



## MONITORING OF ENVIRONMENTAL PLAN FOR JN PORT

### ENVIRONMENTAL MONITORING REPORT

REPORT NO. : UT/ELS/REPORT/EMR-28/2015

Month : June, 2015

Issue No : 01

Revision No : 00

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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 depicted in **Table 1**. The location map of various air quality monitoring stations at JNP is described 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 archeological 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 ambient air samples are carried out as per CPCB Guidelines for Ambient Air Quality Monitoring, Volume-I, 2012. The monitoring is carried-out for air quality parameters mentioned in the National Ambient Air Quality Monitoring Standards (NAAQMS), CPCB Notification published on 18<sup>th</sup> 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, at NGC and SGC is once in a week. The monitoring at Elephanta Caves is once in a month as per schedule directed by Engineer In-charge.

In all above station sampling duration was 24 hour for PM<sub>10</sub>, PM<sub>2.5</sub>, SO<sub>2</sub>, NO<sub>x</sub>, NH<sub>3</sub>, Pb, As, Ni, Benzo(α)pyrene, 8 hour for Ozone & Benzene, and Grab-sampling for CO & CO<sub>2</sub> 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, SO<sub>2</sub>, NO<sub>x</sub> and NH<sub>3</sub>. The EPM 2000 filter paper and PTFE Membrane bound filter paper is used for a period of 24 hours to obtain one sample of PM<sub>10</sub>& PM<sub>2.5</sub>. After PM<sub>10</sub> 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 June, 2015 are given in **Table 2, 3 & 4** respectively. The ambient air quality monitoring data for EC and two movable stations, NGC & SGC are given in **Table 5, 6 & 7** respectively.

Table 2: Results of Air Pollutant Concentration at POC Station of JNP Area during the month of June, 2015													
Sampling Period NAAQMS	Date	Time, [Hrs]	PM <sub>10</sub> , [µg/m <sup>3</sup> ]		PM <sub>2.5</sub> , [µg/m <sup>3</sup> ]		SO <sub>2</sub> , [µg/m <sup>3</sup> ]		NO <sub>x</sub> , [µg/m <sup>3</sup> ]		NH <sub>3</sub> , [µg/m <sup>3</sup> ]		24 hr (Avg) 800 µg/m <sup>3</sup>
			24 hr 100 µg/m <sup>3</sup>	24 hr 60 µg/m <sup>3</sup>	24 hr 60 µg/m <sup>3</sup>	24 hr 60 µg/m <sup>3</sup>	8 hr	24 hr (Avg) 80 µg/m <sup>3</sup>	8 hr	24 hr (Avg) 80 µg/m <sup>3</sup>	8 hr	24 hr (Avg) 400 µg/m <sup>3</sup>	
POC-1	01.06.2015 To 02.06.2015	14:00 to 22:00					13		19		42		44
		22:00 to 06:00	83	10			12	15	19	19	39		
		06:00 to 14:00					19		19		51		
POC-2	04.06.2015 To 05.06.2015	14:00 to 22:00					16		20		60		56
		22:00 to 06:00	108	22			12	14	20	20	58		
		06:00 to 14:00					<10		20		51		
POC-3	08.06.2015 To 09.06.2015	14:00 to 22:00					15		15		27		22
		22:00 to 06:00	47	12			11	12	16	14	22		
		06:00 to 14:00					11		12		17		
POC-4	11.06.2015 To 12.06.2015	14:00 to 22:00					10		24		15		17
		22:00 to 06:00	66	14			10	13	25	25	16		
		06:00 to 14:00					18		25		19		
POC-5	15.06.2015 to 16.06.2015	14:00 to 22:00					11		40		28		29
		22:00 to 06:00	58	16			13	12	39	40	32		
		06:00 to 14:00					<10		39		27		
POC-6	18.06.2015 to 19.06.2015	14:00 to 22:00					15		50		27		26
		22:00 to 06:00	15	<10			14	14	50	50	29		
		06:00 to 14:00					13		50		22		
POC-7	22.06.2015 to 23.06.2015	14:00 to 22:00					11		25		16		19
		22:00 to 06:00	50	<10			15	15	25	25	23		
		06:00 to 14:00					18		25		18		
POC-8	25.06.2015 to 26.06.2015	14:00 to 22:00					12		19		26		31
		22:00 to 06:00	94	10			11	12	20	20	36		
		06:00 to 14:00					12		19		31		
POC-9	29.06.2015 to 30.06.2015	14:00 to 22:00					15		24		25		24
		22:00 to 06:00	94	31			16	14	25	25	29		
		06:00 to 14:00					11		25		18		
Average Standard Dev			68	16				13		26		30	13
			29	8				1		11		13	

Table 2: Results of Air Pollutant Concentration at POC Station of JNP Area during the month of June, 2015											
Sampling Period	Date	Time, [Hrs]	O <sub>3</sub> , [µg/m <sup>3</sup> ]	Pb, [µg/m <sup>3</sup> ]	As, [ng/m <sup>3</sup> ]	Ni, [ng/m <sup>3</sup> ]	C <sub>6</sub> H <sub>6</sub> , [µg/m <sup>3</sup> ]	BaP, [ng/m <sup>3</sup> ]	CO, [mg/m <sup>3</sup> ]	CO <sub>2</sub> , [ppm]	
NAAQMS			3hr 100 µg/m <sup>3</sup>	24 hr 1.0 µg/m <sup>3</sup>	24 hr 6 ng/m <sup>3</sup>	24 hr 20 ng/m <sup>3</sup>	8 hr 5 µg/m <sup>3</sup>	24 hr 1 ng/m <sup>3</sup>	Grab Sampling 4mg/m <sup>3</sup>	Grab Sampling	
POC-1	01.06.2015 To 02.06.2015	14:00 to 22:00	11	0.04	<1	<1	1.6	<0.5	1.4	279	
		22:00 to 06:00									
		06:00 to 14:00									
POC-2	04.06.2015 To 05.06.2015	14:00 to 22:00	9	0.06	<1	<1	1.8	<0.5	1.3	274	
		22:00 to 06:00									
		06:00 to 14:00									
POC-3	08.06.2015 To 09.06.2015	14:00 to 22:00	14	0.01	<1	<1	1.9	<0.5	1.5	268	
		22:00 to 06:00									
		06:00 to 14:00									
POC-4	11.06.2015 To 12.06.2015	14:00 to 22:00	12	0.03	<1	<1	2.1	<0.5	1.2	279	
		22:00 to 06:00									
		06:00 to 14:00									
POC-5	15.06.2015 To 16.06.2015	14:00 to 22:00	28	0.01	<1	<1	1.6	<0.5	0.9	289	
		22:00 to 06:00									
		06:00 to 14:00									
POC-6	18.06.2015 To 19.06.2015	14:00 to 22:00	19	<0.01	<1	<1	1.8	<0.5	1.5	287	
		22:00 to 06:00									
		06:00 to 14:00									
POC-7	22.06.2015 To 23.06.2015	14:00 to 22:00	3	0.02	<1	<1	<1	<0.5	1.6	294	
		22:00 to 06:00									
		06:00 to 14:00									
POC-8	25.06.2015 To 26.06.2015	14:00 to 22:00	3	0.03	<1	<1	1.2	<0.5	2.1	286	
		22:00 to 06:00									
		06:00 to 14:00									
POC-9	29.06.2015 To 30.06.2015	14:00 to 22:00	15	0.03	<1	<1	1.5	<0.5	1.8	290	
		22:00 to 06:00									
		06:00 to 14:00									
Average Standard Dev			14	0.03			1.7		1.5	283	
			6	0.02			0.3		0.3	8	



