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Analytical Methods

for Environmental Water Quality

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Global Environment Monitoring System

with

IAEA

International Atomic Energy Agency

Analytical Methods for Environmental Water Quality

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Introduction

The international water community continues to highlight good water quality as vital for securing the future of human and aquatic ecosystem health. The Millennium Development Goals on water and sanitation are not limited to water scarcity and access. Water quality is an important determinant of availability because water which is not fit for use is in effect unavailable. It is clear, as with any goal, that decision-makers require scientifically sound information with which to base their policies and priorities. There is a need for reliable, current data and information about water resources at the global level for the water and sanitation targets to be measured. Both UNEP GEM/Water Programme and IAEA Isotope Hydrology Section implement quality assurance activities as part of their mandates.

The UNEP GEM/Water Programme is a multi-faceted water science centre oriented towards building knowledge on inland quality issues worldwide. The twin goals of the programme are to improve water quality monitoring and assessment capacity in participating countries, and to determine the state and trends of regional and global water quality. The International Atomic Energy Agency (IAEA) has been promoting and expanding the field of isotope hydrology over the last four decades. The Isotope Hydrology Section of the IAEA provides advice on isotope applications in hydrological and environmental studies, and provides analytical support to the IAEA/WMO Global Network for Isotopes in Precipitation (GNIP). The IAEA also periodically publishes data on stable isotope ratios and tritium in precipitation samples collected at stations worldwide, and maintains a database on isotopes containing basic reference data for researchers in hydrology and atmospheric sciences.

Quality assurance (QA) activities are essential to ensuring the reliability of water quality measurements. The trend through the broader analytical community is to strengthen laboratory QA from simple internal quality control measures, to laboratory accreditation, to international standards such as ISO/IEC 17025. The use of documented analytical methods is also integral to the generation of reliable water quality data. A lack of such documentation can lead to the production, merging and comparison of water quality data generated by different procedures for the same parameter.

The purpose of this book is to provide a compilation of methodologies that are currently in use, or have been used, in laboratories that provide water quality data and information to both GEMS/Water and IAEA. Part A provides an overview of more than 380 analytical methods codes for over 100 parameters. Each entry includes the GEMS/Water method code, the parameter name, a brief method description, method name, measurement units, the number of decimal places reported in the GEMS/Water database, and, where available, a method detection limit, the name of the requesting agency, and a literature reference. The specific methodologies provided for each parameter are not designed to replace or revise methodological protocols that are being used in laboratories.

Part B, by IAEA, provides the definition of, and sampling procedures for, environmental stable and radioactive isotopes, and major and noble gases in precipitation, ground waters, surface waters, vadose waters, and geothermal fluids. Representative sampling and measurement of field parameters are necessary to adequately characterize the resources under study.

Ms. Yvonne D. Stokker led the development of this publication, with Dr. Kshitij Kulkarni of IAEA contributing the section on stable isotopes. Contributions by others are acknowledged and appreciated. The target audience includes water quality laboratories and other partners of UNEP and IAEA. Readers are invited to submit new method descriptions, using the submission form at the end of Part A, and comments, suggestions and updates to Ms. Yvonne Stokker (yvonne.stokker@ec.gc.ca).

PART A: Key to GEMS/Water Analytical Methods Codes

Code	Method Description	Name	Units	Decimals
00120	SUM OF CATIONS Calculated The sum of the cations can be calculated, in milli-equivalents per litre, by the following formula: SC = *Ca + *Mg + *Na + *K +*b* Sr + *b* NH_4-N * ionic forms obligatory for the calculation of ionic balance; b ions used only if in sufficient concentration to significantly modify the ionic balance. Requesting Agency and Date: UNEP GEMS/Water Programme, April 1978. Reference: UNEP GEMS/Water 1992.	SUM OF CATIONS	meq/L	3
00125	SUM OF ANIONS Calculated The sum of the anions can be calculated, in milli-equivalents per litre, by the following formula: SA = *SO_4 + *Cl + *a* *CO_3 + *a* *HCO_3 + *NO_3-N + *b* NO_2-N + *b* PO_4-P * ionic forms obligatory for the calculation of ionic balance; a -can be replaced by Total Alkalinity, in meq/L, (where alk meq/L = alk mg/L $CaCO_3$/50); b ions used only if in sufficient concentration to significantly modify the ionic balance. Requesting Agency and Date: UNEP GEMS/Water Programme, April 1978. Reference: UNEP GEMS/Water 1992.	SUM OF ANIONS	meq/L	3
00130	SUM OF CATIONS + ANIONS Calculated The sum of the cations and anions can be calculated, in milli-equivalents per litre, by the following formula: S(C+A) = Ca + Mg + Na + K + *b* Sr + NH_4-N + SO_4 + Cl + CO_3 + HCO_3 + NO_3-N + *b* NO_2-N + *b* PO_4-P b ions used only if in sufficient concentration to significantly modify the ionic balance. Requesting Agency and Date: UNEP GEMS/Water Programme, December 1997. Reference: UNEP GEMS/Water 1992.	SUM OF CATIONS + ANIONS	meq/L	3

Code	Method Description	Name	Units	Decimals
00190	SAMPLING METHOD, INTEGRATED SAMPLE – (Code is for internal use only) Vertical (V), Horizontal (H), Time (T) Parameter code used for GEMS/Water projects to indicate sampling method. (Integrated sample code is for internal use only): 1 - Vertical Integration (V) 2 - Horizontal Integration (H) 3 - Time Integration (T) 4 - Flow Integration Requesting Agency and Date: UNEP GEMS/Water Programme, April 1978. Reference: UNEP GEMS/Water 1992.	INTEGRATED SAMPLE	Code	0
01000	HYDROGEN SULPHIDE A tablet of Alka-seltzer is added to a sample aliquot; the shaken aliquot evolves gas and reacts with a lead acetate indicator paper in the cap. The black colour of lead sulphide is compared to standard and blank solutions to determine the concentration of hydrogen sulphide. Requesting Agency and Date: Saskatchewan Environment, Canada, July 1977. Reference: APHA 1975.	H_2S	mg/L	2
02003	ABSORPTION at 340 nm Spectrophotometric Absorbance Reading A sample is passed through a 0.45 µm membrane filter paper, then its absorbance is measured spectrometrically, at 340 nm in a 40 mm cell and the result is multiplied by 1000. Requesting Agency and Date: National Institute for Water and Atmosphere, New Zealand, 2000. Reference: Davies-Colley and Vant 1987.	A340	Abs*1000	1
02004	ABSORPTION at 440 nm Spectrophotometric Absorbance Reading A sample is passed through a 0.45 µm membrane filter paper, then its absorbance is measured spectrometrically, at 440 nm, in a 40 mm cell and the result is multiplied by 1000. Requesting Agency and Date: National Institute for Water and Atmosphere, New Zealand, 2000. Reference: Davies-Colley and Vant 1987.	A440	Abs*1000	1
02005	ABSORPTION at 740 nm Spectrophotometric Absorbance Reading A sample is passed through a 0.45 µm membrane filter paper, then its absorbance is measured spectrometrically, at 740 nm, in a 40 mm cell, and the result is multiplied by 1000. Requesting Agency and Date: National Institute for Water and Atmosphere, New Zealand, 2000. Reference: Davies-Colley and Vant 1987.	A740	Abs*1000	1

Code	Method Description	Name	Units	Decimals
02006	ABSORPTION COEFFICIENT at 340 nm Calculated from 440 & 740 NM Absorbances The "apparent" absorbance, measured at 740 nm, is principally caused by light scattering and particulates absorbance. The absorption coefficient (G_{340}) corrects for this interference. Apparent Abs_{740} = Abs_{740} x 740/340 = Abs_{740} x 2.176471 G_{340} = (ln 10) x Corrected Abs/cuvette path length (m) G_{340} = 2.303 (Abs_{340} - App. Abs_{740})/cuvette path length (m) Requesting Agency and Date: National Institute for Water and Atmosphere, New Zealand, 2000. Reference: Davies-Colley and Vant 1987.	G340	M	1
02007	ABSORPTION CO-EFFICIENT at 440 nm Calculated from 340 & 740 NM Absorbances The "apparent" absorbance, measured at 740 nm, is principally caused by light scattering and particulates absorbance. The absorption coefficient (G340) corrects for this interference. Apparent Abs740 = Abs740 x 740/440 = Abs740 x 1.681818 G440 = (ln 10) x Corrected Abs/cuvette path length (m) G340 = 2.303 (Abs440 - App. Abs740)/cuvette path length (m) Requesting Agency and Date: National Institute for Water and Atmosphere, New Zealand, 2000. Reference: Davies-Colley and Vant 1987.	G440	M	1
02011	COLOUR APPARENT Visual Comparison The colour of a shaken sample is determined by visual comparison to known concentration of coloured solutions sealed in glass disks (Hellige Aqua Tester) or by visual comparison with platinum-cobalt standards (chloroplatinate ions). Apparent colour includes colour due to suspended matter (true colour is the colour of the water where turbidity has been removed by centrifuge). The method detection limit is 5 Pt-Co units. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Environment Canada 1974.	COLOUR APPARENT	Rel. Units	1
02040	ELECTRICAL CONDUCTANCE Electrometer Specific Conductance of a solution is the ability of the solution to carry electric current and has some relationship to the Total Ionic Concentration of the solution. The sample temperature is brought to 20^{o}C and the aliquot is measured electrometrically. Requesting Agency and Date: European Environment Agency, no date. Reference: n/a.	ELEC. COND.	µs/cm	0

Code	Method Description	Name	Units	Decimals
02041	ELECTRICAL CONDUCTANCE Conductivity Meter Specific Conductance of a solution is the ability of the solution to carry electric current and has some relationship to the Total Ionic Concentration of the solution. The specific conductance is measured by a conductivity meter with Pt electrodes and is equilibrated to 25°C before the sample measurement is made. The conductivity meter is calibrated on a per use basis. Note: This parameter was formerly measured in µmho/cm. As a result of the change to the metric system, the unit now is µS/cm (microsiemens/cm). 1 umho/cm = 1 µsie/cm. 1 µS/cm The method detection limit is 2 µS/cm. Requesting Agency and Date 1: National Institute for Environmental Studies, Japan, 1998. Requesting Agency and Date 2: Water Supplies Department, Hong Kong SAR, no date. Reference1: Environment Canada 1974. Reference2: APHA 1998, 2510B.	ELEC. COND.	µS/cm	0
02049	ELECTRICAL CONDUCTANCE Radiometer CDM 83 Specific Conductance of a solution is the ability of the solution to carry electric current and has some relationship to the Total Ionic Concentration of the solution. The specific conductance is measured, using a radiometer CDM 83, automatic ranging conductivity meter and a radiometer type CDC 334 jacketed platinum electrode. A one-gallon water bath, with a HAAKE Model E52 temperature controller/circulation pump (or equivalent), accurately maintain the temperature bath at 25°C (± 0.1°C) and continually circulate water through the cell jacket. The sample aliquot is drawn into the conductivity cell via a vacuum and specific conductivity is read directly from the meter after a fifteen second temperature stabilisation period. The radiometer is calibrated on a per use basis. The method detection limit is 0.2 µS/cm. 1 umho/cm = 1 µsie/cm. 1 µS/cm Requesting Agency and Date: Alberta Environment, Canada, March 1984. Reference: Environment Canada 1995.	ELEC. COND.	µS/cm	0
02050	TOTAL DISSOLVED SOLIDS Calibrated Conductivity Meter at 25°C The Total Dissolved Solids (TDS) is measured through a calibrated conductivity meter (Orion 105 or 115, or equivalent) and corrected to 25°C, where the values are compared to the Critical Table Values, with a relative standard deviation (RSD) of 0.87% and an accuracy of ± 0.5%. The resolution is 3 significant digits or 1 mg/L and the range varies between 0 and 19900 mg/L. Requesting Agency and Date: Middle East Technical University, Turkey, no date. Reference: Orion Research Inc. 1996.	TDS	mg/L	0

Code	Method Description	Name	Units	Decimals
02055	SALINITY TDS-Salinity-Conductivity Meter at 25°C Specific Conductance of a solution is the ability of the solution to carry electric current and has some relationship to the Total Ionic Concentration of the solution. The salinity is measured through a calibrated TDS-salinity-conductivity meter (Orion 105 or 115, or equivalent) and corrected to 25°C, where the salinity is compared to a salinity table with a precision of 0.5% and reported in parts per thousand. The range is 0 to 80 ppt. The salinity-conductivity meter is calibrated on a per use basis. Requesting Agency and Date: Middle East Technical University, Turkey, no date. Reference: Orion Research Inc., 1996.	SALINITY	ppt	0
02061	TEMPERATURE Mercury Thermometer Both atmospheric and water temperature are measured upon sample collection. The atmospheric temperature is measured in a well-ventilated area and in the shade, at 1.2 to 1.5 m above the ground, using a 50°C calibrated (liquid in glass) thermometer. The water temperature is measured by immersing a calibrated thermometer into the water or by measuring the temperature immediately after collection using a calibrated thermometer. The Hg-filled thermometer has a precision of ± 0.1°C. Requesting Agency and Date: National Institute for Environmental Studies, Japan, 1998. Reference: Japanese Industrial Standards Committee 1998.	TEMP	°C	1
02062	TEMPERATURE Battery Thermometer Water Temperature is measured with a battery-operated YSI thermistor (or equivalent) calibrated against a certified thermometer. Precision is 0.1°C and accuracy is 0.2 °C. The method detection limit is 0.1°C. Requesting Agency and Date: Fisheries and Oceans, Freshwater Institute, Winnipeg, Canada, no date. Reference: n/a.	TEMP	°C	1

Code	Method Description	Name	Units	Decimals
02070	CLARITY Horizontal Black Disc The black disk is expected to be particularly important in waters where depths are too shallow for deployment of Secchi disk. A disk of 20 mm is used for depth of less than 0.4 m of clarity, a 60 mm disk is used for depth between 0.4 to 1.5 m and a disk of 200 mm is used for depth greater than 1.5 m. The disk is placed vertically in the water (often held in position by water current) and moved away from a mirror, placed at 45 degrees in an open-ended tube; measure the length when the disk disappears; pull the disk back toward the mirror and measure the distance when the disk re-appears. Average these distances to calculate the clarity. The method detection limit is variable, depending on the depth of the waters. Requesting Agency and Date: National Institute of Water and Atmospheric Research, New Zealand, no date. Reference: n/a.	CLARITY	m	1
02071	TURBIDITY Visual Turbidity measurements are based on the light path through a suspension causing the image of the flame of a standard candle to disappear, meaning to become undistinguishable against the general background. The method detection limit is 25 Jackson Turbidity Units (JTU). Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: APHA 1975.	TURBIDITY	JTU	1
02073	TURBIDITY Photometry A light beam is passed through the shaken sample. The light, scattered at 90 degrees to the beam-axis, is measured by photocells. The calibration of the instrument is made using a standard suspension of Formazin (the reaction product of an aqueous solutions of hydrazine sulphate ($N_2H_4.H_2SO_4$) and hexamethylenetetramine solutions). Standardisation of the instrument utilises a polyacrylic plastic rod containing special turbidity material. The method detection limit is 0.05 Jackson Turbidity Units. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Environment Canada 1974.	TURBIDITY	JTU	1
02074	TURBIDITY Nephelometric - Hach In a Hach turbidimeter, a strong light beam is sent upwards through a transparent tube containing a shaken sample. The light, reflected at 90 degrees to the axis, is captured by photocells and their electrical response is proportional to the sample turbidity. The instrument is calibrated using a standard solution of Formazin. Standardization of the instrument uses a polyacrylic plastic rod, containing a special turbidity material, supplied with the instrument. The method detection limit is 0.05 NTU. Requesting Agency and Date: Saskatchewan Environment, Canada, July 1977. Reference: APHA 1975.	TURBIDITY	NTU	1

Code	Method Description	Name	Units	Decimals
02076	TRANSPARENCY 30 CM Secchi Disc The depth at which a 30 cm diameter disc, painted in black and white quadrants, is no longer visible in a body of water. The procedure is to record the point of disappearance as the disk is lowered, allow it to drop a little farther, and then determine the point of re-emergence as the disk is raised. The mean of the two readings is taken as the turbidity light penetration. In turbid waters, the precision is 1 cm and in clear waters 10 cm. Note: cross-reference: star code No. 030. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: UNEP GEMS/Water 1992.	TRANS	m	1
03001	LITHIUM – TOTAL Atomic Absorption Spectrometry - Direct Aspiration A sample is preserved in the field with mineral acid. The shaken sample aliquot is digested with nitric acid and aspirated in an air-acetylene oxidizing flame. The absorbance is measured spectrometrically at 670.8 mμ and is compared to identically-prepared Li standard and blank solutions. The method detection limit is 0.005 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Environment Canada 1974.	Li TOTAL	mg/L Li	1
03101	LITHIUM - DISSOLVED Atomic Absorption Spectrometry - Direct Aspiration A sample is filtered in the field through a 0.45 μm membrane filter and preserved with nitric acid. The sample aliquot is aspirated and the absorbance is measured spectrometrically at 670.8 mμ, and compared to identically-prepared standard and blank solutions, using an air-acetylene oxidizing flame. The method detection limit is 0.005 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Environment Canada 1974.	Li DISS	mg/L Li	1
05001	BORON - TOTAL Atomic Absorption Spectrometry – Graphite furnace A sample is preserved in the field, in a plastic container, with mineral acid. The shaken sample aliquot is digested with nitric acid and the absorbance is measured, spectrometrically by Graphite Furnace, at 249.7 nm, and compared to identically-prepared boron standard solutions The method detection limit is 0.15 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1980. Reference: Perkin-Elmer Corp. 1982.	B TOTAL	mg/L B	1

Code	Method Description	Name	Units	Decimals
05002	BORON – TOTAL Colourimetry A sample is preserved in the field in a plastic container. When a shaken sample aliquot, containing boron, is acidified and evaporated in the presence of curcumin, a red coloured product (rosocyanine) is formed. The rosocyanine is taken up in ethyl alcohol and the absorbance is measured spectrometrically at 540 nm, with a minimum light path of 1 cm, and compared to identically-prepared standard and blank solutions. Interferences: nitrate > 10 mg/L and hardness > 100 gm/L. *(See Appendix 1).* The method detection limit is 0.1 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1980. Reference: Environment Canada 1979.	B TOTAL	mg/L B	1
05009	BORON – TOTAL Inductively Coupled Plasma, by Optical Emission Spectrometry (ICP-OES): ICP 1502 *(See Appendix 2).* A sample is preserved in the field, in a plastic container, with nitric acid. The shaken sample aliquot is digested with nitric acid and HCl (aqua regia), concentrated appropriately and aspirated from an autosampler. The emission is measured at 249.68 nm and compared to identically-prepared standard and blank solutions. The method detection limit is 0.002 mg/L. Requesting Agency and Date: Alberta Environment, Canada, October 1981. Reference: Alberta Environment 1981.	B TOTAL	mg/L B	1
05011	BORON - TOTAL Inductively Coupled Plasma by Optical Emission Spectrometry (ICP-OES): ICP 1503 *(See Appendix 2).* A sample is preserved in the field, in a plastic container, with diluted mineral acid. The shaken sample aliquot is digested with aqua regia and evaporated to near dryness. The residue is dissolved in concentrated HCl and diluted to one-fifth of the aliquot volume. The digested sample aliquot is aspirated and the emission is measured at 249.68 nm and compared to identically-prepared standard and blank solutions. The method detection limit is 0.002 mg/L. Requesting Agency and Date: Alberta Environment, Canada, July 1979. Reference: Alberta Environment 1979.	B TOTAL	mg/L B	1

Code	Method Description	Name	Units	Decimals
05090	BORON – TOTAL Inductively Coupled Plasma, Mass Spectrometry (ECP-MS) ICP-MS A sample is preserved in the field, in a plastic container, with dilute mineral acid. The shaken sample aliquot is aspirated into an argon-based, high temperature radio frequency plasma. The sample is dissolved, atomised and ionised. These ions are extracted from the plasma through a vacuum interface and separated on the basis of their mass to charge ratio by a mass spectrometer. The ions are counted by an electron multiplier detector, compared to identically-prepared standard and blank solutions and the resulting information processed by a computer database system. Requesting Agency and Date: National Institute for Environmental Studies, Japan, 1998. Reference: APHA 1998.	B TOTAL	mg/L B	1
05101	BORON - DISSOLVED Potentiometric Mannitol A sample is filtered in the field through a 0.45 µm membrane filter and preserved in a plastic container. If PO_4 concentration exceeds 10 mg/L, the filtrate is precipitated with $Pb(NO_3)_2$. The excess Pb is removed by precipitation with $NaHCO_3$; the HCO_3 is then removed by acidification with H_2SO_4. If hardness exceeds 100 mg/L of $CaCO_3$ the sample is passed through a strongly acidic cation exchange resin. The final sample aliquot is titrated, with a pH meter, to a pH of 7.00 with NaOH, using mannitol as indicator. The concentration of boron is proportional to the amount of NaOH needed and is compared to identically prepared standard and blank (to compensate for any CO_2 error) solutions. Interference: Ge and tetravalent V also interfere. The method detection limit is 0.01 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: APHA 1971.	B DISS	mg/L B	1
05102	BORON - DISSOLVED Curcumin Method A sample is filtered in the field through a 0.45 µm membrane filter and preserved in a plastic container. A red coloured solution (rosocyanine) is obtained when the sample aliquot, containing boron, is acidified and evaporated in the presence of curcumin (turmeric yellow; 1,7-bis(4-hyroxymethoxy-phenyl)-1,6-heptadiene-3,5-doine), mixed and diluted with ethanol. The diluted sample is read at 540 mµ within one hour after sample has been dried and compared to identically-prepared standard and blank solutions. Interference: NO_3 ion greater than 20 mg/L NO_3. The method detection limit is 0.06 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Environment Canada 1974.	B DISS	mg/L B	1

Code	Method Description	Name	Units	Decimals
05105	BORON - DISSOLVED Colourimetry A sample is filtered in the field through a 0.45 µm membrane filter and preserved in a plastic container. The sample aliquot is mixed with a solution of carminic acid and phenol in concentrated H_2SO_4. The absorbance of the resulting colour is measured spectrometrically at 600 mµ, and compared to identically-prepared standard and blank solutions. Interference: a phenol concentration of 0.05% in the carminic acid solution will suppress the nitrate interference up to 40 mg/L of nitrogen. The method detection limit is 0.02 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: APHA 1971.	B DISS	mg/L B	1
05107	BORON - DISSOLVED Inductively Coupled Plasma by Optical Emission Spectroscopy (ICP-OES) ICP 1516 *(See Appendix 2).* A sample is filtered in the field through a 0.45 µm membrane filter and preserved in a plastic container with dilute mineral acid. The sample aliquot is aspirated and the emission is measured at the wavelength of 249.7 nm and compared to identically-prepared standard and blank solutions. The method detection limit is 0.002 mg/L. Requesting Agency and Date: Alberta Environment, Canada, December 1985. Reference: Alberta Environment 1979.	B DISS	mg/L B	1
05109	BORON - DISSOLVED Inductively Coupled Argon Plasma by Optical Emission Spectrometry (ICP-OES) ICP1502 *(See Appendix 2)* A sample is filtered in the field through a 0.45 µm membrane filter and preserved in a plastic container with dilute mineral acid. The sample aliquot is concentrated appropriately and aspirated from an autosampler. The emission is measured at 249.68 nm and compared to identically-prepared standard and blank solutions. The method detection limit is 0.002 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Alberta Environment 1981.	B DISS	mg/L B	1
05111	BORON - DISSOLVED Inductively Coupled Plasma by Optical Emission Spectroscopy (ICP-OES) ICP 1516 *(See Appendix 2)* A sample is filtered in the field through a 0.45 µm membrane filter and preserved in a plastic container with dilute mineral acid. The sample aliquot is aspirated and the emission is measured at 249.68 nm and compared to identically-prepared standard and blank solutions. The method detection limit is 0.002 mg/L. Requesting Agency and Date: Alberta Environment, Canada, December 1979. Reference: Alberta Environment 1979.	B DISS	mg/L B	1

Code	Method Description	Name	Units	Decimals
05190	BORON - DISSOLVED Inductively Coupled Plasma – Mass Spectrometry (ICP-MS) A sample is filtered in the field through a 0.45 µm membrane filter and preserved in a plastic container with dilute mineral acid. The sample aliquot is aspirated into an argon-based, high temperature radio frequency plasma. The sample is dissolved, atomised and ionised. These ions are extracted from the plasma through a vacuum interface and separated on the basis of their mass to charge ratio by a mass spectrometer and compared to identically-prepared standard and blank solutions. The ions are counted by an electron multiplier detector and the resulting information processed by a computer database system. Requesting Agency and Date: National Institute for Environmental Studies, Japan, 1998. Reference: APHA 1998.	B DISS	mg/L B	1
06001	CARBON - TOTAL ORGANIC Infrared Analysis Single Channel: A small volume of blended sample is acidified with HCl, aerated with air or Nitrogen, and passed into a combustion tube, at 950°C, containing pumice stone impregnated with cobalt oxide. The carbonaceous material in the sample is oxidized, yielding carbon dioxide and steam. The resulting CO_2 is measured by an IR analyzer and compared to identically-prepared organic Carbon standard and blank solutions to give total Organic Carbon. The method detection limit is 0.5 mg/L. Dual Channel: A small volume of a blended sample is injected into a combustion tube, at 950°C, containing pumice stone impregnated with cobalt oxide. The carbonaceous material in the sample is oxidized, yielding carbon dioxide and steam. The resulting CO_2 is measured by an IR analyzer and compared to identically-prepared organic Carbon standard and blank solutions to give total C. An identical volume of sample is injected into a combustion tube, at 150°C containing 85% H_3PO_4 on quartz chips. The airflow carries out the resulting sample which is condensed and the inorganic carbon, as CO_2, is measured by an IR analyzer, and compared to identically-prepared inorganic carbon standard and blank solutions. The total organic carbon is calculated by difference. Interference: Large particles may not be injected. The method detection limit is 0.5 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Environment Canada 1974.	TOC	mg/L C	0

Code	Method Description	Name	Units	Decimals
06076	CARBON ORGANIC - PARTICULATE CHN Analyzer A sample aliquot is washed with 0.3% sulphuric acid to remove all inorganic carbons. The aliquot is then weighed and ignited in a combustion tube, containing MnO_2 catalyst, at 850°C. The resulting CO_2 is measured by thermal conductivity and compared to identically-prepared standard and blank solutions. The method detection limit is 0.001 µg/g. Requesting Agency and Date: Environment Canada, Atlantic Region, December 1976. Reference: Environment Canada 1979.	ORG. CARBON-PART	µg/g	3
06077	CARBON ORGANIC - PARTICULATE Flame Ionization A sample aliquot is acidified prior to the analysis to remove the inorganic carbon and a volume of blended sample is injected into a platinum boat containing manganese oxide. After sample vaporization the boat is advanced to pyrolysis zone at 850°C. Volatile organic compounds pass over a hydrogen-enriched nickel catalyst at 350°C and are reduced to CH_4 which is measured by a flame ionization detector and compared to identically-prepared standard and blank solutions. Requesting Agency and Date: Alberta Environment, Canada, September 1978. Reference: Alberta Environment 1978.	ORG. CARBON-PART	µg/g	3
06101	CARBON ORGANIC - DISSOLVED Infrared Analysis A sample is filtered in the field through a 0.45 µm membrane filter. A small volume is injected into a combustion tube at 950°C containing Cobalt oxide on asbestos. The resulting CO_2 is measured by an IR analyzer and compared with organic carbon standard and blank solutions to give the total dissolved C. An identical volume is injected into a combustion tube at 150°C containing 85% H_3PO_4 on quartz chips. The resulting CO_2 is measured by an IR analyzer and compared to identically-prepared inorganic carbon standard and blank. The dissolved organic C is calculated by difference. The method detection limit is 0.5 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Environment Canada 1974.	ORG. CARBON-DISS	mg/L	1
06201	BICARBONATE Calculated If PA = 0 then HCO_3= 1.219*TA If PA ≤ TA/2 then HCO_3= 1.219*(TA-2*PA) If PA > TA/2 then HCO_3= 0 If TA < PA then no calculations If TA = PA and Not = 0 then no calculations. The method detection limit is 0.5 mg/L. Caution: These calculated results are computed from measured analytical values according to the formula indicated. The computations may be in error if the parameters used in the calculation are subsequently edited or changed. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: APHA 1967.	BICARBON-ATE	mg/L HCO_3	0

Code	Method Description	Name	Units	Decimals
06301	CARBONATE Calculated If PA=0 then CO_3= 0 If PA ≤ TA/2 then CO_3= 1.2*PA If PA> TA/2 then CO_3= 1.2*(TA-PA) If TA<PA then no calculations If TA=PA and Not = 0 then no calculations The method detection limit is 0.5 mg/L. Caution: These calculated results are computed from measured analytical values according to the formula indicated. The computations may be in error if the parameters used in the calculation are subsequently edited or changed. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: APHA 1967.	CARBONATE	mg/L CO_3	0
06402	CO_2 – DISSOLVED Carbon dioxide, dissolved in water, is measured by titrating a sample aliquot with a solution of NaOH/$NaHCO_3$ to a pH of 8.3 using a phenolphthalein indicator until a pink colour persists for 30 seconds in the sample aliquot (potentiometric method can also be used). It is advisable to analyse the sample in the field; if not, then preserve the sample at lower temperature than collected, and analyse within 24 hours. Interference: Anions and cations that quantitatively disturb the equilibrium of carbon dioxide-carbonate. Al, Cr, Cu, Fe are some of the metals with salts that provide bias high analytical results; amines, ammonia, borate, nitrite, phosphate, silicate and sulfide also provide positive results. Mineral acids and salts of strong acids and base should be absent. This method is not applicable in samples containing mine wastes. High total dissolved solids may introduce negative results. The method detection limit is 1 mg/L. Requesting Agency and Date: Environment Canada, September 1978. Reference: APHA 1975.	CO_2 DISS	mg/L	0
06505	POLYAROMATIC HYDROCARBONS (PAHs) Gas Chromatography – Flame Ionization Detector and Mass Spectrometry (GC-FID and GC-MS) The measured sample is vigorously extracted three times with benzene, dried with pre-washed sodium sulphate, and reduced to 10 mL. Direct analysis for PAH is completed by capillary GC-FID and GC-MS and compared to calibration standards and blank solutions. The method detection limit is 0.02 µg/L. Requesting Agency and Date: Environment Canada, March 1980. Reference: Borneff and Kunte 1969.	PAH	µg/L	2

Code	Method Description	Name	Units	Decimals
06510	POLYAROMATIC HYDROCARBONS (PAHs) Fluorescence Spectrophotometry A sample is acidified in the field. The concentration of Aromatic Hydrocarbons, associated with oils, is measured directly on a known volume of water sample, by fluorescence spectrometry, using methyl-naphthalene as a standard. The confirmation is completed by extraction with hexane, The extract is fractionated on an alumina column and analysed by temperature programme GLC using a flame ionization detector (FID). The samples are compared to calibration standards and blank solutions. The method detection limit is 1.0 µg/L. Requesting Agency and Date: Environment Canada, Prairie and Northern Region, June 1974. Reference: n/a.	PAH	µg/L	3
06521	OIL AND GREASE Petroleum Ether Extraction A sample is acidified with H_2SO_4 and extracted twice with petroleum ether, (if the ether layer is turbid, extracted 3 times); the combined extracts are filtered. The ether is partially distilled, then evaporated at 70°C in a tared flask. The flask is cooled and dried in a desiccator, then weighed. The method detection limit is 1 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: APHA 1971.	OIL AND GREASE	mg/L	0
06532	PHENOLS Colourimetry If turbid, a sample is passed through a GF/C glass-fibre filter then preserved with $CuSO_4$ and H_3PO_4 in the field. The phenolic materials (for sea water: the aliquot is diluted to avoid Br contamination) are steam-distilled on a Technicon automated system (or equivalent) under acidic conditions. The distillate is then mixed with an alkaline buffer solution (NH_4OH/NH_4Cl) to a pH of 10 (±0.2), reacted with 4-aminoantipyrine (4-amino-1, 5-deimehty-2- phenyl-3- pyrazolene) and the resulting colour is measured spectrometrically at 505 mµ and compared with identically-prepared phenol standard and blank solutions. Interferences: Br, S compounds and steam distillable aldehydes. The method detection limit is 0.002 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Environment Canada 1974.	PHENOLS	mg/L	3

Code	Method Description	Name	Units	Decimals
06570	HYDROCARBONS - TOTAL IR Intensity Spectroscopy An acidified sample is extracted in freon and silica gel; the silica gel selectively removes the fatty acids and the materials not eliminated by silica gel are considered hydrocarbons. Infrared detection permits measurements of many relatively volatile hydrocarbons. The samples are compared to identically-prepared standard and blank solutions. Interference: any compounds, other than hydrocarbons and fatty matter, recovered by this method will interfere. The method detection limit is 500 µg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: APHA 1998.	HYDROCAR -TOTAL	µg/L	1
06606	CYANIDE Colourimetry If turbid, a sample aliquot is decanted. On an autoanalyser, the sample is acidified with phosphoric and hypophosphorous acid solution and irradiated with UV light to convert the complex cyanides to hydrocyanic acid, HCN. After irradiation, the sample is buffered at pH 5.2 with a potassium dihydrogen phosphate and disodium hydrogen phosphate solution and the HCN is distilled out of the phosphoric acids solution. It is then converted to cyanogen chloride, CNCl, by reaction with Chloradine-T. The CNCl is finally mixed with a mixture a Pyridine-Barbituric reagent and forms a blue dye. The intensity of the colour produced is measured spectrometrically at 580 mµ, and compared to identically-prepared KCN standard and blank solutions. The chemistry is linear over the range 0.5 - 50 µg/L and the sampling rate is 30/hour. Interference: Sulphides interfere and should be removed prior to analysis. Requesting Agency and Date: Environment Canada, Pacific Region, July 1976. Reference: Technicon Industrial Systems (date unknown), Method No. 315-74W.	CN	mg/L CN	3
06711	CHLOROPHYLL α SCOR – UNESCO (colourimetry) The volume of a water sample is measured and noted in the field; 0.1 to 0.2 mL of magnesium carbonate suspension is added and the sample is immediately filtered through GF/C glass-fibre filter. The filter is kept in the dark and frozen at –20°C until analysis. The pigments are extracted in an acetone-water mixture (9:1 V/V), centrifuged and the concentrations are calculated from the optical densities measured at 663, 645 and 630 mµ. The method detection limit is 0.001 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Environment Canada 1979.	CHLORA A	mg/L	4

Code	Method Description	Name	Units	Decimals
07001	NITROGEN KJELDAHL ORGANIC (TKN) Kjeldahl Method A sample is preserved in the field at 4°C. TKN includes all forms of nitrogen, except the nitrate and nitrite compounds. The sum of the free ammonia and organic nitrogen compounds are converted to ammonium bisulphate as follows: the shaken sample aliquot is digested in a solution of concentrated H_2SO_4 with $HgSO_4$ or $CuSO_4$ (as a catalyst) and K_2SO_4 to form NH_4HSO_4. The ammonia is then distilled from an alkaline medium, absorbed in boric acid, determined by titration with standardised sulphuric acid, using the "N point" indicator and compared to identically-prepared standard and blank solutions. The method detection limit is 0.5 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Environment Canada 1974.	N KJEL	mg/L N	1
07004	NITROGEN KJELDAHL ORGANIC (TKN) Colourimetry A sample is collected in the field and preserved at 4°C. The sum of the free ammonia and organic nitrogen compounds are converted to ammonium bisulphate under the following conditions: the shaken sample aliquot of known volume is digested, at 300°C, with $HClO_4$ and H_2SO_4 solutions to convert the organic nitrogen to (NH_4) HSO. The total ammonia-nitrogen is determined colourimetrically, at 660 nm, by the reaction of ammonia with salicylate and dichloro-isocyanurate solutions, in the presence of sodium nitroprusside, to form an indophenol blue complex; the colour intensity is measured at 660 nm and compared to identically-prepared standard and blank solutions. The method detection limit is 0.03 mg/L. Requesting Agency and Date: Department of Fisheries and Environment, New Brunswick, Canada, November 1973. Reference: Technician Industrial Systems (date unknown), Method No. 170-72W.	N KJEL	mg/L N	1
07105	NITROGEN, NITRATE + NITRITE Colourimetry A sample is filtered in the field through a 0.45 µm membrane filter and preserved at 4°C. The sample aliquot is passed through a coil, filled with cadmium filings, to reduce the nitrates to nitrites. The resulting nitrites, plus the original nitrites, are then reacted with sulphanilamide to form a diazo compound. This compound is then reacted with N-(1-naphthyl) ethylenediamine dihydrochloride to form an azo dye. The azo dye colour intensity, proportional to the nitrate + nitrite concentration, is determined colourimetrically at 520 nm and compared to identically-prepared standard and blank solutions. The method detection limit is 0.005 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Environment Canada 1979.	NO_3NO_2	mg/L N	2

Code	Method Description	Name	Units	Decimals
07207	NITRITE Colourimetry (sulphanilamide) A sample is filtered in the field through a 0.45 µm membrane filter and preserved at 4°C. The sample aliquot is reacted with sulphanilamide to form a diazo compound. This compound is then reacted with N-(1-naphthyl) ethylenediamine dihydrochloride to form an azo dye. The azo dye intensity, proportional to the nitrite concentration, is determined colourimetrically at 520 nm and compared to identically-prepared standard and blank solutions. The method detection limit is 0.001 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Environment Canada 1979.	NO_2-N	mg/L N	2
07210	NITROGEN DISSOLVED NITRITE (NO_2-N) Colorimetric method (with Cleve's acid) A sample is filtered in the lab through filter paper. Add sulphanilic and Cleve's (1-naphthylamine-7-sulphonic acid) acids to an aliquot of the filtrate, let stand in the dark for 30 minutes. After colour development, the solutions are determined, at 522 nm, on a calibrated spectrometer and compared to identically-prepared standard nitrite solutions. The method detection limit is 0.001 mg/L. Requesting Agency and Date: Water Supplies Department, Hong Kong SAR, no date. Reference: Holden 1971.	NO_2-N	mg/L N	3
07300	NITRATE Automated Hydrazine Reduction A sample is filtered in the field through a 0.45 µm membrane filter and preserved at 4°C. The sample aliquot is reacted with an alkaline hydrazine sulphate solution, containing a copper catalyst, to reduce the nitrates to nitrites. The resulting nitrites, plus the original nitrites, are reacted with sulphanilamide to form a diazo compound. This compound is then reacted with N-(1-naphthyl) ethylenediamine dihydrochloride to form an azo dye. The azo dye colour intensity, proportional to the nitrate + nitrite concentration, is determined colourimetrically at 520 nm and compared to identically-prepared standard and blank solutions. The method detection limit is 0.014 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Environment Canada 1994.	NO_3-N	mg/L N	3
07302	NITROGEN (NO_3-N + NO_2-N) Calculation The Determination of Nitrogen content is calculated by the summation of Nitrate (07321) and Nitrite (07210) analytical results, analysed separately. Requesting Agency and Date: Water Supplies Department, Hong Kong SAR, no date. Reference: n/a.	NO_3NO_2	mg/L N	2

Code	Method Description	Name	Units	Decimals
07303	NITROGEN (NO_3-N + NO_2-N) Calculation The Determination of Nitrogen content is calculated by the summation of Nitrate (07320) and Nitrite (07210) analytical results, analysed separately. Requesting Agency and Date: Water Supplies Department, Hong Kong SAR, no date. Reference: n/a.	NO_3NO_2	mg/L N	1
07306	NITRATE Brucine Method A sample is filtered in the field through a 0.45 µm membrane filter and preserved at 4°C. The sample aliquot is mixed with a brucine-sulphanilic reagent, in the presence of nitrate, to produce a yellow colour, measured spectrometrically at 410 nm and compared to identically-prepared standard and blank solutions. Interferences: all strong oxidising and reducing agents interfere (addition of orthotolidine against oxidising agents is an option); the addition of sodium arsenite eliminates the residual chlorine interference; high concentrations of organic matters (in wastewater) usually interfere. The method detection limit is 0.1 mg/L. N.B.: This method is recommended for concentrations ranging between 0.1 and 2 mg NO_3-N per litre due to poor sensitivity in the low range and anomalies above this range. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: APHA 1975.	NO_3-N	mg/L N	2
07309	NITRATE Chromotropic Acid A sample is filtered in the field through a 0.45 µm membrane filter and preserved at 4°C. The sample aliquot is treated with sulphite (to eliminate interference against chlorine and oxidizing agents), urea (to convert nitrite to nitrogen gas) and antimony (to mask the chloride interference up to 4000 mg/L) reagent solutions. Swirl between each addition. After four minutes, the aliquot is then mixed with Chromotropic acid reagent and sulphuric acid. After 45 minutes, the absorbance is read at 410 nm and compared to identically-prepared standard and blank solutions. Interference: chloroferrate complex discharged by addition of antimony; barium, lead, strontium, iodide, iodate, selenite and selenate precipitate with this system. The method detection limit is 0.05 mg/L. Requesting Agency and Date: International Joint Commission, 1987. Reference: APHA 1971.	NO_3-N	mg/L N	2

Code	Method Description	Name	Units	Decimals
07313	NITRATE Cadmium Reduction A sample is filtered in the field through a 0.45 µm membrane filter and preserved at 4°C. Nitrates, from the sample aliquot, are reduced through a cadmium column to nitrites. The resulting nitrites, plus the original nitrites, are then reacted with sulphanilamide to form a diazo compound. This compound is then reacted with N-(1-naphthyl) ethylenediamine dihydrochloride to form an azo dye. The azo dye colour intensity, proportional to the nitrate + nitrite concentration, is determined colourimetrically at 520 nm and compared to identically-prepared standard and blank solutions. The nitrate concentration is obtained by subtracting the original nitrite concentration, determined from a duplicate sample. The method detection limit is 0.005 mg/L Requesting Agency and Date: UNEP GEMS/Water Programme, September 1980. Reference: Environment Canada 1979.	NO_3-N	mg/L N	2
07314	NITRATE Devarda's Alloy Method This method is recommended for samples of concentration greater than 2 mg/L. A sample is filtered in the field through a 0.45 µm membrane filter and preserved at 4°C. The nitrate and nitrite compounds are reduced to ammonia under hot alkaline conditions with a reducing agent (Devarda's alloy is composed of 50% Cu, 45% Al and 5% Zn). The distillation is carried out on a Kjeldahl distillation apparatus. The ammonia formed is distilled and trapped in a boric acid solution. The ammonia is then determined by nesslerization (colourimetry) or acidimetry (titration). Interference: Nitrite should be analysed separately and ammonia removed from the solution; the method is not recommended in the presence of amino and albuminoid nitrogen. The method detection limit is 0.02 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1980. Reference: APHA 1975.	$N0_3$-N	mg/L N	2
07316	NITRATE + NITRITE Ion Chromatography A sample is filtered in the field and preserved at 4°C. The sample aliquot is injected into an eluent stream, pumped through two columns (separator and suppressor columns) packed with low capacity anion exchange resin in the form of CO_3^-/HCO_3^-. The nitrate is separated, based on its affinity for the exchange sites of the resin bed. The suppressor column reduces the background conductivity of the eluent and the concentration of nitrate is measured using a conductivity detector. The anion is identified by its retention time and its concentration by its peak height or area and compared to identically-prepared standard and blank solutions. Sample concentrations exceeding the linear range are diluted and re-run. The method detection limit is 0.25 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Environment Canada 1994.	NO_3NO_2	mg/L N	2

Code	Method Description	Name	Units	Decimals
07320	NITROGEN NITRATE (NO_3-N) Ion Specific Electrode and Nitrate Combination Electrode An ion-specific electrode meter with a nitrate combination electrode is calibrated with buffers of standard nitrate solutions. The nitrate concentration of the solution is measured directly by immersing the nitrate combination electrode, stirring constantly until a steady reading is obtained. The method detection limit is 0.5 mg/L. Requesting Agency and Date: Water Supplies Department, Hong Kong SAR, no date. Reference: APHA 1998, 4500D Nitrate Electrode Method.	$N0_3$-N	mg/L N	1
07321	NITROGEN NITRATE (NO_3-N) Ion Chromatography A sample is filtered through a 0.45 µm membrane filter paper. The sample is then injected into a flowing stream carbonate eluent. The sample is pumped through an ion exchange column, then a suppressor device, and into a conductivity detector. An ion chromatogram of response (conductivity) vs. time is generated. Nitrate ions are identified based on their retention times compared to known standards. Quantitation is accomplished by measuring the area and comparing it to a calibration curve generated from known standards. The method detection limit is 0.01 mg N/L. Requesting Agency and Date: Water Supplies Department, Hong Kong SAR, no date. Reference: US-EPA 1999.	$N0_3$-N	mg/L N	2
07401	NITROGEN ORGANIC DISSOLVED Kjeldahl With Removal of NH_3 A sample is collected in the field and preserved at 4^oC. The shaken sample aliquot is neutralized, if necessary, to pH=7. A phosphate buffer solution (pH=7.4) is added. If Ca ion exceeds 250 mg/L, more buffer solution is added, and the solution is titrated to pH=7.4. Approximately one third of the sample is distilled to remove free NH_3. The residual solution is digested with concentrated H_2SO_4, in the presence of $HgSO_4$ (as a catalyst) and K_2SO_4 to give NH_4HSO_4. The solution is made alkaline and the NH_3 is distilled and collected in a H_3BO_3 solution. The distillate is then titrated with 0.02N H_2SO_4, using an 'N Point' indicator and compared to identically-prepared standard and blank solutions. The method detection limit is 0.5 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Environment Canada 1974.	ORG. NIT.-DISS	mg/L	1

Code	Method Description	Name	Units	Decimals
07403	NITROGEN ORGANIC DISSOLVED Difference Calculation Organic Nitrogen = Total Kjeldahl Nitrogen - Total Ammonia The analytical results are expressed as mg/L N. The method detection limit is 0.5 mg/L. Caution: These calculated results are computed from measured analytical values according to the formula indicated. The computations may be in error if the parameters used in the calculation are subsequently edited or changed. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: n/a.	ORG. NIT. DISS	mg/L N	1
07506	AMMONIA Ion Selective Electrode A sample is preserved in the field at 4°C. The sample aliquot is adjusted to pH 12 or greater using a 10 molar solution of NaOH. An identically-prepared series of NH_4Cl standard and blank solutions are prepared and used to calibrate the ion specific electrode meter. The ammonia concentration of the sample is read directly and corrected to 25°C. The method detection limit is 0.05 mg/L. Requesting Agency and Date: Environment Canada, Prairies Region, May 1975. Reference: Orion Research Inc. (date unknown), Form D595-10/1711.	NH_3	mg/L N	2
07507	NITROGEN TOTAL AMMONIA (NH_4-N) Colourimetry (Salicylate method) The sample is filtered through a membrane filter if suspended particles exist. The sample is reacted with salicylate and hypochlorite in the presence of sodium nitroprusside to form a blue compound. Hypochlorite is generated in situ by the alkaline hydrolysis of sodium dichloroisocyanurate. The blue compound is measured spectrometrically at 655 nm and compared with a series of standard solutions and a blank treated in the same way. The method detection limit is 0.02 mg/L N. Requesting Agency and Date: Water Supplies Department, Hong Kong SAR, no date. Reference: ISO 1984, ISO 7150-1.	NH_4-N	mg/L N	2
07550	NITROGEN TOTAL AMMONIA (NH_4-N) By Nesslerization and distillation An aliquot of the sample is distilled in a mixture of Magnesium Carbonate and boiling stones. The distillate is reacted with a Nessler's reagent and left standing for 10 minutes for colour development. The ammonia concentration is determined by comparing the colour of the aliquot to a set of coloured discs. The method detection limit is 0.02 mg/L. Requesting Agency and Date: Water Supplies Department, Hong Kong SAR, no date. Reference: The Institution of Water Engineers 1960.	NH_4-N	mg/L N	2

