CONTINUOUS MONITORING OF SEA WATER IN AND AROUND THE ITPCL POWER PROJECT AT PARANGIPETTAI, CUDDALORE DISTRICT

Monthly Data Report (March -2023)

Submitted by

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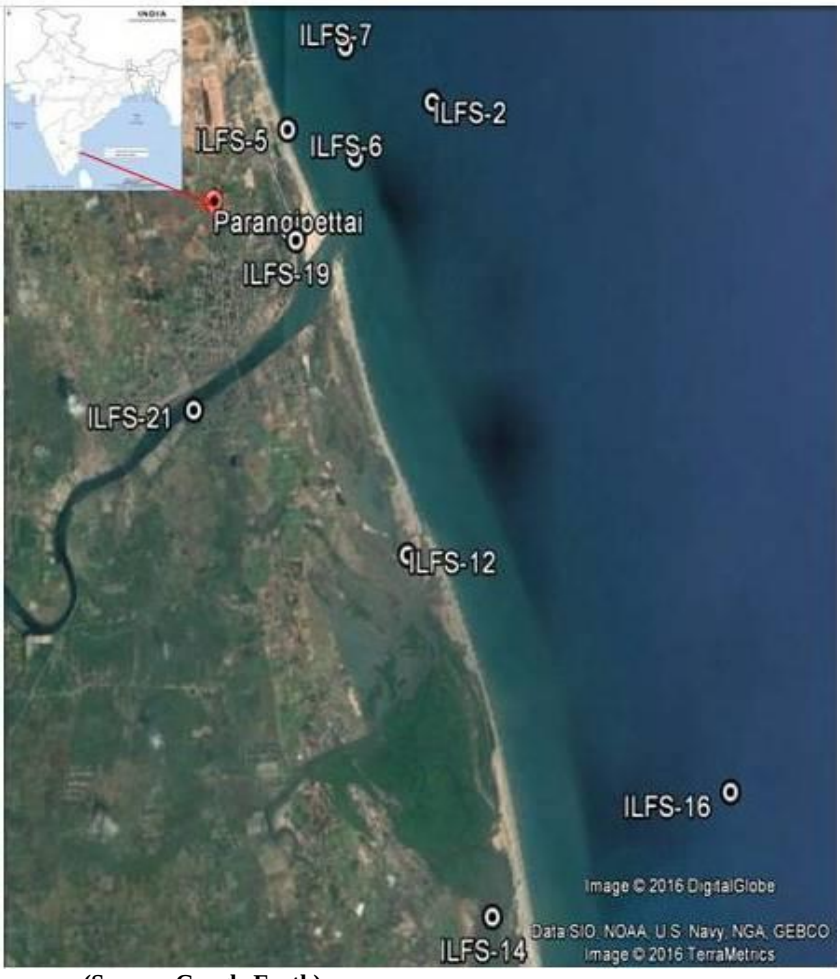
PHYSICO – CHEMICAL AND BIOLOGICAL CHARACTERISTICS

1.1 Sampling Details

As that of previous months, the seawater quality characteristics were studied by conducting sampling in and around the ITPCL Power Project at Parangipettai, Cuddalore District both during low and high tide period during 26.03.2023 in and around the proposed sites including the open sea as shown in Fig.1. The sampling stations details like station code, time, depth and its coordinates are also given in Table 1. Further, water and sediment samples were collected in the pre-determined locations of the open sea, Vellar and Coleroon estuaries.



(Source: Google Earth)

Figure 1 Map showing the sampling Stations in ITPCL site

TABLE 1 Details of sampling stations with GPS coordinates in ITPCL site

Sl. No.	Station Code	Time	GPS Coordinates
1	ILFS-2-HT (Dredged soil dumping)	6.45 AM	11°31'27.94"N 79°47'50.77"E
2	ILFS-2-LT	2.00 PM	
3	ILFS-5-HT (Intake)	7.10 AM	11°31'13.31"N 79°46'14.37"E
4	ILFS-5-LT	2.25 PM	
5	ILFS-6-HT (Outfall)	7.35 AM	11°30'58.78"N 79°46'59.61"E
6	ILFS-6-LT	2.50 PM	
7	ILFS-7-HT (North Break Water)	8.50 AM	11°31'56.49"N 79°46'52.76"E
8	ILFS-7-LT	3.25 PM	
9	ILFS-16-HT (Off shore parallel to Mangroves-2)	9.15 AM	11º25’29.13"N 79º51’10.08"E
10	ILFS-16-LT	3.48 PM	
11	ILFS-12-HT (Pichavaram Mangroves extension from Vellar-2)	9.40 AM	11°27'32.11"N 79°47'34.79"E
12	ILFS-12-LT	4.15 PM	
13	ILFS-14-HT (Pichavaram Mangroves extension from Coleroon-2)	6.45 AM	11°24'23.92"N 79°48'31.59"E
14	ILFS-14-LT	1.45 PM	
15	ILFS-19-HT (Annan kovil landing center)	9.00 AM	11° 30' 15.75"N 79° 46'20.07"E
16	ILFS-19-LT	2.25 PM	
17	ILFS-21-HT (Pappa canal)	9.20 AM	11°28'47.22"N 79°45'12.15"E
18	ILFS-21-LT	2.55 PM	

MATERIALS AND METHODS

Water samples

Water samples were collected from the predetermined stations considering the tidal influences, discharge and non-discharge points. Subsurface water samples were collected at a depth of 0.5 – 0.7 m using Niskin water sampler. For accurate measurements of the *in situ* properties and composition of seawater, proper sampling is of utmost importance. It is essential to ensure that the sampling is contamination free and all the samples were appropriately sub-

sampled and preserved to avoid/minimize changes in the water composition during storage. After sampling, adequate care was taken for measurements of hydrographic, chemical and biological properties of sea water in coastal and near-shore waters. Prior to sampling, the sampler and sampling containers were acid washed with 1N HCl in the laboratory. Sample bottles were rinsed thoroughly with the water and after that the samples were collected.

For dissolved oxygen, the samples were fixed by employing Winkler's reagent on board vessel itself and after fixing the samples were kept in shade until analysis. Temperature and pH in water were measured immediately after collection. The water samples were filtred before analysis. Trace metal samples were collected in acid-washed and pre-cleaned high density polyethylene (HDPE) bottles. Disposable, clean gloves were used while sampling and handling samples for trace metals. All samples were kept in a cool condition away from light to avoid evaporation. All samples (for trace metals) were filtered immediately using 0.22 µM pore size filter paper and acidify the pH till 2 by adding SUPRAPURE NITRIC ACID and stored in metal free plastic bags till analysis, so as to avoid contamination.

Sediment samples

Sediment samples were stored in metal free plastic bags for trace metals and in aluminum foils for organic constituents. These samples were stored in ice boxes for transportation and put to dry in an electric oven at low temperatures (about 60 degrees C) in clean glass petri-dishes.

Collection of Sediment Samples (Grab sampler)

Van veen Grab with a sampling area of 0.1 m^2 was employed as a standard sediment sampler, since it is (i) an efficient sampler for the range of soft surface sediments encountered in the near shore area, (ii) reliable and simple to operate and (iii) widely applied, which allows data comparison with other marine areas.

Preservation and processing of samples

Storage and Preservation of Samples: It is known that the concentration of dissolved constituents is bound to change with time, due to the biological activity of the microorganisms present in the seawater. Trace quantity are vulnerable to adsorption /desorption process, therefore, they were analyzed immediately. When immediate analysis is not possible, the recommended method include freezing the samples in -80 degree C. A quick note for sample collection and preservation procedures is given below.

Temperature, Salinity and pH analysis

The physical parameters such as temperature, salinity and pH were measured *in-situ* in the field. The subsurface temperature was measured with a mercury thermometer (±0.02°C accuracy) and the pH was measured by a calibrated pH pen (pH ep-3 model). Salinity was estimated using a Hand Refractometer (Atago, Japan). Water samples collected for dissolved oxygen estimation were transferred carefully to BOD bottles. The DO was immediately fixed and brought to the laboratory for further analysis.

