Carbon Filter Showerhead Study
Whatcom County

Water Test Results on Two Wells for 1,2-Dichloropropane and Coliform Bacteria

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Bellingham, Washington

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Abstract

Residents of Whatcom County, Washington expressed concern over the public health impact of 1,2-DCP and EDB chemical contamination in their private groundwater wells. Residents who shower with VOC-contaminated water could inhale VOCs that escape from water into the air or be exposed dermally. This study was conducted to provide additional information about the effectiveness of carbon filtration cartridges on showerheads over time. Levels of 1,2-DCP were monitored pre- and post-filter once a month for five (5) months. In addition, coliform samples were collected to determine if the filters became contaminated with bacteria over time. In the recommended three months of usage, the carbon filters reduced 1,2-DCP levels significantly and did not result in unsatisfactory coliform growth for non-drinking water. However, one of the showers became clogged due to the water having high levels of iron and manganese.

As a result of these findings, it is recommended that:

1. Residents should consider installing a carbon filter to minimize inhalation and dermal exposures to 1,2-DCP and EDB from contaminated well water during showering;
2. Residents who install a carbon filter should test their water for iron and manganese (if the water tests high for iron or manganese, residents should consider using treatment to reduce the level of these); and,
3. Carbon filters should be replaced every three months (more frequently if used often).

Background

Residents of Whatcom County, Washington expressed concern over the public health impact of chemical contamination in their private groundwater wells. Monitoring conducted by Whatcom County Health and Human Services, the Washington State Department of Health, the United States Geological Survey, and the Washington Department of Ecology indicated that water from some private wells is contaminated with volatile organic compounds (VOCs) including 1,2-dichloropropane (1,2-DCP) and ethylene dibromide (EDB). For most houses, EDB and 1,2-DCP contamination in drinking water was due to fumigants being injected into the soil to control root nematodes on agricultural crops. Sandy soils overlying the shallow drinking water table in the county allow chemicals applied to the surface of the ground to enter the drinking water. Shallow wells are most at risk of contamination. As a result of the agencies' testing, residents with contaminated wells have been advised to use bottled water for drinking and cooking. However, most continue to use water from their wells for showering and other non-potable uses.

Residents who shower with VOC-contaminated water could inhale VOCs that escape from water into the air or be exposed dermally. In order to assess possible inhalation exposures to VOCs during showering, the Agency for Toxic Substances and Disease Registry (ATSDR) conducted an Exposure Investigation. The Exposure Investigation suggested that a carbon filtration cartridge installed on a showerhead could be effective in reducing inhalation and dermal exposure to 1,2-DCP and EDB while showering.

Purpose

This study was conducted to provide additional information about the effectiveness of carbon filtration cartridges on showerheads over time. Levels of 1,2-DCP were monitored pre- and post-filter once a month for five (5) months. In addition, coliform samples were collected to determine if the filters became contaminated with bacteria over time.

Materials

Two (2) drinking water wells, and showers in the homes served by those wells, were selected for sampling. Selection of these two wells was based on:

(1) The wells having a known level of 1,2-DCP that exceeds the maximum contaminant level (MCL) of 5.0 parts per billion (ppb or ug/l);
(2) Homes not having any existing water treatment systems that would influence sample results;
(3) Gaining cooperation of the current property owner; and
(4) An existing carbon filter installed just prior to the showerhead that could be easily removed to allow sampling of both treated and untreated water.

Well #1 was located in Township 39N and Range 02E.
Well #2 was located in Township 40N and Range 02E.

A Culligan SR-115 carbon shower filter was used for this project [$21.00 plus $15.00 for the replacement cartridges (SRC11)].

Method

Sampling of each residence occurred once a month for five months. The sampling began May 4, 1999. Originally, sampling was going to last for three months; however, due to favorable results, sampling continued for two additional months. A new filter was installed on the day the first sample was taken and was replaced at the end of the study.

Cold water was run in the tub for at least 45 minutes before samples were collected.

In order to collect the pre-filter sample, the carbon filter and the showerhead were removed and the water was run for an additional 10 minutes. Samples of cold water were collected from the showerhead in different vials for 1,2-DCP and coliform bacteria.

In order to collect the post-filter sample, the carbon filter (without the showerhead) was reattached and the 1,2-DCP and coliform samples were collected in separate vials.

Quality control samples included one trip blank for the SOC method. One field duplicate for each sample for 1,2-DCP testing was collected to check both sampling and laboratory variability.
Samples were carried on ice and taken directly to the lab from the monitoring site.

Analysis

Edge Analytical of Burlington, Washington performed the 1,2-DCP analysis using the SOC method 504.1 modified. Avocet Environmental Testing of Bellingham, Washington performed the coliform analysis using coliform bacteria by membrane filtration to produce a total coliform count.

