

ACTION PLAN FOR INDUSTRIAL CLUSTER IN SEVERLY POLLUTED AREA

Monitoring, sampling, analysis of Stack, Ambient Air Quality, Surface Water, Ground Water, Waste Water

चेंबूर Chembur



Maharashtra Pollution Control Board

Kalptaru Point, Sion East, Mumbai - 400022

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By undertaking this project and completing in schedule time, we consider ourselves very lucky since we have helped the mankind by giving the data on pollution load and further action by the Board, to bring down the pollution level.

We also thank our associates for working on this project for making the write up, making graphs and feeding the data on computer.

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Abbreviations:

APHA	American Public Health Association
BDL	Below Detection Limit
BOD	Biochemical Oxygen Demand
CEPI	Comprehensive Environmental Pollution Index
CETP	Common Effluent Treatment Plant
COD	Chemical Oxygen Demand
CPA	Critically Polluted Areas
SPA	Severely Polluted Areas
DO	Dissolved Oxygen
ETP	Effluent Treatment Plant
MIBK	Methyl Isobutyl Ketone
MPCB	Maharashtra Pollution Control Board
NAAQS	National Ambient Air Quality Standards
NO_x	Oxides of Nitrogen
ND	Not Detected
PAH	Poly Aromatic Hydrocarbons
PCB	Poly Chlorinated Biphenyls
PCT	Poly Chlorinated Terphenyls
PM₁₀	Particulate Matter (size less than 10 µm)
PM_{2.5}	Particulate Matter (size less than 2.5 µm)
SO₂	Sulphur Dioxide
STAP	Short Term Action Plan
WHO	World Health Organization

1. Introduction:

Industrial pollution is the contamination of the environment by businesses, particularly plants and factories that dump waste products into the air and water. Industrial waste is one of the largest contributors to the global pollution problem endangering people and the environment. The Central Pollution Control Board (CPCB) has developed a Comprehensive Environmental Pollution Index (CEPI). The main objective of the study is to identify polluted industrial clusters or areas in order to take concerted action and to centrally monitor them at the national level to improve the current status of their environmental components such as air and water quality data, ecological damage, and visual environmental conditions.

The concept of Comprehensive Environmental Pollution Index (CEPI) was evolved by Central Pollution Control Board (CPCB) during 2009-10 as a tool for comprehensive environmental assessment of prominent industrial clusters and formulation of remedial Action Plans for the identified critically polluted areas. Later-on proposals were received from the SPCBs, State Governments, and Industrial Associations and concerned Stakeholders for revisiting the criteria of assessment under CEPI concept. After careful examination and consideration of the suggestions of concerned stake-holders, it was decided to prepare the revised concept of CEPI by eliminating the subjective factors but retaining the factors which can be measured precisely.

The results of the application of the Comprehensive Environmental Pollution Index (CEPI) to selected industrial clusters or areas are presented in this report. The main objective of the study is to identify polluted industrial clusters or areas in order to take concerted action and to centrally monitor them at the national level to improve the current status of their environmental components such as air and water quality data, ecological damage, and visual environmental conditions. A total of 88 industrial areas or clusters have been selected by the Central Pollution Control Board (CPCB) in consultation with the Ministry of Environment & Forests Government of India for the study. The index captures the various dimensions of environment including air, water and land. Comprehensive Environmental Pollution Index (CEPI), which is a rational number to characterize the environmental quality at a given location following the algorithm of source, pathway and receptor have been developed.

Chembur is a suburb in eastern Mumbai, India. Chembur has pollution problems and was ranked 46th in a list of the most polluted industrial clusters in India. Effluents from oil refineries, fertilizer plants and reactors located in Chembur are also said to have polluted sea water in Thane Creek and affected marine life. The Deonar dumping ground in Deonar has caused health issues for the residents of Chembur. In 2008, around 40 residents of Chembur went on a hunger strike to protest against the frequent fires and smoke. Again in 2012, the residents complained to the Brihanmumbai Municipal Corporation on the smoke coming out of the dumping ground, which has been affecting asthma patients.

2. Scope of Work

The Scope of Work consisted of the following:

Monitoring, Sampling, Analysis for Stack, Ambient Air Quality, Surface Water, Waste Water, and Ground Water Quality for identified five Critically Polluted areas (CPAs) in Maharashtra i.e. **Chandrapur, Dombivli, Aurangabad, Navi Mumbai, and Tarapur** and 3 Severely Polluted areas (SPAs) in Maharashtra i.e. **Chembur, Pimpri-Chinchwad and Nashik** as per standard methods.

- At each of the 5 CPAs and 3 SPAs, 24 hourly ambient air quality monitoring to be carried out.

- Representative samples for surface water quality, waste water quality and ground water quality to be collected from prominent surface and ground water bodies located in and around the clusters/areas.
- Submission of complete monitoring, sampling and analysis reports including the summary of the parameters exceeding the prescribed standards/norms for all the 5 CPAs and 3 SPAs.
- Submission of 3 copies of final report with photographs at prominent locations and the CD (soft copy) on completion of the project for every critically polluted and severely polluted area separately.

Monitoring, Sampling, Analysis for Stack, Ambient Air Quality, Surface Water, Waste Water and Ground Water Quality for Chembur:

- The sampling was carried out in 4 days i.e. on 23rd February to & 26th February 2017 for Chembur region.
- A total of 6 Stack Monitoring Samples, 6 Ambient Air Quality Monitoring Samples, 7 Waste Water Samples, 4 Ground Water Samples and 3 VOC Samples from Ambient Air were collected and analyzed.

2.1 Stack Emission Parameters

The Stack Emissions were analyzed with the following parameters:

1. Acid Mist
2. Ammonia
3. Carbon Monoxide
4. Chlorine
5. Fluoride(gaseous)
6. Fluoride (particulate)
7. Hydrogen Chloride
8. Hydrogen Sulphide
9. Oxides of Nitrogen
10. Oxygen
11. Polyaromatic Hydrocarbons (Particulate)
12. Suspended Particulate Matter
13. Sulphur Dioxide
14. Benzene
15. Toluene

16. Xylene
17. Volatile Organic Compounds (VOCs)

2.2 Ambient Air Quality Parameters

The Ambient Air Quality was analyzed with the following parameters:

1. Sulphur Dioxide (SO₂)
2. Nitrogen Dioxide (NO₂)
3. Particulate Matter (PM10)
4. Particulate Matter (PM2.5)
5. Ozone (O₃)
6. Lead (Pb)
7. Carbon Monoxide (CO)
8. Ammonia (NH₃)
9. Benzene (C₆H₆)
10. Benzo (a) Pyrene (BaP) (Particulate Phase Only)
11. Arsenic (As)
12. Nickel (Ni)

2.3 Water/Waste Water Parameters

The Water/Waste Water was analyzed with the following parameters:

- a. Prominent Surface Water bodies such as outfalls of CETPs, ETPs, treated effluent drainage, river, canal, ponds, lakes and other such water supply resources flowing through the area or flowing adjoining the CPA.
- b. Ground Water Quality data of prominent ground water resources such as observation wells of Central Ground Water Board, drinking water wells, hand pumps, bore wells, hand pumps, bore wells and other such water supply resources located in the industrial cluster/area under consideration or in the peripheral areas.

Basic water quality parameters for surface water and ground water both are as follows:

i. Simple Parameters:

1. Sanitary Survey
2. General Appearance

3. Colour
4. Smell
5. Transparency
6. Ecological(Presence of animals like fish, insects) (Applicable to only surface water)

ii. Regular Monitoring Parameters:

7. pH
8. Oil & Grease
9. Suspended Solids
10. Dissolved Oxygen (% saturation) (Not applicable for ground waters)
11. Chemical Oxygen Demand
12. Biochemical Oxygen Demand
13. Electrical Conductivity
14. Nitrite-Nitrogen
15. Nitrate-Nitrogen
16. (NO₂ + NO₃)-Nitrogen
17. Free Ammonia
18. Total Residual Chlorine
19. Cyanide
20. Fluoride
21. Sulphide
22. Dissolved Phosphate
23. Sodium Absorption Ratio (SAR)
24. Total Coliforms (MPN/100 ml)

25. Faecal Coliforms (MPN/100 ml)

iii. Special Parameters:

26. Total Phosphorous

27. Total Kjeldahl Nitrogen(TKN)

28. Total Ammonia ($\text{NH}_4 + \text{NH}_3$)-Nitrogen

29. Phenols

30. Surface Active Agents

31. Organo Chlorine Pesticides

32. Polynuclear aromatic hydrocarbons (PAH)

33. Polychlorinated Biphenyls (PCB)and Polychlorinated Terphenyls (PCT)

34. Zinc

35. Nickel

36. Copper

37. Hexavalent Chromium

38. Chromium (Total)

39. Arsenic (Total)

40. Lead

41. Cadmium

42. Mercury

43. Manganese

44. Iron
45. Vanadium
46. Selenium
47. Boron

iv. Bioassay (Zebra Fish) Test: For specified samples only.

2.3 Methodology followed in Sampling and Analysis

Industries, places and locations that have been chosen for the sampling are representative of the city/area. Sampling has been done at the potential polluted areas so as to arrive at the CEPI. This will further help the authorities to monitor the areas in order to improve the current status of their environmental components such as air and water quality data, ecological damage and visual environmental conditions. Methodology for sampling, preservation and analysis have been done according to the references incorporated. Methodology of various types of parameters is presented under following annexure:

1. Stack Emission Sampling and Analysis Methodology – **Annexure I**
2. Ambient Air Sampling and Analysis Methodology - **Annexure II**
3. Water/Wastewater Sampling and Analysis Methodology - **Annexure III**

3. Result of Analysis:

Results of Analysis are tabulated below for Stack Emission Monitoring, Ambient Air Quality Monitoring, Waste Water Analysis and Water Analysis. These are followed by their respective graphical representation.

***Kindly note:**

- NA specifies the sample is not analysed for the specific parameter.
- BDL specifies that the result obtained is below detection limit.

3.1 Stack Emission:

Stack Emission Monitoring Results are compared against The Environment (Protection) Rules, 1986 General Emission Standard - Part D.

Sr.	Name of Industry	Stack Identity	Table No.
1.	Bharat Petroleum Corporation Ltd.	Boiler	I
2.	HPCL (Refinery Plant)	NUS Furnace	I
3.	HPCL (Refinery Plant)	CCR Inter heater	I

Sr.	Name of Industry	Stack Identity	Table No.
4.	RCF Mahul Village	Boiler	II
5.	RCF Mahul Village	Process Stack	II
6.	Tata Power Chembur	ESP (U#5)	II

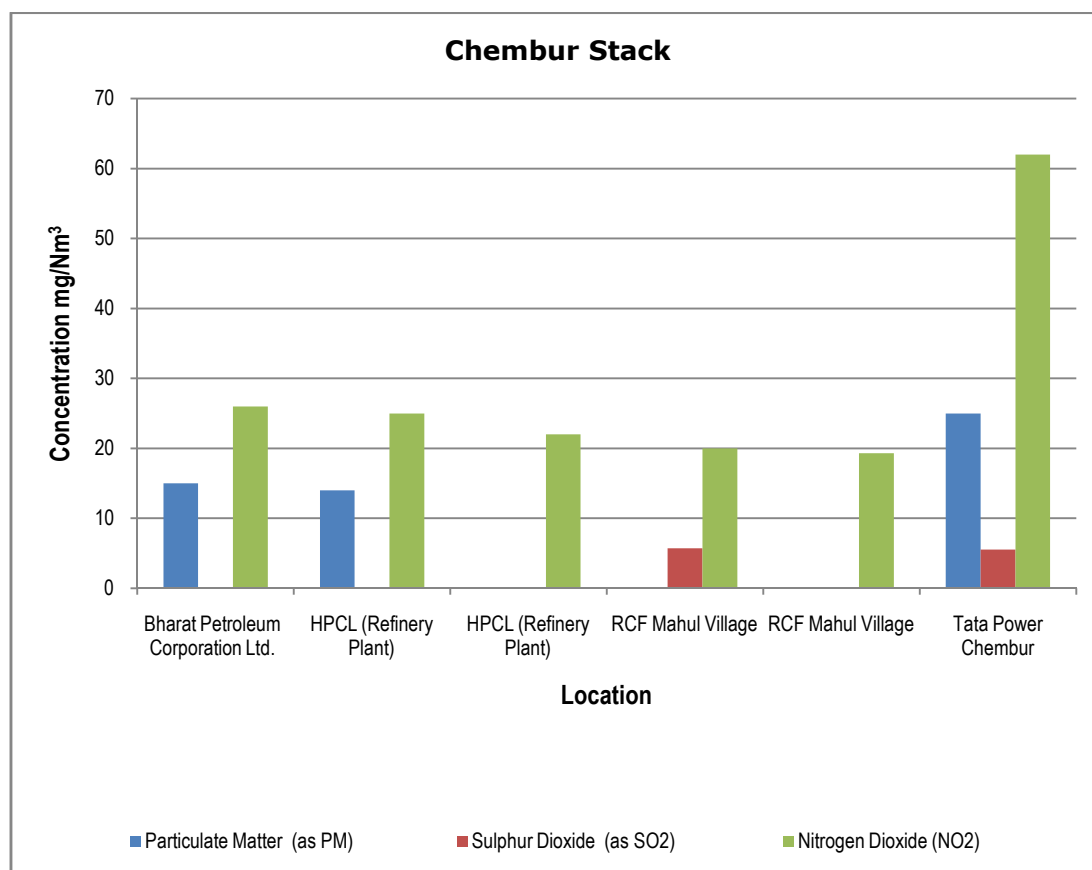
Table No. I

Name of Industry			Bharat Petroleum Corporation Ltd.	HPCL (Refinery Plant)	HPCL (Refinery Plant)
Date of Sampling (XX/02/2017)			23	24	24
Sr.	Parameter	Unit	Results		
1.	Particulate Matter (as PM)	mg/Nm ³	15	14	BDL
	Std. Limit	mg/Nm³	100	100	100
2.	Sulphur Dioxide (as SO ₂)	mg/Nm ³	BDL	BDL	BDL
		kg/day	BDL	BDL	BDL
	Std. Limit	mg/Nm³	-	-	-
3.	Nitrogen Dioxide (NO ₂)	mg/Nm ³	26	25	22
	Std. Limit	mg/Nm³	450	450	450

Table No. II

Name of Industry			RCF Mahul Village	RCF Mahul Village	Tata Power Chembur
Date of Sampling (XX/02/2017)			24	24	25
Sr.	Parameter	Unit	Results		
1.	Particulate Matter (as PM)	mg/Nm ³	BDL	NA	25
	Std. Limit	mg/Nm³	150	NA	100
2.	Sulphur Dioxide (as SO ₂)	mg/Nm ³	5.71	BDL	5.52
		kg/day	4	BDL	120
	Std. Limit	mg/Nm³	50	50	200
3.	Nitrogen Dioxide (NO ₂)	mg/Nm ³	20	19.3	62
	Std. Limit	mg/Nm³	150	150	150

Graphs: Stack Monitoring for Chembur:



3.2 Ambient Air Quality:

In order to arrive at conclusions, the Ambient Air Quality Monitoring Results are compared against National Ambient Air Quality Standards, 2009 (**Annexure IV**).

