

**BEFORE THE NATIONAL GREEN
TRIBUNAL SOUTHERN BENCH, CHENNAI
Original Application No. 14 of 2021.**

In the matter of:

In Re: **“Water Pollution: will Vizag be another Eluru”.**

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**JOINT CHIEF ENVIRONMENTAL ENGINEER (FAC)
AP POLLUTION CONTROL BOARD,
ZONAL OFFICE, VISAKHAPATNAM**

**Report submitted by Andhra Pradesh Pollution Control Board in
O.A No 14 of 2021 as Suo-motu based on E - magazine, BBC,
21st December 2020 on “Water Pollution: will Vizag be another Eluru”.**

1. The above application O.A No 14 of 2021 was suo-motu registered by the Hon’ble Tribunal on the basis of reports published in E - magazine, BBC, 21st December 2020 on “*Water Pollution: will Vizag be another Eluru*” on the allegations that water pollution in Meghadrigedda is causing concern to the people of Visakhapatnam, water supplied by GVMC is contaminated in many places.
2. It is submitted that the main sources of water for the people of Visakhapatnam are from Meghadrigedda Reservoir, Mudasarlova Reservoir, Raiwada Reservoir, Tatipudi reservoir and Gambhirangedda reservoir.
3. The Hon’ble Tribunal in its order dated 26.10.2021 directed the A.P. Pollution Control Board to submit report on quality of the water and the result of the analysis to come to conclusion regarding the nature of quality of water and whether water is contaminated or not, if so what are the remedial measures to be taken. Also, directed to whether the sediments from the reservoir have been collected and tested so as to ascertain as to whether there was any possibility of industrial effluent being mixed or drained in the reservoir.
4. It is submitted that APPCB carried out water sampling in 5 No.s reservoirs supplying drinking water to GVMC and analysed the drinking water parameters as per prescribed standards of Bureau of Indian Standards (BIS) IS 10500 : 2012 drinking water **(Annexure-I)**. The sample locations along with analysis results are as follows:

4.1. MUDASARLOVA RESERVOIR

4.1.A. Sampling locations:

Name of Reservoir	S. No	Location	Sample No.	Latitude	Longitude
Mudasarlova	1	Reservoir East side	W-145	17.763642	83.298179
	2	Reservoir North side	W-146	17.766634	83.297271
	3	Reservoir South side	W-147	17.764277	83.293331
	4	Inlet drain joining the reservoir (West side)	W-148	17.767303	83.289037

4.1.B. Analysis Results of the Mudasarlova Reservoir samples

S. No.	Parameter	Unit	W-145	W-146	W-147	Drinking Water Specification: IS: 10500: 2012 Requirement	
						Requirement (Acceptable Limit)	Permissible Limit in the absence of alternate source
I. Physico Chemical:							
1.	pH	--	7.80	8.19	8.20	6.5-8.5	No Relaxation
2.	Electrical Conductivity	μS/cm	607	586	589	--	--
3.	Dissolved Oxygen	--`	6.8	6.6	7.0		
4.	Total Dissolved Solids	mg/L	384	368	372	500 mg/l	2000 mg/l
5.	Biochemical Oxygen Demand	mg/L	1.8	1.6	1.4	--	--
6.	Chloride (as Cl)	mg/L	92.9	92.9	92.9	250 mg/l	1000 mg/l
7.	Total Alkalinity (as CaCO ₃)	mg/L	192	184	184	200 mg/l	600 mg/l
8.	Total Hardness (as CaCO ₃)	mg/L	140	92	108	200 mg/l	600 mg/l

9.	Calcium (as Ca)	mg/L	19.2	17.6	17.6	75 mg/l	200 mg/l
10.	Magnesium (as Mg)	mg/L	22.35	11.66	15.55	30 mg/l	100 mg/l
11.	Nitrate (as NO ₃)	mg/L	3.18	2.96	2.92	45 mg/l	No Relaxation
12.	Nitrite Nitrogen (as NO ₂ -N)	mg/L	0.01	0.01	0.01	--	--
13.	Ammonical Nitrogen (as NH ₃ -N)	mg/L	BDL	BDL	BDL	--	--
14.	Phosphate (as P)	mg/L	0.01	0.03	0.03	--	--
15.	Sulphate (as SO ₄)	mg/L	21.39	25.10	23.18	200 mg/l	400 mg/l
16.	Fluoride (as F)	mg/L	0.85	0.47	0.86	1.0 mg/l	1.5 mg/l
II Bacteriological							
17.	Fecal Coliform (MPN/100 ml)	MPN/100ml	7	4	7	-	-
18.	Total Coliform (MPN/100 ml)	MPN/100ml	39	20	28	Shall not be detectable in any 100 ml sample	-
III Heavy Metals							
19.	Chromium (as Cr)	mg/L	BDL	BDL	BDL	0.05 mg/l	No Relaxation
20.	Manganese (as Mn)	mg/L	0.001	0.001	0.001	0.1 mg/l	0.3 mg/l
21.	Iron (as Fe)	mg/L	0.011	0.015	0.008	0.3 mg/l	No Relaxation
22.	Nickel (as Ni)	mg/L	0.001	0.001	0.001	0.02 mg/l	No Relaxation
23.	Copper (as Cu)	mg/L	0.001	0.002	0.001	0.05 m/l	1.5 mg/l
24.	Zinc (as Zn)	mg/L	0.002	0.005	0.002	5 mg/l	15 mg/l
25.	Arsenic (as As)	mg/L	0.001	0.001	0.001	0.01 mg/l	0.05 mg/l
26.	Cadmium (as Cd)	mg/L	BDL	BDL	BDL	0.003 mg/l	No Relaxation
27.	Lead (as Pb)	mg/L	BDL	BDL	BDL	0.01 mg/l	No Relaxation
28.	Mercury (as Hg)	mg/L	0.0002	0.0001	BDL	0.001 mg/l	No Relaxation

IV.Pesticides		Unit	W-145	W-146	W-147	Limit
1.	Alpha - BHC	µg/l	BLQ	BLQ	BLQ	0.01
2.	Beta- BHC	µg/l	BLQ	BLQ	BLQ	0.04
3.	Gamma - BHC	µg/l	BLQ	BLQ	BLQ	2.0
4.	4,4' - DDD	µg/l	BLQ	BLQ	BLQ	1.0
5.	4,4' - DDE	µg/l	BLQ	BLQ	BLQ	1.0
6.	4,4' - DDT	µg/l	BLQ	BLQ	BLQ	1.0
7.	Aldrin	µg/l	BLQ	BLQ	BLQ	0.03
8.	Dieldrin	µg/l	BLQ	BLQ	BLQ	0.03
9.	Endosulfan - I	µg/l	BLQ	BLQ	BLQ	0.4
10.	Endosulfan Sulfate	µg/l	BLQ	BLQ	BLQ	0.4
11.	Endrin	µg/l	BLQ	BLQ	BLQ	--
12.	Heptachlor	µg/l	BLQ	BLQ	BLQ	--
13.	Heptachlorapoxide	µg/l	BLQ	BLQ	BLQ	--
14.	Methoxychlor	µg/l	BLQ	BLQ	BLQ	--
15.	Endosulfan - II	µg/l	BLQ	BLQ	BLQ	0.4 µg/l

16.	Delta - BHC	µg/l	BLQ	BLQ	BLQ	0.04 µg/l
17.	Endrin Aldehyde	µg/l	BLQ	BLQ	BLQ	--

Note: BLQ (Below Limit of Quantation (0.05µg/l))

4.1.C. Analysis results of the Inlet drain joining the reservoir

S. No.	Parameter	Unit	W-210	Drinking Water Specification: IS: 10500: 2012 Requirement	
				Requirement (Acceptable Limit)	Permissible Limit in the absence of alternate source
1.	pH	--	6.85	6.5-8.5	No Relaxation
2.	Electrical Conductivity	µS/cm	749	--	--
3.	Dissolved Oxygen	--	1.8	--	--
4.	Total Dissolved Solids	mg/l	480	500 mg/l	2000 mg/l
5.	Biochemical Oxygen Demand	mg/l	4.2	--	--
6.	Chloride (as Cl)	mg/l	83.1	250 mg/l	1000 mg/l
7.	Total Alkalinity (as CaCO ₃)	mg/l	196	200 mg/l	600 mg/l
8.	Total Hardness (as CaCO ₃)	mg/l	180	200 mg/l	600 mg/l
9.	Calcium (as Ca)	mg/l	32.0	75 mg/l	200 mg/l
10.	Magnesium (as Mg)	mg/l	24.3	30 mg/l	100 mg/l
11.	Nitrate (as NO ₃)	mg/l	3.84	45 mg/l	No Relaxation
12.	Nitrite Nitrogen (as NO ₂ -N)	mg/l	0.25	--	--
13.	Ammonical Nitrogen (as NH ₃ -N)	mg/l	0.16	--	--
14.	Phosphate (as P)	mg/l	0.83	--	--
15.	Sulphate (as SO ₄)	mg/l	36.89	200 mg/l	400 mg/l
16.	Fluoride (as F)	mg/l	0.35	1.0 mg/l	1.5 mg/l
17.	Fecal Coliform (MPN/100 ml)	MPN/100ml	15	-	-
18.	Total Coliform (MPN/100 ml)	MPN/100ml	75	Shall not be detectable in any 100 ml sample	-
19.	Chromium (as Cr)	mg/l	BDL	0.05 mg/l	No Relaxation
20.	Manganese (as Mn)	mg/l	0.172	0.1 mg/l	0.3 mg/l
21.	Iron (as Fe)	mg/l	0.083	0.3 mg/l	No Relaxation
22.	Nickel (as Ni)	mg/l	0.001	0.02 mg/l	No Relaxation
23.	Copper (as Cu)	mg/l	0.001	0.05 mg/l	1.5 mg/l
24.	Zinc (as Zn)	mg/l	0.002	5 mg/l	15 mg/l
25.	Arsenic (as As)	mg/l	0.001	0.01 mg/l	0.05 mg/l
26.	Cadmium (as Cd)	mg/l	BDL	0.003 mg/l	No Relaxation
27.	Lead (as Pb)	mg/l	BDL	0.01 mg/l	No Relaxation
28.	Mercury (as Hg)	mg/l	0.0002	0.001 mg/l	No Relaxation

Pesticides		Unit	W-210	Limit
1.	Alpha - BHC	µg/l	BLQ	0.01
2.	Beta- BHC	µg/l	BLQ	0.04
3.	Gamma - BHC	µg/l	BLQ	2.0
4.	4,4' - DDD	µg/l	BLQ	1.0
5.	4,4' - DDE	µg/l	BLQ	1.0
6.	4,4' - DDT	µg/l	BLQ	1.0
7.	Aldrin	µg/l	BLQ	0.03
8.	Dieldrin	µg/l	BLQ	0.03
9.	Endosulfan - I	µg/l	BLQ	0.4
10.	Endosulfan Sulfate	µg/l	BLQ	0.4
11.	Endrin	µg/l	BLQ	--
12.	Heptachlor	µg/l	BLQ	--
13.	Heptachlorapoxide	µg/l	BLQ	--
14.	Methoxychlor	µg/l	BLQ	--

15.	Endosulfan – II	µg/l	BLQ	0.4 µg/l
16.	Delta – BHC	µg/l	BLQ	0.04 µg/l
17.	Endrin Aldehyde	µg/l	BLQ	--

BLQ: Below Limit of Quantation (0.05µg/l)

Inference

Reservoir Water quality

APPCB collected water samples at different locations in the reservoir and analyzed for physico chemical (16 parameters), Bacteriological (2 parameters), heavy metals (10 parameters) and pesticides (17 parameters). As per the analysis of the samples, it is observed that the physico chemical parameters and heavy metals are within the prescribed standards of drinking water as per Bureau of Indian Standards (BIS) IS 10500 : 2012. Presence of Pesticides is not detected indicating that no agricultural runoff is joining into the reservoir. It is common phenomenon finding total coliforms in reservoirs storing surface water. All Municipalities employ disinfection through chlorination to make water free from coliforms and pathogens for supply of safe drinking water to public. Hence, the water of Mudasarlova Reservoir is fit for drinking purpose after disinfection. The analysis also indicates no contribution of industrial wastewater contamination.

Drain water quality joining the reservoir

APPCB collected sample from the inlet drain joining the reservoir and analyzed for physico chemical (16 parameters), Bacteriological (2 parameters), heavy metals (10 parameters) and pesticides (17 parameters). As per the analysis, all the physico chemical parameters and heavy metals are within the prescribed standards of drinking water Bureau of Indian Standards (BIS) IS 10500: 2012. Presence of Pesticides is not detected. BOD (4.2 mg/l) and total coli forms (75 MPN) are exceeding the drinking water standards. This may be due to joining of sewage from nearby residential areas located in the catchment area of Mudasarlova Reservoir.

4.2. GAMBHIRAM GEDDA RESERVOIR

4.2.A. Sampling locations

Name of Reservoir	S. No	Location	Sample No.	Latitude	Longitude
Gambheeram	5	Reservoir East side	W-139	17.876153	83.351783
	6	Reservoir South side	W-140	17.874188	83.350104
	7	Reservoir West side	W-141	17.876494	83.344224
	8	Inlet drain to reservoir (<i>West side</i>)	W-211	17.884004	83.339439

4.2.B. Analysis Results of the Gambheeram Reservoir samples

S. No.	Parameter	Unit	W-139	W-140	W-141	Drinking Water Specification: IS: 10500: 2012 Requirement	
						Requirement (Acceptable Limit)	Permissible Limit in the absence of alternate source
I. Physico Chemical:							
1.	pH	--	7.14	7.10	7.15	6.5-8.5	No Relaxation
2.	Electrical Conductivity	µS/cm	477	568	572	--	--
3.	Dissolved Oxygen	--	7.5	6.0	4.6		
4.	Total Dissolved Solids	mg/L	316	372	384	500 mg/l	2000 mg/l
5.	Biochemical Oxygen Demand	mg/L	1.4	1.6	1.6	--	--

6.	Chlorides (as Cl)	mg/L	63.5	68.4	73.3	250 mg/l	1000 mg/l
7.	Total Alkalinity (as CaCO ₃)	mg/L	172	180	184	200 mg/l	600 mg/l
8.	Total Hardness (as CaCO ₃)	mg/L	116	156	156	200 mg/l	600 mg/l
9.	Calcium (as Ca)	mg/L	19.2	22.4	24.0	75 mg/l	200 mg/l
10.	Magnesium (as Mg)	mg/L	16.52	24.3	23.32	30 mg/l	100 mg/l
11.	Nitrate (as NO ₃)	mg/L	1.92	2.04	2.10	45 mg/l	No Relaxation
12.	Nitrite Nitrogen (as NO ₂ -N)	mg/L	0.08	0.03	0.07	--	--

13	Ammonical Nitrogen (as NH ₃ -N)	mg/L	BDL	BDL	BDL	--	--
14.	Phosphate (as P)	mg/L	0.03	0.02	0.03	--	--
15.	Sulphate (as SO ₄)	mg/L	18.82	35.19	40.81	200 mg/l	400 mg/l
16.	Fluoride (as F)	mg/L	0.56	0.64	0.59	1.0 mg/l	1.5 mg/l

II. Bacteriological

17.	Fecal Coliform (MPN/100 ml)	MPN/100ml	9	7	7	-	-
18.	Total Coliform (MPN/100 ml)	MPN/100ml	23	39	43	Shall not be detectable in any 100 ml sample	-

III. Heavy Metals

19.	Chromium (as Cr)	mg/L	0.001	BDL	BDL	0.05 mg/l	No Relaxation
20.	Manganese (as Mn)	mg/L	0.001	0.002	0.003	0.1 mg/l	0.3 mg/l
21.	Iron (as Fe)	mg/L	0.011	0.014	0.021	0.3 mg/l	No Relaxation
22.	Nickel (as Ni)	mg/L	0.001	0.001	0.001	0.02 mg/l	No Relaxation
23.	Copper (as Cu)	mg/L	0.002	0.002	0.002	0.05 m/l	1.5 mg/l
24.	Zinc (as Zn)	mg/L	0.007	0.004	0.008	5 mg/l	15 mg/l
25.	Arsenic (as As)	mg/L	0.002	0.001	0.001	0.01 mg/l	0.05 mg/l
26.	Cadmium (as Cd)	mg/L	BDL	BDL	BDL	0.003 mg/l	No Relaxation
27.	Lead (as Pb)	mg/L	0.001	BDL	0.001		
28.	Mercury (as Hg)	mg/L	0.0002	0.0001	0.0002	0.001 mg/l	No Relaxation

Note: - All values are expressed in mg/l except pH, Conductivity, T.Coli & F. Coli

IV. Pesticides

1.	Alpha - BHC	µg/l	BLQ	BLQ	BLQ	0.01
2.	Beta- BHC	µg/l	BLQ	BLQ	BLQ	0.04
3.	Gamma - BHC	µg/l	BLQ	BLQ	BLQ	2.0
4.	4,4' - DDD	µg/l	BLQ	BLQ	BLQ	1.0
5.	4,4' - DDE	µg/l	BLQ	BLQ	BLQ	1.0
6.	4,4' - DDT	µg/l	BLQ	BLQ	BLQ	1.0
7.	Aldrin	µg/l	BLQ	BLQ	BLQ	0.03
8.	Dieldrin	µg/l	BLQ	BLQ	BLQ	0.03
9.	Endosulfan - I	µg/l	BLQ	BLQ	BLQ	0.4
10.	Endosulfan Sulfate	µg/l	BLQ	BLQ	BLQ	0.4
11.	Endrin	µg/l	BLQ	BLQ	BLQ	--
12.	Heptachlor	µg/l	BLQ	BLQ	BLQ	--
13	Heptachlorapoxide	µg/l	BLQ	BLQ	BLQ	--
14.	Methoxychlor	µg/l	BLQ	BLQ	BLQ	--
15.	Endosulfan - II	µg/l	BLQ	BLQ	BLQ	0.4 µg/l
16.	Delta - BHC	µg/l	BLQ	BLQ	BLQ	0.04 µg/l
17.	Endrin Aldehyde	µg/l	BLQ	BLQ	BLQ	--

