

National Field Manual for the Collection of Water-Quality Data

Comments and Errata: Revision History from 1999 through July 2005

Chapter 1

Date Posted/ Section/Page	Change From	Change To
05/10/05, Chapter A1 dated 1/2005	Chapter A1 dated 9/98, with minor revisions	Chapter A1 has been changed to Version 2.0 (January 2005) to incorporate small updates and correct Web links.
11/08/04, Chapter A1 dated 9/98, page 14	Update chapter to reflect the closure of the Ocala Water Quality and Research Laboratory	The supplies listed are available from the USGS "One-Stop Shopping."
4/14/03- - <i>Internal</i> USGS Only	A pilot project to establish electronic ASR forms is being coordinated jointly by OWQ and NWQL	The e-ASR has been tested and is now available for use. For more information, click on NWQL Rapi-Note 03-007 at http://wwwnwql.cr.usgs.gov/USGS/rapi-note.html
11/29/02--REF-2		Add reference for Miller, James, ed., 2002, Ground water atlas of the United States, http://capp.water.usgs.gov/gwa/index.html

Chapter 2

Date Posted/ Section/Page	Change From	Change To
11/16/04, Pages 19, 100 (table 2-15) and CF-3	Update Chapter 2, Version 2.0, 3/2003, to reflect the closure of the Ocala Water Quality and Research Laboratory.	Delete references to the Ocala laboratory. Supplies are available through the USGS "One-Stop Shopping."
8/20/03	Update Chapter 2 to reflect current equipment information.	Chapter 2, Version 2.0, 3/2003, has been posted at: water.usgs.gov/owq/FieldManual/Chapter2/Ch2_contents.html . This update is available only in electronic format.
3/6/01 -- Ch. 2, 8/98, p. 79, Table 2-13, 6th row	- Nitric acid/potassium dichromate ampoule	- 6 N ultrapure HCl vial (for Hg samples)
10/27/00 -- 2.2.1.A Churn Splitter - pages 46-47	- To prevent leakage of the spigot, silicone sealant is injected inside the push-button mechanism.	<p>- To remove the spring and retrofit the spigot:</p> <ol style="list-style-type: none"> 1. Cut a 7/8-in. section of 6424-03 Master Flex tubing. (The precision of this length is very important; use a sharp utility knife or instrument that will cut a straight edge. If the edge is jagged, water leakage past the button can occur and potentially contaminate the sample.) 2. Pop the button off of the spigot, using a small-blade screwdriver. 3. Remove the spring, any silicone caulking, rubber O ring, and nylon sleeve from the spigot. 4. Slide the tubing over the sleeve on the inside of the button. 5. Slide the tubing that is now attached to the button over the stopper shaft, and compress the tubing until the button locks into place.
9/13/00--DOC/SOC.	<p>COMMENT: A major revision is being prepared for Sections 2.2.3.C, p. 65-66, and 2.4, p. 78, regarding equipment for collection of</p>	<p>COMMENT: An explanation and description of the changes can be found in a USGS technical memorandum at http://water.usgs.gov/admin/memo/QW/</p>

	DOC and SOC samples. Note that these changes do not reflect a correction of information, but were necessitated because of the decreasing availability of silver filters, which has led to the development and testing of new or different equipment and analytical methods.	qw00.08.html. The attachment linked to this memorandum details the new procedures.
6/28/99 -- p. 10	See "Field Manual Review...": http://water.usgs.gov/lookup/get?viewpubs	http://water.usgs.gov/lookup/get?newpubs
6/28/99 -- p. 50	Under "Advantages of the cone splitter," the first bullet states: "Used to process samples with suspended-sediment concentrations from 1,000 to 10,000 mg/L."	Change wording to read: "Used to process samples with suspended-sediment concentrations from 0 to 10,000 mg/L."

Chapter 3

Date Posted/ Section/Page	Change From	Change To
05/27/05, pg. 62, Step 5	Step 5. Rinse with blank water followed by a methanol rinse.	Step 5. Rinse with methanol followed by a blank water rinse.
10/14/04 (Version 2.0)	The version 1.2 file was in need of reformatting and updating.	Chapter 3, Version 2.0, 4/2004, has been posted at: water.usgs.gov/owq/FieldManual/chapter3/Ch3_contents.html . This update is available only in electronic format.
2/23/04 -- 3.3.4.A, "Disposable capsule		Starting 2/23/2004, a low-capacity (19.6 cm ²) disposable filter-- the "Aquaprep" TM --will be available for USGS use through the One-Stop Shopping program ('Q460FLD--Filter,

<p>filter cleaning procedure"</p>		<p>Aquaprep™, 0.45 micrometer'). This filtration device is acceptable only for filtration of small-volume water samples at sites where the amount of suspended material is sufficiently low so that the filter will not clog during the sample-filtering process. These special conditions for use must be adhered to strictly. To prepare the 19.6 cm²-Aquaprep™ for field use, follow the same procedures as for the 600-cm² disposable Aquaprep™ capsule filter, but use 100 mL (instead of 1,000 mL) of quality-controlled DIW to rinse the interior of the unit.</p>
<p>3/26/03 (Version 1.2)-- This is an update to the entry below dated 2/12/03</p> <p>3.2, pg. 16 (fig. 3-1) and 3.3.9, pg. 49, second para., and pg. 51, fig. 3-5</p>	<p>Page 16, Figure 3-1: The EXPLANATION for methanol includes the sentence: However, this protocol is under review. Delete this sentence.</p> <p>Page 49: The first sentence of the second paragraph reads: The rinse with methanol, or other organic solvent, is under review and appropriate only for samplers being used to collect samples for organic-compound analysis.</p> <p>Page 51, Figure 3-5: Footnote 2 includes the sentence: Methanol rinse procedure is under review. Delete this sentence.</p>	<p>Page 16, Figure 3.1: The EXPLANATION for methanol reads: Current protocol includes methanol rinse except for equipment used to sample for organic-carbon analyses. SAFETY ALERT: Methanol is highly flammable; fumes can be hazardous to human health.</p> <p>Page 49: Delete from the sentence the words "under review and." The sentence reads: The rinse with methanol, or other organic solvent, is appropriate only for samplers being used to collect samples for organic-compound analysis.</p> <p>Page 51, Figure 3-5: Footnote 2 reads: Samples collected for organic-compound analysis. When sampling for total, dissolved, or suspended organic carbon, do not methanol rinse; complete cleaning by rinsing with organic-grade water.</p>
<p>2/12/03 (Version 1.1)-- 3.2.2, pg. 25 (fig. 3-4) and pg. 29 (footnote 2); 3.3.9.B, pg. 51 (fig. 3-5)</p>	<p>The NAWQA Program has requested deleting any statement throughout Chapter 3 to the effect that the methanol rinse step is being reviewed. The reason for this change is that the original NFM version has been misconstrued by some users to indicate that the methanol rinse is</p>	<p>All statements to the effect that the methanol rinse step is under review should be deleted.</p> <p>On page 25, fig. 3-4, footnote 2, change "Methanol rinse procedure is under review." to "Omit when cleaning equipment used to sample for organic carbon analyses."</p>

	an optional part of the equipment decontamination protocol that is in place, rather than being the standard protocol.	<p>On page 29, the last sentence in footnote 2, "This protocol is under review." should be deleted.</p> <p>On page 51, fig. 3-5, footnote 2, The sentence "Methanol rinse procedure is under review." should be deleted.</p>
11/08/01 -- 3.2.1; 3.2.2; 3.3.3; 3.3.4.B; 3.3.5; 3.3.8; 3.3.9	A suggestion has been made to change the current acid-wash requirements as follows: The acid-wash step in the equipment cleaning procedures should not be mandatory if sampling only for nutrients and/or major ions and iron and and manganese.	<p>This comment was reviewed and it was decided that the current protocol stands. Please note that the NFM provides the following guidance for instances in which the standard procedures are not used:</p> <ul style="list-style-type: none"> - Additional QC samples must be collected and analyzed to document the efficacy of the procedure used. In this case, an inorganic equipment or field blank would need to be collected before collecting samples for the inorganic constituents of interest. - The nonstandard method used, how it deviates from standard procedures and the QC data collected need to be documented in a report along with the constituent data it represents. The method must not be cited or otherwise portrayed as USGS policy. <p>Also note that individual studies that are part of a program must take pains to ensure Program approval of any modifications and ensure that the change will not affect data consistency and comparability.</p>

Chapter 4 (9/99)

Date Posted/ Section/Page	Change From	Change To
5/16/05	Review and revisions are needed.	Review and revisions are in progress. Completion is expected by 7/30/05.

