STATE OF COLORADO OIL & GAS CONSERVATION COMMISSION

June 20, 2008 Certified Mail Return Receipt Requested # 7007 1490 0000 6634 5327

Mr. Jason Santistevan
1980 County Road 346
Walsenburg, CO 81089-9517

RE: Complaint 200130733
Water Well Analysis
Well Permit 204215
SWSW 24 28S, 67W Huerfano County, Colorado

Dear Mr. Santistevan:

In response to your concerns regarding possible impacts to water quality from coal bed methane (CBM) operations in the area near your home, the Colorado Oil and Gas Conservation Commission (COGCC) conducted a field visit to your property on April 29, 2008. Water samples were collected for general organic and inorganic water quality testing as well as for analysis of dissolved methane and BART kit tests. A summary of the results of the chemical and bacterial analyses is presented below. The analytical results are also compared to published water quality standards and to results of prior testing of water from your well.

FIELD TESTING

I visited your property on April 29, 2008 and you and I walked to your domestic water well so that I could determine if methane was venting from your water well. I determined that there was no methane venting from the casing of your water well before or during the sampling. We started water flowing from your outdoor hydrant at approximately 10 gallons per minute at 15:31. The water was clear and I did not detect any odors associated with the water during pumping. The water did not effervesce while pumping. We collected samples from your well using the hydrant after pumping the well for 11 minutes. You had used the well extensively the evening before I sampled the well to water vegetation on your property. The samples were shipped to Paragon Analytics in Fort Collins, CO and received on May 1, 2008.

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 your water well was compared to these standards. This information is summarized in Table 1 which is located in Attachment 1 and discussed in narrative form 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 the laboratory are included as Attachment 2.

- **Antimony (Sb):** The CDPHE human health standard for antimony is 0.006mg/l. Antimony is a contaminate metal.

  Antimony was not detected in the sample collected from your water well.

- **Arsenic (As):** The CDPHE human health standard for arsenic is 0.05 mg/l. Arsenic is a highly poisonous metal.

  Arsenic was not detected in the sample collected from your water well.

- **Barium (Ba):** The CDPHE human health standard for barium is 2.0 mg/l. Barium is a contaminate metal.

  Barium was not detected in the sample collected from your water well.

- **Beryllium (Be):** The CDPHE human health standard for beryllium is 0.004mg/l. Beryllium is a contaminate metal.

  Beryllium was not detected in the sample collected from your water well.

- **Cadmium (Cd):** The CDPHE human health standard for cadmium is 0.005 mg/l. Cadmium is a contaminate metal.

  Cadmium was not detected in the sample collected from your water well.

- **Chromium (Cr):** The CDPHE human health standard for chromium is 0.1 mg/l. Chromium is a contaminate metal.

  Chromium was not detected in the sample collected from your water well.

- **Lead (Pb):** The CDPHE human health standard for lead is 0.05 mg/l. Prolonged exposure to this metal can result in serious health effects.

  Lead was detected in the sample collected from your water well at a concentration of 0.00055mg/l which is below the CDPHE human health standard.

- **Nickel (Ni):** The CDPHE human health standard for nickel is 0.1mg/l. Nickel is a contaminate metal.

  Nickel was not detected in the sample collected from your water well.

- **Selenium (Se):** The CDPHE human health standard for selenium is 0.05 mg/l. Selenium is a contaminate metal.

  Selenium was detected in the sample collected from your water well at a concentration of 0.0021mg/l which is below the CDPHE human health standard.

- **Silver (Ag):** The CDPHE human health standard for silver is 0.05 mg/l. Excess amounts of silver may cause a permanent gray discoloration of the skin.

  Silver was not detected in the sample collected from your water well.

- **Thallium (Tl):** The CDPHE human health standard for thallium is 0.002 mg/l. Thallium is a contaminate metal.

  Thallium was not detected in the sample collected from your water well.

- **Uranium (U):** The CDPHE human health standard for thallium is 0.03 mg/l. Uranium can be present due to erosion of natural deposits of this element.

  Uranium was detected in the sample collected from your water well at a concentration of 0.0066mg/l which is below the CDPHE human health standard.

