Annex L

Standard Analytical Methods

Table 1 Analytical Methods for Soil

Parameters	Analytical Method	MRL
pH	Electrometric Method	-
Organic Matter	Walky and Black Method	-
Soil Texture, % Silt, Sand, Clay	Sieve Analysis, Hydrometer Method	-
Available Phosphorous, Avail. P	Bray II Method	-
Exchangeable Potassium, Exch. K	Add NH_3 OAc and Flame AAS Method	-
Exchangeable Calcium, Exch. Ca	Add NH_3 OAc and Flame AAS Method	-
Exchangeable Magnesium, Exch, Mg	Add NH_3 OAc and Flame AAS Method	-
Electrical Conductivity, EC	Electrical Conductivity Method	0.5 dS/m
Salinity	Electrical Conductivity Method	0.0005 dS/m
Chloride, Cl^-	Mercuric Nitrate Method	1.0 mg/kg
Total Nitrogen	Dumas Method	-
Arsenic, As	Hydride Generation AAS Method	0.010 mg/kg
Barium, Ba	Direct Nitrous Oxide-Acetylene Flame Method	5.00 mg/kg
Cadmium, Cd	Direct Air-Acetylene Flame Method	1.00 mg/kg
Total Chromium, Cr	Direct Air-Acetylene Flame Method	2.50 mg/kg
Cr^{6+}	Colorimetric Method	0.10 mg/kg
Lead, Pb	Direct Air-Acetylene Flame Method	5.00 mg/kg
Mercury, Hg	Cold-Vapor AAS Method	0.10 mg/kg
Nickel, Ni	Direct Air-Acetylene Flame Method	2.00 mg/kg
Selenium, Se	Hydride Generation AAS Method	0.010 mg/kg
Silver, Ag	Direct Air-Acetylene Flame Method	1.50 mg/kg
Extractable Copper, Cu	Direct Air-Acetylene Flame Method	1.50 mg/kg
Extractable Iron, Fe	Direct Air-Acetylene Flame Method	2.50 mg/kg
Extractable Manganese, Mn	Direct Air-Acetylene Flame Method	0.15 mg/kg
Extractable Sulpher, S	Turbidimetric Method	-
Extractable Zinc, Zn	Direct Air-Acetylene Flame Method	0.50 mg/kg
TPH-Dext		
- Kerosene Range Hydrocarbons (C_{10}-C_{14})	Gas Chromatography Method	21.8-27.7 mg/kg
- Diesel Range Hydrocarbons (C_{15}-C_{28})	Gas Chromatography Method	21.8-27.7 mg/kg
- Heavy Oil Range Hydrocarbons (C_{29}-C_{36})	Gas Chromatography Method	87.1-111.0 mg/kg
TPH-Gas+BTEX		
- Gasoline Range Hydrocarbons (C_5-C_{12})	Gas Chromatography Method	15.6-19.8 mg/kg
- Benzene (C_6)	Gas Chromatography Method	0.208-0.264 mg/kg
- Toluene (C_7)	Gas Chromatography Method	0.208-0.264 mg/kg
- Ethylbenzene (C_8)	Gas Chromatography Method	0.208-0.264 mg/kg
- Xylenes (C_9)	Gas Chromatography Method	0.625-0.793 mg/kg
Polycyclic Aromatic Hydrocarbons (PAHs)		
- 1 –Methylnaphthalene	Gas Chromatography/Mass Spectrometry Method	5.3-7.4 µg/kg
- 2-Methylnaphthalene	Gas Chromatography/Mass Spectrometry Method	5.3-7.4 µg/kg
- Acenaphthene	Gas Chromatography/Mass	5.3-7.4 µg/kg

Parameters	Analytical Method	MRL
	Spectrometry Method	
- Acenaphthylene	Gas Chromatography/Mass Spectrometry Method	5.3-7.4 µg/kg
- Anthracene	Gas Chromatography/Mass Spectrometry Method	5.3-7.4 µg/kg
- Benzo[a]anthracene	Gas Chromatography/Mass Spectrometry Method	5.3-7.4 µg/kg
- Benzo[a]pyrene	Gas Chromatography/Mass Spectrometry Method	5.3-7.4 µg/kg
- Benzo[b]fluoranthene	Gas Chromatography/Mass Spectrometry Method	5.3-7.4 µg/kg
- Benzo[g,h,i]perylene	Gas Chromatography/Mass Spectrometry Method	5.3-7.4 µg/kg
- Benzo[k]fluoranthene	Gas Chromatography/Mass Spectrometry Method	5.3-7.4 µg/kg
- Chrysene	Gas Chromatography/Mass Spectrometry Method	5.3-7.4 µg/kg
- Dibenz(a,h)anthracene	Gas Chromatography/Mass Spectrometry Method	5.3-7.4 µg/kg
- Fluoranthene	Gas Chromatography/Mass Spectrometry Method	5.3-7.4 µg/kg
- Fluorene	Gas Chromatography/Mass Spectrometry Method	5.3-7.4 µg/kg
- Indeno[1,2,3-cd]pyrene	Gas Chromatography/Mass Spectrometry Method	5.3-7.4 µg/kg
- Naphthalene	Gas Chromatography/Mass Spectrometry Method	5.3-7.4 µg/kg
- Phenanthrene	Gas Chromatography/Mass Spectrometry Method	5.3-7.4 µg/kg
- Pyrene	Gas Chromatography/Mass Spectrometry Method	5.3-7.4 µg/kg

