ACTION PLAN FOR INDUSTRIAL CLUSTER IN CRITICALLY POLLUTED AREA

Monitoring, Sampling, Analysis of Stack, Ambient Air Quality, Surface Water, Ground Water, Waste Water

नवी मुंबई Navi Mumbai

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.

This acknowledgement will be incomplete if we do not thank our laboratory analysts and others who made this project a success by timely analysing the samples.

We also thank our sampling team members for conducting the sampling in this vast area.

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
PM_{10}	Particulate Matter (size less than 10 µm)
$PM_{2.5}$	Particulate Matter (size less than 2.5 µm)
SO_2	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 Stake-holders 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.

The present CEPI study is based on the Navi Mumbai industrial area of Maharashtra state. Navi Mumbai industrial estate was established in 1963 which is often known as TTC MIDC Estate. The Estate is located along the Thane Belapur Road towards Northern side of road and total area of the industrial estate is 27km^2.There are about 2200 industrial units of various category engaged in the manufacture of Chemicals, Dyes, Dye-intermediates, Bulk drugs, Pharmaceuticals, Textile auxiliaries, Pesticides, Petrochemicals, Textile processors, Engineering units etc. Navi Mumbai is a developing town and so many construction activities are going on. Hence, besides the industries, transport, loading, unloading and handling of agro products are other sources which are major contributors for pollution, especially air pollution.

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, Dombivali, 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 Navi Mumbai:

- The sampling was carried out in 5 days at various locations i.e. from 23rd February to 27th February, 2017.

- In Navi Mumbai, a total of 6 Stack Monitoring Samples, 5 Ambient Air Quality Monitoring Samples, 6 Waste Water Samples and 6 Ground Water Samples 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 (SO_2)
2. Nitrogen Dioxide (NO_2)
3. Particulate Matter (PM10)
4. Particulate Matter (PM2.5)
5. Ozone (O_3)
6. Lead (Pb)
7. Carbon Monoxide (CO)
8. Ammonia (NH_3)
9. Benzene (C_6H_6)
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. (NO_2 + NO_3)-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 (NH_4 +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 deductable 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.	RPG Life Science Ltd.	Boiler	Table No. I
2.	Sovotex Textiles Pvt. Ltd.	Boiler	Table No. I
3.	Akash Fabrics Pvt. Ltd.	Boiler	Table No. I
4.	Amines & Plasticizer Ltd.	Boiler	Table No. II
5.	Aarcee Innovation Pvt. Ltd.	Coal Boiler	Table No. II
6.	SI Group India Ltd.	Boiler	Table No. II

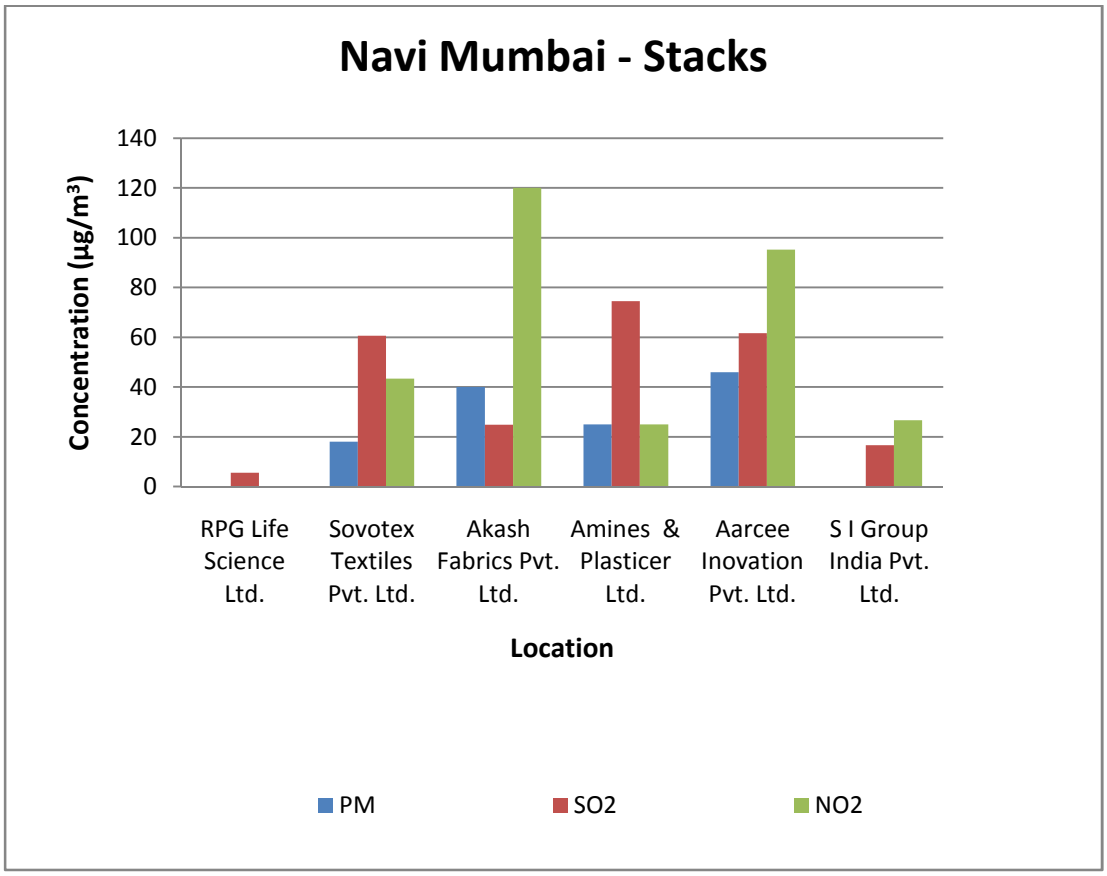
Table No. I

Name of Industry			**RPG Life Science Ltd.**	**Sovotex Textiles Pvt. Ltd.**	**Akash Fabrics Pvt. Ltd.**
Date of Sampling [XX/02/2017]			**23**	**25**	**25**
Sr.	**Parameters**	**Units**	**Results**		
1.	Particulate Matter	mg/Nm^3	BDL	18	40
	Std. Limit	**mg/Nm^3**	**150**	**150**	**150**
2.	Sulphur Dioxide (SO_2)	mg/Nm^3	5.52	60.6	24.8
		kg/day	3.55	28.8	9.93
	Std. Limit	**100mg/Nm^3**	**148**	**100**	**100**
3.	Nitrogen dioxide (NO_2)	mg/Nm^3	-	43.4	120
	Std. Limit	**mg/Nm^3**	**50**	**50**	**50**

Table No. II

Name of Industry			**Amines & Plasticizer Ltd.**	**Aarcee Innovation Pvt. Ltd.**	**SI Group India Ltd.**
Date of Sampling [XX/02/2017]			**27**	**28**	**27**
Sr.	**Parameters**	**Units**	**Results**		
1.	Particulate Matter	mg/Nm^3	25	46	BDL
	Std. Limit	**mg/Nm^3**	**150**	**150**	**150**
2.	Sulphur Dioxide (SO_2)	mg/Nm^3	74.5	61.7	16.6
		kg/day	31.8	17.9	27.8
	Std. Limit	**mg/Nm^3**		**100**	**100**
	Std. Limit	**kg/day**	**69.7**		
3.	Nitrogen dioxide (NO_2)	mg/Nm^3	25	95.2	26.6
	Std. Limit	**mg/Nm^3**	**50**	**50**	**50**

Graphs: Stack Monitoring for Navi Mumbai TTC MIDC:



3.2 Ambient Air Quality:

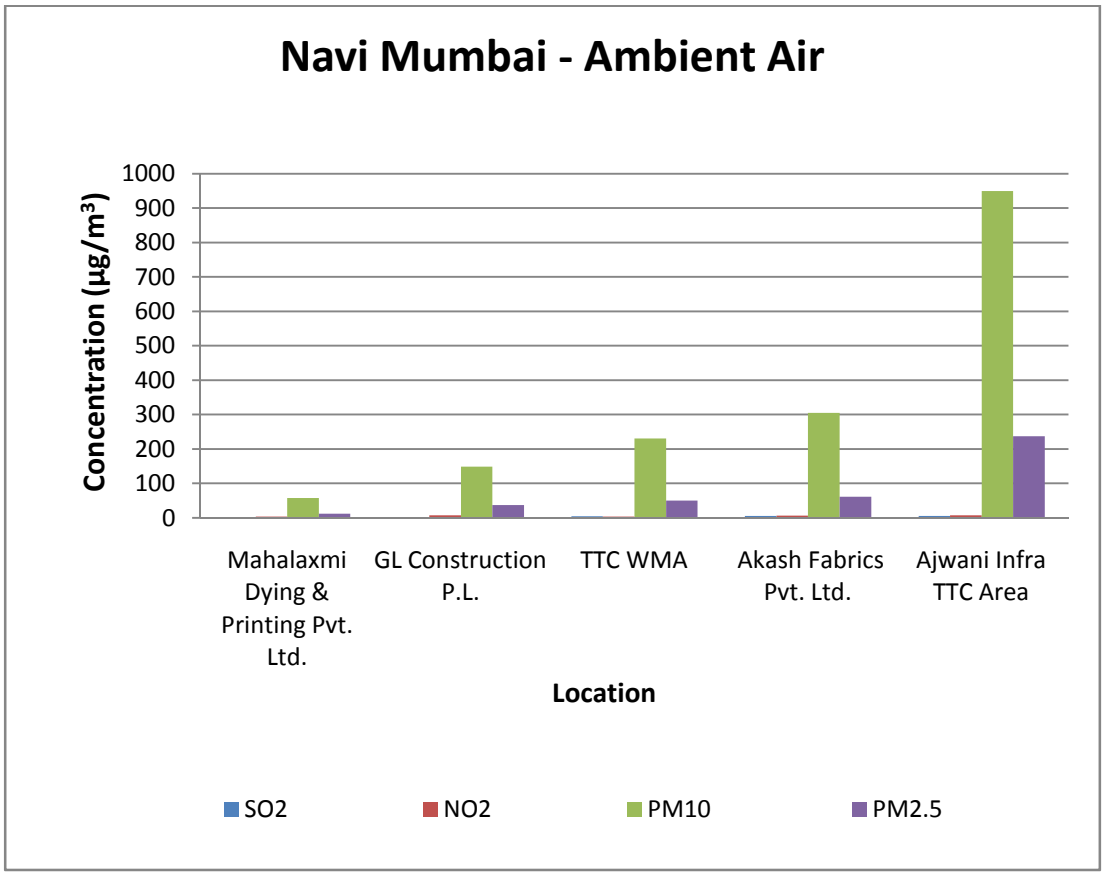
In order to arrive at conclusions, the Ambient Air Quality Monitoring Results are compared against National Ambient Air Quality Standards, 2009 (Annexure I).

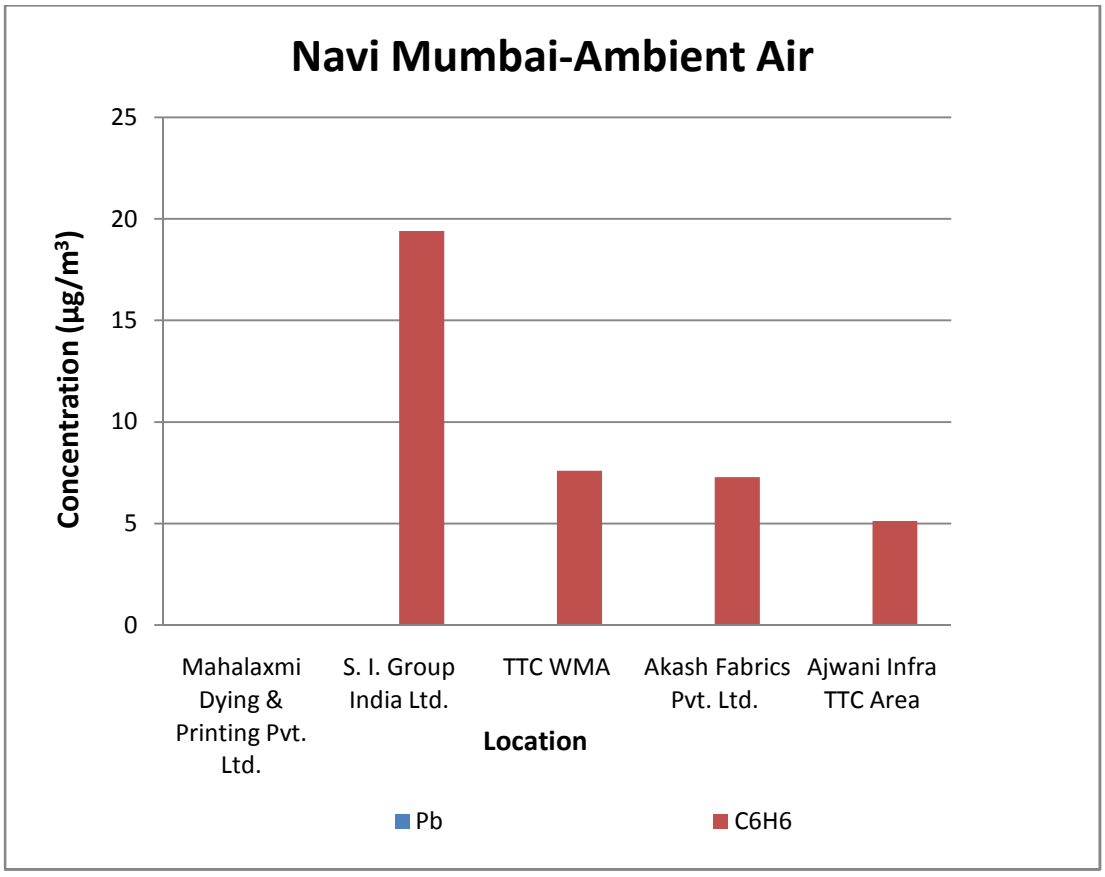
Sr.	Location	Location detail	Table No.
1.	Mahalaxmi Dying and Printing Pvt. Ltd.	Near ETP	Table No. I
2.	G.L. Construction Pvt. Ltd.	Near RMC Plant	Table No. I
3.	TTC WMA	Near Office	Table No. I
4.	Akash Fabrics Pvt. Ltd.	Near Main Gate	Table No. I
5.	Ajwani Infra TTC Area	Near Plant Area	Table No. I

