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 an unregulated chemical without an established Maximum Contaminant Level (MCL). The California notification level (CA-NL) is 0.005 micrograms per liter (µg/L) and the Public Health Goal (PHG) has been established at 0.0007µg/L. The California Response Level (CA-RL) has been established at 0.5 µg/L. California recommends source removal when the chemical is present at levels 100 times the CA-NL for chemicals that pose a cancer risk. Hawaii is the only state that has established a MCL for this chemical at 0.6 µg/L. Common sources of TCP in groundwater include solvent related discharges. Public well data from 2006 to 2016 indicates there are 17 active and standby public wells (12,114 wells tested), with at least one detection above the CA-RL. TCP was detected above the HI-MCL in 8 wells during the same timeframe. Most detections occurred in four counties, Los Angeles (6), Merced (5), Kern (2), and San Bernardino (2).

REGULATORY AND WATER QUALITY LEVELS		
Type	**Agency**	**Concentration**
Federal MCL	US EPA[1]	N/A
State MCL	SWRCB[2]	N/A[5]
Notification Level	SWRCB[2]	0.005 µg/L
CA Response Level (100 times of CA-NL)	SWRCB	0.5 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
Others: State of Hawaii MCL (HI-MCL)	HDH[4]	0.6 µg/L

[1] US EPA - United States Environmental Protection Agency
[2] SWRCB: The California Department of Public Health Drinking Water Program was transferred to the State Water Resources Control Board Division of Drinking Water in 2014.
[3] OEHHA - Office of Environmental Health Hazard Assessment
[4] HDH-Hawaii Department of Health, the only state that has established a MCL for TCP.
[5] The MCL for TCP will be proposed by the Division of Drinking Water in 2016.

SUMMARY OF DETECTIONS IN PUBLIC DRINKING WATER WELLS[6]	
Detection Type	**Number of Wells**
Number of active and standby public wells[7] with TCP concentrations above the CA-NL of 0.005 µg/L.	Concentrations detected above the CA-NL in 325 public wells
Number of active and standby public wells with TCP concentrations above the CA-RL of 0.5 µg/L	Concentrations detected above CA-RL in 17 public wells
Top 4 counties with TCP detections in public wells above the RL-NL.	Los Angeles (6), Merced (5), San Bernardino (2) and Kern (2)

[6] Based on 2006-2016 public well (groundwater source) data collected by the State Water Resources Control Board.
[7] 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[8]	0.005 µg/L
Liquid-Liquid Extraction LLE-GC/MS DWRL[8]	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[9]. 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 an unregulated organic chemical in public water systems requiring monitoring and reporting to the SWRCB. 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 0.0007µg/L Public Health Goal (PHG) in 2009. The Division of Drinking Water recommends source removal when the chemical concentration is 100 times the CA-NL for chemicals that pose a cancer risk. The response level for TCP is 0.5 µg/L. The Division of Drinking Water will subsequently establish a MCL for TCP in the future.

[8] DWRL- California Drinking Water & Radiation Laboratories
[9] 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) 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 then, TCP has been found in 499 public supply wells at concentration ranging from 0.001 to 57µg/L (GeoTracker, 2016). The highest concentration of TCP was measured in Los Angeles County at 57µg/L.
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 it's 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 condition.
Drinking Water and Wastewater Treatment	Above ground treatment may consist of air stripping with activated carbon filtration, as used for other chlorinated hydrocarbons. UV radiation can also be used for a low-flow system. Wastewater treatment plants use chemical oxidizers like potassium permanganate, and are increasingly using biodegradation processes to remove chlorinated hydrocarbons from water. These treatment methods are costly and can be an economic challenge to remove and analyze TCP below its notification level.

