

ENVIRONMENTAL MONITORING REPORT



DETOX GROUP



MONITORING OF ENVIRONMENTAL PLAN FOR JN PORT ENVIRONMENTAL MONITORING REPORT

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1.

AMBIENT AIR QUALITY MONITORING

1.1 INTRODUCTION

As per the Environmental Monitoring Plan of Jawaharlal Nehru Port (JNP), Air monitoring locations are selected in port and outside including nearby residential and eco-sensitive areas. Locations of stations are selected based on the significance of sources, receptors and to get representative data. Three fixed stations are identified namely Port Operational Centre (POC), Indian Molasses Company (IMC) and Residential Colony (RC). Three movable locations are also identified namely Elephanta Caves (EC), North Gate Complex (NGC) and South Gate Complex (SGC). The description of stations is given in **Table 1**. The location map of various air quality monitoring stations at JNP is depicted in **Annexure-I**.

Table 1: Description of Ambient Air Monitoring Stations

Station No.	Station	Location	Selection Criterion
1.	POC	At Port Operational Centre	Main Port Activity Location
2.	IMC	At IMC compound in Liquid Chemical Terminal Area	Major industrial activity centre
3.	RC	At JNP residential township	Impact on human population, receptor oriented
4.	EC	At Elephanta Caves	Impact on Archaeological site, receptor oriented
5.	NGC	Near North Gate Complex	Heavy traffic movement
6.	SGC	Near South Gate Complex	Heavy traffic movement

1.2 AIR QUALITY MONITORING METHODOLOGY

The objective behind Air Quality monitoring survey is to determine the status of existing ambient air quality in the port and to compare it with CPCB specified standards. Sampling and analysis of ambient air samples are carried out as per CPCB Guidelines for Ambient Air Quality Monitoring, Volume-I, NAAQMS/36/2012-2013. The monitoring is carried-out as per air quality parameters mentioned in the National Ambient Air Quality Monitoring Standards (NAAQMS) CPCB Notification published on 18th November 2009. **Annexure-II** represents list of air quality parameters as per NAAQS along with frequency of monitoring.

The monitoring cycle at three fixed stations i.e. POC, IMC and RC is twice a week, while at NGC and SGC it is once a week. However, monitoring at Elephanta Caves is once a month as per schedule of EMP of JNPT.

EMP for JNP | Environmental Monitoring Report – DCPL/JNPT-REPORT/EMR-03/2016

In all above stations, sampling duration is 24 hour for PM₁₀, PM_{2.5}, SO₂, NO_x, NH₃, Pb, As, Ni, Benzo(α) pyrene, 8 hour for Ozone & Benzene, and Grab-sampling for CO & CO₂ measurements.

After a continuous operation of 8 hours of the sampler, the reagents are replaced to obtain 3 samples per day for each parameter namely, SO₂, NO_x and NH₃. The EPM 2000 filter paper and PTFE Membrane bound filter paper are used for a period of 24 hours to obtain one sample each of PM₁₀ & PM_{2.5} respectively. After PM₁₀ measurement, EPM 2000 filter paper is used for estimation of Pb, As, Ni and Benzo (α) pyrene.

1.3 RESULTS

The ambient air quality monitoring data for three fixed stations, POC, IMC & RC for the month of April, 2016 are given in **Tables 2, 3 & 4** respectively. The ambient air quality monitoring data for EC and two movable stations, NGC & SGC are given in **Tables 5, 6 & 7** respectively.

Table 2: Results of Air Pollutant Concentration at POC Station of JNP Area during the month of April, 2016												
	Date	Time [Hrs]	PM ₁₀ [µg/m ³]	PM _{2.5} [µg/m ³]	SO ₂ [µg/m ³]		NOx [µg/m ³]		NH3 [µg/m ³]			
Sampling Period			24 hr	24 hr	8 hr	24hr (Avg.)	8 hr	24hr (Avg.)	8 hr	24hr (Avg.)		
NAAQMS limit			100 µg/m ³	60 µg/m ³		80 µg/m ³		80 µg/m ³		400 µg/m ³		
POC-1	01.04.2016 to 02.04.2016	10:30 PM			42.18		56.98		25.47			
		7:00 AM	126	58	37.66	41.68	56.27	56.98	23.81		21.66	
		3:00 PM			45.19		57.70		15.71			
POC-2	06.04.2016 to 07.04.2016	10:30 PM			20.08		46.30		31.43			
		7:00 AM	222	73	32.13	26.61	47.73	51.29	28.33		27.14	
		3:00 PM			27.61		59.84		21.67			
POC-3	11.04.2016 to 12.04.2016	10:30 PM			21.59		59.84		43.33			
		7:00 AM	159	62	16.07	20.75	64.82	59.36	23.57		33.57	
		3:00 PM			24.60		53.43		33.81			
POC-4	14.04.2016 to 15.04.2016	10:30 PM			26.61		28.49		47.14			
		7:00 AM	175	67	28.62	29.46	39.89	34.19	21.90		39.76	
		3:00 PM			33.14		34.19		50.24			
POC-5	18.04.2016 to 19.04.2016	10:30 PM			34.14		47.73		27.86			
		7:00 AM	248	81	43.68	39.66	60.55	54.85	38.57		30.79	
		3:00 PM			41.17		56.28		25.95			
POC-6	21.04.2016 to 22.04.2016	10:30 PM			27.61		59.12		32.86			
		7:00 AM	192	77	32.13	34.14	44.17	50.10	29.52		28.73	
		3:00 PM			42.68		47.01		23.81			
POC-7	25.04.2016 to 26.04.2016	10:30 PM			31.63		30.63		47.38			
		7:00 AM	121	54	28.12	32.47	35.62	37.28	34.76		35.95	
		3:00 PM			37.66		45.59		25.71			
POC-8	28.04.2016 to 29.04.2016	10:30 PM			31.63		69.81		31.67			
		7:00 AM	202	76	35.65	30.96	56.28	59.13	24.28		32.30	
		3:00 PM			25.61		51.29		40.95			
Monthly Average			181	69		31.97		50.40		31.24		
Standard Deviation			45	10		6.76		9.68		5.56		

Table 2: Results of Air Pollutant Concentration at POC Station of JNP Area during the month of April ,2016

Table 2: Results of Air Pollutant Concentration at POC Station of JNP Area during the month of April ,2016										
	Date	Time , [Hrs]	O ₃ [µg/m ³]	Pb [µg/m ³]	As [ng/m ³]	Ni [ng/m ³]	C ₆ H ₆ [µg/m3]	B(a)P [ng/m ³]	CO [mg/m ³]	CO ₂ [ppm]
Sampling Period			8 hr	24hr	24hr (Avg)	24hr (Avg)	8 hr	24hr (Avg)	Grab Sampling	Grab Sampling
NAAQMS limit			100 µg/m ³	1.0 µg/m ³	6 ng/m ³	20 ng/m ³	5.0 µg/m ³	1.0 ng/m ³	4.0 mg/m ³	-
POC-1	01.04.2016 to 02.04.2016	10:30 PM								
		7:00 AM	9.69	<0.05	<5.0	<1.0	1.74	<0.5	1.05	281
		3:00 PM								
POC-2	06.04.2016 to 07.04.2016	10:30 PM								
		7:00 AM	13.42	<0.05	<5.0	<1.0	<1.0	<0.5	1.08	320
		3:00 PM								
POC-3	11.04.2016 to 12.04.2016	10:30 PM								
		7:00 AM	11.33	<0.05	<5.0	<1.0	1.26	<0.5	<1.0	271
		3:00 PM								
POC-4	14.04.2016 to 15.04.2016	10:30 PM								
		7:00 AM	9.47	<0.05	<5.0	<1.0	<1.0	<0.5	1.10	292
		3:00 PM								
POC-5	18.04.2016 to 19.04.2016	10:30 PM								
		7:00 AM	11.94	<0.05	<5.0	<1.0	<1.0	<0.5	<1.0	259
		3:00 PM								
POC-9	21.04.2016 to 22.04.2016	10:30 PM								
		7:00 AM	7.33	<0.05	<5.0	<1.0	1.61	<0.5	<1.0	284
		3:00 PM								
POC-7	25.04.2016 to 26.04.2016	10:30 PM								
		7:00 AM	10.21	<0.05	<5.0	<1.0	<1.0	<0.5	1.14	263
		3:00 PM								
POC-8	28.04.2016 to 29.04.2016	10:30 PM								
		7:00 AM	9.37	<0.05	<5.0	<1.0	1.12	<0.5	1.35	305
		3:00 PM								
Monthly Average			10.35	-	-	-	1.43	-	1.14	284
Standard Deviation			1.9	-	-	-	0.29	-	0.1	20.9

Table 3: Results of Air Pollutant Concentration at IMC Station of JNP Area during the month of April, 2016												
Sampling Period	Date	Time [Hrs]	PM ₁₀ [µg/m ³]	PM _{2.5} [µg/m ³]	SO ₂ [µg/m ³]		NOx [µg/m ³]		NH ₃ [µg/m ³]		24hr (Avg.)	400 µg/m ³
					8 hr	24hr (Avg.)	8 hr	24hr (Avg.)	8 hr	24hr (Avg.)		
NAAQMS Limit			100 µg/m ³	60 µg/m ³		80 µg/m ³		80 µg/m ³		80 µg/m ³		
IMC-1	01.04.2016 to 02.04.2016	11:35 PM			27.11		44.87		22.38			
		8:00 AM	263	81	30.63	26.78	41.31	44.40	26.43			22.46
		4:15 PM			22.59		47.01		18.57			
IMC-2	06.04.2016 to 07.04.2016	11:35 PM			45.99		45.99		22.62			
		8:00 AM	351	87	33.64	39.26	47.73	45.01	23.33			25.55
		4:15 PM			38.16		41.32		30.71			
IMC-3	11.04.2016 to 12.04.2016	11:35 PM			21.59		52.71		37.62			
		8:00 AM	274	74	28.62	24.94	27.78	37.99	29.52			33.09
		4:15 PM			24.60		33.48		32.14			
IMC-4	14.04.2016 to 15.04.2016	11:35 PM			26.61		48.44		31.67			
		8:00 AM	269	69	28.12	29.29	53.43	49.39	43.33			38.89
		4:15 PM			33.14		46.30		41.66			
IMC-5	18.04.2016 to 19.04.2016	11:35 PM			28.62		49.86		31.43			
		8:00 AM	286	76	34.14	34.40	52.71	55.00	26.90			26.67
		4:15 PM			40.67		64.02		21.67			
IMC-6	21.04.2016 to 22.04.2016	11:35 PM			39.16		58.41		24.76			
		8:00 AM	167	55	34.64	36.82	68.39	57.23	19.52			24.12
		4:15 PM			36.65		44.88		28.09			
IMC-7	25.04.2016 to 26.04.2016	11:35 PM			21.59		34.91		33.09			
		8:00 AM	206	68	26.61	28.12	45.59	39.18	40.95			33.09
		4:15 PM			36.15		37.04		25.24			
IMC-8	28.04.2016 to 29.04.2016	11:35 PM			15.59		27.78		26.90			
		8:00 AM	190	62	22.59	22.77	30.63	35.85	20.24			30.90
		4:15 PM			30.13		49.15		45.57			
Monthly Average			251	72		31.93		48.30				28.46
Standard Deviation			60	10		5.77		7.34				6.27

Table 3: Results of Air Pollutant Concentration at IMC Station of JNP Area during the month of April, 2016												
	Date	Time , [Hrs]	O ₃ [µg/m ³]	Pb [µg/m ³]	As [ng/m ³]	Ni [ng/m ³]	C ₆ H ₆ [µg/m ³]	B(a)P [ng/m ³]	CO [mg/m ³]	CO ₂ [ppm]		
Sampling Period			8 hr	24hr	24hr (Avg)	24hr (Avg)	8 hr	24hr (Avg)	Grab Sampling	Grab Sampling		
NAAQMS limit			100 µg/m ³	1.0 µg/m ³	6 ng/m ³	20 ng/m ³	5.0 µg/m ³	1.0 ng/m ³	4.0 mg/m ³			
IMC 1	01.04.2016 to 02.04.2016	11.35 PM										
		8:00 AM	10.96	<0.05	<5.0	<1.0	1.61	<0.5	1.12	297		
		4:15 PM										
IMC-2	06.04.2016 to 07.04.2016	11.35 PM										
		8:00 AM	8.43	<0.05	<5.0	<1.0	1.84	<0.5	<1.0	294		
		4:15 PM										
IMC-3	11.04.2016 to 12.04.2016	11.35 PM										
		8:00 AM	10.57	<0.05	<5.0	<1.0	<1.0	<0.5	<1.0	288		
		4:15 PM										
IMC 4	14.04.2016 to 15.04.2016	11.35 PM										
		8:00 AM	12.28	<0.05	<5.0	<1.0	1.21	<0.5	1.20	275		
		4:15 PM										
IMC-5	18.04.2016 to 19.04.2016	11.35 PM										
		8:00 AM	12.51	<0.05	<5.0	<1.0	<1.0	<0.5	<1.0	316		
		4:15 PM										
IMC-6	21.04.2016 to 22.04.2016	11.35 PM										
		8:00 AM	10.77	<0.05	<5.0	<1.0	<1.0	<0.5	1.30	292		
		4:15 PM										
IMC 7	25.04.2016 to 26.04.2016	11.35 PM										
		8:00 AM	8.64	<0.05	<5.0	<1.0	1.37	<0.5	1.22	288		
		4:15 PM										
IMC-8	28.04.2016 to 29.04.2016	11.35 PM										
		8:00 AM	11.04	<0.05	<5.0	<1.0	<1.0	<0.5	<1.0	294		
		4:15 PM										
Monthly Average			10.65				1.51		1.21	293		
Standard Deviation			1.48				0.28		0.07	11		

Table 4: Results of Air Pollutant Concentration at RC Station of JNP Area during the month of April, 2016

Table 4: Results of Air Pollutant Concentration at RC Station of JNP Area during the month of April, 2016											
	Date	Time , [Hrs]	PM ₁₀ [µg/m ³]	PM _{2.5} [µg/m ³]	SO ₂ [µg/m ³]		NOx [µg/m ³]		NH3 [µg/m ³]		
Sampling Period NAAQMS limit			24hr 100 µg/m ³	24hr 60 µg/m ³	8 hr	24hr (Avg.) 80 µg/m ³	8 hr	24hr (Avg.) 80 µg/m ³	8 hr	24hr (Avg.) 400 µg/m ³	
RC-1	01.04.2016 to 02.04.2016	12:00AM	197	62	17.57	21.26	44.17	46.78	27.62	27.14	
		8:30 AM			20.59		39.89		31.67		
		4:45 PM			25.61		56.27		22.14		
RC-2	06.04.2016 to 07.04.2016	12:00AM	224	76	29.62	24.43	48.44	45.12	36.43	29.29	
		8:30 AM			22.59		36.33		30.24		
		4:45 PM			21.09		50.58		21.19		
RC-3	11.04.2016 to 12.04.2016	12:00AM	172	57	34.14	29.12	56.28	46.54	50.24	43.33	
		8:30 AM			24.60		43.45		34.05		
		4:45 PM			28.62		39.89		45.71		
RC-4	14.04.2016 to 15.04.2016	12:00AM	268	83	20.59	26.61	59.84	52.71	36.19	30.16	
		8:30 AM			25.61		51.29		30.47		
		4:45 PM			33.64		47.01		23.01		
RC-5	18.04.2016 to 19.04.2016	12:00AM	141	51	27.86	30.71	53.22	55.73	32.62	30.63	
		8:30 AM			33.64		49.86		30.71		
		4:45 PM			30.63		64.11		28.57		
RC-6	21.04.2016 to 22.04.2016	12:00AM	193	68	26.61	31.97	37.04	46.06	30.24	33.17	
		8:30 AM			31.13		54.85		33.57		
		4:45 PM			38.16		46.30		35.71		
RC-7	25.04.2016 to 26.04.2016	12:00AM	252	78	25.10	24.60	44.17	43.69	45.95	36.70	
		8:30 AM			18.58		37.75		35.33		
		4:45 PM			30.13		49.15		28.81		
RC-8	28.04.2016 to 29.04.2016	12:00AM	137	54	36.65	35.82	60.55	63.40	23.33	33.09	
		8:30 AM			42.18		73.37		26.90		
		4:45 PM			28.62		56.28		49.05		
Monthly Average			198	66		27.35		50.00		32.94	
Standard Deviation			48	12		4.74		6.77		5.10	

