GROUNDWATER INFORMATION SHEET

Trichloroethylene (TCE)

The purpose of this groundwater information sheet is to provide general information regarding a specific constituent of concern (COC). The information provided herein relates to wells (groundwater sources) used for public drinking water, not served at the tap.

GENERAL INFORMATION	
Constituent of Concern	Trichloroethylene (TCE)
Synonyms	Ethylene trichloride, Acetylene trichloride, Triclene, Trichloroethene, 1,1,2-Trichloroethylene
Chemical Formula	C_2HCl_3
CAS No.	79-01-6
Storet No.	39180
Summary	The current State Maximum Contaminant Level (MCL) for TCE is 5 micrograms per liter (µg/L). TCE is primarily used as a solvent to remove grease from metal parts. TCE may occur in groundwater in dissolved form and/or as a free product that sinks below the water table in the form of a dense non-aqueous phase liquid (DNAPL). Based on SWRCB data from 2007 to 2017, 186 active and standby public water supply wells (of 8,994 wells sampled) had at least one detection of TCE above the MCL. Most wells with detections of TCE above the MCL occurred in three counties; Los Angeles (153), San Bernardino (14) and Fresno (6).

REGULATORY AND WATER QUALITY LEVELS		
Type	**Agency**	**Concentration**
Federal MCL	US EPA[1]	5 µg/L
State MCL	SWRCB[2]	5 µg/L
Public Health Goal (PHG)	OEHHA[3]	1.7 µg/L[4]
Detection Limits for Purposes of Reporting (DLR)	SWRCB	0.5 µg/L

[1]US EPA - US Environmental Protection Agency
[2]SWRCB - State Water Resources Control Board
[3]OEHHA - Office of Environmental Health Hazard Assessment.
[4] After the US EPA reclassified TCE as a human carcinogen, OEHHA initiated a review of the PHG for TCE in September, 2012.

SUMMARY OF DETECTIONS IN PUBLIC WATER WELLS[5]	
Detection Type	**Number of Groundwater Sources**
Number of active and standby public water wells with TCE concentrations > 5 µg/L.	186, of 8,994 wells sampled.
Counties with active and standby public water wells with TCE concentrations > 5 µg/L.	Los Angeles (153), San Bernardino (14), Fresno (6)

[5]Based on 2007-2017 public active and standby well (groundwater sources) data collected by the SWRCB.
[6] Water from active and standby wells is typically treated to prevent exposure to chemical concentrations above the MCL. Data from private domestic wells and wells less than 15 service connections are not available.

ANALYTICAL INFORMATION	
Analytical Test Methods	US EPA Method 524.2, 502.2, 8260B
Detection Limits	0.2, 0.01, 0.02 µg/L, respectively, by methods listed above.
Known Limitations to Analytical Methods	Sample must be cooled to 4° C upon collection and analyzed within 14 days. Sample must be free of air bubbles.
Public Drinking Water Testing Requirements	TCE is a regulated contaminant for which monitoring is required (Title 22, Section 64431, et seq.).

TCE OCCURRENCE	
Anthropogenic Sources	TCE is primarily used as a solvent to remove grease from metal parts, particularly in the automotive and metal machining industry. As a general solvent or as a component of solvent blends, TCE is used with adhesives, lubricants, paints, varnishes, paint strippers, pesticides, and cold metal cleaners. It can be found in many household products, including paint removers, adhesives, spot removers, and rug-cleaning fluids. It is also used in various chemical manufacturing processes. Historically, TCE was also used in foods, beverages (decaffeination of coffee), pet foods, medicine, pharmaceuticals and cosmetics.
Natural Sources	TCE does not occur naturally in the environment.
History of Occurrence	TCE has been in use for almost a century. The largest sources of TCE in groundwater are releases from chemical waste sites, improper disposal practices, and leaking storage tanks and pipelines. The major sources of TCE to the environment are landfills and air emissions. Historically, TCE at concentrations above the MCL (5 µg/L) was found in over 200 public wells in California, with the majority of occurrence in the Los Angeles, San Bernardino, and Fresno counties.
Contaminant Transport Characteristics	TCE is moderately soluble in water and soil. TCE is denser than water and free phase TCE will sink to the bottom of an aquifer as a dense non-aqueous phase liquid (DNAPL). TCE can destroy the structure of clayey minerals, making them more permeable to dissolved contaminants. TCE is not readily degraded in groundwater, although some TCE may naturally degrade under anaerobic conditions. However, TCE may degrade into compounds that are toxic and more difficult to degrade than TCE, such as dichloroethylene (DCE) and vinyl chloride.