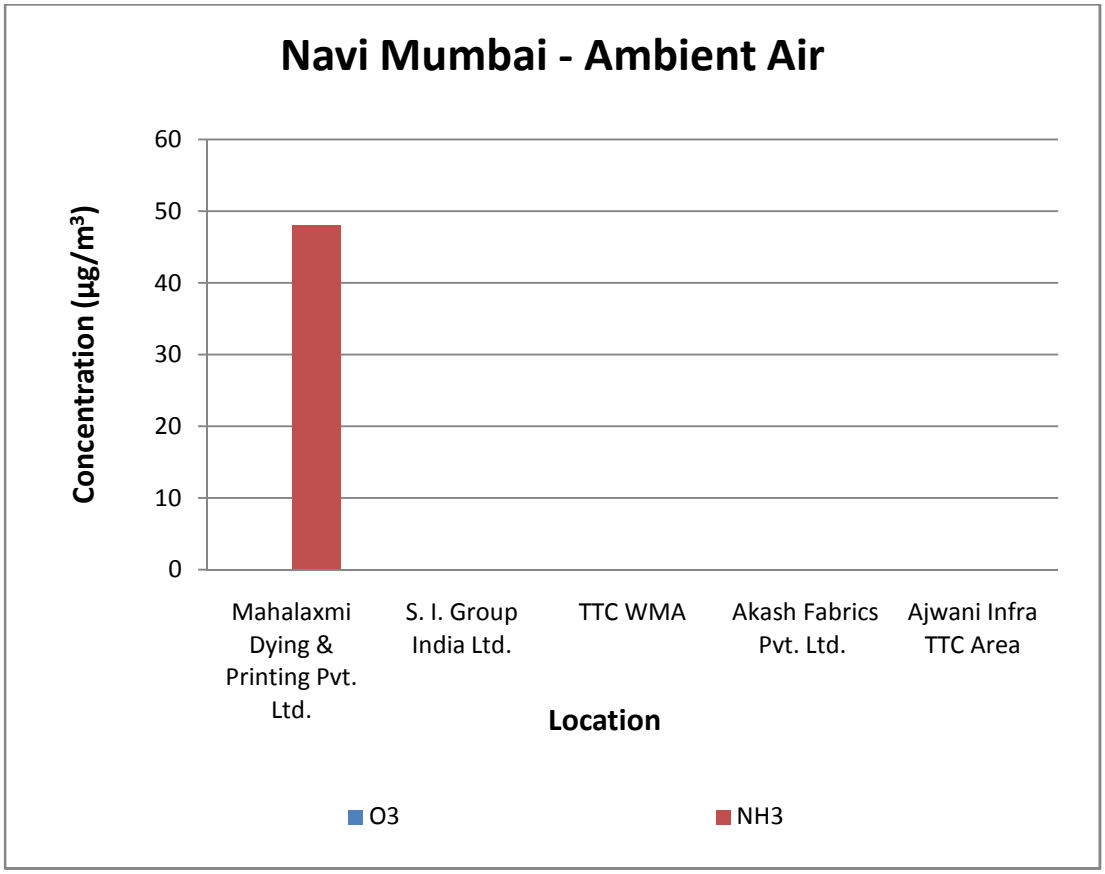
Table No. I:

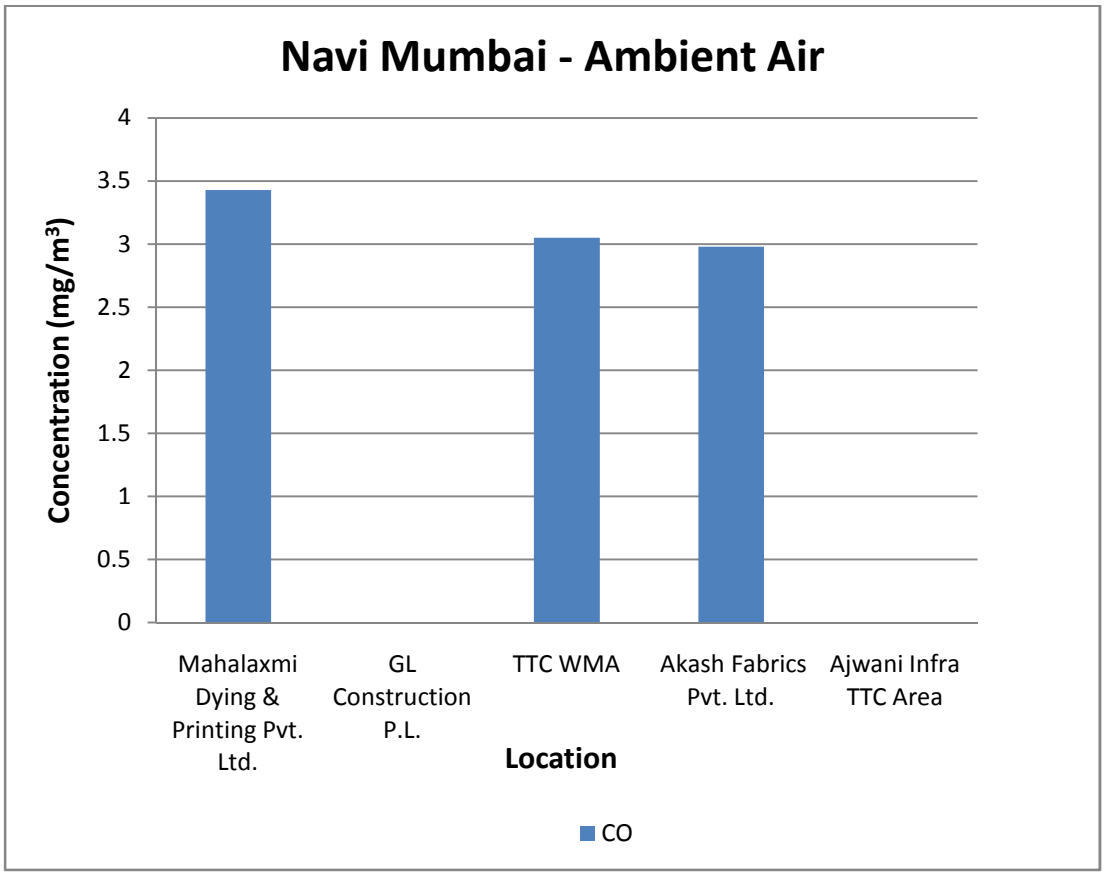
Location				**Mahalaxmi Dying and Printing Pvt. Ltd.**	**G.L. Construction Pvt. Ltd.**	**TTC WMA**	**Akash Fabrics Pvt. Ltd.**	**Ajwani Infra TTC Area**
Date of Sampling [XX/02/2017]				**25**	**25**	**23**	**26**	**26**
Sr.	**Parameters**	**Unit**	**Std. Limit**	**Results**				
1	Sulphur Dioxide (SO_2)	$\mu g/m^3$	**80**	BDL	BDL	4.99	5.66	6.04
2	Nitrogen Dioxide (NO_2)	$\mu g/m^3$	**80**	3.91	7.33	3.92	6.48	7.85
3	Particulate Matter (size less than 10 µm) or PM_{10}	$\mu g/m^3$	**100**	58	149	231	305	950
4	Particulate Matter (size less than 2.5 µm) or $PM_{2.5}$	$\mu g/m^3$	**60**	12	37	50	61	237
5	Ozone (O_3)	$\mu g/m^3$	**180**	BDL	BDL	BDL	BDL	BDL
6	Lead (Pb)	$\mu g/m^3$	**1**	BDL	0.04	0.03	BDL	BDL
7	Carbon Monoxide (CO)	mg/m_3	**04**	3.43	<0.5	3.05	2.98	<0.5
8	Ammonia (NH_3)	$\mu g/m^3$	**400**	48	BDL	BDL	BDL	BDL
9	Benzene (C_6H_6)	$\mu g/m^3$	**5**	BDL	19.4	7.6	7.29	5.13
10	Benzo (a) Pyrene (BaP) – particulate phase only	ng/m^3	**1**	BDL	BDL	BDL	BDL	BDL
11	Arsenic (As)	ng/m^3	**6**	BDL	BDL	0.95	1.24	1.68
12	Nickel (Ni)	ng/m^3	**20**	5.71	92.4	BDL	BDL	BDL

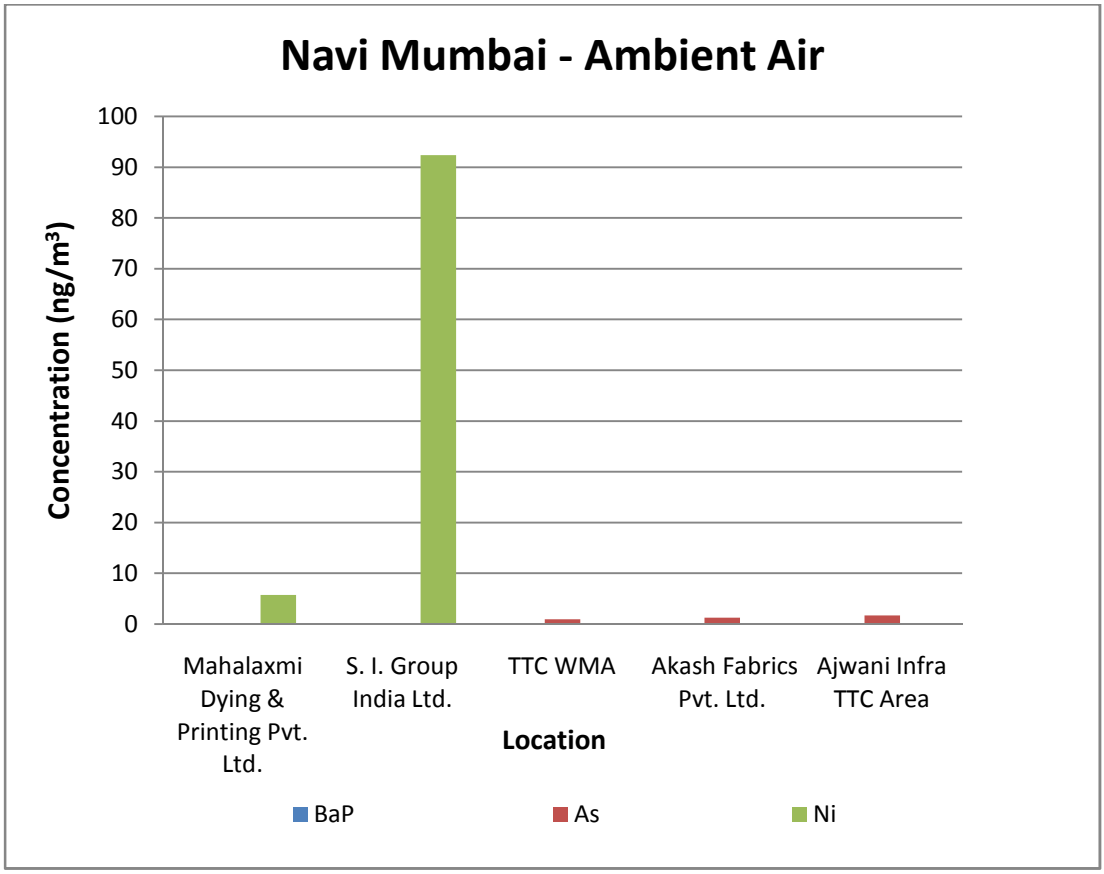
Graphs of Ambient Air Quality Monitoring for Navi Mumbai TTC MIDC:






Navi Mumbai - Ambient Air
Concentration (µg/m³)
60
50
40
30
20
10
0
Mahalaxmi Dying & Printing Pvt. Ltd.
S. I. Group India Ltd.
TTC WMA
Akash Fabrics Pvt. Ltd.
Ajwani Infra TTC Area
Location
O3
NH3


Navi Mumbai - Ambient Air
Concentration (mg/m³)
4
3.5
3
2.5
2
1.5
1
0.5
0
Mahalaxmi Dying & Printing Pvt. Ltd.
GL Construction P.L.
TTC WMA
Akash Fabrics Pvt. Ltd.
Ajwani Infra TTC Area
Location
CO



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.	CETP	Outlet	Table No. I
2.	CETP	Inlet	Table No. I
3.	Croda Chemical	ETP Outlet	Table No. I
4.	Sandoz Ltd.	ETP Outlet	Table No. II
5.	Modepro Pvt. Ltd.	ETP Outlet	Table No. II
6.	S I Group India Pvt. Ltd.	ETP Outlet	Table No. II

Table No. I:

Location				**CETP Outlet**	**CETP Inlet**	**Croda Chemicals**
Date of Sampling [XX/02/17]				**25**	**28**	**28**
Sr.	**Parameters**	**Unit**	**Std. Limit**	**Result**		
1.	Colour	Hazen		200	200	1
2.	Smell	-		Disagreeable	Disagreeable	Agreeable
3.	pH	-	**5.5 -9.0**	6.02	5.26	6.97
4.	Oil & Grease	mg/L	**10.0**	3.4	BDL	1.2
5.	Suspended Solids	mg/L	**100.0**	45	42	12
6.	Dissolved Oxygen (%Saturation)	%		0	85	75
7.	Chemical Oxygen Demand	mg/L	**250.0**	2789	80	179
8.	Biochemical Oxygen Demand (3 days,27°C)	mg/L	**30.0**	851	24	55
9.	Electrical Conductivity (at 25 °C)	µmho/cm		5190	3550	1843
10.	Nitrite Nitrogen (as N)	mg/L		0.153	0.23	0.01
11.	Nitrate Nitrogen (as N)	mg/L	**10.0**	121	6.43	20.8
15.	$(NO_2 + NO_3)$-Nitrogen	mg/L	**5.0**	121	6.65	20.8
16.	Free Ammonia (as NH_3-N)	mg/L	**5.0**	BDL	BDL	BDL
17.	Total Residual Chlorine	mg/L	**1.0**	BDL	BDL	BDL
18.	Cyanide (as CN)	mg/L	**0.2**	BDL	BDL	BDL
19.	Fluoride (as F)	mg/L	**2.0**	BDL	BDL	BDL
20.	Sulphide (as S^{2-})	mg/L	**2.0**	13.6	15.8	BDL

Location				**CETP Outlet**	**CETP Inlet**	**Croda Chemicals**
Date of Sampling [XX/02/17]				**25**	**28**	**28**
Sr.	**Parameters**	**Unit**	**Std. Limit**	**Result**		
21.	Dissolved Phosphate (as P)	mg/L	**5.0**	0.136	BDL	BDL
22.	Sodium Absorption Ratio	-		8.19	8.54	0.98
23.	Total Coliforms	MPN index/ 100 mL	**100.0**	7.9×10^4	7.9×10^3	140×10^3
24.	Faecal Coliforms	MPN index/ 100 mL	**1000.0**	BDL	BDL	79×10^2
25.	Total Phosphorous (as P)	mg/L	**1.0**	0.29	BDL	0.1
26.	Total Kjeldahl Nitrogen (as N)	mg/L	**100.0**	72.4	137	12
27.	Total Ammonia (NH_4+NH_3)-Nitrogen	mg/L	**5.0**	<0.1	22.2	0.26
28.	Phenols (as C_6H_5OH)	mg/L	**3.0**	BDL	BDL	BDL
29.	Surface Active Agents (as MBAS)	mg/L	**3.0**	BDL	BDL	BDL
30.	Organo Chlorine Pesticides	µg/L	**0.1**			
i.	Alachlor	µg/L	**2.0**	BDL	BDL	BDL
ii.	Atrazine	µg/L	**0.2**	BDL	BDL	2.14
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.	Butachlor	µg/L	**3.0**	BDL	BDL	BDL
viii.	Delta HCH	µg/L	**0.2**	BDL	BDL	BDL

Location				**CETP Outlet**	**CETP Inlet**	**Croda Chemicals**
Date of Sampling [XX/02/17]				**25**	**28**	**28**
Sr.	**Parameters**	**Unit**	**Std. Limit**	**Result**		
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
31.	Polynuclear aromatic hydrocarbons (PAH)	µg/L	**0.2**	BDL	BDL	BDL
32.	Polychlorinated Biphenyls (PCB)	µg/L	**2.0**	BDL	BDL	BDL
33.	Zinc (as Zn)	mg/L	**5.0**	0.28	14.8	BDL
34.	Nickel (as Ni)	mg/L	**3.0**	0.15	0.34	BDL
35.	Copper (as Cu)	mg/L		0.033	BDL	BDL
36.	Hexavalent Chromium (as Cr^{6+})	mg/L	**0.1**	BDL	BDL	BDL
37.	Total Chromium (as Cr)	mg/L	**2.0**	0.1	BDL	BDL
38.	Total Arsenic (as As)	mg/L	**0.2**	BDL	BDL	BDL

Location				**CETP Outlet**	**CETP Inlet**	**Croda Chemicals**
Date of Sampling [XX/02/17]				**25**	**28**	**28**
Sr.	**Parameters**	**Unit**	**Std. Limit**	**Result**		
39.	Lead (as Pb)	mg/L	**0.1**	BDL	BDL	BDL
40.	Cadmium (as Cd)	mg/L	**2.0**	BDL	BDL	BDL
41.	Mercury (as Hg)	mg/L	**0.01**	BDL	0.067	BDL
42.	Manganese (as Mn)	mg/L	**2.0**	0.99	2.31	BDL
43.	Iron (as Fe)	mg/L	**3.0**	1.62	8.22	BDL
44.	Vanadium (as V)	mg/L	**0.2**	BDL	BDL	BDL
45.	Selenium (as Se)	mg/L	**0.05**	BDL	BDL	BDL
46.	Boron (as B)	mg/L		0.65	0.26	0.073
47.	Bioassay Test on fish	% survival	**90% survival after 96h in 100%effluent**	0	0	80

Table II:

Location				**Sandoz Ltd.**	**Modepro Pvt. Ltd.**	**S I Group India Pvt. Ltd.**
Date of Sampling [XX/02/17]				**27**	**27**	**27**
Sr.	**Parameters**	**Unit**	**Std. Limit**	**Results**		
1.	Colour	Hazen		1	1	1
2.	Smell	-		Agreeable	Agreeable	Agreeable
3.	pH	-	**5.5 -9.0**	7.17	7.04	7.61

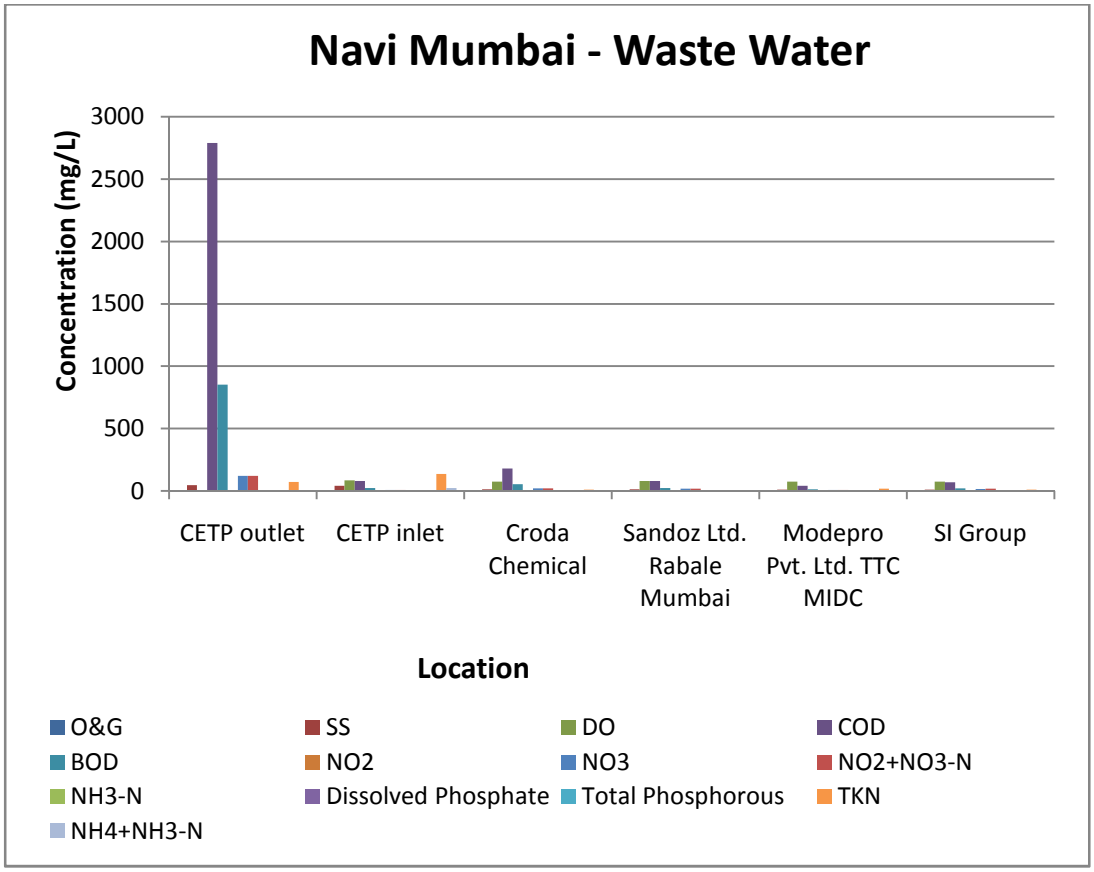
Location				**Sandoz Ltd.**	**Modepro Pvt. Ltd.**	**S I Group India Pvt. Ltd.**
Date of Sampling [XX/02/17]				**27**	**27**	**27**
Sr.	**Parameters**	**Unit**	**Std. Limit**	**Results**		
4.	Oil & Grease	mg/L	**10.0**	BDL	BDL	BDL
5.	Suspended Solids	mg/L	**100.0**	14	9	9
6.	Dissolved Oxygen (%Saturation)	%		80	75	75
7.	Chemical Oxygen Demand	mg/L	**250.0**	80	40	70
8.	Biochemical Oxygen Demand (3 days,27^{o}C)	mg/L	**30.0**	24	12	21
9.	Electrical Conductivity (at 25 ^{o}C)	µmho/cm		1022	1424	8920
10.	Nitrite Nitrogen (as N)	mg/L		0.02	0.29	1.06
11.	Nitrate Nitrogen (as N)	mg/L	**10.0**	17.7	6.9	16.6
12.	(NO_2 + NO_3)-Nitrogen	mg/L	**5.0**	17.7	7.19	17.6
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
18.	Dissolved Phosphate (as P)	mg/L	**5.0**	0.46	0.33	BDL
19.	Sodium Absorption Ratio	-		0.68	0.95	3.6
20.	Total Coliforms	MPN index/100 mL	**100.0**	140	4.5	79
21.	Faecal Coliforms	MPN index 100 mL	**1000.0**	23	BDL	7.8

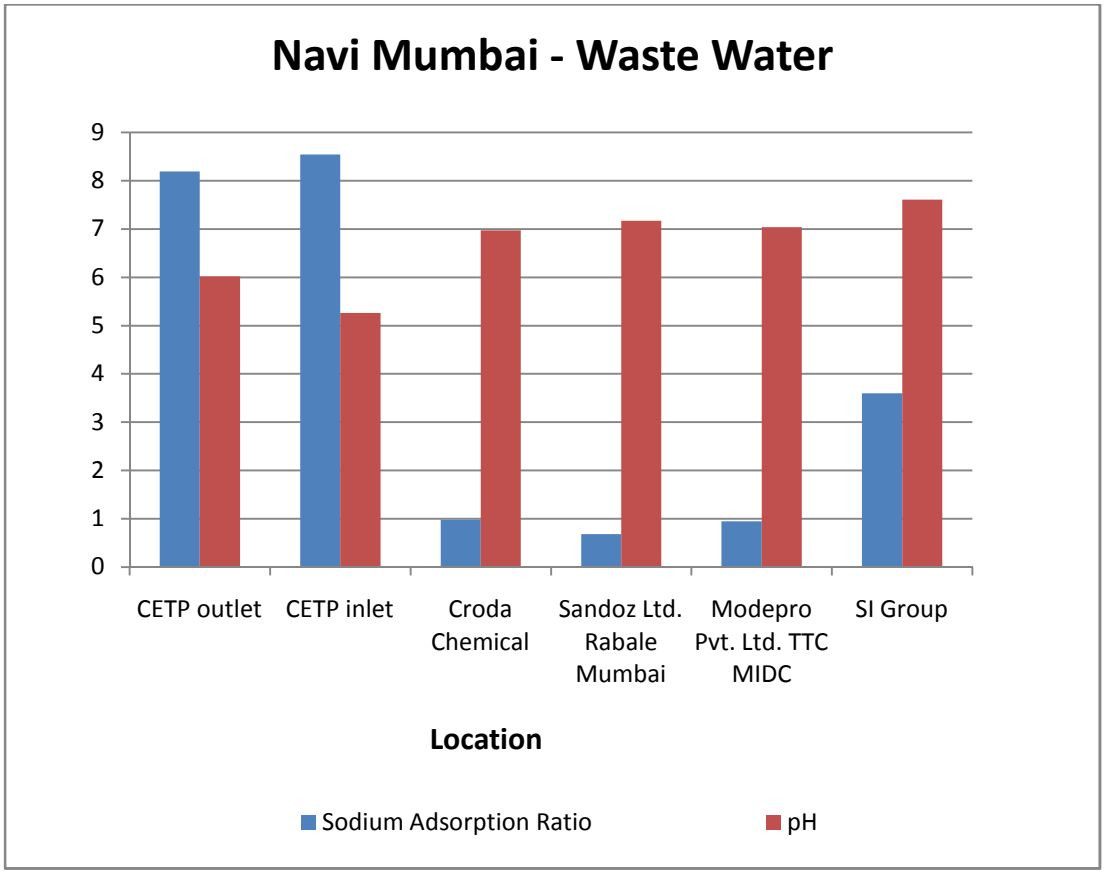
Location				**Sandoz Ltd.**	**Modepro Pvt. Ltd.**	**S I Group India Pvt. Ltd.**
Date of Sampling [XX/02/17]				**27**	**27**	**27**
Sr.	**Parameters**	**Unit**	**Std. Limit**	**Results**		
22.	Total Phosphorous (as P)	mg/L	**1.0**	0.92	0.66	0.13
23.	Total Kjeldahl Nitrogen (as N)	mg/L	**100.0**	1.15	18.1	11.8
24.	Total Ammonia (NH_4+NH_3)-Nitrogen	mg/L	**5.0**	BDL	4.9	0.66
25.	Phenols (as C_6H_5OH)	mg/L	**3.0**	BDL	BDL	BDL
26.	Surface Active Agents (as MBAS)	mg/L	**3.0**	BDL	BDL	BDL
27.	Organo Chlorine Pesticides		**0.1**			
i.	Alachlor	µg/L	**2.0**	BDL	BDL	0.062
ii.	Atrazine	µg/L	**0.2**	0.36	0.12	0.018
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	0.04	BDL
vi.	Beta HCH	µg/L	**2.0**	BDL	BDL	BDL
vii.	Butachlor	µg/L	**3.0**	BDL	BDL	BDL
viii.	Delta HCH	µg/L	**0.2**	BDL	BDL	BDL
ix.	p,p DDT	µg/L	**0.05**	BDL	BDL	0.011
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