- **Fluoride (F)**: The CDPHE human health standard for fluoride is 4.0 mg/l. Where fluoride concentrations are in the range of 0.7 mg/l to 1.2 mg/l health benefits such as reduced dental decay have been observed. Consumption of fluoride at concentrations of greater than 2.0 mg/l can result in mottling of teeth. Consumption of fluoride at concentrations greater than 4.0 mg/l can increase the risk of skeletal fluorosis or other adverse health effects. Fluoride occurs naturally in the ground water in many areas in Colorado at concentrations that exceed the drinking water standard.

  Fluoride was detected in the sample collected from your water well at a concentration of 0.5mg/l which is below the CDPHE human health standard.

- **Nitrate (NO_3):** The CDPHE human health standard for nitrate is 10.0 mg/l. Nitrate can cause cyanosis in infants; a household water supply should not contain nitrate concentration in excess of 10 mg/l.

  Nitrate was detected in the sample collected from your water well at a concentration of 0.46mg/l which is below the CDPHE human health standard.

- **Nitrite (NO_2):** The CDPHE human health standard for nitrite is 1.0 mg/l. Nitrite concentrations exceeding 1.0 mg/l should not be used for feeding infants.

  Nitrite was not detected in the sample collected from your water well.

- **Copper (Cu):** The CDPHE secondary drinking water standard for copper is 1 mg/l.

  Copper was not detected in the sample collected from your water well.

- **Chloride (Cl):** The CDPHE secondary drinking water standard for chloride is 250mg/l. Chloride concentrations in excess of 250 mg/l usually produce a noticeable taste in drinking water.

  Chloride was detected in the sample collected from your water well at a concentration of 10mg/l which is below the CDPHE drinking water standard.

- **Iron (Fe):** The CDPHE secondary drinking water standard for iron is 0.3mg/l. Small amounts of iron are common in ground water. Iron produces a brownish-red color in laundered clothing, can leave reddish stains on fixtures, and impart a metallic taste to beverages and food made with it. After a period of time iron deposits can build up in pressure tanks, water heaters, and pipelines, reducing the effective flow rate and efficiency of the water supply.

  Iron was not detected in the sample collected from your water well.

- **Manganese (Mn):** The CDPHE secondary drinking water standard for manganese is 0.05mg/l. Manganese produces a brownish color in laundered clothing, may stain fixtures and affect the taste of coffee or tea.

  Manganese was not detected in the sample collected from your water well.

- **Sulfate (SO_4):** The CDPHE sulfate secondary standard for human drinking water is 250mg/l. Although CDPHE does not have an agricultural standard for sulfate, other agencies recommend a concentration below 1,500 mg/l for livestock watering. Waters containing high concentrations of sulfate, typically caused by the leaching of natural deposits of magnesium sulfate (Epsom salts) or sodium sulfate (Glauber's salt), may be undesirable because of their laxative effects.

  Sulfate was detected in the sample collected from your water well at a concentration of 98mg/l which is below the CDPHE drinking water standard.

- **pH:** pH is the measure of the hydrogen ion concentration in water. The pH of water in its natural state is generally from 5.5 to 9.0. The CDPHE standard for domestic and agricultural water is a range of 6.5 to 8.5. Seven (7) represents neutrality, while values less than 7 indicate increasing acidity and values greater than 7 indicate increasing alkalinity.

  pH was measured in the water sample from your well with a value of 7.8 which is within the CDPHE drinking water and agricultural standards.

- **Total Dissolved Solids (TDS):** CDPHE's TDS standard for human drinking water is 500 milligrams per liter (mg/l). Although CDPHE does not have an agricultural standard for TDS, other agencies recommend concentrations below 1500 mg/l for irrigation, and below 5,000 mg/l for most livestock watering. TDS occurs naturally in the ground water in many areas of Colorado at concentrations that exceed the drinking water standard.

  TDS was measured in the water sample collected from your well at a concentration of 420mg/l which is below the drinking water standard.

- **Zinc (Zn):** CDPHE's Zn standard for human drinking water is 5 milligrams per liter (mg/l) and the agricultural standard is 2mg/l.

  Zinc was detected in the sample collected from your water well at a concentration of 0.04mg/l which is below the CDPHE drinking water standard.

The following parameters were also measured as part of the laboratory analysis although there are no CDPHE standards.