11/08/04 -- p. CF-5, App. A4-B, and App.A4-C table 1	Update chapter to reflect the closure of the Ocala Water Quality and Research Laboratory	Delete reference to the Ocala laboratory. Supplies are available from the USGS "One-Stop Shopping."
5/2/03 -- NFM 4.2.1, Step 3, page 78	Additional guidance is needed to properly rinse out the sample line during the purge and before samples are collected.	<p>Insert as first sentence for Step 3b: "Discharge initial well water through the waste line that goes to the flowthrough chamber."</p> <p>Insert as first sentence for Step 3c: "When the water runs clear, switch the flow to the sample line (line that goes to the collection chamber) and allow at least two tubing volumes to pass through so as to rinse and condition the sample line with well water. Then. . ." (continue into next sentence, changing the B in Begin to lower case).</p>
5/2/03 -- NFM 4.2.2, Step 3d, page 86	Additional guidance is needed to properly rinse out the sample line during the purge and before samples are collected.	Add a fourth bullet: "While purging the first two well volumes, and before starting field measurements, once the well water is running clear, switch the flow from the "waste" line to the sample line, to ensure that the sample line is thoroughly rinsed of methanol and other equipment-cleaning agents."
11/29/02--REF-2		<p>Add reference for Izbicki, John, Christensen, Allen, and Hanson, Randy, 1999, U.S. Geological Survey combined well-bore flow and depth-dependent water sampler, U.S. Geological Survey Fact Sheet 196-99, 2 p., at http://ca.water.usgs.gov/archive/reports/fs19699.pdf</p> <p>Add reference for Miller, James, ed., 2002, Ground water atlas of the United States, http://capp.water.usgs.gov/gwa/index.html</p>
4/4/01 -- p. 69 of NFM A4	Third bullet, second to last sentence: "... (2) field measurements must be monitored before collecting samples."	"...(2) field-measurement values should be determined before collecting samples, if possible."

3/17/01	COMMENT: Sampling procedures for ground water and for specific analytes are described in NFM Chapter A5.	
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Chapter 5

Date Posted/ Section/Page	Change From	Change To
5/16/05	Chapter needs to be updated and compiled to include new sections.	Update is in process. Expected completion: 8/30/05
1/2005 -- 5.6.4.A	<p>Update references to McCleskey and others (in press)</p> <p>Last dashed item on page 2 reads "aniome" species is present</p> <p>Fourth dashed item on page 3 reads "major-ion concentration"</p> <p>Figure 5-5, second and third dashed items</p>	<p>McCleskey and others was published in Applied Science in 2004.</p> <p>Change to "arsenic" species is present</p> <p>Change to "major-cation concentration"</p> <p>Revise text to read "- SPE Cartridge Conditioning for samples with pH greater than or equal to 4" and "- SPE Cartridge Conditioning for samples with pH less than 4."</p>
11/19/04 -- 5.6.4.A, tables 5-9 and 5-10	Last column: "Supplier and One Stop Shopping item number for USGS studies"	"Supplier" column includes correction of One-Stop stock numbers or change to "Open Market."
11/19/04 -- 5.6.1.F p. 5	- Contact the National Water Quality Laboratory before collecting any samples for antibiotics that will be analyzed using this laboratory's methods.	Delete this sentence.

<p>11/04/04 -- p. 17 and App-B-1. p. REF-4</p>	<p>Reference to nitric acid/potassium dichromate (HNO₃/K₂Cr₂O₇) Reference to qw92.11</p>	<p>Change to HCl, 6N, 2 mL ultrapure Memo qw92.11 is out of date. Delete reference.</p>
<p>9/30/04 -- 5.4.2, Chemical Treatment, p. 93, step 5.c.</p>	<p>Correct the preservation order and update text to reflect current chemical treatments</p>	<p>Correct preservation order and preservatives as follows: 1. Nutrients (4.5 N H₂SO₄) 2. Organic carbon (4.5 N H₂SO₄) 3. Trace elements (HNO₃) 4. Major ions (HNO₃) 5. Mercury (6 N HCL) 6. Others that require acidifying (HCL first) 7. Samples requiring other preservatives (zinc acetate, sodium hydroxide, etc.)</p>
<p>9/28/04 -- 5.1.1, Composites and Subsamples</p>	<p>p. 23, last sentence in 1st paragraph: Inorganic-constituent samples usually are composited in the churn splitter, and organic-compound samples commonly either are composited in a 20-L glass, fluorocarbon polymer, or metal container, or are processed through a cone splitter.</p> <p>p. 26, Technical Note, first sentence: Subsamples totaling 10 L and 5 L can be withdrawn from the 14-L and 10-L churn,</p>	<p>p. 23 replacement sentence: Inorganic-constituent samples usually are composited in the plastic or fluoropolymer churn splitter; organic-compound samples commonly are composited in a fluoropolymer churn splitter or metal container, or are processed through a fluorocarbon polymer cone splitter.</p> <p>p. 26 replacement: Subsamples totaling 10 L and 5 L can be withdrawn from the 14-L and 8-L churn,....</p>
<p>4/14/04 -- 5.6.1.C, Phenols</p>	<p>Label 1-L baked amber glass phenol bottle as "LC0052."</p> <ol style="list-style-type: none"> 1. Fill the bottle with raw sample directly from the sampling or splitting device. 2. Leave a small headspace in the bottle. 3. Add 2 mL of 8.5 percent H₃PO₄ to a 1- 	<p>Label two 500-L baked amber glass phenol bottles as "LC2322" (see NWQL Technical Memorandum 99.03).</p> <ol style="list-style-type: none"> 1. Fill two 500-mL baked amber glass bottles with raw sample directly from the sampling or splitting device. 2. Leave a small headspace in the bottle. 3. Add 1 mL H₂SO₄ to the sample to achieve pH <2. If