Note: MRL means Method Reporting Limit
dS/m means deciSiemens per metre
mg/kg on dry weight basis
µg/kg on dry weight basis

Table 2 Analytical Methods Ambient Air Quality

Parameters	Averaging Time	Sampling/Analytical Method	MRL
TSP	24-hour	High Volume Air Sampler, Gravimetric Method	0.1 mg
PM10	24-hour	Size Selective, High Volume Air Sampler, Gravimetric Method	0.1 mg
CO	8-hour	CO Analyzer, Non Dispersive Infrared Method	0.1 ppm
NO_2	1-hour	NO_2 Analyzer, Chemiluminescence Method	0.1 ppb
SO_2	24-hour	SO_2 Analyzer, Ultraviolet Fluorescense Method	0.1 ppb
SO_2	1-hour	SO_2 Analyzer, Ultraviolet Fluorescense Method	0.1 ppb
Wind Speed and Wind Direction		Wind Vane and Cup Anemometer	0.5 m/s

Note: MRL means Method Reporting Limit

Table 3 Analytical Methods Ambient Noise Quality

Parameter	Sampling Method	MRL
L_{eq} 1 hr	Integrated Sound Level Meter	28 db(A)
L_{eq} 24 hr		
L_{dn}		
L_{10}		
L_{90}		
L_{max}		

Note: MRL means Method Reporting Limit

Table 4 Analytical Methods for Surface Water Quality

Parameter	Container	Preservation Method	Analytical Method	Preserved Duration	MRL
Physical Properties					
Temperature	P, G	-	Field Method	in situ	-
pH	P, G	-	Electrometric Method	in situ	-
Electrical Conductivity (EC)	P, G	-	Electrical Conductivity Method	in situ	0.5 µS
Salinity	P, G	-	Electrical Conductivity Method	in situ	-
Total Dissolved Solids (TDS)	P, G	Stored cold at 4°C	Dried at 180 °C	7 days	50 mg/l
Total Suspended Solids (TSS)	P, G	Stored cold at 4°C	Dried at 103-105 °C	7 days	2.5 mg/l
Chemical Properties					
Biochemical Oxygen Demand (BOD)	P, G	Stored cold at 4°C	5-day BOD Test, Azide Modification Method	48 hours	-
Dissolved Oxygen (DO)	G	Preserved with $MnSO_4$ and AIA 2 ml	Azide Modification Method	8 hours	-
Inorganic Substances					
Alkalinity, HCO_3^-, CO_3^{2-}	P, G	Stored cold at 4°C	Tritation Method	14 days	1.0 mg/l as $CaCO_3$
Ammonia Nitrogen, NH_3-N	P, G	Add H_2SO_4 to pH<2 and store cold at 4°C	Phenate Method	28 days	0.010 mg/l
Chloride, Cl^-	P, G	-	Mercuric Nitrate Method	28 days	1.0 mg/l
Cyanide, CN^-	P, G	Add NaoH to pH>12 and store cold at 4°C	Pyridine Barbituric Acid Method	14 days	0.005 mg/l
Nitrate Nitrogen, NO_3^--N	P, G	Stored cold at 4°C	Cadmium Reduction Method	48 hours	0.010 mg/l
Phosphate, PO_4^{3-}	P, G	Add H_2SO_4 to pH<2 and store cold at 4°C	Ascorbic Acid Method	28 days	0.005 mg/l
Sulfate, SO_4^{2-}	P, G	Stored cold at 4°C	Turbidimetric Method	28 days	1.0 mg/l
Metals					
Calcium, Ca	P, G	Add HNO_3 to pH<2 and store cold at 4°C	Direct Nitrous Oxide-Acetylene Flame Method	6 Months	0.02 mg/l
Magnesium, Mg	P, G	Add HNO_3 to pH<2 and store cold at 4°C	Direct Air-Acetylene Flame Method	6 Months	0.003 mg/l
Potassium, K	P, G	Add HNO_3 to pH<2 and store cold at 4°C	Direct Air-Acetylene Flame Method	6 Months	0.01 mg/l
Sodium, Na	P, G	Add HNO_3 to pH<2 and store cold at 4°C	Direct Air-Acetylene Flame Method	6 Months	0.01 mg/l
Barium, Ba	P, G	Add HNO_3 to pH<2 and store cold at 4°C	Direct Nitrous Oxide-Acetylene Flame Method	6 Months	0.10 mg/l