Code	Method Description	Name	Units	Decimals
07551	AMMONIA Direct Nesslerization A sample is filtered in the field through a 0.45 µm membrane filter and preserved at 4°C. The sample aliquot is dechlorinated with $ZnSO_4$, the pH is adjusted to 10.5 with NaOH to precipitate Ca, Mg, Fe and sulfides and mix. EDTA is also added (or Rochelle salt) to remove the Ca, Mg or other ions producing turbidity before adding the Nessler reagent. Add Nessler reagent (100g HgI_2 + 70g KI in water, add slowly to a cool solution of 160 g NaOH in 500 mL water and dilute to one litre) and mix the sample by inverting the Nessler tube. Visually compare the colour intensity of the sample aliquot against identically-prepared standard and blank solutions. The method detection limit is 0.1 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: APHA 1975.	NH_3	mg/L N	2
07553	AMMONIA Distillation and Titration A sample is filtered in the field through a 0.45 µm membrane filter and preserved at 4°C. If necessary, the sample aliquot is neutralized to pH=7. A phosphate buffer (pH=7.4) solution is added. If Ca ion exceeds 250 mg/L, more buffer solution is added and the solution is titrated to pH=7.4. The sample aliquot is partly distilled and the distillate is collected in a H_3BO_3 solution and then titrated with 0.02N H_2SO_4, using the 'N Point' indicator. The method detection limit is 0.5 mg/L. Requesting Agency and Date: Environment Canada, NWRI, no date. Reference: Environment Canada 1974.	NH_3	mg/L N	2
07554	AMMONIA Distillation + Nesslerization A sample is filtered in the field and preserved at 4°C. An alkaline potassium permanganate solution is added to the sample aliquot and is partly distilled in a boric acid solution, followed by Nesslerization. Visual Comparison with identically-prepared standard (or permanent standards) and blank solutions determines the concentration of the sample. The method detection limit is 0.1 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: APHA 1975.	NH_3	mg/L N	2
07555	AMMONIA Alpha – Naphthol Method (Colourimetry) A sample is filtered in the field and preserved at 4°C. The sample aliquot is mixed with an alkaline phenol solution, followed by sodium hypochlorite and potassium sodium tartrate. The indophenol blue complex produced is read at 630 nm and is compared to the identically-prepared ammonia standard and blank solutions. The method detection limit is 0.001 mg/L. Note: In the case of precipitation samples, a decanted aliquot of the unshaken, unfiltered sample is normally taken for analysis. Requesting Agency and Date: Environment Canada, NWRI, 1973. Reference: Environment Canada 1979.	NH_3	mg/L N	2

Code	Method Description	Name	Units	Decimals
07556	AMMONIA Colourimetry (Indophenol Blue) A sample is filtered in the field and preserved at 4°C. The sample aliquot is treated with an Alkaline phenol solution, followed by a hypochlorite solution as an oxidizing agent, and Na nitroprusside solution ($NA_2FE(CN)_5NO.2H_2O$) as a catalyst; the sample aliquot is mixed and allowed to stand at room temperature for 1 hour. The absorbance is then read at 640 nm and compared to identically-prepared standard and blank solutions. The method detection limit is 0.005 mg/L. Requesting Agency and Date: Environment Canada, Pacific Region, April 1974. Reference: APHA 1971.	NH_3	mg/L N	2
07557	AMMONIA Automated Indophenol Blue Method A sample is filtered in the field through a 0.45 µm membrane filter and preserved at 4°C. The sample aliquot is treated with an Alkaline phenol solution, followed by a hypochlorite solution as an oxidizing agent, and Na nitroprusside solution ($NA_2FE(CN)_5NO.2H_2O$) as a catalyst; the sample aliquot is mixed and allowed to stand at room temperature for 1 hour. The absorbance is then read at 640 nm and compared to identically-prepared standard and blank solutions. The method detection limit is 0.002 mg/L. Requesting Agency and Date: Environment Canada, Pacific Region, June 1974. Reference: Environment Canada 1979.	NH_3	mg/L N	2
07564	AMMONIA DISSOLVED Ion Chromatography A sample is filtered in the field through a 0.45 µm membrane filter and preserved at 4°C The sample aliquot is injected into an eluent stream and pumped through two columns (separator and suppressor columns) before being detected by conductivity, identified by its retention time and peak height or area and compared to identically-prepared standard and blank solutions. The method detection limit is 0.01 mg/L. Requesting Agency and Date: Environment Canada, no date. Reference: n/a.	AMMONIA DISS	mg/L N	1
07601	NITROGEN TOTAL Colourimetry A sample is preserved in the field at 4°C. On an autoanalyzer, a shaken sample aliquot is aerated, acidified and irradiated in a quartz coil by a UV lamp. The sample is made alkaline and the irradiated process repeated. This solution is mixed with an EDTA (disodium dihydrogen ethylenediamine tetraacetate) solution and the nitrates are reduced to nitrites through a column of Cadmium fillings. A sulphanilamide solution, followed by an N-1-Naphthylethylenediamine dihydrochloride solution, is added to the sample to form an azo dye. The intensity of the dye is measure spectrometrically at 550mµ, and compared to identically-prepared NO_3 standard and blank solutions. Interference: Turbidity. The method detection limit is 0.025 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Environment Canada 1974.	TOTAL NITROGEN	mg/L N	2

Code	Method Description	Name	Units	Decimals
07606	TOTAL NITROGEN Alkaline Persulphate digestion A sample is preserved in the field at 4°C. The Nitrogen of the sample aliquot is oxidised to nitrate in an alkaline persulphate solution. The nitrate is then reduced to nitrite in an alkaline hydrazine sulphate solution, containing copper as a catalyst. The resulting nitrites, under acidic conditions, react with sulphanilamine to form a diazo compound and couple with naphthylethylenediamine to form an azo dye. The colour intensity is proportional to the nitrogen concentration, measured spectrometrically at 520nm and compared to identically-prepared standard and blank solutions. Interference: sample with colour absorbing in the same range. If suspected, analyse a sample blank, omitting the naphthylethylenediamine reagent. Also, samples with certain metal concentrations greater than 35 mg/L (i.e.: Hg II, Cu II, iron and manganese). These samples are diluted before digestion. The method detection limit is 0.014 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Environment Canada 1994.	TOTAL NITROGEN	mg/L N	2
07902	NITROGEN ORGANIC - PARTICULATE CHN Analyzer A sample is passed through a pre-ignited Whatman GF/C filter. The residue is washed with diluted H_2SO_4 (0.3%) to remove inorganic ions. The filter containing the residue is dried and inserted into a combustion tube at 950°C. The resulting N_2 is measured by thermal conductivity, and compared with identically-prepared standard and blank solutions. A Hewlett-Packard 185 CHN Analyzer (or equivalent) is used. Requesting Agency and Date: Environment Canada, September 1982. Reference: Environment Canada 1979.	ORG. NIT.-PART	mg/L	3
08001	PERCENT DO SATURATION Calculated or Nomogram Calculated from dissolved oxygen concentration at the temperature and depth of sampling obtained from the "solubility of oxygen table", where: $S' = S \times \frac{P - p}{760 - p}$ S' (mg/L) = solubility under any barometric pressure; S (mg/L) = solubility at 760 mm Hg; P = barometric pressure (mm Hg); p = pressure of saturated water vapour at water temperature, at 760 mm Hg; If elevations are less than 1000 metres and temperatures below 25°C, p can be ignored; therefore: $S' = S \times \frac{P}{760}$ Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: APHA 1975.	% DO SAT	%	0

Code	Method Description	Name	Units	Decimals
08005	PERCENT DO SATURATION Meter (YSI) The YSI oxygen meter contains oxygen-sensitive membrane electrodes of two solid metal electrodes in contact with supporting electrolyte separated from the test solution by a selective membrane. The diffusion current is linearly proportional to the concentration of molecular oxygen and is converted to concentration units (mg/L) through a calibration procedure. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: APHA 1975.	% DO SAT	%	0
08101	DISSOLVED OXYGEN Winkler Method A sample is collected and analysed in the field or preserved at 4^{o}C and analysed as soon as possible. A sample aliquot is treated with manganous sulphate ($MnSO_4$) and a strong alkaline iodide reagent (NaN_3, NaI and NaOH). The manganous hydroxide formed reacts with the dissolved oxygen to form a brown precipitate ($MnO(OH)_2$ (a KF solution is added if ferrous ions are present). Upon acidification, in the presence of iodide, the iodine liberated is equivalent to the dissolved oxygen originally present in the sample. The iodide is titrated with a standardized sodium thiosulphate solution ($Na_2S_2O_3$), starch is used as an indicator. Interferences: ferrous ion at 1 mg/L (if KF is added the interference level for ferrous ion is 100-200 mg/L), SO_3 ion, S_2O_3 ion, polythionate ions, free Cl_2, OCl ion, oxidizing and reducing agents, and turbidity. The method detection limit is 0.01 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Environment Canada 1974.	DISS O_2	mg/L O_2	1
08102	DISSOLVED OXYGEN Oxygen meter Measurements are made in the field using a calibrated dissolved oxygen meter. The electronic cell, containing a gold cathode and a silver anode, is covered with an Oxygen permeable membrane to prevent interferences. Upon entering the cell, the Oxygen is reduced and the current is directly proportional to the oxygen concentration at a specific temperature. The DO ranges are usually automatically temperature corrected (between –5^{0}C and + 40^{o}C). Regular calibration against the Winkler Titration Method is recommended or by exactly following the manufacturer's procedure. (DO meter is calibrated in air saturated with moisture and the reading is taken when steady condition is obtained). The method detection limit is 0.1 mg/L. Requesting Agency and Date: Water Supplies Department, Hong Kong SAR, no date. Reference: APHA 1998, 4500-0 G Membrane Electrode Method.	DISS O_2	mg/L O_2	1
08107	DISSOLVED OXYGEN Calculated from % Sat., H_2O temperature and pressure at site. The method detection limit is 0.1 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: n/a.	DISS O_2	mg/L O_2	1

Code	Method Description	Name	Units	Decimals
08201	OXYGEN BIOCHEMICAL DEMAND (BOD) Five-Day Dilution Method Biochemical Oxygen Demand is defined as the quantity of oxygen necessary for biological and chemical oxidation of water-borne substances under conditions of the test. A sample is preserved in the field at 4°C and the analysis started within 4 hours. A sample is incubated at 20°C under proper conditions. Comparison of the dissolved oxygen content at the beginning and the end of the incubation period is the measure of the Biochemical Oxygen Demand. The procedure depends on the nature of the sample. After aeration of the samples to bring the dissolved oxygen content to saturation, one of the following three variations can be used, depending on the type of samples to be analysed: A – The direct method: If the BOD does not exceed 7 mg/L, the BOD is determined directly by measuring the dissolved content of the water sample before and after a five days incubation period at 20°C. B – Unseeded dilution method: With waters having BOD values greater than 7 mg/L, appropriate sample aliquots are diluted using dilution water, saturated with oxygen, and the oxygen content is determined before and after the incubation period. A minimum of three dilutions per sample, with a final content between 40% and 70% of the original oxygen concentration, will give best results. C – Seeded dilution method: It is extremely important that the conditions be appropriate for the living organisms to function unhindered during the incubation period. Toxic substances should be absent, and necessary nutrients, such as nitrogen and phosphorus, should be present. It is important that a mixed group of organisms (called "seed") be present during the test. The dilution water is seeded with the proper kind and number of organisms and saturated with oxygen (overnight) before the BOD test. Siphon the diluted sample to fill three BOD bottles; one for incubation (five days), one for the determination of the dissolved oxygen content (measured and record as "initial DO"), and the other for the determination of the immediate dissolved oxygen demand (IDOD), after a 15 minutes incubation period (to eliminate the oxygen demand from sulphide, sulphite and/or ferrous ions). A minimum of three dilutions per sample, with a final content between 40% and 70% of the original oxygen concentration, will give best results. DO Winkler method: A sample is treated with manganous sulphate ($MnSO_4$) and a strong alkaline iodide reagent (NaN_3, NaI and NaOH). The manganous hydroxide reacts with the dissolved oxygen to form a brown precipitate ($MnO(OH)_2$. Let stand for one hour. Upon acidification, with concentrated $H2_SO_4$, in the presence of iodide, the iodine liberated is equivalent to the dissolved oxygen originally present in the sample. The iodide is titrated with a standardized sodium thiosulphate ($Na_2S_2O_3$), using starch as an indicator. Interference: Many synthetic organic components from industrial wastewaters are not biodegradable without adding seeding water. Sample containing residual Cl_2, that is acidic or alkaline, must be neutralized to pH=7 and titrated with $Na_2S_2O_3$ solution. The IDOD is determined to eliminate the oxygen demand of sulphide, sulphite and/or ferrous ions. The method detection limit is 0.01 mg/L. Requesting Agency and Date: Department of Fisheries and Environment, New Brunswick, Canada, March 1974. Reference: Environment Canada 1974.	BOD	mg/L 0_2	0

Code	Method Description	Name	Units	Decimals
08202	BIOCHEMICAL OXYGEN DEMAND (BOD) Five days incubation at 20°C BOD is a measure of the oxygen demand produce by carbonaceous and nitrogenous materials in a sample. It is measured by determining the decrease of oxygen content, using a dissolved oxygen meter, after incubation at 20°C for five days. A sample is preserved in the field at 4°C and the analysis started within four hours. The sample aliquot is incubated, at 20°C for five days under proper conditions. The procedure depends on the nature of the sample. After aeration of the samples to bring the dissolved oxygen content to saturation, one of the following three variations can be used, depending on the type of samples to be analysed: 1 – The direct method: If the BOD does not exceed 7 mg/L, then the BOD is determined directly by measuring the dissolved oxygen content of the water, before and after a five days incubation period at 20°C. 2 – Unseeded dilution method: For waters having BOD values greater than 7 mg/L: appropriate sample aliquots are diluted using dilution water, saturated with oxygen, and the oxygen content is determined before and after the incubation period. A minimum of three dilutions per sample, with a final content between 40% and 70% of the original oxygen concentration, will give best results. 3 – Seeded dilution method: It is extremely important that the conditions be appropriate for the living organisms to function unhindered during the incubation period. Toxic substances should be absent, and necessary nutrients, such as nitrogen and phosphorus, should be present. It is important that a mixed group of organisms (called "seed") should be present during the test. The dilution water is seeded with the proper kind and number of organisms and saturated with oxygen (overnight) before the BOD test. Siphon the diluted sample to fill three BOD bottles; one for incubation (five days), one for the determination of the dissolved oxygen content (measured and record as "initial DO") and the other for the determination of the immediate dissolved oxygen demand (IDOD), after a 15 minutes incubation period. A minimum of three dilutions per sample, with a final content between 40% and 70% of the original oxygen concentration, will give best results. Use a calibrated oxygen meter to measure the oxygen concentrations before and after incubation. Interference: Many synthetic organic components from industrial wastewaters are not biodegradable without adding seeding water due to the toxic effect or the absence or deficiency of appropriate microorganisms. Sample containing residual Cl_2, that is acidic or alkaline, must be neutralized to pH=7, and sometimes titrated with a $Na_2S_2O_3$ solution to liberate the chloride from solution. A sample, containing sulphide, sulphite and/or ferrous ions, creates an immediate demand, corrected by the IDOD. The method detection limit is 1 mg/L. Requesting Agency and Date: Environment Canada, NWRI, July 1978. Reference: APHA 1975, 422F and 507.	BOD	mg/L 0_2	0
08203	BIOCHEMICAL OXYGEN DEMAND Five Day Incubation at 20°C with Allylthiourea Dilute the sample, as needed before incubation, adding nutrients such as nitrogen, phosphorus and trace metals. Buffer the solution to ensure that the sample remains in a pH range suitable for bacterial growth (usually pH 6.5 to 7.5). Incubate at 20°C for five days. Results are reported as carbonaceous biochemical oxygen demand ($CBOD_5$) when inhibiting the nitrogenous oxygen demand. When nitrification is not inhibited, results are reported as BOD_5. Requesting Agency and Date: n/a. Reference: n/a.	BOD (ATU)	mg/L	0

Code	Method Description	Name	Units	Decimals
08301	CHEMICAL OXYGEN DEMAND $K_2Cr_2O_7$ digestion Most organic compounds are oxidised by potassium dichromate under acid condition. A sample is preserved in the field at 4°C. The sample aliquot is refluxed for two hours in concentrated H_2SO_4 with a known amount of $K_2Cr_2O_7$, containing sulphamic acid against the interference of nitrites, $HgSO_4$ against the interferences of chlorides and Ag_2SO_4, as a catalyst for organic compounds. The sample is cooled and the excess dichromate is titrated with standardised ferrous ammonium sulphate ($Fe(NH_4)_2(SO_4)_2$), using ferroin (a complex of ferrous ion and 1,10 phenanthroline) as an indicator. The amount of oxidisable organic matter is proportional to the dichromate consumed. A reagent blank is identically analysed. The concentration of COD is calculated from the difference between sample and blank aliquots. The method detection limit is 1 mg/L. Requesting Agency and Date: Saskatchewan Environment, Canada, July 1977. Reference: Environment Canada 1974.	COD	mg/L O_2	0
08305	TOTAL CHEMICAL OXYGEN DEMAND (COD) $KMnO_4$ Method A sample is preserved in the field at 4°C. An acidified sample aliquot is digested with potassium permanganate in a boiling water bath for 30 minutes where reducing substances are oxidized along with part of the carbonaceous material. The remaining permanganate is reacted with a volume of sodium oxalate solution, equivalent to the permanganate originally added. Keeping the solution between 60-80°C, the excess oxalate is back-titrated with the permanganate solution. The permanganate required in this back-titration is equivalent to the $KMnO_4$ chemical oxygen demand. A reagent blank is identically treated. The Total COD is calculated from the difference between sample and blank aliquots. The method detection limit is 0.1 mg/L. Requesting Agency and Date: National Institute for Environmental Studies, Japan, no date. Reference: Environment Canada 1979.	COD	mg/L O_2	0
08401	PERMANGANATE VALUE $KMnO_4$ Method A sample is tightly capped and preserved in the field at 4°C. The sample aliquot is acidified with diluted H_2SO_4 (25%) and $KMnO_4$ solution is added. The solution is then digested 30 minutes on a boiling water bath. An oxalic acid solution equivalent to the original $KMnO_4$ solution is added to the mixture at 70°C. The excess oxalic acid is back-titrated with standard $KMnO_4$ solution at 60°C. A reagent blank is identically treated. The consumed O_2 is calculated by difference between sample and blank aliquots. Interferences: Cl ion concentration in excess of 1000 mg/L. The method detection limit is 0.1 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Environment Canada, 1974.	PERM V	mg/L O_2	0

Code	Method Description	Name	Units	Decimals
08402	PERMANGANATE VALUE $KMnO_4$ Method four-hour digestion A sample is tightly capped and preserved in the field at 4°C. A sample aliquot is acidified with diluted H_2SO_4 (25%) and KMnO4 solution is added. The solution is then digested four hours on a boiling water bath. An oxalic acid solution equivalent to the original $KMnO_4$ solution is added to the mixture at 70°C. The excess oxalic acid is back-titrated with standard $KMnO_4$ solution at 60°C. A reagent blank is identically treated. The consumed O_2 is found by difference between sample and blank aliquots. Interferences: Cl ion concentration in excess of 1000 mg/L. The method detection limit is 0.1 mg/L Requesting Agency and Date: UNEP GEMS/Water Programme, September 1980. Reference: Environment Canada 1974.	PERM V	mg/L O_2	0
09104	FLUORIDE - DISSOLVED Colourimetry Distillation To a round bottom flask, add sample aliquot, concentrated H_2SO_4, glass beads and Ag_2SO_4 (at a rate of 5 mg/mg Cl if concentration is greater than 7000 mg/L) and attached flask to distillation unit. Heat until the temperature of the flask content reaches exactly 180°C. Do not heat over 180°C to prevent SO_4 carry-over. Analysis: The SPADNS colourimetric method is based on the reaction between fluoride and zirconium ions; this reaction is greatly influenced by the acidity (as the reaction can be almost instantaneous). Mix SPADNS and zirconyl-acid reagent to the sample and read the absorbance at 570nm; compare to identically-prepared standard and blank solutions. If the sample concentration exceeds the highest standard, then dilute and re-analyse the sample. *(See Appendix 7).* The method detection limit is 0.01 mg/L. Caution: In seawater, there may be significant interference from Mg or pH. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: APHA 1975.	F DISS	mg/L F	1
09105	FLUORIDE - DISSOLVED Specific Ion Electrode A sample is preserved in the field at 4°C. A sample aliquot is mixed with a Total Ionic Strength Adjustment Buffer (TISAB) solution and compared to identically-prepared standard and blank solutions, using a calibrated specific ion meter. The F ion concentration of the sample is read directly and corrected to 25°C. *(See Appendix 7).* The method detection limit is 0.05 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Environment Canada 1974.	F DISS	mg/L F	1

Code	Method Description	Name	Units	Decimals
09106	FLUORIDE - DISSOLVED Electrode Potential Method A sample is preserved in the field at 4°C. A sample aliquot is mixed with a Total Ionic Strength Adjustment Buffer solution (TISAB). The electrode potential of the solution is measured on a pH meter expanded MV scale and compared to identically-prepared fluoride F standard and blank solutions, and corrected to 25°C. *(See Appendix 7).* The method detection limit is 0.01 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Environment Canada 1974.	F DISS	mg/L F	1
09107	FLUORIDE - DISSOLVED Potentiometric Specific Ion A sample is preserved in the field at 4°C. Fluoride is determined potentiometrically in a flow-through system using a specific ion combination electrode and a digital millivoltmeter. A strip chart recorder and a printer provide continuous monitoring of the electrode output and automatic printout of the potential at optimum peak heights. The method detection limit is 0.02 mg/L. Requesting Agency and Date: Environment Canada, Atlantic Region, August 1979. Reference: Environment Canada 1979.	F DISS	mg/L F	1
09110	FLUORIDE - DISSOLVED Photometric (La-Alizarin Complex) The photometric method is based on the colourimetric reaction between fluoride and lanthanum-alizarin reagent. The sample aliquot is buffered to pH of 4.5 and the lanthanum-alizarin reagent is added to form a stable complex with fluoride (residual chlorine is removed by acetic acid addition). The photometer provides a light path of at least 1 cm and the optical density is read at 622 nm. Read 30 minutes after the addition and mixing of reagents and compare to identically-prepared standard and blank solutions. The method detection limit is 0.1 mg/L Requesting Agency and Date: UNEP GEMS/Water Programme, September 1980. Reference: Greenhalgh and Riley 1961.	F DISS	mg/L F	1

Code	Method Description	Name	Units	Decimals
09116	FLUORIDE - DISSOLVED Ion Chromatography A sample is preserved in the field at 4°C. The sample aliquot is injected into an eluent stream, pumped through two columns (separator and suppressor columns) packed with low capacity anion exchange resin in the form of CO^{3-}/HCO^{3-}. The fluoride is separated, based on its affinity for the exchange sites of the resin bed. The suppressor column reduces the background conductivity of the eluent and the concentration of fluoride is measured using a conductivity detector. The anion is identified by its retention time, peak height or area and compared to identically-prepared standard and blank solutions. The method detection limit is 0.1 mg/L. Note: this method is not recommended for unknown matrices as positive or negative bias has been noticed; it is difficult to quantify F at low concentrations and also, the organic acids (formic, carbonic, etc.) elute close to F and therefore interfere. Requesting Agency and Date: National Institute for Environmental Studies, Japan, 1998. Reference: APHA 1995.	F DISS	mg/L F	1
10101	ALKALINITY TOTAL CaCO3 Potentiometric Titration Alkalinity is defined as the quantitative capacity of a sample to neutralise a strong acid to a selected pH. A sample is preserved in the field at 4°C. If turbid, the sample is allowed to settle. A known volume of the sample aliquot is titrated with a standardized solution of H_2SO_4 (or HCl), to pH=4.5 then to pH=4.2, using an automatic titrator and a pH meter calibrated for 25°C. The total alkalinity is found from both titration volumes. A two endpoint technique is employed to determine the actual inflection point. The method detection limit is 0.5 mg/L of $CaCO_3$. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Environment Canada 1974.	ALK TOTAL	mg/L $CaCO_3$	2
10102	ALKALINITY TOTAL $CaCO_3$ Colourimetric Titration Alkalinity is defined as the quantitative capacity of a sample to neutralise a strong acid to a selected pH. A sample is preserved in the field at 4°C. If turbid, the sample is allowed to settle. A known volume of the sample aliquot is titrated with standardized H_2SO_4 or HCl to the methyl purple end point (pH=4.8 - 5.4) calibrated for 25°C. Methyl purple indicator is used, together with a blue water soluble dye, to sharpen the end point. An indicator blank is also titrated. The method detection limit is 0.5 mg/L of $CaCO_3$. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: ASTM 1971.	ALK TOTAL	mg/L $CaCO_3$	2

Code	Method Description	Name	Units	Decimals
10103	ALKALINITY TOTAL $CaCO_3$ Titration method A known volume of sample aliquot is titrated with standardized HCl to the end point colour change from blue to steel grey with a pH 4.5 indicator. The method detection limit is 1 mg/L. Requesting Agency and Date: Water Supplies Department, Hong Kong SAR, no date. Reference: APHA 1998, 2320-B. Titration Method.	ALK TOTAL	mg/L $CaCO_3$	0
10120	ALKALINITY TOTAL Visual titration Alkalinity is defined as the quantitative capacity of a sample to neutralise a strong acid to a selected pH. A sample is preserved in the field at 4°C. If turbid, the sample is allowed to settle. A sample aliquot is titrated at 25°C, with standard H_2SO_4 using the mixed bromcresol green-methyl red indicator, and the colour response is indicated as follows: above pH 5.2, greenish blue; pH 5.0, light blue with lavender grey; pH 4.8, light-grey with bluish colour; and pH 4.6, light pink. The colour changes can be verified against a calibrated pH meter under the conditions of titratilon. An indicator blank is also titrated. The results are expressed as milliequivalents per litre of $CaCO_3$. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1980. Reference: APHA 1975.	ALK TOTAL	meq/L $CaCO_3$	2
10121	ALKALINITY TOTAL Electrometric Titration Alkalinity is defined as the quantitative capacity of a sample to neutralise a strong acid to a selected pH. Select sample aliquot size (adjust to room temperature: 25°C) and normality of titrant. Add standard acid in increments of 0.5 mL or less, mix thoroughly; as the end point approaches, make smaller additions of acid and be sure the pH has reached equilibrium before adding more titrant. Titrate to pH of 3.7. Construct a titration curve by plotting the observed pH against the cumulative millilitres of titrant used. A smooth curve showing one or more inflections should be obtained (an erratic curve may indicate that equilibrium was not reached between successive additions). Results expressed as milliequivalent per litre of $CaCO_3$. The method detection limit is 0.5 meq/L of $CaCO_3$. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1980. Reference: APHA 1975.	ALK TOTAL	meq/L $CaCO_3$	2

Code	Method Description	Name	Units	Decimals
10123	ALKALINITY TOTAL Electrometric Titration Alkalinity is defined as the quantitative capacity of a sample to neutralise a strong acid to a selected pH at 25°C. Total alkalinity is determined, under a nitrogen atmosphere, by electronic titration of a sample aliquot with a standard strong acid, using a microprocessor-controlled dynamic mode of titration (titroprocessor METROHM-EP or equivalent). The increments are added so that the change of potential (mV/pH) between data points is equal. Successive increments are then added to give small volume addition in the region of the end point. At the end of the titration to an interpolated end point pH, a report containing the calculated data for end point volume, end point pH and alkalinity concentration is automatically printed. Interference: Dissolved gases such as carbon dioxide, hydrogen sulphide or ammonia. The results expressed as mg/L of $CaCO_3$. The method detection limit is 0.30 mg/L of $CaCO_3$. Requesting Agency and Date: UNEP GEMS/Water Programme, 1998. Reference: Environment Canada 1994.	ALK TOTAL	mg/L $CaCO_3$	2
10151	ALKALINITY PHENOLPHTHALEIN Potentiometric Titration A sample is preserved in the field at 4°C. If turbid, the sample is allowed to settle. A known volume of sample aliquot is titrated with standard H_2SO_4 to pH of 8.3, at 25°C, using an automatic titration system and a pH meter (free residual chlorine is removed with sodium thiosulphate). Interference: Turbidity, dissolved gases such as carbon dioxide, hydrogen sulphite and ammonia. The detection limit is 0.1 mg/L of $CaCO_3$. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Environment Canada 1974.	ALKALINITY	mg/L $CaCO_3$	1
10252	ACIDITY TOTAL Titroprocessor Acidity is defined as the quantitative capacity of a water sample to neutralise a strong base to a selected pH. A sample is preserved in the field at 4°C. Total acidity is determined, at room temperature, under nitrogen atmosphere, by electronic titration of a sample aliquot, using a standard alkaline solution (e.g.: 0.01 N NaOH) to the designated end points of pH 4.5 and 8.3. The inflection point is determined automatically. Interference: dissolved gases such as carbon dioxide, hydrogen sulphide or ammonia; complexes from mine drainage samples. The method detection limit is 0.1 mg/L of $CaCO_3$. Requesting Agency and Date: Environment Canada, Ontario Region, April 1981. Reference: Environment Canada 1979.	TOTAL ACIDITY	mg/L $CaCO_3$	2

Code	Method Description	Name	Units	Decimals
10300	pH Colourimetric Method The pH is measured adding an universal indicator (phenolphthalein/methyl red/thymol blue) or using a pH "non bleeding" strip, wait for colour development and compare the colour of the reaction to the coloured chart of the appropriate indicator used. Interference: colour, turbidity, salinity, colloidal matter and various oxidants and reductants can interfere with the indicator. The precision is within 0.5 pH units. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1980. Reference: Snell and Snell 1967.	pH	pH Units	1
10301	pH pH Meter Electrometry The pH meter, with a glass combination electrode and automatic temperature compensation probe, is calibrated with buffers at pH 4.7 and 10 at 25°C. The pH and temperature values of the sample aliquot are recorded upon reading. The precision is within 0.1 pH units. Requesting Agency and Date: Water Supplies Department, Hong Kong SAR, no date. Reference: APHA 1998, 4500-H B Electrometric Method.	pH	pH Units	1
10302	pH pH Meter (Electrometric) at 25°C The temperature of a sample is stabilised at 25°C. A calibrated glass electrode in combination with a reference potential, provided by a saturated calomel (Hg_2Cl_2) electrode, is used for pH determination. The sample aliquot is read at 25°C. The precision is within 0.1 pH units. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Environment Canada 1974.	pH	pH Units	1
10401	SUSPENDED SOLIDS, 105°C Gravimetric method If oil and grease are present, the sample is blended. If large particles, either floating or submerged, are present, they are excluded from the sample. The sample aliquot is passed through a pre-ignited and pre-weighed Whatman GF/C filter. The filter containing the residue is placed in a porcelain dish, oven-dried at 105°C for 2.5 hours, cooled 15 minutes in a desiccator, and weighed to a constant weight. The method detection limit is 10 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Environment Canada 1974.	SUSP SOL - 105	mg/L	0

Code	Method Description	Name	Units	Decimals
10408	SUSPENDED SOLIDS, 180°C Gravimetric method If oil and grease are present, the sample is blended. If large particles, either floating or submerged, are present, they are excluded from the sample. A sample aliquot is passed through a pre-ignited Whatman GF/C filter. The filter containing the residue is placed in a porcelain dish, oven-dried at 180°C for 2.5 hours, cooled 15 minutes in a desiccator and weighed to a constant weight. The method detection limit is 10 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1980. Reference: APHA 1975.	SUSP SOL - 180	mg/L	0
10452	RESIDUE FILTERABLE Gravimetric method If oil and grease are present the sample is blended. A sample aliquot is passed through a Whatman GF/C filter. The filtrate is evaporated to dryness in a pre-weighed ignited dish. The dish containing the residue is oven-dried overnight at 105°C, cooled for 15 minutes in a desiccator, and weighed to constant weight. The method detection limit is 10 mg/L. Requesting Agency and Date: Deptartment of Fisheries and Environment, New Brunswick, Canada, November 1974. Reference: Environment Canada 1974.	RESIDUE - FILT	mg/L	0
10473	RESIDUE TOTAL Gravimetric Micro-Method A small sample volume (< 1.0 mL) is homogenized and an aliquot placed in a pre-weighed 12 mm aluminium pan. The sample is evaporated to dryness at 105°C in approximately 15 minutes and then weighed to a constant weight. The method detection limit is 10 mg/L. Requesting Agency and Date: Alberta Environment, Canada, February 1979. Reference: Carter, Houston and Logsdon 1976.	RESIDUE - TOT	mg/L	0
10501	FIXED SUSPENDED SOLIDS Gravimetric method If oil and grease are present, the sample is blended. If large particles, either floating or submerged, are present, they are excluded from the sample. A sample aliquot is passed through a pre-ignited Whatman GF/C filter. The filter containing the residue is placed in a porcelain dish, ignited in a muffle furnace at 550°C for 30 minutes, cooled in a desiccator, and weighed to constant weight. The method detection limit is 10 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Environment Canada 1974.	FIX SUSP SOLIDS	mg/L	0

Code	Method Description	Name	Units	Decimals
10511	VOLATILE SUSPENDED SOLIDS Gravimetric method It is defined as the weight loss on ignition of non-filterable residue. Calculate the difference between non-filterable residue (parameter code 10401) and fixed non-filterable residue (parameter code 10501). The method detection limit is 10 mg/L Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Environment Canada 1974.	VOL SUSP SOLIDS	mg/L	0
10521	RESIDUE VOLATILE TOTAL Calculated It is defined as the weight loss on ignition of total residue. Calculate the difference between total residue (parameter codes 10401+10452) and fixed total residue (parameter code 10571). The method detection limit is 10 mg/L Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Environment Canada 1974.	RESIDUE - VOL	mg/L	0
10531	VOLATILE DISSOLVED SOLIDS Gravimetric method It is defined as the weight loss on ignition in a muffle furnace of the dried residue of filterable suspended solids. The method detection limit is 10 mg/L. Requesting Agency and Date: Environment Canada, October 1979. Reference: UNEP GEMS/Water Programme 1992.	VOL DISS SOLIDS	mg/L	0
10551	RESIDUE FIXED Gravimetric method If oil and grease are present, the sample is blended. The sample aliquot is passed through a pre-ignited Whatman GF/C filter. The filtrate is evaporated in a pre-ignited dish, dried at 105^{o}C and weighed to constant weight. The dish is then ignited in a muffle furnace at 550^{o}C for one hour, cooled in a desiccator, and weighed to constant weight. The difference in weight is the fixed filterable residue. The method detection limit is 10 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Environment Canada 1974.	RESIDUE - FIXED	mg/L	0

Code	Method Description	Name	Units	Decimals
10571	RESIDUE FIXED TOTAL Gravimetric The dish or crucible with retained residue from the total residue is ignited at 550°C for 30 minutes in a furnace. Increase in weight over that of the ignited empty dish or crucible represents fixed total residue. The method detection limit is 10 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Environment Canada 1974.	RESIDUE-FIXED TOTAL	mg/L	0
10603	HARDNESS TOTAL EDTA Titration If turbid, the sample aliquot is filtered through a 0.45 µm membrane filter. The titration method depends on the ability of the ethylenediamine tetraacetic acid (EDTA) and its sodium salts to form stable unionised complexes with calcium and magnesium ions. A buffer solution (NH_4Cl, NH_4OH, and Mg salt of EDTA) is added to a sample aliquot to adjust the pH between 10.1 – 10.2, followed by an indicator (Eriochrome Black T) *(See Appendix 8)* forming a pink complex. Upon titration, the EDTA removes the calcium and magnesium from the complex dye and changes the solution to its original blue colour as an end point. Interference: Total heavy metal ion concentration of 0.5 mg/L. The method detection limit is 1 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Environment Canada 1974.	HARDNESS TOTAL	mg/L $CaCO_3$	1
10702	ANIONIC TENSIDES MBAS Methylene Blue Active Substances (MBAS) A sample aliquot is made alkaline (phenolphthalein as indicator), extracted with chloroform and methylene blue solutions. The colour intensity, proportional to the concentration of surfactants in the extract, is measured spectrometrically at 652 nm and compared to identically-prepared standard solutions. The method detection limit is 10 ng LAS (Linear Alkylate Sulphonate) and report as MBAS. N.B.: If the concentration is low (i.e.: less than 500 µg/L), this method suffices as there is no surfactant problem in the water supply. If the concentration is higher, it is important to distinguish between interferences and real surfactants: make an infrared determination or purify the LAS and measure colourimetrically. Interference: Organic sulphates, sulphonates, carboxylates, phosphates and phenols complex with methylene blue and inorganic cyanates, chlorides, nitrates and thiocyanates are among the positive interferences. Numerous materials present in wastewater, industrial waste and sludge lead to incorrect results. This method is applied successfully in measuring surfactants in drinking water supplies. Compare sample aliquots to identically-prepared LAS standard solutions. Requesting Agency and Date: UNEP GEMS/Water Programme, May 1980. Reference: APHA 1975.	TENS AN	mg/L	1

Code	Method Description	Name	Units	Decimals
11001	SODIUM - TOTAL Atomic Absorption Spectroscopy The sample is collected and preserved in a polyethylene bottle at 40°C. A shaken sample aliquot is mixed with a lanthanum solution, as an internal standard, and the absorbance is measured spectrometrically at 589 nm and compared to identically-prepared standard and blank solutions, using an air-acetylene oxidizing flame. The method detection limit is 0.1 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1980. Reference: Perkin-Elmer Corp. 1973.	Na TOTAL	mg/L Na	0
11002	SODIUM - TOTAL Flame Photometry The sample is collected and preserved in a polyethylene bottle at 40°C. A sample aliquot is mixed with lithium nitrate and passed into the burner of a flame photometer equipped with filters to isolate the spectral lines of sodium. The intensity of light produced is proportional to the concentration of sodium in the sample and compared to identically-prepared standard and blank solutions, using propane and air flame. The method detection limit is 0.1 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1980. Reference: Environment Canada 1979.	Na TOTAL	mg/L Na	0
11102	SODIUM - DISSOLVED Atomic Absorption Spectroscopy – Direct Aspiration A sample is filtered in the field through a 0.45 µm membrane filter and preserved in a polyethylene bottle at 4°C. The sample aliquot is mixed with a lanthanum solution, as an internal standard, and the absorbance is measured spectrometrically at 589 nm, using an air-acetylene oxidizing flame. The absorbance produced is proportional to the concentration of sodium in the sample and compared to identically-prepared standard and blank solutions. The method detection limit is 0.1 mg/L Requesting Agency and Date: UNEP GEMS/Water Programme, September 1980. Reference: Perkin-Elmer Corp. 1973.	Na DISS	mg/L Na	0
11103	SODIUM - DISSOLVED Flame Photometry A sample is filtered in the field through a 0.45 µm membrane filter and preserved in a polyethylene bottle at 4°C. The sample aliquot is mixed with a $LiNO_3$, 1% V/V H_2SO_4 solution and aspirated in a flame photometer. The light emission is measure at 589 nm and compared with that of internal Li standard at 671nm. The emission is compared to identically-prepared Na standard and blank solutions, using a propane and air flame. The method detection limit is 0.02 mg/L. Note: In the case of precipitation samples, a decanted aliquot of the unshaken, unfiltered sample is normally taken for analysis. Requesting Agency and Date: Environment Canada, Pacific Region, 1973. Reference: Environment Canada 1974.	Na DISS	mg/L Na	0

Code	Method Description	Name	Units	Decimals
11105	SODIUM - DISSOLVED Atomic Absorption Spectroscopy (AAS) - Direct Aspiration A sample is filtered in the field through a 0.45 µm membrane filter and preserved in a polyethylene bottle at 4°C. The absorption is measured at 295 nm and compared with those of standard NaCl solutions. An air-acetylene flame is used. The method detection limit is 0.1 mg/L At 20 mg/L level the standard deviation was 0.23 mg/L. Requesting Agency and Date: Fisheries and Oceans Canada, Freshwater Institute, Winnipeg, Canada, no date. Reference: Perkin-Elmer Corp. 1973.	Na DISS	mg/L Na	0
11111	SODIUM - DISSOLVED Inductively Coupled Plasma by Optical Emission Spectrometry (ICP-OES): ICP 1516 *(See Appendix 2).* The sample is filtered in the field through a 0.45 µm membrane filter and preserved in a polyethylene bottle with dilute mineral acid. The sample aliquot is aspirated and the emission is measured at 589 nm and compared to identically-prepared standard and blank solutions. The method detection limit is 0.03 mg/L. Requesting Agency and Date: Alberta Environment, Canada, December 1979. Reference: Alberta Environment 1979.	Na DISS	mg/L Na	0
11112	SODIUM - DISSOLVED Ion Chromatography A sample is filtered in the field through a 0.45 µm filter and preserved in a polyethylene bottle at 4 °C. A sample aliquot is injected into an eluent stream, pumped through two columns (separator and suppressor columns) before being detected by a conductivity meter. The sample concentration is compared to the peak height or area and retention time of identically-prepared standard and blank solutions. The method detection limit is 0.01 mg/L. Requesting Agency and Date: Environment Canada, Atlantic Region, no date. Reference: Cheam and Chau 1987.	Na DISS	mg/L Na	0
11115	SODIUM - DISSOLVED Inductively Coupled Plasma by Optical Emission Spectrometry (ICP-OES): ICP 1502 *(See Appendix 2).* A sample is filtered in the field through a 0.45 µm membrane filter and preserved in a polyethylene bottle with nitric acid. The sample aliquot is concentrated appropriately and aspirated from an autosampler. The emission is measured at 589.0 nm and compared to identically-prepared standard and blank solutions. The method detection limit is 0.001 mg/L. Requesting Agency and Date: Environment Canada, (NWRI), October 1985. Reference: Alberta Environment 1981.	Na DISS	mg/L Na	0

Code	Method Description	Name	Units	Decimals
11116	SODIUM DISSOLVED Atomic Absorption Spectrometry (AAS) – Emission A sample is filtered in the field through a 0.45 µm membrane filter and preserved in a polyethylene bottle at 4°C. The sample aliquot is mixed with a lanthanum solution. The absorbance is measured spectrometrically at 589 nm and compared to identically-prepared Na standard and blank solutions, using an air-acetylene oxidizing flame. The method detection limit is 0.01 mg/L Requesting Agency and Date: National Institute of Water and Atmospheric Research, New Zealand, no date. Reference: New Zealand DSIR 1971 and 1972, CD 2151.	Na DISS	mg/L Na	2
11201	SODIUM ADSORPTION RATIO (SAR): Difference Calculation Excess Sodium in irrigation water, relative to calcium and magnesium or to total salt content, can affect soil structure, soil aeration, flow rate, permeability, infiltration, etc. The ratio can be calculated as follows: Method 1: $SAR = \frac{Na+}{\sqrt{\frac{Ca^{2+} + Mg^{2+}}{2}}}$ Method 2: SAR = 1.41*0.04350*Na / SQRT(A) where A = 0.01988*TH , if Total Hardness (TH) is present or A = 0.04990*Ca + 0.08226*Mg , if TH is not present. If Na is not present, or A cannot be calculated because of lack of sufficient parameters, SAR is not calculated. Caution: These calculated results are computed from measured analytical values according to the formula indicated. The computations may be in error if the parameters used in the calculation are subsequently edited or changed. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference 1: UNEP GEMS/Water Programme 1992. Reference 2: Environment Canada 1988.	SAR	Relative Units	3
12002	MAGNESIUM - TOTAL Atomic Absorption Spectrometry – direct aspiration A sample is collected and preserved in the field at 4°C. The shaken sample aliquot is mixed with a $LaCl_3$ solution and aspirated in an air-acetylene reducing flame. The absorbance is measured spectrometrically at 285.2 nm and compared to identically-prepared standard and blank solutions. The method detection limit is 0.001 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Environment Canada 1974.	Mg TOTAL	mg/L Mg	0

Code	Method Description	Name	Units	Decimals
12003	MAGNESIUM - TOTAL EDTA Titration A sample is preserved in the field at 4°C. The pH of the sample aliquot is adjusted to 10.0 ± 0.1 with a buffer (NH_4Cl, NH_4OH and Mg EDTA salt) solution; an indicator, Eriochrome Black T, is added and the aliquot then is slowly titrated with EDTA within five minutes to avoid precipitation. The colour changed from a wine red to a blue colour (a fluorescent light is highly recommended to see the complete disappearance of the red). Interference: Ca ion concentration of 1 mg/L, total heavy metal ion concentrations of 0.5 mg/L. *(See Appendix 8).* The method detection limit is 1 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, May 1981. Reference: Environment Canada 1974.	Mg TOTAL	mg/L Mg	0

Code	Method Description	Name	Units	Decimals
12101	MAGNESIUM - DISSOLVED Calculated: A sample is filtered in the field through a 0.45 µm membrane filter and preserved at 4°C. The magnesium concentration in the sample aliquot is calculated from the values of the Total Hardness (determined by EDTA titration) and Calcium Dissolved. Total Hardness (TH), parameter code = 10603: The pH of a sample aliquot is adjusted to 10.0 ± 0.1 with a NaOH solution; an indicator (Eriochrome Black T) is added and the aliquot is slowly titrated with EDTA to remove the calcium and magnesium from the complex dye. The colour changes from a wine red to a blue colour (a fluorescent light is highly recommended to see the complete disappearance of the red). *(See Appendix 8).* TH (as $CaCO_3$) = A x B x 1000/mL sample Calcium: The pH of a sample aliquot is adjusted between 12 and 13 with a NaOH solution to precipitate the magnesium; the indicator (Eriochrome Blue Black R or Murexide) is added and reacts only with calcium if the sample is immediately but slowly titrated with EDTA. mg/L Ca (as $CaCO_3$) = A x B x 1000/mL sample where A = mL of titration B = mg $CaCO_3$ equivalent to 1.00 mL of EDTA titrant METHOD 1: mg/L Mg = TH (mg/L $CaCO_3$) – Ca hardness (mg/L $CaCO_3$) x 0.244. Interference: suspended and colloidal organic matter and high metal concentrations (Cu > 2 mg/L, Fe > 29 mg/L, Mn > 10 mg/L, Zn > 5 mg/L, Pb > 5 mg/L, Al > 5 mg/L, etc). The sample should be diluted to minimise contaminations. The method detection limit is 1.0 mg/L. METHOD 2: Mg = (TH*0.01998 - Ca*0.0499)*12.16 Caution: These calculated results are computed from measured analytical values according to the formula indicated. The computations may be in error if the parameters used in the calculation are subsequently edited or changed. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference1: APHA 1975. Reference2: Environment Canada 1988.	Mg DISS	mg/L Mg	0

