DRAFT
GROUNDWATER INFORMATION SHEET

Nitrate / Nitrite

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The purpose of this groundwater information sheet is to provide general information regarding a specific constituent of concern (COC). The following information is pulled from a variety of sources and data relates mainly to drinking water. For additional information, the reader is encouraged to consult the references cited at the end of the information sheet.

GENERAL INFORMATION	
Constituent of Concern	Nitrate / Nitrite
Aliases	None
Chemical Formula	Nitrate (NO_3) Nitrite (NO_2)
CAS No.	Nitrite 14797-65-0 Nitrate 14797-55-8
Storet No.	
Summary	The California Department of Health Services (DHS) regulates nitrates as a drinking water contaminant. The current State Maximum Contaminant Level (MCL) for nitrate (nitrate-nitrogen), set by DHS, is 45 mg/L. The Federal MCL, set by U.S. EPA for nitrate (nitrate-nitrogen) is 10 mg/L. Nitrate contaminated groundwater is in part caused by excessive use of fertilizer, animal waste from dairies, animal waste from feedlots, explosives and human sewage. Shallow ground water unaffected by human activities commonly contains less than 2 mg/L of nitrate (Mueller and Helsel, 1996). Based on DHS data through 2000, 616 of approximately 16,000 public drinking water wells (active and standby status) have had concentrations of nitrate ≥ 45 mg/L with most detections occurring in Los Angeles, San Bernardino and Kern Counties.

REGULATORY AND WATER QUALITY LEVELS[1] Nitrate-Nitrogen (NO_3-N)		
Type	**Agency**	**Concentration**
Federal MCL	US EPA, Region 9	10 mg/L
State MCL	DHS	45 mg/L Nitrate-Nitrate (equal to 10 mg/L Nitrate-Nitrogen)
Detection Limit for Purposes of Reporting (DLR)	DHS	2 mg/L
Others:		
Public Health Goal (PHG)	OEHHA	10 mg/L
IRIS Reference Dose (noncancer health effect)	US EPA, Region 9	11 mg/L

REGULATORY AND WATER QUALITY LEVELS[1] Nitrite-Nitrogen (NO_2-N)		
Type	**Agency**	**Concentration**
Federal MCL	US EPA, Region 9	1 mg/L
State MCL	DHS	1 mg/L
Detection Limit for Purposes of Reporting (DLR)	DHS	0.4 mg/L as Nitrate
Others:		
Public Health Goal (PHG)	OEHHA	1 mg/L
IRIS Reference Dose (noncancer health effect)	US EPA, Region 9	0.7 mg/L

[1]These levels generally relate to drinking water, other water quality levels may exist. For further information, see A Compilation of Water Quality Goals (Marshack, 2000).

SUMMARY OF DETECTIONS IN PUBLIC DRINKING WATER WELLS[2]	
Detection Type	**Number of Groundwater Sources**
Number of active and standby public drinking water wells[3] with Nitrate (as NO_3) concentration ≥ 45 μg/L.	616 of approximately 16,000
Top 3 Counties having public drinking water wells with Nitrate (as NO_3) concentration ≥ 45 μg/L.	Kern, San Bernardino, Los Angeles
Top 3 Regions having public drinking water wells with Nitrate (as NO_3) concentration ≥ 45 μg/L.	Central Valley, Los Angeles, Santa Ana

[2]Based on DHS data collected from 1984-2000 (Geotracker). See Figure 1.
[3]In general, drinking water from active and standby wells is treated or blended so consumers are not exposed to water exceeding MCLs. Individual wells and wells for small water systems not regulated by DHS are not

included in these figures.

ANALYTICAL INFORMATION		
Method	**Detection Limit**	**Note**
US EPA 300.0, 300.1		Nitrate-Nitrogen by Ion Chromatography
US EPA 353.2 Cal.		Nitrate-Nitrate by Automated Colorimetry
US EPA 9056	1 mg/L	Nitrate-Nitrite
US EPA 9210	2.0 mg/L	Simple Nitrate
Known Limitations to Analytical Methods	See appropriate method. Both 9056 and 9210 have interference and concentration restrictions.	
Public Drinking Water Testing Requirements	Testing of public drinking water wells is required.	

