

Environmental Protection Agency

Pt. 141, Subpt. C, App. A

ALTERNATIVE TESTING METHODS WITH MRL >0.0010 MG/L FOR MONITORING LISTED AT 40 CFR 141.132(b)(3)(ii)(B)

Contaminant	Methodology	EPA method
Bromate	Two-Dimensional Ion Chromatography (IC) ..... Ion Chromatography Electrospray Ionization Tandem Mass Spectrometry (IC-ESI-MS/MS).	302.0 <sup>18</sup> 557 <sup>14</sup>

ALTERNATIVE TESTING METHODS FOR CONTAMINANTS LISTED AT 40 CFR 141.402(c)(2)

Organism	Methodology	SM 20th Edition <sup>6</sup>	SM 21st Edition <sup>1</sup>	SM 22nd Edition <sup>28</sup>	SM Online <sup>3</sup>	Other
<i>E. coli</i> .....	Colilert <sup>®</sup> .....	.....	9223 B .....	9223 B .....	9223 B-97, B-04.	Readycult <sup>®</sup> 20, Modified Colitag <sup>™</sup> 13, Chromocult <sup>®</sup> 21.
	Colisure <sup>®</sup> .....	.....	9223 B .....	9223 B .....	9223 B-97, B-04.	
	Colilert-18 .....	9223 B .....	9223 B .....	9223 B .....	9223 B-97, B-04.	
	Readycult <sup>®</sup> .....	.....	.....	.....	.....	
	Colitag .....	.....	.....	.....	.....	
Enterococci ...	Chromocult <sup>®</sup> EC-MUG .....	.....	.....	9221 F .....	9221 F-06.	Fast Phage <sup>30</sup>
	Tecta EC/TC <sup>33</sup> .....	.....	.....	.....	.....	
Coliphage .....	Multiple-Tube Technique .....	.....	.....	.....	9230 B-04.	Fast Phage <sup>30</sup>
	Two-Step Enrichment Presence-Absence Procedure .....	.....	.....	.....	.....	

ALTERNATIVE TESTING METHODS FOR CONTAMINANTS LISTED AT 40 CFR 141.704(a)

Organism	Methodology	EPA Method
<i>Cryptosporidium</i> .....	Filtration/Immunomagnetic Separation/Immunofluorescence Assay Microscopy.	1623.1 <sup>27</sup>

ALTERNATIVE TESTING METHODS FOR CONTAMINANTS LISTED AT 40 CFR 141.704(b)

Organism	Methodology	SM 20th edition <sup>6</sup>
<i>E. coli</i> .....	Membrane Filtration, Two Step .....	9222 D/9222 G

ALTERNATIVE TESTING METHODS FOR CONTAMINANTS LISTED AT 40 CFR 141.852(a)(5)

Organism	Methodology category	Method	SM 20th, 21st editions <sup>1 6</sup>	SM 22nd Edition <sup>28</sup>	SM Online <sup>3</sup>
Total Coliforms .....	Lactose Fermentation Methods. Enzyme Substrate Methods.	Standard Total Coliform Fermentation Technique.	.....	9221 B.1, B.2 .....	9221 B.1, B.2-06.
		Colilert <sup>®</sup> .....	.....	9223 B .....	9223 B-04.
<i>Escherichia coli</i> .....	<i>Escherichia coli</i> Procedure (following Lactose Fermentation Methods). Enzyme Substrate Methods.	Colisure <sup>®</sup> .....	.....	9223 B .....	9223 B-04.
		Colilert-18 <sup>®</sup> .....	9223 B .....	9223 B .....	9223 B-04.
		Tecta EC/TC, <sup>33</sup> EC-MUG medium ..	.....	9221 F.1 .....	9221 F.1-06.
		Colilert <sup>®</sup> .....	.....	9223 B .....	9223 B-04.
		Colisure <sup>®</sup> .....	.....	9223 B .....	9223 B-04.
		Colilert-18 <sup>®</sup> .....	9223 B .....	9223 B .....	9223 B-04.
		Tecta EC/TC, <sup>33</sup>	.....	.....	.....

ALTERNATIVE TESTING METHODS FOR CONTAMINANTS LISTED AT 40 CFR 143.4(b)

