1, 2, 3 – TCP: California's Response to a Persistent Pollutant

By Lynleigh Love

Bio: Lynleigh Love is a Senior Project Geologist with SCS Engineers. She has been a professional geologist for more than 22 years with extensive technical expertise in environmental assessment, remediation and regulatory compliance. Her experience includes groundwater/soil vapor monitoring, excavation work plans, and remedial action plans.

The U.S. Environmental Protection Agency (EPA) has identified 1, 2, 3 – Trichloropropane (TCP), which does not occur naturally in the environment, as an emerging chemical of concern that can threaten drinking water supplies. It states that TCP is a persistent pollutant in groundwater and has classified it as "likely to be carcinogenic to humans" (8). California State Water Board member Steven Moore called TCP an "insidious chemical" because it persists in the environment, sinks in water and is harmful in even tiny doses (13). Currently, there is no federal maximum contamination level (MCL) for TCP; however, there is a federal non-enforceable health-based screening level of 0.00075 ug/L (7).

Since 2012, TCP has been on the emerging Contaminant Candidate List (CCL), which is a watch list of unregulated contaminants that are known to, or anticipated to, occur in public water systems and may require regulation under the Safe Drinking Water Act (SDWA) (15). The EPA has required, under the Unregulated Contaminant Monitoring Rule (UCMR), that large water systems test for TCP every five years with a minimum reporting level of 0.03 µg/L (6) (15). This rule allows for the EPA to monitor contaminants suspected to be in drinking water that are unregulated under the SDWA. As a result of the testing, TCP has been identified across the US in drinking water sources. Currently, there is no federal maximum contamination level (MCL) for TCP; there is a federal non-enforceable health-based screening level of 0.00075 ug/L (7).

Health effects. Short-term exposure to TCP has been found to cause lower levels of red blood cells and cancers over long term exposure (2). According to the State Water Board, short-term acute exposure can burn the skin and eyes (9). Breathing TCP can cause irritation of the throat and lungs and affect concentration, memory and muscle coordination (9). Long-term ingestion of TCP in drinking water may damage the liver and kidney and increases the likelihood of tumors in multiple organs (9). TCP is a known toxin, and, pursuant to California's Safe Drinking Water and Toxic Enforcement Act of 1986 (Proposition 65), has been identified as a chemical known to cause cancer(4)(7).

What is it? TCP is a man-made chlorinated hydrocarbon (4). In California, it is grouped with synthetic organic chemicals. The presence of TCP found in drinking water sources is attributed to the historic use of agricultural pesticides and various manufacturing industries(4).

Since the 1950s, soil fumigants have been widely used as pesticides and nematicides (4). Some soil fumigants known under the trade name of D-D, manufactured by Shell Chemical Company (Shell); and Telone, manufactured by Dow Chemical Company (Dow), primarily contained the active ingredients 1,3-dichloropropene and 1,2-dichloropropane. However, both these fumigates also contained TCP as an impurity (4), not as an active ingredient. Fumigants D-D is no longer available in the United States and Telone has since been reformulated (4). D-D and Telone were liquid mixtures designed to be injected directly into the soil (13). The active ingredients would volatilize into a gas, spread through the soil, and then break down into harmless byproducts after several days (13). The inactive TCP, on the other hand, was barely volatile and incredibly persistent (13). Consequently, the EPA's UCMR testing has found that there is a legacy of TCP contamination in agricultural areas.

TCP has also been used as an industrial solvent, cleaning and degreasing agent, and paint and varnish remover. It has been associated in urban areas with chlorinated solvent contamination. TCP may also be generated as a byproduct during the production of other compounds (e.g., dichlorohydrin, dichloropropene, epichlorohydrin, glycerol, propylene chlorohydrin, and propylene oxide) (4). TCP is used as a chemical intermediate in the production of dichloropropene, hexafluoropropylene, and polysulfone liquid polymers, and as a cross-linking agent in the synthesis of polysulfides (4).

TCP in the environment TCP does not easily sorb to soil because if its low soil organic carbon-water partition coefficient and therefore easily leaches from soil into groundwater (7). TCP then persists in groundwater for long periods of time because of its low abiotic and biotic degradation rates (7)(2). In typical groundwater conditions, TCP has a half-life of hundreds of years making it one of the most persistent organic contaminants ever encountered (13). TCP in pure form is likely to exist as a dense nonaqueous phase liquid and thus, will sink to the bottom of a groundwater aquifer because its density is greater than that of water (Cal/EPA 2016a) (7). Dense nonaqueous phase liquids are of particular concern as they migrate into deep groundwater and threaten drinking water aquifers.