Table 4: Results of Air Pollutant Concentration at RC Station of JNP Area during the month of April, 2016										
	Date	Time, [Hrs]	O ₃ [$\mu\text{g}/\text{m}^3$]	Pb [$\mu\text{g}/\text{m}^3$]	As [$\mu\text{g}/\text{m}^3$]	Ni [$\mu\text{g}/\text{m}^3$]	C ₆ H ₆ [$\mu\text{g}/\text{m}^3$]	U(a)P [$\mu\text{g}/\text{m}^3$]	CO [mg/m^3]	CO ₂ [ppm]
Sampling Period			0 hr	24hr	24hr (Avg)	24hr (Avg)	0 hr	24hr (Avg)	Grab Sampling	Grab Sampling
NAAQMS Limit			100 $\mu\text{g}/\text{m}^3$	1.0 $\mu\text{g}/\text{m}^3$	6 ng/m^3	20 ng/m^3	5.0 $\mu\text{g}/\text{m}^3$	1.0 ng/m^3	4.0 mg/m^3	
RC 1	01.04.2016 to 02.04.2016	12:00AM	12.24	<0.05	<5.0	<1.0	<1.0	<0.5	1.21	288
		8:30 AM								
		4:45 PM								
RC 2	06.04.2016 to 07.04.2016	12:00AM	11.31	<0.05	<5.0	<1.0	1.44	<0.5	<1.0	277
		8:30 AM								
		4:45 PM								
RC-3	11.04.2016 to 12.04.2016	12:00AM	9.68	<0.05	<5.0	<1.0	<1.0	<0.5	1.18	286
		8:30 AM								
		4:45 PM								
RC-4	14.04.2016 to 15.04.2016	12:00AM	10.11	<0.05	<5.0	<1.0	1.37	<0.5	<1.0	283
		8:30 AM								
		4:45 PM								
RC 5	18.04.2016 to 19.04.2016	12:00AM	10.47	<0.05	<5.0	<1.0	<1.0	<0.5	1.46	269
		8:30 AM								
		4:45 PM								
RC-6	21.04.2016 to 22.04.2016	12:00AM	8.45	<0.05	<5.0	<1.0	1.41	<0.5	1.14	253
		8:30 AM								
		4:45 PM								
RC-7	25.04.2016 to 26.04.2016	12:00AM	9.79	<0.05	<5.0	<1.0	1.26	<0.5	<1.0	295
		8:30 AM								
		4:45 PM								
RC 8	20.04.2016 to 29.04.2016	12:00AM	12.66	<0.05	<5.0	<1.0	<1.0	<0.5	<1.0	311
		8:30 AM								
		4:45 PM								
Monthly Average			10.59				1.37		1.25	283
Standard Deviation			1.41				0.08		0.14	17

Table 5: Results of Air Pollutant Concentration at EC Station of JNP Area during the month of April, 2016

Date	Time (Hrs)	PM ₁₀ [$\mu\text{g}/\text{m}^3$]	PM _{2.5} [$\mu\text{g}/\text{m}^3$]	SO ₂ [$\mu\text{g}/\text{m}^3$]	NOx [$\mu\text{g}/\text{m}^3$]	NEB [$\mu\text{g}/\text{m}^3$]
Sampling Period		24hr	24hr	8 hr	8 hr	8 hr
NAAQMS Limit		100 $\mu\text{g}/\text{m}^3$	60 $\mu\text{g}/\text{m}^3$	80 $\mu\text{g}/\text{m}^3$	80 $\mu\text{g}/\text{m}^3$	400 $\mu\text{g}/\text{m}^3$
EC	09.04.2016 10:00 PM			10.04	28.49	21.19
	to 7:00 AM	102	32	13.56	20.65	17.14
	10.04.2016 3:00 PM			7.03	35.62	24.52
Monthly Average		102	32		28.25	20.95
Standard Deviation		-	-	-	-	-

Table 5: Results of Air Pollutant Concentration at EC Station of JNP Area during the month of April, 2016

Date	Time (Hrs)	O ₃ [$\mu\text{g}/\text{m}^3$]	Pb [$\mu\text{g}/\text{m}^3$]	As [$\mu\text{g}/\text{m}^3$]	Ni [$\mu\text{g}/\text{m}^3$]	C ₆ H ₆ [$\mu\text{g}/\text{m}^3$]	B(a)P [$\mu\text{g}/\text{m}^3$]	CO [$\mu\text{g}/\text{m}^3$]	CO ₂ [ppm]
Sampling Period		8 hr	24hr	24hr (Avg)	24hr (Avg)	8 hr	24hr (Avg)	Grab Sampling	Grab Sampling
NAAQMS Limit		100 $\mu\text{g}/\text{m}^3$	1.0 $\mu\text{g}/\text{m}^3$	6 $\mu\text{g}/\text{m}^3$	20 $\mu\text{g}/\text{m}^3$	5.0 $\mu\text{g}/\text{m}^3$	1.0 $\mu\text{g}/\text{m}^3$	4.0 mg/m^3	-
EC	09.04.2016 10:00 PM								
	to 7:00 AM	8.71	<0.05	<5.0	<1.0		<1.0	<0.5	270
	10.04.2016 3:00 PM								
Monthly Average		8.71	-	-	-	-	-	-	270
Standard Deviation		-	-	-	-	-	-	-	-

Table 6 : Results of Air Pollutant Concentration at NGC Station of JNP Area during the month of April, 2016

Table 6 :Results of Air Pollutant Concentration at NGC Station of [NP] Area during the month of April, 2016								
	Date	Time (Hrs)	PM ₁₀ [µg/m ³]	PM _{2.5} [µg/m ³]	SO ₂ [µg/m ³]		NOx [µg/m ³]	
Sampling Period			24hr	24hr	8hr	24hr (Avg)	8 hr	24hr (Avg)
NAAQS limit			100 µg/m ³	60 µg/m ³		80 µg/m ³		400 µg/m ³
NGC-1	01.04.2016 to 02.04.2016	11:00 PM			17.57		27.78	22.62
		7:30 AM	214	86	20.08	20.08	36.33	33.72
		3:30 PM			22.59		37.04	22.38
NGC-2	14.04.2016 to 15.04.2016	11:00 PM			23.10		58.41	31.19
		7:30 AM	198	68	29.62	30.13	49.15	52.95
		3:30 PM			37.66		51.29	26.90
NGC-3	21.04.2016 to 22.04.2016	11:00 PM			39.66		42.03	26.19
		7:30 AM	207	73	30.13	38.16	69.81	59.13
		3:30 PM			44.69		65.54	32.38
NGC-4	28.04.2016 to 29.04.2016	11:00 PM			49.15		22.39	26.67
		7:30 AM	226	89	37.04	42.50	24.60	22.42
		3:30 PM			41.32		20.08	33.09
Monthly Average			211	79		32.72		42.05
Standard Deviation			12	10		9.36		16.98
								5.39

Table 6 : Results of Air Pollutant Concentration at NGC Station of JNP Area during the month of April, 2016										
Sampling Period	Date	Time, [Hrs]	O ₃ [µg/m ³]	Pb [µg/m ³]	As [ng/m ³]	Ni [ng/m ³]	C ₆ H ₆ [µg/m ³]	B(a)P [ng/m ³]	CO [mg/m ³]	CO ₂ [ppm]
NAAQMS limit			100 µg/m ³	1.0 µg/m ³	6 ng/m ³	20 ng/m ³	5.0 µg/m ³	1.0 ng/m ³	4.0 mg/m ³	-
NGC-1	01.04.2016 to 02.04.2016	11:00 PM	11.74	<0.05	<5.0	<1.0	1.56	<0.5	1.30	310
		7:30 AM								
		3:30 PM								
NGC-2	14.04.2016 to 15.04.2016	11:00 PM	10.93	<0.05	<5.0	<1.0	1.37	<0.5	1.25	284
		7:30 AM								
		3:30 PM								
NGC-3	21.04.2016 to 22.04.2016	11:00 PM	8.51	<0.05	<5.0	<1.0	<1.0	<0.5	1.39	297
		7:30 AM								
		3:30 PM								
NGC-4	28.04.2016 to 29.04.2016	11:00 PM	8.28	<0.05	<5.0	<1.0	1.22	<0.5	1.42	281
		7:30 AM								
		3:30 PM								
Monthly Average			9.87	-	-	-	1.38	-	1.34	293
Standard Deviation			1.7	-	-	-	0.2	-	0.1	13.3

Table 7: Results of Air Pollutant Concentration at SGC Station of JNP Area during the month of April, 2016

Sampling Period	Date	Time, [Hrs]	PM ₁₀ [$\mu\text{g}/\text{m}^3$]	PM _{2.5} [$\mu\text{g}/\text{m}^3$]	SO ₂ [$\mu\text{g}/\text{m}^3$]		NOx [$\mu\text{g}/\text{m}^3$]		NH ₃ [$\mu\text{g}/\text{m}^3$]	
					8 hr	24hr (Avg.)	8 hr	24hr (Avg.)	8 hr	24hr (Avg.)
NAAQMS limit			100 $\mu\text{g}/\text{m}^3$	60 $\mu\text{g}/\text{m}^3$		80 $\mu\text{g}/\text{m}^3$		80 $\mu\text{g}/\text{m}^3$		400 $\mu\text{g}/\text{m}^3$
SGC-1	06.04.2016 to 07.04.2016	11:00 PM	117	63	25.61	33.98	48.44	50.10	22.62	24.76
		7:30 AM			33.64		45.59		17.38	
		3:30 PM			42.68		56.28		34.28	
SGC-2	11.04.2016 to 12.04.2016	11:00 PM	154	72	32.64	34.14	42.74	45.83	31.67	26.43
		7:30 AM			29.12		39.89		22.14	
		3:30 PM			40.67		54.85		25.47	
SGC-3	18.04.2016 to 19.04.2016	11:00 PM	193	85	32.64	31.80	53.43	54.38	27.62	27.70
		7:30 AM			35.15		61.26		31.43	
		3:30 PM			27.61		48.44		24.05	
SGC-4	25.04.2016 to 26.04.2016	11:00 PM	221	91	27.61	33.47	58.41	47.49	38.09	33.89
		7:30 AM			33.14		49.15		36.19	
		3:30 PM			39.66		34.91		27.38	
Monthly Average			171	78	-	33.35	-	49.45	-	28.19
Standard Deviation			45	13	-	1.07	-	3.73	-	3.98

Table 7: Results of Air Pollutant Concentration at SGC Station of JNP Area during the month of April, 2016

	Date	Time, [Hrs]	O ₃ [µg/m ³]	Pb [µg/m ³]	As [ng/m ³]	Ni [ng/m ³]	C ₆ H ₆ [µg/m ³]	B(a)P [ng/m ³]	CO [mg/m ³]	CO ₂ [ppm]
Sampling Period			8 hr	24hr	24hr (Avg)	24hr (Avg)	8 hr	24hr (Avg)	Grab Sampling	Grab Sampling
NAAQMS limit			100 µg/m ³	1.0 µg/m ³	6 ng/m ³	20 ng/m ³	5.0 µg/m ³	1.0 ng/m ³	4.0 mg/m ³	-
SGC-1	06.04.2016 to 07.04.2016	11:00 PM	11.59	<0.05	<5.0	<1.0	1.45	<0.5	1.35	285
		7:30 AM								
		3:30 PM								
SGC-2	11.04.2016 to 12.04.2016	11:00 PM	12.15	<0.05	<5.0	<1.0	<1.0	<0.5	1.38	291
		7:30 AM								
		3:30 PM								
SGC-3	18.04.2016 to 19.04.2016	11:00 PM	13.31	<0.05	<5.0	<1.0	1.27	<0.5	1.34	307
		7:30 AM								
		3:30 PM								
SGC-4	25.04.2016 to 26.04.2016	11:00 PM	9.37	<0.05	<5.0	<1.0	<1.0	<0.5	1.29	276
		7:30 AM								
		3:30 PM								
Monthly Average			11.61	-	-	-	1.36	-	1.34	290
Standard Deviation			1.65	-	-	-	0.13	-	0.04	13

1.4 DISCUSSION

In **Table 8**, the average values of air pollutants are provided at various stations of JNP area for April, 2016. The values obtained are compared with respective CPCB standards described for Industrial, Residential, Rural and ecologically sensitive areas. The values obtained for As, Ni and Benzo (α) Pyrene [BaP] are below detection limits of measurements at all air monitoring stations and hence these parameters are not included in **Table 8**.

Table 8: Monthly Average Values of Air Pollutants at Various Stations in JNP Area during April, 2016

STATION	PM ₁₀ , [$\mu\text{g}/\text{m}^3$]	PM _{2.5} , [$\mu\text{g}/\text{m}^3$]	SO ₂ , [$\mu\text{g}/\text{m}^3$]	NO _x , [$\mu\text{g}/\text{m}^3$]	NH ₃ , [$\mu\text{g}/\text{m}^3$]	O ₃ , [$\mu\text{g}/\text{m}^3$]	Pb [$\mu\text{g}/\text{m}^3$]	C ₆ H ₆ , [$\mu\text{g}/\text{m}^3$]	CO, [mg/m ³]	CO ₂ , [ppm]
NAAQS	100	60	80	80	400	100	1	5	4	-
INDUSTRIAL AREA										
POC	178 \pm 49	68 \pm 8	20.65 \pm 4.28	58.57 \pm 16.27	31.58 \pm 9.47	25.21 \pm 2.10	<0.01	1.15 \pm 0.10	1.19 \pm 0.2	235 \pm 16.7
IMC	259 \pm 70	92 \pm 15	21.59 \pm 4.90	51.96 \pm 10.79	32.30 \pm 4.70	22.97 \pm 1.29	<0.01	1.28 \pm 0.16	1.16 \pm 0.12	244 \pm 19
NG	187 \pm 11	77 \pm 12	21.97 \pm 6.75	47.02 \pm 21.90	25.23 \pm 2.88	21.61	<0.01	1.14	1.25	248 \pm 17.3
SG	146 \pm 43	80 \pm 8	32.96 \pm 5.06	43.50 \pm 8.07	31.05 \pm 2.72	22.62	<0.01	1.22	1.18 \pm 0.04	219 \pm 10
RESIDENTIAL AREA										
RC	209 \pm 108	81 \pm 10	24.23 \pm 10.59	43.12 \pm 17.0	28.23 \pm 9.69	21.78 \pm 0.42	<0.01	1.3 \pm 0.2	1.35 \pm 0.09	239 \pm 16
ECO-SENSITIVE AREA										
EC	121	28	10.95	32.77	24.6	<20.0	<0.01	<1.0	<1.0	245

During the monitoring period, the overall Ambient Air Quality of the port area was found to be well within the desired levels for various pollutants. Daily average pollutant levels are presented in **Tables 2 to 7**. However, the concentrations obtained for particulate matter PM₁₀ and PM_{2.5} at all stations were mostly found to be exceeding the prescribed CPCB limits of 100 $\mu\text{g}/\text{m}^3$ and 60 $\mu\text{g}/\text{m}^3$, respectively except in some instances, when PM_{2.5} was within prescribed standards of NAAQS at POC, IMC and RC. All other pollutants were recorded well below the prescribed limits.

Results for the air quality parameters at Elephanta Caves [EC] station during 9th April'16 to 10th April'16 are represented in **Table 5** which indicates PM_{2.5} was within the standard limits, **Tables 6 & 7** provide the results for NGC and SGC air monitoring stations respectively. NSG and SGC always showed high values of PM₁₀ and PM_{2.5} during April 2016.

In April, 2016 gaseous pollutants were well within the prescribed limits, set for industrial as well as sensitive areas.

1.5 OBSERVATIONS AND CONCLUSIONS

The environmental implications of a port and harbor operational activities must be considered prior to further developments. The process of environmental assessment involves an analysis of the quality of the existing environment due to the port and harbor operational activities and any degradation in the environmental quality because of the execution of additional developmental expansions within the region. Keeping in view the above said objectives, the present environmental monitoring study has been conducted for the JNP to assess Ambient Air Quality. Following are the monthly observations.

Observations for the month of March 2016:

- ✓ All the public and community buildings in residential complex / township are under Renovation. Being temporary activity; it will not affect ambient air quality in the long run. Existing Ambient air Quality of all stations is well within CPCB permissible limits (Annexure-2) except for PM₁₀ and PM_{2.5} viz, 100µg/m³ and 60µg/m³, respectively, which are mostly higher than the prescribed CPCB standards.
- ✓ *Construction of 4th Container Terminal on South side of JNPT:* Land preparation work of 4th C.T. is underway close to South Gate : The transportation of soil and earth shall be considered a vital part as it is potential source of particulates. The overall ambient air quality around the Port area shows no adverse effect. Increase in the PM₁₀ and PM_{2.5} Concentration at South Gate may be attributed due to the earth filling activity of 4th C.T. Where there is heavy traffic movement of Dumpers carrying earth filling materials. These dumpers are seen ferrying without any tarpaulin cover.
- ✓ *Construction of NSIGT Yard is underway to the North side of JNPT:* The nearest Ambient Air Monitoring location is North gate Complex. The overall values of gaseous parameters at this location are well within the CPCB limits except for PM₁₀ and PM_{2.5} Concentration which are found exceeding the CPCB limits. The development of yard for NSIGT and heavy vehicular movement are the probable cause of the elevated values of PM₁₀ and PM_{2.5} Concentration at NGC.
- ✓ *Vehicular Traffic at the gates:* The monitoring of ambient air Quality at South and North gate complexes has been done once a week. These locations are protected by some controlling steps like initiative taken by the port in terms of maintenance of port vehicles & PUC checking of the vehicles visiting port area and enough green cover provided in and around the area accounting as pollutant trap. This will significantly contribute to reduce overall pollution.
- ✓ Road connecting tank farm and township is being updated with construction of over bridge on the railway crossing. Land preparation and foundation work continued during the month of April, 2016 for the Rail over bridge. Nearest location i.e. RC does not show any adverse impact due to this activity. All the AAQM parameters are well within the prescribed CPCB limits except the values of PM₁₀ and PM_{2.5}.

The following measures can be taken to reduce further the PM₁₀ and PM_{2.5} levels in and around the port area:

- ✓ Renovation work, being carried out at JNP Township, should be executed under controlled conditions like covering the close-by area with mesh cloth to prevent dust flow or using a suction system near the construction area.
- ✓ Maximum use of tar roads.
- ✓ Debris and raw material carrying trucks must be covered with tarpaulin sheet during transportation.
- ✓ Minimizing emissions by regular maintenance and PUC checkup of vehicles.
- ✓ Increasing the plantations in and around the port area as well as developing and maintaining thick green cover on both sides of the roads and tank farms.
- ✓ Cleaning and maintaining of paved and unpaved roads regularly to remove spillage of earth/soil material.
- ✓ Regular sprinkling of water at Construction of 4th Container Terminal is required to be done, as significant amount of dust is generated due to earth filling activities at the site.

