

# Pinedale Anticline Ground Water Data Summary

Data collected by the Sublette County Conservation District  
January 1, 2010 through December 31, 2010

Annual Report  
To

Pinedale Anticline Working Group / Bureau of Land Management, Pinedale Field Office  
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*Volume 1 of 4*



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## **Introduction**

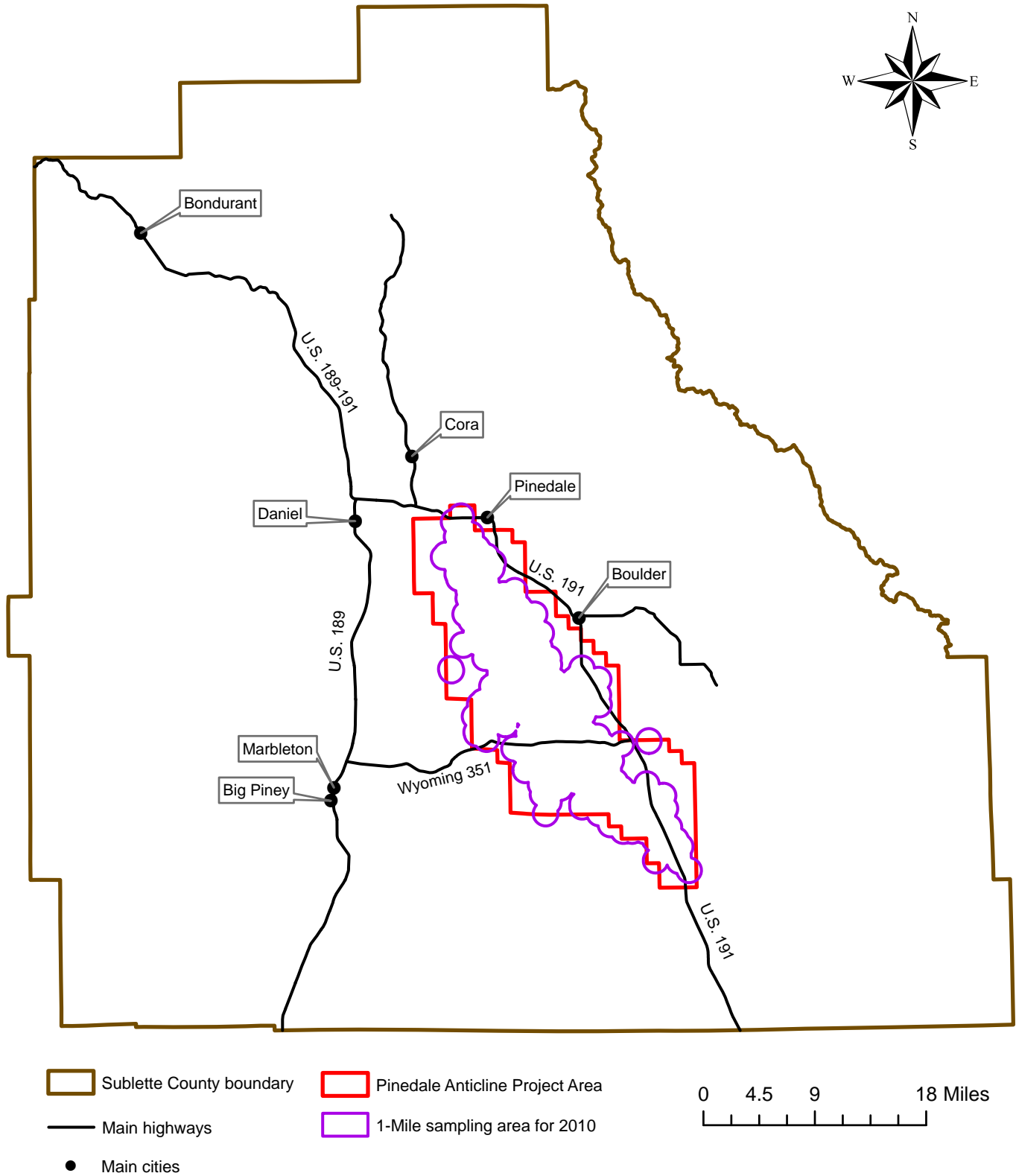
The Pinedale Anticline Project Area (PAPA), which is currently undergoing gas exploration development, is located south of Pinedale, WY and north of the Jonah gas field. It is bordered by the Green River to the west and Highway 191 to the east. The Record of Decision (ROD) for the Environmental Impact 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. As of December 31, 2010, the SCCD has collected 1734 ground water samples from water wells within one mile of an existing or proposed gas well within the PAPA.