TCP health-based guidance and MCLs While there is no federal MCL for TCP in the US, some states are enacting their own public health goals and MCLs. Because only a small amount of TCP is toxic, often values of TCP are refer to in nanograms per liter (ng/L), also referred to as "parts per trillion" (PPT).

Health-based drinking water guidance has been established in California (0.7 PPT), Colorado (0.37 PPT), Minnesota (3 PPT), New Jersey (1.3 PPT), and Texas (30 PPT) amongst other states (6), (7), (14), (10)(11). In 2013, Connecticut developed a 50 PPT action level for TCP in private wells (14). In 2006, Hawaii was the first to has establish an MCL of 600 PPT based on acute impacts and did not consider carcinogenic risk (14).

In July 2017, California was the first to adopt an MCL for TCP in the low parts per trillion (5 PPT) (6), and its threshold aimed to ensure a theoretical cancer risk of less than 1 in 143,000 for those who are exposed to TCP in drinking water over their lifetime (9). As reported, the MCL was set "as close as feasible to the public health goal placing primary emphasis on the protection of public health," while considering economic and technological feasibility of doing so (4). Several labs have been certified to analyze for TCP in drinking water to 5 PPT in the state (4).

In September 2018, New Jersey adopted a somewhat controversial MCL of 30 PPT. At the time the New Jersey MCL was proposed, the MCL was based on the sensitivity of the state-approved analytical method detection limit (MDL), not the health-based value. In response to feedback, it has been proposed to lower the threshold for quarterly monitoring for TCP to 10 PPT, which is the current median MDL obtainable by 18 of the 21 New Jersey state-certified laboratories (11).

Why did California establish an MCL? TCP has been in California groundwater for decades, and even though the state identified the chemical as a carcinogen in 1992, it wasn't until 2009 that the Office of Environmental Health Hazard Assessment (Office) set a public health goal for TCP (9). But that goal of 0.7 PPT was a recommendation, not a regulation, based on the Office's review of the scientific literature and carcinogenic effects (2) (9). Pre-2016 data indicated that about 289 public water wells had confirmed detections of TCP above 5 PPT (initially detected followed up by another sampling event).

At its July 18, 2017 public meeting, the State Water Resources Control Board (State Water Board) adopted an MCL of 5 PPT for TCP and related requirements, including establishing of a detection limit for purposes of reporting, identifying the best available technology for treatment, and setting public notification and consumer confidence report language (3). The regulations also included a method for public water systems to substitute existing water quality data for initial monitoring requirements under certain circumstances (3). The effective start date of the Regulation was December 14, 2017.

A blueprint for other states? Under California's mandatory TCP standard, which started enforcement in January 2018, all water systems in California are required to conduct quarterly monitoring for TCP in water sources for a one-year period (13). Since TCP is not created as a byproduct of reactions in water distribution systems, only source waters must sampled, but this includes groundwater and surface water(2). If a water distribution system buys 100 percent of its water and has no sources, the system does not need to sample for TCP; however, the water wholesaler does (2). Composite samples from multiple sources are not allowed, and each source must be sampled separately (2). However, standby sources only need to be sampled once in a three-year period (by the end of 2020) (2).

The regulations allow for water distribution systems to apply for either a "use" wavier or a "susceptibility" wavier of the mandatory monitoring requirements, but the State Water Board has made it clear that granting these kinds of waivers will be rare (2) and the source will likely need to be located in a pristine area. The State Water Board has stated that waivers will be granted very sparingly because locations of TCP use are not well documented, the chemical degrades very slowly, and small quantities can contaminate large volumes of water(2).The regulations also allow for analytical data to be "grandfathered" or substituted for the initial monitoring period as long as the data was collected prior to December 14, 2015 (within two calendar years prior to the effective date of the TCP regulation). This data may be substituted to satisfy the initial monitoring requirements for up to three quarters (2) (1).