	
Civil Work at JNP Township	Land Preparation at 4th Container Terminal
	
Construction of yard near POC	NSIGT Yard filling work

Conclusion:

From the results obtained for the month of April 2016, it can be concluded that overall Ambient Air quality of the JN Port is within CPCB limits, except the levels of PM₁₀ and PM_{2.5}, which are higher at all locations due to port development activities.

2. MARINE WATER QUALITY MONITORING [HARBOR& CREEK] INCLUDING STUDY OF SEDIMENT CHARACTERISTICS

2.1 INTRODUCTION

For study of Marine ecology, Total 8 fixed harbor stations [W1 to W7 and W9] and 1 movable station [W8/W10] are identified. At Nhava creek 4 fixed stations [W11 to W14] are identified. All above mentioned stations are selected for studying aquatic flora and fauna as well as benthic fauna. The description of stations is mentioned in **Table 9**. The location map of various Marine ecology monitoring stations along with direction of towing is depicted in **Annexure-IV**.

2.2 MARINE WATER QUALITY MONITORING METHODOLOGY

The objective of Marine water quality monitoring is to assess compliance with statutory water quality objectives, to reveal long term changes in water quality and to provide a basis for the planning of pollution control strategies.

Harbour Water Quality Monitoring – Three samples viz., surface, mid depth and bottom waters are collected and composite for each 1st, 3rd and 5th hour of the tide from eight fixed and one moving stations and composited for each harbour water quality monitoring station. In all 54 samples are collected from nine stations.

Creek Water Quality Monitoring– Three samples viz., surface, mid depth and bottom waters are collected and composite from four water quality monitoring stations in the Nhava Creek during the 1st, 3rd and 5th hour of the tide. In all 24 Samples are collected from 4 Nhava creek stations.

Study of Sediment Characteristics – Sediment samples are collected from all 13 stations.

The list of parameters analyzed to assess the Marine Water Quality is presented in **Table 10** along with parameters monitored for sediment characterization. **Annexure-V** describes Primary Water Quality Criterion for **Class SW-IV** Waters (For Harbour Waters).

Table 9: Description of Marine Water Quality Monitoring Stations

Sr. No.	Station	Description	Date of Sampling
1.	W1	Between Elephanta and Nhava Islands, and can be identified at the last green buoy no. <u>F1Green</u> of JNPT approach channel and just opposite to ONGC Depot at the Nhava Island.	9.04.2016
2.	W2	Denoted by buoy no. <u>FG2 RED</u> of JNPT channel. It is near the Elephanta Island, and opposite to Port Craft Jetty	9.04.2016
3.	W3	Identified by the green buoy no. <u>FG2 Green</u> of JNPT approach channel and lies near the landing jetty.	10.04.2016
4.	W4	Located at Uran Patch Beacon (lighthouse on concrete platform) near the Butcher Island filling platform.	10.04.2016
5.	W5	W5 is near to the guide bund and others are along Nhava creek upto Belpada. These are selected to examine the impact of neighboring Nhava Villages and Belpada to the creek water quality.	9.04.2016
	W11 to W14		11.04.2016
6.	W6	This is a mobile station and hence its location is changed during every visit. This sampling station was selected in order to examine the variation of water quality in the area not represented by the fixed stations.	9.04.2016
7.	W7	This station is located near landing jetty. This station was selected in order to examine the water quality due to liquid cargo jetty.	10.04.2016
8.	W9	Located in between GTI and Liquid Cargo Jetty. This station is selected to examine the impact of terminal activities on water qualities	10.04.2016
9.	W8/W10	Located near proposed chemical berth. These stations are variable and selected to examine the impact of proposed chemical terminal and IVth Container terminal activities on water quality.	10.04.2016

Table 10: List of Parameters Monitored for Marine Water Quality

Marine Water Quality Parameters [Harbor Area & Creek Area]
<p>A] Physical parameters of Water: Depth, Temperature, pH, Salinity, Turbidity, Total Solids, Total Dissolved Solids, Total Suspended Solids, Silica, Phosphate, Sulphate, Nitrite, Nitrate, Calcium, Magnesium, Sodium, Potassium</p>
<p>B] Bio-chemical Analysis of Water: Dissolved Oxygen, COD [Chemical Oxygen Demand], BOD [Biochemical Oxygen Demand], NH₃-N, Phenol, Oil & Grease, SPC [Standard Plate Count], Bacteriological count [MPN], Fecal Coliform</p>
<p>C] Sediment Analysis: Total Organic Matter, Organic Carbon, Inorganic Phosphates</p>

2.3 RESULTS

The marine water quality data of nine Harbor water quality monitoring stations, viz., W1 to W7, W9 & W10 are presented in –

Table 11 for Physico-chemical parameters,

Table 12 for Bio-chemical parameters and

Table 13 for Sediment samples collected at these nine locations.

The creek water quality data for four Nhava creek water quality monitoring stations are reported in –

Table 14 for Physico-chemical parameters,

Table 15 for Bio-chemical parameters and

Table 16 for Sediment samples, collected at these locations.

Table 11: Results of Physical parameters of Water Samples Collected from JNP Harbor Area during April 2016

Sample Name		Depth,	Temp.,	Temp., (Average)	pH	pH (Average)	Salinity,	Salinity (Average)
		[m]	[°C]		-	-	[ppt]	
Standard		-	-		6.5 - 9.0		-	
W1	1st	Surface	28.8	28.9	7.68	7.66	33.4	35.6
		Middle						
		Bottom						
	3rd	Surface	29.1		7.09		35.3	
		Middle						
		Bottom						
	5th	Surface	28.9		8.20		38.2	
		Middle						
		Bottom						
W2	1st	Surface	27.9	29.1	7.43	7.83	37.5	33.9
		Middle						
		Bottom						
	3rd	Surface	29.3		8.18		32.9	
		Middle						
		Bottom						
	5th	Surface	30.2		7.89		31.4	
		Middle						
		Bottom						
W3	1st	Surface	30.6	29.6	8.31	8.10	34.3	33.6
		Middle						
		Bottom						
	3rd	Surface	29.7		8.46		35.2	
		Middle						
		Bottom						
	5th	Surface	28.5		7.53		31.4	
		Middle						
		Bottom						
W4	1st	Surface	30.9	29.5	7.18	7.59	32.4	35.7
		Middle						
		Bottom						
	3rd	Surface	29.4		8.02		38.6	
		Middle						
		Bottom						
	5th	Surface	28.3		7.57		36.0	
		Middle						
		Bottom						

Sample Name		Depth,	Turbidity,	Turbidity (Average)	TDS,	TDS (Average)	TSS,	TSS (Average)	TS,	TS (Average)
		[m]	[NTU]		[mg/L]		[mg/L]		[mg/L]	
Standard		-	-		-		-		-	
W1	1st	Surface	55.5	50.3	30800	32323	253	161	42428	41680
		Middle								
		Bottom								
	3rd	Surface	35.7		30200		128		40120	
		Middle								
		Bottom								
	5th	Surface	59.7		35968		102		42492	
		Middle								
		Bottom								
W2	1st	Surface	54.1	53.4	33500	32990	160	173	41800	41264
		Middle								
		Bottom								
	3rd	Surface	53.8		31200		122		40392	
		Middle								
		Bottom								
	5th	Surface	52.4		34269		238		41600	
		Middle								
		Bottom								
W3	1st	Surface	37.0	37.7	31200	32551	93	155	40564	41213
		Middle								
		Bottom								
	3rd	Surface	39.0		32590		159		39713	
		Middle								
		Bottom								
	5th	Surface	37.0		33862		212		43361	
		Middle								
		Bottom								
W4	1st	Surface	34.0	29.3	32093	32678	269	208	42189	42798
		Middle								
		Bottom								
	3rd	Surface	24.0		31107		114		42884	
		Middle								
		Bottom								
	5th	Surface	30.0		34834		241		43320	
		Middle								
		Bottom								

Sample Name		Depth,	Temp.,	Temp., (Average)	pH	pH (Average)	Salinity,	Salinity (Average)
		[m]	[°C]		-	-	[ppt]	
Standard		-	-		6.5 - 9.0		-	
W5	1st	Surface	29.9	29.3	7.60	7.87	34.8	34.2
		Middle						
		Bottom						
	3rd	Surface	29.4		8.24		31.4	
		Middle						
		Bottom						
	5th	Surface	28.6		7.76		36.5	
		Middle						
		Bottom						
W6	1st	Surface	29.4	28.7	7.85	7.77	35.0	35.2
		Middle						
		Bottom						
	3rd	Surface	28.1		7.52		35.7	
		Middle						
		Bottom						
	5th	Surface	28.7		7.93		34.8	
		Middle						
		Bottom						
W7	1st	Surface	27.9	28.5	8.09	7.57	33.6	33.1
		Middle						
		Bottom						
	3rd	Surface	28.5		7.42		32.0	
		Middle						
		Bottom						
	5th	Surface	29.1		7.20		33.8	
		Middle						
		Bottom						
W9	1st	Surface	30.1	30.1	8.39	8.23	32.9	32.6
		Middle						
		Bottom						
	3rd	Surface	29.7		8.31		31.8	
		Middle						
		Bottom						
	5th	Surface	30.6		7.99		33.0	
		Middle						
		Bottom						
W10	1st	Surface	30.5	29.5	8.01	8.04	32.1	33.3
		Middle						
		Bottom						
	3rd	Surface	29.4		8.18		33.4	
		Middle						
		Bottom						
	5th	Surface	28.6		7.92		34.5	
		Middle						
		Bottom						
Min.			27.9		7.09		31.4	
Max.			30.9		8.46		38.6	

Sample Name		Depth,	Turbidity,	Turbidity (Average)	TDS,	TDS (Average)	TSS,	TSS (Average)	TS,	TS (Average)
		[m]	[NTU]		[mg/L]		[mg/L]		[mg/L]	
Standard		-	-		-		-		-	
W5	1st	Surface	31.0	37.8	33459	32980	109	110	40100	41868
		Middle								
		Bottom								
	3rd	Surface	32.0		34280		75		42496	
		Middle								
		Bottom								
	5th	Surface	50.3		31200		145		43008	
		Middle								
Bottom										
W6	1st	Surface	39.0	23.9	32288	32061	84	156	44300	43655
		Middle								
		Bottom								
	3rd	Surface	13.4		30400		252		44256	
		Middle								
		Bottom								
	5th	Surface	19.4		33494		132		42410	
		Middle								
Bottom										
W7	1st	Surface	11.8	26.9	29600	31745	163	227	44928	43589
		Middle								
		Bottom								
	3rd	Surface	32.0		31732		241		43350	
		Middle								
		Bottom								
	5th	Surface	37.0		33904		278		42490	
		Middle								
Bottom										
W9	1st	Surface	18.0	15.9	30972	31836	233	175	40384	40753
		Middle								
		Bottom								
	3rd	Surface	18.2		34335		114		39900	
		Middle								
		Bottom								
	5th	Surface	11.5		30200		177		41976	
		Middle								
Bottom										
W10	1st	Surface	21.5	25.2	31200	33833	97	122	44472	43001
		Middle								
		Bottom								
	3rd	Surface	22.8		33451		158		43300	
		Middle								
		Bottom								
	5th	Surface	31.4		36847		110		41230	
		Middle								
Bottom										
Min.			11.5		29600		75		39713	
Max.			59.7		36847		278		44928	

Table 12: Results of Bio-Chemical Analysis of Water Samples Collected from JNP Harbor Area during April 2016

Sample Name		Depth,	DO,	DO Average	COD,	COD (Average)	BOD,	BOD (Average)	NH ₃ -N,	NH ₃ -N (Average)		
		[m]	[mg/L]		[mg/L]		[mg/L]		[mg/L]			
Standard		-	3.0 mg/L or 40% of saturation value		-		5		-			
W1	1st	Surface	6.2	5.8	65	73	<2.0	<2.0	<1.0	<1.0		
		Middle										
		Bottom										
	3rd	Surface	5.9		73		<2.0		<2.0		<1.0	<1.0
		Middle										
		Bottom										
	5th	Surface	5.7		81		<2.0		<1.0		<1.0	<1.0
		Middle										
		Bottom										
W2	1st	Surface	6.0	5.5	29	43	<2.0	<2.0	<1.0	<1.0		
		Middle										
		Bottom										
	3rd	Surface	5.6		57		<2.0		<2.0		<1.0	<1.0
		Middle										
		Bottom										
	5th	Surface	5.3		42		<2.0		<1.0		<1.0	<1.0
		Middle										
		Bottom										
W3	1st	Surface	6.5	6.1	34	49	<2.0	<2.0	<1.0	<1.0		
		Middle										
		Bottom										
	3rd	Surface	6.2		53		<2.0		<2.0		<1.0	<1.0
		Middle										
		Bottom										
	5th	Surface	5.9		61		<2.0		<1.0		<1.0	<1.0
		Middle										
		Bottom										
W4	1st	Surface	6.1	5.8	86	73	<2.0	<2.0	<1.0	<1.0		
		Middle										
		Bottom										
	3rd	Surface	5.8		73		<2.0		<2.0		<1.0	<1.0
		Middle										
		Bottom										
	5th	Surface	5.6		59		<2.0		<1.0		<1.0	<1.0
		Middle										
		Bottom										

Sample Name		Depth,	Phenol,	Phenol (Average)	O&G,	O & G (Average)	TPC,	TPC (Average)	Fecal Coliforms,	Fecal Coliforms, (Average)	
		[m]	[mg/L]		[mg/L]		[CFU/mL]		[MPN/100 mL]		
Standard		-	-		10		-		500		
W1	1st	Surface	<0.001	<0.001	<4.0	<4.0	61	61	18	18	
		Middle									
		Bottom									
	3rd	Surface	<0.001		<4.0	<4.0	-	61	-		18
		Middle									
		Bottom									
	5th	Surface	<0.001		<4.0	<4.0	-	61	-		18
		Middle									
		Bottom									
W2	1st	Surface	<0.001	<0.001	<4.0	<4.0	92	92	35	35	
		Middle									
		Bottom									
	3rd	Surface	<0.001		<4.0	<4.0	-	92	-		35
		Middle									
		Bottom									
	5th	Surface	<0.001		<4.0	<4.0	-	92	-		35
		Middle									
		Bottom									
W3	1st	Surface	<0.001	<0.001	<4.0	<4.0	59	59	42	42	
		Middle									
		Bottom									
	3rd	Surface	<0.001		<4.0	<4.0	-	59	-		42
		Middle									
		Bottom									
	5th	Surface	<0.001		<4.0	<4.0	-	59	-		42
		Middle									
		Bottom									
W4	1st	Surface	<0.001	<0.001	<4.0	<4.0	82	82	54	54	
		Middle									
		Bottom									
	3rd	Surface	<0.001		<4.0	<4.0	-	82	-		54
		Middle									
		Bottom									
	5th	Surface	<0.001		<4.0	<4.0	-	82	-		54
		Middle									
		Bottom									

Sample Name		Depth,	DO,	DO Average	COD,	COD (Average)	BOD,	BOD (Average)	NH ₃ -N,	NH ₃ -N (Average)		
		[m]	[mg/L]		[mg/L]		[mg/L]		[mg/L]			
Standard		-	3.0 mg/L or 40% of saturation value		-		5		-			
W5	1st	Surface	5.9	5.5	39	62	<2.0	<2.0	<1.0	<1.0		
		Middle										
		Bottom										
	3rd	Surface	5.6		66		<2.0		<2.0		<1.0	<1.0
		Middle										
		Bottom										
	5th	Surface	5.1		82		<2.0		<1.0		<1.0	<1.0
		Middle										
		Bottom										
W6	1st	Surface	5.8	5.4	52	72	<2.0	<2.0	<1.0	<1.0		
		Middle										
		Bottom										
	3rd	Surface	5.5		78		<2.0		<2.0		<1.0	<1.0
		Middle										
		Bottom										
	5th	Surface	4.9		85		<2.0		<1.0		<1.0	<1.0
		Middle										
		Bottom										
W7	1st	Surface	5.5	5.3	49	69	<2.0	<2.0	<1.0	<1.0		
		Middle										
		Bottom										
	3rd	Surface	5.3		56		<2.0		<2.0		<1.0	<1.0
		Middle										
		Bottom										
	5th	Surface	5.0		102		<2.0		<1.0		<1.0	<1.0
		Middle										
		Bottom										
W9	1st	Surface	6.1	5.8	61	78	<2.0	<2.0	<1.0	<1.0		
		Middle										
		Bottom										
	3rd	Surface	5.8		58		<2.0		<2.0		<1.0	<1.0
		Middle										
		Bottom										
	5th	Surface	5.5		115		<2.0		<1.0		<1.0	<1.0
		Middle										
		Bottom										
W10	1st	Surface	6.5	6.3	46	60	<2.0	<2.0	<1.0	<1.0		
		Middle										
		Bottom										
	3rd	Surface	6.4		72		<2.0		<2.0		<1.0	<1.0
		Middle										
		Bottom										
	5th	Surface	6.0		63		<2.0		<1.0		<1.0	<1.0
		Middle										
		Bottom										
Min.			4.9		29		0		0			
Max.			6.8		115		0		0			