- **Sodium (Na):** People on salt restricted diets should be aware of the sodium concentration in the water they drink. A concentration of less than 20 mg/l is recommended by some for people on salt restricted diets or for people suffering from hypertension or heart disease. Sodium occurs naturally in the ground water in many areas of Colorado at concentrations that exceed this health advisory level.

  Sodium was detected in the water sample from your well at a concentration of 47mg/l which is above the recommended level.

- **Boron (B):**

  Boron was not detected in the sample collected from your water well.

- **Calcium (Ca):**

  The calcium concentration in the sample collected from your well was 71mg/l.

- **<u>Magnesium (Mg):</u>**

  The magnesium concentration in the sample collected from your well was 19mg/l.

- **<u>Potassium (K)</u>:**

  The potassium concentration in the sample collected from your well was 1.9mg/l.

- **<u>Molybdenum (Mo):</u>**

  The molybdenum concentration in the sample collected from your well was 0.0014mg/l.

- **<u>Bicarbonate (HCO_3)</u>:**

  Bicarbonate alkalinity was measured in the sample collected from your well at a concentration of 240mg/l.

- **<u>Bromide (Br)</u>:**

  Bromide was not detected in the sample collected from your water well.

<u>METHANE GAS ANALYSIS</u>

Methane was not detected in the water samples collected from your well.

<u>BACTERIAL ANALYSIS</u>

The COGCC collected samples to analyze for the presence of iron, slime and sulfur bacteria in your water well. Samples from your water well were tested for the presence of iron-related (IRB), sulfate reducing (SRB) and slime forming (SLYM) bacteria using Biological Activity Reaction Test (BART) kits. In addition to detecting the presence of bacteria the BART Kits allow for an estimation of the size of the population and/or the rate at which they can metabolize and/or grow through an observable change or reaction. This reaction rate is referred to as the "aggressivity" of the bacterial population. The aggressivity levels of the bacteria are described as **Not Detected, Background, Moderately Aggressive, Very Aggressive, or Extremely Aggressive Levels**. The results of the tests are provided below and documented in Photographs 1 and 2. The progress of the bacterial growth after one day is seen in Photograph 1. Photograph 2 shows the progress of the bacterial tests four days after the cultures were started.

- **<u>Iron-Related Bacteria (IRB)</u>:** Although not harmful, iron-related bacteria can become a nuisance by plugging the well pump, causing red staining on plumbing fixtures and laundered clothing, building up red, slimy accumulations on any surface the water touches, and causing what appears to be a sheen on standing water. Signs that may indicate an iron bacteria problem include "yellowish, red or orange colored water, rusty deposits in toilet tanks and strange smells resembling fuel oil, cucumbers or sewage. Sometimes the odor will only be apparent in the morning or after other extended periods of non-use" (CDPHE, Laboratory Services Division).

  IRB bacteria were detected at *Moderately Aggressive* ***levels in the water sample collected from your water well. The relatively*** *fast* ***development of foam and orange color indicates*** *Moderately Aggressive* ***levels of IRB population present in the water from your well.***

Photograph 1. BART Kits April 30, 2008

- **<u>Sulfate Reducing Bacteria (SRB)</u>**: Sulfate reducing bacteria are serious nuisance organisms in water since they can cause severe taste and odor problems. These bacteria reduce sulfate that occurs naturally in the water and generate hydrogen sulfide (H_2S) gas as they grow. In turn, the hydrogen sulfide (H_2S) gas is a nuisance because it smells like rotten eggs, initiates corrosion on metal surfaces and reacts with dissolved metals such as iron to generate black sulfide deposits.

  The test indicated that SRB were not detected in your well water as shown by the clear liquids in the black capped vial in Photograph 2.

Photograph 2. BART Kits May 3, 2008

- **<u>Slime Forming Bacteria (SLYM)</u>**: Although not usually harmful, Slime Forming Bacteria (SFB) can become a nuisance by plugging well pumps and causing slimy accumulations on plumbing fixtures and standing water. Slimes are often gelatinous in nature and may range in color from white, to red, or black. As slime bacteria mats grow they create an environment in which complex associations of other strains of bacteria can develop.

  SLYM bacteria were not detected in the water sample collected from this well as indicated by the cloudy yellow liquid seen in the green capped vial in Photograph 2.