Preservation and Laboratory Analysis

After collection, the samples were immediately cooled to 4°C and then brought to the laboratory in an insulated Thermocool box. In the laboratory, water samples were filtered through Whatman GF/C filter paper and analysed for organic matter and other nutrients. Unfiltered samples were used for the estimation of total nitrogen and total phosphorus. All the analyses were carried out by adopting Standard procedures for samples of aquatic origin. Briefly, the methodology for each analysis is given below:

Nitrate and Nitrite

The nitrate and nitrite content of samples were analysed by following the methods described by Strickland and Parsons (1972). The nitrite was estimated from the highly coloured azo dye formed by the addition of N (1-Napthyl) ethylene diamine di hydro-chloride and sulfanilamide into the solution was then measured at 543 nm in a spectrophotometer. The same procedure was followed for the estimation of nitrate. For this, nitrate was reduced to nitrite by passing the sample through copper coated cadmium column. The values are expressed in μmol of Nitrogen/l

Inorganic Phosphate

The single solution mixed reagent procedure developed by Murphy and Riley (1962) was followed for the estimation of dissolved inorganic phosphate levels in water samples. This involves the conversion of phosphate into phosphomolybdic acid, which was then reduced to molybdinum blue color complexes and then the intensity of colour was measured at 882 nm in a Spectrophotometer. The calculated values are expressed in µmol of Phosphorus/l.

Total Phosphorus

The Total Phosphate in samples was estimated by adopting the method described by Menzel and Corwin (1964). This procedure involves the conversion of organically bound phosphate into inorganic phosphate by wet oxidation of samples with potassium persulphate in an Autoclave for 30 min at 15 lbs pressure. The converted inorganic phosphate was then estimated by using the method described by Murphy and Riley (1962). The subtraction of original dissolved inorganic phosphate from total phosphate yielded the organic phosphate in the water sample. The calculated value is expressed in µmol of Phosphorus/l.

Reactive Silicate

The reactive silicate content of water was estimated by following the method of Strickland and Parsons (1972). In this method, the intensity of blue color formed by silico-molybdate complex was measured in a Spectrophotometer at 810 nm and the calculated values are expressed in µmol of Silica/l

Sediment Analysis

For the analysis of textural composition and pH, the air-dried sediment samples were used as such. For all other analyses of organic matter, sediment samples were ground to fine powder and dried in an oven at 110°C to constant weight for an hour.

Total Organic Carbon

The estimation of total organic carbon in sediment was performed by adopting the method of El Wakeel and Riley (1956). The procedure involves chromic acid digestion and subsequent titration against ferrous ammonium sulphate solution in the presence of 1-10 Ferrous phenonthroline indicator. The values calculated are expressed in mgC/g of sediment.

Heavy Metal Analysis in Water and Sediment Samples

Seawater samples were collected in pre-cleaned polypropylene bottles with 10% nitric acid and Milli-Q water and acidified till pH ~1.6 using HNO_3 for further metal detection by using ICP-MS (Søndergaard et al., 2015). Sediment samples were collected with the aid of cleaned and dried Teflon/stainless steel coated Peterson grab. Sediment samples were transferred from the Grab to cleaned polyethylene containers using cleaned plastics scoops. The samples were stored in frozen condition for further analysis. The preserved sediment sub-samples were dried at 110°C to constant weight for estimation of metals. Dry powdered sediment was gently heated and digested with Hydrofluoric acid whereby Silica volatizes as Silicon tetra-fluoride.

This is followed by treatment with Nitric acid and Per-chloric acid to destroy the organic matter. The residue after evaporation of acids was dissolved in 0.1 N HCl and desired metals were determined by Atomic Absorption Spectrophotometry (AAS).

Bacteriological Methods

Collection of samples

Surface water samples were collected in 30ml sterile screw capped bottles for bacteriological assessment. Enough air space was left in the bottles to allow thorough mixing. Precautionary measures were taken to avoid contamination through handling. For microbial assessment in sediment samples, a known quantity of samples was collected from the grab samples using sterilised spatula. The central portion of the collected sediment was aseptically transferred into sterile polyethylene bags. All the samples were brought to the laboratory in portable icebox soon after collection and bacteriological analyses were carried out in the laboratory at CAS immediately, with necessary dilution.

Enumeration of Total Viable Counts

TVC was enumerated by adopting the spread plate method using Zobell's Marine Agar medium (EA123, Hi-Media, Mumbai). The samples (water and sediment) were diluted using the sterile sea water and 0.1 ml of the diluted sample was pippeted into the petriplates containing Zobell's Marine Agar and it was spread using a 'L' shaped glass spreader. The plates after inoculation were incubated in an inverted position at a temperature of 28+2°C for 24to 48 h. The colonies were counted and the population density expressed as Colony Forming Unit (CFU) per ml or g of the sample. The bacterial colonies were picked up from the pertidishes and re-streaked in appropriate nutrient agar plates thrice before a pure culture was established in agar slants.

Enumeration of Total Coliforms:

Macconkey agar with 0.15% bile salt, crystal violet and NaCl has been recommended in accordance with USP/Nfxi (1) for the detection, isolation and enumeration of coliforms and intestinal pathogens in water, dairy products, pharmaceutical preparations, etc. The agar weighing 51.5 g in 1000 ml distilled water was heated up to the boiling point to dissolve the medium completely and sterilized by autoclaving at 15 lbs pressure (121°C) for 15 min. suitably diluted samples were inoculated in the petriplates containing medium and were incubated for 48 h. After incubation, the colonies of *E. coli* appeared with pink color.

M-FC agar is employed for detection and enumeration Faecal Coliforms by the membrane filter technique at higher temperature (44.5°C). The agar weighing 52 g was suspended in 1000 ml of distilled water and heated up to the boiling point to dissolve the medium completely, 10ml of Rosolic acid (dissolved in 0.2 N NaOH) was added, heated with frequent agitation and boiled for 1 min. Then the medium was cooled to 50°C. Finally, the medium was poured into small 60mm plates. Samples filtered by Millipore apparatus using 0.45µm Whatman filter papers were impregnated in the petriplates. After 48 h of incubation, the colonies of *E. coli* appeared with blue colour.

Chlorophyll `a':

The samples were filtered through Whatman GF/C filter papers and the chlorophyll was extracted into 90% acetone. The resulting colored acetone extract was measured in a spectrophotometer at different wave lengths and the same acetone extracts were acidified and measured for the phaeo-pigments. The detailed methodology as described in APHA manual (1989) was followed.

Phytoplankton

Phytoplankton samples were collected from the surface waters of the study areas by towing a plankton net (mouth diameter 0.5 m) made of bolting silk (mesh size 20 micron) for half an hour. These samples were preserved in 5% neutralized formalin and used for qualitative analysis. For quantitative analysis of phytoplankton, the settling method as described by Sukhanovo (1978) was adopted. Numerical plankton analysis was carried out using Utermohl's inverted plankton microscope.

Phytoplankton species was identified using the standard works of Hoppenrath (2009), Joosten (2006), Hällfors (2004), Venkataraman (1939), Cupp (1943), Santhanam (1987), Subramanian (1946), King County (2008), Sournia (1978), Simon (2009), Prescott (1954), Desikachary (1959 and 1987), Hendey (1964), Steidinger and Williams (1970) and Taylor (1976) and Anand *et al.* (1986).

Zooplankton

Zooplankton samples were collected from the surface waters of the study area by horizontal towing of plankton net with mouth diameter of 0.35 m, made of bolting silk (No. 70 mesh size 200 µm) for half an hour. After collection, the samples were preserved in 5 - 7% neutralized formalin and used for quantitative analysis. The zooplankton collected were identified to the species level using the classical works of Larink (2006), Helcom (2005), Goswami (2004), Alekseev (2002), Dakin and Colefax (1940), Santhanam and Srinivasan (1994), Newell and Newell (1963), Kasthurirangan (1963) and Wickstead (1965). For quantitative analysis of zooplankton, a known quantity of water (100 L) was filtered through a bag net (0.33 mm mesh size) and filtrate was made up to 1 litre in a wide mouthed bottle and

then enumerated using Utermohl's inverted plankton microscope. The plankton density is expressed as number of organisms/m^3.

