



January 21, 2010

Certified Mail Return Receipt Requested # 7008 3230 0003 3234 7225

Mr. Bruce Hopke  
99 Hawk Ridge Trail  
Walsenburg, CO 81089-9633

RE: Complaint 200217338  
Groundwater Quality of CBM Produced Water

Dear Bruce:

COGCC staff collected water samples from three of Petroglyph's CBM wells in order to better understand the chemistry of water that might be used (after treatment) if Phase 2 of the MIMMP is authorized by the COGCC and other regulatory agencies. All three of these CBM wells are completed in the Vermejo Formation. One of the wells (Rohr 09-04) also has an open hole completion in the Trinidad Sandstone. Water samples were collected for general organic and inorganic water quality testing as well as for analysis of dissolved methane and volatile and semi-volatile organic compounds. A summary of the results of the chemical analyses is presented below. The analytical results are also compared to published water quality standards. Water samples for gas composition and isotopic analyses were collected.

### **FIELD TESTING**

Peter Gintautas of the COGCC conducted the sampling. Replicate samples were collected by staff of Petroglyph. The wells had been pumped for approximately 3 days prior to the sample collection. The samples for general chemical analyses were then shipped to TestAmerica Laboratories, Inc. in Arvada, CO and received on September 18, 2009. The samples for gas composition and isotopic analyses were then shipped to Isotech Laboratories in Champaign, IL and received on September 18, 2009.

### **COMPARISON OF INORGANIC ANALYTICAL RESULTS TO CDPHE INORGANIC STANDARDS**

The Water Quality Control Commission (WQCC) of the Colorado Department of Public Health and Environment (CDPHE) has established "Domestic Use-Quality" human health standards and drinking water standards. Analytical data for the samples from the three CBM wells were compared to these standards. This information is summarized in Tables 1, 2 and 3 which are located in Attachment 1 and discussed in briefly below. Please keep in mind that these "Domestic Use-Quality Standards" were established for **municipal public** drinking water supplies and often people use and consume ground water from private wells that exceed these standards. The analytical reports from TestAmerica Laboratories, Inc. are included as Attachment 2.

Table 1 summarizes the results of general inorganic water quality testing of produced water from the Rohr 09-10 CBM well. Table 2 summarizes the results of general inorganic water quality testing of produced water from the Rohr 04-10 CBM well. Table 3 summarizes the results of general inorganic water quality testing of produced water from the Rohr 09-04 CBM well. Each table also includes results from samples collected by Petroglyph on the same day. The column labeled Accutest results is a summary of the results of testing of the samples collected by Petroglyph staff.

## **VOLATILE ORGANIC COMPOUNDS ANALYTICAL RESULTS**

TestAmerica Laboratories analyzed for the 80 target volatile organic compounds (VOC) in the produced water samples. The lab did not detect any of the 80 compounds above the reporting limit in two of the three samples (Rohr 09-10 and Rohr 04-10). Two VOC target compounds were reported by TestAmerica from the water samples collected from the Rohr 09-04. A summary of VOC results from this and one previous sampling event at the Rohr 09-04 are included in Table 4. All of the compounds detected and reported are aromatic in structure. The applicable upper threshold concentration for Colorado groundwaters is shown in the last column. Some of the results are flagged with a J which indicates the compound was detected as present but the concentration reported is estimated because the reported value is less than the reporting limit established by the lab for that compound.

Analyte	Date Sampled	Date Sampled	Date Sampled	Date Sampled	Ground Water Standard $\mu\text{g/l}$
	11/12/2007	11/12/2007	09/17/2009	09/17/2009	
	Result $\mu\text{g/l}$	Result $\mu\text{g/l}$	Result $\mu\text{g/l}$	Result $\mu\text{g/l}$	
benzene	0.68	0.7	1.1	0.98	5.0
toluene	0.87	0.88	ND <1.0	0.570	560
ethylbenzene	0.1 J	ND <0.50	ND <1.0	ND <0.50	700
xylene, total	0.66 J	ND <0.50	ND <2.0	1.59	1400
1,2,4-trimethylbenzene	0.18 J	ND <0.50	ND <1.0	0.550	No Standard
naphthalene	0.66 J	0.8	1.5	1.46	140

## **SEMI-VOLATILE ORGANIC COMPOUNDS ANALYTICAL RESULTS**

TestAmerica Laboratories analyzed for the 124 target semi-volatile organic compounds (SVOC) in the produced water samples. The lab did not detect any of the 124 compounds above the reporting limit in the samples from the three CBM wells.