The water quality standards apply equally to public and private water distribution systems; however, the action requirements are applied differently to small distribution systems serving less than 3,300 persons. The reporting limit for TCP is the same value as the MCL, therefore, if TCP is detected at a well, it is either at the MCL or over the MCL.

If TCP is not detected in all four quarters of the mandatory monitoring period, the source only needs to be tested again once in a three-year period for small water distribution systems, or twice in a three-year period for large water distribution systems. If TCP is detected, the water system must contact the State Water Board within 48 hours. However, the system has the option to collect up to two confirmation samples. If TCP is not detected in two confirmation samples, the original sample that contained TCP can be disregarded. If one or more of the confirmation samples has TCP then the average value of all samples collected for that sampling event is used as the compliance value.

As TCP has been classified as a synthetic organic chemical by the State of California, the State Water Board uses a Running Annual Average (RAA) to calculate the degree of contamination in the source water. This method requires calculation of an average compliance value for a set number of samples within a time period (and the consideration of possible future sampling results), rather than the actual mathematical average for those samples that have already been collected. Because non-detect values are considered as zeros, a water system may maintain its the RAA compliance value for TCP <u>even</u> if one or more samples exceeds the MCL. For instance, a mathematical average of 5.1 PPT, 5.2 PPT, 5.3 PPT, or 5.4 PPT is rounded down to 5 PPT which is not an exceedance of the MCL and therefore not out of compliance. If at any point the RAA rounds up to 6 PPT or greater, the water system is considered out of compliance, requiring public notification or the shut-down of that source (13).

For a small water system, if the RAA is equal to (or less than) 5 PPT, a subsequent annual sampling event is only required in the quarter of highest detection. Once the RAA is equal to or exceeds 6 PPT, the water system is in violation and the source needs to have ongoing quarterly monitoring conducted until the RAA is less than or equal to 5 PPT.

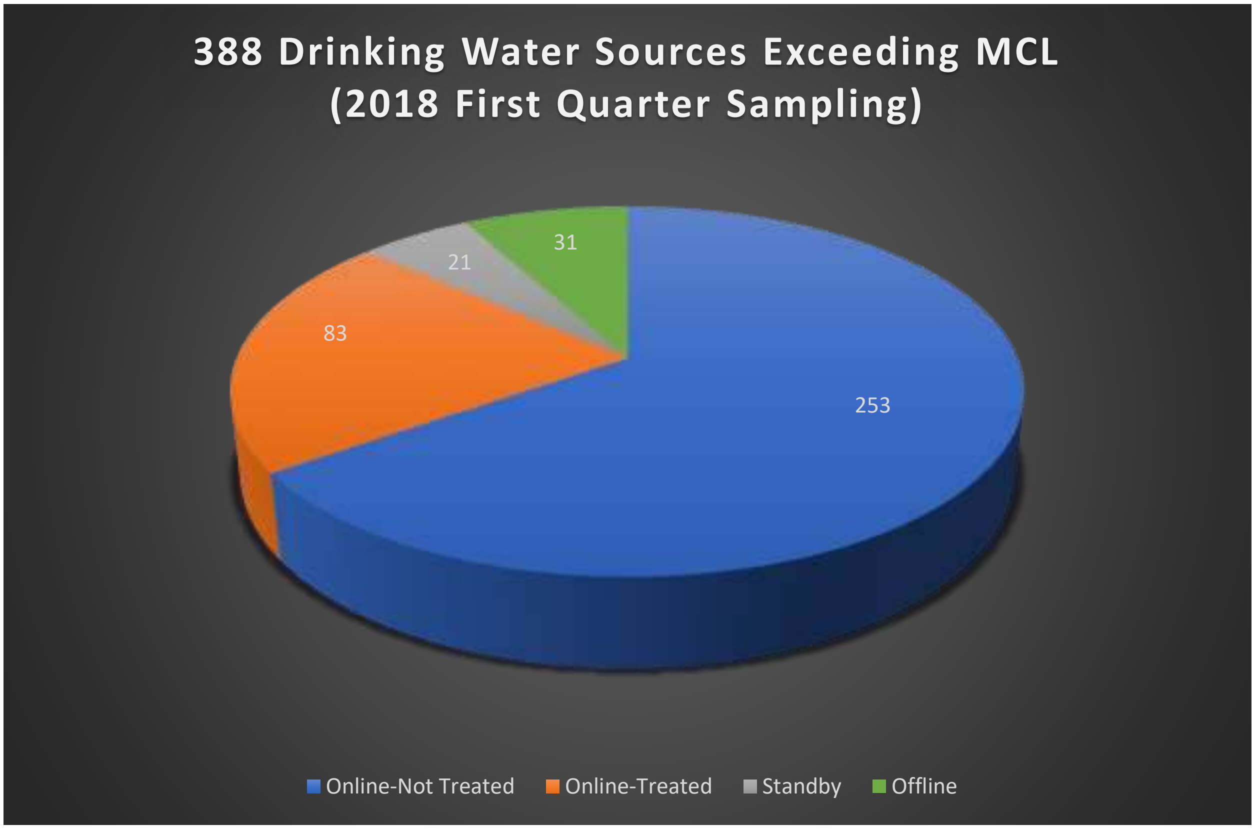
For a large system, if TCP is detected in even a single sample, the system is required to continue quarterly source water sampling and use the RAA for compliance. If a single detection is greater than the MCL, the system must conduct monthly sampling for 6 months. If at the end of the six months the RAA is less than 6 PPT, the system can go back to quarterly monitoring. If the average concentration violates the MCL, i.e., its greater than 6 PPT , the source well is determined to be out of compliance at the point in which the RAA value had exceeded 6 PPT.