Sr.	Location	Location detail	Table No.
1.	Bharat Petroleum Corporation Ltd.	Near HRSG-2	I
2.	HPCL (Refinery Plant)	Near Main Gate	I
3.	RCF Mahul Village	Near Main Gate	I
4.	Tata Power	Near Main Gate	II
5.	Aegis Logistics	Near Main Gate	II
6.	Sea Lord	Near Main Gate	II

*** The VOC result of Ambient Air emission is provided in Table No. III**

Table No. I

Location				Bharat Petroleum Corporation Ltd.	HPCL (Refinery Plant)	RCF Mahul Village
Date of Sampling (XX/02/2017)				23	24	24
Sr.	Parameters	Unit	Std. Limit (NAAQS 2009)	Results		
1.	Sulphur Dioxide (SO ₂)	µg/m ³	80	4.76	4.31	BDL
2.	Nitrogen Dioxide (NO ₂)	µg/m ³	80	67.6	10.7	25.3
3.	Particulate Matter (size less than 10 µm) or PM ₁₀	µg/m ³	100	48	73	28
4.	Particulate Matter (size less than 2.5 µm) or PM _{2.5}	µg/m ³	60	14	19	8
5.	Ozone (O ₃)	µg/m ³	180	BDL	BDL	BDL
6.	Lead (Pb)	µg/m ³	1	0.022	BDL	BDL
7.	Carbon Monoxide (CO)	mg/m ³	4	1.24	1.4	1.75
8.	Ammonia (NH ₃)	µg/m ³	400	49.6	121	45.3
9.	Benzene (C ₆ H ₆)	µg/m ³	5	BDL	14.4	17.5

Location				Bharat Petroleum Corporation Ltd.	HPCL (Refinery Plant)	RCF Mahul Village
Date of Sampling (XX/02/2017)				23	24	24
Sr.	Parameters	Unit	Std. Limit (NAAQS 2009)	Results		
10.	Benzo (a) Pyrene (BaP) – particulate phase only	ng/m ³	1	BDL	BDL	BDL
11.	Arsenic (As)	ng/m ³	6	BDL	BDL	BDL
12.	Nickel (Ni)	ng/m ³	20	4.02	17.7	10.5

Table No. II

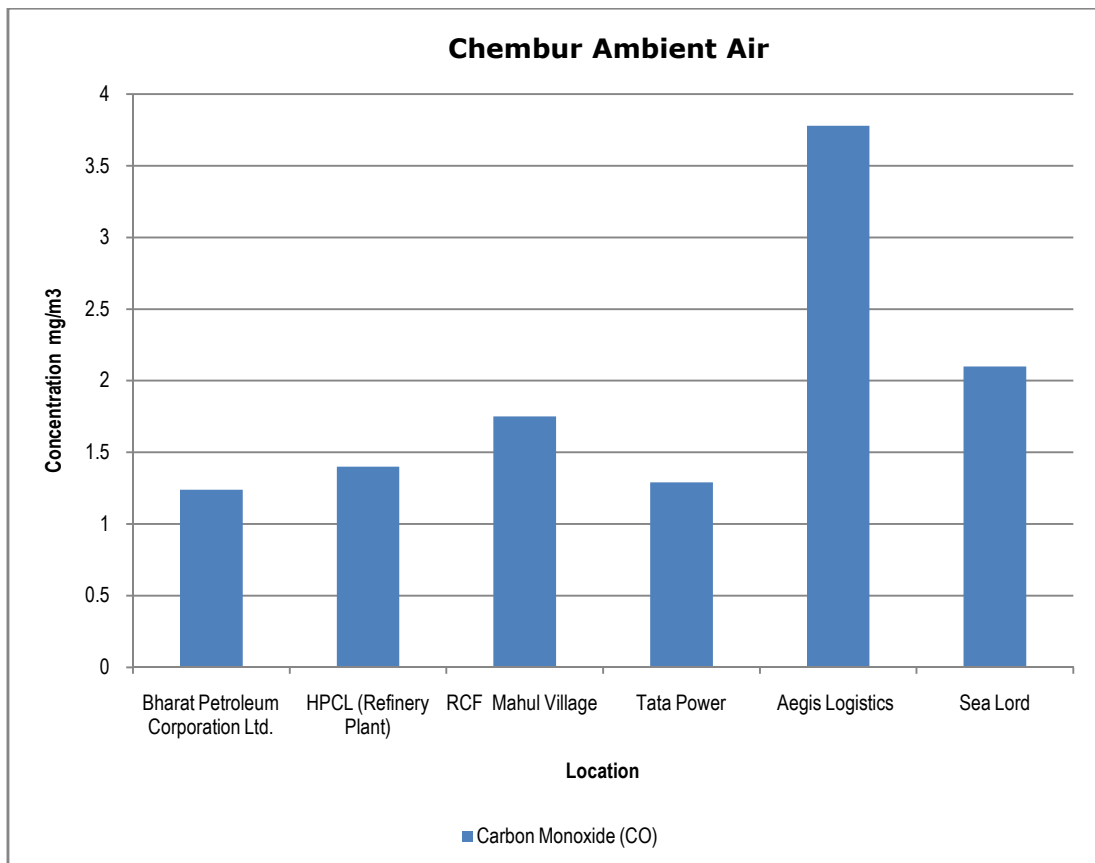
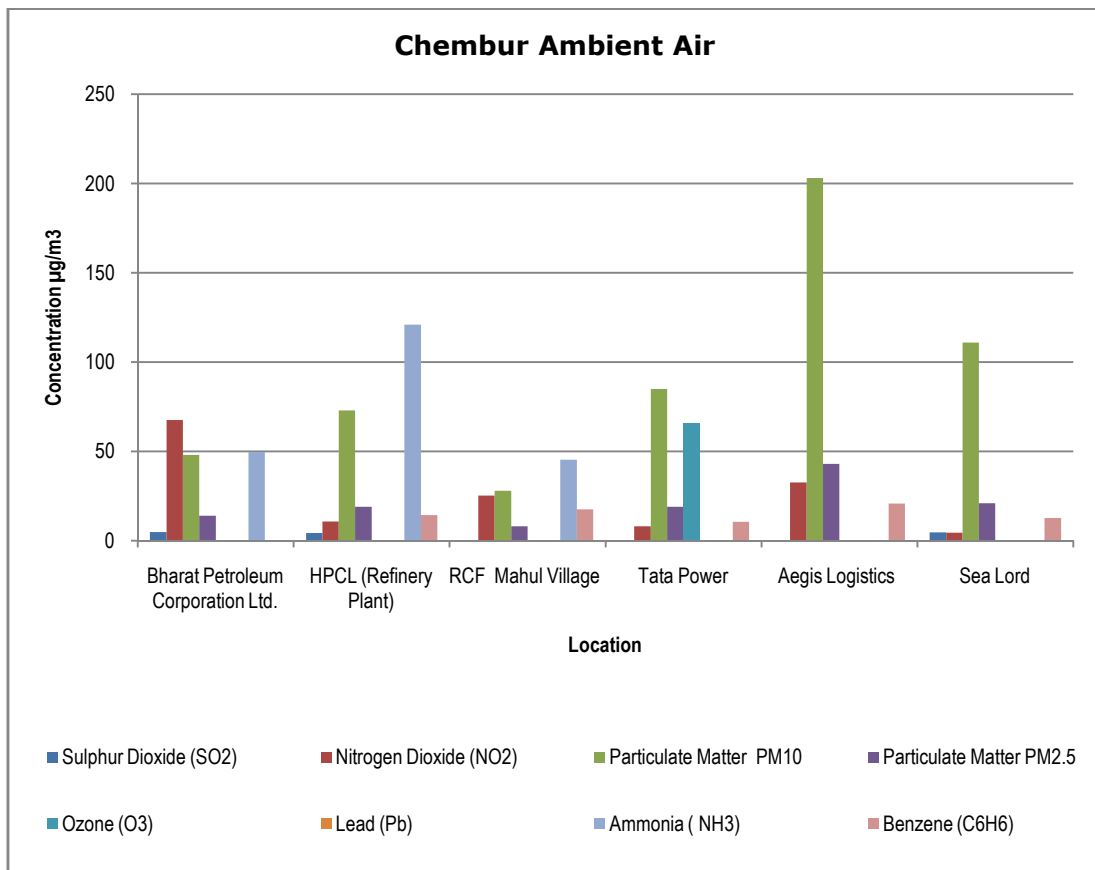
Location				Tata Power	Aegis Logistics	Sea Lord
Date of Sampling (XX/02/2017)				25	25	25
Sr.	Parameters	Unit	Std. Limit (NAAQS 2009)	Results		
1.	Sulphur Dioxide (SO ₂)	µg/m ³	80	BDL	BDL	4.7
2.	Nitrogen Dioxide (NO ₂)	µg/m ³	80	8.03	32.7	4.43
3.	Particulate Matter (size less than 10 µm) or PM ₁₀	µg/m ³	100	85	203	111
4.	Particulate Matter (size less than 2.5 µm) or PM _{2.5}	µg/m ³	60	19	43	21
5.	Ozone (O ₃)	µg/m ³	180	65.6	BDL	BDL
6.	Lead (Pb)	µg/m ³	1	BDL	BDL	0.04
7.	Carbon Monoxide (CO)	mg/m ³	4	1.29	3.78	2.1
8.	Ammonia (NH ₃)	µg/m ³	400	BDL	BDL	BDL
9.	Benzene (C ₆ H ₆)	µg/m ³	5	10.6	20.8	12.7

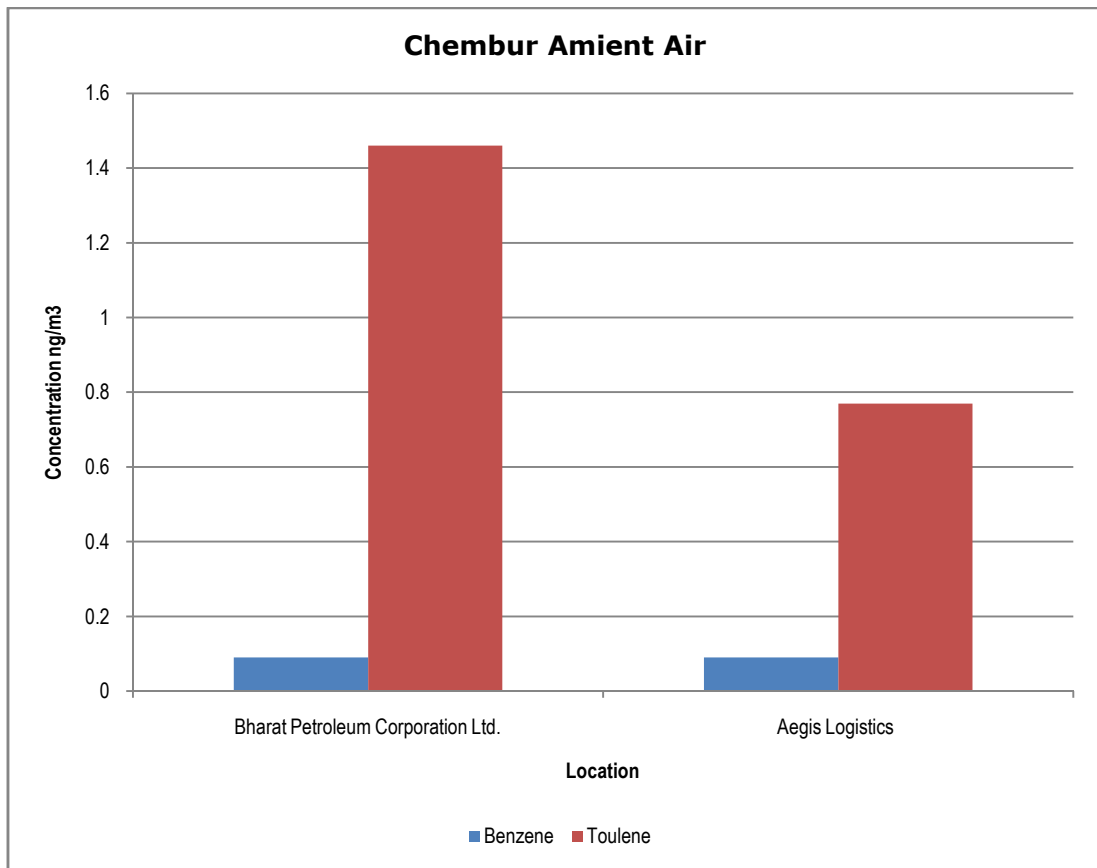
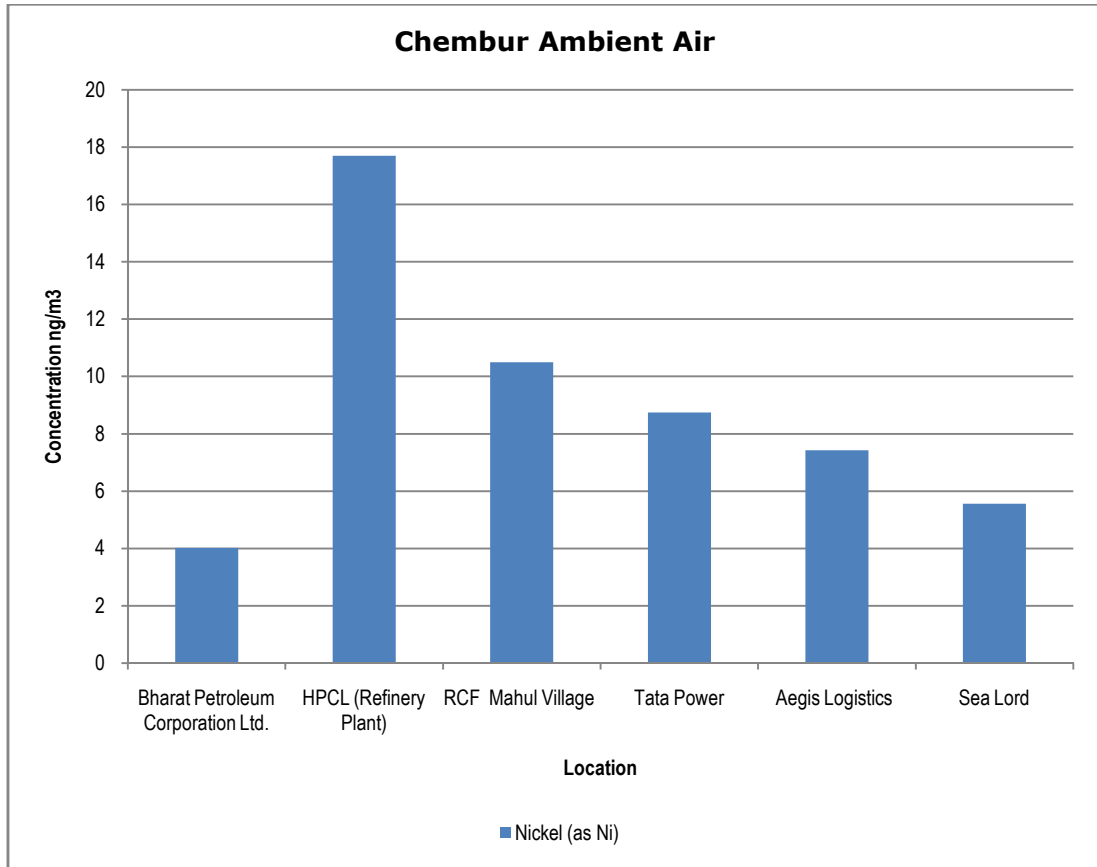
Location				Tata Power	Aegis Logistics	Sea Lord
Date of Sampling (XX/02/2017)				25	25	25
Sr.	Parameters	Unit	Std. Limit (NAAQS 2009)	Results		
10.	Benzo (a) Pyrene (BaP) – particulate phase only	ng/m ³	1	BDL	BDL	BDL
11.	Arsenic (As)	ng/m ³	6	BDL	BDL	BDL
12.	Nickel (Ni)	ng/m ³	20	8.74	7.43	5.56

Table No. III

Location			Bharat Petroleum Corporation Ltd.	Aegis Logistics	Sea Lord
Date of Sampling (XX/02/2017)			23	25	25
Sr.	Parameters	Unit	Results		
1.	VOC				
I.	Methyl Isobutyl Ketone	mg/Nm ³	ND	ND	ND
II.	Benzene	mg/Nm ³	0.09	0.09	ND
III.	Toulene	mg/Nm ³	1.46	0.77	ND
IV.	Xylene	mg/Nm ³	ND	ND	ND
V.	Ethyl Benzene	mg/Nm ³	ND	ND	ND
VI.	Ethyl Acetate	mg/Nm ³	ND	ND	ND

Graphs: Ambient Air Quality Monitoring for Chembur:





3.3 Water/ Waste Water Quality:

Water Analysis Results are compared against CPCB document on criteria for Comprehensive Environmental Assessment of Industrial Clusters-Water Quality Parameters Requirement and Classification (Annexure VI), CPCB Water Quality Criteria (Annexure V) and Drinking Water Specification, IS 10500:2012 (Annexure IV), Wastewater Analysis Results are compared with General Standards for Discharge of Environmental Pollutants Part A: Effluents, The Environment (Protection) Rules, 1986, Schedule VI.