Table 3: Results of Air Pollutant Concentration at IMC Station of JNP Area during the month of June, 2015										
Sampling Period NAAQMS	Date	Time, [Hrs]	PM <sub>10</sub> , [µg/m <sup>3</sup> ] 24 hr 100 µg/m <sup>3</sup>	PM <sub>2.5</sub> , [µg/m <sup>3</sup> ] 24 hr 60 µg/m <sup>3</sup>	SO <sub>2</sub> , [µg/m <sup>3</sup> ] 8 hr	NO <sub>x</sub> , [µg/m <sup>3</sup> ] 8 hr	NO <sub>x</sub> , [µg/m <sup>3</sup> ] 24 hr (Avg) 80 µg/m <sup>3</sup>	NH <sub>3</sub> , [µg/m <sup>3</sup> ] 8 hr	24 hr (Avg) 400 µg/m <sup>3</sup>	
IMC-1	01.05.2015 To 02.05.2015	15:00 to 23:00			21	21		53		
		23:00 to 07:00	165	37	25	28	23	51	55	
		07:00 to 15:00			19	21		55		
IMC-2	04.05.2015 To 05.05.2015	15:05 to 23:05	184	35	22	26	25	38	36	
		23:05 to 07:05			20	26		39		
		07:05 to 15:05			17	22		32		
IMC-3	08.05.2015 To 09.05.2015	15:10 to 23:10			12	24		13		
		23:10 to 07:10	55	16	15	24	25	12	13	
		07:10 to 15:10			10	25		15		
IMC-4	11.05.2015 To 12.05.2015	14:50 to 22:50			<10	21	21	13	16	
		22:50 to 06:50	42	12	12	21		19		
		06:50 to 14:50			19	21		15		
IMC-5	15.05.2015 to 16.05.2015	15:00 to 23:00			23	32		20		
		23:00 to 07:00	35	<10	21	36	35	18	21	
		07:00 to 15:00			19	37		25		
IMC-6	18.05.2015 to 19.05.2015	15:00 to 23:00			15	19	20	9	9	
		23:00 to 07:00	52	15	18	20		9		
		07:00 to 15:00			17	21		9		
IMC-7	22.05.2015 to 23.05.2015	15:00 to 23:00			12	18		37		
		23:00 to 07:00	48	12	10	18	18	39	39	
		07:00 to 15:00			<10	19		41		
IMC-8	25.05.2015 to 26.05.2015	15:00 to 23:00			15	19	18	37	44	
		23:00 to 07:00	75	26	18	17		39		
		07:00 to 15:00			11	18		41		
IMC-9	29.05.2015 to 30.05.2015	15:00 to 23:00			11	14	14	34	44	
		23:00 to 07:00	97	38	12	14	14	39		
		07:00 to 15:00			10	15		53		
Average			84	24			22		31	
Standard Dev			55	11			6		16	

Table 3: Results of Air Pollutant Concentration at IMC Station of JNP Area during the month of June, 2015											
Sampling Period	Date	Time, [Hrs]	O <sub>3</sub> , [µg/m <sup>3</sup> ]	PM <sub>10</sub> , [µg/m <sup>3</sup> ]	As, [ng/m <sup>3</sup> ]	Ni, [ng/m <sup>3</sup> ]	Cd, [µg/m <sup>3</sup> ]	BaP, [ng/m <sup>3</sup> ]	CO, [mg/m <sup>3</sup> ]	CO <sub>2</sub> [ppm]	
IMC-1	01.06.2015	15:00 to 23:00	11	0.09	<1	<1	1.3	<0.5	1.5	279	
	To	23:00 to 07:00									
IMC-2	02.06.2015	07:00 to 15:00	8	0.11	<1	<1	<1	<0.5	1.2	267	
	To	23:05 to 07:05									
IMC-3	05.06.2015	07:05 to 15:05	10	0.03	<1	<1	1.3	<0.5	1.9	275	
	To	23:10 to 07:10									
IMC-4	09.06.2015	07:10 to 15:10	39	0.02	<1	<1	1.2	<0.5	1.3	278	
	To	22:50 to 06:50									
IMC-5	12.06.2015	05:50 to 14:50	27	0.02	<1	<1	2.1	<0.5	1.4	291	
	To	23:00 to 07:00									
IMC-6	15.06.2015	15:00 to 23:00	6	0.02	<1	<1	1.5	<0.5	1.8	276	
	To	23:00 to 07:00									
IMC-7	19.06.2015	07:00 to 15:00	14	0.02	<1	<1	1.8	<0.5	1.6	287	
	To	23:00 to 07:00									
IMC-8	23.06.2015	07:00 to 15:00	5	0.03	<1	<1	1.2	<0.5		268	
	To	23:00 to 07:00									
IMC-9	26.06.2015	07:00 to 15:00	10	0.07	<1	<1	<1	<0.5	2.4	291	
	To	23:00 to 07:00									
Average	30.06.2015	07:00 to 15:00	15	0.05			1.5		1.6	279	
Standard Dev			11	0.04			0.3		0.4	9	



Table 4: Results of Air Pollutant Concentration at RC School Station of JNP Area during the month of June, 2015												
Sampling Period NAAQMS	Date	Time, [Hrs]	PM <sub>10</sub> [ $\mu\text{g}/\text{m}^3$ ] 24 hr 100 $\mu\text{g}/\text{m}^3$	PM <sub>2.5</sub> [ $\mu\text{g}/\text{m}^3$ ] 24 hr 60 $\mu\text{g}/\text{m}^3$	SO <sub>2</sub> [ $\mu\text{g}/\text{m}^3$ ]		NO <sub>x</sub> [ $\mu\text{g}/\text{m}^3$ ]		NH <sub>3</sub> [ $\mu\text{g}/\text{m}^3$ ]			
					8 hr -	24 hr (Avg) 80 $\mu\text{g}/\text{m}^3$	8 hr -	24 hr (Avg) 50 $\mu\text{g}/\text{m}^3$	8 hr -	24 hr (Avg) 400 $\mu\text{g}/\text{m}^3$		
RC-1	01.06.2015 To 02.06.2015	15:20 to 23:20		14	<10		16		35			
		23:20 to 07:20	98		10		<10	13	40		38	
		07:20 to 15:20			<10		10		39			
RC-2	04.06.2015 To 05.06.2015	15:30 to 23:30		11	15		14		52			
		23:30 to 07:30	94		12	13	19	17	52		52	
		07:30 to 15:30			12		<10		51			
RC-3	08.06.2015 To 09.06.2015	15:35 to 23:35			<10		24		13			
		23:35 to 07:35	36	10	12	11	24	24	18		14	
		07:35 to 15:35			10		24		11			
RC-4	11.06.2015 To 12.06.2015	15:30 to 23:30			14		15		15			
		23:30 to 07:30	72	15	16	14	18	16	18		15	
		07:30 to 15:30			11		15		11			
RC-5	15.06.2015 to 16.06.2015	15:30 to 23:30			11		19		34			
		23:30 to 07:30	46	13	<10	11	16	16	48		40	
		07:30 to 15:30			10		14		39			
RC-6	18.06.2015 to 19.06.2015	15:30 to 23:30			16		19		21			
		23:30 to 07:30	52	17	17	15	20	19	24		4	
		07:30 to 15:30			12		17		25			
RC-7	22.06.2015 to 23.06.2015	15:30 to 23:30			19		19		32			
		23:30 to 07:30	45	12	11	13	21	20	39		34	
		07:30 to 15:30			10		20		31			
RC-8	25.06.2015 to 26.06.2015	15:30 to 23:30			10		15		13			
		23:30 to 07:30	60	14	<10	11	16	16	18		18	
		07:30 to 15:30			11		16		22			
RC-9	29.06.2015 to 30.06.2015	15:30 to 23:30			12		25		11			
		23:30 to 07:30	72	25	13	13	23	21	23		21	
		07:30 to 15:30			<10		14		29			
Average			64	15		12		18		26		
Standard Dev			22	4		2		3		15		