Results

Well #1:

	Well #1				
	1,2-DCP (ug/l)			Total Coliform (# / 100 ml)	
	Before filter	After filter	% Reduction	Before filter	After filter
Month 0	22.4	<0.02	>=99.9	<1	<1
Month 1	21.1	<0.02	>=99.9	<1	<1
Month 2	24	0.2 J	99.2	<1	1
Month 3	18.6	2.1	88.7	1.1	<1
Month 4	22.4	3.4	84.8	2.2	6.9
Month 5	21.5	5.8	73.0	<1	<1

The Maximum Contaminant Level (MCL) for 1,2-DCP for drinking water is 5.0 ug/l (ppb).

Well #1 had an exceptionally high level of 1,2-DCP in its water (approximately four times the MCL—ranging from 18.6 to 22.4 ug/l or ppb)—the highest recorded in the county for a drinking water well. A water softener was used to reduce the amount of iron/manganese in the water. High levels of iron and manganese might also interfere with the effectiveness of the filter.

During the course of the study, approximately 1 ½ -10 minute showers per day were taken in this shower. The carbon filter appeared to be extremely effective (89%) in reducing 1,2-DCP levels for the first three months. It was only after five months that the post-filter level of 1,2-DCP increased above the MCL—even so, the filter still provided a 73% reduction in the level of 1,2-DCP. To ensure adequate removal of 1,2-DCP, The Department of Ecology and Culligan (the manufacturer) recommended the filter be replaced every three months. This recommendation appears to be more than sufficient, considering this well has the highest known levels of 1,2-DCP in the county, and the filter removed 1,2-DCP to below half the MCL after three months of use.

In addition, the amount of bacteria did not increase enough to cause a health threat for non-drinking water use. The highest coliform bacteria count after the filter was 6.9 coliforms / 100 ml; however, the coliform bacteria level before the filter was 2.2 coliforms / 100 ml—both are considered unsatisfactory for drinking. Most of the samples taken were at a level of <1 coliform / 100 ml. In addition, both the before and after filter samples taken in the fifth (and final) month were satisfactory for coliform bacteria (<1 coliform / 100 ml). The drinking water standard is <1 coliform / 100 ml. As a comparison, for general recreational surface water use, (not involving significant risk of ingestion), "an average not to exceed 2000 fecal coliforms per 100 ml and a maximum of 4000 per 100 ml…" is suggested[1]. Drinking water standards were referred to in this study because there may be some ingestion risk in the shower.

Well #2:

	Well #2				
	1,2-DCP (ug/l)			**Total Coliform (# / 100 ml)**	
	Before filter	**After filter**	**% Reduction**	**Before filter**	**After filter**
Month 0	11.8	0.058	99.5	<1	<1
Month 1	12.1	0.2 J	98.3	<1	<1
Month 2	12.6	0.3 J	97.6	<1	<1
Month 3	The shower was clogged, so it was no longer testable.				

The Maximum Contaminant Level (MCL) for 1,2-DCP for drinking water is 5.0 ug/l (ppb).

Well #2 had a relatively high level of 1,2-DCP in its water (approximately twice the MCL— ranging from 11.8 to 12.6 ug/l or ppb). A water softener was not used in this house.

During the course of the study, approximately 1 ½ -10 minute showers per day were taken in this shower. The carbon filter was extremely effective (98%) in reducing 1,2-DCP levels to barely detectable levels for the first two months. Unfortunately, by the third month, the shower was clogged, so it was not longer testable.

In addition, in the two months this shower water was tested, the amount of bacteria did not increase to a detectable amount (all the tests confirmed <1 coliform/100 ml).

[1] See Environmental Engineering and Sanitation, 4th Edition, Joseph Salvato, p. 1023, 1992.

Conclusions

1. The results were compared to drinking water quality standards to determine if there were concentrations of contaminants in the drinking water and/or in filtered shower water that could pose an adverse health effect. Since the carbon filters reduced 1,2-DCP levels to below the MCL [5.0 ug/l (ppb)] and did not result in unsatisfactory coliform growth for non-drinking water, installing similar carbon filters in other homes on point of use locations may be warranted.

2. Of substantial concern, however, is the fact that Well #2's shower became clogged after using the filter for a couple of months. After the shower filter was installed, water passing through the showerhead became more restricted and flowed at a slower rate—encouraging the deposition and accumulation of iron and/or manganese in the pipes. House #1 had a water softener to reduce the amount of iron and manganese in the water and therefore did not experience this problem. Typically many drinking water wells in Whatcom County have high levels of iron and manganese and, therefore, may experience similar problems.

3. As a result, it is recommended the water be tested for manganese and iron before a carbon filter is installed on the showerhead. If there is a considerable amount of iron and manganese in the water, a water softener or other comparable water treatment system should be installed.

Recommendations

As a result of these findings, Whatcom County Health and Human Services offers the following suggestions:

1. Residents should consider installing a carbon filter to minimize inhalation and dermal exposures to 1,2-DCP and EDB from contaminated well water during showering.

2. Residents who install a carbon filter should test their water for iron and manganese. If the water tests high for iron or manganese, residents should consider using a water softener to reduce their level.

3. Carbon filters should be replaced every three months (more frequently if used often).