Sr.	Location	Source	Table No.
1.	Bharat Petroleum Corporation Ltd.	ETP Outlet 1	I
2.	HPCL(Refinery Plant) Mahul Village	STP Outlet 1	I
3.	RCF -Mahul Village	ETP Outlet 1	I
4.	RCF -Mahul Village	STP Outlet 1	I
5.	Tata Power	ETP Outlet 1	II
6.	Tata Power	STP Outlet 1	II
7.	Sea Lord Chembur -Mahul Village	STP Outlet 1	II

Table No. I

Location				Bharat Petroleum Corporation Ltd.	HPCL (Refinery Plant) Mahul Village	RCF - Mahul Village	RCF - Mahul Village
Date of Sampling (XX/02/2017)				24	24	24	24
Sr.	Parameters	Unit	Std. Limit	Results			
1.	Colour	Hazen		200	200	1	200
2.	Smell	-		Disagreeable	Disagreeable	Agreeable	Disagreeable
3.	pH	-	5.5 -9.0	6.91	6.51	6.89	6.45
4.	Oil & Grease	mg/L	10.0	1.2	BDL	1.4	BDL
5.	Suspended Solids	mg/L	100.0	20	8	10	12

Location				Bharat Petroleum Corporation Ltd.	HPCL (Refinery Plant) Mahul Village	RCF - Mahul Village	RCF - Mahul Village
Date of Sampling (XX/02/2017)				24	24	24	24
Sr.	Parameters	Unit	Std. Limit	Results			
6.	Dissolved Oxygen (% Saturation)	%	0	90	0	70	
7.	Chemical Oxygen Demand	mg/L	250.0	239	20	239	20
8.	Biochemical Oxygen Demand (3 days, 27° C)	mg/L	30.0	73	6.86	73	7.04
9.	Electrical Conductivity (at 25° C)	µmho/cm		741	2780	2600	149.5
10.	Nitrite Nitrogen (as NO ₂)	mg/L		0.163	0.06	0.043	0.326
11.	Nitrate Nitrogen (as NO ₃)	mg/L	10.0	32	36	44.1	10.3
12.	(NO ₂ + NO ₃)-Nitrogen	mg/L	5.0	32.2	36.1	44.1	10.6
13.	Free Ammonia (as NH ₃ -N)	mg/L	5.0	BDL	BDL	BDL	BDL
14.	Total Residual Chlorine	mg/L	1.0	BDL	BDL	BDL	BDL
15.	Cyanide (as CN)	mg/L	0.2	BDL	BDL	BDL	BDL
16.	Fluoride (as F)	mg/L	2.0	BDL	BDL	BDL	BDL

Location				Bharat Petroleum Corporation Ltd.	HPCL (Refinery Plant) Mahul Village	RCF - Mahul Village	RCF - Mahul Village
Date of Sampling (XX/02/2017)				24	24	24	24
Sr.	Parameters	Unit	Std. Limit	Results			
17.	Sulphide (as S ²⁻)	mg/L	2.0	BDL	BDL	BDL	BDL
18.	Dissolved Phosphate (as P)	mg/L	5.0	BDL	BDL	0.39	0.034
19.	Sodium Absorption Ratio	mg/L		2.19	2.23	2.08	1.49
20.	Total Coliforms	MPN index/ 100 ml	100.0	14	BDL	7.8	7.8
21.	Faecal Coliforms	MPN index/ 100 ml	1000.0	BDL	BDL	BDL	BDL
22.	Total Phosphorous (as P)	mg/L	1.0	BDL	0.144	0.78	0.08
23.	Total Kjeldahl Nitrogen (as TKN)	mg/L	100.0	194	1.15	27.5	0.69
24.	Total Ammonia (NH ₄ +NH ₃)-Nitrogen	mg/L	5.0	141	0.2	5.71	0.12
25.	Phenols (as C ₆ H ₅ OH)	mg/L	3.0	BDL	BDL	BDL	BDL
26.	Surface Active Agents (as MBAS)	mg/L	3.0	BDL	BDL	BDL	BDL

Location				Bharat Petroleum Corporation Ltd.	HPCL (Refinery Plant) Mahul Village	RCF - Mahul Village	RCF - Mahul Village
Date of Sampling (XX/02/2017)				24	24	24	24
Sr.	Parameters	Unit	Std. Limit	Results			
27.	Organo Chlorine Pesticides						
I.	Alachlor	µg/L	2.0	BDL	BDL	BDL	BDL
II.	Atrazine	µg/L	0.2	BDL	BDL	BDL	BDL
III.	Aldrin	µg/L	0.1	BDL	BDL	BDL	BDL
IV.	Dieldrin	µg/L	2.0	BDL	BDL	BDL	BDL
V.	Alpha HCH	µg/L	0.01	BDL	BDL	BDL	BDL
VI.	Beta HCH	µg/L	2.0	BDL	BDL	BDL	BDL
VII.	Delta HCH	µg/L	3.0	BDL	BDL	BDL	BDL
VIII.	Butachlor	µg/L	0.2	BDL	BDL	BDL	BDL
IX.	p,p DDT	µg/L	0.05	BDL	BDL	BDL	BDL
X.	o,p DDT	µg/L	100.0	BDL	BDL	BDL	BDL
XI.	p,p DDE	µg/L	250.0	BDL	BDL	BDL	BDL
XII.	o,p DDE	µg/L	30.0	BDL	BDL	BDL	BDL
XIII.	p,p DDD	µg/L		BDL	BDL	BDL	BDL
XIV.	o,p DDD	µg/L		BDL	BDL	BDL	BDL
XV.	Alpha Endosulfan	µg/L	10.0	BDL	BDL	BDL	BDL
XVI.	Beta Endosulfan	µg/L		BDL	BDL	BDL	BDL
XVII.	Endosulfan Sulphate	µg/L	5.0	BDL	BDL	BDL	BDL
XVIII.	Y HCH (Lindane)	µg/L	1.0	BDL	BDL	BDL	BDL

Location				Bharat Petroleum Corporation Ltd.	HPCL (Refinery Plant) Mahul Village	RCF - Mahul Village	RCF - Mahul Village
Date of Sampling (XX/02/2017)				24	24	24	24
Sr.	Parameters	Unit	Std. Limit	Results			
28.	Polynuclear aromatic hydrocarbons (as PAH)	mg/L	0.2	0.003	0.02	0.01	0.004
29.	Polychlorinated Biphenyls (PCB)	mg/L	2.0	BDL	BDL	BDL	BDL
30.	Zinc (as Zn)	mg/L	5.0	0.21	BDL	BDL	BDL
31.	Nickel (as Ni)	mg/L	3.0	0.013	BDL	BDL	BDL
32.	Copper (as Cu)	mg/L		BDL	BDL	BDL	BDL
33.	Hexavalent Chromium (as Cr ⁶⁺)	mg/L	0.1	BDL	BDL	BDL	BDL
34.	Total Chromium (as Cr)	mg/L	2.0	0.11	BDL	BDL	BDL
35.	Total Arsenic (as As)	mg/L	0.2	BDL	BDL	BDL	BDL
36.	Lead (as Pb)	mg/L	0.1	0.022	0.012	BDL	BDL
37.	Cadmium (as Cd)	mg/L	2.0	BDL	BDL	BDL	BDL
38.	Mercury (as Hg)	mg/L	0.01	0.002	BDL	0.002	0.048
39.	Manganese (as Mn)	mg/L	2.0	0.07	0.048	BDL	BDL
40.	Iron (as Fe)	mg/L	3.0	0.48	BDL	BDL	BDL

Location				Bharat Petroleum Corporation Ltd.	HPCL (Refinery Plant) Mahul Village	RCF - Mahul Village	RCF - Mahul Village
Date of Sampling (XX/02/2017)				24	24	24	24
Sr.	Parameters	Unit	Std. Limit	Results			
41.	Vanadium (as V)	mg/L	0.2	BDL	BDL	0.08	BDL
42.	Selenium (as Se)	mg/L	0.05	0.014	0.007	BDL	BDL
43.	Boron (as B)	mg/L		BDL	0.17	BDL	BDL
44.	Bioassay Test on fish	% survival	90% survival after 96h in 100%effluent	100	100	100	100

Table No. II

Location				Tata Power	Tata Power	Sea Lord Chembur - Mahul Village
Date of Sampling (XX/02/2017)				26	26	26
Sr.	Parameters	Unit	Std. Limit	Results		
1.	Colour	Hazen		1	1	1
2.	Smell	-		Agreeable	Agreeable	Agreeable
3.	pH	-	5.5 -9.0	7.07	7.12	7.4
4.	Oil & Grease	mg/L	10.0	1	1.2	BDL
5.	Suspended Solids	mg/L	100.0	8	9	36

Location				Tata Power	Tata Power	Sea Lord Chembur - Mahul Village
Date of Sampling (XX/02/2017)				26	26	26
Sr.	Parameters	Unit	Std. Limit	Results		
6.	Dissolved Oxygen (% Saturation)	%		70	35	60
7.	Chemical Oxygen Demand	mg/L	250.0	129	179	10
8.	Biochemical Oxygen Demand (3 days, 27° C)	mg/L	30.0	39	61	3.04
9.	Electrical Conductivity (at 25° C)	µmho/cm		1304	4600	1145
10.	Nitrite Nitrogen (as NO ₂)	mg/L		0.02	0.02	0.013
11.	Nitrate Nitrogen (as NO ₃)	mg/L	10.0	16.6	13.1	26.1
12.	(NO ₂ + NO ₃)-Nitrogen	mg/L	5.0	16.6	13.1	26.1
13.	Free Ammonia (as NH ₃ -N)	mg/L	5.0	BDL	BDL	BDL
14.	Total Residual Chlorine	mg/L	1.0	BDL	BDL	BDL
15.	Cyanide (as CN)	mg/L	0.2	BDL	BDL	BDL
16.	Fluoride (as F)	mg/L	2.0	BDL	BDL	BDL
17.	Sulphide (as S ²⁻)	mg/L	2.0	BDL	BDL	BDL

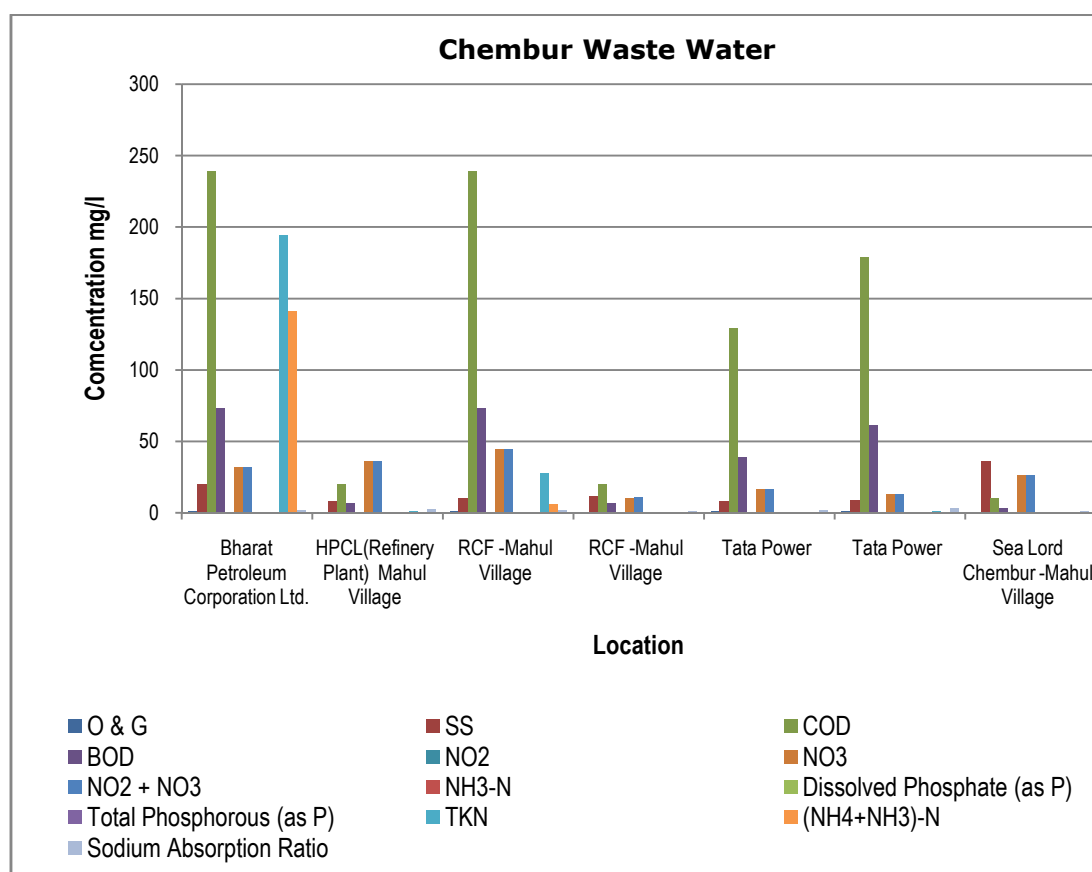
Location				Tata Power	Tata Power	Sea Lord Chembur - Mahul Village
Date of Sampling (XX/02/2017)				26	26	26
Sr.	Parameters	Unit	Std. Limit	Results		
18.	Dissolved Phosphate (as P)	mg/L	5.0	0.19	0.126	0.38
19.	Sodium Absorption Ratio	mg/L		2.05	3.46	1.3
20.	Total Coliforms	MPN index/ 100 ml	100.0	49	7.8	79
21.	Faecal Coliforms	MPN index/ 100 ml	1000.0	BDL	BDL	BDL
22.	Total Phosphorous (as P)	mg/L	1.0	0.49	0.258	BDL
23.	Total Kjeldahl Nitrogen (as TKN)	mg/L	100.0	0.69	1.15	0.69
24.	Total Ammonia (NH ₄ +NH ₃)-Nitrogen	mg/L	5.0	BDL	BDL	BDL
25.	Phenols (as C ₆ H ₅ OH)	mg/L	3.0	BDL	BDL	BDL
26.	Surface Active Agents (as MBAS)	mg/L	3.0	BDL	BDL	BDL
27.	Organo Chlorine Pesticides					
I.	Alachlor	µg/L	2.0	BDL	BDL	BDL

