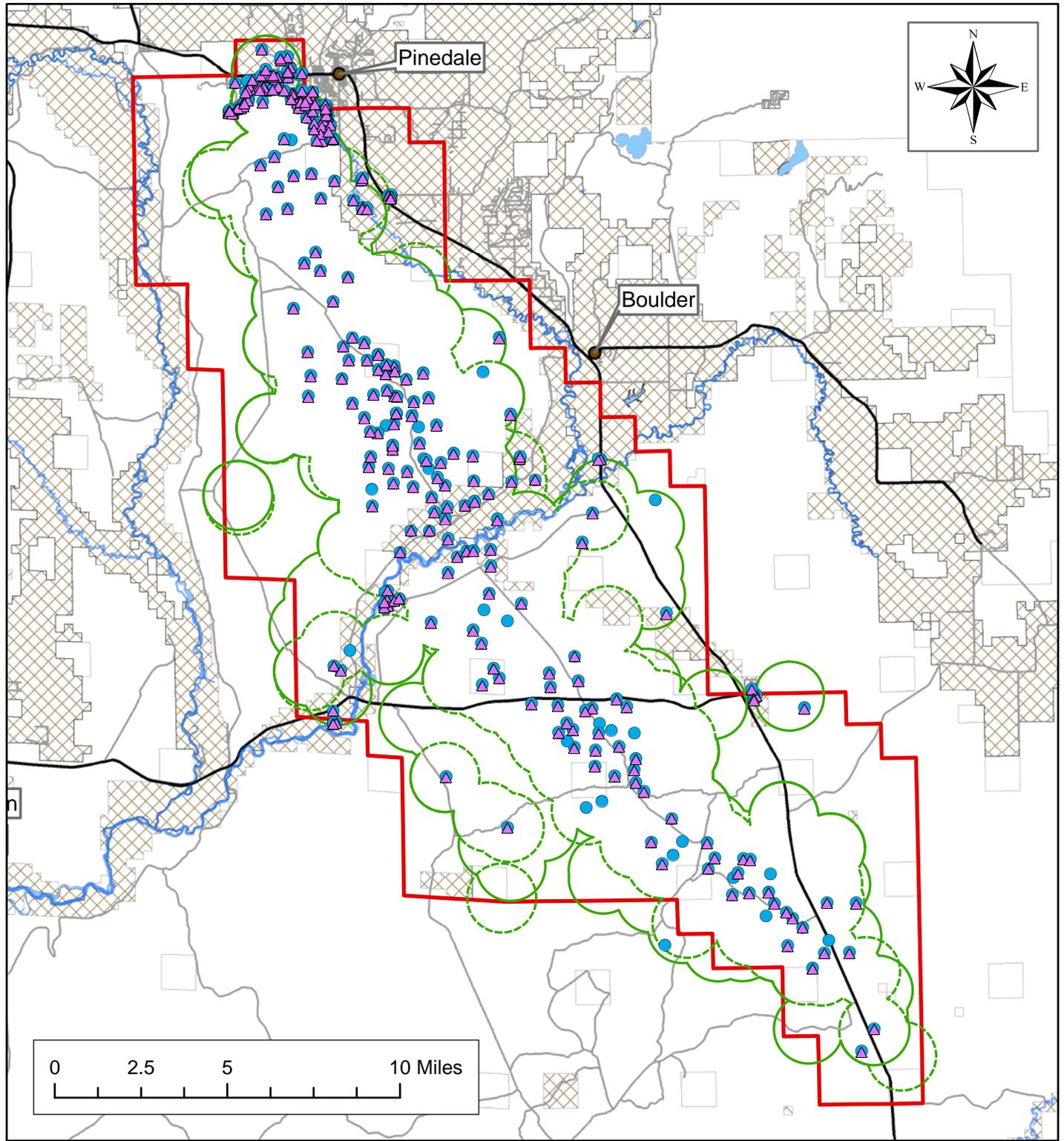
The purpose of this report is to provide a summary of the data collection procedures, field data and the lab analysis results from August 1, 2008 through July 31, 2009. This represents one complete year of sampling. See Map 2.

