COMMUNITY WATER CENTER
EL CENTRO COMUNITARIO POR EL AGUA

123-TCP Treatment Pilot Project for Domestic Well Households in Northern Monterey County

Final Report
June 2023

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Abbreviations

123-TCP	1,2,3-Trichloropropane
DAC	Disadvantaged Community
DWMC-xx	Water System Identification Number
GAC	Granular Activated Carbon
GAMA	Groundwater Ambient Monitoring and Assessment
HPC	Heterotrophic Plate Count
MCL	Maximum Contaminant Level
POE/POU	Point-of-Entry/Point-of-Use
SAFER	Safe and Affordable Funding for Equity and Resilience
SEP	Supplemental Environmental Project
TAC	Technical Advisory Committee
µg/L	Microgram per Liter

Acknowledgments

CWC is extremely grateful for our community partners and project participants who advocated for this project, have had treatment systems installed and monitored at their households and properties, have dedicated substantial time and expertise, and without whom this project would not be possible. We would also like to recognize the contributions of the project team which included numerous staff from Community Water Center (technical, outreach, and advocacy) as well as Harrison Hucks and Craig Drizin from WHA, and Tim Bushman from Culligan QWE Commercial Systems in Salinas.

We would like to acknowledge the invaluable technical and implementation expertise and support provided by the TAC, which included representatives from other technical assistance providers, consulting and engineering companies, State Water Board, Monterey County Environmental Health Department, and Stanford University (see Appendix B for TAC member names and affiliations), as well as the support of other technical experts who were consulted.

CWC would like to recognize the Central Coast Regional Water Quality Control Board and staff's support and administration of this project. The Project was funded through a supplemental environmental project (SEP) as an enforcement action brought by the Central Coast Regional Water Quality Control Board. We also want to thank the Water Foundation for providing supplemental funding to cover unanticipated well repairs that were needed to make this project possible.

Community Leader Roberto Ramirez next to his 7.2-cubic foot system, DWMC-14 in Royal Oaks.

Introduction

The 123-TCP Treatment Pilot Project for Domestic Well Households in Northern Monterey County is taking place in unincorporated communities where residents rely on domestic wells contaminated with high levels of 1,2,3-Trichloropropane (123-TCP). The Project was funded through a supplemental environmental project (SEP) as an enforcement action brought by the Central Coast Regional Water Quality Control Board against Monterey Mushrooms, Inc. and Spawn Mate, Inc. for unauthorized discharges of process wastewater and polluted stormwater in 2017.

The Project goals were to:

- Conduct a pilot project to install 123-TCP Point-of-Entry (POE) household-level water treatment to reduce exposure by treating the water for this contaminant to levels below the California Maximum Contaminant Level (MCL) at up to 20 households supplied by domestic wells or small water systems.
- Monitor and document the project process, costs, and results to inform statewide efforts to effectively and economically implement 123-TCP treatment for domestic wells and state small and local small water systems.

All households participating in the project were also impacted by nitrate contamination, and some had a third or fourth contaminant exceeding an MCL as well. This pilot project focused on only 123-TCP treatment because they were already receiving bottled water deliveries. Bottled water was determined to be the most reliable source of safe water for drinking and cooking for project participants. Additionally, most households considered for the project had nitrate contamination

at levels so high that state-certified residential treatment devices would be unable to treat it. Throughout the project, nine treatment systems were installed and eight systems are currently operating and have successfully reduced 123-TCP levels to below the MCL (0.005 µg/L) and detection limits (typically <0.0006 µg/L).

The 123-TCP project will continue until 2026, with SEP funding until July 2023 using additional funding from the State Water Resources Control Board (State Water Board).

Origins of the Project

Community Water Center (CWC) began organizing in low-income areas of California's Central Coast with high levels of nitrate found in small water systems. These residents were connected to a free drinking water well testing program that helped identify other contaminants in their water including high levels of 123-TCP. CWC also identified additional households potentially eligible for this Project through the Groundwater Ambient Monitoring and Assessment (GAMA) program's Groundwater Information System.[1]

In February 2019, residents in north Monterey County in the area north of Moss Landing formed the El Comité para Tener Agua Sana, Limpia, y Economica (El Comité). El Comité has been working together with CWC to support drinking water solutions for their community, including successfully advocating for a free delivered bottled water program funded by a State Water Board grant administered by Pajaro Sunny Mesa Community Services District. Households outside the El Comité area that participated in this POE treatment project were also receiving bottled water through the State Water Board's Safe and Affordable Funding for Equity and Resilience (SAFER) program or through a program funded by the Salinas Valley Replacement Water Settlement.