Sample Name		Depth,	Phenol,	Phenol (Average)	O&G,	O & G (Average)	TPC,	TPC (Average)	Fecal Coliforms,	Fecal Coliforms, (Average)		
		[m]	[mg/L]		[mg/L]		[CFU/mL]		[MPN/100 mL]			
Standard		-	-		10		-		500			
W5	1st	Surface	<0.001	<0.001	<4.0	<4.0	29	29	18	18		
		Middle										
		Bottom										
	3rd	Surface	<0.001		<4.0		<4.0		-		29	-
		Middle										
		Bottom										
	5th	Surface	<0.001		<4.0		<4.0		-		-	-
		Middle										
		Bottom										
W6	1st	Surface	<0.001	<0.001	<4.0	<4.0	57	57	36	36		
		Middle										
		Bottom										
	3rd	Surface	<0.001		<4.0		<4.0		-		57	-
		Middle										
		Bottom										
	5th	Surface	<0.001		<4.0		<4.0		-		-	-
		Middle										
		Bottom										
W7	1st	Surface	<0.001	<0.001	<4.0	<4.0	93	93	52	52		
		Middle										
		Bottom										
	3rd	Surface	<0.001		<4.0		<4.0		-		93	-
		Middle										
		Bottom										
	5th	Surface	<0.001		<4.0		<4.0		-		-	-
		Middle										
		Bottom										
W9	1st	Surface	<0.001	<0.001	<4.0	<4.0	84	84	6	6		
		Middle										
		Bottom										
	3rd	Surface	<0.001		<4.0		<4.0		-		84	-
		Middle										
		Bottom										
	5th	Surface	<0.001		<4.0		<4.0		-		-	-
		Middle										
		Bottom										
W10	1st	Surface	<0.001	<0.001	<4.0	<4.0	113	113	71	71		
		Middle										
		Bottom										
	3rd	Surface	<0.001		<4.0		<4.0		-		113	-
		Middle										
		Bottom										
	5th	Surface	<0.001		<4.0		<4.0		-		-	-
		Middle										
		Bottom										
Min.			0		0		29		6			
Max.			0		0		113		71			

Table 13: Results of Sediment Samples Collected from JNP Harbour Area during April 2016

Station Name	Organic Matter		Total Carbon		Inorganic Phosphate
	mg/g	%	mg/g	%	mg/kg
W1	149.2	14.92	69.8	6.98	243
W2	72.1	72.1	43.2	4.32	226
W3	132.5	13.25	74.3	7.43	234
W4	96.6	9.66	69.5	6.95	201
W5	102.4	10.24	40.4	4.04	329
W6	162.8	16.28	87.2	8.72	205
W7	123.5	12.35	53.9	5.39	185
W9	105.9	10.59	72.4	7.24	137
W10	183.1	18.31	78.2	7.82	304

Table 14: Results of Physico-Chemical Analysis of Water Samples from Nhava Creek Area

Sample Name		Depth,	Temp.,	Temp., (Average)	pH	pH (Average)	Salinity,	Salinity (Average)
		[m]	[°C]		-	-	[ppt]	
Standard		-	-		6.5 - 9.0		-	
W11	1st	Surface	28.4	29.33	7.89	8.1	33.5	34.3
		Middle						
		Bottom						
	3rd	Surface	29.5		8.02		35.6	
		Middle						
		Bottom						
	5th	Surface	30.1		8.28		33.7	
		Middle						
		Bottom						
W12	1st	Surface	28.6	28.9	7.93	7.63	33.4	34.5
		Middle						
		Bottom						
	3rd	Surface	29.7		7.41		36.0	
		Middle						
		Bottom						
	5th	Surface	28.4		7.56		34.2	
		Middle						
		Bottom						
W13	1st	Surface	29.5	29.9	8.40	8.25	33.8	35.2
		Middle						
		Bottom						
	3rd	Surface	30.3		7.91		36.0	
		Middle						
		Bottom						
	5th	Surface	29.8		8.43		35.8	
		Middle						
		Bottom						
W14	1st	Surface	29.1	29.2	8.34	8.35	36.4	35.3
		Middle						
		Bottom						
	3rd	Surface	30.2		8.26		35.2	
		Middle						
		Bottom						
	5th	Surface	28.4		8.46		34.3	
		Middle						
		Bottom						
Min.			28.4		7.41		33.4	
Max.			30.3		8.46		36.4	

Sample Name		Depth,	Turbidity,	Turbidity (Average)	TDS,	TDS (Average)	TSS,	TSS (Average)	TS,	TS (Average)
		[m]	[NTU]		[mg/L]		[mg/L]		[mg/L]	
Standard		-	-		-		-		-	
W11	1st	Surface	32.5	31.4	34186	34876	102	208.0	42224	43247.0
		Middle								
		Bottom								
	3rd	Surface	30.3		32630		260		44257	
		Middle								
		Bottom								
	5th	Surface	31.5		37812		262		43260	
		Middle								
		Bottom								
W12	1st	Surface	36.2	34.3	32133	32894	258	224.0	43400	44001.3
		Middle								
		Bottom								
	3rd	Surface	38.5		35748		264		46500	
		Middle								
		Bottom								
	5th	Surface	28.1		30800		150		42104	
		Middle								
		Bottom								
W13	1st	Surface	36.9	32.0	32975	33252	180	171.3	41700	43115.3
		Middle								
		Bottom								
	3rd	Surface	34.8		34181		172		43510	
		Middle								
		Bottom								
	5th	Surface	24.4		32600		162		44136	
		Middle								
		Bottom								
W14	1st	Surface	35.9	34.8	32081	34658	282	215.3	43260	43338.0
		Middle								
		Bottom								
	3rd	Surface	37.1		34266		260		43190	
		Middle								
		Bottom								
	5th	Surface	31.3		37628		104		43564	
		Middle								
		Bottom								
Min.			24.4		30800		102		41700	
Max.			38.5		37812		282		46500	

Table 15: Results of Bio-Chemical Analysis of Water Samples Collected from Nhava Creek

Sample Name		Depth,	DO,	DO	COD	COD	BOD	BOD	NH ₃ -N	NH ₃ -N		
		[m]	[mg/L]		[mg/L]		[mg/L]		[mg/L]			
Standard		-	3.0 mg/L or 40% of saturation value		-		5		-			
W11	1st	Surface	5.6	5.3	91	77	<2.0	<2.0	<1.0	<1.0		
		Middle										
		Bottom										
	3rd	Surface	5.3		63		<2.0		<2.0		<1.0	<1.0
		Middle										
		Bottom										
	5th	Surface	4.9		78		<2.0		<1.0		<1.0	<1.0
		Middle										
		Bottom										
W12	1st	Surface	5.1	4.8	85	75	<2.0	<2.0	<1.0	<1.0		
		Middle										
		Bottom										
	3rd	Surface	4.8		71		<2.0		<2.0		<1.0	<1.0
		Middle										
		Bottom										
	5th	Surface	4.5		69		<2.0		<1.0		<1.0	<1.0
		Middle										
		Bottom										
W13	1st	Surface	4.9	4.6	66	82	<2.0	<2.0	<1.0	<1.0		
		Middle										
		Bottom										
	3rd	Surface	4.7		82		<2.0		<2.0		<1.0	<1.0
		Middle										
		Bottom										
	5th	Surface	4.2		97		<2.0		<1.0		<1.0	<1.0
		Middle										
		Bottom										
W14	1st	Surface	4.5	4.2	72	75	<2.0	<2.0	<1.0	<1.0		
		Middle										
		Bottom										
	3rd	Surface	4.2		68		<2.0		<2.0		<1.0	<1.0
		Middle										
		Bottom										
	5th	Surface	3.9		84		<2.0		<1.0		<1.0	<1.0
		Middle										
		Bottom										
Min.			3.9		63		0		0			
Max.			5.3		97		0		0			

Sample Name		Depth,	Phenol,	Phenol (Average)	O&G	O & G (Average)	TPC	TPC (Average)	Fecal Coliforms	Fecal Coliforms, (Average)					
		[m]	[mg/L]		[mg/L]		[CFU/mL]		[MPN/100 mL]						
Standard		-	-		10		-		500						
W11	1st	Surface	<0.001	<0.001	<4.0	<4.0	106	106	28	28					
		Middle													
		Bottom													
	3rd	Surface	<0.001		<4.0		<4.0		-		106	-	28		
		Middle													
		Bottom													
	5th	Surface	<0.001		<4.0		-		106			-		28	
		Middle													
		Bottom													
W12	1st	Surface	<0.001	<0.001	<4.0	<4.0	82	82		56		56			
		Middle													
		Bottom													
	3rd	Surface	<0.001		<4.0		<4.0			-	82		-		56
		Middle													
		Bottom													
	5th	Surface	<0.001		<4.0		-		82	-			56		
		Middle													
		Bottom													
W13	1st	Surface	<0.001	<0.001	<4.0	<4.0	77	77		32		32			
		Middle													
		Bottom													
	3rd	Surface	<0.001		<4.0		<4.0			-	77			-	32
		Middle													
		Bottom													
	5th	Surface	<0.001		<4.0		-		77	-			32		
		Middle													
		Bottom													
W14	1st	Surface	<0.001	<0.001	<4.0	<4.0	85	85		41		41			
		Middle													
		Bottom													
	3rd	Surface	<0.001		<4.0		<4.0			-	85			-	41
		Middle													
		Bottom													
	5th	Surface	<0.001		<4.0		-		85	-			41		
		Middle													
		Bottom													
Min.			0		0		77			28					
Max.			0		0		106			56					

Table 16: Results of Sediment Samples Collected from Nhava Creek during April 2016

Station Name	Organic Matter		Total Carbon		Inorganic Phosphate
	mg/g	%	mg/g	%	mg/kg
W11	86	8.6	42.3	4.23	192
W12	114	11.4	51.6	5.16	205
W13	92	9.2	46.7	4.67	234
W14	80	8	45.7	4.57	143

2.4 DISCUSSION

Observed concentration ranges of various parameters for Marine Water of Harbour and NhavaCreek regions are presented in **Tables 17 and 18** respectively. The observed values are compared with Primary Water Quality Criteria for **Class IV Waters** [Harbour Waters] given by CPCB [refer **Annexure V**].

Table 17: Observed Concentration Ranges of Marine Water for Various Parameters for JNP Harbour Area

Sr. No.	Parameter	Observed Range	Unit	Prescribed Limits
1	Temperature	27.9 – 30.9	°C	-
2	pH	7.09-8.46	-	6.5 - 9.0
3	Salinity	31.4 – 38.6	ppt	-
4	Turbidity	11.5-59.7	NTU	-
5	TDS	29600 – 36847	mg/L	-
6	TSS	75 – 278	mg/L	-
7	TS	39713 – 44928	mg/L	-
8	DO	4.9 – 6.8	mg/L	3.0 mg/L(min.) or 40% of saturation value
9	COD	29 – 115	mg/L	-
10	BOD	<2.0	mg/L	5 (max.)
11	NH ₃ -N	<1.0	mg/L	-
12	Phenol	< 0.001	mg/L	-
13	Oil & Grease	<4.0	mg/L	10 (max.)
14	Total Plate Count	29-113	CFU/ml	-
15	Fecal Coliforms	6-71	MPN/100 mL	500 (max.)

Table 18: Observed Concentration Ranges of Marine Water for Various Parameters for Nhava Creek Area

Sr. No.	Parameter	Observed Range	Unit	Prescribed Limits
1	Temperature	28.4– 30.3	°C	-
2	pH	7.4 – 8.5	-	6.5 - 9.0
3	Salinity	33.4 – 36.4	ppt	-
4	Turbidity	24.4 – 38.5	NTU	-
5	TDS	30800 – 37812	mg/L	-
6	TSS	102 – 282	mg/L	-
7	TS	41700 – 46500	mg/L	-
8	DO	3.9 – 5.3	mg/L	3.0 mg/L(min.) or 40% of saturation value
9	COD	63-97	mg/L	-
10	BOD	<2.0	mg/L	5 (max.)
11	NH ₃ -N	<1.0	mg/L	-
12	Phenol	< 0.001	mg/L	-
13	Oil & Grease	<4.0	mg/L	10 (max.)
14	Total Plate Count	77 – 106	CFU/ml	-
15	Fecal Coliforms	28 – 56	MPN/100 mL	500 (max.)

It is seen from **Table 17** that, the values of various parameters such as pH, Dissolved Oxygen, BOD, Oil & Grease and *Fecal coliforms* obtained for water samples collected from JNP Harbour area during the month of April , 2016 are within the prescribed limits. Also, the concentration ranges observed for various parameters for water samples collected from Nhava Creek area during March, 2016 are also within prescribed limits.

Observed salinity values for Harbour and Creek water samples in the month of April, 2016 varied from 31.4 – 38.6ppt and 33.4– 36.4ppt respectively [**Tables 11&14**]. The earth filling activity for the development of 4th Container Terminal and Dredging works in the region does not seem to be affecting on Marine water Quality. The ranges observed for COD values in mg/L are 39 – 115 and 63-97 respectively for Harbour and Creek water samples. The DO levels were found between 4.9-6.8 mg/L and 3.9-5.3 mg/L for water samples collected from Harbour and Creek areas respectively. The concentrations of Phenol and NH₃ - N were found to be very less in both Harbour and Creek water samples. Bacteriological parameters were also found to be far below the prescribed limits, set for Harbour region.

Table 13 provides the results obtained for sediment quality parameters for the JNP Harbour samples. The values obtained for Organic Matter, Total Organic Carbon and Inorganic Phosphate varied from 9.66 – 72.1 %, 4.04 – 8.72 % and 137 – 329 mg/kg, respectively. **Table 16** shows the values for Organic Matter, Total Organic Carbon and Inorganic Phosphate as 8.0 to 11.4 %, 4.23 to 5.16 % and 143– 234 mg/kg, respectively in Nhava Creek sediments during April, 2016.

2.5 OBSERVATIONS AND CONCLUSION

- ✓ *Construction of 4th Container Terminal on South side of JNPT: Earth Filling work and dredging work of 4th C.T. is underway.*
- ✓ *Construction of NSIGT Yard is underway to the North side of JNPT.*

It is seen from the data as reported in **Tables 11 to 18** and subsequently discussed in above paragraphs; all the parameters mentioned comply with prescribed standard limits, as given in Primary Water Quality Criteria for **Class IV Waters** [Harbour Water by CPCB for Physico-Chemical parameters and Bio-Chemical parameters.

Conclusion:

Considering the activities in the Harbour area and the results obtained for the month of April 2016, it can be concluded that the Port's working does not affect the Quality of the Marine water. The overall Marine water Quality of the Port's Harbour and Creek waters is in good category.

3.**MARINE ECOSYSTEM MONITORING****3.1 INTRODUCTION:**

The Forty Second Amendment to the Constitution in 1976 underscored the importance of 'green thinking'. Article 48A enjoins the state to protect and improve the environment and safeguard the forests and wildlife in the country. Further, Article 51A (g) states that the "fundamental duty of every citizen is to protect and improve the natural environment including forests, lakes, rivers and wildlife and to have compassion for living creatures".

Policy Statement for Abatement of Pollution (1992) has suggested developing relevant legislation and regulation, fiscal incentives, voluntary agreements and educational programs and information campaigns. It emphasizes the need for integration by incorporating environmental considerations into decision making at all levels by adopting frameworks namely, pollution prevention at source, application of best practicable solution, ensure polluter pays for control of pollution, focus on heavily polluted areas and river stretches and involve public in decision-making. The National Conservation Strategy and Policy Statement on Environment and Development, (1992) aimed at "integrating environmental concerns with developmental imperatives to meet the challenges by redirecting the thrust of our developmental process so that the basic needs of our people could be fulfilled by making judicious and sustainable use of natural resources." The priorities mentioned in this policy document include the sustainable use of land and water resources, prevention and control of pollution and preservation of biodiversity.

The National Water Policy, (2002) contains provisions for developing, conserving, sustainable utilizing and managing this important water resources and need to be governed by national perspectives.

MARINE ENVIRONMENT:

On national and state levels, we have several policies and regulation like Water (Prevention and Control of Pollution) Act, 1974, to regulate pollution discharges and restore water quality of our aquatic resources including the prescription of monitoring activities. One of the important provisions of the Water Act, 1974, is to maintain and restore the 'wholesomeness' of our aquatic resources. Water quality monitoring is one of the first steps required in the rational development and management of water resources. In the field of water quality management, there has been a steady evolution in procedures for designing system to obtain information on the changes of water quality. The monitoring comprises all activities to obtain 'information' with respect to the water system.

Sampling Stations:

The monitoring of marine environment for the study of biological and ecological parameters was done on 9th and 10th April-2016 in harbour regions of JNPT and on 11th April -2016 in Nhava Creek during Spring tide period of Third quarter of Lunar Cycle. The surface water samples were collected by a water sampler from nine water quality monitoring stations described in Table 9 of JNP harbour area (viz., W1, W2, W3, W4, W5, W6, W7, W9 and W10) and four stations (W11, W12, W13 and W14) in Nhava Creek for the estimation of phytoplankton, zooplankton density and their population. The list of parameters analyzed to assess the Marine Ecology is presented in Table 19 along with parameters monitored for sediment characterization. Annexure-VI describes recommended ranges of the Ecological parameters for Arabian Sea.

3.2 METHODOLOGY:

Sampling methodology adopted:

A marine sampling is an estimation of the body of information in the population. The theory of the sampling design is depending upon the underlying frequency distribution of the population of interest. The requirement for useful water sampling is to collect a representative sample of suitable volume from the specified depth and retain it free from contamination during retrieval.