Parameter	Container	Preservation Method	Analytical Method	Preserved Duration	MRL
Cadmium, Cd	P, G	Add HNO_3 to pH<2 and store cold at 4°C	Electrothermal AAS Method	6 Months	0.00005 mg/l
Total Chromium, Cr	P, G	Add HNO_3 to pH<2 and store cold at 4°C	Electrothermal AAS Method	6 Months	0.0005 mg/l
Copper, Cu	P, G	Add HNO_3 to pH<2 and store cold at 4°C	Direct Air-Acetylene Flame Method	6 Months	0.03 mg/l
Iron, Fe	P, G	Add HNO_3 to pH<2 and store cold at 4°C	Direct Air-Acetylene Flame Method	6 Months	0.05 mg/l
Lead, Pb	P, G	Add HNO_3 to pH<2 and store cold at 4°C	Electrothermal AAS Method	6 Months	0.002 mg/l
Manganese, Mn	P, G	Add HNO_3 to pH<2 and store cold at 4°C	Direct Air-Acetylene Flame Method	6 Months	0.02 mg/l
Mercury, Hg	P, G	Add HNO_3 to pH<2 and store cold at 4°C	Cold-Vapor AAS Method	28 days	0.0003 mg/l
Nickel, Ni	P, G	Add HNO_3 to pH<2 and store cold at 4°C	Electrothermal AAS Method	6 Months	0.0005 mg/l
Zinc, Zn	P, G	Add HNO_3 to pH<2 and store cold at 4°C	Direct Air-Acetylene Flame Method	6 Months	0.01 mg/l
Arsenic, As	P, G	Add HNO_3 to pH<2 and store cold at 4°C	Hydride Generation AAS Method	6 Months	0.0002 mg/l
Selenium, Se	P, G	Add HNO_3 to pH<2 and store cold at 4°C	Hydride Generation AAS Method	6 Months	0.0002 mg/l
Total Petroleum Hydrocarbons					
- TPH-Dext					
- Kerosene Range Hydrocarbons (C_{10}-C_{14})	G*	Add HCl to pH<2 and store cold at 4°C	Gas Chromatography Method	7 days	0.250 mg/l
- Diesel Range Hydrocarbons (C_{15}-C_{28})	G*	Add HCl to pH<2 and store cold at 4°C	Gas Chromatography Method	7 days	0.250 mg/l
- Heavy Oil Range Hydrocarbons (C_{29}-C_{36})	G*	Add HCl to pH<2 and store cold at 4°C	Gas Chromatography Method	7 days	0.500 mg/l
- TPH-Gas+BTEX					
- Gasoline Range Hydrocarbons (C_5-C_{12})	G*	Add HCl to pH<2 and store cold at 4°C	Gas Chromatography Method	14 days	400 µg/l
- Benzene (C6)	G*	Add HCl to pH<2 and store cold at 4°C	Gas Chromatography Method	14 days	4.00 µg/l
- Toluene (C7)	G*	Add HCl to pH<2 and store cold at 4°C	Gas Chromatography Method	14 days	4.00 µg/l
- Ethylbenzene (C8)	G*	Add HCl to pH<2 and store cold at 4°C	Gas Chromatography Method	14 days	4.00 µg/l
- Xylenes (C9)	G*	Add HCl to pH<2 and store cold at 4°C	Gas Chromatography Method	14 days	12.0 µg/l

Parameter	Container	Preservation Method	Analytical Method	Preserved Duration	MRL
Biological Properties					
Total Coliform Bacteria, TCB	P, G	Store cold at 4°C	Multiple Tube Fermentation Technique Method	24 hours	1.8 M.P.N./100 ml
Fecal Coliform Bacteria, FCB	P, G	store cold at 4°C	Multiple Tube Fermentation Technique Method	24 hours	1.8 M.P.N./100 ml

Note : MRL means Method Reporting Limit
P means plastic bottle
G means glass bottle
G* means glass bottle with Teflon lined caps