Benthic Community

For benthic organisms, sediment samples were collected using a Van veen Grab which covered an area of $0.1m^2$. The wet sediment was sieved with varying mesh sizes for segregating the organisms. The organisms retained in the sieve were fixed in 5-7% formalin and stained further with Rose Bengal solution for easy spotting at the time of sorting. After a day or two, the organisms were sorted into various groups. The number of organisms in each Grab sample was expressed as number per square meter. According to size, benthic animals are divided into three groups: (i) macrobenthos (ii) meiobenthos and (iii) microbenthos (Mare, 1942). All the species were sorted, enumerated and identified to the advanced level possible with the consultation of available literature. The works of Fauvel (1953), Day (1967) were referred for polychaetes; Barnes (1980) and Lyla *et al*. (1999) for crustaceans; Subba Rao *et al.* (1991) and Ramakrishna (2003) for molluscs.

1.2. Physico-chemical Parameters

The physico-chemical parameters such as depth, transparency, atmospheric temperature (AT), water temperature (WT), Turbidity, Total suspended solids (TSS), pH, salinity, dissolved oxygen (DO) and biochemical oxygen demand (BOD) were analyzed and the results are given in Table 2.

TABLE 2 Physio-chemical characteristics in water samples collected in various stations of ITPCL site during March 2023

Station Code	Depth (m)	Transparency (m)	Turbidity (NTU)	TSS (mg/L)	AT (ºC)	WT (ºC)	pH	Salinity (PSU)	DO (mg/l)	BOD (mg/l)
ILFS-2-HT	6.10	2.20	2.19	21.58	26.84	26.38	8.26	33.94	6.20	1.59
ILFS-2-LT	5.80	2.50	2.54	20.43	26.93	26.52	8.19	34.08	6.33	1.65
ILFS-5-HT	6.80	2.40	2.32	19.95	27.16	26.84	8.17	34.25	6.58	1.74
ILFS-5-LT	6.50	2.30	2.29	21.34	27.33	27.05	8.28	34.64	6.24	1.82
ILFS-6-HT	7.64	3.20	1.75	20.22	27.75	27.28	8.19	34.85	6.36	1.94
ILFS-6-LT	7.40	2.00	2.94	21.93	27.96	27.65	8.15	34.93	6.19	2.85
ILFS-7-HT	7.00	2.90	1.62	21.46	28.24	27.94	8.28	33.59	5.85	1.97
ILFS-7-LT	6.80	2.30	2.93	22.38	28.52	28.05	8.26	34.56	5.91	2.62
ILFS-16-HT	6.30	2.40	2.57	20.62	28.95	28.26	8.31	34.62	5.93	2.15
ILFS-16-LT	5.90	2.20	4.74	21.47	29.26	28.43	8.22	34.93	6.06	2.19
ILFS-12-HT	2.30	1.90	5.39	23.06	30.15	29.16	8.19	31.49	5.85	1.82
ILFS-12-LT	1.90	1.10	4.25	22.93	30.32	29.55	8.20	31.52	5.94	1.94
ILFS-14-HT	2.40	1.30	8.31	21.85	30.58	30.18	8.21	29.45	6.19	1.63
ILFS-14-LT	2.10	1.30	10.06	22.63	30.92	30.26	8.16	29.88	6.27	1.75
ILFS-19-HT	2.60	1.40	12.73	23.55	31.25	31.00	7.98	30.19	6.36	1.64
ILFS-19-LT	2.20	1.50	12.49	22.72	31.76	31.06	7.93	29.44	6.58	1.71
ILFS-21-HT	1.40	0.90	10.52	21.95	31.82	31.11	8.12	27.50	5.84	1.86
ILFS-21-LT	1.00	0.80	12.63	23.89	31.97	21.36	8.07	24.69	6.13	1.94

(Reference values: TSS 9.70–58.70mg/L; pH 6.5-9.0; DO 3.51–8.92)

1.3. Nutrients and Petroleum Hydrocarbons

The chemical parameters like nitrite (NO_2-N), nitrate (NO_3-N), ammonia (NH_3-N), total nitrogen (TN), inorganic phosphate (IP), Total phosphorus, silicate and petroleum hydrocarbon (PHC) were analyzed and the results are given in Table 3.

TABLE 3 Nutrients and PHC values recorded in various stations of ITPCL site during March 2023

Station Code	SEAWATER NUTRIENTS (µmol/l)							PHC (µg/l)
	NO_2	NO_3	NH_3	TN	IP	TP	SiO_4	
ILFS-2-HT	0.159	1.168	0.104	7.845	0.365	1.256	9.977	0.486
ILFS-2-LT	0.203	1.137	0.135	8.564	0.345	1.352	10.184	0.715
ILFS-5-HT	0.185	1.396	0.128	9.916	0.296	1.473	9.873	0.673
ILFS-5-LT	0.231	1.465	0.132	7.384	0.335	1.336	11.443	0.592
ILFS-6-HT	0.264	0.846	0.163	9.457	0.414	1.273	10.067	0.650
ILFS-6-LT	0.216	0.814	0.155	10.362	0.376	1.359	12.494	0.742
ILFS-7-HT	0.272	1.558	0.146	8.646	0.352	1.348	11.956	0.693
ILFS-7-LT	0.395	1.926	0.238	10.218	0.487	1.411	9.642	0.741
ILFS-16-HT	0.456	2.014	0.203	9.609	0.596	1.493	10.837	0.636
ILFS-16-LT	0.387	1.443	0.318	8.425	0.452	1.554	9.366	0.594
ILFS-12-HT	0.465	1.507	0.265	10.985	0.419	1.669	10.543	0.685
ILFS-12-LT	0.372	1.863	0.254	11.039	0.468	1.372	11.641	0.672
ILFS-14-HT	0.395	1.439	0.209	11.275	0.464	1.575	12.752	0.469
ILFS-14-LT	0.345	1.548	0.236	9.784	0.483	1.458	10.736	0.324
ILFS-19-HT	0.427	1.526	0.253	10.536	0.499	1.562	11.293	0.351
ILFS-19-LT	0.376	1.940	0.209	11.465	0.463	1.448	12.155	0.363
ILFS-21-HT	0.468	1.682	0.211	12.572	0.428	1.251	11.623	0.342
ILFS-21-LT	0.449	1.906	0.196	11.655	0.472	1.368	10.451	0.460

(Reference values: NO_2: 0.05–1.03µmol/l; TN 0.87–26.16µmol/l; TP: 0.43–7.16µmol/l; NH_3 0.01–3.70 µmol/l)

1.4. Sediment Texture

The results of soil texture and total organic carbon (TOC) analyzed from the sediment samples are given in Table 4.

TABLE 4 Sediment Texture and Organic Carbon recorded in various stations of ITPCL site during March 2023

Station Code	Total Organic Carbon(mgC/g)	Soil Texture (%)		
		Sand	Silt	Clay
ILFS-2-HT	3.89	88.416	7.313	4.271
ILFS-2-LT	4.57	87.164	4.864	7.972
ILFS-5-HT	5.45	91.332	4.942	3.726
ILFS-5-LT	3.76	86.264	7.224	6.512
ILFS-6-HT	4.64	89.386	4.95	5.664
ILFS-6-LT	5.79	90.534	3.624	5.842
ILFS-7-HT	4.9	77.584	9.268	13.148
ILFS-7-LT	4.67	89.562	4.824	5.614
ILFS-16-HT	5.48	84.723	6.62	8.657
ILFS-16-LT	4.93	83.564	6.312	10.124
ILFS-12-HT	5.72	62.234	18.545	19.221
ILFS-12-LT	4.55	61.312	13.314	25.374
ILFS-14-HT	4.98	50.364	19.263	30.373
ILFS-14-LT	6.86	49.263	18.373	32.364
ILFS-19-HT	5.27	45.845	22.534	31.621
ILFS-19-LT	6.36	46.421	24.342	29.237
ILFS-21-HT	6.49	48.638	20.246	31.116
ILFS-21-LT	5.86	51.321	23.434	25.245

1.5. Chlorophyll -*a* and phaeophytin

Chlorophyll '*a*' and phaeophytin, which are considered as an index of phytoplankton density, were analyzed in the samples collected at ITPCL power project site, Parangipettai. The results are given in Table 5.