In addition, data from field visits on July 30<sup>th</sup>, 2008 are being included. Refer to Appendix B, Table 3. Water Well Field and Lab Analysis Data, July 30, 2008. The data was not available as of August 23, 2008 and is intended to conclude the report, Pinedale Anticline Ground Water Data, August 25, 2008. This report and appendices are available at [http://www.blm.gov/wy/st/en/field\\_offices/Pinedale/pawg/DataResults.html](http://www.blm.gov/wy/st/en/field_offices/Pinedale/pawg/DataResults.html).

# Map 1. PAPA Boundary Within Sublette County



# Map 2. Water Wells Visited vs Sampled



- |               |               |                                       |   |
|---------------|---------------|---------------------------------------|---|
| Private Lands | Main Rivers   | This Year's Addition to 1-Mile Buffer | Wells Sampled 08/01/08 through 07/31/09 |
| Public Lands  | Main Highways | Last Year's 1-Mile Buffer             | Wells Visited 08/01/08 through 07/31/09 |
| Cities        | Other Roads   | Pinedale Anticline Project Area       |   |

Sublette County Conservation District / Pinedale Anticline Ground Water Data / Created by Delsa Allen / October 2009

The Sublette County Conservation District shall not be held liable for improper or incorrect use of the data described and/or contained herein. These data are not legal documents and are not intended to be used as such. The information contained in the data is dynamic and changes over time. It is the responsibility of the data user to use the data appropriately and consistently within the limits of the data. The Sublette County Conservation District provides no warranty, expressed or implied, as to the accuracy, reliability, or completeness of the data. Although these data have been processed successfully on a computer system at the Sublette County Conservation District offices, no warranty expressed or implied is made regarding the utility of the data on another system or for general or scientific purposes, nor shall the act of distribution constitute any such warranty. This disclaimer applies both to individual use of the data and consolidated use with other data.

## Methods

Water wells that become part of the SCCD ground water monitoring program are monitored annually. The data collected includes water level, GPS coordinates, field parameters and laboratory analysis data. Field parameters are measured just prior to the laboratory bottles being filled. The parameters measured in the field include pH, conductivity, total dissolved solids (TDS) and temperature (reported in Celsius). Water level is also measured when well access is possible. Field notes are made regarding procedure used to sample, and other field observations.

All samples are further tested for alkalinity, calcium, chloride, fluoride, magnesium, potassium, sodium and sulfate by Energy Laboratories Inc in Casper, Wyoming. Also, all samples are tested for Total Petroleum Hydrocarbons (TPH): Diesel Range Organics (DRO) and Gasoline Range Organics (GRO) using method SW8015B. Samples which show detections for DRO or GRO are sampled a second time and also analyzed for benzene, ethylbenzene, m+p-Xylenes, o-Xylene and toluene (commonly known as BTEX) using method SW8021B.

The Quality Assurance Program Manual and Performance Evaluations for Energy Laboratories, Inc. is located at the following web address in PDF format:

<http://www.energylab.com/QualityControlList.asp?branch=Casper>

Prior to release, all lab and field data is entered into the Sublette County Conservation District database and quality control measures are taken.

## Results

Starting August 1, 2008 through July 31, 2009, 378 field visits took place with 350 samples being collected. Some of these were duplicate samples taken as a quality control measure. Others were second sample sets taken due to previous DRO and / or GRO detections. See Map 2.

The Wyoming Department of Environmental Quality (WYDEQ) and Environmental Protection Agency (EPA) has established drinking water and livestock water quality standards for a handful of parameters. Some of these are analyzed in the SCCD Groundwater Monitoring Program, both in the field and through further lab analysis. The standards for these parameters are given below:

- *Drinking Water Standards:* chloride, 250 mg/L; fluoride, 4 mg/L; sulfate, 250 mg/L; and total dissolved solids, 500 mg/L.
- *Livestock Standards:* chloride, 2000 mg/L; sulfate, 3000 mg/L; and total dissolved solids, 5000 mg/L.