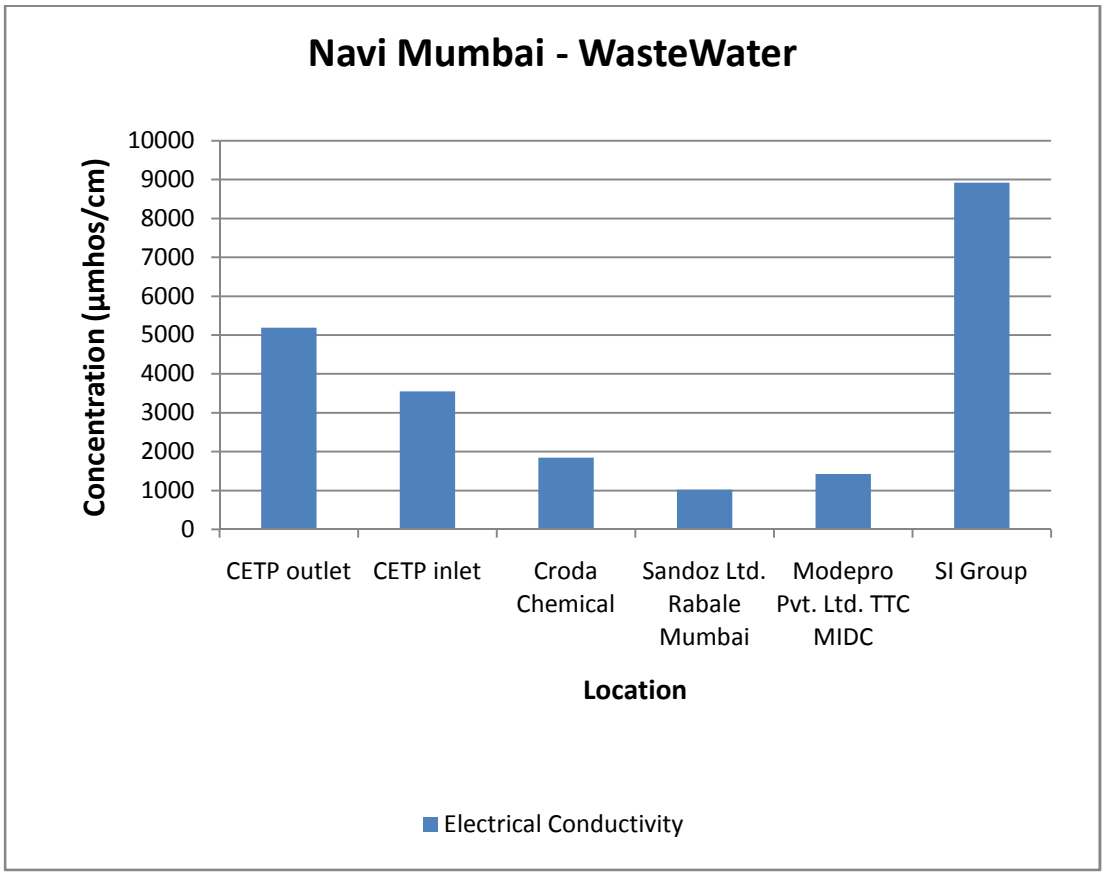
Location				**Sandoz Ltd.**	**Modepro Pvt. Ltd.**	**S I Group India Pvt. Ltd.**
Date of Sampling [XX/02/17]				**27**	**27**	**27**
Sr.	**Parameters**	**Unit**	**Std. Limit**	**Results**		
xv.	Alpha Endosulfan	µg/L	**10.0**	BDL	BDL	BDL
xvi.	Beta Endosulfan	µg/L		BDL	BDL	BDL
xvii.	Endosulfan Sulphate	µg/L	**5.0**	BDL	BDL	BDL
xviii.	Y HCH (Lindane)	µg/L	**1.0**	BDL	BDL	0.013
28.	Polynuclear aromatic hydrocarbons (PAH)	µg/L	**0.2**	BDL	BDL	BDL
29.	Polychlorinated Biphenyls (PCB)	µg/L	**2.0**	BDL	BDL	BDL
30.	Zinc (as Zn)	mg/L	**5.0**	BDL	BDL	0.489
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**	BDL	0.709	0.127
40.	Iron (as Fe)	mg/L	**3.0**	BDL	BDL	BDL
41.	Vanadium (as V)	mg/L	**0.2**	BDL	BDL	BDL
42.	Selenium (as Se)	mg/L	**0.05**	BDL	BDL	BDL
43.	Boron (as B)	mg/L		0.027	0.101	BDL

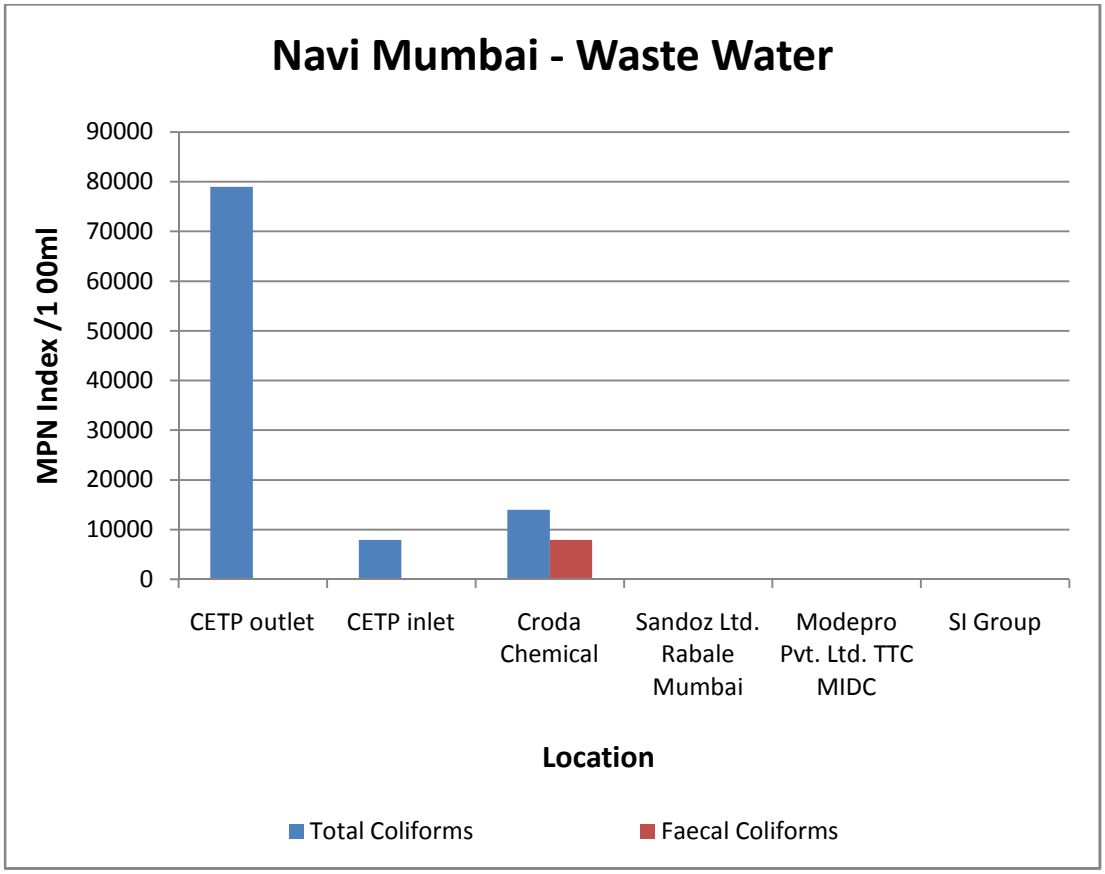
Location				Sandoz Ltd.	Modepro Pvt. Ltd.	S I Group India Pvt. Ltd.
Date of Sampling [XX/02/17]				27	27	27
Sr.	Parameters	Unit	Std. Limit	Results		
44.	Bioassay Test on fish	% survival	90% survival after 96h in 100%effluent	100	70	80

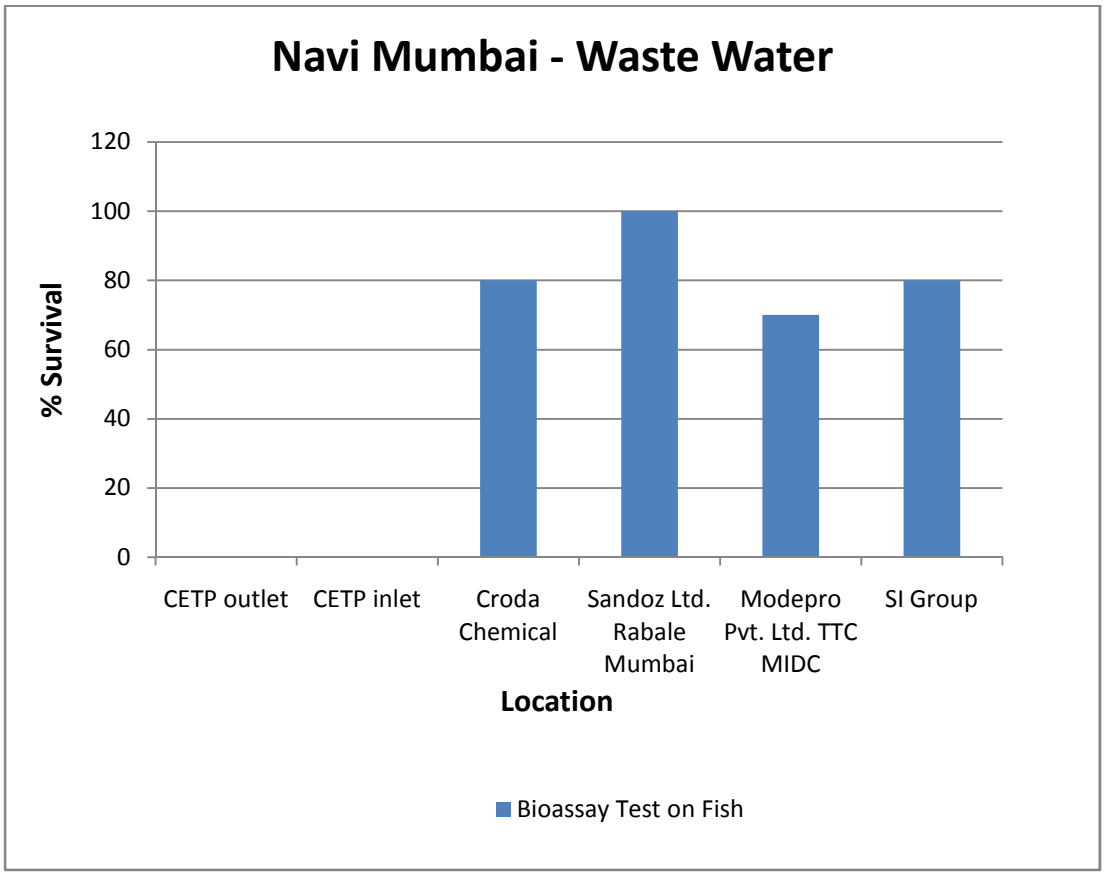
Graphs of Waste Water Quality Monitoring for Navi Mumbai TTC MIDC:




Navi Mumbai - Waste Water
9
8
7
6
5
4
3
2
1
0
CETP outlet
CETP inlet
Croda Chemical
Sandoz Ltd. Rabale Mumbai
Modepro Pvt. Ltd. TTC MIDC
SI Group
Location
Sodium Adsorption Ratio
pH


Navi Mumbai - WasteWater
Concentration (µmhos/cm)
10000
9000
8000
7000
6000
5000
4000
3000
2000
1000
0
CETP outlet
CETP inlet
Croda Chemical
Sandoz Ltd. Rabale Mumbai
Modepro Pvt. Ltd. TTC MIDC
SI Group
Location
Electrical Conductivity


Navi Mumbai - Waste Water
MPN Index /1 00ml
90000
80000
70000
60000
50000
40000
30000
20000
10000
0
CETP outlet
CETP inlet
Croda Chemical
Sandoz Ltd. Rabale Mumbai
Modepro Pvt. Ltd. TTC MIDC
SI Group
Location
Total Coliforms
Faecal Coliforms


