

## TABLE OF CONTENTS

|   | PAGE |
|---|------|
| <b>Part 1000 INTRODUCTION</b>   |      |
| 1010 INTRODUCTION . . . . .   | 1-1  |
| A. Scope and Application of Methods . . . . .   | 1-1  |
| B. Statistics . . . . .   | 1-1  |
| C. Terminology . . . . .  | 1-4  |
| D. Dilution/Concentration Operations . . . . .  | 1-5  |
| 1020 QUALITY ASSURANCE. . . . .   | 1-6  |
| A. Introduction . . . . .   | 1-6  |
| B. Quality Control . . . . .  | 1-7  |
| C. Quality Assessment . . . . .   | 1-15 |
| 1030 DATA QUALITY . . . . .   | 1-16 |
| A. Introduction . . . . .   | 1-16 |
| B. Measurement Uncertainty . . . . .  | 1-17 |
| C. Method Detection Level . . . . .   | 1-20 |
| D. Data Quality Objectives . . . . .  | 1-21 |
| E. Checking Analyses' Correctness . . . . .   | 1-23 |
| 1040 METHOD DEVELOPMENT AND EVALUATION . . . . .  | 1-25 |
| A. Introduction . . . . .   | 1-25 |
| B. Method Validation . . . . .  | 1-25 |
| C. Collaborative Testing . . . . .  | 1-27 |
| 1050 EXPRESSION OF RESULTS . . . . .  | 1-28 |
| A. Units . . . . .  | 1-28 |
| B. Significant Figures . . . . .  | 1-35 |
| C. Other Considerations . . . . .   | 1-37 |
| 1060 COLLECTION AND PRESERVATION OF SAMPLES . . . . .   | 1-38 |
| A. Introduction . . . . .   | 1-38 |
| B. Collection of Samples . . . . .  | 1-40 |
| C. Sample Storage and Preservation . . . . .  | 1-46 |
| 1080 REAGENT WATER . . . . .  | 1-47 |
| A. Introduction . . . . .   | 1-47 |
| B. Methods for Preparing Reagent-Grade Water . . . . .  | 1-48 |
| C. Reagent Water Quality . . . . .  | 1-49 |
| 1090 LABORATORY OCCUPATIONAL HEALTH AND SAFETY . . . . .  | 1-50 |
| A. Introduction . . . . .   | 1-50 |
| B. Safe Laboratory Practices . . . . .  | 1-51 |
| C. Laboratory Facility/Fixed Equipment . . . . .  | 1-56 |
| D. Hazard Evaluation . . . . .  | 1-57 |
| E. Personal Protective Equipment . . . . .  | 1-58 |
| F. Worker Protection Medical Program . . . . .  | 1-61 |
| G. Provisions for Work with Particularly Hazardous Substances . . . . .                                 | 1-62 |
| H. Biological Safety . . . . .  | 1-62 |
| I. Radiological Safety . . . . .  | 1-63 |
| J. Chemical Hygiene Plan . . . . .  | 1-66 |
| K. Mercury Use Avoidance in Laboratory . . . . .  | 1-67 |
| 1100 WASTE MINIMIZATION AND DISPOSAL . . . . .  | 1-67 |
| A. Introduction . . . . .   | 1-67 |
| B. Waste Minimization . . . . .   | 1-67 |
| C. Waste Treatment and Disposal . . . . .   | 1-68 |
| <b>Part 2000 PHYSICAL &amp; AGGREGATE PROPERTIES</b>  |      |
| 2010 INTRODUCTION . . . . .   | 2-1  |
| 2020 QUALITY ASSURANCE/QUALITY CONTROL . . . . .  | 2-1  |
| A. Introduction . . . . .   | 2-1  |
| B. Quality Control Practices . . . . .  | 2-1  |
| 2110 APPEARANCE . . . . .   | 2-5  |
| 2120 COLOR . . . . .  | 2-5  |
| A. Introduction . . . . .   | 2-5  |
| B. Visual Comparison Method . . . . .   | 2-6  |
| C. Spectrophotometric—Single-Wavelength Method (PROPOSED) . . . . .                                     | 2-7  |
| D. Spectrophotometric—Multi-Wavelength Method . . . . .   | 2-8  |
| E. Tristimulus Spectrophotometric Method . . . . .  | 2-11 |
| F. ADMI Weighted-Ordinate Spectrophotometric Method . . . . .   | 2-11 |
| 2130 TURBIDITY . . . . .  | 2-12 |
| A. Introduction . . . . .   | 2-12 |
| B. Nephelometric Method . . . . .   | 2-13 |
| 2150 ODOR . . . . .   | 2-15 |
| A. Introduction . . . . .   | 2-15 |
| B. Threshold Odor Test . . . . .  | 2-16 |
| C. Total Intensity of Odor (PROPOSED) . . . . .   | 2-20 |
| 2160 TASTE . . . . .  | 2-22 |
| A. Introduction . . . . .   | 2-22 |
| B. Flavor Threshold Test (FTT) . . . . .  | 2-22 |
| C. Flavor Rating Assessment (FRA) . . . . .   | 2-24 |
| 2170 FLAVOR PROFILE ANALYSIS . . . . .  | 2-25 |
| A. Introduction . . . . .   | 2-25 |
| B. Flavor Profile Analysis . . . . .  | 2-26 |
| 2310 ACIDITY . . . . .  | 2-33 |
| A. Introduction . . . . .   | 2-33 |
| B. Titration Method . . . . .   | 2-34 |
| 2320 ALKALINITY . . . . .   | 2-36 |
| A. Introduction . . . . .   | 2-36 |
| B. Titration Method . . . . .   | 2-37 |
| 2330 CALCIUM CARBONATE SATURATION. . . . .  | 2-39 |
| A. Introduction . . . . .   | 2-39 |
| B. Indices Indicating a Water's Tendency to Precipitate or Dissolve CaCO <sub>3</sub> . . . . .         | 2-41 |
| C. Indices Predicting the Quantity of CaCO <sub>3</sub> That Can Be Precipitated or Dissolved . . . . . | 2-45 |
| D. Graphical and Computer Methods for CaCO <sub>3</sub> Indices . . . . .                               | 2-46 |

|      |  |      |  |       |
|------|--|------|--|-------|
| 2340 | HARDNESS . . . . .   | 2-48 | B. Oxygen-Consumption Rate . . . . .                                     | 2-92  |
|      | A. Introduction . . . . .  | 2-48 | C. Settled Sludge Volume . . . . .                                       | 2-93  |
|      | B. Hardness by Calculation . . . . .   | 2-48 | D. Sludge Volume Index . . . . .   | 2-94  |
|      | C. EDTA Titrimetric Method . . . . .   | 2-48 | E. Zone Settling Rate . . . . .  | 2-95  |
| 2350 | OXIDANT DEMAND/REQUIREMENT . . . . .   | 2-51 | F. Specific Gravity . . . . .  | 2-96  |
|      | A. Introduction . . . . .  | 2-51 | G. Capillary Suction Time . . . . .                                      | 2-96  |
|      | B. Chlorine Demand/Requirement . . . . .   | 2-52 | H. Time-to-Filter . . . . .  | 2-98  |
|      | C. Chlorine Dioxide<br>Demand/Requirement . . . . .                              | 2-53 | I. Modified Settled Sludge Volume . . . . .                              | 2-99  |
|      | D. Ozone Demand/Requirement—<br>Batch Method . . . . .                           | 2-54 | 2720 ANAEROBIC SLUDGE DIGESTER GAS ANALYSIS .                            | 2-100 |
|      | E. Ozone Demand/Requirement—<br>Semi-Batch Method . . . . .                      | 2-55 | A. Introduction . . . . .  | 2-100 |
| 2510 | CONDUCTIVITY . . . . .   | 2-56 | B. Volumetric Method . . . . .   | 2-101 |
|      | A. Introduction . . . . .  | 2-56 | C. Gas Chromatographic Method . . . . .                                  | 2-102 |
|      | B. Laboratory Method . . . . .   | 2-58 | 2810 DISSOLVED GAS SUPERSATURATION . . . . .                             | 2-105 |
| 2520 | SALINITY . . . . .   | 2-59 | A. Introduction . . . . .  | 2-105 |
|      | A. Introduction . . . . .  | 2-59 | B. Direct-Sensing Membrane-Diffusion<br>Method . . . . .                 | 2-105 |
|      | B. Electrical Conductivity Method . . . . .                                      | 2-60 |  |       |
|      | C. Density Method . . . . .  | 2-61 |  |       |
|      | D. Algorithm of Practical Salinity . . . . .                                     | 2-62 |  |       |
| 2530 | FLOATABLES . . . . .   | 2-62 |  |       |
|      | A. Introduction . . . . .  | 2-62 |  |       |
|      | B. Particulate Floatables . . . . .  | 2-63 |  |       |
|      | C. Trichlorotrifluoroethane-Soluble<br>Floatable Oil and Grease . . . . .        | 2-65 |  |       |
| 2540 | SOLIDS . . . . .   | 2-66 |  |       |
|      | A. Introduction . . . . .  | 2-66 | 3010 INTRODUCTION . . . . .  | 3-1   |
|      | B. Total Solids Dried at 103–105°C . . . . .                                     | 2-68 | A. General Discussion . . . . .  | 3-1   |
|      | C. Total Dissolved Solids Dried at 180°C . . . . .                               | 2-69 | B. Sampling and Sample Preservation . . . . .                            | 3-1   |
|      | D. Total Suspended Solids Dried<br>at 103–105°C . . . . .                        | 2-70 | C. General Precautions . . . . .   | 3-3   |
|      | E. Fixed and Volatile Solids Ignited<br>at 550°C . . . . .                       | 2-71 | 3020 QUALITY ASSURANCE/QUALITY CONTROL . . . . .                         | 3-3   |
|      | F. Settleable Solids . . . . .   | 2-72 | A. Introduction . . . . .  | 3-3   |
|      | G. Total, Fixed, and Volatile Solids in<br>Solid and Semisolid Samples . . . . . | 2-73 | B. Quality Control Practices . . . . .                                   | 3-4   |
| 2550 | TEMPERATURE . . . . .  | 2-74 | 3030 PRELIMINARY TREATMENT OF SAMPLES . . . . .                          | 3-7   |
|      | A. Introduction . . . . .  | 2-74 | A. Introduction . . . . .  | 3-7   |
|      | B. Laboratory and Field Methods . . . . .  | 2-74 | B. Filtration for Dissolved and Suspended<br>Metals . . . . .            | 3-8   |
| 2560 | PARTICLE COUNTING AND SIZE DISTRIBUTION .  | 2-75 | C. Treatment for Acid-Extractable Metals . . . . .                       | 3-9   |
|      | A. Introduction . . . . .  | 2-75 | D. Digestion for Metals . . . . .  | 3-9   |
|      | B. Electrical Sensing Zone Method . . . . .                                      | 2-79 | E. Nitric Acid Digestion . . . . .                                       | 3-10  |
|      | C. Light-Blockage Methods . . . . .  | 2-80 | F. Nitric Acid-Hydrochloric Acid<br>Digestion . . . . .                  | 3-11  |
|      | D. Light-Scattering Method . . . . .   | 2-81 | G. Nitric Acid-Sulfuric Acid Digestion . . . . .                         | 3-12  |
| 2570 | ASBESTOS . . . . .   | 2-83 | H. Nitric Acid-Perchloric Acid Digestion . . . . .                       | 3-12  |
|      | A. Introduction . . . . .  | 2-83 | I. Nitric Acid-Perchloric Acid-<br>Hydrofluoric Acid Digestion . . . . . | 3-13  |
|      | B. Transmission Electron Microscopy<br>Method . . . . .                          | 2-83 | J. Dry Ashing . . . . .  | 3-13  |
|      |  |      | K. Microwave-Assisted Digestion . . . . .                                | 3-13  |
| 2580 | OXIDATION-REDUCTION POTENTIAL (ORP) .  | 2-88 | 3110 METALS BY ATOMIC ABSORPTION<br>SPECTROMETRY . . . . .               | 3-15  |
|      | A. Introduction . . . . .  | 2-88 | 3111 METALS BY FLAME ATOMIC ABSORPTION<br>SPECTROMETRY . . . . .         | 3-16  |
|      | B. Oxidation-Reduction Potential<br>Measurement in Clean Water . . . . .         | 2-89 | A. Introduction . . . . .  | 3-16  |
| 2710 | TESTS ON SLUDGES . . . . .   | 2-92 | B. Direct Air-Acetylene Flame Method . . . . .                           | 3-20  |
|      | A. Introduction . . . . .  | 2-92 | C. Extraction/Air-Acetylene Flame<br>Method . . . . .                    | 3-22  |

|   |             |   |              |
|---|-------------|---|--------------|
| A. Introduction . . . . .   | 3-25        | A. Introduction . . . . .   | 3-85         |
| B. Cold-Vapor Atomic Absorption<br>Spectrometric Method . . . . .                                       | 3-25        | B. Flame Emission Photometric Method . . . . .                          | 3-85         |
| <b>3113 METALS BY ELECTROTHERMAL ATOMIC<br/>ABSORPTION SPECTROMETRY . . . . .</b>                       | <b>3-27</b> | <b>3500-Mg MAGNESIUM . . . . .</b>                                      | <b>3-86</b>  |
| A. Introduction . . . . .   | 3-27        | A. Introduction . . . . .   | 3-86         |
| B. Electrothermal Atomic Absorption<br>Spectrometric Method . . . . .                                   | 3-30        | B. Calculation Method . . . . .   | 3-86         |
| <b>3114 ARSENIC AND SELENIUM BY HYDRIDE<br/>GENERATION/ATOMIC ABSORPTION<br/>SPECTROMETRY . . . . .</b> | <b>3-36</b> | <b>3500-Mn MANGANESE . . . . .</b>                                      | <b>3-87</b>  |
| A. Introduction . . . . .   | 3-36        | A. Introduction . . . . .   | 3-87         |
| B. Manual Hydride Generation/Atomic<br>Absorption Spectrometric Method . . . . .                        | 3-36        | B. Persulfate Method . . . . .  | 3-87         |
| C. Continuous Hydride Generation/Atomic<br>Absorption Spectrometric Method . . . . .                    | 3-40        | <b>3500-K POTASSIUM . . . . .</b>                                       | <b>3-89</b>  |
| <b>3120 METALS BY PLASMA EMISSION<br/>SPECTROSCOPY . . . . .</b>  | <b>3-42</b> | A. Introduction . . . . .   | 3-89         |
| A. Introduction . . . . .   | 3-42        | B. Flame Photometric Method . . . . .                                   | 3-89         |
| B. Inductively Coupled Plasma (ICP)<br>Method . . . . .   | 3-42        | C. Potassium-Selective Electrode Method . . . . .                       | 3-90         |
| <b>3125 METALS BY INDUCTIVELY COUPLED PLASMA—<br/>MASS SPECTROMETRY . . . . .</b>                       | <b>3-48</b> | <b>3500-Se SELENIUM . . . . .</b>                                       | <b>3-91</b>  |
| A. Introduction . . . . .   | 3-48        | A. Introduction . . . . .   | 3-91         |
| B. Inductively Coupled Plasma–Mass<br>Spectrometry (ICP–MS) Method . . . . .                            | 3-49        | B. Sample Preparation . . . . .   | 3-93         |
| <b>3130 METALS BY ANODIC STRIPPING<br/>VOLTAMMETRY . . . . .</b>  | <b>3-59</b> | C. Colorimetric Method . . . . .  | 3-95         |
| A. Introduction . . . . .   | 3-59        | D. Determination of Volatile Selenium . . . . .                         | 3-96         |
| B. Determination of Lead, Cadmium, and<br>Zinc . . . . .  | 3-59        | E. Determination of Nonvolatile Organic<br>Selenium Compounds . . . . . | 3-97         |
| <b>3500-Al ALUMINUM . . . . .</b>   | <b>3-63</b> | <b>3500-Na SODIUM . . . . .</b>   | <b>3-99</b>  |
| A. Introduction . . . . .   | 3-63        | A. Introduction . . . . .   | 3-99         |
| B. Eriochrome Cyanine R Method . . . . .  | 3-63        | B. Flame Emission Photometric Method . . . . .                          | 3-99         |
| <b>3500-As ARSENIC . . . . .</b>  | <b>3-66</b> | <b>3500-Sr STRONTIUM . . . . .</b>                                      | <b>3-101</b> |
| A. Introduction . . . . .   | 3-66        | A. Introduction . . . . .   | 3-101        |
| B. Silver Diethyldithiocarbamate Method . . . . .   | 3-67        | B. Flame Emission Photometric Method . . . . .                          | 3-101        |
| <b>3500-Ca CALCIUM . . . . .</b>  | <b>3-69</b> | <b>3500-V VANADIUM . . . . .</b>  | <b>3-103</b> |
| A. Introduction . . . . .   | 3-69        | A. Introduction . . . . .   | 3-103        |
| B. EDTA Titrimetric Method . . . . .  | 3-69        | B. Gallic Acid Method . . . . .   | 3-103        |
| <b>3500-Cr CHROMIUM . . . . .</b>   | <b>3-70</b> | <b>3500-Zn ZINC . . . . .</b>   | <b>3-104</b> |
| A. Introduction . . . . .   | 3-70        | A. Introduction . . . . .   | 3-104        |
| B. Colorimetric Method . . . . .  | 3-71        | B. Zincon Method . . . . .  | 3-105        |
| C. Ion Chromatographic Method . . . . .   | 3-73        | <b>3500 OTHER METALS . . . . .</b>                                      | <b>3-106</b> |
| <b>3500-Cu COPPER . . . . .</b>   | <b>3-76</b> | <b>3500-Sb ANTIMONY . . . . .</b>                                       | <b>3-106</b> |
| A. Introduction . . . . .   | 3-76        | <b>3500-Ba BARIUM . . . . .</b>   | <b>3-106</b> |
| B. Neocuproine Method . . . . .   | 3-76        | <b>3500-Be BERYLLIUM . . . . .</b>                                      | <b>3-107</b> |
| C. Bathocuproine Method . . . . .   | 3-78        | <b>3500-Bi BISMUTH . . . . .</b>  | <b>3-107</b> |
| <b>3500-Fe IRON . . . . .</b>   | <b>3-79</b> | <b>3500-B Boron . . . . .</b>   | <b>3-107</b> |
| A. Introduction . . . . .   | 3-79        | <b>3500-Cd CADMIUM . . . . .</b>  | <b>3-107</b> |
| B. Phenanthroline Method . . . . .  | 3-80        | <b>3500-Cs CESIUM . . . . .</b>   | <b>3-108</b> |
| <b>3500-Pb LEAD . . . . .</b>   | <b>3-82</b> | <b>3500-Co COBALT . . . . .</b>   | <b>3-108</b> |
| A. Introduction . . . . .   | 3-82        | <b>3500-Ga GALLIUM . . . . .</b>  | <b>3-108</b> |
| B. Dithizone Method . . . . .   | 3-83        | <b>3500-Ge GERMANIUM . . . . .</b>                                      | <b>3-109</b> |
| <b>3500-Li LITHIUM . . . . .</b>  | <b>3-85</b> | <b>3500-Au GOLD . . . . .</b>   | <b>3-109</b> |
|   |             | <b>3500-In INDIUM . . . . .</b>   | <b>3-109</b> |
|   |             | <b>3500-Ir IRIDIUM . . . . .</b>  | <b>3-109</b> |
|   |             | <b>3500-Hg MERCURY . . . . .</b>  | <b>3-110</b> |
|   |             | <b>3500-Mo MOLYBDENUM . . . . .</b>                                     | <b>3-110</b> |
|   |             | <b>3500-Ni NICKEL . . . . .</b>   | <b>3-110</b> |
|   |             | <b>3500-Os OSMIUM . . . . .</b>   | <b>3-111</b> |
|   |             | <b>3500-Pd PALLADIUM . . . . .</b>                                      | <b>3-111</b> |
|   |             | <b>3500-Pt PLATINUM . . . . .</b>                                       | <b>3-111</b> |
|   |             | <b>3500-Re RHENIUM . . . . .</b>  | <b>3-111</b> |
|   |             | <b>3500-Rh RHODIUM . . . . .</b>  | <b>3-112</b> |
|   |             | <b>3500-Ru RUTHENIUM . . . . .</b>                                      | <b>3-112</b> |
|   |             | <b>3500-Ag SILVER . . . . .</b>   | <b>3-112</b> |