Note: BLQ (Below Limit of Quantation (0.05µg/l))

4.2.C. Analysis results of the Inlet drain joining the reservoir

S. No.	Parameter	Unit	W-211	Drinking Water Specification: IS: 10500: 2012 Requirement	
				Requirement (Acceptable Limit)	Permissible Limit in the absence of alternate source
I. Physico Chemical:					
1.	pH	--	6.89	6.5-8.5	No Relaxation
2.	Electrical Conductivity	µS/cm	434	--	--
3.	Dissolved Oxygen	--	6.2	--	--
4.	Total Dissolved Solids	mg/L	280	500 mg/l	2000 mg/l
5.	Biochemical Oxygen Demand	mg/L	2.4	--	--
6.	Chloride (as Cl)	mg/L	24.4	250 mg/l	1000 mg/l
7.	Total Alkalinity (as CaCO ₃)	mg/L	188	200 mg/l	600 mg/l
8.	Total Hardness (as CaCO ₃)	mg/L	180	200 mg/l	600 mg/l
9.	Calcium (as Ca)	mg/L	36.8	75 mg/l	200 mg/l
10.	Magnesium (as Mg)	mg/L	21.38	30 mg/l	100 mg/l
11.	Nitrate (as NO ₃)	mg/L	2.06	45 mg/l	No Relaxation
12.	Nitrite Nitrogen (as NO ₂ -N)	mg/L	0.01	--	--
13.	Ammonical Nitrogen (as NH ₃ -N)	mg/L	BDL	--	--
14.	Phosphate (as P)	mg/L	0.03	--	--
15.	Sulphate (as SO ₄)	mg/L	48.91	200 mg/l	400 mg/l
16.	Fluoride (as F)	mg/L	0.38	1.0 mg/l	1.5 mg/l
II. Bacteriological					
17.	Fecal Coliform (MPN/100 ml)	MPN/100ml	9	-	-
18.	Total Coliform (MPN/100 ml)	MPN/100ml	28	Shall not be detectable in any 100 ml sample	-
III. Heavy Metals					
19.	Chromium (as Cr)	mg/l	BDL	0.05 mg/l	No Relaxation
20.	Manganese (as Mn)	mg/l	0.048	0.1 mg/l	0.3 mg/l
21.	Iron (as Fe)	mg/l	0.035	0.3 mg/l	No Relaxation
22.	Nickel (as Ni)	mg/l	0.001	0.02 mg/l	No Relaxation
23.	Copper (as Cu)	mg/l	0.001	0.05 mg/l	1.5 mg/l
24.	Zinc (as Zn)	mg/l	0.002	5 mg/l	15 mg/l
25.	Arsenic (as As)	mg/l	0.001	0.01 mg/l	0.05 mg/l
26.	Cadmium (as Cd)	mg/l	BDL	0.003 mg/l	No Relaxation
27.	Lead (as Pb)	mg/l	BDL	0.01 mg/l	No Relaxation
28.	Mercury (as Hg)	mg/l	0.0003	0.001 mg/l	No Relaxation

Note: - All values are expressed in mg/l except pH, Conductivity, T.Coli & F. Coli.

IV. Pesticides				
1.	Alpha - BHC	µg/l	BLQ	0.01
2.	Beta- BHC	µg/l	BLQ	0.04
3.	Gamma - BHC	µg/l	BLQ	2.0
4.	4,4' - DDD	µg/l	BLQ	1.0
5.	4,4' - DDE	µg/l	BLQ	1.0
6.	4,4' - DDT	µg/l	BLQ	1.0
7.	Aldrin	µg/l	BLQ	0.03
8.	Dieldrin	µg/l	BLQ	0.03
9.	Endosulfan - I	µg/l	BLQ	0.4

10.	Endosulfan Sulfate	µg/l	BLQ	0.4
11.	Endrin	µg/l	BLQ	--
12.	Heptachlor	µg/l	BLQ	--
13.	Heptachlorapoxide	µg/l	BLQ	--
14.	Methoxychlor	µg/l	BLQ	--
15.	Endosulfan – II	µg/l	BLQ	0.4 µg/l
16.	Delta – BHC	µg/l	BLQ	0.04 µg/l
17.	Endrin Aldehyde	µg/l	BLQ	--

Note : BLQ(Below Limit of Quantation (0.05µg/l)

Inference

Reservoir Water quality

APPCB collected water samples at different locations in the reservoir and analyzed for physico chemical (16 parameters), Bacteriological (2 parameters), heavy metals (10 parameters) and pesticides (17 parameters). As per the analysis of the samples, it is observed that the physico chemical parameters and heavy metals are within the prescribed standards of drinking water as per Bureau of Indian Standards (BIS) IS 10500 : 2012. Presence of Pesticides is not detected indicating that no agricultural runoff is joining into the reservoir. It is common phenomenon finding total coliforms in reservoirs storing surface water. All Municipalities employ disinfection through chlorination to make water free from coliforms and pathogens for supply of safe drinking water to public. Hence, the water of Gambheeram Reservoir is fit for drinking purpose after disinfection. The analysis also indicates no contribution of industrial wastewater contamination.

Drain water quality joining the reservoir

APPCB collected sample from the inlet drain of Gambhiramedda reservoir and analyzed for physico chemical (16 parameters), Bacteriological (2 parameters), heavy metals (10 parameters) and pesticides (17 parameters). As per the analysis, it is observed that all the physico chemical parameters and heavy metals are within the prescribed standards of drinking water as per IS 10500: 2012. Presence of Pesticides is not detected. It is common phenomenon to find total coli forms in surface water drains. The analysis also indicates no contribution of industrial wastewater.

4.3. THATIPUDI RESERVOIR

4.3.A. Sampling locations

Thatipudi	9	Reservoir East side	W-148	18.171900	83.196576
	10	Reservoir South side	W-149	18.171601	83.193890
	11	Reservoir South west	W-150	18.172447	83.191256
	12	Inlet drain to reservoir at Kasipatnam village.	W-214	18.216406	83.122610

4.3.B Analysis Results of the Thatipudi Reservoir samples

S.No.	Parameter	Unit	W-148	W-149	W-150	Drinking Water Specification: IS: 10500: 2012 Requirement	
						Requirement (Acceptable Limit)	Permissible Limit in the absence of alternate source
I. Physico Chemical:							
1.	pH	--	7.76	7.79	7.79	6.5-8.5	No Relaxation
2.	Electrical Conductivity	µS/cm	244	241	249	--	--
3.	Dissolved Oxygen	--	6.1	7.0	7.0		

4.	Total Dissolved Solids	mg/L	164	160	168	500 mg/l	2000 mg/l
5.	Biochemical Oxygen Demand	mg/L	1.2	1.2	1.4	--	--
6.	Chlorides (as Cl)	mg/L	14.6	14.6	14.6	250 mg/l	1000 mg/l
7.	Total Alkalinity (as CaCO ₃)	mg/L	136	136	140	200 mg/l	600 mg/l
8.	Total Hardness (as CaCO ₃)	mg/L	116	108	104	200 mg/l	600 mg/l
9.	Calcium (as Ca)	mg/L	25.6	25.6	27.2	75 mg/l	200 mg/l
10.	Magnesium (as Mg)	mg/L	12.63	10.69	8.74	30 mg/l	100 mg/l
11.	Nitrate (as NO ₃)	mg/L	1.12	1.02	1.16	45 mg/l	No Relaxation
12.	Nitrite Nitrogen (as NO ₂ -N)	mg/L	BDL	BDL	0.01	--	--
13.	Ammonical Nitrogen (as NH ₃ -N)	mg/L	BDL	BDL	BDL	--	--
14.	Phosphate (as P)	mg/L	0.02	0.02	0.02	--	--
15.	Sulphate (as SO ₄)	mg/L	0.38	1.09	1.04	200 mg/l	400 mg/l
16.	Fluoride (as F)	mg/L	0.25	0.36	0.19	1.0 mg/l	1.5 mg/l

II Bacteriological							
17.	Fecal Coliform (MPN/100 ml)	MPN/100ml	4	4	3	-	-
18.	Total Coliform (MPN/100 ml)	MPN/100ml	14	15	11	Shall not be detectable in any 100 ml sample	-

III Heavy Metals							
19.	Chromium (as Cr)	mg/L	BDL	BDL	BDL	0.05 mg/l	No Relaxation
20.	Manganese (as Mn)	mg/L	BDL	BDL	0.001	0.1 mg/l	0.3 mg/l
21.	Iron (as Fe)	mg/L	0.012	0.013	0.014	0.3 mg/l	No Relaxation
22.	Nickel (as Ni)	mg/L	0.001	BDL	0.001	0.02 mg/l	No Relaxation
23.	Copper (as Cu)	mg/L	BDL	BDL	0.001	0.05 m/l	1.5 mg/l
24.	Zinc (as Zn)	mg/L	0.003	0.002	0.004	5 mg/l	15 mg/l
25.	Arsenic (as As)	mg/L	0.001	0.001	0.001	0.01 mg/l	0.05 mg/l
26.	Cadmium (as Cd)	mg/L	BDL	BDL	BDL	0.003 mg/l	No Relaxation
27.	Lead (as Pb)	mg/L	BDL	0.002	BDL	0.01 mg/l	No Relaxation
28.	Mercury (as Hg)	mg/L	BDL	BDL	BDL	0.001 mg/l	No Relaxation

Pesticides		Unit	W-148	W-149	W-150	Limit
IV. Pesticides						
1.	Alpha - BHC	µg/l	BLQ	BLQ	BLQ	0.01
2.	Beta- BHC	µg/l	BLQ	BLQ	BLQ	0.04
3.	Gamma - BHC	µg/l	BLQ	BLQ	BLQ	2.0
4.	4,4' - DDD	µg/l	BLQ	BLQ	BLQ	1.0
5.	4,4' - DDE	µg/l	BLQ	BLQ	BLQ	1.0
6.	4,4' - DDT	µg/l	BLQ	BLQ	BLQ	1.0
7.	Aldrin	µg/l	BLQ	BLQ	BLQ	0.03
8.	Dieldrin	µg/l	BLQ	BLQ	BLQ	0.03
9.	Endosulfan - I	µg/l	BLQ	BLQ	BLQ	0.4
10.	Endosulfan Sulfate	µg/l	BLQ	BLQ	BLQ	0.4
11.	Endrin	µg/l	BLQ	BLQ	BLQ	--
12.	Heptachlor	µg/l	BLQ	BLQ	BLQ	--
13.	Heptachlorapoxide	µg/l	BLQ	BLQ	BLQ	--
14.	Methoxychlor	µg/l	BLQ	BLQ	BLQ	--
15.	Endosulfan - II	µg/l	BLQ	BLQ	BLQ	0.4 µg/l
16.	Delta - BHC	µg/l	BLQ	BLQ	BLQ	0.04 µg/l
17.	Endrin Aldehyde	µg/l	BLQ	BLQ	BLQ	--

Note: BLQ (Below Limit of Quantation (0.05µg/l))

4.3. C. Analysis results of the Inlet drain joining the reservoir:

S.No.	Parameter	Unit	W-214	Drinking Water Specification: IS: 10500: 2012 Requirement	
				Requirement (Acceptable Limit)	Permissible Limit in the absence of alternate source
I. Physico Chemical:					
1.	pH	--	7.19	6.5-8.5	No Relaxation
2.	Electrical Conductivity	µS/cm	240	--	--
3.	Dissolved Oxygen	--	7.0	--	--
4.	Total Dissolved Solids	mg/L	172	500 mg/l	2000 mg/l
5.	Biochemical Oxygen Demand	mg/L	1.2	--	--
6.	Chloride (as Cl)	mg/L	14.6	250 mg/l	1000 mg/l
7.	Total Alkalinity (as CaCO ₃)	mg/L	132	200 mg/l	600 mg/l
8.	Total Hardness (as CaCO ₃)	mg/L	108	200 mg/l	600 mg/l
9.	Calcium (as Ca)	mg/L	24.0	75 mg/l	200 mg/l
10.	Magnesium (as Mg)	mg/L	11.66	30 mg/l	100 mg/l
11.	Nitrate (as NO ₃)	mg/L	1.28	45 mg/l	No Relaxation
12.	Nitrite Nitrogen (as NO ₂ -N)	mg/L	0.03	--	--
13.	Ammonical Nitrogen (as NH ₃ -N)	mg/L	BDL	--	--
14.	Phosphate (as P)	mg/L	0.08	--	--
15.	Sulphate (as SO ₄)	mg/L	17.22	200 mg/l	400 mg/l
16.	Fluoride (as F)	mg/L	BDL	1.0 mg/l	1.5 mg/l
II Bacteriological					
17.	Fecal Coliform (MPN/100 ml)	MPN/100ml	7	-	-
18.	Total Coliform (MPN/100 ml)	MPN/100ml	23	Shall not be detectable in any 100 ml sample	-
III Heavy Metals					
19.	Chromium (as Cr)	mg/L	BDL	0.05 mg/l	No Relaxation
20.	Manganese (as Mn)	mg/L	0.001	0.1 mg/l	0.3 mg/l
21.	Iron (as Fe)	mg/L	0.025	0.3 mg/l	No Relaxation
22.	Nickel (as Ni)	mg/L	0.009	0.02 mg/l	No Relaxation
23.	Copper (as Cu)	mg/L	0.003	0.05 mg/l	1.5 mg/l
24.	Zinc (as Zn)	mg/L	0.021	5 mg/l	15 mg/l
25.	Arsenic (as As)	mg/L	BDL	0.01 mg/l	0.05 mg/l
26.	Cadmium (as Cd)	mg/L	BDL	0.003 mg/l	No Relaxation
27.	Lead (as Pb)	mg/L	BDL	0.01 mg/l	No Relaxation
28.	Mercury (as Hg)	mg/L	0.0003	0.001 mg/l	No Relaxation

S. No.	Parameter	Unit	W-214	Limit
IV.Pesticides				
1.	Alpha - BHC	µg/l	BLQ	0.01
2.	Beta- BHC	µg/l	BLQ	0.04
3.	Gamma - BHC	µg/l	BLQ	2.0
4.	4,4' - DDD	µg/l	BLQ	1.0
5.	4,4' - DDE	µg/l	BLQ	1.0
6.	4,4' - DDT	µg/l	BLQ	1.0
7.	Aldrin	µg/l	BLQ	0.03
8.	Dieldrin	µg/l	BLQ	0.03
9.	Endosulfan - I	µg/l	BLQ	0.4
10.	Endosulfan Sulfate	µg/l	BLQ	0.4
11.	Endrin	µg/l	BLQ	--
12.	Heptachlor	µg/l	BLQ	--
13.	Heptachlorapoxide	µg/l	BLQ	--
14.	Methoxychlor	µg/l	BLQ	--
15.	Endosulfan - II	µg/l	BLQ	0.4 µg/l
16.	Delta - BHC	µg/l	BLQ	0.04 µg/l
17.	Endrin Aldehyde	µg/l	BLQ	--

Note: BLQ (Below Limit of Quantation (0.05µg/l))

Inference

Reservoir Water quality

APPCB collected water samples at different locations in the reservoir and analyzed for physico chemical (16 parameters), Bacteriological (2 parameters), heavy metals (10 parameters) and pesticides (17 parameters). As per the analysis of the samples, it is observed that the physico chemical parameters and heavy metals are within the prescribed standards of drinking water as per Bureau of Indian Standards (BIS) IS 10500 : 2012. Presence of Pesticides is not detected indicating that no agricultural runoff is joining into the reservoir. It is common phenomenon finding total coliforms in reservoirs storing surface water. All Municipalities employ disinfection through chlorination to make water free from coliforms and pathogens for supply of safe drinking water to public. Hence, the water of Thatipudi Reservoir is fit for drinking purpose after disinfection. The analysis also indicates no contribution of industrial wastewater contamination.

Drain water quality joining the reservoir

APPCB collected samples from the inlet drain of Thatipudi reservoir and analyzed for physico chemical (16 parameters), Bacteriological (2 parameters), heavy metals (10 parameters) and pesticides (17 parameters). As per the analysis, it is observed that all the physico chemical parameters and heavy metals are within the prescribed standards of drinking water as per IS 10500 : 2012. Presence of Pesticides is not detected. It is common phenomenon to find total coli forms in surface water drains. The analysis also indicates no contribution of industrial wastewater.