Niskin sampler was used to sample sea water from the sub surface, these bottles are non-metallic, free-flushing sampler recommended for general purpose water sampling. During the sampling this plastic cylinder, was lowered to the desired depth with both ends open. Closure of the cylinder was usually triggered by a mechanical messenger. In Niskin sampler, top and bottom cap are held open by a clamp against the tension of a rubber string connecting the through the cylinder. The action of the messenger release clamp and caps are pulled into a position closing off top and bottom of the cylinder by retaining the water column in the cylinder from the depth and time of closure. This water can be retrieved without any contamination from the upper lying water column. 50 liters of the water sample were collected from Sub surface by using Niskin sampler. The collected samples were first collected in a clean bucket to reduce the heterogeneity. From the collected water sample 1 liter of water sample were taken in an opaque plastic bottle for chlorophyll estimation. Quantitative Plankton samples were collected by filtering rest of the water sample using plankton net of 20 μ m mesh size.

Samples Processing for chlorophyll estimation:

Samples for the chlorophyll estimation were preserved in ice box on board in darkness to avoid degradation in opaque container covered with aluminium foil. Immediately after reaching the shore after sampling, 1 liter of collected water sample was filtered

through GF/F filters (pore size 0.45 μm) by using vacuum filtration assembly. After vacuum filtration the glass micro fiber filter paper was grunted in tissue grinder, macerating of glass fiber filter paper along with the filtrate was done in 90% aqueous Acetone in the glass tissue grinder with glass grinding tube. Glass fiber filter paper will assist breaking the cell during grinding and chlorophyll content was extracted with 10 ml of 90% Acetone, under cold dark conditions along with saturated magnesium carbonate solution in glass screw cap tubes. After an extraction period of 24 hours, the samples were transferred to calibrated centrifuge tubes and adjusted the volume to original volume with 90% aqueous acetone solution to make up the evaporation loss. The extract was clarified by using centrifuge in closed tubes. The clarified extracts were then decanted in clean cuvette and optical density was observed at wavelength 630, 664, 665 nm. By using corrected optical density, Chlorophyll-a value was calculated as given in (APHA, 1998). The extract of pigments was then measured by spectrophotometer at wavelength of 750 nm and 664 nm before acidification and at 665 nm after acidification by 0.1ml of 0.1N HCl.

PLANKTON:

The entire area open water in the sea is the pelagic realm. Pelagic organisms live in the open sea. In contrast to the pelagic realm, the benthic realm comprises organisms and zone of the bottom of the sea. Vertically the pelagic realm can be dividing into two zones based on light penetration; upper photic or euphotic zone and lower dark water mass, aphotic zone below the photic zone.

The term plankton is general term for organisms have such limited powers of locomotion that they are at the mercy of the prevailing water movement. Plankton is subdivided to phytoplankton and zooplankton. Phytoplankton is free floating organisms that are capable of photosynthesis and zooplankton is the various free floating animals.

Phytoplankton:

The phytoplankton includes a wide range of photosynthetic and phototrophic organisms. Marine phytoplankton is mostly microscopic and unicellular floating flora, which are the primary producers that support the pelagic food-chain. The two most prominent groups of phytoplankton are diatoms (Bacillariophyceae) and dinoflagellates (Dinophyceae). The phytoplankton those normally captured in the net from the creek near JNPT is normally dominated by these two major groups; diatoms and dinoflagellates.

Zooplankton:

Zooplankton can be subdivided into holoplankton, i.e., permanent members of the plankton (e.g., Calanoid copepods), and meroplankton, i.e., temporary members in the plankton e.g., larvae of fish, shrimp, and crab). The meroplankton group consists of larval and young stages of animals that will adopt a different lifestyle once they mature. In contrast to phytoplankton which consist of a relatively smaller variety of organisms, Zooplankton are extremely divers, consist of a host of larval and adult forms representing many animal phylum.

Among the zooplankton two group always dominate than others; they are the members of sub class copepods (Phylum Athropoda), and Tintinids(Phylum Protozoa) among the net planktons. These small animals are of vital importance in marine ecosystem as one of the primary herbivores animals in the sea, and it is they provide vital link between primary producer (autotrophs) and numerous small and large marine consumers.

Spatial distribution of Plankton:

A characteristic of plankton population is that they tend to occur in patches, which are varying spatially on a scale of few meters to far as few kilometres in distance. They also vary in time scale, season as well as vertically in the water column. It is this patchiness and its constant changes in time and spot, that has made it so difficult for plankton biologist to learn about the ecology of plankton. The biological factors that causes this patchiness is due to the ability of zooplankton to migrate vertically and graze out the phytoplankton at a rapid rate that can create patchiness. Similarly the active swimming ability by certain zooplankton organisms can cause to aggregate in dense group.

At its most extreme, because the water in which plankton is suspended is constantly moving, each sample taken by the plankton biologists remain a different volume of water, so each sample is unique and replicate does not exist.

Plankton may also exhibit vertical patchiness. Physical factors contribute to this type of patchiness include light intensity, nutrients and density gradients in the water column. Phytoplankton in particular tends to be unequally distributed vertically, which leads to the existence of different concentration of a chlorophyll value between photic zone and below the photic zone.

Methodology adopted for Plankton sampling:

Mixed plankton sample for qualitative evaluation were obtained from the sub surface layer at each sampling locations by towing the net horizontally with the weight .After the tow of about 15-20minutes at speed of 1-1.5 m/s, plankton net was pulled up and washed down to the tail and collected the plankton adhered to plankton net in the collection bucket at the bottom by springing outer and inner surface of the net with sea

water, while the net was hanging with the mouth upward. As already mentioned for quantitative evaluation 50 L water samples were collected from subsurface layer and filtered through 20 μ m mesh size net assembly.

Preservation and storage:

Both filtered plankton and those collected from the plankton net were preserved with 5% buffered formalin and stored in 1L plastic container for further processing in the laboratory.

Sample concentration:

The collected plankton samples were concentrated by using centrifuge and made up to 50 ml with 5% formalin -Glycerine mixture.

Taxonomic evaluation:

Before processing, the sample was mixed carefully and a subsample was taken with a calibrated Stempel-pipette. 1 ml of the concentrated plankton samples were transferred on a glass slide with automatic pipette. The plankton sample on the glass slides were stained by using Lugol's iodine and added glycerine to avoid drying while observation. The plankton samples were identified by using Labex triangular Research microscope with photographic attachment. Microphotographs of the plankton samples were taken for record as well as for confirming the identification. The bigger sized zooplankton was observed through dissecting stereomicroscope with magnification of 20-30 x. Plankton organisms in the whole slide were identified to the lowest taxon possible. A thorough literature search was conducted for the identification of the different groups of zooplankton that were encountered

Cell counts by drop count method:

The common glass slide mounted with a 1ml of concentrated phytoplankton/zooplankton sample in glycerol and covered with cover slip 22x 60mm was placed under the compound microscope provided with a mechanical stage. The plankton was then counted from the microscopic field of the left top corner of the slide. Then slide is moved horizontally along the right side and plankton in each microscopic field was thus counted. When first microscopic field row was finished the next consecutive row was adjusted using the mechanical device of the stage. In this way all the plankton present in entire microscopic field are counted.

From this total number in 1ml of the concentrated plankton, total number of plankton in the original volume of sample filtered was calculated as units/L.

BENTHIC ORGANISMS:

Benthos is those organisms that are associated with the sea bed or benthic habitats. Epibenthic organisms live attached to a hard substratum or rooted to a shallow depth below the surface. In fauna organisms live below the sediment-water interface. Interstitial organisms live and move in pore water among sedimentary grains.

Because the benthic organisms are often collected and separated on sieves, a classification based on the overall size is used. Macro benthos include organisms whose shortest dimension is greater than or equal to 0.5 mm. Meio benthos are smaller than 0.5mm but larger than 42 μ in size.

The terms such as macro fauna and Meio fauna generally have little relevance with taxonomic classification. The terms Meio fauna and macro fauna depend on the size. Meio fauna were considered as good bioassay of community health and rather sensitive indicators of environmental changes

Sample sieving:

Sediments samples were sieved to extract the organisms. Sieving was performed carefully as possible to avoid any damage to the animals. The large portion of the sediment was split in to smaller portions and mixed with sea water in a bucket. The cohesive lumps were broken down by continuous stirring. The disaggregated sediments were then passed through the sieves.

Sample staining:

Sorting of the Meio fauna from the sieve is difficult task especially in the preserved material, because organisms are not easily detectable. To facilitate the animal detection the entire sample retained on the sieve after sieving operation were stained by immersing the sieve in a flat bottom tub with 1% Rose Bengal stain; a protein stain. A staining period of 10-30 minutes is sufficient for sample detection.

3.3 RESULTS:

CHLOROPHYLL - a & PHEOPHTIN-A

Water Samples for the chlorophyll estimation were collected from sub surface, mid depth and bottom layer during 1st hour and III rd hour and 5th hour of the tidal cycle and composite was made for each sampling locations and analysed for Chlorophyll -a and after acidification for Pheophytin -a. Chlorophyll- a value was used as algal biomass indicator (APHA 1998). The chlorophyll-in the sampling station was comparatively low, due the very low representation by phytoplankton. Chlorophyll-a

was varying from 0.172-1.511 mg/M3. Pheophytin – a level was below detectable limit in the all 13 sampling stations during sampling done in April 2016 (Table – 24b).

PRODUCTIVITY ESTIMATION, OXYGEN METHOD:

Productivity is defined as the rate at which inorganic carbon is converted to an organic form. Chlorophyll-bearing organisms (phytoplankton, periphytons,) serves as primary producers in the aquatic food chains. Photosynthesis ultimately results in the formation of a wide range of organic compounds, release of oxygen and reduction of Carbon dioxide (CO₂) in the surrounding waters. Primary Productivity can be determined by measuring the changes in the Oxygen and CO₂ concentration. There are two methods of measuring the rate of carbon uptake and net photosynthesis in situ, Oxygen method and the Carbon 14 method. In both methods, clear (light) and darkened (Dark) bottles are filled with water samples and suspended at particular depth for an incubation period of several hours or samples are incubated under controlled conditions in chambers in the laboratory.

The chief advantages of the Oxygen method are that it provides estimates of gross and net productivity and respiration and those analyses can be performed with inexpensive laboratory equipment and common reagents. The dissolved oxygen (DO) concentration is determined at the beginning and end of the incubation period. Productivity is calculated on the assumption that one atom of carbon is assimilated for each molecule of oxygen released.

Methodology:

Depth of euphotic zone was determined (region that receives surface illumination) with a Sacchi disc. Three BOD bottles were filled with the water collected from the desired depth. Used water from the same grab sample to fill a “set” (one light, one dark and one initial bottle). One of the BOD bottle was fixed for DO estimation immediately after the collection to measure oxygen concentration by titration after wards. Kept all the samples out of direct sunlight during handling. The remaining two BOD Bottles (One light and one dark) with Introduced samples taken from each preselected depth were submerged in the same photic zone in the water for at least two hours, but never longer than it takes for oxygen – gas bubbles to form in the clear bottles or DO to be depleted in

the dark bottles. At the end of the exposure period, DO in the BOD bottles (light and dark) were fixed immediately to determine DO. The increase in oxygen concentration in the light bottle during incubation is a measure of net production which, because of the concurrent use of oxygen in respiration, is somewhat less than the total (or gross) production. The loss of oxygen in the dark bottle is used as an estimate of total plankton respiration,

Calculated the gross or net production for each incubation depth and plot by using the formula, $\text{mg carbon fixed/m}^3 = \text{mg oxygen released/L} \times 12/32 \times 1000 \text{L/m}^3 \times K$, where K is the photosynthetic quotient (PQ), ranging from 1 to 2, depending on the nitrogen supply. The factor 12/32 was used to convert oxygen to carbon because under ideal conditions 1 mole of O_2 (32g) is released for each mole of carbon (12g) fixed. Productivity is defined as the rate of production and generally is reported in grams carbon fixed per sq. meter per day. (APHA, 1999).

PRODUCTIVITY IN THE COMPOSITE SAMPLES FROM SAMPLING STATIONS IN JNP HARBOUR AREA AND NHAVA CREEK

Tide	Sampling Station	Net Productivity (mg carbon fixed/ m^3)	Gross productivity mg carbon fixed/ m^3
JNP HARBOUR AREA	W1	150.0	75
	W2	187.5	75
	W3	150.0	112.5
	W4	150.0	75
	W5	150.0	112.5
	W6	150.0	75
	W7	150.0	37.5
	W9	150.0	75
	W10	150.0	75.0
NHAVA CREEK	W11	150.0	37.5
	W12	150.0	75
	W13	150.0	75
	W14	150.0	112.5

PHYTOPLANKTON POPULATION:

For the evaluation of the Phytoplankton population in JNPT harbour area within the immediate surroundings of the port sampling was conducted from 13 sampling

locations (Nine in harbour area and four in the Nhava Creek). The phytoplankton community of the Composite samples from different layers during 1st hour, 3rd Hour and 5th Hour of tidal cycle in the harbour and during the 3rd Hour in Nhava creek was represented by mainly two groups, Diatoms and Dinoflagellates; Diatoms were represented by 11 genera belongs to 5 classes, 6 orders, and 8 families. Dinoflagellates were represented by 1 genera, belongs to 1 class, 1 order and 1 family. Phytoplankton of the sampling stations at sub surface layer was varying from 44-70 units/ L in harbour area and 51-64 units/ L in Nhava creek.

Table 19: List of Parameters to Monitor for Marine Ecology

Marine Ecology Parameters [Harbor Area & Creek Area]

A] Aquatic Flora & Fauna:

Primary Productivity (Net & Gross), Phytoplankton Diversity: Population Density, Species Identification, Relative Abundance, Zooplankton Diversity: Population Density, Species Identification, Relative Abundance, Chlorophyll-a, Pheophytin-a, Secchi Depth

B] Benthic Fauna:

Species Identification & Density

C] Nutrients Analysis in Water:

Anions: Silicates, PO_4^{3-} - P, SO_4^{2-} , NO_2^- - N, NO_3^- - N,

Cations: Ca^{2+} , Mg^{2+} , Na^+ , K^+

D] Nutrient Analysis in Sediment :

Anions: Silicates, PO_4^{3-} - P, SO_4^{2-} , NO_2^- - N, NO_3^- - N,

Cations: Ca^{2+} , Mg^{2+} , Na^+ , K^+

Table 20: Phytoplankton variations in abundance, No. Of species and diversity in composite samples from sampling stations in JNP harbour area and Nhava creek

Tide	Sampling Station	Sub Surface water		
		Abundance In units/L	No of Species observed / total species	Diversity %
JNP HARBOUR AREA	W1	59	12/12	100
	W2	62	10/12	83.3
	W3	46	8/12	66.6
	W4	44	10/12	83.3
	W5	45	9/12	75.0
	W6	70	10/12	83.3
	W7	58	11/12	75.0
	W9	59	10/12	83.3
	W10	59	9/12	75.0
NHAVA CREEK	W11	64	9/12	75.0
	W12	58	10/12	83.3
	W13	58	10/12	83.3
	W14	51	10/12	83.3

Table 21: Abundance of phytoplankton in JNP harbour area and Nhava creek

Location	Surface		No of Sampling location	Group of phytoplankton	Range in Units/L
JNP HARBOUR AREA	Sub surface mid depth Bottom	I st hour III rd Hour and V th Hour	9	DIATOMS	41-60
				DINO FLAGELLATES	0-6
				TOTAL PHYTO PLANKTON	44-62
NHAVA CREEK	Sub surface	III rd Hour	4	DIATOMS	52-64
				DINO FLAGELLATES	0-6
				TOTAL PHYTO PLANKTON	51-64

ZOOPLANKTON POPULATION:

Zooplankton sample was collected from the sub surface layer during highest high tide period in 9 different sampling locations, JNP harbour area and four locations in Nhava Creek. Zooplankton community was represented by six groups of plankton; Copepods, Decapoda, Urochordate, Arrow worms, Ctenophores and larval forms of Copepods, Brachurian larvae, Trachophore larvae, and Bivalve larvae. Among these holoplankton of this region; Copepods were the most dominant group followed by Ctenophores and decapoda members. Tintinids which were dominant in the February 2016 was represented by only one species in March 2016. While Tintinids were totally absent in April 2016. The Nauplius Larvae and Zoea larvae were also dominated the net plankton at all the sampling locations. During this sampling run, Trochophore larvae of Polychaete were observed in its various growing stage. The zooplankton density was varying from 79-110 No/L In Harbour area and 73-100 No/L in Nhava Creek

Table 22: Zooplankton variation in abundance , No. of species and diversity in sub surface water in JNP harbour area and Nhava creek

Tide	Sampling Station	Sub Surface water		
		Abundance In No /L	No of Species/groups observed /total species/group	Diversity %
JNP HARBOUR AREA	W1	91	20/25	80
	W2	79	16/25	64
	W3	86	15/25	60
	W4	103	20/25	80
	W5	87	14/25	56
	W6	110	22/25	88
	W7	85	17/25	68
	W9	83	18/25	72
	W10	91	16/25	64
NHAVA CREEK	W11	86	11/25	44
	W12	81	12/25	48
	W13	73	13/25	52
	W14	100	18/25	72

Table 23: Abundance of zooplankton in Sub Surface water of JNP harbour and Nhava creek