*Water Wells Permitted Through the Wyoming State Engineer’s Office for Domestic, Stock and Domestic/Stock Use*

The following results were taken with a Hanna HI 991300 field meter and represent the range of data collected from the specific well-use group.

<b><i>Field Data Collected</i></b>	<b><i>Range</i></b>
<i>Conductivity (us/cm)</i>	
Domestic	64 to 1830
Domestic/Stock	274 to 1202
Stock	204 to 1634
<i>TDS (ppm)</i>	
Domestic	40 to 1154
Domestic/Stock	172 to 769
Stock	119 to 817
<i>Temperature (Celcius)</i>	
Domestic	1.9 to 32.1
Domestic/Stock	7.5 to 19.6
Stock	6 to 24.1
<i>pH</i>	
Domestic	5.76 to 9.59
Domestic/Stock	7.48 to 9.53
Stock	5.84 to 9.33
<i>Water Levels (feet)</i>	
Domestic	0 to 114.52
Domestic/Stock	5.62 to 30.44
Stock	1.41 to 21.19

When comparing TDS results from field analysis with the standards listed earlier in this summary, 13 domestic wells (AD016, AD018, AD046, AD057, AD063, AD137, AD145, AD174, AD213, AD215, AD222, AD224 and AD235) exceeded the drinking water standard, 1 domestic/stock well (ADS028) exceeded the drinking water standard; and 0 stock wells exceeded the livestock standard.

Water level is taken only when access into the well is possible.

The complete field data is provided in Appendix A, Table 1. Water Well Field and Lab Analysis Data – Domestic and Stock Wells.

*Laboratory Data*

The following laboratory results are from 109 samples collected from domestic water wells, 16 from domestic/stock wells and 22 from stock wells. They represent the range of data collected from the specific well-use group. “ND” represents non-detectible.

<b><i>Lab Data</i></b>	<b><i>Range</i></b>
<i>Alkalinity (mg/L)</i>	
Domestic	34 to 328
Domestic/Stock	125 to 243
Stock	79 to 292
<i>Calcium (mg/L)</i>	
Domestic	ND to 86
Domestic/Stock	ND to 58
Stock	ND to 101
<i>Chloride (mg/L)</i>	
Domestic	ND to 114
Domestic/Stock	ND to 11
Stock	ND to 60
<i>Fluoride (mg/L)</i>	
Domestic	ND to 8.9
Domestic/Stock	0.1 to 5.6
Stock	ND to 8.1
<i>Magnesium (mg/L)</i>	
Domestic	ND to 25
Domestic/Stock	ND to 11
Stock	ND to 16
<i>Potassium (mg/L)</i>	
Domestic	ND to 3
Domestic/Stock	ND to 2
Stock	ND to 14
<i>Sodium (mg/L)</i>	
Domestic	3 to 329
Domestic/Stock	15 to 262
Stock	9 to 386
<i>Sulfate (mg/L)</i>	
Domestic	ND to 565
Domestic/Stock	1 to 320
Stock	3 to 707
<i>TDS (mg/L)</i>	
Domestic	37 to 1120
Domestic/Stock	150 to 171
Stock	119 to 1250

When comparing chloride results from lab analysis with the standards listed earlier in this summary, there were no drinking or livestock water exceedences for domestic, domestic/stock or livestock water wells.

When comparing fluoride results from lab analysis with the standards listed earlier in this summary, 6 domestic wells exceeded the drinking water standard (AD020, AD021, AD022, AD193, AD197, AD206); 1 domestic/stock well (ADS004) exceeded the drinking water standard; and there were 0 stock wells that exceeded the livestock standard.

When comparing sulfate results from lab analysis with the standards listed earlier in this summary, 7 domestic wells exceeded the drinking water standard (AD016, AD018, AD057, AD063, AD145, AD213 and AD222), 1 domestic/stock well exceeded the drinking water standard (ADS028); and there were 0 stock wells that exceeded the livestock standard.