4.4. RAIWADA RESERVOIR

4.4.A. Sampling locations

Name of Reservoir	S. No	Location	Sample No.	Latitude	Longitude
Raiwada	13	Reservoir South east	W - 142	18.008335	82.984576
	14	Reservoir South side	W - 143	18.011479	82.977588
	15	Reservoir South west	W - 144	18.007139	82.965317
	16	Inlet drain to reservoir at Tamarabba village	W - 212	18.052091	83.013582
	17	Inlet drain to reservoir at Jeenapadu village	W - 213	18.041737	82.949168

4.4.B. Analysis Results of the Mudasarlova Reservoir samples

S.No.	Parameter	Unit	W-142	W-143	W-144	Drinking Water Specification: IS: 10500: 2012 Requirement	
						Requirement (Acceptable Limit)	Permissible Limit in the absence of alternate source
I. Physico Chemical:							
1.	pH	--	7.17	7.83	8.07	6.5-8.5	No Relaxation
2.	Electrical Conductivity	µS/cm	204	198	212	--	--
3.	Dissolved Oxygen	--`	6.6	7.0	7.3		
4.	Total Dissolved Solids	mg/l	140	136	148	500 mg/l	2000 mg/l
5.	Biochemical Oxygen Demand	mg/l	1.2	1.0	1.2	--	--

6.	Chloride (as Cl)	mg/l	14.6	14.6	19.5	250 mg/l	1000 mg/l
7.	Total Alkalinity (as CaCO ₃)	mg/l	116	112	112	200 mg/l	600 mg/l
8.	Total Hardness (as CaCO ₃)	mg/l	96	88	100	200 mg/l	600 mg/l
9.	Calcium (as Ca)	mg/l	19.2	17.6	20.8	75 mg/l	200 mg/l
10.	Magnesium (as Mg)	mg/l	11.66	10.69	11.66	30 mg/l	100 mg/l
11.	Nitrate (as NO ₃)	mg/l	1.08	1.14	1.28	45 mg/l	No Relaxation
12.	Nitrite Nitrogen (as NO ₂ -N)	mg/l	BDL	0.01	BDL	--	--
13.	Ammonical Nitrogen (as NH ₃ -N)	mg/l	BDL	BDL	BDL	--	--
14.	Phosphate (as P)	mg/l	0.01	0.01	0.01	--	--
15.	Sulphate (as SO ₄)	mg/l	1.17	1.54	1.67	200 mg/l	400 mg/l
16.	Fluoride (as F)	mg/l	0.33	0.19	0.49	1.0 mg/l	1.5 mg/l
II Bacteriological							
17.	Fecal Coliform (MPN/100 ml)	mg/l	4	4	7	-	-
18.	Total Coliform (MPN/100 ml)	mg/l	15	21	28	Shall not be detectable in any 100 ml sample	-
III Heavy Metals							
19.	Chromium (as Cr)	mg/l	BDL	BDL	BDL	0.05 mg/l	No Relaxation
20.	Manganese (as Mn)	mg/l	0.001	0.003	0.004	0.1 mg/l	0.3 mg/l
21.	Iron (as Fe)	mg/l	0.011	0.015	0.015	0.3 mg/l	No Relaxation
22.	Nickel (as Ni)	mg/l	BDL	0.001	0.001	0.02 mg/l	No Relaxation
23.	Copper (as Cu)	mg/l	0.001	0.002	0.001	0.05 m/l	1.5 mg/l
24.	Zinc (as Zn)	mg/l	0.008	0.010	0.007	5 mg/l	15 mg/l
25.	Arsenic (as As)	mg/l	0.001	0.001	0.001	0.01 mg/l	0.05 mg/l
26.	Cadmium (as Cd)	mg/l	BDL	BDL	BDL	0.003 mg/l	No Relaxation
27.	Lead (as Pb)	mg/l	BDL	BDL	BDL	0.01 mg/l	No Relaxation
28.	Mercury (as Hg)	mg/l	BDL	BDL	BDL	0.001 mg/l	No Relaxation

IV. Pesticides		Unit	W-142	W-143	W-144	Limit
1.	Alpha - BHC	µg/l	BLQ	BLQ	BLQ	0.01
2.	Beta- BHC	µg/l	BLQ	BLQ	BLQ	0.04
3.	Gamma - BHC	µg/l	BLQ	BLQ	BLQ	2.0
4.	4,4' - DDD	µg/l	BLQ	BLQ	BLQ	1.0
5.	4,4' - DDE	µg/l	BLQ	BLQ	BLQ	1.0
6.	4,4' - DDT	µg/l	BLQ	BLQ	BLQ	1.0
7.	Aldrin	µg/l	BLQ	BLQ	BLQ	0.03
8.	Dieldrin	µg/l	BLQ	BLQ	BLQ	0.03

9.	Endosulfan – I	µg/l	BLQ	BLQ	BLQ	0.4
10.	Endosulfan Sulfate	µg/l	BLQ	BLQ	BLQ	0.4
11.	Endrin	µg/l	BLQ	BLQ	BLQ	--
12.	Heptachlor	µg/l	BLQ	BLQ	BLQ	--
13	Heptachlorapoxide	µg/l	BLQ	BLQ	BLQ	--
14.	Methoxychlor	µg/l	BLQ	BLQ	BLQ	--
15.	Endosulfan – II	µg/l	BLQ	BLQ	BLQ	0.4 µg/l
16.	Delta – BHC	µg/l	BLQ	BLQ	BLQ	0.04 µg/l
17.	Endrin Aldehyde	µg/l	BLQ	BLQ	BLQ	--

Note: BLQ (Below Limit of Quantation (0.05µg/l))

4.4.C. Analysis results of the Inlet drain joining the reservoir

S. No.	Parameter	Unit	W-212	W-213	Drinking Water Specification: IS: 10500: 2012 Requirement	
					Requirement (Acceptable Limit)	Permissible Limit in the absence of alternate source
1.	pH	--	6.90	7.43	6.5-8.5	No Relaxation
2.	Electrical Conductivity	µS/cm	173	192	--	--
3.	Dissolved Oxygen	--	6.4	6.8	--	--
4.	Total Dissolved Solids	mg/L	116	132	500 mg/l	2000 mg/l
5.	Biochemical Oxygen Demand	mg/L	1.2	1.0	--	--
6.	Chloride (as Cl)	mg/L	14.6	14.6	250 mg/l	1000 mg/l
7.	Total Alkalinity (as CaCO ₃)	mg/L	76	104	200 mg/l	600 mg/l
8.	Total Hardness (as CaCO ₃)	mg/L	60	80	200 mg/l	600 mg/l
9.	Calcium (as Ca)	mg/L	16.0	19.2	75 mg/l	200 mg/l
10.	Magnesium (as Mg)	mg/L	4.86	7.77	30 mg/l	100 mg/l
11.	Nitrate (as NO ₃)	mg/L	1.48	1.60	45 mg/l	No Relaxation
12.	Nitrite Nitrogen (as NO ₂ -N)	mg/L	0.01	BDL	--	--
13	Ammonical Nitrogen (as NH ₃ -N)	mg/L	BDL	BDL	--	--
14.	Phosphate (as P)	mg/L	0.03	BDL	--	--
15.	Sulphate (as SO ₄)	mg/L	4.24	2.69	200 mg/l	400 mg/l
16.	Fluoride (as F)	mg/L	BDL	0.09	1.0 mg/l	1.5 mg/l
17.	Fecal Coliform (MPN/100 ml)	MPN/100ml	4	4	Shall not be detectable in any 100 ml sample	-
18.	Total Coliform (MPN/100 ml)	MPN/100ml	21	20		-
19.	Chromium (as Cr)	mg/L	BDL	BDL	0.05 mg/l	No Relaxation
20.	Manganese (as Mn)	mg/L	0.002	0.001	0.1 mg/l	0.3 mg/l
21.	Iron (as Fe)	mg/L	0.067	0.028	0.3 mg/l	No Relaxation
22.	Nickel (as Ni)	mg/L	0.000	0.000	0.02 mg/l	No Relaxation

23.	Copper (as Cu)	mg/L	0.001	0.001	0.05 m/l	1.5 mg/l
24.	Zinc (as Zn)	mg/L	0.001	0.003	5 mg/l	15 mg/l
25.	Arsenic (as As)	mg/L	BDL	0.001	0.01 mg/l	0.05 mg/l
26.	Cadmium (as Cd)	mg/L	BDL	BDL	0.003 mg/l	No Relaxation
27.	Lead (as Pb)	mg/L	BDL	BDL	0.01 mg/l	No Relaxation
28.	Mercury (as Hg)	mg/L	BDL	BDL	0.001 mg/l	No Relaxation

Pesticides		Unit	W-212	W-213	Limit
1.	Alpha - BHC	µg/l	BLQ	BLQ	0.01
2.	Beta- BHC	µg/l	BLQ	BLQ	0.04
3.	Gamma - BHC	µg/l	BLQ	BLQ	2.0
4.	4,4' - DDD	µg/l	BLQ	BLQ	1.0
5.	4,4' - DDE	µg/l	BLQ	BLQ	1.0
6.	4,4' - DDT	µg/l	BLQ	BLQ	1.0
7.	Aldrin	µg/l	BLQ	BLQ	0.03
8.	Dieldrin	µg/l	BLQ	BLQ	0.03
9.	Endosulfan - I	µg/l	BLQ	BLQ	0.4
10.	Endosulfan Sulfate	µg/l	BLQ	BLQ	0.4
11.	Endrin	µg/l	BLQ	BLQ	--
12.	Heptachlor	µg/l	BLQ	BLQ	--
13.	Heptachlorapoxide	µg/l	BLQ	BLQ	--
14.	Methoxychlor	µg/l	BLQ	BLQ	--
15.	Endosulfan - II	µg/l	BLQ	BLQ	0.4 µg/l
16.	Delta - BHC	µg/l	BLQ	BLQ	0.04 µg/l
17.	Endrin Aldehyde	µg/l	BLQ	BLQ	--

Note: BLQ (Below Limit of Quantation (0.05µg/l))

Inference

Reservoir Water quality

APPCB collected water samples at different locations in the reservoir and analyzed for physico chemical (16 parameters), Bacteriological (2 parameters), heavy metals (10 parameters) and pesticides (17 parameters). As per the analysis of the samples, it is observed that the physico chemical parameters and heavy metals are within the prescribed standards of drinking water as per Bureau of Indian Standards (BIS) IS 10500 : 2012. Presence of Pesticides is not detected indicating that no agricultural runoff is joining into the reservoir. It is common phenomenon finding total coliforms in reservoirs storing surface water. All Municipalities employ disinfection through chlorination to make water free from coliforms and pathogens for supply of safe drinking water to public. Hence, the water of Raiwada Reservoir is fit for drinking purpose after disinfection. The analysis also indicates no contribution of industrial wastewater contamination.

Drain water quality joining the reservoir

APPCB collected samples from the inlet drain of Raiwada reservoir and analyzed for physico chemical (16 parameters), Bacteriological (2 parameters), heavy metals (10 parameters) and pesticides (17 parameters). As per the analysis, it is observed that all the physico chemical parameters and heavy metals are within the prescribed standards of drinking water as per IS 10500 : 2012. Presence of Pesticides is not detected. It is common phenomenon to find total coli forms in surface water drains. The analysis also indicates no contribution of industrial wastewater.

4.5. MEGHADRIGEDDA RESERVOIR

4.5.A. Sampling locations

Name of Reservoir	S. No	Location	Sample No.	Latitude	Longitude
Meghadrigedda	18	Reservoir Southeast side (ME-1)	W-163	17.759258	83.194832
	19	Reservoir Southside (ME-2)	W-164	17.757295	83.184875
	20	Reservoir Southwest side (ME-3)	W-165	17.758453	83.182142
	21	Reservoir Northeast side (ME-4)	W-166	17.783102	83.189959
	22	Reservoir inlet drain 1 near under bridge (Vepagunta to Sabbavaram road)	W-167	17.797573	83.190761
	23	Reservoir inlet drains 2, Pinagadi Village.	W-168	17.798367	83.167217
	24	Reservoir inlet drain 3, Chintalagatla village.	W-169	17.786677	83.160332

4.5.B. Analysis Results of the Meghadrigedda Reservoir samples

S.No	Parameter	Unit	W-163	W-164	W-165	W-166	Drinking Water Specification: IS: 10500: 2012 Requirement	
							Requirement (Acceptable Limit)	Permissible Limit in the absence of alternate source
I. Physico Chemical								
1.	pH	--	7.82	7.88	7.78	7.68	6.5-8.5	No Relaxation
2.	Electrical Conductivity	µS/cm	487	466	460	502	--	--
3.	Dissolved Oxygen	--	5.8	6.6	7.0	5.4		
4.	Total Dissolved Solids	mg/L	312	304	296	320	500 mg/l	2000 mg/l
5.	Biochemical Oxygen Demand	mg/L	1.4	1.6	1.4	1.8	--	--
6.	Chloride (as Cl)	mg/L	58.7	53.8	58.7	63.5	250 mg/l	1000 mg/l
7.	Total Alkalinity (as CaCO ₃)	mg/L	188	192	188	196	200 mg/l	600 mg/l
8.	Total Hardness (as CaCO ₃)	mg/L	128	128	116	128	200 mg/l	600 mg/l
9.	Calcium (as Ca)	mg/L	20.8	22.4	22.4	20.8	75 mg/l	200 mg/l
10.	Magnesium (as Mg)	mg/L	18.46	17.49	14.58	18.46	30 mg/l	100 mg/l
11.	Nitrate (as NO ₃)	mg/L	2.72	2.48	2.40	2.88	45 mg/l	No Relaxation
12.	Nitrite Nitrogen (as NO ₂ -N)	mg/L	0.01	BDL	BDL	0.01	--	--
13.	Ammonical Nitrogen (as NH ₃ -N)	mg/L	0.15	BDL	BDL	BDL	--	--
14.	Phosphate (as P)	mg/L	0.03	0.03	0.03	0.05	--	--
15.	Sulphate (as SO ₄)	mg/L	12.05	15.23	14.82	13.17	200 mg/l	400 mg/l
16.	Fluoride (as F)	mg/L	0.62	0.56	0.35	0.77	1.0 mg/l	1.5 mg/l
II Bacteriological								
17.	Fecal Coliform (MPN/100 ml)	MPN/100ml	9	7	7	11	-	-
18.	Total Coliform (MPN/100 ml)	MPN/100ml	28	39	21	39	Shall not be detectable in any 100 ml sample	-
III Heavy Metals								
19.	Chromium (as Cr)	mg/L	BDL	BDL	BDL	BDL	0.05 mg/l	No Relaxation
20.	Manganese (as Mn)	mg/L	BDL	0.001	0.001	0.001	0.1 mg/l	0.3 mg/l
21.	Iron (as Fe)	mg/L	0.009	0.010	0.011	0.012	0.3 mg/l	No Relaxation

22.	Nickel (as Ni)	mg/L	BDL	BDL	BDL	BDL	0.02 mg/l	No Relaxation
23.	Copper (as Cu)	mg/L	0.001	0.001	0.001	BDL	0.05 m/l	1.5 mg/l
24.	Zinc (as Zn)	mg/L	0.001	0.001	0.002	0.002	5 mg/l	15 mg/l
25.	Arsenic (as As)	mg/L	0.001	0.002	0.001	0.002	0.01 mg/l	0.05 mg/l
26.	Cadmium (as Cd)	mg/L	BDL	BDL	BDL	BDL	0.003 mg/l	No Relaxation
27.	Lead (as Pb)	mg/L	BDL	BDL	BDL	BDL	0.01 mg/l	No Relaxation
28.	Mercury (as Hg)	mg/L	BDL	0.0002	BDL	BDL	0.001 mg/l	No Relaxation

S.No.	Parameter	Unit	W-163	W-164	W-165	W-166	Limit
IV. Pesticides							
1.	Alpha - BHC	µg/l	BLQ	BLQ	BLQ	BLQ	0.01
2.	Beta- BHC	µg/l	BLQ	BLQ	BLQ	BLQ	0.04
3.	Gamma - BHC	µg/l	BLQ	BLQ	BLQ	BLQ	2.0
4.	4,4' - DDD	µg/l	BLQ	BLQ	BLQ	BLQ	1.0
5.	4,4' - DDE	µg/l	BLQ	BLQ	BLQ	BLQ	1.0
6.	4,4' - DDT	µg/l	BLQ	BLQ	BLQ	BLQ	1.0
7.	Aldrin	µg/l	BLQ	BLQ	BLQ	BLQ	0.03
8.	Dieldrin	µg/l	BLQ	BLQ	BLQ	BLQ	0.03
9.	Endosulfan - I	µg/l	BLQ	BLQ	BLQ	BLQ	0.4
10.	Endosulfan Sulfate	µg/l	BLQ	BLQ	BLQ	BLQ	0.4
11.	Endrin	µg/l	BLQ	BLQ	BLQ	BLQ	--
12.	Heptachlor	µg/l	BLQ	BLQ	BLQ	BLQ	--
13.	Heptachlorapoxide	µg/l	BLQ	BLQ	BLQ	BLQ	--
14.	Methoxychlor	µg/l	BLQ	BLQ	BLQ	BLQ	--
15.	Endosulfan - II	µg/l	BLQ	BLQ	BLQ	BLQ	0.4 µg/l
16.	Delta - BHC	µg/l	BLQ	BLQ	BLQ	BLQ	0.04 µg/l
17.	Endrin Aldehyde	µg/l	BLQ	BLQ	BLQ	BLQ	--

Note: BLQ(Below Limit of Quantation (0.05µg/l)