|   |   |       |   |      |
|---|---|-------|---|------|
| 3500-Te   | TELLURIUM . . . . .   | 3-113 | B. Preliminary Treatment of Samples . . . . .   | 4-41 |
| 3500-Tl   | THALLIUM . . . . .  | 3-113 | C. Total Cyanide after Distillation . . . . .   | 4-44 |
| 3500-Th   | THORIUM . . . . .   | 3-113 | D. Titrimetric Method . . . . .   | 4-45 |
| 3500-Sn   | TIN . . . . .   | 3-113 | E. Colorimetric Method . . . . .  | 4-46 |
| 3500-Ti   | TITANIUM . . . . .  | 3-114 | F. Cyanide-Ion Selective Electrode<br>Method . . . . .  | 4-48 |
| 3500-U  | URANIUM . . . . .   | 3-114 | G. Cyanides Amenable to Chlorination<br>after Distillation . . . . .                          | 4-49 |
| <b>Part 4000 INORGANIC NONMETALLIC<br/>CONSTITUENTS</b> |   |       |   |      |
| 4010  | INTRODUCTION . . . . .  | 4-1   | H. Cyanides Amenable to Chlorination<br>without Distillation (Short-Cut<br>Method) . . . . .  | 4-50 |
| 4020  | QUALITY ASSURANCE/QUALITY CONTROL . . .   | 4-1   | I. Weak Acid Dissociable Cyanide . . . . .  | 4-52 |
|   | A. Introduction . . . . .   | 4-1   | J. Cyanogen Chloride . . . . .  | 4-53 |
|   | B. Quality Control Practices . . . . .  | 4-1   | K. Spot Test for Sample Screening . . . . .   | 4-54 |
| 4110  | DETERMINATION OF ANIONS BY ION<br>CHROMATOGRAPHY . . . . .  | 4-7   | L. Cyanates . . . . .   | 4-55 |
|   | A. Introduction . . . . .   | 4-7   | M. Thiocyanate . . . . .  | 4-56 |
|   | B. Ion Chromatography with Chemical<br>Suppression of Eluent Conductivity .                           | 4-7   | N. Total Cyanide after Distillation, by<br>Flow Injection Analysis . . . . .                  | 4-58 |
|   | C. Single-Column Ion Chromatography<br>with Direct Conductivity Detection .                           | 4-10  | O. Total Cyanide and Weak Acid<br>Dissociable Cyanide by Flow<br>Injection Analysis . . . . . | 4-60 |
|   | D. Ion Chromatographic Determination of<br>Oxyhalides and Bromide . . . . .                           | 4-11  |   |      |
| 4120  | SEGMENTED CONTINUOUS FLOW ANALYSIS .  | 4-14  | 4500-Cl CHLORINE (RESIDUAL) . . . . .   | 4-61 |
|   | A. Introduction . . . . .   | 4-14  | A. Introduction . . . . .   | 4-61 |
|   | B. Segmented Flow Analysis Method . .   | 4-15  | B. Iodometric Method I . . . . .  | 4-63 |
| 4130  | INORGANIC NONMETALS BY FLOW INJECTION<br>ANALYSIS . . . . .   | 4-16  | C. Iodometric Method II . . . . .   | 4-65 |
|   | A. Introduction . . . . .   | 4-16  | D. Amperometric Titration Method . . . . .  | 4-67 |
|   | B. Quality Control . . . . .  | 4-17  | E. Low-Level Amperometric Titration<br>Method . . . . .                                       | 4-69 |
| 4140  | INORGANIC ANIONS BY CAPILLARY ION<br>ELECTROPHORESIS . . . . .  | 4-17  | F. DPD Ferrous Titrimetric Method . . . . .   | 4-69 |
|   | A. Introduction . . . . .   | 4-17  | G. DPD Colorimetric Method . . . . .  | 4-72 |
|   | B. Capillary Ion Electrophoresis with<br>Indirect UV Detection . . . . .                              | 4-17  | H. Syringaldazine (FACTS) Method . . . . .  | 4-73 |
| 4500-B  | BORON . . . . .   | 4-27  | I. Iodometric Electrode Technique . . . . .   | 4-74 |
|   | A. Introduction . . . . .   | 4-27  | 4500-Cl <sup>-</sup> CHLORIDE . . . . .   | 4-75 |
|   | B. Curcumin Method . . . . .  | 4-27  | A. Introduction . . . . .   | 4-75 |
|   | C. Carmine Method . . . . .   | 4-29  | B. Argentometric Method . . . . .   | 4-75 |
| 4500-Br <sup>-</sup>                                    | BROMIDE . . . . .   | 4-30  | C. Mercuric Nitrate Method . . . . .  | 4-76 |
|   | A. Introduction . . . . .   | 4-30  | D. Potentiometric Method . . . . .  | 4-77 |
|   | B. Phenol Red Colorimetric Method . .   | 4-30  | E. Automated Ferricyanide Method . . . . .  | 4-79 |
|   | C. (Reserved) . . . . .   | 4-31  | F. (Reserved) . . . . .   | 4-80 |
|   | D. Flow Injection Analysis . . . . .  | 4-31  | G. Mercuric Thiocyanate Flow Injection<br>Analysis . . . . .                                  | 4-80 |
| 4500-CO <sub>2</sub>                                    | CARBON DIOXIDE . . . . .  | 4-32  | 4500-ClO <sub>2</sub> CHLORINE DIOXIDE . . . . .  | 4-82 |
|   | A. Introduction . . . . .   | 4-32  | A. Introduction . . . . .   | 4-82 |
|   | B. Nomographic Determination of Free<br>Carbon Dioxide and the Three Forms<br>of Alkalinity . . . . . | 4-33  | B. Iodometric Method . . . . .  | 4-82 |
|   | C. Titrimetric Method for Free Carbon<br>Dioxide . . . . .  | 4-33  | C. Amperometric Method I . . . . .  | 4-83 |
|   | D. Carbon Dioxide and Forms of Alkalinity<br>by Calculation . . . . .                                 | 4-38  | D. (Reserved) . . . . .   | 4-84 |
| 4500-CN <sup>-</sup>                                    | CYANIDE . . . . .   | 4-39  | E. Amperometric Method II . . . . .   | 4-84 |
|   | A. Introduction . . . . .   | 4-39  | 4500-F <sup>-</sup> FLUORIDE . . . . .  | 4-86 |

|                                   |  |       |
|-----------------------------------|--|-------|
|                                   | G. Ion-Selective Electrode Flow Injection Analysis . . . . .   | 4-92  |
| 4500-H <sup>+</sup>               | pH VALUE . . . . .   | 4-95  |
|                                   | A. Introduction . . . . .  | 4-95  |
|                                   | B. Electrometric Method . . . . .  | 4-95  |
| 4500-I                            | IODINE . . . . .   | 4-100 |
|                                   | A. Introduction . . . . .  | 4-100 |
|                                   | B. Leuco Crystal Violet Method . . . . .   | 4-100 |
|                                   | C. Amperometric Titration Method . . . . .   | 4-102 |
| 4500-I <sup>-</sup>               | IODIDE . . . . .   | 4-102 |
|                                   | A. Introduction . . . . .  | 4-102 |
|                                   | B. Leuco Crystal Violet Method . . . . .   | 4-103 |
|                                   | C. Catalytic Reduction Method . . . . .  | 4-104 |
|                                   | D. Voltammetric Method . . . . .   | 4-105 |
| 4500-IO <sub>3</sub> <sup>-</sup> | IODATE . . . . .   | 4-107 |
|                                   | A. Introduction . . . . .  | 4-107 |
|                                   | B. Polarographic Method . . . . .  | 4-107 |
| 4500-N                            | NITROGEN . . . . .   | 4-108 |
|                                   | A. Introduction . . . . .  | 4-108 |
|                                   | B. In-Line UV/Persulfate Digestion and Oxidation with Flow Injection Analysis . . . . .              | 4-109 |
|                                   | C. Persulfate Method . . . . .   | 4-110 |
|                                   | D. Conductimetric Determination of Inorganic Nitrogen . . . . .                                      | 4-112 |
| 4500-NH <sub>3</sub>              | NITROGEN (AMMONIA) . . . . .   | 4-114 |
|                                   | A. Introduction . . . . .  | 4-114 |
|                                   | B. Preliminary Distillation Step . . . . .   | 4-114 |
|                                   | C. Titrimetric Method . . . . .  | 4-116 |
|                                   | D. Ammonia-Selective Electrode Method . . . . .  | 4-117 |
|                                   | E. Ammonia-Selective Electrode Method Using Known Addition . . . . .                                 | 4-118 |
|                                   | F. Phenate Method . . . . .  | 4-119 |
|                                   | G. Automated Phenate Method . . . . .  | 4-120 |
|                                   | H. Flow Injection Analysis . . . . .   | 4-122 |
| 4500-NO <sub>2</sub> <sup>-</sup> | NITROGEN (NITRITE) . . . . .   | 4-124 |
|                                   | A. Introduction . . . . .  | 4-124 |
|                                   | B. Colorimetric Method . . . . .   | 4-124 |
| 4500-NO <sub>3</sub> <sup>-</sup> | NITROGEN (NITRATE) . . . . .   | 4-126 |
|                                   | A. Introduction . . . . .  | 4-126 |
|                                   | B. Ultraviolet Spectrophotometric Screening Method . . . . .   | 4-127 |
|                                   | C. Second-Derivative Ultraviolet Spectrophotometric Method . . . . .                                 | 4-128 |
|                                   | D. Nitrate Electrode Method . . . . .  | 4-129 |
|                                   | E. Cadmium Reduction Method . . . . .  | 4-131 |
|                                   | F. Automated Cadmium Reduction Method . . . . .  | 4-133 |
|                                   | G. (Reserved) . . . . .  | 4-134 |
|                                   | H. Automated Hydrazine Reduction Method . . . . .  | 4-135 |
|                                   | I. Cadmium Reduction Flow Injection Method . . . . .   | 4-136 |
| 4500-N <sub>org</sub>             | NITROGEN (ORGANIC) . . . . .   | 4-138 |
|                                   | A. Introduction . . . . .  | 4-138 |
|                                   | B. Macro-Kjeldahl Method . . . . .   | 4-139 |
|                                   | C. Semi-Micro-Kjeldahl Method . . . . .  | 4-140 |
|                                   | D. Block Digestion and Flow Injection Analysis . . . . .   | 4-142 |
| 4500-O                            | OXYGEN (DISSOLVED) . . . . .   | 4-144 |
|                                   | A. Introduction . . . . .  | 4-144 |
|                                   | B. Iodometric Methods . . . . .  | 4-144 |
|                                   | C. Azide Modification . . . . .  | 4-146 |
|                                   | D. Permanganate Modification . . . . .   | 4-148 |
|                                   | E. Alum Flocculation Modification . . . . .  | 4-149 |
|                                   | F. Copper Sulfate-Sulfamic Acid Flocculation Modification . . . . .                                  | 4-149 |
|                                   | G. Membrane-Electrode Method . . . . .   | 4-149 |
|                                   | H. Optical-Probe Method . . . . .  | 4-153 |
| 4500-O <sub>3</sub>               | OZONE (RESIDUAL) . . . . .   | 4-154 |
|                                   | A. Introduction . . . . .  | 4-154 |
|                                   | B. Indigo Colorimetric Method . . . . .  | 4-154 |
| 4500-P                            | PHOSPHORUS . . . . .   | 4-156 |
|                                   | A. Introduction . . . . .  | 4-156 |
|                                   | B. Sample Preparation . . . . .  | 4-160 |
|                                   | C. Vanadomolybdophosphoric Acid Colorimetric Method . . . . .  | 4-161 |
|                                   | D. Stannous Chloride Method . . . . .  | 4-163 |
|                                   | E. Ascorbic Acid Method . . . . .  | 4-164 |
|                                   | F. Automated Ascorbic Acid Reduction Method . . . . .  | 4-165 |
|                                   | G. Flow Injection Analysis for Orthophosphate . . . . .  | 4-166 |
|                                   | H. Manual Digestion and Flow Injection Analysis for Total Phosphorus . . . . .                       | 4-168 |
|                                   | I. In-line UV/Persulfate Digestion and Flow Injection Analysis for Total Phosphorus . . . . .        | 4-169 |
|                                   | J. Persulfate Method for Simultaneous Determination of Total Nitrogen and Total Phosphorus . . . . . | 4-170 |
| 4500-KMnO <sub>4</sub>            | POTASSIUM PERMANGANATE . . . . .   | 4-173 |
|                                   | A. Introduction . . . . .  | 4-173 |
|                                   | B. Spectrophotometric Method . . . . .   | 4-173 |
| 4500-SiO <sub>2</sub>             | SILICA . . . . .   | 4-174 |
|                                   | A. Introduction . . . . .  | 4-174 |
|                                   | B. (Reserved) . . . . .  | 4-175 |
|                                   | C. Molybdsilicate Method . . . . .   | 4-175 |
|                                   | D. Heteropoly Blue Method . . . . .  | 4-177 |
|                                   | E. Automated Method for Molybdate-Reactive Silica . . . . .  | 4-179 |
|                                   | F. Flow Injection Analysis for Molybdate-Reactive Silicate . . . . .                                 | 4-179 |
| 4500-S <sup>2-</sup>              | SULFIDE . . . . .  | 4-181 |
|                                   | A. Introduction . . . . .  | 4-181 |
|                                   | B. Separation of Soluble and Insoluble Sulfides . . . . .  | 4-183 |
|                                   | C. Sample Pretreatment to Remove Interfering Substances or to Concentrate the Sulfide . . . . .      | 4-183 |

|   |                          |   |      |
|---|--------------------------|---|------|
| D. Methylene Blue Method . . . . .  | 4-184                    | 5510 AQUATIC HUMIC SUBSTANCES . . . . .                                       | 5-38 |
| E. Gas Dialysis, Automated Methylene Blue Method . . . . .                | 4-185                    | A. Introduction . . . . .   | 5-38 |
| F. Iodometric Method . . . . .  | 4-187                    | B. Diethylaminoethyl (DEAE) Method . . . . .                                  | 5-38 |
| G. Ion-Selective Electrode Method . . . . .                               | 4-187                    | C. XAD Method . . . . .   | 5-40 |
| H. Calculation of Un-ionized Hydrogen Sulfide . . . . .                   | 4-189                    | 5520 OIL AND GREASE . . . . .   | 5-41 |
| I. Distillation, Methylene Blue Flow Injection Analysis Method . . . . .  | 4-192                    | A. Introduction . . . . .   | 5-41 |
| J. Acid-Volatile Sulfide . . . . .  | 4-193                    | B. Liquid-Liquid, Partition-Gravimetric Method . . . . .                      | 5-42 |
| <b>4500-SO<sub>3</sub><sup>2-</sup></b>                                   | <b>SULFITE . . . . .</b> | C. Partition-Infrared Method . . . . .  | 5-44 |
| A. Introduction . . . . .   | 4-194                    | D. Soxhlet Extraction Method . . . . .  | 5-45 |
| B. Iodometric Method . . . . .  | 4-194                    | E. Extraction Method for Sludge Samples . . . . .                             | 5-46 |
| C. Phenanthroline Method . . . . .  | 4-195                    | F. Hydrocarbons . . . . .   | 5-46 |
| <b>4500-SO<sub>4</sub><sup>2-</sup></b>                                   | <b>SULFATE . . . . .</b> | G. Solid-Phase, Partition-Gravimetric Method . . . . .                        | 5-47 |
| A. Introduction . . . . .   | 4-197                    | 5530 PHENOLS . . . . .  | 5-49 |
| B. (Reserved) . . . . .   | 4-197                    | A. Introduction . . . . .   | 5-49 |
| C. Gravimetric Method with Ignition of Residue . . . . .                  | 4-197                    | B. Cleanup Procedure . . . . .  | 5-49 |
| D. Gravimetric Method with Drying of Residue . . . . .                    | 4-199                    | C. Chloroform Extraction Method . . . . .                                     | 5-50 |
| E. Turbidimetric Method . . . . .   | 4-199                    | D. Direct Photometric Method . . . . .  | 5-52 |
| F. Automated Methylthymol Blue Method . . . . .                           | 4-200                    | 5540 SURFACTANTS . . . . .  | 5-53 |
| G. Methylthymol Blue Flow Injection Analysis . . . . .                    | 4-201                    | A. Introduction . . . . .   | 5-53 |
| <b>Part 5000 AGGREGATE ORGANIC CONSTITUENTS</b>                           |                          | B. Surfactant Separation by Sublation . . . . .                               | 5-53 |
| 5010 INTRODUCTION . . . . .   | 5-1                      | C. Anionic Surfactants as MBAS . . . . .                                      | 5-55 |
| A. General Discussion . . . . .   | 5-1                      | D. Nonionic Surfactants as CTAS . . . . .                                     | 5-58 |
| B. Sample Collection and Preservation . . . . .                           | 5-1                      | 5550 TANNIN AND LIGNIN . . . . .  | 5-61 |
| 5020 QUALITY ASSURANCE/QUALITY CONTROL . . . . .                          | 5-1                      | A. Introduction . . . . .   | 5-61 |
| A. Introduction . . . . .   | 5-1                      | B. Colorimetric Method . . . . .  | 5-61 |
| B. Quality Control Practices . . . . .                                    | 5-2                      | 5560 ORGANIC AND VOLATILE ACIDS . . . . .                                     | 5-62 |
| 5210 BIOCHEMICAL OXYGEN DEMAND (BOD) . . . . .                            | 5-5                      | A. Introduction . . . . .   | 5-62 |
| A. Introduction . . . . .   | 5-5                      | B. Chromatographic Separation Method for Organic Acids . . . . .              | 5-62 |
| B. 5-Day BOD Test . . . . .   | 5-6                      | C. Distillation Method . . . . .  | 5-64 |
| C. Ultimate BOD Test . . . . .  | 5-11                     | D. Gas Chromatographic Method . . . . .                                       | 5-65 |
| D. Respirometric Method . . . . .   | 5-14                     | 5710 FORMATION OF TRIHALOMETHANES AND OTHER DISINFECTION BYPRODUCTS . . . . . | 5-67 |
| 5220 CHEMICAL OXYGEN DEMAND (COD) . . . . .                               | 5-17                     | A. Introduction . . . . .   | 5-67 |
| A. Introduction . . . . .   | 5-17                     | B. Trihalomethane Formation Potential (THMFP) . . . . .                       | 5-70 |
| B. Open Reflux Method . . . . .   | 5-18                     | C. Simulated Distribution System Trihalomethanes (SDS-THM) . . . . .          | 5-74 |
| C. Closed Reflux, Titrimetric Method . . . . .                            | 5-20                     | D. Formation of Other Disinfection Byproducts (DBPs) . . . . .                | 5-75 |
| D. Closed Reflux, Colorimetric Method . . . . .                           | 5-21                     | 5910 UV-ABSORBING ORGANIC CONSTITUENTS . . . . .                              | 5-77 |
| 5310 TOTAL ORGANIC CARBON (TOC) . . . . .                                 | 5-23                     | A. Introduction . . . . .   | 5-77 |
| A. Introduction . . . . .   | 5-23                     | B. Ultraviolet Absorption Method . . . . .                                    | 5-78 |
| B. High-Temperature Combustion Method . . . . .                           | 5-26                     |   |      |
| C. Persulfate-Ultraviolet or Heated-Persulfate Oxidation Method . . . . . | 5-29                     |   |      |
| D. (Reserved) . . . . .   | 5-31                     |   |      |
| 5320 DISSOLVED ORGANIC HALOGEN . . . . .                                  | 5-31                     |   |      |
| A. Introduction . . . . .   | 5-31                     |   |      |
| B. Adsorption-Pyrolysis-Titrimetric Method . . . . .                      | 5-32                     |   |      |
| <b>Part 6000 INDIVIDUAL ORGANIC COMPOUNDS</b>                             |                          |   |      |
| 6010 INTRODUCTION . . . . .   | 6-1                      |   |      |
| A. General Discussion . . . . .   | 6-1                      |   |      |
| B. Sample Collection and Preservation . . . . .                           | 6-3                      |   |      |
| C. Analytical Methods . . . . .   | 6-4                      |   |      |
| 6020 QUALITY ASSURANCE/QUALITY CONTROL . . . . .                          | 6-6                      |   |      |
| A. Introduction . . . . .   | 6-6                      |   |      |
| B. Quality Control Practices . . . . .                                    | 6-7                      |   |      |