## **Report Objective**

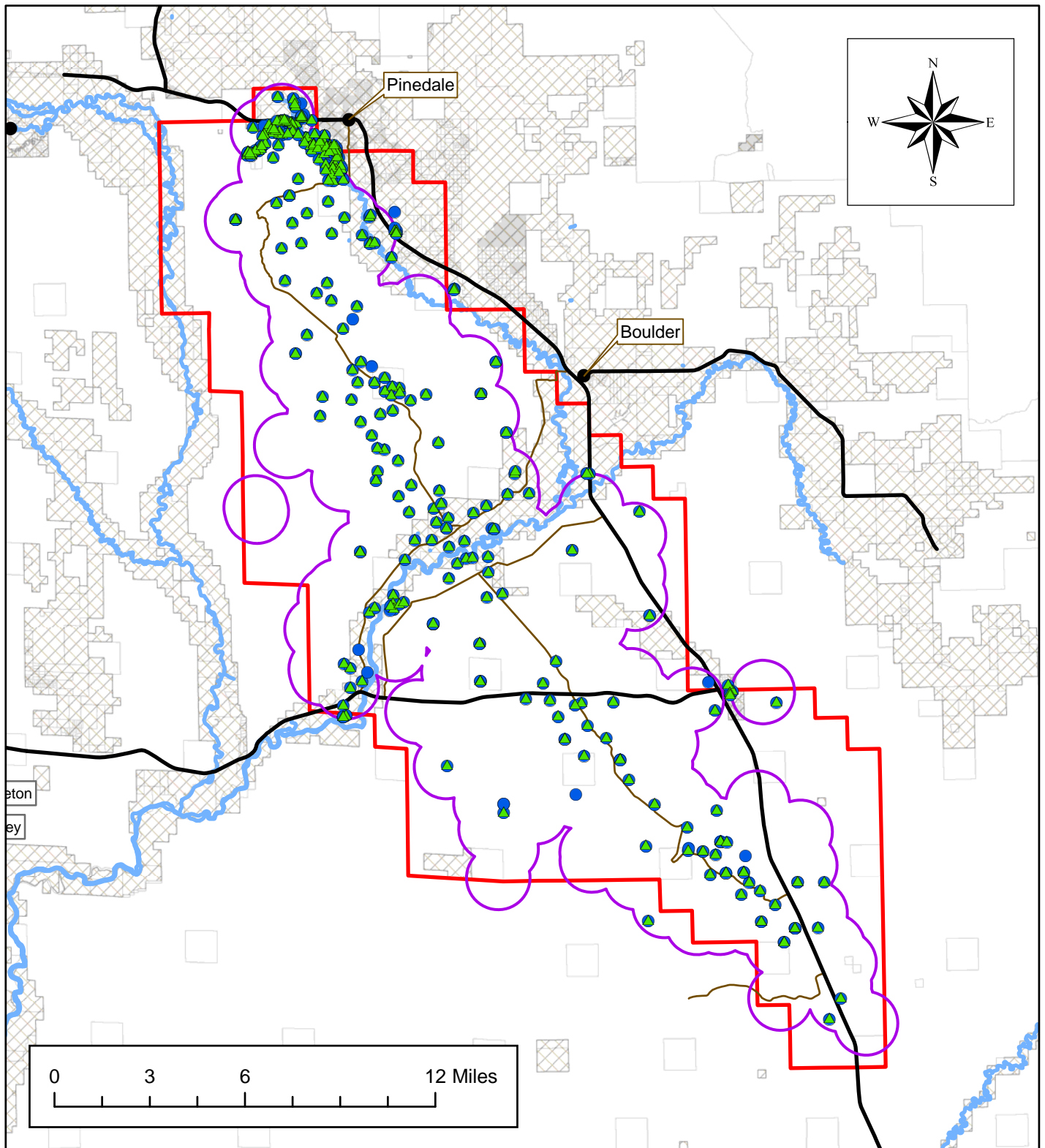
The purpose of this report is to provide a summary of the data collection procedures, field data and the lab analysis results from January 1, 2010 through December 31, 2010. See Map 2. Historical results have been included in Appendix A, Table 1 and Table 2, for reference purposes.