TABLE 5 Chlorophyll -*a* and phaeophytin levels recorded in water samples collected in various stations of ITPCL site during March 2023

Station Code	Chlorophyll 'a'(mg/m^3)	Phaeophytin (mg/m^3)
ILFS-2-HT	1.557	0.976
ILFS-2-LT	1.482	0.863
ILFS-5-HT	1.645	0.977
ILFS-5-LT	1.297	0.846
ILFS-6-HT	1.601	0.714
ILFS-6-LT	1.395	0.687
ILFS-7-HT	1.452	0.873
ILFS-7-LT	1.367	0.766
ILFS-16-HT	1.755	0.748
ILFS-16-LT	1.549	0.709
ILFS-12-HT	2.038	0.786
ILFS-12-LT	1.972	0.735
ILFS-14-HT	1.895	0.672
ILFS-14-LT	1.604	0.615
ILFS-19-HT	2.193	0.769
ILFS-19-LT	1.826	0.753
ILFS-21-HT	1.763	0.863

1.6. Heavy metals in seawater and sediments

The level of Heavy metals recorded in seawater and sediments samples in and around ITPCL site is given in the Tables 6 and 7.

Table 6 Heavy Metals (µg/l) in Seawater samples collected from various stations of ITPCL sites during March 2023

Station Code	Fe	Zn	Mn	Cd	Ni	Cr	Pb	Cu	Hg
ILFS-2	15.26	21.55	39.47	3.98	3.67	1.65	3.64	16.58	0.54
ILFS-5	16.39	17.32	41.82	2.84	3.34	2.09	4.87	15.68	0.67
ILFS-6	17.08	18.91	38.51	2.09	2.56	1.58	3.7	15.46	0.53
ILFS-7	16.56	19.85	41.63	1.97	2.96	1.42	3.28	15.25	0.76
ILFS-16	18.71	19.46	39.81	2.66	1.68	1.85	4.39	16.42	0.58
ILFS-12	15.65	20.68	41.96	2.22	1.97	1.96	3.92	16.18	0.62
ILFS-19	13.28	21.19	38.41	2.46	2.04	1.85	4.04	15.27	0.64
ILFS-21	15.46	20.66	40.75	1.75	1.85	1.76	4.65	15.6	0.57

(Reference values: Zn 1.02–34.11µg/L; Mn 1.02–51.77µg/L; Cd 4.56-9.43µg/L; Ni 0.52–36.18µg/L; Cr 6.55-13.9µg/L and Hg 0.52-13.45µg/L)

Table 7 Heavy Metals (µg/g) in sediment samples collected from various stations of ITPCL sites during March 2023

Station Code	Fe	Zn	Mn	Cd	Ni	Cr	Pb	Cu	Hg
ILFS - 2	1315.4	16.48	75.07	9.44	15.07	9.57	8.49	23.76	0.63
ILFS - 5	1469.2	14.37	77.82	11.86	14.84	10.28	7.34	27.84	0.78
ILFS - 6	1603.4	16.58	74.95	9.57	15.62	9.59	8.27	25.61	0.64
ILFS - 7	1549.2	18.17	72.14	10.25	13.55	10.43	9.54	33.72	0.87
ILFS - 16	1496.7	15.69	69.49	11.67	14.16	9.75	10.43	24.34	0.65
ILFS - 12	1547.5	14.86	68.05	12.95	15.09	10.84	8.65	25.59	0.79
ILFS - 19	1295.4	16.34	64.69	10.04	13.53	9.29	7.51	25.33	0.81
ILFS - 21	1366.3	13.52	69.17	10.39	12.46	8.06	8.94	23.61	0.65

(Reference values: Hg 0.0-3.7 µg/g; Cu 16-62 µg/g; Mn 34.36-177.3µg/g; Ni 30-55µg/g; Pb 7.4-47.1µg/g and Cr 12.08–112.9 µg/g)

1.7. MICROBIOLOGY

Water samples

The microbial parameters such as Total viable counts (TVC), total coliforms and *Streptococcus faecalis* (SF) were analyzed for seawater samples in and around the ITPCL power project site at Parangipettai. The results are given in Table 8. Similarly, the results of microbial parameters analysed in sediment samples are given in Table 9.

TABLE 8 Bacterial populations recorded in water samples collected in various stations of ITPCL site during March 2023

Station Code	Total Viable Count (TVC)	Total Coliforms (TC)	*Streptococcus faecalis* (SF)
ILFS-2-HT	11×10^3	5×10^3	6×10^3
ILFS-2-LT	13×10^2	7×10^2	8×10^3
ILFS-5-HT	9×10^3	6×10^3	9×10^2
ILFS-5-LT	10×10^2	8×10^2	11×10^3
ILFS-6-HT	10×10^3	5×10^3	12×10^2
ILFS-6-LT	11×10^2	4×10^2	13×10^3
ILFS-7-HT	12×10^3	3×10^3	10×10^2
ILFS-7-LT	16×10^2	6×10^2	9×10^3
ILFS-16-HT	17×10^3	7×10^2	11×10^2
ILFS-16-LT	16×10^2	9×10^3	13×10^3
ILFS-12-HT	22×10^2	5×10^3	12×10^2
ILFS-12-LT	23×10^2	4×10^3	15×10^2
ILFS-14-HT	19×10^2	6×10^2	10×10^3
ILFS-14-LT	21×10^2	4×10^2	11×10^2
ILFS-19-HT	25×10^2	7×10^3	14×10^3
ILFS-19-LT	24×10^2	8×10^2	12×10^2
ILFS-21-HT	25×10^3	10×10^3	13×10^3
ILFS-21-LT	26×10^3	8×10^2	15×10^2

TABLE 9 Bacterial populations recorded in sediment samples collected from various stations of ITPCL site during March 2023

Station Code	Total Viable Count (TVC)	Total Coliforms (TC)	*Streptococcus faecalis* (SF)
ILFS-2-HT	21×10^2	7×10^3	14×10^3
ILFS-2-LT	23×10^3	5×10^2	15×10^3
ILFS-5-HT	22×10^2	6×10^2	18×10^2
ILFS-5-LT	24×10^2	5×10^3	17×10^3
ILFS-6-HT	21×10^2	7×10^2	18×10^2
ILFS-6-LT	23×10^3	6×10^2	14×10^3
ILFS-7-HT	21×10^2	4×10^3	13×10^2
ILFS-7-LT	20×10^2	5×10^3	16×10^2
ILFS-16-HT	25×10^3	8×10^2	18×10^3
ILFS-16-LT	29×10^2	7×10^3	13×10^2
ILFS-12-HT	30×10^3	11×10^2	20×10^3
ILFS-12-LT	31×10^2	7×10^3	16×10^2
ILFS-14-HT	28×10^2	9×10^2	14×10^2
ILFS-14-LT	32×10^3	11×10^2	20×10^3
ILFS-19-HT	31×10^2	8×10^2	15×10^2
ILFS-19-LT	33×10^3	10×10^3	20×10^3
ILFS-21-HT	32×10^3	12×10^2	21×10^2
ILFS-21-LT	34×10^3	14×10^3	19×10^3

1.8 Phytoplankton Density and Diversity

The results of qualitative and quantitative estimation of the phytoplankton samples done in various sampling stations are given in Tables 10(a) and 10(b). The population density varied from 7362 to 9964 Nos. /L with minimum density was recorded at station ILFS-19-LT during low tide (Annan kovil landing center) and the maximum was in the outfall open sea (Station ILFS-6-HT).

