

CHAPTER

5

Volatile Organic Chemicals (VOCs)

Volatile Organic Chemicals (VOCs) are solvents that have been widely used as cleaning agents, degreasers, and as intermediate chemicals in manufacturing. There are 21 regulated VOCs. This chapter will discuss these 21 VOCs and explain the monitoring requirements.

Illinois EPA Assistance

In most cases, as a monitoring requirement approaches for a community water system (CWS), the Illinois EPA will send reminder notifications that detail the requirement and specific timeline for completion. Please remember that these are “reminder” notifications and does not relieve the CWS in meeting the monitoring schedule deadlines. If a CWS is unsure of its schedule or timeframe described in any Illinois EPA notification, it is very important that the CWS contact the Drinking Water Compliance Unit at 217/785-0561 for clarification. All VOC correspondence should be sent to:

VOC Coordinator
Illinois EPA /BOW/CAS #19
P.O. Box 19276
Springfield, IL 62794-9276
Telephone: 217-785-0561
Fax 217-557-1407

Sample Bottles

If your supply participates in the Community Water Supply Testing Fund (CWSTF), sample containers will be sent to your supply during the monitoring period. If your supply does **not** participate in the CWSTF, it is your responsibility to have all testing completed by an Illinois EPA certified laboratory and submitted on the correct reporting forms. The VOC certified laboratory reporting form is available on the Internet (see next page). This form must be submitted within 10 days after the end of a monitoring period. If the laboratory you choose submits data electronically, it is not necessary to submit a paper copy. However, it is the responsibility of the CWS to insure data reaches the Illinois EPA within 10 days of the end of the monitoring period.

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Certified Laboratory Result Reporting Forms can be downloaded at:

<http://www.epa.state.il.us/water/forms.html#compliance-and-enforcement-drinking-water>

If Internet access is unavailable, please contact the VOC Coordinator at 217-785-0561 for a copy of this form.

VOC Sample Locations

VOC samples must be collected at locations that represent each well or surface water source after all treatment but prior to entering the distribution system. If water from several sources is combined and treated at a common location, then one sample can be collected to represent all combined sources.

If a well pumps directly to the distribution system (no added treatment), then a representative sample must be collected prior to the first distribution location. This is not a common situation.

On occasion the Illinois EPA will require a VOC sample to be collected directly from a well prior to treatment. If the case, the sample collector will receive specific sample collection instructions.

Monitoring Requirements

Initially, per sample location as specified above, VOC samples are collected quarterly for a minimum of four consecutive quarters. Once a base line is established with no detections for a sample location, monitoring can be reduced to annual. After a total of three consecutive years of monitoring without detections, triennial monitoring will be considered.

Quarterly monitoring must be initiated for any new source of water (i.e. new well). Reduced monitoring for new sources will be considered once four consecutive quarterly samples are collected without detection.

Please remember that several factors influence monitoring requirements; such as, violation of regulations, new regulations, and/or contaminant detections. It is recommended that each CWS water operator and/or sample collector periodically (at least quarterly) download a new schedule since monitoring schedules change frequently. A CWS can download their most current monitoring schedule at:

<http://www.epa.state.il.us/water/compliance/drinking-water/sdwis/index.html>

Monitoring Requirements for Sample Locations with VOC Detections

Quarterly monitoring must continue for any detected VOC until results demonstrate “reliably and consistently” low results. Groundwater CWS must demonstrate results “reliably and consistently” below one half of the Maximum Contaminant Level (MCL) for a minimum of two consecutive quarters. Surface water system must demonstrate results “reliably and consistently” below the laboratory detection limit for a minimum of four consecutive quarters. Once this has been established, the CWS/sample location may qualify for reduced monitoring.

Reduced Monitoring

The Illinois EPA will periodically review sample data to determine if a sample location qualifies for reduced monitoring. If a sample location qualifies, the Illinois EPA will send written notification to the CWS that sampling has been reduced.

As mentioned, this is a periodic review. It is strongly recommended that the CWS routinely evaluate their data. If it is felt that a sample location qualifies for reduced monitoring, a request in writing should be sent to the VOC Coordinator (address on page 1 of this Chapter).

When a sample location is eligible for reduced monitoring, it will move from a quarterly frequency to an annual frequency. After three years of annual samples, the sample frequency may be further reduced to triennial if no detections have occurred regardless.