Contaminant	Methodology	EPA method	ASTM <sup>4</sup>	SM 21st Edition <sup>1</sup>	SM 22nd Edition <sup>2a</sup>	SM online <sup>3</sup>
Aluminum	Axially viewed inductively coupled plasma-atomic emission spectrometry (AVICP-AES).	200.5, Revision 4.2 <sup>2</sup>				
Chloride	Atomic Absorption; Direct			3111 D	3111 D	3113 B-04, B-10.
	Atomic Absorption; Furnace			3113 B	3113 B	
	Inductively Coupled Plasma			3120 B	3120 B	
	Silver Nitrate Titration		D 512-04 B, 12 B D 4327-11	4500-Cl <sup>-</sup> B 4110 B	4500-Cl <sup>-</sup> B 4110 B	
Color	Potentiometric Titration			4500-Cl <sup>-</sup> D	4500-Cl <sup>-</sup> D	
	Visual Comparison			2120 B	2120 B	
Foaming Agents	Methylene Blue Active Substances (MBAS).			5540 C	5540 C	
Iron	Axially viewed inductively coupled plasma-atomic emission spectrometry (AVICP-AES).	200.5, Revision 4.2 <sup>2</sup>				
Manganese	Atomic Absorption; Direct			3111 B	3111 B	3113 B-04, B-10.
	Atomic Absorption; Furnace			3113 B	3113 B	
	Inductively Coupled Plasma			3120 B	3120 B	
	Axially viewed inductively coupled plasma-atomic emission spectrometry (AVICP-AES).	200.5, Revision 4.2 <sup>2</sup>				
Odor	Atomic Absorption; Direct			3111 B	3111 B	3113 B-04, B-10.
	Atomic Absorption; Furnace			3113 B	3113 B	
	Inductively Coupled Plasma			3120 B	3120 B	
	Threshold Odor Test			2150 B	2150 B	
Silver	Axially viewed inductively coupled plasma-atomic emission spectrometry (AVICP-AES).	200.5, Revision 4.2 <sup>2</sup>				
Sulfate	Atomic Absorption; Direct			3111 B	3111 B	3113 B-04, B-10.
	Atomic Absorption; Furnace			3113 B	3113 B	
	Inductively Coupled Plasma			3120 B	3120 B	
	Ion Chromatography		D 4327-11	4110 B	4110 B	
Total Dissolved Solids	Gravimetric with ignition of residue.			4500-SO <sub>4</sub> <sup>2-</sup> C	4500-SO <sub>4</sub> <sup>2-</sup> C	4500-SO <sub>4</sub> <sup>2-</sup> C-97
	Gravimetric with drying of residue.			4500-SO <sub>4</sub> <sup>2-</sup> D	4500-SO <sub>4</sub> <sup>2-</sup> D	4500-SO <sub>4</sub> <sup>2-</sup> D-97
	Turbidimetric method		D 516-07, 11	4500-SO <sub>4</sub> <sup>2-</sup> E	4500-SO <sub>4</sub> <sup>2-</sup> E	4500-SO <sub>4</sub> <sup>2-</sup> E-97
	Automated methylthymol blue method.			4500-SO <sub>4</sub> <sup>2-</sup> F	4500-SO <sub>4</sub> <sup>2-</sup> F	4500-SO <sub>4</sub> <sup>2-</sup> F-97
Total Dissolved Solids	Total Dissolved Solids Dried at 180 deg C.			2540 C	2540 C	

Zinc	Axially viewed inductively coupled plasma-atomic emission spectrometry (AV/ICP-AES).	Atomic Absorption; Direct Aspiration.	Inductively Coupled Plasma ...	200.5, Revision 4.2 <sup>2</sup>	3111 B	3120 B
					3111 B	3120 B

<sup>1</sup> Standard Methods for the Examination of Water and Wastewater, 21st edition (2005). Available from American Public Health Association, 800 I Street, NW., Washington, DC 20001-3710.

<sup>2</sup> EPA Method 200.5, Revision 4.2. "Determination of Trace Elements in Drinking Water by Axially Viewed Inductively Coupled Plasma-Atomic Emission Spectrometry." 2003. EPA/600/R-06/115. (Available at <http://www.epa.gov/nerlc/www/ordmeth.htm>).

<sup>3</sup> Standard Methods Online are available at <http://www.standardmethods.org>. The year in which each method was approved by the Standard Methods Committee is designated by the last two digits in the method number. The methods listed are the only online versions that may be used.

<sup>4</sup> Available from ASTM International, 100 Barr Harbor Drive, West Conshohocken, PA 19428-2959 or <http://astm.org>. The methods listed are the only alternative versions that may be used.

<sup>5</sup> Method D99-003, Revision 3.0. "Free Chlorine Species (HOCl<sup>-</sup> and OCl<sup>-</sup>) by Test Strip." November 21, 2003. Available from Industrial Test Systems, Inc., 1875 Langston St., Rock Hill, SC 29730.

<sup>6</sup> Standard Methods for the Examination of Water and Wastewater, 20th edition (1998). Available from American Public Health Association, 800 I Street, NW., Washington, DC 20001-3710.

<sup>7</sup> Method ME355.01, Revision 1.0. "Determination of Cyanide in Drinking Water by GC/MS Headspace." May 26, 2009. Available at <http://www.nemi.gov> or from James Eaton, H & E Testing Laboratory, 221 State Street, Augusta, ME 04333. (207) 287-2727.

<sup>8</sup> Systea Easy (1-Reagent). "Systea Easy (1-Reagent) Nitrate Method." February 4, 2009. Available at <http://www.nemi.gov> or from Systea Scientific, LLC, 900 Jorie Blvd., Suite 35, Oak Brook, IL 60523.

<sup>9</sup> EPA Method 524.3, Version 1.0. "Measurement of Purgeable Organic Compounds in Water by Capillary Column Gas Chromatography/Mass Spectrometry." June 2009. EPA 815-B-09-009. Available at [http://epa.gov/safewater/methods/analyticalmethods\\_09waw/himi](http://epa.gov/safewater/methods/analyticalmethods_09waw/himi).

<sup>10</sup> Mitchell Method M527.1, Revision 1.1. "Determination of Turbidity by Laser Nephelometry." March 5, 2009. Available at <http://www.nemi.gov> or from Leck Mitchell, PH.D., PE, 656 Independence Valley Dr., Grand Junction, CO 81507.

<sup>11</sup> Mitchell Method M5331, Revision 1.1. "Determination of Turbidity by LED Nephelometry." March 5, 2009. Available at <http://www.nemi.gov> or from Leck Mitchell, PH.D., PE, 656 Independence Valley Dr., Grand Junction, CO 81507.

