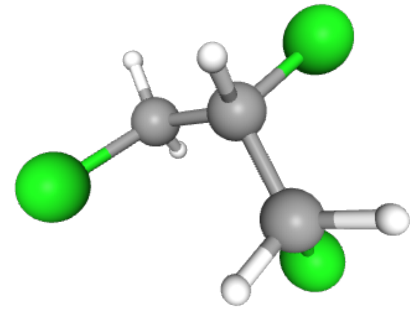
Groundwater Fact Sheet
1,2,3 - Trichloropropane (TCP)



Constituent of Concern
1,2,3 - Trichloropropane

Synonym
Allyl trichloride, glycerol trichlorohydrin, trichlorohydrin

Chemical Formula
$C_3H_5Cl_3$

CAS Number
96-18-4

Storet Number
77443

Summary

1,2,3-Trichloropropane (TCP) is a regulated chemical in California with an established State Maximum Contaminant Level (MCL) in drinking water of 0.005 µg/L, or 5 parts per trillion (ppt). TCP is a chlorinated hydrocarbon with high chemical stability. It is a man-made chemical, typically found at industrial or hazardous waste sites. It has been used as a solvent and as a cleaning and degreasing agent. It can result from the production of soil fumigants or be used as an intermediate in the production of other chemicals (e.g., dichloropropane, hexafluoropropylene). TCP is a dense nonaqueous phase liquid (DNAPL) and as such it sinks to lower aquifer portion, slowly dissolving and being transported by groundwater. Besides, its degradation rates are low, making it a persistent contaminant in groundwater. The Environmental Protection Agency (EPA) has classified TCP as likely to be carcinogenic to humans.

Based on State Water Resources Control Board (SWRCB) data from 2007 to 2017, 395 active and standby public supply water supply wells (of 5,863 wells tested, 412 detections) had at least one detection above the CA-MCL. Most detections above the CA-MCL occurred in Kern (110), Fresno (64) and Los Angeles County (51).

REGULATORY WATER QUALITY LEVELS[1]

1,2,3 - TRICHLOROPROPANE (TCP)

Type	Agency	Concentration
Federal MCL	EPA[2]	NA
State MCL	SWRCB[3]	0.005 µg/L (or 5 ppt)
Detection Limit for Purposes of Reporting (DLR)	SWRCB[3]	0.005 µg/L
Public Health Goal (PHG)	OEHHA[4]	0.0007 µg/L

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

TCP DETECTIONS IN PUBLIC WATER WELL SOURCES[5]	
Number of active and standby public water wells with TCP concentrations > 0.005 µg/L [6]	395 of 5,863 wells tested with 412 detections.
Top 3 counties with TCP detection in public wells above the MCL	Kern (110), Fresno (64) and Los Angeles (51)

[5]Based on 2007-2017 public standby and active 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 MCL. Data from private domestic wells and wells with less than 15 service connections are not available.

ANALYTICAL INFORMATION			
Approved methods	EPA 504.1	PT-GC/MS (DWRL)[7]	LLE-GC/MS (DWRL)[7]
Detection Limit (µg/L)	0.02	0.005	0.005
Notes	Microextraction and Gas Chromatography	Purge and Trap – Gas Chromatography/ Mass Spectrometry	Liquid-Liquid Extraction – Gas Chromatography/ Mass Spectrometry
Known Limitations to Analytical Methods	Two methods: LLE-GC/MS and PT-GC/MS can measure TCP at the MCL level. They were developed by DWRL but are expensive and require experienced laboratory analysts. EPA method 504.1 is State certified for field testing.		
Public Drinking Water Testing Requirements	TCP is a regulated organic chemical in public water systems requiring monitoring and reporting to the SWRCB, starting in January 2018. The notification level was established at 0.005 µg/L in 1999. Analytical methods to meet the notification level were established in 2002. Based on detections of TCP in California's groundwater, OEHHA established a 0.0007 µg/L Public Health Goal (PHG) in 2009. In July 2017, the SWRCB Division of Drinking Water adopted the MCL for TCP at 0.005 µg/L.		

[7]DWRL- California Drinking Water & Radiation Laboratories

Perchlorate Occurrence

Anthropogenic Sources

TCP is typically found at industrial and hazardous waste sites. TCP has been used mainly as a solvent and an extracting agent (paint and varnish remover, cleaning and degreasing agent, and cleaning and maintenance solvent). Currently, TCP is used as a chemical intermediate in the production of polysulfone liquid polymers and dichloropropane, in the synthesis of hexafluoropropylene, and as a cross-linking agent in the synthesis of polysulfides. TCP has been formulated with dichloropropane in the manufacturing of a soil fumigant (nematicide) D-D, which is no longer available in the United States.