|      |  |      |  |       |
|------|--|------|--|-------|
| 6040 | CONSTITUENT CONCENTRATION BY GAS EXTRACTION . . . . .                                      | 6-11 | A. Introduction . . . . .  | 6-87  |
|      | A. Introduction . . . . .  | 6-11 | B. Liquid-Liquid Extraction Gas Chromatographic Method . . . . .   | 6-87  |
|      | B. Closed-Loop Stripping, Gas Chromatographic/Mass Spectrometric Analysis . . . . .        | 6-11 | C. Liquid-Liquid Extraction Gas Chromatographic/Mass Spectrometric Method . . . . .                                      | 6-93  |
|      | C. Purge and Trap Technique . . . . .  | 6-22 | 6431 POLYCHLORINATED BIPHENYLS (PCBs) . . . . .  | 6-93  |
|      | D. Solid-Phase Microextraction (SPME) . . . . .  | 6-22 | A. Introduction . . . . .  | 6-93  |
|      | E. Solid-Phase Microextraction (SPME) with CI GC/MS/MS . . . . .                           | 6-25 | B. Liquid-Liquid Extraction Gas Chromatographic Method . . . . .   | 6-93  |
| 6200 | VOLATILE ORGANIC COMPOUNDS . . . . .   | 6-30 | C. Liquid-Liquid Extraction Gas Chromatographic/Mass Spectrometric Method . . . . .                                      | 6-93  |
|      | A. Introduction . . . . .  | 6-30 | 6440 POLYNUCLEAR AROMATIC HYDROCARBONS . . . . .   | 6-93  |
|      | B. Purge and Trap Capillary-Column Gas Chromatographic/Mass Spectrometric Method . . . . . | 6-33 | A. Introduction . . . . .  | 6-93  |
|      | C. Purge and Trap Capillary-Column Gas Chromatographic Method . . . . .                    | 6-38 | B. Liquid-Liquid Extraction Chromatographic Method . . . . .   | 6-94  |
| 6211 | METHANE . . . . .  | 6-43 | C. Liquid-Liquid Extraction Gas Chromatographic/Mass Spectrometric Method . . . . .                                      | 6-99  |
|      | A. Introduction . . . . .  | 6-43 | 6450 NITROSAMINES . . . . .  | 6-99  |
|      | B. Combustible-Gas Indicator Method . . . . .  | 6-43 | A. Introduction . . . . .  | 6-99  |
|      | C. Volumetric Method . . . . .   | 6-45 | B. Carbonaceous-Resin Solid-Phase Extraction GC/MS Method . . . . .  | 6-100 |
| 6231 | 1,2-DIBROMOETHANE (EDB) AND 1,2-DIBROMO-3-CHLOROPROPANE (DBCP) . . . . .                   | 6-45 | C. Micro Liquid-Liquid Extraction GC/MS Method . . . . .   | 6-109 |
|      | A. Introduction . . . . .  | 6-45 | 6610 CARBAMATE PESTICIDES . . . . .  | 6-112 |
|      | B. Liquid-Liquid Extraction Gas Chromatographic Method . . . . .                           | 6-45 | A. Introduction . . . . .  | 6-112 |
|      | C. Purge and Trap Gas Chromatographic/ Mass Spectrometric Method . . . . .                 | 6-48 | B. High-Performance Liquid Chromatographic Method . . . . .  | 6-113 |
|      | D. Purge and Trap Gas Chromatographic Method . . . . .                                     | 6-48 | 6630 ORGANOCHLORINE PESTICIDES . . . . .   | 6-121 |
| 6232 | TRIHALOMETHANES AND CHLORINATED ORGANIC SOLVENTS . . . . .                                 | 6-48 | A. Introduction . . . . .  | 6-121 |
|      | A. Introduction . . . . .  | 6-48 | B. Liquid-Liquid Extraction Gas Chromatographic Method I . . . . .   | 6-121 |
|      | B. Liquid-Liquid Extraction Gas Chromatographic Method . . . . .                           | 6-49 | Appendix—Standardization of Magnesia-Silica Gel Column by Weight Adjustment Based on Adsorption of Lauric Acid . . . . . | 6-127 |
|      | C. Purge-and-Trap Gas Chromatographic/ Mass Spectrometric Method . . . . .                 | 6-54 | C. Liquid-Liquid Extraction Gas Chromatographic Method II . . . . .  | 6-128 |
|      | D. Purge-and-Trap Gas Chromatographic Method . . . . .                                     | 6-54 | D. Liquid-Liquid Extraction Gas Chromatographic/Mass Spectrometric Method . . . . .                                      | 6-135 |
| 6251 | DISINFECTION BYPRODUCTS: HALOACETIC ACIDS AND TRICHLOROPHENOL . . . . .                    | 6-55 | 6640 ACIDIC HERBICIDE COMPOUNDS . . . . .  | 6-135 |
|      | A. Introduction . . . . .  | 6-55 | A. Introduction . . . . .  | 6-135 |
|      | B. Micro Liquid-Liquid Extraction Gas Chromatographic Method . . . . .                     | 6-55 | B. Micro Liquid-Liquid Extraction Gas Chromatographic Method . . . . .   | 6-136 |
| 6252 | DISINFECTION BYPRODUCTS: ALDEHYDES (PROPOSED) . . . . .                                    | 6-65 | 6651 GLYPHOSATE HERBICIDE . . . . .  | 6-146 |
|      | A. Introduction . . . . .  | 6-65 | A. Introduction . . . . .  | 6-146 |
|      | B. PFBHA Liquid-Liquid Extraction Gas Chromatographic Method . . . . .                     | 6-66 | B. Liquid Chromatographic Post-Column Fluorescence Method . . . . .  | 6-146 |
| 6410 | EXTRACTABLE BASE/NEUTRALS AND ACIDS . . . . .  | 6-73 | 6710 TRIBUTYL TIN . . . . .  | 6-149 |
|      | A. Introduction . . . . .  | 6-73 | A. Introduction . . . . .  | 6-149 |
|      | B. Liquid-Liquid Extraction Gas Chromatographic/Mass Spectrometric Method . . . . .        | 6-74 | B. Gas Chromatographic/Mass Spectrometric Method . . . . .   | 6-149 |
| 6420 | PHENOLS . . . . .  | 6-87 |  |       |

|   |       |  |
|---|-------|--|
| C. Gas Chromatographic/Flame Photometric Detector Method . . . . .                            | 6-154 |  |
| <b>6810 PHARMACEUTICALS AND PERSONAL CARE</b>   |       |  |
| PRODUCTS . . . . .  | 6-155 |  |
| A. Introduction . . . . .   | 6-155 |  |
| B. Polymeric-Resin Solid-Phase Extraction LC-MS/MS Method . . . . .                           | 6-156 |  |
| <b>Part 7000 RADIOACTIVITY</b>  |       |  |
| <b>7010 INTRODUCTION</b> . . . . .  | 7-1   |  |
| A. General Discussion . . . . .   | 7-1   |  |
| B. Sample Collection and Preservation . . . . .   | 7-2   |  |
| <b>7020 QUALITY SYSTEM</b> . . . . .  | 7-3   |  |
| A. Quality Systems/Quality Assurance/Quality Control Program . . . . .                        | 7-3   |  |
| B. Quality Control for Wastewater Samples . . . . .   | 7-8   |  |
| C. Statistics . . . . .   | 7-9   |  |
| D. Calculation and Expression of Results . . . . .  | 7-12  |  |
| <b>7030 COUNTING INSTRUMENTS</b> . . . . .  | 7-13  |  |
| A. Introduction . . . . .   | 7-13  |  |
| B. Description and Operation of Instruments . . . . .   | 7-13  |  |
| <b>7040 FACILITIES</b> . . . . .  | 7-19  |  |
| A. Counting Room . . . . .  | 7-19  |  |
| B. Radiochemistry Laboratory . . . . .  | 7-19  |  |
| C. Laboratory Safety . . . . .  | 7-20  |  |
| D. Pollution Prevention . . . . .   | 7-20  |  |
| E. Waste Management . . . . .   | 7-21  |  |
| <b>7110 GROSS ALPHA AND GROSS BETA</b>  |       |  |
| RADIOACTIVITY (TOTAL, SUSPENDED, AND DISSOLVED) . . . . .                                     | 7-21  |  |
| A. Introduction . . . . .   | 7-21  |  |
| B. Evaporation Method for Gross Alpha-Beta . . . . .  | 7-21  |  |
| C. Coprecipitation Method for Gross Alpha Radioactivity in Drinking Water . . . . .           | 7-25  |  |
| <b>7120 GAMMA-EMITTING RADIONUCLIDES</b> . . . . .  | 7-26  |  |
| A. Introduction . . . . .   | 7-26  |  |
| B. Gamma Spectroscopic Method . . . . .   | 7-26  |  |
| <b>7500-Cs RADIOACTIVE CESIUM</b> . . . . .   | 7-30  |  |
| A. Introduction . . . . .   | 7-30  |  |
| B. Precipitation Method . . . . .   | 7-30  |  |
| <b>7500-I RADIOACTIVE IODINE</b> . . . . .  | 7-31  |  |
| A. Introduction . . . . .   | 7-31  |  |
| B. Precipitation Method . . . . .   | 7-32  |  |
| C. Ion-Exchange Method . . . . .  | 7-33  |  |
| D. Distillation Method . . . . .  | 7-34  |  |
| <b>7500-Ra RADIUM</b> . . . . .   | 7-35  |  |
| A. Introduction . . . . .   | 7-35  |  |
| B. Precipitation Method . . . . .   | 7-35  |  |
| C. Emanation Method . . . . .   | 7-38  |  |
| D. Sequential Precipitation Method . . . . .  | 7-44  |  |
| E. Gamma Spectroscopy Method . . . . .  | 7-46  |  |
| <b>7500-Rn RADON</b> . . . . .  | 7-51  |  |
| A. Introduction . . . . .   | 7-51  |  |
| B. Liquid Scintillation Method . . . . .  | 7-51  |  |
| <b>7500-Sr TOTAL RADIOACTIVE STRONTIUM AND STRONTIUM-90</b> . . . . .                         | 7-54  |  |
| A. Introduction . . . . .   | 7-54  |  |
| B. Precipitation Method . . . . .   | 7-54  |  |
| <b>7500-<sup>3</sup>H TRITIUM</b> . . . . .   | 7-58  |  |
| A. Introduction . . . . .   | 7-58  |  |
| B. Liquid Scintillation Spectrometric Method . . . . .  | 7-58  |  |
| <b>7500-U URANIUM</b> . . . . .   | 7-59  |  |
| A. Introduction . . . . .   | 7-59  |  |
| B. Radiochemical Method . . . . .   | 7-60  |  |
| C. Isotopic Method . . . . .  | 7-61  |  |
| <b>Part 8000 TOXICITY</b>   |       |  |
| <b>8010 INTRODUCTION</b> . . . . .  | 8-1   |  |
| A. General Discussion . . . . .   | 8-1   |  |
| B. Terminology . . . . .  | 8-2   |  |
| C. Basic Requirements for Toxicity Tests . . . . .  | 8-3   |  |
| D. Conducting Toxicity Tests . . . . .  | 8-4   |  |
| E. Preparing Organisms for Toxicity Tests . . . . .   | 8-7   |  |
| F. Toxicity Test Systems, Materials, and Procedures . . . . .                                 | 8-15  |  |
| G. Calculating, Analyzing, and Reporting Results of Toxicity Tests . . . . .                  | 8-21  |  |
| H. Interpreting and Applying Results of Toxicity Tests . . . . .                              | 8-24  |  |
| I. Selected Toxicological Literature . . . . .  | 8-26  |  |
| <b>8020 QUALITY ASSURANCE AND QUALITY CONTROL IN LABORATORY TOXICITY TESTS</b> . . . . .      | 8-26  |  |
| A. General Discussion . . . . .   | 8-26  |  |
| B. Elements of QA/QC . . . . .  | 8-27  |  |
| <b>8030 MUTAGENESIS</b> . . . . .   | 8-30  |  |
| A. Introduction . . . . .   | 8-30  |  |
| B. <i>Salmonella</i> Microsomal Mutagenicity Test . . . . .                                   | 8-32  |  |
| <b>8050 BACTERIAL BIOLUMINESCENCE</b> . . . . .   | 8-38  |  |
| A. Introduction . . . . .   | 8-38  |  |
| B. Bacterial Bioluminescence Test . . . . .   | 8-38  |  |
| <b>8070 P450 REPORTER GENE RESPONSE TO DIOXIN-LIKE ORGANIC COMPOUNDS</b> . . . . .            | 8-42  |  |
| A. Introduction . . . . .   | 8-42  |  |
| B. The P450 RGS Test . . . . .  | 8-42  |  |
| <b>8071 COMET/SINGLE-CELL GEL ELECTROPHORESIS ASSAY FOR DETECTION OF DNA DAMAGE</b> . . . . . | 8-44  |  |
| A. Introduction . . . . .   | 8-44  |  |
| B. Comet/Single-Cell Gel Electrophoresis Assay . . . . .                                      | 8-44  |  |
| <b>8080 SEDIMENT POREWATER TESTING</b> . . . . .  | 8-48  |  |
| A. Introduction . . . . .   | 8-48  |  |
| B. Sediment Collection and Storage . . . . .  | 8-49  |  |