Navi Mumbai - Waste Water
% Survival
120
100
80
60
40
20
0
CETP outlet
CETP inlet
Croda Chemical
Sandoz Ltd. Rabale Mumbai
Modepro Pvt. Ltd. TTC MIDC
SI Group
Location
Bioassay Test on Fish

3.4 Ground Water Analysis Results:

Sr.	Location	Source	Table No.
1.	Vashi Creek	Borewell	Table No. I
2.	TTl WMA Site	Borewell	Table No. I
3.	MSW Site Navi Mumbai	Borewell	Table No. I
4.	Turbhe Village	Borewell	Table No. II
5.	Alok Nalla Koparkharaine	Ground Water Nala	Table No. II
6.	TTC Plot no. 142, MIDC Navi Mumbai	Borewell	Table No. II

Table No. I:

Name of Industry				**Vashi Creek**	**TTl WMA Site**	**MSW Site Navi Mumbai**
Date of Sampling [XX/02/2017]				**25**	**25**	**25**
Sr.	**Parameters**	**Unit**	**Std. Limit**	**Results**		
1.	Colour	Hazen	**5**	1	1	1
2.	Smell	-	**Agreeable**	Agreeable	Agreeable	Agreeable
3.	pH	-	**6.5-8.5**	7.05	7.24	6.57
4.	Oil & Grease	mg/L	**100**	BDL	BDL	BDL
5.	Suspended Solids	mg/L	**500**	8	5	7
6.	Chemical Oxygen Demand	mg/L	**10 (WHO, 1993)**	10	17	15
7.	Biochemical Oxygen Demand (3 days,27^{o}C)	mg/L	**6 (WHO, 1993)**	3.04	5.18	4.57
8.	Electrical Conductivity (at 25 ^{o}C)	µmho/cm	**750**	2420	1852	1117

Name of Industry				**Vashi Creek**	**TTI WMA Site**	**MSW Site Navi Mumbai**
Date of Sampling [XX/02/2017]				**25**	**25**	**25**
Sr.	**Parameters**	**Unit**	**Std. Limit**	**Results**		
9.	Nitrite Nitrogen (as N)	mg/L		0.02	BDL	BDL
10.	Nitrate Nitrogen (as N)	mg/L	**45**	1.5	4.4	2.96
11.	$(NO_2 + NO_3)$-Nitrogen	mg/L	**1.0**	1.52	4.4	2.96
12.	Free Ammonia (as NH_3-N)	mg/L	**0.5**	BDL	BDL	BDL
13.	Total Residual Chlorine	mg/L	**0.2**	BDL	BDL	BDL
14.	Cyanide(as CN)	mg/L	**1.5**	BDL	BDL	BDL
15.	Fluoride (as F)	mg/L	**1**	BDL	BDL	BDL
16.	Sulphide (as S^{2-})	mg/L	**0.05**	BDL	BDL	BDL
17.	Dissolved Phosphate (as P)	mg/L		BDL	BDL	BDL
18.	Sodium Absorption Ratio	-		0.73	1.26	0.96
19.	Total Coliforms	MPN index/ 100 mL	**ND**	240	23	23
20.	Faecal Coliforms	MPN index/ 100 mL	**ND**	BDL	BDL	BDL
21.	Total Phosphorous (as P)	mg/L	**0.5**	BDL	BDL	BDL
22.	Total Kjeldahl Nitrogen (as N)	mg/L	**0.001**	1.03	1.04	0.92

Name of Industry				**Vashi Creek**	**TTI WMA Site**	**MSW Site Navi Mumbai**
Date of Sampling [XX/02/2017]				**25**	**25**	**25**
Sr.	**Parameters**	**Unit**	**Std. Limit**	**Results**		
23.	Total Ammonia (NH_4+NH_3)-Nitrogen	mg/L	**0.5**	BDL	BDL	BDL
24.	Phenols (as C_6H_5OH)	mg/L	**0.001**	BDL	BDL	BDL
25.	Surface Active Agents (as MBAS)	mg/L	**0.02**	BDL	BDL	BDL
26.	Organo Chlorine Pesticides	µg/L	**0.05**			
i.	Alachlor	µg/L	**20**	BDL	BDL	BDL
ii.	Atrazine	µg/L	**2**	BDL	BDL	BDL
iii.	Aldrin	µg/L	**0.03**	BDL	BDL	BDL
iv.	Dieldrin	µg/L	**0.03**	BDL	BDL	BDL
v.	Alpha HCH	µg/L	**0.01**	BDL	BDL	BDL
vi.	Beta HCH	µg/L	**0.04**	BDL	BDL	BDL
vii.	Butachlor	µg/L	**125**	BDL	BDL	BDL
viii.	Delta HCH	µg/L	**0.04**	BDL	BDL	BDL
ix.	p,p DDT	µg/L	**1**	BDL	BDL	BDL
x	o,p DDT	µg/L	**1**	BDL	BDL	BDL
xi.	p,p DDE	µg/L	**1**	BDL	BDL	BDL
xii.	o,p DDE	µg/L	**1**	BDL	BDL	BDL
xiii.	p,p DDD	µg/L	**1**	BDL	BDL	BDL
xiv.	o,p DDD	µg/L	**1**	BDL	BDL	BDL
xv.	Alpha Endosulfan	µg/L	**0.4**	BDL	BDL	BDL
xvi.	Beta Endosulfan	µg/L	**0.4**	BDL	BDL	BDL

Name of Industry				**Vashi Creek**	**TTl WMA Site**	**MSW Site Navi Mumbai**
Date of Sampling [XX/02/2017]				**25**	**25**	**25**
Sr.	**Parameters**	**Unit**	**Std. Limit**	**Results**		
xvii.	Endosulfan Sulphate	µg/L	**0.4**	BDL	BDL	BDL
xviii.	Y HCH (Lindane)	µg/L	**2.0**	BDL	BDL	BDL
27.	Polynuclear aromatic hydrocarbons (PAH)	µg/L	**0.0001**	BDL	BDL	BDL
28.	Polychlorinated Biphenyls (PCB)	µg/L	**0.0005**	BDL	BDL	BDL
29.	Zinc (as Zn)	mg/L	**5.0**	BDL	BDL	BDL
30.	Nickel (as Ni)	mg/L	**0.02**	BDL	BDL	BDL
31.	Copper (as Cu)	mg/L	**0.05**	BDL	0.03	BDL
32.	Hexavalent Chromium (as Cr^{6+})	mg/L	**1**	BDL	BDL	BDL
33.	Total Chromium (as Cr)	mg/L	**0.05**	BDL	BDL	BDL
34.	Total Arsenic (as As)	mg/L	**0.01**	BDL	BDL	BDL
35.	Lead (as Pb)	mg/L	**0.01**	BDL	BDL	BDL
36.	Cadmium (as Cd)	mg/L	**0.003**	BDL	BDL	BDL
37.	Mercury (as Hg)	mg/L	**0.001**	BDL	BDL	BDL
38.	Manganese (as Mn)	mg/L	**0.1**	BDL	BDL	0.03
39.	Iron (as Fe)	mg/L	**0.3**	BDL	0.19	BDL
40.	Vanadium (as V)	mg/L		BDL	BDL	BDL
41.	Selenium (as Se)	mg/L	**0.01**	0.006	0.008	BDL

Name of Industry				**Vashi Creek**	**TTI WMA Site**	**MSW Site Navi Mumbai**
Date of Sampling [XX/02/2017]				**25**	**25**	**25**
Sr.	**Parameters**	**Unit**	**Std. Limit**	**Results**		
42.	Boron (as B)	mg/L		BDL	0.14	BDL
43.	Bioassay Test on fish	% survival		100	100	100

Table II:

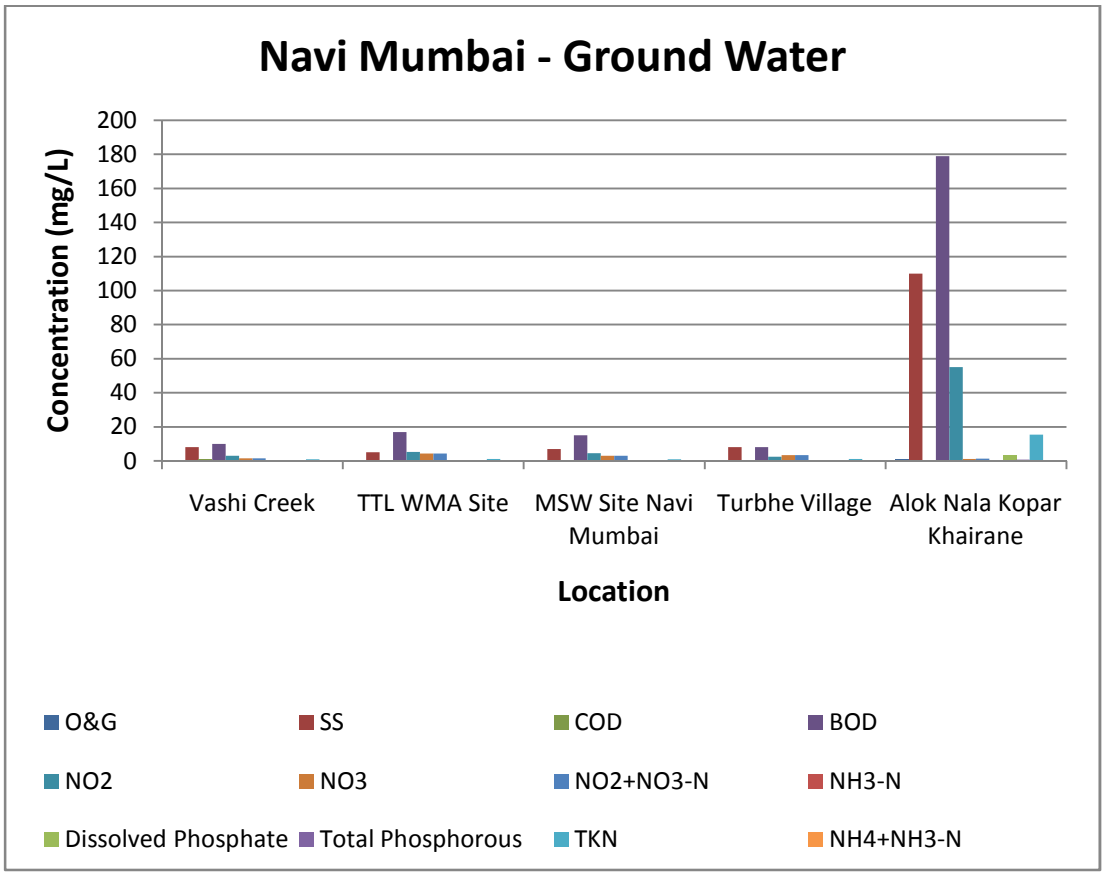
Location				**Turbhe Village**	**Alok Nalla**	**TTC Plot no. 142**
Date of Sampling [XX/02/2017]				**25**	**25**	**27**
Sr.	**Parameters**	**Unit**	**Std. Limit**	**Results**		
1.	Colour	Hazen	**5**	1	100	1
2.	Smell	-	**Agreeable**	Agreeable	Disagreeable	Agreeable
3.	pH	-	**6.5-8.5**	6.76	6.34	6.63
4.	Oil & Grease	mg/L	**100**	BDL	1.2	BDL
5.	Suspended Solids	mg/L	**500**	8	110	8
6.	Chemical Oxygen Demand	mg/L	**10 (WHO, 1993)**	8	179	21
7.	Biochemical Oxygen Demand (3 days,27°C)	mg/L	**6 (WHO, 1993)**	2.43	55	6.4
8.	Electrical Conductivity (at 25 °C)	µmho/cm	**750**	460	1227	1189
9.	Nitrite Nitrogen (as N)	mg/L		BDL	0.156	0.01