When comparing TDS results from lab analysis with the standards listed earlier in this summary, 14 domestic wells exceeded the drinking water standard (AD009, AD016, AD018, AD063, AD046, AD057, AD137, AD145, AD174, AD213, AD215, AD222, AD224 and AD238), 1 domestic/stock well exceeded the drinking water standard (ADS028); and there were 0 stock wells that exceeded the livestock standard.

The complete lab analysis data is provided in Appendix A, Table 1. Water Well Field and Lab Analysis Data – Domestic and Stock Wells.

*Water Wells Permitted Through the Wyoming State Engineer's Office for Miscellaneous Use*

Wells permitted for miscellaneous-use may include wells used for industrial purposes within the PAPA.

The following results are from field visits taken with a Hanna HI 991300 field meter.

<b><i>Field Data Collected</i></b>	<b><i>Range</i></b>
<i>Conductivity (us/cm)</i>	166 to 3999
<i>TDS (ppm)</i>	103 to 2000
<i>Temperature (Celcius)</i>	5.2 to 28.2
<i>pH</i>	6.0 to 10.0
<i>Water Levels (feet)</i>	4.5 to 517.52

The complete field data is provided in Appendix A, Table 2. Water Well Field and Lab Analysis Data – Miscellaneous Wells.

*Laboratory Data*

The following results are from 158 samples. “ND” represents non-detectible.

<b><i>Lab Data</i></b>	<b><i>Range</i></b>
<i>Alkalinity (mg/L)</i>	85 to 291
<i>Calcium (mg/L)</i>	ND to 103
<i>Chloride (mg/L)</i>	ND to 253
<i>Fluoride (mg/L)</i>	ND to 12.8
<i>Magnesium (mg/L)</i>	ND to 30
<i>Potassium (mg/L)</i>	ND to 7
<i>Sodium (mg/L)</i>	5 to 857
<i>Sulfate (mg/L)</i>	ND to 1610
<i>TDS (mg/L)</i>	178 to 2570

The complete lab analysis data is provided in Appendix A, Table 2. Water Well Field and Lab Analysis Data – Miscellaneous Wells.

## *Total Petroleum Hydrocarbon Results*

When dealing with TPH in water wells, WYDEQ does have a set of ground water cleanup levels to help guide them in determining a point of contamination:

- *Ground Water Cleanup Levels:* DRO, 1.1 mg/L or 10 mg/L; GRO, 7.3 mg/L; benzene, 5 ug/L; ethylbenzene, 700 ug/L; m+p-Xylenes, 10,000 ug/L; o-Xylene, 10,000 ug/L; and toluene, 1,000 ug/L.

The cleanup level for DRO can be either 1.1 mg/L or 10 mg/L depending on the results of other parameters, some of which are not currently tested for by SCCD.

TPH reported as Diesel Range Organics (DRO), Gasoline Range Organics (GRO) or BTEX have been detected in a total of 26 wells from August 1, 2008 through July 31, 2009. Twenty -three of these water wells are miscellaneous use, two are domestic use and one is a stock well. Details regarding the sampling of the two domestic use wells are below:

*AD213:* The first year this well was sampled (2008), there was a slight detection of GRO. Further analysis showed non-detect for GRO and BTEX. SCCD had learned that the well was new and hadn't been run much. The well was last sampled August 2009 with non-detects for all TPH parameters.

*AD238:* This well was first sampled with new polyethylene bailers in June, 2009. The results came back with DRO and GRO detections, with the GRO being over the cleanup level. Another sample was collected a month later, again with new polyethylene bailers. The results confirmed the DRO and GRO detections, as well as detections of benzene over the cleanup level and o-Xylene under the cleanup level. The well was drilled two years prior, but has never had a pump installed. SCCD is currently working with the well owner to have a pump installed for further testing.