## **GAS COMPOSITION AND ISOTOPIC ANALYSIS**

Isotech Laboratories analyzed water samples collected from the three CBM wells for composition of gases present in the water and determined isotopic ratios for methane, water and inorganic carbon present in the water. The analytical reports are included as Attachment 3 to this letter. Figure 1 in Attachment 4 is a plot of all available methane isotopic data from CBM wells in Huerfano county, from domestic water wells in Huerfano county and from soil gas seeps in Huerfano county. The isotopic ratios as well as the gas composition for most of the samples are consistent with thermogenic coal bed sources for the methane present in the samples. Oxidation processes may have altered some of the isotopic ratios.

## **CONCLUSIONS**

Tables 1, 2 and 3 in Attachment 1 compare the results of the September 2009 sampling and analysis event to the groundwater standards promulgated by the Water Quality Control Commission of the Colorado Department of Public Health and the Environment. All parameters tested are below the groundwater standards with the exception of fluoride (F), total dissolved solids (TDS) and pH. No standard exists for dissolved methane in groundwater or drinking water. However the staff of the COGCC view concentrations of dissolved methane greater than 1.1mg/l as a potential hazard. Dissolved methane at concentrations greater than 1.1mg/l can theoretically lead to degassing of the water with subsequent buildup to explosive levels in

small confined spaces. The three samples contain dissolved methane at concentrations that greatly in excess of the 1.1mg/l concentration of concern.

These samples were collected from three wells identified by Petroglyph as potential sources of water to use in Phase 2 of the MIMMP assuming all necessary regulatory approvals are granted. This data should aid the staff of the COGCC and others in evaluating potential implementation of the MIMMP Phase 2. Thank you for your concern and continued cooperation in this matter.

If you have any questions or would like to discuss these matters further, please contact me at 719-846-3091 or by email at [peter.gintautas@state.co.us](mailto:peter.gintautas@state.co.us) . We appreciate your continued cooperation with the staff of the COGCC in granting continued access to sample and investigate the occurrence of methane in the Poison Canyon aquifer.

Sincerely,  
Colorado Oil and Gas Conservation Commission

Peter Gintautas  
Environmental Protection Specialist

Attachments:    Attachment 1 -   Tables 1, 2 and 3 - Analytical Summaries  
                         Attachment 2 -   TestAmerica Laboratories Reports  
                         Attachment 3 -   Isotech Laboratories Reports  
                         Attachment 4 -   Methane Isotopic Composition Plot

cc:                 David Neslin, COGCC Director w/o attachments  
                         Debbie Baldwin, COGCC Environmental Protection Manager w/o attachments  
                         Tom Melland, Petroglyph w/o attachments