# Map 1. PAPA Boundary Within Sublette County



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# Map 2. Water Wells Visited vs Sampled



- |               |                             |                                 |                       |
|---------------|-----------------------------|---------------------------------|-----------------------|
| Private lands | Main highways               | Pinedale Anticline Project Area | Wells sampled in 2010 |
| Main rivers   | Secondary roads within PAPA | 1-Mile sampling area for 2010   | Wells visited in 2010 |
| Main cities   |                             |                                 |                       |

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## 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.

Samples have been tested further for alkalinity, calcium, chloride, fluoride, magnesium, potassium, sodium, sulfate and TDS 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 methods SW8021B and SW8260.

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 to insure credibility.

## Results

Starting January 1, 2010 through December 31, 2010, 305 field visits took place with 309 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) have 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*

*Field Data*

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.

<i><b>Field Data Collected</b></i>	<i><b>Range</b></i>
<i>Conductivity (us/cm)</i>	
Domestic	102 to 2009
Domestic/Stock	285 to 1488
Stock	207 to 2421
<i>TDS (ppm)</i>	
Domestic	51 to 1005
Domestic/Stock	143 to 744
Stock	103 to 1211
<i>Temperature (Celcius)</i>	
Domestic	6.0 to 25.9
Domestic/Stock	2.2 to 19.0
Stock	4.9 to 17.3
<i>pH</i>	
Domestic	6.59 to 9.78
Domestic/Stock	6.82 to 9.60
Stock	6.60 to 9.65
<i>Water Levels (feet)</i>	
Domestic	0 to 111.3
Domestic/Stock	1.3 to 113.82
Stock	0 to 365.85

When comparing TDS results from field analysis with the standards listed earlier in this summary, 13 domestic wells (AD016, AD018, AD046, AD057, AD063, AD145, AD174, AD194, AD213, AD215, AD222, AD234 and AD242) exceeded the drinking water standard, 1 domestic/stock well exceeded the drinking water standard (ADS028), 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 Data, 01/01/10 – 12/31/10 Plus Historical Results 01/01/04 – 12/31/10: Wells Permitted for Domestic-use and Stock-use.

*Laboratory Data*

The following laboratory results are from 119 samples collected from domestic water wells, 14 from domestic/stock wells and 31 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	50 to 523
Domestic/Stock	136 to 269
Stock	66 to 263
<i>Calcium (mg/L)</i>	
Domestic	ND to 79
Domestic/Stock	ND to 55
Stock	ND to 95
<i>Chloride (mg/L)</i>	
Domestic	ND to 96
Domestic/Stock	ND to 11
Stock	2 to 64
<i>Fluoride (mg/L)</i>	
Domestic	ND to 8.7
Domestic/Stock	0.1 to 5.2
Stock	0.1 to 7.8
<i>Magnesium (mg/L)</i>	
Domestic	ND to 21
Domestic/Stock	ND to 10
Stock	ND to 13
<i>Potassium (mg/L)</i>	
Domestic	ND to 3
Domestic/Stock	ND to 2
Stock	ND to 8
<i>Sodium (mg/L)</i>	
Domestic	3 to 373
Domestic/Stock	18 to 249
Stock	8 to 574
<i>Sulfate (mg/L)</i>	
Domestic	ND to 581
Domestic/Stock	0 to 319
Stock	0 to 1070
<i>TDS (mg/L)</i>	
Domestic	57 to 1300
Domestic/Stock	162 to 722
Stock	133 to 1710

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 stock water wells.