	<p>L sample to achieve pH 4, and 10 mL of CuSO₄ to a 1-L sample (100 g/L).</p> <p>4. Chill and maintain at or below 4 degrees C without freezing.</p>	<p>chlorine is suspected in the sample water, add 0.5 mL of a 100 g/L (or 1 mL of a 50 g/L) FeSO₄ solution.</p> <p>4. Chill and maintain at or below 4 degrees C without freezing.</p>
2/24/04	<p>To correct an inconsistency with the persistent URL for Chapter 5 (pubs.water.usgs.gov/twri9A5/) the URL for the index page for version 2 of chapter 5 dated 4/02 has been changed. The URL was water.usgs.gov/owq/FieldManual/chapter5_V2/html/Ch5_contents.html</p> <p>The index page for the archived, original version of chapter 5 has been changed. The URL was water.usgs.gov/owq/FieldManual/Archive/chapter5_V1/html/Ch5_contents.html</p>	<p>The URL for NFM 5, version 2, which the persistent URL goes to, is now water.usgs.gov/owq/FieldManual/chapter5/html/Ch5_contents.html</p> <p>The URL for the original NFM 5 is now water.usgs.gov/owq/FieldManual/Chapter5-Archive/html/Ch5_contents.html</p>
2/23/04 -- 5.2.2, "Filtration"		<p>Starting 2/23/2004, a low-capacity (19.6 cm²) disposable filter-- the "Aquaprep"TM--will be available for USGS use through the One-Stop Shopping program ('Q460FLD--Filter, AquaprepTM, 0.45 micrometer'). This filtration device only is acceptable for filtration of small-volume water samples at sites at which the amount of suspended material is sufficiently low so that the filter will not clog during the sample-filtering process. These special conditions for use must be adhered to strictly. To prepare the 19.6 cm²-AquaprepTM for field use, follow the same procedures as for the 600-cm² disposable AquaprepTM capsule filter, but use 100 mL (instead of 1,000 mL) of quality-controlled DIW to rinse the interior of the unit.</p>

<p>1/5/04 -- 5.6.1.E, Oil and Grease</p>	<p>COMMENT -- The procedure for adding acid to adjust sample pH to 2 or less should provide guidance as to how to determine the volume of acid needed for a given sample.</p>	<p>ACTION -- The next version of section 5.6.1.E will be revised by adding the following technical note under Step 3: TECHNICAL NOTE: To establish the volume of H₂SO₄ required, collect a separate aliquot of sample and adjust the pH of this aliquot by adding the acid until pH indicator paper verifies that the pH has been lowered to or less than 2. This aliquot is for testing purposes only and is not to be used for oil and grease analysis. Add the volume of acid determined to the sample to be analyzed. Do not dip pH paper, a pH electrode, a stirring rod, or other materials into a sample that will be used for Hexane Extractable Materials or Silica Gel Treated - Hexane Extractable Materials determination.</p>
<p>1/2/04 -- 5.6.2, page 108</p>	<p>COMMENT: Instructions given are for samples collected for routine mercury analysis. Add instructions on how to sample for lower concentration levels, using methods developed by Krabbenhoft.</p>	<p>RESPONSE: An updated section for collection and processing of samples for mercury analysis using Krabbenhoft's methods is in development and is expected to be released during FY 2004.</p>
<p>1/2/04 -- 5.0.1, 5.0.3, 5.6.2</p>	<p>COMMENT: IBW should be used instead of DIW for rinsing bottles used for mercury and other trace-element samples if the DIW is not of known quality and could contaminate the sample.</p>	<p>NFM 5.0.1 -- RESPONSE: (page 16, 2nd arrow, 2nd dash), add "inorganic-grade blank water (IBW) or" before the words "deionized water (DIW)" and after "(DIW)" add "of appropriate quality." Same section, page 18: second dash, add "IBW or" before each occurrence of "DIW." NFM 5.0.3 -- RESPONSE: (page 21), first sentence, before the word "DIW" add "IBW or"; Table 5-2, add "IBW, inorganic-grade blank water" to headnote. Changes to both bullets -- add "IBW or" before "DIW" in all places and delete footnote 1. NFM 5.6.2 -- RESPONSE: (page 107), after first sentence add: "Use IBW instead of DIW for the pre-field bottle rinse/fill if the composition of the DIW could contain target</p>

		<p>analytes at detectable concentrations for the analysis to be performed on the environmental samples. (DIW could have measureable concentrations of trace elements, for example, if the ion-exchange column is nearing its exchange capacity or is defective; DIW should be analyzed periodically to determine that the system is operating as intended).</p> <p>Alternatively, if the pre-field bottle rinse/fill procedure is not being used, the sample bottle should be rinsed in the field twice with IBW, followed by a field rinse with sample (wholewater for wholewater samples, filtrate for filtered samples) before filling the bottle (NFM 5.0.3). The DIW/IBW rinse of bottles for samples being collected for wholewater analysis can be substituted by field rinsing with sample a minimum of three times before filling the bottle."</p>
6/20/03 -- 5.6.4.A, Arsenic Speciation		<p><i>USGS Internal</i> -- A new section for Chapter 5, 5.6.4.A, "Arsenic Speciation," has received Director's approval and is available to USGS personnel pending final preparation. The approved section is available from the NFM contents Web page water.usgs.gov/owq/FieldManual</p>
5/21/03 -- 5.6.3.K, Chlorofluorocarbons, p. 122-125.	<p>A new method for collecting CFC age dating samples has been developed that eliminates the need for flame sealing of the samples for most sampling applications. Add the description of the new method to all appropriate references in Chapter 5, including section 5.6.3.K. (Chapter 5 is in the process of being revised and new instructions will be incorporated.)</p>	<p>A new method for collecting CFC age dating samples has been developed that eliminates the need for flame sealing of the samples for most sampling applications. The new method is similar to the method for collecting dissolved gas samples. Bottles with special caps are filled and capped under water. Check for information at the webpage water.usgs.gov/lab/cfc/ under "New Sampling Method for CFCs." The new method simplifies sample collection greatly. If long-term archival of samples is desired, the original flame sealing technique can still be applied.</p>
4/11/03	<p>Chapter 5 needs to be updated and sections added for wastewater,</p>	<p>Updates are scheduled for completion by 9/2003. A new section on Wastewater, Pharmaceutical, and Antibiotic</p>

	pharmaceutical, and antibiotic compounds and for arsenic speciation.	Compounds (5.6.1.F) has been approved and is posted on the Chapter 5 contents page at water.usgs.gov/owq/FieldManual/chapter5_V2/html/Ch5_contents.html
11/29/02 -- REF-1		Add reference to Izbicki, John, Christensen, Allen, and Hanson, Randy, 1999, U.S. Geological Survey combined well-bore flow and depth-dependent water sampler, U.S. Geological Survey Fact Sheet 196-99, 2 p., at ca.water.usgs.gov/archive/reports/fs19699.pdf
7/23/02 -- New version of chapter online	Chapter 5 dated 5/99 has been replaced online with Chapter 5, Version 2, dated 4/02.	Version 2 incorporates the changes noted in the errata entries below for section 5.2.2.C, 5.6.1.D (11/26/01), and 5.6.2.B (7/23/02). The 5/99 version of 5.2.2.C has been moved to the end of the document as Appendix A5-D. The original files for Chapter 5 are archived at http://water.usgs.gov/owq/FieldManual/Archive/chapter5_V1/html/Ch5_contents.html
7/23/02 -- 5.6.2.B, Nutrients (Nitrogen and Phosphorus)		First paragraph, add Tech Memo 2000.08 to references and add the following sentence: See 5.6.1.D and 5.2.2.C for processing of a Total Particulate Nitrogen (TPN) sample, LC2607. Add to the second bullet for #1: A clean, graduated cylinder may be used when the volume of sample to be filtered is less than 64 mL.
2/19/02 -- Organic carbon	COMMENT: The revision of Section 5.2.2.C on organic carbon has been approved and is being prepared in HTML and PDF formats. A provisional pdf version is available at http://water.usgs.gov/owq/FieldManual/chapter5/pdf/5_2_2_c.pdf	