<sup>12</sup> Orion Method AQ4500, Revision 1.0. "Determination of Turbidity by LED Nephelometry." May 8, 2009. Available at <http://www.nemi.gov> or from Thermo Scientific, 166 Cummings Center, Beverly, MA 01915. <http://www.thermo.com>.

<sup>13</sup> Modified Collig<sup>™</sup> Method. "Modified Collig<sup>™</sup> Test Method for the Simultaneous Detection of E. coli and other Total Coliforms in Water (ATP D05-0035)." August 28, 2009. Available at <http://www.nemi.gov> or from CPI, International, 580 Skyline Boulevard, Santa Rosa, CA 95403.

<sup>14</sup> EPA Method 557. "Determination of Haloacetic Acids, Bromate, and Dapalon in Drinking Water by Ion Chromatography Electrospray Ionization Tandem Mass Spectrometry (IC-ESI-MS/MS)." September 2009. EPA 815-B-09-012. Available at [http://www.epa.gov/scitech/drinkingwater/abstracts/analyticalmethods\\_expanded.cfm](http://www.epa.gov/scitech/drinkingwater/abstracts/analyticalmethods_expanded.cfm).

<sup>15</sup> AMI Turbwell. "Continuous Measurement of Turbidity Using a SWAN AMI Turbwell Turbidimeter." August 2009. Available at <http://www.nemi.gov> or from Markus Bernasconi, SWAN Analytische Instrumente AG, Stubschiessstrasse 13, CH-8340 Hinwil, Switzerland.

<sup>16</sup> EPA Method 334.0. "Determination of Residual Chlorine in Drinking Water Using an On-line Chlorine Analyzer." August 2009. EPA 815-B-09-013. Available at [http://epa.gov/safewater/methods/analyticalmethods\\_09waw/himi](http://epa.gov/safewater/methods/analyticalmethods_09waw/himi).

<sup>17</sup> ChloroSense. "Measurement of Free and Total Chlorine in Drinking Water by Palintest ChloroSense." August 2009. Available at <https://www.nemi.gov> or from Palintest Ltd, 1455 Jamike Avenue (Suite 100), Erlanger, KY 41018.

<sup>18</sup> EPA Method 302.0. "Determination of Bromate in Drinking Waters using Two-Dimensional Ion Chromatography with Suppressed Conductivity Detection." September 2009. EPA 815-B-09-014. Available at [http://epa.gov/safewater/methods/analyticalmethods\\_09waw/himi](http://epa.gov/safewater/methods/analyticalmethods_09waw/himi).

<sup>19</sup> EPA 415.3, Revision 1.2. "Determination of Total Organic Carbon and Specific UV Absorbance at 254 nm in Source Water and Drinking Water." September 2009. EPA/600/R-09/122. Available at <http://www.epa.gov/nerlc/www/ordmeth.htm>.

<sup>20</sup> ReadyCult<sup>™</sup> Method. "ReadyCult<sup>™</sup> Coliforms 100 Presence/Absence Test for Detection and Identification of Coliform Bacteria and Escherichia coli in Finished Waters." January, 2007. Version 1.1. Available from EMD Millipore (division of Merck KGaA, Darmstadt, Germany) 290 Concord Road, Billerica, MA 01821.

<sup>21</sup> Coli-Check<sup>™</sup> Method. "Coli-Check<sup>™</sup> Coliform Agar Presence/Absence Membrane Filter Test Method for Detection and Identification of Coliform Bacteria and Escherichia coli in Finished Waters." November 2000. Version 1.0. EMD Millipore (division of Merck KGaA, Darmstadt, Germany), 290 Concord Road, Billerica, MA 01821.

<sup>22</sup> Hach Company Method. "Hach Company SPADNS 2 (Arsenic-free) Fluoride Method 10225—Spectrophotometric Measurement of Fluoride in Water and Wastewater." January 2011. 5600 Lindbergh Drive, P.O. Box 389, Loveland, Colorado 80539. (Available at <http://www.hach.com>).

<sup>23</sup> Hach Company. "Hach Company TNTplus<sup>™</sup> 835/836 Nitrate Method 10206—Spectrophotometric Measurement of Nitrate in Water and Wastewater." January 2011. 5600 Lindbergh Drive, P.O. Box 389, Loveland, Colorado 80539. (Available at <http://www.hach.com>).

<sup>24</sup> EPA Method 525.3. "Determination of Semivolatile Organic Chemicals in Drinking Water by Solid Phase Extraction and Capillary Column Gas Chromatography/Mass Spectrometry (GC/MS)." February 2012. EPA/600/R-12/010. Available at <http://www.epa.gov/nerlc/www/ordmeth.htm>.

<sup>25</sup> EPA Method 536. "Determination of Triazine Pesticides and their Degradates in Drinking Water by Liquid Chromatography Electrospray Ionization Tandem Mass Spectrometry (LC/ESI-MS/MS)." October 2007. EPA 815-B-07-302. Available at <http://water.epa.gov/drink>.