Table 4: Results of Air Pollutant Concentration at RC Station of JNP Area during the month of June, 2015													
Sampling Period NAAQMS	Date	Time [Hrs]	O <sub>3</sub> [ $\mu\text{g}/\text{m}^3$ ]	Pb, [ $\mu\text{g}/\text{m}^3$ ]	As, [ $\text{ng}/\text{m}^3$ ]	Ni, [ $\text{ng}/\text{m}^3$ ]	C <sub>6</sub> H <sub>6</sub> , [ $\mu\text{g}/\text{m}^3$ ]	BAP, [ $\text{ng}/\text{m}^3$ ]	CO, [ $\text{mg}/\text{m}^3$ ]	CO <sub>2</sub> [ppm]			
			8 hr 100 $\mu\text{g}/\text{m}^3$	24 hr 1.0 $\mu\text{g}/\text{m}^3$	24 hr 6 $\text{ng}/\text{m}^3$	24 hr 20 $\text{ng}/\text{m}^3$	8 hr 5 $\mu\text{g}/\text{m}^3$	24 hr 1 $\text{ng}/\text{m}^3$	Grab Sampling 4 $\text{mg}/\text{m}^3$	Grab Sampling			
RC-1	01.06.2015	15:20 to 23:20											
	To	23:20 to 07:20	11	0.06	<1	<1	<1	<0.5	1.5	279			
RC-2	02.06.2015	07:20 to 15:20											
	To	15:30 to 23:30	9	0.04	<1	<1	<1	<0.5	1.8	282			
RC-3	05.06.2015	07:30 to 15:30											
	To	15:35 to 23:35	15	<0.01	<1	<1	<1	<0.5	2.1	294			
RC-4	09.06.2015	07:35 to 15:35											
	To	15:30 to 23:30	42	0.04	<1	<1	<1	<0.5	2.1	286			
RC-5	12.06.2015	07:30 to 15:30											
	tc	15:30 to 23:30	3.6	0.01	<1	<1	<1	<0.5	1.9	278			
RC-6	16.06.2015	07:30 to 15:30											
	tc	15:30 to 23:30	6	0.01	<1	<1	<1	<0.5	1.6	284			
RC-7	19.06.2015	07:30 to 15:30											
	tc	15:30 to 23:30	9.8	0.09	<1	<1	<1	<0.5	1.6	291			
RC-8	23.06.2015	07:30 to 15:30											
	tc	15:30 to 23:30	14.2	0.1	<1	<1	<1	<0.5	1.8	278			
RC-9	26.06.2015	07:30 to 15:30											
	tc	15:30 to 23:30	13.6	0.06	<1	<1	<1	<0.5	1.9	276			
Average Standard Dev	30.06.2015	07:30 to 15:30	12	0.05					1.8	283			
			8	0.03					0.2	6			

**Table 5: Results of Air Pollutant Concentration at EC Station monitored during June, 2015**

Sampling Period	Date	Time, [Hrs]	PM <sub>10</sub> , [µg/m <sup>3</sup> ]	PM <sub>2.5</sub> , [µg/m <sup>3</sup> ]	SO <sub>2</sub> , [µg/m <sup>3</sup> ]	NO <sub>x</sub> , [µg/m <sup>3</sup> ]	NT <sub>s</sub> , [µg/m <sup>3</sup> ]
NAAQMS	11.05.2015 To 12.05.2015	24 hr	100 µg/m <sup>3</sup>	50 µg/m <sup>3</sup>	-	80 µg/m <sup>3</sup>	24 hr (Avg)
		14:00 to 22:00		15	30	44	8 hr
		22:00 to 06:00	29	18	24	49	24 hr (Avg)
		06:00 to 14:00		12	27	45	400 µg/m <sup>3</sup>

**Table 5: Results of Air Pollutant Concentration at EC Station monitored during June, 2015**

Sampling Period	Date	Time, [Hrs]	O <sub>3</sub> , [µg/m <sup>3</sup> ]	Pb, [µg/m <sup>3</sup> ]	As, [µg/m <sup>3</sup> ]	Mn, [µg/m <sup>3</sup> ]	Cd, [µg/m <sup>3</sup> ]	BeP, [µg/m <sup>3</sup> ]	CO, [mg/m <sup>3</sup> ]	CO <sub>2</sub> , [ppm]
NAAQMS	11.06.2015 To 12.06.2015	8 hr	100 µg/m <sup>3</sup>	1.0 µg/m <sup>3</sup>	6 µg/m <sup>3</sup>	20 µg/m <sup>3</sup>	5 µg/m <sup>3</sup>	1 µg/m <sup>3</sup>	4 mg/m <sup>3</sup>	-
		14:00 to 22:00								
		22:00 to 06:00	14	<0.01	<1	<1	<1	<0.5	0.6	255

Sampling Period	Date	Time, [Hrs]	PM <sub>10</sub> , [µg/m <sup>3</sup> ]		PM <sub>2.5</sub> , [µg/m <sup>3</sup> ]		SO <sub>2</sub> , [µg/m <sup>3</sup> ]		NO <sub>x</sub> , [µg/m <sup>3</sup> ]		NH <sub>3</sub> , [µg/m <sup>3</sup> ]	
			24 hr 100 µg/m <sup>3</sup>	24 hr 60 µg/m <sup>3</sup>	24 hr (Avg) 30 µg/m <sup>3</sup>	8 hr	24 hr (Avg) 80 µg/m <sup>3</sup>	8 hr	24 hr (Avg) 400 µg/m <sup>3</sup>			
NG-1	04.06.2015 To 05.06.2015	16:00 to 00:00					12		29		16	
		00:00 to 08:00	187	37		15	14	21	23	23	19	
		08:00 to 16:00				14		18		18		
NG-2	11.06.2015 To 12.06.2015	15:50 to 23:50					<10		25		16	
		23:50 to 07:50	49	12	11	10		24	25	21	18	
		07:50 to 15:50				12		25		18		
NG-3	18.06.2015 to 19.06.2015	15:40 to 23:40					13		35		38	
		23:40 to 07:40	22	<10	12	10		34	35	39	35	
		07:40 to 15:40				<10		35		27		
NG-4	25.06.2015 to 26.06.2015	15:40 to 23:40					10		19		10	
		23:40 to 07:40	79	15	10	10		11	15	18	14	
		07:40 to 15:40				<10		<10		13		
Average			84	21	12				24		21	
Standard Dev			72	14	1				8		9	

Sampling Period	Date	Time, [Hrs]	O <sub>3</sub> , [µg/m <sup>3</sup> ]		Pb, [µg/m <sup>3</sup> ]		As, [ng/m <sup>3</sup> ]		Ni, [ng/m <sup>3</sup> ]		BaP, [ng/m <sup>3</sup> ]		CO, [mg/m <sup>3</sup> ]		CO <sub>2</sub> , [ppm]
			8 hr	100 µg/m <sup>3</sup>	24 hr	1.0 µg/m <sup>3</sup>	24 hr	6 ng/m <sup>3</sup>	24 hr	20 ng/m <sup>3</sup>	8 hr	5 µg/m <sup>3</sup>	1 ng/m <sup>3</sup>	Grab Sampling	
NAAQMS	04.06.2015 To 05.06.2015	16:00 to 00:00													
		00:00 to 08:00	11		0.11	<1	<1	1.3	<0.5	2.1	<0.5	287			
		08:00 to 16:00													
NG-2	11.06.2015 To 12.06.2015	15:50 to 23:50	40		0.02	<1	<1	1.7	<0.5	1.7	<0.5	276			
		23:50 to 07:50													
		07:50 to 15:50													
NG-3	18.06.2015 to 19.06.2015	15:40 to 23:40	4.3		<0.01	<1	<1	1.6	<0.5	1.6	<0.5	277			
		23:40 to 07:40													
		07:40 to 15:40													
NG-4	25.06.2015 to 26.06.2015	15:40 to 23:40	38		0.03	<1	<1	1.3	<0.5	1.3	<0.5	279			
		23:40 to 07:40													
		07:40 to 15:40													
Average			22		0.1			1.7		1.3		280			
Standard Dev			17		0.0			0.1		0.2		5			

Sampling Period NA/AQMS	Date	Time, [Hrs]	PM <sub>10</sub> , [µg/m <sup>3</sup> ]		PM <sub>2.5</sub> , [µg/m <sup>3</sup> ]		SO <sub>2</sub> , [µg/m <sup>3</sup> ]		NO <sub>x</sub> , [µg/m <sup>3</sup> ]		NH <sub>3</sub> , [µg/m <sup>3</sup> ]	
			24 hr 100 µg/m <sup>3</sup>	24 hr 60 µg/m <sup>3</sup>	24 hr 30 µg/m <sup>3</sup>	8 hr -	24 hr (Avg) 80 µg/m <sup>3</sup>	8 hr -	24 hr (Avg) 80 µg/m <sup>3</sup>	8 hr -	24 hr (Avg) 400 µg/m <sup>3</sup>	
SG-1	01.06.2015 To 02.06.2015	16:30 to 00:30				12		16		52		
		00:30 to 08:30	105	40	11	13	17		55	49		
		08:30 to 16:30			15		19		41			
SG-2	08.06.2015 To 09.06.2015	16:15 to 00:15			18		24		28			
		00:15 to 08:15	102	39	11	15	25		13	21		
		08:15 to 16:15			16		25		23			
SG-3	15.06.2015 to 16.06.2015	16:15 to 00:15			11		31		40			
		00:15 to 08:15	39	11	10	11	34		31	36		
		08:15 to 16:15			<10		33		38			
SG-4	22.06.2015 to 23.06.2015	16:15 to 00:15			12		21		11			
		00:15 to 08:15	49	10	16	13	21		19	17		
		08:15 to 16:15			11		22		21			
SG-5	29.06.2015 to 30.06.2015	16:15 to 00:15			10		27		58			
		00:15 to 08:15	99	37	10	10	27		50	55		
		08:15 to 16:15			<10		77		58			
Average			79	27		12		25		36		
Standard Dev			32	15		2		6		17		