11/26/01 -- Organic carbon	<p>COMMENT: A major revision has been drafted for Sections 5.2.2.C, p. 61-74, and 5.6.1.D, p. 106, on procedures for processing samples for analysis of dissolved and suspended organic carbon. Note that these changes do not reflect a correction of information, but were necessitated because of the decreasing availability of silver filters, which has led to the development and testing of new or different equipment and analytical methods.</p>	<p>COMMENT: Replace all the information related to DOC and SOC in sections 5.2.2.C, p. 61-74 and 5.6.1.D, p. 106, with the information in the revision to 5.2.2.C that has been colleague reviewed and is being prepared for Director's approval. Address any comments or suggestions to fwilde@usgs.gov.</p>
3/17/01 -- CFC sampling, p. 123-128 of NFM A5	<p>COMMENT: CFC sampling -- SF₆ sampling methods and information can be found at http://water.usgs.gov/lab/cfc/sampling/sf6.html. This information should be used in conjunction with the instructions for CFC sampling on p. 123-128 of NFM A5, for samples to be analyzed by the USGS CFC Laboratory.</p>	n/a
3/17/01 -- Dissolved gases sampling (in ground water).	<p>Comment: Sampling procedures for collection of methane and other dissolved gases in ground water can be found at http://water.usgs.gov/lab/dissolved-gas/ and in "Baedecker, M.J., and Cozzarelli, I.M., 1992, The determination and fate of unstable constituents of contaminated groundwater, <i>in</i> Lesage, Suzanne, and Jackson, R.E., eds., 1992, Groundwater contamination and analysis at hazardous waste sites: New York, Marcel Dekkar, Inc., p. 425-461." The method to be</p>	<p>n/a Suggestion: Collection and processing methods for commonly sampled gases should be added to NFM Chapter A5</p>

	selected depends on study objectives, site conditions, and the analyzing laboratory.	
3/15/01 -- 5.4.2, 1st paragraph, p. 91. Change to take place as of 4/1/2001	The most frequently used chemical preservatives...contain one of the following: nitric acid (HNO ₃), hydrochloric acid (HCl), sulfuric acid (H ₂ SO ₄), nitric acid/potassium dichromate (HNO ₃ /K ₂ Cr ₂ O ₇), sodium hydroxide (NaOH), or phosphoric acid/copper sulfate (H ₃ PO ₄ /CuSO ₄).	The most frequently used chemical preservatives...contain one of the following: ultrapure nitric acid (HNO ₃), hydrochloric acid (HCl), sulfuric acid (H ₂ SO ₄), sodium hydroxide (NaOH), or phosphoric acid/copper sulfate (H ₃ PO ₄ /CuSO ₄). [delete nitric acid/potassium dichromate] <i>February 2002: Original text has been modified.</i>
3/15/01 -- 2nd bullet, p. 92. Change to take place as of 4/1/2001	Refer to OWQ Technical Memorandum 92.11 on the return of spent HNO ₃ /K ₂ Cr ₂ O ₇ ampoules to the laboratory.	Delete this sentence. <i>February 2002: Original text has been modified.</i>
3/15/01 -- 5.c.ii, p. 93. Change to take place as of 4/1/2001	Mercury sample(s): Add contents of the HNO ₃ /K ₂ Cr ₂ O ₇ ampoule to the sample(s) designated RAM or FAM (Appendix A5-B). Place the spent ampoule into the HNO ₃ /K ₂ Cr ₂ O ₇ ampoule waste container.	Mercury sample(s): Add contents of the vial containing 2 mL of 6N ultrapure HCl to the sample(s) designated RAM or FAM (Appendix A5-B). Place the spent ampoule into the HCl vial waste container. <i>February 2002: Original text has been modified.</i>
3/15/01 -- 5.6.2.A, 2nd bullet under no. 3, p. 108	Mercury: Add contents of ampoule containing 10 mL of HNO ₃ /K ₂ Cr ₂ O ₇ .	Mercury: Add contents of vial containing 2 mL of 6N ultrapure hydrochloric acid (HCl).

and p. 109. Change to take place as of 4/1/2001		<i>February 2002: Original text has been modified.</i>
11/8/00 -- Appendix A5-A, p. APP-A-1, column 1, Phenols	In second column, change "1-L baked amber glass bottle." In fourth column, replace current entry.	Replace entry with "500-mL baked glass bottle." Replace entry as follows: Fill bottle to shoulder. Add 1 mL concentrated sulfuric acid to adjust to pH <2. If chlorine is suspected in the sample, add 100 mg ferrous sulfate. Mix, chill, and maintain at 4 degrees C. <i>February 2002: Original text has been modified.</i>
11/8/00 -- Appendix A5-A, p. APP-A-2, column 1, MBAS	In second column, change "500-mL polyethylene bottle."	Replace entry with "250-mL polyethylene bottle." <i>February 2002: Original text has been modified.</i>
11/8/00 -- Appendix A5-A, p. APP-A-2, column 1, Oil and grease	In third column, change "LC0127"	Replace entry with "GCC (LC2125)" <i>February 2002: Original text has been modified.</i>
11/8/00 -- Appendix A5-A, p. APP-A-2, column 1, Append to table a listing for "Total petroleum hydrocarbons"	Add an entry for total petroleum hydrocarbons to the table	Add to the first column "Total petroleum hydrocarbons." Repeat in the second and fourth columns the information in those columns for "Oil and grease"; the third column should read "GCC (LC2126)." <i>February 2002: Original text has been modified.</i>
11/8/00 -- Appendix A5-A, p. APP-A-2, column 1, Append to table a listing for "Ultraviolet-absorbing substances"	Comment: An entry for ultraviolet absorbing substances will be added to the table in the future.	Comment: Bottle type and other instructions are in development. Contact Ron Brenton/NWQL (rbrenton@usgs.gov, 303-236-3210) for update.

10/27/00 -- 5.3 Solid-Phase Extraction by C-18 Column - pages 77-82	A COMMENT has been made to update the C-18 SPE method, method 2011, and change the reference to Sandstrom and others (2000). Add to Fig. 5-2 a line for "Extraction Date". Add a line to Fig. 5-3 about the addition of NaCl to the sample in the sample field form for 2051.	NO CHANGE AT THIS TIME. ANALYSIS: Users are alerted to this information and that these changes will be made in a future version but, at this time, have been assigned a noncritical status.
10/19/00 -- Appendix A5-A, page APP-A-1	In fourth row, last column, change "Filtered sample (0.7-um GF/F), untreated. Chill/maintain at 4 degrees C."	Replace with "Raw, untreated sample. Chill/maintain at 4 degrees C."

Chapter 6

Date Posted/ Section/Page	Change From	Change To
September 10, 2012 Section 6.6	Update Section 6.6, version 3 and replace it with the new version. The new version replaces the "simple speciation method" for calculating carbonate species with the "advanced speciation method."	Section 6.6, version 3, has been replaced with Section 6.6, version 4.0. Version 4.0 provides guidelines and establishes policy for USGS projects, implementing use of the "advanced speciation method" as the standard method for calculation of carbonate and bicarbonate species. The simple speciation method has been discontinued. Explanation of this method and policy change is given in Technical Memorandum qw12.05 (see http://water.usgs.gov/admin/memo/QW/).
5/16/05 -- Sections 6.2, 6.3, 6.4, 6.5	Updates are being made to listed sections, and references will be included with each section rather than being grouped in the back of the chapter.	6.2 Dissolved Oxygen (major rewrite) 6.3 Specific Electrical Conductance (minor updates) 6.4 pH (minor updates) 6.5 Redox (minor updates)
2/2/05 -- Section 6.7 - "Turbidity" (version 2.0, 8/2004)	Selected references (see "Change To" column) to NTU should be updated to include NTRU.	p. 36, section 1b, 3rd line: Insert "or NTRU" after "in NTU" p. 38, section 1, first bullet, 2nd line down: Insert "or NTRU"