TABLE 10 (a) Density of Phytoplankton recorded in various stations of ITPCL Power project site during March 2023

Sl. No.	Name of the Species	Nos./L									
		ILFS-2-HT	ILFS-2-LT	ILFS-5-HT	ILFS-5-LT	ILFS-6-HT	ILFS-6-LT	ILFS-7-HT	ILFS-7-LT	ILFS-16-HT	ILFS-16-LT
	Bacillariaceae										
1	*Nitzschia longissima*	142	236	164	154	280	214	150	160	198	216
2	*Navicula henneydii*	246	234	282	240	258	264	140	256	246	214
3	*Stephanopyxis palmeriana*	242	264	232	250	322	230	222	254	210	148
	Ceratiaceae										
4	*Ceratium* sp.	150	164	186	150	296	128	160	128	174	130
5	*C. furca*	164	164	152	172	142	152	142	290	360	158
6	*C. lineatum*	234	166	164	180	278	140	162	110	138	150
	Chaetocereae										
7	*Bacteriastrum delicatulum*	250	210	240	140	264	150	246	254	240	160
8	*B. hyalinium*	242	176	114	140	120	124	160	128	260	150
9	*B. varians*	150	288	150	170	136	164	128	126	126	*
10	*Chaetoceros affinis*	194	172	122	230	338	214	242	232	240	160
11	*C. clacitrans*	178	216	130	346	128	342	264	110	126	150

12	*C. coarctatus*	164	272	324	164	320	152	250	460	246	162
	Biddulphoidae										
13	*Biddulphia heteroceros*	336	228	118	120	228	114	118	116	138	168
14	*B. reticulate*	186	214	248	142	*	206	110	128	182	178
	Coscinodisceae										
15	*Coscinodiscus centralis*	282	264	246	246	254	230	280	240	650	240
16	*C. gigas*	236	216	140	118	274	188	148	*	122	114
17	*C. granii*										
18	*Skeletonema costatum*	246	140	150	124	230	252	140	152	168	160
19	*Melosira borreri*	136	152	158	132	398	128	134	130	254	230
20	*Lauderia borealis*										
	Eucampiinae	220	126	114	100	316	132	218	120	214	236
21	*Eucampia groenlandica*	132	128	246	324	130	250	326	142	140	348
22	*E. zoodiacus*	362	382	120	180	242	162	244	180	312	216
	Fragilariaceae										
23	*Diatoma anceps*	276	256	280	264	*	346	328	314	322	*
24	*Thalassiosira subtilis*	172	132	426	128	142	132	254	*	166	148
25	*Thalassionema nitzschioides*	286	246	242	124	332	420	154	280	350	*
26	*T. punctigera*	160	140	150	184	170	160	274	182	286	274
	Naviculoideae										
27	*Gyrosigma acuminatum*	230	132	140	322	456	352	142	160	134	214
28	*G. balticum*	128	188	214	254	216	230	284	264	126	240
29	*Pleurosigma normanii*	*	256	270	240	338	260	280	240	230	240
30	*Asterionella* sp.	248	152	346	134	218	142	142	314	146	128

31	*Asterionella glacialis*	184	146	240	182	368	236	328	108	170	234
	Peridiniaceae										
32	*Peridinium claudicans*	240	118	172	234	356	283	128	152	246	264
33	*Protoperidinium oceanicum*	186	142	*	168	198	239	128	122	254	378
	Soleniae										
34	*Leptocylindrus danicus*	126	238	320	170	244	264	138	120	*	282
35	*Rhizosolenia alata*	246	326	282	140	250	230	128	214	172	256
36	*R. imbricate*										
	Pyrophacaceae										
37	*Pyrophacus steinii*	262	254	300	246	230	282	264	240	214	240
38	*Dinophysis acuta*	126	128	256	240	246	216	230	326	150	128
39	*D. caudata*	142	*	160	146	166	128	142	128	228	134
	Triceratiinae										
40	*Lithodesmium undulatum*	180	170	160	182	280	240	260	270	*	346
41	*Odontella mobiliensis*	420	246	280	320	346	260	364	270	240	264
	Cyanophyceae										
42	*Oscillatoria* sp.	134	224	142	264	210	312	242	186	188	214
43	*Anabaena circinails*	162	128	264	254	244	216	130	214	378	268
	Total	**8400**	**8034**	**8444**	**8018**	**9964**	**8884**	**8324**	**7820**	**8744**	**7940**

*** Organisms not present**

TABLE 10 (b) Density of Phytoplankton recorded in various stations of ITPCL Power project site during March 2023

Sl. No.	Name of the Species	Nos./L							
		ILFS-12-HT	ILFS-12-LT	ILFS-14-HT	ILFS-14-LT	ILFS-19-HT	ILFS-19-LT	ILFS-21-HT	ILFS-21-LT
	Bacillariaceae								
1	*Nitzschia longissima*	126	320	264	120	180	138	144	138
2	*Navicula henneydii*	142	260	228	328	130	*	166	142
3	*Stephanopyxis palmeriana*	140	130	278	264	210	136	132	138
	Ceratiaceae								
4	*Ceratium* sp.	156	240	164	146	150	134	154	138
5	*C. furca*	154	*	246	*	184	160	142	*
6	*C. lineatum*	120	164	190	132	130	164	154	168
	Chaetocereae								
7	*Bacteriastrum delicatulum*	76	182	160	240	286	134	*	286
8	*B. hyalinium*	148	174	250	234	284	182	164	152
9	*B. varians*	198	216	152	338	140	150	210	250
10	*Chaetoceros affinis*	264	276	280	234	264	251	246	252
11	*C. clacitrans*	178	118	230	182	164	162	109	242
12	*C. coarctatus*	242	196	210	240	230	256	468	100
	Biddulphoidae								
13	*Biddulphia heteroceros*	346	208	680	380	276	284	280	170
14	*B. reticulate*	180	258	180	276	164	162	194	170
	Coscinodisceae								
15	*Coscinodiscus centralis*	148	230	248	158	128	138	120	130

16	*C. gigas*	352	122	320	330	134	140	110	132
17	*C. granii*	127	264	216	130	246	128	144	130
18	*Skeletonema costatum*	230	*	232	219	146	206	*	352
19	*Melosira borreri*	338	160	140	150	130	164	312	*
20	*Lauderia borealis*	240	204	224	*	228	*	248	226
	Eucampiinae								
21	*Eucampia groenlandica*	*	134	254	262	148	164	246	242
22	*E. zoodiacus*	142	160	140	230	152	162	264	*
	Fragilariaceae								
23	*Diatoma anceps*	178	230	246	250	*	270	156	264
24	*Thalassiosira subtilis*	218	*	124	245	264	220	182	234
25	*Thalassionema nitzschioides*	224	224	374	334	228	*	242	148
26	*T. punctigera*	152	*	142	*	172	152	*	124
	Naviculoideae								
27	*Gyrosigma acuminatum*	252	*	234	*	170	164	192	312
28	*G. balticum*	280	260	*	230	280	*	240	270
29	*Pleurosigma normanii*	296	252	242	386	212	122	142	148
30	*Asterionella* sp.	130	150	340	208	156	128	128	168
31	*Asterionella glacialis*	216	242	*	232	170	216	138	142
	Peridiniaceae								
32	*Peridinium claudicans*	212	228	362	124	252	184	122	118
33	*Protoperidinium oceanicum*	132	138	216	128	210	218	136	128
	Soleniae								
34	*Leptocylindrus danicus*	*	142	116	214	256	124	134	142
35	*Rhizosolenia alata*	320	312	350	346	320	342	286	276

36	*R. imbricate*	152	234	160	112	250	145	234	128
	Pyrophacaceae								
37	*Pyrophacus steinii*	246	*	350	216	*	352	248	116
38	*Dinophysis acuta*	253	226	160	326	128	282	124	168
39	*D. caudata*	348	312	294	118	138	164	246	214
	Triceratiinae								
40	*Lithodesmium undulatum*	284	262	180	128	196	146	328	236
41	*Odontella mobiliensis*	136	132	346	270	346	264	316	280
	Cyanophyceae								
42	*Oscillatoria* sp.	250	218	164	152	234	196	216	136
43	*Anabaena circinails*	*	170	180	160	150	258	218	268
	Total	**8326**	**7748**	**9866**	**8772**	**8236**	**7362**	**8035**	**7578**

***Organisms not present**

9. Zooplankton Density and Diversity

As done for phytoplankton, zooplankton density was studied in the coastal waters of ITPCL power project site at Parangipettai, and the results observed are given in Tables 11(a) and 11(b). The population density varied from 6285 to 7450 Nos./m^3 with minimum density at station ILFS-21-LT (Pappa canal) during low tide and maximum was at the outfall open sea (station ILFS-6-HT).