Code	Method Description	Name	Units	Decimals
12102	MAGNESIUM - DISSOLVED Atomic Absorption Spectrometry – Direct Aspiration A sample is filtered in the field through a 0.45 µm membrane filter and preserved at 4°C. The sample aliquot is mixed with a $LaCl_3$ solution and aspirated in an air-acetylene reducing flame. The absorbance is measured spectrometrically at 285.2 nm and compared to identically-prepared standard and blank solutions. The method detection limit is 0.01 mg/L. Note: In the case of precipitation samples, a decanted aliquot of the unshaken, unfiltered sample is normally taken for analysis. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1980. Reference1: Environment Canada 1974. Reference2: Environment Canada 1979.	Mg DISS	mg/L Mg	0
12103	MAGNESIUM - DISSOLVED EDTA Titration A sample is filtered in the field through a 0.45 µm membrane filter and preserved at 4°C. The pH of the sample aliquot is adjusted to 10.0 ± 0.1 with a buffer (NH_4Cl, NH_4OH and Mg EDTA salt) solution; an indicator (Eriochrome Black T) is added and the aliquot then is slowly titrated with EDTA within five minutes to avoid precipitation. The colour changed from a wine red to a blue colour (a fluorescent light is highly recommended to see the complete disappearance of the red). Interference: Ca ion concentration of 1 mg/L, total heavy metal ion concentrations of 0.5 mg/L. *(See Appendix 8).* The method detection limit is 1 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1980. Reference: Environment Canada 1974.	Mg DISS	mg/L Mg	0
12109	MAGNESIUM - DISSOLVED Ion Chromatography A sample is filtered in the field through a 0.45 µm membrane filter and preserved at 4°C. The sample aliquot is injected into an eluent stream, pumped through two columns (separator and suppressor columns) before being detected by a conductivity meter. The sample concentration is compared to the peak height or area and retention time of identically-prepared standard and blank solutions. The method detection limit is 0.05 mg/L Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Cheam and Chau 1987.	Mg DISS	mg/L Mg	0

Code	Method Description	Name	Units	Decimals
12111	MAGNESIUM - DISSOLVED Inductively Coupled Plasma by Optical Emission Spectrometry (ICP-OES): ICP 1516 *(See Appendix 2).* A sample is filtered in the field through a 0.45 µm membrane filter and preserved with dilute mineral acid. The sample aliquot is aspirated and the emission is measured at 279.5 nm and compared to identically-prepared standard and blank solutions. The method detection limit is 0.002 mg/L. Requesting Agency and Date: Alberta Environment, Canada, December 1979. Reference: Alberta Environment 1979.	Mg DISS	mg/L Mg	0
12115	MAGNESIUM - DISSOLVED Inductively Coupled Plasma by Optical Emission Spectrometry (ICP-OES): ICP 1502 *(See Appendix 2).* A Sample is filtered in the field through a 0.45 µm membrane filter and preserved with nitric acid. The sample aliquot is concentrated appropriately and aspirated from an autosampler. The emission is measured at 279.5 nm and compared to identically-prepared standard and blank solutions. The method detection limit is 0.001 mg/L. Requesting Agency and Date: Environment Canada, NWRI, October 1985. Reference: Alberta Environment 1981.	Mg DISS	mg/L Mg	0
13001	ALUMINUM TOTAL Colourimetry A sample is filtered in the field through a 0.45 µm membrane filter and preserved with diluted mineral acid. A hydroxylamine hydrochloride ($NH_2OH.HCl$) solution, containing $BeSO_4$ (to minimize the interference of fluoride), is added to two aliquots: one is the test aliquot and the other is the colour correction aliquot. A solution, containing ferron and orthophenanthroline (9, 10-phenanthroline) (to minimize the interference of iron), is added to one of the sample aliquots. Sodium acetate solution is added to both sample aliquots. The absorbance of the aliquot, containing ferron/orthophenanthroline, is measured spectrometrically at 520 nm, and compared to identically-prepared Al standard and blank solutions. A colour correction is made, using the aliquot without ferron and orthophenanthroline. The Al concentration measured is corrected for Fe, Mn and F ions, by the following equation: mg/L Al = A – B – C + D where, A = apparent mg/L Al B = (0.12 x mg/L Fe) C = 0.04 x mg/L Mn) D = (0.05 x mg/L F) *(See Appendix 8).* The method detection limit is 0.01 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Environment Canada 1974.	Al TOTAL	mg/L Al	3

Code	Method Description	Name	Units	Decimals
13002	ALUMINUM - TOTAL Atomic Absorption Spectrometry - Direct Aspiration A sample is preserved in the field with nitric acid. The sample aliquot is digested with nitric acid and aspirated in a N_2O-C_2H_2 reducing flame. The absorbance is measured spectrometrically at 309.3 nm. The sample is compared to identically-prepared Al standard and blank solutions. The method detection limit is 1 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Environment Canada 1974.	Al TOTAL	mg/L Al	3
13003	ALUMINUM - TOTAL AAS – Solvent Extraction A sample is preserved in the field with nitric acid. The sample aliquot is digested with nitric acid. The aliquot is buffered to a pH between 7.5 and 8.5 and oxine reagent is added. The solution is extracted on a mechanical shaker and the solvent layer is aspirated and the absorbance is measured spectrometrically at 309.3 nm and compared to identically-prepared standard and blank solutions, using a N_2O-C_2H_2 reducing flame. See nomenclature definitions 199. *(See Appendix 5).* The method detection limit is 0.002 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Environment Canada 1974.	Al TOTAL	mg/L Mg	3
13009	ALUMINUM - TOTAL Inductively Coupled Plasma by Optical Emission Spectrometry (ICP-OES): ICP 1502 *(See Appendix 2).* A sample is preserved in the field with nitric acid. The sample aliquot is digested with concentrated nitric acid or aqua regia, concentrated appropriately, and aspirated from an autosampler. The emission is measured at 309.3 nm *(See Appendix 4)* and compared to identically-prepared standard and blank solutions. The method detection limit is 0.001 mg/L. Requesting Agency and Date: Environment Canada, July 1984. Reference: Alberta Environment 1981.	Al TOTAL	mg/L Al	3
13011	ALUMINUM - TOTAL Inductively Coupled Plasma by Optical Emission Spectrometry (ICP-OES): ICP 1503 *(See Appendix 2)* A sample is preserved in the field with diluted mineral acid. The sample aliquot is digested with aqua regia and evaporated near dryness. The residue is dissolved in concentration HCl and diluted appropriately. The digested sample aliquot is aspirated and the emission is measured spectrometrically at 309.3 nm *(See Appendix 4)* and compared to identically-prepared Al standard and blank solutions. The method detection limit is 0.001 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Alberta Environment 1979.	Al TOTAL	mg/L Al	3

Code	Method Description	Name	Units	Decimals
13090	ALUMINUM - TOTAL Inductively Coupled Plasma by Mass Spectrometry (ICP – MS) A sample is preserved in the field with diluted mineral acid. The sample aliquot is digested in mineral acids and introduced in an argon stream high temperature and radio frequency plasma through a pneumatic pump. The energy from the plasma is transferred to the sample and causes desolvation, atomisation and ionisation. The ions generated are extracted from the plasma, through a vacuum interface, and separated on the basis of their mass to charge ratio in the mass spectrometer, the ions are counted by an electron multiplier detector, the data are processed by a computer data handling system and compared to identically-prepared standard and blank solutions. Interference: Isobaric elemental interferences are calculated automatically by the data system; the abundance sensitivity should be corrected through adjustment of the spectrometer resolution; physical interferences are usually corrected by ensuring the water sample does not contain more than 0.5% dissolved solids; ionisation interferences are corrected by the addition of internal standards and sufficient wash time should minimise memory interferences. Requesting Agency and Date: National Institute for Environmental Studies, Japan, no date. Reference: APHA 1998.	Al TOTAL	mg/L Al	3
13101	ALUMINUM - DISSOLVED Colourimetry A sample is filtered in the field through a 0.45 µm membrane filter and preserved with diluted mineral acid. A hydroxylamine hydrochloride ($NH_2OH.HCl$) solution, containing $BeSO_4$ (to minimize the interference of fluoride), is added to two aliquots: one is the test aliquot and the other is the colour correction aliquot. A solution, containing ferron and orthophenanthroline (9, 10-phenanthroline) (to minimize the interference of iron), is added to one of the sample aliquots. Sodium acetate solution is added to both sample aliquots. The absorbance of the aliquot, containing ferron and orthophenanthroline, is measured spectrometrically at 520 nm, and compared to identically-prepared Al standard and blank solutions. A colour correction is made, using the aliquot without ferron and orthophenanthroline. The Al concentration measured is corrected for Fe, Mn and F ions, by the following equation: mg/L Al = A – B – C + D where, A = apparent mg/L Al B = (0.12 x mg/L Fe) C = 0.04 x mg/L Mn) D = (0.05 x mg/L F) *(See Appendix 8).* The method detection limit is 0.01 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Environment Canada 1974.	Al DISS	mg/L Al	3

Code	Method Description	Name	Units	Decimals
13102	ALUMINUM - DISSOLVED Atomic Absorption Spectrometry – Direct Aspiration A sample is filtered in the field through a 0.45 µm membrane filter and preserved with diluted mineral acid. The sample aliquot is aspirated and the absorbance measured spectrometrically at 309.3 nm, and compared with to identically-prepared Al standard and blank solutions, using a N_2O-C_2H_2 reducing flame. The method detection limit is 0.10 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Environment Canada 1974.	Al DISS	mg/L Al	3
13103	ALUMINUM - DISSOLVED Atomic Absorption Spectrometry - Solvent Extraction A sample is filtered in the field through a 0.45 µm membrane filter and preserved with diluted mineral acid. An 8-hydroxy-quinoline and a buffer solution (pH=8) are added to the sample aliquot to adjust the pH between 7.5 and 8.5. This solution is extracted twice with $CHCl_3$. The extractions are combined and the solvent layer is aspirated and the absorbance is measured spectrometrically at 309.3 nm and compared to identically-prepared standard and blank solutions, using a N_2O-C_2H_2 reducing flame. *(See Appendix 5).* The method detection limit is 0.05 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Environment Canada 1974.	Al DISS	mg/L Al	3
13104	ALUMINUM - DISSOLVED Colourimetry A sample is filtered in the field through a 0.45 µm membrane filter and preserved with diluted mineral acid. The 50 ml sample aliquot is mixed with ascorbic acid and aluver powder pillows. Bleaching powder is added to the equally-split sample aliquot and the bleached and unbleached aliquots are measured colourimetrically at 522 nm and the absorbance is compared to identically-prepared standard and blank solutions, in the range is from 0.02 to 0.75 mg/L. Interference: Fluoride is a major interference. The method detection limit is 0.02 mg/L. Requesting Agency and Date: Environment Canada, September 1982. Reference: n/a.	Al DISS	mg/L Al	2
13109	ALUMINUM - DISSOLVED Inductively Coupled Plasma by Optical Emission Spectrometry (ICP-OES): ICP 1502 *(See Appendix 2)* A sample is filtered in the field through a 0.45 µm membrane filter and preserved with nitric acid. The sample aliquot is concentrated appropriately and aspirated from an autosampler. The emission is measured at 309.3 nm and compared to identically-prepared Al standard and blank solutions. The method detection limit is 0.001 mg/L. Requesting Agency and Date: Environment Canada, NWRI, October 1985. Reference: Alberta Environment 1981.	Al DISS	mg/L Al	3

Code	Method Description	Name	Units	Decimals
13111	ALUMINUM - DISSOLVED Inductively Coupled Plasma by Optical Emission Spectrometry (ICP-OES)3: ICP 1516 *(See Appendix 2)* A sample is filtered in the field through a 0.45 µm membrane filter and preserved with dilute mineral acid. The sample aliquot is aspirated and the emission is measured at 309.3 nm and compared to identically-prepared standard and blank solutions. The method detection limit is 0.002 mg/L. Requesting Agency and Date: Alberta Environment, Canada, December 1979. Reference: Alberta Environment 1979.	Al DISS	mg/L Al	3
13190	ALUMINUM - DISSOLVED Inductively Coupled Plasma - Mass Spectrometry (ICP – MS) A sample is filtered in the field through a 0.45 µm membrane filter and preserved with dilute mineral acid. The sample aliquot is introduced in an argon stream high temperature and radio frequency plasma through a pneumatic pump. The energy from the plasma is transferred to the sample and causes desolvation, atomisation and ionisation. The ions generated are extracted from the plasma, through a vacuum interface, and separated on the basis of their mass to charge ratio in the mass spectrometer, the ions are counted by an electron multiplier detector, the data are processed by a computer data handling system and compared to identically-prepared standard and blank solutions. Interference: Isobaric elemental interferences are calculated automatically by the data system; the abundance sensitivity should be corrected through adjustment of the spectrometer resolution; physical interferences are usually corrected by ensuring the water sample does not contain more than 0.5% dissolved solids; ionisation interferences are corrected by the addition of internal standards and sufficient wash time should minimise memory interferences. Requesting Agency and Date: National Institute for Environmental Studies, Japan, 1998. Reference: APHA 1998.	Al DISS	mg/L Al	3
13901	ALUMINUM - DISSOLVED Flameless Atomic Absorption Spectrometry A sample is filtered in the field through a 0.45 µm membrane filter and preserved with mineral acid. The sample aliquot is usually heated in three stages in a graphite furnace or an electrically heated atomiser where: first, a low current is applied to dry the sample; the second stage chars the sample by destroying the organic matter and volatilises other matrix compounds; finally, the third stage applies a high current which heats the tube to incandescence and atomises the aluminum to be determined. The absorbance of the resultant ground state atoms is measured at 309.3 nm and is compared to identically-prepared Al standard and blank solutions. The method detection limit is 0.02 mg/L. Requesting Agency and Date: National Institute for Environmental Studies, Japan, September 1998. Reference: Japanese Industrial Standards Committee 1998.	Al DISS	mg/L Al	3

Code	Method Description	Name	Units	Decimals
13911	ALUMINUM – TOTAL Flameless Atomic Absorption Spectrometry A sample is preserved in the field with mineral acid. The sample aliquot is digested in nitric acid or aqua regia. The aliquot is then heated, usually in three stages in a graphite furnace or an electrically heated atomiser where: first, a low current is applied to dry the sample; the second stage chars the sample by destroying the organic matter and volatilises other matrix compounds; finally, the third stage applies a high current which heats the tube to incandescence and atomises the aluminum to be determined. The absorbance of the resultant ground state atoms is measured at 309.3 nm and is compared to identically-prepared Al standard and blank solutions. The method detection limit is 0.02 mg/L Requesting Agency and Date: National Institute for Environmental Studies, Japan, September 1998. Reference: Japanese Industrial Standards Committee 1998.	Al TOTAL	mg/L Al	3
14019	SILICA - REACTIVE Inductively Coupled Plasma by Optical Emission Spectrometry (ICP-OES): ICP 1502 *(See Appendix 2)* A sample is preserved in the field with nitric acid. The shaken sample aliquot is digested with concentrated nitric acid or aqua regia, concentrated appropriately, and aspirated from an autosampler. The emission is measured at 288.1 nm and compared to identically-prepared standard and blank solutions. The method detection limit is 0.01 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1980. Reference: Alberta Environment 1981.	SI REAC	mg/L SIO_2	2
14101	SILICA - REACTIVE Colourimetry A sample is filtered in the field through a 0.45 µm membrane filter and preserved with diluted mineral acid. $NaHCO_3$(S) is added to the sample aliquot, heated for one hour at 100°C and cooled. Slowly add H_2SO_4 and dilute to volume. Add 50% HCl and $(NH_4)_6Mo_7O_{24}$ solutions and shake. Oxalic acid solution (to destroy the molybdophosphoric acid and decrease tannin interference) is added, followed by a 1-amino-2-naphthol-4-sulphonic acid solution (as a reducing agent), containing Na_2SO_3 and $NaHSO_3$. The resulting heteropoly blue colour is measured, at least two minutes after (but before 15 minutes) adding the oxalic acid, spectrometrically at 815 nm (or 650 nm) and compared to identically-prepared standard and blank solutions. Interferences: High Fe concentrations, colour, sulphide ion, and tannin (the method lessens tannin interference). The method detection limit is 0.02 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1980. Reference: APHA 1971.	SI REAC	mg/L SIO_2	2

Code	Method Description	Name	Units	Decimals
14105	SILICA - REACTIVE Colourimetry A sample is filtered in the field through a 0.45 µm membrane filter and preserved at 4°C. If the sample is seawater all SiO_2 standard solutions are prepared with synthetic seawater. The sample aliquot is mixed with a solution of ammonium molybdate $(NH_4)_6Mo_7O_{24}$ in diluted H_2SO_4. The sample is then mixed with an oxalic acid solution, to destroy the molybdophosphoric acid, and an ascorbic acid solution to form a heteropoly blue complex. The colour is measured spectrometrically at 660 nm and compared to identically-prepared SiO_2 standard and blank solutions. The method detection limit is 0.2 mg/L. Requesting Agency and Date: Environment Canada, Pacific Region, March 1973. Reference: Environment Canada 1974.	SI REAC	mg/L SIO_2	3
14111	SILICA - DISSOLVED Inductively Coupled Plasma by Optical Emission Spectrometry (ICP-OES): ICP 1516 A sample is filtered in the field through a 0.45 µm membrane filter and preserved with dilute mineral acid. The sample aliquot is aspirated and the emission is measured at 288.1 nm and compared to identically-prepared standard and blank solutions. The method detection limit is 0.008 mg/L. Requesting Agency and Date: Alberta Environment, Canada, December 1979. Reference: Alberta Environment 1979.	SI DISS	mg/L SIO_2	2
15103	PHOSPHORUS - DISSOLVED Colourimetry A sample is filtered in the field through a 0.45 µm membrane filter and preserved with 0.2% H_2SO_4. The sample aliquot is autoclaved with $K_2S_2O_8$ and H_2SO_4 for 30 minutes at 121°C. The sample is then mixed with ammonium molybdate, ascorbic acid and antimonyl tartrate to form a molybdenum blue complex measured at 660 nm and compared to identically-prepared standard phosphorus and blank solutions. The method detection limit is 0.003 mg/L. Requesting Agency and Date: Environment Canada, October 1974 Reference: Environment Canada 1979.	P DISS	mg/L P	3

Code	Method Description	Name	Units	Decimals
15205	ORTHOPHOSPHATE – TOTAL Colourimetry A sample is collected and preserved at 4°C (if not analysed immediately). The shaken sample aliquot is mixed with ammonium molybdate to form the heteropoly molybdophosphoric acid and is reduced with stannous chloride, in an aqueous sulphuric acid medium, at 30°C, to form a molybdenum blue complex. The resulting blue colour is measured spectrometrically at 660 nm and compared to identically-prepared standard and blank solutions. Interferences: Hg, at concentration of 1 mg/L, (sample should not be preserved with mercuric chloride) and As also interfere with stannous chloride. The method detection limit is 0.002 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Environment Canada 1974.	P ORTHO TOTAL	mg/L P	3
15254	ORTHOPHOSPHATE SOL REACTIVE Colourimetry A sample is filtered in the field through a 0.45 µm membrane filter and preserved at 4°C (if not analysed immediately). The sample aliquot is mixed with ammonium molybdate to form the heteropoly molybdophosphoric acid and is reduced with stannous chloride, in an aqueous sulphuric acid medium, at 30°C, to form a molybdenum blue complex. The resulting blue colour is measured spectrometrically at 660 nm, and compared to identically-prepared PO_4 standard and blank solutions. Interferences: Hg, at concentration of 1 mg/L, and As also interfere with the stannous chloride reagent. The method detection limit is 0.005 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Environment Canada 1974.	PO_4-P SOL	mg/L PO_4	3
15255	ORTHOPHOSPHATE – DISSOLVED Colourimetry A sample is filtered in the field through a 0.45 µm membrane filter and preserved at 4°C (if not analysed immediately). The sample aliquot is mixed with ammonium molybdate to form the heteropoly molybdophosphoric acid and reduced with stannous chloride, in an aqueous sulphuric acid medium, at 30°C, to form a molybdenum blue complex. The resulting blue colour is measured spectrometrically at 660 nm and compared to identically-prepared PO_4 standard and blank solutions. Interferences: Hg, at concentration at 1 mg/L, and As interfere with the reduction reaction of stannous chloride. The method detection limit is 0.0002 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Environment Canada 1974.	P ORTHO DISS	mg/L P	3

Code	Method Description	Name	Units	Decimals
15256	ORTHOPHOSPHATE – DISSOLVED Molbdenum Blue-Ascorbic Acid Reduction A sample is filtered in the field through a 0.45 µm membrane filter and preserved at 4°C (if not analysed immediately). The sample aliquot is mixed with ammonium molybdate, antimonyl tartrate and ascorbic acid solutions to form a molybdenum blue complex. The resulting blue colour is measured spectrometrically at 880 nm and compared to identically-prepared PO_4 standard and blank solutions. The method detection limit is 0.002 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Environment Canada 1974.	P ORTHO DISS	mg/L P	3
15313	PHOSPHORUS - TOTAL INORGANIC Colourimetry A sample is preserved in the field with 0.2% H_2SO_4. The shaken sample aliquot is autoclaved with H_2SO_4 for 30 minutes at 121°C. If turbid, the aliquot is filtered on a 0.45 µm membrane filter. The aliquot is then mixed with ammonium molybdate to form the heteropoly molybdophosphoric acid and is reduced with stannous chloride, in an aqueous sulphuric acid medium, at 30°C, to form a molybdenum blue complex. The resulting molybdenum blue complex is measured spectrometrically at 660 nm and compared to identically-prepared standard and blank solutions. Interferences: Hg concentration at 1 mg/L and As. The method detection limit is 0.005 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Environment Canada 1974.	P INORG AH TOTAL	mg/L P	3
15403	PHOSPHATE - TOTAL Colourimetry A sample is preserved in the field with 0.2% H_2SO_4. The shaken sample aliquot is autoclaved with $K_2S_2O_8$ and H_2SO_4 for 30 minutes at 121°C. If turbid, the aliquot is filtered through 0.45 µm membrane filter. The sample is then mixed with ammonium molybdate to form the heteropoly molybdophosphoric acid and is reduced with stannous chloride, in an aqueous sulphuric acid medium, at 30°C, to form a molybdenum blue complex. The resulting blue colour is measured spectrometrically at 660 nm and compared to identically-prepared standard and blank solutions. Interferences: Hg concentration of 1 mg/L and As. The method detection limit is 0.005 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Environment Canada 1974.	PO_4 TOTAL	mg/L PO_4	3

Code	Method Description	Name	Units	Decimals
15405	PHOSPHORUS - TOTAL Colourimetry A sample is preserved in the field with 0.2% H_2SO_4. The shaken sample aliquot is boiled with $K_2S_2O_8$ and H_2SO_4 for 90 minutes, maintaining the volume of the aliquot. The sample is then mixed with ammonium molybdate to form the heteropoly molybdophosphoric acid. This is reduced with stannous chloride, in an aqueous sulphuric acid medium to form a molybdenum blue complex. The resulting blue colour is measured spectrometrically at 660 nm and compared to identically-prepared standard and reagent blank solutions. Interferences: Hg concentration of 1 mg/L and As. The method detection limit is 0.002 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Environment Canada 1974.	P TOTAL	mg/L P	3
15406	PHOSPHORUS TOTAL Acid Persulphate Digestion A sample is preserved in the field with 0.2% H_2SO_4. The shaken sample aliquot is autoclaved with $K_2S_2O_8$ and H_2SO_4 for 30 minutes at 121°C. If turbid, the aliquot is filtered through 0.45 µm membrane filter. The sample aliquot is mixed with ammonium molybdate, antimonyl tartrate and ascorbic acid solutions to form a molybdenum blue complex. The resulting blue colour is measured spectrometrically at 660 nm and compared to identically-prepared standard and blank solutions Interference: High iron concentrations The method detection limit is 0.002 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Environment Canada 1974.	P TOTAL	mg/L P	3
15408	PHOSPHATE - TOTAL Colourimetry The sample is preserved in the field with 0.2% H_2SO_4. The shaken sample aliquot is autoclaved with $K_2S_2O_8$ and H_2SO_4 for 30 minutes at 121°C. If turbid, the aliquot is filtered through 0.45 µm membrane filter. The sample aliquot is mixed with ammonium molybdate, antimonyl tartrate and ascorbic acid solutions to form a molybdenum blue complex. The resulting blue colour is measured spectrometrically at 880 nm and compared to identically-prepared standard and blank solutions. The method detection limit is 0.002 mg/L. Requesting Agency and Date: Saskatchewan Environment, Canada, July 1977. Reference: Environment Canada 1974.	PO_4 TOTAL	mg/L P	3

Code	Method Description	Name	Units	Decimals
15417	PHOSPHORUS TOTAL DISSOLVED Colourimetry A sample is filtered in the field through a 0.80 pre-clean µm glass fibre filter paper and preserved with 0.2% H_2SO_4. The sample aliquot is digested with H_2SO_4, $(NH_4)S_2O_8$ or $K_2S_2O_8$ solutions and mixed with ammonium molybdate, antimonyl tartrate and ascorbic acid solutions to form a molybdenum blue complex. The resulting blue colour is measured spectrometrically at 880 nm and compared to identically-prepared phosphorus standard and blank solutions. The method detection limit is 0.01 mg/L. Requesting Agency and Date1: International Joint Commission, no date. Requesting Agency and Date 2: Water Supplies Department, Hong Kong SAR, no date. Reference: APHA 1998, 4500-P E Ascorbic Acid Method.	P TOTAL DISS	mg/L P	3
15901	PHOSPHORUS - PARTICULATE Difference calculation The difference between total phosphorus (parameter codes 15406) and total dissolved phosphorus (code 15103), filtered through a 0.45 µm membrane filter, is used to report the particulate phosphorus concentration in a water sample. PP = TP – TDP PP = Particulate Phosphorus TP = Total Phosphorus TDP = Total Dissolved Phosphorus The method detection limit is 0.003 mg/L. Caution: These calculated results are computed from measured analytical values according to the formula indicated. The computations may be in error if the parameters used in the calculation are subsequently edited or changed. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: n/a.	P PART	mg/L P	3
15902	PHOSPHORUS TOTAL PARTICULATE Difference calculation The difference between the total phosphorus (code 15408) and total dissolved phosphorus (code 15417) is used to report the phosphorus particulate concentration in a water sample. PP = TP – TDP PP = Particulate Phosphorus TP = Total Phosphorus TDP = Total Dissolved Phosphorus Caution: These calculated results are computed from measured analytical values according to the formula indicated. The computations may be in error if the parameters used in the calculation are subsequently edited or changed. Requesting Agency and Date: Alberta Environment, Canada, January 1980. Reference: n/a	P TOTAL PART.	µg/g	3

Code	Method Description	Name	Units	Decimals
15903	PHOSPHORUS TOTAL PARTICULATE Acid-Extraction Colourimetry A sample is filtered through a glass fibre filter paper. The filter paper is ignited at low temperature and then acid extracted to dissolve the particulates. The extract is reacted with ammonium molybdate and ascorbic acid to form a molybdenum blue complex, measured colourimetrically at 660 nm and compared to identically-prepared standard and blank solutions. Requesting Agency and Date: Environment Canada, FWI/ELA Field Laboratory, August 1984. Reference: Environment Canada 1994.	P TOTAL PART.	µg/g	3
16301	SULPHATE Gravimetric Method A sample is filtered in the field through a 0.45 µm membrane filter and preserved at 4°C. The sulphate in the sample aliquot is precipitated in an HCl medium as barium sulphate by the addition of barium chloride. After a period of digestion, near the boiling point, the precipitate is filtered, washed, ignited, and weighed as $BaSO_4$. The method detection limit is 1.0 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: APHA 1975.	SO_4	mg/L SO_4	0
16302	SULPHATE Turbidimetric Method A sample is filtered in the field through a 0.45 µm membrane filter and preserved at 4°C. The sulphate in a sample aliquot is precipitated in a hydrochloric acid medium with barium chloride. The absorbance of the barium sulphate suspension is measured by a photometer and the sulphate concentration is compared to a calibration curve from identically-prepared standard and blank solutions. Interference: Colour and/or suspended matter in large amounts, silica in concentration greater than 500 mg/L will interfere. Organic matter may also interfere. The method detection limit is 1 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: APHA 1975.	SULPHATE	mg/L SO_4	0
16303	SULPHATE Titration A sample is filtered in the field through a 0.45 µm membrane filter and preserved at 4°C. The sample aliquot is passed through a strongly acidic cation exchange resin. Thorin *(See Appendix 8)*, used as an indicator, and 95% ethanol are added to the eluent. The pH of the eluent is adjusted between 3.8 and 4.0 with 1% NH_4OH and 1% HCl solution and titrated, with a barium chloride solution, until the sample turns just pink. Compare against identically-prepared standard and blank solutions. Interference: Cl ion concentration of 1000 mg/L. The method detection limit is 1.0 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Environment Canada 1974.	SULPHATE	mg/L SO_4	0

Code	Method Description	Name	Units	Decimals
16304	SULPHATE Autoanalyzer A sample is filtered in the field through a 0.45 µm membrane filter and preserved at 4°C. The sulphate in the sample aliquot is precipitated in a hydrochloric acid medium with barium chloride. The transmittance of the barium sulphate suspension is measured spectrometrically at 420 nm and the sulphate concentration is compared against identically-prepared standard and blank solutions. Interference: Colour and/or suspended matter in large amounts, silica in concentration greater than 500 mg/L will interfere. Organic matter may also interfere. The method detection limit is 5 mg/L Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: APHA 1975.	SULPHATE	mg/L SO_4	0
16306	SULPHATE Colourimetry A sample is filtered in the field through a 0.45 µm membrane filter and preserved at 4°C. SO_4 ions from the sample aliquot are reacted with an equimolar solution of $BaCl_2$ and methylthymol blue at pH 2.3 - 3.0 producing barium sulphate. The pH is raised to 12.5 - 13.0 and the excess Ba ions in solution complex with the methylthymol blue to produce a blue colour, leaving a grey uncomplexed methylthymol blue in solution. The absorbance of the excess methylthymol blue, equivalent to the concentration of sulphate removed, is measured at 460 nm and compared to identically-prepared standard and blank solutions. *(See Appendix 8).* The method detection limit is 0.2 mg/L. Note: In the case of precipitation samples, a decanted aliquot of the unshaken, unfiltered sample is normally taken for analysis. Requesting Agency and Date: Environment Canada, NWRI, April 1974. Reference: Environment Canada 1979.	SULPHATE	mg/L SO_4	0
16309	SULPHATE Ion Chromatography A sample is filtered in the field through a 0.45 µm membrane filter and preserved at 4°C. The sample aliquot is injected into an eluent stream, passed through separator and suppressor columns packed with low capacity anion exchange resin. The sulphate is separated, based on its affinity for the exchange sites, and the background conductivity of the eluent is reduced to a negligible level by being converted to its acid form. The concentration is measured by conductivity and identified by its retention time. The sample is compared to identically-prepared standard and blank solutions. The method detection limit is 0.01 mg/L. Requesting Agency and Date: Environment Canada, January 1980. Reference: Environment Canada 1994.	SULPHATE	mg/L SO_{4+}	0

Code	Method Description	Name	Units	Decimals
17201	CHLORIDE - DISSOLVED Mercuric Nitrate Titration A sample is filtered in the field through a 0.45 µm membrane filter and preserved at 4°C. If the total alkalinity of the sample aliquot is < 150 mg/L, add a diphenylcarbazone-acidifier indicator (*see Appendix 8*) and 10 mg of sodium bicarbonate to bring the pH to 2.5 ± 0.1 (error of about 1% per 0.1 pH unit change) and titrate with a standardized mercuric nitrate solution to a blue colour end-point. The measurements are then compared to identically-prepared standard and blank solutions. For high chloride concentrations, dilute the sample aliquot (use no more than 5 mL of titrant), add 0.5 mL of mixed indicator *(See Appendix 8)* and agitate (the colour should be purple). Add 0.1 N nitric acid dropwise until colour turns to yellow and titrate with standardized mercuric nitrate to the first permanent dark purple colour. The measurements are then compared to identically-prepared standard and blank solutions. Interference: Bromide and iodide are also titrated with mercuric chloride; chromate, ferric and sulphite ions interfere if the concentration is greater than 10 mg/L. The method detection limit is 0.1 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: APHA 1975.	Cl DISS	mg/L Cl	0
17202	CHLORIDE - DISSOLVED Silver Nitrate Potentiometric A sample is filtered in the field through a 0.45 µm membrane filter and preserved at 4°C. Neutralise the sample aliquot with nitric acid and add 2.0 mL in excess. Measure, by potentiometric titration, using a silver nitrate solution with a calibrated glass and silver-silver chloride electrode system. An electronic voltmeter detects the change in potential between the electrodes. The end point of the titration is when the instrument reads the greatest change in voltage for a small and consistent addition of silver nitrate (if the exact end point cannot be determined, plot the differential titration curve to inspect the data: plot the change in instrument reading for equal increments against the volume of silver nitrate added). Interference: Bromide and iodide are titrated as chloride; ferricyanide causes high results and needs to be removed; chromate and dichromate should be reduced to chromic state; iron interferes if present in concentration greater than chloride. The method detection limit is 0.1 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: APHA 1975.	Cl DISS	mg/L Cl	0

Code	Method Description	Name	Units	Decimals
17203	CHLORIDE - DISSOLVED Colourimetry A sample is filtered in the field through a 0.45 µm membrane filter and preserved at 4°C. The method is based on the displacement of thiocyanate ion (SCN) from mercuric thiocyanate by chloride ion and the subsequent reaction of the liberated thiocyanate with ferric ion, from an acidified (nitric acid) ferric ammonium sulphate solution, forming a coloured complex with ferric thiocyanate. This colour is proportional to the original chloride concentration and is measured spectrometrically at 480 nm. The sample is compared to identically-prepared standard and blank solutions. The method detection limit is 0.1 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Environment Canada 1974.	Cl DISS	mg/L Cl	0
17204	CHLORIDE - DISSOLVED Silver Nitrate Titration A sample is filtered in the field through a 0.45 µm membrane filter and preserved at 4°C. If a sample aliquot is highly coloured, add $Al(OH)_3$ suspension, mix, let settle and filter; if sulphide, sulphite or thiosulphate is present, add H_2O_2 and stir for one minute. The pH of the sample should be between 7 and 10 (if not, adjust with diluted sulphuric acid or sodium hydroxide). Titrate with a standardised silver nitrate solution, using potassium chromate *(See Appendix 8)* as an indicator, to a pinkish yellow end point and compare to identically-prepared standard and blank solutions. Interference: Bromide, cyanide and iodide interfere as equivalent chloride concentrations; soluble reactive phosphorus in excess of 25 mg/L precipitates as silver phosphate; iron greater than 10 mg/L masks the end point. Calculation: mg/L Cl = $\frac{(A - B) \times N \times 35.450}{\text{mL sample}}$ A = mL of titrant for sample B = mL of titrant for blank N = normality of silver nitrate (mg/L NaCl = mg/L Cl x 1.65). The method detection limit is 5 mg/L. Requesting Agency and Date 1: UNEP GEMS/Water Programme, September 1985. Requesting Agency and Date 2: Water Supplies Department, Hong Kong SAR, no date. Reference: APHA 1998, 4500-Cl- B. Argentometric Method.	Cl DISS	mg/L Cl	0

Code	Method Description	Name	Units	Decimals
17205	CHLORIDE - DISSOLVED Specific Ion Electrode A sample is filtered in the field through a 0.45 µm membrane filter and preserved at 4°C. The sample aliquot is mixed with an ionic strength adjustor and read on a calibrated specific ion meter. The sample aliquot is consistently and slowly stirred and the Cl ion concentration is read at the same temperature as the standard solutions (a difference of 1°C will result in a 2% error) and compared to identically-prepared standard and blank solutions (the electrode should be calibrated hourly to ensure reproducibility). Interference: Temperature differences between sample aliquot and standard solutions must be carefully controlled. A surface layer of silver may be formed by reducing salts when the electrode needs to be polished. Mercury must be absent, and complexing chloride agents reduce the chloride concentration, as only free ions are measured. The method detection limit is 1.0 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Man/Tech Associates Co Ltd. 1998.	Cl DISS	mg/L Cl	0
17207	CHLORIDE DISSOLVED Ion Exchange A sample is filtered in the field through a 0.45 µm membrane filter and preserved at 4°C. The sample aliquot is split in two fractions, each being passed through an ion exchange column. In Column 1, a strong acid cation resin exchanges the sample aliquot cations for H ions. The H ion concentration in the effluent is equivalent to Cl + SO_4 ion concentrations and is measured by conductivity. Column 2 contains a two-step resin bed. In the first stage, the sample aliquot cations are exchanged for Ag ions to precipitate the Cl ions as AgCl. In the second stage, the Ag ions are exchanged for H ions. The resulting effluent is identical to that of Column 1 except that HCl has been removed. Thus the H ions concentration, measured by conductivity, in the effluent from Column 2 is equivalent to SO_4 ions concentration. The difference in H ion concentration is calculated by substracting Column 2 from Column 1 and is equivalent to Cl ion concentration. The conductance measurements are compared to identically-prepared standard and blank solutions. Interference: Corrections must be made when NO_3, PO_4 and F ions are present in significant amounts. At 10 mg/L Cl ions level the standard deviation was 0.15 mg/L. The method detection limit is 1.0 mg/L Requesting Agency and Date: Fisheries and Oceans Canada, Freshwater Institute, Winnipeg, Canada, no date. Reference: n/a.	Cl DISS	mg/L Cl	0

Code	Method Description	Name	Units	Decimals
17209	CHLORIDE - DISSOLVED Ion Chromatography A sample is filtered in the field through a 0.45 µm membrane filter and preserved at 4°C. The sample aliquot is injected into an eluent stream, passed through separator and suppressor columns packed with low capacity anion exchange resin. The chloride is separated, based on its affinity for the exchange sites, and the background conductivity of the eluent is reduced to a negligible level by being converted to its acid form. The concentration is measured by conductivity and identified by its retention time. The sample is compared to identically-prepared standard and blank solutions. Interferences from ions with similar retention time and large concentration of an adjacent anion are usually removed by dilution; particulate matter can clog the separator column, causing sluggish instrument performance. The method detection limit is 0.01 mg/L. Requesting Agency and Date: Environment Canada, January 1980. Reference: Environment Canada, 1994.	Cl DISS	mg/L Cl	0
17860	ORGANOCHLORINE COMPOUNDS TOTAL Gas Chromatography A sample is extracted three times in benzene or hexane. Add saturated sodium sulphate, methanol, iso-propanol or two-octanol to break down the emulsions. Add iso-octane and concentrate the combined extract, using a rotary evaporator flask. The extract is loaded on a Florisil® column and four separate fractions are eluted using hexane, 6% ethyl ether in petroleum ether, 15% ethyl ether in petroleum ether, then 50% ethyl ether in petroleum ether or chloroform. Concentrate in a rotary flask, transfer to a graduated centrifuge tube. Add iso-octane as a keeper and concentrate under a gentle stream of nitrogen at 40°C. The sample extract is then injected into a dual column GC/ECD and quantitated, according to each retention time and peak height/area, using a multi-point calibration curve. Confirmation is achieved by chemical derivation techniques, TLC, or Mass Spectrometry. Interference: Other pesticide residues and their degradation products or metabolites and organic compounds, other than OCs and PCBs, may interfere. As many of these compounds cannot be separated, confirmation is required. The method detection limit is 0.01 µg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, November 1984. Reference: Chau 1972.	ORGANO CL CMPDS	µg/L	3

Code	Method Description	Name	Units	Decimals
18000	P,P'-DDT Gas Chromatography A sample is extracted three times in benzene or hexane. Add saturated sodium sulphate, methanol, iso-propanol or two-octanol to break down the emulsions. Add iso-octane and concentrate the combined extract, using a rotary evaporator flask. The extract is loaded on a Florisil® column and four separate fractions are eluted using hexane, 6% ethyl ether in petroleum ether, 15% ethyl ether in petroleum ether, then 50% ethyl ether in petroleum ether or chloroform. Concentrate in a rotary flask, transfer to a graduated centrifuge tube. Add iso-octane as a keeper and concentrate under a gentle stream of nitrogen at 40°C. The sample extract is then injected into a dual column GC/ECD and quantitated, according to its retention time and peak height/area, using a multi-point calibration curve. Confirmation is achieved by chemical derivation techniques, TLC, or Mass Spectrometry. Interference: Other pesticide residues and their degradation products or metabolites and organic compounds, other than OCs and PCBs, may interfere. As many of these compounds cannot be separated, confirmation is required. The method detection limit is 0.001 µg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, November 1984. Reference: Chau 1972.	P,P-DDT	µg/L	3
18002	DDT - TOTAL Gas Chromatography A sample is extracted three times in benzene or hexane. Add saturated sodium sulphate, methanol, iso-propanol or two-octanol to break down the emulsions. Add iso-octane and concentrate the combined extract, using a rotary evaporator flask. The extract is loaded on a Florisil® column and four separate fractions are eluted using hexane, 6% ethyl ether in petroleum ether, 15% ethyl ether in petroleum ether, then 50% ethyl ether in petroleum ether or chloroform. Concentrate in a rotary flask, transfer to a graduated centrifuge tube. Add iso-octane as a keeper and concentrate under a gentle stream of nitrogen at 40°C. The sample extract is then injected into a dual column GC/ECD and quantitated, according to its retention time and peak height/area, using a multi-point calibration curve. Confirmation is achieved by chemical derivation techniques, TLC, or Mass Spectrometry. Interference: Other pesticide residues and their degradation products or metabolites and organic compounds, other than OCs and PCBs, may interfere. As many of these compounds cannot be separated, confirmation is required. The method detection limit is 0.001 µg/L. Requesting Agency and Date: IJC, PLUARG, 1987. Reference: Environment Canada 1974.	DDT TOTAL	µg/L	3

Code	Method Description	Name	Units	Decimals
18005	O,P-DDT Gas Chromatography A sample is extracted three times in benzene or hexane. Add saturated sodium sulphate, methanol, iso-propanol or two-octanol to break down the emulsions. Add iso-octane and concentrate the combined extract, using a rotary evaporator flask. The extract is loaded on a Florisil® column and four separate fractions are eluted using hexane, 6% ethyl ether in petroleum ether, 15% ethyl ether in petroleum ether, then 50% ethyl ether in petroleum ether or chloroform. Concentrate in a rotary flask, transfer to a graduated centrifuge tube. Add iso-octane as a keeper and concentrate under a gentle stream of nitrogen at 40°C. The sample extract is then injected into a dual column GC/ECD and quantitated, according to its retention time and peak height/area, using a multi-point calibration curve. Confirmation is achieved by chemical derivation techniques, TLC, or Mass Spectrometry. Interference: Other pesticide residues and their degradation products or metabolites and organic compounds, other than OCs and PCBs, may interfere. As many of these compounds cannot be separated, confirmation is required. The method detection limit is 0.001 µg/L. Requesting Agency and Date: Environment Canada, NWRI, no date. Reference: Environment Canada 1974.	O,P-DDT	µg/L	3
18010	P,P-DDD Gas Chromatography A sample is extracted three times in benzene or hexane. Add saturated sodium sulphate, methanol, iso-propanol or two-octanol to break down the emulsions. Add iso-octane and concentrate the combined extract, using a rotary evaporator flask. The extract is loaded on a Florisil® column and four separate fractions are eluted using hexane, 6% ethyl ether in petroleum ether, 15% ethyl ether in petroleum ether, then 50% ethyl ether in petroleum ether or chloroform. Concentrate in a rotary flask, transfer to a graduated centrifuge tube. Add iso-octane as a keeper and concentrate under a gentle stream of nitrogen at 40°C. The sample extract is then injected into a dual column GC/ECD and quantitated, according to its retention time and peak height/area, using a multi-point calibration curve. Confirmation is achieved by chemical derivation techniques, TLC, or Mass Spectrometry. Interference: Other pesticide residues and their degradation products or metabolites and organic compounds, other than OCs and PCBs, may interfere. As many of these compounds cannot be separated, confirmation is required. Alternate name: P,P'-TDE The method detection limit is 0.001 µg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, November 1984. Reference: Environment Canada 1974.	P,P-DDD	µg/L	3

Code	Method Description	Name	Units	Decimals
18015	O,P-DDD Gas Chromatography A sample is extracted three times in benzene or hexane. Add saturated sodium sulphate, methanol, iso-propanol or two-octanol to break down the emulsions. Add iso-octane and concentrate the combined extract, using a rotary evaporator flask. The extract is loaded on a Florisil® column and four separate fractions are eluted using hexane, 6% ethyl ether in petroleum ether, 15% ethyl ether in petroleum ether, then 50% ethyl ether in petroleum ether or chloroform. Concentrate in a rotary flask, transfer to a graduated centrifuge tube. Add iso-octane as a keeper and concentrate under a gentle stream of nitrogen at 40°C. The sample extract is then injected into a dual column GC/ECD and quantitated, according to its retention time and peak height/area, using a multi-point calibration curve. Confirmation is achieved by chemical derivation techniques, TLC, or Mass Spectrometry. Interference: Other pesticide residues and their degradation products or metabolites and organic compounds, other than OCs and PCBs, may interfere. As many of these compounds cannot be separated, confirmation is required. Alternative name: O,P'- DDD The method detection limit is 0.001 µg/L. Requesting Agency and Date: Environment Canada, NWRI, no date. Reference: Environment Canada 1974.	O,P-DDD	µg/L	3
18020	P,P-DDE Gas Chromatography A sample is extracted three times in benzene or hexane. Add saturated sodium sulphate, methanol, iso-propanol or two-octanol to break down the emulsions. Add iso-octane and concentrate the combined extract, using a rotary evaporator flask. The extract is loaded on a Florisil® column and four separate fractions are eluted using hexane, 6% ethyl ether in petroleum ether, 15% ethyl ether in petroleum ether, then 50% ethyl ether in petroleum ether or chloroform. Concentrate in a rotary flask, transfer to a graduated centrifuge tube. Add iso-octane as a keeper and concentrate under a gentle stream of nitrogen at 40°C. The sample extract is then injected into a dual column GC/ECD and quantitated, according to its retention time and peak height/area, using a multi-point calibration curve. Confirmation is achieved by chemical derivation techniques, TLC, or Mass Spectrometry. Interference: Other pesticide residues and their degradation products or metabolites and organic compounds, other than OCs and PCBs, may interfere. As many of these compounds cannot be separated, confirmation is required. The method detection limit is 0.001 µg/L. Requesting Agency and Date: Environment Canada, NWRI, no date. Reference: Environment Canada 1974.	P,P-DDE	µg/L	3

Code	Method Description	Name	Units	Decimals
18025	O,P-DDE Gas Chromatography A sample is extracted three times in benzene or hexane. Add saturated sodium sulphate, methanol, iso-propanol or 2-octanol to break down the emulsions. Add iso-octane and concentrate the combined extract, using a rotary evaporator flask. The extract is loaded on a Florisil® column and four separate fractions are eluted using hexane, 6% ethyl ether in petroleum ether, 15% ethyl ether in petroleum ether, then 50% ethyl ether in petroleum ether or chloroform. Concentrate in a rotary flask, transfer to a graduated centrifuge tube. Add iso-octane as a keeper and concentrate under a gentle stream of nitrogen at 40°C. The sample extract is then injected into a dual column GC/ECD and quantitated, according to its retention time and peak height/area, using a multi-point calibration curve. Confirmation is achieved by chemical derivation techniques, TLC, or Mass Spectrometry. Interference: Other pesticide residues and their degradation products or metabolites and organic compounds, other than OCs and PCBs, may interfere. As many of these compounds cannot be separated, confirmation is required. The method detection limit is 0.001 µg/L. Requesting Agency and Date: Environment Canada, NWRI, no date. Reference: Environment Canada 1974.	O,P-DDE	µg/L	3
18070	LINDANE (GAMMA – BHC) Gas Liquid Chromatography (ECD) A sample is extracted three times in benzene or hexane. Add saturated sodium sulphate, methanol, iso-propanol or two-octanol to break down the emulsions. Add iso-octane and concentrate the combined extract, using a rotary evaporator flask. The extract is loaded on a Florisil® column and four separate fractions are eluted using hexane, 6% ethyl ether in petroleum ether, 15% ethyl ether in petroleum ether, then 50% ethyl ether in petroleum ether or chloroform. Concentrate in a rotary flask, transfer to a graduated centrifuge tube. Add iso-octane as a keeper and concentrate under a gentle stream of nitrogen at 40°C. The sample extract is then injected into a dual column GC/ECD and quantitated, according to its retention time and peak height/area, using a multi-point calibration curve. Confirmation is achieved by chemical derivation techniques, TLC, or Mass Spectrometry. Interference: Other pesticide residues and their degradation products or metabolites and organic compounds, other than OCs and PCBs, may interfere. As many of these compounds cannot be separated, confirmation is required. The method detection limit is 0.001 µg/L. Requesting Agency and Date: Environment Canada, NWRI, no date. Reference: Environment Canada 1974.	LINDANE	µg/L	3