|  |      |   |       |
|--|------|---|-------|
| C. Extraction of Sediment Pore Water . . . . .   | 8-49 | D. Sediment Test Procedures Using the<br>Marine Polychaete <i>Neanthes<br/>arenaceodentata</i> . . . . .  | 8-94  |
| D. Toxicity Testing Procedures . . . . .   | 8-51 | E. Sediment Test Procedures Using the<br>Marine Polychaete <i>Polydora cornuta</i> .  | 8-97  |
| 8110 ALGAE . . . . .   | 8-52 | F. Sediment Test Procedures Using the<br>Freshwater and Marine Oligochaetes<br><i>Pristina leidyi</i> , <i>Tubifex tubifex</i> , and<br><i>Lumbriculus variegatus</i> . . . . . | 8-98  |
| 8111 BIOSTIMULATION (ALGAL PRODUCTIVITY) . .   | 8-53 | G. Data Evaluation . . . . .  | 8-99  |
| A. General Principles . . . . .  | 8-53 | 8610 MOLLUSKS . . . . .   | 8-99  |
| B. Planning and Evaluating Algal Assays .  | 8-53 | A. Introduction . . . . .   | 8-99  |
| C. Apparatus . . . . .   | 8-54 | B. Selecting and Preparing<br>Test Organisms . . . . .  | 8-100 |
| D. Sample Handling . . . . .   | 8-55 | C. Short-Term Test Procedures Using<br>Marine Mollusk Larvae . . . . .  | 8-101 |
| E. Synthetic Algal Culture Medium . . . . .  | 8-55 | D. Sediment Bioaccumulation Test<br>Procedures Using Marine Bivalves .  | 8-104 |
| F. Inoculum . . . . .  | 8-55 | E. Field Test Procedures Using Freshwater<br>and Marine Bivalves . . . . .  | 8-106 |
| G. Test Conditions and Procedures . . . . .  | 8-56 | 8710 ARTHROPODS . . . . .   | 8-110 |
| H. Effect of Additions . . . . .   | 8-57 | 8711 DAPHNIA . . . . .  | 8-110 |
| I. Data Analysis and Interpretation . . . . .  | 8-58 | A. Introduction . . . . .   | 8-110 |
| 8112 PHYTOPLANKTON . . . . .   | 8-59 | B. Selecting and Preparing<br>Test Organisms . . . . .  | 8-112 |
| A. Introduction . . . . .  | 8-59 | C. Toxicity Test Procedures . . . . .   | 8-114 |
| B. Inoculum . . . . .  | 8-59 | 8712 CERIODAPHNIA . . . . .   | 8-116 |
| C. Test Conditions and Procedures . . . . .  | 8-59 | A. Introduction . . . . .   | 8-116 |
| 8113 MARINE MACROALGAE . . . . .   | 8-60 | B. Selecting and Preparing<br>Test Organisms . . . . .  | 8-117 |
| A. Introduction . . . . .  | 8-60 | C. Toxicity Test Procedures . . . . .   | 8-119 |
| B. Selecting and Preparing <i>Macrocystis<br/>pyrifera</i> Sporophylls . . . . .                                       | 8-60 | 8714 MYSIDS . . . . .   | 8-121 |
| C. Toxicity Test Procedures . . . . .  | 8-62 | A. Introduction . . . . .   | 8-121 |
| D. Data Evaluation . . . . .   | 8-65 | B. Selecting and Preparing<br>Test Organisms . . . . .  | 8-122 |
| 8200 AQUATIC FLOWERING PLANTS . . . . .  | 8-66 | C. Toxicity Test Procedures . . . . .   | 8-127 |
| 8211 DUCKWEED . . . . .  | 8-66 | 8740 DECAPODS . . . . .   | 8-131 |
| A. Introduction . . . . .  | 8-66 | A. Introduction . . . . .   | 8-131 |
| B. Selecting and Preparing<br>Test Organisms . . . . .   | 8-67 | B. Selecting and Preparing<br>Test Organisms . . . . .  | 8-132 |
| C. Toxicity Test Procedure . . . . .   | 8-68 | C. Toxicity Test Procedures . . . . .   | 8-139 |
| 8220 AQUATIC EMERGENT PLANTS . . . . .   | 8-70 | D. Data Evaluation . . . . .  | 8-143 |
| A. Introduction . . . . .  | 8-70 | 8750 AQUATIC INSECTS . . . . .  | 8-143 |
| B. Selecting and Preparing<br>Test Organisms . . . . .   | 8-71 | A. Introduction . . . . .   | 8-143 |
| C. Toxicity Test Procedure . . . . .   | 8-72 | B. Selecting and Preparing<br>Test Organisms . . . . .  | 8-144 |
| 8310 CILIATED PROTOZOA . . . . .   | 8-74 | C. Toxicity Test Procedures . . . . .   | 8-146 |
| A. Introduction . . . . .  | 8-74 | D. Data Evaluation . . . . .  | 8-150 |
| B. Growth Inhibition Test with Freshwater<br>Ciliate <i>Dexiostoma</i> (syn. <i>Colpidium<br/>campylum</i> ) . . . . . | 8-75 | 8810 ECHINODERM FERTILIZATION AND<br>DEVELOPMENT . . . . .  | 8-150 |
| C. Chemotactic Test with Freshwater<br>Ciliate <i>Tetrahymena thermophila</i> . .                                      | 8-77 | A. Introduction . . . . .   | 8-150 |
| D. Growth Inhibition Test with the Soil<br>Ciliate <i>Colpoda inflata</i> . . . . .                                    | 8-79 | B. Selecting and Preparing<br>Test Organisms . . . . .  | 8-151 |
| 8420 ROTIFERS . . . . .  | 8-80 | C. Echinoderm Fertilization Test . . . . .  | 8-153 |
| A. Introduction . . . . .  | 8-80 |   |       |
| B. Selecting and Preparing<br>Test Organisms . . . . .   | 8-81 |   |       |
| C. Toxicity Test Procedures . . . . .  | 8-82 |   |       |
| 8510 ANNELEIDS . . . . .   | 8-84 |   |       |
| A. Introduction . . . . .  | 8-84 |   |       |
| B. Selecting and Preparing<br>Test Organisms . . . . .   | 8-85 |   |       |
| C. Toxicity Test Procedures . . . . .  | 8-91 |   |       |

|   |       |  |      |
|---|-------|--|------|
| D. Echinoderm Embryo Development<br>Test . . . . .                          | 8-157 | C. Spread Plate Method . . . . .   | 9-57 |
| 8910 FISH . . . . .   | 8-160 | D. Membrane Filter Method . . . . .  | 9-58 |
| A. Introduction . . . . .   | 8-160 | E. Enzyme Substrate Method . . . . .   | 9-59 |
| B. Fish Selection and Culture Procedures . . . . .                          | 8-160 | 9216 DIRECT TOTAL MICROBIAL COUNT . . . . .  | 9-60 |
| C. Toxicity Test Procedures . . . . .                                       | 8-164 | A. Introduction . . . . .  | 9-60 |
| 8921 FATHEAD MINNOW . . . . .   | 8-171 | B. Epifluorescence Microscopic Method<br>Using Acridine Orange . . . . .   | 9-60 |
| A. Introduction . . . . .   | 8-171 | 9217 ASSIMILABLE ORGANIC CARBON . . . . .  | 9-62 |
| B. Culture and Maintenance of<br>Test Organisms . . . . .                   | 8-172 | A. Introduction . . . . .  | 9-62 |
| C. Toxicity Test Procedures . . . . .                                       | 8-173 | B. <i>Pseudomonas fluorescens</i> Strain P-17,<br><i>Spirillum</i> Strain NOX Method . . . . .                                       | 9-64 |
| 8930 AMPHIBIANS (PROPOSED) . . . . .  | 8-180 | 9218 AEROBIC ENDOSPORES . . . . .  | 9-67 |
| A. Introduction . . . . .   | 8-180 | A. Introduction . . . . .  | 9-67 |
| B. Culture and Maintenance of<br>Test Organisms . . . . .                   | 8-181 | B. Membrane Filter Method . . . . .  | 9-67 |
| C. Toxicity Test Procedures . . . . .                                       | 8-184 | 9221 MULTIPLE-TUBE FERMENTATION TECHNIQUE<br>FOR MEMBERS OF THE COLIFORM GROUP . . . . .   | 9-68 |
| <b>Part 9000 MICROBIOLOGICAL EXAMINATION</b>                                |       | A. Introduction . . . . .  | 9-68 |
| 9010 INTRODUCTION . . . . .   | 9-1   | B. Standard Total Coliform Fermentation<br>Technique . . . . .   | 9-69 |
| 9020 QUALITY ASSURANCE/QUALITY CONTROL . . . . .                            | 9-2   | C. Estimation of Bacterial Density . . . . .   | 9-72 |
| A. Introduction . . . . .   | 9-2   | D. Presence-Absence (P-A) Coliform<br>Test . . . . .   | 9-75 |
| B. Intralaboratory Quality Control<br>Guidelines . . . . .                  | 9-4   | E. Thermotolerant (Fecal) Coliform<br>Procedure . . . . .  | 9-77 |
| C. Interlaboratory Quality Control . . . . .                                | 9-27  | F. <i>Escherichia coli</i> Procedure Using<br>Fluorogenic Substrate . . . . .  | 9-78 |
| 9030 LABORATORY APPARATUS . . . . .   | 9-29  | G. Other <i>Escherichia coli</i> Procedures . . . . .  | 9-80 |
| A. Introduction . . . . .   | 9-29  | 9222 MEMBRANE FILTER TECHNIQUE FOR MEMBERS<br>OF THE COLIFORM GROUP . . . . .  | 9-81 |
| B. Equipment Specifications . . . . .                                       | 9-29  | A. Introduction . . . . .  | 9-81 |
| 9040 WASHING AND STERILIZATION . . . . .                                    | 9-33  | B. Standard Total Coliform Membrane<br>Filter Procedure using Endo Media . . . . .   | 9-82 |
| 9050 PREPARATION OF CULTURE MEDIA . . . . .                                 | 9-34  | C. Delayed-Incubation Total Coliform<br>Procedure . . . . .  | 9-88 |
| A. General Procedures . . . . .   | 9-34  | D. Thermotolerant (Fecal) Coliform<br>Membrane Filter Procedure . . . . .  | 9-89 |
| B. Water . . . . .  | 9-35  | E. Delayed-Incubation Thermotolerant<br>(Fecal) Coliform Procedure . . . . .   | 9-91 |
| C. Media Specifications . . . . .   | 9-35  | F. <i>Klebsiella</i> Membrane Filter Procedure . . . . .   | 9-92 |
| 9060 SAMPLES . . . . .  | 9-36  | G. Partitioning Thermotolerant Coliforms<br>from MF Total Coliform Using EC<br>Broth . . . . .                                       | 9-93 |
| A. Collection . . . . .   | 9-36  | H. Partitioning <i>E. coli</i> from MF Total<br>Coliform using EC-MUG Broth . . . . .  | 9-94 |
| B. Preservation and Storage . . . . .                                       | 9-39  | I. Partitioning <i>E. coli</i> from MF Total<br>Coliforms using NA-MUG Agar . . . . .  | 9-95 |
| 9211 RAPID DETECTION METHODS . . . . .                                      | 9-40  | J. Simultaneous Detection of Total<br>Coliform and <i>E. coli</i> by Dual-<br>Chromogen Membrane Filter<br>Procedure . . . . .       | 9-96 |
| A. Introduction . . . . .   | 9-40  | K. Simultaneous Detection of Total<br>Coliforms and <i>E. coli</i> by Fluorogen/<br>Chromogen Membrane Filter<br>Procedure . . . . . | 9-97 |
| B. Seven-Hour Fecal Coliform Test . . . . .                                 | 9-40  |  |      |
| C. Special Techniques . . . . .   | 9-40  |  |      |
| 9212 STRESSED MICROORGANISMS . . . . .                                      | 9-42  |  |      |
| A. Introduction . . . . .   | 9-42  |  |      |
| B. Recovery Enhancement . . . . .   | 9-44  |  |      |
| 9213 RECREATIONAL WATERS . . . . .  | 9-45  |  |      |
| A. Introduction . . . . .   | 9-45  |  |      |
| B. Swimming Pools . . . . .   | 9-46  |  |      |
| C. Whirlpools . . . . .   | 9-49  |  |      |
| D. Natural Bathing Beaches . . . . .  | 9-49  |  |      |
| E. Membrane Filter Technique for<br><i>Pseudomonas aeruginosa</i> . . . . . | 9-51  |  |      |
| F. Multiple-Tube Technique for<br><i>Pseudomonas aeruginosa</i> . . . . .   | 9-52  |  |      |
| 9215 HETEROTROPHIC PLATE COUNT . . . . .                                    | 9-53  |  |      |
| A. Introduction . . . . .   | 9-53  |  |      |
| B. Pour Plate Method . . . . .  | 9-56  |  |      |
| 9223 ENZYME SUBSTRATE COLIFORM TEST . . . . .                               | 9-98  |  |      |

|   |       |  |       |
|---|-------|--|-------|
| A. Introduction . . . . .   | 9-98  | B. Virus Concentration from Small Sample Volumes by Adsorption to and Elution from Microporous Filters . . . | 9-194 |
| B. Enzyme Substrate Test . . . . .  | 9-99  | C. Virus Concentration from Large Sample Volumes by Adsorption to and Elution from Microporous Filters . . . | 9-196 |
| 9224 DETECTION OF COLIPHAGES . . . . .  | 9-102 | D. Virus Concentration by Aluminum Hydroxide Adsorption-Precipitation . .                                    | 9-201 |
| A. Introduction . . . . .   | 9-102 | E. Hydroextraction-Dialysis with Polyethylene Glycol . . . . .   | 9-202 |
| B. Somatic Coliphage Assay . . . . .  | 9-103 | F. Recovery of Viruses from Suspended Solids in Water and Wastewater . . .                                   | 9-203 |
| C. Male-Specific Coliphage Assay Using <i>Escherichia coli</i> Famp . . . . .     | 9-105 | G. Assay and Identification of Viruses in Sample Concentrates . . . . .                                      | 9-205 |
| D. Male-Specific Coliphage Assay Using <i>Salmonella typhimurium</i> WG49 . . . . | 9-106 | 9610 DETECTION OF FUNGI . . . . .  | 9-208 |
| E. Single-Agar-Layer Method . . . . .   | 9-108 | A. Introduction . . . . .  | 9-208 |
| F. Membrane Filter Method . . . . .   | 9-109 | B. Pour Plate Technique . . . . .  | 9-212 |
| 9225 DIFFERENTIATION OF COLIFORM BACTERIA . . . . .                               | 9-110 | C. Spread Plate Technique . . . . .  | 9-213 |
| A. Introduction . . . . .   | 9-110 | D. Membrane Filter Technique . . . . .   | 9-214 |
| B. Culture Purification . . . . .   | 9-111 | E. Technique for Yeasts . . . . .  | 9-215 |
| C. Identification . . . . .   | 9-112 | F. Zoosporic Fungi . . . . .   | 9-215 |
| D. Media, Reagents, and Procedures . . .  | 9-114 | G. Aquatic Hyphomycetes . . . . .  | 9-217 |
| E. Reporting Results . . . . .  | 9-117 | H. Fungi Pathogenic to Humans . . . . .  | 9-217 |
| 9230 FECAL ENTEROCOCCUS/STREPTOCOCCUS GROUPS . . . . .                            | 9-117 | I. Polymerase Chain Reaction (PCR) Methods . . . . .   | 9-218 |
| A. Introduction . . . . .   | 9-117 | 9711 PATHOGENIC PROTOZOA . . . . .   | 9-219 |
| B. Multiple-Tube Technique . . . . .  | 9-118 | A. Introduction . . . . .  | 9-219 |
| C. Membrane Filter Techniques . . . . .   | 9-119 | B. Detection of <i>Giardia</i> and <i>Cryptosporidium</i> in Water . . . . .                                 | 9-224 |
| D. Fluorogenic Substrate Enterococcus Test . . . . .                              | 9-122 | C. Detection of <i>Giardia</i> and <i>Cryptosporidium</i> in Wastewater . . . . .                            | 9-230 |
| 9240 IRON AND SULFUR BACTERIA . . . . .   | 9-123 | D. Infectivity of <i>Cryptosporidium</i> in Cell Culture . . . . .   | 9-231 |
| A. Introduction . . . . .   | 9-123 |  |       |
| B. Iron Bacteria . . . . .  | 9-124 |  |       |
| C. Sulfur Bacteria . . . . .  | 9-129 |  |       |
| D. Enumerating, Enriching, and Isolating Iron and Sulfur Bacteria . . . . .       | 9-131 |  |       |
| E. Bacteria Living in Acidic Environments . . . . .                               | 9-137 |  |       |
| 9245 NITRIFYING BACTERIA . . . . .  | 9-142 |  |       |
| A. Introduction . . . . .   | 9-142 | <b>Part 10000 BIOLOGICAL EXAMINATION</b>   |       |
| B. Multiple-Tube Method . . . . .   | 9-144 | 10010 INTRODUCTION . . . . .   | 10-1  |
| 9250 DETECTION OF ACTINOMYCETES . . . . .   | 9-145 | 10200 PLANKTON . . . . .   | 10-2  |
| A. Introduction . . . . .   | 9-145 | A. Introduction . . . . .  | 10-2  |
| B. Actinomycete Plate Count . . . . .   | 9-147 | B. Sample Collection . . . . .   | 10-3  |
| 9260 DETECTION OF PATHOGENIC BACTERIA . . . . .                                   | 9-149 | C. Concentration Techniques . . . . .  | 10-11 |
| A. Introduction . . . . .   | 9-149 | D. Preparing Slide Mounts . . . . .  | 10-13 |
| B. <i>Salmonella</i> . . . . .  | 9-152 | E. Microscopes and Calibrations . . . . .  | 10-15 |
| C. (Reserved) . . . . .   | 9-157 | F. Phytoplankton Counting Techniques . .   | 10-17 |
| D. (Reserved) . . . . .   | 9-157 | G. Zooplankton Counting Techniques . .   | 10-21 |
| E. <i>Shigella</i> . . . . .  | 9-157 | H. Chlorophyll . . . . .   | 10-22 |
| F. Diarrheagenic <i>Escherichia coli</i> . . . .                                  | 9-160 | I. Determination of Biomass (Standing Crop) . . . . .  | 10-30 |
| G. <i>Campylobacter</i> . . . . .   | 9-165 | J. Metabolic Rate Measurements . . . . .   | 10-32 |
| H. <i>Vibrio</i> . . . . .  | 9-167 | 10300 PERIPHYTON . . . . .   | 10-36 |
| I. <i>Leptospira</i> . . . . .  | 9-174 | A. Introduction . . . . .  | 10-36 |
| J. <i>Legionella</i> . . . . .  | 9-177 | B. Sample Collection . . . . .   | 10-36 |
| K. <i>Yersinia enterocolitica</i> . . . . .                                       | 9-181 | C. Sample Analysis . . . . .   | 10-38 |
| L. <i>Aeromonas</i> . . . . .   | 9-185 | D. Primary Productivity . . . . .  | 10-41 |
| M. <i>Mycobacterium</i> . . . . .   | 9-187 | E. Interpreting and Reporting Results . .  | 10-50 |
| 9510 DETECTION OF ENTERIC VIRUSES . . . . .                                       | 9-191 |  |       |
| A. Introduction . . . . .   | 9-191 |  |       |

|       |   |        |       |  |        |
|-------|---|--------|-------|--|--------|
| 10400 | MACROPHYTES . . . . .                       | 10-52  | 10750 | NEMATOLOGICAL EXAMINATION . . . . .        | 10-102 |
|       | A. Introduction . . . . .                   | 10-52  |       | A. Introduction . . . . .                  | 10-102 |
|       | B. Preliminary Survey . . . . .             | 10-53  |       | B. Collection and Processing Techniques    |        |
|       | C. Vegetation Mapping Methods . . . . .     | 10-53  |       | for Nematodes . . . . .                    | 10-104 |
|       | D. Population Estimates . . . . .           | 10-55  |       | C. Illustrated Key to Freshwater           |        |
|       | E. Productivity . . . . .                   | 10-59  |       | Nematodes . . . . .                        | 10-106 |
| 10500 | BENTHIC MACROINVERTEBRATES . . . . .        | 10-67  | 10900 | IDENTIFICATION OF AQUATIC ORGANISMS . . .  | 10-122 |
|       | A. Introduction . . . . .                   | 10-67  |       | A. Identification Procedure . . . . .      | 10-122 |
|       | B. Sample Collection . . . . .              | 10-70  |       | B. Key to Major Groups of Aquatic          |        |
|       | C. Sample Processing and Analysis . . . . . | 10-79  |       | Organisms (Plates 1-40) . . . . .          | 10-122 |
|       | D. Data Evaluation, Presentation, and       |        |       | Acknowledgments . . . . .                  | 10-126 |
|       | Conclusions . . . . .                       | 10-81  |       | C. Key for Identification of Common        |        |
| 10600 | FISHES . . . . .                            | 10-84  |       | Freshwater Algae (Plates 1A, 1B,           |        |
|       | A. Introduction . . . . .                   | 10-84  |       | 4A, 4B, and 28-40) . . . . .               | 10-160 |
|       | B. Data Acquisition . . . . .               | 10-85  |       | D. Index to Illustrations . . . . .        | 10-165 |
|       | C. Sample Preservation . . . . .            | 10-94  |       | E. Selected Taxonomic References . . . . . | 10-168 |
|       | D. Analysis of Collections . . . . .        | 10-95  |       |  |        |
|       | E. Investigation of Fish Kills . . . . .    | 10-100 |       |  |        |
| 10700 | BENTHIC MEIOFAUNA . . . . .                 | 10-101 |       |  |        |