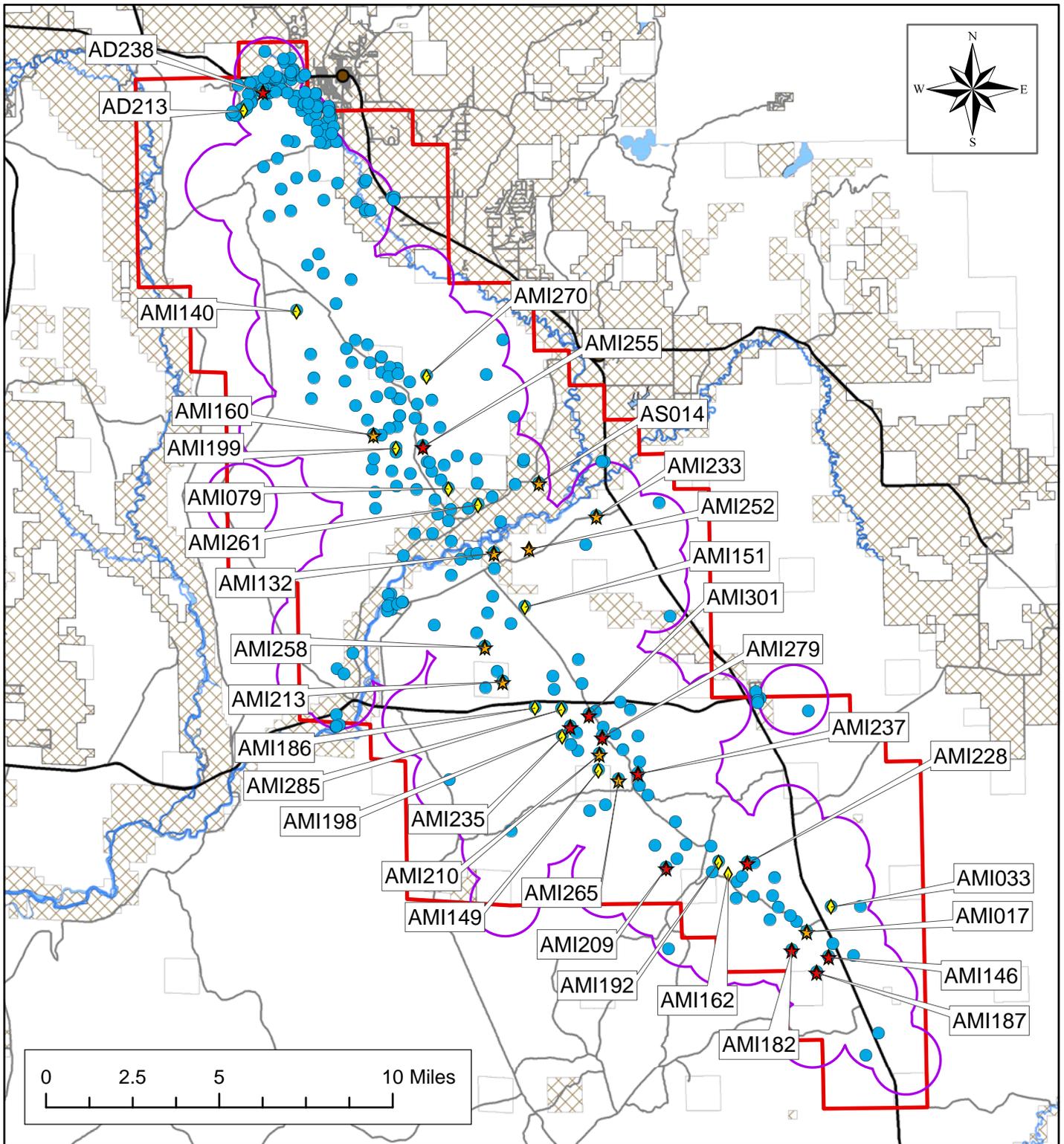
The following laboratory results are from samples collected from August 1, 2008 through July 31, 2009. BTEX (benzene, ethylbenzene, m+p-Xylenes, o-Xylene, and toluene) was only tested for when previous results showed a detection of DRO and / or GRO for a particular water well.

