GROUNDWATER INFORMATION SHEET

1,2,3-Trichloropropane (TCP)

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	1,2,3-Trichloropropane (TCP)
Aliases	Allyl trichloride, glycerol trichlorohydrin, trichlorohydrin
Chemical Formula	$C_3H_5Cl_3$
CAS No.	96-18-4
Storet No.	77443
Summary	1,2,3-Trichloropropane (TCP) is a regulated chemical with an established State Maximum Contaminant Level (MCL) in drinking water of 0.005 μg/L, or 5 parts per trillion (ppt). The MCL for TCP was adopted by the State Water Resources Control Board Division of Drinking Water on July 18, 2017. The regulation will require that public water systems statewide begin quarterly sampling for TCP in their drinking water sources in January 2018. Systems will be in or out of compliance with the new drinking water standard based on average of four quarters of sampling. If a water system's four-quarter average is above the 5 ppt standard, it must publicly notify its customers of the violation and take corrective action to resolve the exceedance and avoid future violations of the standard. Common sources of TCP in groundwater include solvent-related discharges. Based on SWRCB data from 2007 to 2017, 395 active and standby public water supply wells (of 5,863 wells sampled) had at least one detection above the CA-MCL. Most wells with detections above the CA-MCL occurred in Kern (110), Fresno (64) and Los Angeles (51) counties.

REGULATORY AND WATER QUALITY LEVELS		
Type	**Agency**	**Concentration**
Federal MCL	US EPA[1]	N/A
State MCL	SWRCB[2]	0.005 µg/L
Detection Limit for Purposes of Reporting (DLR)	SWRCB[2]	0.005 µg/L
CA Public Health Goal	OEHHA[3]	0.0007 µg/L

[1] US EPA - United States Environmental Protection Agency
[2] SWRCB: California State Water Resources Control Board.
[3] OEHHA - Office of Environmental Health Hazard Assessment

SUMMARY OF DETECTIONS IN PUBLIC WATER WELLS[4]	
Detection Type	**Number of Wells**
Number of active and standby public water wells[5] with TCP concentrations above the CA-MCL > 0.005 µg/L.	395 of 5,863 wells sampled
Top 3 counties with TCP detections in public water wells above the CA-MCL > 0.005 µg/L	Kern (110), Fresno (64) and Los Angeles (51)

[4] Based on 2007-2017 active and standby public well (groundwater source) data collected by the SWRCB.

[5] 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.

ANNALYTICAL INFORMATION	
Method	**Detection Limit**
US EPA 504.1	0.02 µg/L
Purge and Trap PT-GC/MS DWRL[6]	0.005 µg/L
Liquid-Liquid Extraction LLE-GC/MS DWRL[6]	0.005 µg/L
Known Limitations to Analytical Methods	Two methods: LLE-GC/MS and PT-GC/MS are able to measure TCP at the DLR[7] level. They were developed by DWRL, but are expensive and require experienced laboratory analysts. US 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.

[6]DWRL- California Drinking Water & Radiation Laboratories
[7] DLR – Detection Limit for Purposes of Reporting

TCP 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 dichloropropene, in the synthesis of hexafluoropropylene, and as a cross-linking agent in the synthesis of polysulfides. TCP has been formulated with dichloropropenes in the manufacturing of a soil fumigant (nematicide), 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 (GeoTracker GAMA, 2017).
Contaminant Transport Characteristics	TCP is slightly soluble in water, with a reported solubility of 1,750 mg/L at 25^{o}C, and has a low soil sorption coefficient (1.7-2.0, US 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).

REMEDIATION & TREATMENT TECHNOLOGIES	
Groundwater Remediation	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 has the ability to remove TCP from groundwater to below 0.005 µg/L. **Natural Attenuation** 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 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 headache, 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 REFERENCES

1. Agency for Toxic Substances Control and Disease Registry (ATSDR), ToxFAQs for 1,2,3-Trichloropropane. http://www.atsdr.cdc.gov/toxfaqs/tfacts57.pdf

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3. Dombeck, G., Borg C., Multi-contaminant Treatment for 1,2,3-Trichloropropane Destruction Using the HiPOx Reactor- Ascend Innovations Inc., Applied Process Technology, Inc. http://citrix.ngwa.org/gwol/pdf/062181324.pdf