Tide	Sampling depth	Sampling repetitions	No of Sampling locations	Group of Zooplankton	Range No/L
JNP HARBOUR AREA	Sub surface mid depth Bottom	I st hour III rd Hour and V th Hour	9	Copepods	44-64
				Decapoda	2-10
				Urochordata	0-4
				Arrow worms	2-6
				Ctenophores	2-8
				Larval forms	16-28
				TOTAL ZOOPLANKTON NO/L	79-110
NHAVA CREEK	Sub surface	III rd Hour	4	Copepods	37-59
				Decapoda	2-5
				Urochordata	0
				Arrow worms	2-4
				Ctenophores	2-8
				Larval forms	19-35
				TOTAL ZOOPLANKTON NO/L	73-100

Table 24a: Systematic account of phytoplankton in the sampling locations in JNP harbour area and Nhava creek

GROUP	PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	#
DIATOMS	Bacillariophyta	Coscinodiscophyceae	Coscinodisciales	Coscinodiscaceae	<i>Coscinodiscus</i> sp.	D1
			Thalassiosirales	Skeletonemataceae	<i>Skeletonemas</i> sp.	D2
		Biddulphiophycidae	Biddulphiales	Biddulphiaceae	<i>Biddulphia</i> sp.	D3
		Chaetocerotophycidae	Chaetocerotales	Chaetocerotaceae	<i>Chaetoceros</i>	D4
		Bacillariophycidae	Naviculales	Naviculaceae	<i>Navicula</i> sp.	D5
				Pleurosigmaaceae	<i>Pleurosigma</i> sp.	D6
					<i>Gyrosigma</i>	D7
			Bacillariales	Bacillariaceae	<i>Bacillaria</i> sp.	D8
					<i>Nitzschia</i>	D9
		Fragilariophycidae	Fragilariales	Fragilariaceae	<i>Synedra</i> sp.	D10
					<i>Asterionellopsis</i>	D11
DINO FLAGELLATES	Pyrrophyta	Desmophyceae	Peridinales	Protoperidiniaceae	<i>Protoperidinium</i> sp.	F1

Table 24b: Chlorophyll-a & Pheophytin-a and Algal Bio massing composite samples in JNP Harbour and Nhava Creek sampling Locations

Sr.No.	Station	Chlorophyll-a (mg/m ³)	Pheophytin- a (mg/m ³)	Algal Biomass (Chlorophyll method)mg/m ³
JNPHARBOUR AREA				
1	W1	0.629	BDL	42.14
2	W2	0.952	BDL	63.78
3	W3	0.172	BDL	11.52
4	W4	0.936	BDL	62.71
5	W5	1.187	BDL	79.53
6	W6	0.850	BDL	56.95
7	W7	1.392	BDL	93.26
8	W9	0.966	BDL	64.72
9	W10	1.275	BDL	85.43
NHAVA CREEK				
10	W11	0.952	BDL	63.78
11	W12	1.511	BDL	101.24
12	W13	1.290	BDL	86.43
13	W14	0.952	BDL	63.78

BDL- Below Detection Limit

Table 25; Quantitative evaluation of marine phytoplankton in the composite samples in JNP harbour area and Nhava creek

#	GENUS/SPECIES	ABUNDANCE IN UNITS/CELLS / L OF MARINE WATER FROM DIFFERENT SAMPLING STATIONS													
		JNP HARBOUR AREA										NHAVA CREEK			
		W1	W2	W3	W4	W5	W6	W7	W9	W10	W11	W12	W13	W14	
	DIATOMS														
D1	Coscinodiscussp.	8	14	12	10	14	10	8	16	18	14	10	12	18	
D2	Skeletonemasp	4	6	4	2	0	8	10	6	4	7	4	6	5	
D3	Biddulphia sp.	6	4	4	2	2	8	4	5	4	6	4	2	8	
D4	Chaetoceros	2	6	4	5	3	4	6	2	4	7	6	4	2	
D5	Naviculasp.	4	2	0	0	4	2	2	0	4	2	6	8	2	
D6	Pleurosigma sp.	7	8	4	4	2	6	4	4	6	4	8	4	2	
D7	Gyrosigma	8	6	4	3	6	10	4	4	8	10	6	4	2	
D8	Bacillaria sp.	4	0	0	2	0	0	2	0	0	0	0	0	0	
D9	Nitzschia	4	0	0	2	0	0	0	6	0	0	0	0	0	
D10	Synedra sp.	2	4	6	4	2	2	6	4	2	2	4	2	2	
D11	Asterionellopsis	6	10	8	10	8	14	8	10	9	12	6	10	8	
	DIATOMS TOTAL UNITS/L	55	60	46	44	41	64	54	57	59	64	54	52	49	
DINO FLAGELLATES															
F1	Protoperidiniumsp	4	2	0	0	4	6	4	2	0	0	4	6	2	
	DINOFLAGELLATES TOTAL UNITS/ L	4	2	0	0	4	6	4	2	0	0	4	6	2	
	TOTAL PHYTOPLANKTON UNITS/L	59	62	46	44	45	70	58	59	59	64	58	58	51	

TABLE 26: Systematic account of zooplankton from the sampling locations in JNP harbour area and Nhava creek

GROUP	PHYLUM	CLASS	ORDER	FAMILY	GENUS/SPECIES	#
COPEPODS	ARTHROPODA CRUSTACEA	Sub class copepoda	Calanoida	Calanidae	<i>Canthocalanussp</i>	C1
					<i>Cosmocalanusdarw inii</i>	C2
				Paracalanidae	<i>Acrocalanus</i>	C3
				Clausocalanidae	<i>Clausocalanus minor</i>	C4
				Euchaetidae	<i>Euchaeta sp.</i>	C5
				Centropagidae	<i>Centropages sp.</i>	C6
				Pontellidae	<i>Labidocera sp.</i>	C7
					<i>Pontelloopsis sp.</i>	C8
				Acartiidae	<i>Acartia sp.</i>	C9
					<i>Acartiella sp.</i>	C10
			Temoridae	<i>Temora sp.</i>		C11
			Cyclopoida	Oithonidae	<i>Oithona sp.</i>	C12
			Harpacticoida	Euterpinae	<i>Euterpina sp.</i>	C13
				Clytemnestridae	<i>Clytemnestra scutellata</i>	C14
DECAPODA	ARTHROPODA CRUSTACEA	Malacostraca	Decapoda	Oplophoridae	<i>Acanthephyra sp.</i>	D1
				Solenoceridae	<i>Solenoceracrassico rnis</i>	D2
				Luciferidae	<i>Lucifersp</i>	D3
UROCHORDAT A	UROCHORDAT A	Appendiculari an		Fritillariidae	<i>Fritillaria sp.</i>	U1
ARROW WORMS	CHAETOGNAT HA	Sagittoidea	Aphragmoph ora	Sagittidae	<i>Sagitta sp.</i>	A1
CTENOPHORE S	CTENOPHORA				<i>Pleurobrachia sp.</i>	C1
FORAMINIFER A	PROTOZOA	Rhizopoda	Foraminiferid a	Rotalidae	<i>Globogerina sp.</i>	
(CRUSTACEAN LARVAE	ARTHROPODA (CRUSTACEA)	Copepoda	-	-	Nauplius larvae of Copepods	L1
(BRACHYURAI AN LARVAE	ARTHROPODA CRUSTACEA	Decapoda (brachyura)			Zoea Larvae	L2
CIRRIPEDES LARVAE		Cirripedia			CirripedeNauplius	L3
PLOCHATE LARVAE					Trachophore larvae	L4
BIVALVE LARVAE	Mollusca	Pelcypoda			Bivalve larvae	L5

TABLE 27: Quantitative evaluation of marine zooplankton in the sampling locations in JNP harbour area and Nhava creek

#	GENUS/SPECIES	ABUNDANCE IN No / L OF MARINE WATER FROM DIFFERENT SAMPLING STATIONS													
		JNP HARBOUR AREA									NHAVA CREEK				
		W1	W2	W3	W4	W5	W6	W7	W9	W 10	W 11	W 12	W 13	W 14	
COPEPODS															
C1	Canthocalanus	4	5	6	2	5	6	4	2	5	7	5	3	4	
C2	Cosmocalanusdarwini	0	0	2	2	0	4	2	0	3	4	2	0	0	
C3	Acrocalanus	2	0	0	0	2	0	0	4	2	6	4	2	6	
C4	Clausocalanus minor	4	6	4	7	5	3	4	2	2	6	4	2	6	
C5	Euchaeta sp.	2	6	0	0	0	4	0	2	4	0	0	4	8	
C6	Centropages sp.	12	10	9	14	16	12	14	10	9	12	14	9	10	
C7	Labidocera sp.	2	4	0	2	0	2	4	4	2	0	0	0	5	
C8	Pontellopsis sp.	2	0	0	2	0	4	0	3	0	0	0	4	2	
C9	Acartia sp.	4	2	3	0	4	3	6	4	5	0	4	2	4	
C10	Acartiella sp.	3	4	6	8	4	2	2	5	4	4	2	3	2	
C11	Temora sp.	4	0	2	4	0	6	0	4	0	0	0	0	6	
C12	Oithona sp.	2	0	0	2	2	4	0	0	0	0	0	0	4	
C13	Euterpina sp.	14	10	8	12	15	10	8	9	12	14	10	8	2	
C14	Clytemnestra sp.	2	0	0	2	0	4	0	2	0	0	0	0	0	
COPEPODS Total N/L		57	47	40	57	53	64	44	51	48	53	45	37	59	
Decapoda															
D 1	AcanthePHYra sp.	2	2	0	4	0	2	0	0	0	0	0	0	0	
D 2	Solenoceracrassicornis	0	2	4	0	2	2	0	0	0	0	0	0	0	
D 3	Lucifersp	2	2	2	4	4	6	2	2	6	4	5	3	2	
Decapoda Total N/L		4	6	6	8	6	10	2	2	6	4	5	3	2	
UROCHORDATA															
U	Fritillaria sp.	2	0	0	4	0	2	2	0	0	0	0	0	0	

1														
Urochordata Total N/L		2	0	0	4	0	2	2	0	0	0	0	0	0
ARROW WORMS														
A 1	Sagitta sp.	4	6	6	2	4	4	4	2	6	4	2	4	2
ARROW WORMS Total No/L		4	6	6	2	4	4	4	2	6	4	2	4	2
CTENOPHORES														
Pleurobrachia sp.		6	4	8	4	4	4	6	2	8	6	4	8	2
Ctenophores Total N/L		6	4	8	4	4	4	6	2	8	6	4	8	2
LARVAL FORMS														
L1	Nauplius larvae of Copepods	12	10	16	18	14	17	10	18	14	15	17	16	20
L2	Zoea Larvae	6	4	8	2	6	7	9	6	7	4	8	5	6
L3	Cirriped Nauplius	0	0	0	4	0	0	2	0	2	0	0	0	4
L4	Trachpore larvae	0	2	0	4	0	2	2	0	0	0	0	0	0
L5	Molluscan larvae	0	0	2	0	0	0	4	2	0	0	0	0	5
Larval forms total no/l		18	16	26	28	20	26	27	26	23	19	25	21	35
TOTAL ZOOPLANKTON NO/L		91	79	86	103	87	110	85	83	91	86	81	73	100
Biomass by displacement ml/m3		0.2 4	0.2 9	0.2 5	0.2 5	0.2 6	0.3 2	0.3 0	0.2 6	0.2 7	0.2 8	0.2 1	0.2 0	0.3 4

BENTHIC ORGANISMS:

Benthic organism collected along with sediments by using the Vanveen grabs were represented by two groups macro benthic organisms, Polychaetes and Decapoda their number was varying from 20-60 N/M². Few starfish larvae were observed attached to few pebbles in this sampling location. The sediments were dominated by many dead shells of bivalves and Gastropods but no live forms were recorded during this sampling run.(Table - 28)

TABLE 28: Abundance of benthic Fauna in sampling locations in JNP harbour area and Nhava creek

	ABUNDANCE IN NO/M ² DIFFERENT SAMPLING STATIONS REPRESENTATION BY GROUP											
	W1	W2	W3	W4	W5	W6	W7	W9	W10	W11	W12	W13
POLYCHAETES												
Family : Nephthydidae <i>Nephtys sp.</i>	10	0	10	20	40	10	20	40	20	40	20	20
Total Polychates N/m ²	10	0	10	20	40	10	20	40	20	40	20	20
DECAPODA												
Total Decapoda N/m ²	10	20	20	10	20	10	10	20	20	10	20	10
TOTAL macro Benthic Fauna NUMBER/ m ²	20	20	30	30	60	20	30	60	40	50	40	30
BIOMASS gm/m ²	0.30	0.35	0.5	0.45	0.50	0.30	0.40	0.50	0.56	0.40	0.30	0.25

WATER QUALITY NUTRIENTS (BIOTIC):

Table 29: Concentration of Nutrients in Water at JNP Harbour Area and Nhava Creek

Station Name	Ca ²⁺ [mg/L]	Mg ⁺ [mg/L]	K ⁺ [mg/L]	Na ⁺ [mg/L]	PO ₄ ³⁻ -P [µg/L]	NO ₃ ¹⁻ -N [µg/L]	NO ₂ ¹⁻ -N [µg/L]	SiO ₂ ²⁻ [µg/L]	SO ₄ ²⁻ [µg/L]
Standard	-	-	-	-	0.1 - 90	1.0 - 500	<125	10 - 5000	-
JNP HARBOUR AREA									
W1	548	1426	282	10600	167	2680	<10	2057	2464
W2	481	1385	278	10492	223	2057	<10	2177	2440
W3	454	1417	283	10442	227	2183	<10	2057	2636
W4	468	1377	271	10700	183	2207	<10	1963	2420
W5	449	1412	267	10650	217	2610	<10	2480	2376
W6	428	1393	274	10608	190	2307	<10	2147	2432
W7	428	1450	277	10733	260	2480	<10	1810	2460
W9	433	1463	276	10675	197	2777	<10	1720	2348
W10	409	1469	272	10358	180	2180	<10	1813	2444
JNP NHAVA CREEK AREA									
W11	399	1197	280	10692	160	2410	<10	2070	2847
W12	398	1338	286	10810	143	2533	<10	1737	2668
W13	428	1280	278	10942	180	2127	<10	1810	2450
W14	411	1348	285	11470	170	2317	<10	1330	2665

SEDIMENT QUALITY NUTRIENTS (BIOTIC):

Table 30: Concentration of Nutrients in Sediments at JNP Harbour area and Nhava Creek

Station Name	Ca ²⁺ [mg/Kg]	Mg ⁺ [mg/Kg]	K ⁺ [mg/Kg]	Na ⁺ [mg/Kg]	PO ₄ ³⁻ -P [mg/Kg]	NO ₃ ¹⁻ -N [mg/Kg]	NO ₂ ¹⁻ -N [mg/Kg]	SiO ₂ ²⁻ [mg/Kg]	SO ₄ ²⁻ [mg/Kg]
Standard	-	-	-	-	-	-		-	-
JNP HARBOUR AREA									
W1	4571	278	382	4125	296	12	0.15	32	3513
W2	5687	174	223	3847	259	15	0.12	29	2874
W3	4162	359	301	4546	331	10	0.14	51	3339
W4	6139	323	233	3996	228	9	<0.1	43	2590
W5	4677	230	457	3502	163	8	0.18	56	2876
W6	4982	243	492	3264	234	12	<0.1	34	2059
W7	6136	265	289	4359	286	11	<0.1	45	3273
W9	5915	210	353	4088	303	10	0.13	28	3857
W10	6588	346	371	4553	277	8	0.15	61	3112
JNP NHAVA CREEK AREA									
W11	4257	309	483	4573	269	12	0.12	35	5643
W12	5239	255	518	3436	151	9	0.15	72	4589
W13	5181	183	421	4112	297	18	0.13	63	4935
W14	4566	267	399	4997	384	15	0.11	87	4172

3.4. Nutrients

Nutrients are measured using a variety of wet chemistry techniques, which generate a color reaction measurable with a colorimeter or spectrophotometer. The technique involves adding a reagent (or reagents) to the seawater sample, allowing a color to develop and then measuring the intensity of the color against blanks and standards. Manual methods usually allow the color to develop fully before measurement, whereas most automated methods (e.g. segmented flow analysis, flow injection analysis) provide partial color development with time controls. Concentrations of nutrients are measured in optical cells (static or flow through), using a spectrophotometer tuned to defined wavelengths.

a. Anions:

The nutrients at various stations in JNP harbor water and Nhava Creek are presented in **Table 29**. In harbor region the Phosphate was found to be in the range of 167µg/L – 260µg/L. The average concentration of Phosphate was found to be 205µg/L in JNP harbor region, the Phosphate values are above the prescribed standard range [0.1 – 90µg/L]. Nitrate was found to be between 2057µg/L – 2777µg/L. The minimum value of Nitrate 2057µg/L was found at W2 station and maximum value 2777µg/L at W9 station. The average concentration of Nitrate was found to be 2387µg/L. At locations W1, W2, W3, W4, W5, W6, W7, W9&W10 the Nitrate concentration was found to be above prescribed standard range [1.0 to 500 µg/L]. Silica is another important nutrient in seawater. The requirement of silica by diatoms is however, entirely limited to skeletal formation and has particular importance in coastal upwelling region where diatoms form a dominant part of phytoplankton. Silica in the form of silicate in JNP harbor water was found between 1720 – 2480µg/L with an average of 2025µg/L. The minimum concentration of silica was found at W9 station of JNP harbor region and the maximum concentration of silica was found at W5 station. The values of silica were observed to be well within the prescribed limits [10 to 5000 µg/L]. The Sulphate was found between 2348 – 2636 mg/L, the minimum value recorded at W9 station and maximum at W3 station. The average concentration of Sulphate was found to be 2447mg/L.