- *DRO* was detected in a total of 14 wells with results ranging from 1.0 mg/L to 78 mg/L. Of those, 13 were miscellaneous-use wells (AMI017, AMI033, AMI079, AMI132, AMI151, AMI187, AMI209, AMI228, AMI255, AMI258, AMI265, AMI279 and AMI301). The remaining well is AD238, a domestic use well. Two wells (AMI187 and AMI258) had DRO detections that were over the cleanup level.
- *GRO* was detected in a total of 13 wells with results ranging from .083 mg/L to 21.4 mg/L. Of those, 11 were miscellaneous-use wells (AMI017, AMI132, AMI146, AMI182, AMI187, AMI210, AMI213, AMI233, AMI237, AMI258 and AMI301). The remaining 2 wells were domestic use wells, AD213 and AD238. One well's GRO detections was over the cleanup level (AD238). The remaining wells had GRO levels under the cleanup level.

- *Benzene* was detected in a total of 8 wells with results ranging from .56 ug/L to 84 ug/L. Of those, 7 were miscellaneous-use wells (AMI132, AMI146, AMI182, AMI187, AMI198, AMI237 and AMI258). The remaining well is AD238, a domestic use well. Benzene levels, for all but 2 wells (AMI132 and AMI258), were over the cleanup level.
- *Ethylbenzene* was detected in a total of 3 wells with results ranging from 1.5 ug/L to 16 ug/L. All 3 were miscellaneous-use wells (AMI132, AMI237 and AMI258) with levels under the cleanup level.
- *m+p-Xylenes* was detected in a total of 5 wells with results ranging from 1.5 ug/L to 110 ug/L. All 5 were miscellaneous-use wells (AMI132, AMI198, AMI209, AMI237 and AMI258) with levels under the cleanup level.
- *o-Xylene* was detected in a total of 4 wells with results ranging from 3.7 ug/L to 44 ug/L. Three of those were miscellaneous-use wells (AMI132, AMI237 and AMI258) and 1 was a domestic use well (AD238). All levels of o-Xylene were under the cleanup level.
- *Toluene* was detected in a total of 12 wells with results ranging from 1.2 ug/L to 150 ug/L. All were miscellaneous-use wells (AMI017, AMI132, AMI146, AMI151, AMI160, AMI192, AMI198, AMI209, AMI213, AMI233, AMI237 and AMI258) with levels under the cleanup level.

The TPH data for all wells with detectable TPH is provided in Appendix C, Table 4. Water Wells With Historical TPH Detections. Water wells with past TPH detections are included in the report for comparison purposes. Any result exceeding the cleanup level used by WYDEQ are indicated in red. For samples collected after July 31, 2009, dates are indicated in blue. These samples fall outside of this report's cut-off date and will be included in the report prepared by SCCD in 2010. See Map 3. for locations of water wells with past TPH detections.

# Map 3. Water Wells With Past Hydrocarbon Detections



- |               |               |   |  |
|---------------|---------------|---|--|
| Private Lands | Main Rivers   | Pinedale Anticline Project Area         | Wells With Hydrocarbon Detections - Under Standard Last Time Sampled |
| Public Lands  | Main Highways | 1-Mile Buffer for 2009                  | Wells With Hydrocarbon Detections - Over Standard Last Time Sampled  |
| Cities        | Other Roads   | Wells Visited 08/01/08 through 07/31/09 | Wells With Past Hydrocarbon Detections                               |

Sublette County Conservation District / Pinedale Anticline Ground Water Data / Created by Delsa Allen / October 2009

The Sublette County Conservation District shall not be held liable for improper or incorrect use of the data described and/or contained herein. These data are not legal documents and are not intended to be used as such. The information contained in the data is dynamic and changes over time. It is the responsibility of the data user to use the data appropriately and consistently within the limits of the data. The Sublette County Conservation District provides no warranty, expressed or implied, as to the accuracy, reliability, or completeness of the data. Although these data have been processed successfully on a computer system at the Sublette County Conservation District offices, no warranty expressed or implied is made regarding the utility of the data on another system or for general or scientific purposes, nor shall the act of distribution constitute any such warranty. This disclaimer applies both to individual use of the data and consolidated use with other data.