123-TCP poses significant health risks when inhaled or ingested.[2] Despite bottled water deliveries, no solution was available to prevent exposure to 123-TCP while showering. CWC and El Comité advocated for funding for POE treatment to reduce exposure.

Voices from the Community: Testimonials from Project Participants

Reasons for interest in the project:

"Because our health and the health of our kids and grandkids matters greatly to us."

"For my children's health, they can't shower comfortably. It would relieve my stress to get [the 123-TCP] treated."

"To try to make things better for everyone and to improve the water system."

"To help this study and help elevate [the need] and make the machines less expensive so that people can afford it."

Thoughts on 123-TCP and other contamination in drinking water:

"I am tired of it. I lived here for the last 40 years. I am 67 years old now. I cannot do anything else to make this right. It's hard! It's hard living here."

"It scares me that it's in such high concentrations in my water and the steam."

Background

What is 123-TCP?

123-TCP is a human-made colorless and odorless organic chemical. Groundwater in some areas of California is contaminated with 123-TCP because the chemical was included as an unnecessary impurity in Shell Oil and Dow Chemical Company soil fumigants manufactured before the 1980s. Even though 123-TCP is no longer included in the manufacture of fumigant pesticides, it is extremely persistent and has remained in soils and groundwater since its early application.

Risks Associated with 123-TCP

Exposure to 123-TCP at levels that exceed the legal limit, or Maximum Contaminant Level (MCL) can potentially increase the risk of cancer. 123-TCP's toxicity threshold is very low, and even minute concentrations of 123-TCP in drinking water pose a health risk. The MCL in California for 123-TCP in drinking water is 0.005 µg/L. Exposure to 123-TCP can take place through drinking or cooking with contaminated water, or by inhaling the vapor of contaminated water while showering. For this reason, it is important to treat all residential water for 123-TCP, not just water that is used for drinking and cooking. For more information, refer to CWC's 123-TCP Contaminant Factsheet (Appendix A).

Household 123-TCP Treatment in California

The California State Water Resources Control Board maintains a list of residential drinking water treatment devices registered for use in California.[3] However, no devices are currently registered for the treatment of 123-TCP. Given the lack of certified treatment devices, household treatment of 123-TCP should be supervised by a water treatment professional. More studies like this pilot are needed to improve the understanding of how to effectively treat 123-TCP at the household level. The State Water Board's draft Point-of-Use Point-of-Entry report provides an overview of the status of point-of-use and POE treatment in the state.[4]

Implementation of the Project

Project Participants

Community Partners: All partners rely on domestic wells with 123-TCP contamination exceeding the MCL and are located in or near northern Monterey County. Partners agreed to the installation of a POE treatment system at their property and/or residence and to allow contractors and CWC to access the system for installation, monthly monitoring, and operation and maintenance over the course of the study. Partners also agreed all project data could be shared with the public through a water system ID (e.g. DWMC-01). In many cases, partners also made required repairs to their water systems before the 123-TCP treatment systems were installed.

Community Water Center (CWC): Community Water Center works towards realizing the Human Right to Water for all communities in California through education, organizing, and advocacy. CWC serves as the project lead, responsible for outreach and enrollment of pilot project participants, convening and facilitation of the Technical Advisory Committee (TAC), selection and management of contractors, and all project deliverables.

Weber, Hayes & Associates (WHA): Watsonville-based environmental consulting, engineering, and water systems operation firm. WHA leads the design (with input from CWC and TAC), installation, operation, maintenance, and monitoring of the treatment systems.

Culligan QWE Commercial Systems (Culligan): Culligan, located in Salinas, was subcontracted by WHA to provide and install the POE treatment systems. Culligan also provides certain repairs, such as fixing leaks in the treatment system plumbing (covered under warranty), and maintenance activities such as carbon replacement.

