James M. Waldron

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PROFESSIONAL EXPERIENCE

SC Hydrogeology, San Clemente California

Sole Proprietor – April 2014 to Present

Clients:

Western States Petroleum Association (Sump issues, Kern County EIR consultation)
Kennedy Jenks (Kern River aquifer exemption)
Valley Water Management Company (Sump issues, hydrogeological consultation)
Gibson, Dunn & Crutcher LLP (Expert services related to groundwater beneficial uses and hydrogeological consultation)
L+G, LLP (Central Coast energy issues consultation and presentations)
Quad Knopf, Inc. (Kern County EIR consultation)

Chevron U.S.A., Inc., Bakersfield California

Chevron Senior Advisor - Hydrogeologist December 1985 - March 2014

- Conduct, or manage the conduct of, chemical, physical, and biological water quality monitoring or sampling to ensure compliance with recognized water quality standards.
- Conduct, or manage the conduct of, investigations on matters such as water storage, wastewater discharge, pollutants, permits, or other compliance and regulatory issues.
- Conduct technical studies for water resources on topics such as pollutants and water treatment options.
- Identify and characterize specific causes or sources of water pollution.
- Meet with and interact with Federal, State and Local agencies and regulators.

Chevron Production Geologist, June 1983 - December 1985
Chevron Exploration Geologist, September 1979 - June 1983

EDUCATION

University of Southern California

Earned M.S. in Geology, 1981

California Lutheran University, California

Earned B.S. in Geology, 1976

Additional Skills

Considerable experience and proficiency with computers. Very knowledgeable with MS Office.

California Licenses

California Professional Geologist #4461
California Certified Hydrogeologist #567

Summary of Expert Testimony
Groundwater Quality
by
Jim Waldron

Groundwater Quality – Race Track Hill/Section 34 "C" Plant

Groundwater quality beneath the Race Track Hill facility and the Section 34 "C" Plant facility was firmly established in 2 phases of groundwater investigation done over the last year. As previously mentioned, the groundwater quality investigations consisted of a shallow investigation and a deep investigation. Groundwater quality was quantified by laboratory analyses and is discussed below.

Section 34 "C" Plant

One deep monitor well, C-1D, was installed at the "C" Plant facility in February 2015 to a depth of 460 feet. The "C" Plant facility is located north of the town of Edison near the southwest corner of Section 34, T29S/R29E. Sampling was done in March 2015 and the laboratory results were obtained a few weeks later. The results were conclusive. No constituents of concern or any evidence of produced water mixing from the directly overlying produced water ponds was found. This can be seen clearly on the Piper diagram[1] and the H/O isotopic analysis[2] shown below. Water from C-1D had a TDS concentration of 800 mg/1, a chloride concentration of 229 mg/l and a boron concentration of 0.2 mg/1; all of which are indicative of background levels of groundwater present in the vicinity.