Iron related bacteria were present in your well at background levels. Since this type of bacteria were detected in the water distribution system or the well you should consider treating the well and distribution system with disinfecting solutions if populations of bacteria increase in your well. Once bacterial colonies are established they are difficult to eliminate; therefore, you may need to establish a schedule for periodic disinfection of your well system to help control the bacteria present in it. The chlorination process is more easily accomplished if you have a frost-proof hydrant near the well head that you can use to remove the chlorinated water from the well. One technique that water well professionals use is to re-circulate the chlorine solution down the sides of the well shortly after adding the chlorine. This helps to kill bacteria on the sides of the well and on the pipes in the well.

Pamphlets published by the CDPHE that provide more information concerning the treatment of iron and sulfur bacteria and shock chlorination treatment of bacteria are included as Attachment 3. You may also want to contact a licensed water well contractor for additional information or for help in disinfecting your well and distribution system. Additional information and assistance can be provided through the State of Colorado Health Department. Contact information for the agency is provided below.

Colorado Department of Public Health and Environment

Colorado Drinking Water Program
4300 Cherry Creek Drive South
Denver, CO 80246-1530
Phone: 303-692-3500
Fax: 303-782-0390

<u>CONCLUSIONS</u>

The inorganic chemistry of water from your well is not similar to coal bed methane (CBM) produced water and does not appear to have been impacted by CBM operations in the vicinity of your home. CBM produced water is typically much higher in sodium content that your well water is. CBM produced water typically has much greater levels of total dissolved solids than water from your well. Table 2 below compares analytical results from your well to data from two CBM wells and to data from the Cuhcara River located near your home. The locations of the wells are shown in Attachment 4.

The water from your well is predominantly of a calcium-sulfate-bicarbonate character. Waters produced from CBM wells in the Raton Basin are generally of a sodium-bicarbonate character as in the Passow 22-08 and the State 2W. The chemistry of the water sample collected from the Cuchara River in 1999 is very similar to the chemistry of water produced from your well.

Table 2. Comparison of Major Ion Chemistry

Analyte	units	Santistevan Water Well	Cuchara River (03/1999)	Passow 22-08	State 2W
TDS	mg/l	420	440	1100	691
Na	mg/l	47	50	470	291
Ca	mg/l	71	73.6	3	1.1
Mg	mg/l	19	21.3	0.31	0.12
Cl	mg/l	10	11.8	85	25.4
HCO_3	mg/l	240	293	840	472
SO_4	mg/l	98	131	NA	NA
pH	s.u.	7.8	8.38	8.4	8.9
SAR	ratio	1.3	1.3	69	70

NA = not analyzed

Table 1 shows a comparison of results from the sample collected from your well in 2008 to groundwater standards established by the Water Quality Control Commission. None of the analytes exceed the groundwater standards. The water quality data for the 2008 sampling and analysis does not show any impacts from nearby CBM drilling and production activities.

Since you sometimes use your well water on plants in your yard, I have enclosed a fact sheet from CSU Extension (Attachment 5). The effects of water quality when used for irrigation are discussed in that brochure. The sodium adsorption ratio (SAR) of water from your well is below the level which is thought to cause harm to most crops or soils.

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 .

Sincerely,
Colorado Oil and Gas Conservation Commission

Peter Gintautas
Environmental Protection Specialist

Attachments: Attachment 1 - Table 1 - Analytical Summary
Attachment 2 - Paragon Analytics Reports
Attachment 3 - CDPHE water well pamphlets
Attachment 4 - Locations of CBM and Water Wells in Table 2
Attachment 5 - CSU Cooperative Extension Irrigation Water Quality no. 0.506

cc: David Neslin, Acting COGCC Director w/o attachments
Debbie Baldwin, COGCC Environmental Protection Manager w/o attachments
Margaret Ash, COGCC Environmental Protection Specialist w/o attachments