A sample location reduced from quarterly to annual monitoring must be scheduled to be collected during the calendar quarter in which the highest quarterly detection occurred for that contaminant. This is a requirement and if the sample is not collected during the specified quarter it will result in a monitoring violation.

EXAMPLE

A CWS is required to collect quarterly benzene samples due to a routine VOC sample detection. This CWS is a ground water supply, thus will need two consecutive quarters of results below ½ the MCL for benzene to qualify for reduced annual sampling. The MCL for benzene is 5ug/L, so ½ of the MCL would be 2.5ug/L.

Sample Location	Date Collected	Benzene Concentration (ug/l)
TP01 Well 1	01/06/07	3.2
TP01 Well 1	04/22/07	4.4
TP01 Well 1	08/02/07	Not Detected
TP01 Well 1	10/03/07	4.0
TP01 Well 1	01/16/08	0.6
TP01 Well 1	04/02/08	0.7
CWS now has two quarters of results “reliably and consistently” below ½ the MCL (yellow). The CWS is now eligible for reduced annual monitoring. The annual sample must be collected during the calendar quarter in which the highest quarterly detection occurred (blue) or in this example, the April thru June quarter.		
TP01 Well 1	04/02/09	0.7
TP01 Well 1	04/22/10	Not Detected
TP01 Well 1	04/09/11	Not Detected
TP01 Well 1	4/15/12	Not Detected
Three annual sample with no detections qualifies for triennial monitoring		
TP01 Well 1	04/18/15	Not Detected
If at any time benzene is again detected above ½ the MCL or any other detection, quarterly monitoring will resume.		

Monitoring Requirements for Emergency Wells

All wells that are active and are either on back-up or emergency status must be monitored every three years. If the CWS purchases its primary source of water from another CWS, annual samples are required from the well(s). There is no exception to this requirement.

If there is detection below the MCL, the CWS may be required to locate the source of the contamination and remediate.

If there is detection above the MCL, the CWS will be required to locate the source of the contamination and remediate in an established amount of time or properly abandon the well.

VOC Vulnerability Waiver Program

The Illinois EPA has a “vulnerability waiver” program that many systems already utilize which allows VOC monitoring to be reduced to one sample per sample location every six years.

The objective of the VOC vulnerability monitoring waiver program is to reduce monitoring, while assuring the safety of the drinking water currently provided by the public water supplies. The intent of this program is to recognize where natural protection exists by differentiating between confined and unconfined aquifer systems. A confined aquifer more readily qualifies for a waiver. For aquifers determined to be unconfined this program includes: mapping the 5-year recharge area; identifying potential sources and routes of contamination located within the recharge area; contingency planning; and managing potential sources and potential routes of contamination, thereby reducing vulnerability to contamination. The program requires the identification and sealing of potential routes of contamination located within 1,000 feet of wells.

To obtain a waiver, the PWS must evaluate the vulnerability of their wells to potential contamination sources. Systems vulnerable to contamination must develop a management program for controlling potential contamination sources and routes. If a CWS is interested and would like more information, please call the VOC coordinator at 217-785-0561. The application is on line at:

<http://www.epa.state.il.us/water/compliance/drinking-water/forms/phase-2-and-5-monitoring-waiver-application-and-instructions.pdf>

Compliance with the VOC Maximum Contaminant Levels (MCL)

Compliance is based on the running annual average of quarterly samples. This is calculated for entry point to the distribution system. If one sample location is out of compliance, the entire system is out of compliance unless that part of the system is entirely separate (no inter-connections) from the rest of the system.

If any single sampling result is high enough to cause the annual average to be exceeded, the supply is out of compliance immediately (for example, the analytical result is greater than four times the MCL or two analytical results are greater than twice the MCL, etc.).

Systems monitoring annually or triennially whose sample result exceeds the MCL, must revert to quarterly sampling for that contaminant the next quarter. Systems are only required to conduct quarterly monitoring at the sampling point at which the sample was collected and for the specific contaminant that triggered the system into the increased monitoring frequency. An exceedance is not necessarily a violation. Systems triggered into increased monitoring will not be considered in violation of the MCL until they have completed one year of quarterly sampling unless any sample collected during quarterly monitoring would result in the annual average exceeding the MCL.

Systems may monitor more frequently than quarterly. Samples must be clearly marked as “compliance/routine samples” prior to being submitted to the laboratory (and not after the results are known). If the case, all samples must be used when determining compliance (the system cannot pick and choose results). Samples marked as “special” samples will not be used for compliance and cannot later be changed to routine samples. There are no exceptions to this rule.