Sampling Period NA/AQMS	Date	Time, [Hrs]	PM <sub>10</sub> , [µg/m³]		PM <sub>2.5</sub> , [µg/m³]		SO <sub>2</sub> , [µg/m³]		NO <sub>x</sub> , [µg/m³]		NH <sub>3</sub> , [µg/m³]	
			24 hr 100 µg/m³	24 hr 60 µg/m³	24 hr 30 µg/m³	8 hr -	24 hr (Avg) 80 µg/m³	8 hr -	24 hr (Avg) 80 µg/m³	8 hr -	24 hr (Avg) 400 µg/m³	
SG-1	01.06.2015 To 02.06.2015	16:30 to 00:30				12		16		52		
		00:30 to 08:30	105	40	11	13	17		55	49		
		08:30 to 16:30			15		19		41			
SG-2	08.06.2015 To 09.06.2015	16:15 to 00:15			18		24		28			
		00:15 to 08:15	102	39	11	15	25		13	21		
		08:15 to 16:15			16		25		23			
SG-3	15.06.2015 to 16.06.2015	16:15 to 00:15			11		31		40			
		00:15 to 08:15	39	11	10	11	34		31	36		
		08:15 to 16:15			<10		33		38			
SG-4	22.06.2015 to 23.06.2015	16:15 to 00:15			12		21		11			
		00:15 to 08:15	49	10	16	13	21		19	17		
		08:15 to 16:15			11		22		21			
SG-5	29.06.2015 to 30.06.2015	16:15 to 00:15			10		27		58			
		00:15 to 08:15	99	37	10	10	27		50	55		
		08:15 to 16:15			<10		27		58			
Average			79	27		12		25		36		
Standard Dev			32	15		2		6		17		

## 1.4 DISCUSSION

In **Table 8**, the average concentration values of air pollutants are provided at various stations of JNP area for the month of June, 2015. The values obtained are compared with respective CPCB standards described for Industrial, Residential, Rural and ecologically sensitive areas. The values obtained for Pb, As, Ni and Benzo( $\alpha$ )Pyrene [BaP] are below detection limits of measurements at all air monitoring stations for the month June, 2015 and hence these parameters are not included in **Table 8**.

**Table 8:** Monthly Average Values of Air Pollutant Concentration at Various Stations of JNP Area during the month of June, 2015

STATION	PM <sub>10</sub> , [ $\mu\text{g}/\text{m}^3$ ]	PM <sub>2.5</sub> , [ $\mu\text{g}/\text{m}^3$ ]	SO <sub>2</sub> , [ $\mu\text{g}/\text{m}^3$ ]	NO <sub>x</sub> , [ $\mu\text{g}/\text{m}^3$ ]	NH <sub>3</sub> , [ $\mu\text{g}/\text{m}^3$ ]	O <sub>3</sub> , [ $\mu\text{g}/\text{m}^3$ ]	Pb [ $\mu\text{g}/\text{m}^3$ ]	C <sub>6</sub> H <sub>6</sub> , [ $\mu\text{g}/\text{m}^3$ ]	CO, [mg/m <sup>3</sup> ]	CO <sub>2</sub> , [ppm]
NAAQMS	100	60	80	80	400	100	1	5	4	-
<b>INDUSTRIAL AREA</b>										
POC	68 $\pm$ 29	16 $\pm$ 08	13 $\pm$ 1	26 $\pm$ 11	30 $\pm$ 13	14 $\pm$ 06	0.03 $\pm$ 0.02	1.7 $\pm$ 0.3	1.5 $\pm$ 0.3	283 $\pm$ 08
IMC	84 $\pm$ 55	24 $\pm$ 11	16 $\pm$ 4	22 $\pm$ 6	31 $\pm$ 16	15 $\pm$ 11	0.05 $\pm$ 0.04	1.5 $\pm$ 0.3	1.6 $\pm$ 0.4	279 $\pm$ 09
NG	84 $\pm$ 72	21 $\pm$ 14	12 $\pm$ 1	24 $\pm$ 8	21 $\pm$ 0.9	22 $\pm$ 17	0.1 $\pm$ 0.05	1.7 $\pm$ 0.1	1.8 $\pm$ 0.2	280 $\pm$ 05
SG	79 $\pm$ 32	27 $\pm$ 15	12 $\pm$ 2	25 $\pm$ 6	36 $\pm$ 17	18 $\pm$ 13	0.09 $\pm$ 0.03	1.8 $\pm$ 0.3	2.0 $\pm$ 0.3	284 $\pm$ 05
<b>RESIDENTIAL AREA</b>										
RC	64 $\pm$ 22	15 $\pm$ 4	12 $\pm$ 2	18 $\pm$ 3	26 $\pm$ 15	12 $\pm$ 8	0.05 $\pm$ 0.03	1.2 $\pm$ 0.1	1.8 $\pm$ 0.2	283 $\pm$ 06
<b>ECO-SENSITIVE AREA</b>										
EC	29	<10	15	27	46	14	<0.01	<1	0.6	265

During the monitoring period, the overall Ambient Air Quality of the port area was found to be well within the prescribed levels for various pollutants. The pollutants concentrations, mainly PM<sub>10</sub> and PM<sub>2.5</sub> values, were drastically reduced due to precipitation scavenging during monsoon.

Daily average pollutant levels are depicted in **Table 2** through **7**. The concentrations obtained for particulate matter concentrations at all stations comply with the prescribed national standards. All pollutants were recorded well below the prescribed limits. Monthly average values obtained for the month of June, 2015. (**Table 8**)

All the monitoring stations have higher particulate (PM<sub>10</sub>) levels in the first week of June, 2015. Highest levels among port stations were at NG and IMC. NG is port vehicle entry points have particulate concentrations above prescribed standards because of ongoing road maintenance and heavy vehicular movement. Rest of the month the particulates were washed down because of precipitation, and concentrations abruptly gone down.

Results for the air quality parameters at Elephanta Caves [EC] station during 10<sup>th</sup> June'15 to 11<sup>th</sup> June'15 were represented in **Table 5. Table 6 & 7** provide the results for NGC and SGC air monitoring stations respectively.

In the month of June'15 particulate & gaseous pollutants were well within the prescribed limits set for industrial as well as sensitive area.

## 1.5 OBSERVATIONS AND CONCLUSIONS

The environmental implications of a port and harbor operational activities must be considered before further developments are made. 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 June'15:*

- ✓ All the public and community buildings in residential complex / township are under renovation. These account for partially elevated particulate concentrations. This is being temporary activity.
- ✓ *Construction of 4<sup>th</sup> Container Terminal on South side of JNPT:* Land preparation work of 4<sup>th</sup> C.T. is underway.
- ✓ Solid waste was being disposed near CFS i.e. Karal village and PUB backyard in haphazard manner.
- ✓ *Vehicular Traffic at three gates:* The monitoring of ambient air Quality at South gate and North gate complexes are done once a week. The average particulate matter concentrations found within CPCB limits. The initiative taken by the port in terms of maintenance of port vehicles, PUC checking of vehicles visiting port and enough green cover provided in and around the area contributes significantly 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 June'15.





### **Civil Work at NSIGT Yard and Land Preparation at 4<sup>th</sup> Container Terminal**

The following measures can be taken to reduce further the PM<sub>10</sub> and PM<sub>2.5</sub> levels in and around the port area:

- ✓ Renovation work being carried out at JNP Township should be executed under controlled conditions.
- ✓ 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.

### **Conclusion:**

From the results obtained for the month of June, 2015 it can be concluded that overall Ambient Air quality of the JN Port is within CPCB limits.

## 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 [W08] 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 depicted in **Table 9**. The location map of various Marine ecology monitoring stations along with direction of towing are described 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.