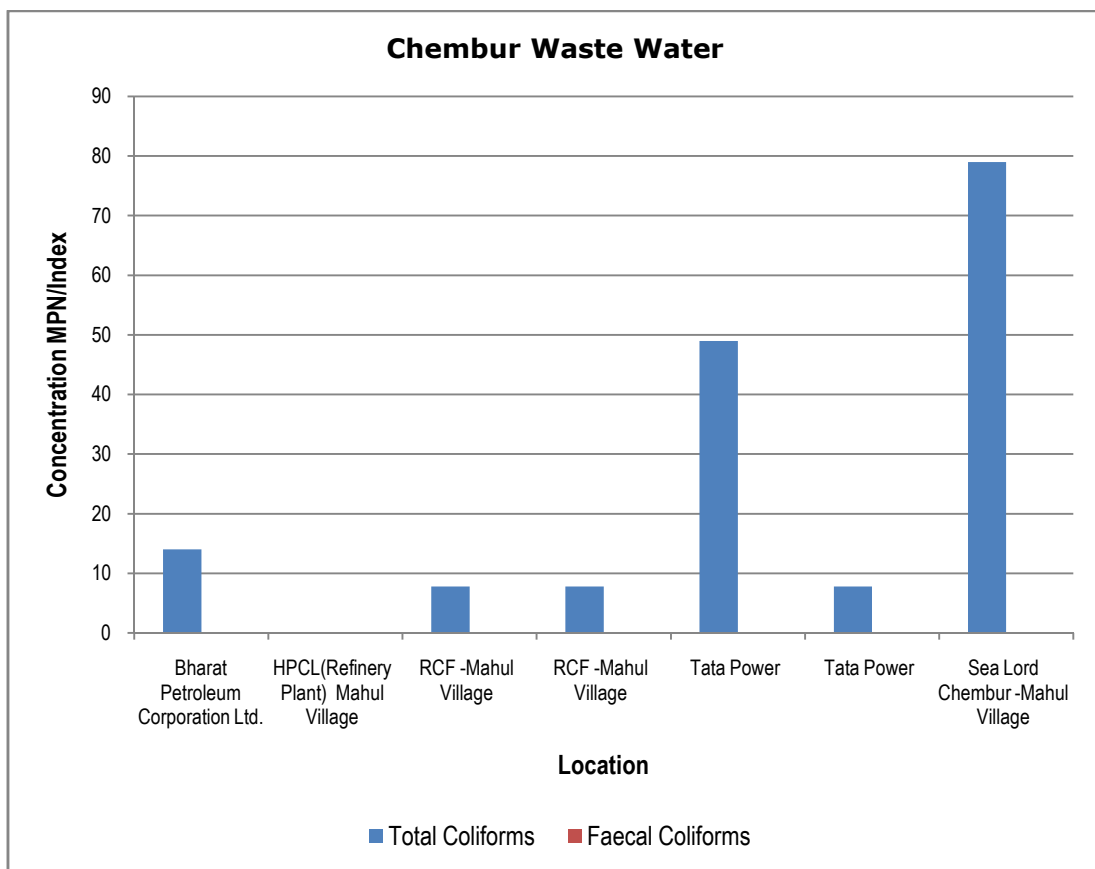
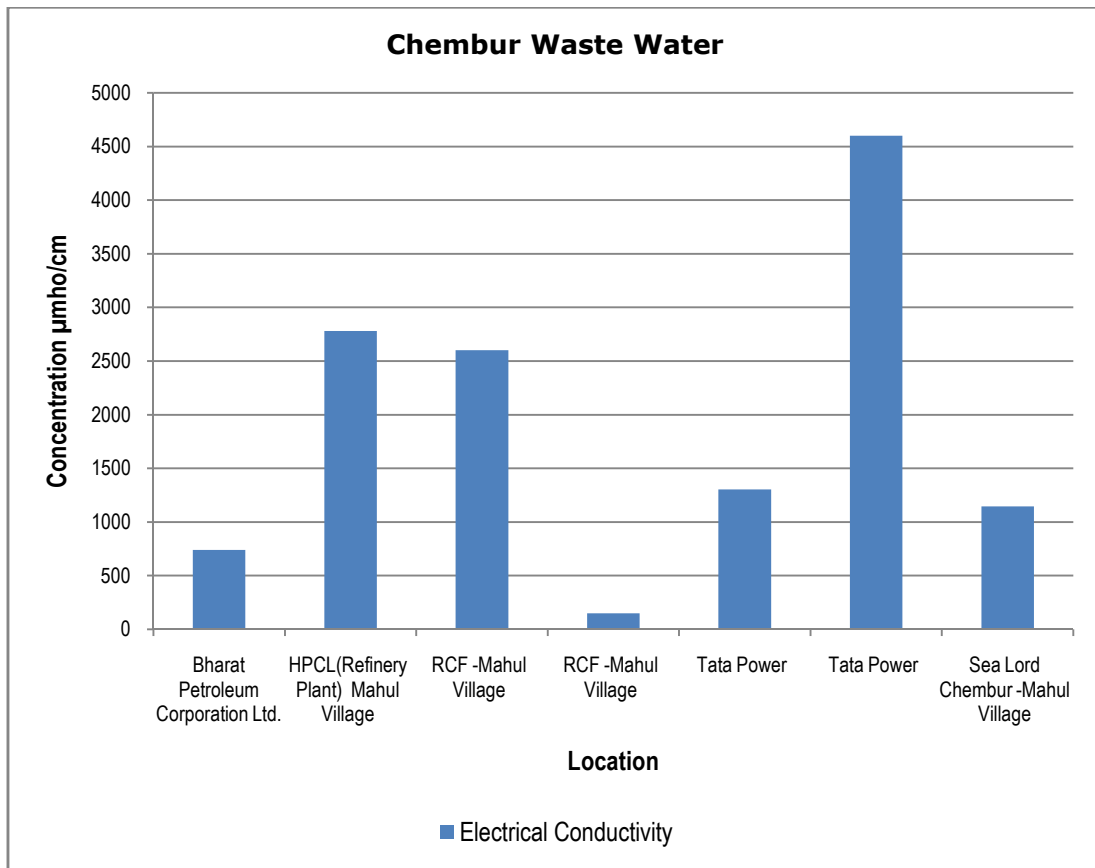
Location				Tata Power	Tata Power	Sea Lord Chembur - Mahul Village
Date of Sampling (XX/02/2017)				26	26	26
Sr.	Parameters	Unit	Std. Limit	Results		
II.	Atrazine	µg/L	0.2	BDL	BDL	BDL
III.	Aldrin	µg/L	0.1	BDL	BDL	BDL
IV.	Dieldrin	µg/L	2.0	BDL	BDL	BDL
V.	Alpha HCH	µg/L	0.01	BDL	BDL	BDL
VI.	Beta HCH	µg/L	2.0	BDL	BDL	BDL
VII.	Delta HCH	µg/L	3.0	BDL	BDL	BDL
VIII.	Butachlor	µg/L	0.2	BDL	BDL	BDL
IX.	p,p DDT	µg/L	0.05	BDL	BDL	BDL
X.	o,p DDT	µg/L	100.0	BDL	BDL	BDL
XI.	p,p DDE	µg/L	250.0	BDL	BDL	BDL
XII.	o,p DDE	µg/L	30.0	BDL	BDL	BDL
XIII.	p,p DDD	µg/L		BDL	BDL	BDL
XIV.	o,p DDD	µg/L		BDL	BDL	BDL
XV.	Alpha Endosulfan	µg/L	10.0	BDL	BDL	BDL
XVI.	Beta Endosulfan	µg/L		BDL	BDL	BDL
XVII.	Endosulfan Sulphate	µg/L	5.0	BDL	BDL	BDL
XVIII.	Y HCH (Lindane)	µg/L	1.0	BDL	BDL	BDL
28.	Polynuclear aromatic hydrocarbons (as PAH)	mg/L	0.2	0.002	0.01	0.11

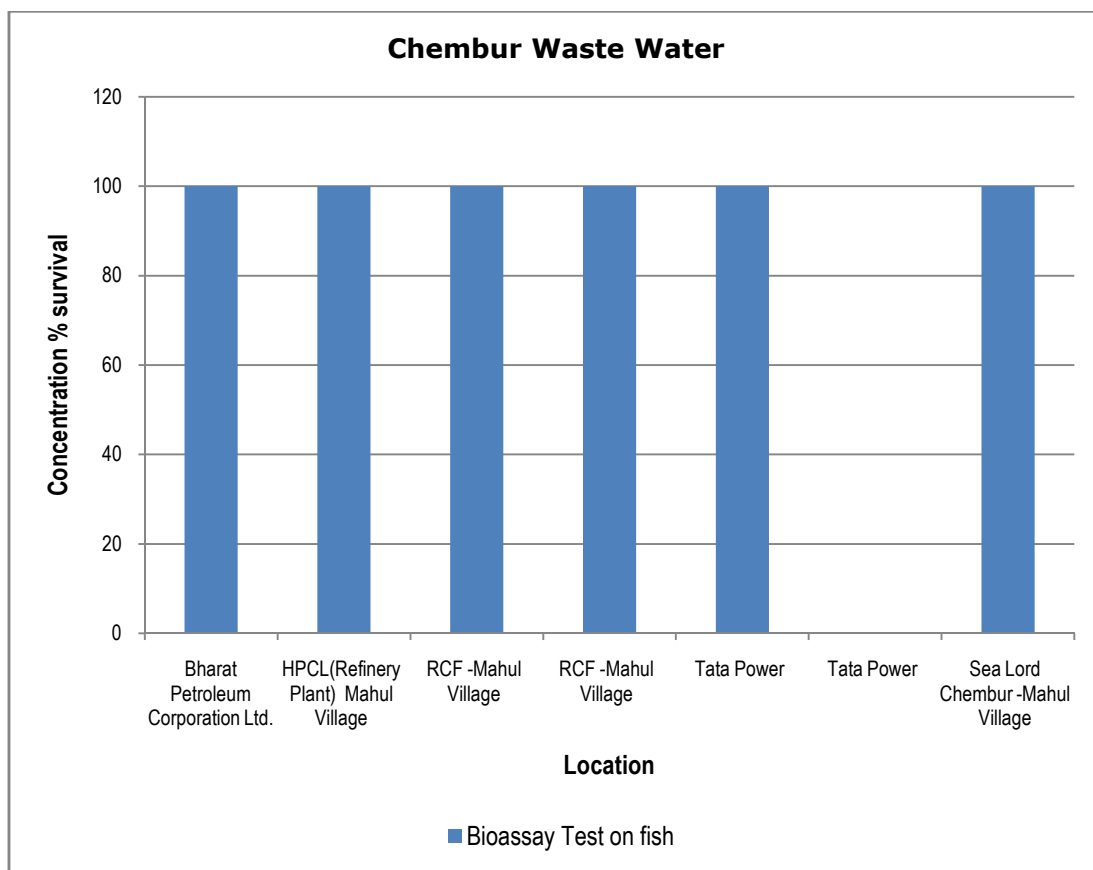
Location				Tata Power	Tata Power	Sea Lord Chembur - Mahul Village
Date of Sampling (XX/02/2017)				26	26	26
Sr.	Parameters	Unit	Std. Limit	Results		
29.	Polychlorinated Biphenyls (PCB)	mg/L	2.0	BDL	BDL	BDL
30.	Zinc (as Zn)	mg/L	5.0	BDL	BDL	BDL
31.	Nickel (as Ni)	mg/L	3.0	BDL	BDL	BDL
32.	Copper (as Cu)	mg/L		BDL	BDL	BDL
33.	Hexavalent Chromium (as Cr ⁶⁺)	mg/L	0.1	BDL	BDL	BDL
34.	Total Chromium (as Cr)	mg/L	2.0	BDL	BDL	BDL
35.	Total Arsenic (as As)	mg/L	0.2	BDL	BDL	BDL
36.	Lead (as Pb)	mg/L	0.1	BDL	BDL	BDL
37.	Cadmium (as Cd)	mg/L	2.0	BDL	BDL	BDL
38.	Mercury (as Hg)	mg/L	0.01	BDL	BDL	BDL
39.	Manganese (as Mn)	mg/L	2.0	0.092	BDL	BDL
40.	Iron (as Fe)	mg/L	3.0	0.084	0.068	BDL
41.	Vanadium (as V)	mg/L	0.2	BDL	0.019	0.024
42.	Selenium (as Se)	mg/L	0.05	BDL	BDL	BDL
43.	Boron (as B)	mg/L		BDL	0.11	0.029

Location				Tata Power	Tata Power	Sea Lord Chembur - Mahul Village
Date of Sampling (XX/02/2017)				26	26	26
Sr.	Parameters	Unit	Std. Limit	Results		
44.	Bioassay Test on fish	% survival	90% survival after 96h in 100%effluent	100	0	100

Graphs: Water/Waste Water Quality Monitoring for Chembur:







3.4 Ground Water Quality:

Sr.	Location	Source	Table No.
1.	Bharat Petroleum Corporation Ltd.	Borewell water	I
2.	HPCL(Refinery Plant) Mahul Village	Borewell water	I
3.	RCF -Mahul Village	Borewell water	I
4.	Sea Lord	Borewell water	I

Table No. I

Location				Bharat Petroleum Corporation Ltd.	HPCL (Refinery Plant) Mahul Village	RCF - Mahul Village	Sea Lord
Date of Sampling (XX/02/2017)				24	24	24	26
Sr.	Parameters	Unit	Std. Limit	Results			
1.	Colour	Hazen		1	1	1	1
2.	Smell	-	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable
3.	pH	-	6.5-8.5	7.2	7.06	6.43	7.51
4.	Oil & Grease	mg/L		BDL	BDL	BDL	BDL
5.	Suspended Solids	mg/L	100	6	10	7	6
6.	Dissolved Oxygen (%Saturation)	%		80	75	40	85
7.	Chemical Oxygen Demand	mg/L	500	13	8	16	11
8.	Biochemical Oxygen Demand (3 days,27°C)	mg/L	10 (WHO, 1993)	3.96	2.43	4.88	3.35
9.	Electrical Conductivity (at 25°C)	µmho/cm	6 (WHO, 1993)	2730	863	3060	771
10.	Nitrite Nitrogen (as NO ₂)	mg/L	0.3 (WHO, 1993)	0.01	BDL	0.045	0.015
11.	Nitrate Nitrogen (as NO ₃)	mg/L		2.11	BDL	17.4	7.9
12.	(NO ₂ + NO ₃)-Nitrogen	mg/L	45	2.12	BDL	17.4	7.91