If a system does not collect all required quarterly samples, compliance will be based on the running annual average of the samples collected. If a sample result is less than the method reporting, zero will be used to calculate the annual average.

The Illinois EPA has the flexibility to require confirmation samples for positive or negative results. The Illinois EPA may require more than one confirmation sample to determine the average exposure. If confirmation samples are required by the Illinois EPA, the average of the analytical result and the confirmation sample will be used for compliance determinations.

Example 1: A ground water supply was on triennial monitoring at TP01 Well 1. Benzene was detected at 5.6ug/L in the sample collected on 10/18/2007. The detection triggered quarterly monitoring. The MCL for benzene is 5ug/L.

Sample Location	Date Collected	Single Result (ug/L)	*Quarterly Average	Running Annual Average
TP01 Well 1	10/18/07	5.6	5.6	$5.6 / 4 = 1.4$ (no MCL)
TP01 Well 1	01/05/08	5.9	5.9	$5.6 + 5.9 / 4 = 2.8$ (no MCL)
TP01 Well 1	04/20/08	6.3	6.3	$5.6 + 5.9 + 6.3 / 4 = 4.4$ (no MCL)
TP01 Well 1	07/08/08	6.2	6.2	$5.6 + 5.9 + 6.3 + 6.2 / 4 = 6$ (MCL Violation)
TP01 Well 1	10/02/08	5.4	5.4	$5.9 + 6.3 + 6.2 + 5.4 / 4 = 5.9$ (MCL Violation)
TP01 Well 1	01/05/09	2.4	2.4	$6.3 + 6.2 + 5.4 + 2.4 / 4 = 5.0$ (no MCL)

* Only one sample collected per quarter

The water supply had 2 quarters in which the running annual average exceeded the MCL; therefore, the water supply was in violation. Public notice is required for these two quarters (see Chapter 1 Public Notification for requirements).

In this example, the water supply would remain on quarterly monitoring until it could demonstrate reliably and consistently results below 2.5 ug/L for a minimum of two consecutive quarters. See “Monitoring Requirements for Sample Locations with VOC Detections” of this Chapter.

If more than one sample is collected during the quarter from the same sample location, the samples are averaged to calculate a quarterly average. See example below.

Example 2: A water supply was on triennial monitoring at TP02 Well 2. Dichloromethane was detected at 23.3ug/L in the sample collected on 10/18/2007. A confirmation sample was collected on 11/12/07 and was 27.2ug/L. The detections triggered quarterly monitoring. The MCL for dichloromethane is 5ug/L.				
Sample Location	Date Collected	Single Result (ug/L)	Quarterly Average	Running Annual Average
TP02 Well 2	10/18/07	23.3	$23.3 + 27.2 / 2 = 25.2$	$25.2 / 4 = 6.3$ (MCL violation)
TP02 Well 2	11/12/07	27.2		
TP02 Well 2	2/12/08	6	6	$25.2 + 6 / 4 = 7.8$ (MCL Violation)
TP02 Well 2	04/20/08	4	4	$25.2 + 6 + 4 / 4 = 8.8$ (MCL Violation)
TP02 Well 2	07/08/08	18	$18 + 2 / 2 = 10$	$25.2 + 6 + 4 + 10 / 4 = 11.3$ (MCL Violation)
TP02 Well 2	8/2/08	2		
TP02 Well 2	10/02/08	No detect	0	$6 + 4 + 10 + 0 / 4 = 5$ (no MCL)
TP02 Well 2	01/05/09	No detect	0	$4 + 10 + 0 + 0 / 4 = 3.5$ (no MCL)
The water supply had 4 quarters in which the running annual average exceeded the MCL; therefore, the water supply was in violation. Public notice is required for these four quarters (see Chapter 1 Public Notification for requirements).				

VOC Contaminants

Below are the 21 regulated VOCs.