**Harbor Water Quality Monitoring** – Three samples from the surface, mid depth and bottom are collected and composite from each harbor water quality monitoring station during spring and neap tidal cycle. The samples are after 1<sup>st</sup>, 3<sup>rd</sup> and 5<sup>th</sup> hour from eight fixed and one moving station every month. In all 54 samples are collected from nine stations.

**Creek Water Quality Monitoring**– Three samples from the surface, mid depth and bottom are collected and composite from four water quality monitoring stations in the Nhava Creek during spring and 3<sup>rd</sup> hour of neap tide only because of very low water depth available (mud flat) at these stations. In all 24 samples are collected from four 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 depicted in **Table 10** along with parameters to be monitored for sediment characterization. Annexure-V describes Primary Water Quality Criterion for **Class SW-IV** Waters (For Harbor 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.	10 <sup>th</sup> June, 2015
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	10 <sup>th</sup> June, 2015
3.	W3	Identified by the green buoy no. <u>FG2 Green</u> of JNPT approach channel and lies near the landing jetty.	11 <sup>th</sup> June, 2015
4.	W4	Located at Uran Patch Beacon (lighthouse on concrete platform) near the Butcher Island filling platform.	11 <sup>th</sup> June, 2015
5.	W5	W5 is near to the guide bund and others are along Nhava creek uptoBelpada. These are selected to examine the impact of neighboring Nhava Villages and Belpada to the creek water quality	10 <sup>th</sup> June, 2015
	W11 to W14		12 <sup>th</sup> June, 2015
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.	10 <sup>th</sup> June, 2015
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.	11 <sup>th</sup> June, 2015
8.	W9	Located in between GTI and Liquid Cargo Jetty. This station is selected to examine the impact of terminal activities on water qualities	11 <sup>th</sup> June, 2015
9.	W10	Located near proposed chemical berth. These stations are variable and selected to examine the impact of proposed chemical terminal and IV <sup>th</sup> Container terminal activities on water quality.	11 <sup>th</sup> June, 2015

**Table 10: List of Parameters to Monitor for Marine Water Quality**

Marine Water Quality Parameters [Harbor Area & Creek Area]
<b>A] Physico-chemical Analysis of Water:</b> Depth, Temperature, pH, Salinity, Turbidity, Total Solids, Total Dissolved Solids, Total Suspended Solids,
<b>B] Bio-chemical Analysis of Water:</b> Dissolved Oxygen, COD [Chemical Oxygen Demand],BOD [Biochemical Oxygen Demand],NH <sub>3</sub> - N, Phenol, Oil & Grease, SPC [Standard Plate Count],Bacteriological count [MPN],Fecal Coliform
<b>C] Sediment Analysis:</b> Total Organic Matter, Organic Carbon, Inorganic Phosphates

## 2.3 RESULTS

The marine water quality data for nine Harbor water quality monitoring stations is depicted in **Table 11** for Physico-chemical parameter analysis, **Table 12** for Bio-chemical parameter analysis and **Table 13** for analysis of Sediment samples collected at these nine locations. The creek water quality data for four Nhava creek water quality monitoring stations is depicted in **Table 14** for Physico-chemical parameter analysis, **Table 15** for Bio-chemical parameter analysis and **Table 16** for analysis of Sediment samples collected at these four locations.

**Table 11: Results of Physico-Chemical Analysis of Water Samples Collected from JNP Harbor Area during June, 2015**

Sample Name		Depth, [m]	Temp., [°C]	pH	Salinity, [ppth]	Turbidity, [NTU]	TDS, [mg/L]	TSS, [mg/L]	TS, [mg/L]
Standard		-	-	6.5 - 9.0	-	-	-	-	-
W1	SS	13.0	29.2	7.73	38.7	26	30360	86	30446
	SM		30.4	7.67	38.7	5	30240	99	30339
	SB		30.1	7.67	37.4	72	30192	323	30515
	NS	10.8	28.9	7.77	36.8	23	30078	108	30186
	NM		29.2	7.62	37.4	12	30156	92	30248
	NB		28.4	7.69	38.7	84	30224	300	30524
W2	SS	5.5	30.0	7.87	38.7	23	30342	95	30437
	SM		29.5	7.79	38.1	18	30268	104	30372
	SB		29.4	7.68	38.1	16	30172	180	30352
	NS	4.6	29.0	7.85	38.7	30	30214	74	30288
	NM		29.4	7.83	37.4	21	30222	103	30325
	NB		29.2	7.82	38.7	18	30232	133	30365
W3	SS	6.9	29.6	7.81	36.8	16	30304	100	30404
	SM		29.5	7.66	38.1	23	30244	84	30328
	SB		29.1	7.79	38.1	17	30314	90	30404
	NS	6.5	29.6	7.81	38.7	21	30412	79	30491
	NM		29.6	7.72	37.4	19	30214	92	30306
	NB		29.0	7.79	38.1	17	30228	104	30332
W4	SS	8.2	30.0	7.81	38.1	22	29942	94	30036
	SM		29.5	7.74	38.7	19	29984	86	30070
	SB		30.0	7.78	37.4	16	30142	82	30224
	NS	7.8	28.9	7.79	36.8	17	30012	86	30098
	NM		29.0	7.76	38.1	19	30018	86	30104
	NB		28.8	7.87	38.7	26	30112	101	30213
W5	SS	10.5	30.0	7.62	37.4	18	30012	117	30129
	SM		30.2	7.81	38.7	24	30112	91	30203
	SB		29.5	7.68	38.1	16	30082	98	30180
	NS	9.3	29.5	7.77	37.4	20	30074	95	30169
	NM		29.4	7.71	38.7	17	30110	78	30188
	NB		29.2	7.77	38.1	19	30124	103	30227

SS – SPRING SURFACE    NS – NEAP SURFACE  
SM – SPRING MIDDLE    NM – NEAP MIDDLE  
SB – SPRING BOTTOM    NB – NEAP BOTTOM

Sample Name		Depth, [m]	Temp., [°C]	pH	Salinity, [ppth]	Turbidity, [NTU]	TDS, [mg/L]	TSS, [mg/L]	TS, [mg/L]
Standard		-	-	6.5 - 9.0	-	-	-	-	-
W6	SS	10.6	30.5	7.86	38.7	22	30132	90	30222
	SM		30.2	7.96	38.1	27	30204	99	30303
	SB		30.1	7.87	38.7	25	30212	94	30306
	NS	9.7	30.3	7.84	37.4	19	30174	109	30283
	NM		29.8	7.74	38.1	19	30140	94	30234
	NB		30.2	7.87	38.1	20	30152	97	30249
W7	SS	5.8	30.4	7.61	38.7	18	30082	114	30196
	SM		30.1	7.81	38.1	23	30114	101	30215
	SB		29.8	7.78	38.7	18	30128	86	30214
	NS	5.3	30.0	7.80	38.1	18	30134	90	30224
	NM		29.6	7.71	36.8	20	30084	96	30180
	NB		30.0	7.43	37.4	11	30142	100	30242
W10	SS	12.9	30.0	7.73	38.7	27	30314	112	30426
	SM		30.1	7.63	38.1	19	30280	122	30402
	SB		29.5	7.73	38.7	23	30276	96	30372
	NS	11.8	29.9	7.78	38.1	24	30292	114	30406
	NM		30.0	7.79	38.7	26	30186	96	30282
	NB		29.8	7.81	37.4	28	30322	88	30410
W9	SS	3.7	30.2	7.51	37.4	19	30212	83	30295
	SM		30.0	7.54	38.7	20	30174	110	30284
	SB		30.6	7.64	38.7	18	30208	93	30301
	NS	2.8	29.9	7.70	38.1	24	30242	108	30350
	NM		30.2	7.69	37.4	23	30186	113	30299
	NB		29.8	7.71	38.7	18	30222	99	30321

**SS - SPRING SURFACE**   **NS - NEAP SURFACE**  
**SM - SPRING MIDDLE**   **SM - NEAP MIDDLE**  
**SB - SPRING BOTTOM**   **SB - NEAP BOTTOM**