Code	Method Description	Name	Units	Decimals
18075	ALPHA-BHC Gas Chromatography A sample is extracted three times in benzene or hexane. Add saturated sodium sulphate, methanol, iso-propanol or 2-octanol to break down the emulsions. Add iso-octane and concentrate the combined extract, using a rotary evaporator flask. The extract is loaded on a Florisil® column and four separate fractions are eluted using hexane, 6% ethyl ether in petroleum ether, 15% ethyl ether in petroleum ether, then 50% ethyl ether in petroleum ether or chloroform. Concentrate in a rotary flask, transfer to a graduated centrifuge tube. Add iso-octane as a keeper and concentrate under a gentle stream of nitrogen at 40°C. The sample extract is then injected into a dual column GC/ECD and quantitated, according to its retention time and peak height/area, using a multi-point calibration curve. Confirmation is achieved by chemical derivation techniques, TLC, or Mass Spectrometry. Interference: Other pesticide residues and their degradation products or metabolites and organic compounds, other than OCs and PCBs, may interfere. As many of these compounds cannot be separated, confirmation is required. The method detection limit is 0.001 µg/L. Requesting Agency and Date: Environment Canada, NWRI, no date. Reference: Environment Canada 1974.	ALPHA-BHC	µg/L	3
18125	MIREX Gas Chromatography A sample is extracted three times in benzene or hexane. Add saturated sodium sulphate, methanol, iso-propanol or two-octanol to break down the emulsions. Add iso-octane and concentrate the combined extract, using a rotary evaporator flask. The extract is loaded on a Florisil® column and four separate fractions are eluted using hexane, 6% ethyl ether in petroleum ether, 15% ethyl ether in petroleum ether, then 50% ethyl ether in petroleum ether or chloroform. Concentrate in a rotary flask, transfer to a graduated centrifuge tube. Add iso-octane as a keeper and concentrate under a gentle stream of nitrogen at 40°C. The sample extract is then injected into a dual column GC/ECD and quantitated, according to its retention time and peak height/area, using a multi-point calibration curve. Confirmation is achieved by chemical derivation techniques, TLC, or Mass Spectrometry. Interference: Other pesticide residues and their degradation products or metabolites and organic compounds, other than OCs and PCBs, may interfere. As many of these compounds cannot be separated, confirmation is required. The method detection limit is 0.001 µg/L. Requesting Agency and Date 1: Environment Canada, Atlantic Region, July, 1980. Requesting Agency and Date 2: IJC PLUARG, 1987. Reference: Environment Canada 1974.	MIREX	µg/L	3

Code	Method Description	Name	Units	Decimals
18130	ALDRIN Gas Chromatography A sample is extracted three times in benzene or hexane. Add saturated sodium sulphate, methanol, iso-propanol or two-octanol to break down the emulsions. Add iso-octane and concentrate the combined extract, using a rotary evaporator flask. The extract is loaded on a Florisil® column and four separate fractions are eluted using hexane, 6% ethyl ether in petroleum ether, 15% ethyl ether in petroleum ether, then 50% ethyl ether in petroleum ether or chloroform. Concentrate in a rotary flask, transfer to a graduated centrifuge tube. Add iso-octane as a keeper and concentrate under a gentle stream of nitrogen at 40°C. The sample extract is then injected into a dual column GC/ECD and quantitated, according to its retention time and peak height/area, using a multi-point calibration curve. Confirmation is achieved by chemical derivation techniques, TLC, or Mass Spectrometry. Interference: Other pesticide residues and their degradation products or metabolites and organic compounds, other than OCs and PCBs, may interfere. As many of these compounds cannot be separated, confirmation is required. The method detection limit is 0.001 µg/L. Requesting Agency and Date: Environment Canada, NWRI, no date. Reference: Environment Canada 1974.	ALDRIN	µg/L	3
18140	ENDRIN Gas Chromatography A sample is extracted three times in benzene or hexane. Add saturated sodium sulphate, methanol, iso-propanol or two-octanol to break down the emulsions. Add iso-octane and concentrate the combined extract, using a rotary evaporator flask. The extract is loaded on a Florisil® column and four separate fractions are eluted using hexane, 6% ethyl ether in petroleum ether, 15% ethyl ether in petroleum ether, then 50% ethyl ether in petroleum ether or chloroform. Concentrate in a rotary flask, transfer to a graduated centrifuge tube. Add iso-octane as a keeper and concentrate under a gentle stream of nitrogen at 40°C. The sample extract is then injected into a dual column GC/ECD and quantitated, according to its retention time and peak height/area, using a multi-point calibration curve. Confirmation is achieved by chemical derivation techniques, TLC, or Mass Spectrometry. Interference: Other pesticide residues and their degradation products or metabolites and organic compounds, other than OCs and PCBs, may interfere. As many of these compounds cannot be separated, confirmation is required. The method detection limit is 0.001 µg/L. Requesting Agency and Date: Environment Canada, NWRI, no date. Reference: Environment Canada 1974.	ENDRIN	µg/L	3

Code	Method Description	Name	Units	Decimals
18150	DIELDRIN Gas Chromatography A sample is extracted three times in benzene or hexane. Add saturated sodium sulphate, methanol, iso-propanol or two-octanol to break down the emulsions. Add iso-octane and concentrate the combined extract, using a rotary evaporator flask. The extract is loaded on a Florisil® column and four separate fractions are eluted using hexane, 6% ethyl ether in petroleum ether, 15% ethyl ether in petroleum ether, then 50% ethyl ether in petroleum ether or chloroform. Concentrate in a rotary flask, transfer to a graduated centrifuge tube. Add iso-octane as a keeper and concentrate under a gentle stream of nitrogen at 40°C. The sample extract is then injected into a dual column GC/ECD and quantitated, according to its retention time and peak height/area, using a multi-point calibration curve. Confirmation is achieved by chemical derivation techniques, TLC, or Mass Spectrometry. Interference: Other pesticide residues and their degradation products or metabolites and organic compounds, other than OCs and PCBs, may interfere. As many of these compounds cannot be separated, confirmation is required. The method detection limit is 0.005 µg/L. Requesting Agency and Date: Environment Canada, NWRI, no date. Reference: Environment Canada 1974.	DIELDRIN	µg/L	3
18165	PCBS Gas Chromatography A sample aliquot is extracted three times with benzene. The extract is loaded on a Florisil® column and eluted using 15% dichloromethane in hexane. Concentrate in a rotary flask, transfer to graduated centrifuge tube. Add iso-octane as a keeper and concentrate under a gentle stream of nitrogen at 40°C. The sample extract is then injected into a dual column GC/ECD and quantitated, according to its retention time and peak height/area. A gas chromatograph equipped with a mass selective detector (GC/MSD) is used for confirmation. Interference: All solvents are checked for background interference. The method detection limit is 0.1 µg/L. Requesting Agency and Date: Environment Canada, NWRI, July 1985. Reference: Environment Canada 1979.	PCBS	µg/L	3
18415	ATRAZINE - TOTAL Gas Chromatography A sample aliquot is extracted with dichloromethane three times. The extract is loaded on a Florisil® column and two separate fractions are eluted using 15% dichloromethane in hexane for fraction A and 2% methanol in dichloromethane for fraction B (which contains the atrazine). Concentrate in a rotary flask, transfer to a graduated centrifuge tube. Add iso-octane as a keeper and concentrate under a gentle stream of nitrogen at 40°C. The sample extract is then injected into a dual column GC/NPD and quantitated, according to its retention time and peak height/area, using a multi-point calibration curve. A gas chromatograph equipped with a mass selective detector (GC/MSD) is used if confirmation is required. Interference: Some organic compounds may co-extract with atrazine but most interferences are eliminated by Florisil® clean up. All solvents are checked for background interference. The method detection limit is 0.1 µg/L. Requesting Agency and Date: Environment Canada, NWRI, July 1985. Reference: Environment Canada 1979.	ATRAZINE	µg/L	1

Code	Method Description	Name	Units	Decimals
18444	ALDICARB High Pressure Liquid Chromatography HPLC – UV and Fluorescent Detectors A water sample is extracted with dichloromethane under different pH conditions. The extract is concentrated and subjected to adsorption chromatography on alumina and/or size exclusion chromatography on μ styragel to remove interfering substances. The eluents are evaporated to dryness and dissolved in 45:55 methanol/water solution and analysed, using reverse phase HPLC with UV and fluorescent detectors, at a flow rate of 2 mL/min in the mobile phase. Some carbamate pesticides elute very closely during HPLC separation; therefore, the identification is done through adsorption and fluorescence response ratios or by extracting the sample under acidic (pH 2) and neutral conditions. Quantify by monitoring the UV adsorption at 205 nm as well as the fluorescence at 313 nm or 390 nm, using an excitation wavelength of 254 nm, and compared to multi-point calibration standards and blank solutions. Interference: Many high molecular weight compounds (lipids, humic/fulvic acids, phenols, amines, PAHs, etc) can co-extract and interfere. The clean-up procedures using solvent partitioning, gel permeation chromatography or micro-alumina column chromatography will remove most interferences. UV light and hydrolysis under certain strong acidic or alkaline conditions can also interfere. The method detection limit is 0.09 μg/L. Requesting Agency and Date: Environment Canada, August 1982. Reference: Afghan and Ryan 1982.	ALDICARB	μg/L	2
18503	2,4-D Electron Capture – GLC A water sample is collected and acidified at a pH ≤ 1.0 with 50% sulphuric acid. The sample is extracted with dichloromethane and evaporated. The residue is dissolved and esterified with BCl_3/2-chloroethanol to pentafluoro-benzyl esters. Add benzene and potassium bicarbonate (2%), shake and dry the benzene extract with anhydrous sodium. Add iso-octane as a keeper and concentrate under a gentle stream of nitrogen at 40°C. Load to a silica gel column and elute with 25% benzene in hexane to remove the excess reagent and contaminants from the extract: discard this product. Elute fraction A with benzene and fraction B with 10% diethyl ether in benzene (with a benzene wash between the two fractions to remove extraneous interfering peaks). Quantify the 2,4-D (fraction A) by GC-ECD, according to its retention time and peak height/area, using multi-point calibration curve. Interference: Some non-target compounds may co-extract but most interferences are removed through silica gel chromatography. The method detection limit is 0.03 μg/L. Requesting Agency and Date: Environment Canada, NWRI, July 1985. Reference: Environment Canada 1979.	2,4-D	μg/L	2

Code	Method Description	Name	Units	Decimals
18803	P,P-DDD OLEFIN Gas Chromatography The sample is passed through a XAD-2 resin and eluted with diethyl ether, followed by concentration. The extract is concentrated with iso-octane under a stream of nitrogen at 40°C, then cleaned and separated into three fractions, using iso-octane, 20% benzene in iso-octane and benzene, in a high pressure liquid chromatograph (HPLC). The sample extract is then injected into a dual column GC/ECD and quantified, according to its retention time and peak height/area, using a multi-point calibration curve. Confirmation is achieved by chemical derivation techniques, TLC, or Mass Spectrometry. Interference: Large amounts of particulate interfere with the flow in the resin column; high salt contents reduce the effectiveness of the column, so does a water sample with pH outside 5 to 8. Sulphur must be removed with mercury prior to LC cleanup. The method detection limit is 1.0 µg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1980. Reference: Environment Canada 1979.	P,P-DDD OLEFIN	µg/L	3
18814	BHC Gas Chromatography The sample is passed through a XAD-2 resin and eluted with diethyl ether, followed by concentration. The extract is concentrated with iso-octane under a stream of nitrogen at 40°C, then cleaned and separated into three fractions, using iso-octane, 20% benzene in iso-octane and benzene, in a high pressure liquid chromatograph (HPLC). The sample extract is then injected into a dual column GC/ECD and quantified, according to its retention time and peak height/area, using a multi-point calibration curve. Confirmation is achieved by chemical derivation techniques, TLC, or Mass Spectrometry. Interference: Large amounts of particulate interfere with the flow in the resin column; high salt contents reduce the effectiveness of the column, so does a water sample with pH outside 5 to 8. Sulphur must be removed with mercury prior to LC cleanup. The method detection limit is 1.0 µg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1980. Reference: Environment Canada 1979.	BHC	µg/L	3
19001	POTASSIUM - TOTAL Atomic Absorption Spectrometry A sample is preserved in the field at 4°C. The sample aliquot, mixed with an alkaline salt to overcome the ionisation effect, is aspirated through a burner head, measured spectrometrically at a wavelength of 766.5 nm and compared to identically-prepared standard and blank solutions, using an air-acetylene oxidizing flame. The method detection limit is 0.1 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Perkin-Elmer Corp. 1973.	K TOTAL	mg/L K	1

Code	Method Description	Name	Units	Decimals
19002	POTASSIUM - TOTAL Flame Photometry A sample is preserved in the field at 4°C. The sample aliquot is mixed with a lithium nitrate solution, as an internal standard, and passed through the burner of a flame photometer equipped with interference filters isolating the spectral lines of potassium. The intensity of light produced is proportional to the amount of potassium present in the sample and is compared to identically-prepared standard and blank solutions, using propane and oxygen flame. The method detection limit is 0.1 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1980. Reference: Environment Canada 1979.	K TOTAL	mg/L K	1
19102	POTASSIUM - DISSOLVED Atomic Absorption Spectrometry A sample is filtered in the field through a 0.45 µm membrane filter and preserved at 4°C. The sample aliquot, mixed with an alkaline salt to overcome the ionisation effect, is aspirated through a burner head, measured spectrometrically at a wavelength of 766.5 nm and compared to identically-prepared standard and blank solutions, using an air-acetylene oxidizing flame. The method detection limit is 0.1 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1980. Reference: Perkin-Elmer Corp. 1973.	K DISS	mg/L K	1
19103	POTASSIUM - DISSOLVED Flame Photometry A sample is filtered in the field through a 0.45 µm membrane filter and preserved at 4°C. The sample aliquot is mixed with a lithium nitrate solution, as an internal standard, and aspirated into a flame photometer at the wavelength of 768 nm and compared to the internal standard at 671 nm and compared to identically-prepared standard and blank solutions, using a propane and air flame. The method detection limit is 0.02 mg/L. Note: In the case of precipitation samples, a decanted aliquot of the unshaken, unfiltered sample is normally taken for analysis. Requesting Agency and Date: Environment Canada, May 1973. Reference 1: Environment Canada 1974. Reference 2: Environment Canada 1979.	K DISS	mg/L K	1
19105	POTASSIUM - DISSOLVED Atomic Absorption Spectrometry – Direct Aspiration A sample is filtered in the field through a 0.45 µm membrane filter and preserved at 4°C. The absorption of the sample aliquot is measured at 766.5 nm and compared to identically-prepared standard and blank solutions, using an air-C_2H_2 flame. The method detection limit is 0.02 mg/L. Requesting Agency and Date: Fisheries and Oceans, Freshwater Institute, Winnipeg, Canada, no date. Reference: Perkin-Elmer Corp., 1973.	K DISS	mg/L K	1

Code	Method Description	Name	Units	Decimals
19111	POTASSIUM - DISSOLVED Inductively Coupled Plasma by Optical Emission Spectrometry (ICP-OES): ICP 1516 *(See Appendix 2).* A sample is filtered in the field through a 0.45 µm membrane filter and preserved at 4°C. The sample aliquot is aspirated and the emission is measured at 766.5 nm and compared to identically-prepared standard and blank solutions. The method detection limit is 0.3 mg/L. Requesting Agency and Date: Alberta Environment, Canada, December 1979. Reference: Alberta Environment 1979.	K DISS	mg/L K	1
19112	POTASSIUM - DISSOLVED Ion Chromatography A sample is filtered in the field through a 0.45 µm membrane filter and preserved at 4°C. The sample aliquot is injected into an eluent stream, passed through separator and suppressor columns packed with low capacity cation exchange. The potassium is separated, based on its affinity for the exchange sites, and the background conductivity of the eluent is reduced to a negligible amount. The concentration is measured by conductivity and identified by its retention time. The sample aliquot is compared to identically-prepared standard and blank solutions. Interference of ions with similar retention time and large concentration of an adjacent cation can interfere. Dilution of sample usually removes these interferences. Particulate matter can clog the separator column, causing sluggish instrument performance. The method detection limit is 0.05 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1980. Reference: Cheam and Chau 1987.	K DISS	mg/L K	1
19115	POTASSIUM - DISSOLVED Inductively Coupled Plasma by Optical Emission Spectrometry (ICP-OES): ICP 1502 *(See Appendix 2)* A sample is filtered in the field and preserved at 4°C. The sample aliquot is aspirated from an autosampler. The emission is measured at 766.5 nm and compared to identically-prepared standard and blank solutions. The method detection limit is 0.001 mg/L. Requesting Agency and Date: Environment Canada, October 1985. Reference: Alberta Environment 1981.	K DISS	mg/L K	1
20003	CALCIUM - TOTAL Atomic Absorption Spectrometry A sample is preserved in the field at 4°C. A $LaCl_3$ solution is added to the sample aliquot, mixed and aspirated. The absorbance is measured spectrometrically at 422.7 nm, and compared to identically-prepared standard and blank solutions. The method detection limit is 0.002 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1980. Reference: Environment Canada 1974.	Ca TOTAL	mg/L Ca	3

Code	Method Description	Name	Units	Decimals
20101	CALCIUM - DISSOLVED EDTA Titration A sample is filtered in the field through a 0.45 µm membrane filter and preserved at 4°C. The pH of the sample aliquot is adjusted between 12 and 13, with a 1 N NaOH solution, to precipitate the magnesium to its hydroxide form. Add Calver II *(See Appendix 8)* indicator and titrate the aliquot with a standardised EDTA (disodium dihydrogen ethylenediamine tetraacetate) solution. The colour changes from pink to purple when the calcium is removed. The samples are compared to identically-prepared standard and blank solutions. Interferences: Total heavy metal ion concentration of 0.5 mg/L. The method detection limit is 0.5 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Environment Canada 1974.	Ca DISS	mg/L Ca	3
20103	CALCIUM - DISSOLVED Atomic Absorption Spectrometry A sample is filtered in the field through a 0.45 µm membrane filter and preserved at 4°C. A $LaCl_3$ solution is added to the sample aliquot, mixed and aspirated. The absorbance is measured spectrometrically at 422.7 nm and compared to identically-prepared standard and blank solutions, using an air-acetylene reducing flame. The method detection limit is 0.05 mg/L. Note: With precipitation samples, a decanted aliquot of the unshaken, unfiltered sample is normally taken for analysis. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Environment Canada 1979.	Ca DISS	mg/L Ca	3
20105	CALCIUM - DISSOLVED Flame Emission A sample is filtered in the field through a 0.45 µm membrane filter and preserved at 4°C. The sample aliquot is aspirated in a flame and the emission is measured at 422.6 nm and compared to identically-prepared standard and blank solutions, using nitrous oxide-acetylene flame. The method detection limit is 0.07 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1980. Reference: Perkin-Elmer Corp. 1971.	Ca DISS	mg/L	3

Code	Method Description	Name	Units	Decimals
20106	CALCIUM HARDNESS EDTA Titration A sample is filtered in the field through a 0.45 µm membrane filter and preserved at 4°C. Adjust the pH of the sample aliquot between 12 and 13 with 1N NaOH solution (to precipitate the magnesium), add the Eriochrome Black T indicator *(See Appendix 8)* and immediately titrate, with the standard EDTA solution while continually stirring; the dye turns from red to its blue colour when the calcium has been removed. mg/L as $CaCO_3$ = (A x B x 1000) / mL of sample A = mL of titrant B = mg $CaCO_3$ equivalent to 1.00 mL of EDTA Interferences: Heavy metal concentrations in excess of 0.5 mg/L. The method detection limit is 1.0 mg/L. Requesting Agency and Date: Deptartment of Fisheries and Environment, New Brunswick, Canada, November 1974. Reference: APHA 1971.	Ca HARDNESS	mg/L $CaCO_3$	1
20109	CALCIUM - DISSOLVED Ion Chromatography A sample is filtered in the field through a 0.45 µm membrane filter and preserved at 4°C. The sample aliquot is injected into an eluent stream, passed through separator and suppressor columns packed with low capacity cation exchange. The calcium is separated, based on its affinity for the exchange sites, and the background conductivity of the eluent is reduced negligibly. The concentration is measured by conductivity and identified by its retention time. The sample is compared to identically-prepared standard and blank solutions. Ions with similar retention time and large concentration of adjacent cations can interfere. Dilution of sample usually removes these interferences. Particulate matter can clog the separator column, causing sluggish instrument performance. The method detection limit is 0.001 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1980. Reference: Cheam and Chau 1987.	Ca DISS	mg/L $CaCO_3$	3
20111	CALCIUM - DISSOLVED Inductively Coupled Plasma by Optical Emission Spectrometry (ICP-OES): ICP 1516 *(See Appendix 2)* A sample is filtered in the field through a 0.45 µm membrane filter and preserved at 4°C. The sample aliquot is aspirated and the emission is measured at 317.9 nm and compared to identically-prepared standard and blank solutions. The method detection limit is 0.006 mg/L. Requesting Agency and Date: Alberta Environment, Canada, December 1979. Reference: Alberta Environment 1979.	Ca DISS	mg/L Ca	3

Code	Method Description	Name	Units	Decimals
20115	CALCIUM -DISSOLVED Inductively Coupled Plasma by Optical Emission Spectrometry (ICP-OES): ICP 1502 *(See Appendix 2)* A sample is filtered in the field through a 0.45 µm membrane filter and preserved at 4ºC. The sample aliquot is aspirated from an autosampler. The emission is measured at 317.9 nm and compared to identically-prepared standard and blank solutions. The method detection limit is 0.001 mg/L. Requesting Agency and Date: Environment Canada, NWRI, October 1985. Reference: Alberta Environment 1981.	Ca DISS	mg/L Ca	3
24002	CHROMIUM - TOTAL Atomic Absorption Spectrometry – Direct Aspiration A sample is preserved in the field with nitric acid. Digest the sample aliquot at pH of 1.6 (usual pH if sample is preserved with 0.2% nitric acid) with nitric acid then add bromine water to the sample aliquot and warm on water bath until the colour disappears. The sample aliquot is aspirated and the absorbance is measured at a wavelength of 358.0 nm and compared to identically-prepared chromium standard and blank solutions, using a C_2H_2-air reducing flame. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1980. Reference: Environment Canada 1974.	Cr TOTAL	mg/L Cr	3
24009	CHROMIUM - TOTAL Inductively Coupled Plasma by Optical Emission Spectrometry (ICP-OES): ICP 1502 *(See Appendix 2)* A sample is preserved in the field with nitric acid. The sample aliquot is digested with concentrated nitric acid or aqua regia, concentrated appropriately and aspirated from an autosampler. The emission is measured at 267.7 nm and compared to identically-prepared standard and blank solutions. The method detection limit is 0.002 mg/L. Requesting Agency and Date: Alberta Environment, Canada, October 1981. Reference: Alberta Environment 1981.	Cr TOTAL	mg/L Cr	3
24011	CHROMIUM -TOTAL Inductively Coupled Plasma by Optical Emission Spectrometry (ICP-OES): ICP 1503 *(See Appendix 2)* A sample is preserved in the field with diluted mineral acid. The sample aliquot is digested with aqua regia and evaporated to near dryness. The residue is dissolved in concentrated HCl and diluted to one-fifth of the aliquot original volume. The emission is measured spectrometrically at 267.7 nm and compared to identically-prepared standard and blank solutions. The method detection limit is 0.002 mg/L. Requesting Agency and Date: Alberta Environment, Canada, July 1979. Reference: Alberta Environment 1979.	Cr TOTAL	mg/L Cr	3

Code	Method Description	Name	Units	Decimals
24052	CHROMIUM - DISSOLVED Atomic Absorption Spectrometry by direct absorption: AAS A sample is filtered in the field through a 0.45 µm membrane filter and preserved with 0.2% nitric acid. To the sample aliquot, add bromine water and warm on a water bath until the colour disappears. The absorbance is then measured spectrometrically at 358.0 nm and the concentration is compared to identically-prepared standard and blank solutions, using air-acetylene oxidising flame. The method detection limit is 0.1 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Environment Canada 1974.	Cr DISS	mg/L Cr	3
24090	CHROMIUM - TOTAL ICP-MS The sample is preserved in the field with nitric acid. The sample is aspirated into an argon-based, high temperature radio frequency plasma. The sample is dissolved, atomised and ionised. These ions are extracted from the plasma through a vacuum interface and separated on the basis of their mass to charge ratio by a mass spectrometer. The ions are counted by an electron multiplier detector and the resulting information processed by a computer database system and compared to identically-prepared standard and blank solutions. Requesting Agency and Date: National Institute for Environmental Studies, Japan, 1998. Reference: APHA 1998.	Cr TOTAL	mg/L Cr	3
24101	CHROMIUM HEXAVALENT Colourimetry A sample is preserved in the field with mineral acid. The sample aliquot is mixed with diphenylcarbazide in an acid solution. A red-violet colour is produced. (The reaction is very sensitive as the absorbancy index per gram of chromium is approximately 40,000 at 540 nm). The absorbance is measured and compared to identically-prepared standard and blank solutions, ensuring the blank is subtracted, at a wavelength of 540 nm. Note: If the solution is turbid, take an absorbance reading before adding the diphenylcarbazide reagent and correct the absorbance reading of the final coloured solution. Interferences: Hexavalent molybdenum and mercury salts will form a colour with the reagent but the intensities are much lower than chromium at the specified pH (concentration of molybdenum and mercury up to 200 mg/L can be tolerated); vanadium interferes if the concentration is 10 times greater than chromium. The method detection limit is 0.005 mg/L. Requesting Agency and Date: UNEP GEMS/Water Prorgamme, September 1985. Reference: APHA 1975.	Cr	mg/L Cr	3

Code	Method Description	Name	Units	Decimals
24111	CHROMIUM DISSOLVED Inductively Coupled Plasma by Optical Emission Spectrometry (ICP-OES): ICP 1516 *(See Appendix 2)* The sample is filtered in the field through a 0.45 µm membrane filter and preserved with nitric acid. The sample aliquot is aspirated and the emission is measured at 267.7 nm and compared to identically-prepared standard and blank solutions. The method detection limit is 0.002 mg/L. Requesting Agency and Date: Alberta Environment, Canada, July 1979. Reference: Alberta Environment 1979.	Cr DISS	mg/L Cr	3
24190	CHROMIUM - DISSOLVED ICP – MS The sample is filtered in the field through a 0.45 µm membrane filter and preserved with nitric acid. The sample aliquot is aspirated into an argon-based, high temperature radio frequency plasma. The sample is dissolved, atomised and ionised. These ions are extracted from the plasma through a vacuum interface and separated on the basis of their mass to charge ratio by a mass spectrometer. The ions are counted by an electron multiplier detector and the resulting information processed by a computer database system and compared to identically-prepared standard and blank solutions. Requesting Agency and Date: National Institute for Environmental Studies, Japan, 1998. Reference: APHA 1998.	Cr DISS	mg/L Cr	3
24202	CHROMIUM - SUSPENDED Atomic Absorption Spectrometry – Direct Aspiration A measured sample volume is passed through a 0.45 µm membrane filter. The filter, containing the residue, is digested with nitric acid at a pH of 1.6. The solution is aspirated and the absorbance is measured spectrometrically at 358.0 nm and compared to identically-prepared standard and blank solutions, using a C_2H_2-air reducing flame. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Environment Canada 1974.	Cr PARTICU-LATE	µg/g	3
24901	CHROMIUM - DISSOLVED Flameless Atomic Absorption Spectrometry A sample is filtered in the field through a 0.45 µm membrane filter and preserved with nitric acid. The sample aliquot is heated, usually in three stages in a graphite furnace or an electrically heated atomiser in which: the first stage, a low current is applied to dry the sample; the second stage chars the sample by destroying the organic matter and volatilises other matrix compounds; finally, the third stage applies a high current which heats the tube to incandescence and atomises the chromium to be determined. The absorbance of the resultant ground state atoms is measured at 357.9 nm and is compared to identically-prepared standard and blank solutions. The method detection limit is 0.002 mg/L. Requesting Agency and Date: National Institute for Environmental Studies, Japan, September 1998. Reference: Japanese Industrial Standards Committee 1998.	Cr DISS	mg/L Cr	3

Code	Method Description	Name	Units	Decimals
24911	CHROMIUM - TOTAL Flameless Atomic Absorption Spectrometry A sample is preserved in the field with nitric acid. The shaken sample aliquot is digested in nitric acid or aqua regia. The aliquot is then heated, usually in three stages in a graphite furnace or an electrically heated atomiser where: the first stage, a low current is applied to dry the sample; the second stage chars the sample by destroying the organic matter and volatilises other matrix compounds; finally, the third stage applies a high current which heats the tube to incandescence and atomises the chromium to be determined. The absorbance of the resultant ground state atoms is measured at 357.9 nm and is compared to identically-prepared standard and blank solutions. The method detection limit is 0.002 mg/L. Requesting Agency and Date: National Institute for Environmental Studies, Japan, September 1998. Reference: Japanese Industrial Standards Committee 1998.	Cr TOTAL	mg/L Cr	3
25004	MANGANESE - TOTAL Atomic Absorption Spectrometry – Direct Aspiration A sample is preserved in the field with nitric acid. The sample aliquot is digested with nitric acid. The solution is aspirated and the absorbance is measured spectrometrically at 279.8 nm and compared to identically-prepared standard and blank solutions, using an air-acetylene oxidizing flame. The method detection limit is 0.01 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Environment Canada 1974.	Mn TOTAL	mg/L Mn	2
25005	MANGANESE - TOTAL Atomic Absorption Spectrometry – Solvent Extraction A sample is preserved in the field with nitric acid. The sample aliquot is digested with nitric acid. The pH of the digest is adjusted between 10 and 11 with an ammonium hydroxide solution, mixed with an ammonium pyrrolidine dithiocarbamate (APDC) solution then extracted with a methyl isobutyl ketone (MIBK) solution containing 8-hydroxyquinoline. The solvent layer *(See Appendix 5)* is aspirated at the wavelength of 279.8 nm and compared to identically-prepared standard and blank solutions, using an air-acetylene oxidizing flame. The method detection limit is 0.001 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Environment Canada 1974.	Mn TOTAL	mg/L Mn	2
25009	MANGANESE - TOTAL Colourimetry A sample is preserved in the field with nitric acid. The sample aliquot is digested in nitric acid and oxidized with sodium bismithate. The colour is read on a spectrometer 20 (or equivalent) and compared with identically-prepared standard and blank solutions. The method detection limit is 1 mg/L. Requesting Agency and Date: Saskatchewan Environment, Canada, July 1977. Reference: Park 1935.	Mn TOTAL	mg/L Mn	2

Code	Method Description	Name	Units	Decimals
25010	MANGANESE - TOTAL Inductively Coupled Plasma by Optical Emission Spectrometry (ICP-OES): ICP 1502 *(See Appendix 2)* A sample is preserved in the field with nitric acid. The sample aliquot is digested with concentrated nitric acid or aqua regia, concentrated appropriately and aspirated from an autosampler. The emission is measured at 257.6 nm and compared to identically-prepared standard and blank solutions. The method detection limit is 0.001 mg/L. Requesting Agency and Date: Environment Canada, July 1984. Reference: Alberta Environment 1981.	Mn TOTAL	mg/L Mn	2
25011	MANGANESE - TOTAL Inductively Coupled Plasma by Optical Emission Spectrometry (ICP-OES): ICP 1503 *(See Appendix 2)* A sample is preserved in the field with diluted mineral acid. The sample aliquot is digested with aqua regia and evaporated to near dryness. The residue is dissolved in concentrated HCl and diluted to one-fifth of the aliquot original volume. The emission is measured at 257.6 nm and compared to identically-prepared standard and blank solutions. The method detection limit is 0.001 mg/L. Requesting Agency and Date: Alberta Environment, Canada, July 1979. Reference: Alberta Environment 1979.	Mn TOTAL	mg/LMn	2
25090	MANGANESE - TOTAL ICP - MS A sample is preserved in the field with mineral acid. The sample aliquot is aspirated into an argon-based, high temperature radio frequency plasma. The sample is dissolved, atomised and ionised. These ions are extracted from the plasma through a vacuum interface and separated on the basis of their mass to charge ratio by a mass spectrometer. The ions are counted by an electron multiplier detector and the resulting information processed by a computer database system and compared to identically-prepared standard and blank solutions. Requesting Agency and Date: National Institute for Environmental Studies, Japan, no date. Reference: APHA 1998.	Mn TOTAL	mg/L Mn	2
25101	MANGANESE - DISSOLVED Colourimetry A sample is filtered in the field through a 0.45 µm membrane filter and preserved with mineral acid. The sample aliquot is mixed with an NH_4OH solution, a KIO_4 solution, and a buffer (pH = 4.75) solution. A Tetrabase (tetramethyldiaminodiphenylmethane) solution is finally added and mixed. The resulting colour is immediately visually compared to those of simultaneously and identically-prepared MnO_4 standard and blank solutions. The method detection limit is 0.01 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Environment Canada 1974.	Mn DISS	mg/L Mn	2

Code	Method Description	Name	Units	Decimals
25104	MANGANESE - DISSOLVED Atomic Absorption Spectrometry – Direct Aspiration A sample is filtered in the field through a 0.45 µm membrane filter and preserved with nitric acid. The sample aliquot is aspirated and the absorbance is measured spectrometrically at 279.8 nm and compared to identically-prepared standard and blank solutions, using an air-acetylene oxidizing flame. The method detection limit is 0.01 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Environment Canada 1974.	Mn DISS	mg/L Mn	2
25105	MANGANESE - DISSOLVED Atomic Absorption Spectrometry – Solvent Extraction A sample is filtered in the field through a 0.45 µm membrane filter and preserved with nitric acid. The pH of the digest is adjusted between 10 and 11 with an ammonium hydroxide solution, mixed with an ammonium pyrrolidine dithiocarbamate (APDC) solution then extracted with a methyl isobutyl ketone (MIBK) solution containing 8-hydroxyquinoline. The solvent layer *(See Appendix 5)* is aspirated at the wavelength of 279.8 nm and compared to identically-prepared standard and blank solutions, using an air-acetylene oxidising flame. The method detection limit is 0.001 mg/L. Requesting Agency and Date: UNEP GEMS/ Water Programme, September 1985. Reference: Environment Canada 1974.	Mn DISS	mg/LMn	2
25109	MANGANESE - DISSOLVED Inductively Coupled Plasma by Optical Emission Spectrometry (ICP-OES): ICP 1502 *(See Appendix 2)* A sample is filtered in the field through a 0.45 µm filter paper and preserved with nitric acid. The sample aliquot is concentrated appropriately and aspirated from an autosampler. The emission is measured at 257.6 nm and compared to identically-prepared standard and blank solutions. The method detection limit is 0.001 mg/L. Requesting Agency and Date: Environment Canada, NWRI, October 1985. Reference: Alberta Environment 1981.	Mn DISS	mg/L Mn	2
25111	MANGANESE - DISSOLVED Inductively Coupled Plasma by Optical Emission Spectrometry (ICP-OES): ICP 1516 *(See Appendix 2)* A sample is filtered in the field through a 0.45 µm membrane filter and preserved with nitric acid. The sample aliquot is aspirated and the emission is measured at 257.6 nm and compared to identically-prepared standard and blank solutions. The method detection limit is 0.001 mg/L. Requesting Agency and Date: Alberta Environment, Canada, July 1979. Reference: Alberta Environment 1979.	MN DISS	mg/L Mn	2

Code	Method Description	Name	Units	Decimals
25190	MANGANESE - DISSOLVED ICP - MS The sample is filtered in the field through a 0.45 µm membrane filter and preserved with nitric acid. The sample is aspirated into an argon-based, high temperature radio frequency plasma. The sample is dissolved, atomised and ionised. These ions are extracted from the plasma through a vacuum interface and separated on the basis of their mass to charge ratio by a mass spectrometer. The ions are counted by an electron multiplier detector and the resulting information processed by a computer database system and compared to identically-prepared standard and blank solutions. Requesting Agency and Date: National Institute for Environmental Studies, Japan, September 1998. Reference: APHA 1998.	Mn DISS	mg/L Mn	2
25204	MANGANESE - SUSPENDED Atomic Absorption Spectrometry – Direct Aspiration The sample is passed through a 0.45 µm membrane filter. The filter, containing the residue, is digested with nitric acid. The resulting solution is then aspirated and the absorbance is measured spectrometrically at 279.8 nm and compared to identically-prepared standard and blank solutions, using an air-acetylene oxidizing flame. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Environment Canada 1974.	Mn PARTICULATE	µg/g	3
25901	MANGANESE - DISSOLVED Flameless Atomic Absorption Spectrometry A sample is filtered in the field through a 0.45 µm membrane filter and preserved with nitric acid. The sample aliquot is heated, usually in three stages, in a graphite furnace or an electrically heated atomiser in which: in the first stage, a low current is applied to dry the sample; the second stage chars the sample by destroying the organic matter and volatilises other matrix compounds; finally, the third stage applies a high current which heats the tube to incandescence and atomises the manganese to be determined. The absorbance of the resultant ground state atoms is measured at 279.5 nm and is compared to identically-prepared standard and blank solutions. Requesting Agency and Date: National Institute for Environmental Studies, Japan, September 1998. Reference: Japanese Industrial Standards Committee 1998.	Mn DISS	mg/L Mn	2
25911	MANGANESE - TOTAL Flameless Atomic Absorption Spectrometry A sample is preserved in the field with nitric acid. The sample aliquot is digested in nitric acid or aqua regia. The aliquot is then heated, usually in three stages in a graphite furnace or an electrically heated atomiser where: in the first stage, a low current is applied to dry the sample; the second stage chars the sample by destroying the organic matter and volatilises other matrix compounds; finally, the third stage applies a high current which heats the tube to incandescence and atomises the manganese to be determined. The absorbance of the resultant ground state atoms is measured at 279.5 nm and is compared to identically-prepared standard and blank solutions. The method detection limit is 0.0002 mg/L. Requesting Agency and Date: National Institute for Environmental Studies, Japan, September 1998. Reference: Japanese Industrial Standards Committee 1998.	Mn TOTAL	mg/L Mn	2

Code	Method Description	Name	Units	Decimals
26002	IRON - TOTAL Colourimetry A sample is preserved in the field with nitric acid. The sample aliquot is digested with nitric acid, mixed with HCl, followed by hydroxylamine hydrochloride ($NH_2OH.HCl$) solution (reducing ferric to ferrous ions). This solution is mixed with TPTZ (2,4,6-tripyridyl-s-triazine) solution and buffered at pH 4.75. The absorbance of the resulting violet colour is measured spectrometrically at 588 nm and compared to identically-prepared standard and blank solutions. Interference: Precipitable organic compounds. The method detection limit is 0.001 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Environment Canada 1974.	Fe TOTAL	mg/L Fe	2
26004	IRON - TOTAL Atomic Absorption Spectrometry – Direct Aspiration A sample is preserved in the field with nitric acid. The sample aliquot is digested in nitric acid, diluted appropriately, then aspirated and the absorbance is measured spectrometrically at 248.3 nm and compared to identically-prepared standard and blank solutions, using an air-acetylene oxidizing flame. The method detection limit is 0.05 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Environment Canada 1974.	Fe TOTAL	mg/L Fe	2
26005	IRON -TOTAL Atomic Absorption Spectrometry – Solvent Extraction A sample is preserved in the field with nitric acid. The sample aliquot is digested in nitric acid. The digest is buffered to 4.75. Ammonium pyrrolidine dithiocarbamate (APDC) solution is mixed to the digest then extracted with a methyl isobutyl ketone (MIBK) solution. The solvent layer *(See Appendix 5)* is aspirated at the wavelength of 248.3 nm and compared to identically-prepared standard and blank solutions, using an air-acetylene oxidizing flame. The method detection limit is 0.001 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Environment Canada 1974.	Fe TOTAL	mg/L Fe	2
26009	IRON - TOTAL Inductively Coupled Plasma by Optical Emission Spectrometry (ICP-OES): ICP 1502 *(See Appendix 2)* A sample is preserved in the field with nitric acid. The sample aliquot is digested in nitric acid or aqua regia, concentrated appropriately and aspirated from an autosampler. The emission is measured at 259.9 nm and compared to identically-prepared standard and blank solutions. The method detection limit is 0.002 mg/L. Requesting Agency and Date: Alberta Environment, Canada, October 1981. Reference: Alberta Environment 1981.	Fe TOTAL	mg/L Fe	2

Code	Method Description	Name	Units	Decimals
26011	IRON - TOTAL Inductively Coupled Plasma by Optical Emission Spectrometry (ICP-OES): ICP 1503 *(See Appendix 2)* A sample is preserved in the field with diluted mineral acid. The sample aliquot is digested in aqua regia solution and evaporated to near dryness. The residue is dissolved in concentrated HCl and diluted to one-fifth of the aliquot's original volume. The emission is measured at 259.9 nm and compared to identically-prepared standard and blank solutions. The method detection limit is 0.002 mg/L. Requesting Agency and Date: Alberta Environment, Canada, July 1979. Reference: Alberta Environment 1979.	Fe TOTAL	mg/L Fe	2
26090	IRON - TOTAL ICP – MS A sample is preserved in the field with nitric acid. The sample aliquot is aspirated into an argon-based, high temperature radio frequency plasma. The sample is dissolved, atomised and ionised. These ions are extracted from the plasma through a vacuum interface and separated on the basis of their mass to charge ratio by a mass spectrometer. The ions are counted by an electron multiplier detector and the resulting information processed by a computer database system and compared to identically-prepared standard and blank solutions. The method detection limit is 0.007 mg/L. Requesting Agency and Date: National Institute for Environmental Studies, Japan, no date. Reference: APHA 1998.	Fe TOTAL	mg/L Fe	2
26102	IRON - DISSOLVED Colourimetry A sample is filtered in the field through a 0.45 µm membrane filter and preserved with nitric acid. The sample aliquot is mixed with HCl solution, followed by hydroxylamine hydrochloride ($NH_2OH.HCl$) solution (reducing ferric to ferrous ions). This solution is mixed with TPTZ (2,4,6-tripyridyl-s-triazine) solution, then buffered at 4.75. The resulting violet colour is spectrometrically measured at 588 nm and compared to identically-prepared standard and blank solutions. Interference: Precipitable organic compounds. The method detection limit is 0.001 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Environment Canada 1974.	Fe DISS	mg/L Fe	2
26104	IRON - DISSOLVED Atomic Absorption Spectrometry– Direct Aspiration A sample is filtered in the field through a 0.45 µm membrane filter and preserved with nitric acid. The sample aliquot is aspirated and the absorbance is measured spectrometrically at 248.3 nm and compared to identically-prepared standard and blank solutions, using an air-acetylene oxidizing flame. The method detection limit is 0.05 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Environment Canada 1974.	Fe DISS	mg/L Fe	2

Code	Method Description	Name	Units	Decimals
26105	IRON - DISSOLVED Atomic Absorption Spectrometry – Solvent Extraction The sample is filtered in the field through a 0.45 µm membrane filter and preserved with nitric acid. The sample aliquot is buffered at pH of 4.75. Ammonium pyrrolidine dithiocarbamate (APDC) solution is mixed to the aliquot then extracted with a methyl isobutyl ketone (MIBK) solution. The solvent layer *(See Appendix 5)* is aspirated at the wavelength of 248.3 nm and compared to identically-prepared standard and blank solutions, using an air-acetylene oxidizing flame. The method detection limit is 0.001 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Environment Canada 1974.	Fe DISS	mg/L Fe	2
26109	IRON - DISSOLVED Inductively Coupled Plasma by Optical Emission Spectrometry (ICP-OES): ICP 1502 *(See Appendix 2)* A sample is filtered in the field through a 0.45 µm membrane filter and preserved with nitric acid. The sample aliquot is concentrated appropriately, and aspirated from an autosampler. The emission is measured at 259.9 nm and compared to identically-prepared standard and blank solutions. The method detection limit is 0.001 mg/L. Requesting Agency and Date: Environment Canada, NWRI, October 1985. Reference: Alberta Environment 1981.	Fe DISS	mg/L Fe	2
26111	IRON - DISSOLVED Inductively Coupled Plasma by Optical Emission Spectrometry (ICP-OES): ICP 1516 *(See Appendix 2)* A sample is filtered in the field through a 0.45 µm membrane filter and preserved with nitric acid. The sample aliquot is aspirated and the emission is measured at 259.9 nm and compared to identically-prepared standard and blank solutions. The method detection limit is 0.002 mg/L. Requesting Agency and Date: Alberta Environment, Canada, July 1979. Reference: Alberta Environment 1979.	Fe DISS	mg/L Fe	2
26190	IRON - DISSOLVED ICP – MS A sample is filtered in the field through a 0.45 µm membrane filter and preserved with nitric acid. The sample aliquot is aspirated into an argon-based, high temperature radio frequency plasma. The sample is dissolved, atomised and ionised. These ions are extracted from the plasma through a vacuum interface and separated on the basis of their mass to charge ratio by a mass spectrometer. The ions are counted by an electron multiplier detector and the resulting information processed by a computer database system and compared to identically-prepared standard solutions. The method detection limit is 0.007 mg/L. Requesting Agency and Date: National Institute for Environmental Studies, Japan, September 1998. Reference: APHA 1998.	Fe DISS	mg/L Fe	2

Code	Method Description	Name	Units	Decimals
26204	IRON SUSPENDED Atomic Absorption Spectrometry– Direct Aspiration A sample is filtered in the field through a 0.45 µm membrane filter. The filter, containing the residue, is digested in nitric acid. The resulting solution is then aspirated and the absorbance is measured spectrometrically at 248.3 nm and compared to identically-prepared standard and blank solutions, using an air-acetylene oxidizing flame. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Environment Canada 1974.	Fe PARTICULATE	µg/g	3
26901	IRON - DISSOLVED Flameless Atomic Absorption Spectrometry A sample is filtered in the field through a 0.45 µm membrane filter and preserved with nitric acid. The sample aliquot is heated, usually in three stages, in a graphite furnace or an electrically heated atomiser where: in the first stage, a low current is applied to dry the sample; the second stage chars the sample by destroying the organic matter and volatilises other matrix compounds; finally, the third stage applies a high current which heats the tube to incandescence and atomises the iron to be determined. The absorbance of the resultant ground state atoms is measured at 248.3 nm by Flameless Atomic Absorption and is compared to identically-prepared standard and blank solutions. Requesting Agency and Date: National Institute for Environmental Studies, Japan, September 1998. Reference: Japanese Industrial Standards Committee 1998.	Fe DISS	mg/L	2
27009	COLBALT TOTAL Inductively Coupled Plasma by Optical Emission Spectrometry (ICP-OES): ICP 1502 *(See Appendix 2)* A sample is preserved in the field with nitric acid. The sample aliquot is digested in nitric acid or aqua regia, concentrated appropriately, and aspirated from an autosampler. The emission is measured at 228.6 nm and compared to identically-prepared standard and blank solutions. The method detection limit is 0.002 mg/L. Requesting Agency and Date: Alberta Environment, Canada, October 1981. Reference: Alberta Environment 1981.	Co TOTAL	mg/L Co	3
28001	NICKEL - TOTAL Atomic Absorption Spectrometry – Direct Aspiration A sample is preserved in the field with nitric acid. The sample aliquot is digested in nitric acid. The digest is aspirated and the absorbance is measured spectrometrically at 232.0 nm and compared to identically-prepared standard and blank solutions, using an air-acetylene oxidizing flame. The method detection limit is 0.01 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Environment Canada 1974.	Ni TOTAL	mg/L Ni	3