Regardless of the size of the water system, if at any time a sample exceeds 10 times the TCP MCL (i.e., greater than 50 PPT) the system must resample within 24 hours. The results of the resampling event must be reported to the State Board within 24 hours. If the average of both the initial sample and confirmation sample still exceeds 50 PPT, the water source shall be immediately evaluated for discontinuation as a water source. A formally discontinued source cannot be brought back to service without written approval from the State Water Board (2).

While California's Division of Drinking Water appears likely to give water systems time to implement corrective action for MCL violations, especially smaller systems in disadvantaged communities, failure to comply with the MCL can eventually lead to fines and other consequences (13).

TCP Detection in California During the first quarter of 2018, 388 drinking water sources located within 23 counties exceeded the TCP MCL (1). TCP has been detected in surface water sources, but there are currently no surface water sources with ongoing or persistent detections of TCP (4). The data shows correlation between the locations of drinking water sources that exceed the TCP MCL and agricultural/industrial areas (1). The majority of the impacted drinking water sources are in the Central Valley, the state's major region for agricultural production (9); TCP occurrence is attributed to the past agricultural practice of using soil fumigants that contained it(1).

Of the 388 drinking water sources that exceeded the MCL during the first quarter 2018 sampling, 253 remain online with no treatment, 83 remain online and treated, 21 are sources on standby, and 31 sources are offline (1).



Not all of the State's 4,000 water systems reported their sampling results from the mandatory testing for TCP during the first quarter. Possible reasons include system waiver, use of "grandfathered" TCP data, incorrect data entry, or simply failing to perform the testing. The State Board has made it clear that they will be issuing Notices of Violation to water systems that failed to sample(1).

Treatment options and costs TCP is expensive to remove from drinking water supplies (13). As part of its MCL regulation for TCP, California has designated Granular Activated Carbon (GAC) treatment as the "best available technology" for TCP removal (13). The State Board stated that *"just because GAC is the BAT, that does not mean that there aren't alternative technologies capable of removing TCP*" (2). However, there has not been enough studies on alternative methods to give the State Board confidence on any other method yet. In addition, GAC technology is already widely used in the California Central Valley for other volatile organic compounds.

Activated carbon treatment involves the installation of several large vessels containing thousands of pounds of activated carbon (13). As the water passes through the vessels, the TCP and other organic matter attach to the surface of the carbon granules and are removed from the water (13). TCP tends to require more frequent carbon change outs than other organic contaminants (13).

The high costs of TCP treatment systems has spurred a line of lawsuits that stretches the California Central Valley (9). Many of these lawsuits are aimed at the manufacturers of the soil fumigants and some lawsuits have already dragged on for years (9). One successful law group that represents several cities suing soil fumigant manufactures reported the cases are unusual (9). *"In environmental cases, typically causation is the biggest hurdle to overcome, proving where the contamination came from, who's responsible for it,"* he says (9). *"With TCP in the Central Valley it really is about as straightforward* *as an environmental tort case could be (9). In a rural area like the Central Valley there is really only one possible source of 1,2,3-TCP – if you find it in a well it came from the use of soil fumigants*." (9). In the only TCP case to go to trial so far, a jury in December 2016 ordered Shell to pay the City of Clovis $22 million (9).