Benzene	MCL = 5 ug/L (or 5 parts per billion)
Benzene is a clear, colorless aromatic liquid. It is highly flammable. The greatest use of benzene is as a building block for making plastics, rubber, resins and synthetic fabrics like nylon and polyester. Other uses include: as a solvent in printing, paints, dry cleaning, etc.	
Carbon Tetrachloride	MCL = 5 ug/L (or 5 parts per billion)
Carbon tetrachloride is a clear heavy organic liquid with a sweet aromatic odor similar to chloroform. Most of it is used to make chlorofluorocarbon propellants and refrigerants, though this has been declining steadily. Other uses have included: as dry cleaning agent and fire extinguisher, in making nylon, as a solvent for rubber cement, soaps, insecticides, etc.	
Chlorobenzene	MCL = 100 ug/L (or 100 parts per billion)
Chlorobenzene is a colorless organic liquid with a faint, almond-like odor. The greatest use of chlorobenzene is in the manufacture of other organic chemicals, dyestuffs and insecticides. It is also a solvent for adhesives, drugs, rubber, paints and dry-cleaning, and as a fiber-swelling agent in textile processing.	
Ortho-dichlorobenzene (o-DCB)	MCL = 600 ug/L (or 600 parts per billion)
Ortho-dichlorobenzene, (o-DCB) is a colorless organic liquid with a pleasant, aromatic odor. The greatest use of o-dichlorobenzene is as a chemical intermediate for making agricultural chemicals, primarily herbicides. Other present and past uses include: solvent for waxes, gums, resins, wood preservatives, paints; insecticide for termites and borers; in making dyes; as a coolant, deodorizer, and degreaser.	
Para-dichlorobenzene (p-DCB)	MCL = 75 ug/L (or 75 parts per billion)
Para-dichlorobenzene (p-DCB) is an organic solid of white crystals with a mothball-like odor. It is used mainly as an insecticidal fumigant against clothes moths and as a deodorant for garbage and restrooms. It is also used as an insecticide and fungicide on crops, and in the manufacture of other organic chemicals and in plastics, dyes, pharmaceuticals.	

1,2-Dichloroethane (1,2-DCA)	MCL = 5 ug/L (or 5 parts per billion)
1, 2-Dichloroethane (1, 2-DCA) is a colorless, oily, organic liquid with a sweet, chloroform-like odor. The greatest use of 1, 2-dichloroethane is in making chemicals involved in plastics, rubber and synthetic textile fibers. Other uses include: as a solvent for resins and fats, photography, photocopying, cosmetics, drugs; and as a fumigant for grains and orchards.	
1,1-Dichloroethylene (1,1-DCE)	MCL = 7 ug/L (or 7 parts per billion)
1, 1-Dichloroethylene (1,1-DCE) is an organic liquid with a mild, sweet, chloroform-like odor. Virtually all of it is used in making adhesives, synthetic fibers, refrigerants, food packaging and coating resins such as the saran types.	
cis- 1,2-Dichloroethylene	MCL = 70 ug/L (or 70 parts per billion)
trans- 1,2-Dichloroethylene	MCL = 100 ug/L (or 100 parts per billion)
1,2-Dichloroethylene (1,2-DCE) is an odorless organic liquid that has two slightly different forms, a "cis" form and a "trans" form. Both the cis and trans forms - usually as a mixture - are used as a solvent for waxes and resins; in the extraction of rubber; as a refrigerant; in the manufacture of pharmaceuticals and artificial pearls; in the extraction of oils and fats from fish and meat; and in making other organics.	
Dichloromethane (DCM)	MCL = 5 (or 5 parts per billion)
Dichloromethane (DCM) is a colorless organic liquid with a sweet, chloroform-like odor. The greatest use of DCM is as a paint remover. Other uses include: solvent and cleaning agent in a variety of industries, a fumigant for strawberries and grains; and to extract substances from foodstuffs.	
1,2-Dichloropropane (1,2-DCP)	MCL = 5 ug/L (or 5 parts per billion)
1,2-Dichloropropane (1,2-DCP) is a colorless organic liquid with a chloroform-like odor. The greatest use of 1,2-dichloropropane is in making other organic chemicals. It is also used in making lead-free gasoline, paper coating, soil fumigant for nematodes, and insecticide for stored grain.	
Xylene (Total)	MCL = 10,000 ug/L (or 10,000 parts per billion)
A xylene is any of a group of very similar organic compounds. They are clear liquids with a sweet odor. The greatest use of xylenes is as a solvent which is much safer than benzene. Other uses include: in gasoline as part of the BTX component (benzene-toluene-xylene); Xylene mixtures are used to make phthalate plasticizers, polyester fiber, film and fabricated items.	
Ethylbenzene	MCL = 700 ug/L (or 700 parts per billion)
Ethylbenzene is a colorless organic liquid with a sweet, gasoline-like odor. The greatest use - over 99 percent - of ethylbenzene is to make styrene, another organic liquid used as a building block for many plastics. It is also used as a solvent for coatings, and in making rubber and plastic wrap.	
Styrene	MCL = 100 ug/L (or 100 parts per billion)
Styrene is an oily organic liquid with an aromatic, almost floral odor. Initially, styrene was used primarily in the synthetic rubber industry, but it is currently used as a building block for polymers in making plastics, resins, coatings, and paints.	
Tetrachloroethylene (PCE)	MCL = 5 ug/L (or 5 parts per billion)
Tetrachloroethylene (PCE) is a colorless organic liquid with a mild, chloroform-like odor. Its greatest use is in the textile industry, and as a component of aerosol dry-cleaning products.	
Toluene	MCL = 1,000 ug/L (or 1,000 parts per billion)
Toluene is an organic liquid with a sweet, benzene-like odor. The largest chemical use for toluene is to make benzene and urethane.	