In Nhava Creek, Phosphate was found between 143µg/L – 180 µg/L with an average 163µg/L which is above the prescribed standard range [0.1 – 90 µg/L]. The minimum value was recorded at W12 and maximum at W13 location. Nitrate was found to be 2127 (at W13) – 2533µg/L (at W12) with an average 2347µg/L. The silica content in Nhava creek was found to be 1330 – 2070 µg/L with an average of 1737 µg/L. The minimum silica content was found at station W14 station and maximum was found at W11 station. The values of silica were observed to be well within the prescribed limits. Sulphate was found between 2450 – 2847 mg/L with an average of 2658 mg/L. The minimum value for Sulphate was found at W13 station and maximum value at W11 station.

The nutrients in sediments at various stations in JNP harbour area and Nhava Creek area are given in **Table 30**. In harbour region, the sediment was found nine locations. Phosphate was found between 163 – 331 mg/kg with an average of 264.1 mg/kg. The minimum value of 163mg/kg was found at W5 location while maximum value 331mg/kg) was found at W3. The Nitrate was found to be minimum at W5 & W10 station i.e. 8 mg/kg and maximum at W2 station i.e. 15mg/kg. The average concentration of Nitrate was found to be 1.6 mg/kg. The Nitrite was found to be between <0.1 – 0.18 mg/kg with an average of 0.10 mg/kg. The minimum concentration of nitrite was found at W4, W6 & W7 station and maximum value at W5 station. Silica in the form of silicate in JNP harbour sediments were found between 28 and 61 mg/kg with an average of 42.1mg/kg. The minimum concentration of silica was found at W9 station i.e. 28mg/kg and maximum value was found at W10 station i.e. 61 mg/kg. The Sulphate was found between 2059 - 3857 mg/kg, with minimum value i.e. 2059mg/kg at W6 station and maximum value i.e. 3857 mg/kg at W9 station. The average concentration of Sulphate was found to be 3054.8 mg/kg.

In Nhava Creek region the sediment found at four locations. Phosphate levels were 151to 384 mg/kg with an average of 275 mg/kg. Nitrate was found to be 9 to 18 mg/kg. The average concentration of Nitrate was found to be 13.5 mg/kg. The Nitrite was found to be 0.11 and 0.15 mg/kg. The average concentration of Nitrite was found to be 0.10 mg/kg. Silica in the form of silicate in JNP creek sediments was found to be 35 to 87 mg/kg with an average of 64.3 mg/kg. The Sulphate was found to be 4172 to 5643mg/kg. The average concentration of Sulphate was found to be 4834.8 mg/kg.

b. Cations:

In harbour region water, the Calcium was found between 409 to 548mg/L with an average of 455 mg/L given in **Table 29**. The minimum value for Calcium i.e. 409 mg/L was found at W10 location whereas the maximum value i.e. 548 mg/L was found at W1 location. The Magnesium was found to be 1377 – 1469 mg/L, with minimum value i.e. 1377 mg/L at W4 location whereas maximum value i.e. 1469 was found at W10 stations. The average concentration of Magnesium was found to be 1421 mg/L. The minimum concentration of Potassium 267 mg/L was found at W5 location and maximum concentration 283 mg/L at W3 location with an average of 276 mg/L. The Sodium was found between 10358 to 10733 mg/L with an average of 10584 mg/L. The minimum concentration of sodium i.e. 30258 mg/L was found at W10 stations and maximum value i.e. 10733 mg/L of at W7 station.

In Nhava Creek, Calcium concentration was found with an average 409 mg/L given in **Table 29**. The minimum value 398 mg/L was found at W12 and maximum 428 mg/L at W13 station. Magnesium concentration was found to be 1197 – 1348mg/L with an average of 1291 mg/L. The minimum value i.e. 1197 mg/L of Magnesium was found at W11 station and maximum value 1348 mg/L was found at W14 station. The Potassium

content in Nhava creek was found to be 278 mg/L at W13 – 286 mg/L at W12 station with an average of 282 mg/L. Sodium minimum concentration was found to be 10692 mg/L at W11 and maximum of 11470 mg/L at W14. The average concentration of sodium was found to be 10978 mg/L.

In harbour region sediments, the Calcium was found to be 4162 to 6588 mg/Kg with an average of 5428.6 mg/Kg given in **Table 30**. The minimum Concentration of Calcium 4162 mg/kg was found at W3 station and maximum concentration 6588 mg/kg at W10 station. Magnesium was found to be 174 to 359 mg/Kg, with minimum value 179 mg/kg at W2 station and maximum 359 mg/kg was recorded at W3 station. The average concentration of Magnesium was found to be 269.8 mg/Kg. Potassium in JNP harbor sediment was found to be 223 to 492 mg/Kg with an average of 344.6 mg/Kg. The minimum concentration of Potassium was found at W2 station and maximum at W6 station. Sodium was found to be 3264 to 4553 mg/Kg with an average of 4031.1 mg/Kg. The minimum concentration of sodium 3264 mg/kg was found at W6 station and maximum value 4553 mg/kg at W10 station.

In Nhava Creek sediments, Calcium was found to be 4257 mg/kg at W11 and 5239 mg/Kg at W12 locations, with an average 4810.8 mg/Kg given in **Table 30**. Average magnesium was found to be 253.5 mg/Kg. The minimum concentration of magnesium was found at W13 location i.e. 183 mg/kg, whereas maximum concentration was observed at W11 location with value 309 mg/kg. The minimum concentration of potassium 399 mg/kg was observed at W14 and maximum concentration 518 mg/kg was observed at W12 station. Average potassium content in Nhava creek was found to be 455.3 mg/Kg. The minimum sodium value 3436 mg/kg was found at W14 station and maximum value 4997 mg/kg at W14. The average concentration of sodium was found to be 4279.5 mg/kg.

3.5 OBSERVATIONS AND CONCLUSIONS

Considering the various activities in JNP Harbour and NHAVA Creek area, it is seen from the following table that apparently the marine ecosystem is not adversely affected by following activities.

- ✓ *Construction of 4th Container Terminal on South side of JNPT:* Earth Filling work of 4thC.T. is underway.
- ✓ *Construction of NSIGT Yard is underway to the North side of JNPT.*
- ✓ *Plying of Ferry Boats:* There were large numbers of ferry boats plying in the area from Gateway of India to Elephanta.

It is seen from the data of Marine Ecology, as reported in **Tables 20 to 29** and subsequently discussed in above paragraphs, the major parameters comply with recommended ranges of the ecological parameters for Arabian Sea during April, 2016

Some Observations related to the impact on quality of marine water and ecology:

- ❖ There are four lotic water bodies; viz. Thane creek, Ulhas river, Panvel creek and Patalganga river that join the sea in the vicinity of the sampling area. Amongst these four, most of the sampling points are either within or close to Thane and Panvel creek confluence, resulting in direct impact on harbour water.
- ❖ The creek is narrow at Northern end, where it is fed partially by River Ulhas. Along the east and west sides of the creek, many industrial units have come up. Thane and Panvel creek is the ultimate recipient of all the liquid discharges from these industries and mostly untreated sewage discharges. The discharges into the creek on its western side are dominated by Mumbai city sewerage and wastes from petrochemical, fertilizer and thermal plants at Chembur, besides the pharmaceutical and chemical complexes at Vikhroli, Bhandup and Mulund.
- ❖ It may be mentioned that JN Port is not handling any dry bulk cargo containing Phosphate.

Based on observations of the overall ecological parameters in JNP Harbor and Nhava Creek area, it can be inferred that the marine ecosystem is not affected due to port operational activities. Untreated discharges of sewage and industrial waste from the towns / villages around the area, like Navi-Mumbai, Thane, and Panvel etc., may probably affect nitrate and phosphate levels.

4.

DRINKING WATER QUALITY MONITORING

4.1 INTRODUCTION

Drinking Water Quality Monitoring was carried out at eighteen stations in the port and port's township area. A list of locations for collecting the drinking water samples is presented below:

Table 32: Description of Drinking Water Quality Monitoring Stations

Sr. No.	Stations	Locations
Outside the Port Area		
1	DW1	Administration Building
2	DW2	Secondary School
3	DW3	PUB Canteen
4	DW4	Hospital Canteen
5	DW5	JNPT Inlet
6	DW9	Sector II
7	DW8	Sector III
8	DW13	CISF Canteen
9	DW14	Custom Canteen
10	DW15	JNPT Guest House
Inside the Port Area		
11	DW6	NSICT Canteen
12	DW7	GTI Canteen
13	DW10	POC Canteen
14	DW11	JNPT Workshop
15	DW12	C.T. Canteen
16	DW16	PPD Site Office
17	DW17	GTI -2
18	DW18	GTI CGC

Out of 18 stations, 10 are in outside the port while 8 are inside the port. All samples were collected from the port area of JNP on 11th April, 2016.

The water samples are analyzed for various parameters, viz. Colour, Odour, pH, Turbidity, Total Dissolved Solids, Aluminium as Al, NH₃- N, Barium as Ba, Boron, Calcium as Ca, Chloride as Cl⁻, Copper as Cu, Fluoride, Free Residual Chlorine, Iron as Fe, Magnesium as Mg, Manganese as Mn, Oil & grease, Nitrate as NO₃⁻, Phenolic compound, Selenium as Se, Silver as Ag, Sulphate as SO₄⁻², Total Alkalinity as CaCO₃, Total Hardness as CaCO₃, Zinc as Zn, Cyanide, Lead as Pb, Mercury as Hg, Molybdenum as Mo, Nickel as Ni, Pesticides, Total Arsenic as As, Total Chromium as Cr, Total Coliforms and *E. coli*.

4.2 RESULTS

The drinking water quality monitoring data for eighteen stations are given in **Table 33**.

Parameter	Unit of Measurement	Station Name					
		DW1	DW2	DW3	DW4	DW5	DW6
Color	Hazen	Colorless	Colorless	Colorless	Colorless	Colorless	Colorless
Odour	-	Odorless	Odorless	Odorless	Odorless	Odorless	Odorless
pH	-	7.52	7.78	7.13	7.20	7.50	7.26
Turbidity	NTU	<1	<1	<1	<1	<1	<1
Total Dissolved Solids	mg/l	104	87	72	68	53	78
Aluminium as Al	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
NH ₃ -N	mg/l	<1	<1	<1	<1	<1	<1
Barium as Ba	mg/l	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Boron	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Calcium as Ca	mg/l	11.22	10.58	10.5	11.70	11.38	11.54
Chloride as Cl	mg/l	14.71	11.96	11.85	14.6	14.41	14.32
Copper as Cu	mg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Flouride	mg/l	0.05	0.16	0.19	0.25	0.11	0.05
Free Residual Chlorine	mg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Iron as Fe	mg/l	<0.01	<0.01	<0.01	0.20	0.11	0.20
Magnesium as Mg	mg/l	4.17	3.30	3.93	3.01	3.49	3.49
Manganese as Mn	mg/l	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Oil & Grease	mg/l	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Nitrate as NO ₃	mg/l	3.80	3.35	3.05	3.65	2.6	2.75
Phenolic Compound	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Selenium as Se	mg/l	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Silver as Ag	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Sulphate as SO ₄	mg/l	4.80	4.44	5.04	5.40	4.92	4.80
Total Alkalinity as CaCO ₃	mg/l	33.2	34.8	32.4	33.2	36.8	30.4
Total Hardness as CaCO ₃	mg/l	45.2	40	42.4	41.6	42.8	43.2
Zinc as Zn	mg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Cyanide	mg/l	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Lead as Pb	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Mecury as Hg	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel as Ni	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Pesticides	mg/l						
Total Arsenic as As	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total Chromium as Cr	mg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Total Coliforms	MPN/100ml	Absent	Absent	Absent	Absent	Absent	Absent
E Coli	-	Absent	Absent	Absent	Absent	Absent	Absent

Parameter	Unit of Measurement	Station Name					
		DW7	DW8	DW9	DW10	DW11	DW12
Color	Hazen	Colorless	Colorless	Colorless	Colorless	Colorless	Colorless
Odour	-	Odorless	Odorless	Odorless	Odorless	Odorless	Odorless
pH	-	7.42	7.42	7.50	7.40	7.41	7.46
Turbidity	NTU	<1	<1	<1	<1	<1	<1
Total Dissolved Solids	mg/l	82	94	76	84	68	59
Aluminium as Al	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
NH ₃ -N	mg/l	<1	<1	<1	<1	<1	<1
Barium as Ba	mg/l	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Boron	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Calcium as Ca	mg/l	16.03	11.86	11.54	11.86	12.02	11.22
Chloride as Cl	mg/l	14.71	11.96	14.12	14.41	13.63	13.92
Copper as Cu	mg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Flouride	mg/l	0.14	0.13	<0.05	0.08	0.14	0.08
Free Residual Chlorine	mg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1
Iron as Fe	mg/l	0.4	0.32	0.2	0.18	<0.01	<0.01
Magnesium as Mg	mg/l	4.27	3.69	3.40	2.52	3.40	3.98
Manganese as Mn	mg/l	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04
Oil & Grease	mg/l	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5
Nitrate as NO ₃	mg/l	4.17	3.35	2.23	2.6	3.2	2.98
Phenolic Compound	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Selenium as Se	mg/l	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004
Silver as Ag	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Sulphate as SO ₄	mg/l	5.28	4.68	4.56	4.2	4.8	4.2
Total Alkalinity as CaCO ₃	mg/l	36.4	36.8	34.8	34	33.6	32.4
Total Hardness as CaCO ₃	mg/l	57.6	44.8	42.8	40	44	44.4
Zinc as Zn	mg/l	<0.1	<0.1	<0.1	0.10	<0.1	<0.1
Cyanide	mg/l	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03
Lead as Pb	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Mecury as Hg	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001
Nickel as Ni	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Pesticides	mg/l						
Total Arsenic as As	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01
Total Chromium as Cr	mg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02
Total Coliforms	MPN/100ml	Absent	Absent	Absent	Absent	Absent	Absent
E Coli	-	Absent	Absent	Absent	Absent	Absent	Absent

Parameter	Unit of Measurement	Station Name						
		DW13	DW14	DW15	DW16	DW17	DW18	Standard*
Color	Hazen	Colorless	Colorless	Colorless	Colorless	Colorless	Colorless	5
Odour	-	Odorless	Odorless	Odorless	Odorless	Odorless	Odorless	Agreeable
pH	-	7.45	7.55	7.56	7.55	7.45	7.52	6.5-8.5
Turbidity	NTU	<1	<1	<1	<1	<1	<1	1
Total Dissolved Solids	mg/l	92	84	102	96	62	80	500
Aluminium as Al	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.03
NH ₃ -N	mg/l	<1	<1	<1	<1	<1	<1	0.5
Barium as Ba	mg/l	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.7
Boron	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.5
Calcium as Ca	mg/l	10.74	10.58	9.61	11.22	10.5	11.22	75
Chloride as Cl	mg/l	12.06	11.86	14.22	14.32	11.86	14.71	250
Copper as Cu	mg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.05
Flouride	mg/l	<0.05	0.05	0.14	0.11	<0.05	0.08	1
Free Residual Chlorine	mg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.2
Iron as Fe	mg/l	0.35	0.19	0.14	0.19	<0.01	<0.01	0.3
Magnesium as Mg	mg/l	3.20	3.98	4.66	3.40	3.74	4.17	30
Manganese as Mn	mg/l	<0.04	<0.04	<0.04	<0.04	<0.04	<0.04	0.1
Oil & Grease	mg/l	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.5
Nitrate as NO ₃	mg/l	3.72	3.2	2.9	2.6	2.16	2.83	45
Phenolic Compound	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001
Selenium as Se	mg/l	<0.004	<0.004	<0.004	<0.004	<0.004	<0.004	0.01
Silver as Ag	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.1
Sulphate as SO ₄	mg/l	4.56	4.8	6	8.88	4.2	4.44	200
Total Alkalinity as CaCO ₃	mg/l	35.2	35.6	35.2	34.8	34.8	35.2	200
Total Hardness as CaCO ₃	mg/l	40	42.8	43.2	42	41.6	45.2	200
Zinc as Zn	mg/l	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	5
Cyanide	mg/l	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	0.05
Lead as Pb	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01
Mecury as Hg	mg/l	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001
Nickel as Ni	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.02
Pesticides	mg/l							0.5
Total Arsenic as As	mg/l	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01
Total Chromium as Cr	mg/l	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.05
Total Coliforms	MPN/100m l	Absent	Absent	Absent	Absent	Absent	Absent	Nil
E Coli	-	Absent	Absent	Absent	Absent	Absent	Absent	Absent

*IS 10500:2012, Drinking Water Specification

4.3 DISCUSSION

Table 33 provides the observed results for various parameters analyzed for drinking water samples collected from eighteen stations in and around the port's activity during the monitoring period of April, 2016 are compared with acceptable limits as prescribed in **IS 10500:2012** – Drinking Water Specification. It is seen from the analysis data that during the study period the water was safe for human consumption at all drinking water monitoring stations in and around the port.

The colour of all drinking water samples was < 5 Hazen unit and odour of the samples was also agreeable. The values of Turbidity Aluminium as Al, Barium, Boron, and Ammonia as NH₃-N were observed to be below detection limits of measurement i.e. <0.01, <0.5 mg/L, <0.01 mg/L and <1.0 mg/L respectively. Apparently these parameters are not at alarming levels.