**Table 12: Results of Bio-Chemical Analysis of Water Samples Collected from JNP Harbor Area during June, 2015**

Sample Name		DO, [mg/L]	COD, [mg/L]	BOD, [mg/L]	NH <sub>4</sub> <sup>+</sup> -N, [mg/L]	Phenol, [mg/L]	O&G, [mg/L]	TPC, [CFU/mL]	Fecal Coliforms [MPN/100 mL]
Standard		3.0 mg/L or 40% of saturation value	-	5	-	-	10	-	500
W1	SS#	-	-	-	-	-	1	108	33
	SS	6.6	40	<2	<0.1	<0.01			
	SM	6.5	36	-	-	-			
	SB	6.3	44	-	-	-			
	NS#	-		-	-	-	2	<30	4
	NS	6.3	48	<2	<0.1	<0.01			
	NM	6.2	32	-	-	-			
	NB	6.0	40	-	-	-			
W2	SS#	-					2	164	50
	SS	6.4	48	<2	<0.1	<0.01			
	SM	6.3	44	-					
	SB	5.9	36	-					
	NS#	-					1	52	14
	NS	6.3	40	<2	<0.1	<0.01			
	NM	6.2	52	-					
	NB	6.0	32	-					
W3	SS#	-	-	-	-	-	2	121	17
	SS	6.5	52	<2	<0.1	<0.01			
	SM	6.3	68	-	-	-			
	SB	6.2	60	-	-	-			
	NS#	-		-	-	-	2	65	4
	NS	6.3	36	<2	<0.1	<0.01			
	NM	6.0	44	-	-	-			
	NB	5.9	64	-	-	-			
W4	SS#	-	-	-	-	-	2	72	23
	SS	6.4	60	<2	<0.1	<0.01			
	SM	6.1	44	-	-	-			
	SB	6.1	40	-	-	-			
	NS#	-		-	-	-	1	87	2
	NS	6.3	36	<2	<0.1	<0.01			
	NM	6.2	40	-	-	-			
	NB	6.3	48	-	-	-			
W5	SS#	-	-	-	-	-	2	<30	4
	SS	6.4	32	<2	<0.1	<0.01			
	SM	5.9	40	-	-	-			
	SB	6.0	48	-	-	-			
	NS#	-	-	-	-	-	1	<30	<2
	NS	6.2	36	<2	<0.1	<0.01			
	NM	5.9	52	-	-	-			
	NB	5.8	40	-	-	-			

SS# - SPRING SAMPLE  
SS - SPRING SURFACE  
SM - SPRING MIDDLE  
SB - SPRING BOTTOM

NS# - NEAP SAMPLE  
NS - NEAP SURFACE  
NM - NEAP MIDDLE  
NB - NEAP BOTTOM



Sample Name		DO, [mg/L]	COD, [mg/L]	BOD, [mg/L]	NH <sub>4</sub> <sup>+</sup> -N, [mg/L]	Phenol, [mg/L]	O&G, [mg/L]	TPC, [CFU/mL]	Fecal Coliforms [MPN/100 mL]
Standard		3.0 mg/L or 40% of saturation value	-	5	-	-	10	-	500
W6	SS <sup>#</sup>	-	-	-	-	-	2	<30	27
	SS	6.3	44	<2	<0.1	<0.01	-	-	-
	SM	6.2	48	-	-	-	-	-	-
	SB	6.0	32	-	-	-	-	-	-
	NS <sup>#</sup>	-	-	-	-	-	2	92	2
	NS	6.4	36	<2	<0.1	<0.01	-	-	-
	NM	6.2	24	-	-	-	-	-	-
	NB	6.1	28	-	-	-	-	-	-
W7	SS <sup>#</sup>	-	-	-	-	-	1	39	17
	SS	6.4	36	<2	<0.1	<0.01	-	-	-
	SM	6.2	28	-	-	-	-	-	-
	SB	6.1	44	-	-	-	-	-	-
	NS <sup>#</sup>	-	-	-	-	-	<1	<30	<2
	NS	6.3	24	<2	<0.1	<0.01	-	-	-
	NM	6.1	48	-	-	-	-	-	-
	NB	6.0	32	-	-	-	-	-	-
W10	SS <sup>#</sup>	-	-	-	-	-	2	56	14
	SS	6.4	40	<2	<0.1	<0.01	-	-	-
	SM	6.3	36	-	-	-	-	-	-
	SB	6.0	28	-	-	-	-	-	-
	NS <sup>#</sup>	-	-	-	-	-	3	85	4
	NS	6.2	48	<2	<0.1	<0.01	-	-	-
	NM	6.0	32	-	-	-	-	-	-
	NB	5.9	44	-	-	-	-	-	-
W9	SS <sup>#</sup>	-	-	-	-	-	3	<30	11
	SS	6.5	44	<2	<0.1	<0.01	-	-	-
	SM	6.2	48	-	-	-	-	-	-
	SB	6.0	32	-	-	-	-	-	-
	NS <sup>#</sup>	-	-	-	-	-	2	35	4
	NS	6.3	36	<2	<0.1	<0.01	-	-	-
	NM	6.1	40	-	-	-	-	-	-
	NB	5.9	28	-	-	-	-	-	-

SS<sup>#</sup> - SPRING SAMPLE  
 SS - SPRING SURFACE  
 SM - SPRING MIDDLE  
 SB - SPRING BOTTOM

NS<sup>#</sup> - NEAP SAMPLE  
 NS - NEAP SURFACE  
 NM - NEAP MIDDLE  
 NB - NEAP BOTTOM

**Table 13: Results of Sediment Samples Collected from JNP Harbor Area during June, 2015**

Station Name	Organic Matter		Total Carbon		Inorganic Phosphate mg/kg
	mg/g	%	mg/g	%	
W1	103.0	10.3	59.5	5.9	136
W2	132.0	13.2	76.6	7.7	92
W3	146.1	14.6	84.7	8.5	145
W4	137.3	13.7	79.6	8.0	102
W5	Sample Not Found				
W6	146.1	14.6	84.7	8.5	125
W7	150.0	15.0	87.0	8.7	90
W10	143.6	14.4	83.3	8.3	115
W9	Sample Not Found				

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

Sample Name		Depth, [m]	Temp., [°C]	pH	Salinity, [ppt]	Turbidity, [NTU]	TDS, [mg/L]	TSS, [mg/L]	TS, [mg/L]
Standard		-	-	6.5 - 9.0	-	-	-	-	-
W11	SS	3.5	27.7	7.84	38.1	24	30220	104	30324
	SM		27.5	7.82	37.4	25	30242	101	30343
	SB		27.2	7.75	36.8	25	30310	99	30409
	NS	3.0	29.2	7.81	38.1	26	30224	172	30396
	NM		29.1	7.78	38.1	23	30280	95	30375
	NB		29.2	7.75	36.1	24	30242	233	30475
W12	SS	3.6	28.7	7.74	37.4	21	30314	71	30385
	SM		29.0	7.78	38.1	27	30340	119	30459
	SB		28.6	7.84	38.7	24	30332	106	30438
	NS	2.4	29.4	7.80	36.8	22	30262	96	30358
	NM		29.2	7.76	38.1	26	30280	166	30446
	NB		29.2	7.77	38.7	22	30254	91	30345
W13	SS	2.8	28.7	7.76	38.1	20	30240	96	30336
	SM		28.6	7.76	37.4	25	30226	103	30329
	SB		28.7	7.77	38.7	23	30312	101	30413
	NS	1.6	28.2	7.88	38.1	25	30174	93	30267
	NM		28.4	7.78	37.4	26	30208	111	30319
	NB		28.0	7.76	38.7	26	30188	111	30299
W14	SS	2.2	28.2	7.83	38.1	23	30218	92	30310
	SM		28.2	7.82	38.1	22	30324	99	30423
	SB		28.0	7.81	38.7	26	30224	143	30367
	NS	1.5	29.0	7.81	38.1	23	30302	104	30406
	NM		28.5	7.79	37.4	25	30282	124	30406
	NB		28.7	7.73	38.7	22	30222	96	30318

SS – SPRING SURFACE    NS – NEAP SURFACE  
SM – SPRING MIDDLE    NM – NEAP MIDDLE  
SB – SPRING BOTTOM    NB – NEAP BOTTOM