When comparing fluoride results from lab analysis with the standards listed earlier in this summary, 4 domestic wells (AD020, AD022, AD197 and AD203) exceeded the drinking water standard, 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, 9 domestic wells (AD016, AD018, AD057, AD063, AD145, AD194, AD213, AD222 and AD234) exceeded the drinking water standard, 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, 15 domestic wells (AD016, AD018, AD046, AD057, AD063, AD137, AD145, AD174, AD194, AD213, AD215, AD222, AD224, AD234 and AD242) exceeded the drinking water standard, 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 Data, 01/01/10 – 12/31/10 Plus Historical Results 01/01/04 – 12/31/10: Wells Permitted for Domestic-use and Stock-use.

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

*Field Data*

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>	255 to 2521
<i>TDS (ppm)</i>	128 to 1261
<i>Temperature (Celcius)</i>	5.0 to 18.8
<i>pH</i>	7.03 to 10.17
<i>Water Levels (feet)</i>	0 to 692.57

The complete field data is provided in Appendix A, Table 2. Water Well Field Data, 01/01/10 – 12/31/10 Plus Historical Results 01/01/04 – 12/31/10: Wells Permitted for Miscellaneous-use.

*Laboratory Data*

The following results are from 145 samples. "ND" represents non-detectible.

<b><i>Lab Data</i></b>	<b><i>Range</i></b>
<i>Alkalinity (mg/L)</i>	76 to 350
<i>Calcium (mg/L)</i>	ND to 72
<i>Chloride (mg/L)</i>	1 to 271
<i>Fluoride (mg/L)</i>	0.1 to 13
<i>Magnesium (mg/L)</i>	ND to 12
<i>Potassium (mg/L)</i>	1 to 2
<i>Sodium (mg/L)</i>	7 to 597
<i>Sulfate (mg/L)</i>	ND to 1060
<i>TDS (mg/L)</i>	172 to 1770

The complete lab analysis data is provided in Appendix A, Table 2. Water Well Field Data, 01/01/10 – 12/31/10 Plus Historical Results 01/01/04 – 12/31/10: Wells Permitted for Miscellaneous-use.

## *Total Petroleum Hydrocarbon Results*

When dealing with TPH in water wells, WYDEQ uses a set of ground water clean-up 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 have not been tested for by SCCD.

TPH reported as Diesel Range Organics (DRO), Gasoline Range Organics (GRO) or BTEX have been detected in a total of 14 wells from January 1, 2010 through December 31, 2010. Thirteen of these water wells are permitted for miscellaneous-use and one is a stock-use water well.

The following laboratory results are from samples collected from January 1, 2010 through December 31, 2010. BTEX (benzene, ethylbenzene, m+p-Xylenes, o-Xylene, and toluene) was only tested for when previous results showed TPH detections.

- *DRO* was detected in a total of 3 wells with results ranging from 10 mg/L to 85 mg/L. All 3 were miscellaneous-use wells (AMI187, AMI214 and AMI258). All levels were at or over the cleanup levels.
- *GRO* was detected in a total of 10 wells with results ranging from 0.044 mg/L to 0.73 mg/L. Of those, 9 were miscellaneous-use wells (AMI017, AMI146, AMI182, AMI187, AMI214, AMI237, AMI240, AMI258 and AMI285). The remaining well is AS064, a stock well. All levels were under the cleanup level.
- *Benzene using method SW8021B* was detected in a total of 5 wells with results ranging from 5.8 ug/L to 76 ug/L. All were miscellaneous-use wells (AMI146, AMI182, AMI187, AMI237 and AMI285) with levels over the cleanup level.
- *Benzene using method SW8260B* was detected in a total of 2 wells with results ranging from 5.8 ug/L to 64 ug/L. Both were miscellaneous-use wells (AMI237 and AMI285) with levels over the cleanup level.
- *Ethylbenzene using method SW8021B* was detected in a total of 2 wells with results ranging from 1.7 ug/L to 4.5 ug/L. Both were miscellaneous-use wells (AMI237 and AMI258) with levels under the cleanup level.
- *Ethylbenzene using method SW8260B* was detected in a total of 2 wells with results ranging from 1.3 ug/L to 4.5 ug/L. Both were miscellaneous-use wells (AMI237 and AMI258) with levels under the cleanup level.
- *m+p-Xylenes using method SW8021B* was detected in a total of 4 wells with results ranging from 4.9 ug/L to 36 ug/L. All were miscellaneous-use wells (AMI134, AMI214, AMI237 and AMI258) with levels under the cleanup level.
- *m+p-Xylenes using method SW8260B* was detected in a total of 4 wells with results ranging from 2.2 ug/L to 37 ug/L. All were miscellaneous-use wells

(AMI134, AMI237, AMI258 and AMI285) with levels under the cleanup level.