TABLE 1
ANALYTICAL SUMMARY
Complaint 200130733
Santistevan Water Well

Parameter	Sample Date 29-Apr-08		CDPHE Standards		
	Result	Unit	Domestic	Agriculture	Units
Antimony	ND	mg/l	0.006	NS	mg/l
Boron	ND	mg/l	NS	0.75	mg/l
Copper	ND	mg/l	1	0.2	mg/l
Arsenic	ND	mg/l	0.05	0.1	mg/l
Barium	ND	mg/l	2.0	NS	mg/l
Berylium	ND	mg/l	0.004	0.1	mg/l
Cadmium	ND	mg/l	0.005	0.01	mg/l
Calcium	71	mg/l	NS	NS	
Chromium	ND	mg/l	0.1	0.1	mg/l
Cobalt	ND	mg/l			
Iron	ND	mg/l	0.3	5	mg/l
Lead	0.00055	mg/l	0.05	0.1	mg/l
Lithium	ND	mg/l	NS	NS	
Magnesium	19	mg/l	NS	NS	
Manganese	ND	mg/l	0.05	0.2	mg/l
Molybdenum	0.0014	mg/l	0.035	NS	mg/l
Nickel	ND	mg/l	0.1	0.2	mg/l
Potassium	1.9	mg/l	NS	NS	
Selenium	0.0021	mg/l	0.05	0.02	mg/l
Silver	ND	mg/l	0.05	NS	mg/l
Strontium	1.6	mg/l	NS	NS	
Sodium	47	mg/l	NS	NS	
Thallium	ND	mg/l	0.002	NS	mg/l
Uranium	0.0066	mg/l	0.03	NS	mg/l
Zinc	0.04	mg/l	5	2	mg/l
Chloride	10	mg/l	250	NS	mg/l
Nitrite	ND	mg/l	1.0	10	mg/l
Nitrate	0.46	mg/l	10.0	100	mg/l
Total Nitrite/Nitrate	0.46	mg/l	10.0	100	mg/l
Fluoride	0.5	mg/l	4.0	NS	mg/l
Total Dissolved Solids	420	mg/l	400	*1500	mg/l
pH	7.8	No units	6.5 - 8.5	6.5 - 8.5	No units
Sulfate	98	mg/l	250	NS	mg/l
Bromide	ND	mg/l	NS	NS	
Total Alkalinity	240	mg/l	NS	NS	
Bicarbonate	240	mg/l	NS	NS	
Carbonate	ND	mg/l	NS	NS	
Conductivity	645	umhos/cm	NS	NS	
methane	ND	mg/l	NS	NS	

Notes

CDPHE	Colorado Department of Public Health and the Environment.
Domestic	Water Quality Control Commission 5 CCR 1002-41, Regulation No. 41 - The Basic Standards For Groundwater.
Agriculture	* Standards for agriculture complied from CDPHE and other of sources.
mg/l	milligrams per liter (ppm or parts per million).
µmhos/cm	micromhos per centimeter
NA	Not analyzed.
ND	Not detected.
NS	No Standard.
**	Health Advisory.
(yellow)	Human health standard.
(orange)	Secondardy standard.