**TABLE 1**  
**ANALYTICAL SUMMARY**  
**Complaint 200218267**  
**Rohr 09-10**

Parameter	Rohr 09-10 Water Samples			CDPHE Standards		
	Sample Date					
	17-Sep-09					
	Test America Result	Accutest Result	Unit	Domestic	Agriculture	Units
Antimony	<0.002	<0.002	mg/l	0.006	NS	mg/l
Aluminum	<0.1	0.12	mg/l	NS	5	mg/l
Arsenic	<0.005	<0.002	mg/l	0.01	0.1	mg/l
Barium	0.054	0.058	mg/l	2.0	NS	mg/l
Beryllium	<0.001	<0.001	mg/l	0.004	0.1	mg/l
Boron	0.16	<0.2	mg/l	NS	0.75	mg/l
Cadmium	<0.0012	<0.0005	mg/l	0.005	0.01	mg/l
Calcium	1.3	1.6	mg/l	NS	NS	
Chromium	<0.01	0.0082	mg/l	0.1	0.1	mg/l
Cobalt	<0.01	NA	mg/l	NS	0.05	mg/l
Copper	<0.015	<0.01	mg/l	1	0.2	mg/l
Iron	<0.1	<0.2	mg/l	0.3	5	mg/l
Lead	<0.001	<0.001	mg/l	0.05	0.1	mg/l
Lithium	<0.01	NA	mg/l	NS	NS	
Magnesium	<0.2	0.087	mg/l	NS	NS	
Manganese	<0.01	0.0053	mg/l	0.05	0.2	mg/l
Mercury	NA	<0.0001	mg/l	0.002		mg/l
Molybdenum	0.0036	<0.005	mg/l	0.035	NS	mg/l
Nickel	<0.04	<0.01	mg/l	0.1	0.2	mg/l
Potassium	<3	0.99	mg/l	NS	NS	
Selenium	<0.005	0.0031	mg/l	0.05	0.02	mg/l
Silver	<0.001	<0.0002	mg/l	0.05	NS	mg/l
Sodium	260	276	mg/l	NS	NS	
Strontium	0.098	0.1	mg/l	NS	NS	
Thallium	<0.001	<0.001	mg/l	0.002	NS	mg/l
Uranium	<0.001	NA	mg/l	0.03	NS	mg/l
Vanadium	<0.01	NA		NS	0.1	mg/l
Zinc	<0.02	<0.005	mg/l	5	2	mg/l
Chloride	48	47.3	mg/l	250	NS	mg/l
Nitrite	NA	<0.31	mg/l	1.0	10	mg/l
Nitrate	NA	<0.045	mg/l	10.0	100	mg/l
Fluoride	11	12.4	mg/l	4.0	NS	mg/l
Total Dissolved Solids	610	622	mg/l	400	*1500	mg/l
pH	9	8.92	No units	6.5 - 8.5	6.5 - 8.5	No units
Sulfate	<5	0.49	mg/l	250	NS	mg/l
Bromide	0.38	0.41	mg/l	NS	NS	
Sulfide	NA	0.8	mg/l	NS	NS	
Total Alkalinity	460	452	mg/l	NS	NS	
Bicarbonate	380	401	mg/l	NS	NS	
Carbonate	79	50.9	mg/l	NS	NS	
Conductivity	1000	NA	umhos/cm	NS	NS	
methane	10	5.9	mg/l	NS	NS	

**Notes**

**CDPHE**

**Domestic**

**Agriculture**

**mg/l**

**umhos/cm**

**NA**

**ND**

**NS**

**\*\***

Colorado Department of Public Health and the Environment.

Water Quality Control Commission 5 CCR 1002-41, Regulation No. 41 - The Basic Standards For Groundwater.

\* Standards for agriculture complied from CDPHE and other of sources.

milligrams per liter (ppm or parts per million).

micromhos per centimeter

Not analyzed.

Not detected.

No Standard.

Health Advisory.

Human health standard.

Secondary standard.

Test America metals results are dissolved fraction. *Accutest metals results are total fraction.*