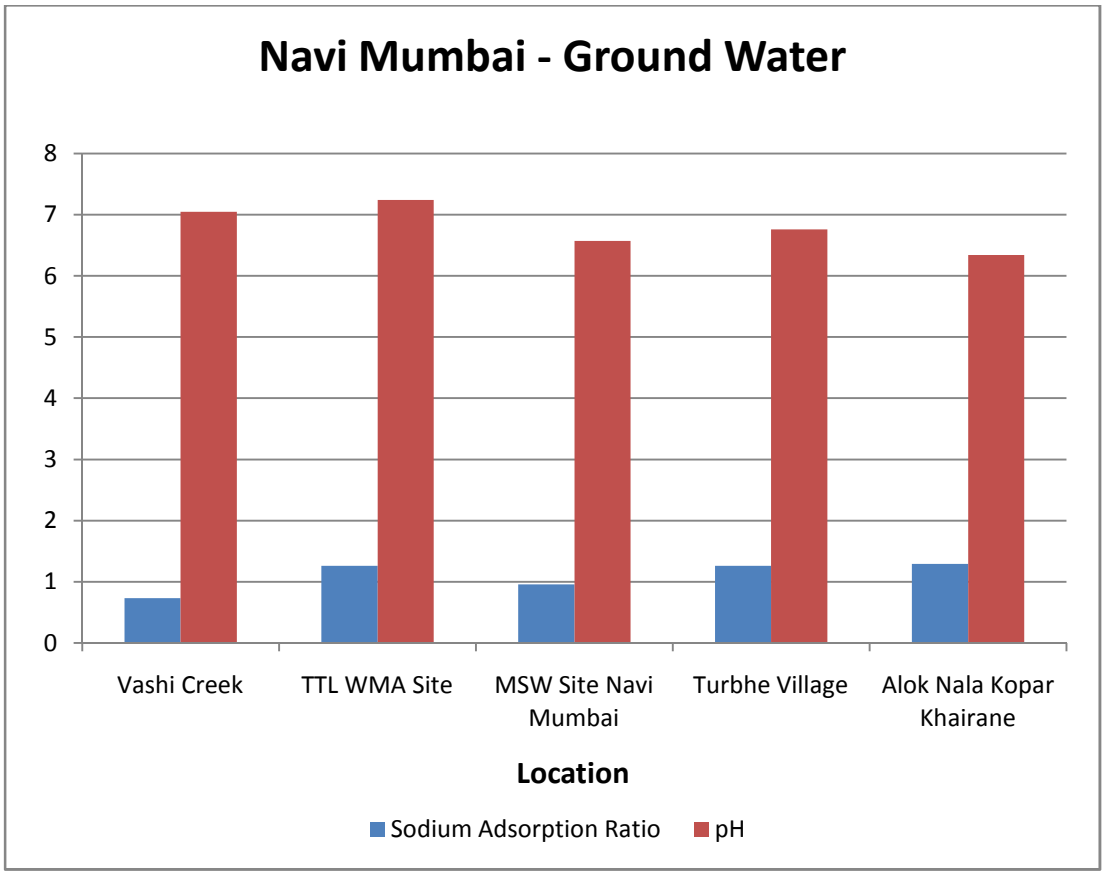
Location				**Turbhe Village**	**Alok Nalla**	**TTC Plot no. 142**
Date of Sampling [XX/02/2017]				**25**	**25**	**27**
Sr.	**Parameters**	**Unit**	**Std. Limit**	**Results**		
10.	Nitrate Nitrogen (as N)	mg/L	**45**	3.47	1.18	5.98
11.	$(NO_2 + NO_3)$-Nitrogen	mg/L	**1.0**	3.47	1.33	5.99
12.	Free Ammonia (as NH_3-N)	mg/L	**0.5**	BDL	BDL	BDL
13.	Total Residual Chlorine	mg/L	**0.2**	BDL	BDL	BDL
14.	Cyanide(as CN)	mg/L	**1.5**	BDL	BDL	BDL
15.	Fluoride (as F)	mg/L	**1**	BDL	BDL	BDL
16.	Sulphide (as S^{2-})	mg/L	**0.05**	BDL	BDL	BDL
17.	Dissolved Phosphate (as P)	mg/L		BDL	3.22	BDL
18.	Sodium Absorption Ratio	-		1.26	1.29	0.83
19.	Total Coliforms	MPN index/ 100 mL	**ND**	49	920	4.5
20.	Faecal Coliforms	MPN index/ 100 mL	**ND**	BDL	BDL	BDL
21.	Total Phosphorous (as P)	mg/L	**0.5**	0.1	0.72	BDL
22.	Total Kjeldahl Nitrogen (as N)	mg/L	**0.001**	1.15	15.5	17.8
23.	Total Ammonia (NH_4+NH_3)-Nitrogen	mg/L	**0.5**	BDL	BDL	4.88
24.	Phenols (as C_6H_5OH)	mg/L	**0.001**	BDL	BDL	BDL

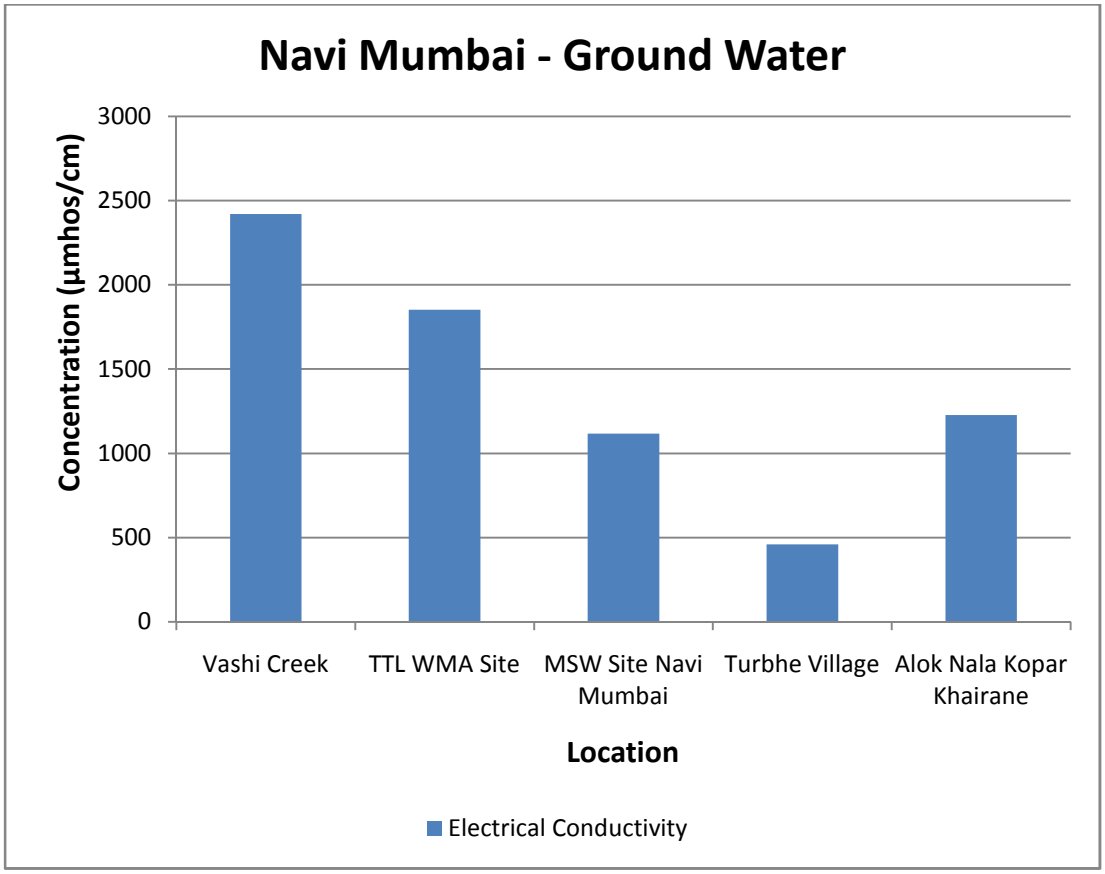
Location				**Turbhe Village**	**Alok Nalla**	**TTC Plot no. 142**
Date of Sampling [XX/02/2017]				**25**	**25**	**27**
Sr.	**Parameters**	**Unit**	**Std. Limit**	**Results**		
25.	Surface Active Agents (as MBAS)	mg/L	**0.02**	BDL	BDL	BDL
26.	Organo Chlorine Pesticides		**0.05**			
i.	Alachlor	µg/L	**20**	BDL	BDL	BDL
ii.	Atrazine	µg/L	**2**	BDL	BDL	BDL
iii.	Aldrin	µg/L	**0.03**	BDL	BDL	BDL
iv.	Dieldrin	µg/L	**0.03**	BDL	BDL	BDL
v.	Alpha HCH	µg/L	**0.01**	BDL	BDL	BDL
vi.	Beta HCH	µg/L	**0.04**	BDL	BDL	BDL
vii.	Butachlor	µg/L	**125**	BDL	BDL	BDL
viii.	Delta HCH	µg/L	**0.04**	BDL	BDL	BDL
ix.	p,p DDT	µg/L	**1**	BDL	BDL	BDL
x	o,p DDT	µg/L	**1**	BDL	BDL	BDL
xi.	p,p DDE	µg/L	**1**	BDL	BDL	BDL
xii.	o,p DDE	µg/L	**1**	BDL	BDL	BDL
xiii.	p,p DDD	µg/L	**1**	BDL	BDL	BDL
xiv.	o,p DDD	µg/L	**1**	BDL	BDL	BDL
xv.	Alpha Endosulfan	µg/L	**0.4**	BDL	BDL	BDL
xvi.	Beta Endosulfan	µg/L	**0.4**	BDL	BDL	BDL
xvii.	Endosulfan Sulphate	µg/L	**0.4**	BDL	BDL	BDL
xviii.	Y HCH (Lindane)	µg/L	**2.0**	BDL	BDL	BDL
27.	Polynuclear aromatic hydrocarbons (PAH)	µg/L	**0.0001**	BDL	BDL	BDL

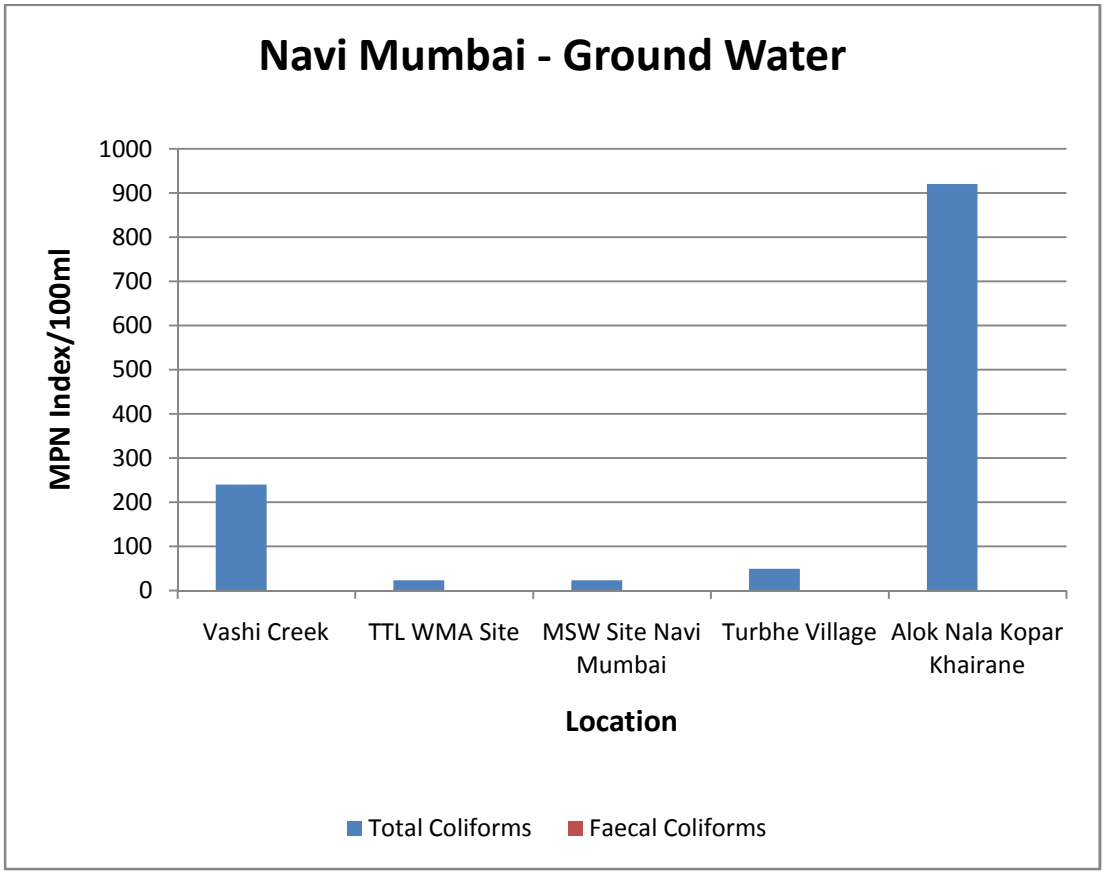
Location				**Turbhe Village**	**Alok Nalla**	**TTC Plot no. 142**
Date of Sampling [XX/02/2017]				**25**	**25**	**27**
Sr.	**Parameters**	**Unit**	**Std. Limit**	**Results**		
28.	Polychlorinated Biphenyls (PCB)	µg/L	**0.0005**	BDL	BDL	BDL
29.	Zinc (as Zn)	mg/L	**5.0**	BDL	BDL	BDL
30.	Nickel (as Ni)	mg/L	**0.02**	BDL	BDL	BDL
31.	Copper (as Cu)	mg/L	**0.05**	BDL	BDL	BDL
32.	Hexavalent Chromium (as Cr^{6+})	mg/L	**1**	BDL	BDL	BDL
33.	Total Chromium (as Cr)	mg/L	**0.05**	BDL	BDL	BDL
34.	Total Arsenic (as As)	mg/L	**0.01**	BDL	0.006	BDL
35.	Lead (as Pb)	mg/L	**0.01**	BDL	0.04	BDL
36.	Cadmium (as Cd)	mg/L	**0.003**	BDL	BDL	BDL
37.	Mercury (as Hg)	mg/L	**0.001**	BDL	BDL	BDL
38.	Manganese (as Mn)	mg/L	**0.1**	0.12	0.51	1.3
39.	Iron (as Fe)	mg/L	**0.3**	BDL	0.44	BDL
40.	Vanadium (as V)	mg/L		BDL	BDL	BDL
41.	Selenium (as Se)	mg/L	**0.01**	BDL	BDL	BDL
42.	Boron (as B)	mg/L		BDL	0.26	0.021
43.	Bioassay Test on fish	% survival		20	0	100