4.5.C. Analysis results of the Inlet drain joining the reservoir

S.No	Parameter	Unit	W-167	W-168	W-169	Drinking Water Specification: IS: 10500: 2012 Requirement	
						Requirement (Acceptable Limit)	Permissible Limit in the absence of alternate source
I. Physico Chemical:							
1.	pH	--	7.06	7.21	7.22	6.5-8.5	No Relaxation
2.	Electrical Conductivity	µS/cm	574	676	642	--	--
3.	Dissolved Oxygen	--	5.6	5.2	6.0	--	--
4.	Total Dissolved Solids	mg/L	364	420	408	500 mg/l	2000 mg/l
5.	Biochemical Oxygen Demand	mg/L	4.2	4.8	4.6	--	--
6.	Chloride (as Cl)	mg/L	68.4	88.0	83.1	250 mg/l	1000 mg/l
7.	Total Alkalinity (as CaCO ₃)	mg/L	188	196	180	200 mg/l	600 mg/l
8.	Total Hardness (as CaCO ₃)	mg/L	140	144	136	200 mg/l	600 mg/l
9.	Calcium (as Ca)	mg/L	27.2	20.8	19.2	75 mg/l	200 mg/l
10.	Magnesium (as Mg)	mg/L	17.49	22.35	21.38	30 mg/l	100 mg/l
11.	Nitrate (as NO ₃)	mg/L	3.96	4.72	4.28	45 mg/l	No Relaxation
12.	Nitrite Nitrogen (as NO ₂ -N)	mg/L	0.01	BDL	0.14	--	--
13.	Ammonical Nitrogen (as NH ₃ -N)	mg/L	0.05	BDL	BDL	--	--
14.	Phosphate (as P)	mg/L	0.16	0.06	0.04	--	--
15.	Sulphate (as SO ₄)	mg/L	17.17	24.98	16.93	200 mg/l	400 mg/l
16.	Fluoride (as F)	mg/L	0.68	0.92	0.89	1.0 mg/l	1.5 mg/l

II Bacteriological							
17.	Fecal Coliform (MPN/100 ml)	MPN/100ml	11	14	14	-	-
18.	Total Coliform (MPN/100 ml)	MPN/100ml	64	93	75	Shall not be detectable in any 100 ml sample	-
III Heavy Metals							
19.	Chromium (as Cr)	mg/L	BDL	BDL	BDL	0.05 mg/l	No Relaxation
20.	Manganese (as Mn)	mg/L	0.107	0.006	0.001	0.1 mg/l	0.3 mg/l
21.	Iron (as Fe)	mg/L	0.043	0.021	0.014	0.3 mg/l	No Relaxation
22.	Nickel (as Ni)	mg/L	0.001	0.001	0.001	0.02 mg/l	No Relaxation
23.	Copper (as Cu)	mg/L	0.001	0.001	0.001	0.05 m/l	1.5 mg/l
24.	Zinc (as Zn)	mg/L	0.004	0.006	0.001	5 mg/l	15 mg/l
25.	Arsenic (as As)	mg/L	0.002	0.002	0.002	0.01 mg/l	0.05 mg/l
26.	Cadmium (as Cd)	mg/L	BDL	BDL	BDL	0.003 mg/l	No Relaxation
27.	Lead (as Pb)	mg/L	0.002	BDL	BDL	0.01 mg/l	No Relaxation
28.	Mercury (as Hg)	mg/L	BDL	0.0002	0.0001	0.001 mg/l	No Relaxation

IV. Pesticides							
1.	Alpha - BHC	$\mu\text{g/l}$	BLQ	BLQ	BLQ		0.01
2.	Beta- BHC	$\mu\text{g/l}$	BLQ	BLQ	BLQ		0.04
3.	Gamma - BHC	$\mu\text{g/l}$	BLQ	BLQ	BLQ		2.0
4.	4,4' - DDD	$\mu\text{g/l}$	BLQ	BLQ	BLQ		1.0
5.	4,4' - DDE	$\mu\text{g/l}$	BLQ	BLQ	BLQ		1.0
6.	4,4' - DDT	$\mu\text{g/l}$	BLQ	BLQ	BLQ		1.0
7.	Aldrin	$\mu\text{g/l}$	BLQ	BLQ	BLQ		0.03
8.	Dieldrin	$\mu\text{g/l}$	BLQ	BLQ	BLQ		0.03
9.	Endosulfan - I	$\mu\text{g/l}$	BLQ	BLQ	BLQ		0.4
10.	Endosulfan Sulfate	$\mu\text{g/l}$	BLQ	BLQ	BLQ		0.4
11.	Endrin	$\mu\text{g/l}$	BLQ	BLQ	BLQ		--
12.	Heptachlor	$\mu\text{g/l}$	BLQ	BLQ	BLQ		--
13.	Heptachlorapoxide	$\mu\text{g/l}$	BLQ	BLQ	BLQ		--
14.	Methoxychlor	$\mu\text{g/l}$	BLQ	BLQ	BLQ		--
15.	Endosulfan - II	$\mu\text{g/l}$	BLQ	BLQ	BLQ		0.4 $\mu\text{g/l}$
16.	Delta - BHC	$\mu\text{g/l}$	BLQ	BLQ	BLQ		0.04 $\mu\text{g/l}$
17.	Endrin Aldehyde	$\mu\text{g/l}$	BLQ	BLQ	BLQ		--

Note: BLQ (Below Limit of Quantation (0.05 $\mu\text{g/l}$))

Inference

Reservoir Water quality

APPCB collected water samples at different locations in the reservoir and analyzed for physico chemical (16 parameters), Bacteriological (2 parameters), heavy metals (10 parameters) and pesticides (17 parameters). As per the analysis of the samples, it is

observed that the physico chemical parameters and heavy metals are within the prescribed standards of drinking water as per Bureau of Indian Standards (BIS) IS 10500 : 2012. Presence of Pesticides is not detected indicating that no agricultural runoff is joining into the reservoir. It is common phenomenon finding total coliforms in reservoirs storing surface water. All Municipalities employ disinfection through chlorination to make water free from coliforms and pathogens for supply of safe drinking water to public. Hence, the water of Meghadrigedda Reservoir is fit for drinking purpose after disinfection. The analysis also indicates no contribution of industrial wastewater contamination.

Drain water quality joining the reservoir

APPCB collected samples from the inlet drains joining the reservoir and analyzed for physico chemical (16 parameters), Bacteriological (2 parameters), heavy metals (10 parameters) and pesticides (17 parameters). As per the analysis, all the physico chemical parameters and heavy metals are within the prescribed standards of drinking water as per IS 10500 : 2012. Presence of Pesticides is not detected. BOD (4.2 mg/l to 4.8 mg/l) and total coli forms (64 to 93 MPN) are slightly exceeding the drinking water standards. This may be due sewage contamination from residential areas of Pendurthi, GVMC limits.

- Sediment samples are also collected from the five reservoirs and drains joining to reservoirs to ascertain the quality of the water in the reservoir. There are no standards prescribed for the sediment quality. The analysis results are compared with the available Canadian Sediment Quality guidelines for the protection of aquatic life, CCME, 2001. **(Annexure-II)**. APPCB collected the sediment samples in the same locations mentioned above in the concerned reservoirs and analysed for metals.

5.1. MUDASARLOVA RESERVOIR

5.1.1. Analysis Results of sediments

S. No.	Parameter	Unit	SL-004	SL-005	SL-006	SL-020	Canadian SQ guidelines **	
							PEL	ISQG
1.	pH	--	7.60	7.58	7.72	7.62	---	---
2.	Chromium (as Cr)	mg/kg	0.92	0.22	0.84	23.76	90	37.3
3.	Manganese (as Mn)	mg/kg	106.44	1.85	111.94	295.09	---	---
4.	Iron (as Fe)	mg/kg	184.59	117.70	269.33	1294.80	---	---
5.	Nickel (as Ni)	mg/kg	6.20	0.18	4.67	9.11	---	---
6.	Copper (as Cu)	mg/kg	2.13	0.67	2.15	7.77	197	35.7
7.	Zinc (as Zn)	mg/kg	19.47	2.13	15.35	36.87	315	123
8.	Arsenic (as As)	mg/kg	0.79	0.06	0.22	0.86	17	5.9
9.	Cadmium (as Cd)	mg/kg	0.05	0.01	0.06	BDL	3.5	0.6
10.	Lead (as Pb)	mg/kg	1.54	0.20	1.22	6.11	91.3	35
11.	Mercury (as Hg)	mg/kg	0.02	0.01	0.03	0.06	0.486	0.17

**Canadian Sediment Quality guidelines for the protection of aquatic life, CCME, 2001.
ISQG : Interim Fresh water Sediment Quality guidelines. PEL : Probable Effect Level.

Inference

Sediment Quality

APPCB collected sediment samples in the reservoirs and inlet drains and analysed for metals. As per the analysis, the concentrations of Chromium, Copper, Zinc, Arsenic, Cadmium, Lead, Mercury, Iron, Manganese and Nickel in the sediments were below Canadian Sediment Quality guidelines for the protection of aquatic life, CCME, 2001.

5.2. GAMBHEERAM RESERVOIR

5.2.1. Analysis Results of sediments

S. No.	Parameter	Unit	SL-001	SL-002	SL-003	SL-021	Canadian SQ guidelines **	
							PEL	ISQG
1.	pH	--	7.42	7.48	7.54	7.82	---	---
2.	Chromium (as Cr)	mg/kg	37.55	42.07	40.58	16.96	90	37.3
3.	Manganese (as Mn)	mg/kg	387.95	468.78	248.56	275.1	---	---
4.	Iron (as Fe)	mg/kg	32346.58	35584.55	29970.45	9759.9	---	---
5.	Nickel (as Ni)	mg/kg	16.63	14.28	16.15	7.89	---	---
6.	Copper (as Cu)	mg/kg	21.15	19.96	19.58	9.46	197	35.7
7.	Zinc (as Zn)	mg/kg	33.91	25.27	23.49	15.48	315	123
8.	Arsenic (as As)	mg/kg	0.98	1.71	1.29	0.60	17	5.9
9.	Cadmium (as Cd)	mg/kg	0.08	0.06	0.07	BDL	3.5	0.6
10.	Lead (as Pb)	mg/kg	12.14	10.75	8.83	8.05	91.3	35
11.	Mercury (as Hg)	mg/kg	0.01	0.02	0.01	0.03	0.486	0.17

**Canadian Sediment Quality guidelines for the protection of aquatic life, CCME, 2001.
ISQG : Interim Fresh water Sediment Quality guidelines. PEL : Probable Effect Level.

Inference

Sediment Quality

APPCB collected sediment samples in the reservoir and inlet drain and analysed for metals. As per the analysis, the concentrations of Chromium, Copper, Zinc, Arsenic, Cadmium, Lead Mercury & Nickel in the sediments were below Canadian Sediment Quality guidelines for the protection of aquatic life, CCME, 2001.

5.3. TATIPUDI RESERVOIR

5.3.1. Analysis Results of sediments

S.No.	Parameter	Unit	SL-007	SL-008	SL-009	SL-024	Canadian SQ guidelines **	
							PEL	ISQG
1.	pH	--	7.52	7.37	7.32	6.57	---	---
2.	Chromium (as Cr)	mg/kg	16.05	8.26	15.01	36.53	90	37.3
3.	Manganese (as Mn)	mg/kg	196.72	65.45	140.60	839.08	---	---
4.	Iron (as Fe)	mg/kg	10710.87	4369.99	8312.41	28236.34	---	---
5.	Nickel (as Ni)	mg/kg	7.63	3.17	6.18	17.99	---	---
6.	Copper (as Cu)	mg/kg	6.48	3.06	4.44	23.82	197	35.7
7.	Zinc (as Zn)	mg/kg	11.47	8.01	12.00	41.78	315	123
8.	Arsenic (as As)	mg/kg	0.42	0.25	0.42	3.57	17	5.9
9.	Cadmium (as Cd)	mg/kg	0.02	0.02	0.02	BDL	3.5	0.6
10.	Lead (as Pb)	mg/kg	6.04	2.95	6.72	8.77	91.3	35
11.	Mercury (as Hg)	mg/kg	0.01	0.02	0.01	0.06	0.486	0.17

**Canadian Sediment Quality guidelines for the protection of aquatic life, CCME, 2001.
ISQG : Interim Fresh water Sediment Quality guidelines. PEL : Probable Effect Level.

Inference

Sediment Quality

APPCB collected sediment samples in the reservoir and inlet drains and analysed for metals. As per the analysis, the concentrations of Chromium, Copper, Zinc, Arsenic, Cadmium, Lead, Mercury, Nickel, in the sediments were below Canadian Sediment Quality guidelines for the protection of aquatic life, CCME, 2001.

5.4. RAIWADA RESERVOIR

5.4.1. Analysis Results of sediments

S. No.	Parameter	Unit	SL-010	SL-011	SL-012	SL-022	SL-023	Canadian SQ guidelines **	
								PEL	ISQG
1.	pH	--	7.34	7.29	7.19	6.68	6.53	---	---
2.	Chromium (as Cr)	mg/kg	26.12	13.25	16.55	42.37	40.30	90	37.3
3.	Manganese (as Mn)	mg/kg	820.44	338.55	407.20	2294.59	1103.89	---	---
4.	Iron (as Fe)	mg/kg	24156.06	10414.42	13757.14	40186.19	40119.87	---	---
5.	Nickel (as Ni)	mg/kg	12.39	9.67	11.33	16.92	14.06	---	---
6.	Copper (as Cu)	mg/kg	22.24	12.48	15.17	14.35	13.64	197	35.7
7.	Zinc (as Zn)	mg/kg	28.14	16.79	22.34	62.20	58.00	315	123
8.	Arsenic (as As)	mg/kg	1.53	0.86	1.03	3.17	2.23	17	5.9
9.	Cadmium (as Cd)	mg/kg	0.07	0.05	0.05	BDL	BDL	3.5	0.6
10.	Lead (as Pb)	mg/kg	7.86	4.90	6.22	13.72	11.64	91.3	35
11.	Mercury (as Hg)	mg/kg	0.01	0.01	0.01	0.03	0.02	0.486	0.17

**Canadian Sediment Quality guidelines for the protection of aquatic life, CCME, 2001.
ISQG : Interim Fresh water Sediment Quality guidelines. PEL : Probable Effect Level.

Inference

Sediment Quality

APPCB collected sediment samples in the reservoir and inlet drains and analysed for metals. As per the analysis, the concentrations of Chromium, Copper, Zinc, Arsenic, Cadmium, Lead, Mercury, Nickel in the sediments were below Canadian Sediment Quality guidelines for the protection of aquatic life, CCME, 2001.

5.5. MEGADRIGEDDA RESERVOIR

5.5.1. Analysis Results of sediments

S. No.	Parameter	Unit	SL-013	SL-014	SL-015	SL-016
1.	pH	--	7.16	7.46	7.14	6.65
2.	Chromium (as Cr)	mg/kg	11.66	14.74	13.75	10.34
3.	Manganese (as Mn)	mg/kg	342.27	360.52	244.07	37.62
4.	Iron (as Fe)	mg/kg	6289.94	10009.11	10624.68	4612.81
5.	Nickel (as Ni)	mg/kg	8.61	10.43	9.78	5.00
6.	Copper (as Cu)	mg/kg	12.90	11.92	14.63	10.50
7.	Zinc (as Zn)	mg/kg	86.08	38.65	18.55	15.30
8.	Arsenic (as As)	mg/kg	0.61	0.70	0.54	0.52
9.	Cadmium (as Cd)	mg/kg	0.11	0.13	0.04	0.26
10.	Lead (as Pb)	mg/kg	8.39	7.73	6.33	7.88
11.	Mercury(as Hg)	mg/kg	0.02	0.04	0.02	0.03

S.No.	Parameter	Unit	SL-017	SL-018	SL-019	Canadian SQ guidelines **	
						PEL	ISQG
1.	pH	--	6.99	7.92	8.03	---	---
2.	Chromium (as Cr)	mg/kg	10.68	9.92	13.41	90	37.3
3.	Manganese (as Mn)	mg/kg	631.62	126.35	109.37	---	---
4.	Iron (as Fe)	mg/kg	7997.52	3134.44	2796.96	---	---
5.	Nickel (as Ni)	mg/kg	7.02	3.89	2.76	---	---
6.	Copper (as Cu)	mg/kg	26.61	4.50	3.58	197	35.7
7.	Zinc (as Zn)	mg/kg	57.84	8.90	6.55	315	123
8.	Arsenic (as As)	mg/kg	1.06	0.32	0.29	17	5.9
9.	Cadmium (as Cd)	mg/kg	0.12	0.10	0.03	3.5	0.6
10.	Lead (as Pb)	mg/kg	7.78	4.59	3.40	91.3	35
11.	Mercury (as Hg)	mg/kg	0.03	0.02	0.04	0.486	0.17

**Canadian Sediment Quality guidelines for the protection of aquatic life, CCME, 2001.
ISQG : Interim Fresh water Sediment Quality guidelines. PEL : Probable Effect Level.

Inference

Sediment Quality

APPCB collected sediment samples in the reservoirs and inlet drains and analysed for metals. As per the analysis, the concentrations of Chromium, Copper, Zinc, Arsenic, Cadmium, Lead, Mercury, Iron, Manganese and Nickel in the sediments of reservoir are below Canadian Sediment Quality guidelines for the protection of aquatic life, CCME, 2001.