**TABLE 2**  
**ANALYTICAL SUMMARY**  
**Complaint 200218267**  
**Rohr 04-10**

Parameter	Rohr 04-10 Water Samples			CDPHE Standards		
	Sample Date					
	17-Sep-09					
	Test America Result	Accutest Result	Unit	Domestic	Agriculture	Units
Antimony	<0.002	<0.002	mg/l	0.006	NS	mg/l
Aluminum	<0.1	0.11	mg/l	NS	5	mg/l
Arsenic	<0.005	<0.002	mg/l	0.01	0.1	mg/l
Barium	0.11	0.11	mg/l	2.0	NS	mg/l
Beryllium	<0.001	<0.001	mg/l	0.004	0.1	mg/l
Boron	0.15	<0.2	mg/l	NS	0.75	mg/l
Cadmium	<0.0012	<0.0005	mg/l	0.005	0.01	mg/l
Calcium	1.9	2.6	mg/l	NS	NS	
Chromium	<0.01	0.0041	mg/l	0.1	0.1	mg/l
Cobalt	<0.01	NA	mg/l	NS	0.05	mg/l
Copper	<0.015	<0.01	mg/l	1	0.2	mg/l
Iron	<0.1	<0.2	mg/l	0.3	5	mg/l
Lead	<0.001	<0.001	mg/l	0.05	0.1	mg/l
Lithium	0.023	NA	mg/l	NS	NS	
Magnesium	<0.2	0.14	mg/l	NS	NS	
Manganese	0.011	0.0095	mg/l	0.05	0.2	mg/l
Mercury	NA	<0.0001	mg/l	0.002		mg/l
Molybdenum	<0.002	<0.005	mg/l	0.035	NS	mg/l
Nickel	<0.04	<0.01	mg/l	0.1	0.2	mg/l
Potassium	<3	0.99	mg/l	NS	NS	
Selenium	<0.005	0.0028	mg/l	0.05	0.02	mg/l
Silver	<0.001	<0.0002	mg/l	0.05	NS	mg/l
Sodium	270	266	mg/l	NS	NS	
Strontium	0.14	0.13	mg/l	NS	NS	
Thallium	<0.001	<0.001	mg/l	0.002	NS	mg/l
Uranium	<0.001	NA	mg/l	0.03	NS	mg/l
Vanadium	<0.01	NA		NS	0.1	mg/l
Zinc	<0.02	<0.005	mg/l	5	2	mg/l
Chloride	51	50.5	mg/l	250	NS	mg/l
Nitrite	NA	<0.31	mg/l	1.0	10	mg/l
Nitrate	NA	<0.045	mg/l	10.0	100	mg/l
Fluoride	8.4	10.2	mg/l	4.0	NS	mg/l
Total Dissolved Solids	670	670	mg/l	400	*1500	mg/l
pH	8.8	8.76	No units	6.5 - 8.5	6.5 - 8.5	No units
Sulfate	<5	0.84	mg/l	250	NS	mg/l
Bromide	0.44	0.46	mg/l	NS	NS	
Sulfide	NA	2.7	mg/l	NS	NS	
Total Alkalinity	490	490	mg/l	NS	NS	
Bicarbonate	420	454	mg/l	NS	NS	
Carbonate	76	35.7	mg/l	NS	NS	
Conductivity	1100	NA	umhos/cm	NS	NS	
methane	11	6.4	mg/l	NS	NS	

**Notes**

**CDPHE**

**Domestic**

**Agriculture**

**mg/l**

**umhos/cm**

**NA**

**ND**

**NS**

**\*\***

Colorado Department of Public Health and the Environment.

Water Quality Control Commission 5 CCR 1002-41, Regulation No. 41 - The Basic Standards For Groundwater.

\* Standards for agriculture complied from CDPHE and other of sources.

milligrams per liter (ppm or parts per million).

micromhos per centimeter

Not analyzed.

Not detected.

No Standard.

Health Advisory.

Human health standard.

Secondary standard.

Test America metals results are dissolved fraction. *Accutest metals results are total fraction.*