## INDEX

I-1

## FIGURES

|        |  |      |           |   |       |
|--------|--|------|-----------|---|-------|
| 1010:1 | Three types of frequency distribution curves—normal Gaussian (A), positively skewed (B), and negatively skewed (C)—and their measures of central tendency: mean, median, and mode. . . . . | 1-2  | 2710:3    | Capillary suction time apparatus. . . . .   | 2-97  |
|        |  |      | 2710:4    | TTF equipment. . . . .  | 2-98  |
|        |  |      | 2710:5    | Schematic diagram of settling column and stirring rods for modified sludge volume test. . . . .             | 2-99  |
| 1020:1 | Control charts for means. . . . .  | 1-12 | 2720:1    | Gas collection apparatus. . . . .   | 2-100 |
| 1020:2 | Duplicate analyses of a standard. . . . .  | 1-12 | 2810:1    | Time response for the membrane-diffusion method. . . . .  | 2-106 |
| 1020:3 | Range chart for variable concentrations. .   | 1-13 | 3112:1    | Schematic arrangement of equipment for measuring mercury by cold-vapor atomic absorption technique. . . . . | 3-26  |
| 1020:4 | Range chart for variable ranges. . . . .   | 1-13 |           | Manual reaction cell for producing As and Se hydrides. . . . .  | 3-37  |
| 1020:5 | Means control chart with out-of-control data. . . . .  | 1-14 | 3114:1    | Schematic of a continuous hydride generator. . . . .  | 3-41  |
| 1030:1 | Detection level relationship. . . . .  | 1-21 |           | Correction curves for estimation of aluminum in the presence of fluoride. .                                 | 3-64  |
| 1060:1 | Approximate number of samples required in estimating a mean concentration. . .   | 1-43 | 3114:2    | Arsine generator and absorber assembly. . . . .   | 3-67  |
| 2120:1 | Chromaticity diagrams. . . . .   | 2-10 | 3500-Al:1 | General scheme for speciation of selenium in water. . . . .   | 3-92  |
| 2150:1 | Odor-free-water generator. . . . .   | 2-17 |           | Graphical method of computing strontium concentration. . . . .  | 3-102 |
| 2170:1 | Taste and odor wheel . . . . .   | 2-27 | 3500-As:1 | Typical inorganic anion separation. . . . .   | 4-8   |
| 2530:1 | Floatables sampler with mixer. . . . .   | 2-63 |           | Typical inorganic anion separation. . . . .   | 4-10  |
| 2530:2 | Floatables flotation funnel and filter holder. . . . .   | 2-64 | 3500-Se:1 | Typical separation in a simulated drinking water sample. . . . .  | 4-12  |
| 2530:3 | Flotation funnels and mixing unit. . . . .   | 2-64 | 3500-Sr:1 | Schematic of a segmented flow analyzer. . . . .   | 4-15  |
| 2530:4 | Floatable oil tube, 1-L capacity. . . . .  | 2-66 |           |   |       |
| 2560:1 | Schematic of filtration apparatus for preparing particle-free dilution water or electrolyte solution. . . . .  | 2-76 |           |   |       |
| 2710:1 | Schematic diagram of settling vessel for settled sludge volume test. . . . .   | 2-94 | 4110:1    |   |       |
| 2710:2 | Schematic diagram of settling vessel for zone settling rate test. . . . .  | 2-95 | 4110:2    |   |       |
|        |  |      | 4110:3    |   |       |
|        |  |      | 4120:1    |   |       |

|                                      |  |       |  |  |  |
|--------------------------------------|--|-------|--|--|--|
| 4140:1                               | Electropherogram of the inorganic anions and typically found organic acids using capillary ion electrophoresis and chromate electrolyte. . . . . | 4-18  | 4500-N <sub>org</sub> :1<br>4500-N <sub>org</sub> :2<br>4500-O:1<br>4500-O:2 | Micro-Kjeldahl distillation apparatus. . . . .<br>FIA total Kjeldahl nitrogen manifold. . . . .<br>DO and BOD sampler assembly. . . . .<br>Effect of temperature on electrode sensitivity. . . . .<br>The salting-out effect at different temperatures. . . . .<br>Typical trend of effect of stirring on electrode response. . . . .<br>Steps for analysis of phosphate fractions. . . . .<br>Phosphate manifold for automated analytical system. . . . .<br>FIA orthophosphate manifold. . . . .<br>FIA total phosphorus manifold. . . . .<br>FIA in-line total phosphorus manifold. . . . .<br>Correlation between manual and in-line total phosphorus methods. . . . .<br>Silica manifold. . . . .<br>FIA manifold. . . . .<br>Analytical flow paths for sulfide determination. . . . .<br>Sulfide manifold. . . . .<br>Proportion of H <sub>2</sub> S and HS <sup>-</sup> in dissolved sulfide. . . . .<br>FIA sulfide manifold. . . . .<br>Apparatus for acid-volatile sulfide analysis. . . . .<br>Apparatus for evolution of SO <sub>2</sub> from samples for colorimetric analysis. . . . .<br>Sulfate manifold. . . . .<br>4500-SO <sub>4</sub> <sup>2-</sup> :1<br>4500-SO <sub>4</sub> <sup>2-</sup> :2<br>4500-SO <sub>4</sub> <sup>2-</sup> :3<br>4500-SO <sub>4</sub> <sup>2-</sup> :4<br>4500-SO <sub>4</sub> <sup>2-</sup> :5 | 4-141<br>4-142<br>4-145<br>4-150<br>4-150<br>4-151<br>4-158<br>4-165<br>4-167<br>4-168<br>4-169<br>4-170<br>4-179<br>4-180<br>4-182<br>4-186<br>4-190<br>4-192<br>4-193<br>4-195<br>4-201<br>4-202<br>5-43<br>5-54<br>5-65<br>8-68<br>5-69<br>5-69<br>6-13<br>6-13<br>6-14<br>6-14<br>6-15 |
| 4140:2                               | Electropherogram of 0.1 mg/L inorganic anions at minimum detection level. . . . .  | 4-19  | 4500-O:3   |  |  |
| 4140:3                               | Representative electropherograms of Youden anion standards. . . . .  | 4-20  | 4500-O:4   |  |  |
| 4140:4                               | Linearity calibration curve for chloride, bromide, and sulfate. . . . .  | 4-21  | 4500-P:1   |  |  |
| 4140:5                               | Linearity calibration curve for fluoride and <i>o</i> -phosphate. . . . .  | 4-21  | 4500-P:2   |  |  |
| 4140:6                               | Linearity calibration curve for nitrite and nitrate. . . . .   | 4-21  | 4500-P:3   |  |  |
| 4140:7                               | Electropherogram of typical drinking water. . . . .  | 4-22  | 4500-P:4<br>4500-P:5<br>4500-P:6   |  |  |
| 4140:8                               | Electropherogram of typical municipal wastewater discharge, undiluted. . . . .   | 4-22  |  |  |  |
| 4140:9                               | Electropherogram of typical industrial wastewater discharge, undiluted. . . . .  | 4-22  | 4500-SiO <sub>2</sub> :1   |  |  |
| 4500-Br <sup>-</sup> :1              | FIA bromide manifold. . . . .  | 4-31  | 4500-S <sup>2-</sup> :1  |  |  |
| 4500-CO <sub>2</sub> :1              | Nomograph for evaluation of hydroxide ion concentration. . . . .   | 4-34  | 4500-S <sup>2-</sup> :2  |  |  |
| 4500-CO <sub>2</sub> :2              | Nomograph for evaluation of bicarbonate alkalinity. . . . .  | 4-35  | 4500-S <sup>2-</sup> :3  |  |  |
| 4500-CO <sub>2</sub> :3              | Nomograph for evaluation of carbonate alkalinity. . . . .  | 4-36  | 4500-S <sup>2-</sup> :4  |  |  |
| 4500-CO <sub>2</sub> :4              | Nomograph for evaluation of free carbon dioxide content. . . . .   | 4-37  | 4500-S <sup>2-</sup> :5  |  |  |
| 4500-CN <sup>-</sup> :1              | Cyanide distillation apparatus. . . . .  | 4-44  | 4500-SO <sub>3</sub> <sup>2-</sup> :1  |  |  |
| 4500-CN <sup>-</sup> :2              | FIA cyanide manifold. . . . .  | 4-58  | 4500-SO <sub>4</sub> <sup>2-</sup> :1  |  |  |
| 4500-CN <sup>-</sup> :3              | FIA in-line total and WAD cyanide manifold. . . . .  | 4-60  | 4500-SO <sub>4</sub> <sup>2-</sup> :2  |  |  |
| 4500-Cl <sup>-</sup> :1              | Example of differential titration curve (endpoint is 25.5 mL). . . . .   | 4-78  | 5520:1<br>5540:1<br>5560:1   |  |  |
| 4500-Cl <sup>-</sup> :2              | Flow scheme for automated chloride analysis. . . . .   | 4-79  | 5710:1   |  |  |
| 4500-Cl <sup>-</sup> :3              | FIA chloride manifold. . . . .   | 4-80  |  |  |  |
| 4500-ClO <sub>2</sub> :1             | Chlorine dioxide generation and absorption system. . . . .   | 4-83  |  |  |  |
| 4500-F <sup>-</sup> :1               | Direct distillation apparatus for fluoride. . . . .  | 4-88  |  |  |  |
| 4500-F <sup>-</sup> :2               | Fluoride manifold. . . . .   | 4-92  | 5710:2a  |  |  |
| 4500-F <sup>-</sup> :3               | FIA fluoride manifold. . . . .   | 4-93  |  |  |  |
| 4500-H <sup>+</sup> :1               | Electrode potential vs. pH. . . . .  | 4-96  |  |  |  |
| 4500-H <sup>+</sup> :2               | Typical pH electrode response as a function of temperature. . . . .  | 4-96  | 5710:2b  |  |  |
| 4500-N:1                             | FIA in-line total nitrogen manifold. . . . .   | 4-109 |  |  |  |
| 4500-N:2                             | Continuous-flow conductimetric analyzer system. . . . .  | 4-113 |  |  |  |
| 4500-NH <sub>3</sub> :1              | Ammonia manifold. . . . .  | 4-121 | 6040:1   |  |  |
| 4500-NH <sub>3</sub> :2              | FIA ammonia manifold. . . . .  | 4-122 |  |  |  |
| 4500-NO <sub>3</sub> <sup>-</sup> :1 | Reduction column. . . . .  | 4-131 | 6040:2   |  |  |
| 4500-NO <sub>3</sub> <sup>-</sup> :2 | Nitrate-nitrite manifold. . . . .  | 4-133 | 6040:3   |  |  |
| 4500-NO <sub>3</sub> <sup>-</sup> :3 | Nitrate-nitrite manifold. . . . .  | 4-135 | 6040:4   |  |  |
| 4500-NO <sub>3</sub> <sup>-</sup> :4 | FIA nitrate + nitrite manifold. . . . .  | 4-136 | 6040:5   |  |  |

|         |   |      |         |   |       |
|---------|---|------|---------|---|-------|
| 6040:6  | Effect of filter resistance, measured as flow, on recovery of earthy-musty odorants and C <sub>1</sub> –C <sub>10</sub> internal standard. . . . .      | 6-15 | 6410:11 | Gas chromatogram of PCB-1254. . . . .   | 6-83  |
|         |   |      | 6410:12 | Gas chromatogram of PCB-1260. . . . .   | 6-83  |
|         |   |      | 6410:13 | Tailing factor calculation. . . . .   | 6-83  |
| 6040:7  | Mass spectrum of 2-methylisoborneol. . .  | 6-19 | 6420:1  | Gas chromatogram of phenols. . . . .  | 6-90  |
| 6040:8  | Mass spectrum of geosmin. . . . .   | 6-19 | 6420:2  | Gas chromatogram of PFB derivatives of phenols. . . . .                             | 6-90  |
| 6040:9  | Mass spectrum of IPMP with methanol as the chemical ionization reagent. . .   | 6-29 | 6440:1  | Liquid chromatogram of polynuclear aromatic hydrocarbons. . . . .                   | 6-96  |
| 6040:10 | Mass spectrum of IBMP with methanol as the chemical ionization reagent. . .   | 6-29 | 6440:2  | Liquid chromatogram of polynuclear aromatic hydrocarbons. . . . .                   | 6-97  |
| 6040:11 | Mass spectrum of MIB with methanol as the chemical ionization reagent. . . . .  | 6-29 | 6440:3  | Gas chromatogram of polynuclear aromatic hydrocarbons. . . . .                      | 6-97  |
| 6040:12 | Mass spectrum of geosmin with methanol as the chemical ionization reagent. . . . .  | 6-29 | 6450:1  | Typical chromatogram of a nitrosamine mix (200 µg/L) . . . . .                      | 6-106 |
| 6040:13 | Mass spectrum of TCA with methanol as the chemical ionization reagent. . . . .  | 6-29 | 6450:2  | Calibration curve for solid-phase extraction of NDMA (2–100 ng/L). . . . .          | 6-106 |
| 6200:1  | Purging device. . . . .   | 6-34 | 6450:3  | Example chromatogram of 200 ng/L MLLE extracted nitrosamine standard .              | 6-110 |
| 6200:2  | Trap packings and construction to include desorb capability. . . . .  | 6-34 | 6450:4  | Calibration curve for NDMA by micro liquid–liquid extraction (10–500 ng/L). . . . . | 6-111 |
| 6200:3  | GC/MS chromatogram. . . . .   | 6-37 | 6610:1  | Sample chromatogram of target analytes . . . . .                                    | 6-117 |
| 6200:4  | PID chromatogram. . . . .   | 6-41 |         | Results of gas chromatographic procedure for organochlorine pesticides. . . . .     | 6-123 |
| 6200:5  | ELCD chromatogram. . . . .  | 6-41 |         | Results of gas chromatographic procedure for organochlorine pesticides. . . . .     | 6-123 |
| 6211:1  | Combustible gas indicator circuit and flow diagram. . . . .   | 6-44 | 6630:1  | Chromatogram of pesticide mixture. . . . .  | 6-123 |
| 6231:1  | Extract of reagent water with 0.114 µg/L added EDB and DBCP. . . . .  | 6-47 | 6630:2  | Chromatogram of pesticide mixture. . . . .  | 6-124 |
| 6232:1  | Chromatogram for THMs and chlorinated organic solvents. . . . .   | 6-51 |         | Chromatogram of pesticide mixture. . . . .  | 6-124 |
| 6251:1  | Haloacetic acids separation from other commonly produced disinfection by-products on a DB-1701 column. . . . .  | 6-56 | 6630:3  | Gas chromatogram of pesticides. . . . .   | 6-131 |
| 6251:2  | Easy-to-use diazomethane generator apparatus for preparing small amounts of diazomethane in methyl <i>tertiary-butyl ether</i> ( <i>MtBE</i> ). . . . . | 6-57 | 6630:4  | Gas chromatogram of chlordane. . . . .  | 6-131 |
| 6251:3  | Easy-to-use alternative diazomethane generator for preparing small amounts of diazomethane in MtBE. . . . .   | 6-58 | 6630:5  | Gas chromatogram of toxaphene. . . . .  | 6-132 |
| 6251:4  | Chromatogram produced by reagent water with known additions. . . . .  | 6-60 | 6630:6  | Gas chromatogram of PCB-1016. . . . .   | 6-132 |
| 6252:1  | Chromatogram for analytical (primary) column. . . . .   | 6-70 | 6630:7  | Gas chromatogram of PCB-1221. . . . .   | 6-132 |
| 6252:2  | Chromatogram for confirmation column. .   | 6-70 | 6630:8  | Gas chromatogram of PCB-1232. . . . .   | 6-132 |
| 6410:1  | Gas chromatogram of base/neutral fraction. . . . .  | 6-80 | 6630:9  | Gas chromatogram of PCB-1242. . . . .   | 6-133 |
| 6410:2  | Gas chromatogram of acid fraction. . . . .  | 6-80 | 6630:10 | Gas chromatogram of PCB-1248. . . . .   | 6-133 |
| 6410:3  | Gas chromatogram of pesticide fraction. .   | 6-81 | 6630:11 | Gas chromatogram of PCB-1254. . . . .   | 6-133 |
| 6410:4  | Gas chromatogram of chlordane. . . . .  | 6-81 | 6630:12 | Gas chromatogram of PCB-1260. . . . .   | 6-133 |
| 6410:5  | Gas chromatogram of toxaphene. . . . .  | 6-81 | 6630:13 | Chromatogram of chlorphenoxy herbicides on a primary column. . . . .                | 6-141 |
| 6410:6  | Gas chromatogram of PCB-1016. . . . .   | 6-81 | 6630:14 | Chromatogram of the chlorphenoxy herbicides on confirmation column. . . . .         | 6-142 |
| 6410:7  | Gas chromatogram of PCB-1221. . . . .   | 6-82 | 6630:15 | Schematic of post-column reaction HPLC system. . . . .                              | 6-147 |
| 6410:8  | Gas chromatogram of PCB-1232. . . . .   | 6-82 | 6640:1  | Apparatus setup for HMB generation. . . . .   | 6-150 |
| 6410:9  | Gas chromatogram of PCB-1242. . . . .   | 6-82 | 6640:2  | Tributyl tin spectrum with selected ion monitoring. . . . .                         | 6-152 |
| 6410:10 | Gas chromatogram of PCB-1248. . . . .   | 6-82 | 6651:1  | Sample chromatogram for the electrospray ionization (ESI) positive method. . . . .  | 6-161 |