Code	Method Description	Name	Units	Decimals
28002	NICKEL - TOTAL Atomic Absorption Spectrometry – Solvent Extraction A sample is preserved in the field with nitric acid. A sample aliquot is digested in nitric acid. The digest is buffered to 4.75. Ammonium pyrrolidine dithiocarbamate (APDC) solution is mixed to the digest then extracted with a methyl isobutyl ketone (MIBK) solution. The solvent layer *(See Appendix 5)* is aspirated at the wavelength of 232.0 nm and compared to identically-prepared standard and blank solutions, using an air-acetylene oxidizing flame. The method detection limit is 0.001 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Environment Canada 1974.	Ni TOTAL	mg/L Ni	3
28009	NICKEL - TOTAL Inductively Coupled Plasma by Optical Emission Spectrometry (ICP-OES): ICP 1502 *(See Appendix 2)* A sample is preserved in the field with nitric acid. The sample aliquot is digested in nitric acid or aqua regia, concentrated appropriately, and aspirated from an autosampler. The emission is measured at 231.6 nm and compared to identically-prepared standard and blank solutions. The method detection limit is 0.002 mg/L. Requesting Agency and Date: Alberta Environment, Canada, October 1981. Reference: Alberta Environment 1981.	Ni TOTAL	mg/L Ni	3
28011	NICKEL - TOTAL Inductively Coupled Plasma by Optical Emission Spectrometry (ICP-OES): ICP 1503 *(See Appendix 2)* A sample is preserved in the field with nitric acid. The sample aliquot is digested in an aqua regia solution and evaporated to near dryness. The residue is dissolved in concentrated HCl and diluted to one-fifth of the aliquot original volume. The emission is measured spectrometrically at 231.6 nm and compared to identically-prepared standard and blank solutions. The method detection limit is 0.002 mg/L. Requesting Agency and Date: Alberta Environment, Canada, July 1979. Reference: Alberta Environment 1979.	Ni TOTAL	mg/L Ni	3
28090	NICKEL - TOTAL ICP – MS A sample is preserved in the field with nitric acid. The sample aliquot is aspirated into an argon-based, high temperature radio frequency plasma. The sample is dissolved, atomised and ionised. These ions are extracted from the plasma through a vacuum interface and separated on the basis of their mass to charge ratio by a mass spectrometer. The ions are counted by an electron multiplier detector and the resulting information processed by a computer database system and compared to identically-prepared standard solutions. Requesting Agency and Date: National Institute for Environmental Studies, Japan, September 1998. Reference: APHA 1998.	Ni TOTAL	mg/L Ni	3

Code	Method Description	Name	Units	Decimals
28101	NICKEL -DISSOLVED Atomic Absorption Spectrometry – Direct Aspiration A sample is filtered in the field through a 0.45 µm membrane filter and preserved with nitric acid. The acidified aliquot is aspirated and the absorbance is measured spectrometrically at 232.0 nm and compared with identically-prepared standard and blank solutions, using an air-acetylene oxidizing flame. The method detection limit is 0.01 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Environment Canada 1974.	Ni DISS	mg/L Ni	3
28102	NICKEL - DISSOLVED Atomic Absorption Spectrometry – Solvent Extraction A sample is filtered in the field through a 0.45 µm membrane filter and preserved with nitric acid. The sample aliquot is buffered to 4.75. Ammonium pyrrolidine dithiocarbamate (APDC) solution is added to the aliquot then extracted with a methyl isobutyl ketone (MIBK) solution. The solvent layer *(See Appendix 5)* is aspirated at the wavelength of 232.0 nm and compared to identically-prepared standard and blank solutions, using an air-acetylene oxidizing flame. The method detection limit is 0.001 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Environment Canada 1974.	Ni DISS	mg/L Ni	3
28109	NICKEL - DISSOLVED Inductively Coupled Plasma by Optical Emission Spectrometry (ICP-OES): ICP 1502 *(See Appendix 2)* A sample is filtered in the field through a 0.45 µm membrane filter and preserved with nitric acid. The sample aliquot is concentrated appropriately, and aspirated from an autosampler. The emission is compared to identically-prepared standard and blank solutions. The method detection limit is 0.001 mg/L. Requesting Agency and Date: Environment Canada, NWRI, October 1985. Reference: Alberta Environment 1981.	Ni DISS	mg/L Ni	3
28111	NICKEL - DISSOLVED Inductively Coupled Plasma by Optical Emission Spectrometry (ICP-OES): ICP 1516 *(See Appendix 2)* The sample is filtered in the field through a 0.45 µm membrane filter and preserved with nitric acid. A sample aliquot is aspirated and the emission is measured at 231.6 nm and compared with identically-prepared standard and blank solutions. The method detection limit is 0.002 mg/L. Requesting Agency and Date: Alberta Environment, Canada, 1979. Reference: Alberta Environment 1979.	Ni DISS	mg/L Ni	3

Code	Method Description	Name	Units	Decimals
28190	NICKEL - DISSOLVED ICP – MS A sample is filtered in the field through a 0.45 µm membrane filter and preserved with nitric acid. The sample aliquot is aspirated into an argon-based, high temperature radio frequency plasma. The sample is dissolved, atomised and ionised. These ions are extracted from the plasma through a vacuum interface and separated on the basis of their mass to charge ratio by a mass spectrometer. The ions are counted by an electron multiplier detector and the resulting information processed by a computer database system and compared to identically-prepared standard and blank solutions. Requesting Agency and Date: National Institute for Environmental Studies, Japan, September 1998. Reference: APHA 1998.	Ni DISS	mg/L Ni	3
28901	NICKEL - DISSOLVED Flameless Atomic Absorption Spectrometry A sample is filtered in the field through a 0.45 µm membrane filter and preserved with nitric acid. The sample aliquot is heated, usually in three stages in a graphite furnace or an electrically heated atomiser where: at the first stage, a low current is applied to dry the sample; the second stage chars the sample by destroying the organic matter and volatilising other matrix compounds; finally, the third stage applies a high current which heats the tube to incandescence and atomises the nickel to be determined. The absorbance of the resultant ground state atoms is measured at 232.0 nm and is compared to identically-prepared standard and blank solutions. The method detection limit is 0.001 mg/L. Requesting Agency and Date: National Institute for Environmental Studies, Japan, September 1998. Reference: APHA 1995.	Ni DISS	mg/L Ni	3
28911	NICKEL - TOTAL Flameless Atomic Absorption Spectrometry A sample is preserved in the field with nitric acid. The sample aliquot is digested in nitric acid or aqua regia. The aliquot is then heated, usually in three stages in a graphite furnace or an electrically heated atomiser in which: in the first stage, a low current is applied to dry the sample; the second stage chars the sample by destroying the organic matter and volatilising other matrix compounds; finally, the third stage applies a high current which heats the tube to incandescence and atomises the nickel to be determined. The absorbance of the resultant ground state atoms is measured at 232.0 nm and is compared to identically-prepared standard and blank solutions. The method detection limit is 0.001 mg/L. Requesting Agency and Date: National Institute for Environmental Studies, Japan, September 1998. Reference: APHA 1995.	Ni TOTAL	mg/L Ni	3

Code	Method Description	Name	Units	Decimals
29001	COPPER - TOTAL Colourimetry A sample is preserved in the field with nitric acid. To the sample aliquot, blank and standard solutions, add HCl, hydroxylamine hydrochloride, sodium citrate and bathocuproine disulphonate (2,9-dimethyl-4,7-diphenyl-1,10-phenanthrolinedisulphonic acid, disodium salt). An orange complex develops; the solution is then passed through a cell, and the absorbance is measured at 484 nm and compared to identically-prepared standard and blank solutions. The method detection limit is 0.020 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1980. Reference: APHA 1975.	Cu TOTAL	mg/L Cu	3
29005	COPPER - TOTAL Atomic Absorption Spectrometry – Solvent Extraction A sample is preserved in the field with nitric acid. The sample aliquot is digested in nitric acid. The pH of the digest is adjusted to 4.7 with a buffer solution. Ammonium pyrrolidine dithiocarbamate (APDC) solution is added to the digest and then extracted with a methyl isobutyl ketone (MIBK) solution. The solvent layer *(See Appendix 5)* is aspirated at the wavelength of 324.7 nm and compared to identically-prepared standard and blank solutions, using an air-acetylene oxidizing flame. The method detection limit is 0.001 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Environment Canada 1974.	Cu TOTAL	mg/L Cu	3
29006	COPPER - TOTAL Atomic Absorption Spectrometry – Direct Aspiration A sample is preserved in the field with nitric acid. The sample aliquot is digested in nitric acid. The digest is aspirated and the absorbance is measured spectrometrically at 324.7 nm and compared to identically-prepared standard and blank solutions, using an air-propane oxidizing flame. The method detection limit is 0.01 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Environment Canada 1974.	Cu TOTAL	mg/L Cu	3
29009	COPPER - TOTAL Inductively Coupled Plasma by Optical Emission Spectrometry (ICP-OES): ICP 1502 *(See Appendix 2)* A sample is preserved in the field with nitric acid. The sample aliquot is digested in nitric acid or aqua regia, concentrated appropriately, and aspirated from an autosampler. The emission is measured spectrometrically at 324.7 nm and compared to identically-prepared standard and blank solutions. The method detection limit is 0.001 mg/L. Requesting Agency and Date: Alberta Environment, Canada, October 1981. Reference: Alberta Environment 1981.	Cu TOTAL	mg/L Cu	3

Code	Method Description	Name	Units	Decimals
29011	COPPER - TOTAL Inductively Coupled Plasma by Optical Emission Spectrometry (ICP-OES): ICP 1503 *(See Appendix 2)* A sample is preserved in the field with diluted mineral acid. The sample aliquot is digested in an aqua regia solution and evaporated to near dryness. The residue is dissolved in concentrated HCl and diluted to one-fifth of the aliquot original volume. The emission is measured spectrometrically at 324.7 nm and compared to identically-prepared standard and blank solutions. The method detection limit is 0.001 mg/L. Requesting Agency and Date: Alberta Environment, Canada, July 1979. Reference: Alberta Environment 1979.	Cu TOTAL	mg/L Cu	3
29090	COPPER - TOTAL ICP – MS A sample is preserved in the field with nitric acid. The sample aliquot is aspirated into an argon-based, high temperature radio frequency plasma. The sample is dissolved, atomised and ionised. These ions are extracted from the plasma through a vacuum interface and separated on the basis of their mass to charge ratio by a mass spectrometer. The ions are counted by an electron multiplier detector and the resulting information processed by a computer database system and compared to identically-prepared standard and blank solutions. The method detection limit is 0.006 mg/L. Requesting Agency and Date: National Institute for Environmental Studies, Japan, September 1998. Reference: APHA 1998.	Cu TOTAL	mg/L Cu	3
29101	COPPER - DISSOLVED Colourimetry A sample is filtered in the field through a 0.45 µm membrane filter and preserved with nitric acid. The sample aliquot is extracted in a 20% solution of acetylacetone in chloroform to remove the iron interference. Discard the organic phase. The pH of the aqueous phase is adjusted to 10 with an ammonium hydroxide solution. Precipitate all copper by dropwise addition of sodium diethyldithiocarbamate (DDTC) and extract with three portions of 5:2 mixture of chloroform and acetone. Dilute the combined extracts with chloroform, mix and measure the wavelength in a one cm cell or longer at 440 nm against a blank (the colour is stable for two hours). Compared to identically-prepared standard and blank solutions, using an air-acetylene oxidizing flame. The method detection limit is 0.01 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1980. Reference: Chalmers and Dick 1965.	Cu DISS	mg/L Cu	3

Code	Method Description	Name	Units	Decimals
29105	COPPER - DISSOLVED Atomic Absorption Spectrometry – Solvent Extraction A sample is filtered in the field through a 0.45 µm membrane filter and preserved with nitric acid. The pH of the sample aliquot is adjusted to 4.75 with a buffer solution. Ammonium pyrrolidine dithiocarbamate (APDC) solution is added to the aliquot then extracted with a methyl isobutyl ketone (MIBK) solution. The solvent layer *(See Appendix 2)* is aspirated at the wavelength of 324.7 nm and compared to identically-prepared standard and blank solutions, using an air-acetylene oxidizing flame. The method detection limit is 0.001 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Environment Canada 1974.	Cu DISS	mg/L Cu	3
29106	COPPER - DISSOLVED Atomic Absorption Spectrometry – Direct Aspiration A sample is filtered in the field through a 0.45 µm membrane filter and preserved with nitric acid. The sample aliquot is aspirated and the absorbance is measured spectrometrically at 324.7 nm and compared to identically-prepared standard and blank solutions, using an air-acetylene oxidizing flame. The detection limit is 0.01 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Environment Canada 1974.	Cu DISS	mg/L Cu	3
29109	COPPER - DISSOLVED Inductively Coupled Plasma by Optical Emission Spectrometry (ICP-OES): ICP 1502 *(See Appendix 2)* A sample is filtered in the field through a 0.45 µm membrane filter and preserved with nitric acid. The sample aliquot is concentrated appropriately and aspirated from an autosampler. The emission is measured at 324.7 nm and compared to identically-prepared standard and blank solutions. The method detection limit is 0.001 mg/L. Requesting Agency and Date: Environment Canada, NWRI, October 1985. Reference: Alberta Environment 1981.	Cu DISS	mg/L Cu	3
29111	COPPER - DISSOLVED Inductively Coupled Plasma by Optical Emission Spectrometry (ICP-OES): ICP 1516 *(See Appendix 2)* A sample is filtered in the field through a 0.45 µm filter paper and preserved with nitric acid. The sample aliquot is aspirated and the emission is measured at 324.7 nm and compared to identically-prepared standard and blank solutions. Requesting Agency and Date: Alberta Environment, Canada, July 1979. Reference: Alberta Environment 1979.	Cu DISS	mg/L Cu	3

Code	Method Description	Name	Units	Decimals
29190	COPPER - DISSOLVED ICP - MS A sample is filtered in the field through a 0.45 µm membrane filter and preserved with nitric acid. A sample aliquot is aspirated into an argon-based, high temperature radio frequency plasma. The sample is dissolved, atomised and ionised. These ions are extracted from the plasma through a vacuum interface and separated on the basis of their mass to charge ratio by a mass spectrometer. The ions are counted by an electron multiplier detector and the resulting information processed by a computer database system and compared to identically-prepared standard and blank solutions. Requesting Agency and Date: National Institute for Environmental Studies, Japan, September 1998. Reference: APHA 1998.	Cu DISS	mg/L Cu	3
29206	COPPER SUSPENDED Atomic Absorption Spectrometry – Direct Aspiration A sample is filtered in the field through a 0.45 µ membrane filter. The filter, containing the residue, is digested in nitric acid. The resulting solution is then aspirated and the absorbance is measured spectrometrically at 324.7 nm and compared to identically-prepared standard and blank solutions, using an air-acetylene oxidizing flame. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Environment Canada 1974.	Cu PARTICULATE	µg/g	3
29901	COPPER - DISSOLVED Flameless Atomic Absorption Spectrometry The sample is filtered in the field through a 0.45 µm membrane filter and preserved with nitric acid. The sample aliquot is heated, usually in three stages in a graphite furnace or an electrically heated atomiser in which: first, a low current is applied to dry the sample; the second stage chars the sample by destroying the organic matter and volatilises other matrix compounds; finally, the third stage applies a high current which heats the tube to incandescence and atomises the copper to be determined. The absorbance of the resultant ground state atoms is measured at 324.7 nm and is compared to identically-prepared standard and blank solutions. The method detection limit is 0.005 mg/L Requesting Agency and Date: National Institute for Environmental Studies, Japan, September 1998. Reference: Japanese Industrial Standards Committee 1998.	Cu DISS	mg/L Cu	3

Code	Method Description	Name	Units	Decimals
29911	COPPER - TOTAL Flameless Atomic Absorption Spectrometry The sample is preserved in the field with nitric acid. A sample aliquot is digested in nitric acid or aqua regia. The digest is then heated, usually in three stages in a graphite furnace or an electrically heated atomiser where: first, a low current is applied to dry the sample; the second stage chars the sample by destroying the organic matter and volatilises other matrix compounds; finally, the third stage applies a high current which heats the tube to incandescence and atomises the copper to be determined. The absorbance of the resultant ground state atoms is measured at 324.7 nm and is compared to identically-prepared standard and blank solutions. The method detection limit is 0.005 mg/L. Requesting Agency and Date: National Institute for Environmental Studies, Japan, September 1998. Reference: Japanese Industrial Standards Committee 1998.	Cu TOTAL	mg/L Cu	3
30001	ZINC - Total Colourimetry A sample is preserved in the field with nitric acid. The sample aliquot is evaporated to dryness to remove the excess acid and brought back to volume. The aliquot is then reacted with diphenylthiocarbazone (dithizone) to produce a coloured complex. The complex is extracted with an organic solvent (carbon tetrachloride) and most interferences are overcome by adjusting the pH between 4.0 and 5.5 and adding sufficient sodium thiosulphate (which tends to slow the coloured reaction). The sample, and the standard and blank solutions must be identically-prepared and the pH kept constant. The absorbance is read at 535 nm in a path light of 2 cm or longer. Interferences: Many metals could interfere with this reaction without the complexion by sodium thiosulphate and pH adjustment. This reaction is extremely sensitive and the glassware used should be dedicated to zinc analysis only. Dithizone and dithizonates decompose in strong light: perform analysis in subdued lighting The method detection limit is 0.001 mg/L Requesting Agency and Date: UNEP GEMS/Water Programme, September 1980. Reference: APHA 1975.	Zn TOTAL	mg/L Zn	3
30004	ZINC - TOTAL Atomic Absorption Spectrometry – Direct Aspiration A sample is preserved in the field with nitric acid. The sample aliquot is digested in nitric acid. The digest is aspirated and the absorbance is measured spectrometrically at 213.8 nm and compared to identically-prepared standard and blank solutions, using an air-propane oxidizing flame. The method detection limit is 0.01 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Environment Canada 1974.	Zn TOTAL	mg/L Zn	3

Code	Method Description	Name	Units	Decimals
30005	ZINC - TOTAL Atomic Absorption Spectrometry – Solvent Extraction A sample is preserved in the field with nitric acid. The sample aliquot is digested in nitric acid. The pH of the digest is adjusted to 4.75 with a buffer solution. Ammonium pyrrolidine dithiocarbamate (APDC) solution is added to the digest then extracted with a methyl isobutyl ketone (MIBK) solution. The solvent layer *(See Appendix 5)* is aspirated at the wavelength of 213.8 nm and compared to identically-prepared standard and blank solutions, using an air-acetylene oxidizing flame. The method detection limit is 0.001 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Environment Canada 1974.	Zn TOTAL	mg/L Zn	3
30009	ZINC - TOTAL Inductively Coupled Plasma by Optical Emission Spectrometry (ICP-OES): ICP 1502 *(See Appendix 2)* A sample is preserved in the field with nitric acid. The sample aliquot is digested in nitric acid or aqua regia, concentrated appropriately, and aspirated from an autosampler. The emission is measured at 213.8 nm and compared to identically-prepared standard and blank solutions. The method detection limit is 0.002 mg/L. Requesting Agency and Date: Alberta Environment, Canada, October 1981. Reference: Alberta Environment 1981.	Zn TOTAL	mg/L Zn	3
30011	ZINC - TOTAL Inductively Coupled Plasma by Optical Emission Spectrometry (ICP-OES): ICP 1503 *(See Appendix 2)* A sample is preserved in the field with diluted mineral acid. The sample aliquot is digested in aqua regia and evaporated to near dryness. The residue is dissolved in concentrated HCl and diluted to one-fifth of the aliquot original volume. The emission is measured spectrometrically at 213.8 nm and compared to identically-prepared standard and blank solutions. The method detection limit is 0.002 mg/L. Requesting Agency and Date: Alberta Environment, Canada, July 1979. Reference: Alberta Environment 1979.	Zn TOTAL	mg/L Zn	3
30090	ZINC - TOTAL ICP – MS A sample is preserved in the field with nitric acid. The sample aliquot is aspirated into an argon-based, high temperature radio frequency plasma. The sample is dissolved, atomised and ionised. These ions are extracted from the plasma through a vacuum interface and separated on the basis of their mass to charge ratio by a mass spectrometer. The ions are counted by an electron multiplier detector and the resulting information processed by a computer database system and compared to identically-prepared standard and blank solutions. Requesting Agency and Date: National Institute for Environmental Studies, Japan, September 1998. Reference: APHA 1998.	Zn TOTAL	mg/L Zn	3

Code	Method Description	Name	Units	Decimals
30101	ZINC - DISSOLVED Colourimetry A sample is filtered in the field through a 0.45 µm membrane filter and preserved with mineral acid. To a series of sample aliquots, standards, blanks and QC solutions, add, in sequence and mix after each addition, sodium ascorbate, KCN, buffer and zincon (2-carboxy-2'-hydroxy-5'-sulphoformazyl benzene) solutions. Add a chloral hydrate solution and time for exactly five minutes; measure the absorbance at 620 nm and compare to identically-prepared standard and blank solutions. The method detection limit is 0.01 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: APHA 1975.	Zn DISS	mg/L Zn	3
30104	ZINC - DISSOLVED Atomic Absorption Spectrometry – Direct Aspiration A sample is filtered in the field through a 0.45 µm membrane filter and preserved with nitric acid. The sample aliquot is aspirated and the absorbance is measured spectrometrically at 213.8 nm and compared to identically-prepared standard and blank solutions, using an air-propane oxidizing flame. The method detection limit is 0.01 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Environment Canada 1974.	Zn DISS	mg/L Zn	3
30105	ZINC- DISSOLVED Atomic Absorption Spectrometry – Solvent Extraction A sample is filtered in the field through a 0.45 µm membrane filter and preserved with nitric acid. The pH of the sample aliquot is adjusted to 4.75 with a buffer solution. Ammonium pyrrolidine dithiocarbamate (APDC) solution is added, mixed, then extracted with a methyl isobutyl ketone (MIBK) solution. The solvent layer *(See Appendix 8)* is aspirated at the wavelength of 213.8 nm and compared to identically-prepared standard and blank solutions, using an air-acetylene oxidizing flame. The method detection limit is 0.001 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Environment Canada 1974.	Zn DISS	mg/L Zn	3
30109	ZINC - DISSOLVED Inductively Coupled Plasma by Optical Emission Spectrometry (ICP-OES): ICP 1502 *(See Appendix 2)* A sample is filtered in the field through a 0.45 µm membrane filter and preserved with nitric acid. The sample aliquot is concentrated appropriately and aspirated from an autosampler. The emission is measured at 213.8 nm and compared to identically-prepared standard and blank solutions. The method detection limit is 0.001 mg/L. Requesting Agency and Date: Environment Canada, NWRI, October 1985. Reference: Alberta Environment 1981.	Zn DISS	mg/L Zn	3

Code	Method Description	Name	Units	Decimals
30111	ZINC - DISSOLVED Inductively Coupled Plasma by Optical Emission Spectrometry (ICP-OES): ICP 1516 *(See Appendix 2)* A sample is filtered in the field through a 0.45 µm membrane filter and preserved with nitric acid. The sample aliquot is aspirated and the emission is measured at 213.8 nm and compared to identically-prepared standard and blank solutions. The method detection limit is 0.002 mg/L. Requesting Agency and Date: Alberta Environment, Canada, July 1979. Reference: Alberta Environment 1979.	Zn DISS	mg/L Zn	3
30190	ZINC - DISSOLVED ICP – MS A sample is filtered in the field through a 0.45 µm membrane filter and preserved with nitric acid. The sample aliquot is aspirated into an argon-based, high temperature radio frequency plasma. The sample is dissolved, atomised and ionised. These ions are extracted from the plasma through a vacuum interface and separated on the basis of their mass to charge ratio by a mass spectrometer. The ions are counted by an electron multiplier detector and the resulting information processed by a computer database system and compared to identically-prepared standard and blank solutions. Requesting Agency and Date: National Institute for Environmental Studies, Japan, September 1998. Reference: APHA 1998.	Zn DISS	mg/L Zn	3
30204	ZINC SUSPENDED Atomic Absorption Spectrometry – Direct Aspiration A sample is filtered through a 0.45 µm membrane filter. The filter, containing the residue, is digested in nitric acid. The resulting solution is then aspirated and the absorbance is measured spectrometrically at 213.8 nm and compared to identically-prepared standard and blank solutions, using an air-propane oxidizing flame. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Environment Canada 1974.	Zn Particulate	µg/g	3
30901	ZINC - DISSOLVED Flameless Atomic Absorption Spectrometry A sample is filtered in the field through a 0.45 µm membrane filter and preserved with nitric acid. The sample aliquot is heated, usually in three stages in a graphite furnace or an electrically heated atomiser in which: first, a low current is applied to dry the sample; the second stage chars the sample by destroying the organic matter and volatilises other matrix compounds; finally, the third stage applies a high current which heats the tube to incandescence and atomises the zinc to be determined. The absorbance of the resultant ground state atoms is measured at 213.8 nm and is compared with those of identically-prepared standard and blank solutions. The method detection limit is 0.001 mg/L. Requesting Agency and Date: National Institute for Environmental Studies, Japan, September 1998. Reference: APHA 1995.	Zn DISS	mg/L Zn	3

Code	Method Description	Name	Units	Decimals
30911	ZINC - TOTAL Flameless Atomic Absorption Spectrometry The sample is preserved in the field with nitric acid. A sample aliquot is digested in nitric acid or aqua regia. The sample aliquot is heated, usually in three stages in a graphite furnace or an electrically heated atomiser in which: first, a low current is applied to dry the sample; the second stage chars the sample by destroying the organic matter and volatilises other matrix compounds; finally, the third stage applies a high current which heats the tube to incandescence and atomises the zinc to be determined. The absorbance of the resultant ground state atoms is measured at 213.8 nm and is compared with those of identically-prepared standard and blank solutions. The method detection limit is 0.001 mg/L. Requesting Agency and Date: National Institute for Environmental Studies, Japan, September 1998. Reference: APHA 1995.	Zn TOTAL	mg/L Zn	3
33003	ARSENIC - TOTAL Colourimetry A sample is preserved in the field at 4°C. The sample aliquot is digested in nitric acid. Add consecutively HCl, KI and $SnCl_2$ solutions (swirl between each addition) to the sample aliquot and allow one hour for reduction. The inorganic arsenic is reduced (gaseous arsine) by zinc in an acid medium. The arsine is then passed through a scrubber containing glass wool impregnated with lead acetate to remove sulphide and finally through an absorber tube containing Silver Diethyl Dithiocarbamate in pyridine. The arsenic reacts with the silver salt and forms a red colour, measured spectrometrically at 540 nm and compared to identically-prepared standard and blank solutions. Interferences: Sb and other heavy metal ions at high concentrations. The method detection limit is 0.005 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Environment Canada 1974.	As TOTAL	mg/L As	3
33007	ARSENIC - TOTAL Flameless Atomic Absorption Spectrometry A sample is preserved in the field at 4°C. The sample aliquot is digested and oxidised with an acidic potassium persulphate solution, then all forms of arsenic are reduced to arsenite (As^{3+}) with HCl. Hydrides of arsenic are formed in an acidic sodium borohydride solution. The arsine vapours are separated from the solution by heating, usually in three stages in a graphite furnace or an electrically heated atomiser in which: first, a low current is applied to dry the sample; the second stage chars the sample by destroying the organic matter and volatilises other matrix compounds; finally, the third stage applies a high current which heats the tube to incandescence and atomises the arsenic to be determined. The absorbance of the resultant ground state atoms is measured at 193.7 nm and is compared to identically-prepared standard and blank solutions. The method detection limit is 0.001 mg/L Requesting Agency and Date: Environment Canada, Atlantic Region, December 1979. Reference: Environment Canada 1979.	As TOTAL	mg/L As	3

Code	Method Description	Name	Units	Decimals
33008	ARSENIC - TOTAL Inductively Coupled Plasma by Optical Emission Spectrometry (ICP-OES). A sample is preserved in the field at 4°C. From the sample aliquot, all organoarsenides are decomposed with acidic persulphate. After reduction to arsenite with HCl, the metal is converted to its hydride form with sodium borohydride in an automated system and passed though an argon plasma torch where it is decomposed to its arsenic atoms, measured by emission spectrometry at 193.7 nm and compared to identically-prepared standard and blank solutions. Requesting Agency and Date: Environment Canada, NWRI, April 1981. Reference: Environment Canada 1979.	As TOTAL	mg/L As	3
33009	ARSENIC - TOTAL Inductively Coupled Plasma by Optical Emission Spectrometry (ICP-OES): ICP 1502 *(See Appendix 2)* A sample is preserved in the field with nitric acid. The sample aliquot is digested with nitric acid and H_2O_2 to oxidise all organoarsenides, then passed through a tube furnace at 850°C, using a 1000 ppm nickel nitrate solution as a matrix modifier, and the arsenic atoms and measured spectrometrically at 193.7 nm and compared to identically-prepared standard and blank solutions. The method detection limit is 0.001 mg/L. Requesting Agency and Date: Government of Québec at Longueuil, Canada, 1982. Reference: Alberta Environment 1981.	As TOTAL	mg/L As	3
33011	ARSENIC - TOTAL Flameless Atomic Absorption Spectrometry – Hydride A sample is preserved in the field at 4°C. The sample aliquot and standard solutions are digested with H_2SO_4, HNO_3, and $HClO_4$. Arsenic is reduced to arsine with acidic $NaBH_4$ solution and is then sparged into a heated quartz combustion tube, decomposing the hydride to form arsenic atoms. The absorbance is measured spectrometrically at 193.7 nm and compared to identically-prepared standard and blank solutions. Requesting Agency and Date: Alberta Environment, Canada, May 1985. Reference: Alberta Environment 1979.	As TOTAL	mg/L As	3
33090	ARSENIC - TOTAL ICP – MS A sample is preserved in the field with mineral acid. The sample aliquot is aspirated into an argon-based, high temperature radio frequency plasma. The sample is dissolved, atomised and ionised. These ions are extracted from the plasma through a vacuum interface and separated on the basis of their mass to charge ratio by a mass spectrometer. The ions are counted by an electron multiplier detector and the resulting information processed by a computer database system and compared to identically-prepared standard and blank solutions. Requesting Agency and Date: National Institute for Environmental Studies, Japan, September 1998. Reference: APHA 1998.	As TOTAL	mg/L As	3

Code	Method Description	Name	Units	Decimals
33103	ARSENIC - DISSOLVED Colourimetry A sample is filtered in the field through a 0.45 µm membrane filter and preserved at 4°C. Add consecutively HCl, KI and $SnCl_2$ solutions (swirl between each addition) to the sample aliquot and allow one hour for reduction. The inorganic arsenic is reduced (gaseous arsine) by zinc in an acid medium. The arsine is then passed through a scrubber containing glass wool impregnated with lead acetate to remove sulphide and finally through an absorber tube containing Silver Diethyl Dithiocarbamate in pyridine. The arsenic reacts with the silver salt and forms a red colour, measured spectrometrically at 540 nm and compared to identically-prepared standard and blank solutions. Interferences: Sb and other heavy metal ions at high concentrations. The method detection limit is 0.005 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Environment Canada 1974.	As DISS	mg/L As	3
33104	ARSENIC - DISSOLVED Flameless Atomic Absorption Spectrometry A sample is filtered in the field through a 0.45 µm membrane filter and preserved at 4°C. The sample aliquot is digested with sulphuric acid, nitric acid and potassium permanganate until a white fume of sulphuric acid is generated. Dissolve the residue with HCl and transfer into reactor vessel generator. Add KI, $SnCl_2$ and ferric solutions (10 mg/L Fe), mix and let stand 15 minutes. Connect generator to Atomic Absorption Analyser, replace air with argon, quickly add one gram of zinc powder. Pass arsenic hydride into hydrogen-argon flame and the absorbance of the resultant ground state atoms is measured at 193.7 nm and is compared to identically-prepared standard and blank solutions. Requesting Agency and Date: National Institute for Environmental Studies, Japan, September 1998. Reference: Japanese Industrial Standards Committee 1998.	As DISS	mg/L As	3
33108	ARSENIC - DISSOLVED Inductively Coupled Plasma by Optical Emission Spectrometry (ICP-OES). A sample is filtered in the field through a 0.45 µm membrane filter and preserved at 4°C. All organoarsenides, from the sample aliquot, are decomposed with acidic persulphate. After reduction to arsenite with HCl, the metal is converted to its hydride form with sodium borohydride in an automated system and passed though an argon plasma torch where it is decomposed to its arsenic atoms, measured by emission spectrometry at 193.7 nm and compared to identically-prepared standard and blank solutions. Requesting Agency and Date: Environment Canada, NWRI, September 1983. Reference: Environment Canada 1979.	As DISS	mg/L As	3

Code	Method Description	Name	Units	Decimals
33190	ARSENIC - DISSOLVED ICP- MS A sample is filtered in the field through a 0.45 µm membrane filter and preserved with nitric acid. The sample aliquot is aspirated into an argon-based, high temperature radio frequency plasma. The sample is dissolved, atomised and ionised. These ions are extracted from the plasma through a vacuum interface and separated on the basis of their mass to charge ratio by a mass spectrometer. The ions are counted by an electron multiplier detector and the resulting information processed by a computer database system and compared to identically-prepared standard and blank solutions. Requesting Agency and Date: National Institute for Environmental Studies, Japan 1998. Reference: APHA 1998.	As DISS	mg/L As	3
33202	ARSENIC SUSPENDED Flameless Atomic Absorption Spectrometry – Acid Digestion A sample is preserved in the field. Arsenic is extracted from the soil or sediment aliquot by digestion with HNO_3, $HClO_4$, $KMnO_4$, $K_2S_2O_8$ and HF to its inorganic forms. Following the oxidation and complete solubilization, an automated system is used to determine arsenic. After reduction to arsenite with HCl, the metal is converted to its hydride form with sodium borohydride in an automated system and passed though an argon plasma torch where it is decomposed to its arsenic atoms, measured by emission spectrometry at 193.7 nm and compared to identically-prepared standard and blank solutions. Requesting Agency and Date: Environment Canada, NWRI, December 1979. Reference: Agemian and Bedek 1980.	As PARTICU-LATE	µg/g	3
34002	SELENIUM - TOTAL Atomic Absorption Spectrometry A sample is preserved in the field at 4ºC. The sample aliquot is oxidized, in acidic persulphate, to Selenate $(Se^{-6}O_4)^{-2}$, reducted to selenite $(Se^{-4}O_3)^{-2}$ in HCl, then converted to its hydride form (hydrogen selenide: H_2Se) with sodium borohydride in an acid medium. The sample is aspirated into the flame and the selenium absorbance is measured spectrometrically at 196.0 nm and compared to identically-prepared standard and blank solutions. Interference: Chromium, cobalt, copper, mercury, molybdenum, nickel, platinum and silver may interfere in large concentration. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1980. Reference: Environment Canada 1979.	Se TOTAL	mg/L Se	3

Code	Method Description	Name	Units	Decimals
34007	SELENIUM - TOTAL Flameless Atomic Absorption Spectrometry – Hydride A sample is preserved in the field at 4°C. The sample aliquot is digested and oxidised with acidic potassium persulphate, then concentrated HCl reduces all forms of selenium to selenite. The hydride is formed by the action of $NaBH_4$ in acidic solution then sparged into a quartz tube cell and decomposes at 800°C to form selenium atoms. The absorbance is measured spectrometrically at 196.1 nm and compared to identically-prepared standard and blank solutions. The method detection limit is 0.001 mg/L Requesting Agency and Date: Environment Canada, Atlantic Region, December 1979. Reference: Environment Canada 1979.	Se TOTAL	mg/L Se	3
34008	SELENIUM - TOTAL Inductively Coupled Plasma by Optical Emission Spectrometry (ICP-OES). A sample is preserved in the field at 4°C. All organoselenides, from the sample aliquot, are oxidised in acidic persulphate. After reduction to selenite with HCl, the metal is converted to its hydride with sodium borohydride on an automated system and passed through an argon plasma torch where it is decomposed to its selenium atoms, measured by emission spectrometry at 196.0 nm and compared to identically-prepared standard and blank solutions. The method detection limit is 0.03 µg/L. Requesting Agency and Date: Environment Canada, NWRI, April 1981. Reference: Goulden, Anthony and Austen 1981.	Se TOTAL	mg/ Se	3
34090	SELENIUM - TOTAL ICP – MS A sample is preserved in the field at 4°C. The sample aliquot is aspirated into an argon-based, high temperature radio frequency plasma. The sample is dissolved, atomised and ionised. These ions are extracted from the plasma through a vacuum interface and separated on the basis of their mass to charge ratio by a mass spectrometer. The ions are counted by an electron multiplier detector and the resulting information processed by a computer database system and compared to identically-prepared standard and blank solutions. Requesting Agency and Date: National Institute for Environmental Studies, Japan, 1998. Reference: APHA 1998.	Se TOTAL	mg/L Se	3

Code	Method Description	Name	Units	Decimals
34102	SELENIUM - DISSOLVED Flameless Atomic Absorption Spectrometry A sample is filtered in the field through a 0.45 µm membrane filter and preserved at 4°C. The sample aliquot is digested with 2% potassium persulphate (oxidising the organoselenides to selenates) and concentrated HCl (reducing selenates to selenites). In an automated system, the selenium is mixed with a potassium iodide-stannous chloride mixture and an aluminum slurry in sulphuric acid to form hydrogen selenide (H_2Se). This is then separated from solution, passed into a quartz tube atomiser, decomposed to its selenium atoms, measured spectrometrically at 196.1 nm and is compared to identically-prepared standard and blank solutions. Requesting Agency and Date: National Institute for Environmental Studies, Japan, September 1998. Reference: Environment Canada 1979.	Se DISS	mg/L Se	3
34108	SELENIUM - DISSOLVED Inductively Coupled Plasma by Optical Emission Spectrometry (ICP-OES). A sample is filtered in the field and preserved at 4°C. All organoselenides, from a sample aliquot, are decomposed with acidic persulphate. After reduction to selenite with HCl, the metal is converted to its hydride with sodium borohydride on an automated system and passed through an argon plasma torch where it is decomposed to its selenium atoms, measured by emission spectrometry at 196.0 nm and compared to identically-prepared standard and blank solutions. The method detection limit is 0.00003 mg/L. Requesting Agency and Date: Environment Canada, NWRI, September 1983. Reference: Environment Canada 1982.	Se DISS	mg/L Se	3
34190	SELENIUM - DISSOLVED ICP – MS A sample is filtered in the field through a 0.45 µm membrane filter and preserved at 4°C. The sample aliquot is aspirated into an argon-based, high temperature radio frequency plasma. The sample is dissolved, atomised and ionised. These ions are extracted from the plasma through a vacuum interface and separated on the basis of their mass to charge ratio by a mass spectrometer. The ions are counted by an electron multiplier detector and the resulting information processed by a computer database system and compared to identically-prepared standard and blank solutions. Requesting Agency and Date: National Institute for Environmental Studies, Japan, 1998. Reference: APHA 1998.	Se DISS	mg/L Se	3

Code	Method Description	Name	Units	Decimals
36001	COLIFORMS - TOTAL Multiple Test Tube: Minor variations in analytical techniques can cause change in results; therefore microbiological methods and sterilising procedures must be standardized to obtain uniform results from different laboratories. The results are an estimate of the mean density of coliforms in the sample and are reported as MPN. Unless a large portion of fermentation tubes are used, the precision is low. Presumptive Phase: Use sufficient medium (lauryl tryptose broth) in fermentation tubes, incubate at 20°C overnight before use and discard tubes with growth or bubbles. Arrange fermentation tubes in rows of five or ten in test tube rack. For potable water, use five 20mL portions, ten 10mL portions tubes or a single 100mL portion. For non-potable water, use five tubes per dilution (10, 1.0, 0.1 mL, etc). Shake sample well, inoculate and mix test tubes in the medium by gentle agitation. Incubate inoculated tubes or bottles at 35°C ± 0.5°C. After 24 hours, swirl each container and check for growth, gas or acidic reaction (producing a shade of yellow colour) and document. If absent, re-incubate for another 24 hours. The absence of acidic reaction or gas formation constitutes a negative test. Confirmed Phase: Submit all presumptive tubes with growth, gas or acidic reaction. Transfer culture to the fermentation tube (containing brilliant green lactose bile broth) or insert a sterile applicator into the culture, quickly remove and insert to the bottom of fermentation tube containing the broth. Remove and discard applicator. Repeat for all positive presumptive tubes. Incubate at 35°C ± 0.5°C. Formation of gas at any time within 48 hours ± 3 hours constitutes a positive confirmed phase. Alternative Procedure (for polluted waters): If all presumptive tubes are positive in two or more consecutive dilutions within 24 hours, only submit, to the confirmed phase, all tubes with the highest dilution (also submit all positive tubes produced after 48 hours). Calculate the MPN value from the number of positive brilliant green lactose bile tubes. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: APHA 1995.	COLIFORM TOTAL	No/100 mL MF	0

Code	Method Description	Name	Units	Decimals
36002	COLIFORMS - TOTAL Membrane Filtration Minor variations in analytical techniques can cause change in results; therefore microbiological methods and sterilising procedures must be standardized to obtain uniform results from different laboratories. The Membrane Filter technique is usually more rapid and more reproducible than the multiple-tube technique in monitoring drinking water and a variety of natural waters. MF has limitations: i.e.: testing samples with high turbidity or large background (non-coliforms) bacteria. Apply sufficient medium (lauryl tryptose broth) in fermentation tubes, incubate at 20°C overnight before use and discard tubes with growth or bubbles. The coliform group is defined as all bacteria that produce a red colony with a metallic (golden) sheen within 24 hours at 35°C on an Endo-type medium containing lactose (production of aldehydes). The medium is stable for a maximum of three weeks and the broth for four days at 4°C. Filter 100 to 1000 mL of water, place filter paper on saturated lactose pad for two hours at 35ºC, remove from incubator and transfer to M-endo medium pad, incubate for 20 to 22 hours at 35°C ± 0.5°C, then count the colonies on membrane filters using a 10 to 15 times magnifying binocular wide field dissecting microscope or equivalent, with a cool white fluorescent light source directed to provide maximum viewing of the sheen. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: APHA 1995.	COLIFORM TOTAL	No/100 mL	0
36011	FAECAL COLIFORM BACTERIA Multiple Test Tube: Elevated temperature distinguishes fecal coliforms from total coliforms. Minor variations in analytical techniques can cause change in analytical results; therefore microbiological methods and sterilising procedures must be standardized to obtain uniform results from different laboratories. Use sufficient EC medium in fermentation tubes and incubate at 20°C overnight before use; discard tubes with growth or bubbles. Arrange fermentation tubes in rows of five or ten each in test tube rack. For potable water, use five 20 mL portions, ten 10 mL portions tubes or a single 100 mL portion. For non-potable water, use five tubes per dilution (10, 1.0, 0.1 mL, etc). Shake sample well, inoculate and mix test tubes in the medium by gentle agitation. Incubate inoculated tubes or bottles at 44.5°C ± 0.2°C. Gas production with growth in an EC broth culture tube within 24 hours ± 2 hours or less is considered positive faecal coliform reaction. If absent, re-incubate for another 24 hours. The absence of acidic reaction or gas formation constitutes a negative test. Gently shake or rotate the tubes/bottles to re-suspend the organisms. With a sterile loop, transfer one or more loopfuls of culture to the fermentation tube containing brilliant green lactose bile broth (or insert a sterile applicator into the culture, quickly remove and insert to the bottom of fermentation tube containing the broth. Remove and discard applicator). Repeat for all positive presumptive tubes. Incubate at 44.5°C ± 0.2°C. Formation of gas at any time within 48 hours ± 3 hours constitutes a positive confirmed phase. Failure to produce gas (with little or no growth) constitutes a negative reaction. Calculate from the number of positive EC broth tubes. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: APHA 1995.	FAEC COL	No/100 mL MF	0

Code	Method Description	Name	Units	Decimals
36012	FAECAL COLIFORM BACTERIA Membrane Filtration Elevated temperature distinguishes faecal coliforms from total coliforms. Minor variations in analytical techniques can cause change in analytical results; therefore microbiological methods and sterilising procedures must be standardized to obtain uniform results from different laboratories. Method 1: Filter a volume of sample (to yield counts of 20 to 80 faecal coliform colonies), rinse with sterile water between filtration; analyse a blank membrane filter and a duplicate sample after every 10 samples. Place a sterile absorbing pad in each culture dish and saturate with M-FC medium. Place the prepared filter on medium pad, insert in waterproof container and incubate by placing in a plastic bag and immerge in a water bath at 44.5°C ± 0.2°C for 24 hours. Colonies produced by faecal coliform bacteria on M-FC medium are various shades of blue (nonfaecal coliform colonies are grey to cream coloured.). Count colonies on membrane filters using a 10 to 15 times magnifying binocular wide field microscope, with a cool white fluorescent light. Count coliforms based on 100 mL of sample. Method 2: A measured volume of water sample is filtered through a sterile cellulose ester membrane where the pore size is small enough to retain the organisms to be enumerated. The membrane is placed on an absorbent pad saturated with membrane lauryl sulphate broth (containing lactose and phenol red as indicator of acidity) and incubated 4 hours at 30°C then 14 hours at 44°C. The colonies of organism with characteristic colour and morphology are counted with subsequent confirmation of the ability to produce acid and gas from the lactose broth and indole formation from tryptophan broth. The results are expressed in number per 100 mL of sample. Requesting Agency and Date: Water Supplies Department, Hong Kong SAR, no date. Reference: HMSO 1982.	FAEC COL	No/100 mL MPN	0
36101	FAECAL STREPTOCOCCI Multiple Test Tube Minor variations in analytical techniques can cause change in results; therefore microbiological methods and sterilising procedures must be standardized to obtain uniform results from different laboratories. Inoculate a series of tubes in azide dextrose broth, using appropriate volumes of sample. Use portions of 10mL or less; double the strength of broth usage for 10 mL inocula. Incubate inoculated tubes at 35°C ± 0.5°C. Examine each tube for turbidity after 24 hours; if no definite turbidity, incubate for a total of 48 hours. All turbid broth tubes are subject to a confirmation test: streak a portion of growth from dextrose broth tubes on PSE (Pfizer Selective Enterococcus) agar. Incubate the inverted dish at 35°C ± 0.5°C for 24 hours ± 2 hours. Brownish-black colonies with brown halos confirm the presence of fecal streptococci. Estimate its densities from the number of positive tubes in each dilution series that are positive on PSE agar. Compute the combination of positives and document as the most probable number (MPN). Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: APHA 1995.	FAEC STREP	No/100 mL MF	0