Technical Advisory Committee (TAC): Made up of technical and implementation experts from the State Water Board, the Monterey County Environmental Health Bureau, other technical assistance providers, consulting firms, and the research community. The TAC provides guidance and feedback on project design and implementation on a voluntary basis. A list of TAC members and TAC meeting minutes and slides can be found in Appendix B.

Source Water Quality

Water quality results from the domestic wells where treatment systems were installed are summarized in Appendix C. This includes regulated contaminants and compounds in the water such as iron and organic carbon that can affect the treatment of 123-TCP. All wells had nitrate contamination above the MCL and one site also exceeded the public health goal for hexavalent chromium.

Treatment System Design

123-TCP is removed from the drinking water using granular activated carbon (GAC)[5]. Water passes through tanks containing carbon, and 123-TCP attaches to the carbon granules. The water passes through two tanks during treatment, a lead tank and a lag tank. Over time, the carbon becomes saturated with 123-TCP and is no longer able to remove the contaminant. Once this happens, the lag tank is moved into the lead position, and the GAC in the lead tank is replaced, ensuring no 123-TCP passes out of the treatment system to the home. More treatment system design details can be found in Appendix D.

Photos of the 123-TCP treatment systems are shown below in **Figure 1**.

Figure 1: Project participants in front of a 24-cubic foot system (DWMC-09) near Salinas (left), and a CWC staff member next to a 7.2-cubic foot system, DWMC-19 in Royal Oaks (right).

Project Implementation

1 Initial outreach: CWC identified low-income areas of Monterey County with contaminated domestic wells based on available data and conducted preliminary outreach to community members. Residents participated in a well-testing program, formed El Comité, identified 123-TCP as a health concern, and requested support in finding a solution.

2 Funding proposal development: CWC identified SEP funding for the 123-TCP POE treatment project to ensure community drinking water needs are addressed.

3 Pilot project outreach: CWC developed materials in Spanish and English about the pilot project, and shared them with community partners, property owners, and others relying on drinking water wells contaminated by 123-TCP. CWC met with these residents and property owners to inform them about the project and ask if they would be interested in participating.

4 Site assessments: If residents and property owners expressed interest in the project and signed participation agreements, WHA conducted site assessment visits to evaluate if and where a POE treatment system could be installed for the household. WHA also collected water samples from the well to confirm the presence of 123-TCP and test the water for other parameters that can affect 123-TCP treatment, such as total coliform and E. coli bacteria, iron, manganese, and total organic carbon.

5 Well or water system repairs (as needed): In most cases, before the treatment system could be installed, repairs had to be made to the well or water system to eliminate routes through which bacteria or other microbes could enter the water system. See Appendix E for more information on the specific repairs required at each location.

6 Treatment installation: CWC, the residents, and the property owner signed an Implementation Agreement (see Appendix F) detailing how the system would be installed, maintained, and monitored. Once this agreement was signed, Culligan installed the treatment system.

7 Monthly monitoring: WHA visits the treatment systems monthly to collect water samples to confirm the treatment systems are removing 123-TCP to below the MCL, and monitor for total coliform, E. coli, and heterotrophic plate count bacteria upstream and downstream of the treatment systems. Sample results are reported to community partners on a monthly basis and can be found in Appendix G.

8 Operation and Maintenance: Community residents reported small issues related to system function, including leaks, to CWC and/or WHA. During the monthly visits, WHA also identifies any problems with the treatment system, such as leaks, and works with Culligan to resolve the problems. Operation and maintenance activities include:

- Pre- and post-filter replacement
- Replacement of GAC in lead tank and disposal of old carbon
- Backwashing of lead GAC tank
- Any other miscellaneous activities, such as the repair of leaks in system piping

All project repairs and maintenance were documented in an operation and maintenance log, which is included as Appendix H.

Systems Installed

Nine systems were installed during the project and are summarized below in **Table 1**.