NITRATE / NITRITE OCCURRENCE	
Anthropogenic Sources	The greatest use of nitrates is as a fertilizer. Some of the major contributors to nitrate contaminated groundwater include: fertilizer application, industry, septic systems, waste water holding ponds, leaking sewer lines, sludge and manure application and explosives.
Natural Sources	Natural sources of nitrates include animal waste, nitrogen-fixing bacteria, geologic formations, and atmospheric nitrogen. Shallow ground water unaffected by human activities commonly contains less than 2 mg/L of nitrate (Mueller and Helsel, 1996).
History of Occurrence	There are numerous nitrate groundwater plumes in California. In general, most are associated with dairies, feedlots, industrial waste, septic systems, waste water holding ponds, leaking sewer lines, sludge and manure application and the manufacture and use of explosives. The U.S. EPA has estimated that as many as 52% of community water wells and 57% of domestic water wells in the U.S. are contaminated by nitrates. According to estimates by the U.S. Geological Survey, up to 15% of wells in agricultural and urban areas have nitrate levels exceeding U.S. EPA standards.
Contaminant Transport Characteristics	Nitrates are soluble and mobile in groundwater.

REMEDIATION & TREATMENT TECHNOLOGIES

Nitrates are easily dissolved in water and extremely difficult to remove. Some of the methods of reducing or removing nitrate are demineralization by distillation, reverse osmosis and ion exchange. Evidently, biological denitrification is a process that can be used. Distillation may be very expensive, but may be used in conjunction with other technologies, such as ion exchange (treatment of the regenerant) to reduce waste streams.

Demineralization removes nitrate and all other minerals from the water. Distillation is one of the most effective types of demineralization.

Reverse osmosis is another way to demineralize water. In a reverse osmosis system, the water is put under pressure and forced through a membrane that filters out minerals and nitrate.

Both of these demineralization systems require time and energy to operate efficiently. They are also low-yield systems, and storage space for treated water is required.

Ion Exchange is also used to treat nitrate contamination. Ion Exchange is the same type of process used for water softening. Most often chloride is exchanged for nitrate. The ion-exchange unit is a tank filled with special resin beads that are charged with chloride. As water containing nitrate flows through the tank, the resin takes up the nitrate and replaces it with chloride. The chloride is exchanged for nitrate. The resin can then be recharged by back washing with a brine solution (sodium chloride) and reused.

Ion-exchange systems can treat large volumes of water. However, in addition to exchanging nitrate, the resin beads will also take up sulfate in exchange for chloride. Therefore, if sulfates are present in the water supply, the capacity of the resin to take up nitrate is reduced. Second, the exchange process may also make the water corrosive. For this reason, the water must go through a neutralizing system after going through the ion-exchange unit. Finally, the backwash brines, which are high in nitrate, must be disposed of properly so they do not re-contaminate the groundwater supply.

There is no simple way to remove all nitrates from water. Although it is common to think of boiling, softening, or filtration as a means of purifying water, none of these methods reduce nitrate contamination. Boiling water is, in fact, the worst thing to do because it actually concentrates the nitrate. Softening and filtration do nothing at all to remove nitrate.

Other options include: pump with beneficial uses, pump and waste, phytoremediation, and biochemically denitrify water above ground.