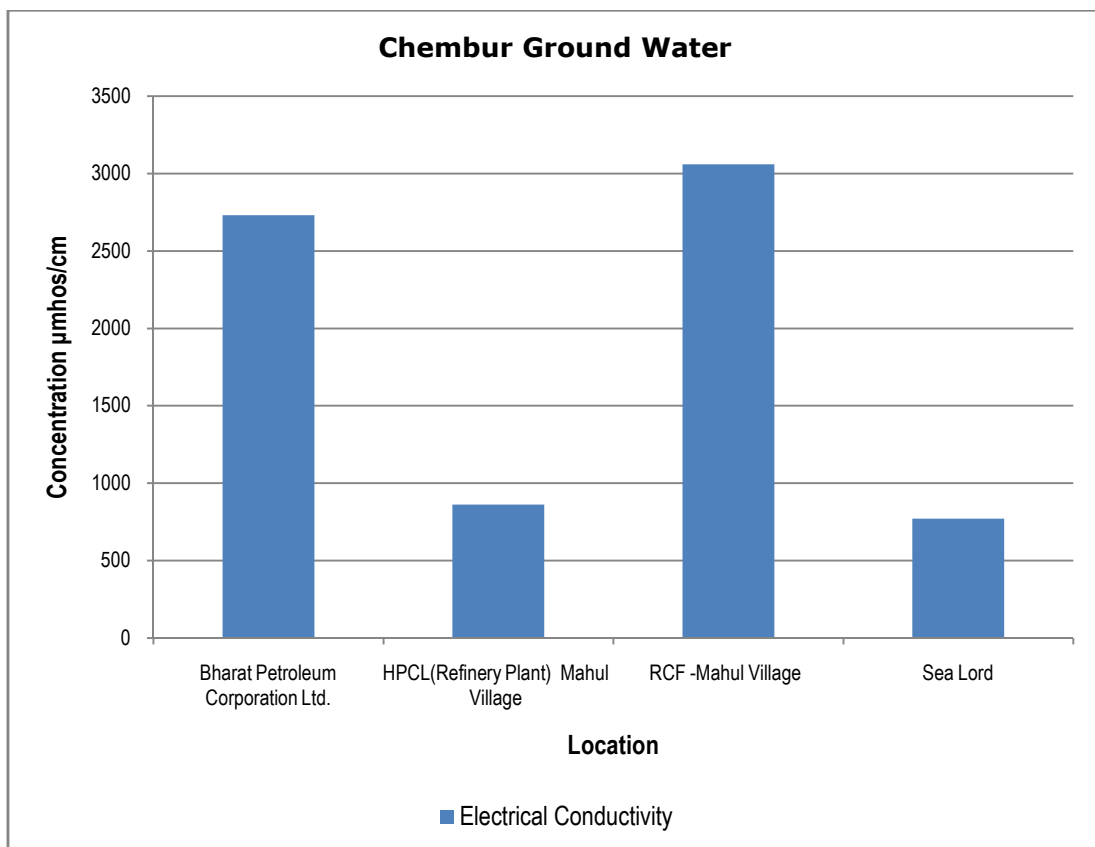
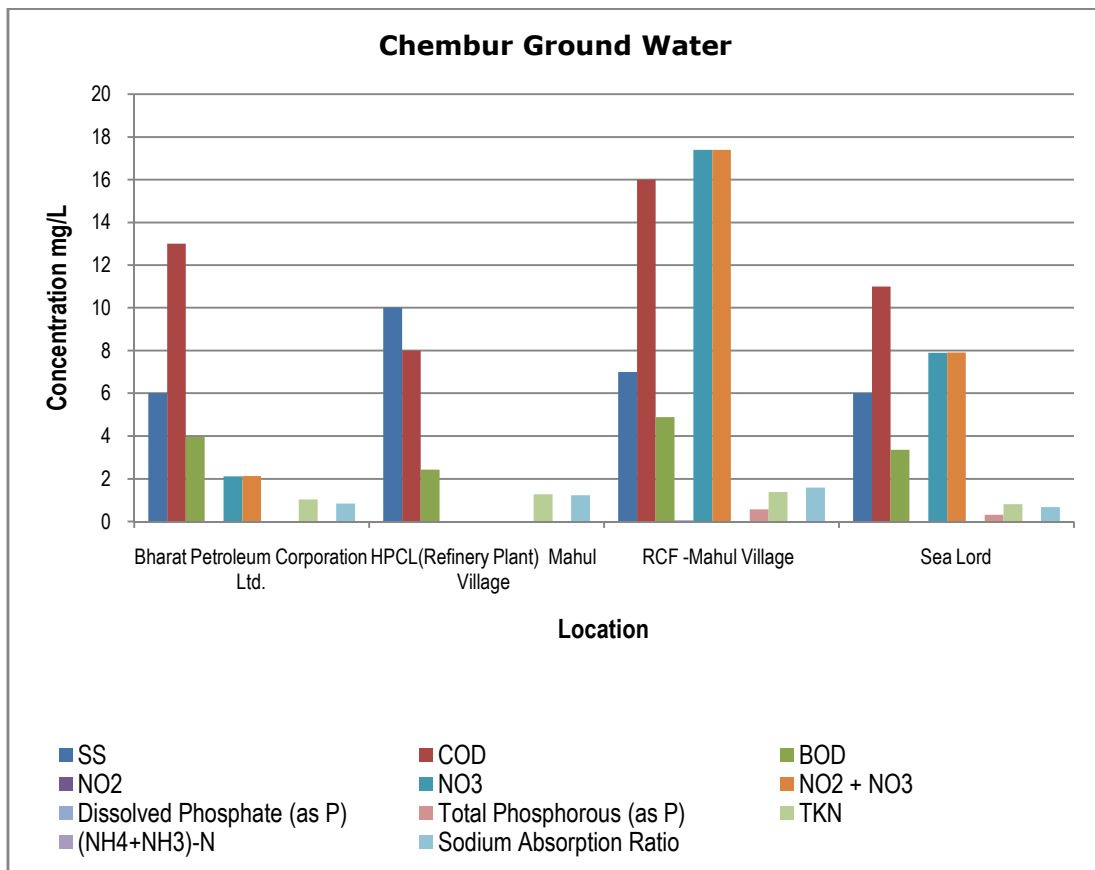
Location				Bharat Petroleum Corporation Ltd.	HPCL (Refinery Plant) Mahul Village	RCF - Mahul Village	Sea Lord
Date of Sampling (XX/02/2017)				24	24	24	26
Sr.	Parameters	Unit	Std. Limit	Results			
13.	Free Ammonia (as NH ₃ -N)	mg/L	1.0	BDL	BDL	BDL	BDL
14.	Total Residual Chlorine	mg/L	0.5	BDL	BDL	BDL	BDL
15.	Cyanide (as CN)	mg/L	0.2	BDL	BDL	BDL	BDL
16.	Fluoride (as F)	mg/L		BDL	BDL	0.26	BDL
17.	Sulphide (as S ²⁻)	mg/L	1	BDL	BDL	BDL	BDL
18.	Dissolved Phosphate (as P)	mg/L	0.05	BDL	BDL	0.266	BDL
19.	Sodium Absorption Ratio	mg/L		0.84	1.23	1.59	0.68
20.	Total Coliforms	MPN index/100 ml		7.8	BDL	79	23
21.	Faecal Coliforms	MPN index/100 ml	ND	BDL	BDL	BDL	BDL
22.	Total Phosphorous (as P)	mg/L	ND	BDL	BDL	0.576	0.32
23.	Total Kjeldahl Nitrogen	mg/L	0.5	1.03	1.27	1.38	0.81
24.	Total Ammonia (NH ₄ +NH ₃)-Nitrogen	mg/L	0.001	BDL	BDL	BDL	BDL

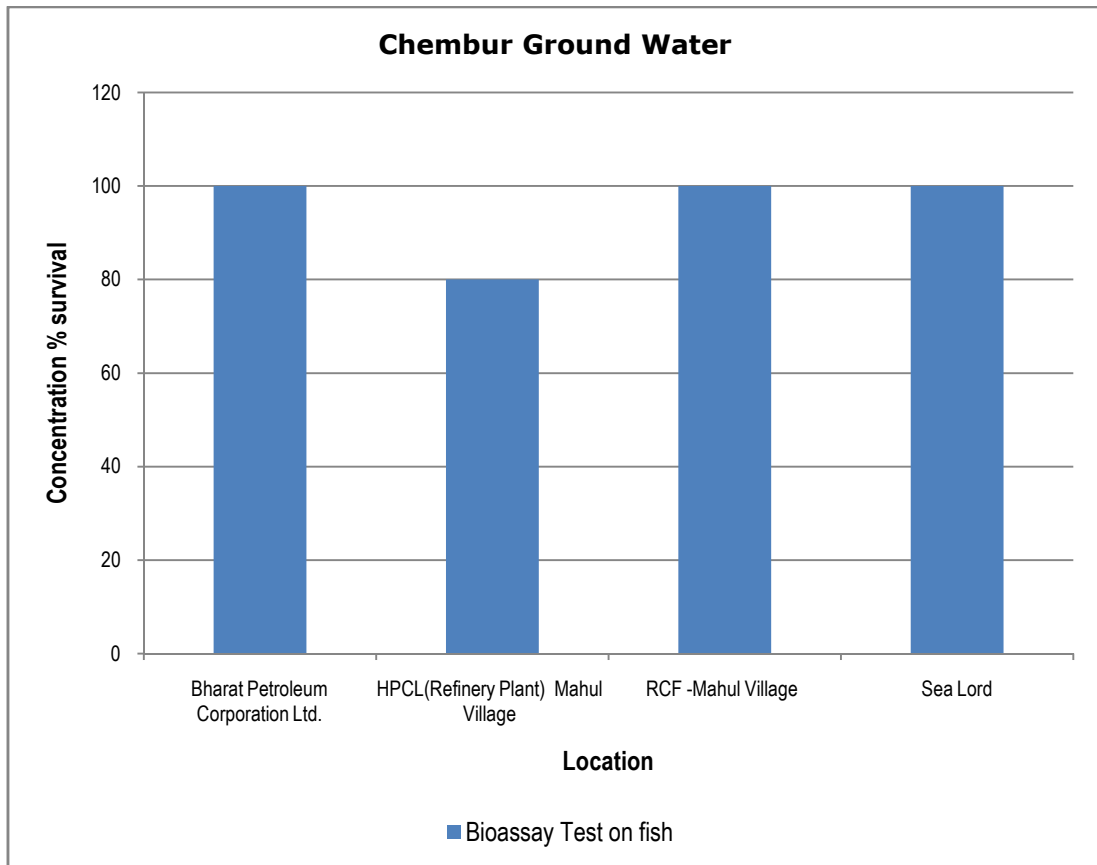
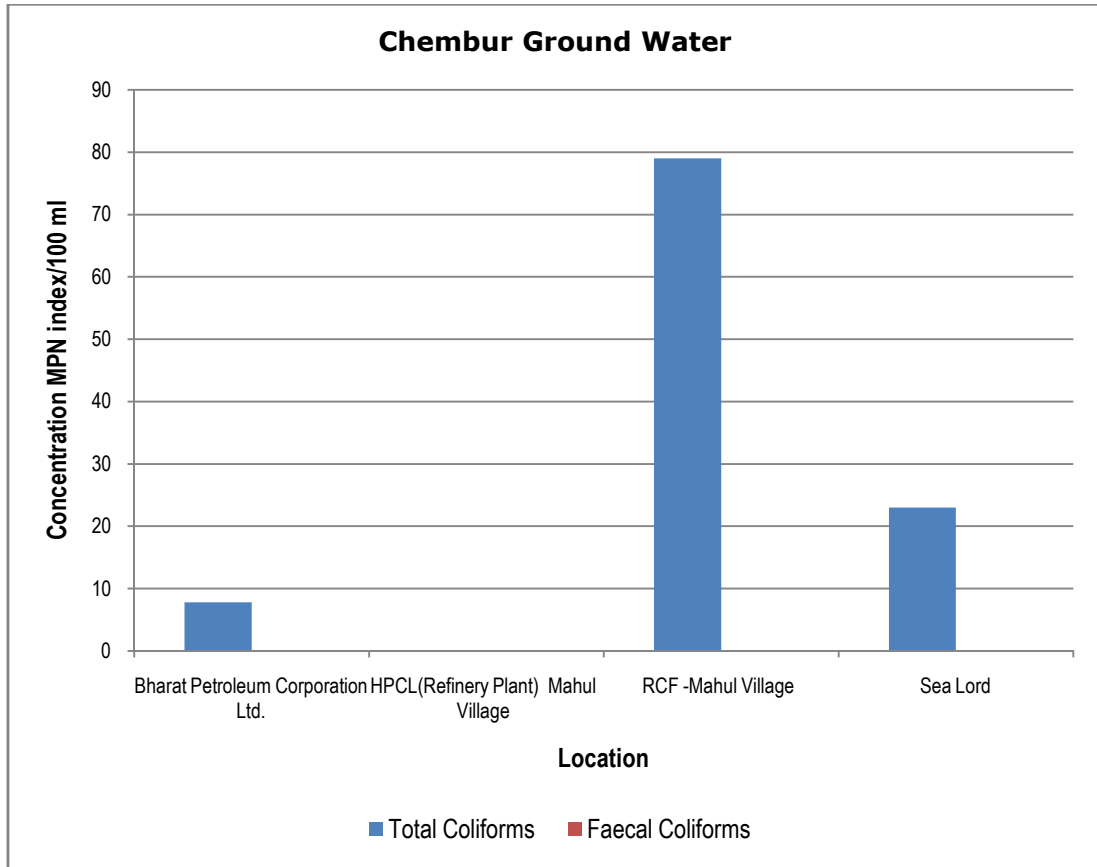
Location				Bharat Petroleum Corporation Ltd.	HPCL (Refinery Plant) Mahul Village	RCF - Mahul Village	Sea Lord
Date of Sampling (XX/02/2017)				24	24	24	26
Sr.	Parameters	Unit	Std. Limit	Results			
25.	Phenols (as C ₆ H ₅ OH)	mg/L	0.5	BDL	BDL	BDL	BDL
26.	Surface Active Agents (as MBAS)	mg/L	0.001	BDL	BDL	BDL	BDL
27.	Organo Chlorine Pesticides						
I.	Alachlor	µg/L	0.05	BDL	BDL	BDL	BDL
II.	Atrazine	µg/L	20	BDL	BDL	BDL	BDL
III.	Aldrin	µg/L	2	BDL	BDL	BDL	BDL
IV.	Dieldrin	µg/L	0.03	BDL	BDL	BDL	BDL
V.	Alpha HCH	µg/L	0.03	BDL	BDL	BDL	BDL
VI.	Beta HCH	µg/L	0.01	BDL	BDL	BDL	BDL
VII.	Delta HCH	µg/L	0.04	BDL	BDL	BDL	BDL
VIII.	Butachlor	µg/L	125	BDL	BDL	BDL	BDL
IX.	p,p DDT	µg/L	0.04	BDL	BDL	BDL	BDL
X.	o,p DDT	µg/L	1	BDL	BDL	BDL	BDL
XI.	p,p DDE	µg/L	1	BDL	BDL	BDL	BDL
XII.	o,p DDE	µg/L	1	BDL	BDL	BDL	BDL
XIII.	p,p DDD	µg/L	1	BDL	BDL	BDL	BDL
XIV.	o,p DDD	µg/L	1	BDL	BDL	BDL	BDL
XV.	Alpha Endosulfan	µg/L	1	BDL	BDL	BDL	BDL

Location				Bharat Petroleum Corporation Ltd.	HPCL (Refinery Plant) Mahul Village	RCF - Mahul Village	Sea Lord
Date of Sampling (XX/02/2017)				24	24	24	26
Sr.	Parameters	Unit	Std. Limit	Results			
XVI.	Beta Endosulfan	µg/L	0.4	BDL	BDL	BDL	BDL
XVII.	Endosulfan Sulphate	µg/L	0.4	BDL	BDL	BDL	BDL
VIII.	Y HCH (Lindane)	µg/L	0.4	BDL	BDL	BDL	BDL
28.	Polynuclear aromatic hydrocarbons (as PAH)	mg/L	2.0	BDL	BDL	BDL	BDL
29.	Polychlorinated Biphenyls (PCB)	mg/L	0.0001	BDL	BDL	BDL	BDL
30.	Zinc (as Zn)	mg/L	0.0005	BDL	BDL	BDL	BDL
31.	Nickel (as Ni)	mg/L	5.0	BDL	BDL	BDL	BDL
32.	Copper (as Cu)	mg/L	0.02	BDL	BDL	BDL	BDL
33.	Hexavalent Chromium (as Cr6+)	mg/L	0.05	BDL	BDL	BDL	BDL
34.	Total Chromium (as Cr)	mg/L	1	BDL	BDL	BDL	BDL
35.	Total Arsenic (as As)	mg/L	0.05	BDL	BDL	BDL	BDL
36.	Lead (as Pb)	mg/L	0.01	BDL	BDL	BDL	BDL
37.	Cadmium (as Cd)	mg/L	0.01	BDL	BDL	BDL	BDL

Location				Bharat Petroleum Corporation Ltd.	HPCL (Refinery Plant) Mahul Village	RCF - Mahul Village	Sea Lord
Date of Sampling (XX/02/2017)				24	24	24	26
Sr.	Parameters	Unit	Std. Limit	Results			
38.	Mercury (as Hg)	mg/L	0.003	BDL	BDL	BDL	BDL
39.	Manganese (as Mn)	mg/L	0.001	0.09	BDL	0.03	0.09
40.	Iron (as Fe)	mg/L	0.1	BDL	BDL	0.08	BDL
41.	Vanadium (as V)	mg/L	0.3	BDL	0.04	0.02	0.03
42.	Selenium (as Se)	mg/L		BDL	BDL	BDL	BDL
43.	Boron (as B)	mg/L	0.01	BDL	BDL	0.27	BDL
44.	Bioassay Test on fish	% survival		100	80	100	100

Graphs: Ground Water Quality Monitoring for Chembur:





4. Summary of the results

Based on the study done, the results are summarised and concluded as follows:

4.1 Stack Emission Monitoring:

Six industries from Chembur were selected for Stack emission monitoring.