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

Sample Name		DO, [mg/L]	COD, [mg/L]	BOD, [mg/L]	NH <sup>4+</sup> -N, [mg/L]	Phenol, [mg/L]	O&G, [mg/L]	TPC, [CFU/mL]	Fecal Coliforms, [MPN/100 mL]
Standard		3.0 mg/L or 40% of saturation value	-	5	-	-	10	-	500
W11	SS	5.5	44	<2	<0.1	<0.01	2	35	2
	SM	5.0	40	-	-	-	-	-	-
	SB	5.1	48	-	-	-	-	-	-
	NS	6.0	28	<2	<0.1	<0.01	2	<30	<2
	NM	5.8	32	-	-	-	-	-	-
	NB	5.9	36	-	-	-	-	-	-
W12	SS	5.6	36	<2	0.1	<0.01	1	<30	14
	SM	5.3	40	-	-	-	-	-	-
	SB	5.4	44	-	-	-	-	-	-
	NS	5.7	32	<2	<0.1	<0.01	2	42	11
	NM	5.6	48	-	-	-	-	-	-
	NB	5.6	28	-	-	-	-	-	-
W13	SS	5.4	44	<2	0.1	<0.01	2	89	21
	SM	5.2	40	-	-	-	-	-	-
	SB	5.3	36	-	-	-	-	-	-
	NS	5.9	48	<2	0.1	<0.01	1	56	17
	NM	5.8	32	-	-	-	-	-	-
	NB	5.6	28	-	-	-	-	-	-
W14	SS	5.7	32	<2	<0.1	<0.01	1	<30	17
	SM	5.4	48	-	-	-	-	-	-
	SB	5.4	36	-	-	-	-	-	-
	NS	5.4	28	<2	<0.1	<0.01	<1	<30	4
	NM	6.0	40	-	-	-	-	-	-
	NB	5.4	44	-	-	-	-	-	-

SS – SPRING SURFACE  
SM – SPRING MIDDLE  
SB – SPRING BOTTOM

NS – NEAP SURFACE  
NM – NEAP MIDDLE  
NB – NEAP BOTTOM

**Table 16: Results of Sediment Samples Collected from Nhava Creek during June, 2015**

Sample Name	Organic Matter		Total Carbon		Inorganic Phosphate
	mg/g	%	mg/g	%	
W11	Sediment not found				
W12					
W13	223.2	22.3	129.5	12.9	130
W14	257.4	25.7	149.3	14.9	99

## 2.4DISCUSSION

In **Table 17**, the observed concentration range for various parameters for Harbor region is collected while in **Table 18**, the observed concentration range for various parameters for Nhava creek region is collected. The observed values are compared with Primary Water Quality Criteria for **Class IV Waters** [Harbor Waters] given by CPCB [refer **Annexure V**].

**Table 17:** Observed Concentration Ranges of Various Parameters for JNP Harbor Area

Sr. No.	Parameter	Observed Range	Unit	Prescribed Limits
1	Temperature	28.4 – 30.6	°C	-
2	pH	7.43–7.96	-	<b>6.5 - 9.0</b>
3	Salinity	36.8– 38.7	ppth	-
4	Turbidity	5.0 – 84.0	NTU	-
5	TDS	29942 – 30412	mg/L	-
6	TSS	74 – 323	mg/L	-
7	TS	30036 – 30524	mg/L	-
8	DO	5.8 – 6.6	mg/L	<b>3.0 mg/L or 40% of</b>
9	COD	24– 68	mg/L	-
10	BOD	< 2.0	mg/L	<b>5</b>
11	NH <sub>4</sub> <sup>+</sup> -N	< 1.0	mg/L	-
12	Phenol	< 0.01	mg/L	-
13	Oil & Grease	1 – 3	mg/L	<b>10</b>
14	Total Plate Count	35 – 164	CFU/ml	-
15	Fecal Coliforms	2 – 50	MPN/100 mL	<b>500</b>

**Table 18:** Observed Concentration Ranges of Various Parameters for NhavaCreek Area

Sr. No.	Parameter	Observed Range	Unit	Prescribed Limits
1	Temperature	27.2 – 29.4	°C	-
2	pH	7.73–7.88	-	<b>6.5 - 9.0</b>
3	Salinity	36.1 – 38.7	Ppth	-
4	Turbidity	20 – 27	NTU	-
5	TDS	30174 – 30340	mg/L	-
6	TSS	71 – 233	mg/L	-
7	TS	30475 – 30267	mg/L	-
8	DO	5.0 – 6.0	mg/L	<b>3.0 mg/L or 40% of</b>
9	COD	28 – 48	mg/L	-
10	BOD	< 2.0	mg/L	<b>5</b>
11	NH <sub>4</sub> <sup>+</sup> -N	< 1.0	mg/L	-
12	Phenol	< 0.01	mg/L	-
13	Oil & Grease	1 – 2	mg/L	<b>10</b>
14	Total Plate Count	35 – 89	CFU/ml	-
15	Fecal Coliforms	2–21	MPN/100 mL	<b>500</b>

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 Harbor area during the month of June, 2015 are found to be well within the prescribed limits. Also, the concentration ranges observed for various parameters for water samples collected from Nhava Creek area during June, 2015 are found to be well within prescribed limits.

Observed salinity values for Harbor and Creek water samples in the month of June, 2015 are ranges from 32.8 to 38.6ppth. [Refer **Tables 11 & 14**]. The ranges observed for COD values in mg/L are 27.8 – 53.4 and 32.6 – 57.1 respectively for Harbor and Creek water samples. The DO levels are ranges between 4.4 to 6.4 for water samples collected from Harbor and Creek area. The concentration of Phenol and  $\text{NH}_4^+ - \text{N}$  is found to be very less in JNP Harbor as well as Nhava Creek water samples. Bacteriological parameters are also found to be far below the prescribed limits set for Harbor region.

**Table 13** provides the results obtained for sediment quality parameters for the sediment samples collected from JNP Harbor area during the month of June, 2015. The values obtained for Organic Matter, Total Organic Carbon and Inorganic Phosphate are ranges between 9.1 – 15.0%, 5.3% – 8.7% and 89 – 140mg/kg, respectively. While, it is seen from **Table 16** that the values obtained for Organic Matter, Total Organic Carbon and Inorganic Phosphate are between 15.5 & 17.8%, 9.0 & 10.3% and 103 – 107mg/kg, respectively for sediment samples collected from Nhava Creek area during the month of June, 2015.

## 2.5 OBSERVATIONS AND CONCLUSION

### *Observations for the month of June:*

- ✓ *Construction of 4<sup>th</sup> Container Terminal on South side of JNPT:* Earth Filling work of 4<sup>th</sup> C.T. is underway.
- ✓ *Plying of Ferry Boats:* There were large numbers of ferry boats plying in the area from Gateway of India to Elephanta. The discharges from these boats are not monitored.

It is seen from the data reported in **Tables 11** through **18** and subsequently discussed in above paragraphs, all the parameters mentioned are complying with prescribed standard limits given in Primary Water Quality Criteria for **Class IV Waters** [Harbor Waters] given by CPCB for Physico-Chemical parameters and Bio-Chemical parameters collected from JNP Harbor area and Nhava Creek area during June, 2015. The characteristic parameters for sediments are also showing normal variation in concentrations for JNP Harbor area and Nhava Creek area during June, 2015.

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**Conclusion:**

Considering the activities in the Harbor area and the results obtained for the month of June, 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 Harbor and Creek waters is in good category.

### 3. MARINE ECOSYSTEM MONITORING

#### 3.1 INTRODUCTION

For study of Marine ecology, Total 8 fixed harbor stations [W1 to W7 and W9] and 1 movable station [W08] 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 depicted in **Table 9**. The location map of various Marine ecology monitoring stations along with direction of towing are described in **Annexure-IV**.

#### 3.2 MARINE ECOSYSTEM MONITORING METHODOLOGY

The objective of Marine ecology monitoring is to assess aquatic flora and fauna, to assess benthic flora and to assess nutrient content in water and sediments.

**Marine Ecology Monitoring** –Monitoring of marine ecology is carried out on the levels of high and low water of spring and neap tides at twelve fixed stations and one moving station in Port's water limit. Phytoplankton and Zooplankton samples are collected during spring tide and neap tide from all the 12 fixed [W1 to W7, W9 and W11 to W14] and one moving [W08] water quality monitoring stations.

The list of parameters analyzed to assess the Marine Ecology is depicted in **Table 19** along with parameters to be monitored for sediment characterization. **Annexure-VI** describes recommended ranges of the Ecological parameters for Arabian Sea.