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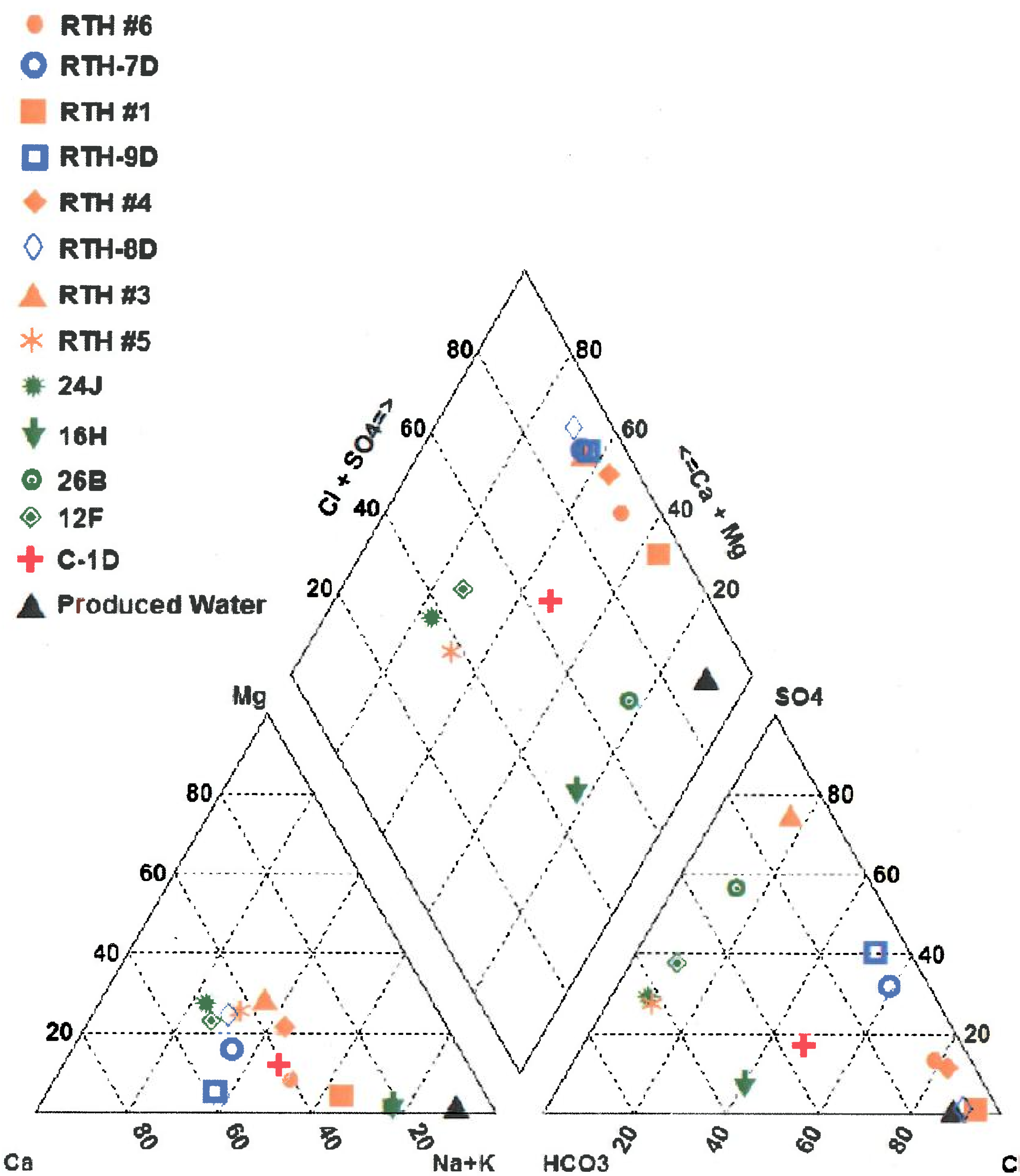
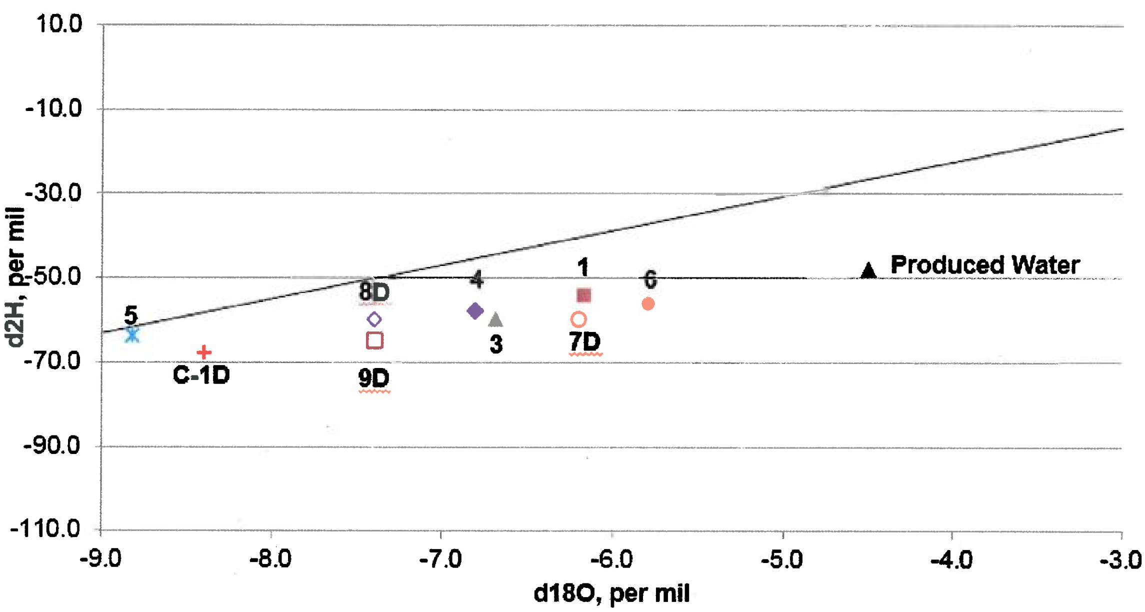
[1] A Piper Diagram is a graphical representation of the chemistry of a water sample or samples. The cations and anions are shown by separate ternary plots. The apexes of the cation plot are calcium, magnesium and sodium plus potassium cations. The apexes of the anion plot are sulfate, chloride and carbonate plus hydrogen carbonate anions. The two ternary plots are then projected onto a diamond, which represents a matrix transformation of a graph of the anions (sulfate + chloride/ total anions) and cations (sodium + potassium/total cations). Piper Diagrams are very useful for presenting and comparing geochemistry from a number of different water samples.

