GROUNDWATER INFORMATION SHEET

Tetrachloroethylene (PCE)

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 water served at the tap.

GENERAL INFORMATION	
Constituent of Concern	Tetrachloroethylene (PCE)
Aliases	Tetrachloroethene, Perchloroethylene, Carbon Dichloride, Perchlor, Antisol 1, Ankilostin
Chemical Formula	C_2Cl_4
CAS No.	127-18-4
Storet No.	34475
Summary	PCE is a regulated contaminant with an established Maximum Contaminant Level (MCL) for drinking water at 5 micrograms per liter (µg/L). Common anthropogenic sources of PCE include discharges related to dry cleaning operations and metal degreasing processes. Based on SWRCB data from 2007 to 2017, 173 active and standby public water supply wells (of 8,994 wells sampled) had at least one detection of PCE above the MCL (5 µg/L). Most wells with detections occurred in Los Angeles (128 wells), San Bernardino (9 wells), and Tulare (5 wells) counties.

REGULATORY AND WATER QUALITY LEVELS[1]		
Type	**Agency**	**Concentration**
Federal MCL	US EPA[2]	5 µg/L
State MCL	SWRCB[3]	5 µg/L
Detection Limit for Purposes of Reporting (DLR)	SWRCB[3]	0.5 µg/L
Public Health Goal (PHG)	OEHHA[4]	0.06 µg/L

[1]These levels generally relate to drinking water. Other water quality levels may exist. For more information, see *A Compilation of Water Quality Goals,* 17th Edition (SWRCB, 2016).
[2]US EPA - US Environmental Protection Agency
[3]SWRCB - State Water Resources Control Board.
[4]OEHHA – Office of Environmental Health Hazard Assessment

SUMMARY OF DETECTIONS IN PUBLIC WATER WELLS[5]	
Detection Type	**Number of Wells**
Number of active and standby public water wells[6] with PCE concentrations > 5 µg/L.	173 of 8,994 wells sampled.
Top 3 counties with PCE detections in active and standby public water wells with PCE concentrations > 5 µg/L.	Los Angeles (128), San Bernardino (9) and Tulare (5)

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

ANALYTICAL INFORMATION	
Analytical Test Methods	US EPA Methods 502.2, 524.2, 551.1
Detection Limit	0.04 µg/L(EPA 502.2), 0.05 µg/L (EPA 524.2), 0.002 µg/L (EPA 551.1)
Known Limitations to Analytical Methods	Sample must be cooled to 4 °C upon collection, analyzed within 14 days and free of air bubbles.
Public Drinking Water Testing Requirements	Groundwater sources must be initially monitored for PCE during four consecutive quarterly sampling events. If PCE is not detected the groundwater system must take annual samples for a minimum of three consecutive years. The groundwater system may then reduce monitoring to one sample per each compliance period. If granted a waiver for VOC monitoring, a system using groundwater shall collect a minimum of one sample every six years. If PCE is detected in groundwater, the site will have to be monitored for vinyl chloride during each compliance period.

PCE OCCURRENCE	
Anthropogenic Sources	PCE is a contaminant in the environment associated with dry cleaning, textile operations, and metal degreasing activities. It was also widely used in the production of CFC-113 (Freon-113) and other fluorocarbons. PCE is also used in rubber coatings, solvent soaps, printing inks, adhesives and glues, sealants, polishes, lubricants and pesticides.
Natural Sources	PCE is a manufactured chemical and does not occur naturally in the environment.
History of Occurrence	PCE has been used as a metal degreaser by military services and industry since the 1940s. Later, PCE was also used in dry cleaning processes. Due to poor handling and disposal practices, solvents such as PCE and trichloroethylene (TCE) entered the environment through evaporation, leaks, and improper disposal. U.S. EPA has found tetrachloroethylene in at least 945 of the 1,699 current or former National Priority List (NPL) sites. In California, numerous solvent plumes have originated from dry cleaning facilities in the Central Valley, Southern California, and San Francisco Bay Area.
Contaminant Transport Characteristics	Mobility of PCE is described as moderate to high with an average solubility in groundwater of 150 mg/L (at 20 deg. C), soil sorption coefficient of 2.4 (log K_{oc}), and octanol/water partition coefficient of 2.5 (log K_{ow}). PCE is a dense non-aqueous phase liquid (DNAPL). A DNAPL is denser than and immiscible in water. In the presence of water, it will form a separate phase. The half-life degradation rate in groundwater is estimated to be between 1 to 2 years, based on aqueous aerobic biodegradation (Howard et al 1991) but may be considerably longer under certain conditions.