- 1. Particulate matter (PM):** Out of the 6 stacks; Particulate matter was collected only from 5 stacks. All the results obtained are within the standard emission for the specified industry.
- 2. Sulphur dioxide (SO₂):** 4 stacks out of the 6 stacks, were below the detectable limit and 2 stack results are within the limits.
- 3. Nitrogen dioxide (NO₂):** NO₂ was sampled from 6 stacks. The higher concentration of NO₂ was observed at Tata Power with 62 mg/Nm³.

4.2 Ambient Air Quality Monitoring:

Six ambient air samples were collected from Chembur region. The parameters monitored were studied as per the NAAQS standards. The variations of each parameter within the area under study are discussed below:

- 1. Sulphur dioxide (SO₂):** All the locations are observed with very low concentrations of SO₂, with 3 stacks out of the 6 showing results below the detection limit. The highest level of SO₂ was observed at Bharat Petroleum Corporation Ltd. with 4.76 µg/m³ which is very much lower than the standard limit of NAAQS i.e. 80 µg/m³.
- 2. Nitrogen dioxide (NO₂):** Values of nitrogen dioxide are also observed below the standard limit of 80 µg/m³ at all the 6 locations. The highest level of NO₂ was observed at Bharat Petroleum Corporation Ltd. with a result of 67.6 µg/m³.
- 3. Particulate Matter (PM₁₀):** 3 sampled locations in Chembur region showed higher level of PM₁₀ concentration than the standard limit of NAAQS. The level of PM₁₀ was higher at Tata Power, Aegis Logistics and Sea Lord with 103 µg/m³, 263 µg/m³ and 140 µg/m³ respectively.
- 4. Particulate Matter (PM_{2.5}):** PM_{2.5} concentration was higher than the limit of NAAQS at HPCL (Refinery Plant) with 66 µg/m³. All other 5 locations monitored were well within the standard limit.
- 5. Ozone (O₃):** Ozone was found to be below detectable limit in all locations except at Tata Power with a concentration of 65.6 µg/m³.
- 6. Lead (Pb):** Two locations out of 6 locations monitored were detected with concentration of lead and were well within the NAAQS standard.
- 7. Carbon Monoxide (CO):** Concentration of carbon monoxide has been found to be well within the limits in all 6 locations monitored with the highest concentration at Tata Power with 3.78 mg/m³.
- 8. Ammonia (NH₃):** Ammonia was below the detectable limit in 3 locations out of the 6 locations monitored. The level of NH₃ was well within the limits.

9. **Benzene (C₆H₆):** Out of 6 locations monitored, one location showed below the detectable limit and 5 locations was having benzene concentration higher than 5 µg/m³ which is the standard limit as per NAAQS.
10. **Benzo(a)pyrene (BaP):** BaP was below detectable limit in all 6 locations monitored.
11. **Arsenic (As):** As was also below detectable limit in all 6 locations monitored.
12. **Nickel (Ni):** Concentration of Nickel was well within the permissible limit of 20ng/m³ at 6 locations monitored. The highest level of Nickel was observed at HPCL (Refinery Plant) with 17.7 ng/m³.

4.3 Waste Water Quality Monitoring:

To understand the quality of treated effluent, samples were collected from 7 industries of Chembur. Considering the general parameters of all the industries mentioned, following are the conclusions:

1. **Colour:** Colour units are found high with more than 100 Hazen unit in 3 water sample collected.
2. **Odour:** odour of 3 samples is found disagreeable at 7 water samples collected.
3. **pH:** it is observed in between 6.5 and 7.4 which is well within the range.
4. **Suspended Solids:** Suspended solids of all 7 water sample is well within the limits and ranged in between 8 mg/L to 36 mg/l.
5. **Chemical Oxygen Demand:** All samples collected, were well within the limit required as per standard. The highest COD was observed at Bharat Petroleum Corporation Ltd. and RCF -Mahul Village with 239 mg/L concentration.
6. **Biochemical Oxygen Demand:** 3 out of the 7 samples collected was exceeding the limit required as per standard of BOD. The highest BOD was observed at Bharat Petroleum Corporation Ltd. and RCF -Mahul Village with 73 mg/L concentration.
7. **Sulphide:** 7 samples collected were found to have below detectable limit.
8. **Total Ammonia:** 2 water samples collected had high concentration of Ammonia ranging in between 5.71 mg/L to 141 mg/L.
9. **Total Kjeldahl Nitrogen:** Out of 6 water samples collected, only one sample had high concentration of TKN with a concentration of 194 mg/L.
10. **Fish Bioassay:** 100% Survival was attained in 6 water samples collected for Bioassay test and in 1 water samples, no fishes survived at all.
11. **Heavy metals:** All the heavy metals are found below the standard limits in all the samples.

4.3 Ground Water Quality Monitoring:

Four ground water samples were collected from Chembur region.

- 1) **Colour** (Hazen Units): Colour units are below the acceptable standard of all water samples collected.
- 2) **Odour**: odour of all the samples is found agreeable.
- 3) **Chemical Oxygen Demand**: The COD of all 4 samples was found in the range between 8 mg/L to 16 mg/L.
- 4) **Biological Oxygen Demand**: BOD of all 4 samples was found in the range between 2.43 mg/L to 4.88 mg/L.

Following are the parameters which are compared with ISO 10500:2012 Drinking water specifications.

- 1) **Nitrite**: Values of Nitrite at all location was well within the standard.
- 2) **Nitrate**: Results of Nitrate are also observed below standard limit (45mg/l).
- 3) **Residual Free Chlorine**: Values are below the detectable limit in all 4 samples collected.
- 4) **Total Ammonia**: Values are below the detectable limit in all samples collected.
- 5) **Fluoride**: Values are below the acceptable standards, below <0.05mg/L.
- 6) **Sulphide**: All the readings of sulphide are below detectable limit in all 4 samples collected.
- 7) **Sodium Absorption Ratio**: These values fit within range of water quality criteria of CPCB.
- 8) **Total Kjeldahl nitrogen**: All 4 water sample collected exceeded the standard limit of TKN and ranged in between 0.81 mg/L to 1.38 mg/L concentration.
- 9) **Fish Bioassay**: HPCL(Refinery Plant) Mahul Village borewell water sample 80% survival was observed. Remaining all location 100% survival was observed.
- 10) ***Boron**: Values are below the acceptable standards.

(* CPCB Water Quality criteria for Irrigation, Industrial Cooling & Controlled Waste disposal).
- 11) **Surface Active Agents**: All 4 samples showed below detectable limit.
- 12) **Metals**: All the metals except manganese at few locations are observed within the acceptable limits of drinking water standards.

5. CEPI Score

Comprehensive Environmental Pollution Index (CEPI) is intended to act as early warning tool which helps in categorization of industrial clusters/areas in terms of priority of needing attention. CPCB had evolved certain methodology to calculate CEPI, in which a score has been fixed for different environmental components based on the level of pollution. The scoring system involves an algorithm that takes into account the basic selection criteria. This approach is based on the basic hazard assessment logic that can be summarized as below.

Hazard = pollutant source, pathways, and receptor

CPCB has calculated CEPI for the identified critically polluted industrial clusters in 2009. It is calculated separately for air, water, and land. The basic framework and scoring system of the CEPI – based on three factors namely pollutant, pathway, and receptor – has been described below.

Based on Sub-index Score (score of individual environmental component like air, water etc.):

- **Score more than 63:** A Critical Level of Pollution in the respective level of environmental component
- **Score between 51-63:** Severe to critical level of pollution with reference to respective environmental component

Cut-off Score

- **Score 50:** Severely Polluted Industrial Clusters/areas
- **Score 60:** Critically Polluted Industrial Clusters/areas

Based on Aggregated CEPI Score (score includes sub-index score of all individual environmental components together):

- **Aggregated CEPI score >70:** Critically polluted areas
- **Aggregated CEPI score between 60-70:** Severely polluted areas

Since the inception of the programme, MPCB has also formulated Action Plans to mitigate the environmental pollution problems for each of the 8 Critically Polluted Areas (CPAs) in Maharashtra. Based on available information, parameters selected and monitored in continuation with this, CEPI has been calculated and Short Term Action Plan (STAP) as well as Long Term Action Plan (LTAP) was prepared in 2010.

Subsequently NAAQS 2009 came in force. List of parameters to be considered increased and expanded including more critical and hazardous pollutants like benzene, BaP, Metals, etc. existing in the environment. There was revision of standards (limiting values) as well. In this present report of 2017 prepared by MPCB, CEPI is calculated considering all these revised standards' limiting values, list of parameters and complete scope of monitoring.

Below given Table shows aggregated CEPI of present report in comparison with CPCB report (2009).

The result shows that CEPI score of present report is 63.2 which is lesser than the CPCB CEPI score of 2009 which was 69.19.

5.1 Comparison of CEPI scores:

Results show that present CEPI score (63.2) of Chembur considering all revised standards is lesser than the CPCB CEPI Score of 2009 (69.19) report.

Detailed results of Air, Water and Land are given below:

Air

	A1	A2	A	B1	B2	B3	B	C1	C2	C3	C	D	CEPI
Present Report 2017	3	5	15	5	0	0	5	5	5	0	25	10	55
CPCB Report 2009	5.7 5	5	28. 75	6	0	0	6	5	3	0	15	10	59.75

Water:

	A1	A2	A	B1	B2	B3	B	C1	C2	C3	C	D	CEPI
Present Report 2017	2	3.8	7.6	5	0	3	8	5	3	0	15	10	40.6
CPCB Report 2009	3	5	15	7.7 5	1.5	1.5	10. 75	5	2	5	15	10	50.75

Land:

	A1	A2	A	B1	B2	B3	B	C1	C2	C3	C	D	CEPI
Present Report 2017	3	4.3	12. 9	5	3	3	11	4	2	3	11	10	44.9
CPCB Report 2009	3	5	15	3	1.5	1.5	6	5	2	5	15	10	46.00

Aggregated CEPI:

	Air Index	Water Index	Land Index	CEPI
Present Report 2017 (Considering all parameters)	55	40.6	44.9	63.2
CPCB Report 2009	59.75	50.75	46.00	69.19

6. Conclusion

Chembur is a largely industrial and used to be known as the 'gas chamber' of Mumbai. There are many major petrochemical industry, Oil refineries, Fertilizer plants and Power industry situated in the region. The HPCL Lubricating Oils Refinery set up at Chembur, Mumbai is largest lube refinery in India. The CEPI score of 63.2 comes under the criteria of severely polluted areas which shall be kept under surveillance and pollution control measures should be efficiently implemented.

We have taken samples of 6 stacks from various industries around the region to carry out the study. It was observed that the results obtained were well within the limits prescribed to specific industry by the Pollution control board. The refinery plants, chemical industry and power plant which were monitored also have implemented Environmental protection measures as suggested by statutory bodies like CPCB and State PCBs and complied with standard limits and regulations.

Six ambient air samples were also collected in checking the ambient air quality of the region. PM₁₀ and Benzene was found to have exceeded the limit of 5 µg/m³ as per NAAQS in only some regions monitored. Automobile exhaust accounts for the concentration of Benzene and PM₁₀ in the area. The Concentration of Benzene is also high due to the presence of refinery plant and Power plant.

The waste water samples were collected from the ETP outlet and STP outlet of the region. Only the concentration of nitrogen was found to be beyond the limit in some of the samples identified. We can correct this by taking better measures in the treatment plant so that the outlet water is in the prescribed limit for disposal.

In the ground water samples collected, Electrical Conductivity, Total Kjeldahl Nitrogen and Manganese was found in higher concentration. The ground water collected is from Borewell and is not used for drinking purpose.

The overall pollution load in the region is reduced and continuous efforts have been inputted by the Regional pollution control board and state pollution control board in bringing the pollution lesser.

	A1	A2	A	B1	B2	B3	B	C1	C2	C3	C	D	CEPI
Air Index	3	5	15	5	0	0	5	5	5	0	25	10	55
Water Index	2	3.8	7.6	5	0	3	8	5	3	0	15	10	40.6
Land Index	3	4.3	12.9	5	3	3	11	4	2	3	11	10	44.9
Aggregated CEPI													63.2

7. References

- 1) Criteria for Comprehensive Environmental Assessment of Industrial Clusters, December 2009,CPCB, EIAS/4/2009-10
- 2) Comprehensive Environmental Assessment of Industrial Clusters, December 2009,CPCB, EIAS/5/2009-10
- 3) Action Plan for Industrial Cluster: Chandrapur, November 2010,MPCB
- 4) Action Plan for Industrial Cluster: Chembur, November 2010,MPCB
- 5) Action Plan for Industrial Cluster: Aurangabad, November 2010,MPCB
- 6) Action Plan for Industrial Cluster: NaviMumbai, November 2010,MPCB
- 7) Action Plan for Industrial Cluster: Navi Mumbai, November 2010,MPCB
- 8) Standard Methods for the Examination of Water and Waste Water, American Public Health Association, 22nd Edition, 2012.
- 9) IS 3025 (various parts)
- 10) www.mpcb.gov.in
- 11) www.cpcb.gov.in

8. Annexure

Annexure I: Stack Emission Sampling and Analysis Methodology

Sr.	Parameters	Method References	Techniques	Detection Limit
1.	Acid Mist (as Sulphuric Acid)	US EPA Method no.m-8	Barium thorine titration Method	0.6 mg/Nm ³
2.	Ammonia	IS 11255 (Part 6):1999, Reaffirmed 2003	Titration/Nessler Reagent / Spectrophotometric Method	1 mg/Nm ³
3.	Carbon Monoxide	USEPA Method 10B	GC-FID Method	0.2 mg/Nm ³
4.	Chlorine	US EPA Method 26 for sampling	Titrimetric	0.001 mg/Nm ³
5.	Fluoride (Gaseous)	US EPA Method 13 A	SPADNS Zirconium Lake Spectrophotometric Method	0.025 mg/Nm ³
6.	Fluoride (Particulate)	US EPA Method 13 A	SPADNS Zirconium Lake Spectrophotometric Method	0.005 mg/Nm ³
7.	Hydrogen Chloride	US EPA Method 26 for sampling	Titrimetric	0.25 mg/Nm ³
8.	Hydrogen Sulphide	IS 11255 (Part 4):1985	Titrimetric	1 mg/Nm ³
9.	Oxides of Nitrogen	IS 11255 (Part 7): 2005	PDSA Colorimetric Method	10 mg/Nm ³
10.	Oxygen	IS 13270 : 1992	ORSAT Apparatus	1 %
11.	Poly Aromatic Hydrocarbons (Particulate)	IS 5182 (Part 12) : 2004, Reaffirmed 2009 CPCB Guidelines, May 2011, Page No.39	GC-FID Method	0.25 mg/Nm ³
12.	Suspended Particulate Matter	IS 11255 (Part 1):1985, Reaffirmed 2003	Gravimetric Method	10 mg/Nm ³