Natural Sources

TCP is a manufactured chemical and does not occur naturally in the environment.

History of Occurrence

TCP was found in extracts of treated groundwater associated with hazardous waste cleanup at a southern California Superfund site in the late 1990's. Since 2007, TCP has been detected in 412 active and standby public supply wells at a maximum concentration of 25 µg/L in Los Angeles County.

Contaminant Transport Characteristics

TCP is slightly soluble in water, with a reported solubility of 1,750 mg/L at 25°C, and has a low soil sorption coefficient (1.7-2.0, EPA) resulting in easy migration with groundwater flow. TCP is not readily degraded in most groundwaters and would be readily transported within an aquifer. Because its density (1.4) is heavier than water, pure phase liquid TCP will sink into deeper parts of an aquifer in the form of a dense non-aqueous phase liquid (DNAPL). As a result of low abiotic and biotic degradation rates, TCP may remain in groundwater for long periods of time.

Remediation and Treatment Technologies

TCP can be removed using traditional methods applied for other chlorinated hydrocarbons, such as pump and treat by granular activated carbon filters (GAC), *in-situ* oxidation, permeable reactive barriers (zero-valent zinc), dechlorination by hydrogen-releasing compounds, and emerging biodegradation techniques. The cleanup method will depend on TCP concentrations in groundwater or in soil, the extent of the contaminated zone, and the specific physical, chemical, and biological conditions of soil and groundwater. Recently, a new method was developed; a continuous, in-line, pressurized advanced oxidation process (HiPOx) that can remove TCP from groundwater to below 0.005 µg/L.

There were no data found on natural attenuation of TCP, but it may occur under favorable conditions. The half-life of TCP in groundwater is reported to be from one to two years. However, these rates will be longer under anaerobic conditions.

Drinking Water and Wastewater Treatment

Above ground treatment usually consists of activated carbon filtration, as used for other chlorinated hydrocarbons (Water Research Foundation, March 2016). Wastewater treatment plants have experimented with chemical oxidizers such as potassium permanganate and biodegradation processes to remove chlorinated hydrocarbons from water; however, these methods have proven to be costly and ineffective for TCP removal.

Health Effect Information

Acute Health Effects

Contact with TCP can irritate and burn the skin and eyes. Breathing TCP can irritate the nose, throat and lungs, cause headaches, and affect concentration, memory, and muscle coordination.

Chronic Health Effects

Animal studies have shown that long-term exposure to TCP may cause liver and kidney damage, reduced body weight and increased incidence of tumors in numerous organs. EPA has established a chronic oral reference dose (RfD) at $4x10^{-3}$ mg/kg/day.

Cancer Hazard

TCP has been shown to cause cancer in animals and is recognized by the State of California as a human carcinogen. For purposes of the Safe Drinking Water and Toxic Enforcement Act of 1986

(Proposition 65), TCP was added to the list of carcinogens in 1992. The MCL and PHG for drinking water are based on potential cancer risk.

Key Resources

1. Agency for Toxic Substances Control and Disease Registry (ATSDR), ToxFAQs for 1,2,3-Trichloropropane. http://www.atsdr.cdc.gov/toxfaqs/tfacts57.pdf
2. California State Water Resources Control Board, A Compilation of Water Quality Goals, 17th Edition, (SWRCB, 2016). http://www.waterboards.ca.gov/water_issues/programs/water_quality_goals/docs/wq_goals_text.pdf
3. California State Water Resources Control Board, Division of Drinking Water: Media Release, State Water Board Approves Drinking Water Standard for 1,2,3-Trichloropropane. https://www.waterboards.ca.gov/press_room/press_releases/2017/pr071817_123tcp.pdf
4. California State Water Resources Control Board, Division of Drinking Water: Determination of 1,2,3-Trichloropropane in Drinking Water by Continuous Liquid-Liquid Extraction and Gas Chromatography/Mass Spectometry, February 2002. http://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/documents/drinkingwaterlabs/TCPbyLLE-GCMS.pdf
5. Dombeck G., Brog C., Multi-contaminant treatment for 1,2,3-trichloropropane destruction using the HiPOx reactor. Proceedings of NGWA conference on MTBE and perchlorate. In: Proceedings of the Sixth International Conference on Remediation of Chlorinated and Recalcitrant Compounds, May 2008, Monterey, CA
6. Howard P. H. Handbook of Environmental Degradation Rates. CRC Press LLC. 1991.
7. Montgomery, J. H. Groundwater Chemicals Desk Reference. 3rd Edition, Lewis Publishers, 2000.
8. EPA - NEPIS - Technical Fact Sheet 1,2,3-Trichloropropane (TCP), 2014 https://nepis.epa.gov/Exe/ZyNET.EXE?ZyActionL=Register&User=anonymous&Password=anonymous&Client=EPA&Init=1
9. EPA - Regional Screening Table, http://www.epa.gov/risk/regional-screening-table
10. Water Research Foundation, 1,2,3-Trichloropropane State of the Science, March 2016. http://www.environmentalrestoration.wiki/images/d/d2/1,2,3-Trichloropropane_state_of_science.pdf