REMEDIATION & TREATMENT TECHNOLOGIES

Air Stripping, Ultraviolet (UV) Light, and Activated Carbon: TCE is typically removed from groundwater using a traditional pump and treat system where water is treated above ground by air-stripping and activated carbon filtration and/or UV treatment.
Permeable Reactive Barriers (PRB): PRB are filled with zero-valent iron granules and/or organic matter has been used to remediate and contain TCE plumes in-situ.
Innovative Methods: Oxidation, using potassium permanganate, thermal remediation using electrodes, and steam or enhanced biodegradation are currently being tested. An increasing variety of nanoscale materials with environmental applications has been developed over the past several years. For example, nanoscale materials have been used to remediate contaminated soil and groundwater at hazardous waste sites, such as sites contaminated by chlorinated solvents or oil spills.

Drinking water may be treated using various in-line processes. Traditionally, air stripping and activated carbon filters are used to remove TCE and other volatile organic carbons (VOCs) from water. Ultraviolet radiation with the addition of hydrogen peroxide is also used for low-flow systems. Wastewater treatment plants use chemical oxidizers (such as potassium permanganate) and biodegradation processes to remove VOCs from water.

HEALTH EFFECT INFORMATION

Acute overexposure to TCE vapor can affect the central nervous system, e.g., light-headedness, drowsiness, and headache. Acute exposure may lead to unconsciousness or in extreme circumstances to death. TCE may irritate the respiratory tract at high vapor concentrations. Prolonged contact with the chemical in liquid form can cause irritation of the skin and eyes.

Chronic (repeated) exposure, in excess of recommended occupational limits, has been associated with damage to the liver, kidneys, and nervous system. TCE is considered a carcinogen to the State of California, and was added to the list of carcinogens in 1988. US EPA determined TCE to be carcinogenic to humans by all routes of exposure.

KEY REFERENCES

1. California Environmental Protection Agency. Office of Environmental Health Hazard Assessment. Public Health Goal for Trichloroethylene in Drinking Water. July, 2009 http://www.oehha.ca.gov/water/phg/tce070909.html

2. California Environmental Protection Agency. Office of Environmental Health Hazard Assessment, Initiation of Process to Update Public Health Goals for Three Chemicals in Drinking Water, September 2012. https://oehha.ca.gov/water/public-health-goal-report/initiation-process-update-public-health-goals-three-chemicals