[2] Oxygen and hydrogen are found in many forms in the earth's hydrosphere, biosphere, and geosphere. Oxygen is the most abundant element in the earth's crust. Hydrogen also is common in the biosphere and is a constituent of many minerals found in the geosphere. Most importantly, oxygen and hydrogen combine to form water (H_2O), thus making their isotopic composition a powerful tracer of the hydrosphere. Waters develop unique isotopic compositions that can be indicative of their source or the processes that formed them. An H/O isotopic analysis can be used to show multiple contributions to a groundwater source.



As seen from this Piper Diagram, the samples at C-1D and RTH #5 differ from the produced water characteristics, and none of the sampling locations exactly mirror the produced water.

H/O Isotope Graph – Racetrack Hill

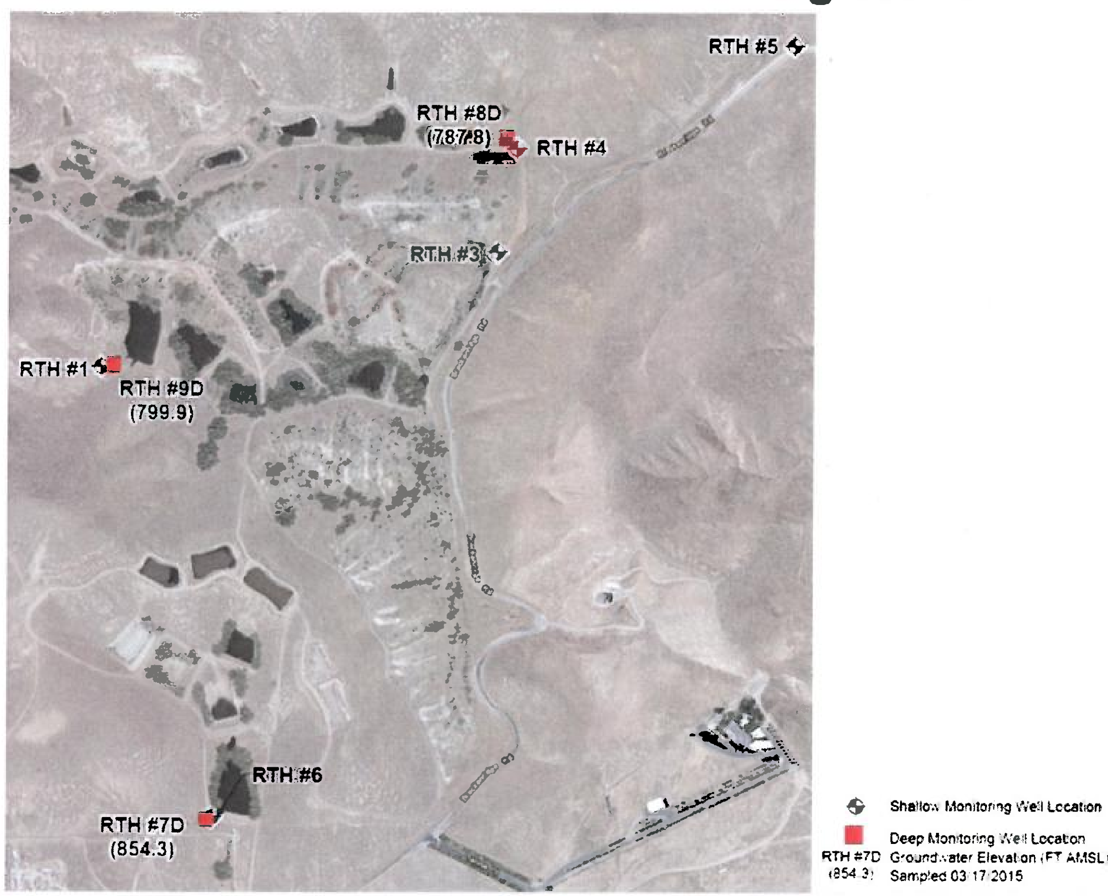


As with the Piper Diagram, this H/O isotope graph demonstrates that the samples at C-1D and RTH #5 are distinctly different from the produced water characteristics, and none of the sampling locations exactly mirror the produced water.

