

NITRATE ION CONCENTRATION IN WELL WATER

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Significant variations in levels of nitrate ion concentration can occur in analysis of water samples collected from the same well. Variations seem to be associated with at least two factors: (1) the time lag between sampling and actual analysis and (2) time of continuous pumping prior to sampling. A nearly two-fold increase in the level of nitrate ion in water samples from Well 1 occurred within four hours, during which the pump was not running, and a 3½-fold increase after 24 hours—pointing to a multiple aquifer source of water, one or more aquifers of which may be the source of NO₃ concentration in the well water. The change in nitrate ion concentration, with time after sampling, suggests that some undetermined factor is involved that changes nitrates to some other form of nitrogen.

CONCENTRATIONS OF NITRATE in water samples ranging from a trace to moderately high were reported from the same well at U.C. Kearney Horticultural Field Station, Reedley, in 1963, 1965, and 1967. Recently eight different laboratories, using various analytical methods, reported an average nitrate concentration of 2,059 mg/l that ranged from a low of 1,612 mg/l to a high of 3,200 mg/l in the same very salty (100,000 ppm) drain water sample. The variability in the laboratory analysis of this very saline water indicates that some methods may be more sensitive than others to the presence of interfering ions. Present experiments were designed to trace additional sources of discrepancy in nitrate ion concentrations as observed in the well at the field station.

Water samples were taken at various times of the day once a week from three different wells at the Kearney Station. The wells were located from 270 to 670 yards apart (wells 2 and 3 were 290 ft deep, open end wells, whereas well 1 was drilled to a depth of only 157 ft with casings perforated to 132 ft). Standing water level averages about 70 ft in all wells. Sampling was done from two to five minutes after starting the pump if not in operation at the time. The number of hours of continuous pumping was recorded for some samples. Nitrate determinations were made within 15 minutes

after the sampling, with the exception of samples kept under refrigeration for time lag studies.

The Orion nitrate electrode was used for all tests along with an exchange resin. This method was chosen for its reproducibility, instant reading capability, and because it was rated as one of two methods that had noticeable advantages over six other standard methods for nitrate determinations according to a special evaluation study made by the USBR laboratory at Sacramento.

Sharp decrease

A sharp decrease in nitrate ion concentration in all wells tested was noticeable after mid-May, 1968 (table 1). Prior to this period, pumping of the wells was at a low rate. The nitrate ion concentration in wells 2 and 3 began to dip from a relatively low starting concentration about a month after the annual irrigation season began on April 15, 1968. Daily irrigation practices after May 15 required almost continuous pumping from these wells and pumps were set on automatic operation. Only slight fluctuations were observed in the nitrate content in the water samples from these wells after mid-May. Water samples from well 1 persistently showed higher concentrations of nitrate than water from wells 2 and 3.

Two sets of water samples from wells 1 and 2 were kept at 5°C in stoppered bottles for nitrate determinations. These determinations were repeated periodically following the sampling. A gradual decline in nitrate ion concentration with time after sampling is shown in table 2.

The concentration of nitrate ion decreased as the period of continuous pumping prior to the sampling increased. This is particularly apparent in the case of well 1, as shown in table 3. It suggests that a replenishment of the water in the well takes place from more than one aquifer; and that the aquifer of low nitrate content has the greater supplying ability causing a dilution of the nitrate concentration under continuous pumping. The data presented in table 4 corroborate this multiple aquifer concept, particularly for well 1. The nitrate concentration and specific electric conductivity readings of samples from this well increased within a period of about a four hour pump shutdown. This indicates that

the source of contamination is one or more of several aquifers supplying water to the well at different rates of flow.

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TABLE 1. NITRATE ION CONCENTRATION LEVELS IN WELL WATER

Date samples	NO ₃ ppm		
	Well 1	Well 2	Well 3*
May 2	31.0	15.4	14.8
May 9	33.0	15.5	14.5
May 16	42.0	18.2	15.2
May 23	30.6	13.6	12.0
May 30	26.5	7.0	5.0
June 6	27.4	3.6	4.2
June 13	28.4	3.2	3.3
June 20	26.0	3.0	3.1
June 27	29.0	3.3	3.2
July 3	28.8	3.4	3.2
July 10	28.2	3.3	3.0
July 17	29.2	3.7	3.5
July 24	28.7	3.1	2.9

* Well 3 is partly for domestic water supply, sampled from storage tank (1000 gallons capacity).

TABLE 2. NITRATE ION CONCENTRATION LEVELS IN WELL WATER DETERMINED AT DIFFERENT TIME PERIODS AFTER SAMPLING

Hours after sampling	No ₃ ppm	
	Well 1	Well 2
0.5	28.9	7.9
1.0	28.6	6.8
4.0	27.5	5.9
8.0	25.2	5.3
24.0	15.0	4.1
48.0	9.4	3.5
72.0	8.9	3.2
96.0	7.8	3.1

TABLE 3. NITRATE ION CONCENTRATION LEVELS IN WELL WATER SAMPLED AT DIFFERENT TIMES OF DAY AND AFTER DIFFERENT LENGTH OF TIME OF PUMPING OPERATION

Well No.	Sampling time	NO ₃ ppm	EC mho/cm at 25°C	Continuous pumping
	11:45 AM	23	310	½ hrs.
	3:35 PM	17	328	½ hrs.
2	7:47 AM	3.5	100	Aut.
	11:42 AM	3.2	80	Aut.
	3:32 PM	2.4	108	Aut.
3	7:44 AM	3.5	150	23 hrs.
	11:39 AM	3.1	118	26 hrs.
	3:29 PM	3.0	170	30 hrs.

TABLE 4. NUMBER OF HOURS THE PUMP IS CONTINUOUSLY ON OR OFF BEFORE WATER SAMPLING, ELECTRIC CONDUCTIVITY AND NITRATE ION CONCENTRATION (WELL 1)

Time of sampling	Continuous pumping	Pump off	NO ₃ ppm	EC/ u mho/cm
7:30 AM	24 hours	0 hrs.	8.0	205
11:30 AM	*	4 hrs.	15.0	320
3:30 PM	*	1 hrs.	8.2	200
3:30 PM the following day *		24 hrs.	27.2	388

* Pump started just for sampling.