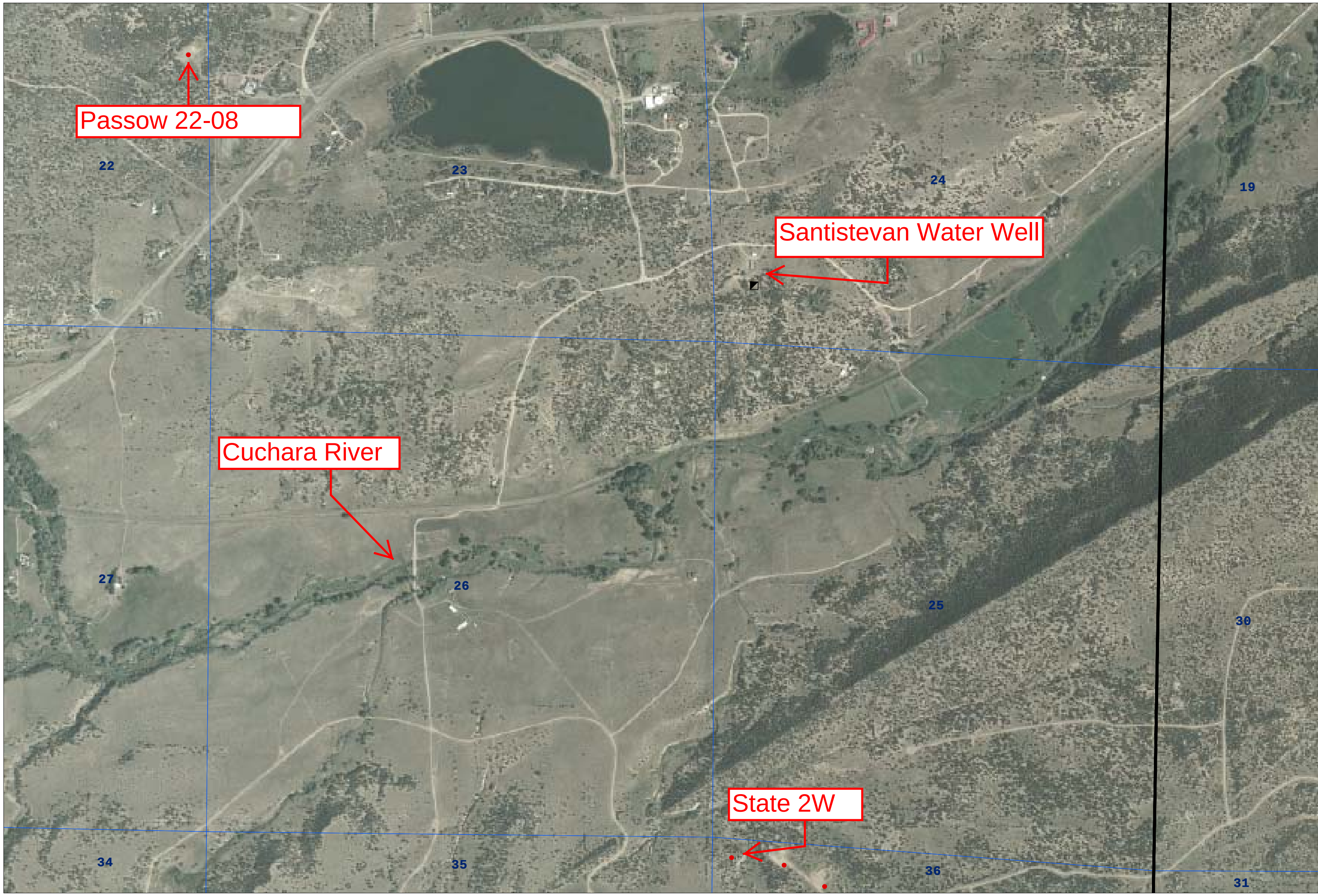
Santistevan Water Well Location

Red Lines

OIL AND GAS WELLS

Oil and Gas Wells

COLOR AERIALS 2005



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FEET

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IRRIGATION

Irrigation Water Quality Criteria no. 0.506

by R.H. Follett and P.N. Soltanpour [1]

Quick Facts...

Colorado irrigation water varies from excellent (water that can be used with confidence without special restriction) to very poor (water that should not be used).

The quality of Colorado water generally is limited by salinity hazard and sodium hazard.

There are four basic criteria for evaluating water quality for irrigation purposes:

1. Total soluble salt content (salinity hazard).
2. Relative proportion of sodium cations (Na+) to other cations (sodium hazard). (An ion is an electrically charged atom or groups of atoms. Cations carry a positive charge, and anions have a negative charge.)
3. Excessive concentration of elements that causes ionic imbalance in plants or toxicity.
4. Bicarbonate anion (HCO_3-) concentration as related to calcium (Ca++) plus magnesium (Mg++) cations.

The first two criteria are of major concern in Colorado and are used by the Colorado State University Soil Testing Laboratory in determining irrigation water quality.

There also are many nonwater factors to consider in deciding the usefulness of water for a specific situation. These include soil texture and structure, drainage conditions, gypsum and lime content of the soil, salt and sodium tolerance of the crop, and irrigation method and management.

Salinity Hazard

Excess salt increases the osmotic pressure of the soil solution that can result in a physiological drought condition. Even though the field appears to have plenty of moisture, the plants wilt because insufficient water is absorbed by the roots to replace that lost from transpiration.

The total soluble salt content of irrigation water generally is measured either by determining its electrical conductivity (EC), reported as micromhos per centimeter, or by determining the actual salt content in parts per million (ppm). Table 1 presents the basic guidelines for water use relative to its salt content.