TABLE 11(a) Density of Zooplankton recorded in various stations of ITPCL Power project site during March 2023

Sl. No.	Name of the Species	Nos./m^3									
		ILFS-2-HT	ILFS-2-LT	ILFS-5-HT	ILFS-5-LT	ILFS-6-HT	ILFS-6-LT	ILFS-7-HT	ILFS-7-LT	ILFS-16-HT	ILFS-16-LT
	Protozoans										
1	*Globigernia* sp.	162	152	144	156	234	180	152	246	218	210
2	*G. bulloides*	118	126	120	114	214	116	118	120	242	132
3	*G. opima*	194	204	226	148	*	242	232	226	148	*
	Annelida										
4	Polychaete larvae	142	136	126	138	130	130	210	116	114	156
	Calanoid Copepod										
5	*Acartia danae*	150	158	134	142	128	260	142	140	248	152
6	*A. erythraea*	150	166	154	214	148	140	240	152	*	176
7	*A. spinicauda*	138	160	280	186	138	128	134	138	116	156
8	*Acrocalanus gibber*	168	140	162	150	168	130	140	140	108	152
9	*A. gracilis*	148	140	150	128	128	124	312	128	124	128
10	*Calanopia minor*	130	134	180	128	164	132	140	160	148	152
11	*Centropages furcatus*	342	286	170	186	140	178	134	210	214	158
12	*Labidocera acuta*	148	138	138	120	270	148	156	140	132	148
13	*Nannocalanus minor*	380	376	342	290	480	260	260	124	460	276
14	*Paracalanus parvus*	228	432	332	232	228	130	206	118	402	120
15	*Pseudodiaptomus aurivilli*	116	118	120	*	350	120	120	*	326	114
16	*Temora stylifera*	128	291	160	430	160	106	116	156	140	246
	Harpacticoid copepod										
17	*Clytmnestra scutellata*	164	218	216	224	152	242	164	140	160	160

18	*Euterpina acutifrons*	242	118	230	242	168	336	182	114	264	152
19	*Macrosetella gracilis*										
20	*Microsetella* sp.	128	*	142	140	130	160	146	160	166	162
21	*Metis jousseaumei*	230	264	222	232	200	222	210	212	*	132
	Cyclopoid copepod										
22	*Corycaeus catus*	196	142	164	164	150	162	106	162	164	214
23	*Oithona brevicornis*	156	*	148	146	280	162	168	230	256	*
24	*O. rigida*	128	140	140	138	146	*	156	142	130	130
25	*O. similes*	130	128	346	264	152	110	150	134	140	178
26	*Sapphirina* sp.	122	138	230	242	240	232	160	230	256	194
	Coelenterate										
27	*Aurelia aurita*	156	133	264	126	250	138	130	180	142	142
28	*Diphysis* sp.	140	170	186	164	264	146	248	144	150	148
	Spirotrichea	148	288	228	118	242	242	178	184	246	250
29	*Favella brevis*	*	140	130	132	246	138	164	278	234	264
30	*F. philipiensis*	124	*	120	*	116	124	156	206	148	138
31	*Tintinnopsis tubulosa*	164	142	148	160	122	118	188	136	140	164
	Decapoda	158	144	134	130	128	154	150	106	121	116
32	*Lucifer hanseni*	118	154	140	120	130	216	164	216	142	166
	Other Crustacean forms										
33	Barnacle nauplii	130	120	172	108	104	102	154	124	108	224
34	Copepod nauplii	164	150	156	134	148	128	158	216	*	126
35	Mysis larvae	126	112	152	234	124	*	260	142	136	246
	Mollusca										
36	Gastropod veliger	122	128	174	122	258	216	132	148	164	168

	Larvacea										
37	*Oikopleura parva*	120	154	146	168	138	132	120	128	231	228
38	*O. dioica*	232	124	154	264	152	138	342	120	210	284
	Rotatoria										
39	*Brachionus rubens*	168	140	*	150	168	130	140	140	108	152
40	*Keretella* sp.	*	124	196	176	162	133	160	108	112	*
	Total	**6408**	**6528**	**7276**	**6860**	**7450**	**6405**	**7098**	**6414**	**7068**	**6614**

***Organisms not present**

TABLE 11(b) Density of Zooplankton recorded in various stations of ITPCL Power project site during March 2023

Sl. No.	Name of the Species	Nos./m^3							
		ILFS-12-HT	ILFS-12-LT	ILFS-14-HT	ILFS-14-LT	ILFS-19-HT	ILFS-19-LT	ILFS-21-HT	ILFS-21-LT
	Protozoans								
1	*Globigernia* sp.	120	110	*	118	166	160	138	240
2	*G. bulloides*	236	*	210	222	140	142	170	146
3	*G. opima*	130	128	226	124	130	140	132	240
	Annelida								
4	Polychaete larvae	120	104	142	216	126	156	158	144
	Calanoid Copepod								
5	*Acartia danae*	144	132	138	126	122	126	142	144
6	*A. erythraea*	164	382	242	124	204	240	*	110
7	*A. spinicauda*	230	430	126	178	118	*	242	175
8	*Acrocalanus gibber*	210	214	140	242	196	468	134	172

9	*A. gracilis*	110	146	*	326	*	142	150	116
10	*Calanopia minor*	210	128	152	118	212	171	216	*
11	*Centropages furcatus*	170	142	248	156	124	*	142	134
12	*Labidocera acuta*	130	132	130	270	216	216	142	138
13	*Nannocalanus minor*	126	128	152	144	142	140	150	154
14	*Paracalanus parvus*	136	360	220	146	122	102	128	122
15	*Pseudodiaptomus aurivilli*	204	178	198	242	178	232	198	324
16	*Temora stylifera*	160	124	152	156	128	130	150	128
	Harpacticoid copepod								
17	*Clytmnestra scutellata*	160	148	150	128	*	258	154	158
18	*Euterpina acutifrons*	180	240	140	*	132	138	160	142
19	*Macrosetella gracilis*	158	154	170	138	140	240	132	148
20	*Microsetella* sp.	144	*	150	164	114	108	140	142
21	*Metis jousseaumei*	160	124	152	156	128	130	150	128
	Cyclopoid copepod								
22	*Corycaeus catus*	*	152	238	226	*	110	132	*
23	*Oithona brevicornis*	151	168	150	186	178	124	148	152
24	*O. rigida*	174	206	352	*	264	288	324	170
25	*O. similes*	116	150	230	146	164	138	148	144
26	*Sapphirina* sp.	284	240	140	217	372	360	346	360
	Coelenterate								
27	*Aurelia aurita*	264	170	234	184	186	154	256	160
28	*Diphysis* sp.	250	230	112	160	124	110	134	234
	Spirotrichea								
29	*Favella brevis*	164	158	282	182	174	176	134	182

30	*F. philipiensis*	192	188	194	*	186	226	148	164
31	*Tintinnopsis tubulosa*	134	148	250	254	210	*	254	116
	Decapoda								
32	*Lucifer hanseni*	142	128	134	260	142	128	114	218
	Other Crustacean forms								
33	Barnacle nauplii	146	214	148	212	208	164	120	206
34	Copepod nauplii	132	142	120	216	162	248	150	162
35	Mysis larvae	140	126	140	348	240	142	158	168
	Mollusca								
36	Gastropod veliger	140	152	120	212	142	110	160	124
	Larvacea								
37	*Oikopleura parva*	114	*	118	164	180	240	150	160
38	*O. dioica*	168	136	128	142	156	126	326	*
	Rotatoria								
39	*Brachionus rubens*	138	126	226	164	128	220	164	134
40	*Keretella* sp.	523	234	164	273	242	*	178	226
	Total	**6774**	**6572**	**6718**	**7040**	**6296**	**6503**	**6672**	**6285**

***Organisms not present**

2.0. Macro benthos Density and Diversity

The density and species diversity of Macrobenthos recorded in various stations of ITPCL power project site at Parangipettai are given in Tables 12(a) and 12(b). The population density varied from 1900 to 2550 Nos./m^3 with minimum density was recorded at station ILFS-19-LT (Pichavaram Mangroves) during low tide and maximum in the outfall open sea (station ILFS-6-LT).