Table 1: Systems Installed (through April 2023)

System ID	Households Served	Location*	Time System has Been in Service (months)	Source Water 123-TCP Range (µg/L)	Average Volume of Water Treated (gal/day)	Volume of Carbon (cubic ft)	Number of Carbon Tanks
DWMC-01	2	Moss Landing	5	0.062-0.109	762	7.2	2
DWMC-02	1	Moss Landing	23	<0.0006-0.017	133	24	4
DWMC-04	1	Moss Landing	22	0.019-0.070	119	24	4
DWMC-09	2	Salinas	22	0.031-0.074	385	24	4
DWMC-10	1	Salinas	12	<0.0006-0.128	38	4.0	2
DWMC-14	1	Royal Oaks	7	0.081-0.128	144	7.2	2
DWMC-15 (offline)**	1	Royal Oaks	0	0.014-0.021	N/A	4.0	2
DWMC-19	1	Royal Oaks	2	0.0066-0.10	269	7.2	2
DWMC-21	1	Moss Landing	12	0.048-0.066	149	4.0	2

*This location indicates the general geographic area in which treatment systems are located. All systems are located on or near households served by private drinking water wells in unincorporated areas.

**DWMC-15 is installed but is currently offline until high-priority well repairs can be made to eliminate potential microbial contamination routes.

Project Results

Effectiveness of 123-TCP Treatment Systems

Throughout the project, all treatment systems in operation have successfully reduced 123-TCP levels to below the MCL (0.005 µg/L) and detection limits (typically <0.0006 µg/L), reducing household health risks in relation to this contaminant. Treatment systems have been in operation on average for 12 months (ranging from 0 to 23 months).

Project Costs

Costs through April 2023 for the treatment project that were covered by the SEP are summarized in **Tables 2 – 4** below. These costs do not include costs of well and water system repairs prior to installation (see Appendix C), some of which were covered by project participants. Due to the relatively short duration of this pilot project, long-term operation and maintenance costs, including the frequency of GAC replacement, are unknown. Outreach, coordination, project management, and monitoring make up a substantial portion of the project costs (Appendix I). While some of these costs may be lower for a larger-scale implementation than for this project, outreach to individual households including the signing and negotiation of implementation agreements, site assessments for individual water systems, and regular monitoring will always be critical for the effective and reliable implementation of POE treatment.

Table 2: Average Capital Costs

Installation of 4.0 Cubic Foot System *(without shade structure*)*	$9,752
Installation of 7.2 Cubic Foot System *(without shade structure*)*	$10,560
Installation of 24 Cubic Foot System *(without shade structure*)*	$15,728
Shade Structure* *(only required for some systems)*	$3,250

*Shade structures may be recommended if system location is in an area of direct sunlight for much of the day. Shade structures help regulate temperature within the system and extend the life of plumbing.

Table 3: Average Monthly Costs

Average Monthly Monitoring Labor Cost (WHA)	$378
Average Monthly Lab Costs*	123-TCP: $107 E. coli and Total Coliform: $19 Heterotrophic Plate Count (HPC): $24
Average Minor Monthly Maintenance Costs (see Table 4)	$76

*The lab costs shown here reflect a substantial discount that CWC receives due to being a non-profit organization.

Table 4: Specific Maintenance Costs

Type of Maintenance	Average Cost ($)	Average Time until Maintenance Required (for systems requiring the maintenance)*	Percentage of Systems that have Needed this Maintenance
Replace carbon in lead tank(s)	4.0-cubic foot system: $771 7.2-cubic foot system: $1,317 24-cubic foot system: $2,915 (costs are estimated)	not yet required**	0% (0 of 8 systems)
Replace carbon in lead and lag tanks and pre- and post-filters due to E. coli contamination	7.2-cubic foot system: $2,275 (has not yet been required for other-sized systems)	2 months	25% (2 of 8 systems)
Pressure gauge replacement	$45 – $62	6 months	25% (2 of 8 systems)
Hose bib replacement	$13	8 months	50% (4 of 8 systems)
O-ring replacement	$5	10 months	25% (2 of 8 systems)
Fix leak	Covered under warranty†	3 months	38% (3 of 8 systems)
Pre-filter replacement (24-cubic foot system)	$206	22 months	100% (3 of 3 systems)
Pre-filter replacement (4.0- and 7.2-cubic foot system)	$34-$40	2 months‡	40% (2 of 5 systems)
Post-filter replacement	$35	5 months	50% (4 of 8 systems)

*The method for calculating average time until maintenance is detailed in Appendix I.

**For two installed systems, carbon was replaced in both lead tanks due to bacteria contamination. However, carbon replacement due to inability to remove 123-TCP has not yet been needed.