Sodium Hazard

The sodium hazard of irrigation water usually is expressed as the sodium adsorption ratio (SAR). This is the proportion of Na+ to Ca++ plus Mg++ in the water. The following formula is used to calculate SAR:

$$SAR = \frac{Na^{+}}{\sqrt{\dfrac{Ca^{++} + Mg^{++}}{2}}}$$

Ions in the equation are expressed in milliequivalents per liter.

Although sodium contributes directly to the total salinity and may be toxic to sensitive crops, such as fruit trees, the main problem

Colorado State University Cooperative Extension

Table 1: Salinity hazard of irrigation water.

Hazard	Dissolved salt content ppm	EC-micromhos/cm
Water for which no detrimental effects will usually be noticed.	500	750
Water that may have detrimental effects on sensitive crops.	500-1,000	750-1,500
Water that may have adverse effects on many crops and require careful management practices.	1,000-2,000	1,500-3,000
Water that can be used for salt-tolerant plants on permeable soils with careful management practices and only occasionally for more sensitive crops.	2,000-5,000	3,000-7,500

Table 2: Boron (B).

Concentration	Effect on crops
Below 0.5 ppm	Satisfactory for all crops.
0.5-1.0 ppm	Satisfactory for most crops.
1.0-2.0 ppm	Satisfactory for semi-tolerant crops.
2.0-4.0 ppm	Satisfactory for tolerant crops only.

Table 3: Chlorine (C).

Concentration me/l	Concentration ppm	Effect on crops
< 2	< 70	Generally safe for all plants.
2-4	70-140	Sensitive plants show injury.
4-10	140-350	Moderately tolerant plants show injury.
> 10	> 350	Can cause severe problems.

with a high sodium concentration is its effect on the physical properties of soil.

Avoid using water with an SAR value greater than 10 if it will be the only source of irrigation water for long periods. This is true even if the total salt content is relatively low.

If the soil contains an appreciable amount of gypsum, a SAR value of 10 may be exceeded somewhat. The gypsum content of the soil can be determined by the Colorado State University Soil Testing Laboratory.

Continued use of water with a high SAR value leads to a breakdown in the physical structure of the soil caused by excessive amounts of colloidally absorbed sodium. This breakdown results in the dispersion of soil clay that causes the soil to become hard and compact when dry and increasingly impervious to water penetration due to dispersion and swelling when wet. Fine-textured soils, those high in clay, are especially subject to this action.

Toxic Elements

Direct toxicity to crops may result from some specific chemical element in irrigation water. The actual concentration of an element in water that will cause toxic symptoms varies depending on the crop.

When an element is added to the soil through irrigation, it may be inactivated by chemical reactions, or it may build up in the soil until it reaches a toxic level. An element at a given concentration in water may be immediately toxic to a crop or it may require a number of years to accumulate in the soil before it becomes toxic.

There is a long list of elements that can cause a toxic effect on crops, including boron, chlorine and others. Table 2 shows the interpretation of boron results, and Table 3 of chlorine results.

Bicarbonate Concentration

Waters high in bicarbonate (HCO_3^-) will tend to precipitate calcium carbonate ($CaCO_3$) and magnesium carbonate ($MgCO_3$) when the soil solution concentrates through evapotranspiration. This means that the SAR value will increase — the relative proportion of sodium ions becoming greater. This, in turn, will increase the sodium hazard of the water to a level greater than indicated by the SAR value.

Recent Findings

Irrigation water high in chloride (Cl^-) and/or sulfate (SO_4^{--}) ions reduce phosphorus availability to plants and reduce the concentration of organic acids in plants to suboptimal levels.

References

Soltanpour, P.N., M.M. Al-Wardy, J.A. Ippolito, J.B. Rodriguez, J. Self, M. Gillaume, and D. Mathews. 1999. "Chloride versus Sulfate Salinity Effects on Alfalfa Shoot Growth and Ionic Balance," *Soil Sci. Soc. Am. J.* 63:111-116.

United States Salinity Laboratory Staff. 1969. *Diagnosis and Improvement of Saline and Alkali Soils*. USDA Agricultural Handbook 60.

[1]*R.H. Follett, former Colorado State University Cooperative Extension agronomist and professor, and P.N. Soltanpour, professor; soil and crop sciences.*

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