		<p>after "and NTU"</p> <p>p. 41, section 6e, first bullet: Insert "or NTRU" after "use NTU".</p>																																
<p>1/31/05 -- Section 6.7 - "Turbidity." On Web page water.usgs.gov/owq/FieldManual/Chapter6/6.7_contents.html, go to the link for "Turbidity parameter codes and methods codes" (Excel spreadsheet)</p>	<p>For the Orion AQ4500 turbidity meter (Thermo Electron Corporation), the correct reporting unit and NWIS pcode for white-light source are NTRU (63676). Delete NTU 63675 codes. Also, add the AU 63678 and FAU 63683 codes.</p>	<p>The changes for the Orion AQ4500 listed below will be entered with the next update of the Excel spreadsheet as follows:</p> <table border="1"> <thead> <tr> <th>Instrument:</th> <th>Orion AQ4500</th> <th>Method</th> <th></th> </tr> <tr> <th>NWIS Pcode</th> <th>Rep.</th> <th></th> <th>Source</th> </tr> <tr> <th>Unit</th> <th>Description/</th> <th></th> <th></th> </tr> </thead> <tbody> <tr> <td>63676</td> <td>NTRU</td> <td>EPA 180</td> <td></td> </tr> <tr> <td>63680</td> <td>FNU</td> <td>ISO-NEPH</td> <td></td> </tr> <tr> <td>63683</td> <td>FAU</td> <td>ISO-ABSB and IR%T</td> <td></td> </tr> <tr> <td>63681</td> <td>FNRU</td> <td>IR RATIO</td> <td></td> </tr> <tr> <td>63678</td> <td>AU</td> <td>WHITE %T</td> <td></td> </tr> </tbody> </table>	Instrument:	Orion AQ4500	Method		NWIS Pcode	Rep.		Source	Unit	Description/			63676	NTRU	EPA 180		63680	FNU	ISO-NEPH		63683	FAU	ISO-ABSB and IR%T		63681	FNRU	IR RATIO		63678	AU	WHITE %T	
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<p>11/18/04 -- Section 6.6.7 - "Reporting"</p>	<p>Sentence in first paragraph: "Titration values from unfiltered samples are to be entered and published as ANC (the current NWIS parameter code dictionary uses the outdated term "alkalinity, unfiltered" instead of ANC)."</p>	<p>Delete the comment in parentheses, as this is no longer the case.</p>																																
<p>11/18/04 -- Section 6.6.5.A - "Alkalinity or ANC"</p>	<p>Sentence after the equation: "By default, the correction factor CF is equal to 1.0. Hach Company has determined that some digital titrator cartridges cause slightly larger volumes of acid to be delivered than are indicated."</p>	<p>The correction factor CF is equal to 1.01 as determined by the NWQL, resulting from a bias caused by the configuration of Hach digital titrator cartridges.</p>																																
<p>11/18/04 -- Sections 6.0.1, 6.5.1, 6.6.1, 6.6.5.A, Conversion Factors and</p>	<p>Update chapter to reflect the closure of the Ocala Water Quality and Research Laboratory.</p>	<p>Delete references to Ocala. Supplies are available through the USGS One-Stop Shopping or through commercial vendors of scientific products.</p>																																

Selected Terms, and References		
8/11/04 -- Section 6.7, "Turbidity"	Add a section or explanation on how to use calibration constants to troubleshoot and quality assure turbidity calibrations.	<p>This suggestion is likely to be incorporated into the next update of section 6.7. An example of use of calibration constants for quality assurance of the turbidity determination follows:</p> <p>The submersible probes manufactured by YSI (models 6026 and 6136) have a desired operating range for their constants (see the YSI 6-series manual); these can be quite valuable in determining the validity of a calibration. For example, a discrepancy was found in some calibrations when going from an old bottle of Formazin to a new one (from the same manufacturer). Technical support at YSI suggested checking the constants, and the resulting data showed significant improvement in the constant when a new bottle of standard was used. Also, data showing deterioration of the constant after instrument calibration indicates that there may be a problem with the instrument sensor or with the particular bottle of standard used. Constants also can be used to determine how carefully field personnel mix standards. For the YSI units, the constants can be easily retrieved using a display unit or they can be downloaded as a printable historic record/file using their Ecowatch software (usually provided free with the purchase of a sonde unit). Assuming that one keeps good notes and careful track of their standards, monitoring the constants could potentially save time and money when trying to clear up confusion or subtle problems that might arise with successive calibrations.</p>
<i>Internal USGS</i> 6/22/04 -- Section 6.7,		The revised turbidity protocol (6/2004) contains a major change in the way USGS will report and store turbidity data. We will use reporting units, including 8 that are new and one that, although previously established, has

<p>version 2 (Director-approved, in preparation)</p>		<p>been used mostly in Europe before now. These new reporting units, with corresponding new pcodes, will provide traceability to the instrument design that was used to make the measurement. For example, the use of "NTU" as a reporting unit will be restricted to instruments with a single 90-degree detector and white light source as specified in EPA Method 180.1 (a drinking water method). The new parameter codes and reporting units are detailed in Table 6.7-4 of the revised protocol. The genesis and much of the background material for this revision is described in Circular 1250 (http://water.usgs.gov/pubs/circ/2003/circ1250/).</p> <p>In accordance with the attempt to increase consistency among measurements with the same reporting unit, and to provide traceability to the specific instrument model used for the measurement, USGS will also document the instrument model in NWIS through the use of new method codes - there will be a unique method code that corresponds to each individual instrument. Each reporting unit also has one method code for "other, or undefined" instruments. The new method codes and their matching instruments are provided in Table A-1 in the revised protocol.</p> <p>The changes outlined above and in the protocol are likely to cause some confusion and a number of questions. To anticipate the questions and provide guidance, an OWQ Tech Memo is in preparation, a cyberseminar (or two) is being planned for later this water year, in addition to a FAQ. There is also a spreadsheet being maintained with up-to-date modifications to the equipment list, and new method codes as they can be assigned.</p> <p>The new protocol is being revised slightly as follows: a couple of the new method codes are being switched to help ensure consistent designation of the "other, undefined" codes across all new pcodes. The method codes in question are not to be populated until the change has been completed and announced; these method codes correspond to (A) "other, undefined" instruments in any of the new parameter codes, and (B) the Orebeco Hellige 966IR turbidimeter. The parameter codes and method codes may be populated for other instruments.</p>
<p>4/8/04 -- Section 6.1, Table 6.1-1, first item</p>	<p>Calibration thermometer, liquid-in-glass sensor, certified by National Institute of Standards and Technology (NIST):</p>	<p>Calibration thermometer, liquid-in-glass or electronic-thermistor thermometer, either National Institute of Standards and Technology (NIST) certified or manufacturer-certified as NIST traceable. Must carry certificate of NIST traceability;</p>