†Culligan is providing a one-year warranty on equipment and appurtenances they supply for installation and a five-year warranty on the filter tanks after installation. This warranty does not include WHA staff time to coordinate repairs and the granular activated carbon (GAC) filter media or pre- or post-filter cartridges. Operation and maintenance activities not covered under Culligan's warranty are performed by WHA and Culligan according to costs shown in CWC's contract with WHA or on a time and materials basis.

‡Includes pre-filter replacement occurring eight times in twelve months at DWMC-21 due to sediment coming from the well.

Challenges Encountered

Information on costs and effectiveness is limited since the systems have only been treating 123-TCP for a limited duration. Due to the decision to implement this project in phases, some systems have only been functioning for a short period. This pilot project will be extended until June 2026 with funding from the State Water Board to continue monitoring, operation, and maintenance of the existing systems, and install additional systems. This will help to better understand operation and maintenance costs and system effectiveness over an extended period.

CWC was in contact with several interested community partners who had high levels of 123-TCP, but landlords declined to participate for a variety of reasons such as the limited duration of funding for operation and maintenance, the visual appearance of the system, disturbance of their yard/property, and concern that if they acknowledged contamination they could be held responsible to fix it. CWC is actively working to secure longer-term funding for operation and maintenance. WHA and CWC worked with property owners and residents to limit any disturbance caused by the treatment systems. Implementation Agreements include a provision for CWC to use project funding to remove treatment systems at the end of the project if property owners want them to be removed.

Due to the variability of 123-TCP concentrations in groundwater, there were some sites where 123-TCP was detected at levels above the MCL in one initial sample but was not detected in follow-up sampling. To maximize the benefit provided by the project, CWC prioritized sites with consistent 123-TCP contamination. However, the intermittent 123-TCP contamination presents a valid concern for homeowners and residents because their well had high levels of 123-TCP at one time and then was not found in subsequent samples. Without regular monitoring of drinking water wells, community partners are left wondering if 123-TCP is still present at levels below detection limits or intermittently at higher levels and potentially still a health risk for their families.

The majority (78%) of the sites considered for or included in this project had source water contaminated with total coliform bacteria and in a few cases E. coli bacteria. The presence of these bacteria indicates surface water or other contaminated water has entered the well or water system. To address the challenge of bacterial contamination, based on TAC guidance:

- CWC and WHA worked with property owners to make repairs to wells and water systems to eliminate contamination routes and to disinfect the systems. Depending on the case, these repairs were paid for by property owners, with SEP funds, or with funding from other grants secured by CWC.
- In cases where total coliform contamination could not be eliminated, property owners and residents signed consent forms acknowledging the presence of total coliform bacteria, consenting to continue the operation of the treatment systems despite the presence of coliform bacteria, and agreeing to use bottled water for drinking and cooking to protect themselves from exposure to nitrate and microbial contaminants.
- Systems were not installed at sites where E. coli was detected. If the presence of E. coli was detected and confirmed at a site where a treatment system was already installed, the treatment system was taken offline until the contamination had been addressed. Before placing the treatment system online again, the GAC was replaced and the treatment system was disinfected.
- CWC is planning to pilot the installation of UV disinfection as part of the project

extension.

Many sites had challenging source water quality, with high hardness and total dissolved solids, and significant concentrations of non-volatile organic carbon. Based on TAC guidance:

- Periodic backflush of the carbon tanks was included in the operation and maintenance budget in case biological growth or inorganic precipitates clogged the carbon bed and caused excessive pressure loss.
- CWC is aware that high hardness could hinder the effectiveness and reliability of UV disinfection and will take the hardness into account for any future piloting of UV disinfection.

It was difficult to secure the timely services of well or water system contractors to disinfect and repair wells and domestic water systems due to a shortage of contractors in the area. CWC and WHA were proactive in searching for available well/water system contractors and asking for secondary quotes when possible to ensure the proposed repairs were needed.