Code	Method Description	Name	Units	Decimals
36102	FAECAL STREPTOCOCCI Membrane Filtration Minor variations in analytical techniques can cause change in results; therefore microbiological methods and sterilising procedures must be standardized to obtain uniform results from different laboratories. Select appropriate sample volumes and filter through a 0.45 µm, gridded, sterile membrane filter to give 20 to 80 colonies on the membrane surface. Transfer filter to an agar medium petri dish, invert culture plates and incubate at 41°C ± 0.5°C for 48 hours. Carefully transfer filter to EIA medium (stable for 30 days if kept in the dark between 2°C to 10°C) and incubate at 41°C ± 0.5°C for 20 minutes. Count the colonies (per 100 mL) using a fluorescent lamp and magnifying lens. Growth of catalase-negative, gram-positive cocci on bile esculin agar and at 45°C, in brain-heart infusion broth, verifies that the colony is of the fecal streptococcus group (growth at 45°C and in 6.5% NaCl broth indicates that the colony belongs to the enterococcus group). Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: APHA 1995.	FAEC STREP	No/100 mL MPN	0
36220	SALMONELLA The sample is filtered (on membrane or appropriate filter) and inoculated into a pre-enrichment medium. After enrichment, the sample is transferred into an isolating gelose for identification. Requesting Agency and Date: European Environmental Agency (EEA), October 2000. Reference: EEA 2000.	SALMONEL LA	No/L	0
36301	PHYTOPLANKTON COUNT Total Number Observed Lackey method: With a calibrated dropper, a known volume of aliquot is put on a coverglass. Agitate the aliquot to evenly distribute the organisms, carefully cover with a square coverglass and count. Record the number. Similarly, count another drop (several drops should be counted, on a large and uniform sample, to improve the precision). Calculate the total number per drop as follows: Total number/drop = $\frac{\text{Area of cover glass}}{\text{Area of 1 transect}} \times \text{Individual counts/transect}$ Requesting Agency and Date: UNEP GEMS/Water Programme, September 1980. Reference: Vollenweider, Talling and Westlake 1974.	PHYTO COUNT	No/L	0
36302	PHYTOPLANKTON BIOMASS Using a calibrated microscope, equipped with an eyepiece, identify and count the number of individual species of phytoplankton in multiple cells of a known volume of sample. The sample is weighed on a wet or dry basis and the number of cells are multiplied or divided by the dilution or concentration factor of the sample. N.B.: The number and variety of species available can serve as an indicator of water quality and identify trends in water degradation. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1980. Reference: APHA 1975.	PHYHTO BIO	mg/m^3	1

Code	Method Description	Name	Units	Decimals
36304	PHYTOPLANKTON COUNT Total Number Observed Pour a known volume of sample into a sedimentation chamber. After suitable sedimentation time, transversely remove the chamber and counting of sediment collected at the bottom plate is done visually. Enumeration may be done in two steps. First, the bottom area is scanned under a low magnifying microscope to count the large forms, generally in small numbers. Then the nannoplankton individuals of two crossed diameter transects are enumerated using high power magnification. The total number of cells is calculated by multiplying the number of individuals counted in the transects by the ratio of the whole chamber area. 100 mL is usually the maximum volume needed. Requesting Agency and Date: UNEP GEMS/Water Programme, August 1981. Reference: Vollenweider, Talling and Westlake 1974.	PHYTO COUNT	No/mL	0
47101	SILVER DISSOLVED Atomic Absorption Spectrometry – Direct Aspiration A sample is filtered in the field through a 0.45 µm membrane filter and preserved with EDTA. The sample aliquot is acidified with nitric acid, aspirated and the absorbance is measured spectrometrically at 328.1 nm and compared to identically-prepared standard and blank solutions, using an air-acetylene oxidizing flame. The method detection limit is 0.010 mg/L. Requesting Agency and Date: Instituto Nacional del Agua, Argentina, no date. Reference: Environment Canada 1974.	Ag DISS	mg/L	2
48001	CADMIUM - TOTAL Atomic Absorption Spectrometry – Direct Aspiration A sample is preserved in the field with nitric acid. The shaken sample aliquot is digested with nitric acid. The digest is aspirated into the flame and the absorbance is measured spectrometrically at 228.8 nm and compared to identically-prepared standard and blank solutions, using an air-acetylene oxidizing flame. The method detection limit is 0.01 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Environment Canada 1974.	Cd TOTAL	mg/L Cd	3
48002	CADMIUM - TOTAL Atomic Absorption Spectrometry - Solvent Extraction A sample is preserved in the field with nitric acid. The shaken sample aliquot is digested in nitric acid. The pH of the digest is adjusted to 4.75 with a buffer solution. Ammonium pyrrolidine dithiocarbonate (APDC) solution is added to the aliquot and then extracted with a methyl isobutyl ketone (MIBK). The solvent layer *(See Appendix 5)* is aspirated at the wavelength of 228.8 nm and compared with identically-prepared standard and blank solutions, using an air-acetylene oxidizing flame. The method detection limit is 0.001 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Environment Canada 1974.	Cd TOTAL	mg/L Cd	3

Code	Method Description	Name	Units	Decimals
48009	CADMIUM - TOTAL Inductively Coupled Plasma by Optical Emission Spectrometry (ICP-OES): ICP 1502 *(See Appendix 2)* A sample is preserved in the field with nitric acid. The shaken sample aliquot is digested in nitric acid or aqua regia, concentrated appropriately and aspirated from an autosampler. The emission is measured at 228.8 nm and compared to identically-prepared standard and blank solutions. The method detection limit is 0.001 mg/L. Requesting Agency and Date: Alberta Environment, Canada, October 1981. Reference: Alberta Environment 1981.	Cd TOTAL	mg/L Cd	3
48011	CADMIUM - TOTAL Inductively Coupled Plasma by Optical Emission Spectrometry (ICP-OES): ICP 1503 *(See Appendix 2)* A sample is preserved in the field with nitric acid. The shaken sample aliquot is digested in aqua regia and evaporated to near dryness. The residue is dissolved in concentrated HCl and diluted to one-fifth of the aliquot original volume. The emission is measured spectrometrically at 228.8 nm and compared with identically-prepared standard and blank solutions. The method detection limit is 0.001 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Alberta Environment 1979.	Cd TOTAL	mg/L Cd	3
48090	CADMIUM - TOTAL ICP – MS A sample is preserved in the field with nitric acid. The shaken sample aliquot is aspirated into an argon-based, high temperature radio frequency plasma. The sample is dissolved, atomised and ionised. These ions are extracted from the plasma through a vacuum interface and separated on the basis of their mass to charge ratio by a mass spectrometer. The ions are counted by an electron multiplier detector and the resulting information processed by a computer database system and compared to identically-prepared standard and blank solutions. Requesting Agency and Date: National Institute for Environmental Studies, Japan, 1998. Reference: APHA 1998.	Cd TOTAL	mg/L Cd	3
48101	CADMIUM - DISSOLVED Atomic Absorption Spectrometry – Direct Aspiration A sample is filtered in the field through a 0.45 µm membrane filter and preserved with nitric acid. The sample aliquot is aspirated and the absorbance is measured spectrometrically at 228.8 nm and compared to identically-prepared standard and blank solutions, using an air-acetylene oxidizing flame. The method detection limit is 0.01 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Environment Canada 1974.	Cd DISS	mg/L Cd	3

Code	Method Description	Name	Units	Decimals
48102	CADMIUM - DISSOLVED Atomic Absorption Spectrometry – Solvent Extraction A sample is filtered in the field through a 0.45 µm membrane filter and preserved with nitric acid. The pH of the sample aliquot is adjusted to 4.75 with a buffer solution. Ammonium pyrrolidine dithiocarbonate (APDC) solution is added to the aliquot and then extracted with a methyl isobutyl ketone (MIBK) solution. The solvent layer *(See Appendix 5)* is aspirated at the wavelength of 228.8 nm and compared to identically-prepared standard and blank solutions, using an air-acetylene oxidizing flame. The method detection limit is 0.001 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Environment Canada 1974.	Cd DISS	mg/L Cd	3
48109	CADMIUM - DISSOLVED Inductively Coupled Plasma by Optical Emission Spectrometry (ICP-OES): ICP 1502 *(See Appendix 2)* A sample is filtered in the field through a 0.45 µm membrane filter and preserved with nitric acid. The sample aliquot is concentrated appropriately and aspirated from an autosampler. The emission is measured at 228.8 nm and compared to identically-prepared standard and blank solutions. The method detection limit is 0.001 mg/L. Requesting Agency and Date: Environment Canada, NWRI, October 1985. Reference: Alberta Environment 1981.	Cd DISS	mg/L Cd	3
48111	CADMIUM - DISSOLVED Inductively Coupled Plasma by Optical Emission Spectrometry (ICP-OES): ICP 1516 *(See Appendix 2)* A sample is filtered in the field through a 0.45 µm membrane filter and preserved with nitric acid. The sample aliquot is aspirated and the emission is measured at 228.8 nm and compared with identically-prepared standard and blank solutions. The method detection limit is 0.001 mg/L. Requesting Agency and Date: Alberta Environment, Canada, July 1979. Reference: Alberta Environment 1979.	Cd DISS	mg/L Cd	3
48190	CADMIUM - DISSOLVED ICP - MS The sample is filtered in the field through a 0.45 µm membrane filter and preserved with nitric acid. A sample aliquot is aspirated into an argon-based, high temperature radio frequency plasma. The sample is dissolved, atomised and ionised. These ions are extracted from the plasma through a vacuum interface and separated on the basis of their mass to charge ratio by a mass spectrometer. The ions are counted by an electron multiplier detector and the resulting information processed by a computer database system and compared to identically-prepared standard and blank solutions. Requesting Agency and Date: National Institute for Environmental Studies, Japan, 1998. Reference: APHA 1998.	Cd DISS	mg/L Cd	3

Code	Method Description	Name	Units	Decimals
48201	CADMIUM SUSPENDED Atomic Absorption Spectrometry – Direct Aspiration A measured sample volume is passed through a 0.45 µm membrane filter. The filter, containing the residue, is digested in nitric acid. The resulting solution is then aspirated and the absorbance is measured spectrometrically at 228.8 nm and compared to identically-prepared standard and blank solutions, using an air-acetylene oxidizing flame. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Environment Canada 1974.	Cd PARTICULATE	µg/g	3
48901	CADMIUM - DISSOLVED Flameless Atomic Absorption Spectrometry A sample is filtered in the field through a 0.45 µm membrane filter and preserved with nitric acid. Add pallanium nitrate to the sample aliquot, as a matrix modifier, and heat, usually in three stages, in a graphite furnace or an electrically heated atomiser where: first, a low current is applied to dry the sample; the second stage chars the sample by destroying the organic matter and volatilises other matrix compounds; finally, the third stage applies a high current which heats the tube to incandescence and atomises the cadmium to be determined. The absorbance of the resultant ground state atoms is measured at 228.8 nm and is compared with those of identically-prepared standard and solutions. Requesting Agency and Date: National Institute for Environmental Studies, Japan, September 1998. Reference: Japanese Indutrial Standards Committee 1998.	Cd DISS	mg/L Cd	3
48911	CADMIUM - TOTAL Flameless Atomic Absorption Spectrometry A sample is preserved in the field with nitric acid. The shaken sample aliquot is digested in nitric acid or aqua regia. The aliquot is then heated, usually in three stages, in a graphite furnace or an electrically heated atomiser in which: first, a low current is applied to dry the sample; the second stage chars the sample by destroying the organic matter and volatilises other matrix compounds; finally, the third stage applies a high current which heats the tube to incandescence and atomises the cadmium to be determined. The absorbance of the resultant ground state atoms is measured at 228.8 nm and is compared to identically-prepared standard and blank solutions. Requesting Agency and Date: National Institute for Environmental Studies, Japan, September 1998. Reference: Japanese Indutrial Standards Committee 1998.	Cd TOTAL	mg/L Cd	3
51101	ANTIMONY DISSOLVED Atomic Absorption Spectrometry – Direct Aspiration A sample is filtered in the field through a 0.45 µm membrane filter and preserved with nitric acid. The sample aliquot is aspirated and the absorbance is measured spectrometrically at 217.6 nm and compared to identically-prepared standard and blank solutions, using an air-acetylene oxidising flame. The method detection limit is 0.2 mg/L. Requesting Agency and Date: Instituto Nacional del Agua, Argentina, no date. Reference: Environment Canada 1974.	Sb DISS	mg/L	1

Code	Method Description	Name	Units	Decimals
56001	BARIUM - TOTAL Atomic Absorption Spectrometry – Direct Aspiration A sample is preserved in the field with nitric acid. The shaken sample aliquot is digested in nitric acid. A NaCl solution is added to the digest (to overcome the ionisation interference) and then aspirated into the flame. The absorbance is then measured spectrometrically at 553.6 nm and compared to identically-prepared standard and blank solutions, using a nitrous oxide-acetylene reducing flame. The method detection limit is 0.1 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Environment Canada 1974.	Ba TOTAL	mg/L Ba	1
56002	BARIUM - TOTAL Atomic Emission Spectrometry - Flame Emission The sample is preserved in the field with nitric acid. A shaken sample aliquot is digested in nitric acid. The aliquot is aspirated into the flame and the emission is measured spectrometrically at 553.6 nm and compared to identically-prepared standard and blank solutions, using a nitrous oxide-acetylene flame. The method detection limit is 0.02 mg/L. Requesting Agency and Date: Environment Canada, May 1974. Reference: Perkin-Elmer Corp. 1973.	Ba TOTAL	mg/L Ba	1
56101	BARIUM - DISSOLVED Atomic Absorption Spectrometry – Direct Aspiration A sample is filtered in the field through a 0.45 µm membrane filter and preserved with nitric acid. A NaCl solution is added to the acidified sample aliquot (to overcome the ionisation interference) and then aspirated into the flame. The absorbance is then measured spectrometrically at 553.6 nm and compared to identically-prepared standard and blank solutions, using a nitrous oxide-acetylene reducing flame. The method detection limit is 0.1 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Environment Canada 1974.	Ba DISS	mg/L Ba	1
80011	MERCURY - TOTAL Semi-Automated and Flameless Atomic Absorption Spectrometry A sample is preserved in the field with potassium dichromate and sulphuric acid. The shaken sample aliquot is digested with sulphuric acid, potassium permanganate and potassium persulphate. The mercury compounds are reduced with stannous sulphate, in a hydroxylamine sulphate-sodium chloride solution, to elemental mercury, then sparged from the solution with a stream of air and the absorption is measured spectrometrically, using a mercury lamp, at 253.7 nm and compared to identically-prepared standard and blank solutions. The method detection limit is 0.05 µg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Environment Canada 1974.	Hg TOTAL	µg/L Hg	3

Code	Method Description	Name	Units	Decimals
80016	MERCURY - TOTAL Cold Br Wet Oxidation P AAS The sample is preserved in the field with potassium dichromate and sulphuric acid. The shaken sample aliquot and its particulates are digested with sulphuric acid, potassium dichromate and ultra violet (UV) photo-oxidation. The mercury compounds are reduced with stannous sulphate in a hydroxylamine sulphate-sodium chloride solution to elemental mercury, then sparged from the solution with a stream of air and the absorption is measured spectrometrically, using a mercury lamp, at 253.7 nm and compared to identically-prepared standard and blank solutions. The method is applicable to surface, ground and saline waters. The method detection limit is 0.02 µg/L. Requesting Agency and Date: Environment Canada, October 1979. Reference: Environment Canada 1979.	Hg TOTAL	µg/L Hg	3
80111	MERCURY - DISSOLVED Flameless Atomic Absorption Spectrometry A sample is filtered in the field through a 0.45 µm membrane filter and preserved with potassium dichromate and sulphuric acid. The sample aliquot is digested with sulphuric acid, potassium permanganate and potassium persulphate. The mercury compounds are reduced with stannous sulphate in a hydroxylamine sulphate-sodium chloride solution to elemental mercury, then sparged from the solution with a stream of air and the absorption is measured spectrometrically, using a mercury lamp, at 253.7 nm and compared to identically-prepared standard and blank solutions. The method detection limit is 0.05 µg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Environment Canada 1974.	Hg DISS	µg/L Hg	3
80201	MERCURY SUSPENDED Flameless Atomic Absorption Spectrometry A sample is filtered in the field through a 0.45 µm membrane filter and preserved. The filter, containing the residue, is digested in nitric, sulphuric and hydrochloric acids and potassium permanganate and persulphate solutions. The mercury compounds are reduced with stannous sulphate in a hydroxylamine sulphate-sodium chloride solution to elemental mercury, then sparged from the solution with a stream of air and the absorption is measured spectrometrically, using a mercury lamp, at 253.7 nm and compared to identically-prepared standard and blank solutions. The method detection limit is 0.05 µg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Environment Canada 1974.	Hg PARTICU-LATE	µg/g	3

Code	Method Description	Name	Units	Decimals
82001	LEAD - TOTAL Atomic Absorption Spectrometry – Direct Aspiration A sample is preserved in the field with nitric acid. The sample aliquot is digested in nitric acid. The digest is aspirated and the absorbance is measured spectrometrically at 283.3 nm and compared to identically-prepared standard and blank solutions, using an air-acetylene oxidizing flame. The method detection limit is 0.05 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Environment Canada 1974.	Pb TOTAL	mg/L Pb	3
82002	LEAD - TOTAL Atomic Absorption Spectrometry – Solvent Extraction A sample is preserved in the field with nitric acid. The sample aliquot is digested in nitric acid. The pH of the digest is adjusted to 4.75 with a buffer solution. Ammonium pyrrolidine dithiocarbamate (APDC) solution is added to the digest and then extracted with a methyl isobutyl ketone (MIBK) solution. The solvent layer *(See Appendix 5)* is aspirated at the wavelength of 283.3 nm and compared to identically-prepared standard and blank solutions, using an air-acetylene oxidizing flame. The method detection limit is 0.001 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Environment Canada 1974.	Pb TOTAL	mg/L Pb	3
82009	LEAD - TOTAL Inductively Coupled Plasma by Optical Emission Spectrometry (ICP-OES): ICP 1502 *(See Appendix 2)* A sample is preserved in the field with nitric acid. The sample aliquot is digested in nitric acid or aqua regia, concentrated appropriately, and aspirated from an autosampler. The emission is measured at 220.3 nm and compared to identically-prepared standard and blank solutions. The method detection limit is 0.01 mg/L. Requesting Agency and Date: Alberta Environment, Canada, October 1981. Reference: Alberta Environment 1981.	Pb TOTAL	mg/L Pb	3
82011	LEAD - TOTAL Inductively Coupled Plasma by Optical Emission Spectrometry (ICP-OES): ICP 1503 *(See Appendix 2)* A sample is preserved in the field with nitric acid. The sample aliquot is digested with aqua regia and evaporated to near dryness. The residue is dissolved in concentrated HCl and diluted to one-fifth of the aliquot original volume. The sample aliquot is aspirated and the emission is measured at 220.3 nm and compared with identically-prepared standard and blank solutions. The method detection limit is 0.01 mg/L. Requesting Agency and Date: Alberta Environment, Canada, July 1979. Reference: Alberta Environment 1979.	Pb TOTAL	mg/L Pb	3

Code	Method Description	Name	Units	Decimals
82090	LEAD - TOTAL ICP – MS A sample is preserved in the field with nitric acid. The sample aliquot is aspirated into an argon-based, high temperature radio frequency plasma. The sample is dissolved, atomised and ionised. These ions are extracted from the plasma through a vacuum interface and separated on the basis of their mass to charge ratio by a mass spectrometer. The ions are counted by an electron multiplier detector and the resulting information processed by a computer database system and compared to identically-prepared standard and blank solutions. Requesting Agency and Date: National Institute for Environmental Studies, Japan, 1998. Reference: APHA 1998.	Pb TOTAL	mg/L Pb	3
82101	LEAD - DISSOLVED Atomic Absorption Spectrometry – Direct Aspiration A sample is filtered in the field through a 0.45 µm membrane filter and preserved with nitric acid. The sample aliquot is aspirated into the flame and the absorbance is measured spectrometrically at 283.3 nm and compared to identically-prepared standard and blank solutions, using an air-acetylene oxidizing flame. The method detection limit is 0.05 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Environment Canada 1974.	Pb DISS	mg/L Pb	3
82102	LEAD - DISSOLVED Colourimetry A sample is filtered in the field through a 0.45 µm membrane filter and preserved with nitric acid. Interfering metals are removed by preliminary extraction at a pH of 2 to 3. Add a tartrate solution to prevent formation of hydroxide before bringing the pH of the solution to between 8 and 9 with an ammonium hydroxide/sodium cyanide solution. Lead is extracted with a diluted solution of dithizone (pink colour); the excess dithizone masks the colour (intense green colour) and this excess is removed from the carbon tetrachloride layer by the alkaline cyanide solution, leaving lead dithizonate in the organic layer. This solution is diluted and the colour is measured spectrometrically at 520 nm and compared to identically-prepared standard and blank solutions. Interference: Bismuth, stannous tin and thallium interfere in the extraction of lead in cyanide medium. The sample is fumed with perchloric and nitric acids to remove the organic compounds and then reduced with hydrazine acetate to lower the oxidation state of elements (tin and iron) and compounds capable of oxidizing dithizone. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1980. Reference: APHA 1975.	Pb DISS	mg/L Pb	3

Code	Method Description	Name	Units	Decimals
82103	LEAD - DISSOLVED Atomic Absorption Spectrometry – Solvent Extraction A sample is filtered in the field through a 0.45 µm membrane filter and preserved with nitric acid. The pH of the sample aliquot is adjusted to 4.75 with a buffer solution. Ammonium pyrrolidine dithiocarbamate (APDC) solution is added to the digest then extracted with a methyl isobutyl ketone (MIBK) solution. The solvent layer *(See Appendix 5)* is aspirated, measured spectrometrically at the wavelength of 283.3 nm and compared to identically-prepared standard and blank solutions, using an air-acetylene oxidizing flame. The method detection limit is 0.001 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Environment Canada 1974.	Pb DISS	mg/L Pb	3
82109	LEAD - DISSOLVED Inductively Coupled Plasma by Optical Emission Spectrometry (ICP-OES): ICP 1502 *(See Appendix 2)* A sample is filtered in the field through a 0.45 µm membrane filter and preserved with nitric acid. The sample aliquot is concentrated appropriately and aspirated from an autosampler. The emission is measured spectrometrically at 220.3 nm and compared to identically-prepared standard and blank solutions. The method detection limit is 0.001 mg/L. Requesting Agency and Date: Environment Canada, NWRI, October 1985. Reference: Alberta Environment 1981.	Pb DISS	mg/L Pb	3
82111	LEAD - DISSOLVED Inductively Coupled Plasma by Optical Emission Spectrometry (ICP-OES): ICP 1516 *(See Appendix 2)* A sample is filtered in the field through a 0.45 µm membrane filter and preserved with nitric acid. The sample aliquot is aspirated and the emission is measured spectrometrically at 220.3 nm and compared with identically-prepared standard and blank solutions. The method detection limit is 0.01 mg/L. Requesting Agency and Date: Alberta Environment, Canada, July 1979. Reference: Alberta Environment 1979.	Pb DISS	mg/L Pb	3
82190	LEAD - DISSOLVED ICP - MS A sample is filtered in the field through a 0.45 µm membrane filter and preserved with nitric acid. The sample aliquot is aspirated into an argon-based, high temperature radio frequency plasma. The sample is dissolved, atomised and ionised. These ions are extracted from the plasma through a vacuum interface and separated on the basis of their mass to charge ratio by a mass spectrometer. The ions are counted by an electron multiplier detector and the resulting information processed by a computer database system and compared to identically-prepared standard and blank solutions. Requesting Agency and Date: National Institute for Environmental Studies, Japan, 1998. Reference: APHA 1998.	Pb DISS	mg/L Pb	3

Code	Method Description	Name	Units	Decimals
82201	LEAD - SUSPENDED Atomic Absorption Spectrometry – Direct Aspiration A sample is filtered in the field through a 0.45 µm membrane filter. The filter, containing the residue, is digested with nitric acid. The resulting solution is then aspirated and the absorbance is measured spectrometrically at 283.3 nm and compared to identically-prepared standard and blank solutions, using an air-acetylene oxidizing flame. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Environment Canada 1974.	Pb PARTICULATE	µg/g	3
82360	LEAD - TOTAL Inductively Coupled Plasma by Optical Emission Spectrometry (ICP-OES): ICP – AES *(See Appendix 2)* A sample is preserved in the field with nitric acid. The sample aliquot is digested with aqua regia, evaporated to dryness, dissolved in HCL, concentrated appropriately, and aspirated from an autosampler. The emission is measured at 220.3 nm and compared to identically-prepared standard and blank solutions. The method detection limit is 0.001 mg/L. Requesting Agency and Date: UNEP GEMS/Water Programme, September 1985. Reference: Alberta Environment 1979.	Pb TOTAL	mg/L Pb	3
82901	LEAD - DISSOVED Flameless Atomic Absorption. Spectrometry A sample is filtered in the field through a 0.45 µm membrane filter and preserved with nitric acid. The sample aliquot is heated, usually in three stages in a graphite furnace or an electrically heated atomiser where: first, a low current is applied to dry the sample; the second stage chars the sample by destroying the organic matter and volatilises other matrix compounds; finally, the third stage applies a high current which heats the tube to incandescence and atomises the lead to be determined. The absorbance of the resultant ground state atoms is measured spectrometrically at 283.3 nm and is compared to identically-prepared standard and blank solutions. The method detection limit is 0.005 mg/L. Requesting Agency and Date: National Institute for Environmental Studies, Japan, September 1998. Reference: Japanese Indutrial Standards Committee 1998.	Pb DISS	mg/L Pb	3

Code	Method Description	Name	Units	Decimals
82911	LEAD - TOTAL Flameless Atomic Absorption Spectrometry A sample is preserved in the field with nitric acid. The sample aliquot is digested in nitric acid or aqua regia. The aliquot is then heated, usually in three stages in a graphite furnace or an electrically heated atomiser where: first, a low current is applied to dry the sample; the second stage chars the sample by destroying the organic matter and volatilises other matrix compounds; finally, the third stage applies a high current which heats the tube to incandescence and atomises the lead to be determined. The absorbance of the resultant ground state atoms is measured at 283.3 nm and is compared to identically-prepared standard and blank solutions. The method detection limit is 0.005 mg/L. Requesting Agency and Date: National Institute for Environmental Studies, Japan, September 1998. Reference: Japanese Indutrial Standards Committee 1998.	Pb TOTAL	mg/L Pb	3
95000	BENZOIC ACID Gas Chromatography A 1 L water sample is spiked with deuterated surrogate standards and serially extracted with methylene chloride, first at a pH greater than 11 for the phenol fraction and secondly at a pH less than 2 for the benzoic fraction, in a separatory funnel. The methylene chloride extract is taken to dryness, and re-constituted to a volume of 100 µl with methylene chloride, and spiked with deuterated internal standards. The acidic solution is analysed using a capillary column and mass spectrometry detection. Screening is performed using the relative retention time and relative abundance of two or more characteristic ions. Full identification of organic compounds screened and their quantification are performed using full reference spectra, multi internal standards and extracted areas of characteristic ions. Non-target compounds are tentatively identified using mass spectral libraries, approximate concentration ranges are based on relative total ion counts. The method detection limit is 2.0 µg/L. Requesting Agency and Date: Alberta Environment, Canada, no date. Reference: n/a.	BENZOIC ACID	µg/L	0
95011	PHENOLS GC – MS A 1 L water sample is spiked with deuterated surrogate standards and serially extracted with methylene chloride, first at a pH greater than 11 for the phenol fraction and secondly at a pH less than 2 for the benzoic fraction, in a separatory funnel. The methylene chloride extract is taken to dryness, and re-constituted to a volume of 100 µl with methylene chloride, and spiked with deuterated internal standards. The alkaline solution is analysed using a capillary column and mass spectrometry detection. Screening is performed using the relative retention time and relative abundance of two or more characteristic ions. The full identification of organic compounds screened and their quantification are performed using the full reference spectra, multi internal standards and extracted areas of characteristic ions. Non-target compounds are tentatively identified using mass spectral libraries, approximate concentration ranges are based on relative total ion counts. The method detection limit is 1.0 µg/L. Requesting Agency and Date: Alberta Environment, Canada, no date. Reference: n/a.	PHENOLS	µg/L	1

Code	Method Description	Name	Units	Decimals
95100	BENZENE Purge-and-Trap/Capillary Column Gas Chromatography/Mass Spectrometry: GC – MS A surface water sample (150 ml) is spiked with deuterated surrogate standards and internal standards, purged with helium, and the released volatiles are adsorbed onto a Tenax GC trap. This is followed by thermal desorption and analysis using a 25 meter DB-5 capillary column with mass spectrometry detection. Screening is performed using the relative retention time and relative abundance of two or more characteristic ions. Full identification of organic compounds screened and their quantification are performed using full reference spectra, multi internal standards and extracted areas of characteristic ions. Non-target compounds are tentatively identified using mass spectral libraries. Approximate concentration ranges are based on relative total ion counts. The method detection limit is 0.1 µg/L. Requesting Agency and Date: Alberta Environment, Canada, no date. Reference: n/a.	BENZENE	µg/L	1
97060	TEMPERATURE – AIR Air temperature is measured with a calibrated thermometer with a scale marked for every 0.1ºC, and reported in degrees Celsius. The method precision is within 0.1ºC Requesting Agency and Date: Saskatchewan Environment, Canada, July 1977. Reference: APHA 1975.	TEMP-AIR	^{o}C	1
97160	INSTANTANEOUS DISCHARGE Gauge Height The Instantaneous Discharge is measured at or near the sampling site in cubic metre per second. The method detection limit is ± 1 m^3/s. Requesting Agency and Date: Environment Canada, Atlantic Region, May 1979. Reference: n/a.	INST DISCHG	m^3/s	1
97184	DISCHARGE MONTHLY MEAN Calculated The monthly mean discharge is measured in cubic metre per second. The method precision is ± 1 m^3/s. Requesting Agency and Date: n/a. Reference: n/a.	DISCH. MON.MEAN	m^3/s	0

Code	Method Description	Name	Units	Decimals
97320	CLOUD COVER Estimated Percent The units of measurement are by fractional cover (by type) and estimated in percentage. The hourly means are calculated, from stations equipped with short-wave radiometers, 10-daily for satellite products. The special resolution is 10 to 50 km. The measurement methods are: Tiers 1-2: kilometres (sky cameras) Tier 3: ocular estimates Tier 5: spectral radiance The method precision is ± 10% absolute. Requesting Agency and Date: Saskatchewan Environment, Canada, July 1977. Reference: n/a.	CLOUD COVER	%	0

Appendix 1 Method Codes in Alphabetical Order

CODE	METHOD CODE DESCRIPTION	CODE ABBREVIATION	UNITS	ANALYTICAL METHOD
18503	2,4-D	2,4-D	µg/L	ELECTRON CAPTURE - GLC
02003	ABSORBANCE at 340nm	A340	Abs*1000	SPECTROPHOTOMETRIC ABSORBANCE READING
02004	ABSORBANCE at 440nm	A440	Abs*1000	SPECTROPHOTOMETRIC ABSORBANCE READING
02005	ABSORBANCE at 740nm	A740	Abs*1000	SPECTROPHOTOMETRIC ABSORBANCE READING
02006	ABSORBANCE CO-EFFICIENT at 340nm	G340	M	CALCULATED FROM 440&740 NM ABSORBANCES
02007	ABSORBANCE CO-EFFICIENT at 440nm	G440	M	CALCULATED FROM 340&740 NM ABSORBANCES
10252	ACIDITY TOTAL	TOTAL ACIDITY	mg/L $CaCO_3$	TITROPROCESSOR
18444	ALDICARB	ALDICARB	µg/L	HIGH PRESSURE LIQUID CHROMATOGRAPHY
18130	ALDRIN	ALDRIN	µg/L	GAS CHROMATOGRAPHY
10151	ALKALINITY PHENOL PHTHALEIN	ALKALINITY	mg/L $CaCO_3$	POTENTIOMETRIC TITRATION
10120	ALKALINITY TOTAL	ALK TOTAL	meq/L $CaCO_3$	VISUAL TITRATION
10121	ALKALINITY TOTAL	ALK TOTAL	meq/L $CaCO_3$	ELECTROMETRIC TITRATION
10123	ALKALINITY TOTAL	ALK TOTAL	mg/L $CaCO_3$	ELECTROMETRIC TITRATION
10101	ALKALINITY TOTAL (CaCO3)	ALK TOTAL	mg/L $CaCO_3$	POTENTIOMETRIC TITRATION
10102	ALKALINITY TOTAL (CaCO3)	ALK TOTAL	mg/L $CaCO_3$	COLOURIMETRIC TITRATION
10103	ALKALINTIY TOTAL (CaCO3)	ALK TOTAL	mg/L $CaCO_3$	TITRATION
18075	ALPHA-BHC	ALPHA-BHC	µg/L	GAS CHROMATOGRAPHY
13101	ALUMINUM - DISSOLVED	Al DISS	mg/L Al	COLOURIMETRY
13102	ALUMINUM - DISSOLVED	Al DISS	mg/L Al	AAS - DIRECT ASPIRATION
13103	ALUMINUM - DISSOLVED	Al DISS	mg/L Al	AAS - SOLVENT EXTRACTION
13104	ALUMINUM - DISSOLVED	Al DISS	mg/L Al	COLOUIMETRY
13109	ALUMINUM - DISSOLVED	Al DISS	mg/L Al	ICP 1502
13111	ALUMINUM - DISSOLVED	Al DISS	mg/L Al	ICP 1516
13190	ALUMINUM - DISSOLVED	Al DISS	mg/L Al	ICP - MS
13901	ALUMINUM - DISSOLVED	AL DISS	mg/L Al	AAS - FLAMELESS
13001	ALUMINUM - TOTAL	Al TOTAL	mg/L Al	COLOURIMETRY
13002	ALUMINUM - TOTAL	Al TOTAL	mg/L Al	AAS - DIRECT ASPIRATION
13003	ALUMINUM - TOTAL	Al TOTAL	mg/L Al	AAS - SOLVENT EXTRACTION
13009	ALUMINUM - TOTAL	Al TOTAL	mg/L Al	ICP 1502
13011	ALUMINUM - TOTAL	Al TOTAL	mg/L Al	ICP 1503
13090	ALUMINUM - TOTAL	Al TOTAL	mg/L Al	ICP - MS
13911	ALUMINUM - TOTAL	Al TOTAL	mg/L Al	AAS - FLAMELESS
13050	ALUMINUM SEDIMENTS	Al - PARTICULATE	µg/g	AAS - ACID DIGESTION
07506	AMMONIA	NH3	mg/L N	ION SELECTIVE ELECTRODE
07551	AMMONIA	NH3	mg/L N	DIRECT NESSLERIZATION
07553	AMMONIA	NH3	mg/L N	DISTILLATION AND TITRATION
07554	AMMONIA	NH3	mg/L N	DISTILLATION + NESSLERIZATION

CODE	METHOD CODE DESCRIPTION	CODE ABBREVIATION	UNITS	ANALYTICAL METHOD
07555	AMMONIA	NH3	mg/L N	ALPHA - NAPHTHOL METHOD (COLOURIMETRY)
07556	AMMONIA	NH_3	mg/L N	COLOURIMETRY(INDOPHENOL BLUE)
07557	AMMONIA	NH_3	mg/L N	AUTOMATED INDOPHENOL BLUE METHOD
07564	AMMONIA DISSOLVED	AMMONIA DISS	mg/L N	ION CHROMATOGRAPHY
10702	ANIONIC TENSIDES MBAS	TENS AN	mg/L	MBAS
51101	ANTIMONY DISSOLVED	Sb DISS	mg/L	AAS – DIRECT ASPIRATION
33103	ARSENIC - DISSOLVED	As DISS	mg/L As	COLOURIMETRY
33104	ARSENIC - DISSOLVED	As DISS	mg/L As	AAS - FLAMELESS
33108	ARSENIC - DISSOLVED	As DISS	mg/L As	ICP
33190	ARSENIC - DISSOLVED	As DISS	mg/L As	ICP - MS
33003	ARSENIC - TOTAL	As TOTAL	mg/L As	COLOURIMETRY
33007	ARSENIC - TOTAL	As TOTAL	mg/L As	AAS - FLAMELESS
33008	ARSENIC - TOTAL	As TOTAL	mg/L As	ICP
33009	ARSENIC - TOTAL	As TOTAL	mg/L As	ICP 1502
33011	ARSENIC - TOTAL	As TOTAL	mg/L As	AAS - HYDRIDE
33090	ARSENIC - TOTAL	As TOTAL	mg/L As	ICP - MS
33202	ARSENIC SUSPENDED	As - PARTICULATE	µg/g	AAS - FLAMELESS -ACID DIGESTION
18415	ATRAZINE - TOTAL	ATRAZINE	µg/L	GAS - LIQUID CHROMATOGRAPHY
56101	BARIUM - DISSOLVED	Ba DISS	mg/L Ba	AAS - DIRECT ASPIRATION
56001	BARIUM - TOTAL	Ba TOTAL	mg/L Ba	AAS - DIRECT ASPIRATION
56002	BARIUM - TOTAL	Ba TOTAL	mg/L Ba	FLAME EMISSION
95100	BENZENE	BENZENE	µg/L	GC - MS
95000	BENZOIC ACID	BENZOIC ACID	µg/L	GAS CHROMATOGRAPHY
18814	BHC	BHC	µg/L	GAS CHROMATOGRAPHY
06201	BICARBONATE	BICARBONATE	mg/L HCO_3	CALCULATED
08201	BIOCHEMICAL OXYGEN DEMAND	BOD	mg/L O_3	5-DAY DILUTION METHOD
08202	BIOCHEMICAL OXYGEN DEMAND	BOD	mg/L O_3	5 DAY INCUBATION at 20°C
08203	BIOCHEMICAL OXYGEN DEMAND	BOD(ATU)	Mg/L	5 DAY INCUBATION at 20°C ALLYL THIOUREA
05101	BORON - DISSOLVED	B DISS	mg/L B	POTENTIOMETRIC - Mannitol
05102	BORON - DISSOLVED	B DISS	mg/L B	CURCUMIN METHOD
05105	BORON - DISSOLVED	B DISS	mg/L B	COLOURIMETRY
05107	BORON - DISSOLVED	B DISS	mg/L B	ICP 1516
05109	BORON - DISSOLVED	B DISS	mg/L B	ICP 1502
05111	BORON - DISSOLVED	B DISS	µg/L B	ICP 1516
05190	BORON - DISSOLVED	B DISS	mg/L B	ICP - MS
05001	BORON - TOTAL	B TOTAL	mg/L B	AAS
05002	BORON - TOTAL	B TOTAL	mg/L B	COLOURIMETRY
05009	BORON - TOTAL	B TOTAL	mg/L B	ICP 1502
05011	BORON - TOTAL	B TOTAL	mg/L B	ICP 1503
05090	BORON - TOTAL	B TOTAL	mg/L B	ICP - MS

CODE	METHOD CODE DESCRIPTION	CODE ABBREVIATION	UNITS	ANALYTICAL METHOD
48101	CADMIUM - DISSOLVED	Cd DISS	mg/L Cd	AAS - DIRECT ASPIRATION
48102	CADMIUM - DISSOLVED	Cd DISS	mg/L Cd	AAS - SOLVENT EXTRACTION
48109	CADMIUM - DISSOLVED	Cd DISS	mg/L Cd	ICP 1502
48111	CADMIUM - DISSOLVED	Cd DISS	mg/L Cd	ICP 1516
48190	CADMIUM - DISSOLVED	Cd DISS	mg/L Cd	ICP - MS
48901	CADMIUM - DISSOLVED	Cd DISSOLVED	mg/L Cd	AAS - FLAMELESS
48001	CADMIUM - TOTAL	Cd TOTAL	mg/L Cd	AAS - DIRECT ASPIRATION
48002	CADMIUM - TOTAL	Cd TOTAL	mg/L Cd	AAS - SOLVENT EXTRACTION
48009	CADMIUM - TOTAL	Cd TOTAL	mg/L Cd	ICP 1502
48011	CADMIUM - TOTAL	Cd TOTAL	mg/L Cd	ICP 1503
48090	CADMIUM - TOTAL	Cd TOTAL	mg/L Cd	ICP - MS
48911	CADMIUM - TOTAL	Cd TOTAL	mg/L Cd	AAS - FLAMELESS
48201	CADMIUM SUSPENDED	Cd - PARTICULATE	µg/g	AAS - DIRECT ASPIRATION
20101	CALCIUM - DISSOLVED	Ca DISS	mg/L Ca	EDTA TITRATION
20103	CALCIUM - DISSOLVED	Ca DISS	mg/L Ca	AAS
20105	CALCIUM - DISSOLVED	Ca DISS	mg/L Ca	FLAME EMISSION
20109	CALCIUM - DISSOLVED	Ca DISS	mg/L $CaCO_3$	ION CHROMATOGRAPHY
20111	CALCIUM - DISSOLVED	Ca DISS	mg/L Ca	ICP 1516
20115	CALCIUM - DISSOLVED	Ca DISS	mg/L Ca	ICP 1502
20003	CALCIUM - TOTAL	Ca TOTAL	mg/L Ca	AAS
20106	CALCIUM HARDNESS	Ca HARDNESS	mg/L CaCO3	EDTA TITRATION
06001	CARBON - TOTAL ORGANIC	TOC	mg/L C	INFRARED ANALYSIS - DUAL CHANNEL
06101	CARBON ORGANIC - DISSOLVED	ORG. CARBON-DISS	mg/L	INFRARED ANALYSIS
06076	CARBON ORGANIC - PARTICULATE	ORG. CARBON-PART	µg/g	CHN ANALYZER
06077	CARBON ORGANIC - PARTICULATE	ORG. CARBON-PART	µg/g	FLAME IONIZATION
06301	CARBONATE	CARBONATE	mg/L CO_3	CALCULATED
08301	CHEMICAL OXYGEN DEMAND	COD	mg/L O_2	$K_2Cr_20_7$ METHOD
17201	CHLORIDE - DISSOLVED	Cl DISS	mg/L Cl	MERCURIC NITRATE TITRATION
17202	CHLORIDE - DISSOLVED	Cl DISS	mg/L Cl	SILVER NITRATE POTENTIOMETRIC
17203	CHLORIDE - DISSOLVED	Cl DISS	mg/L Cl	COLOURIMETRY
17204	CHLORIDE - DISSOLVED	Cl DISS	mg/L Cl	SILVER NITRATE TITRATION
17205	CHLORIDE - DISSOLVED	Cl DISS	mg/L Cl	SPECIFIC ION ELECTRODE
17207	CHLORIDE - DISSOLVED	Cl DISS	mg/L Cl	ION EXCHANGE
17209	CHLORIDE - DISSOLVED	Cl DISS	mg/L Cl	ION CHROMATOGRAPHY
06711	CHLOROPHYLL A	CHLORO A	mg/L	SCOR - UNESCO (COLOURIMETRY)
24052	CHROMIUM - DISSOLVED	Cr DISS	mg/L Cr	AAS
24111	CHROMIUM - DISSOLVED	Cr DISS	mg/L Cr	ICP 1516
24190	CHROMIUM - DISSOLVED	Cr DISS	mg/L Cr	ICP - MS
24901	CHROMIUM - DISSOLVED	Cr DISS	mg/L Cr	AAS - FLAMELESS
24202	CHROMIUM - SUSPENDED	Cr - PARTICULATE	µg/g	AAS - DIRECT ASPIRATION

CODE	METHOD CODE DESCRIPTION	CODE ABBREVIATION	UNITS	ANALYTICAL METHOD
24002	CHROMIUM - TOTAL	Cr TOTAL	mg/L Cr	AAS - DIRECT ASPIRATION
24009	CHROMIUM - TOTAL	Cr TOTAL	mg/L Cr	ICP 1502
24011	CHROMIUM - TOTAL	Cr TOTAL	mg/L Cr	ICP 1503
24090	CHROMIUM - TOTAL	Cr TOTAL	mg/L Cr	ICP - MS
24911	CHROMIUM - TOTAL	Cr TOTAL	mg/L Cr	AAS - FLAMELESS
24101	CHROMIUM HEXAVALENT	Cr HEX	mg/L Cr	COLOURIMETRY
02070	CLARITY	CLARITY	m	HORIZONTAL BLACK DISC
97320	CLOUD COVER	CLOUD COVER	PERCENT	ESTIMATED PERCENT
06402	CO_2 - DISSOLVED	CO_2 DISS	mg/L	
27009	COLBALT TOTAL	Co TOTAL	mg/L Co	ICP 1502
36001	COLIFORM - TOTAL	COLIFORM TOTAL	No./100 ml MF	MULTIPLE TEST TUBE
36002	COLIFORM - TOTAL	COLIFORM TOTAL	No./100 ml MPN	MEMBRANE FILTRATION
02011	COLOUR APPARENT	COLOUR APPARENT	Rel. Units	VISUAL COMPARISON
29101	COPPER - DISSOLVED	Cu DISS	mg/L Cu	COLOURIMETRY
29105	COPPER - DISSOLVED	Cu DISS	mg/L Cu	AAS - SOLVENT EXTRACTION
29106	COPPER - DISSOLVED	Cu DISS	mg/L Cu	AAS - DIRECT ASPIRATION
29109	COPPER - DISSOLVED	Cu DISS	mg/L Cu	ICP 1502
29111	COPPER - DISSOLVED	Cu DISS	mg/L Cu	ICP 1516
29190	COPPER - DISSOLVED	Cu DISS	mg/L Cu	ICP - MS
29901	COPPER - DISSOLVED	Cu DISS	mg/L Cu	AAS - FLAMELESS
29001	COPPER - TOTAL	Cu TOTAL	mg/L Cu	COLOURIMETRY
29005	COPPER - TOTAL	Cu TOTAL	mg/L Cu	AAS - SOLVENT EXTRACTION
29006	COPPER - TOTAL	Cu TOTAL	mg/L Cu	AAS - DIRECT ASPIRATION
29009	COPPER - TOTAL	Cu TOTAL	mg/L Cu	ICP 1502
29011	COPPER - TOTAL	Cu TOTAL	mg/L Cu	ICP 1503
29090	COPPER - TOTAL	Cu TOTAL	mg/L Cu	ICP - MS
29911	COPPER - TOTAL	Cu TOTAL	mg/L Cu	AAS - FLAMELESS
29206	COPPER SUSPENDED	Cu - PARTICULATE	µg/g	AAS - DIRECT ASPIRATION
06606	CYANIDE	CN	mg/L CN	COLOURIMETRY
18002	DDT - TOTAL	DDT TOTAL	µg/L	GAS CHROMATOGRAPHY
18150	DIELDRIN	DIELDRIN	µg/L	GAS CHROMATOGRAPHY
97184	DISCHARGE MONTHLY MEAN	DISCH.MON.MEAN	M3/s	CALCULATED
08101	DISSOLVED OXYGEN	DISS O_2	mg/L O_2	WINKLER METHOD
08102	DISSOLVED OXYGEN	DISS O_2	mg/L O_2	DISSOLVED OXYGEN METER
08107	DISSOLVED OXYGEN	DISS O_2	mg/L O_2	CALCULATED FROM % SAT., H_2O TEMP, AND PRESSURE AT SITE.
02040	ELECTRICAL CONDUCTANCE	ELEC. COND.	µs/cm	ELECTROMETER
02049	ELECTRICAL CONDUCTANCE	ELEC COND	µs/cm	RADIOMETER CDM 83
02041	ELECTRICAL CONDUCTIVITY	ELEC COND	µs/cm	CONDUCTIVITY METER
18140	ENDRIN	ENDRIN	µg/L	GAS CHROMATOGRAPHY
36011	FAECAL COLIFORM BACTERIA	FAEC COL	No./100 ml MF	MULTIPLE TEST TUBE
36012	FAECAL COLIFORM BACTERIA	FAEC COL	No./100 ml MPN	MEMBRANE FILTRATION