TABLE 12(a) Density and Diversity of Macrobenthos recorded in various stations of ITPCL Power project site during March 2023

Sl. No.	Name of the Species	Nos/m^2									
		ILFS-2-HT	ILFS-2-LT	ILFS-5-HT	ILFS-5-LT	ILFS-6-HT	ILFS-6-LT	ILFS-7-HT	ILFS-7-LT	ILFS-16-HT	ILFS-16-LT
	Polychaetes										
1	*Ampharete acutifrons*	50	25	25	25	25	25	25	50	50	50
2	*Dorvillea rudolphi*	25	125	25	50	75	25	25	75	100	75
3	*Chone collaris*	50	75	25	*	175	25	75	25	50	25
4	*C. filicaudata*	25	25	50	175	25	25	25	50	75	50
5	*Cirratulus chrysoderma*	*	50	25	25	25	*	50	75	50	25
6	*C. cirratus*	25	50	50	50	50	50	50	*	150	50
7	*Cossura coasta*	50	75	50	75	50	50	75	50	75	75
8	*Diopatra* sp.	75	25	25	50	75	75	50	25	25	50
9	*Euchone rosea*	25	125	25	25	25	25	25	50	*	50
10	*Euclymene lumbricoides*	125	75	75	75	50	25	25	75	50	50
11	*Eunice* sp.	25	125	75	50	25	275	175	50	50	25
12	*Exogone clavator*	50	50	50	*	50	*	25	50	175	50

13	*Glycera benguellana*	25	25	25	25	125	25	50	75	50	75
14	*Goniada emerita*	75	50	50	75	75	150	75	25	175	25
15	*Nephtys dibranchis*	25	*	100	25	50	*	50	25	50	75
16	*Nereis* sp.	50	75	75	50	25	50	50	75	125	75
17	*Notomastus aberans*	75	75	25	250	25	*	50	25	25	50
18	*N. faveli*	75	150	50	125	50	25	75	75	25	*
19	*Onuphis eremita*	50	25	75	50	25	150	50	25	25	25
20	*O. gracilis*	75	75	25	125	25	50	75	25	50	50
21	*Owenia fusiformis*	25	25	25	25	25	25	25	225	50	50
22	*Pisione* sp.	125	*	50	50	25	50	125	100	75	75
23	*Pista cristata*	75	75	75	*	25	175	75	50	50	50
24	*Prionospio cirrifera*	125	50	50	25	50	75	50	25	25	25
25	*Pygospio elegans*	25	50	50	50	75	125	125	50	25	50
26	*Scolelepis squamata*	25	75	75	100	25	50	25	50	50	50
27	*Syllis gracilis*	50	50	25	50	25	150	25	50	25	*
28	*Terebellides stroemi*	100	75	75	50	75	75	75	50	50	50
	Gastropods										
1	*Cerithedia cingulata*	50	50	25	25	50	25	50	50	50	*
2	*Nassarius stollatus*	75	100	25	25	100	75	75	50	150	50
3	*Natica didyma*	50	*	75	175	50	150	*	50	100	50
4	*Turritella attenuata*	75	75	100	25	25	25	50	75	50	125
5	*Umbonium vestiarium*	25	50	50	*	25	50	75	*	75	75
	Crustaceans										
1	*Ampithoe rubricata*	100	*	150	50	100	50	50	25	*	75
2	*Campylaspis* sp.	*	75	*	175	50	25	25	50	*	50

3	Copepod nauplii	25	25	50	25	50	50	125	100	50	25
4	Penaeid shrimp larvae	75	50	50	50	75	100	75	50	50	25
	Bivalves										
1	Cardium veligers	50	50	75	75	75	50	75	50	25	75
2	*Crassostrea madrasensis*	25	25	25	50	50	50	25	75	*	25
3	*Donax scortum*	50	*	75	50	*	75	25	25	25	25
4	*Perna viridis*	*	75	*	50	75	50	50	50	*	50
	Total	**2125**	**2275**	**2050**	**2450**	**2100**	**2550**	**2325**	**2175**	**2300**	**1950**

*** Organisms not present**

TABLE 12(b) Density and Diversity of Macrobenthos recorded in various stations of ITPCL Power project site during March 2023

Sl.No.	Name of the Species	Nos/m^2							
		ILFS-12-HT	ILFS-12-LT	ILFS-14-HT	ILFS-14-LT	ILFS-19-HT	ILFS-19-LT	ILFS-21-HT	ILFS-21-LT
	Polychaetes								
1	*Ampharete acutifrons*	25	100	50	25	50	50	25	75
2	*Dorvillea rudolphi*	50	25	50	25	50	25	50	25
3	*Chone collaris*	50	25	175	25	50	50	75	75
4	*C. filicaudata*	25	50	50	*	50	50	50	50
5	*Cirratulus chrysoderma*	50	75	25	50	75	50	25	75
6	*C. cirratus*	25	25	25	25	25	75	50	50
7	*Cossura coasta*	50	25	75	25	50	25	75	25

8	*Diopatra* sp.	25	50	25	*	25	175	50	25
9	*Euchone rosea*	50	75	50	25	50	25	125	25
10	*Euclymene lumbricoides*	50	25	75	25	25	50	50	75
11	*Eunice* sp.	50	75	50	25	50	100	50	75
12	*Exogone clavator*	50	50	50	25	25	*	25	50
13	*Glycera benguellana*	125	75	25	*	150	50	25	125
14	*Goniada emerita*	50	25	`25	25	50	25	50	25
15	*Nephtys dibranchis*	75	75	*	75	75	75	25	25
16	*Nereis* sp.	25	*	50	125	25	50	50	150
17	*Notomastus aberans*	75	25	50	25	75	25	25	25
18	*N. faveli*	25	50	*	25	75	25	25	25
19	*Onuphis eremita*	75	50	50	75	25	75	75	75
20	*O. gracilis*	50	25	50	75	75	25	25	*
21	*Owenia fusiformis*	25	50	75	100	225	25	50	50
22	*Pisione* sp.	25	25	125	75	125	50	*	50
23	*Pista cristata*	50	50	50	75	75	25	125	25
24	*Prionospio cirrifera*	75	75	25	50	50	50	150	50
25	*Pygospio elegans*	50	25	50	150	25	*	25	75
26	*Scolelepis squamata*	50	75	75	50	75	75	75	25
27	*Syllis gracilis*	75	125	50	25	125	25	25	25
28	*Terebellides stroemi*	25	50	25	50	50	125	150	*
	Gastropods								
1	*Cerithedia cingulata*	50	50	50	100	25	50	50	25

2	*Nassarius stollatus*	25	25	50	50	50	25	50	75
3	*Natica didyma*	50	150	75	25	25	150	150	50
4	*Turritella attenuata*	25	75	75	25	25	125	50	25
5	*Umbonium vestiarium*	75	25	50	50	*	75	*	75
	Crustaceans								
1	*Ampithoe rubricata*	50	75	50	50	50	50	25	50
2	*Campylaspis* sp.	125	25	25	100	75	25	25	25
3	Copepod nauplii	50	25	75	75	25	25	25	75
4	Penaeid shrimp larvae	75	*	175	25	75	25	50	25
	Bivalves								
1	Cardium veligers	25	25	25	25	25	50	25	25
2	*Crassostrea madrasensis*	*	25	50	150	25	75	50	50
3	*Donax scortum*	50	50	*	50	50	25	50	25
4	*Perna viridis*	75	*	125	50	50	*	25	*
	Total	**2050**	**1950**	**2225**	**2050**	**2325**	**2100**	**2125**	**1900**

***Organisms not present**

2.1. Meiobenthos Density and Diversity

The density and species diversity of Meiobenthos recorded in various stations of ITPCL power project site at Parangipettai are given in Tables 13(a) and 13(b). The population density varied from 176 to 282 Nos/10cm^2 with minimum density was recorded at station ILFS-12-LT (Pichavaram Mangroves extension from Vellar-2) during low tide and maximum was at the Outfall location (station ILFS-6-HT).