6. APPCB collected ground water samples on 29.11.2021 and 30.11.2021 from nearby bore wells of 5 no. reservoirs and analysed the drinking water parameters as per prescribed standards of Bureau of Indian Standards (BIS) IS 10500 : 2012 drinking water. The sample locations along with analysis results are as follows :

6.1. Analysis results of ground water samples near MUDASARLOVA reservoir

S. No.	Parameter	Unit	W-298	W-299	Drinking Water Specification: IS: 10500: 2012 Requirement	
					Requirement (Acceptable Limit)	Permissible Limit in the absence of alternate source
1.	pH	--	6.74	6.80	6.5-8.5	No Relaxation
2.	Electrical Conductivity (as $\mu\text{S}/\text{cm}$)	$\mu\text{S}/\text{cm}$	1589	1173	--	--
3.	Total Dissolved Solids at 105°C	mg/L	1040	760	500 mg/l	2000 mg/l
4.	Chlorides (as Cl)	mg/L	281	199	250 mg/l	1000 mg/l
5.	Total Alkalinity (as CaCO_3)	mg/L	420	320	200 mg/l	600 mg/l
6.	Total Hardness (as CaCO_3)	mg/L	512	340	200 mg/l	600 mg/l
7.	Calcium (as Ca)	mg/L	44.8	48.0	75 mg/l	200 mg/l
8.	Magnesium (as Mg)	mg/L	97.2	53.4	30 mg/l	100 mg/l
9.	Nitrate (as NO_3)	mg/L	6.46	5.48	45 mg/l	No Relaxation
10.	Nitrite Nitrogen (as $\text{NO}_2\text{-N}$)	mg/L	0.06	0.08	--	--
11.	Ammonical Nitrogen (as $\text{NH}_3\text{-N}$)	mg/L	0.01	0.02	--	--
12.	Phosphate (as P)	mg/L	BDL	0.02	--	--
13.	Sulphate (as SO_4)	mg/L	52.8	33.3	200 mg/l	400 mg/l
14.	Fluoride (as F)	mg/L	1.32	1.22	1.0 mg/l	1.5 mg/l
15.	Sodium (as Na^{++})	mg/L	157.84	114.76	--	--
16.	Potassium (as K^{++})	mg/L	4.37	3.26	--	--
17.	Chromium (as Cr)	mg/L	<0.001	<0.001	0.05 mg/l	No Relaxation
18.	Manganese (as Mn)	mg/L	<0.001	<0.001	0.1 mg/l	0.3 mg/l
19.	Iron (as Fe)	mg/L	0.018	0.011	0.3 mg/l	No Relaxation
20.	Nickel (as Ni)	mg/L	<0.001	<0.001	0.02 mg/l	No Relaxation
21.	Copper (as Cu)	mg/L	<0.001	<0.001	0.05 mg/l	1.5 mg/l
22.	Zinc (as Zn)	mg/L	0.001	0.001	5 mg/l	15 mg/l
23.	Arsenic (as As)	mg/L	<0.001	<0.001	0.01 mg/l	0.05 mg/l
24.	Cadmium (as Cd)	mg/L	<0.001	<0.001	0.003 mg/l	No Relaxation
25.	Lead (as Pb)	mg/L	<0.001	<0.001	0.01 mg/l	No Relaxation
26.	Mercury (as Hg)	mg/L	<0.001	<0.001	0.001 mg/l	No Relaxation

W – 298 : Bore well sample collected from Mudasarlova Village near Sewage Treatment Plant, Mudasarlova Reservoir

W – 299 : Bore well sample collected from Arilova Colony near Mudasarlova Reservoir

6.2. Analysis results of ground water samples near GAMBHEERAM Reservoir

S. No.	Parameter	Unit	W-296	W-297	Drinking Water Specification: IS: 10500: 2012 Requirement	
					Requirement (Acceptable Limit)	Permissible Limit in the absence of alternate source
1.	pH	--	6.78	7.01	6.5-8.5	No Relaxation
2.	Electrical Conductivity (as $\mu\text{S}/\text{cm}$)	$\mu\text{S}/\text{cm}$	782	1106	--	--
3.	Total Dissolved Solids at 105°C	mg/L	512	720	500 mg/l	2000 mg/l
4.	Chlorides (as Cl)	mg/L	73	121	250 mg/l	1000 mg/l
5.	Total Alkalinity (as CaCO_3)	mg/L	260	304	200 mg/l	600 mg/l
6.	Total Hardness (as CaCO_3)	mg/L	312	376	200 mg/l	600 mg/l
7.	Calcium (as Ca)	mg/L	46.4	91.2	75 mg/l	200 mg/l
8.	Magnesium (as Mg)	mg/L	47.62	35.96	30 mg/l	100 mg/l
9.	Nitrate (as NO_3)	mg/L	30.63	39.48	45 mg/l	No Relaxation
10.	Nitrite Nitrogen (as $\text{NO}_2\text{-N}$)	mg/L	0.04	0.13	--	--
11.	Ammonical Nitrogen (as $\text{NH}_3\text{-N}$)	mg/L	0.02	0.08	--	--
12.	Phosphate (as P)	mg/L	BDL	BDL	--	--
13.	Sulphate (as SO_4)	mg/L	35.42	42.51	200 mg/l	400 mg/l
14.	Fluoride (as F)	mg/L	0.46	0.45	1.0 mg/l	1.5 mg/l
15.	Sodium (as Na^{++})	mg/L	44.06	64.11	--	--
16.	Potassium (as K^{++})	mg/L	12.90	10.95	--	--
17.	Chromium (as Cr)	mg/L	<0.001	<0.001	0.05 mg/l	No Relaxation
18.	Manganese (as Mn)	mg/L	<0.001	<0.001	0.1 mg/l	0.3 mg/l
19.	Iron (as Fe)	mg/L	0.039	0.021	0.3 mg/l	No Relaxation
20.	Nickel (as Ni)	mg/L	<0.001	<0.001	0.02 mg/l	No Relaxation
21.	Copper (as Cu)	mg/L	<0.001	<0.001	0.05 mg/l	1.5 mg/l
22.	Zinc (as Zn)	mg/L	0.002	<0.001	5 mg/l	15 mg/l
23.	Arsenic (as As)	mg/L	<0.001	<0.001	0.01 mg/l	0.05 mg/l
24.	Cadmium (as Cd)	mg/L	<0.001	<0.001	0.003 mg/l	No Relaxation
25.	Lead (as Pb)	mg/L	<0.001	<0.001	0.01 mg/l	No Relaxation
26.	Mercury (as Hg)	mg/L	<0.001	<0.001	0.001 mg/l	No Relaxation

W - 296 : Bore well sample collected from Boyapalem Village near Gambheeram Reservoir

W - 297 : Bore well sample collected from Boyapalem Village near Ramalayam, Gambheeram Reservoir

6.3. Analysis results of ground water samples near Thatipudi Reservoir

S. No.	Parameter	Unit	W-292	W-293	Drinking Water Specification: IS: 10500: 2012 Requirement	
					Requirement (Acceptable Limit)	Permissible Limit in the absence of alternate source
1.	pH	--	6.64	6.72	6.5-8.5	No Relaxation
2.	Electrical Conductivity (as $\mu\text{S}/\text{cm}$)	$\mu\text{S}/\text{cm}$	651	377	--	--
3.	Total Dissolved Solids at 105°C	mg/L	420	248	500 mg/l	2000 mg/l
4.	Chlorides (as Cl)	mg/L	48.5	33.9	250 mg/l	1000 mg/l
5.	Total Alkalinity (as CaCO_3)	mg/L	328	180	200 mg/l	600 mg/l
6.	Total Hardness (as CaCO_3)	mg/L	344	192	200 mg/l	600 mg/l
7.	Calcium (as Ca)	mg/L	70.4	46.4	75 mg/l	200 mg/l
8.	Magnesium (as Mg)	mg/L	40.82	18.46	30 mg/l	100 mg/l
9.	Nitrate (as NO_3)	mg/L	2.61	2.47	45 mg/l	No Relaxation
10.	Nitrite Nitrogen (as $\text{NO}_2\text{-N}$)	mg/L	BDL	BDL	--	--
11.	Ammonical Nitrogen (as $\text{NH}_3\text{-N}$)	mg/L	BDL	BDL	--	--
12.	Phosphate (as P)	mg/L	0.05	0.08	--	--
13.	Sulphate (as SO_4)	mg/L	4.11	2.00	200 mg/l	400 mg/l
14.	Fluoride (as F)	mg/L	1.29	1.02	1.0 mg/l	1.5 mg/l

15.	Sodium (as Na ⁺⁺)	mg/L	22.23	19.79	--	--
16.	Potassium (as K ⁺⁺)	mg/L	1.21	1.80	--	--
17.	Chromium (as Cr)	mg/L	<0.001	<0.001	0.05 mg/l	No Relaxation
18.	Manganese (as Mn)	mg/L	<0.001	<0.001	0.1 mg/l	0.3 mg/l
19.	Iron (as Fe)	mg/L	0.034	0.028	0.3 mg/l	No Relaxation
20.	Nickel (as Ni)	mg/L	<0.001	<0.001	0.02 mg/l	No Relaxation
21.	Copper (as Cu)	mg/L	<0.001	<0.001	0.05 m/l	1.5 mg/l
22.	Zinc (as Zn)	mg/L	0.002	0.001	5 mg/l	15 mg/l
23.	Arsenic (as As)	mg/L	<0.001	<0.001	0.01 mg/l	0.05 mg/l
24.	Cadmium (as Cd)	mg/L	<0.001	<0.001	0.003 mg/l	No Relaxation
25.	Lead (as Pb)	mg/L	<0.001	<0.001	0.01 mg/l	No Relaxation
26.	Mercury (as Hg)	mg/L	<0.001	<0.001	0.001 mg/l	No Relaxation

W – 292 : Bore well sample collected from Shivalayam near Tatipudi Reservoir

W – 293 : Bore well sample collected from Ramalayam near Tatipudi Reservoir

6.4. Analysis results of ground water samples near Raiwada Reservoir

S. No.	Parameter	Unit	W-294	W-295	Drinking Water Specification: IS: 10500: 2012 Requirement	
					Requirement (Acceptable Limit)	Permissible Limit in the absence of alternate source
1.	pH	--	6.62	6.71	6.5-8.5	No Relaxation
2.	Electrical Conductivity (as μ S/cm)	μ S/cm	836	410	--	--
3.	Total Dissolved Solids at 105 ^o C	mg/L	540	268	500 mg/l	2000 mg/l
4.	Chlorides (as Cl)	mg/L	87.4	29.1	250 mg/l	1000 mg/l
5.	Total Alkalinity (as CaCO ₃)	mg/L	240	180	200 mg/l	600 mg/l
6.	Total Hardness (as CaCO ₃)	mg/L	368	200	200 mg/l	600 mg/l
7.	Calcium (as Ca)	mg/L	94.4	43.2	75 mg/l	200 mg/l
8.	Magnesium (as Mg)	mg/L	32.07	22.35	30 mg/l	100 mg/l
9.	Nitrate (as NO ₃)	mg/L	34.97	1.56	45 mg/l	No Relaxation
10.	Nitrite Nitrogen (as NO ₂ -N)	mg/L	0.02	BDL	--	--
11.	Ammonical Nitrogen (as NH ₃ -N)	mg/L	BDL	BDL	--	--
12.	Phosphate (as P)	mg/L	0.02	0.05	--	--
13.	Sulphate (as SO ₄)	mg/L	31.18	3.01	200 mg/l	400 mg/l
14.	Fluoride (as F)	mg/L	0.92	1.24	1.0 mg/l	1.5 mg/l
15.	Sodium (as Na ⁺⁺)	mg/L	32.97	8.83	--	--
16.	Potassium (as K ⁺⁺)	mg/L	1.08	2.00	--	--
17.	Chromium (as Cr)	mg/L	<0.001	<0.001	0.05 mg/l	No Relaxation
18.	Manganese (as Mn)	mg/L	<0.001	<0.001	0.1 mg/l	0.3 mg/l
19.	Iron (as Fe)	mg/L	0.012	0.020	0.3 mg/l	No Relaxation
20.	Nickel (as Ni)	mg/L	<0.001	<0.001	0.02 mg/l	No Relaxation
21.	Copper (as Cu)	mg/L	<0.001	<0.001	0.05 m/l	1.5 mg/l
22.	Zinc (as Zn)	mg/L	<0.001	<0.001	5 mg/l	15 mg/l
23.	Arsenic (as As)	mg/L	<0.001	<0.001	0.01 mg/l	0.05 mg/l
24.	Cadmium (as Cd)	mg/L	<0.001	<0.001	0.003 mg/l	No Relaxation
25.	Lead (as Pb)	mg/L	<0.001	<0.001	0.01 mg/l	No Relaxation
26.	Mercury (as Hg)	mg/L	<0.001	<0.001	0.001 mg/l	No Relaxation

W – 294 : Bore well sample collected from Raiwada Village, near Raiwada Reservoir

W – 295 : Bore well sample collected from Erakamma Temple, near Raiwada Reservoir

6.5. Analysis results of ground water samples near Meghadrigedda Reservoir

S. No.	Parameter	Unit	W-300	W-301	Drinking Water Specification: IS: 10500: 2012 Requirement	
					Requirement (Acceptable Limit)	Permissible Limit in the absence of alternate source
1.	pH	--	6.76	6.85	6.5-8.5	No Relaxation
2.	Electrical Conductivity (as $\mu\text{S}/\text{cm}$)	$\mu\text{S}/\text{cm}$	644	2400	--	--
3.	Total Dissolved Solids at 105°C	mg/L	416	1568	500 mg/l	2000 mg/l
4.	Chlorides (as Cl)	mg/L	97	427	250 mg/l	1000 mg/l
5.	Total Alkalinity (as CaCO_3)	mg/L	140	516	200 mg/l	600 mg/l
6.	Total Hardness (as CaCO_3)	mg/L	200	528	200 mg/l	600 mg/l
7.	Calcium (as Ca)	mg/L	41.6	78.4	75 mg/l	200 mg/l
8.	Magnesium (as Mg)	mg/L	23.32	80.67	30 mg/l	100 mg/l
9.	Nitrate (as NO_3)	mg/L	17.48	13.67	45 mg/l	No Relaxation
10.	Nitrite Nitrogen (as $\text{NO}_2\text{-N}$)	mg/L	BDL	0.02	--	--
11.	Ammonical Nitrogen (as $\text{NH}_3\text{-N}$)	mg/L	BDL	BDL	--	--
12.	Phosphate (as P)	mg/L	BDL	BDL	--	--
13.	Sulphate (as SO_4)	mg/L	29.99	126.5	200 mg/l	400 mg/l
14.	Fluoride (as F)	mg/L	1.07	1.04	1.0 mg/l	1.5 mg/l
15.	Sodium (as Na^{++})	mg/L	52.33	301.35	--	--
16.	Potassium (as K^{++})	mg/L	3.37	1.77	--	--
17.	Chromium (as Cr)	mg/L	<0.001	<0.001	0.05 mg/l	No Relaxation
18.	Manganese (as Mn)	mg/L	<0.001	<0.001	0.1 mg/l	0.3 mg/l
19.	Iron (as Fe)	mg/L	0.022	0.041	0.3 mg/l	No Relaxation
20.	Nickel (as Ni)	mg/L	<0.001	<0.001	0.02 mg/l	No Relaxation
21.	Copper (as Cu)	mg/L	<0.001	<0.001	0.05 mg/l	1.5 mg/l
22.	Zinc (as Zn)	mg/L	<0.001	0.012	5 mg/l	15 mg/l
23.	Arsenic (as As)	mg/L	<0.001	<0.001	0.01 mg/l	0.05 mg/l
24.	Cadmium (as Cd)	mg/L	<0.001	<0.001	0.003 mg/l	No Relaxation
25.	Lead (as Pb)	mg/L	<0.001	<0.001	0.01 mg/l	No Relaxation
26.	Mercury (as Hg)	mg/L	<0.001	<0.001	0.001 mg/l	No Relaxation

W – 300 : Bore well sample collected from HC Venkatapuram Village, Chinagadili near Meghadrigedda Reservoir,

W – 301 : Bore well sample collected from Santoshnagar, Kothapalli Village, Gopalapatnam

7. It is submitted that the analysis results of water quality of reservoirs and ground water samples near reservoirs are meeting the prescribed BIS Standards which is fit for drinking purpose. The sediment quality of reservoirs for metals is good as per Canadian Sediment Quality guidelines for the protection of aquatic life, CCME, 2001.

8. At present there is no need for remediation of 5 No.s reservoirs supplying the drinking water to GVMC.

9. Status of W.P. (PIL) No.248 of 2020:

The Writ Petition of W.P (PIL) No. 248 of 2020 still pending before the Hon'ble High Court of Andhra Pradesh. It is submitted that there are no directions to A.P. Pollution Control Board from the Hon'ble High Court of Andhra Pradesh till date in the matter.

The above report is placed before the Hon'ble Tribunal for its kind consideration to pass appropriate directions.



JOINT CHIEF ENVIRONMENTAL ENGINEER (FAC)
AP POLLUTION CONTROL BOARD,
ZONAL OFFICE, VISAKHAPATNAM

भारतीय मानक
पीने का पानी — विशिष्टि
(दूसरा पुनरीक्षण)

Indian Standard
DRINKING WATER — SPECIFICATION
(*Second Revision*)

ICS 13.060.20

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BUREAU OF INDIAN STANDARDS
MANAK BHAVAN, 9 BHADUR SHAH ZAFAR MARG
NEW DELHI 110002

FOREWORD

This Indian Standard (Second Revision) was adopted by the Bureau of Indian Standards, after the draft finalized by the Drinking Water Sectional Committee had been approved by the Food and Agriculture Division Council.

This standard was originally published in 1983. A report prepared by the World Health Organization in cooperation with the World Bank showed that in 1975, some 1 230 million people were without safe water supplies. These appalling facts were central to the United Nations decision to declare an International Drinking Water Supply and Sanitation decade, beginning in 1981. Further, the VI Five-Year Plan of India had made a special provision for availability of safe drinking water for the masses. Therefore, the standard was formulated with the objective of assessing the quality of water resources, and to check the effectiveness of water treatment and supply by the concerned authorities.

The first revision was undertaken to take into account the up-to-date information available about the nature and effect of various contaminants as also the new techniques for identifying and determining their concentration. Based on experience gained additional requirements for alkalinity; aluminium and boron were incorporated and the permissible limits for dissolved solids, nitrate and pesticides residues modified.