- <sup>26</sup> EPA Method 523. "Determination of Triazine Pesticides and their Degradates in Drinking Water by Gas Chromatography/Mass Spectrometry (GC/MS)," February 2011. EPA 815-R-11-002. Available at <http://water.epa.gov/drink>.
- <sup>27</sup> EPA Method 1623.1. "Cryptosporidium and Giardia in Water by Filtration/IMS/FA," 2012. EPA-816-R-12-001. (Available at <http://water.epa.gov/drink>)
- <sup>28</sup> *Standard Methods for the Examination of Water and Wastewater*, 22nd edition (2012). Available from American Public Health Association, 800 I Street NW., Washington, DC 20001-3710.
- <sup>29</sup> EPA Method 524.4, Version 1.0. "Measurement of Purgeable Organic Compounds in Water by Gas Chromatography/Mass Spectrometry using Nitrogen Purge Gas," May 2013. EPA 815-R-13-002. Available at <http://water.epa.gov/drink>.
- <sup>30</sup> Charm Sciences Inc. "Fast Phage Test Procedure. Presence/Absence for Coliphage in Ground Water with Same Day Positive Prediction". Version 009. November 2012. 659 Andover Street, Lawrence, MA 01843. Available at [www.charmsciences.com](http://www.charmsciences.com).
- <sup>31</sup> EPA Method 523. "Determination of Triazine Pesticides and their Degradates in Drinking Water by Gas Chromatography/Mass Spectrometry (GC/MS)," February 2011. EPA 815-R-11-002. Available at <http://water.epa.gov/drink>.
- <sup>32</sup> EPA Method 1623.1. "Cryptosporidium and Giardia in Water by Filtration/IMS/FA," 2012. EPA-816-R-12-001. (Available at <http://water.epa.gov/drink>)
- <sup>33</sup> *Standard Methods for the Examination of Water and Wastewater*, 22nd edition (2012). Available from American Public Health Association, 800 I Street NW., Washington, DC 20001-3710.
- <sup>34</sup> EPA Method 524.4, Version 1.0. "Measurement of Purgeable Organic Compounds in Water by Gas Chromatography/Mass Spectrometry using Nitrogen Purge Gas," May 2013. EPA 815-R-13-002. Available at <http://water.epa.gov/drink>.
- <sup>35</sup> Charm Sciences Inc. "Fast Phage Test Procedure. Presence/Absence for Coliphage in Ground Water with Same Day Positive Prediction". Version 009. November 2012. 659 Andover Street, Lawrence, MA 01843. Available at [www.charmsciences.com](http://www.charmsciences.com).
- <sup>36</sup> Hach Company. "Hach Method 10260—Determination of Chlorinated Oxidants (Free and Total) in Water Using Disposable Planar Reagent-filled Cuvettes and Mesofluidic Channel Colorimetry," April 2013. 5600 Lindbergh Drive, P.O. Box 389, Loveland, CO 80539. (Available at <http://www.hach.com>).
- <sup>37</sup> ChloroX Plus. "Chlorine Dioxide and Chlorite in Drinking Water by Amperometry using Disposable Sensors," November 2013. Available from Palintest Ltd, Jamike Avenue (Suite 100), Erlanger, KY 41018.
- <sup>38</sup> Teclia EC/TC. "Presence/Absence Method for Simultaneous Detection of Total Coliforms and *Escherichia coli* (E. coli) in Drinking Water," April 2014. Available from Veolia Water Solutions and Technologies, Suite 4697, Biosciences Complex, 116 Barrie Street, Kingston, Ontario, Canada K7L 3N6.

[74 FR 38353, Aug. 3, 2009, as amended at 74 FR 57914, Nov. 10, 2009; 74 FR 63069, Dec. 2, 2009; 75 FR 32299, June 8, 2010; 76 FR 37018, June 24, 2011; 77 FR 38527, June 28, 2012; 78 FR 32565, May 31, 2013; 78 FR 37463, June 21, 2013; 79 FR 35086, June 19, 2014; 79 FR 36428, June 27, 2014]

NTU in at least 95 percent of the measurements taken each month, the State may substitute this higher turbidity limit for that system. However, in no case may the State approve a turbidity limit that allows more than 7 NTU in more than 5 percent of the samples taken each month, measured as specified in § 141.74 (a)(1) and (c)(1).

(2) The turbidity level of representative samples of a system's filtered water must at no time exceed 5 NTU, measured as specified in § 141.74 (a)(1) and (c)(1).

(3) Beginning January 1, 2002, systems serving at least 10,000 people must meet the turbidity requirements in § 141.173(c).

(4) Beginning January 1, 2005, systems serving fewer than 10,000 people must meet the turbidity requirements in §§ 141.550 through 141.553.

(b) *Slow sand filtration.* (1) For systems using slow sand filtration, the turbidity level of representative samples of a system's filtered water must be less than or equal to 1 NTU in at least 95 percent of the measurements taken each month, measured as specified in § 141.74 (a)(1) and (c)(1), except that if the State determines there is no significant interference with disinfection at a higher turbidity level, the State may substitute this higher turbidity limit for that system.

(2) The turbidity level of representative samples of a system's filtered water must at no time exceed 5 NTU, measured as specified in § 141.74 (a)(1) and (c)(1).

(c) *Diatomaceous earth filtration.* (1) For systems using diatomaceous earth filtration, the turbidity level of representative samples of a system's filtered water must be less than or equal to 1 NTU in at least 95 percent of the measurements taken each month, measured as specified in § 141.74 (a)(1) and (c)(1).

(2) The turbidity level of representative samples of a system's filtered water must at no time exceed 5 NTU, measured as specified in § 141.74 (a)(1) and (c)(1).

(d) *Other filtration technologies.* A public water system may use a filtration technology not listed in paragraphs (a) through (c) of this section if it demonstrates to the State, using pilot

plant studies or other means, that the alternative filtration technology, in combination with disinfection treatment that meets the requirements of § 141.72(a), consistently achieves 99.9 percent removal and/or inactivation of *Giardia lamblia* cysts and 99.99 percent removal and/or inactivation of viruses. For a system that makes this demonstration, the requirements of paragraph (b) of this section apply. Beginning January 1, 2002, systems serving at least 10,000 people must meet the requirements for other filtration technologies in § 141.173(b). Beginning January 14, 2005, systems serving fewer than 10,000 people must meet the requirements for other filtration technologies in § 141.550 through 141.553.