**TABLE 3**  
**ANALYTICAL SUMMARY**  
**Complaint 200218267**  
**Rohr 09-04**

Parameter	Rohr 09-04 Water Samples			CDPHE Standards		
	Sample Date					
	17-Sep-09					
	Test America Result	Accutest Result	Unit	Domestic	Agriculture	Units
Antimony	<0.002	<0.002	mg/l	0.006	NS	mg/l
Aluminum	<0.1	0.18	mg/l	NS	5	mg/l
Arsenic	<0.005	0.0024	mg/l	0.01	0.1	mg/l
Barium	0.14	0.15	mg/l	2.0	NS	mg/l
Beryllium	<0.001	<0.001	mg/l	0.004	0.1	mg/l
Boron	0.21	0.25	mg/l	NS	0.75	mg/l
Cadmium	<0.0012	<0.0005	mg/l	0.005	0.01	mg/l
Calcium	2.1	2.1	mg/l	NS	NS	
Chromium	<0.01	0.0086	mg/l	0.1	0.1	mg/l
Cobalt	<0.01	NA	mg/l	NS	0.05	mg/l
Copper	<0.015	<0.01	mg/l	1	0.2	mg/l
Iron	<0.1	<0.2	mg/l	0.3	5	mg/l
Lead	<0.001	<0.001	mg/l	0.05	0.1	mg/l
Lithium	0.05	NA	mg/l	NS	NS	
Magnesium	<0.2	0.19	mg/l	NS	NS	
Manganese	0.011	0.011	mg/l	0.05	0.2	mg/l
Mercury	NA	<0.0001	mg/l	0.002		mg/l
Molybdenum	0.0029	<0.005	mg/l	0.035	NS	mg/l
Nickel	<0.04	<0.01	mg/l	0.1	0.2	mg/l
Potassium	<3	1.4	mg/l	NS	NS	
Selenium	<0.005	0.0046	mg/l	0.05	0.02	mg/l
Silver	<0.001	<0.0002	mg/l	0.05	NS	mg/l
Sodium	280	306	mg/l	NS	NS	
Strontium	0.16	0.17	mg/l	NS	NS	
Thallium	<0.001	<0.001	mg/l	0.002	NS	mg/l
Uranium	<0.001	NA	mg/l	0.03	NS	mg/l
Vanadium	<0.01	NA		NS	0.1	mg/l
Zinc	<0.02	<0.005	mg/l	5	2	mg/l
Chloride	71	69.9	mg/l	250	NS	mg/l
Nitrite	NA	<0.31	mg/l	1.0	10	mg/l
Nitrate	NA	<0.045	mg/l	10.0	100	mg/l
Fluoride	11	12.4	mg/l	4.0	NS	mg/l
Total Dissolved Solids	710	704	mg/l	400	*1500	mg/l
pH	8.6	8.53	No units	6.5 - 8.5	6.5 - 8.5	No units
Sulfate	<5	0.81	mg/l	250	NS	mg/l
Bromide	0.67	0.67	mg/l	NS	NS	
Sulfide	NA	1.5	mg/l	NS	NS	
Total Alkalinity	520	493	mg/l	NS	NS	
Bicarbonate	460	476	mg/l	NS	NS	
Carbonate	56	17.3	mg/l	NS	NS	
Conductivity	1200	NA	umhos/cm	NS	NS	
methane	17	7.3	mg/l	NS	NS	

**Notes**

**CDPHE**

**Domestic**

**Agriculture**

**mg/l**

**umhos/cm**

**NA**

**ND**

**NS**

**\*\***

Colorado Department of Public Health and the Environment.

Water Quality Control Commission 5 CCR 1002-41, Regulation No. 41 - The Basic Standards For Groundwater.

\* Standards for agriculture complied from CDPHE and other of sources.

milligrams per liter (ppm or parts per million).

micromhos per centimeter

Not analyzed.

Not detected.

No Standard.

Health Advisory.

Human health standard.

Secondary standard.

Test America metals results are dissolved fraction. *Accutest metals results are total fraction.*

Lab #: 171129 Job #: 11984  
 Sample Name/Number: 05-055-06166 (Rohr 04-10)  
 Company: Colorado Oil & Gas Conservation  
 Date Sampled: 9/17/2009  
 Container: Dissolved Gas Bottle  
 Field/Site Name: Complaint 200218267  
 Location: Huerfano County  
 Formation/Depth:  
 Sampling Point:  
 Date Received: 9/18/2009 Date Reported: 10/01/2009

Component	Chemical mol. %	Delta 13C per mil	Delta D per mil	Delta 18O per mil
Carbon Monoxide -----	nd			
Hydrogen Sulfide -----	nd			
Helium -----	nd			
Hydrogen -----	nd			
Argon -----	na			
Oxygen + Argon -----	2.18			
Nitrogen -----	22.67			
Carbon Dioxide -----	0.33			
Methane -----	74.81	-51.14	-233.2	
Ethane -----	0.0077			
Ethylene -----	nd			
Propane -----	nd			
Iso-butane -----	nd			
N-butane -----	nd			
Iso-pentane -----	nd			
N-pentane -----	nd			
Hexanes + -----	nd			
Water -----			-85.9	-11.94
Dissolved Inorganic Carbon		-6.22		

Total BTU/cu.ft. dry @ 60deg F & 14.7psia, calculated: 758

Specific gravity, calculated: 0.663

Remarks: Analysis is of gas extracted from water by headspace equilibration. Analysis has been corrected for helium added to create headspace. Helium dilution factor = 0.64

\*Addition of helium negates the ability to detect native helium or hydrogen.