|           |   |       |        |  |       |
|-----------|---|-------|--------|--|-------|
| 6810:2    | Sample chromatogram for the electrospray ionization (ESI) negative method. . . . .  | 6-161 | 8610:2 | Schematic layout of cages, consisting of mesh bags attached to PVC frames, suspended from a line attached to a buoy at water surface and anchor at bottom. . . . . | 8-106 |
| 6810:3    | Representative calibration curve. . . . .   | 6-162 |        | Cage suspended from a fixed mooring. . .   | 8-108 |
| 7030:1    | Shape of counting rate-anode voltage curves. . . . .  | 7-14  | 8610:3 | Cages placed directly on sediment  |       |
| 7500-I:1  | Distillation apparatus for iodine analysis . . . . .  | 7-34  | 8610:4 | (above) and on attached legs a fixed distance above sediment (below). . . . .  | 8-108 |
| 7500-Ra:1 | De-emanation assembly. . . . .  | 7-39  | 8711:1 | <i>Daphnia</i> sp., adult female. . . . .  | 8-111 |
| 7500-Sr:1 | Yttrium-90 vs. strontium-90 activity as a function of time. . . . .   | 7-57  | 8711:2 | <i>Daphnia pulex</i> : (above) postabdomen; (below) postabdominal claw. . . . .  | 8-111 |
| 7500-U:1  | Electrodeposition apparatus. . . . .  | 7-62  | 8711:3 | <i>Daphnia magna</i> : (above) postabdomen; (below) postabdominal claw. . . . .  | 8-111 |
| 8010:1    | Holding tank design for fish and macroinvertebrates. . . . .  | 8-10  | 8712:1 | <i>Ceriodaphnia dubia</i> . . . . .  | 8-117 |
| 8010:2    | Algal culture units. . . . .  | 8-13  | 8712:2 | <i>Ceriodaphnia dubia</i> . . . . .  | 8-118 |
| 8010:3    | Basic components of flow-through system. . . . .  | 8-15  | 8712:3 | <i>Ceriodaphnia dubia</i> , toothed-pecten variety . . . . .   | 8-118 |
| 8050:1    | Incubator diagram for acute toxicity testing of one sample at multiple dilutions. . . . .   | 8-40  | 8714:1 | <i>Neomysis mercedis</i> . . . . .   | 8-122 |
| 8080:1    | Pneumatic system for porewater extraction. . . . .  | 8-49  | 8714:2 | <i>Americanamysis almyra</i> . . . . .   | 8-123 |
| 8080:2    | Detail of porewater extraction cylinder. . . . .  | 8-50  | 8714:3 | <i>Holmesimysis costata</i> . . . . .  | 8-124 |
| 8113:1    | The life cycle of the giant kelp, <i>Macrocystis pyrifera</i> . . . . .   | 8-61  | 8714:4 | <i>Americanamysis bahia</i> . . . . .  | 8-125 |
| 8113:2    | Examples of nongerminated (A and B) and germinated (C and D) giant kelp zoospores and germ-tube-length measurement of germinated zoospores (E). . . . . | 8-64  | 8714:5 | <i>Americanamysis bigelowi</i> . . . . .   | 8-126 |
| 8211:1    | Common duckweed: <i>Lemna minor</i> . . . . .   | 8-66  | 8740:1 | Rearing and exposure beaker and automatic siphon for dungeness crab larvae. . . . .  | 8-133 |
| 8220:1    | <i>Echinochloa crusgalli</i> (Japanese millet or duck millet). . . . .  | 8-72  | 8740:2 | Egg-hatching tank for lobsters. . . . .  | 8-134 |
| 8310:1    | <i>Colpidium campylum</i> . . . . .   | 8-75  | 8740:3 | Hughes lobster-rearing tank. . . . .   | 8-135 |
| 8310:2    | <i>Tetrahymena thermophila</i> . . . . .  | 8-77  | 8740:4 | Crustacean embryos. . . . .  | 8-139 |
| 8310:3    | Test apparatus for T-maze chemotactic test. . . . .   | 8-78  | 8740:5 | Crustacean larvae. . . . .   | 8-140 |
| 8420:1    | Schematic diagram of rotifer static life-cycle toxicity tests. . . . .  | 8-83  | 8740:6 | Water table. . . . .   | 8-140 |
| 8420:2    | Schedule of reproduction. . . . .   | 8-83  | 8740:7 | Proportional diluter. . . . .  | 8-141 |
| 8510:1    | Marine polychaetes. . . . .   | 8-85  | 8810:1 | Early development stages of sea urchins and sand dollars. . . . .  | 8-156 |
| 8510:2    | Marine polychaetes. . . . .   | 8-86  | 8921:1 | Adult fathead minnows in breeding condition. . . . .   | 8-171 |
| 8510:3    | Freshwater oligochaetes. . . . .  | 8-87  | 8921:2 | Newly hatched fathead minnow larvae . .  | 8-171 |
| 8510:4    | Life stages of <i>Capitella capitata</i> . . . . .  | 8-88  | 8921:3 | Examples of abnormal fathead minnow larvae. . . . .  | 8-176 |
| 8510:5    | <i>Neanthes arenaceodentata</i> . . . . .   | 8-89  | 9020:1 | Frequency curve (positively skewed distribution). . . . .  | 9-24  |
| 8510:6    | Life stages of selected marine polychaetes. . . . .   | 8-89  | 9215:1 | Preparation of dilutions. . . . .  | 9-56  |
| 8510:7    | Life stages of <i>Polydora cornuta</i> . . . . .  | 8-90  | 9221:1 | Schematic outline of presumptive, confirmed, and completed phases for total coliform detection. . . . .  | 9-76  |
| 8510:8    | <i>Capitella capitata</i> . . . . .   | 8-93  | 9240:1 | Filaments of <i>Crenothrix polyspora</i> showing variation of size and shape of cells in the sheath. . . . .   | 9-125 |
| 8510:9    | Experimental setup for sediment testing. . . . .  | 8-94  | 9240:2 | Filaments of <i>Sphaerotilus natans</i> , showing cells in the filaments and some free "swarmer" cells. . . . .  | 9-126 |
| 8510:10   | <i>Neanthes arenaceodentata</i> . . . . .   | 8-95  | 9240:3 | Laboratory culture of <i>Gallionella ferruginea</i> , showing cells, stalks excreted by cells, and branching of stalks where cells have divided. . . . .           | 9-126 |
| 8610:1    | Abalone: (left) normal veliger; (right) abnormal veliger. . . . .   | 8-104 |        |  |       |

|         |   |       |          |   |        |
|---------|---|-------|----------|---|--------|
| 9240:4  | Stalk of <i>Gallionella ferruginea</i> . . . . .  | 9-127 | 10200:10 | The Folsom plankton splitter. . . . .   | 10-22  |
| 9240:5  | Single-celled iron bacterium<br><i>Siderocapsa</i> . . . . .  | 9-127 | 10200:11 | Reverse-phase HPLC chromatogram for<br>a fivefold dilution of EPA sample. . . . .   | 10-26  |
| 9240:6  | Multiple colonies of <i>Siderocapsa spp.</i> . .  | 9-127 | 10200:12 | Reverse-phase HPLC pigment<br>chromatogram for a mixture of<br>common algal pigments found in<br>freshwater systems. . . . .              | 10-28  |
| 9240:7  | Schematic of flowcell: (left) assembly;<br>(right) slide holder insert. . . . .   | 9-128 |          |   |        |
| 9240:8  | Photosynthetic purple sulfur bacteria. . . . .  | 9-129 |          |   |        |
| 9240:9  | Colorless filamentous sulfur bacteria:<br><i>Beggiatoa alba</i> trichomes, containing<br>globules of sulfur. . . . .  | 9-130 | 10300:1  | Periphyton sampler. . . . .   | 10-37  |
| 9240:10 | Colorless filamentous sulfur bacteria:<br>portion of a colony, showing<br>branching of the mucoid filament,<br>identified as <i>Thiodendron mucosum</i> . . . | 9-130 | 10300:2  | Component processes in the oxygen<br>metabolism of a section of a<br>hypothetical stream during the course<br>of a cloudless day. . . . . | 10-43  |
| 9240:11 | <i>Thiothrix unzii</i> after 24 h in lactate-<br>thiosulfate medium. . . . .  | 9-130 | 10300:3  | Gross periphytic primary production ( $P_G$ )<br>determined by the O'Connell–Thomas<br>Chamber. . . . .                                   | 10-44  |
| 9240:12 | Colorless nonfilamentous sulfur bacteria:<br>dividing cell of <i>Thiovulum majus</i> ,<br>containing sulfur globules. . . . .                                 | 9-130 | 10300:4  | Calculation of gross primary production<br>at a single station. . . . .   | 10-46  |
| 9250:1  | Bacterial colonies—typical colony type<br>vs. actinomycete colony type, 50×. . . . .  | 9-148 | 10300:5  | Calculation of gross periphytic primary<br>productivity from upstream–<br>downstream diurnal curves. . . . .                              | 10-48  |
| 9260:1  | Number of drinking water-related disease<br>outbreaks in the United States, 1971–<br>1998. . . . .  | 9-150 | 10400:1  | Allen curve for a cohort of a population<br>of aquatic macrophytes. . . . .   | 10-61  |
| 9260:2  | Agents responsible for drinking water-<br>related disease outbreaks. . . . .  | 9-150 | 10500:1  | Petersen grab. . . . .  | 10-72  |
| 9510:1  | Two-stage microporous filter adsorption-<br>elution method for concentrating<br>viruses from large volumes of water<br>with electronegative filters. . . . .  | 9-197 | 10500:2  | Ponar® grab. . . . .  | 10-72  |
| 9510:2  | Schematic of apparatus for first-stage<br>concentration with negatively charged<br>filters. . . . .   | 9-198 | 10500:3  | Van Veen grab. . . . .  | 10-72  |
| 9711:1  | Equipment configuration for sample<br>collection using EPA Method 1623. . . . .   | 9-226 | 10500:4  | Smith-McIntyre grab. . . . .  | 10-72  |
| 10200:1 | Structural features of common water<br>samplers, Kemmerer (left) and Van<br>Dorn (right). . . . .   | 10-6  | 10500:5  | Shipek grab. . . . .  | 10-73  |
| 10200:2 | The Schindler–Patalas plankton trap. . . .  | 10-7  | 10500:6  | Ekman grab. . . . .   | 10-73  |
| 10200:3 | Examples of commonly used plankton<br>sampling nets. . . . .  | 10-9  | 10500:7  | Surber or square-foot sampler. . . . .  | 10-73  |
| 10200:4 | Examples of commonly used high-speed<br>zooplankton samplers. . . . .   | 10-9  | 10500:8  | Phleger core sampler. . . . .   | 10-74  |
| 10200:5 | Filter funnel for concentrating<br>zooplankton. . . . .   | 10-12 | 10500:9  | KB corer. . . . .   | 10-74  |
| 10200:6 | Ocular micrometer ruling. . . . .   | 10-15 | 10500:10 | Wilding or stovepipe sampler. . . . .   | 10-75  |
| 10200:7 | Calibration of Whipple Square . . . . .   | 10-16 | 10500:11 | Drift net sampler. . . . .  | 10-75  |
| 10200:8 | Counting cell (Sedgwick–Rafter),<br>showing method of filling. . . . .  | 10-18 | 10500:12 | Hester–Dendy artificial substrate unit. . . . .   | 10-76  |
| 10200:9 | A simple, efficient device for<br>concentrating plankton. . . . .   | 10-21 | 10500:13 | Basket sampler. . . . .   | 10-76  |
|         |   |       | 10500:14 | Marsh net sampler. . . . .  | 10-77  |
|         |   |       | 10600:1  | Diagram of a sunken trap net. . . . .   | 10-87  |
|         |   |       | 10600:2  | A typical enclosure sampler, the drop<br>sampler, in action. . . . .  | 10-89  |
|         |   |       | 10600:3  | Bag seine in operation in a stream. . . . .   | 10-89  |
|         |   |       | 10600:4  | Diagram of electrofishing boat. . . . .   | 10-90  |
|         |   |       | 10600:5  | Types of tags commonly used. . . . .  | 10-92  |
|         |   |       | 10600:6  | Passive integrated transponder (PIT)<br>tagging system. . . . .   | 10-93  |
|         |   |       | 10600:7  | Key organs and external body parts of a<br>soft-rayed (upper) and spiny-rayed<br>(lower) fish. . . . .                                    | 10-96  |
|         |   |       | 10600:8  | Fish scale. . . . .   | 10-97  |
|         |   |       | 10750:1  | <i>Butlerius</i> sp., a freshwater nematode. . . . .  | 10-103 |

## TABLES

|          |  |      |          |   |      |
|----------|--|------|----------|---|------|
| 1010:I   | Critical Values for 5% and 1% Tests of Discordancy for a Single Outlier in a Normal Sample . . . . .   | 1-3  | 1090:VI  | Procedures Involving Potential Exposure to Ionizing Radiation . . . . .                                   | 1-64 |
| 1020:I   | Factors for Computing Lines on Range Control Charts . . . . .  | 1-12 | 2020:I   | Methods in Part 2000 Indicating or Amenable to Initial Quality Control . .                                | 2-3  |
| 1020:II  | Example Data Qualifiers . . . . .  | 1-14 | 2020:II  | Summary of Ongoing Quality Control for Methods in Part 2000 . . . . .                                     | 2-4  |
| 1020:III | Example Audit of a Soil Analysis Procedure. . . . .  | 1-15 | 2120:I   | Selected Ordinates for Spectrophotometric Color Determinations . . . . .                                  | 2-9  |
| 1040:I   | Precision and Bias for a Single Concentration in a Single Matrix . . . . .   | 1-25 | 2120:II  | Color Hues for Dominant Wavelength Ranges . . . . .   | 2-9  |
| 1040:II  | Variations in Factors for Method Ruggedness Determination . . . . .  | 1-26 | 2150:I   | Threshold Odor Numbers Corresponding to Various Dilutions . . . . .                                       | 2-18 |
| 1040:III | Factor Matrix for Method Ruggedness Determination . . . . .  | 1-26 | 2150:II  | Dilutions for Various Odor Intensities . . . . .  | 2-18 |
| 1040:IV  | Sample Collaborative Test Results . . . . .  | 1-28 | 2150:III | Dosing Chart for Dechlorinating Agent . .   | 2-20 |
| 1040:V   | Method Precision and Bias . . . . .  | 1-28 | 2150:IV  | Hexanal Odor Reference Standard Concentrations and Total Intensity of Odor Rating Scale . . . . .         | 2-21 |
| 1050:I   | Commonly Used Expressions of Mass Concentration . . . . .  | 1-29 |          | Flavor Threshold Numbers Corresponding to Various Dilutions . . . . .                                     | 2-23 |
| 1050:II  | Density of Water Free from Dissolved Atmospheric Gases, at a Pressure of 101.325 Pa . . . . .  | 1-30 | 2160:I   | Dilutions for Determining the FTN . . . . .   | 2-23 |
| 1050:III | Conversion Factors (Milligrams per Liter – Milliequivalents per Liter) . . . . .   | 1-31 | 2160:II  | Confirmed Odor References . . . . .   | 2-28 |
| 1050:IV  | Effective Hydrated Radius for Common Ions . . . . .  | 1-33 | 2170:I   | Representative Odor Reference Standards . . . . .   | 2-29 |
| 1050:V   | Values of A and B from 0 to 100°C for Debye-Hückel Equation . . . . .  | 1-34 | 2170:II  | Substitute Odor Reference Standards . . . . .   | 2-29 |
| 1050:VI  | Examples of Alternative Expressions of Analytical Results . . . . .  | 1-37 | 2170:III | Basic Taste Standards . . . . .   | 2-30 |
| 1060:I   | Summary of Special Sampling and Handling Requirements . . . . .  | 1-44 | 2170:IV  | Stoichiometric Dosages of Dechlorinating Agents . . . . .   | 2-32 |
| 1080:I   | Water Purification Processes . . . . .   | 1-48 | 2170:V   | Dechlorinating Agent Dosage Chart for Chlorine . . . . .  | 2-32 |
| 1080:II  | Reagent Water Specifications . . . . .   | 1-49 | 2170:VI  | Endpoint pH Values . . . . .  | 2-37 |
| 1090:I   | Permissible Exposure Limits, Threshold Limit Values, Short-Term Exposure Limits, and/or Ceilings for Some Inorganic Chemicals Specified in <i>Standard Methods</i> . . . . . | 1-54 | 2320:I   | Alkalinity Relationships . . . . .  | 2-38 |
| 1090:II  | Permissible Exposure Limits, Threshold Limit Values, Short-Term Exposure Limits, and/or Ceilings for Organic Solvents Specified in <i>Standard Methods</i> . . . . .         | 1-55 | 2320:II  | Estimating Equilibrium Constants and Activity Coefficients . . . . .                                      | 2-41 |
| 1090:III | Permissible Exposure Limits, Threshold Limit Values, Short-Term Exposure Limits, and/or Ceilings for Some of the Reagents Specified in <i>Standard Methods</i> . . . . .     | 1-55 | 2330:I   | Precalculated Values For <i>pK</i> and <i>A</i> at Selected Temperatures . . . . .                        | 2-42 |
| 1090:IV  | Glove Selection for Organic Chemical Handling . . . . .  | 1-59 | 2330:II  | Quality Assurance/Quality Control Examples for Saturation Index by Calculation . . . . .                  | 2-44 |
| 1090:V   | Glove Selection for Inorganic Chemical Handling . . . . .  | 1-60 | 2330:III | Graphical and Computer Methods That Can Be Used to Calculate $\text{CaCO}_3$ Saturation Indices . . . . . | 2-47 |
|          |  |      | 2340:I   | Maximum Concentrations of Interferences Permissible with Various Inhibitors . . . . .                     | 2-49 |
|          |  |      | 2510:I   | Equivalent Conductivity, $\Lambda$ , and Conductivity, $k$ , of Potassium Chloride at 25.0°C . . . . .    | 2-56 |
|          |  |      | 2510:II  | Sample Analysis Illustrating Calculation of Conductivity, $k_{\text{calc}}$ , for Natural Waters. . . . . | 2-57 |