As per the eleventh five year plan document of India (2007-12), there are about 2.17 lakh quality affected habitations in the country with more than half affected with excess iron, followed by fluoride, salinity, nitrate and arsenic in that order. Further, approximately, 10 million cases of diarrhoea, more than 7.2 lakh typhoid cases and 1.5 lakh viral hepatitis cases occur every year a majority of which are contributed by unclean water supply and poor sanitation. The eleventh five year plan document of India (2007-2012) recognizes dealing with the issue of water quality as a major challenge and aims at addressing water quality problems in all quality affected habitations with emphasis on community participation and awareness campaigns as well as on top most priority to water quality surveillance and monitoring by setting up of water quality testing laboratories strengthened with qualified manpower, equipments and chemicals.

The second revision was undertaken to upgrade the requirements of the standard and align with the internationally available specifications on drinking water. In this revision assistance has been derived from the following:

- a) EU Directives relating to the quality of water intended for human consumption (80/778/EEC) and Council Directive 98/83/EC.
- b) USEPA standard — National Primary Drinking Water Standard. EPA 816-F-02-013 dated July, 2002.
- c) WHO Guidelines for Drinking Water Quality. 3rd Edition Vol. 1 Recommendations, 2008.
- d) Manual on Water Supply and Treatment, third edition — revised and updated May 1999, Ministry of Urban Development, New Delhi.

This standard specifies the acceptable limits and the permissible limits in the absence of alternate source. It is recommended that the acceptable limit is to be implemented as values in excess of those mentioned under 'Acceptable' render the water not suitable. Such a value may, however, be tolerated in the absence of an alternative source. However, if the value exceeds the limits indicated under 'permissible limit in the absence of alternate source' in col 4 of Tables 1 to 4, the sources will have to be rejected.

Pesticide residues limits and test methods given in Table 5 are based on consumption pattern, persistence and available manufacturing data. The limits have been specified based on WHO guidelines, wherever available. In cases where WHO guidelines are not available, the standards available from other countries have been examined and incorporated, taking in view the Indian conditions.

In this revision, additional requirements for ammonia, chloramines, barium, molybdenum, silver, sulphide, nickel, polychlorinated biphenyls and trihalomethanes have been incorporated while the requirements for colour, turbidity, total hardness, free residual chlorine, iron, magnesium, mineral oil, boron, cadmium, total arsenic, lead, polynuclear aromatic hydrocarbons, pesticides and bacteriological requirements have been modified.

In this revision, requirement and test method for virological examination have been included. Further, requirements and test methods for cryptosporidium and giardia have also been specified.

Routine surveillance of drinking water supplies should be carried out by the relevant authorities to understand the risk of specific pathogens and to define proper control procedures. The WHO Guidelines for Drinking Water Quality, 3rd Edition, Vol. 1 may be referred for specific recommendations on using a water safety approach incorporating risk identification. Precautions/Care should be taken to prevent contamination of drinking water from chlorine resistant parasites such as cryptosporidium species and giardia.

Indian Standard

DRINKING WATER — SPECIFICATION

(Second Revision)

1 SCOPE

This standard prescribes the requirements and the methods of sampling and test for drinking water.

2 REFERENCES

The standards listed in Annex A contain provisions which through reference in this text, constitute provisions of this standard. At the time of publication, the editions indicated were valid. All standards are subject to revision and parties to agreements based on this standard are encouraged to investigate the possibility of applying the most recent editions of the standards indicated in Annex A.

3 TERMINOLOGY

For the purpose of this standard the following definition shall apply.

3.1 Drinking Water — Drinking water is water intended for human consumption for drinking and cooking purposes from any source. It includes water (treated or untreated) supplied by any means for human consumption.

4 REQUIREMENTS

Drinking water shall comply with the requirements given in Tables 1 to 4. The analysis of pesticide residues given in Table 3 shall be conducted by a recognized laboratory using internationally established test method meeting the residue limits as given in Table 5.

Drinking water shall also comply with bacteriological requirements (*see 4.1*), virological requirements (*see 4.2*) and biological requirements (*see 4.3*).

4.1 Bacteriological Requirements

4.1.1 Water in Distribution System

Ideally, all samples taken from the distribution system including consumers' premises, should be free from coliform organisms and the following bacteriological quality of drinking water collected in the distribution system, as given in Table 6 is, therefore specified when tested in accordance with IS 1622.

4.2 Virological Requirements

4.2.1 Ideally, all samples taken from the distribution

Table 1 Organoleptic and Physical Parameters

(Foreword and Clause 4)

SI No.	Characteristic	Requirement (Acceptable Limit)	Permissible Limit in the Absence of Alternate Source	Method of Test, Ref to Part of IS 3025	Remarks
(1)	(2)	(3)	(4)	(5)	(6)
i)	Colour, Hazen units, <i>Max</i>	5	15	Part 4	Extended to 15 only, if toxic substances are not suspected in absence of alternate sources
ii)	Odour	Agreeable	Agreeable	Part 5	a) Test cold and when heated b) Test at several dilutions
iii)	pH value	6.5-8.5	No relaxation	Part 11	—
iv)	Taste	Agreeable	Agreeable	Parts 7 and 8	Test to be conducted only after safety has been established
v)	Turbidity, NTU, <i>Max</i>	1	5	Part 10	—
vi)	Total dissolved solids, mg/l, <i>Max</i>	500	2 000	Part 16	—

NOTE — It is recommended that the acceptable limit is to be implemented. Values in excess of those mentioned under 'acceptable' render the water not suitable, but still may be tolerated in the absence of an alternative source but up to the limits indicated under 'permissible limit in the absence of alternate source' in col 4, above which the sources will have to be rejected.

Table 2 General Parameters Concerning Substances Undesirable in Excessive Amounts
(Foreword and Clause 4)

Sl No.	Characteristic	Requirement (Acceptable Limit)	Permissible Limit in the Absence of Alternate Source	Method of Test, Ref to	Remarks
(1)	(2)	(3)	(4)	(5)	(6)
i)	Aluminium (as Al), mg/l, <i>Max</i>	0.03	0.2	IS 3025 (Part 55)	—
ii)	Ammonia (as total ammonia-N), mg/l, <i>Max</i>	0.5	No relaxation	IS 3025 (Part 34)	—
iii)	Anionic detergents (as MBAS) mg/l, <i>Max</i>	0.2	1.0	Annex K of IS 13428	—
iv)	Barium (as Ba), mg/l, <i>Max</i>	0.7	No relaxation	Annex F of IS 13428* or IS 15302	—
v)	Boron (as B), mg/l, <i>Max</i>	0.5	1.0	IS 3025 (Part 57)	—
vi)	Calcium (as Ca), mg/l, <i>Max</i>	75	200	IS 3025 (Part 40)	—
vii)	Chloramines (as Cl ₂), mg/l, <i>Max</i>	4.0	No relaxation	IS 3025 (Part 26)* or APHA 4500-Cl G	—
viii)	Chloride (as Cl), mg/l, <i>Max</i>	250	1 000	IS 3025 (Part 32)	—
ix)	Copper (as Cu), mg/l, <i>Max</i>	0.05	1.5	IS 3025 (Part 42)	—
x)	Fluoride (as F) mg/l, <i>Max</i>	1.0	1.5	IS 3025 (Part 60)	—
xi)	Free residual chlorine, mg/l, <i>Min</i>	0.2	1	IS 3025 (Part 26)	To be applicable only when water is chlorinated. Tested at consumer end. When protection against viral infection is required, it should be minimum 0.5 mg/l
xii)	Iron (as Fe), mg/l, <i>Max</i>	0.3	No relaxation	IS 3025 (Part 53)	Total concentration of manganese (as Mn) and iron (as Fe) shall not exceed 0.3 mg/l
xiii)	Magnesium (as Mg), mg/l, <i>Max</i>	30	100	IS 3025 (Part 46)	—
xiv)	Manganese (as Mn), mg/l, <i>Max</i>	0.1	0.3	IS 3025 (Part 59)	Total concentration of manganese (as Mn) and iron (as Fe) shall not exceed 0.3 mg/l
xv)	Mineral oil, mg/l, <i>Max</i>	0.5	No relaxation	Clause 6 of IS 3025 (Part 39) Infrared partition method	—
xvi)	Nitrate (as NO ₃), mg/l, <i>Max</i>	45	No relaxation	IS 3025 (Part 34)	—
xvii)	Phenolic compounds (as C ₆ H ₅ OH), mg/l, <i>Max</i>	0.001	0.002	IS 3025 (Part 43)	—
xviii)	Selenium (as Se), mg/l, <i>Max</i>	0.01	No relaxation	IS 3025 (Part 56) or IS 15303*	—
xix)	Silver (as Ag), mg/l, <i>Max</i>	0.1	No relaxation	Annex J of IS 13428	—
xx)	Sulphate (as SO ₄) mg/l, <i>Max</i>	200	400	IS 3025 (Part 24)	May be extended to 400 provided that Magnesium does not exceed 30
xxi)	Sulphide (as H ₂ S), mg/l, <i>Max</i>	0.05	No relaxation	IS 3025 (Part 29)	—
xxii)	Total alkalinity as calcium carbonate, mg/l, <i>Max</i>	200	600	IS 3025 (Part 23)	—
xxiii)	Total hardness (as CaCO ₃), mg/l, <i>Max</i>	200	600	IS 3025 (Part 21)	—
xxiv)	Zinc (as Zn), mg/l, <i>Max</i>	5	15	IS 3025 (Part 49)	—

NOTES

1 In case of dispute, the method indicated by '*' shall be the referee method.

2 It is recommended that the acceptable limit is to be implemented. Values in excess of those mentioned under 'acceptable' render the water not suitable, but still may be tolerated in the absence of an alternative source but up to the limits indicated under 'permissible limit in the absence of alternate source' in col 4, above which the sources will have to be rejected.

Table 3 Parameters Concerning Toxic Substances
(Foreword and Clause 4)

Sl No.	Characteristic	Requirement (Acceptable Limit)	Permissible Limit in the Absence of Alternate Source	Method of Test, Ref to	Remarks
(1)	(2)	(3)	(4)	(5)	(6)
i)	Cadmium (as Cd), mg/l, <i>Max</i>	0.003	No relaxation	IS 3025 (Part 41)	—
ii)	Cyanide (as CN), mg/l, <i>Max</i>	0.05	No relaxation	IS 3025 (Part 27)	—
iii)	Lead (as Pb), mg/l, <i>Max</i>	0.01	No relaxation	IS 3025 (Part 47)	—
iv)	Mercury (as Hg), mg/l, <i>Max</i>	0.001	No relaxation	IS 3025 (Part 48)/ Mercury analyser	—
v)	Molybdenum (as Mo), mg/l, <i>Max</i>	0.07	No relaxation	IS 3025 (Part 2)	—
vi)	Nickel (as Ni), mg/l, <i>Max</i>	0.02	No relaxation	IS 3025 (Part 54)	—
vii)	Pesticides, µg/l, <i>Max</i>	See Table 5	No relaxation	See Table 5	—
viii)	Polychlorinated biphenyls, mg/l, <i>Max</i>	0.000 5	No relaxation	ASTM 5175*	—
ix)	Polynuclear aromatic hydro- carbons (as PAH), mg/l, <i>Max</i>	0.000 1	No relaxation	APHA 6440	or APHA 6630 —
x)	Total arsenic (as As), mg/l, <i>Max</i>	0.01	0.05	IS 3025 (Part 37)	—
xi)	Total chromium (as Cr), mg/l, <i>Max</i>	0.05	No relaxation	IS 3025 (Part 52)	—
xii)	Trihalomethanes:				
a)	Bromoform, mg/l, <i>Max</i>	0.1	No relaxation	ASTM D 3973-85* or APHA 6232	—
b)	Dibromochloromethane, mg/l, <i>Max</i>	0.1	No relaxation	ASTM D 3973-85* or APHA 6232	—
c)	Bromodichloromethane, mg/l, <i>Max</i>	0.06	No relaxation	ASTM D 3973-85* or APHA 6232	—
d)	Chloroform, mg/l, <i>Max</i>	0.2	No relaxation	ASTM D 3973-85* or APHA 6232	—

NOTES

1 In case of dispute, the method indicated by '*' shall be the referee method.

2 It is recommended that the acceptable limit is to be implemented. Values in excess of those mentioned under 'acceptable' render the water not suitable, but still may be tolerated in the absence of an alternative source but up to the limits indicated under 'permissible limit in the absence of alternate source' in col 4, above which the sources will have to be rejected.

Table 4 Parameters Concerning Radioactive Substances
(Foreword and Clause 4)

Sl No.	Characteristic	Requirement (Acceptable Limit)	Permissible Limit in the Absence of Alternate Source	Method of Test, Ref to Part of IS 14194	Remarks
(1)	(2)	(3)	(4)	(5)	(6)
i)	Radioactive materials:				
a)	Alpha emitters Bq/l, <i>Max</i>	0.1	No relaxation	Part 2	—
b)	Beta emitters Bq/l, <i>Max</i>	1.0	No relaxation	Part 1	—

NOTE — It is recommended that the acceptable limit is to be implemented. Values in excess of those mentioned under 'acceptable' render the water not suitable, but still may be tolerated in the absence of an alternative source but up to the limits indicated under 'permissible limit in the absence of alternate source' in col 4, above which the sources will have to be rejected.

Table 5 Pesticide Residues Limits and Test Method
(Foreword and Table 3)

Sl No.	Pesticide	Limit µg/l	Method of Test, Ref to	
			USEPA (4)	AOAC/ ISO (5)
(1)	(2)	(3)	(4)	(5)
i)	Alachlor	20	525.2, 507	—
ii)	Atrazine	2	525.2, 8141 A	—
iii)	Aldrin/ Dieldrin	0.03	508	—
iv)	Alpha HCH	0.01	508	—
v)	Beta HCH	0.04	508	—
vi)	Butachlor	125	525.2, 8141 A	—
vii)	Chlorpyrifos	30	525.2, 8141 A	—
viii)	Delta HCH	0.04	508	—
ix)	2,4- Dichlorophenoxyacetic acid	30	515.1	—
x)	DDT (<i>o, p</i> and <i>p, p</i> – Isomers of DDT, DDE and DDD)	1	508	AOAC 990.06
xi)	Endosulfan (alpha, beta, and sulphate)	0.4	508	AOAC 990.06
xii)	Ethion	3	1657 A	—
xiii)	Gamma — HCH (Lindane)	2	508	AOAC 990.06
xiv)	Isoproturon	9	532	—
xv)	Malathion	190	8141 A	—
xvi)	Methyl parathion	0.3	8141 A	ISO 10695
xvii)	Monocrotophos	1	8141 A	—
xviii)	Phorate	2	8141 A	—

NOTE — Test methods are for guidance and reference for testing laboratory. In case of two methods, USEPA method shall be the reference method.

Table 6 Bacteriological Quality of Drinking Water¹⁾
(Clause 4.1.1)

Sl No.	Organisms	Requirements
(1)	(2)	(3)
i)	<i>All water intended for drinking:</i>	
a)	<i>E. coli</i> or thermotolerant coliform bacteria ^{2), 3)}	Shall not be detectable in any 100 ml sample
ii)	<i>Treated water entering the distribution system:</i>	
a)	<i>E. coli</i> or thermotolerant coliform bacteria ²⁾	Shall not be detectable in any 100 ml sample
b)	Total coliform bacteria	Shall not be detectable in any 100 ml sample
iii)	<i>Treated water in the distribution system:</i>	
a)	<i>E. coli</i> or thermotolerant coliform bacteria	Shall not be detectable in any 100 ml sample
b)	Total coliform bacteria	Shall not be detectable in any 100 ml sample

¹⁾Immediate investigative action shall be taken if either *E.coli* or total coliform bacteria are detected. The minimum action in the case of total coliform bacteria is repeat sampling; if these bacteria are detected in the repeat sample, the cause shall be determined by immediate further investigation.

²⁾Although, *E. coli* is the more precise indicator of faecal pollution, the count of thermotolerant coliform bacteria is an acceptable alternative. If necessary, proper confirmatory tests shall be carried out. Total coliform bacteria are not acceptable indicators of the sanitary quality of rural water supplies, particularly in tropical areas where many bacteria of no sanitary significance occur in almost all untreated supplies.

³⁾It is recognized that, in the great majority of rural water supplies in developing countries, faecal contamination is widespread. Under these conditions, the national surveillance agency should set medium-term targets for progressive improvement of water supplies.

system including consumers' premises, should be free from virus.

4.2.2 None of the generally accepted sewage treatment methods yield virus-free effluent. Although a number of investigators have found activated sludge treatment to be superior to trickling filters from this point of view, it seems possible that chemical precipitation methods will prove to be the most effective.

4.2.3 Virus can be isolated from raw water and from springs, enterovirus, reovirus, and adenovirus have been found in water, the first named being the most resistant to chlorination. If enterovirus are absent from chlorinated water, it can be assumed that the water is safe to drink. Some uncertainty still remains about the virus of infectious hepatitis, since it has not so far been isolated but in view of the morphology and resistance of enterovirus it is likely that, if they have been inactivated hepatitis virus will have been inactivated also.

4.2.4 An exponential relationship exists between the rate of virus inactivation and the redox potential. A redox potential of 650 mV (measured between platinum and calomel electrodes) will cause almost instantaneous inactivation of even high concentrations of virus. Such a potential can be obtained with even a low concentration of free chlorine, but only with an extremely high concentration of combined chlorine. This oxidative inactivation may be achieved with a number of other oxidants also, for example, iodine, ozone and potassium permanganate, but the effect of the oxidants will always be counteracted, if reducing components, which are mainly organic, are present. As a consequence, the sensitivity of virus towards disinfectants will depend on the *milieu* just as much as on the particular disinfectant used.