CODE	METHOD CODE DESCRIPTION	CODE ABBREVIATION	UNITS	ANALYTICAL METHOD
36101	FAECAL STREPTOCOCCI	FAEC STREP	No./100 ml MF	MULTIPLE TEST TUBE
36102	FAECAL STREPTOCOCCI	FAEC STREP	No./100 ml MPN	MEMBRANE FILTRATION
10501	FIXED SUSPENDED SOLIDS	FIX SUSP SOLIDS	mg/L	GRAVIMETRIC METHOD
09104	FLUORIDE - DISSOLVED	F DISS	mg/L F	COLOURIMETRY
09105	FLUORIDE - DISSOLVED	F DISS	mg/L F	SPECIFIC ION ELECTRODE
09106	FLUORIDE - DISSOLVED	F DISS	mg/L F	ELECTRODE POTENTIAL METHOD
09107	FLUORIDE - DISSOLVED	F DISS	mg/L F	POTENTIOMETRIC - SPECIFIC ION
09110	FLUORIDE - DISSOLVED	F DISS	mg/L F	PHOTOMETRIC (LA-ALIZARIN COMPLEX)
09116	FLUORIDE - DISSOLVED	F DISS	mg/L F	ION CHROMATOGRAPHY
10603	HARDNESS TOTAL	HARDNESS TOTAL	mg/L $CaCO_3$	EDTA TITRATION
06570	HYDROCARBONS - TOTAL	HYDROCAR.-TOTAL	µg/L	IR INTENSITY SPECTROSCOPY
01000	HYDROGEN SULPHIDE	H2S	mg/L	
97160	INSTANTANEOUS DISCHARGE	INST DISCHG	m^3/s	GAUGE HEIGHT
00190	INTEGRATED SAMPLE Code is for internal use only	INTEG SAMPLE	N/A	VERTICAL (V),HORIZONTAL (H), TIME (T)
26102	IRON - DISSOLVED	Fe DISS	mg/L Fe	COLOURIMETRY
26104	IRON - DISSOLVED	Fe DISS	mg/L Fe	AAS - DIRECT ASPIRATION
26105	IRON - DISSOLVED	Fe DISS	mg/L Fe	AAS - SOLVENT EXTRACTION
26109	IRON - DISSOLVED	Fe DISS	mg/L Fe	ICP 1502
26111	IRON - DISSOLVED	Fe DISS	mg/L Fe	ICP 1516
26190	IRON - DISSOLVED	Fe DISS	mg/L Fe	ICP - MS
26901	IRON - DISSOLVED	Fe DISS	mg/L	AAS - FLAMELESS
26002	IRON - TOTAL	Fe TOTAL	mg/L Fe	COLOURIMETRY
26004	IRON - TOTAL	Fe TOTAL	mg/L Fe	AAS - DIRECT ASPIRATION
26005	IRON - TOTAL	Fe TOTAL	mg/L Fe	AAS - SOLVENT EXTRACTION
26009	IRON - TOTAL	Fe TOTAL	mg/L Fe	ICP 1502
26011	IRON - TOTAL	Fe TOTAL	mg/L Fe	ICP 1503
26090	IRON - TOTAL	Fe TOTAL	mg/L Fe	ICP - MS
26204	IRON SUSPENDED	Fe PARTICULATE	µg/g	AAS - DIRECT ASPIRATION
82101	LEAD - DISSOLVED	Pb DISS	mg/L Pb	AAS - DIRECT ASPIRATION
82102	LEAD - DISSOLVED	Pb DISS	mg/L Pb	COLOURIMETRY
82103	LEAD - DISSOLVED	Pb DISS	mg/L Pb	AAS - SOLVENT EXTRACTION
82109	LEAD - DISSOLVED	Pb DISS	mg/L Pb	ICP 1502
82111	LEAD - DISSOLVED	Pb DISS	mg/L Pb	ICP 1516
82190	LEAD - DISSOLVED	Pb DISS	mg/L Pb	ICP - MS
82901	LEAD - DISSOLVED	Pb DISS	mg/L Pb	AAS - FLAMELESS
82001	LEAD - TOTAL	Pb TOTAL	mg/L Pb	AAS - DIRECT ASPIRATION
82002	LEAD - TOTAL	Pb TOTAL	mg/L Pb	AAS - SOLVENT EXTRACTION
82009	LEAD - TOTAL	Pb TOTAL	mg/L Pb	ICP 1502
82011	LEAD - TOTAL	Pb TOTAL	mg/L Pb	ICP 1503
82090	LEAD - TOTAL	Pb TOTAL	mg/L Pb	ICP - MS
82360	LEAD - TOTAL	Pb TOTAL	mg/L Pb	ICP - AES

CODE	METHOD CODE DESCRIPTION	CODE ABBREVIATION	UNITS	ANALYTICAL METHOD
82911	LEAD - TOTAL	Pb TOTAL	mg/L Pb	AAS - FLAMELESS
82201	LEAD SUSPENDED	Pb PARTICULATE	µg/g	AAS - DIRECT ASPIRATION
18070	LINDANE (GAMMA - BHC)	LINDANE	µg/L	GAS-LIQUID CHROMATOGRAPHY (ECD)
03101	LITHIUM - DISSOLVED	Li DISS	mg/L Li	AAS - DIRECT ASPIRATION
03001	LITHIUM - TOTAL	Li TOTAL	mg/L Li	AAS - DIRECT ASPIRATION
12102	MAGNESIUM - DISSOLVED	Mg DISS	mg/L Mg	AAS - DIRECT ASPIRATION
12103	MAGNESIUM - DISSOLVED	Mg DISS	mg/L Mg	EDTA TITRATION
12109	MAGNESIUM - DISSOLVED	Mg DISS	mg/L Mg	ION CHROMATOGRAPHY
12111	MAGNESIUM - DISSOLVED	Mg DISS	mg/L Mg	ICP 1516
12115	MAGNESIUM - DISSOLVED	Mg DISS	mg/L Mg	ICP 1502
12001	MAGNESIUM - TOTAL	Mg TOTAL	mg/L Mg	COLOURIMETRY
12002	MAGNESIUM - TOTAL	Mg TOTAL	mg/L Mg	AAS - DIRECT ASPIRATION
12003	MAGNESIUM - TOTAL	Mg TOTAL	mg/L Mg	EDTA TITRATION
25101	MANGANESE - DISSOLVED	Mn DISS	mg/L Mn	COLOURIMETRY
25104	MANGANESE - DISSOLVED	Mn DISS	mg/L Mn	AAS - DIRECT ASPIRATION
25105	MANGANESE - DISSOLVED	Mn DISS	mg/L Mn	AAS - SOLVENT EXTRACTION
25109	MANGANESE - DISSOLVED	Mn DISS	mg/L Mn	ICP 1502
25111	MANGANESE - DISSOLVED	Mn DISS	mg/L Mn	ICP 1516
25190	MANGANESE - DISSOLVED	Mn DISS	mg/L Mn	ICP - MS
25901	MANGANESE - DISSOLVED	Mn DISS	mg/L Mn	AAS - FLAMELESS
25004	MANGANESE - TOTAL	Mn TOTAL	mg/L Mn	AAS - DIRECT ASPIRATION
25005	MANGANESE - TOTAL	Mn TOTAL	mg/L Mn	AAS - SOLVENT EXTRACTION
25009	MANGANESE - TOTAL	Mn TOTAL	mg/L Mn	COLOURIMETRY
25010	MANGANESE - TOTAL	Mn TOTAL	mg/L Mn	ICP 1502
25011	MANGANESE - TOTAL	Mn TOTAL	mg/L Mn	ICP 1503
25090	MANGANESE - TOTAL	Mn TOTAL	mg/L Mn	ICP - MS
25911	MANGANESE - TOTAL	Mn TOTAL	mg/L Mn	AAS - FLAMELESS
25204	MANGANESE SUSPENDED	Mn PARTICULATE	µg/g	AAS - DIRECT ASPIRATION
80111	MERCURY - DISSOLVED	Hg DISS	µg/L Hg	AAS - FLAMELESS
80011	MERCURY - TOTAL	Hg TOTAL	µg/L Hg	AAS - FLAMELESS
80016	MERCURY - TOTAL	Hg TOTAL	µg/L Hg	COLD BR WET OXIDATION P AAS
80201	MERCURY SUSPENDED	Hg PARTICULATE	µg/g	AAS - FLAMELESS
18125	MIREX	MIREX	µg/L	GAS CHROMATOGRAPHY
28101	NICKEL - DISSOLVED	Ni DISS	mg/L Ni	AAS - DIRECT ASPIRATION
28102	NICKEL - DISSOLVED	Ni DISS	mg/L Ni	AAS - SOLVENT EXTRACTION
28109	NICKEL - DISSOLVED	Ni DISS	mg/L Ni	ICP 1502
28111	NICKEL - DISSOLVED	Ni DISS	mg/L Ni	ICP 1516
28190	NICKEL - DISSOLVED	Ni DISS	mg/L Ni	ICP - MS
28901	NICKEL - DISSOLVED	Ni DISS	mg/L Ni	AAS - FLAMELESS
28001	NICKEL - TOTAL	Ni TOTAL	mg/L Ni	AAS - DIRECT ASPIRATION
28002	NICKEL - TOTAL	Ni TOTAL	mg/L Ni	AAS - SOLVENT EXTRACTION
28009	NICKEL - TOTAL	Ni TOTAL	mg/L Ni	ICP 1502

CODE	METHOD CODE DESCRIPTION	CODE ABBREVIATION	UNITS	ANALYTICAL METHOD
28011	NICKEL - TOTAL	Ni TOTAL	mg/L Ni	ICP 1503
28090	NICKEL - TOTAL	Ni TOTAL	mg/L Ni	ICP - MS
28911	NICKEL - TOTAL	Ni TOTAL	mg/L Ni	AAS - FLAMELESS
07300	NITRATE	NO_3-N	mg/L N	AUTOMATED HYDRAZINE REDUCTION
07306	NITRATE	NO_3-N	mg/L N	BRUCINE METHOD
07309	NITRATE	NO_3-N	mg/L N	CHROMOTROPIC ACID
07313	NITRATE	NO_3-N	mg/L N	CADMIUM REDUCTION
07314	NITRATE	NO_3-N	mg/L N	DEVARDA'S ALLOY METHOD
07320	NITRATE	NO_3-N	mg/L N	ION SPECIFIC ELECTRODE
07321	NITRATE	NO_3-N	mg/L N	ION CHROMATOGRAPHY
07316	NITRATE + NITRITE	NO_3NO_2	mg/L N	ION CHROMATOGRAPHY
07207	NITRITE	NO_2-N	mg/L N	COLOURIMETRY (SULFANILAMIDE)
07210	NITRITE	NO_2-N	mg/L N	COLOURIMETRIC (CLEVE'S ACID)
07302	NITROGEN (NO3-N + NO2-N)	NO_3NO_2	mg/L N	CALCULATED (CODES 07321 + 07210)
07303	NITROGEN (NO3-N + NO2-N)	NO_3NO_2	mg/L N	CALCULATED (CODES 07320 + 07210)
07001	NITROGEN KJELDAHL ORGANIC	N KJEL	mg/L N	KJELDAHL METHOD
07004	NITROGEN KJELDAHL ORGANIC	N KJEL	mg/L N	COLOURIMETRY
07902	NITROGEN ORGANIC - PARTICULATE	ORG. NIT. -PART	mg/L N	CHN ANALYZER
07401	NITROGEN ORGANIC DISSOLVED	ORG. NIT.-DISS	mg/L	KJELDAHL WITH REMOVAL OF NH_3
07403	NITROGEN ORGANIC DISSOLVED	ORG. NIT.-DISS	mg/L	DIFFERENCE CALCULATION
07601	NITROGEN TOTAL	TOTAL NITROGEN	mg/L N	COLOURIMETRY
07606	NITROGEN TOTAL	TOTAL NITROGEN	mg/L N	ALKALINE PERSULPHATE DIGESTION
07507	NITROGEN TOTAL AMMONIA	NH_4-N	mg/L N	COLOURIMETRIC (SALICYLATE METHOD)
07550	NITROGEN TOTAL AMMONIA	NH_4-N	mg/L N	NESSLERIZATION & DISTILLATION
07105	NITROGEN,NITRATE + NITRITE	NO_3NO_2	mg/L N	COLOURIMETRY
18015	O,P-DDD	O,P-DDD	µg/L	GAS CHROMATOGRAPHY
18025	O,P-DDE	O,P-DDE	µg/L	GAS CHROMATOGRAPHY
18005	O,P-DDT	O,P-DDT	µg/L	GAS CHROMATOGRAPHY
06521	OIL AND GREASE	OIL AND GREASE	mg/L	PETROLEUM ETHER EXTRACTION
17860	ORGANO CL COMPOUNDS TOTAL	ORGANO Cl CMPDS	µg/L	GAS CHROMATOGRAPHY
15255	ORTHOPHOSPHATE - DISSOLVED	P ORTHO DISS	mg/L P	COLOURIMETRY
15256	ORTHOPHOSPHATE - DISSOLVED	P ORTHO DISS	mg/L P	MOLBDENUM BLUE-ASCORBIC ACID REDUCTION
15205	ORTHOPHOSPHATE - TOTAL	P ORTHO TOTAL	mg/L P	COLOURIMETRY
15254	ORTHOPHOSPHATE SOL REACTIVE	PO_4-P SOL	mg/L PO_4	COLOURIMETRY
18010	P,P-DDD	P,P-DDD	µg/L	GAS CHROMATOGRAPHY
18803	P,P-DDD OLEFIN	P,P-DDD OLEFIN	µg/L	GAS CHROMATOGRAPHY
18020	P,P-DDE	P,P-DDE	µg/L	GAS CHROMATOGRAPHY
18000	P,P-DDT	P,P-DDT	µg/L	GAS CHROMATOGRAPHY

CODE	METHOD CODE DESCRIPTION	CODE ABBREVIATION	UNITS	ANALYTICAL METHOD
18165	PCBS	PCBS	µg/L	GAS - LIQUID CHROMATOGRAPHY
08001	PERCENT DO SATURATION	PERCENT DO SAT	PERCENT	CALCULATION OR NOMOGRAM
08005	PERCENT DO SATURATION	PERCENT DO SAT	PERCENT	METER (YSI)
08401	PERMANGANATE VALUE	PERM V	mg/L O_2	KMnO4 METHOD
08402	PERMANGANATE VALUE	PERM V	mg/L O_2	KMnO4 METHOD - 4 HOUR DIGESTION
10300	pH	pH	pH Units	COLORIMETRIC METHOD
10301	pH	pH	pH Units	pH METER (ELECTROMETRIC)
10302	pH	pH	pH Units	pH METER(ELECTROMETRIC) AT 25° C
06532	PHENOLS	PHENOLS	mg/L	COLOURIMETRY
95011	PHENOLS	PHENOLS	µg/L	GC - MS
15403	PHOSPHATE - TOTAL	PO_4 TOTAL	mg/L PO_4	COLOURIMETRY
15408	PHOSPHATE - TOTAL	PO_4 TOTAL	mg/L P	COLOURIMETRY
15313	PHOSPHATE - TOTAL INORGANIC	P INORG AH TOTAL	mg/L P	COLOURIMETRY
15406	PHOSPHATE TOTAL	P TOTAL	mg/L P	ACID PERSULPHATE DIGESTION
15103	PHOSPHORUS - DISSOLVED	P DISS	mg/L P	COLOURIMETRY
15901	PHOSPHORUS - PARTICULATE	P PART	mg/L P	DIFFERENCE CALCULATION
15405	PHOSPHORUS - TOTAL	P TOTAL	mg/L P	COLOURIMETRY
15417	PHOSPHORUS TOTAL DISSOLVED	P TOTAL DISS.	mg/L P	COLOURIMETRY
15902	PHOSPHORUS TOTAL PARTICULATE	P TOTAL PART.	µg/g	DIFFERENCE CALCULATION
15903	PHOSPHORUS TOTAL PARTICULATE	P TOTAL PART.	µg/g	ACID-EXTRACTION COLOURIMETRY
36302	PHYTOPLANKTON BIOMASS	PHYTO BIO	mg/m^3	
36301	PHYTOPLANKTON COUNT	PHYTO COUNT	No./L	TOTAL NUMBER OBSERVED
36304	PHYTOPLANKTON COUNT	PHYTO COUNT	No./ml	TOTAL NUMBER OBSERVED
06510	POLY AROMATIC HYDROCARBONS	PAH	µg/L	FLUORESCENCE SPECTROPHOTOMETRY
06505	POLYAROMATIC HYDROCARBONS	PAH	µg/L	GC - MS
19102	POTASSIUM - DISSOLVED	K DISS	mg/L K	AAS
19103	POTASSIUM - DISSOLVED	K DISS	mg/L K	FLAME PHOTOMETRY
19105	POTASSIUM - DISSOLVED	K DISS	mg/L K	AAS - DIRECT ASPIRATION
19111	POTASSIUM - DISSOLVED	K DISS	mg/L K	ICP 1516
19112	POTASSIUM - DISSOLVED	K DISS	mg/L K	ION CHROMATOGRAPHY
19115	POTASSIUM - DISSOLVED	K DISS	mg/L K	ICP 1502
19001	POTASSIUM - TOTAL	K TOTAL	mg/L K	AAS
19002	POTASSIUM - TOTAL	K TOTAL	mg/L K	FLAME PHOTOMETRY
10452	RESIDUE FILTERABLE	RESIDUE - FILT	mg/L	GRAVIMETRIC METHOD
10551	RESIDUE FIXED	RESIDUE - FIXED	mg/L	GRAVIMETRIC METHOD
10571	RESIDUE FIXED TOTAL	RESIDUE FIX TOT	mg/L	GRAVIMETRIC
10473	RESIDUE TOTAL	RESIDUE - TOT	mg/L	GRAVIMETRIC MICRO-METHOD
10521	RESIDUE VOLATILE TOTAL	RESIDUE - VOL	mg/L	CALCULATED
02055	SALINITY	SALINITY	ppt	TDS-SALINITY-CONDUCTIVITY METER at 25° C
36220	SALMONELLA	SALMONELLA	No./L	CONCENTRATION BY FILTRATION

CODE	METHOD CODE DESCRIPTION	CODE ABBREVIATION	UNITS	ANALYTICAL METHOD
34102	SELENIUM - DISSOLVED	Se DISS	mg/L Se	AAS - FLAMELESS
34108	SELENIUM - DISSOLVED	Se DISS	mg/L Se	ICP
34190	SELENIUM - DISSOLVED	Se DISS	mg/L Se	ICP - MS
34002	SELENIUM - TOTAL	Se TOTAL	mg/L Se	AAS
34007	SELENIUM - TOTAL	Se TOTAL	mg/L Se	AAS - FLAMELESS - HYDRIDE
34008	SELENIUM - TOTAL	Se TOTAL	mg/L Se	ICP
34090	SELENIUM - TOTAL	Se TOTAL	mg/L Se	ICP - MS
14111	SILICA - DISSOLVED	SI DISS	mg/L SiO_2	ICP 1516
14019	SILICA - REACTIVE	SI REAC	mg/L SiO_2	ICP 1502
14101	SILICA - REACTIVE	SI REAC	mg/L SiO_2	COLOURIMETRY
14105	SILICA REACTIVE	SI REAC	mg/L SiO_2	COLOURIMETRY
47101	SILVER DISSOLVED	Ag DISS	mg/L	AAS – DIRECT ASPITATION
11102	SODIUM - DISSOLVED	Na DISS	mg/L Na	AAS
11103	SODIUM - DISSOLVED	Na DISS	mg/L Na	FLAME PHOTOMETRY
11105	SODIUM - DISSOLVED	Na DISS	mg/L Na	AAS - DIRECT ASPIRATION
11111	SODIUM - DISSOLVED	Na DISS	mg/L Na	ICP 1516
11112	SODIUM - DISSOLVED	Na DISS	mg/L Na	ION CHROMATOGRAPHY
11115	SODIUM - DISSOLVED	Na DISS	mg/L Na	ICP 1502
11001	SODIUM - TOTAL	Na TOTAL	mg/L Na	AAS
11002	SODIUM - TOTAL	Na TOTAL	mg/L Na	FLAME PHOTOMETRY
11201	SODIUM ADSORPTION RATIO	SAR	Rel Unit	DIFFERENCE CALCULATION
11116	SODIUM DISSOLVED	Na DISS	mg/L Na	AAS - EMISSION
16301	SULPHATE	SULPHATE	mg/L SO4	GRAVIMETRIC METHOD
16302	SULPHATE	SULPHATE	mg/L SO4	TURBIDIMETRIC METHOD
16303	SULPHATE	SULPHATE	mg/L SO4	TITRATION
16304	SULPHATE	SULPHATE	mg/L SO4	AUTOANALYZER
16306	SULPHATE	SULPHATE	mg/L SO4	COLOURIMETRY
16309	SULPHATE	SULPHATE	mg/L SO4	ION CHROMATOGRAPHY
00125	SUM OF ANIONS	SUM OF ANIONS	meq/L	CALCULATED
00120	SUM OF CATIONS	SUM OF CATIONS	meq/L	CALCULATED
00130	SUM OF CATIONS + ANIONS	SUM OF CATIONS + ANIONS	meq/L	CALCULATED
10401	SUSPENDED SOLIDS 105 DEG	SUSP SOL - 105	mg/L	GRAVIMETRIC METHOD
10408	SUSPENDED SOLIDS 180 DEG	SUSP SOL - 180	mg/L	GRAVIMETRIC METHOD
02061	TEMPERATURE	TEMP	Deg. C	MERCURY THERMOMETER
02062	TEMPERATURE	TEMP	Deg. C	BATTERY THERMOMETER
97060	TEMPERATURE - AIR	TEMP-AIR	Deg. C	
08305	TOTAL COD	COD	mg/L O_2	KMnO4 METHOD
02050	TOTAL DISSOLVED SOLIDS	TDS	mg/L	CALIBRATED CONDUCTIVITY at 25°C
02076	TRANSPARENCY	TRANS	Meter	30 CM SECCHI DISC
02071	TURBIDITY	TURBIDITY	JTU	VISUAL
02073	TURBIDITY	TURBIDITY	JTU	PHOTOMETRY
02074	TURBIDITY	TURBIDITY	NTU	NEPHELOMETRIC - HACH

CODE	METHOD CODE DESCRIPTION	CODE ABBREVIATION	UNITS	ANALYTICAL METHOD
02075	TURDIBITY LIGHT PENETRATION (transparency)	TRANSPARENCY	Metre	SECCHI DEPTH
10531	VOLATILE DISSOLVED SOLIDS	VOL DISS SOLIDS	mg/L	GRAVIMETRIC METHOD
10511	VOLATILE SUSPENDED SOLIDS	VOL SUSP SOLIDS	mg/L	GRAVIMETRIC METHOD
30101	ZINC - DISSOLVED	Zn DISS	mg/L Zn	COLOURIMETRY
30104	ZINC - DISSOLVED	Zn DISS	mg/L Zn	AAS - DIRECT ASPIRATION
30105	ZINC - DISSOLVED	Zn DISS	mg/L Zn	AAS - SOLVENT EXTRACTION
30109	ZINC - DISSOLVED	Zn DISS	mg/L Zn	ICP 1502
30111	ZINC - DISSOLVED	Zn DISS	mg/L Zn	ICP 1516
30190	ZINC - DISSOLVED	Zn DISS	mg/L Zn	ICP - MS
30901	ZINC - DISSOLVED	Zn DISS	mg/L Zn	AAS - FLAMELESS
30001	ZINC - TOTAL	Zn TOTAL	mg/L Zn	COLOURIMETRY
30004	ZINC - TOTAL	Zn TOTAL	mg/L Zn	AAS - DIRECT ASPIRATION
30005	ZINC - TOTAL	Zn TOTAL	mg/L Zn	AAS - SOLVENT EXTRACTION
30009	ZINC - TOTAL	Zn TOTAL	mg/L Zn	ICP 1502
30011	ZINC - TOTAL	Zn TOTAL	mg/L Zn	ICP 1503
30090	ZINC - TOTAL	Zn TOTAL	mg/L Zn	ICP - MS
30911	ZINC - TOTAL	Zn TOTAL	mg/L Zn	AAS - FLAMELESS
30204	ZINC SUSPENDED	Zn - PARTICULATE	µg/g	AAS - DIRECT ASPIRATION

Appendix 2 Inductively Coupled Plasma for Metals Analysis

Inductively Coupled Plasma (ICP) replaces the term ICAP.

ICP 1502 (total metals, digested and concentrated)
Inductively Coupled Plasma by Optical Emission Spectrometry (ICP-OES),
A sample is preserved in the field with nitric acid. The shaken sample aliquot is digested with nitric acid or aqua regia, concentrated appropriately (e.g. from 100 mL to 20 mL, or by Ultra Sonic Nebuliser [USN]), and aspirated from an autosampler. The emission is measured at the appropriate wavelength and compared to identically-prepared standard and blank solutions.

ICP 1503 (total metals, digested to dryness and concentrated in HCl)
Inductively Coupled Plasma by Optical Emission Spectrometry (ICP-OES),
A sample is preserved in the field with nitric acid. The shaken sample aliquot is digested with aqua regia and evaporated to near dryness. The residue is dissolved in concentrated HCl and diluted to one-fifth of the aliquot original volume. The digested sample is aspirated and the emission is measured at the appropriate wavelength and compared to identically-prepared standard and blank solutions.

ICP 1516 (direct aspiration for dissolved metals)
Inductively Coupled Plasma by Optical Emission Spectrometry (ICP-OES).
A sample is filtered in the field through a 0.45 μm membrane filter and preserved with nitric acid. The sample aliquot is aspirated and the emission is measured at the appropriate wavelength and compared to identically-prepared standard and blank solutions.

ICP (concentrated and aspirated):
A shaken sample aliquot is concentrated appropriately (e.g. by USN), and aspirated from an autosampler. The emission is measured at the appropriate wavelength and compared to identically-prepared standard and blank solutions.

Dissolved analysis:
The sample is filtered in the field and preserved with nitric acid. The analysis is performed WITHOUT digestion.

Appendix 3 Definition of Metals Analyses

Total metals
The sample is preserved in the field with nitric acid; a shaken aliquot is digested and analysed in the laboratory.

Dissolved metals
The sample is filtered in the field through a 0.45 μm membrane filter and preserved with nitric acid; an aliquot is analysed in the laboratory without digestion.

Extractable metals
The sample is preserved in the field with nitric acid. A decanted or pipetted sample aliquot is taken for analysis in the laboratory, concentrated appropriately [by Ultra Sonic Nebuliser (USN)], aspirated and the emission is compared to identically-prepared standard and blank solutions.
(Codes ending with 009 for Total and 109 for Dissolved)
(Codes ending with 115 for Dissolved Sodium, Potassium, Calcium and Magnesium)

N.B.: Unless conditions are rigidly controlled, extractable results will be meaningless and imprecise. Final concentrations can be close to total metal concentrations or measured concentrations may even be higher than total value due to greater uncertainty, especially if the analytical results are in the region of the method detection limits. This often creates logistic problems for clients.

Appendix 4 Wavelengths for ICP-OES Analyses

Aluminum	309.3 nm
Arsenic	193.7 nm
Barium	493.3 nm
Beryllium	313.0 nm
Boron	249.68 nm
Cadmium	228.8 nm
Calcium	317.9 nm
Chromium	267.7 nm
Cobalt	228.6 nm
Copper	324.7 nm
Iron	259.9 nm
Lead	220.3 nm
Magnesium	279.5 nm
Manganese	257.6 nm
Molybdenum	202.0 nm
Nickel	231.6 nm
Potassium	766.5 nm
Selenium	196.1 nm
Silicon	288.1 nm
Sodium	589.0 nm
Strontium	421.5 nm
Vanadium	292.4 nm
Tin	189.9 nm
Titanium	334.9 nm
Zinc	213.8 nm

Appendix 5 Solvent Extraction Notation

If volumetric flasks are available, the extracts from each aliquot are combined in a volumetric flask. The inorganic and organic layers are allowed to separate in the flask and reagent water is slowly added to the side of the flask, held at a 45 degree angle, allowing the organic layer to float into the neck of the volumetric flask. This technique improves the ease of analysis, especially where many elements are analysed by AAS from the same extract.

Appendix 6 Quality Control Samples

Calibration curve linearity
The use of five or more calibration standard solutions of different concentration, prepared identically to the sample solutions, is recommended to measure the linearity of the calibration curve.

System Stability
It is recommended that a verification standard, with a concentration of 20 to 50% of the analytical range, be analysed after every 20 samples to verify the stability of the analytical system.

Accuracy
Reference material (certified or prepared in the laboratory) should be used to verify the accuracy of the analytical system

Precision
Reference material duplicates, from the reference material, separated by at least twenty positions (or in the second half of the batch) should be analysed to verify the precision of the analytical system.

Interference
Analyte or surrogate spikes should be analysed, after every twenty samples or at least once per analysis batch, to verify the method recovery or matrix interference of the samples.

Contamination
Method blanks, compared to identically-prepared sample solutions, should be analysed to ensure the analytical system is not contaminated.

Appendix 7 Reagent Nomenclature and Preparation

EDTA (hardness, magnesium)
ethylenediamine tetraacetic acid

LAS (anionic tensile surfactants)
Linear Alkylate Sulphonate

MBAS (surfactants anionic tensides)
Methylene Blue Active Substances

Murexide (calcium hardness)
Dissolve 150 g of ammonium purpurate (murexide) into 100 g of ethylene glycol.

Oxine reagent
Dissolve 1.0 g of oxine (8-hydroxyquiloline) in 200 mL of methyl isobutyl ketone (MIBK).

SPADNS
Dissolve 958 mg SPADNS, sodium 2-(parasulphophenylazo)-1,8-dihydroxy-3,6-naphthalene disulphonate, also called 4,5-dihydroxy-3-(parasluphophenylazo)-2,7-naphthalenedisulphonic acid trisodium salt, in distilled water and dilute to 500 mL. This solution is stable indefinitely if protected from direct sunlight.

TISAB - Total Ionic Strength Adjustment Buffer solution (fluoride analysis)
To approximately 500 mL distilled water, add 57 mL glacial acetic acid (CH_3COOH), 58 g sodium chloride (NaCl), and 4.0 g 1,2-cyclohexylenediaminetetraacetic acid (CDTA). Stir to dissolve. Slowly add 5 M sodium hydroxide (NaOH) (about 125 mL) until the solution has a pH of 5.3 to 5.5. Dilute with distilled water to 1 litre in a volumetric flask.

Appendix 8 Indicator Preparation

Calver II (calcium analysis)
Available from Hach Chemical Co, Ames, Iowa, Cat. no. 281.

Curcumin
Dissolve 40 mg of finely ground curcumin (Eastman no. 1179 or equivalent) and 5.0 g of oxalic acid in 80 mL of 95% ethyl alcohol. Add 4.2 mL of concentrated HCl and make up to 100 mL with ethyl alcohol. This reagent is stable for several days if stored in a refrigerator.

Diphenylcarbazone-acidifier (chloride analysis)
Dissolve 250 mg s-diphenylcarbazone, 4.0 mL concentrated nitric acid and 30 mg of xylene cyanol FF in 100 mL 95% ethyl alcohol or iso-propanol. Store in dark bottle and refrigerate.
N.B.: For highly alkaline or acid waters, adjust pH to 8 before adding the indicator.

Eriochrome Black T (calcium analysis)
Sodium salt of 1-(1-hydroxy-2-naphthylazo)-5-nitro-2-naphthol-4-sulfonic. Dissolve 0.5 g dye in 100 g triethanolamine or ethylene glycol monomethyl ether. Add 2 drops per 50 mL solution to be titrated. Adjust volume if necessary. If the end point colour change of this indicator is not clear and sharp, it usually means that an appropriate complexing agent is required. If NaCN inhibitor does not sharpen the end point, the indicator probably is at fault. Stable for one year.

Eriochrome cyanine R* dye
Dissolve 300 mg of the dye in 50mL of distilled water, adjust pH to 2.9 with 50% acetic acid (approximately 2 mL is required) and dilute to 100 mL.
(A product of Pfaltz and Bauer Inc.)

Ferron/phenanthroline (aluminium analysis)
7-iodo-8-hydroxyquinoline-5-sulphonic acid/C12H8N2.

Methylthymol Blue (sulphate analysis)
Dissolve 0.1286 g of methylthymol blue, 3'3"-Bis-({N,N-bis(carboxymethyl)-amino}-methyl) thymolsulphonephthalein trisodium salt in 25 mL of barium chloride (1.526 $BaCl_2.2H_2O$ in 1L of distilled water) solution. Add 4.0 mL of 1 N HCl, 71 mL of distilled water, 0.5 mL Brij-35 solution and dilute to 500 mL with ethanol. Prepare fresh daily and store in a brown bottle.

Mixed indicator (chloride analysis)
Dissolve 5 g of diphenylcarbazone powder and 0.5 g bromphenol blue powder in 750mL of 95% ethyl or isopropyl alcohol and dilute to 1L with the alcohol.

Murexide
Dissolve 150 g of ammonium purpurate (murexide) into 100 g of ethylene glycol.

Potassium chromate (chloride analysis)
Dissolve 50 g of K_2CrO_4 in distilled water. Add silver nitrate solution until a red precipitate is formed. Let stand for 12 hours, filter and dilute to 1L with distilled water.

Thorin (sulphate analysis)
Dissolve 0.2 g of thorin (2(2'-Hydroxy-3,6-disulpho-1-Naphthylazo) benzene arsonic Acid) in 100 mL of distilled water.

Submission Form for New Method Codes

Send to:
UNEP GEMS/Water Programme
c/o National Water Research Institute
867 Lakeshore Road, P.O. Box 5050
Burlington, Ontario L7R 4A6, Canada
Fax:+1-905-336-4582
Email: yvonne.stokker@ec.gc.ca

Please provide your contact name, organization and address:

Please complete the following information:

Title of Method:

Method Description:

Method Detection Limit (MDL):

Equipment used:

Requesting Agency:

Literature Reference:

GEMS/Water Method Code[1]	MDL (include units)[2]	Upper Limit (include limit)[3]	Wavelength (if applicable)	Atomic Mass (if applicable)	Start Date of Method Use[4]

[1] Will be assigned by UNEP GEMS/Water Programme.

[2] Required criterion before a method code can be included in the GEMS/Water database.

[3] Determines the linear range of an analytical method (optional).

[4] Sampling date of first analytical data reported for this method to GEMS/Water.

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PART B: IAEA Sampling Procedures for Isotopes in Hydrological Investigations

1. Introduction

Detailed knowledge of hydrological systems forms an integral part of the sustainable resource development. Isotope techniques are effective tools for satisfying critical hydrologic information needs like the origin of groundwater, recharge, residence time, impact of climate change on water resources, interconnections between water bodies, among others. Isotopes provide information that sometimes could not be obtained by other techniques. Stable and radioactive environmental isotopes have now been used for more than four decades to study various aspects of hydrological systems. Applications of isotopes in hydrology are based on the general concept of "tracing", in which either intentionally introduced isotopes or naturally occurring (environmental) isotopes are employed. Environmental isotopes (either radioactive or stable) have a distinct advantage over injected (artificial) tracers in that they facilitate the study of various hydrological processes on a much larger temporal and spatial scale through their natural distribution in a hydrological system. Thus, environmental isotope methodologies are unique in regional studies of water resources to obtain time and space integrated characteristics whereas the artificial tracers generally are effective for site–specific, local applications. In hydrological investigations, isotope techniques should be used routinely along with hydrochemical and hydrogeological techniques. As all isotopic, hydrogeological, hydrochemical, and hydrodynamic interpretations are space and time related, it is imperative that one should consider all the related aspects of water sampling and prevailing hydrogeological conditions in a study area. A large variety of environmental stable and radioactive isotopes are employed for hydrological studies (e.g., ^{2}H, ^{3}H, ^{3}He, ^{4}He, ^{6}Li, ^{11}B, ^{13}C, ^{14}C, ^{15}N, ^{18}O, ^{34}S, ^{36}Cl, ^{37}Cl, ^{81}Br, ^{81}Kr, ^{87}Sr, ^{129}I, etc.). More specific advice on isotope applications in hydrological and environmental studies is available from the Isotope Hydrology Section, International Atomic Energy Agency (IAEA), Wagramer Strasse 5, P.O. Box 100, A–1400, Vienna, Austria.

2. Environmental Isotopes in Hydrology

Environmental isotopes, both stable and radioactive, occur in the atmosphere and the hydrosphere in varying concentrations. So far, the most frequently used environmental isotopes include those of the water molecule, hydrogen ^{2}H or D – also called deuterium, and ^{3}H – also called tritium) and oxygen (^{18}O), as well as of carbon (^{13}C and ^{14}C – also called radiocarbon or carbon–14) occurring in water as constituents of dissolved inorganic and organic carbon compounds. ^{2}H, ^{13}C and ^{18}O are stable isotopes of the respective elements whereas ^{3}H and ^{14}C are radioactive isotopes. The stable isotopes are usually measured, using an isotope ratio mass spectrometer, in terms of the isotope ratios of the less abundant to more abundant isotope, e.g., $^{2}H/^{1}H$ and $^{18}O/^{16}O$ (^{1}H and ^{16}O being the number of atoms of the most abundant isotopes of the respective elements). The radioactive isotopes are measured either by counting of their radioactive decays (low–level counting, e.g., by liquid scintillation counter) or the number of atoms (using accelerator mass spectrometry (AMS)) in a given sample. In this section, a brief review of various stable and radioisotopes applied in hydrological investigations is made.

2.1 Stable Isotopes

Stable isotopes of many elements are used in hydrological investigations (e.g., ^{2}H, ^{3}He, ^{6}Li, ^{11}B, ^{13}C, ^{15}N, ^{18}O, ^{34}S, ^{37}Cl, ^{81}Br, ^{87}Sr, etc.). The most commonly used are those of oxygen and hydrogen.

Variations in the stable isotope ratios of natural compounds are governed by chemical reactions and phase changes due to the energy difference between chemical bonds in different isotopes of an element. Such energy differences are caused by the relative mass difference between isotopes. The stable isotopes of light elements show greater variations because they have larger relative mass differences.

The interest of an isotope hydrologist lies in the relative deviation of the ratio of less abundant heavy isotope to more abundant lighter isotope (exceptions: helium, lithium and boron isotope ratios) with respect to a reference rather than the "absolute" isotope ratio of a given sample. Therefore, a material is selected as a primary standard, and its stable isotope ratio defines the zero point of a relative conventional scale. For convenience the measurements are not reported as isotope ratios, but given as relative deviation from the isotope ratio of a standard expressed as δ (delta) in permil (‰) and is defined as,

$$\delta\,(‰) = \frac{R_{sample} - R_{standard}}{R_{standard}} \cdot 1000$$

where, δ (e.g., δ^2H, $\delta^{13}C$, $\delta^{15}N$, $\delta^{18}O$, $\delta^{34}S$) is the normalised difference of the isotope concentration ratios R ($^2H/^1H$, $^{13}C/^{12}C$, $^{15}N/^{14}N$, $^{18}O/^{16}O$, $^{34}S/^{32}S$) of a sample and a standard. The International Atomic Energy Agency (IAEA), Vienna Austria distributes isotope reference materials to all interested users.

2.1.1 Deuterium (H–2) and Oxygen–18

Hydrogen has two stable isotopes, the hydrogen atom (^1H, with abundance of 99.984 %), and deuterium (^2H, the principal component of heavy water with abundance of 0.015 %). The ratio of these isotopes can be used as an ideal tracer of water molecule in hydrological cycle. Similar to hydrogen isotopes, oxygen has three stable isotopes i.e., ^{16}O (99.76 %), ^{17}O (0.04 %) and ^{18}O (0.2 %). In terrestrial materials, the ^{17}O geochemistry echoes that of the 5 times more abundant ^{18}O and therefore in hydrological applications ^{17}O is usually not considered separately. The stable isotope measurements of hydrogen and oxygen isotopes are generally made using isotope ratio mass spectrometer (IRMS) and are reported as permil (‰) difference from the standard, Standard Mean Ocean Water (SMOW) or Vienna Standard Mean Ocean Water (VSMOW), the internationally accepted reference standard for stable isotopes of hydrogen and oxygen in water samples. Most of the applications of stable isotopes of hydrogen and oxygen in groundwater studies use the variations in isotopic ratios in atmospheric precipitation, that is, the input to a hydrogeological system. These variations result from a variety of physical processes, the most important being evaporation and condensation. During evaporation, the light molecule of water, $H_2{}^{16}O$, is more volatile than the heavier molecules (that is, $^1H^2H^{16}O$ or $H_2{}^{18}O$). When this atmospheric water vapour undergoes successive cooling and condensation with production of clouds and precipitation, the less volatile (heavy) water molecules condense preferentially, leaving a residual vapour more and more depleted in ^2H and ^{18}O. A worldwide relation between ^{18}O of precipitation and mean annual air temperature (with some exceptions) has been observed. This dependency on temperature produces different effects like seasonal isotope variations of precipitation (winter precipitation is depleted in heavy isotopes with respect to summer precipitation), latitude effect (high latitude precipitation is depleted with respect to low latitude precipitation), and altitude effect (heavy isotope content of precipitation decreases with increasing altitude). These effects allow the use of these isotopes to delineate various hydrogeological processes as well as indicators of past and present climate changes and of palaeowaters.

When precipitation infiltrates to recharge groundwater, mixing in the unsaturated zone and selective infiltration of precipitation, result in attenuation of seasonal isotopic variations in precipitation. In most aquifers, isotopic composition of water does not change further unless exchange with the oxygen of rocks occurs. This process of exchange is significant and important for high–temperature geothermal systems only. The isotopic composition of groundwater is thus related to that of precipitation in the recharge area of an aquifer at the time of recharge. Groundwater may be of a very old age, and climatic conditions of the region at the time of recharge may have been different from those of today. This implies that the isotopic composition of precipitation could have been different from the present one, due to the correlation between δ–values and temperature. Stable isotopes of hydrogen and oxygen have been extensively used to characterize different components and the dynamics of the geothermal waters. Stable isotopes of hydrogen and oxygen are thus the most useful in gaining insights into various aspects of different components of the hydrological cycle.

2.1.2 Carbon–13

Carbon has two environmental stable isotopes: ^{12}C (98.89 %) and ^{13}C (1.11 %). Carbon is ubiquitous element of the biosphere and the hydrosphere. $^{13}C/^{12}C$ measurements are made on CO_2 gas using isotope ratio mass spectrometer (IRMS). The ratios are expressed in δ–notation with reference to the calcite rostrum of the *Belemnitella americana* fossil found in the Cretaceous Pee Dee Formation of South Carolina, abbreviated as PDB. PDB is the standard for ^{13}C and ^{18}O in carbonate minerals. It has been accepted as the standard for all carbon compounds, both inorganic and organic. VSMOW is used for measurement of hydrogen and oxygen isotopes in organic compounds. The International Atomic Energy Agency, Vienna has defined VPDB, considered identical to PDB, as a standard relative to which all ^{13}C and carbonate–^{18}O results are reported. In hydrological applications ^{18}O of carbonates is generally reported relative to VSMOW. Initially, carbon isotope ratios were used to reconstruct palaeotemperature scale using marine carbonates. The chemistry of many groundwaters is strongly dependent on carbonate geochemistry. Analyses of ^{13}C and ^{18}O of carbonate species in water contribute directly to understanding of the carbonate geochemistry and geochemical evolution of groundwater. Such knowledge is also essential for interpretation of ^{14}C measurements. Carbon isotopes in geothermal systems have been used for gaining insights into such systems and for geothermometry of such waters. They are also valuable in tracing sources of contaminants to groundwater.

2.1.3 Nitrogen–15

There are two stable isotopes of nitrogen: ^{14}N and ^{15}N. Due to high oxidation–reduction potential, wide range of nitrate and ammonium compounds of nitrogen are found in nature. Nitrogen isotope ratios are generally reported in permil deviation relative to nitrogen in atmospheric air. The average abundance of nitrogen in air is constant, with $^{15}N/^{14}N$ value of 1/272. For interlaboratory comparison purpose different reference materials are used. For example, $\delta^{15}N$ values can be normalized using the IAEA ammonium sulphate reference materials N–1 and N–2, which have the values +0.45 ‰ and +20.35 ‰, respectively. $^{15}N/^{14}N$ ratios are measured using isotope ratio mass spectrometer. There are number of sources of nitrogen compounds like chemical fertilizers, human and animal waste, and other natural processes. Various biogeochemical controls affect their transport to the water. Nitrogen and oxygen isotopes of nitrates in water facilitate understanding hydrological flowpaths and sources of nitrogen compounds for determining the impact of contaminants on water resources.

2.1.4 Sulphur–34

Sulphur has four stable isotopes: ^{32}S (95.02 %), ^{33}S (0.75 %), ^{34}S (4.21 %), and ^{36}S (0.02 %). In hydrological studies only ^{34}S and ^{32}S are considered. Concentrations of sulphur isotopes are measured using isotope ratio mass spectrometer and are expressed as permil (‰) differences relative to the iron sulphide (troilite) of the Canyon Diablo meteorite (CDT). Sulphate originates in water by the dissolution of sulphate minerals, primarily gypsum and anhydrite, or by the oxidation of sulphide minerals, primarily pyrite. The sulphur in groundwaters is dominated by sulphate ion ($SO4^{2-}$) therefore, the isotopic composition of both sulphur and oxygen are employed to trace origin and geochemical history of sulphur in groundwater. In addition, where reduced sulphur species do occur, their sulphur isotopic composition is a reflection not only of the origin of the sulphide but also of the type of redox reaction that might have been responsible for their formation. One very important consideration in groundwater investigations is the fact that sulphur isotope values directly reflect their source unless biological or redox activity exists. The source of the oxygen isotopes of sulphate is subject to variations due to mixing between dissolved oxygen, water oxygen, and biological activity. Exchange with water oxygen continues in an aquifer until equilibration is reached. However, without biological mediation, such reactions are usually of extremely long duration. Sulphur isotope geothermometers are common in investigations of geothermal waters. Thus overall, isotope analysis of aqueous sulphur compounds can provide insight into recharge environments, aquifer matrix, flowpaths, and the geochemical history of groundwaters.

2.1.5 Chlorine–37

Chlorine has two stable isotopes: ^{35}Cl (75.7 %) and ^{37}Cl (24.2 %). Chloride in water acts as a conservative tracer. Values are expressed in permil ratios with respect to the standard mean oceanic chloride (SMOC) standard. $^{37}Cl/^{35}Cl$ ratios characterise the origin of chloride in fresh, saline, and contaminated groundwaters. Chlorine isotopes usefully fingerprint the chlorine–containing contaminants in groundwater. The ratios ($^{37}Cl/^{35}Cl$) are measured using an IRMS. In order to differentiate between various sources, high precision of measurement must be achieved.

2.1.6 Lithium–6, Boron–11, Bromine–81

These isotopes have potential application in studies related to groundwater salinity. Their natural abundances are – $^{6}Li/^{7}Li$: 7.5 %, $^{11}B/^{10}B$: 80.1 %, and $^{81}Br/^{79}Br$: 49.31 %. The reference standards used are NBS S-SVEC, NBS SRM951, and standard mean ocean bromide (SMOB), respectively. Their measurement is carried out using different mass spectrometric techniques, such as solid source mass spectrometry, inductively coupled plasma mass spectrometry (ICP–MS), accelerator mass spectrometry (AMS), etc. Their analytical procedures are still in development stage and are not well established yet.

2.1.7 Strontium–87

Strontium is a minor constituent of groundwater. Strontium has four stable isotopes: ^{84}Sr (0.56 %), ^{86}Sr (9.86 %), ^{87}Sr (7.02 %) and ^{88}Sr (82.56 %). Among these only $^{87}Sr/^{86}Sr$ ratios are generally considered for hydrological applications. The reference standard for strontium–87 measurements is the NIST Sr standard NBS 987. Strontium concentration in rainfall is generally low and can vary over two orders of magnitude from $2x10^{-3}$ to $3x10^{-1}$ mg/L. The much higher concentration in groundwater may be due to dissolution of Sr–bearing minerals. No natural fractionation of stable strontium isotopes has been observed during natural processes. This property makes the isotopic ratio of strontium a reliable tool for evaluating mixing of groundwaters and for tracing water–rock interactions. The $^{87}Sr/^{86}Sr$ ratios are measured using thermal ionisation mass spectrometry (TIMS) and are traditionally expressed as atomic ratios with four- to six-place decimal notation.