|          |  |       |             |   |       |
|----------|--|-------|-------------|---|-------|
| 2510:III | Equivalent Conductances, $\lambda_+$ and $\lambda_-$ ,<br>(mho-cm <sup>2</sup> /equivalent) for Ions in<br>Water at 25.0°C. . . . .          | 2-57  | 3125:II     | Method Performance with Standard<br>Reference Water . . . . .   | 3-49  |
| 2530:I   | Coefficient of Variation and Recovery<br>for Particulate Floatables Test . . . . .   | 2-65  | 3125:III    | Recommended Analyte Masses,<br>Instrument Detection Limits (IDL),<br>and Internal Standards . . . . .                               | 3-50  |
| 2560:I   | Example Calculations for Particle Size<br>Distribution Analysis . . . . .  | 2-78  | 3125:IV.A   | Elemental Abundance Equations and<br>Common Molecular Ion Correction<br>Equations . . . . .   | 3-50  |
| 2580:I   | Potential of ZoBell's Solution as<br>Function of Temperature . . . . .   | 2-89  | 3125:IV.B   | Elements, Masses, Abundances, and<br>Correction Equations (Updated 2008) .  | 3-51  |
| 2580:II  | Preparation of Redox Standard<br>Solutions . . . . .   | 2-90  | 3125:V      | Common Molecular Ion Interferences in<br>ICP-MS . . . . .   | 3-52  |
| 2580:III | Recommended Combinations for<br>Selected Sample Types . . . . .  | 2-91  | 3125:VI     | Suggested Analytical Run Sequence . . .   | 3-54  |
| 2710:I   | Temperature Correction Factor . . . . .  | 2-96  | 3125:VII    | Summary of Performance Criteria . . .   | 3-55  |
| 2810:I   | Bunsen Coefficient for Oxygen in Fresh<br>Water . . . . .  | 2-107 | 3125:VIII   | Quality Control Analyses for ICP-MS<br>Method . . . . .   | 3-56  |
| 2810:II  | Vapor Pressure of Fresh Water . . . . .  | 2-108 | 3125:IX     | Method Performance with Calibration<br>Verification Standards . . . . .   | 3-56  |
| 3030:I   | Acids Used with HNO <sub>3</sub> for Sample<br>Preparation . . . . .   | 3-9   | 3125:X      | Method Performance for Recovery of<br>Known Addition in Natural Waters .  | 3-57  |
| 3111:I   | Atomic Absorption Concentration<br>Ranges with Direct Aspiration Atomic<br>Absorption . . . . .  | 3-17  | 3125:XI     | Method Performance with Calibration<br>Verification Standards . . . . .   | 3-57  |
| 3111:II  | Interlaboratory Precision and Bias Data<br>for Atomic Absorption Methods—<br>Direct Aspiration and Extracted<br>Metals . . . . .             | 3-18  | 3130:I      | Precision of Cadmium, Lead, and Zinc<br>Analysis by ASV . . . . .   | 3-62  |
| 3111:III | Single-Operator Precision and<br>Recommended Control Ranges for<br>Atomic Absorption Methods—Direct<br>Aspiration and Extracted Metals . . . | 3-19  | 3500-Cr:I   | Ion Chromatographic Conditions . . . .  | 3-74  |
| 3112:I   | Interlaboratory Precision and Bias of<br>Cold-Vapor Atomic Absorption<br>Spectrometric Method for Mercury .                                  | 3-27  | 3500-Cr:II  | Single-Laboratory Precision and Bias .  | 3-74  |
| 3113:I   | Potential Matrix Modifiers for<br>Electrothermal Atomic Absorption<br>Spectrometry . . . . .   | 3-28  | 3500-Cr:III | Multilaboratory Determination of Bias<br>for Hexavalent Chromium . . . . .  | 3-75  |
| 3113:II  | Detection Levels and Concentration<br>Ranges for Electrothermal Atomization<br>Atomic Absorption Spectrometry .                              | 3-29  | 3500-Fe:I   | Selection of Light Path Length for<br>Various Iron Concentrations . . . . .   | 3-81  |
| 3113:III | Interlaboratory Single-Analyst Precision<br>Data for Electrothermal Atomization<br>Methods . . . . .   | 3-33  | 3500-K:I    | Concentration of Cations Interfering at<br>Various Concentrations of Potassium .  | 3-90  |
| 3113:IV  | Interlaboratory Overall Precision Data<br>for Electrothermal Atomization<br>Methods . . . . .  | 3-34  | 3500-V:I    | Concentration at Which Various Ions<br>Interfere in the Determination of<br>Vanadium . . . . .                                      | 3-103 |
| 3113:V   | Interlaboratory Relative Error Data for<br>Electrothermal Atomization Methods .  | 3-35  | 4020:I      | Minimum Quality Controls for Methods<br>in Part 4000 . . . . .  | 4-4   |
| 3120:I   | Suggested Wavelengths, Estimated<br>Detection Levels, Alternate<br>Wavelengths, Calibration<br>Concentrations, and Upper Limits .            | 3-43  | 4110:I      | Detection Level for Anions in Reagent<br>Water . . . . .  | 4-8   |
| 3120:II  | ICP Precision and Bias Data . . . . .  | 3-46  | 4110:II     | Stock Standard Preparations . . . . .   | 4-8   |
| 3125:I   | Method Performance with Calibration<br>Verification Standards . . . . .  | 3-48  | 4110:III    | Single-Laboratory Precision (One<br>Standard Deviation) and Bias Data for<br>30 Sets of Samples over a 2-Month-<br>Period . . . . . | 4-9   |
|          |  |       | 4110:IV     | Detection Level for Anions in Reagent<br>Water . . . . .  | 4-11  |
|          |  |       | 4110:V      | Single-Column Chromatography Single-<br>Operator Precision and Bias . . . . .   | 4-11  |
|          |  |       | 4110:VI     | Detection Level for Anions in Reagent<br>Water . . . . .  | 4-12  |
|          |  |       | 4110:VII    | Stock Standard Preparation . . . . .  | 4-12  |
|          |  |       | 4110:VIII   | Single-Operator Precision and Accuracy<br>for Bromide, Chlorate, Chlorite, and<br>Bromate . . . . .                                 | 4-13  |

|                                      |  |       |                                       |   |       |
|--------------------------------------|--|-------|---------------------------------------|---|-------|
| 4140:I                               | Collaborative Design as Four Youden Pair Sets . . . . .  | 4-20  | 4500-P:I                              | Precision and Bias Data for Manual Phosphorus Methods . . . . .   | 4-159 |
| 4140:II                              | Anion Migration Time Reproducibility from Youden Pair Standards . . . . .  | 4-20  | 4500-P:II                             | Comparison of Precision and Bias of Ascorbic Acid Methods . . . . .   | 4-165 |
| 4140:III                             | Comparison of Capillary Ion Electrophoresis and Other Methods . . . . .  | 4-24  | 4500-P:III                            | Results of Single-Laboratory Studies with Selected Matrices . . . . .   | 4-167 |
| 4140:IV                              | Capillary Ion Electrophoresis Reproducibility and Precision . . . . .  | 4-24  | 4500-P:IV                             | Recoveries of Total Phosphorus . . . . .  | 4-169 |
| 4140:V                               | Capillary Ion Electrophoresis Known-Addition Recovery and Precision of Performance Evaluation Standard with Drinking Water . . . . . | 4-24  | 4500-P:V                              | Comparison of Manual and In-Line Total Phosphorus Methods . . . . .   | 4-170 |
| 4140:VI                              | Comparison of Capillary Ion Electrophoresis with Chromate Electrolyte with Other Methods for the Determination of Anions . . . . .   | 4-25  | 4500-SiO <sub>2</sub> :I              | Selection of Light Path Length for Various Silica Concentrations . . . . .  | 4-176 |
| 4500-CN <sup>-</sup> :I              | Results of Single-Laboratory Studies with Selected Matrices . . . . .  | 4-59  | 4500-S <sup>2-</sup> :I               | Preparation of Permanent Color Standards for Visual Determination of Silica . . . . .                                 | 4-177 |
| 4500-Cl <sup>-</sup> :I              | Results of Single-Laboratory Studies with Selected Matrices . . . . .  | 4-81  | 4500-S <sup>2-</sup> :II              | Dilution of Sulfide Stock Solution for Preparation of Standards (100 mL Total Volume) . . . . .                       | 4-188 |
| 4500-CIO <sub>2</sub> :I             | Equivalent Weights for Calculating Concentrations on the Basis of Mass . . . . .   | 4-86  | 4500-S <sup>2-</sup> :III             | Conditional First Dissociation Constant of Hydrogen Sulfide, Fresh Water . . . . .                                    | 4-191 |
| 4500-F <sup>-</sup> :I               | Concentration of Some Substances Causing 0.1-mg/L Error at 1.0 mg F <sup>-</sup> /L in Fluoride Methods . . . . .                    | 4-87  | 4500-SO <sub>4</sub> <sup>2-</sup> :I | Conditional First Dissociation Constant of Hydrogen Sulfide, Seawater . . . . .                                       | 4-191 |
| 4500-F <sup>-</sup> :II              | Results of Single-Laboratory Studies with Selected Matrices . . . . .  | 4-94  | 5020:I                                | Results of Single-Laboratory Studies with Selected Matrices . . . . .   | 4-202 |
| 4500-H <sup>+</sup> :I               | Preparation of pH Standard Solutions . . . . .   | 4-97  | 5210:I                                | Minimum Quality Control for Methods in Part 5000 . . . . .  | 5-4   |
| 4500-H <sup>+</sup> :II              | Standard pH Values . . . . .   | 4-98  | 5220:I                                | UBOD Results for Wastewater Sample . . . . .  | 5-12  |
| 4500-N:I                             | Recoveries of Total Nitrogen . . . . .   | 4-110 | 5320:I                                | Sample and Reagent Quantities for Various Digestion Vessels . . . . .   | 5-20  |
| 4500-N:II                            | Precision Data for Total Nitrogen, Persulfate Method, Based on Triplicate Analyses of Nicotinic Acid . . . . .                       | 4-111 | 5540:I                                | Intralaboratory, Single-Operator, Dissolved Organic Halogen (Microcolumn Procedure)—Precision and Bias Data . . . . . | 5-35  |
| 4500-NH <sub>3</sub> :I              | Precision and Bias of Ammonia-Selective Electrode . . . . .  | 4-118 | 5560:I                                | Surfactant Recovery by Sublation . . . . .  | 5-55  |
| 4500-NH <sub>3</sub> :II             | Values of Q vs. ΔE (59 mV Slope) for 10% Volume Change . . . . .   | 4-119 | 5560:II                               | Single-Laboratory Laboratory-Fortified Sample Recovery and Precision . . . . .  | 5-67  |
| 4500-NH <sub>3</sub> :III            | Precision Data for Manual Phenate Method Based on Triplicate Analyses of Ammonium Sulfate . . . . .                                  | 4-120 | 5710:I                                | Single-Laboratory Duplicate Sample Precision . . . . .  | 5-67  |
| 4500-NH <sub>3</sub> :IV             | Results of Single-Laboratory Studies with Selected Matrices . . . . .  | 4-123 | 5710:II                               | Single-Operator Precision and Bias Data for THMFP . . . . .   | 5-72  |
| 4500-NO <sub>3</sub> <sup>-</sup> :I | Results of Single-Laboratory Studies with Selected Matrices . . . . .  | 4-137 | 5910:I                                | Single-Operator Precision and Bias Data for TTHM (pH = 9.2) . . . . .   | 5-73  |
| 4500-N <sub>org</sub> :I             | Precision Data for Kjeldahl Nitrogen Method Based on Mean of Triplicate Analyses of Nicotinic Acid . . . . .                         | 4-140 | 5910:II                               | Precision of UV Analyses and Correlation to KHP Samples . . . . .   | 5-79  |
| 4500-N <sub>org</sub> :II            | Results of Single-Laboratory Studies with Selected Matrices . . . . .  | 4-143 | 6010:I                                | Single-Operator Precision for UV Absorption Measurements of Fulvic Acid Solutions . . . . .                           | 5-80  |
| 4500-O:I                             | Solubility of Oxygen in Water Exposed to Water-Saturated Air at Atmospheric Pressure (101.3 kPa) . . . . .                           | 4-147 | 6010:II                               | Analysis Methods for Specific Organic Compounds . . . . .   | 6-1   |
| 4500-O:II                            | Dissolved Oxygen Saturation in Water (mg/L) . . . . .  | 4-152 | 6020:I                                | Recommended Preservation for Volatile Organic Compounds . . . . .   | 6-3   |
|                                      |  |       | 6040:I                                | Minimum Quality Control for Methods in Part 6000 . . . . .  | 6-8   |
|                                      |  |       |                                       | Method Detection Levels for Earthy-Musty Smelling Compounds by CLSA-GC/MS . . . . .                                   | 6-11  |

|            |  |      |           |  |      |
|------------|--|------|-----------|--|------|
| 6040:II    | Method Detection Levels for Selected Organic Compounds by CLSA-GC/MS . . . . .   | 6-12 | 6200:IV   | Single-Laboratory Bias and Precision<br>Data in Reagent Water . . . . .  | 6-38 |
| 6040:III   | 7-Day Holding Time Study for MIB and Geosmin . . . . .   | 6-16 | 6200:V    | Retention Times and Method Detection Levels . . . . .  | 6-39 |
| 6040:IV    | Comparison of Monitoring and Quantitation Ions for Chlorodecane and Deuterated MIB and Geosmin Internal Standards . . . . .                | 6-17 | 6231:I    | Single-Laboratory Bias and Precision<br>Data in Reagent Water . . . . .  | 6-42 |
| 6040:V     | Typical Operating Conditions for GC/MS Analysis of CLSA Extracts . . . . .   | 6-18 | 6231:II   | Chromatographic Conditions for 1,2-Dibromoethane (EDB) and 1,2-Dibromo-3-Chloropropane (DBCP) . . . . .  | 6-46 |
| 6040:VI    | GC/MS Data for Three Internal Standards and Two Earthy-Musty Smelling Compounds . . . . .  | 6-19 | 6232:I    | Single-Laboratory Precision and Bias for EDB and DBCP in Tap Water . . . . .   | 6-47 |
| 6040:VII   | Single-Laboratory Bias for Selected Organic Compounds Causing Taste and Odor . . . . .   | 6-20 | 6251:I    | Precision and Bias Data for THM-Chlorinated Organic Solvent Method, DB-5 Column . . . . .  | 6-54 |
| 6040:VIII  | Precision Data for Selected Organic Compounds Causing Taste and Odor . . . . .   | 6-20 | 6251:II   | Method Detection Levels and Precision Data . . . . .   | 6-57 |
| 6040:IX    | Recovery and Precision Data for Selected Priority Pollutants . . . . .   | 6-21 | 6251:III  | Analytical Standards . . . . .   | 6-58 |
| 6040:X     | Method Detection Level (MDL) in Reagent Water for MIB, Geosmin, and IPMP Using Method 6040D . . . . .                                      | 6-22 | 6251:IV   | Retention Times . . . . .  | 6-61 |
| 6040:XI    | Internal Standard Corrected Response Factor for 5–100 ng/L Taste- and Odor-Causing Compounds in Reagent Water Using Method 6040D . . . . . | 6-23 | 6251:V    | Recommended Quantitation Limits . . . . .  | 6-61 |
| 6040:XII   | Calibration for 1–100 ng/L Taste- and Odor-Causing Compounds Without an Internal Standard at 65°C. . . . .                                 | 6-23 | 6251:VI   | Additive Recovery in Reagent Water . . . . .   | 6-62 |
| 6040:XIII  | Comparison of Methods 6040B and D in a Single Laboratory . . . . .   | 6-25 | 6251:VII  | Absolute Recovery Data for Reagent Water with Known Additions . . . . .  | 6-63 |
| 6040:XIV   | Comparison of Results for MIB and Geosmin in Two Different Laboratories . . . . .  | 6-25 | 6251:VIII | Sample Duplicate Data from Two Laboratories . . . . .  | 6-64 |
| 6040:XV    | Analytes with Parent and Quantitation Ions for Method 6040E . . . . .  | 6-26 | 6251:IX   | Field Sample Recovery with Known Additions to Drinking Water, in Two Laboratories . . . . .  | 6-64 |
| 6040:XVI   | Method Detection Level (MDL) in Reagent Water for MIB and Geosmin by Method 6040E . . . . .  | 6-26 | 6251:X    | Relative Percent Difference (RPD) Determinations from Duplicate Samples . . . . .  | 6-64 |
| 6040:XVII  | RSD and Mean Areas for IPMP, IBMP, and TCA . . . . .   | 6-27 | 6252:I    | Percent Recovery Determinations from Fortified Samples . . . . .   | 6-65 |
| 6040:XVIII | Combipal Conditions/Parameters . . . . .   | 6-27 | 6252:II   | Method Detection Levels and Precision Data . . . . .   | 6-67 |
| 6040:XIX   | GC/MS Parameters for Method 6040E . . . . .  | 6-28 | 6252:III  | Analytical Standards of Carbonyl Compounds Used in the PFBHA Method . . . . .  | 6-68 |
| 6040:XX    | Comparison of Results for MIB and Geosmin in Two Different Laboratories using Method 6040E . . . . .                                       | 6-29 | 6252:IV   | Recovery of Triplicate <i>In Situ</i> Derivatized Aldehydes Compared to the Recovery of Pure Oxime Derivatives from Organic-Free Water . . . . . | 6-69 |
| 6200:I     | Compounds Determinable by Gas Chromatographic Methods for Purgeable Organic Compounds . . . . .  | 6-31 | 6410:I    | Retention Times (RTs) for Derivatized Carbonyls, Derivatized Surrogate Standard, and Internal Standard on Electron-Capture Detector . . . . .    | 6-72 |
| 6200:II    | BFB Key <i>m/z</i> Abundance Criteria . . . . .  | 6-35 | 6410:II   | Chromatographic Conditions, Method Detection Levels, and Characteristic Masses for Base/Neutral Extractables . . . . .                           | 6-75 |
| 6200:III   | Primary Quantitation Ion, Retention Times, and Method Detection Levels . . . . .   | 6-36 | 6410:III  | Chromatographic Conditions, Method Detection Levels, and Characteristic Masses for Acid Extractables . . . . .                                   | 6-76 |
|            |  |      | 6410:IV   | DFTPP Key Masses and Abundance Criteria . . . . .  | 6-77 |
|            |  |      |           | Suggested Internal and Surrogate Standards . . . . .   | 6-77 |