3. Howard, H. Philip, et al., Environmental Degradation Rates. 1991. Lewis Publisher.

4. Montgomery H. J., Groundwater Chemicals-Desk Reference. 2000. Lewis Publisher

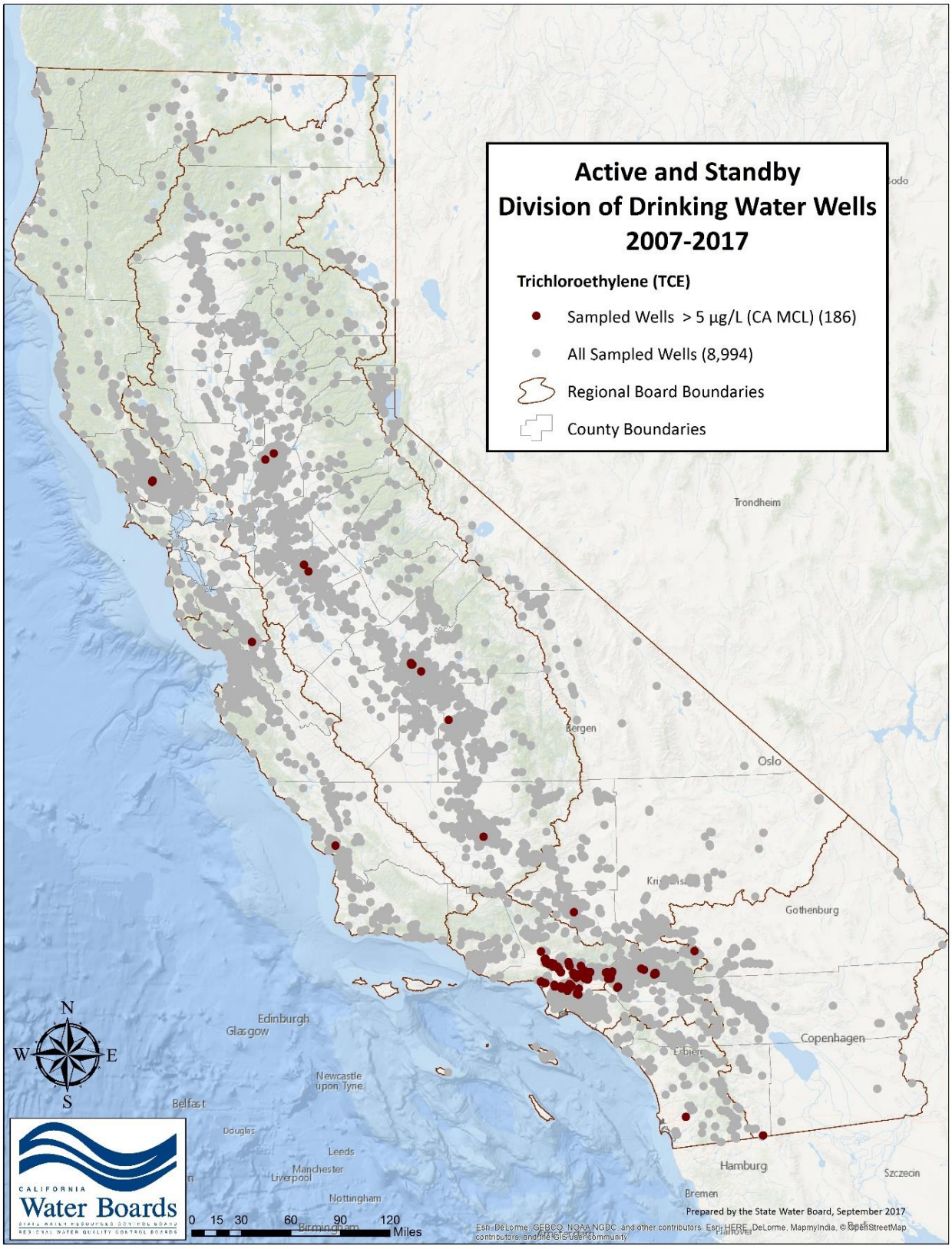
5. Nanotechnology: Applications for Environmental Remediation Overview, http://www.clu-in.org/techfocus/default.focus/sec/Nanotechnology%3A_Applications_for_Environmental_Remediation/cat/Overview/

6. State Water Resources Control Board. January 2016. *A Compilation of Water Quality Goals, 17th Edition, (SWRCB, 2016).* http://www.waterboards.ca.gov/water_issues/programs/water_quality_goals/index.shtml

7. U.S. Environmental Protection Agency. Technologies- Permeable Reactive Barriers. https://clu-in.org/techfocus/default.focus/sec/Permeable_Reactive_Barriers%2C_Permeable_Treatment_Zones%2C_and_Application_of_Zero-Valent_Iron/cat/Overview/

8. U.S. Environmental Protection Agency, Contaminated Site Clean-Up Information. Bioremediation Overview. http://www.clu-in.org/techfocus/default.focus/sec/Bioremediation/cat/Overview/

9. US Environmental Protection Agency, Contaminated Site Clean-Up Information, Contaminant focus-Trichloroethylene. https://clu-in.org/contaminantfocus/default.focus/sec/Trichloroethylene_(TCE)/cat/Overview/



Active and standby public drinking water wells that had at least one detection of TCE above the MCL, 2007-2017, 186 wells. (*Source: Public well data using GeoTracker-GAMA)*