HEALTH EFFECT INFORMATION

DHS sets drinking water standards and has determined that nitrate poses an acute health concern at certain levels of exposure. Unlike most drinking water MCLs, the nitrate MCL is based upon an observed human effect in highly sensitive persons. There is no safety factor incorporated into the standard. Excessive levels of nitrate in drinking water have caused serious illness and sometimes death in infants less than six months of age. The serious illness in infants is caused because nitrate is converted to nitrite in the body. Nitrite interferes with the oxygen carrying capacity of the child's blood (Methemoglobinemia). This is an acute disease in that symptoms can develop rapidly in infants. In most cases, health deteriorates over a period of days. Symptoms include shortness of breath and blueness of the skin. DHS has set the drinking water standard at 10 part per million (ppm) nitrate as nitrogen (approximately equivalent to the 45 parts per million nitrate as nitrate drinking water standard) to protect against the risk of these adverse effects. DHS has also set a drinking water standard for nitrite at 1 ppm. To allow for the fact that the toxicity of nitrate and nitrite are additive, DHS has also established a standard for the sum of nitrate and nitrite at 10 ppm as nitrogen.
Cases of methemoglobinemia are known to have occurred in infants exposed to nitrate concentrations only slightly above 10 mg/l.

KEY REFERENCES

1. California Environmental Protection Agency. Office of Environmental Health Hazard Assessment December 1997. Public Health Goals for Nitrate and Nitrite in Drinking Water. http://www.oehha.ca.gov/water/phg/pdf/nit2_c.pdf

2. California Environmental Protection Agency / Regional Water Quality Control Board, Central Valley Region. August 2000. *A Compilation of Water Quality Goals*. Prepared by Jon B. Marshack. http://www.swrcb.ca.gov/rwqcb5/available_documents/wq_goals/wq_goals.pdf

3. California Department of Health Services. *Health Effects Language*. http://www.dhs.ca.gov/ps/ddwem/technical/dwp/tmf/Health_effects_language.htm (Oct. 23, 2002)

4. Interstate Technology Regulatory Cooperation Work Group, Enhanced In-Situ Biodenitrification Work Team. June 2000. Emerging Technologies for Enhanced In-Situ Biodenitrification (EISBD) of Nitrate-Contaminated Ground Water. http://www.itrcweb.org/common/default.asp (Oct. 23, 2002)

5. Mueller, David K. and Dennis R. Helsel. U.S. Geological Survey. 1996. Nutrients in the Nation's Waters -Too Much of a Good Thing? http://water.usgs.gov/nawqa/CIRC-1136.html (Oct. 23, 2002)

6. The National Environmental Education & Training Foundation. What's in the Water: NEETF's Guide to Consumer Confidence Reports on Drinking Water Quality. http://www.waterqualityreports.org (Oct. 23, 2002)

7. Nolan, Bernard T. U.S. Geological Survey. Relating Nitrogen Sources and Aquifer Susceptibility to Nitrate in Shallow Ground Waters of the United States. http://water.usgs.gov/nawqa/nutrients/pubs/gw_v39_no2/gw_v39_no2.pdf (Oct. 23, 2002)

8. Nolan, Bernard T., Barbara C. Ruddy, Kerie J. Hitt, and Dennis R. Helsel. U.S. Geological Survey. *A National Look at Nitrate Contamination of Ground Water.* http://water.usgs.gov/nawqa/wcp/ (Oct. 23, 2002)

9. U.S. Environmental Protection Agency. Nonpoint Source News-Notes February/March 1999, Issue #56. *Nitrogen-laden Rocks Contribute to High Levels of Nitrate in California River.* http://www.epa.gov/owow/info/NewsNotes/issue56/techncl56.html#nitrogen (Oct. 23, 2002)

10. U.S. Geological Survey. *A Reconnaissance Study of the Effect of Irrigated Agriculture on Water Quality in the Ogallala Formation, Central High Plains Aquifer.* http://webserver.cr.usgs.gov/nawqa/hpgw/factsheets/MCMAHONFS1.html (Oct. 23, 2002)