REMEDIATION & TREATMENT TECHNOLOGIES	
Groundwater Remediation	Treatment of groundwater containing PCE includes traditional pump-and-treat technology (using air stripping or activated carbon filtration), *in situ* chemical oxidation with peroxide or ozone, de-chlorination by Hydrogen-Releasing Compound (HRC) and emerging biodegradation techniques. An important part of PCE DNAPL remediation is source removal. This is accomplished often by integrating various methods of DNAPL mobilization using co-solvents, surfactants or thermal treatment and subsequent source removal - either by pump and treat or air sparging and soil vapor extraction. The bacteria strain (Dehalococcoides ethenogenes strain 195) preferentially uses PCE as a source of energy. Slow natural biodegradation of PCE may occur under anaerobic conditions when microorganisms are acclimated. However, the biodegradation process degrades PCE to TCE and eventually to vinyl chloride, which are also considered human carcinogens.
Drinking Water and Wastewater Treatment	Drinking water can be treated by various in-line processes. Traditionally, air stripping and activated carbon filters are used to remove PCE and other volatile organic carbons (VOCs) from water. Ultra-violet radiation is also used for low-flow systems. Wastewater treatment plants use chemical oxidation and are increasingly using biodegradation processes to remove VOCs from water.

HEALTH EFFECT INFORMATION

***Acute*:** At levels above 100-200 mg/L in air, PCE may cause eye irritation and light-headedness; above 400 mg/L, eye and nasal irritation, lack of coordination within 2 hours; 600 mg/L, dizziness within 10 minutes; 1,500 mg/L, extreme irritation to eyes and respiratory tract, dizziness within 2 minutes, unconsciousness within 30 minutes.

***Chronic*:** Long-term exposures in drinking water above the MCL (5 µg/L) can cause adverse effects to the liver, kidneys, and central nervous system. Prolonged dermal exposure can cause irritation, dryness, and dermatitis.

***Carcinogen*:** Scientific evidence shows PCE may cause cancer from prolonged exposure even at levels below the MCL. The US EPA classifies PCE as a probable human carcinogen. The calculated PHG of 0.06 µg/L represents a negligible risk of contracting cancer from drinking water containing PCE in a household environment over a lifetime.

KEY REFERENCES

1. Agency for Toxic Substances and Diseases Registry, Public Health Statement, Tetrachloroethylene, October 2014. https://www.atsdr.cdc.gov/ToxProfiles/tp18-c1-b.pdf

2. California State Water Resources Control Board. GeoTracker-Groundwater Database. http://geotracker.waterboards.ca.gov/gama/

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

4. ITRC. DNAPL Source Reduction: Facing the Challenge, April 2002. http://www.itrcweb.org/Guidance/GetDocument?documentID=19

5. Montgomery, John H. Groundwater Chemicals, Desk Reference, 3rd Edition, 2000.

6. National Environmental Methods Index (NEMI), Tetrachloroethylene. https://www.nemi.gov/methods/keyword/?keyword_search_field=tetrachloroethylene