Values observed for TDS for all the samples were in the range of 53 to 104 mg/L which are well below the acceptable standard limits (500 mg/L). pH values of all the samples were in the range of 7.1 to 7.7 which is within the permissible standard 6.5 to 8.5. Total Hardness as CaCO₃ values of all the eighteen samples were found to be in the range of 40 to 57.6 mg/L and found to be within the acceptable limit (200 mg/L).

Concentration levels observed for Chlorides as Cl⁻ and Sulphate as SO₄²⁻ were in the range of 11.8 to 14.7 mg/L, 4.2 to 8.9 mg/L respectively. The observed values for these parameters are well within the acceptable standard limits.

Analysis of the bacteriological parameter at all location and Total Coliform values is well within the prescribed standard limits. Hence the Total Coliform and E-Coli values showed that all the drinking water samples were safe from any bacteriological contamination.

4.4 CONCLUSIONS AND MITIGATION MEASURES:

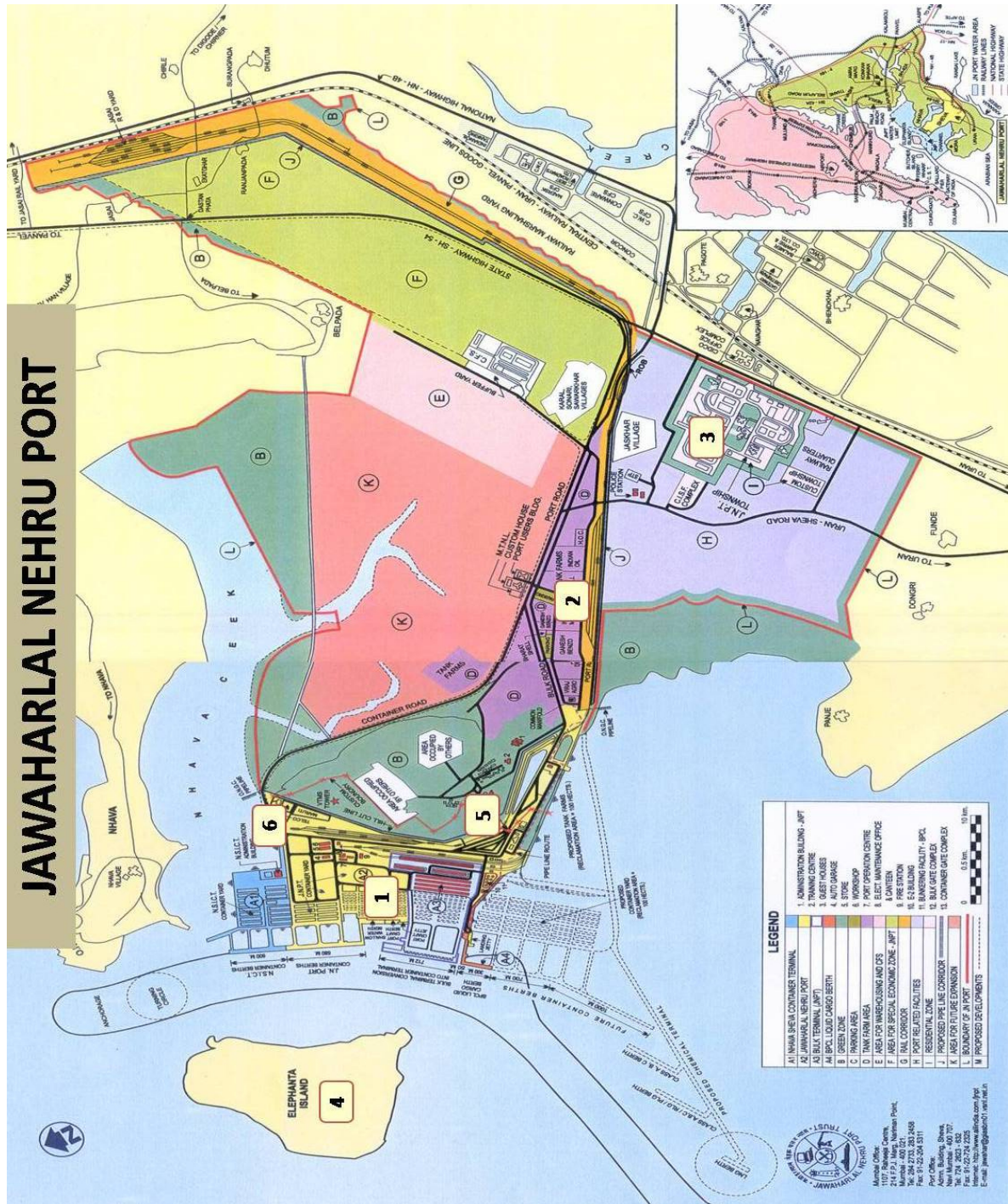
As per the drinking water specifications, given in IS 10500:2012 and also on the basis of above described analysis parameters, the water is safe for drinking purpose at all drinking water monitoring stations around port area.

It is advisable that, utmost care has to be taken to keep drinking water premises clean and sanitized. Water Filters and purifiers have to be regularly cleaned and should be covered under AMC.

5.

ANNEXURES

Annexure-I: Location map for Ambient Air Monitoring Stations



Annexure-II: National Ambient Air Quality Monitoring Standard

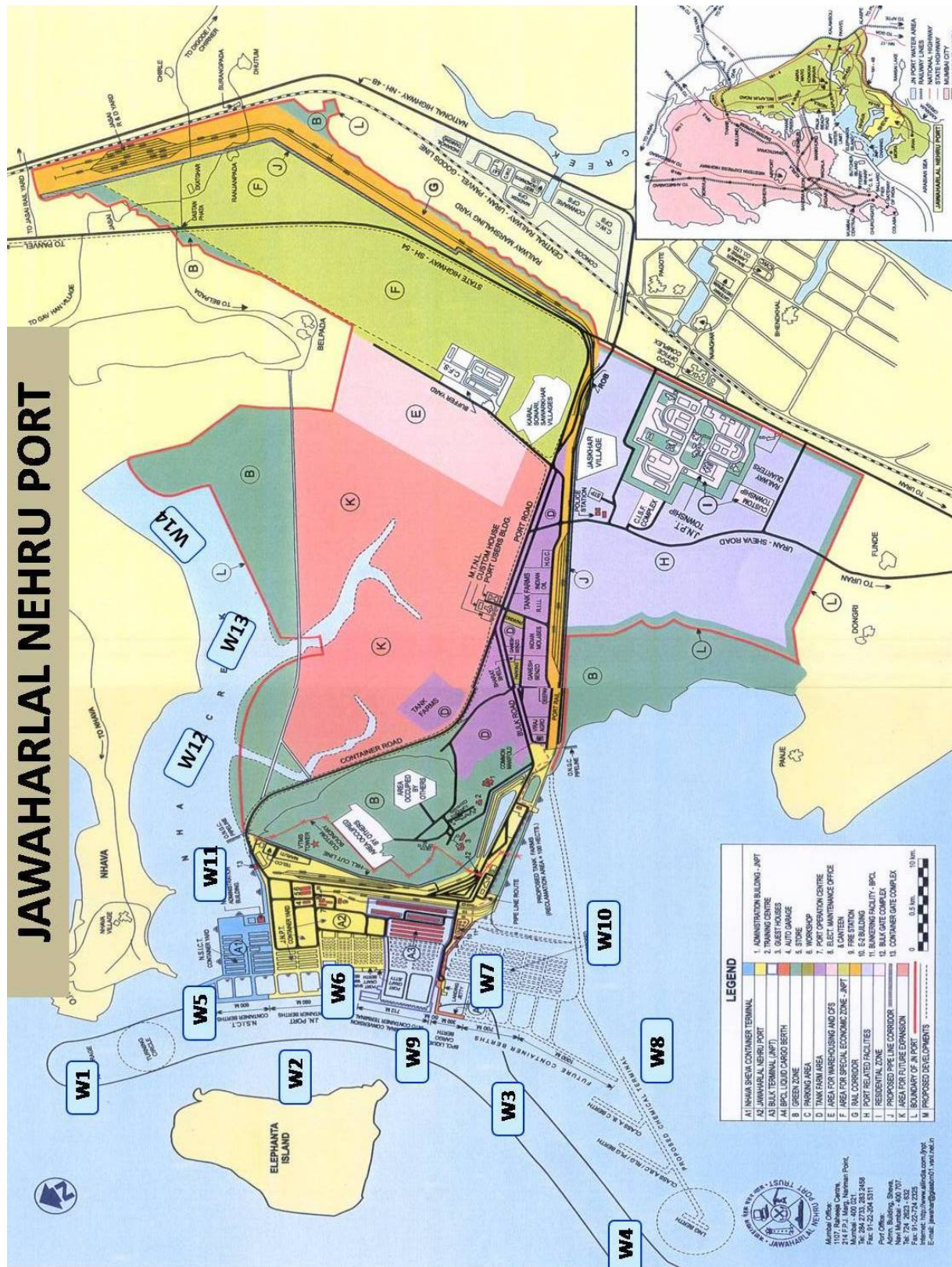
Sr. No.	Pollutant	Time Weighted Average	Concentration in Ambient Air		
			Industrial, Residential, Rural and Other Area	Ecologically Sensitive Area (notified by Central Government)	Methods of Measurement
1.	Sulphur Dioxide (SO ₂), µg/m ³	Annual* 24 hours**	50 80	20 80	-Improved West and Geake -Ultraviolet fluorescence
2.	Nitrogen Dioxide (NO ₂), µg/m ³	Annual* 24 hours**	40 80	30 80	-Modified Jacob & Hochheiser (Na-Arsenite) -Chemiluminescence
3.	Particulate Matter (size less than 10µm) or PM ₁₀ , µg/m ³	Annual* 24 hours**	60 100	60 100	-Gravimetric -TOEM -Beta attenuation
4.	Particulate Matter (size less than 2.5µm) or PM _{2.5} , µg/m ³	Annual* 24 hours**	40 60	40 60	-Gravimetric -TOEM -Beta attenuation
5.	Ozone (O ₃), µg/m ³	8 hours** 1 hour**	100 180	100 180	-UV photometric -Chemiluminescence -Chemical Method
6.	Lead (Pb), µg/m ³	Annual* 24 hours**	0.5 1.0	0.5 1.0	-AAS/ICP method after sampling on EPM 2000 or equivalent filter paper -ED-XRF using Teflon filter
7.	Carbon Monoxide (CO), mg/m ³	8 hours** 1 hour**	02 04	02 04	-Non Dispersive Infra-Red (NDIR) spectroscopy
8.	Ammonia (NH ₃), µg/m ³	Annual* 24 hours**	100 400	100 400	-Chemiluminescence -Indophenol blue method
9.	Benzene (C ₆ H ₆), µg/m ³	Annual*	05	05	-Gas chromatography based continuous analyzer -Adsorption and Desorption followed by GC analysis
10.	BenzoPyrene (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

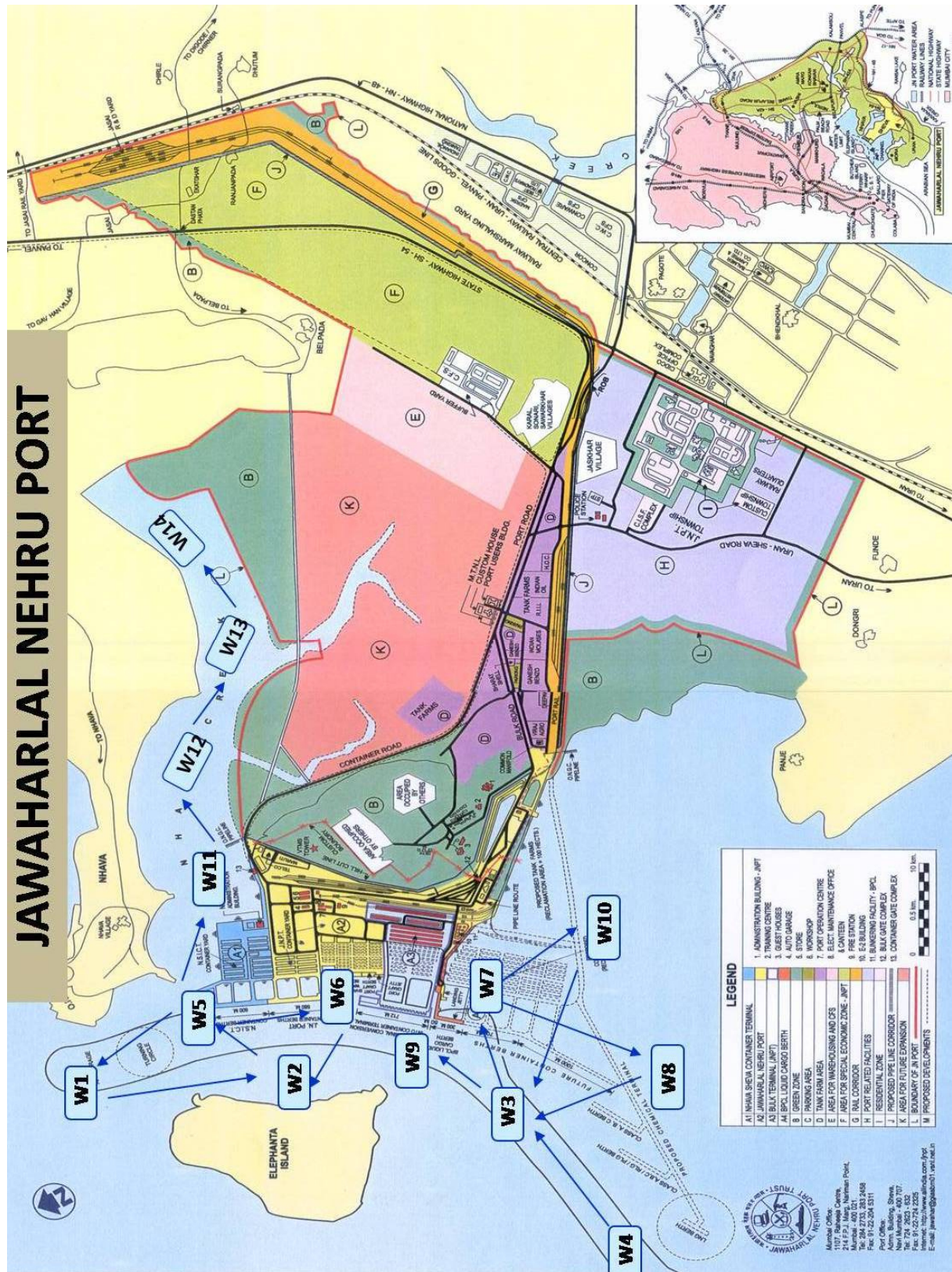
** 24 hourly or 08 hourly or 01 hourly monitored values, as applicable, shall be compiled with 98% of the time in a year. 2% of the time, they may exceed the limits but not on two consecutive days of monitoring.

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 investigations.

Annexure-III: Location map for Marine Water Monitoring Stations



Annexure-IV: Map for Ecological monitoring Stations and Towing Directions



Annexure-V: Primary Criterion for Class SW-IV Waters (For Harbor Waters)

Sr. No.	Parameter	Criteria	Rationale/Remarks
1.	pH range	6.5 - 9.0	To minimize the corrosive and scaling effects.
2.	Dissolved Oxygen	3.0 mg/L or 40 % of the saturation value, whichever is higher	Considering bio-degradation of oil and inhibition to oxygen production through photosynthesis.
3.	Color and Odor	No visible color or offensive order	None from reactive chemicals which may corrode paints/metallic surfaces.
4.	Floating objects oil, grease and scum (including the petroleum products)	10 mg/L	Floating matter should be free from excessive living organisms which may clog or coat operative parts of marine vessels/equipment.
5.	Fecal Coliform	500/ 100 ml (MPN)	Not exceeding 1000/100 ml in 20 % of the samples in the year and in 3 consecutive samples in the monsoon months.
6.	Biochemical Oxygen Demand (3 days at 27°C)	5 mg/L	To maintain water relatively free from the pollution caused by sewage and other decomposable wastes.

Annexure-VI: Recommended Ranges of the Ecological Parameters for Arabian Sea

Sr. No.	Parameter	Criteria	Rationale/Remarks
1.	Net primary productivity	<1500 mgC/m ³ /day at surface	High productivity indicates the abundance of phytoplankton crop available to primary producers this could lead to poor water quality.
2.	Chlorophyll-a	< 4 mg/m ³ 4-10 mg/m ³ >10 mg/m ³	Oligotrophic class of water Mesotrophic class of water Eutrophic class of water
3.	Phosphate	0.1- 90 µg/L	A nutrient that acts as a fertilizer. High level of this nutrient causes excessive plant and algal growth in aquatic ecosystem
4.	Nitrate	1.0- 500 µg/L	This is also a nutrient produced in natural water by decomposition of nitrogenous organic compounds. High level of nitrate represents the presence of more nitrogenous compounds and resulting in to excessive growth of algae and other aquatic vegetation.
5.	Nitrite	<125 µg/L	Nitrite in water poisons the fish by binding to the haemoglobin in the blood preventing oxygen carrying capacity, in effect suffocating the fish .The gills of fish dying as a result of nitrite poisoning are characteristic brown color.
6.	Particulate Organic Carbon (POC)	10-100 mg/m ³	POC is directly related to primary productivity. High concentration of POC represents the region of high productivity.
7.	Silicate (SiO ₂)	10-5000 µg/L	Nucleic acid synthesis and skeletal formation of Diatoms.

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Thank You