4.2.5 Viruses are generally resistant to disinfectants as well as get protected on account of presence of particulate and organic matter in water. Because the difference between the resistance of coliform organisms and of virus to disinfection by oxidants increases with increasing concentration of reducing components, for example, organic matter, it cannot be assumed that the absence of available coliform organisms implies freedom from active virus under circumstances where a free chlorine residual cannot be maintained. Sedimentation and slow sand filtration in themselves may contribute to the removal of virus from water.

4.2.6 In practice, >0.5 mg/l of free chlorine for 1 h is sufficient to inactivate virus, even in water that was originally polluted provided the water is free from particulates and organic matter.

4.2.7 MS2 phage are indicator of viral contamination in drinking water. MS2 phage shall be absent in 1 litre of water when tested in accordance with USEPA method 1602. If MS2 phage are detected in the drinking water, virological examination shall be done by the Polymerase Chain Reaction (PCR) method for virological examination as given in Annex B. USEPA method in Manual of Method for Virology Chapter 16, June 2001 shall be the alternate method. If viruses are detected, the cause shall be determined by immediate further investigation.

4.3 Biological Requirements

4.3.1 Ideally, all samples taken including consumers premises should be free from biological organisms. Biological examination is of value in determining the causes of objectionable tastes and odours in water and controlling remedial treatments, in helping to interpret the results of various chemical analysis, and in explaining the causes of clogging in distribution pipes and filters. In some instances, it may be of use in demonstrating that water from one source has been mixed with that from another.

4.3.2 The biological qualities of water are of greater importance when the supply has not undergone the conventional flocculation and filtration processes, since increased growth of methane-utilizing bacteria on biological slimes in pipes may then be expected, and the development of bryozoal growths such as *Plumatella* may cause operational difficulties.

4.3.3 Some of the animalcules found in water mains may be free-living in the water, but others such as *Dreissena* and *Asellus* are more or less firmly attached to the inside of the mains. Although these animalcules are not themselves pathogenic, they may harbour pathogenic organisms or virus in their intestines, thus protecting these pathogens from destruction by chlorine.

4.3.4 Chlorination, at the dosages normally employed in waterworks, is ineffective against certain parasites, including amoebic cysts; they can be excluded only by effective filtration or by higher chlorine doses than can be tolerated without subsequent dechlorination. *Amoebiasis* can be conveyed by water completely free from enteric bacteria; microscopic examination after concentration is, therefore, the only safe method of identification.

4.3.5 Strict precautions against back-syphonage and cross-connections are required, if amoebic cysts are found in a distribution system containing tested water.

4.3.6 The *cercariae of schistosomiasis* can be detected by similar microscopic examination, but there is, in

any case, no evidence to suggest that this disease is normally spread through piped water supplies.

4.3.7 The cyclops vector of the embryos of *Dracunculus medinensis* which causes dracontiasis or Guinea-worm disease can be found in open wells in a number of tropical areas. They are identifiable by microscopic examination. Such well supplies are frequently used untreated, but the parasite can be relatively easily excluded by simple physical improvements in the form of curbs, drainage, and apron surrounds and other measures which prevent physical contact with the water source.

4.3.8 Cryptosporidium shall be absent in 10 liter of water when tested in accordance with USEPA method 1622 or USEPA method 1623* or ISO 15553 : 2006.

4.3.9 Giardia shall be absent in 10 liter of water when tested in accordance with USEPA method 1623* or ISO 15553 : 2006.

4.3.10 The drinking water shall be free from microscopic organisms such as algae, zooplanktons, flagellates, parasites and toxin producing organisms. An illustrative (and not exhaustive) list is given in Annex C for guidance.

NOTE — In case of dispute, the method indicated by '*' in **4.3.8** and **4.3.9** shall be referee method.

5 SAMPLING

Representative samples of water shall be drawn as prescribed in IS 1622 and IS 3025 (Part 1).

ANNEX A

(Clause 2)

LIST OF REFERRED INDIAN STANDARDS

IS No.	Title	IS No.	Title
1622 : 1981	Methods of sampling and microbiological examination of water (<i>first revision</i>)	(Part 41) : 1992	Cadmium (<i>first revision</i>)
3025	Methods of sampling and test (physical and chemical) for water and waste water:	(Part 42) : 1992	Copper (<i>first revision</i>)
(Part 1) : 1987	Sampling (<i>first revision</i>)	(Part 43) : 1992	Phenols (<i>first revision</i>)
(Part 2) : 2002	Determination of 33 elements by inductively coupled plasma atomic emission spectroscopy	(Part 46) : 1994	Magnesium
(Part 4) : 1983	Colour (<i>first revision</i>)	(Part 47) : 1994	Lead
(Part 5) : 1983	Odour (<i>first revision</i>)	(Part 48) : 1994	Mercury
(Part 7) : 1984	Taste threshold (<i>first revision</i>)	(Part 49) : 1994	Zinc
(Part 8) : 1984	Tasting rate (<i>first revision</i>)	(Part 52) : 2003	Chromium
(Part 10) : 1984	Turbidity (<i>first revision</i>)	(Part 53) : 2003	Iron
(Part 11) : 1983	pH value (<i>first revision</i>)	(Part 54) : 2003	Nickel
(Part 16) : 1984	Filterable residue (total dissolved solids) (<i>first revision</i>)	(Part 55) : 2003	Aluminium
(Part 21) : 1983	Total hardness (<i>first revision</i>)	(Part 56) : 2003	Selenium
(Part 23) : 1983	Alkalinity (<i>first revision</i>)	(Part 57) : 2005	Boron
(Part 24) : 1986	Sulphates (<i>first revision</i>)	(Part 59) : 2006	Manganese
(Part 26) : 1986	Chlorine residual (<i>first revision</i>)	(Part 60) : 2008	Fluoride
(Part 27) : 1986	Cyanide (<i>first revision</i>)	13428 : 2003	Packaged natural mineral water — Specification (<i>first revision</i>)
(Part 29) : 1986	Sulphide (<i>first revision</i>)	14194	Radionuclides in environmental samples — Method of estimation:
(Part 32) : 1988	Chloride (<i>first revision</i>)	(Part 1) : 1994	Gross beta activity measurement
(Part 34) : 1988	Nitrogen (<i>first revision</i>)	(Part 2) : 1994	Gross alpha activity measurement
(Part 37) : 1988	Arsenic (<i>first revision</i>)	15302 : 2002	Determination of aluminium and barium in water by direct nitrous oxide-acetylene flame atomic absorption spectrometry
(Part 39) : 1989	Oil and grease	15303 : 2002	Determination of antimony, iron and selenium in water by electrothermal atomic absorption spectrometry
(Part 40) : 1991	Calcium		

ANNEX B (Clause 4.2.7)

POLYMERASE CHAIN REACTION (PCR) METHOD

B-1 GENERAL

The method involves the concentration of viruses from 100 litre of drinking water to 1 ml by membrane filter technique. The concentrate is subjected to amplification using polymerase chain reaction (PCR) and primers based on highly conserved regions of viral genomes. This method can detect as low as 10 genome copies. Stringent precautions are needed to avoid contamination with amplified DNA products leading to false positive reactions. Detection of hepatitis A virus (HAV) RNA and enterovirus (EV) RNA is considered as an indication of presence of viruses in water. Steps involved include concentration of water, RNA extraction, complementary DNA (cDNA) synthesis and PCR.

B-2 CONCENTRATION OF DRINKING WATER

B-2.1 Apparatus

B-2.1.1 Pressure Pump

B-2.1.2 Membrane Filter Assembly with 144 mm Diameter with Tripod Stand

B-2.1.3 Pressure Vessel (50 litre capacity) with Pressure Gauge

B-2.1.4 Inter-connecting Pressure Tubes

B-2.2 Reagents

Autoclaved double distilled water shall be used for the preparation of reagents/buffers in this study.

B-2.2.1 Aluminium Chloride

B-2.2.2 HCl/NaOH Urea (Extra Pure)

B-2.2.3 Disodium Hydrogen Phosphate ($\text{Na}_2\text{HPO}_4 \cdot 2\text{H}_2\text{O}$) — 0.2 M, filter sterilized.

B-2.2.4 Sodium Dihydrogen Phosphate ($\text{NaH}_2\text{PO}_4 \cdot 2\text{H}_2\text{O}$) — 0.2 M, filter sterilized.

B-2.2.5 Citric Acid — 0.1 M, filter sterilized.

B-2.2.6 L-Arginine — 0.5 M, filter sterilized.

B-2.2.7 Urea-Arginine Phosphate Buffer (U-APB) — Mix 4.5 g of urea with 2 ml of 0.2 M NaH_2PO_4 and 2 ml of 0.5 M L - Arginine and make up the volume to 50 ml with sterile distilled water. The pH of the eluent shall be 9.0.

B-2.2.8 Magnesium Chloride (MgCl_2) — 1 M.

B-2.2.9 McII Vaines Buffer (pH 5.0) — Mix 9.7 ml of

0.1 M citric acid with 10.3 ml of 0.2 M $\text{Na}_2\text{HPO}_4 \cdot 2\text{H}_2\text{O}$ under sterile conditions.

B-2.3 Procedure

Filter 100 litre of drinking water sample through membrane filter assembly using either positively charged membrane of 144 mm diameter or 0.22 micron diameter pore size nitrocellulose membrane. For positively charged membrane the test water pH need not be adjusted. But for the 0.22 micron nitrocellulose membrane adjust the pH to 3.5 after adding the aluminium chloride as a coagulant to a final concentration of 0.000 5 M.

At lower pH pass the water through the membrane. The flow rate shall be 40 litre/h approximately. After the completion of the filtration, elute the adsorbed particles using 100 ml of urea-arginine phosphate buffer (U-APB). Precipitate the suspended particles using 1 ml of magnesium chloride (1 M). Dissolve the resultant precipitate centrifuged out of the sample in 800-1.0 ml of McII vaines buffer. The processed sample can be stored at refrigerator until required.

B-3 RNA EXTRACTION

B-3.1 Apparatus

B-3.1.1 Cooling Centrifuge

B-3.1.2 Deep Freezer (-20°C)

B-3.1.3 Vortex Mixer

B-3.1.4 Pipette Man

B-3.2 Reagents

B-3.2.1 Cetyl Trimethyl Ammonium Bromide (CTAB) Buffer

CTAB	:	1 percent
Sodium Dodecyl Sulphate (SDS)	:	1 percent
EDTA	:	20 mM
Sodium Chloride	:	1 M

B-3.2.2 Phenol, Chloroform and Isoamylalcohol in the ratio of 25:24:1 (PCI)

B-3.2.3 Ethanol

B-3.2.4 TE Buffer (pH 8.0)

Tris base	:	1 M
EDTA	:	0.5 M

B-3.2.5 Sodium Acetate — 3 M.

B-3.3 Procedure

Treat 300 µl of concentrated water sample with equal volume of CTAB and 1/10th volume of PCI. Vortex and centrifuge at 5 000 × g for 30 min at 4°C. Add 1/10th volume of 3 M sodium acetate and double the volume of cold ethanol to the aqueous layer. Keep the mixture at either at -20°C for overnight or in liquid nitrogen for 2-5 min. Centrifuge at 10 000 × g, for 30 min at 4°C. Discard the supernatant and air dry the pellet and dissolve it in 20 µl TE buffer.

B-4 COMPLEMENTARY DNA (c DNA) SYNTHESIS**B-4.1 Apparatus****B-4.1.1 PCR Machine****B-4.1.2 Deep Freezer (-20°C)****B-4.2 Reagents****B-4.2.1 cDNA Synthesis Kit****B-4.3 Procedure**

Suspend the extracted RNA in 20 µl of cDNA reaction mixture, which consists of 4 µl of 5X reverse transcriptase reaction buffer [250 mM TRIS-HCl (pH 8.5), 40 mM KCl, 150 mM MgCl₂, 5 mM dithiothreitol (DTT)], 0.5 µl of 10 mM deoxynucleotide phosphate (dNTP), 2 µl of hexa nucleotide mixture, 1 µl of 25 U of Maloney Murine Leukaemia Virus (M-MuLV) reverse transcriptase, 0.5 µl of 20 U of human placental RNase inhibitor. Heat the reaction mixture to 95°C for 5 min and rapidly chill on ice, this is followed by the addition of 1 µl (25 U/µl) of M-MuLV reverse transcriptase. Incubate the reaction mixture as given by the manufacturer of the kit and quickly chill the reaction tube on ice.

B-5 PCR AMPLIFICATION**B-5.1 Apparatus****B-5.1.1 PCR Machine****B-5.1.2 Deep Freezer (-20°C)****B-5.1.3 Micropipette****B-5.2 Reagents****B-5.2.1 Primers for EV and HAV**

EV sense primer, 5' — TCC TCC GGC CCC
TGA ATG CG — 3'
antisense primer, 5' — ATT GTC ACC
ATA AGC AGC CA — 3'
HAV sense primer, 5' — GTTTT GCTCC
TCTTT ATCAT GCTAT G-3'

antisense primer, 5' — GGAAA TGTCT
CAGGT ACTTT CTTTG-3'

B-5.2.2 PCR Master Mix**B-5.2.3 Mineral Oil****B-5.3 Procedure****B-5.3.1 PCR Amplification for Hepatitis A Virus (HAV)**

In 5 µl of cDNA, add 95 µl of a PCR Master Mix (10 mM TRIS-HCl (pH 8.3), 50 mM KCl, 2.5 mM MgCl₂, 0.01 percent gelatin (1× PCR buffer), 200 µM of each dNTP, 1.5 U of *Thermus aquaticus* polymerase). Add 25 pico moles of sense and antisense oligonucleotide primers of HAV and overlay with mineral oil. Appropriate positive and negative controls shall be included with each run. Set the following reaction at thermo cycler:

Denaturation at 94°C for 2 min	} 35 cycles
Denaturation for 1.0 min at 94°C	
Annealing for 1.0 min at 57°C	
Extension for 1.3 min at 72°C	
Final extension at 72°C for 7 min.	

B-5.3.2 PCR Amplification for Enterovirus (EV)

In 5 µl of cDNA, add 95 µl of a PCR Master Mix (10 mM TRIS-HCl (pH 8.3), 50 mM KCl, 2.5 mM MgCl₂, 0.01 percent gelatin (1X PCR buffer), 200 µM of each dNTP, 1.5 U of *Thermus aquaticus* polymerase). Add 25 pico moles of sense and antisense oligonucleotide primers of EV and overlay with mineral oil. Appropriate positive and negative controls shall be included with each run. Set the following reaction at thermo cycler:

Denaturation at 94°C for 2 min	} 35 cycles
Denaturation for 1.0 min at 94°C	
Annealing for 1.0 min at 42°C	
Extension for 2.0 min at 72°C	
Final extension at 72°C for 7 min.	

B-6 AGAROSE GEL ELECTROPHORESIS**B-6.1 Apparatus****B-6.1.1 Micropipette****B-6.1.2 Electrophoresis Apparatus****B-6.1.3 Gel Documentation System****B-6.2 Reagents****B-6.2.1 Running Buffer — 50X TAE buffer**

Tris base/Tris buffer : 121.00 g

Glacial acetic acid : 28.55 ml
0.5 M EDTA : 50 .00 ml
Distilled water : 300.45 ml
(autoclaved)

Make the final volume upto 1 000 ml with deionised distilled water, sterilize and store at 4°C. The final concentration for the preparation of agarose gel and to run the gel shall be 1X.

B-6.2.2 Tracking Dye — 6X bromophenol blue.

B-6.2.3 Ethidium Bromide — 0.5 µg/ml.

B-6.3 Procedure

Run the PCR amplified product of EV and HAV on 1.5 percent agarose gel using 1X TAE buffer. Load 10 µl of amplified product after mixing it with 1 µl 10X loading dye. Run the molecular weight marker along with the samples. Run the electrophoresis at 100 V for 30 min. Stain the gel with ethidium bromide (0.5 µl/ml) for 20 min. Wash it with distilled water and view under UV transilluminator and photograph the gel to analyse the band pattern. EV gives the band as 155 base pair and the HAV gives band as 225 base pair.