nd = not detected. na = not analyzed. Isotopic composition of carbon is relative to VPDB. Isotopic composition of hydrogen and oxygen are relative to VSMOW. Calculations for BTU and specific gravity per D3588. Chemical compositions are normalized to 100%. Mol. % is approximately equal to vol. %. ASTM Chemical analysis based on standards accurate to within 2%

Lab #: 171130 Job #: 11984  
 Sample Name/Number: 05-055-06290 (Rohr 09-04)  
 Company: Colorado Oil & Gas Conservation  
 Date Sampled: 9/17/2009  
 Container: Dissolved Gas Bottle  
 Field/Site Name: Complaint 200218267  
 Location: Huerfano County  
 Formation/Depth:  
 Sampling Point:  
 Date Received: 9/18/2009 Date Reported: 10/01/2009

Component	Chemical mol. %	Delta 13C per mil	Delta D per mil	Delta 18O per mil
Carbon Monoxide -----	nd			
Hydrogen Sulfide -----	nd			
Helium -----	nd			
Hydrogen -----	nd			
Argon -----	na			
Oxygen + Argon -----	1.09			
Nitrogen -----	15.88			
Carbon Dioxide -----	0.74			
Methane -----	82.28	-49.31	-238.6	
Ethane -----	0.0109			
Ethylene -----	nd			
Propane -----	nd			
Iso-butane -----	nd			
N-butane -----	nd			
Iso-pentane -----	nd			
N-pentane -----	nd			
Hexanes + -----	nd			
Water -----			-83.6	-11.73
Dissolved Inorganic Carbon		4.09		

Total BTU/cu.ft. dry @ 60deg F & 14.7psia, calculated: 834

Specific gravity, calculated: 0.633

Remarks: Analysis is of gas extracted from water by headspace equilibration. Analysis has been corrected for helium added to create headspace. Helium dilution factor = 0.73

\*Addition of helium negates the ability to detect native helium or hydrogen.

nd = not detected. na = not analyzed. Isotopic composition of carbon is relative to VPDB. Isotopic composition of hydrogen and oxygen are relative to VSMOW. Calculations for BTU and specific gravity per D3588. Chemical compositions are normalized to 100%. Mol. % is approximately equal to vol. %. ASTM Chemical analysis based on standards accurate to within 2%



Lab #: 171131 Job #: 11984  
 Sample Name/Number: 05-055-06165 (Rohr 09-10)  
 Company: Colorado Oil & Gas Conservation  
 Date Sampled: 9/17/2009  
 Container: Dissolved Gas Bottle  
 Field/Site Name: Complaint 200218267  
 Location: Huerfano County  
 Formation/Depth:  
 Sampling Point:  
 Date Received: 9/18/2009 Date Reported: 10/01/2009

Component	Chemical mol. %	Delta 13C per mil	Delta D per mil	Delta 18O per mil
Carbon Monoxide -----	nd			
Hydrogen Sulfide -----	nd			
Helium -----	nd			
Hydrogen -----	nd			
Argon -----	na			
Oxygen + Argon -----	16.66			
Nitrogen -----	46.63			
Carbon Dioxide -----	0.31			
Methane -----	36.40	-50.70	-238.1	
Ethane -----	nd			
Ethylene -----	nd			
Propane -----	nd			
Iso-butane -----	nd			
N-butane -----	nd			
Iso-pentane -----	nd			
N-pentane -----	nd			
Hexanes + -----	nd			
Water -----			-86.4	-12.00
Dissolved Inorganic Carbon		3.23		

Total BTU/cu.ft. dry @ 60deg F & 14.7psia, calculated: 369

Specific gravity, calculated: 0.841

Remarks: Analysis is of gas extracted from water by headspace equilibration. Analysis has been corrected for helium added to create headspace. Helium dilution factor = 0.77

\*Addition of helium negates the ability to detect native helium or hydrogen.

nd = not detected. na = not analyzed. Isotopic composition of carbon is relative to VPDB. Isotopic composition of hydrogen and oxygen are relative to VSMOW. Calculations for BTU and specific gravity per D3588. Chemical compositions are normalized to 100%. Mol. % is approximately equal to vol. %. ASTM Chemical analysis based on standards accurate to within 2%

**Isotopic Composition of Methane  
Huerfano County - Raton Basin**