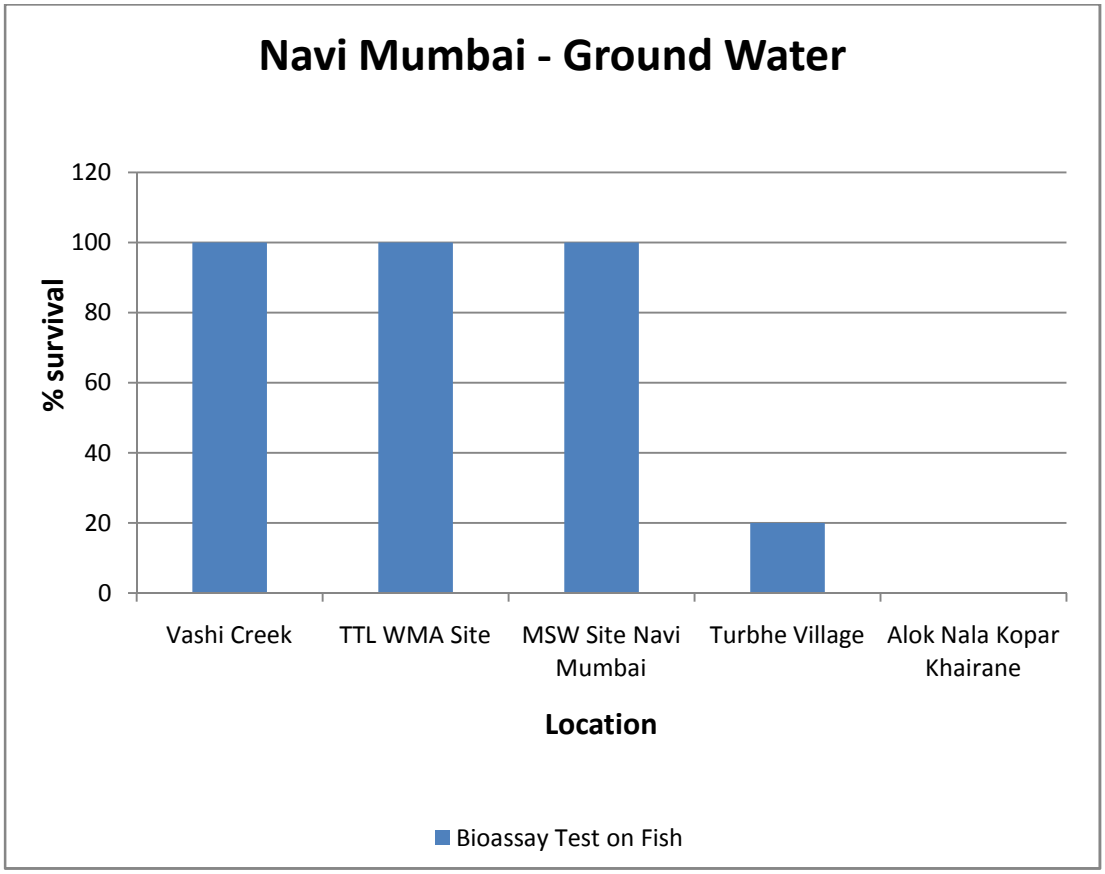
Graphs of Ground Water Quality Monitoring for Navi Mumbai TTC MIDC:






Navi Mumbai - Ground Water
Concentration (µmhos/cm)
3000
2500
2000
1500
1000
500
0
Vashi Creek
TTL WMA Site
MSW Site Navi Mumbai
Turbhe Village
Alok Nala Kopar Khairane
Location
Electrical Conductivity


Navi Mumbai - Ground Water
MPN Index/100ml
1000
900
800
700
600
500
400
300
200
100
0
Vashi Creek
TTL WMA Site
MSW Site Navi Mumbai
Turbhe Village
Alok Nala Kopar Khairane
Location
Total Coliforms
Faecal Coliforms



4. Summary and Conclusions

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

4.1 Stack Emission Monitoring:

Six different industries were selected for Stack monitoring All the three parameters detected and analyzed in the samples are observed below the standard limits.

Particulate matter was observed below 10mg/Nm^3 at 2 locations namely RPG Life Science Ltd. and S I Group Pvt. Ltd. Rest all locations are observed with the range of 18 to 46 mg/Nm^3 Particulate matter.

Sulphur dioxide values were observed in the range of 5.52 to 74.5mg/Nm^3. It is observed minimum at RPG Life Science Ltd. and Maximum at Amines & Plasticer Ltd. Nitrogen dioxide was observed in the range of 25.0 to 120 mg/Nm^3.

4.2 Ambient Air Quality Monitoring:

In the present study, five Ambient Air Quality monitoring stations were selected for sampling. They are (i) Mahalaxmi Dying & Printing Pvt. Ltd. (ii) G.L. Construction Pvt. Ltd. (iii) TTC WMA (iv) Akash Fabrics Pvt. Ltd. (v) Ajwani Infra TTC Area.

The parameters monitored were studied as per the NAAQ standards. The variations of each parameter within the area under study are discussed below:

1. **Sulphur dioxide**: All the locations are observed with very low concentrations of SO_2 (<4 to 6.04 µg/m^3), which are quiet lower than the standard limit of NAAQS i.e. 80 µg/m^3. It was observed below 4µg/m^3 at 2 of the studied locations i.e. at Mahalaxmi Dying and Printing Pvt. Ltd. and G.L. Construction Pvt. Ltd.

2. **Nitrogen dioxide:** Values of nitrogen dioxide are also observed below the standard limit of 80µg/m^3 at all the locations. It is detected in the range of 3.91 to 7.28µg/m^3

3. **Particulate Matter (PM_{10})**: PM_{10} is considered as one of the major causes of ambient air pollution. Out of all the five sampled locations, 4 are exceeding the standard limit of 100 µg/m^3. They are G.L. Construction Pvt. Ltd. (149 µg/m^3), TTC WMA (231 µg/m^3), Akash Fabrics Pvt. Ltd. (305µg/m^3) and Ajwani Infra TTC Area (950µg/m^3).

4. **Particulate Matter ($PM_{2.5}$)**: Like PM_{10} it is also categorized as a probable carcinogen. In the present study, Two samples are found to exceed the standard limit of $PM_{2.5}$ (i.e. 60 µg/m^3). It is observed with minimum of 12 µg/m^3 at Mahalaxmi Fabrics and Printing Pvt. Ltd. and maximum 563 µg/m^3 at Ajwani Infra TTC Area.

5. **Ozone (O_3)**: Concentration of Ozone is also observed lower than its standard limit. All the readings are found below 19 µg/m^3.

6. **Carbon Monoxide (CO)**: Concentration of carbon monoxide has been found to exceed the standard limit (2.0 µg/m^3) at three sampling locations except G.L. Construction Pvt. Ltd. and Ajwani Infra TTC Area where it is found below detection limit.

7. **Ammonia (NH_3):** Likewise ozone, all the readings of ammonia are also found quiet lower (<40 µg/m^3) as compared to the standard value (400 µg/m^3), except at Mahalaxmi Fabrics and Printing Pvt. Ltd. (40 µg/m^3).

8. **Benzene (C_6H_6):** Out of all, only one sample i.e. Mahalaxmi fabrics and Printing Pvt. Ltd. Is found below 1 µg/m^3. Rest all samples exceeded the standard limit of 5 µg/m^3 in the range of 5.13 µg/m^3 to 19.4 µg/m^3. Benzene is a known carcinogen, hence it is unsafe when exceeds the limit.

9. **Benzo(a)pyrene:** BaP is also considered as a critical pollutant hence lethal if exceeds the limits. The study shows that the concentration of BaP is below 0.2 ng/m^3 at all locations.

10. **Lead:** Lead is a known carcinogen, hence can also be lethal, if present above the standard limit (1 µg/m^3) prescribed by NAAQS. In the present study, all the locations are found safe and lead is observed below the standard limit with a range of <0.02 to 0.04 µg/m^3.

11. **Arsenic:** Concentration of Arsenic at all the studied locations is found below the standard 6 µg/m^3.

12. **Nickel:** Concentration of Nickel is also found below the standard limit (20 ng/m^3), at all the studied locations of Navi Mumbai with an exception at G.L. Construction Pvt. Ltd., where it is found in exceptionally high concentration (92.4 ng/m^3).

4.3 Waste water Quality Monitoring:

To understand the quality of treated effluent, samples were collected from following industries - (i) CETP Outlet (ii) CETP Inlet (iii) Croda chemical (iv) Sandoz Ltd. Rabale Mumbai (v) Modepro Pvt. Ltd. TTC MIDC (vi) S I Group India Pvt. Ltd.

Considering the general parameters of all the industries mentioned, following are the conclusions.

1. **Colour** (Hazen Units): Colour units are found below the acceptable standard except outlet and inlet CETP water samples.

2. **Odour**: odour of all the samples is found agreeable except CETP outlet and CETP inlet water samples which are found disagreeable.

3. **pH**: it is observed in between 5.26 and 7.61 which is well within the range.

4. **Suspended Solids**: Except outlet (13.6mg/L) and inlet (15.8mg/L) water sample of CETP, suspended solids of treated outlet water of all the other five locations appeared to be clean, as suspended solids is observed <0.25mg/L.

5. **Chemical Oxygen Demand**: Out of all, only CETP outlet (2789mg/L) is observed to exceed standard limit (250mg/L). However, other five samples are ranged between 40 mg/L to 179 mg/L.

6. **Biochemical Oxygen Demand**: CETP outlet (851mg/L) and Croda Chemicals (55mg/L) are found to exceed the standard limit (30mg/L). Results for remaining samples ranged from 12 to 24mg/L.

7. **Sulphide**: Except at location Reliance Life Science Koperkhairne (<0.025mg/L), all the other locations exceed the standard limit of sulphide. CETP outlet 13.6mg/L and CETP inlet 15.8mg/L

8. **Total Ammoia**: All the water samples are found below the standard limit of 5mg/L.

9. **Total Kjeldahl Nitrogen**: All the water samples are found below the standard limit (100mg/L), except CETP inlet water (137mg/L).

10. **Fish Bioassay**: In case of waters of Sandoz Ltd. Rabale Mumbai 100% of fish survival is observed at the end of 96h. Croda chemical and S I Group India Pvt. Ltd. exhibits 80% of fish survival followed by Modepro Pvt. Ltd. TTC MIDC 70% of fish survival at the end of 96 h.

11. **Heavy metals**: all the heavy metals are found below the standard limits in all the samples. However, only CETP inlet water samples are found to contain exceeding concentrations of Zinc (14.8mg/L), Manganese (2.31mg/L) and Iron (8.22mg/L).

Following parameters meet the criteria as prescribed by CPCB.

12. Free Ammonia

13. Total Residual Chlorine

14. Cyanide

15. Fluoride

16. Dissolved Phosphate

17. Phenolic compounds

4.4 Ground water Quality Monitoring:

Five borewell samples were collected from different locations namely: (i) Vashi Creek (ii) TTL WMA Site (3) MSW Site (iv) Turbhe Village (v) Alok Nala, Kopar Khairane (vi) TTC Plot no. 142 MIDC, Navi Mumbai. Parameters which are not included in ISO 10500:2012 are compared with WHO standards like BOD (6mg/L) and COD (10mg/ L).

1) **Colour** (Hazen Units): Colour units are below the acceptable standard, except alok nalla.

2) **Odour**: odour of all the samples is found agreeable except alok nalla which is found disagreeable.

3) **Chemical Oxygen Demand:** Out of all the samples, 50% of the samples are detected above standard limit of WHO. These are TTL WMA Site (17mg/L), MSW Site (15mg/L), Alok Nala Kopar Khairane (179mg/L) and TTC Plot no. 142 MIDC, Navi Mumbai (21mg/L).

4) **Biological Oxygen Demand:** BOD samples of Alok Nalla (55mg/L) and TTC area (6.4mg/L) are found above the standard limit of WHO.

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

1) **Nitrite**: Values of Nitrite are at below detection level.

2) **Nitrate:** Results of Nitrate are also observed below standard limit (45mg/l). It is observed in the range of 1.5 to 5.98mg/L.

3) **Residual Free Chlorine**: Values are below the acceptable standards.

4) **Total Ammonia**: All readings are found within the acceptable range.

5) **Fluoride:** Values are below the acceptable standards, below <0.05mg/L.

6) **Sulphide:** All the readings of sulphide are observed below 0.025mg/L, which is quiet below the standard limit 0.05mg/L.

7) **Sodium Absorption Ratio:** These values fit within range of water quality criteria of CPCB.

8) **Total Kjeldahl nitrogen:** Except Alok Nalla and TTC area, all water samples are observed below standard limit.

9) **Fish Bioassay**: In case of water samples of Vashi Creek, TTL WMA Site, MSW Site and TTC Plot no. 142 MIDC, Navi Mumbai 100% of fish survival is observed at the end of 96h. However, in the water sample of Turbhe Village only 20 and in the sample of Alok Nalla zero fish survival is observed at the end of 96h.

10) ***Boron:** Values are below the acceptable standards.

(*CPCB Water Quality criteria for Irrigation, Industrial Cooling & Controlled Waste disposal).

11) **Surface Active Agents:** It exceeds the standard of drinking water.

12) **Metals:** All the metals except manganese and iron at few locations are observed within the acceptable limits of drinking water standards.

13) **PAH & PCB** is also below the acceptable limits.

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 2016 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 the CEPI Score 2013 and CPCB report (2009).