	Temperature range at least -5 to +45 degrees C; 0.1 degrees C graduated	use not allowed after expiration of certification: Temperature range at least -5 to +45 degrees C; 0.1 degrees C graduations (liquid-in-glass) or less
4/8/04 -- Section 6.1, Table 6.1-1, second item	Thermometer, liquid-in-glass sensor: temperature range -5 to +45 degrees C; Minimum 0.5 degrees C graduated; Calibrated accuracy within 1 percent of full scale or 0.5 degrees C, whichever is less; Calibrated and District certified against calibration (NIST) thermometer	Thermometer, liquid-in-glass sensor, non-mercury for field use: temperature range -5 to +45 degrees C; Minimum 0.5 degrees C graduated; Calibrated accuracy within 1 percent of full scale or 0.5 degrees C, whichever is less; Calibrated and District certified against a properly certified thermometer (see column to the left).
4/8/04 -- Section 6.1, next page (p. 5)	For the arrow for the Liquid-in-glass thermometer	After the first sentence add new sentence: Thermometers for field use must not be mercury-filled.
4/8/04 -- Section 6.1.2, Calibration	The third arrow under "Minimum calibration requirements" says, "The standard thermometer against which all other thermometers are calibrated must be certified by the National Institute of Standards and Technology (NIST). It must be accurate to 0.1 degrees C."	Revise to read: The standard thermometer against which all other thermometers are calibrated must be either NIST certified or NIST traceable, and carry a certificate of NIST certification or traceability from the manufacturer. The calibration thermometer may only be used within the period for which it was certified as NIST traceable; once certification has expired, the calibration thermometer either must be replaced or sent to an accredited laboratory for recertification. These protocols apply to electronic thermistor thermometers as well as to liquid-in-glass thermometers. The calibration thermometer must be accurate to at least 0.1 degrees C.
4/8/04 -- Section 6.1.2, page 9	Second to the last paragraph should read as per the column to the right.	Corrections can be applied to measurements made with a thermometer that is within +/- 1 percent of full scale or +/- 0.5 degrees C of the calibration thermometer. Corrections should be applied by using a calibration curve or table, which is plotted in the log book for the instrument. thermistors found to be out of calibration by more than 0.2 degrees C must be recalibrated per manufacturer's instructions or returned to the manufacturer for proper calibration and (or) repairs.

4/8/04 -- Section 6.1.3.C	Item number 3 reads: "Allow the thermometer sensor to equilibrate with the well water for 5 minutes;..."	Change item number "3" to read "no less than 60 seconds"
1/2/04 -- 6.6.4, page 22	QUESTION/COMMENT: Page 22 states that "pH >8.1 is used to determine the carbonate equivalence point using the IPT method." Our office has traditionally used a pH >8.3 when determining contributing carbonate species concentrations. A question has come up as to which is correct, especially as it relates to using PCFF.	ANSWER: The guidance was lowered to pH 8.1 from the standard 8.3 to ensure that the maximum amount of information is gained from the titration. Not all carbonate equivalence points land at a pH of 8.3; some land at higher and some at lower pH. If your sample has a high enough pH to contain information around the carbonate equivalence point, then it is important to titrate slowly as you approach and pass that point, so that you do not miss the carbonate information when the actual equivalence point is nearer to 8.1 or 8.2. The same reasoning should be followed when determining the bicarbonate equivalence point. Moreover, previous knowledge of sample alkalinity at the field site should be taken into account; for example, if it is known that the sample has a very low alkalinity (and a low inorganic carbon concentration) where the bicarbonate equivalence point commonly occurs at pH 5.0, then the incremental titration procedure should be slowed down at a pH of 5.5 or 6.0, rather than at the 5.0 guidance value given in the NFM.
12/29/03 -- References	The list of "Publications on Techniques of Water-Resources Investigations" contained outdated information.	"Publications on Techniques of Water-Resources Investigations" now links to http://pubs.water.usgs.gov/twri/ .
10/19/00 -- Appendix A5-A, page APP-A-1	In fourth row, last column, change "Filtered sample (0.7-um GF/F), untreated. Chill/maintain at 4 degrees C."	Replace with "Raw, untreated sample. Chill/maintain at 4 degrees C."
10/27/03 -- References		The following references are added to the references for section 6.6: Gran, G., 1952, Determination of the equivalence point in

		<p>potentiometric titrations: <i>Analyst</i>, v. 77, n. 920, p. 661-671.</p> <p>Pankow, J.F., 1991, <i>Aquatic Chemistry Concepts</i>: Chelsea, Michigan, Lewis Publishers, 673 p.</p> <p>Parkhurst, D.L., and Appelo, C.A.J., 1999, <i>User's guide to PHREEQC (version 2)</i>-- A computer program for speciation, batch-reaction, one-dimensional transport, and inverse geochemical calculations: U.S. Geological Survey Water-Resources Investigations Report 99-4259, 312 p.</p>
9/11/03 -- Acknowledgments		<p>The following names were added to the list of colleague reviewers near the end of the Web page water.usgs.gov/owq/FieldManual/Chapter6/abstract.html</p> <p>R.E. Broshears J.V. Davis F.A. Rinella G.F. Ritz</p>
9/03/03-- Conversion Factors section, pg. CF-3, "Selected Terms and Symbols"	The abbreviation and definition for micromoles per liter should be changed from "micromoles per liter ($\mu\text{moles/L}$): A solution having a concentration of one million moles of a substance per liter solution (micromolar solution)."	The correction is: "micromoles per liter ($\mu\text{mol/L}$): A solution having a concentration of one millionth of a mole of a substance per liter solution (micromolar solution)."
8/28/03-- Section 6.4.1	Second paragraph begins: "Measurement of pH can be either electrometric or colorimetric."	Delete this sentence.
8/18/03-- Sections 6.0 and 6.4	Errata: correct the method for computing a mean pH.	Corrections have been made in section 6.0.2 and in 6.4 to the method for computing a mean pH.
3/7/02 -- Conversion Factors, pg. CF-1	Multiply milligram (mg) by 35.27×10^{-5} to obtain ounce, avoirdupois	Multiply milligram (mg) by 3.527×10^{-5} to obtain ounce, avoirdupois

<p>4/19/02--Table 6.6-2 in subsection 6.6.4.A</p>	<p>The first-column heading for table 6.6-2 in the html file reads "ANC or alkalinity (meg/L)"</p> <p>In column 4, row 2 reads "1.6N"</p> <p>This change is needed only in the HTML version.</p>	<p>The following changes were made on 4/19/2002:</p> <p>Milliequivalents per liter is the correct term: "ANC or alkalinity (meq/L)"</p> <p>The titrant normality for a sample with alkalinity/ANC in the range of 50 to 200 mg/L as CaCO₃ is 0.1600</p>
<p>3/7/02 -- Conversion Factors, pg. CF-1</p>	<p>Multiply milligram (mg) by 35.27×10^{-5} to obtain ounce, avoirdupois</p>	<p>Multiply milligram (mg) by 3.527×10^{-5} to obtain ounce, avoirdupois</p>
<p>12/5/01 -- Section 6.6, Alkalinity and ANC</p>	<p>COMMENT: This section needs to be revised.</p>	<p>See http://water.usgs.gov/owq/FieldManual/Chapter6/section6.6/ for the latest revision (Version 9/2001) of Section 6.6.</p>
<p>10/11/01--Section 6.6, Alkalinity and ANC, subsection 6.6.4.A, Digital titrator</p>	<p>COMMENT on the effect of delivery accuracy for the HACH digital titrator: According to the HACH Company, titrant additions are accurate to +/- 1 unit per each 100 unit addition, or 1 percent per each 100. If there is a 1 percent error per hundred, then there is the statistical chance of having a 100 percent error in each single unit (count) addition. In this case, if executing titrations in the critical areas adding single counts, then, statistically, there is a chance of adding zero, one, or two counts, even though the titrator has been turned to indicate only one count. If the volumetric increment is too small (and therefore has a higher relative error), then the resulting calculation of the first derivative will</p>	<p>ACTION: When using the Hach digital titrator, deliver titrant in increments of no less than three units (digital counts).</p>