TABLE 13(a) Density and Diversity of Meiobenthos recorded in various stations of ITPCL Power project site during March 2023

Sl. No.	Name of the Species	Nos./10cm^2									
		ILFS-2-HT	ILFS-2-LT	ILFS-5-HT	ILFS-5-LT	ILFS-6-HT	ILFS-6-LT	ILFS-7-HT	ILFS-7-LT	ILFS-16-HT	ILFS-16-LT
	Nematodes										
1	*Daptonema conicum*	4	8	4	10	4	4	10	6	6	6
2	*Epsilonema* sp.	10	6	16	6	8	6	8	12	8	2
3	*Halalaimus filum*	6	2	4	8	10	8	14	6	10	6
4	*Astomonema jenneri*	4	4	4	4	8	4	6	*	8	4
5	*Pselionema* sp.	10	4	12	6	4	6	6	*	6	*
6	*Quadricoma* sp.	4	8	6	4	6	8	14	4	8	10
7	*Stephanolaimus* sp.	12	6	10	8	10	6	8	6	*	6
8	*Theristus* sp.	8	8	6	10	12	12	10	4	10	12
9	*Quadricoma* sp.	10	10	10	4	6	10	*	8	6	8
10	*Araeolaimus longicauda*	6	5	4	10	12	6	10	6	4	10
	Foraminiferans										
11	*Ammonia beccarii*	10	8	4	8	*	4	8	8	6	10

12	*Ammonia tepida*	5	5	12	6	14	6	6	4	12	6
13	*Bolivina limbata*	12	10	8	8	6	10	10	6	6	6
14	*Elphidium texanum*	4	5	4	*	14	12	10	4	4	4
15	*Lagena lacunata*	6	*	*	4	6	5	4	14	6	8
16	*Lagena semistriata*	4	5	6	10	12	6	10	6	4	10
17	*Nonion depressulum*	10	6	8	8	4	4	*	8	6	8
18	*Discorbis* sp.	*	9	*	6	6	*	8	12	12	10
19	*Quinqueloculina* sp.	12	8	9	14	10	8	6	8	5	4
20	*Eponides repandus*	4	*	*	8	10	12	2	4	10	4
21	*Globigerina rubber*	4	4	*	6	8	*	4	6	10	6
22	*Rosalina globularis*	6	8	4	10	4	4	10	6	9	6
23	*Rotalia vilardeboana*	10	4	18	6	8	6	*	12	8	2
24	*Spirillina limbata*	6	2	6	8	10	8	14	6	10	6
25	*Spiroloculina excavata*	10	4	12	6	4	6	6	*	6	*
26	*Textularia agglutinans*	4	8	6	4	6	8	14	4	8	10
	Ostrocodes										
27	*Leguminocythereis oertlii*	6	4	12	8	12	14	8	4	10	8
28	*Patagonia theretricostata*	12	6	8	10	8	8	10	6	*	6
29	*Eucythere argus*	12	6	10	8	10	6	8	6	*	6
30	*Paracytheroma sudaustralis*	8	8	6	10	12	12	10	4	10	12
31	*Cytheromorpha fuscata*	10	10	10	6	6	10	*	8	6	8
32	*Stenocypris major*	6	6	10	*	4	4	*	10	4	6
	Harpacticoids										
33	*Diarthrodes major*	8	10	6	6	6	4	12	4	*	4
34	*Euterpina acutifrons*	9	7	4	4	4	4	*	6	4	8

35	*Harpacticus chelifer*	6	10	9	8	6	5	4	2	12	*
36	*Paramesochra dubia*	*	14	14	4	8	8	12	6	4	2
37	*Macrosetella gracilis*	6	*	6	2	4	2	8	*	6	10
	Total	**264**	**228**	**268**	**248**	**282**	**246**	**270**	**216**	**244**	**234**

*** Organisms not present**

TABLE 13(b) Density and Diversity of Meiobenthos recorded in various stations of ITPCL Power project site during March 2023

Sl. No.	Name of the Species	Nos./10cm²							
		ILFS-12-HT	**ILFS-12-LT**	**ILFS-14-HT**	**ILFS-14-LT**	**ILFS-19-HT**	**ILFS-19-LT**	**ILFS-21-HT**	**ILFS-21-LT**
	Nematodes								
1	*Daptonema conicum*	8	14	14	8	2	6	*	6
2	*Epsilonema* sp.	16	6	4	10	12	9	9	8
3	*Halalaimus filum*	8	8	6	6	8	5	9	12
4	*Astomonema jenneri*	12	6	6	4	6	*	8	4
5	*Pselionema* sp.	10	*	12	2	4	6	*	4
6	*Quadricoma* sp.	8	2	0	6	10	*	16	12
7	*Stephanolaimus* sp.	*	6	6	4	6	10	8	4
8	*Theristus* sp.	10	4	10	10	8	*	*	6
9	*Quadricoma* sp.	6	8	4	6	2	10	6	4
10	*Araeolaimus longicauda*	9	8	6	8	4	4	4	6
	Foraminiferans								
11	*Ammonia beccarii*	12	6	*	4	4	*	8	4

12	*Ammonia tepida*	4	4	6	8	6	10	6	4
13	*Bolivina limbata*	12	8	6	4	6	6	10	6
14	*Elphidium texanum*	8	*	9	8	14	*	8	4
15	*Lagena lacunata*	10	*	6	4	6	6	5	8
16	*Lagena semistriata*	10	8	14	2	*	8	9	6
17	*Nonion depressulum*	9	6	6	8	4	4	7	12
18	*Discorbis* sp.	4	*	4	6	8	6	10	4
19	*Quinqueloculina* sp.	6	12	6	*	10	*	9	*
20	*Eponides repandus*	10	*	12	*	2	9	8	6
21	*Globigerina rubber*	4	*	8	6	4	8	4	12
22	*Rosalina globularis*	6	2	2	10	6	8	6	4
23	*Rotalia vilardeboana*	8	14	14	4	2	6	*	6
24	*Spirillina limbata*	*	6	8	10	12	9	12	8
25	*Spiroloculina excavata*	8	8	4	16	8	4	10	12
26	*Textularia agglutinans*	10	*	12	2	4	6	*	4
	Ostrocodes								
27	*Leguminocythereis oertlii*	8	2	0	6	10	*	4	4
28	*Patagonia theretricostata*	*	6	6	4	16	10	8	8
29	*Eucythere argus*	*	4	10	10	8	*	*	6
30	*Paracytheroma sudaustralis*	6	8	4	6	2	10	8	4
31	*Cytheromorpha fuscata*	8	6	4	4	4	*	6	10
32	*Stenocypris major*	*	4	2	2	2	6	6	*
	Harpacticoids								
33	*Diarthrodes major*	*	6	2	12	8	6	12	4
34	*Euterpina acutifrons*	2	*	4	6	12	*	6	4

35	*Harpacticus chelifer*	6	*	10	10	6	2	2	2
36	*Paramesochra dubia*	6	*	6	12	12	8	6	6
37	*Macrosetella gracilis*	10	4	6	4	6	4	*	4
	Total	**254**	**176**	**239**	**232**	**244**	**186**	**230**	**218**

***Organisms not present**

CONCLUDING REMARKS

In the present survey, made on 26.03.2023, as has been done during previous months, the physico-chemical and biological parameters were analyzed both in the water and sediment samples collected from 18 stations by considering high and low tides at ITPCL Power Project site, Parangipettai. As a whole, the physico-chemical parameters did not vary much except a few parameters which indicated only minimal variations. Further, as noticed in the previous months, the results of physico-chemical and biological parameters indicate that the water is well oxygenated and nutrient parameters were adequate enough supporting relatively good planktonic organisms as they form base in the food chain. Regarding biological parameters, the diatom species recorded during this survey were *Nitzschia longissima, Navicula henneydii, Stephanopyxis palmeriana, Ceratium furca, B. hyalinium, Chaetoceros affinis, C. coarctatus, Biddulphia heteroceros, Coscinodiscus centralis, C. granii,* and *Lauderia borealis* were recorded commonly during the survey. Besides, the conservative macro benthic species like *Peridinium claudicans, Protoperidinium oceanicum, Polydora capensis*, *Euclymene lumbricoides, Nephtys polybranchia,* and *Cirratulus chrysoderma* were predominantly reported in the ITPCL site, Parangipettai coastal waters, which are again indicating the stable nature of the ecosystem. Not only is that, the metal concentration in coastal water and sediment samples indicates that it is well within the ERM (Effective Range Median) values which means that there are no possibilities of Heavy metal contamination in the region. In short, comparing the values of the seawater quality, sediment quality and biotic components in and around the ITPCL Power Project at Parangipettai collected during previous months suggests that there is no marked variation in the levels of physico-chemical parameters and are found to be within the recommended limits.