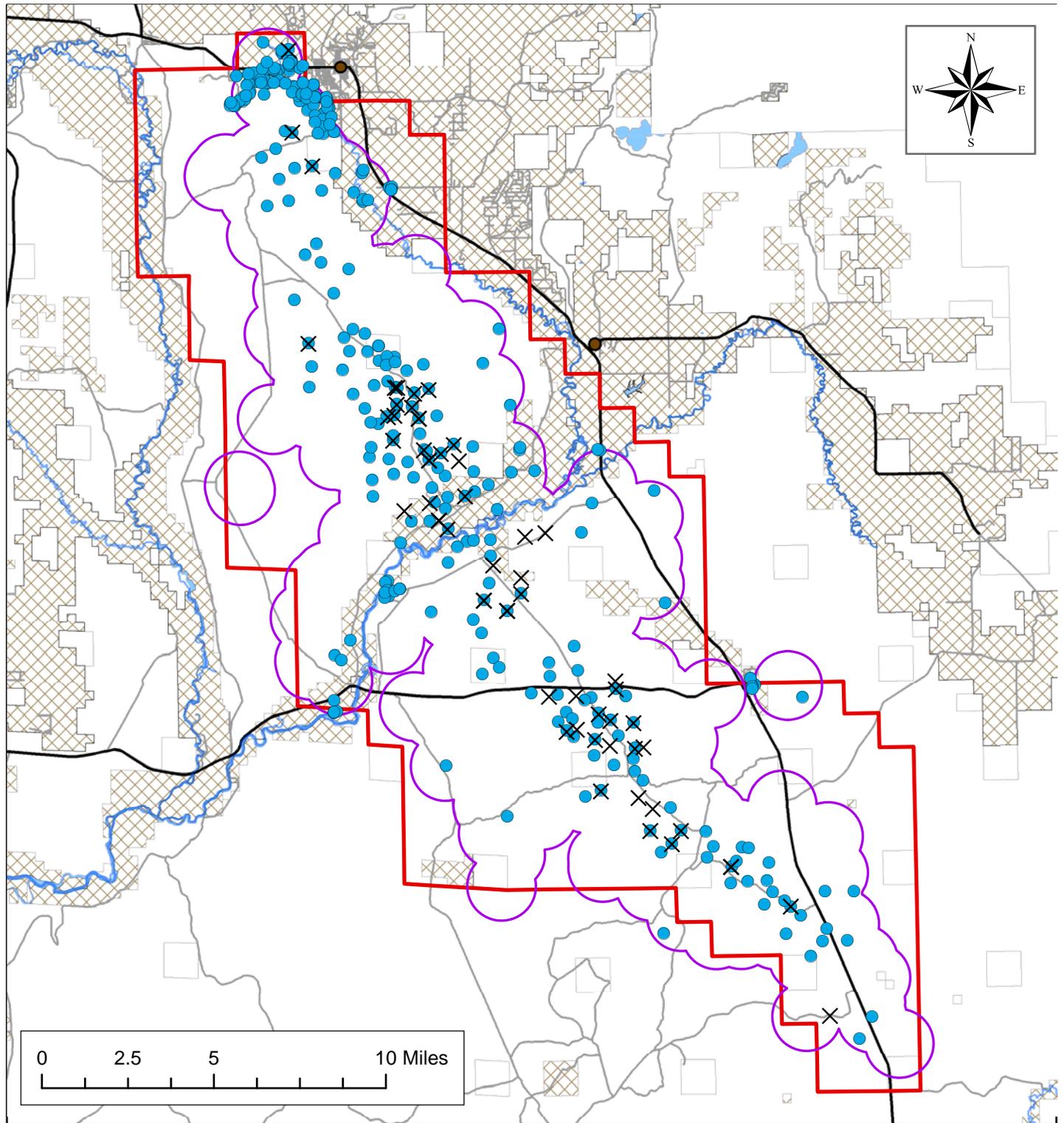
### *Plugged Water Wells*

A number of water wells have been plugged and abandoned within the PAPA since the beginning of the SCCD ground water monitoring program. Below are the wells plugged as of 2009:

AMI005	New Fork Unit #13-10W	AMI164	Mesa 1-33
AMI010	Lizard Head 11-8 WW	AMI169	Mesa 5-35
AMI012	Pinedale Federal #13-19W	AMI181	MESA 2-35
AMI015	Antelope 14-22W	AMI183	MESA 11-22
AMI016	Sherlock Federal 15-8	AMI184	MESA 6-18
AMI026	New Fork Unit #11-24W	AMI193	Warbonnet 4-10
AMI032	Mesa 10-21D Water Well	AMI196	Warbonnet 8-22
AMI034	Antelope 11-4W	AMI197	Warbonnet 11-23
AMI037	Rainbow 7-31	AMI202	Warbonnet 3-3
AMI080	Gannett 13-16	AMI203	Warbonnet 16-4
AMI081	Mesa 7-27-32-109	AMI204	Warbonnet 16-10
AMI083	Jensen #1	AMI206	Warbonnet 5-9
AMI089	Warbonnet 6-26	AMI210	Warbonnet 10-9D
AMI094	Mesa Unit # 10-21D # 2	AMI230	Mesa 3-27
AMI097	Mesa 8-28 Water Well	AMI231	Riverside 10-13
AMI098	Mesa 7-28 Water Well	AMI232	Warbonnet 5-25
AMI107	Riverside 9-2	AMI234	Warbonnet 5-4
AMI108	Jensen # 11-11W	AMI245	Mesa 9-22 CD
AMI123	Riverside 16-3	AMI247	Boulder 15-18
AMI127	Mesa 7-34	AMI251	BOULDER 14-34
AMI128	Mesa 9-34	AMI252	Boulder 15D-7D
AMI128	Mesa 9-34	AMI257	Mesa 7C-35D
AMI130	Riverside 4-10	AMI263	Warbonnet 1-21
AMI137	Warbonnet 9-26	AMI266	Warbonnet 6-5
AMI147	Warbonnet 13-11	AMI267	Warbonnet 8B-10D
AMI151	Boulder 7-19 Water Well	AMI269	Warbonnet 8-8
AMI157	Mesa 1-28D Well # 2	AS045	Wilson #2

Three of the above water wells had TPH detections, all under-standard: AMI151, AMI210 and AMI252. Refer to Appendix A, Table 4. Water Wells With Past TPH Detections for further information.

# Map 4. Plugged Water Wells



- |               |               |                                 |   |
|---------------|---------------|---------------------------------|---|
| Private Lands | Main Rivers   | Pinedale Anticline Project Area | Wells Visited 08/01/08 through 07/31/09 |
| Public Lands  | Main Highways | 1-Mile Buffer for 2009          | Plugged Water Wells                     |
| Cities        | Other Roads   |                                 |   |

Sublette County Conservation District / Pinedale Anticline Ground Water Data / Created by Delsa Allen / October 2009

The Sublette County Conservation District shall not be held liable for improper or incorrect use of the data described and/or contained herein. These data are not legal documents and are not intended to be used as such. The information contained in the data is dynamic and changes over time. It is the responsibility of the data user to use the data appropriately and consistently within the limits of the data. The Sublette County Conservation District provides no warranty, expressed or implied, as to the accuracy, reliability, or completeness of the data. Although these data have been processed successfully on a computer system at the Sublette County Conservation District offices, no warranty expressed or implied is made regarding the utility of the data on another system or for general or scientific purposes, nor shall the act of distribution constitute any such warranty. This disclaimer applies both to individual use of the data and consolidated use with other data.

## Literature Cited

The Record of Decision for the Environmental Impact Statement for the Pinedale Anticline Oil and Gas Exploration and Development Project, Sublette County, Wyoming, Bureau of Land Management, Pinedale Field Office, July 2000.

Water Quality Rules and Regulations, Chapter 8, Wyoming Department of Environmental Quality, 2003.

Voluntary Remediation Program, Fact Sheet #12, Soil Cleanup Level Look-Up Table, Appendix A: Cleanup Levels for Total Petroleum Hydrocarbons in Soil and Groundwater, Wyoming Department of Environmental Quality, 2008