ANNEX C (Clause 4.3.10)

ILLUSTRATIVE LIST OF MICROSCOPIC ORGANISMS PRESENT IN WATER

Sl No.	Classification of Microscopic Organism	Group and Name of the Organism	Habitat	Effect of the Organisms and Significance
(1)	(2)	(3)	(4)	(5)
i)	Algae	a) Chlorophyceae:		
		1) <i>Species of</i> Coelastrum, Gomphospherium, Micractinium, Mougeotia, Oocystis, Euastrum, Scenedesmus, Actinastrum, Gonium, Eudorina Pandorina, Pediastrum, Zygnema, Chlamydomonas, Careteria, Chlorella, Chroococcus, Spirogyra, Tetraedron, Chlorogonium, Stigeoclonium	Polluted water, impounded sources	Impart colouration
		2) <i>Species of</i> Pandorina, Volvox, Gomphospherium, Staurastrum, Hydrodictyon, Nitella	Polluted waters	Produce taste and odour
		3) <i>Species of</i> Rhizoclonium, Cladotrix, Ankistrodesmus, Ulothrix, Micrasterias, Chromulina	Clean water	Indicate clean condition
		4) <i>Species of</i> Chlorella, Tribonema, Clostrium, Spirogyra, Palmella	Polluted waters, impounded sources	Clog filters and create impounded difficulties
		b) Cyanophyceae:		
		1) <i>Species of</i> Anacystis and Cylindrospermum	Polluted waters	Cause water bloom and impart colour
		2) <i>Species of</i> Anabena, Phormidium, Lyngbya, Arthrospira, Oscillatoria	Polluted waters	Impart colour
		3) <i>Species of</i> Anabena, Anacystis, Aphanizomenon	Polluted waters, impounded sources	Produce taste and odour
		4) <i>Species of</i> Anacystis, Anabena, Coelospherium, Cleotrichina, Aphanizomenon	Polluted waters	Toxin producing
		5) <i>Species of</i> Anacystis, Rivularia, Oscillatoria, Anabena	Polluted waters	Clog filters

<i>Sl No.</i>	<i>Classification of Microscopic Organism</i>	<i>Group and Name of the Organism</i>	<i>Habitat</i>	<i>Effect of the Organisms and Significance</i>
(1)	(2)	(3)	(4)	(5)
		6) <i>Species of Rivularia</i>	Calcareous waters and also rocks	Bores rocks and calcareous strata and causes matted growth
		7) <i>Species of Lemanea</i>	Agmenellum, Microcoleus, Clean waters	Indicators of purification
		c) Diatoms (Bacillareophyceae):		
		1) <i>Species of Stauroneis</i>	Fragillaria, Stephanodiscus, —	Cause discoloration
		2) <i>Species of Asterionella</i>	Tabellaria	Hill streams high altitude, torrential and temperate waters
		3) <i>Species of Synedra</i>	and Fragillavia	Polluted waters
		4) <i>Species of Nitzchia</i>	Gomphonema	Moderately polluted waters
		5) <i>Species of Cymbela</i>	Synedra, Melosira, Navicula, Cyclotella, Fragillaria, Diatoma, Pleurosigma	Rivers and streams impounded sources
		6) <i>Species of Pinnularia</i>	Surinella, Cyclotella, Meridion, Cocconeis	Clean waters
		d) Xanthophyceae:		
		<i>Species of Botryococcus</i>		Hill streams, high altitude and temperate waters
ii)	Zooplankton	a) Protozoa:		
		1) Amoeba, Giardia, Lamblia, Arcella, Diffugia, Actinophrys		Polluted waters
		2) Endamoeba, Histolytica		Sewage and activated sludge
		b) Ciliates:		
		Paramoecium, Vorticella, Carchesium, Stentor, Colpidium, Coleps, Euplotes, Colopoda, Bodo		Highly polluted waters, sewage and activated sludge
		c) Crustacea:		
		1) Bosmina, Daphnia		Stagnant polluted waters
		2) Cyclops		Step wells in tropical climate
iii)	Rotifers	a) Rotifers:		
		Anurea, Rotaria, Philodina		Polluted and Algae laden waters
		b) Flagellates:		
		1) Ceratium, Dinobryon	Glenodinium, Peridinium	Rocky strata, iron bearing and acidic waters
		2) Euglena, Phacus		Polluted waters

<i>Sl No.</i>	<i>Classification of Microscopic Organism</i>	<i>Group and Name of the Organism</i>	<i>Habitat</i>	<i>Effect of the Organisms and Significance</i>
(1)	(2)	(3)	(4)	(5)
iv)	Miscellaneous Organisms	a) Sponges, Hydra	Fresh water	Clog filters and affect purification systems
		b) Tubifex, Eristalls, Chironomids	Highly polluted waters, sewage and activated sludge and bottom deposits	Clog filters and render water unaesthetic
		c) Plumatella	Polluted waters	Produces biological slimes and causes filter operational difficulties
		c) Dreissena, Asellus	Polluted waters	Harbour pathogenic organisms

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Canadian Sediment Quality Guidelines for the Protection of Aquatic Life

SUMMARY TABLES

Table 1. Interim freshwater sediment quality guidelines (ISQGs; dry weight), probable effect levels (PELs; dry weight), and incidence (%) of adverse biological effects in concentration ranges defined by these values.*

Substance	ISQG	PEL	% ≤ ISQG	ISQG < % < PEL	% ≥ PEL
Acenaphthene [See Polycyclic aromatic hydrocarbons (PAHs)]					
Acenaphthylene [See Polycyclic aromatic hydrocarbons (PAHs)]					
Anthracene [See Polycyclic aromatic hydrocarbons (PAHs)]					
Aroclor 1254 [See Polychlorinated biphenyls (PCBs)]					
Arsenic	5.9 mg·kg ⁻¹	17.0 mg·kg ⁻¹	5	25	12
Benz(<i>a</i>)anthracene [See Polycyclic aromatic hydrocarbons (PAHs)]					
Benzo(<i>a</i>)pyrene [See Polycyclic aromatic hydrocarbons (PAHs)]					
Cadmium	0.6 mg·kg ⁻¹	3.5 mg·kg ⁻¹	11	12	47
Chlordane	4.50 µg·kg ⁻¹	8.87 µg·kg ⁻¹	2	17	70
Chromium	37.3 mg·kg ⁻¹	90.0 mg·kg ⁻¹	2	19	49
Chrysene [See Polycyclic aromatic hydrocarbons (PAHs)]					
Copper	35.7 mg·kg ⁻¹	197 mg·kg ⁻¹	4	38	44
DDTs					
DDD [†] (2,2-Bis(<i>p</i> -chlorophenyl)-1,1,-dichloroethane; Dichloro diphenyl dichloroethane)	3.54 µg·kg ⁻¹	8.51 µg·kg ⁻¹	3	30	85
DDE [†] (1,1-Dichloro-2,2,bis(<i>p</i> -chlorophenyl)-ethene; Diphenyl dichloro ethylene)	1.42 µg·kg ⁻¹	6.75 µg·kg ⁻¹	6	20	47
DDT [†] (2,2-Bis(<i>p</i> -chlorophenyl)-1,1,1-trichloroethane; Dichloro diphenyl trichloroethane)	1.19 µg·kg ⁻¹ ‡	4.77 µg·kg ⁻¹ §	8	5	59
Dibenz(<i>a,h</i>)anthracene [See Polycyclic aromatic hydrocarbons (PAHs)]					
Dieldrin	2.85 µg·kg ⁻¹	6.67 µg·kg ⁻¹	1	10	60
Endrin	2.67 µg·kg ⁻¹	62.4 µg·kg ⁻¹	1	64	59
Fluoranthene [See Polycyclic aromatic hydrocarbons (PAHs)]					
Fluorene [See Polycyclic aromatic hydrocarbons (PAHs)]					

Continued.

SUMMARY TABLES

Canadian Sediment Quality Guidelines
for the Protection of Aquatic Life

Table 1. Continued.

Substance	ISQG	PEL	% ≤ ISQG	ISQG < % < PEL	% ≥ PEL
Heptachlor epoxide	0.60 µg·kg ⁻¹	2.74 µg·kg ⁻¹	3	12	67
Hexachlorocyclohexane [See Lindane]					
Lead	35.0 mg·kg ⁻¹	91.3 mg·kg ⁻¹	5	23	42
Lindane (Hexachlorocyclohexane)	0.94 µg·kg ⁻¹	1.38 µg·kg ⁻¹	0	50	49
Mercury	0.17 mg·kg ⁻¹	0.486 mg·kg ⁻¹	8	34	36
2-Methylnaphthalene [See Polycyclic aromatic hydrocarbons (PAHs)]					
Naphthalene [See Polycyclic aromatic hydrocarbons (PAHs)]					
PAHs [See Polycyclic aromatic hydrocarbons (PAHs)]					
PCBs [See Polychlorinated biphenyls (PCBs)]					
PCDD/Fs [see Polychlorinated dibenzo- <i>p</i> -dioxins and polychlorinated dibenzofurans]					
Phenanthrene [See Polycyclic aromatic hydrocarbons (PAHs)]					
Polychlorinated biphenyls (PCBs)					
Aroclor 1254	60 µg·kg ⁻¹ #	340 µg·kg ⁻¹ **			
Total PCBs	34.1 µg·kg ⁻¹	277 µg·kg ⁻¹	4	40	50
Polychlorinated dibenzo- <i>p</i> -dioxins and polychlorinated dibenzofurans	0.85 ng·TEQ/kg dw §§	21.5 ng·TEQ/kg dw §§	0 ^{##}	24 ^{##}	46 ^{##}
Polycyclic aromatic hydrocarbons (PAHs)					
Acenaphthene	6.71 µg·kg ⁻¹ †	88.9 µg·kg ⁻¹ §			
Acenaphthylene	5.87 µg·kg ⁻¹ †	128 µg·kg ⁻¹ §			
Anthracene	46.9 µg·kg ⁻¹ †	245 µg·kg ⁻¹ §			
Benz(<i>a</i>)anthracene	31.7 µg·kg ⁻¹	385 µg·kg ⁻¹	13	6	38
Benzo(<i>a</i>)pyrene	31.9 µg·kg ⁻¹	782 µg·kg ⁻¹	11	16	30
Chrysene	57.1 µg·kg ⁻¹	862 µg·kg ⁻¹	8	14	25
Dibenz(<i>a,h</i>)anthracene	6.22 µg·kg ⁻¹ †	135 µg·kg ⁻¹ §			
Fluoranthene	111 µg·kg ⁻¹	2355 µg·kg ⁻¹	8	23	49
Fluorene	21.2 µg·kg ⁻¹ †	144 µg·kg ⁻¹ §			
2-Methylnaphthalene	20.2 µg·kg ⁻¹ †	201 µg·kg ⁻¹ §			
Naphthalene	34.6 µg·kg ⁻¹ †	391 µg·kg ⁻¹ §			
Phenanthrene	41.9 µg·kg ⁻¹	515 µg·kg ⁻¹	4	17	44
Pyrene	53.0 µg·kg ⁻¹	875 µg·kg ⁻¹	7	16	32
Pyrene [See Polycyclic aromatic hydrocarbons (PAHs)]					
Toxaphene	0.1 µg·kg ⁻¹ ††	— ††			
Zinc	123 mg·kg ⁻¹	315 mg·kg ⁻¹	5	32	36

* ISQGs and PELs presented here have been calculated using a modification of the NSTP approach (CCME 1995).

† Sum of *p,p'* and *o,p'* isomers.

‡ Provisional; adoption of marine ISQG.

§ Provisional; adoption of marine PEL.

Provisional; adoption of lowest effect level from Ontario (Persaud et al. 1993).

** Provisional; 1% TOC; adoption of severe effect level of 34 µg·g⁻¹ TOC from Ontario (Persaud et al. 1993).

†† Provisional; 1% TOC; adoption of the chronic sediment quality criterion of 0.01 µg·g⁻¹ TOC of the New York State Department of Environmental Conservation (NYSDEC 1994).

‡‡ No PEL derived.

§§ Values are expressed as toxic equivalency (TEQ) units, based on WHO 1998 TEF values for fish.

Note that the incidence of adverse biological effects below the TEL, between the TEL and PEL, and above the PEL were 22%, 24% and 65%, respectively, prior to the application of a safety factor.

**Canadian Sediment Quality Guidelines
for the Protection of Aquatic Life**
SUMMARY TABLES
Table 2. Interim marine sediment quality guidelines (ISQGs; dry weight), probable effect levels (PELs; dry weight), and incidence (%) of adverse biological effects in concentration ranges defined by these values.*

Substance	ISQG	PEL	% ≤ ISQG	ISQG < % < PEL	% ≥ PEL
Acenaphthene [See Polycyclic aromatic hydrocarbons; (PAHs)]					
Acenaphthylene [See Polycyclic aromatic hydrocarbons (PAHs)]					
Anthracene [See Polycyclic aromatic hydrocarbons (PAHs)]					
Aroclor 1254 [See Polychlorinated biphenyls (PCBs)]					
Arsenic	7.24 mg·kg ⁻¹	41.6 mg·kg ⁻¹	3	13	47
Benz(<i>a</i>)anthracene [See Polycyclic aromatic hydrocarbons (PAHs)]					
Benzo(<i>a</i>)pyrene [See Polycyclic aromatic hydrocarbons (PAHs)]					
Cadmium	0.7 mg·kg ⁻¹	4.2 mg·kg ⁻¹	6	20	71
Chlordane	2.26 µg·kg ⁻¹	4.79 µg·kg ⁻¹	9	12	17
Chromium	52.3 mg·kg ⁻¹	160 mg·kg ⁻¹	4	15	53
Chrysene [See Polycyclic aromatic hydrocarbons (PAHs)]					
Copper	18.7 mg·kg ⁻¹	108 mg·kg ⁻¹	9	22	56
DDTs					
DDD [†] (2,2-Bis(<i>p</i> -chlorophenyl)-1,1,-dichloroethane; Dichloro diphenyl dichloroethane)	1.22 µg·kg ⁻¹	7.81 µg·kg ⁻¹	4	11	46
DDE [†] (1,1-Dichloro-2,2,bis(<i>p</i> -chlorophenyl)-ethene; Diphenyl dichloro ethylene)	2.07 µg·kg ⁻¹	374 µg·kg ⁻¹	5	16	50
DDT [†] (2,2-Bis(<i>p</i> -chlorophenyl)-1,1,1-trichloroethane; Dichloro diphenyl trichloroethane)	1.19 µg·kg ⁻¹	4.77 µg·kg ⁻¹	8	5	59
Dibenz(<i>a,h</i>)anthracene [See Polycyclic aromatic hydrocarbons (PAHs)]					
Dieldrin	0.71 µg·kg ⁻¹	4.30 µg·kg ⁻¹	4	13	50
Endrin	2.67 µg·kg ⁻¹ ‡	62.4 µg·kg ⁻¹ §			
Fluoranthene [See Polycyclic aromatic hydrocarbons (PAHs)]					
Fluorene [See Polycyclic aromatic hydrocarbons (PAHs)]					
Heptachlor epoxide	0.60 µg·kg ⁻¹ ‡	2.74 µg·kg ⁻¹ §			
Hexachlorocyclohexane [See Lindane]					
Lead	30.2 mg·kg ⁻¹	112 mg·kg ⁻¹	6	26	58
Lindane (Hexachlorocyclohexane)	0.32 µg·kg ⁻¹	0.99 µg·kg ⁻¹	3	21	26

Continued.

SUMMARY TABLES

Canadian Sediment Quality Guidelines
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Table 2. Continued.

Substance	ISQG	PEL	% ≤ ISQG	ISQG < % < PEL	% ≥ PEL
Mercury	0.13 mg·kg ⁻¹	0.70 mg·kg ⁻¹	8	24	37
2-Methylnaphthalene [See Polycyclic aromatic hydrocarbons (PAHs)]					
Naphthalene [See Polycyclic aromatic hydrocarbons (PAHs)]					
PAHs [See Polycyclic aromatic hydrocarbons (PAHs)]					
PCBs [See Polychlorinated biphenyls (PCBs)]					
PCDD/Fs [see Polychlorinated dibenzo- <i>p</i> -dioxins and polychlorinated dibenzo furans]					
Phenanthrene [See Polycyclic aromatic hydrocarbons (PAHs)]					
Polychlorinated biphenyls (PCBs)					
Aroclor 1254	63.3 µg·kg ⁻¹	709 µg·kg ⁻¹	1	24	76
Total PCBs	21.5 µg·kg ⁻¹	189 µg·kg ⁻¹	16	37	55
Polychlorinated dibenzo- <i>p</i> -dioxins and polychlorinated dibenzo furans	0.85 ng TEQ/kg dw ⁺⁺	21.5 ng TEQ/kg dw ⁺⁺			
Polycyclic aromatic hydrocarbons (PAHs)					
Acenaphthene	6.71 µg·kg ⁻¹	88.9 µg·kg ⁻¹	8	29	57
Acenaphthylene	5.87 µg·kg ⁻¹	128 µg·kg ⁻¹	7	14	51
Anthracene	46.9 µg·kg ⁻¹	245 µg·kg ⁻¹	9	20	75
Benz(<i>a</i>)anthracene	74.8 µg·kg ⁻¹	693 µg·kg ⁻¹	9	16	78
Benzo(<i>a</i>)pyrene	88.8 µg·kg ⁻¹	763 µg·kg ⁻¹	8	22	71
Chrysene	108 µg·kg ⁻¹	846 µg·kg ⁻¹	9	19	72
Dibenz(<i>a,h</i>)anthracene	6.22 µg·kg ⁻¹	135 µg·kg ⁻¹	16	12	65
Fluoranthene	113 µg·kg ⁻¹	1 494 µg·kg ⁻¹	10	20	80
Fluorene	21.2 µg·kg ⁻¹	144 µg·kg ⁻¹	12	20	70
2-Methylnaphthalene	20.2 µg·kg ⁻¹	201 µg·kg ⁻¹	0	23	82
Naphthalene	34.6 µg·kg ⁻¹	391 µg·kg ⁻¹	3	19	71
Phenanthrene	86.7 µg·kg ⁻¹	544 µg·kg ⁻¹	8	23	78
Pyrene	153 µg·kg ⁻¹	1 398 µg·kg ⁻¹	7	19	83
Pyrene [See Polycyclic aromatic hydrocarbons (PAHs)]					
Toxaphene	0.1 µg·kg ⁻¹ #	— **			
Zinc	124 mg·kg ⁻¹	271 mg·kg ⁻¹	4	27	65

* ISQGs and PELs presented here have been calculated using a modification of the NSTP approach (CCME 1995).

† Sum of *p,p'* and *o,p'* isomers.

* Provisional; adoption of freshwater ISQG.

§ Provisional; adoption of freshwater PEL.

Provisional; 1% TOC; adoption of the chronic sediment quality criterion of 0.01 µg·g⁻¹TOC of the New York State Department of Environmental Conservation (NYSDEC 1994).

** No PEL derived.

++ Values are expressed as toxic equivalency (TEQ) units, based on WHO 1998 TEF values for fish.

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