Conclusion Water agencies and environmental groups hailed the move by the California State Water Board to establish a TCP MCL (9). "*We applaud this important step to protect Californians impacted by 1,2,3-TCP*," said Phoebe Seaton, codirector of the Leadership Council for Justice and Accountability, which works on economic and environmental justice issues in the San Joaquin Valley (9). "*The challenge that remains, however, is securing the funds and resources necessary to help impacted communities and residents gain access to treatment mechanisms.*"(9).

1 - https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/documents/123-tcp/123_tcp_sampling_q1_2018.pdf. June23,2018

2 – 1 2 3 TCP Public Water System Information video.
https://www.waterboards.ca.gov/videos/video_pages/123tcp_utility_training.shtml

3 - https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/SBDDW-17-001_123TCP_MCL.html SBDDW-17-001 1,2,3-Trichloropropane MCL. State Water Resources Control Board Division of Drinking Water. Final Statement of Reasons for Rulemaking, Including Comments and Agency Response. MAXIMUM CONTAMINANT LEVEL (MCL) FOR 1,2,3-TRICHLOROPROPANE (1,2,3-TCP) Public Hearing Date: July 18, 2017 Agenda Item No.: 3

4- https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/documents/123-tcp/sbddw17_001/tab15/15a-isor.pdf. INITIAL STATEMENT OF REASONS 1,2,3-Trichloropropane Maximum Contaminant Level Regulations Title 22, California Code of Regulations SBDDW-17-001 Febuary 2017

5 - https://www.waterboards.ca.gov/drinking_water/certlic/drinkingwater/documents/123-tcp/pws_123tcp_122917.pdf Notification to Community and Noncommunity Water Systems in California

6 - https://www.epa.gov/sites/production/files/2014-03/documents/ffrrofactsheet_contaminant_tcp_january2014_final.pdf
EPA Technical Fact Sheet – 1,2,3-Trichloropropane (TCP) January 2014

7 - https://www.epa.gov/sites/production/files/2017-10/documents/ffrrofactsheet_contaminants_tcp_9-15-17_508.pdf
Technical Fact Sheet – 1,2,3-Trichloropropane (TCP) November 2017

8 - EPA. Integrated Risk Information System (IRIS). 2009. "1,2,3-Trichloropropane (CASRN 96-18-4)." www.epa.gov/iris/subst/0200.htm.

9 - https://www.newsdeeply.com/water/articles/2017/08/10/californias-plan-to-tackle-a-carcinogen-widespread-in-water California's Plan to Tackle a Carcinogen Widespread in Water by Tara Lohan 8/10/17

10- https://www.capemaycountyherald.com/news/environment/article_75eb39f6-b065-11e8-b9d8-ffcb34d6e276.html NJ Makes Regulatory History; Safe Drinking Water Standard for PFNA Adopted. Cape May County Herald

11- https://www.state.nj.us/dep/watersupply/pdf/123tcp-dwqi-presentation.pdf SUMMARY OF AVAILABLE ANALYTICAL PERFORMANCE DATA FOR THE ANALYSIS OF 1,2,3-TRICHLOROPROPANE (123-TCP) IN DRINKING WATER. Recommendation to Integrate More Sensitive Methods for 123-TCP for Use by NJDEP. May 25, 2018

12- https://rbwaterlaw.com/people/todd-e-robins/

13 - http://rbwaterlaw.com/tcp-litigation/

14 - http://www.integral-corp.com/wp-content/uploads/2016/06/Integral_EC_State-Summary-Report_Final.pdf Compendium of State Regulatory Activities on Emerging Contaminants. May 2016

15 - https://www.epa.gov/dwucmr/learn-about-unregulated-contaminant-monitoring-rule

CalEPA OEHHA, 2009. Public Health Goal for 1,2,3-Trichloropropane in Drinking Water, California Environmental Protection Agency, Office of Environmental Health Hazard Assessment, August 2009 (http://oehha.ca.gov/media/downloads/water/chemicals/phg/082009tcpphg.pdf).