Race Track Hill Facility

At the Race Track Hill Facility, located east of Bakersfield in Section 24, T29S/R29E, four shallow soil borings were advanced and monitoring wells were installed and sampled at three of the boring locations (RTH-1, RTH-3 and RTH-4). The shallow investigation at the Race Track Hill Facility also included the installation and sampling of two additional monitoring wells (RTH-5 and RTH-6) that were placed in assumed down-gradient locations to supplement the three shallow monitoring wells. Adjacent to the shallow monitoring wells next to the ponds, deep monitoring wells (RTH-7D, RTH-8D, and RTH-9D) were also installed with the initial monitoring completed in March 2015. In total, there are eight monitoring wells, shown below, that characterize shallow and deep groundwater conditions at the Race Track Hill Facility.

Racetrack Hill Groundwater Monitoring Wells



The results of the April 2015 and December 2014 shallow groundwater sampling events are shown in the table below. The first encountered shallow groundwater beneath the Race Track Hill Facility has been mixed with the produced water disposed of in the percolation/evaporation ponds since 1958 at three locations: RTH #1, RTH #4, and RTH #6. In fact, it can be presumed that after 10 years of saline produced water discharge via percolation, that by 1968 the underlying ground water reflected the mixing with produced water. Groundwater with a TDS of greater than 3000 mg/L or EC of greater than 5000 µmhos/cm provide an exception to the Sources of Drinking Water Policy that could apply to the shallow groundwater. The detected concentrations of boron and chloride in these locations are explained by the mixing of native groundwater with produced water. RTH #3 is at the base of Race Track Hill and, based on water quality and especially sulfate concentrations, likely has water quality affected by more than one water source. Water quality at RTH #5, near Cottonwood Creek, has a very different water quality than any other wells and does not show any effects from the produced water ponds and irrigation.

Groundwater sampling of the deep monitor wells was conducted during March of 2015. The results of this monitoring exercise indicate that produced water from the surface impoundments has mixed with native groundwater directly beneath the ponds. Total dissolved solids (TDS) concentrations in the water samples from the deep monitor wells ranged from 2,960 to 4,180 mg/l. The lowest TDS concentration was at RTH-9D (2960 mg/l), and the highest (3,900 to 4,180 mg/l) were in waters from RTH-7D and RTH-8D. Chloride concentrations in water from these wells ranged from 820 to 2,060 mg/l. The chloride concentration was highest in water from RTH-8D and was lowest in water from RTH-9D. Boron concentrations in water from these wells ranged from 0.2 to 9.1 mg/l. The lowest boron concentrations (0.2 to 0.3 mg/l) were in water from wells RTH-7D and RTH-9D, and the highest concentration was in water from RTH-8D. Total petroleum hydrocarbon-diesel (TPH-d) concentrations ranged from less than detect to a low concentration of 280 µg/l (ppb). There is no MCL for TPH-d, however, a typical groundwater clean-up level would be to 1.0 mg/l (ppm).

The data can be summarized by looking at the Piper diagram in conjunction with the isotopic analysis. The Piper diagram shows a linear cluster along the upper right side of the graph that indicates produced water mixing with groundwater. The H/O Isotope diagram indicates the same as you move left from the produced water sample position. It is clear from those two diagrams that mixing of produced water migrating downward from the surface impoundments has occurred to some extent in all monitoring wells except for RTH-5 and C-1D. It is interesting to note that this occurs as a continuum based on the diagrams above. Produced water is not found at 100% in any of the six wells, demonstrating that mixing of produced water and native groundwater is occurring. If migration were significant after more than 50 years of percolation, only produced water would be found in monitoring wells directly beneath the ponds. As can be seen in the diagrams that is not happening. Since this is not the case, and migration appears to be limited, no imminent threat exists to down-gradient fresh water wells.

Analytical Results for Groundwater and Produced Water

Sample	EC µmhos/cm	TDS, mg/L	Sodium, mg/L	Boron, mg/L	Chloride, mg/L	Sulfate, mg/L	Ca & Mg, mg/L
Produced Water	5,700	3,000	1,300	**13**	1,500	18	110
RTH #1	8,700	7,000	1,300	**16**	2,900	40	605
RTH #9D	4,000	2,960	321	**0.2**	820	860	490
RTH #4	6,540	5,100	680	**5.4**	2,000	370	670
RTH #8D	6,490	4,180	376	**9.1**	2,060	23	675
RTH #6	4,680	3,500	570	**3.0**	1,300	290	448
RTH #7D	5,420	3,900	411	**0.3**	1,250	910	639
RTH #3	1,920	1,500	180	**0.65**	130	800	251
RTH #5	624	450	51	**0.07**	26	92	87
C1-D	1,400	800	130	**0.2**	229	110	119