FOR MORE INFORMATION, CONTACT:
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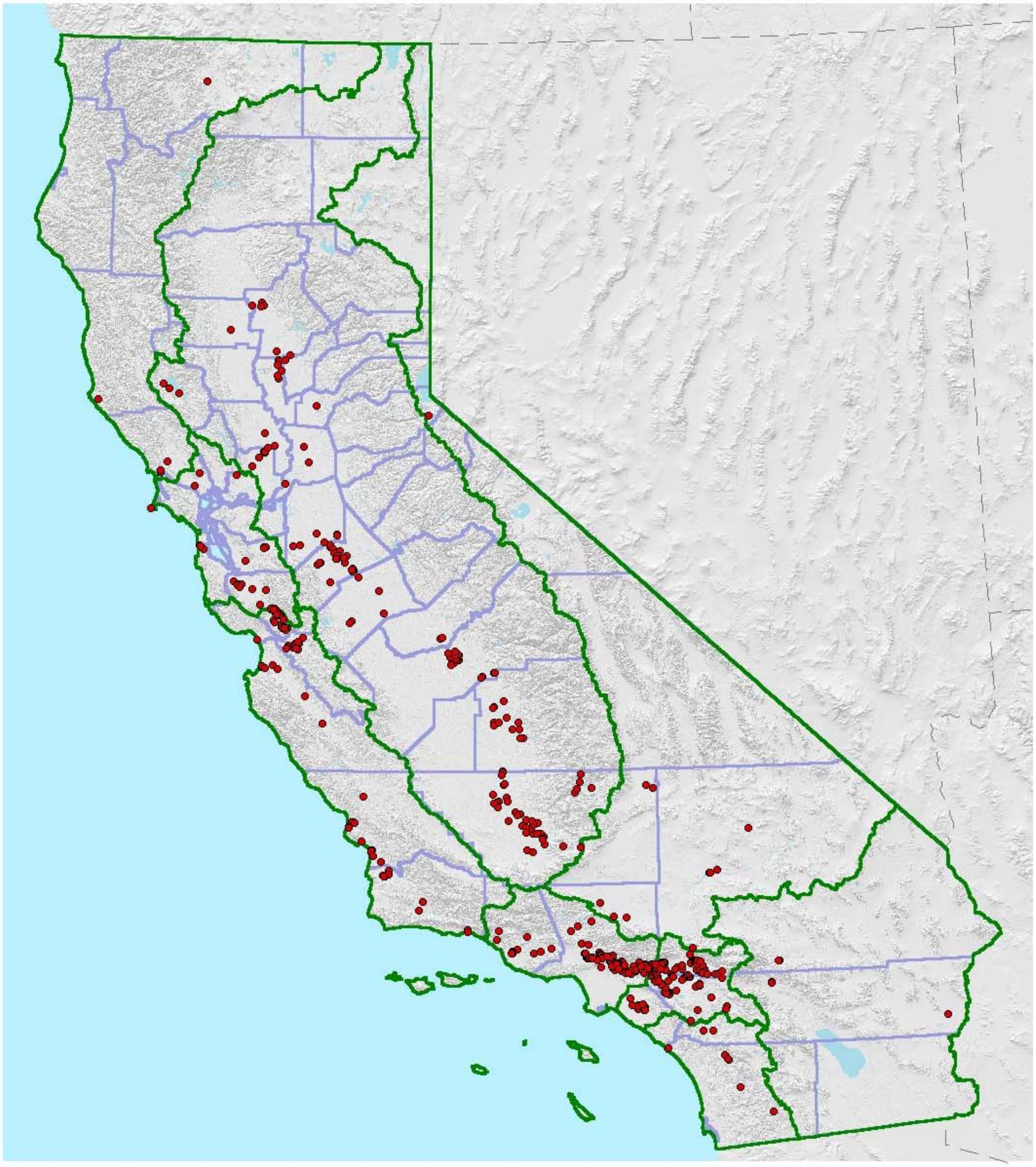
Groundwater Information Sheet: Nitrate
Figure 1



Active and Standby DHS Wells (616 Total) with at Least One Detection of Nitrate (as NO3) >= 45 PPM MCL

Source: 1984 - 2000 DHS Data (Map Revised 10/02/02)

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GEOTRACKER