[54 FR 27527, June 29, 1989, as amended at 63 FR 69516, Dec. 16, 1998; 66 FR 3776, Jan. 16, 2001; 67 FR 1836, Jan. 14, 2002; 69 FR 23855, June 29, 2004]

**§ 141.74 Analytical and monitoring requirements.**

(a) *Analytical requirements.* Only the analytical method(s) specified in this paragraph, or otherwise approved by EPA, may be used to demonstrate compliance with §§ 141.71, 141.72 and 141.73. Measurements for pH, turbidity, temperature and residual disinfectant concentrations must be conducted by a person approved by the State. Measurement for total coliforms, fecal coliforms and HPC must be conducted by a laboratory certified by the State or EPA to do such analysis. Until laboratory certification criteria are developed for the analysis of fecal coliforms and HPC, any laboratory certified for total coliforms analysis by the State or EPA is deemed certified for fecal coliforms and HPC analysis. The following procedures shall be conducted in accordance with the publications listed in the following section. This incorporation by reference was approved by the Director of the Federal Register in accordance with 5 U.S.C. 552(a) and 1 CFR part 51. Copies of the methods published in *Standard Methods for the Examination of Water and Wastewater* may be obtained from the American Public Health Association et al., 1015 Fifteenth Street, NW., Washington, DC 20005; copies of the Minimal Medium ONPG-MUG Method as set forth in the

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article "National Field Evaluation of a Defined Substrate Method for the Simultaneous Enumeration of Total Coliforms and *Escherichia coli* from Drinking Water: Comparison with the Standard Multiple Tube Fermentation Method" (Edberg et al.), *Applied and Environmental Microbiology*, Volume 54, pp. 1595-1601, June 1988 (as amended under Erratum, *Applied and Environmental Microbiology*, Volume 54, p. 3197, December, 1988), may be obtained from the American Water Works Association Research Foundation, 6666 West Quincy Avenue, Denver, Colorado, 80235; and copies of the Indigo Method as set forth in the article "Determination of Ozone in Water by the Indigo Method" (Bader and Hoigne), may be obtained from Ozone Science & Engineering, Pergamon Press Ltd., Fairview Park, Elmsford, New York 10523. Copies may be inspected at the U.S. Environmental Protection Agency, Room EB15, 401 M St., SW., Washington, DC 20460 or at the National Archives and Records Administration (NARA). For information on the availability of this material at NARA, call 202-741-6030, or go to: [http://www.archives.gov/federal\\_register/code\\_of\\_federal\\_regulations/ibr\\_locations.html](http://www.archives.gov/federal_register/code_of_federal_regulations/ibr_locations.html).

(1) Public water systems must conduct analysis of pH and temperature in accordance with one of the methods listed at § 141.23(k)(1). Public water systems must conduct analysis of total coliforms, fecal coliforms, heterotrophic bacteria, and turbidity in accordance with one of the following analytical methods or one of the alternative methods listed in appendix A to subpart C of this part and by using analytical test procedures contained in *Technical Notes on Drinking Water Methods*, EPA-600/R-94-173, October 1994. This document is available from the National Service Center for Environmental Publications (NSCEP), P.O. Box 42419, Cincinnati, OH 45242-0419 or <http://www.epa.gov/nscep/>.

Organism	Methodology	Citation <sup>1</sup>
Total Coliform <sup>2</sup> .....	Total Coliform Fermentation Technique <sup>3-5</sup>	9221 A, B, C
	Total Coliform Membrane Filter Technique <sup>6</sup>	9222 A, B, C
	ONPG-MUG Test <sup>7</sup>	9223

Organism	Methodology	Citation <sup>1</sup>
Fecal Coliforms <sup>2</sup> ...	Fecal Coliform Procedure <sup>8</sup>	9221 E
	Fecal Coliform Filter Procedure.	9222 D
Heterotrophic bacteria <sup>2</sup> .	Pour Plate Method	9215 B
	SimPlate <sup>11</sup> .	
Turbidity <sup>13</sup> .....	Nephelometric Method.	2130 B
	Nephelometric Method.	180.1 <sup>9</sup>
	Great Lakes Instruments.	Method 2 <sup>10</sup>
	Hach FilterTrak ....	10133 <sup>12</sup>

The procedures shall be done in accordance with the documents listed below. The incorporation by reference of the following documents listed in footnotes 1, 6, 7 and 9-12 was approved by the Director of the Federal Register in accordance with 5 U.S.C. 552(a) and 1 CFR part 51. Copies of the documents may be obtained from the sources listed below. Information regarding obtaining these documents can be obtained from the Safe Drinking Water Hotline at 800-426-4791. Documents may be inspected at EPA's Drinking Water Docket, 1301 Constitution Avenue, NW., EPA West, Room B102, Washington DC 20460 (Telephone: 202-566-2426); or at the National Archives and Records Administration (NARA). For information on the availability of this material at NARA, call 202-741-6030, or go to: [http://www.archives.gov/federal\\_register/code\\_of\\_federal\\_regulations/ibr\\_locations.html](http://www.archives.gov/federal_register/code_of_federal_regulations/ibr_locations.html).