Source: STS Green (2014)

Table 5 Analytical Methods for Groundwater Quality

Parameter	Container	Preservation Method	Analytical Method	Preserved Duration	MRL
Physical Properties					
Temperature	P, G	-	Field Method	in situ	-
pH	P, G	-	Electrometric Method	in situ	-
Electrical Conductivity, EC	P, G	-	Electrical Conductivity Method	in situ	0.5 µS
Salinity	P, G	-	Electrical Conductivity Method	in situ	-
Total Dissolved Solids, TDS	P, G	Stored cold at 4°C	Dried at 180 °C	7 days	50 mg/l
Total Suspended Solids, TSS	P, G	Stored cold at 4°C	Dried at 103-105 °C	7 days	2.5 mg/l
Chemical Properties					
Inorganic Substances					
Chloride, Cl^-	P, G	-	Mercuric Nitrate Method	28 days	1.0 mg/l
Cyanide, CN^-	P, G	Add NaoH to pH>12 and store cold at 4°C	Pyridine Barbituric Acid Method	14 days	0.005 mg/l
Metals					
Arsenic, As	P, G	Add HNO_3 to pH<2 and store cold at 4°C	Hydride Generation AAS Method	6 Months	0.0002 mg/l
Barium, Ba	P, G	Add HNO_3 to pH<2 and store cold at 4°C	Direct Nitrous Oxide-Acetylene Flame AAS Method	6 Months	0.10 mg/l
Cadmium, Cd	P, G	Add HNO_3 to pH<2 and store cold at 4°C	Electrothermal AAS Method	6 Months	0.00005 mg/l
Total Chromium, Cr	P, G	Add HNO_3 to pH<2 and store cold at 4°C	Electrothermal AAS Method	6 Months	0.0005 mg/l
Copper, Cu	P, G	Add HNO_3 to pH<2 and store cold at 4°C	Direct Air-Acetylene Flame AAS Method	6 Months	0.03 mg/l
Iron, Fe	P, G	Add HNO_3 to pH<2 and store cold at 4°C	Direct Air-Acetylene Flame AAS Method	6 Months	0.05 mg/l
Lead, Pb	P, G	Add HNO_3 to pH<2 and store cold at 4°C	Electrothermal AAS Method	6 Months	0.002 mg/l
Manganese, Mn	P, G	Add HNO_3 to pH<2 and store cold at 4°C	Direct Air-Acetylene Flame AAS Method	6 Months	0.02 mg/l
Mercury, Hg	P, G	Add HNO_3 to pH<2 and store cold at 4°C	Cold-Vapor AAS Method	28 days	0.0003 mg/l
Nickel, Ni	P, G	Add HNO_3 to pH<2 and store cold at 4°C	Electrothermal AAS Method	6 Months	0.0005 mg/l
Selenium, Se	P, G	Add HNO_3 to pH<2 and store cold at 4°C	Hydride Generation AAS Method	6 Months	0.0002 mg/l
TPH-Dext					
- Kerosene Range Hydrocarbons (C_{10}-C_{14})	G*	Add HCl to pH<2 and store cold at 4°C	Gas Chromatography Method	7 days	0.250 mg/l

Parameter	Container	Preservation Method	Analytical Method	Preserved Duration	MRL
- Diesel Range Hydrocarbons (C15-C28)	G*	Add HCl to pH<2 and store cold at 4°C	Gas Chromatography Method	7 days	0.250 mg/l
- Heavy Oil Range Hydrocarbons (C29-C36)	G*	Add HCl to pH<2 and store cold at 4°C	Gas Chromatography Method	7 days	0.500 mg/l
TPH-Gas+BTEX					
- Gasoline Range Hydrocarbons (C_5-C_{12})	G*	Add HCl to pH<2 and store cold at 4°C	Gas Chromatography Method	14 days	400 µg/l
- Benzene (C_6)	G*	Add HCl to pH<2 and store cold at 4°C	Gas Chromatography Method	14 days	4.00 µg/l
- Toluene (C_7)	G*	Add HCl to pH<2 and store cold at 4°C	Gas Chromatography Method	14 days	4.00 µg/l
- Ethylbenzene (C_8)	G*	Add HCl to pH<2 and store cold at 4°C	Gas Chromatography Method	14 days	4.00 µg/l
- Xylenes (C_9)	G*	Add HCl to pH<2 and store cold at 4°C	Gas Chromatography Method	14 days	12.0 µg/l

Note : MRL means Method Reporting Limit
P means plastic bottle
G means glass bottle
G* means glass bottle with Teflon lined caps

Source: STS Green (2014)