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, 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 NL 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

2. California State Water Resources Control Board, A Compilation of Water Quality Goals, 17th Edition, Report prepared by Jon, B. Marshack. January 2016 http://www.waterboards.ca.gov/water_issues/programs/water_quality_goals/docs/wq_goals_text.pdf

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://info.ngwa.org/GWOL/pdf/062181324.pdf

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

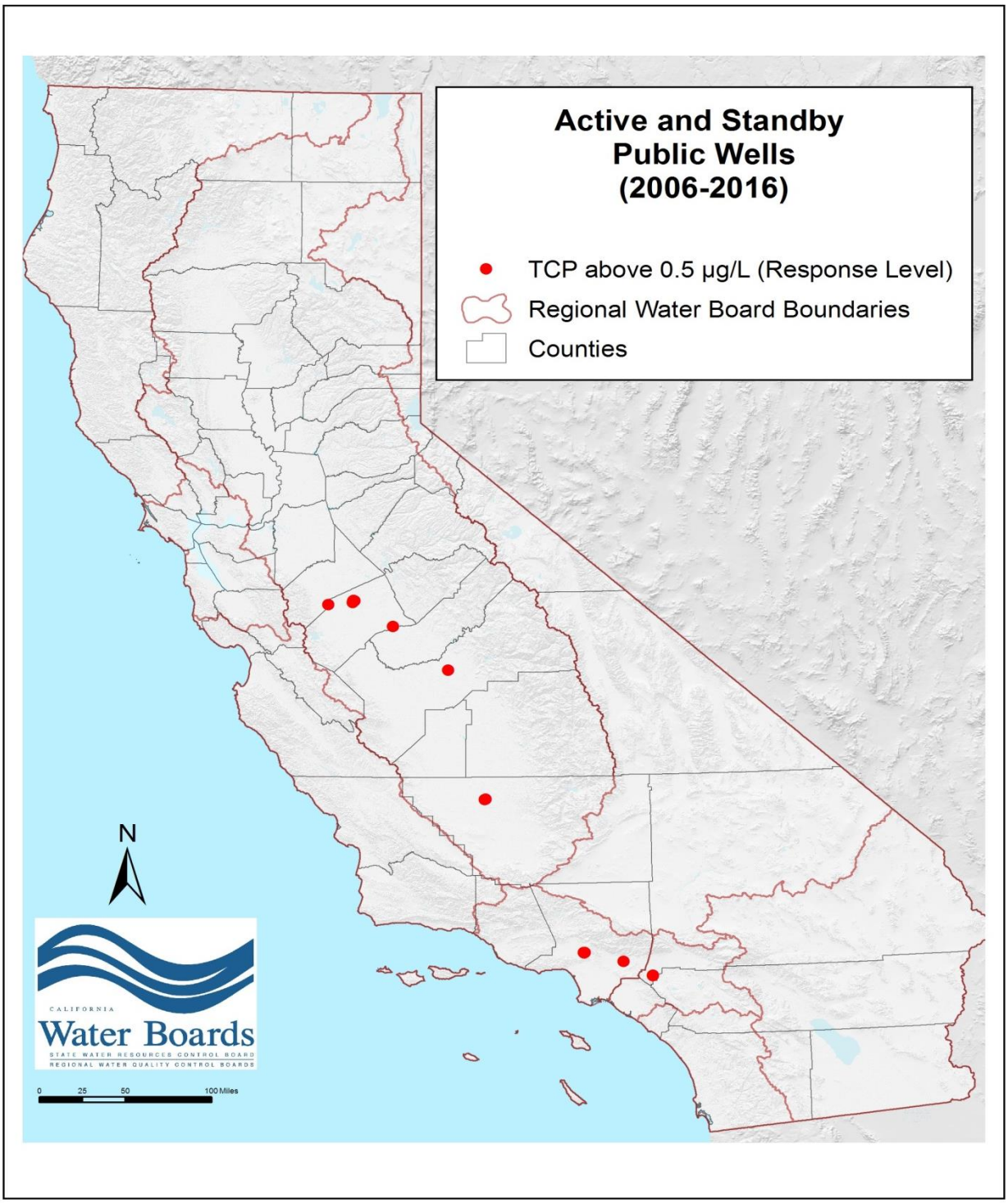
5. Montgomery, J. H. Groundwater Chemicals Desk Reference. 3rd Edition, Lewis Publishers, 2000.

6. California State Water Resources Control Board, Division of Drinking Water: Chemicals and Contaminants in Drinking Water, Unregulated Contaminants http://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/123TCP.shtml

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



Active and Standby Public Wells with at least one detection of TCP above the RL of 0.5 µg/L, 17 wells. *(Source: Public Well data using GeoTracker GAMA)*