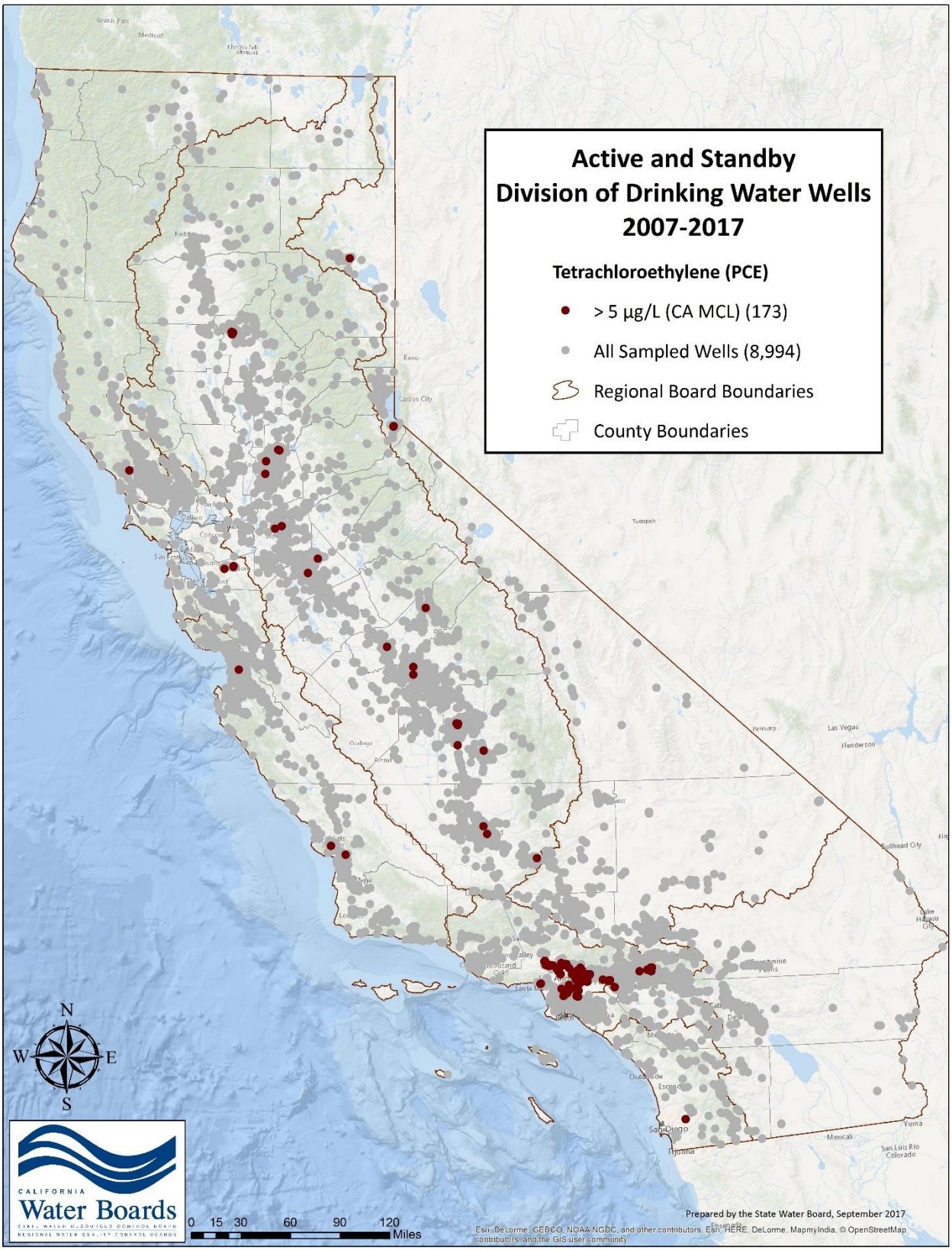
7. Office of Environmental Health Hazard Assessment. Public Health Goal for Tetrachloroethylene in Drinking Water. August 2001. https://oehha.ca.gov/media/downloads/water/chemicals/phg/pceaug2001_0.pdf

8. Safety Data Sheet, Perchloroethylene, All Grades, 2015. http://www.ppe.com/msds/MRS-3.PDF

9. State Water Resources Control Board, *A Compilation of Water Quality Goals*. 17th Edition. 2016. http://www.waterboards.ca.gov/water_issues/programs/water_quality_goals/docs/wq_goals_text.pdf

10. U.S. Environmental Protection Agency, Technology Innovation Office, Contaminated Site Clean-Up Information. http://www.clu-in.org/contaminantfocus/default.focus/sec/Dense_Nonaqueous_Phase_Liquids_(DNAPLs)/cat/Overview/

11. Yinjie J. Tang, Shan Yi, Wei-Qin Zhuang, Stephen H. Zinder, Jay D. Keasling, and Lisa Alvarez-Cohen, Investigation of Carbon Metabolism in "Dehalococcoides ethenogenes" Strain 195 by Use of Isotopomer and Transcriptomic Analyses. http://jb.asm.org/content/191/16/5224.full



Active and standby public drinking water wells that had at least one detection of PCE above the MCL, 2007-2017, 173 wells. (*Source: Public supply well data in GeoTracker GAMA).*