4. Howard P. H. Handbook of Environmental Degradation Rates. CRC Press LLC. 1991.

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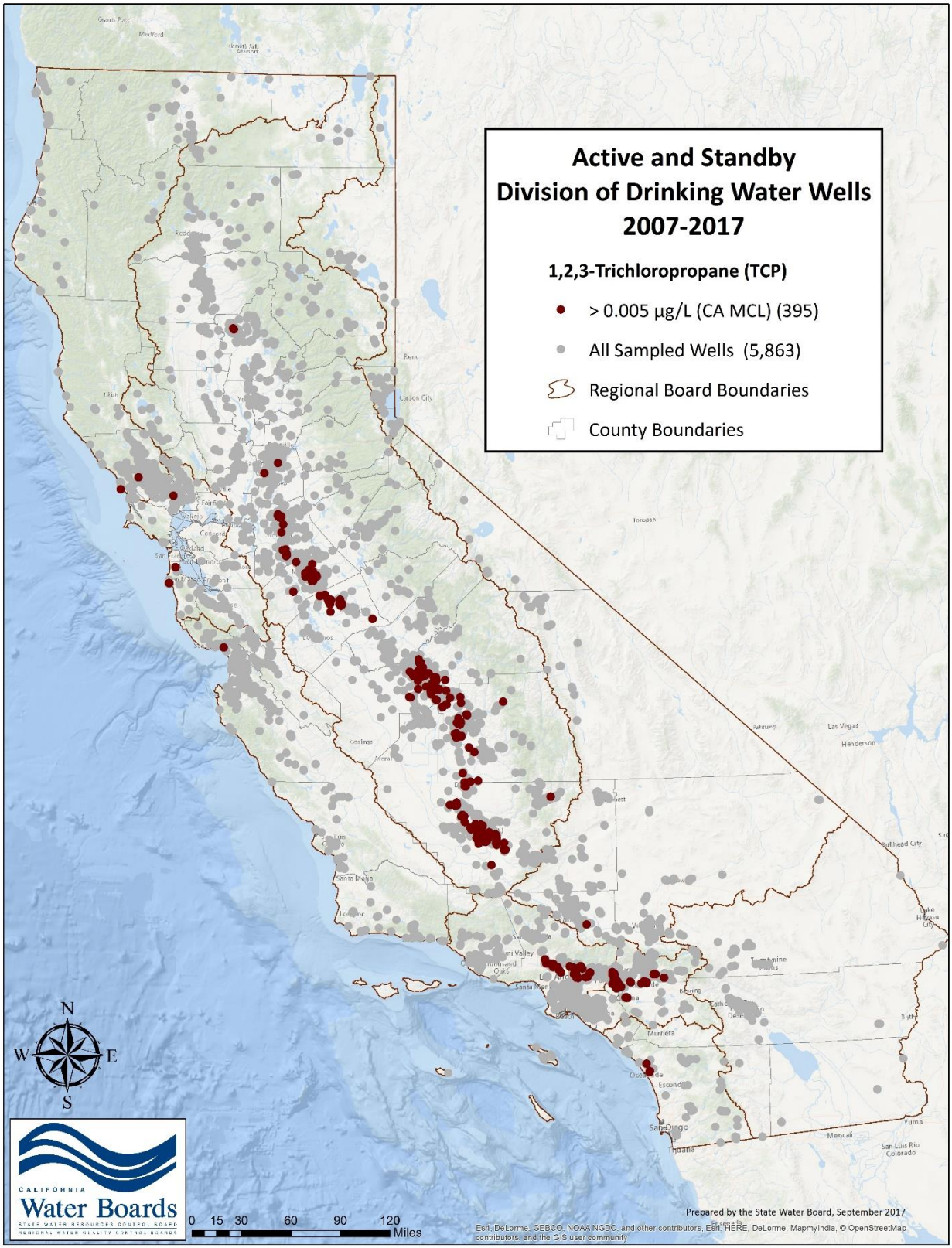
6. California State Water Resources Control Board, Division of Drinking Water: Media Release, State Water Board Approves Drinking Water Standard for 1,2,3-Trichloropropane. https://www.waterboards.ca.gov/press_room/press_releases/2017/pr071817_123tcp.pdf

7. 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

8. U. S. Environmental Protection Agency, Regional Screening Table, http://www.epa.gov/risk/regional-screening-table

9. U.S. Envinronmental Protection Agency, Technical Fact Sheet, 1,2,3-Trichloropropane (TCP), http://www2.epa.gov/sites/production/files/2014-03/documents/ffrrofactsheet_contaminant_tcp_january2014_final.pdf

10. Water Research Foundation, 1,2,3-Trichloropropane State of the Science, March 2016. http://www.waterrf.org/resources/StateOfTheScienceReports/1,2,3-Trichloropropane.pdf



Active and standby public drinking water wells that had at least one detection of TCP above the MCL, 2007-2017, 395 wells. (Source: Public supply well data in GeoTracker-GAMA.)