1,2,4-Trichlorobenzene (1,2,4-TCB)	MCL = 70 ug/L (or 70 parts per billion)
1,2,4-Trichlorobenzene (1,2,4-TCB) is an aromatic, colorless organic liquid. The greatest use of 1,2,4-trichlorobenzene is primarily as a dye carrier. It is also used to make herbicides and other organic chemicals; as a solvent; in wood preservatives; in abrasives. It was once used as a soil treatment for termite control.	
1,1,1-Trichloroethane (1,1,1-TCA)	MCL = 200 ug/L (or 200 parts per billion)
1,1,1-Trichloroethane (1,1,1-TCA) is an organic liquid with a chloroform-like odor. It is largely used as a solvent removing grease from machined metal products, in textile processing and dyeing and in aerosols.	
1,1,2-Trichloroethane (1,1,2-TCE)	MCL = 5 ug/L (or 5 parts per billion)
1,1,2-Trichloroethane (1,1,2-TCE) is an organic liquid with a chloroform-like odor. It is only used to make vinylidene chloride which is in turn used to make synthetic fibers and plastic wraps such as the saran wrap.	
Trichloroethylene	MCL = 5 ug/L (or 5 parts per billion)
Trichloroethylene is a colorless or blue organic liquid with a chloroform-like odor. The greatest use of trichloroethylene is to remove grease from fabricated metal parts and some textiles.	
Vinyl Chloride	MCL = 2 ug/L (or 2 parts per billion)
Vinyl chloride is a colorless organic gas with a sweet odor. It is used in the manufacture of numerous products in building and construction, automotive industry, electrical wire insulation and cables, piping, industrial and household equipment, medical supplies, and is depended upon heavily by the rubber, paper, and glass industries.	

MTBE (methyl-t-butyl ether) Monitoring

MTBE is a member of a group of chemicals commonly known as fuel oxygenates and is added to fuel to increase its oxygen content. MTBE is used in gasoline throughout the United States to reduce carbon monoxide and ozone levels caused by auto emissions. MTBE replaced the use of lead as an octane enhancer since 1979. Releases of MTBE to ground and surface water can occur through leaking underground storage tanks and pipelines, spills, emissions from marine engines into lakes and reservoirs, and to some extent from air deposition. In order to determine the extent of possible MTBE contamination, the Illinois EPA requests that MTBE be tested and reported in conjunction with your routine VOC samples. This additional test should not increase the lab cost to the CWS.

VOC Sample Collection – Things to Remember

Sample instructions should be supplied with the sample containers from the laboratory. If the laboratory fails to include sample instructions, contact the laboratory and request sample instructions. Some general practices to remember:

- A sample “blank” will accompany each sampling set (the blank will already be filled with water by the laboratory and should not be opened)
- Samples should be collected at the entry point to the distribution system after all treatment (finished water)

- Select a sampling faucet that does NOT have an aerator (sampling must be done with minimum aeration)
- Run the water until the temperature is as cold as it gets
- Just before sample collection, adjust to a very low flow. Do not change the flow while collecting sample
- When filling sample bottle, tip bottle slightly so that water flows down the side wall of the container. Bring bottle to an upright position as it fills. Fill just to the point of overflowing.
- Reinstall the cap and invert the sample bottle to check for an air bubble. If an air bubble is present, remove the cap and add a few additional drops of water. Continue checking and adding drops of water until the bubble is completely gone
- Call the laboratory if bottles are received broken (or break while collecting samples)
- If a sample location is out of service (for an extended period of time), notify the VOC Coordinator in writing or by phone at 217-785-0561
- The owner or operator of a water supply must maintain chemical analysis reports (results) or a summary of those reports for at least 10 years