	reflect that increased error. Too many points with too small a volumetric addition results in increased noise in the data and can result in problems identifying the endpoint. This being unacceptable, the NFM guidance stipulates that there should be no addition smaller than three counts indicated on the titrator display.	
7/17/01 -- Sections 6.6.1 and 6.6.4.A (Digital titrator)	ALERT: HACH Company 1.6N sulfuric acid cartridges, lot numbers 7143, 8149, 8275, 8352, 0070, 0098, 0231, 0350 and A1096 and 0.16N sulfuric acid cartridges, lot numbers A1075 and A1131 have experienced a manufacturing problem.	CORRECTION: When determining alkalinity using any of these lot numbers, multiply the determined mg/L CaCO ₃ by 1.013 to obtain a final value. DO NOT APPLY THE CORRECTION FACTOR TO OTHER HACH CARTRIDGE LOTS! OWQRL will continue to quality assure each lot they distribute to USGS personnel.
6/01/01 -- Section 6.1, page T-9, second to last paragraph	Corrections can be applied to measurements made with a thermistor instrument system if necessary, using a calibration curve or table plotted in the log book. Thermometers found to be out of calibration by more than 0.2 degrees C must be recalibrated per manufacturer's instructions or returned to the manufacturer for proper calibration and (or) repairs.	Corrections can be applied to measurements made with a thermometer found to be within +/-1 percent of full scale or +/-0.5 degrees C of the NIST-certified thermometer. Corrections should be applied by using a calibration curve or table plotted in the log book. Thermistors found to be out of calibration by more than 0.2 degrees C must be recalibrated per manufacturer's instructions or returned to the manufacturer for proper calibration and (or) repairs.
1/18/00 -- Section 6.0.2.A, p. 12 - EDI, "When making field measurements," step 2	"...for pH, it is necessary to calculate the mean from the logarithm of each measurement and then convert the answer back to the antilogarithm..."	"...for pH it is necessary to calculate the mean by (1) converting each pH measurement to its antilogarithm times minus one ($10^{-(pH)}$), (2) using these transformed values to calculate the mean, and (3) converting the mean value to a logarithm multiplied by minus one.."

1/18/00 -- Section 6.0.2.A, p. 15 - EWI, "When making field measurements," step 2	"...for pH, calculate the mean from the logarithm of each measurement and then convert the answer back to the antilogarithm..."	"for pH it is necessary to calculate the mean by (1) converting each pH measurement to its antilogarithm times minus one ($10^{-(pH)}$), (2) using these transformed values to calculate the mean, and (3) converting the mean value to a logarithm multiplied by minus one..."
1/18/00 -- Section 6.4.3.A, p. 19, "To compute a mean pH for the stream:"	"(1) Sum the products of each subsection area, using the logarithm of the median pH determined for each subsection;...(3) convert back to pH by taking the antilogarithm of the quotient."	"(1) Sum the products of each subsection area, using the negative antilogarithm of the median pH determined for each subsection;...(3) express the mean value in terms of pH by converting it to a logarithm multiplied by minus one."
1/18/00 -- Section 6.4.3, p. 20, "In situ measurement," step 7	"Note that pH values must be converted to a logarithm before calculating a mean value."	"Note that pH values must be converted to their negative antilogarithm before calculating a mean value; to express the mean value in terms of pH, convert it back to a logarithm multiplied by minus one."
11/19/99 -- Conversion Factors, page CF-1	cubic meter per second (cm^3/s)	cubic meter per second (m^3/s)
11/19/99 -- Definition of micromoles per liter: Conversion Factors, page CF-3	A solution having a concentration of one million moles of a substance per liter solution (micromolar solution). A mole of substance is its atomic or molecular weight in grams.	A solution having a concentration of one millionth of a mole of a substance per liter solution (micromolar solution). A mole of substance is its atomic or molecular weight in grams.

Chapter 7

Date Posted/ Section/Page	Change From	Change To
11/30/04 Section 7.1	Version 1.1, dated 9/2004:	Version 1.2, dated 11/2004

	<p>Supplies are no longer available due to the closure of the Ocala Water Quality and Research Laboratory.</p> <p>Table 7.1-2. Item: Buffered water. Description: Specific to the test method and prepared in advance of field work.</p> <p>Table 7.1-5. The "Buffered water type" is phosphate-buffered water with peptone.</p>	<p>Supplies are available from One-Stop Shopping or a commercial vendor.</p> <p>Table 7.1-2. Item: Buffered water. Update "Description" to read: Sterile phosphate-buffered water with MgCl₂.</p> <p>Table 7.1-5. The "Buffered water type" column is updated. MgCl₂ replaces peptone and phosphate-buffered water is deleted in most rows.</p>
<p>9/28/04 p. FIB-55, FIB-56, Steps 3.d. and 3.e.</p>	<p>Replace current text for Steps 3.d. and 3.e.</p>	<p>Step 3.d.: If the plates will be poured right away: allow the medium to cool to 45-50 deg. C. Add 0.5 mL of freshly prepared Cefsulodin solution to each dilution bottle of tempered agar medium. The final pH should be 6.95 +/- 0.2. Proceed to step (e). If the plates will NOT be poured right away: store the medium in the dilution bottles, under refrigeration (at approximately 5 deg. C) for up to 6 months. When ready to prepare the petri dishes, melt the medium by autoclaving the MI-medium-containing dilution bottles (as needed) for 5 minutes at 121 deg. C or by placing them into a boiling water bath. Be sure to loosen the screw tops on the bottles before they are heated to allow air to escape. Cool the medium to 45-50 deg. C. Add 0.5 mL of freshly prepared Cefsulodin solution to each dilution bottle of tempered agar medium. The final pH should be 6.95 +/- 0.2. Proceed to step (e).</p> <p>Step 3.e.: Pour 6 to 7 mL of the medium into each 50-mm petri dish.</p>
<p>3/04</p>	<p>Second Edition</p>	<p>The third edition of Chapter 7, dated 11/2003, replaces the second edition dated 3/2003. Section 7.3, Protozoan Pathogens,</p>

		has been added to the third edition. Web address: water.usgs.gov/owq/FieldManual/Chapter7/index.html
9/9/03		The second edition of Chapter 7, dated 3/2003, replaced the edition dated 9/99 on the Web page water.usgs.gov/owq/FieldManual/Chapter7/index.html
4/11/03		The new edition of Chapter 7 has been approved and is in preparation for posting on the NFM Web site.
2/5/03 -- For NFM 7.1 (7/17/97), page 36, no. 4e.	change "(0.22mm)"	Text should read "(0.22 microns)"
1/10/03		Preparation of a new edition of Chapter 7 is near completion. Section 7.1 on fecal indicator bacteria has been updated to include MI tests for <i>E. coli</i> and total coliforms and the mCP test for <i>Clostridium perfringens</i> . A new section, 7.2, on fecal indicator viruses (coliphages) has been added. The original section 7.2 on BOD has been renumbered as section 7.0.
3/7/02 -- Conversion Factors, section 7.1, page CF-1	Multiply milligram (mg) by 35.27×10^{-5} to obtain ounce, avoirdupois	Multiply milligram (mg) by 3.527×10^{-5} to obtain ounce, avoirdupois
3/9/01		The information following the entries for chapter 7 is an addendum to the current version (7/97) of Chapter 7.1. This is a summary of methods used for analysis of indicator bacteria, current as of February 23, 2001. *Methods that have been added since Chapter 7.1 was published are asterisked. The number in brackets at the end of each entry is the parameter code used in the USGS NWIS database as of March 1, 2001. Scroll to the bottom of the Chapter 7 entries for details.
10/27/00 -- 7.1.3.C Membrane Filtration	A COMMENT has been made that "Analysis of domestic ground-water sources for bacteria can produce randomly	NO CHANGE AT THIS TIME. COMMENT is being analyzed, as well as the suggestion that