- *o-Xylene using method SW8021B* was detected in a total of 3 wells with results ranging from 1.1 ug/L to 9.1 ug/L. All were miscellaneous-use wells (AMI214, AMI237 and AMI258) with levels under the cleanup level.
- *o-Xylene using method SW8260B* was detected in a total of 3 wells with results ranging from 1.1 ug/L to 7.0 ug/L. All were miscellaneous-use wells (AMI134, AMI237 and AMI258) with levels under the cleanup level.
- *Toluene using method SW8021B* was detected in a total of 10 wells with results ranging from 1.1 ug/L to 160 ug/L. Nine were miscellaneous-use wells (AMI017, AMI033, AMI162, AMI187, AMI214, AMI228, AMI237, AMI258 and AMI285). The remaining well is AS064, a stock well. All levels were under the cleanup level.
- *Toluene using method SW8260B* was detected in a total of 9 wells with results ranging from 1.2 ug/L to 170 ug/L. Eight were miscellaneous-use wells (AMI017, AMI033, AMI187, AMI214, AMI228, AMI237, AMI258 and AMI285). The remaining well is AS064, a stock well. All levels were under the cleanup level.

The complete TPH analysis data is provided in Appendix B, Table 3. History of Water Wells With TPH Detections 01/01/04 – 12/31/10 including additional parameters tested for with method SW8260B.



*Details of water wells with new detectible TPH since last reported (Pinedale Anticline Ground Water Data Summary, March 30, 2010).*

AMI214 / Warbonnet 12-9 / Shell

This well has been sampled since 2005. The first TPH detection was from the 06/15/10 sample with a DRO detection of 15 mg/L and a GRO detection of 0.28 mg/L. The confirmation sample collected 07/26/10 showed a DRO detection of 10 mg/L and a GRO detection 0.22 mg/L. BTEX method SW8021B showed detections of m+p-Xylenes, o-Xylene and toluene. BTEX method SW8260B showed a detection of toluene. All BTEX detections were under WYDEQ clean-up levels. Both 2010 samples were collected with bailers.

AMI240 / Stewart Point 6-17 / QEP

This well has been sampled since 2008. The first TPH detection was from the 06/29/10 sample with a GRO detection of 0.044 mg/L. The confirmation sample collected 07/23/10 showed ND (non-detect) for DRO, GRO and BTEX other than an acetone detection of 40 ug/L using method SW8260B. Both 2010 samples were collected with bailers.

AS064 / Baumgartner #21-24 (also known as the Blackhawk well) / BLM stock well

This well has not been sampled prior to 2010. The first TPH detection was from the 07/06/10 sample with a GRO detection of 0.068 mg/L. Two confirmation samples were collected 08/04/10. The first confirmation sample was collected after 3 casing volumes had been flushed (after about an hour). Due to the low water pressure, a second confirmation sample was collected after another 3 casing volumes of water had been flushed. Both confirmation samples showed ND (non-detect) for both DRO and GRO, yet showed detections of toluene with both BTEX methods, SW8021B and SW8260B. The toluene results from the second confirmation sample showed a level that was less than half from the first confirmation sample. The 07/06/10 sample was collected using a pump that was powered by a propane generator. The 08/04/10 samples were collected using a pump that was powered by a portable gas generator. All toluene results were under WYDEQ clean-up levels. The permittee using this well indicated that the pump was pulled from the well earlier in 2010 and felt the detections could be associated with materials used when the pump and piping was put back into the well after maintenance was performed.

The complete TPH analysis data is provided in Appendix B, Table 3. History of Water Wells With TPH Detections 01/01/04 – 12/31/10 including additional parameters tested for with method SW8260B.

## 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

Pinedale Anticline Ground Water Data Summary, Sublette County Conservation District, March 30, 2010