Recommendations

Based on the findings of this pilot project, CWC has developed the following recommendations for future work regarding point-of-use (POU) and point-of-entry (POE) treatment for domestic well households:

1. All POU and POE treatment projects for domestic well households should include a sufficient budget for outreach to identify eligible households and inform them about water quality risks and the proposed treatment. This outreach should be in a format (language and mode of communication) that is accessible to all eligible households.
2. Every household, well, and water system is unique. Work closely alongside community partners to understand their situation, needs and concerns, and assess the feasibility of the proposed treatment to ensure successful implementation.
3. Use proven technology to reduce the concentrations of all harmful contaminants present in water to safe levels. Use a state-certified device when available and ensure that the device is operated within the parameters of that device (e.g. level of total dissolved solids, pressure, contaminant level).
4. Prior to installation, inspect the well and water system and test the well for all contaminants that pose a risk to health and that could interfere with treatment. Any microbial contamination issues (the presence of total coliform or E. coli and/or potential contamination routes) should be addressed prior to installing treatment.
5. Closely monitor the performance of a newly installed treatment device to ensure it performs properly with the specific well's source water quality. Continue regular monitoring after installation to ensure the device is working properly.
6. Develop a plan and budget for operation and maintenance for as long as the treatment will be needed, including unexpected repair of leaks and routine replacement of parts.
7. If a proven treatment technology cannot be properly implemented, monitored, and maintained to treat all drinking water contaminants in a domestic well, residents should

use bottled water for drinking and cooking.

8. When possible, other more proven and robust long-term drinking water solutions such as consolidation with a public water system should be selected over POU and POE treatment.
9. Much remains to be learned about how to reliably implement POU and POE treatment for households supplied by domestic wells. More pilots should be implemented and should include comprehensive source water quality monitoring, regular monitoring to determine if and how long the system works with that particular source water quality, detailed documentation of costs, and support from a technical assistance provider for all aspects of the project to ensure quality and follow-up.

CWC and partner organizations also provided more detailed comments regarding the State Water Board's Draft Point-Of-Use Point-Of-Entry Report on February 15, 2023, and December 8, 2022.

Next Steps

This pilot project will be extended for an additional three years with State Water Board funding. The extension includes continued operation and maintenance and monitoring of installed systems, installing a limited number of additional systems, and piloting disinfection at systems where well and water system repairs have not eliminated bacteria contamination. Extending the pilot project will provide a continued reduction in residents' exposure to 123-TCP and documentation of long-term operation and maintenance costs (particularly carbon replacement) for the different-sized treatment systems installed.

FAQ/Help Guide

Q: How do I find out if I have 123-TCP in my well?

A: If you are on the Central Coast, you can reach out to (844) 613-5152 for information about the Central Coast Regional Water Board's free well testing program. If you are in other areas of the state we recommend that you contact a technical assistance provider to inquire about well testing. Self Help Enterprises (SHE) samples wells in the Central Valley and can be reached by phone or email: (559) 802-1285 or waterquality@selfhelpenterprises.org.

Q: If I have 123-TCP, can I get one of these systems installed?

A: If you are in Monterey or San Benito County, please reach out to CWC by phone at (831) 809-5937 to see if you would qualify to participate in the extension of this pilot project. If you are in other parts of the state, we recommend that you contact a water treatment professional or technical assistance provider to inquire about potential options for 123-TCP treatment. Self Help Enterprises (SHE) provides 123-TCP POE treatment systems in the Central Valley and can be reached by phone or email: (559) 802-1285 or waterquality@selfhelpenterprises.org.

Q: If I have 123-TCP and am not able to install treatment, what can I do to reduce the risk to my health?

A: To reduce your exposure, you can drink and cook with bottled water and avoid bathing, showering, or washing with hot water that produces excessive steam.

Endnotes

1 GAMA Groundwater Information System: https://gamagroundwater.waterboards.ca.gov/gama/gamamap/public/

2 National Toxicology Program, Department of Health and Human Services (2016), "Report on Carcinogens, 14th Edition, 1,2,3-Trichloropropane," available at http://ntp.niehs.nih.gov/ntp/roc/content/profiles/trichloropropane.pdf

3 California State Water Board. Residential Water Treatment Devices. https://www.waterboards.ca.gov/drinking_water/certlic/device/watertreatmentdevices.html

4 California State Water Board. Point-of-Use Point-of-Entry Report. Draft Report. November 2022. https://www.waterboards.ca.gov/safer/docs/2022/draft-2022-pou-poe-report.pdf

5 GAC is the only best available technology for 123-TCP treatment according to California water code (Title 22 CA Code of Regs 64447.4).