Sr.	Parameters	Method References	Techniques	Detection Limit
13.	Sulphur Dioxide	IS 11255 (Part 2): 1985, Reaffirmed 2003	Titrimetric IPA thorine Method	5.0mg/Nm ³
				0.02kg/day
14.	BTX (Benzene, Toluene, Xylene)	NIOSH (NMAM) 1501	Adsorption and Desorption followed by GC-FID analysis	0.001 mg/Nm ³
15.	VOC (Volatile Organic Compounds)	NIOSH (NMAM) 1501 for sampling	Adsorption and Desorption followed by GC-FID or GC/MS analysis	-
i	Methyl Isobutyl Ketone	-	-	0.001 mg/Nm ³
ii	Benzene	-	-	0.001 mg/Nm ³
iii	Toluene	-	-	0.001 mg/Nm ³
iv	Xylene	-	-	0.001 mg/Nm ³
v	Ethyl Benzene	-	-	0.001 mg/Nm ³
vi	Ethyl Acetate	-	-	0.001 mg/Nm ³

Annexure II: Ambient Air Sampling and Analysis Methodology

Sr.	Parameters	Method References	Techniques	Detection Limit
1.	Sulphur Dioxide (SO ₂)	CPCB Guidelines for the Measurement of Ambient Air Pollutants, Volume I, May 2011, Page No.1	Improved West & Gaeke Method	4 µg/m ³
2.	Nitrogen Dioxide (NO ₂)	CPCB Guidelines for the Measurement of Ambient Air Pollutants, Volume I, May 2011, Page No.7	Modified Jacob & Hochheiser Method	3 µg/m ³
3.	Particulate Matter (size less than 10 µm) or PM ₁₀	CPCB Guidelines for the Measurement of Ambient Air Pollutants, Volume I, May 2011, Page No.11	Gravimetric Method	2 µg/m ³
4.	Particulate Matter (size less than 2.5 µm) or PM _{2.5}	CPCB Guidelines for the Measurement of Ambient Air Pollutants, Volume I, May 2011, Page No. 15	Gravimetric Method	0.4 µg/m ³
5.	Ozone (O ₃)	APHA, Method No. 820, Page no. 836	Chemical Method	19.6 µg/m ³
6.	Lead (Pb)	CPCB Guidelines for the Measurement of Ambient Air Pollutants, Volume I, May 2011, Page No. 47	AAS Method	0.02 µg/m ³
7.	Carbon Monoxide (CO)	CPCB Guidelines for the Measurement of Ambient Air Pollutants, Volume II, May 2011, Page No. 16	Non Dispersive Infra Red (NDIR) spectroscopy	0.05 mg/m ³
8.	Ammonia (NH ₃)	CPCB Guidelines for the Measurement of Ambient Air Pollutants, Volume I, May 2011, Page No. 35	Indophenol Blue Method	4.0µg/m ³
9.	Benzene (C ₆ H ₆)	IS 5182 (Part 11):2006	Adsorption and Desorption followed by GC-FID analysis	1.0 µg/m ³
10.	Benzo (a) Pyrene (BaP) – particulate phase only,	CPCB Guidelines for the Measurement of Ambient Air Pollutants, Volume I, May 2011, Page No. 39	Solvent extraction followed by GC-FID analysis	0.2 ng/m ³

Sr.	Parameters	Method References	Techniques	Detection Limit
11.	Arsenic (As)	CPCB Guidelines for the Measurement of Ambient Air Pollutants, Volume I, May 2011, Page No. 47	AAS Method	0.3ng/m ³
12.	Nickel (Ni)	CPCB Guidelines for the Measurement of Ambient Air Pollutants, Volume I, May 2011, Page No. 47	AAS Method	3.0ng/m ³

Annexure III: Water/Wastewater Sampling and Analysis Methodology

Sr.	Parameters	Methods References	Techniques	Detection Limit
1.	Sampling Procedure for Chemical Parameters	IS 3025 (Part 1): 1987, Reaffirmed 1998, Amds.1& APHA, 22 nd Ed., 2012, 1060 B, 1-39	-	-
2.	Sampling Procedure for Microbiological Parameters	APHA, 22 nd Ed., 2012,1060 B, 1-39, 9040, 9-17, and 9060B, 9-35	-	-
3.	Temperature	APHA, 22 nd Ed., 2012, 2550-B, 2-69	By Thermometer	-
4.	Colour	APHA, 22 nd Ed., 2012 , 2120-B, 2-26	Visible Comparison Method	1 Hazen Unit
5.	Odour	IS 3025 (Part 5): 1983, Reaffirmed 2006	Qualitative Method	-
6.	pH	APHA, 22 nd Ed., 2012, 4500-H ⁺ - B, 4-92	By pH Meter	1
7.	Oil & Grease	APHA, 22 nd Ed., 2012, 5520-B, 5-40	Liquid -liquid Partition-Gravimetric Method	1.0 mg/L
8.	Suspended Solids	IS 3025(Part 17): 1984, Reaffirmed 2006,Amds.1	Filtration /Gravimetric Method	5.0 mg/L
9.	Dissolved Oxygen	IS 3025(Part 38): 1989, Reaffirmed 2009	Iodometric Method-Azide modification	0.05 mg/L
10.	Chemical Oxygen Demand	APHA,22 nd Ed., 2012 , 5220-B, 5-17	Open Reflux Method	5.0 mg/L
11.	Biochemical Oxygen Demand	IS 3025(Part 44): 1993,Reaffirmed 2009,Amds.1	Iodometric Method	5.0 mg/L
12.	Electrical Conductivity	APHA, 22 nd Ed., 2012, 2510- B, 2-54	By Conductivity Meter	0.1 μ mho/cm
13.	Nitrite-Nitrogen	APHA, 22 nd Ed., 2012, 4500-NO ₂ -B, 4-120	Colorimetric Method	0.006 mg/L

Sr.	Parameters	Methods References	Techniques	Detection Limit
14.	Nitrate-Nitrogen	APHA, 22 nd Ed., 2012, 4500-NO ₃ , B-4-122	UV Spectrophotometer Screening Method	0.2 mg/L
15.	(NO ₂ + NO ₃)-Nitrogen	APHA, 22 nd Ed., 2012, 4500-NO ₂ -B, 4-120 APHA, 22 nd Ed., 2012, 4500-NO ₃ , B-4-122	Colorimetric Method V Spectrophotometer Screening Method	0.2 mg/L
16.	Free Ammonia	APHA, 22 nd Ed., 2012, 4500 NH ₃ , F, 4-115	Colorimetric Method	0.006 mg/L
17.	Total Residual Chlorine	IS 3025 (Part 26) :1986, Reaffirmed 2009, Ed. 2.1(2004-02)	Iodometric Method	0.1 mg/L
18.	Cyanide (CN)	APHA, 22 nd Ed., 2012, 4500-CN, C & E, 4-41 & 4-43	Colorimetric Method	0.001 mg/L
19.	Fluoride (F)	APHA, 22 nd Ed., 2012, 4500-F ⁻ , D, 4-87	SPADNS Method	0.05 mg/L
20.	Sulphide (S ²⁻)	APHA, 22 nd Ed., 2012, 4500 -S ²⁻ , C-4-175, F-4-178	Iodometric Method	0.08 mg/L
21.	Dissolved Phosphate (P)	APHA, 22 nd Ed., 2012, 4500 P, E, 4-155	Ascorbic Acid Method	0.03 mg/L
22.	Sodium Absorption Ratio	IS 11624 :1986, Reaffirmed 2006	By Calculation	0.3
23.	Total Phosphorous (P)	APHA, 22 nd Ed., 2012, 4500 P, E, 4-155	Ascorbic Acid Method	0.03 mg/L
24.	Total Kjeldahl Nitrogen	APHA, 22 nd Ed., 2012, 4500 NH ₃ , B & C, 4-110, 4-112	Titrimetric Method	0.1 mg/L
25.	Total Ammonia (NH ₄ + NH ₃)-Nitrogen	APHA, 22 ^d Ed., 2012, 4500 NH ₃ , F, 4-115	Colorimetric Method	0.001 mg/L
26.	Phenols (C ₆ H ₅ OH)	APHA, 22 nd Ed., 2012, 5530- B & C, 5-44 & 5-47	Chloroform Extraction Method	0.001 mg/L
27.	Surface Active	APHA, 22 nd Ed., 2012	Methylene Blue	0.1 mg/L

Sr.	Parameters	Methods References	Techniques	Detection Limit
	Agents	, 5540-B & C,5-50	Extraction Method	
28.	Organo Chlorine Pesticides	APHA, 22 nd Ed., 2012,6410B,6-74	GC MS-MS Method	0.01 µg/L
29.	Polynuclear aromatic hydrocarbons (PAH)	APHA, 22 nd Ed., 2012,6410B,6-74	GC MS-MS Method	0.01 µg/L
30.	Polychlorinated Biphenyls (PCB)	APHA, 22 nd Ed., 2012,6410B,6-74	GC MS-MS Method	0.01 µg/L
31.	Zinc (Zn)	IS 3025(Part 2): 2004	ICP Method	0.1 mg/L
32.	Nickel (Ni)	IS 3025(Part 2): 2004	ICP Method	0.05 mg/L
33.	Copper (Cu)	IS 3025(Part 2): 2004	ICP Method	0.03 mg/L
34.	Hexavalent Chromium (Cr ⁶⁺)	APHA, 22 nd Ed., 2012,3500-Cr,B,3-69	Colorimetric Method	0.02 mg/L
35.	Total Chromium (Cr)	IS 3025(Part 2): 2004	ICP Method	0.02 mg/L
36.	Total Arsenic (As)	IS 3025(Part 2): 2004	ICP Method	0.005 mg/L
37.	Lead (Pb)	IS 3025(Part 2): 2004	ICP Method	0.008 mg/L
38.	Cadmium (Cd)	IS 3025(Part 2): 2004	ICP Method	0.002 mg/L
39.	Mercury (Hg)	IS 3025(Part 2): 2004	ICP Method	0.0008 mg/L
40.	Manganese (Mn)	IS 3025(Part 2): 2004	ICP Method	0.02 mg/L
41.	Iron (Fe)	IS 3025(Part 2): 2004	ICP Method	0.06 mg/L
42.	Vanadium (V)	IS 3025(Part 2): 2004	ICP Method	0.05 mg/L
43.	Selenium (Se)	IS 3025(Part 2): 2004	ICP Method	0.005 mg/L

Sr.	Parameters	Methods References	Techniques	Detection Limit
44.	Boron (B)	IS 3025(Part 2): 2004	ICP Method	0.1 mg/L
45.	Total Coliforms	APHA, 22 nd Ed., 2012,9221-B, 9-66	Multiple tube fermentation technique (MPN/100ml)	1.1 MPN/100ml
46.	Faecal Coliforms	APHA, 22 nd Ed., 2012,9221-E, 9-74	Multiple tube fermentation technique (MPN/100ml)	1.1 MPN/100ml
47.	Bioassay Test (Zebra Fish)	IS 6582, 1971, Reaffirmed 1987	Static Technique	-

Annexure IV: National Ambient Air Quality Standards, 2009

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National Ambient Air Quality Standards: Central Pollution Control Board

In exercise of the powers conferred by Sub-section (2) (h) of section 16 of the Air (Prevention and Control of Pollution) Act, 1981 (Act No.14 of 1981), and in suppression of the Notification No(s). S.O.384(E), dated 11th April, 1994 and S.O.935(E), dated 14th October, 1998, the **Central Pollution Control Board** hereby notify the National Ambient Air Quality Standards **with immediate effect**, namely:

Sr. No.	Pollutant	Time Weighted Average	Concentration in Ambient Air		
			Industrial, Residential, Rural and Other Areas	Ecologically Sensitive Areas (Notified by Central Government)	Methods of Measurement
(1)	(2)	(3)	(4)	(5)	(6)
1	Sulphur Dioxide (SO ₂) $\mu\text{g}/\text{m}^3$	Annual *	50	20	– Improved West and Gaeke – Ultraviolet fluorescence
		24 hours **	80	80	
2	Nitrogen Dioxide (NO ₂) $\mu\text{g}/\text{m}^3$	Annual *	40	30	– Modified Jacob & Hochheiser (Na-Arsenite) – Chemiluminescence
		24 hours **	80	80	
3	Particulate Matter (size less than 10 μm) or PM ₁₀ $\mu\text{g}/\text{m}^3$	Annual *	60	60	– Gravimetric – TOEM – Beta attenuation
		24 hours **	100	100	
4	Particulate Matter (size less than 2.5 μm) or PM _{2.5} $\mu\text{g}/\text{m}^3$	Annual *	40	40	– Gravimetric – TOEM – Beta attenuation
		24 hours **	60	60	
5	Ozone (O ₃) $\mu\text{g}/\text{m}^3$	8 hours **	100	100	– UV photometric – Chemiluminescence – Chemical Method
		1 hour **	180	180	
6	Lead (Pb) $\mu\text{g}/\text{m}^3$	Annual *	0.50	0.50	– AAS/ICP method after sampling on EPM 2000 or equivalent filter paper – EDXRF using Teflon filter
		24 hours **	1.0	1.0	
7	Carbon Monoxide (CO) mg/m^3	8 hours **	02	02	– Non Dispersive Infra Red (NDIR) spectroscopy
		1 hour **	04	04	
8	Ammonia (NH ₃) $\mu\text{g}/\text{m}^3$	Annual *	100	100	– Chemiluminescence – Indophenol blue method
		24 hours **	400	400	
9	Benzene (C ₆ H ₆) $\mu\text{g}/\text{m}^3$	Annual *	05	05	– Gas Chromatography based continuous analyzer – Adsorption and Desorption followed by GC analysis
10	Benzo (a) Pyrene (BaP) – particulate phase only, ng/m^3	Annual *	01	01	– Solvent extraction followed by HPLC/GC analysis
11	Arsenic (As) ng/m^3	Annual *	06	06	– AAS/ICP method after sampling on EPM 2000 or equivalent filter paper.
12	Nickel (Ni) ng/m^3	Annual *	20	20	– AAS/ICP method after sampling on EPM 2000 or equivalent filter paper.

* Annual arithmetic mean of minimum 104 measurements in a year at a particular site taken twice a week 24 hourly at uniform intervals.

** 24 hourly or 08 hourly monitored values, as applicable, shall be complied with 98% of the time in a year. 2 % of the time, they may exceed the limits but not on two consecutive days of monitoring.

Note: Whenever and wherever monitoring results on two consecutive days of monitoring exceed the limits specified above for the respective category, it shall be considered adequate reason to institute regular or continuous monitoring and further investigation.

SANT PRASAD GAUTAM, Chairman, Central Pollution Control Board [ADVT-III/4/184/09/Exty.]

Note: The notifications on National Ambient Air Quality Standards were published by the Central Pollution Control Board in the Gazette of India. Extraordinary vide notification No(s). S.O. 384(E), dated 11th April, 1994 and S.O. 935(E), dated 14th October, 1998.