2.2. Radioactive Isotopes

Among the environmental radioisotopes, tritium and carbon–14 have found the widest application in groundwater studies. Radioactive isotopes (also called radioisotopes) in groundwater originate from natural and/or artificial nuclear processes. Cosmogenic radioisotopes are produced in nuclear reactions between the nucleonic component of cosmic radiation and the atmosphere. Anthropogenic radioisotopes are produced in nuclear bomb tests and nuclear reactors. The concentrations of all these radioisotopes in groundwater are very low and usually measured by counting their decay rate *A* in a given sample. The number of atoms *N* in a sample can be derived from *A* by the relationship: $A = \lambda \cdot N$, where λ denotes the decay constant which is related to half–life $T_{1/2}$ by the equation $\lambda = \ln 2 / T_{1/2}$. For long–lived radioisotopes such as ^{36}Cl and ^{129}I, the decay rate becomes immeasurably small. In these cases the number of atoms has to be measured directly, which is possible by the accelerator mass spectrometry (AMS) technique. The AMS technique is superior to the conventional decay counting for ^{14}C also, since AMS requires a very small sample size (up to 1000 times less than conventional requirement) for measurement.

2.2.1 Tritium

Tritium (^{3}H), the radioisotope of hydrogen, emits low–energy β radiation ($E_{max.}$ = 18 keV). Tritium content in water is expressed in tritium units (TU). 1 TU is equal to 1 atom of ^{3}H per 10^{18} atoms of ^{1}H, which is equivalent to 0.118 Bq or 3.193 pCi per litre of water. The half–life of tritium is fixed as 12.32 years. The concentration of tritium in natural waters is generally very low. In hydrological studies, therefore, electrolytic enrichment of tritium is often carried out prior to decay counting using liquid scintillation or proportional counters.

Environmental tritium occurs in precipitation from both natural and anthropogenic sources. The natural production results from interaction of cosmic ray produced neutrons in the upper atmosphere with nitrogen atoms. Tritium oxidizes rapidly to HTO and enters the global hydrological cycle. The natural content of tritium in precipitation is estimated to be about 2 to 5 TU. The second source of tritium is from atmospheric detonation of thermonuclear devices from 1952 to 1962, and minor releases from industrial nuclear facilities. The atmospheric testing injected periodic pulses of tritium into the stratosphere, and its concentration in precipitation increased by more than three orders of magnitude in the Northern Hemisphere in 1963 above that arising from cosmic–ray source (~5 TU). An increase in concentration was also noted in the Southern Hemisphere, but by only two orders of magnitude, because of the lower ratio of land to ocean in the Southern Hemisphere and poor trans–equatorial mixing of the air masses. The history of tritium content in precipitation is well known, because of the global network of stations jointly established by the IAEA and the WMO.

The International Atomic Energy Agency in Vienna publishes data on the concentration of stable isotopes and tritium in precipitation samples collected at a large number of stations around the globe, from which it is possible to estimate the tritium deposition at most places of interest. The detail information, references, and data can be found on the website: <http://www.iaea.org/programmes/ripc/ih>.

Over the past four decades, groundwater studies have considerably benefited from the transient behaviour of bomb tritium. The detection of bomb tritium in shallow groundwater is a fingerprint for a component of recent recharge in the groundwater. A more quantitative treatment of tritium data in shallow unconfined aquifers permits determination of the residence time distribution in groundwater, from which relevant parameters of the groundwater system can be estimated, especially the recharge rate. Presently, tritium concentration in precipitation approaches the natural level, which makes such evaluations of tritium data more difficult.

However, the combined measurement of tritium and its decay product, helium (^{3}He), still provides a powerful tool for estimating groundwater residence time and recharge rate, and for characterizing flow and dispersion regimes in shallow aquifers. With this approach, the transient behaviour of bomb tritium could be exploited to an advantage even when most of this tritium has already decayed. Advantage lies in the fact that the method does not rely upon the complicated tritium input function.

2.2.2. Carbon–14 or Radiocarbon (^{14}C)

Radiocarbon is produced in the transitional region between stratosphere and troposphere by cosmic ray neutrons reacting with nitrogen atoms. ^{14}C oxidizes to carbon dioxide, becomes a part of the atmospheric carbon dioxide reservoir, and subsequently enters the biosphere and the hydrosphere. ^{14}C has also been added to the atmosphere as a result of the testing of thermonuclear devices since 1952.

^{14}C emits β radiation ($E_{max.}$ = 156 keV) and has a half–life of 5730 years. For hydrogeological applications, the ^{14}C

concentration is expressed as a percentage of the modern (pre–bomb) carbon activity of biosphere material used (percent of modern carbon or pMC). This refers to the ratio of the activity of a sample to 95 % of the activity (in 1950) of the accepted oxalic acid standard from the US National Institute of Standards and Technology (NIST). The 100 % corresponds to specific ^{14}C activity of 13.56 ± 0.07 disintegrations per minute per gram of carbon. Decay counting that uses gas proportional counting, or liquid scintillation spectrometry is generally employed for the measurement of activity of ^{14}C. More recently, measurement of atoms using the AMS technique is also common.

The addition of artificial radiocarbon to the atmosphere has increased the natural levels; the maximum increase was about 100 % in 1963 in the Northern Hemisphere and 70 % in 1965 in the Southern Hemisphere. This effect is important for very young groundwaters near the recharge areas.

^{14}C determinations are generally carried out on the total dissolved inorganic carbon (TDIC), that is, dissolved carbonate species CO_2 (aq.), HCO_3^{1-} and CO_3^{2-}, the bicarbonate ions being the species by far prevailing at the pH values normally encountered in groundwater. Use of dissolved organic carbon (DOC) for ^{14}C measurements has also been attempted in recent years. The major part of carbon enters the groundwater through soil CO_2, during the infiltration processes. However, chemical and biochemical reactions along a flow path can modify the initial ^{14}C content of groundwater. Therefore, in application of radiocarbon "dating" of groundwater, appropriate adjustments for effects of these reactions should be made in order to determine the initial activity of ^{14}C in the groundwater. Several models have been developed considering the ^{13}C and other physicochemical parameters for the required corrections.

2.2.3 Chlorine–36

Chlorine–36, the only long–lived chlorine isotope, has a half–life of 3.01 x 10^5 years. It emits β^- particles and is measured using accelerator mass spectrometry. Due to its long half–life, ^{36}Cl is suitable to date very old groundwaters. It is primarily produced in the atmosphere either by thermonuclear explosions or in small quantities by isotope spallation by cosmic rays converting ^{40}Ar to ^{36}Cl. Lithogenic production of ^{36}Cl is minor but significant for source term corrections. ^{36}Cl is usually reported as atomic ratio of ^{36}Cl to total chloride in a given sample, typical values ranging from 10^{-15} to 10^{-11}. ^{36}Cl has a variety of applications in hydrological studies like characterisation of water bodies and of salt deposits, assessment of degree of mixing, determination of groundwater flowpaths, estimation of infiltration, identification of very young (thermonuclear) groundwater, identification of source of salinity, estimation of palaeohydrologic conditions, etc.

2.2.4 Iodine–129

Iodine has two isotopes: ^{127}I (stable) and ^{129}I (radioactive). ^{129}I emits β particles and has half–life of 15.7 x 10^6 years. ^{129}I is similar to ^{36}Cl in many ways. It is produced by cosmogenic, lithogenic, and thermonuclear reactions. It is reported as ratio of ^{129}I to total I. $^{129}I/I$ ratios are smaller, in the range of 10^{-14} to 10^{-10}. ^{129}I is measured by AMS technique. Earlier methods of measurement included β^- decay counting, neutron activation, and negative–ion mass spectrometry. Iodine occurs in multiple ionic forms, iodide and iodate. These have different chemical behaviour and pose analytical problems. Therefore, ^{129}I has fewer applications than those of ^{36}Cl. Nevertheless, ^{129}I has been used to place constraints on groundwater age, determination of groundwater flowpaths, sources of salinity and of salts in evaporite deposits among others.

2.2.5 Uranium Series Nuclides

Uranium isotope disequilibrium occurs commonly in circulating groundwaters and associated rocks, and it is related to the geological environment through which water flows. Therefore, the $^{234}U/^{238}U$ disequilibrium in particular has been used in hydrological investigations. The measurement of uranium series isotopes uses α–spectrometry and more recently TIMS. Various uranium series isotopes — ^{222}Rn, ^{226}Ra, ^{230}Th, ^{234}U, ^{238}U — have been applied to environmental studies such as computation of mixing volumes and identification of water masses, water–rock interactions in aquifers and in geothermal systems, as indicators of palaeohydrologic conditions in aquifers, in characterization of submarine groundwater discharge, etc.

2.2.6 Isotopes of Noble Gases

Isotopes of noble gases, e.g., ^3He, ^4He, ^{39}Ar, ^{81}Kr, ^{85}Kr, etc. are relatively new tools in isotope hydrology. The solubility of atmospheric noble gases in water depends on temperature (solubility increases with temperature) and their concentration in air. Except for helium, effects of non–atmospheric contributions to noble gas concentrations in groundwater are generally negligible for neon, argon, krypton, and xenon, and could be assessed from the isotopic ratios. Neon concentration, which is almost independent of temperature, is used for correcting xenon and krypton concentrations. Helium is measured as $^3He/^4He$ using a specially designed noble gas mass spectrometer as both these isotopes are stable. ^3He, the daughter product of tritium, provides ages of young groundwater without knowing the tritium input function. ^4He

in groundwaters is used for dating old groundwaters as well as for understanding possible mixing of waters of different ages. Various corrections need to be applied before meaningful estimates are obtained.

^{39}Ar, a radioactive isotope of argon, is formed in the upper atmosphere by neutrons of cosmic radiation and is transported to aquatic reservoirs by air–saturated water. The half–life of ^{39}Ar is 269 years, which is suitable to fill the gap in dating range between ^{3}H and ^{14}C. Being chemically inert it is a useful groundwater tracer. Its activity is measured using ultra low–level gas proportional counters in specialized laboratories. ^{39}Ar activity in atmospheric argon is considered to be 100 %. Anthropogenic and *in situ* production of argon can be significant in some cases and caution should be observed while interpretation of data. ^{39}Ar is an excellent isotope for dating glacier ice, for understanding rock–water interactions in crystalline formations, and as a steady state tracer in oceanographic studies.

Krypton has two radioisotopes: ^{81}Kr and ^{85}Kr. With the half–life of 2.1 x 10^5 years ^{81}Kr gives valuable information about old groundwater (50000 to 80000 year old). It is an inert, cosmic–ray–produced isotope, with an estimated production rate about 0.04 disintegrations per minute (dpm) per litre krypton, and with negligible underground production. Another isotope of krypton, ^{85}Kr has the half–life of 10.76 years. It is produced during the atmospheric thermonuclear tests and is released from nuclear reactors and fuel processing plants. Dating of young groundwaters with ^{85}Kr is possible, as the history of atmospheric ^{85}Kr is becoming well known. ^{81}Kr is measured using mass spectrometric techniques whereas ^{85}Kr measurements are usually made by low–level decay counting using high–pressure gas proportional counters.

3. Sampling Procedures

An isotope geochemical investigation should be well planned with clear definition of goals or purpose of the study, assessment of applicable methods, and available resources. A representative, well-conceived field sampling campaign with robust QA/QC controls will result in quality data leading to logical, realistic interpretation of results and ensuring high quality of an investigation undertaken. Some sampling procedures may be very simple and some very complex. In most of the sampling programs, a required volume of water is collected in the desired containers and sent to an isotope laboratory for further processing and analysis. Sometimes field processing of samples is also required depending on the analysis to be carried out in the laboratory. The main concern during sampling, transport and storage is to avoid changes in isotope composition through evaporation or diffusive loss of water vapour, and/or isotope exchange with the surroundings as well as with the container material. Appropriate materials and methods can minimize such detrimental effects. A careful selection of materials and methods needs to be made at an early stage before the sampling campaign is undertaken.

Water sampling requires different procedures and precautions not only for different isotopes but also for different types of sampling like, precipitation, groundwater, surface water, vadose water, geothermal fluids, etc. Additional information about the site, sample containers, labels, storage, preservation, chemicals, field measurement of physico-chemical parameters, etc. will certainly facilitate processing, analysis, and calculations in a laboratory as well as in interpretation of data. Following sections are a synthesis of information published in the Agency publications as well as other important publications in isotope hydrology. Some publications are listed in the bibliography section for the interested readers.

3.1 General Considerations

There can be a number of sources like, precipitation, river, canal, lake, pond, spring, artesian well, production well, ocean, etc. to be considered as a representative source for sampling. Similarly, water samples can be collected from single or multiple points and/or depths. Therefore, depending upon the nature of study and the study area, locations, type of source, number of sampling points, depths for sampling and frequency of sampling should be carefully selected.

3.1.1 Amount of Sample

The amount of water sample varies with the isotopes and procedures followed for analysis. For example, the measurement of ^{14}C by liquid scintillation counting may require 25 to 500 L of water whereas 500 mL may be more than sufficient for measurement using AMS technique. The general information about the amount of sample needed for different isotopic analyses is given at the appropriate places. However, due to continuous improvement in sample processing and analytical techniques it is strongly advised to contact the intended analytical laboratory to know the type and design of sample containers as well as the type and required amount of sample before undertaking any field activity.

3.1.2 Sample Bottles and Labels

Normally, glass bottles with double caps are the best to collect water samples, but the handling and transportation of glass bottles require extra care. There is always a risk of losing the sample. High–density polyethylene (HDPE) or polypropylene (PP) bottles with double caps or self–sealing caps are recommended. In case of gas samples, if possible, only glass bottles or laboratory–recommended special containers should be used. Gases diffuse much more slowly

through glass than through plastic. But, in case of non-availability of the recommended type of bottles, one can also use properly cleaned and leak–proof product bottles with tight screw caps for water and gas sampling. Different isotopes will need a different amount of sample. It is always recommended to collect a slightly larger volume, as the same sample cannot be collected later. Finally, one should keep the following points in mind while sampling:

- The most secure vessels for storage are glass bottles, allowing storage of at least a decade as long as the seal is not broken.
- High-density polyethylene bottles are recommended to avoid loss of samples during transportation and for storage of a few months (water and carbon dioxide easily diffuse through low-density plastics).
- Bottles with narrow mouth and double caps or caps with positive seals (plastic inserts, neoprene, etc.) are recommended. Avoid rubber caps as these may contain bacterial colonies.
- Fill the sample bottles completely. If there is chance of freezing during air transport, then fill the bottles two-thirds full.

A proper labelling is one of the most important aspects to avoid misleading results and confusion during measurement in a laboratory or errors during interpretation of data. Repeated sampling from a selected site will produce more samples. Therefore date, time, isotopes to be analysed should be recorded on the label. Sometimes the name of sites may be same although they are located at different places, therefore, other specific identification should also be mentioned along with the site name. Labelling should be short and unique. Always use waterproof markers or suitable pencils. Maximum details should be recorded in the notebook. Specific information like, field temperature, alkalinity, filtration and preservation, conductivity, etc. can also be mentioned on the labels depending upon the isotope to be analysed. Additional information like, geological setting, type of sample (precipitation, air/gas, ice/snow, river, lake, ocean, open well, hand pump, tube well, piezometer, spring, fresh/saline water, etc.), sampling method (depth-water sampler, bailer, submersible suction pump, grab sampler, etc.), sampling depth, total depth (water body/ well/ piezometer etc.), condition of sampling site (newly installed piezometer, regularly pumped well, unused open well, artesian well, etc.), environmental conditions (Arid, semi–arid, tropical, humid, etc.) other hydrometeorological and hydrogeological data (precipitation, temperature, water level/table, type of soil/lithology, runoff, discharge of river/stream), physico-chemical parameters (sample temperature, pH, alkalinity, dissolved oxygen, conductivity, salinity, etc.), well/piezometer construction details, etc. should also be collected, as they may be helpful in the interpretation of isotopic data.

3.1.3 Preservation, Chemicals and Storage

Preservation is not generally required for most of the isotopes. In certain cases however, sample preservation may become necessary as chemical reactions and biological activity can alter the isotopic composition of the sample. A small amount (~0.5 mL per litre sample) of sodium azide (NaN_2) or mercuric chloride is added to the sample to avoid biological activity. In some cases, samples are acidified or treated chemically at the field sites for reducing the sample amount to be transported to the laboratory. For this purpose, the chemicals used should be of analytical reagent grade (AR or GR grade) to avoid contamination.

The time and temperature during storage depend upon the isotope to be analysed. In some cases, evaporation has to be minimised while in other cases biological and chemical changes have to be avoided. Accordingly, sample storage time and temperature have to be taken into account. In general, the sample container's cap should be sealed with wax and the samples should be stored at 4°C, if they are to be stored for a longer time. If the storage period is not too long, then refrigerators can also be used for storing the water samples. Specific information on the chemical treatment and preservation has been provided in the following sections.

3.2 Precipitation Sampling for ^{2}H, ^{18}O and ^{3}H

Isotopic composition of precipitation is an essential reference for isotope hydrological studies. The IAEA maintains the database of the global network for isotopes in precipitation (GNIP). However, sampling stations may be required in study areas with complicated weather/precipitation pattern or inadequate isotope data. Data such as amount of precipitation, air temperature, and relative humidity should also be recorded with the precipitation sampling for correlation of isotopic data with meteorological parameters and also for weighting calculations.

Precipitation occurs in different forms, i.e., rain, snow, hailstone, and fog or mist, depending upon the altitude and geographic location. For precipitation sampling, the most important aspects are – samples must represent integrity over a certain period of time and not a single event, and to avoid evaporation causing significant change in the isotopic composition of the water sample.

3.2.1 Rainwater Sampling

Any rain gauge, e.g., ordinary rain gauge, standard recording type rain gauge, tipping bucket type, or weighting type rain

gauge, with suitable arrangement for storing rainwater can be installed at a desired place for collection of rainwater. Rainwater sampling is carried out by integrating daily rain samples for a certain pre-designated period. For example, a monthly sample represents rain collected over the period beginning on the first day of a month and continuing until the end of the month. The rainwater from the rain gauge is collected daily into a large capacity (~5 litres) container having tight inner lid and a screw cap. This process continues for a month. At the end of the month, the integrated monthly rainwater sample is drawn from this volume of water collected over the entire month.

About 50 mL water sample is required for stable isotopes and about 500 mL for environmental tritium. Only one sample bottle for both ^{2}H and ^{18}O is required. It is recommended that the samples for stable isotopes and tritium be collected in separate containers. Narrow-mouth high-density polyethylene (HDPE) or polypropylene (PP) bottles are sufficient for rainwater sampling. There is no need of any preservatives or filtration. Diffusive and evaporative losses from rain gauges and storage containers are avoided by use of liquid paraffin or silicon oil. A layer of at least 2 mm thickness should be maintained above the water surface in the storage container. It should be ensured that no traces of liquid paraffin and silicon oil are left in the integrated samples drawn from this volume for ^{2}H and ^{18}O analyses as it may interfere during the measurements.

The process described above is repeated every month depending on the rainfall. Depending upon the aim and requirements of an investigation, precipitation could be also collected for every event, weekly, monthly, quarterly, etc. Sampling can also be started from any date. Relevant information like location, date (period), and amount of total rainfall should be clearly marked on the labels of the bottles.

3.2.2 Fog or Mist Sampling

Fog or mist dominates in certain areas due to prevailing climatic conditions and precipitation occurs as a result of condensation of fog or mist. Therefore, their sampling is only possible through an interceptor of a galvanized sheet or stainless steel wire mesh. The interceptor always faces the dominant wind direction and intercepts the mist that is collected in the form of water in a glass bottle beneath of lower point. Sometimes atmospheric moisture or vapour(s) need to be collected for isotope sampling. In such cases metal funnels are used. They are cooled on one side using liquid nitrogen or ice facilitating condensation of moisture or vapours on the other side, which is then collected in the bottles.

3.2.3 Snow and Ice Sampling

Snow samples can be collected in sealable plastic bags or containers. In order to avoid sublimation, re-crystallization, redistribution, melting and rainfall on snow, which alter the isotopic composition of snow and ice, the snow sampling is carried out shortly after every snowfall. Once, the snow is melted in containers, the water can be transferred to plastic bottles as described in case of rain samples for ^{2}H, ^{18}O and ^{3}H analyses. A similar procedure can be followed for hailstones sampling.

Depth profiles of snow/ice samples can be collected using a hand auger up to a few metres only. Power drills are required for collection of deep ice cores. The ice cores could be suitably divided and stored in bottles for analysis or total cores must be kept under frozen conditions.

3.3 Surface Water Sampling for ^{2}H, ^{18}O and ^{3}H

Surface water bodies such as rivers, canals, ponds, lakes, reservoirs, and oceans etc. can be sampled for isotopic measurements of ^{2}H, ^{18}O and ^{3}H as well as for other isotopes. In general, surface water collection poses few problems. Field measurements of physico-chemical parameters, like temperature, pH, alkalinity, dissolved oxygen, salinity/conductivity are recommended. To inhibit the biological activity sodium azide or mercuric chloride in very minor quantities may be necessary. River, stream, canal samples should be collected from the mid-stream sections or flowing portions. Standing water should be avoided as the section might have been affected by evaporation or contamination. Sampling at the confluence should be done with great care due to problems of incomplete mixing. Sampling just before the confluence will provide isotope characteristics of joining tributaries. The water sampling in ponds, lakes, and reservoirs can be done either from shallow or deeper depths, or from both. If the water body is shallow, the water samples are collected from a desired location below the water surface to avoid the effect of evaporation or at the outlet, where representative sample could be obtained, directly by dipping the sample bottle into the water body. In case of sampling from deeper water bodies, depth-water samplers or suction pumps are used. In such multilevel sampling physico-chemical parameters should be measured at every sampling point to obtain variation along the water column. Once a water sample is collected, it can be pored into a plastic container of appropriate size as described in the preceding sections for ^{2}H, ^{18}O and ^{3}H analyses.

3.4 Sampling Unsaturated Zone Water for ^{2}H, ^{18}O and ^{3}H

The isotopic profile of soil moisture can provide information on groundwater recharge as well as insights into downward migration of contaminants. Soil water and gas samples are generally collected from the unsaturated zone. Gas samples need to be taken from various depths of interest using specially developed sampling probes that are placed at different depths during the development of the study site. Water samples are often extracted from the soil cores. These could also be collected *in situ* using porous porcelain suction cups that are placed in the profile. The most common methods of extraction of vadose water from the soil cores are – (i) vacuum distillation, (ii) freeze drying, (iii) squeezing using wetting liquids, and (iv) centrifugation. Water samples extracted through squeezing or centrifuge methods could be used for chemistry as well as for isotope analyses of water as well as of solutes whereas water extracted through heating under vacuum could only be used for stable isotopes alone.

3.5 Groundwater Sampling for ^{2}H, ^{18}O and ^{3}H

Groundwater samples can be collected from hand pumps, private and government tube wells, piezometers, springs, artesian wells, open wells/dug wells etc. However, it is necessary to ensure that a sample represents *in situ* groundwater without any contamination, evaporation, or effect of exchange with the atmosphere. Further, groundwater quality and isotopic composition may vary with depth and location. Therefore, the best way to collect the representative groundwater samples is to first collect the hydrogeological data of the study area. This helps to select sampling points and depth of sampling in different aquifers. Periodic sampling in wet and dry seasons may be necessary to understand spatial and temporal variations.

In mountainous regions, natural springs can be considered as ideal source for sampling groundwater and the dissolved constituents. The sampling point should be located as close as possible to the discharge point of a spring to minimize the loss of gases and to get unaltered representative water sample.

When the groundwater samples are to be collected from shallow aquifers, hand-pumped wells and shallow tube wells can be used after purging the standing water column for a few minutes. Shallow domestic wells or dug wells are found in large numbers in many of the countries. These wells are regularly used for irrigation and drinking water supplies and mostly represent shallow aquifers. But these are open and large in diameter; the groundwater in such wells is often subjected to evaporation and therefore it is not suitable for sampling. Such samples should be avoided if a nearby shallow hand-pumped well or tube well is available. However, if there is no other source, water samples can be collected from such wells after continuous pumping for various isotopic analyses.

Most of the production wells that are developed by various agencies/individuals for irrigation purposes tap groundwater from the deeper aquifers. These sources may be used to sample the deeper groundwater. But in these cases, the groundwater could be a mixture of groundwaters from different depth horizons. Wells of different depths with single screens are preferred to wells with multiple screens. Piezometers constructed to monitor groundwater in different aquifers are most suitable for isotopic analyses. Positive pressure systems (submersible pumps) should be used to avoid degassing. Air jet pumps must be avoided, as the atmospheric air will alter the samples. Tube wells should be operated for 10-15 minutes to flush out the standing water column before sampling. One should check the plumbing system prior to sampling to avoid inadvertent sampling of groundwater mixed with water softeners and purifiers, aeration with atmospheric air, etc. as these alter the water chemistry and isotope composition of dissolved constituents in groundwater.

Sampling groundwater for ^{2}H, ^{18}O and ^{3}H is simple and straightforward. Only 10 mL sample is required for ^{2}H and ^{18}O, but to be on safer side and for repeated measurements, 50 mL sample should be collected in HDPE/PP/Glass bottles. For low level tritium measurements using electrolytic enrichment followed by liquid scintillation counting, samples should be collected in similar bottles of 500 mL capacity. Fill the bottles completely and ensure airtight seal. If the samples are to be stored for longer period, they should be sealed with wax and stored at low temperature (4°C). No other treatment such as filtration and preservation is required. On site measurements like sample temperature, pH, conductivity, dissolved oxygen, alkalinity, etc. along with all other relevant site information should be recorded. Caution should be exercised to crosscheck the information on labels and that recorded in the field notebook.

Sampling for tritium measurement using ^{3}He in-growth technique requires special containers such as copper tubes with clamps or tight-sealed glass bottles. The concerned laboratory should be consulted for use of customized containers. In any case, atmospheric exposure must be avoided and the seal should be helium-tight.

Table-1: Summary of sampling for ^{2}H, ^{18}O and ^{3}H in precipitation, surface water, vadose water, and groundwater

Isotope	Method of Analysis	Analytical precision	Sample amount	Preservation and sampling bottle	Storage
^{18}O	IRMS	± 0.1 ‰	10 mL	no preservative, plastic bottle	>1 year
^{2}H	IRMS	± 1 ‰	10 mL	no preservative, plastic bottle	>1 year
^{3}H	Enrichment + LSC	± 0.8 TU	500 mL	no preservative, plastic bottle	Decay: $T_{1/2}$=12.32 a
	Propane synthesis	± 0.1 TU	1000 mL	no preservative, glass bottle	
	^{3}He in-growth + MS	± 0.1 TU	50 mL	no preservative, glass bottle	

3.6 Sampling for Carbon Isotopes in Dissolved Inorganic Carbon (DIC)

Water contains carbon in both inorganic and organic forms. The total dissolved inorganic carbon (TDIC) in groundwater is the sum of CO_2(aq.), H_2CO_3,, HCO_3^{1-} and CO_3^{2-}. Sampling for ^{13}C could be carried out separately for tracing various biogeochemical processes or together with radiocarbon sampling for correction and interpretation of ^{14}C data.

3.6.1 Sampling for Carbon–13 in DIC

Water samples (250 mL to 1 L) could be collected in a high density plastic or a dark glass bottle with a tight seal. If the sample is to be stored for more than a week, sodium azide (NaN_2) or mercuric chloride (Hg_2Cl_2) should be added to avoid alteration due to biological activity. Generally, 5 to 10 mg HCO_3^{1-} is sufficient for mass spectrometric measurement. The sample should be stored in a dark and cool place. The following criteria can be used as a guide for determining the required volume of water.

Alkalinity (mg/L HCO_3^{1-})	Vol. of sample (mL)
10	500
50	100
100	50
200	25

In practice, a slightly larger amount of sample is recommended keeping in view the efficiencies of different associated processes and the need for repetitive measurements. In a laboratory, direct evolution of carbon dioxide gas is achieved by acidification under vacuum.

Another method of sampling for ^{13}C analysis in DIC is precipitating carbon as $BaCO_3$ in an alkaline medium. Carbonate-free NaOH and reagent grade $BaCl_2 \cdot H_2O$ are typically employed. Sampling for ^{13}C must be done in closed systems because the exchange with atmospheric CO_2 reservoir may impact the carbon isotopic composition. This procedure is similar to the sampling for radiocarbon on a very small scale hence sometimes there is a chance of more error. In some investigations, secondary carbonates from aquifer formations are necessary for characterization purpose. The measurements for ^{13}C and ^{18}O are carried out in a laboratory on carbon dioxide evolved by acidification under vacuum.

3.6.2 Sampling for C–14 in DIC

About 2.5 g of carbon is required for measurement of carbon-14 activity by gas proportional counting (GPC) or liquid scintillation counting (LSC). For example, for water containing 250 mg/L bicarbonate, a sample of 60 litres is sufficient. If the total alkalinity content is lower, a proportionally larger water volume is required. In order to avoid shipment of large volumes of water, a procedure for precipitating the dissolved carbonate species is used as described below.

The volume of water required for carbon-14 sampling depends on the concentration of carbonate species in the water. About 2.5 g of carbon is desired which corresponds to approximately 12.5 g of bicarbonate. The minimum required volume of water sample may be estimated by the total alkalinity titration. Any silicate, borate, hydroxide etc. in the water will also be included in the titration and may give higher alkalinity value. The result is an underestimation of the volume of water sample required. Hence, as a general rule, it is recommended to sample 25 % more than the volume obtained by

the calculation. The Table-2 below serves as a general guide for amount of water sample and barium chloride required for precipitation of carbonates for ^{14}C measurement. The main precaution to be observed in sampling for ^{14}C is minimum exposure to the atmosphere. The atmospheric carbon dioxide is contaminated with ^{14}C from the fallout and if incorporated into the sample, it will result in age that is too recent.

It is possible to carry out the precipitation in the field. The procedure for obtaining the sample for carbon-14 analysis consists of precipitating the carbonates from a water sample in a conical precipitation apparatus of about 60 litres capacity with a stopcock/spigot for collection of precipitate. The procedure is very simple, but requires attention to details, particularly minimising the exposure to air. The precipitate is formed by adding barium chloride to the water after adjusting the pH to about 11, which converts all bicarbonate to carbonates. A mixed precipitate of barium carbonate and co-precipitated sulphate is formed. Normally, such a precipitate is very fine and requires several hours to settle completely. Iron salt (ferrous sulphate: $FeSO_4 \cdot 7H_2O$) and polyacrylamide, flocculating agents, are added to shorten settling time. The precipitate is collected in 1-litre bottle and shipped to the laboratory. Proper labelling of all sample bottles before shipment should be ensured. Sampling for radiocarbon must be accompanied by sampling for ^{13}C and careful determination of sample temperature, pH, alkalinity, conductivity, dissolved oxygen, and major ion chemistry.

Table-2: Volume of water and $BaCl_2 \cdot 2H_2O$ required for sampling of ^{14}C in DIC.

SO_4^{2-} (mg/L) →	0	50	100	200	400	500	600	800	1000	1500	2000	Volume of Sample (L) For 3 g C
Alkalinity HCO_3^{1-} (mg/L)	Minimum $BaCl_2 \cdot 2H_2O$ required per 50 L sample volume (g)											
10	1	4	7	14	24	32	38	50	65	93	133	1500
25	2.5	6	9	15	26	34	40	53	66	96	137	600
50	5	8	11	18	30	37	43	56	69	100	140	300
100	10	13	16	23	35	42	48	61	74	105	145	150
150	15	18	21	28	40	47	53	66	79	110	150	100
200	20	23	26	33	45	52	58	71	84	115	155	75
250	25	28	31	38	50	57	63	76	89	120	160	60
300	30	33	36	43	55	62	68	81	94	125	165	60
350	35	38	41	48	60	67	73	86	99	130	170	50
400	40	43	46	53	65	72	78	91	104	135	175	44
450	45	48	51	58	70	77	83	96	109	140	180	35
500	50	53	56	63	75	82	88	101	114	145	185	30
600	60	63	66	73	85	92	98	111	124	155	195	25
1000	100	103	106	113	125	132	138	151	164	195	235	15

The accelerator mass spectrometric (AMS) technique requires only 5 mg carbon for measurement. This reduces the sample size drastically. Direct sampling of water (250 mL to 1 L depending on alkalinity) in dense plastic or glass bottles with absolutely tight caps is recommended. The procedure is same as outlined in the section 3.6.1. If biological activity is suspected, sodium azide (NaN_2) should be added. The sample is acidified in the laboratory to extract the CO_2 for further processing. The other way of sampling DIC for AMS is precipitating $BaCO_3$ from 250 mL to 1 L water sample as discussed in the preceding section. The precipitate could be processed at the AMS facility for desired measurements. A special care should be exercised to avoid atmospheric or other contamination during the sampling.

Table-3: Summary of sampling for ^{13}C and ^{14}C in dissolved inorganic carbon in water samples.

Isotope	Method of Analysis	Analytical precision	Sample amount	Field measurement, preservation and sampling bottle	Storage
^{13}C	IRMS	± 0.15 ‰	10 mg HCO_3^{1-}	pH, temp., alkalinity, NaN_2, glass/plastic bottle	Months, 4ºC
	IRMS	± 0.15 ‰	25 mg $BaCO_3$	pH, temp., alkalinity, $BaCO_3$ precipitation, plastic bottle	~1 year
^{14}C	C_6H_6 + LSC	± 0.3 pMC	0.5-3 g C	pH, temp., alkalinity, $BaCO_3$ precipitation, ^{13}C, plastic bottle	~1 year
	Carbasorb® + LSC	± 5 pMC	1-3 g C	pH, temp., alkalinity, ^{13}C, plastic bottle, $BaCO_3$ precipitation or Strip CO_2 into Carbasorb solution	Unlimited

	CO_2 + GPC	<± 0.3 pMC	3-5 g C	pH, temp., alkalinity, $BaCO_3$ precipitation, ^{13}C, plastic bottle	~1 year
	AMS	<±0.3 pMC	5 mg C	pH, temp., alkalinity, ^{13}C, plastic bottle, $BaCO_3$ precipitation or Glass/plastic bottle + CO_2 evolution	~1 year Months, 4°C

3.7 Sampling for Carbon Isotopes in Dissolved Organic Carbon (DOC)

The fulvic acids are thought to represent the soil component of DOC. The DOC concentrations in groundwater are generally low (<5 mg/L). Therefore, large amounts of groundwater are required to extract DOC.

The high molecular weight (HMW, representing humic acids (HA)) and low molecular weight (LMW, representing fulvic acids (FA)) fractions of DOC are isolated from large groundwater samples (20-120 L depending upon the carbon contents) for ^{14}C and ^{13}C analyses. The samples are filtered through 0.45 μm membrane filters and acidified to pH 2 with hydrochloric acid to precipitate the HA component (HMW). The residual fulvic acid fraction of the DOC is isolated from water sample using ion exchange resin. Although it may not be possible to collect the entire DOC present in water sample, more than 80 % of DOC can be extracted by this method. The DOC can then be eluted from resin and dried in the laboratory. CO_2 is produced by combustion of DOC for ^{13}C determination and ^{14}C by AMS technique.

Table-4: Summary of sampling for ^{13}C and ^{14}C in dissolved organic carbon in water samples.

Isotope	Method of Analysis	Analytical precision	Sample amount	Field measurement, preservation and sampling bottle	Storage
^{13}C	IRMS	± 0.5 ‰	20 mg C	pH, filtration, ion exchange resin, NaN_2, glass bottle	1 month
^{14}C	AMS	± 0.5 pMC	5 mg C	pH, filtration, ion exchange resin, NaN_2, glass bottle	<1 month on resin

3.8 Sampling of Dissolved Nitrogen (Nitrate and Ammonium) for ^{15}N and ^{18}O

The dissolved inorganic nitrogen-15 is measured as $\delta^{15}N$ of nitrate or/and ammonium. ^{15}N sampling requires large amounts of water samples, but NO_3^{1-} and NH_4^{1+} components can be collected by concentrating them on anion or cation exchange resins, respectively. The sample can also be boiled to enrich nitrate, but if the investigator is also interested in ammonium, the sample should be first acidified with concentrated sulphuric acid to a pH < 2 to prevent volatile losses during boiling. This reduces the quantity of water sample for processing. About 200 μg nitrogen required for ^{15}N analysis using IRMS. Therefore, the amount of water required on the basis of nitrate concentration in water can be determined. However, the investigator should first contact the analytical laboratory to know the amount of nitrogen required for analysis in order to collect appropriate sample of water. The samples are filtered through 0.45 μm filters (0.1 μm filters are preferred if available) and collected in rinsed glass bottles. Concentrated sulphuric acid or hydrochloric acid is added to lower the ph to less than 2 in order to preserve the sample against biological activity. Sodium azide (NaN_2) and nitric acid are not appropriate for preservation in this case, as these will alter nitrogen isotope composition of a sample. Samples need to be sent to the laboratory as early as possible.

3.8.1 Oxygen-18 in Nitrate

Nitrate is also analysed for oxygen-18 in some laboratories. Less than 1 mM NO_3^{1-} is required for measuring ^{18}O, and the sample collected for nitrate is also used for oxygen-18. The PO_4^{3-} and SO_4^{2-} interfere with ^{18}O in nitrate. Therefore, these are removed by adding $BaCl_2$ solution after passing the sample through a column to exchange cations for H^+. Then the filtrate is dried and cooked with $Hg(CN)_2$ at 550ºC to produce CO_2 for mass spectrometric measurement of ^{18}O.

Table-5: Summary of sampling Nitrate (NO_3^{1-}) and Ammonium (NH_4^{1+}) for ^{15}N and ^{18}O.

Isotope	Method of Analysis	Analytical precision	Sample amount	Field measurement, preservation and sampling bottle	Storage
^{15}N	IRMS	± 0.2 ‰	4 mg N_2	Acidification to pH 2 with HCl, glass bottle	~3 months
^{18}O	IRMS	± 0.5 ‰	25 mg NO_3	Acidification to pH 2 with HCl, glass bottle	~3 months

3.9 Sampling of Dissolved Sulphate and Sulphide for ^{34}S and ^{18}O

Sampling of aqueous sulphate for ^{34}S is simple when no sulphides are present. The $BaSO_4$ precipitation is achieved by adding $BaCl_2 \cdot 2H_2O$ to water sample at low pH (4 to 5) to discourage the precipitation of carbonates as $BaCO_3$. The volume of water is collected depending upon the concentration of sulphate in water. About 20 mg $BaSO_4$ is required for ^{34}S measurement. The following table may be used as a rough guide to deduce the amount of water required and $BaCl_2 \cdot 2H_2O$ to be added to develop $BaSO_4$ precipitate.

Aqueous Sulphate (mg/L)	Volume of sample	$BaCl_2 \cdot 2H_2O$
10	2 L	~ 100 mg
50	500 mL	~ 150 mg
100	250 mL	~ 150 mg
200	100 mL	~ 100 mg

When the amount of sulphate is very low in the water sample, anion exchange resin could be used to concentrate the sulphate. The collection of sulphate on exchange resins avoids the problems of incomplete precipitation of $BaSO_4$ in dilute samples. Groundwater samples with low sulphate contents are first acidified and then passed through ion exchange columns. This reduces the volume of concentrated $BaCl_2$ added to elute sulphate from the resin. The $BaSO_4$ precipitate is collected in a 20 mL HPDE bottle by filtration.

The presence of dissolved sulphide can be detected by smell. If sulphide is present, the exposure of the sample to atmospheric oxygen should be avoided as it will convert sulphide to sulphate and the neither component will represent the representative *in situ* conditions. Groundwater samples are filled in a clean 2 L bottle (using a tygon tube placed at the bottom of the bottle to avoid contact with air) containing 1 to 2 g of cadmium acetate to precipitate sulphides. A bright yellow precipitate forms, which is separated by filtering. The filtrant is then used to precipitate sulphate as described above using $BaCl_2$. One can also use less toxic zinc acetate that forms white precipitate.

3.9.1 Oxygen-18 in Sulphate

Sulphate is also analysed for oxygen-18 in some laboratories. For ^{18}O measurements, there is no need of separate sampling and sample collected for ^{34}S could be used for the purpose. CO_2 is produced by the combustion of sulphate-graphite mixtures at high temperatures for mass spectrometric measurement of ^{18}O.

Table-6: Summary of sampling of dissolved sulphate (SO_4^{2-}) and sulphide (H_2S, HS^{1-}) for ^{34}S and ^{18}O.

Isotope	Method of Analysis	Analytical precision	Sample size	Field measurement, treatment and sample bottle	Storage
$^{34}S(SO_4^{2-})$	IRMS	± 0.3 ‰	20 mg $BaSO_4$	Filtration of sulphate, plastic bottle	Unlimited
$^{18}O(SO_4^{2-})$	IRMS	± 0.5 ‰	0.1 g SO_4		Unlimited
^{34}S (H_2S, HS^{1-})	IRMS	± 0.3 ‰	25 mg CdS	Filtration of sulphide, plastic bottle	Unlimited

3.10 Sampling for Strontium–87

For strontium analysis ($^{87}Sr/^{86}Sr$) only a 100 mL water sample is collected, filtered through a 0.45 μm membrane filter and acidified to pH < 2. pre-cleaned glass or HDPE bottles are sufficient for sampling. Strontium in the sample is separated using a cation exchange column, purified, and processed for mass spectrometric measurement using Thermal

Ionisation Mass Spectrometer (TIMS).

3.11 Sampling of halides for ^{36}Cl, ^{37}Cl, and ^{129}I

In general, halides in water samples are conservative. Hence, their sampling is simple and involves only the collection and shipment of water to the laboratory without any preservation or treatment. About 1-10 mg chloride or iodide is required for the measurement using AMS. Water samples are filtered through 0.45 μm membrane filters and shipped to the laboratory in HDPE or glass bottles. 250 mL to 1 L volume is sufficient for chlorine isotopes. These isotopes are useful in salinity studies where dissolved solids are high. However, iodide in groundwaters may be in low quantities and due care should be exercised to collect appropriate volume of water sample to obtain sufficient amount for measurement.

Table-7: Summary of sampling of halides for chlorine and iodine isotopes.

Isotope	Method of Analysis	Analytical precision	Sample size	Field measurement, treatment and sampling bottle	Storage
^{37}Cl	IRMS	± 0.1 ‰	1-10 mg Cl	filtration, plastic bottle	Unlimited
^{36}Cl	AMS	$\pm 10^{-15}$	1-10 mg Cl	filtration, plastic bottle	Unlimited
^{129}I	AMS	$\pm 10^{-15}$	2-10 mg I	filtration, plastic bottle	Unlimited

3.12 Sampling for Gases in Groundwater

Major gases such as N_2, O_2, CO_2, and CH_4 and noble gases like He, Ar, Kr, Xe, etc. are useful in groundwater, limnological, and oceanographic studies. The sampling procedures for major gases and noble gases are described below. However, it is recommended that the analysing laboratory may be contacted in advance to understand protocol for particular sampling. Utmost care should be exercised to avoid atmospheric contamination.

3.12.1 Major Gases

Major gases and their isotopic ratios can provide additional insights into the isotopic and geochemical processes taking place in the subsurface. Sampling a separate gas phase in a spring or artesian well can be done easily provided a small pool exists at the discharge point and gas bubbles are formed. A well-rinsed glass bottle is filled with sample water and inverted into water. A funnel is fitted into the neck of the bottle and gas in the form of rising bubbles is collected displacing at least 50 % of the volume of water. The funnel is removed and bottle is capped under water surface. The sample bottle is transported upside-down to keep the cap wet and minimize the loss of gas through diffusion. Reversing the procedure in the laboratory allows extraction of a portion of the gas for analysis. Alternatively, screw cap with a silicon septum can be used with the bottle through which the gas can be taken out by a syringe. If flowing boreholes exist, a simple flow-through arrangement based on the displacement technique can be installed. Glass or thick-walled polypropylene bottles can be used to collect the major gases samples, alternatively empty soda pop or soft drinks bottles with a screw cap work fine.

In many confined aquifers, degassing can occur and a gas phase may not naturally exist. Depth samplers are used to collect water samples at formation pressures and gas phase is separated in the laboratory by flushing the water sample with helium (used as a carrier gas in gas chromatography).

3.12.2 Sampling for Noble Gases

For helium sampling, a glass vessel, of about 100 mL volume, with stopcocks at both ends can be used. Alternatively, soft copper tubes (10 mm diameter, ~50 cm length) with clamps at both ends can also be used for sampling. A crib is used to hold a 50 cm tube with the clamps partially tightened at both ends. The copper tubing is connected to an outlet of a well and the system is pressurised by restricting the flow through the tubing. After several sample volumes have been discharged to remove adsorbed gases on the copper, the clamps at the exit and then the one at the inlet are closed.
Not all wells or pumps are suitable for noble gas sampling. It is very important that any contact of water with air or any other gas phase is avoided during the sampling process. Closed boreholes are necessary, open wells or springs hardly work, as they allow the gas exchange with the atmosphere. The water should be kept under enough pressure to avoid degassing. Wells pumped using a submersible pump are ideal. General guidelines are mentioned below:

- Pump long enough to flush the borehole completely.

- Avoid pressure tanks, sucking pumps, and any contact with air or gas phases.
- Connect the copper tube by a tight combination of tubings.
- Check if the connections withstand the pressure when the outlet is closed.
- Flush the tubing, remove bubbles in the hoses, and keep pressure high.
- Check that the Cu-tube is approximately centred on the clamp.
- Close clamp at the outlet completely (no free space), then at the inlet. Protect the ends of the copper tube from bending and breaking. Label the samples with all on-site details.

Argon must be degassed from a large volume of water in the field. From a few hundred litres of a water sample gases are extracted and argon is separated using gas chromatographic techniques. The proportional counting of the ^{39}Ar (β^- decay) requires at least 2 L of argon extracted from about 15 m^3 of water. This degassing procedure is carried out in the field using special customised equipment. In the laboratory, the gas is purified using physical and chemical methods. Measurements are made by counting β^- decay events in a high-pressure gas proportional counter over a period of about one month.

For ^{85}Kr measurements, about 20 μL of krypton gas is needed, which is extracted from a 100 L groundwater sample in a vacuum chamber customised to prevent atmospheric contamination. By contrast, due to the extremely low concentrations of ^{81}Kr in groundwater, it requires large volumes, a few hundred litres, for extraction of krypton which is then measured by counting atoms using AMS.

3.13 Sampling of Geothermal Fluids

In geothermal fluids (hot water, steam, and gases), isotope ratios such as $\delta^{18}O$ in water and sulphate, $\delta^{2}H$ in water and hydrogen gas, $\delta^{34}S$ in sulphate and sulphide, $\delta^{13}C$ in CO_2, CH_4, and aqueous carbonate species, etc. along with chemistry provide information on origin, geothermometry, and dynamics of a system.

A sample of geothermal fluids should be collected from narrow vents rather than large pools as an exposure of thermal water to the atmosphere in large pools may change their chemical and isotopic composition. The procedures and precautions for water and gas sampling discussed in the preceding sections apply to geothermal fluids as well. If the water samples are of high temperature, a cooling coil may be needed to decrease the temperature of the water before collection into bottles. It is recommended to collect both steam and gas because such sampling provides more information than collection of a dry gas samples alone.

3.14 On–site Measurements and Sampling for Chemistry

The on site measurements of physico-chemical parameters and chemistry of water are necessary for calculations and corrections as well as for interpretation of stable and radioactive isotopes data in hydrological investigations. Temperature, electrical conductivity (EC), pH, dissolved oxygen, alkalinity, etc. should be carried out in the field using portable equipment. Sampling, filtration, treatment and preservation for chemistry should be carried out employing standardised procedures.

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