|           |   |       |          |   |       |
|-----------|---|-------|----------|---|-------|
| 6410:V    | QC Acceptance Criteria . . . . .  | 6-84  | 6450:XV  | Single-Laboratory Method Precision and Bias for Nitrosamines, Micro Liquid-Liquid Extraction . . . . .  | 6-111 |
| 6410:VI   | Method Bias and Precision as Functions of Concentration . . . . .   | 6-86  |          |   |       |
| 6420:I    | Chromatographic Conditions and Method Detection Levels . . . . .  | 6-88  | 6450:XVI | Interlaboratory Bias and Precision Data for Nitrosamines Added to Chloraminated Potable Surface Water and Secondary Wastewater Effluent, Micro Liquid-Liquid Extraction . . . . . | 6-112 |
| 6420:II   | Silica Gel Fractionation and Electron Capture Gas Chromatography of PFBB Derivatives . . . . .  | 6-88  |          | Detection Levels in Reagent Water . . . . .   | 6-113 |
| 6420:III  | QC Acceptance Criteria . . . . .  | 6-92  | 6610:I   | Single-Analyst Precision and Accuracy of Compound Detection in Various Waters at Low (0.20 µg/L) and High (10 µg/L) Fortification Levels . . . . .                                | 6-114 |
| 6420:IV   | Method Bias and Precision as Functions of Concentration . . . . .   | 6-92  | 6610:II  | Preparation of Calibration (CAL) Curve Solutions . . . . .  | 6-116 |
| 6440:I    | High-Performance Liquid Chromatography Conditions and Method Detection Levels . . . . .   | 6-95  | 6610:III | Instrument Gradient and Conditions . . . . .  | 6-116 |
| 6440:II   | Gas Chromatographic Conditions and Retention Times . . . . .  | 6-95  | 6610:IV  | Retention Times for Analytes . . . . .  | 6-116 |
| 6440:III  | QC Acceptance Criteria . . . . .  | 6-98  | 6610:V   | Summary of Requirements for Initial Demonstration of Capability (IDC) . . . . .   | 6-118 |
| 6440:IV   | Method Bias and Precision as Functions of Concentration . . . . .   | 6-98  | 6610:VI  | Summary of Quality Control Requirements . . . . .   | 6-119 |
| 6450:I    | Target Nitrosamine Analytes: Formula, Molecular Weight, Internal Standard, and Quantitation Ion . . . . .   | 6-100 | 6610:VII | Retention Ratios of Various Organochlorine Pesticides Relative to Aldrin . . . . .  | 6-126 |
| 6450:II   | Method Detection Levels for Nitrosamines in Reagent Water, Solid-Phase Extraction . . . . .   | 6-101 | 6630:I   | Precision and Bias Data for Selected Organochlorine Pesticides . . . . .  | 6-127 |
| 6450:III  | Procedural Calibration Standards . . . . .  | 6-103 | 6630:II  | Chromatographic Conditions and Method Detection Levels . . . . .  | 6-129 |
| 6450:IV   | Gas Chromatograph Injection Program Temperature Conditions for Nitrosamine Analyses . . . . .   | 6-103 | 6630:III | Distribution of Chlorinated Pesticides and PCBs into Magnesia-Silica Gel Column Fractions . . . . .   | 6-130 |
| 6450:V    | Gas Chromatograph Injection Program Split Conditions for Nitrosamine Analyses . . . . .   | 6-104 | 6630:IV  | QC Acceptance Criteria . . . . .  | 6-134 |
| 6450:VI   | Gas Chromatograph Column Conditions for Nitrosamine Analyses . . . . .  | 6-104 | 6630:V   | Method Precision and Bias as Functions of Concentration . . . . .   | 6-135 |
| 6450:VII  | Chemical Ionization Settings . . . . .  | 6-105 | 6630:VI  | Single-Laboratory Method Detection Levels in Reagent Water . . . . .  | 6-137 |
| 6450:VIII | Methanol CI/MS/MS Conditions . . . . .  | 6-105 | 6640:I   | Chromatographic Conditions and Average Retention Time Data for Primary Column . . . . .   | 6-141 |
| 6450:IX   | Acetonitrile CI/MS/MS Conditions . . . . .  | 6-105 | 6640:II  | Chromatographic Conditions and Average Retention Time Data for Confirmation Column . . . . .  | 6-142 |
| 6450:X    | Absolute Recovery of Nitrosamines in Reagent Water Fortified at 100 ng/L, Solid-Phase Extraction . . . . .  | 6-106 | 6640:III | Method Precision and Bias in Selected Matrices . . . . .  | 6-144 |
| 6450:XI   | Single-Laboratory Bias and Precision Data for Nitrosamines Added to Potable and Secondary Effluent Waters, Solid-Phase Extraction . . . . .                 | 6-107 | 6640:IV  | Effect of Sample Holding Time on Recovery for Samples from a Chlorinated Surface Water Fortified with Method Analytes . . . . .   | 6-145 |
| 6450:XII  | Interlaboratory Bias and Precision Data for Nitrosamines Added to Potable Surface Water and Secondary Wastewater Effluent, Solid-Phase Extraction . . . . . | 6-108 | 6640:V   | Effect of Extract Holding Time on Recovery for Samples from a Chlorinated Surface Water Fortified with Method Analytes . . . . .  | 6-145 |
| 6450:XIII | Method Detection Levels in Reagent Water, Micro Liquid-Liquid Extraction . . . . .  | 6-109 | 6640:VI  | Single-Laboratory Method Detection Level in Wastewater . . . . .  | 6-150 |
| 6450:XIV  | Absolute Recovery of Nitrosamines in Reagent Water Fortified at 100 ng/L, Micro Liquid-Liquid Extraction . . . . .  | 6-111 | 6710:I   |   |       |

|           |  |       |             |   |      |
|-----------|--|-------|-------------|---|------|
| 6710:II   | Ion Abundance Criteria for Decafluorotriphenylphosphine (DFTPP) . . . . .  | 6-150 | 7500-Ra:II  | Factors for Decay of Radon-222, Growth of Radon-222 from Radium-226, and Correction of Radon-222 Activity for Decay During Counting . . . . .                                       | 7-41 |
| 6710:III  | Calibration Standards Concentration Levels and Preparation Method . . . . .  | 6-151 | 7500-Ra:III | Results of $^{224}\text{Ra}$ Collaborative Study . . . . .  | 7-49 |
| 6710:IV   | Gas Chromatograph Operating Parameters . . . . .   | 6-152 | 7500-Ra:IV  | $^{226}\text{Ra}$ and $^{228}\text{Ra}$ Collaborative Study: Interlaboratory Results for Accuracy and Precision . . . . .   | 7-49 |
| 6710:V    | Assigned Quantitation Ion and Internal Standards . . . . .   | 6-153 | 7500-Ra:V   | $^{226}\text{Ra}$ and $^{228}\text{Ra}$ Collaborative Study: Lead Carrier Equivalency Study, LFM, LFMD Sample Results . . . . .   | 7-50 |
| 6710:VI   | Calibration Acceptance Criteria . . . . .  | 6-153 |             | Recommended Composition for Reconstituted Freshwater . . . . .  | 8-11 |
| 6710:VII  | Minimum QC Samples for Each Batch and Respective Acceptance Limits . . . . .   | 6-153 | 8010:I      | Quantities of Reagent-Grade Chemicals to be Added to Aerated Soft Reconstituted Freshwater for Buffering pH . . . . .   | 8-11 |
| 6710:VIII | Single-Laboratory Method Detection Level in Artificial Seawater . . . . .  | 6-155 | 8010:II     | Procedure for Preparing Reconstituted Seawater . . . . .  | 8-11 |
| 6710:IX   | Gas Chromatograph Operating Parameters . . . . .   | 6-155 | 8010:III    | Macronutrient Stock Solution . . . . .  | 8-12 |
| 6810:I    | Target Pharmaceutical and Personal Care Product Analytes: Formula, Molecular Weight, Quantification Transition and Internal Standard . . . . . | 6-157 | 8010:IV.A   | Micronutrient Stock Solution . . . . .  | 8-12 |
| 6810:II   | Lowest Concentration Minimum Reporting Level (LCMRL) for PPCPs in Reagent Water (ng/L) from Five Laboratories . . . . .                        | 6-157 | 8010:IV.B   | Nutrients for Algal Culture Medium in Seawater . . . . .  | 8-12 |
| 6810:III  | Calibration Standards . . . . .  | 6-159 | 8010:V      | Percentage of Ammonia Un-ionized in Distilled Water . . . . .   | 8-18 |
| 6810:IV   | HPLC Gradient Profile for the ESI Positive Method . . . . .  | 6-160 | 8020:I      | Summary of Typical Test Deviations and Need for Retesting . . . . .   | 8-29 |
| 6810:V    | HPLC Gradient Profile for the ESI Negative Method . . . . .  | 6-160 | 8030:I      | Diagnostic Mutagens for Tester Strains TA98 and TA100 . . . . .   | 8-35 |
| 6810:VI   | Internal Standard (IS) Recovery and Accuracy for Single-Laboratory Validation . . . . .  | 6-163 | 8211:I      | Duckweed Nutrient Solution . . . . .  | 8-67 |
| 6810:VII  | Precision and Accuracy for Five-Laboratory Validation Using Drinking Water . . . . .   | 6-163 | 8220:I      | Example of Seed Germination and Seedling Growth Test Conditions . . . . .   | 8-73 |
| 7010:I    | Sample Handling, Preservation, and Holding Times . . . . .   | 7-3   | 8310:I      | Summary of Ecological and Testing Conditions For the Freshwater Ciliate <i>Dexiostoma</i> ( <i>syn. Colpidium campylum</i> ) . . . . .  | 8-76 |
| 7020:I    | Laboratory Precision—One Standard Deviation Values for Various Analyses in Safe Drinking Water Compliance Samples . . . . .                    | 7-5   | 8310:II     | Summary of Ecological and Test Conditions for the Freshwater Ciliate <i>Tetrahymena thermophila</i> . . . . .   | 8-78 |
| 7020:II   | Propagation-of-Uncertainty Formulas . . . . .  | 7-9   | 8310:III    | Summary of Ecological and Test Conditions for the Soil Ciliate <i>Colpoda inflata</i> . . . . .   | 8-79 |
| 7030:I    | Energy Resolution for Various Detector Types . . . . .   | 7-17  | 8420:I      | Summary of Ecological and Test Conditions That Should Be Considered When Conducting Toxicity Tests with <i>B. calyciflorus</i> (BC) or <i>B. plicatilis</i> (BP) Rotifers . . . . . | 8-81 |
| 7120:I    | Gamma-Emitters Recovery and Precision Estimate Regression Line Equations . . . . .   | 7-29  | 8420:II     | Sample Test Results . . . . .   | 8-84 |
| 7120:II   | Gamma-Emitters Study: Summary of Participants . . . . .  | 7-29  | 8510:I      | Summary of Ecological and Test Conditions for <i>Neanthes arenaceodentata</i> . . . . .   | 8-92 |
| 7500-Ra:I | Chemical and Radiochemical Composition of Samples Used to Determine Bias and Precision of Radium-226 Method . . . . .                          | 7-37  | 8510:II     | Summary of Ecological and Sediment Test Conditions for Conducting Tests with <i>Polydora cornuta</i> . . . . .  | 8-97 |

|           |   |       |          |   |       |
|-----------|---|-------|----------|---|-------|
| 8610:I    | Summary of Test Conditions for the Marine Bivalve Larval Toxicity Test . . . . .  | 8-102 | 9221:II  | MPN Index and 95% Confidence Limits for All Combinations of Positive and Negative Results When Five 20-mL Portions Are Used . . . . .   | 9-72  |
| 8610:II   | Summary of Test Conditions for the Marine Gastropod Larval Toxicity Test . . . . .  | 8-102 | 9221:III | MPN Index and 95% Confidence Limits for All Combinations of Positive and Negative Results When Ten 10-mL Portions Are Used . . . . .  | 9-72  |
| 8610:III  | Summary of Test Conditions for the Sediment Bioaccumulation Test Using Marine Bivalves . . . . .  | 8-105 | 9221:IV  | MPN Index and 95% Confidence Limits for Various Combinations of Positive Results When Five Tubes Are Used per Dilution (10 mL, 1.0 mL, 0.1 mL) . . . . .                        | 9-73  |
| 8711:I    | Summary of Short-Term and Long-Term Toxicity Tests with <i>Daphnia</i> spp. . . . .   | 8-115 | 9221:V   | Examples for Choice of Three Combinations of Positives from Five Dilutions . . . . .  | 9-74  |
| 8712:I    | Summary of Ecological and Toxicological Test Conditions Using <i>Ceriodaphnia dubia</i> . . . . .   | 8-119 | 9222:I   | Suggested Sample Volumes for Membrane Filter Total Coliform Test . . . . .  | 9-84  |
| 8750:I    | Summary of Test Conditions for the Ontario Ministry of the Environment's <i>Hexagenia</i> spp. Survival and Growth Test . . . . .   | 8-145 | 9222:II  | Numbers of Colonies in the Ideal Range for Quantitative Determinations . . . . .  | 9-85  |
| 8750:II   | Comparative Test Conditions and Acceptability Criteria for Short-Term (10-d) Sediment and Water Toxicity Tests with the Midges <i>Chironomus dilutus</i> and <i>Chironomus riparius</i> . . . . . | 8-148 | 9222:III | Confidence Limits for Membrane Filter Coliform Results Using 100-mL Sample . . . . .  | 9-87  |
| 8750:III  | Comparative Test Conditions and Test Acceptability Criteria for Long-Term Sediment and Water Toxicity Tests with the Midge <i>Chironomus dilutus</i> . . . . .                                    | 8-149 | 9222:IV  | Suggested Sample Volumes for Membrane Filter Thermotolerant Coliform or <i>E. coli</i> Test . . . . .   | 9-90  |
| 8910:I    | Recommended Prophylactic and Therapeutic Treatments for Freshwater Fish to Be Used for Experimental Purposes . . . . .  | 8-162 | 9223:I   | Color Changes for Various Media . . . . .   | 9-100 |
| 8921:I    | Test Conditions Common to Various Fathead Minnow Short-Term Tests . . . . .   | 8-174 | 9225:I   | Biochemical Reactions of Several Species of the Family <i>Enterobacteriaceae</i> . . . . .  | 9-113 |
| 8921:II   | Test Conditions Specific to Various Fathead Minnow Short-Term Tests . . . . .   | 8-175 | 9230:I   | Selected Characteristics of <i>Enterococcus</i> and <i>Streptococcus</i> Species Isolated from Feces . . . . .  | 9-118 |
| 9020:I    | Key Quality Control Practices . . . . .   | 9-5   | 9250:I   | General Macroscopic Properties of Bacterial Colonies on Solid Medium . . . . .  | 9-148 |
| 9020:II   | Quality of Reagent Water Used in Microbiology Testing . . . . .   | 9-14  | 9260:I   | Screening Tests, Key Reactions, and Properties of <i>Salmonella</i> , <i>Shigella</i> , <i>Escherichia coli</i> , <i>Yersinia</i> and Other <i>Enterobacteriaceae</i> . . . . . | 9-155 |
| 9020:III  | Reagent Additions for Water Quality Test . . . . .  | 9-15  | 9260:II  | Typical Reactions of Common Bacteria on Triple Sugar Iron (TSI) and Lysine Iron Agar (LIA) . . . . .  | 9-158 |
| 9020:IV   | Time and Temperature for Autoclave Sterilization . . . . .  | 9-17  | 9260:III | Growth of <i>Vibrio</i> Cultures on TCBS Agar . . . . .   | 9-167 |
| 9020:V    | Holding Times for Prepared Media . . . . .  | 9-18  | 9260:IV  | Biochemical Test Results and Other Properties of the 12 <i>Vibrio</i> Species that Occur in Human Clinical Specimens . . . . .  | 9-169 |
| 9020:VI   | Suggested Control Cultures for Microbiological Tests . . . . .  | 9-19  | 9260:V   | Components and Supplements of BCYE Agar for Culturing Legionellae From the Environment . . . . .  | 9-178 |
| 9020:VII  | Calculation of Precision Criterion . . . . .  | 9-21  | 9260:VI  | Association of <i>Yersinia enterocolitica</i> with Biogroup, Serogroup, Ecologic, and Geographic Distribution . . . . .   | 9-182 |
| 9020:VIII | Daily Checks on Precision of Duplicate Counts . . . . .   | 9-22  |          |   |       |
| 9020:IX   | Coliform Counts and Their Logarithms . . . . .  | 9-24  |          |   |       |
| 9020:X    | Comparison of Frequency of MPN Data . . . . .   | 9-25  |          |   |       |
| 9020:XI   | Comparison of Frequency of Log MPN Data . . . . .   | 9-25  |          |   |       |
| 9060:I    | Sodium Thiosulfate Equivalents . . . . .  | 9-36  |          |   |       |
| 9211:I    | Special Rapid Techniques . . . . .  | 9-41  |          |   |       |
| 9221:I    | Preparation of Lauryl Tryptose Broth . . . . .  | 9-70  |          |   |       |

|           |  |       |          |   |       |
|-----------|--|-------|----------|---|-------|
| 9260:VII  | Definition of the Six Biogroups of <i>Yersinia enterocolitica</i> Based on Reactions at 25°C . . . . . | 9-183 |          | High-Performance Liquid Chromatography (cf. Figure 10200:12) . . . . .  | 10-27 |
| 9260:VIII | Reactions of Enteric Bacteria on TSI and LIA Media . . . . .   | 9-186 | 10200:IV | HPLC Solvent System Program . . . . .   | 10-29 |
| 9260:IX   | Reactions of <i>Aeromonas</i> and Enteric Bacteria on Kaper's Medium . . . . .                         | 9-186 | 10300:I  | Sample Calculation Ledger for Computation of Corrected Rate of Oxygen Change from a Single-Station Diurnal Curve . . . . .  | 10-47 |
| 9260:X    | Mycobacteria of Waterborne or Unknown Origin . . . . .   | 9-188 | 10300:II | Sample Calculation Ledger for Computation of Corrected Rates of Oxygen Change from the Upstream-Downstream Diurnal Curves of Oxygen Concentration and Temperature . . . . . | 10-49 |
| 9260:XI   | Phenotypic Characteristics of Clinically Significant Environmental Mycobacteria . . . . .              | 9-189 | 10400:I  | Methods Used to Determine Macrophyte Production . . . . .   | 10-59 |
| 10200:I   | Characteristics of Commonly Used Plankton Nets . . . . .   | 10-8  |          |   |       |
| 10200:II  | Conversion Table for Membrane Filter Technique (Based on 30 Scored Fields) . . . . .                   | 10-19 |          |   |       |
| 10200:III | Extinction Coefficients and Chromatographic Properties of Pigments Separated by Reverse-Phase          |       |          |   |       |

## PLATES

**Black and white plates of aquatic organisms**

|  |        |
|--|--------|
| 1A. Cyanobacteria (Blue-green algae) and Chlorophyta<br>(Green algae).....               | 10-127 |
| 1B. Chrysophyta (Yellow-green, golden-brown algae)<br>and Chlorophyta (Green algae)..... | 10-128 |
| 2A. Types of large marine algae.....   | 10-129 |
| 2B. Types of large marine algae and marine grasses. .                                    | 10-130 |
| 3A. Higher plants.....   | 10-131 |
| 3B. Higher plants.....   | 10-132 |
| 3C. Higher plants.....   | 10-133 |
| 4A. Flagellates.....   | 10-134 |
| 4B. Flagellates.....   | 10-135 |
| 5A. Amoebas .....  | 10-136 |
| 5B. Amoebas and nonpigmented flagellates. ....   | 10-137 |
| 6. Ciliates.....   | 10-138 |
| 7. Sponges and coelenterates. ....   | 10-139 |
| 8. Rotifers. ....  | 10-140 |
| 9. Roundworms, flatworms, and segmented worms. .   | 10-141 |
| 10. Segmented marine worms. ....   | 10-142 |
| 11. Crustaceans.. ....   | 10-143 |
| 12. Crustaceans and Pycnogonid. ....   | 10-144 |
| 13. Stoneflies and mayflies. ....  | 10-145 |
| 14. Damselflies, dragonflies. ....   | 10-146 |
| 15. Hellgrammite and relatives, and caddisflies. ....                                    | 10-147 |
| 16. Two-winged flies. ....   | 10-148 |
| 17. Beetles. ....  | 10-149 |

|                                       |        |
|---------------------------------------|--------|
| 18. True bugs.....                    | 10-150 |
| 19. Snails.....                       | 10-151 |
| 20. Some marine mollusks. ....        | 10-152 |
| 21. Bivalves. ....                    | 10-153 |
| 22. Miscellaneous invertebrates. .... | 10-154 |
| 23. Echinoderm types. ....            | 10-155 |
| 24. Some types of fishes. ....        | 10-156 |
| 25. Types of amphibians. ....         | 10-157 |
| 26. Bacteria and fungi. ....          | 10-158 |
| 27. Fungi. ....                       | 10-159 |

**Color plates of algae (special color section) following p. 10-176**

|                                   |  |
|-----------------------------------|--|
| 28. Charophyta                    |  |
| 29. Chlorophyta                   |  |
| 30. Chrysophyta—Bacillariophyceae |  |
| 31. Chrysophyta—Chrysophyceae     |  |
| 32. Chrysophyta—Synurophyceae     |  |
| 33. Chrysophyta—Xanthophyceae     |  |
| 34. Cryptophyta                   |  |
| 35. Cyanobacteria                 |  |
| 36. Euglenophyta                  |  |
| 37. Haptophyta                    |  |
| 38. Pyrrophyta                    |  |
| 39. Raphidiophyta                 |  |
| 40. Rhodophyta                    |  |