<sup>1</sup> Except where noted, all methods refer to *Standard Methods for the Examination of Water and Wastewater*, 18th edition (1992), 19th edition (1995), or 20th edition (1998), American Public Health Association, 1015 Fifteenth Street, NW., Washington, DC 20005. The cited methods published in any of these three editions may be used. In addition, the following online versions may also be used: 2130 B-01, 9215 B-00, 9221 A, B, C, E-99, 9222 A, B, C, D-97, and 9223 B-97. Standard Methods Online are available at <http://www.standardmethods.org>. The year in which each method was approved by the Standard Methods Committee is designated by the last two digits in the method number. The methods listed are the only Online versions that may be used.

<sup>2</sup> The time from sample collection to initiation of analysis may not exceed 8 hours. Systems must hold samples below 10 deg. C during transit.

<sup>3</sup> Lactose broth, as commercially available, may be used in lieu of lauryl tryptose broth, if the system conducts at least 25 parallel tests between this medium and lauryl tryptose broth using the water normally tested, and this comparison demonstrates that the false-positive rate and false-negative rate for total coliform, using lactose broth, is less than 10 percent.

<sup>4</sup> Media should cover inverted tubes at least one-half to two-thirds after the sample is added.

<sup>5</sup> No requirement exists to run the completed phase on 10 percent of all total coliform-positive confirmed tubes.

<sup>6</sup> M1 agar also may be used. Preparation and use of M1 agar is set forth in the article, "New medium for the simultaneous detection of total coliform and *Escherichia coli* in water" by Brenner, K.P., et al., 1993, *Appl. Environ. Microbiol.* 59:3534-3544. Also available from the Office of Water Resource Center (RC-4100T), 1200 Pennsylvania Avenue, NW., Washington DC 20460, EPA/600/J-99/225. Verification of colonies is not required.

<sup>7</sup> The ONPG-MUG Test is also known as the Autoanalysis Colilert System.

<sup>8</sup> A-1 broth may be held up to 7 days in a tightly closed screw cap tube at 4 °C.

<sup>9</sup> "Methods for the Determination of Inorganic Substances in Environmental Samples", EPA/600/R-93/100, August 1993. Available at NTIS, PB94-121811.

<sup>10</sup> GLI Method 2, "Turbidity," November 2, 1992, Great Lakes Instruments, Inc., 8855 North 55th Street, Milwaukee, WI 53223.

<sup>11</sup> A description of the SimPlate method, "IDEXX SimPlate TM HPC Test Method for Heterotrophs in Water," November 2000, can be obtained from IDEXX Laboratories, Inc., 1 IDEXX Drive, Westbrook, ME 04092, telephone (800) 321-0207.

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<sup>12</sup>A description of the Hach FilterTrak Method 10133, "Determination of Turbidity by Laser Nephelometry," January 2000, Revision 2.0, can be obtained from; Hach Co., P.O. Box 389, Loveland, CO 80539-0389, telephone: 800-227-4224.

<sup>13</sup>Styrene divinyl benzene beads (e.g., AMCO-AEPA-1 or equivalent) and stabilized formazin (e.g., Hach StablCal™ or equivalent) are acceptable substitutes for formazin.

(2) Public water systems must measure residual disinfectant concentrations with one of the analytical methods in the following table or one of the alternative methods listed in appendix A to subpart C of this part. If approved by the State, residual disinfectant concentrations for free chlorine and combined chlorine also may be measured by using DPD colorimetric test kits. In addition States may approve the use of the ITS free chlorine test strip for the

determination of free chlorine. Use of the test strips is described in Method D99-003, "Free Chlorine Species (HOCl<sup>-</sup> and OCl<sup>-</sup>) by Test Strip," Revision 3.0, November 21, 2003, available from Industrial Test Systems, Inc., 1875 Langston St., Rock Hill, SC 29730. Free and total chlorine residuals may be measured continuously by adapting a specified chlorine residual method for use with a continuous monitoring instrument provided the chemistry, accuracy, and precision remain the same. Instruments used for continuous monitoring must be calibrated with a grab sample measurement at least every five days, or with a protocol approved by the State.

Residual	Methodology	SM <sup>1</sup>	SM Online <sup>2</sup>	Other
Free Chlorine	Amperometric Titration	4500-CI D	4500-CI D-00	D1253-03 <sup>3</sup>
	DPD Ferrous Titrimetric	4500-CI F	4500-CI F-00	
	DPD Colorimetric	4500-CI G	4500-CI G-00	
	Syringaldazine (FACTS)	4500-CI H	4500-CI H-00	
Total Chlorine	Amperometric Titration	4500-CI D	4500-CI D-00	D1253-03 <sup>3</sup>
	Amperometric Titration (low level measurement)	4500-CI E	4500-CI E-00	
	DPD Ferrous Titrimetric	4500-CI F	4500-CI F-00	
	DPD Colorimetric	4500-CI G	4500-CI G-00	
Chlorine Dioxide	Iodometric Electrode	4500-CI I	4500-CI I-00	
	Amperometric Titration	4500-ClO <sub>2</sub> C	4500-ClO <sub>2</sub> C-00	
	DPD Method	4500-ClO <sub>2</sub> D		
	Amperometric Titration	4500-ClO <sub>2</sub> E	4500-ClO <sub>2</sub> E-00	
Ozone	Spectrophotometric			327.0, Revision 1.1 <sup>4</sup>
	Indigo Method	4500-O <sub>3</sub> B	4500-O <sub>3</sub> B-97	