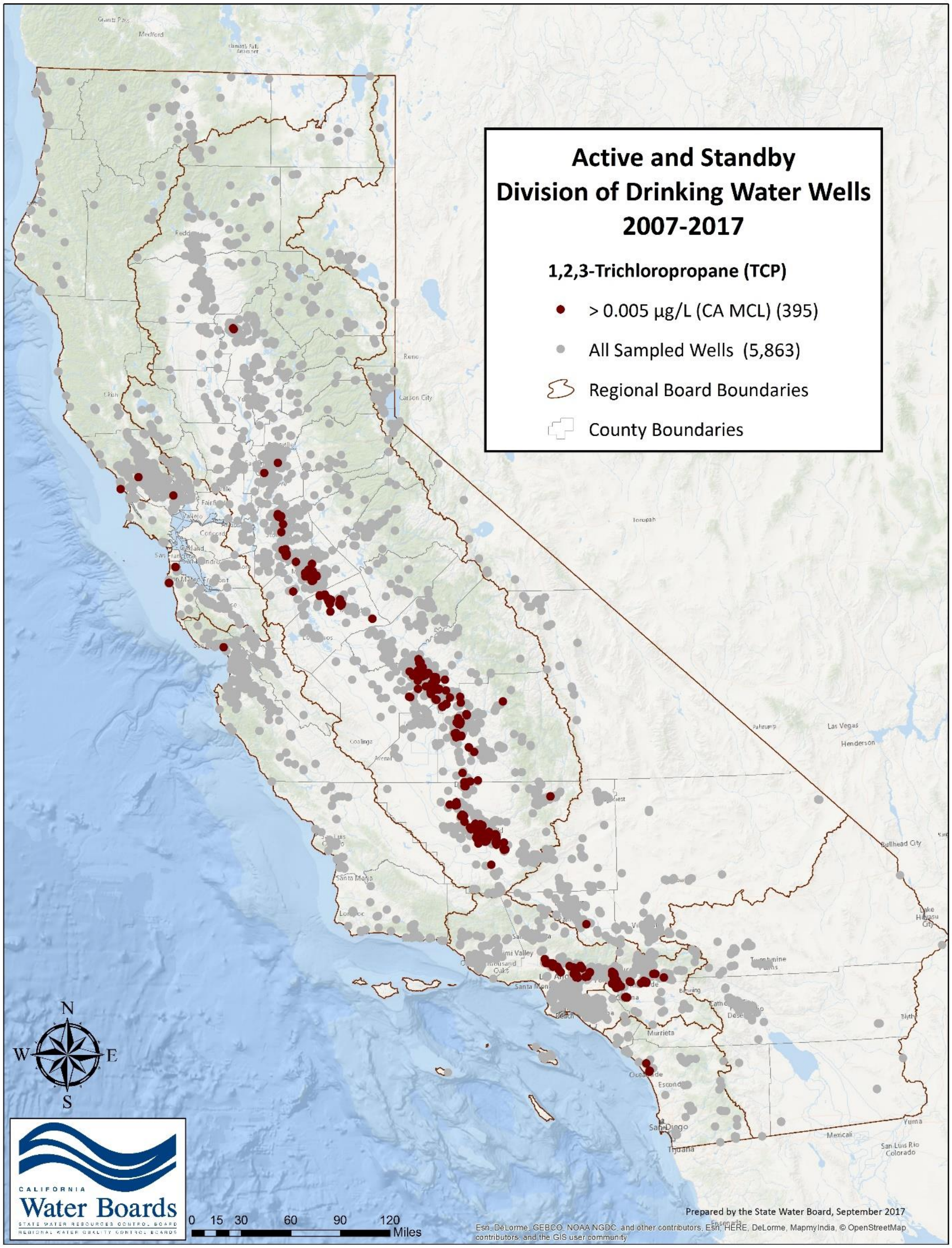


Figure 1. Active and standby public drinking water wells that had at least one detection of TCP above the California MCL, 2007-2017, 395 wells. (*Source: Public supply well data in [GAMA GIS](#)*).