$\mu\text{g}/\text{m}^3$: micro-gram/ m^3 i.e. $10^{-6}\text{gm}/\text{m}^3$

ng/m^3 : nano-gram/ m^3 i.e. $10^{-9}\text{gm}/\text{m}^3$

Annexure V: General Standards for Discharge of Environmental Pollutants, Part A: Effluents (The Environment (Protection) Rules, 1986, Schedule VI)

Sr.	Parameter	Standards			
		Inland surface Water	Public Sewers	Land for Irrigation	Marine Coastal Areas
1.	Colour and Odour	See Note 1	--	See Note I	See Note 1
2.	Suspended solids, mg/L, Max.	100	600	200	a. For process waste water - 100 b. For cooling water effluent- 10 percent above total suspended matter of influent cooling water.
3.	Particle size of suspended solids	Shall pass 850 micron IS Sieve			a. Floatable solids, Max 3 mm b. Settleable solids Max 850 microns
4.	Dissolved solids (Inorganic), mg/L, Max.	2100	2100	2100	--
5.	pH value	5.5 -9.0	5.5 -9.0	5.5 -9.0	5.5-9.0

Sr.	Parameter	Standards			
		Inland surface Water	Public Sewers	Land for Irrigation	Marine Coastal Areas
6.	Temperature °C, Max	Shall not exceed 40 in any section of the stream within 15 mts. Downstream from the effluent outlet	45 at the point of discharge	--	45 at the point of discharge
7.	Oil and Grease, mg/L, Max	10	20	10	20
8.,	Total Residual chlorine, mg/L, Max	1.0	--	--	1.0
9.	Ammonical Nitrogen (as N), mg/L, Max	50	50	--	50
10.	Total Kjeldahl Nitrogen (as N), mg/L, Max.	100	--	--	100
11.	Free Ammonia (as NH ₃), mg/L, Max	5.0	--	--	5.0
12.	Biochemical oxygen demand (5 days, at 20° c) mg/L, Max	30	350	100	100
13.	Chemical oxygen demand, mg/L, Max	250	--	--	250
14.	Arsenic (as As), mg/l, Max	0.2	0.2	0.2	0.2
15.	Mercury (as Hg). Mg/L, Max	0.01	0.01	--	0.01
16.	Lead (as Pb), mg/L, Max	0.1	1.0	-	1.0
17.	Cadmium (as Cd), mg/L,	2.0	1.0	--	2.0

Sr.	Parameter	Standards			
		Inland surface Water	Public Sewers	Land for Irrigation	Marine Coastal Areas
18.	Hexavalent Chromium (as Cr ⁺⁶) mg/L, Max	.1	2.0	--	1.0
19.	Total Chromium (as Cr), mg/L, Max	2.0	2.0	--	2.0
20.	Copper (as Cu), mg/L, Max.	3.0	3.0	--	3.0
21.	Zinc (as Zn), mg/L, Max.	5.0	15	0--	15
22	Selenium (as Se), mg/l, Max.	0.05	0.05	--	0.05
23	Nickel (as Ni), mg/l, Max.	3.0	3.0	--	5.0
24	Boron (as B), mg/l, Max.	2.0	2.0	2.0	--
25.	Percent Sodium, Max.	--	60	60	--
26.	Residual Sodium carbonate, mg/l, Max.	--	--	5.0	--
27.	Cyanide (as Cn), mg/L, Max.	0.2	2.0	0.2	0.2
28.	Chloride (as Cl), mg/L, Max.	1000	1000	600	--
29.	Fluoride (as F), mg/IL, Max.	2.0	15	--	15
30.	Dissolved Phosphate (as P), mg/L, Max.	5.0	--	--	--

Sr.	Parameter	Standards			
		Inland surface Water	Public Sewers	Land for Irrigation	Marine Coastal Areas
31.	Sulphate (as SO ₄), mg/L, Max.	1000	1000	1000	--
32.	Sulphide (as S), mg/L, Max.	2.0	--	--	5.0
33.	Pesticides	Absent	Absent	Absent	Absent
34.	Phenolic compounds (as C ₆ H ₅ OH), mg/L, Max.	1.0	5.0	--	5.0
35.	Radioactive materials:				
	a. Alpha emitters MC/ml., Max.	10 ⁻⁷	10 ⁻⁷	10 ⁻⁸	10 ⁻⁷
	b. Beta emitters µc/ml., Max	10 ⁻⁶	10 ⁻⁶	10 ⁻⁷	10 ⁻⁶

Annexure VI: Drinking Water Specification-IS 10500:2012

Sr.	Characteristic	Unit	Requirement (Acceptable Limit)	Permissible Limit in the Absence of Alternate Source
Table 1	Organoleptic and Physical Parameters			
1.	Colour	Hazen units	Max 5	Max 15
2.	Odour	-	Agreeable	Agreeable
3.	pH value	-	6.5-8.5	No relaxation
4.	Taste	-	Agreeable	Agreeable
5.	Turbidity	NTU	Max 1	Max 5
6.	Total dissolved solids	mg/L	Max 500	Max 2000
Table 2	General parameters concerning substances undesirable in excessive amounts			
7.	Aluminium (as Al)	mg/L	Max 0.03	Max 0.2
8.	Ammonia (as total ammonia- N)	mg/L	Max 0.5	No relaxation
9.	Anionic detergents (as MBAS)	mg/L	Max 0.2	Max 1.0
10.	Barium (as Ba)	mg/L	Max 0.7	No relaxation
11.	Boron (as B)	mg/L	Max 0.5	Max 1.0
12.	Calcium (as Ca)	mg/L	Max 75	Max 200
13.	Chloramines (as Cl ₂)	mg/L	Max 4.0	No relaxation
14.	Chlorides (as Cl)	mg/L	Max 250	Max 1000
15.	Copper (as Cu)	mg/L	Max 0.05	Max 1.5
16.	Fluoride (as F)	mg/L	Max 1.0	Max 1.5
17.	Free residual chlorine	mg/L	Min 0.2	Min 1

Sr.	Characteristic	Unit	Requirement (Acceptable Limit)	Permissible Limit in the Absence of Alternate Source
18.	Iron (as Fe)	mg/L	Max 0.3	No relaxation
19.	Magnesium (as Mg)	mg/L	Max 30	Max100
20.	Manganese (as Mn)	mg/L	Max 0.1	Max 0.3
21.	Mineral Oil	mg/L	Max 0.5	No relaxation
22.	Nitrate (as NO ₃)	mg/L	Max 45	No relaxation
23.	Phenolic compounds (as C ₆ H ₅ OH)	mg/L	Max 0.001	Max 0.002
24.	Selenium (as Se)	mg/L	Max 0.01	No relaxation
25.	Silver (as Ag)	mg/L	Max 0.1	No relaxation
26.	Sulphate (as SO ₄)	mg/L	Max 200	Max 400
27.	Sulphide (as H ₂ S)	mg/L	Max 0.05	No relaxation
28.	Total Alkalinity as calcium carbonate	mg/L	Max 200	Max600
29.	Total hardness (as CaCO ₃)	mg/L	Max 200	Max 600
30.	Zinc (as Zn)	mg/L	Max 5	Max15
Table 3	Parameters Concerning Toxic Substances			
31.	Cadmium (as Cd)	mg/L	Max 0.003	No relaxation
32.	Cyanide (as CN)	mg/L	Max 0.05	No relaxation
33.	Lead (as Pb)	mg/L	Max 0.01	No relaxation
34.	Mercury (as Hg)	mg/L	Max 0.001	No relaxation
35.	Molybdenum (as Mo)	mg/L	Max 0.07	No relaxation
36.	Nickel (as Ni)	mg/L	Max 0.02	No relaxation
37.	Pesticides	mg/L	See Table 5	No relaxation
38.	Polychlorinatedbiphenyls	mg/L	Max 0.0005	No relaxation

Sr.	Characteristic	Unit	Requirement (Acceptable Limit)	Permissible Limit in the Absence of Alternate Source
39.	Poly nuclear aromatic Hydrocarbons (as PAH)	mg/L	Max 0.0001	No relaxation
40.	Total Arsenic(as As)	mg/L	Max 0.01	Max0.05
41.	Total Chromium (as Cr)	mg/L	Max 0.05	No relaxation
42.	Trihalomethanes			
a)	Bromoform	mg/L	Max 0.1	No relaxation
b)	DibromochloroMethane	mg/L	Max 0.1	No relaxation
c)	Bromodichloromethane	mg/L	Max 0.06	No relaxation
d)	Chloroform	mg/L	Max 0.2	No relaxation
Table 4	Parameters Concerning Radioactive Substances			
43.	Radioactive Materials			
a)	Alpha emitters	Bq/L	Max 0.1	No relaxation
b)	Beta emitters	Bq/L	Max 1.0	No relaxation
Table 5	Pesticide Residues Limits and Test Method			
i)	Alachor	µg/L	20	No relaxation
ii)	Atrazine	µg/L	2	No relaxation
iii)	Aldrin/ Dieldrin	µg/L	0.03	No relaxation
iv)	Alpha HCH	µg/L	0.01	No relaxation
v)	Beta HCH	µg/L	0.04	No relaxation
vi)	Butachlor	µg/L	125	No relaxation
vii)	Chlorpyriphos	µg/L	30	No relaxation
viii)	Delta HCH	µg/L	0.04	No relaxation
ix)	2,4- Dichlorophenoxyacetic acid	µg/L	30	No relaxation

Sr.	Characteristic	Unit	Requirement (Acceptable Limit)	Permissible Limit in the Absence of Alternate Source
x)	DDT (o,p&p,p – Isomers of DDT, DDE and DDD)	µg/L	1	No relaxation
xi)	Endosulfan (α,β & sulphate)	µg/L	0.4	No relaxation
xii)	Ethion	µg/L	3	No relaxation
xiii)	Gamma - HCH (Lindane)	µg/L	2	No relaxation
xiv)	Isoproturon	µg/L	9	No relaxation
xv)	Malathion	µg/L	190	No relaxation
xvi)	Methyl parathion	µg/L	0.3	No relaxation
xvii)	Monocrotophos	µg/L	1	No relaxation
xviii)	Phorate	µg/L	2	No relaxation
Table 6	Bacteriological Quality of Drinking Water			
44.	E.coli or thermotolerant coliform bacteria	/100	Not detectable	-
45.	Total coliform bacteria	/100 mL	Not detectable	-
	Virological Requirements			
46.	MS2 phage	/1 L	Absent	-
	Biological Requirements			
47.	Cryptosporidium	/10 L	Absent	-
48.	Giardia	/10 L	Absent	-
49.	Microscopic organisms such as algae, zooplanktons, flagellates, parasites and toxin producing organisms		Free from microscopic organisms	-

Annexure VII: CPCB Water Quality Criteria:

Designated best use	Quality Class	Primary Water Quality Criteria
Drinking water source without conventional treatment but with chlorination	A	<ul style="list-style-type: none"> ➤ Total coliform organisms (MPN*/100 ml) shall be 50 or less ➤ pH between 6.5 and 8.5 ➤ Dissolved Oxygen 6 mg/L or more, and ➤ Biochemical Oxygen Demand 2 mg/L or less
Outdoor bathing (organized)	B	<ul style="list-style-type: none"> ➤ Total coliform organisms (MPN/100 ml) shall be 500 or less ➤ pH between 6.5 and 8.5 ➤ Dissolved Oxygen 5 mg/L or more, and ➤ Biochemical Oxygen Demand 3 mg/L or less
Drinking water source with conventional treatment	C	<ul style="list-style-type: none"> ➤ Total coliform organisms (MPN/100ml) shall be 5000 or less ➤ pH between 6 and 9 ➤ Dissolved Oxygen 4 mg/L or more, and ➤ Biochemical Oxygen Demand 3 mg/L or less
Propagation of wildlife and fisheries	D	<ul style="list-style-type: none"> ➤ pH between 6.5 and 8.5 ➤ Dissolved Oxygen 4 mg/L or more, and ➤ Free ammonia (as N) 1.2 mg/L or less
Irrigation, industrial cooling, and controlled disposal	E	<ul style="list-style-type: none"> ➤ pH between 6.0 and 8.5 ➤ Electrical conductivity less than 2250 micro mhos/cm, ➤ Sodium Absorption Ratio less than 26, ➤ and Boron less than 2 mg/l.
	Below E	<ul style="list-style-type: none"> ➤ Not Meeting A, B, C, D & E Criteria

Annexure VIII: Water Quality Parameters Requirements and Classification

Water quality parameters are classified into three categories, given in Table (i), (ii) and (iii) (Source: CPCB, 2002, "Water Quality Criteria and Goals", Monitoring of Indian National aquatic Resources Series: MINARS/17/2001-2002).

Table: Basic Water Quality Requirement and Classification (Surface Water + Ground Water)

i) Simple Parameters:

Sr.	Parameters	Requirement for Waters of Class		
		A-Excellent	B-Desirable	C-Acceptable
(i)	Sanitary Survey	Very Clean neighborhood and catchment	Reasonably clean neighborhood	Generally clean neighborhood
(ii)	General Appearance	No floating matter	No floating matter	No floating matter
(iii)	Colour	Absolutely Colourless	Almost colourless, very light shade if any	No colour of anthropogenic origin
(iv)	Smell	Odourless	Almost odourless	No unpleasant odour
(v)	Transparency	>1.0 depth	>0.5 to 0.1m depth	>0.2 to 0.5 m depth
(vi)	Ecological* (Presence of Animals)	Fish & Insects	Fish & Insects	Fish & Insects

* Applicable to only surface water

ii) Regular Monitoring Parameters:

Sr.	Parameters	Requirement for Waters of Class		
		A Excellent	B-Desirable	C-Acceptable
(i)	pH	7.0 to 8.5	6.5 to 9.0	6.5 to 9.0
(ii)	DO (% Saturation)	90-110	80-120	60-140
(iii)	BOD, mg/l	Below 2	Below 5	Below 8
(iv)	EC, μ mhos/cm	<1000	<2250	<4000
(v)	(NO ₂ +NO ₃)-Nitrogen, mg/l	<5	<10	<15
(vi)	Suspended solid, mg/l	<25	<50	<100

Sr.	Parameters	Requirement for Waters of Class		
		A Excellent	B-Desirable	C-Acceptable
(vii)	Fecal Coliform, MPN/ 100 ml	<20 per 100 ml	<200 per 100 ml	<2000 per 100 ml
(viii)	Bio-assay (Zebra Fish)	No death in 5 days	No death in 3 days	No death in 2 days

Note:

1. Dissolved Oxygen (DO) not applicable for ground waters.
2. Dissolved Oxygen in eutrophicated waters should include measurement for diurnal variation.
3. Suspended solid limit is applicable only during non-monsoon period.
4. Faecal Coliform values should meet for 90% times.
5. Static Bio-Assay method may be adopted.

iii) Specific Parameters: (Only in case of need/apprehensions)

Sr.	Parameters	Requirement for Waters of Class		
		A- Excellent	B-Desirable	C-Acceptable
(i)	Total Phosphorous	<0.1 mg/l	< 0.2 mg/l	< 0.3 mg/l
(ii)	T.K.N	< 1.0 mg/l	<2.0 mg/l	<3.0 mg/l
(iii)	Total Ammonia (NH ₄ + NH ₃)-Nitrogen	< 0.5 mg/l	< 1.0 mg/l	< 1.5 mg/l
(iv)	Phenols	< 2µg/l	< 5µg/l	<10 µg/l
(v)	Surface Active Agents	<20 µg/l	<100µg/l	< 200µg/l
(vi)	Organo Chlorine Pesticides	< 0.05µg/l	< 0.1µg/l	< 0.2µg/l
(vii)	PAH	< 0.05µg/l	<0.1 µg/l	<0.2 µg/l
(viii)	PCB and PCT	< 0.01µg/l	< 0.01µg/l	< 0.02µg/l
(ix)	Zinc	< 100µg/l	< 200µg/l	<300 µg/l
(x)	Nickel	< 50µg/l	< 100µg/l	< 200µg/l
(xi)	Copper	< 20µg/l	< 50µg/l	<100µg/l

Sr.	Parameters	Requirement for Waters of Class		
		A- Excellent	B-Desirable	C-Acceptable
(xii)	Chromium (Total)	< 20µg/l	< 50µg/l	< 100µg/l
(xiii)	Arsenic (Total)	< 20µg/l	<50 µg/l	<100 µg/l
(xiv)	Lead	< 20µg/l	< 50µg/l	< 100µg/l
(xv)	Cadmium	< 1.0µg/l	<2.5 µg/l	< 5.0µg/l
(xvi)	Mercury	< 0.2µg/l	< 0.5µg/l	< 1.0µg/l