1. CEPI score by CPCB in 2009

2. CEPI score 2013

(considering all revised standards, scope and limiting values of 2013)

3. CEPI score MPCB 2016, (considering all parameters)

4. CEPI score MPCB 2017, this report (considering all parameters)

The result shows that CEPI score of present report is 59.46. This is higher than the CEPI score of 2016 studies (56.86), but lower than the studies done by CPCB 2009 (73.77) and CEPI score 2013 (77.39).

The higher CEPI score in the present study as compared to the 2016 score is may be due to the time period when sampling was done. In 2016, sampling was carried out in monsoon season (July month) and this time it was done in post monsoon (February month). It is proved that in monsoon season, pollutants load gets decreased in air as well as in water bodies due to dilution and in post monsoon season, it again gets increased or comes to normal. This has resulted in lower CEPI score in 2016 and again increase in 2017 score.

However, it should also be noticed over here that MPCB's efforts through the formulation of action plans decreased the overall concentration of pollutants in all aspects i.e. air, land and water in Navi Mumbai area in past three years. This has also resulted in decreased score of CEPI now.

5.1 Comparison of CEPI scores:

Results show that present CEPI score (59.46) of Navi Mumbai considering all revised standards and parameters has decreased by almost 18 points if compared with the CEPI Score of 2013 (77.39) report. This clearly indicates the successful application of STAP and LTAP of MPCB which resulted in a cleaner environment of Navi Mumbai in past three years.

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	6	3	3	12	3	3	5	14	10	**51**
CEPI score 2016	3	5	15	6	0	0	6	3	1.5	0	4.5	10	**35.5**
CEPI score 2013 (considering all revised standards, scope and limiting values of 2013)	6	5	30	8	0	0	8	3	5	0	15	10	**63**
CPCB Report 2009	6	5	30	6	0	0	6	3	5	0	15	10	**61**

Water:

	A1	A2	A	B1	B2	B3	B	C1	C2	C3	C	D	CEPI
Present Report 2017	1	5	5	8	0	0	8	5	5	5	30	5	**48**
CEPI score 2016	1	5	5	8	0	0	8	5	5	5	30	5	**48**
CEPI score 2013 (considering all revised standards, scope and limiting values of 2013)	4	5	20	8	0	0	8	5	4.8	5	28.6	5	**61.8**
CPCB Report 2009	3	5	15	8	3	3	14	5	3	5	20	10	**59**

Land:

	A1	A2	A	B1	B2	B3	B	C1	C2	C3	C	D	CEPI
Present Report 2017	1	5	5	6	0	0	6	5	3	5	20	5	**36**
CEPI score 2016	1	5	5	8	0	0	8	5	5	5	30	5	**48**
CEPI score 2013 (considering all revised standards, scope and limiting values of 2013)	4	5	20	8	0	0	8	5	5	5	30	5	**63**
CPCB Report 2009	3	5	15	6	15	3	10	5.5	3	5	20	10	**55.5**

Aggregated CEPI:

	Air Index	Water Index	Land Index	CEPI
Present Report 2017 (Considering all parameters)	51	48	36	**59.46**
CEPI Score 2016 (Considering all parameters)	30.5	48	48	**56.86**
CEPI score 2013 (considering all revised standards, scope and limiting values of 2013)	63	61.75	63	**77.39**
CPCB Report 2009	61	59	55.5	**73.77**

6. Conclusions

The Present study has been an attempt to check the characteristics and status of environment among the different industrial clusters of Navi Mumbai city. It shows that the concentration of pollutants in air, ground water and surface water is lowered down as compared to past studies, as most of the results are observed below their standards with an exception of one or two parameters. Among all the sampling locations, Government Hospital is found the most critical location in view of pollution in all the environmental components i.e. Air, Water and Land.

Parameters of air sampling are observed within the standard limit except PM_{10} and $PM_{2.5}$ as compared to their standards at 5 sampling locations. Similarly, Carbon Monoxide is also observed higher than the standard limit at 3 locations.

Among waste water samples, BOD of CETP Inlet and CETP outlet samples are found beyond standard limit. Few samples of suspended solids and sulphides also exceed their standard limits in the samples.

Similarly, in ground water samples BOD and COD of few samples are observed higher than the permissible limits. Among all the samples, water of Alok Nalla is observed severely polluted.

Moreover, the lower value (59.46) of Comprehensive Environmental Pollution Index (CEPI) in the present study as compared to past few years study also reveals the fact that the environmental pollution in this city is substantially decreased over the period of times. To achieve this target, improvement in conventional practice and procedures adopted by the industries coupled with initiatives taken by Maharashtra Pollution Control Board played a major role. Although, a decrease in environmental pollution is observed, but still there is lot of scope to improve the environmental quality of the city, for which continuous efforts, strategies, planning and actions are required.

	A1	**A2**	**A**	**B1**	**B2**	**B3**	**B**	**C1**	**C2**	**C3**	**C**	**D**	**CEPI**
Air Index	3	5	15	6	3	3	12	3	3	5	14	10	**51**
Water Index	1	5	5	8	0	0	8	5	5	5	30	5	**48**
Land Index	1	5	5	6	0	0	6	5	3	5	20	5	**36**
Aggregated CEPI													**59.46**

7. Efforts taken for the reduction in pollution:

The regional office of Maharashtra pollution control board has taken various initiatives in reducing the CEPI Score of 77.39 of 2013 to 59.46 of 2017. Below mentioned are some of the efforts:

a) About 17 industries have started using Natural Gas as fuel (PNG) since last 4 years. Gas Pipeline works started from 2011.

b) Due to Change in Fuel Pattern the SO_2 Reduction: 576.70 T/A.

c) All major polluting industries having their own full fledge ETP in their premises for treatment of effluent generated during activities. And then treated effluent is sent to CETP for further treatment and disposal in the Creek.

d) The treated effluent of the industries is discharged into Common Effluent Treatment Plant (CETP) for further treatment and disposal and then discharged into TTC creek through closed pipeline at the point recommended by National Institute of Oceanography (NIO) nearly 3 km inside Vashi creek.

e) All Large /Medium/ small scale industries has installed dust collectors and scrubbing systems as Air Pollution Control Devices.

f) All the bulk mfg. units (12 nos) are being proposed to install VOC analyser including alarm system.

g) About 57 major polluting industries are closed, namely – NOCIL Petrochemicals, Reliance Silicons, Standard Alkali (Chemical Division), Corromandal Fertilizers, Jaysynth Dyechem, Unique Chemicals, Cabbot India etc.

h) Implementation of CEPI Action Plan by improvement of Environmental Pollution Control System has resulted in Reduction of Pollution Load. This has resulted in low pollution levels & hence improvement in CEPI status. Use of CNG for industrial and transportation already started

8. Photographs

Alok Nalla

Alok Nalla, Koparkharaine

CETP Inlet

CETP Outlet

CETP Navi Mumbai

MSW Site Navi Mumbai- Borewell Ground Water

Savotex Textile Stack Navi Mumbai MIDC

TTC WMA Site Borewell Ground Water

Turbhe Village Borewell Ground Water

Vashi Creek

9. 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: Dombivali, 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

10. 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_6H_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, 22nd Ed., 2012, 1060 B, 1-39	-	-
2.	Sampling Procedure for Microbiological Parameters	APHA, 22nd Ed., 2012,1060 B, 1-39, 9040, 9-17, and 9060B, 9-35	-	-
3.	Temperature	APHA, 22nd Ed., 2012, 2550-B, 2-69	By Thermometer	-
4.	Colour	APHA, 22nd 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, 22nd Ed., 2012, 4500-H^+- B, 4-92	By pH Meter	1
7.	Oil & Grease	APHA, 22nd 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,22nd 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, 22nd Ed., 2012, 2510- B, 2-54	By Conductivity Meter	0.1 µmho/cm
13.	Nitrite-Nitrogen	APHA, 22nd 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,22nd Ed.,2012 ,4500-NO_3,B-4-122	UV Spectrophotometer Screening Method	0.2 mg/L
15.	(NO_2 + NO_3)-Nitrogen	APHA, 22nd Ed., 2012, 4500-NO_2-B, 4-120 APHA,22nd Ed.,2012,4500-NO_3,B-4-122	Colorimetric Method V Spectrophotometer Screening Method	0.2 mg/L
16.	Free Ammonia	APHA, 22nd 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, 22nd Ed., 2012 ,4500-CN, C & E, 4-41 & 4-43	Colorimetric Method	0.001 mg/L
19.	Fluoride (F)	APHA, 22nd Ed., 2012, 4500-F^-, D, 4-87	SPADNS Method	0.05 mg/L
20.	Sulphide (S^{2-})	APHA, 22nd Ed., 2012, 4500 –S^2 , C-4-175, F-4-178	IodometricMethod	0.08 mg/L
21.	Dissolved Phosphate (P)	APHA,22nd Ed., 2012 , 4500 P,E, 4-155	Ascorbic Acid Method	0.03 mg/L
22.	Sodium Absorption Ratio	IS11624 :1986, Reaffirmed 2006	By Calculation	0.3
23.	Total Phosphorous (P)	APHA,22nd Ed., 2012 , 4500 P,E, 4-155	Ascorbic Acid Method	0.03 mg/L
24.	Total Kjeldahl Nitrogen	APHA, 22nd 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,22d Ed., 2012 , 4500 NH_3, F, 4 -115	Colorimetric Method	0.001 mg/L
26.	Phenols (C_6H_5OH)	APHA,22nd Ed., 2012 , 5530- B & C, 5-44 & 5-47	Chloroform Extraction Method	0.001 mg/L

Sr.	Parameters	Methods References	Techniques	Detection Limit
27.	Surface Active Agents	APHA,22nd Ed., 2012 , 5540-B & C,5-50	Methylene Blue Extraction Method	0.1 mg/L
28.	Organo Chlorine Pesticides	APHA, 22nd Ed., 2012,6410B,6-74	GC MS-MS Method	0.01 µg/L
29.	Polynuclear aromatic hydrocarbons (PAH)	APHA, 22nd Ed., 2012,6410B,6-74	GC MS-MS Method	0.01 µg/L
30.	Polychlorinated Biphenyls (PCB)	APHA, 22nd 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, 22ndEd., 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, 22nd Ed., 2012,9221-B, 9-66	Multiple tube fermentation technique (MPN/100ml)	1.1 MPN/100ml
46.	Faecal Coliforms	APHA, 22nd Ed., 2012,9221-E, 9-74	Multiple tube fermentation technique (MPN/100ml)	1.1 MPN/100ml
47.	Bioassay (Zebra Fish) Test	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 (Prevntion 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) µg/m³	Annual *	50	20	– Improved West and Gaeke – Ultraviolet fluorescence
		24 hours **	80	80	
2	Nitrogen Dioxide (NO_2) µg/m³	Annual *	40	30	– Modified Jacob & Hochheiser (Na-Arsenite) – Chemilminescence
		24 hours **	80	80	
3	Particulate Matter (size less than 10 µm) or PM_{10} µg/m³	Annual *	60	60	– Gravimetric – TOEM – Beta attenuation
		24 hours **	100	100	
4	Particulate Matter (size less than 2.5 µm) or $PM_{2.5}$ µg/m³	Annual *	40	40	– Gravimetric – TOEM – Beta attenuation
		24 hours **	60	60	
5	Ozone (O_3) µg/m³	8 hours **	100	100	– UV photometric – Chemiluminescence – Chemical Method
		1 hour **	180	180	
6	Lead (Pb) µg/m³	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/m³	8 hours **	02	02	– Non Dispersive Infra Red (NDIR) spectroscopy
		1 hour **	04	04	
8	Ammonia (NH_3) µg/m³	Annual *	100	100	– Chemiluminescence – Indophenol blue method
		24 hours **	400	400	
9	Benzene (C_6H_6) µg/m³	Annual *	05	05	– Gas Chromatography based continuous analyzer – Adsorption and Desorption followed by GC analysis
10	Benzo (a) Pyrene (BaP) – particulate phase only, ng/m³	Annual *	01	01	– Solvent extraction followed by HPLC/GC analysis
11	Arsenic (As) ng/m³	Annual *	06	06	– AAS/ICP method after sampling on EPM 2000 or equivalent filter paper.
12	Nickel (Ni) ng/m³	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.

µg/m³: micro gram/m³ i.e. 10^{-6}gm/m³ ng/m³ : nano gram/m³ i.e 10^{-9}gm/m³

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 mailer 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
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

Sr.	Parameter	Standards			
		Inland surface Water	**Public Sewers**	**Land for Irrigation**	**Marine Coastal Areas**
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
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

Sr.	Parameter	Standards			
		Inland surface Water	**Public Sewers**	**Land for Irrigation**	**Marine Coastal Areas**
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	--	--	--
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_6H_5OH), mg/L, Max.	1.0	5.0	--	5.0

Sr.	Parameter	Standards			
		Inland surface Water	**Public Sewers**	**Land for Irrigation**	**Marine Coastal Areas**
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 $C1_2$)	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_6H_5OH)	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_2S)	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 (asCd)	mg/L	Max 0.003	No relaxation
32.	Cyanide (asCN)	mg/L	Max 0.05	No relaxation
33.	Lead (as Pb)	mg/L	Max 0.01	No relaxation
34.	Mercury (asHg)	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	➢ 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	➢ 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	➢ 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	➢ 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	➢ 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	➢ 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, µmhos/cm	<1000	<2250	<4000

(v)	(NO_2+NO_3)-Nitrogen, mg/l	<5	<10	<15
(vi)	Suspended solid, mg/l	<25	<50	<100
(vii)	Feacal 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 (NH4 + NH3)-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
(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