<sup>1</sup> All the listed methods are contained in the 18th, 19th, and 20th editions of *Standard Methods for the Examination of Water and Wastewater*, 1992, 1995, and 1998; the cited methods published in any of these three editions may be used.  
<sup>2</sup> Standard Methods Online are available at <http://www.standardmethods.org>. The year in which each method was approved by the Standard Methods Committee is designated by the last two digits in the method number. The methods listed are the only Online versions that may be used.  
<sup>3</sup> *Annual Book of ASTM Standards*, Vol. 11.01, 2004; ASTM International; any year containing the cited version of the method may be used. Copies of this method may be obtained from ASTM International, 100 Barr Harbor Drive, P.O. Box C700 West Conshohocken, PA, 19428-2959.  
<sup>4</sup> EPA Method 327.0, Revision 1.1, "Determination of Chlorine Dioxide and Chlorite Ion in Drinking Water Using Lissamine Green B and Horseradish Peroxidase with Detection by Visible Spectrophotometry," USEPA, May 2005, EPA 815-R-05-008. Available online at <http://www.epa.gov/safewater/methods/sourcecall.html>.



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(b) *Monitoring requirements for systems that do not provide filtration.* A public water system that uses a surface water source and does not provide filtration treatment must begin monitoring, as specified in this paragraph (b), beginning December 31, 1990, unless the State has determined that filtration is required in writing pursuant to §1412(b)(7)(C)(iii), in which case the State may specify alternative monitoring requirements, as appropriate, until filtration is in place. A public water system that uses a ground water source under the direct influence of surface water and does not provide filtration treatment must begin monitoring as specified in this paragraph (b) beginning December 31, 1990, or 6 months after the State determines that the ground water source is under the direct influence of surface water, whichever is later, unless the State has determined that filtration is required in writing pursuant to §1412(b)(7)(C)(iii), in which case the State may specify alternative monitoring requirements, as appropriate, until filtration is in place.

(1) Fecal coliform or total coliform density measurements as required by §141.71(a)(1) must be performed on representative source water samples immediately prior to the first or only point of disinfectant application. The system must sample for fecal or total coliforms at the following minimum frequency each week the system serves water to the public:

System size (persons served)	Samples/week <sup>1</sup>
≤500 .....	1
501 to 3,300 .....	2
3,301 to 10,000 .....	3
10,001 to 25,000 .....	4
>25,000 .....	5

<sup>1</sup> Must be taken on separate days.

Also, one fecal or total coliform density measurement must be made every day the system serves water to the public and the turbidity of the source water exceeds 1 NTU (these samples count towards the weekly coliform sampling requirement) unless the State determines that the system, for logistical reasons outside the system's control, cannot have the sample analyzed within 30 hours of collection.

(2) Turbidity measurements as required by §141.71(a)(2) must be performed on representative grab samples of source water immediately prior to the first or only point of disinfectant application every four hours (or more frequently) that the system serves water to the public. A public water system may substitute continuous turbidity monitoring for grab sample monitoring if it validates the continuous measurement for accuracy on a regular basis using a protocol approved by the State.

(3) The total inactivation ratio for each day that the system is in operation must be determined based on the CT<sub>99.9</sub> values in tables 1.1-1.6, 2.1, and 3.1 of this section, as appropriate. The parameters necessary to determine the total inactivation ratio must be monitored as follows:

(i) The temperature of the disinfected water must be measured at least once per day at each residual disinfectant concentration sampling point.

(ii) If the system uses chlorine, the pH of the disinfected water must be measured at least once per day at each chlorine residual disinfectant concentration sampling point.

(iii) The disinfectant contact time(s) ("T") must be determined for each day during peak hourly flow.

(iv) The residual disinfectant concentration(s) ("C") of the water before or at the first customer must be measured each day during peak hourly flow.

(v) If a system uses a disinfectant other than chlorine, the system may demonstrate to the State, through the use of a State-approved protocol for on-site disinfection challenge studies or other information satisfactory to the State, that CT<sub>99.9</sub> values other than those specified in tables 2.1 and 3.1 in this section other operational parameters are adequate to demonstrate that the system is achieving the minimum inactivation rates required by §141.72(a)(1).

TABLE 1.1—CT VALUES (CT<sub>99.9</sub>) FOR 99.9 PERCENT INACTIVATION OF GIARDIA LAMBLIA CYSTS BY FREE CHLORINE AT 0.5 °C OR LOWER<sup>1</sup>

Residual (mg/l)	pH						
	≤6.0	6.5	7.0	7.5	8.0	8.5	≤9.0
≤0.4 ...	137	163	195	237	277	329	390
0.6 .....	141	168	200	239	286	342	407
0.8 .....	145	172	205	246	295	354	422
1.0 .....	148	176	210	253	304	365	437
1.2 .....	152	180	215	259	313	376	451
1.4 .....	155	184	221	266	321	387	464
1.6 .....	157	189	226	273	329	397	477
1.8 .....	162	193	231	279	338	407	489
2.0 .....	165	197	236	286	346	417	500
2.2 .....	169	201	242	297	353	426	511
2.4 .....	172	205	247	298	361	435	522
2.6 .....	175	209	252	304	368	444	533
2.8 .....	178	213	257	310	375	452	543
3.0 .....	181	217	261	316	382	460	552

<sup>1</sup> These CT values achieve greater than a 99.99 percent inactivation of viruses. CT values between the indicated pH values may be determined by linear interpolation. CT values between the indicated temperatures of different tables may be determined by linear interpolation. If no interpolation is used, use the CT<sub>99.9</sub> value at the lower temperature and at the higher pH.