Procedure - pages FIB 20-22	quantized results if sample sizes are limited to 100 mL as a result of the statistics of non-ideal plate counts. For some studies, larger volumes could be informative. Results could be stored in NWIS using the least-significant-digit-plus-one convention, with normal tables presented to a precision of 1 col/100 mL, but analysis possible at greater precision."	footnote 1 of Table 7.1.6 be extended to include: "Sample volumes in excess of 100 mL may be useful in some projects."
10/27/00 -- 7.1.4 Calculation and Reporting - pages FIB 30-33	A COMMENT has been made that "...some analysts interpret case on page FIB-33 as requiring a computation of $5(+1)100/(10+3)=50$ col/100 mL..."	NO CHANGE AT THIS TIME. COMMENT is being analyzed, as well as recommendation to (1) add text to page FIB-30 before the examples: "Computations are based on all plates that count within the ideal range, if any do. If any plates contain typical colonies, but none are in the ideal range, computations are based on all counted plates. Finally, if no plates could be counted (either zero or TNTC), the assumed values are used in the calculations;" (2) on page FIB-31, change caption to read: "Case 2: Colony counts are less than or greater than the ideal range. Do not use plates that are zero or TNTC (too numerous to count)"; (3) add the following to the Case 2 example on FIB-31: "Vol 1 mL, count 0 (do not use);" (4) on page FIB-33, delete Case 4 and renumber Case 5 and Case 4."

TOTAL COLIFORM:

- **Total coliform, mENDO MF method, water, colonies/100 ml** - This is the membrane filter, mENDO agar method (Britton and Greeson, 1987, p. 13-16) [31501]
- ***Total coliform, Colilert Quantitray method, water, mpn/100 ml** - Idexx Laboratories, Westbrook, Maine [50569]
- ***Total coliform, MI MF method, water, colonies/100 ml** - This is the MI agar method and allows the simultaneous enumeration of total coliforms and *Escherichia coli* (U.S. Environmental Protection Agency, 2000a). It is recommended for use in analyzing ground-water samples. [90900]

FECAL COLIFORM:

- **Fecal coliform, mFC MF method, water, colonies/100 ml** - Britton and Greeson, 1987, p. 37-40. [31625].
- ***Fecal coliform, mFC MF method, sediment/bed material, colonies/gm (dry weight)** - [50469]

ESCHERICHIA COLI (*E. COLI*):

- ***E. coli*, mTEC MF method, water, colonies/100 ml** - This is the mTEC agar method (U.S. Environmental Protection Agency, 1986 and 2000b) for water and is widely used for monitoring recreational and ambient surface waters. [31633]
- ***E. coli*, NA-MUG MF medium, water, colonies/100 ml** - This is the NA-MUG method for water (U.S. Environmental Protection Agency, 1991), to be used as a secondary incubation with mENDO medium for total coliform. This method is recommended for use in analyzing ground-water samples. [50278]
- ****E. coli*, mTEC MF method, sediment/bed material, colonies/gm (dry weight)** - [50466]
- ****E. coli*, Colilert Quantitray method, sediment/bed material, mpn/gm (dry weight)** - [50467]
- ****E. coli*, Colilert Quantitray method, water, mpn/100 ml** - [50468]
- ****E. coli*, MI MF agar, water, colonies/100 ml** - U.S. Environmental Protection Agency, 2000a [90901]
- ****E. coli*, modified mTEC MF method, water, colonies/100 ml** - This is the modified mTEC method for water (U.S. Environmental Protection Agency, 2000b) and is a one-step alternative to the standard mTEC method for monitoring recreational and ambient surface waters. [90902]

FECAL STREPTOCOCCI:

- **Fecal Streptococci, KF streptococcus MF method, water, colonies/100 ml** - Britton and Greeson, 1987, p. 47-50. [31673]

ENTEROCOCCI: (Either method for enterococci may be used with equal preference.)

- **Enterococci, mE MF method, water, colonies/100 ml** - This is a 48-hour, two-step test for enterococci using the mE agar method (U.S. Environmental Protection Agency, 1986). [31649]

- **Enterococci, mEI MF method, water, colonies/100 ml** - This is the 24-hour, one-step test for enterococci using mEI agar (U.S. Environmental Protection Agency, 1997 and 2000b). [90909]

CLOSTRIDIUM PERFRINGENS:

- ***Clostridium perfringens, mCP MF method, water, colonies/100 ml** - The mCP agar method (U.S. Environmental Protection Agency, 1996) is done in the laboratory. [90915]

REFERENCES:

U.S. Environmental Protection Agency, 1996, EPA Information Collection Rule microbial laboratory manual: Washington, D.C., EPA/600/R-95/178, section XI.

U.S. Environmental Protection Agency, 1997, Method 1600--Membrane filter test method for enterococci in water: Washington, D.C., EPA/821/R-97/004, May 1997.

U.S. Environmental Protection Agency, 2000a, Membrane filter method for the simultaneous detection of total coliforms and *Escherichia coli* in drinking water: Cincinnati, Ohio, EPA 600-R-00-013, 20 p.

U.S. Environmental Protection Agency, 2000b, Improved enumeration methods for the recreational water quality indicators: Enterococci and *Escherichia coli*: Washington, D.C., EPA/821/R-97/004, March 2000.

Additional information on methods for collecting and analyzing water and sediment samples for microbiology can be found at <https://www.usgs.gov/centers/oki-water/science/ohio-microbiology-program-analytical-services>.

Chapter 8

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11/16/04, p. 21, 25, 39, CF-1	Update chapter to reflect the closure of the Ocala Water Quality and Research Laboratory and other minor changes.	Delete references to the Ocala Laboratory. Supplies are available through USGS "One-Stop Shopping." Version 1.1 (6/2005) of Chap. 8 was posted on 07/12/05.
10/09/02	A question has been asked about sampling and sample processing equipment described in Chap. 8 (Bottom-Material Samples) of the National Field Manual. Several times (e.g., p. 16) the statement is made that equipment contacting samples for analysis of inorganic analytes must be non-metallic. However, nearly all the grab samplers described for bottom sediments (table 8-2) are made of stainless steel (at best), including the Ekman sampler. Is a stainless steel sampler really not acceptable for bottom sediments intended for analysis of total or extractable metals?	The following statement is being prepared for incorporation into Chapter 8: Use of stainless steel is appropriate for collecting sediment samples to be analyzed for inorganic constituents, provided that the sample-contacting portion of the sampling device is not scratched or otherwise marred or damaged so as to release metallic substances for which the sample is being analyzed.

Chapter 9

Comment: For the latest comprehensive safety policy on streamgaging, see USGS Water Resources Division (WRD) Memorandum 99.32, SAFETY--WRD Policy for Safety Associated with Discharge Measurements, Sampling, and Related Streamgaging Activities. The memo is available at: <http://water.usgs.gov/admin/memo/>. Click on "WRD Policy and Safety", scroll down the page and click on "wrdpolicy99.32.html". This memo not only provides policy, but it also is meant to improve safety awareness. Emphasizing safety in the workplace does reduce the chance of serious injury and benefits everyone.

Notice: The U.S. Geological Survey Safety Manager has issued a safety alert recommending that the use of the Mustang Ocean Commander Immersion Suit be immediately discontinued. This alert has been posted on the Bureau Safety Management Office Safety Web site. The URL address for Bureau safety alerts is: <http://www.usgs.gov:8888/ops/safetynet/smoalert.html>.

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10/10/00 -- p. 11 Section 9.1.1, first paragraph	Reference for <i>A Guide to Safe Field Operations</i> is U.S. Geological Survey, 1995	Change reference to read: <i>A Guide to Safe Field Operations</i> (Yobbi and others, 1996)