TABLE 1.2—CT VALUES (CT<sub>99.9</sub>) FOR 99.9 PERCENT INACTIVATION OF GIARDIA LAMBLIA CYSTS BY FREE CHLORINE AT 5.0 °C<sup>1</sup>

Free residual (mg/l)	pH						
	≤6.0	6.5	7.0	7.5	8.0	8.5	≤9.0
≤0.4 ...	97	117	139	166	198	236	279
0.6 ..	100	120	143	171	204	244	291
0.8 ..	103	122	146	175	210	252	301
1.0 ..	105	125	149	179	216	260	312
1.2 ..	107	127	152	183	221	267	320
1.4 ..	109	130	155	187	227	274	329
1.6 ..	111	132	158	192	232	281	337
1.8 ..	114	135	162	196	238	287	345
2.0 ..	116	138	165	200	243	294	353
2.2 ..	118	140	169	204	248	300	361
2.4 ..	120	143	172	209	253	306	368
2.6 ..	122	146	175	213	258	312	375
2.8 ..	124	148	178	217	263	318	382
3.0 ..	126	151	182	221	268	324	389

<sup>1</sup> These CT values achieve greater than a 99.99 percent inactivation of viruses. CT values between the indicated pH values may be determined by linear interpolation. CT values between the indicated temperatures of different tables may be determined by linear interpolation. If no interpolation is used, use the CT<sub>99.9</sub> value at the lower temperature, and at the higher pH.

TABLE 1.3—CT VALUES (CT<sub>99.9</sub>) FOR 99.9 PERCENT INACTIVATION OF GIARDIA LAMBLIA CYSTS BY FREE CHLORINE AT 10.0 °C<sup>1</sup>

Free residual (mg/l)	pH						
	≤6.0	6.5	7.0	7.5	8.0	8.5	≤9.0
≤0.4 ...	73	88	104	125	149	177	209
0.6 .....	75	90	107	128	153	183	218
0.8 .....	78	92	110	131	158	189	226
1.0 .....	79	94	112	134	162	195	234

TABLE 1.3—CT VALUES (CT<sub>99.9</sub>) FOR 99.9 PERCENT INACTIVATION OF GIARDIA LAMBLIA CYSTS BY FREE CHLORINE AT 10.0 °C<sup>1</sup>—Continued

Free residual (mg/l)	pH						
	≤6.0	6.5	7.0	7.5	8.0	8.5	≤9.0
1.2 ..	80	95	114	137	166	200	240
1.4 ..	82	98	116	140	170	206	247
1.6 ..	83	99	119	144	174	211	253
1.8 ..	86	101	122	147	179	215	259
2.0 ..	87	104	124	150	182	221	265
2.2 ..	89	105	127	153	186	225	271
2.4 ..	90	107	129	157	190	230	276
2.6 ..	92	110	131	160	194	234	281
2.8 ..	93	111	134	163	197	239	287
3.0 ..	95	113	137	166	201	243	292

<sup>1</sup> These CT values achieve greater than a 99.99 percent inactivation of viruses. CT values between the indicated pH values may be determined by linear interpolation. CT values between the indicated temperatures of different tables may be determined by linear interpolation. If no interpolation is used, use the CT<sub>99.9</sub> value at the lower temperature, and at the higher pH.

TABLE 1.4—CT VALUES (CT<sub>99.9</sub>) FOR 99.9 PERCENT INACTIVATION OF GIARDIA LAMBLIA CYSTS BY FREE CHLORINE AT 15.0 °C<sup>1</sup>

Free residual (mg/l)	pH						
	≤6.0	6.5	7.0	7.5	8.0	8.5	≤9.0
≤0.4 ...	49	59	70	83	99	118	140
0.6 ..	50	60	72	86	102	122	146
0.8 ..	52	61	73	88	105	126	151
1.0 ..	53	63	75	90	108	130	156
1.2 ..	54	64	76	92	111	134	160
1.4 ..	55	65	78	94	114	137	165
1.6 ..	56	66	79	96	116	141	169
1.8 ..	57	68	81	98	119	144	173
2.0 ..	58	69	83	100	122	147	177
2.2 ..	59	70	85	102	124	150	181
2.4 ..	60	72	86	105	127	153	184
2.6 ..	61	73	88	107	129	156	188
2.8 ..	62	74	89	109	132	159	191
3.0 ..	63	76	91	111	134	162	195

<sup>1</sup> These CT values achieve greater than a 99.99 percent inactivation of viruses. CT values between the indicated pH values may be determined by linear interpolation. CT values between the indicated temperatures of different tables may be determined by linear interpolation. If no interpolation is used, use the CT<sub>99.9</sub> value at the lower temperature, and at the higher pH.

TABLE 1.5—CT VALUES (CT<sub>99.9</sub>) FOR 99.9 PERCENT INACTIVATION OF GIARDIA LAMBLIA CYSTS BY FREE CHLORINE AT 20 °C<sup>1</sup>

Free residual (mg/l)	pH						
	≤6.0	6.5	7.0	7.5	8.0	8.5	≤9.0
≤0.4 ...	36	44	52	62	74	89	105
0.6 .....	38	45	54	64	77	92	109
0.8 .....	39	46	55	66	79	95	113
1.0 .....	39	47	56	67	81	98	117
1.2 .....	40	48	57	69	83	100	120
1.4 .....	41	49	58	70	85	103	123
1.6 .....	42	50	59	72	87	105	126