**Table 19: List of Parameters to Monitor Marine Ecology**

Marine Ecology Parameters [Harbor Area & Creek Area]
<b>A] Aquatic Flora &amp; Fauna:</b> Primary Productivity (Net & Gross), Phytoplankton Diversity: Population Density, Species Identification, Relative Abundance, Zooplankton Diversity: Population Density, Species Identification, Relative Abundance, Particulate Organic Carbon, Chlorophyll-a, Pheophytin-a, Secchi Depth
<b>B] Benthic Fauna:</b> Species Identification & Density
<b>C] Nutrients Analysis in Water:</b> Anions: Silicates, $\text{PO}_4^{3-}$ - P, $\text{SO}_4^{2-}$ , $\text{NO}_2^-$ - N, $\text{NO}_3^-$ - N, Cations: $\text{Ca}^{2+}$ , $\text{Mg}^{2+}$ , $\text{Na}^+$ , $\text{K}^+$
<b>D] Sediment Analysis:</b> Anions: Silicates, $\text{PO}_4^{3-}$ - P, $\text{SO}_4^{2-}$ , $\text{NO}_2^-$ - N, $\text{NO}_3^-$ - N, Cations: $\text{Ca}^{2+}$ , $\text{Mg}^{2+}$ , $\text{Na}^+$ , $\text{K}^+$



### 3.3 RESULTS

The net and gross primary productivity of three water quality monitoring stations of JNP and one water quality monitoring station at Nhava creek were measured and values are presented in **Table 20**.

The enumeration of phytoplankton genera, observed in the JNP Harbor area and Nhava creek area are furnished in **Tables 21** and **Table 22**. The details of Secchi Depth of JNP Harbor and Nhava creek area are given in **Table 23**. The enumeration of zooplankton genera recorded in the JNP Harbor area and Nhava creek area are represented in **Tables 24** and **Table 25**. **Table 26** shows Chlorophyll-*a* contents in JNP Harbor and Nhava creek area.

Benthic fauna recorded in JNP Harbor area and Nhava were collected and the data are presented in **Table 28**. Concentrations of nutrients in water and sediments at JNP have been presented in **Tables 29** and **Table 30** respectively.

**Table 20: Primary productivity of JNP Harbor area and Nhava Creek**

Sr. No.	Station	Gross Primary Productivity [mgC/m <sup>3</sup> /d]	Net Primary Productivity [mgC/m <sup>3</sup> /d]
<b>JNP Harbour Area</b>			
1.	W1	275	175
2.	W2	250	175
3.	W3	315	215
4.	W4	350	275
5.	W5	215	175
6.	W6	150	115
7.	W7	415	315
8.	W9	375	215
9.	W10	215	175
<b>Nhava Creek Area</b>			
10.	W11	310	275
11.	W12	215	175
12.	W13	375	215
13.	W14	315	215

**Table 21: Enumeration of Phytoplankton in JNP Harbor area and Nhava Creek**

				Percent Composition of Algal Groups			
Sr. No.	Sampling station	Sample Location	Phytoplankton [No/ml]	Bacillario-phyceae	Chloro-phyceae	Cyano-phyceae	Chryso-phyceae
JNP Harbour Area							
1	W1	Surface	380	50	20	20	10
		Bottom	210	40	30	20	10
2	W2	Surface	420	65	25	10	-
		Bottom	310	50	20	20	10
3	W3	Surface	260	55	15	20	10
		Bottom	190	40	20	20	20
4	W4	Surface	490	70	20	5	5
		Bottom	310	45	25	20	10
5	W5	Surface	460	55	25	10	10
		Bottom	320	60	20	20	-
6	W6	Surface	315	65	15	10	10
		Bottom	190	64	16	10	10
7	W7	Surface	590	80	10	10	-
		Bottom	415	60	20	20	-
8	W9	Surface	530	60	20	10	10
		Bottom	475	65	25	10	-
9	W10	Surface	390	55	20	10	20
		Bottom	210	45	25	10	20
NhavaCreek							
10	W11	Surface	450	52	18	10	20
		Bottom	310	50	20	30	-
11	W12	Surface	370	60	20	20	-
		Bottom	250	50	20	20	10
12	W13	Surface	220	50	30	20	-
		Bottom	150	65	20	15	-
13	W14	Surface	410	60	20	20	-
		Bottom	350	50	30	10	10

**Table 22: Phytoplankton Genera Observed in JNP Harbor Area and Nhava Creek Area**

Sr.	Bacillariophyceae	Chlorophyceae	Cyanophyceae	Chrysophyceae
1.	<i>Naviculasp.</i>	<i>Closteriumsp.</i>	<i>Gloeocapsa sp.</i>	<i>Coscinodiscus sp.</i>
2.	<i>Nitzschiasp.</i>	<i>Cosmariumsp.</i>	<i>Oscillatoriasp.</i>	-
3.	<i>Gyrosigma sp.</i>	<i>Scenedesmus sp.</i>	<i>Anabaena sp.</i>	-
4.	<i>Fragillariasp.</i>	<i>Ulothrix sp.</i>	<i>Aphanocapsa sp.</i>	-
5.	<i>Surirellasp.</i>	-	-	-
6.	<i>Coscinodiscus sp.</i>	-	-	-
7.	<i>Stephanodiscussp.</i>	-	-	-
8.	<i>Gomphoneissp.</i>	-	-	-

**Table 23: Secchi Depth Details of JNP Harbor area and Nhava Creek**

Sr. No.	Station	Secchi Depth
<b>JNP Harbour Area</b>		
1.	W1	50
2.	W2	40
3.	W3	40
4.	W4	40
5.	W5	50
6.	W6	40
7.	W7	40
8.	W9	40
9.	W10	50
<b>Nhava Creek Area</b>		
10.	W11	40
11.	W12	50
12.	W13	50
13.	W14	40

**Table 24: Enumeration of Zooplankton in JNP Harbor area and Nhava Creek**

Sr. No.	Towing between Stations	Zooplankton, [No/m <sup>3</sup> ]	Percent Composition of Zooplankton Groups			
			<i>Copepoda</i>	<i>Cladocera</i>	<i>Foraminifera</i>	<i>Rotifera</i>
JNP Harbour Area						
1.	W1-W2	370	46	36	10	18
2.	W2-W5	315	60	10	20	10
3.	W5-W1	270	45	15	20	20
4.	W5-W6	290	45	25	20	10
5.	W6-W2	350	50	20	10	20
6.	W4-W3	390	50	20	20	10
7.	W3-W7	215	65	25	10	-
8.	W7-W10	320	60	20	20	-
9.	W10-W3	250	50	20	20	10
10.	W9-W3	325	40	20	20	20
Nhava Creek						
11.	W5-W11	210	50	20	30	-
12.	W11-W12	350	50	20	20	10
13.	W12-W13	320	50	20	30	-
14.	W13-W14	380	50	20	30	-

**Table 25: Zooplankton Genera Recorded in JNP Harbor Area and Nhava Creek Area**

Sr. No.	Copepoda	Rotifera	Cladocera	Foraminifera
1.	<i>Cyclops</i> sp.	<i>Keratella</i> sp.	<i>Daphnia</i> sp.	<i>Rotaliasp.</i>
2.	<i>Diaptomus</i> sp.	<i>Brachionus</i> sp.	<i>Moinasp.</i>	<i>Globulinasp.</i>
3.	-	<i>Asplanchnasp.</i>	<i>Alonellasp.</i>	-
4.	-	<i>Filinasp.</i>	-	-

**Table 26: Chlorophyll-a Content in JNP Harbor area and Nhava Creek**

Sr. No.	Station	Chlorophyll- <i>a</i> [mg/m <sup>3</sup> ]		Pheophytin- <i>a</i> [mg/m <sup>3</sup> ]		Algal Biomass
		Surface	Bottom	Surface	Bottom	(mg/m <sup>3</sup> )
JNP Harbour Area						
1.	W1	3.2	2.1	BDL	BDL	213
2.	W2	4.5	2.6	0.7	BDL	300
3.	W3	2.9	1.9	BDL	BDL	193
4.	W4	3.8	2.5	BBL	BDL	253
5.	W5	4.7	3.5	BDL	BDL	313
6.	W6	5.2	4.0	0.5	BDL	346
7.	W7	6.5	5.3	BDL	BDL	433
8.	W9	4.5	3.1	BDL	BDL	300
9.	W10	2.7	2.0	BDL	BDL	246
Nhava Creek Area						
10.	W11	5.6	4.2	BDL	BDL	373
11.	W12	4.2	3.0	BDL	BDL	280
12.	W13	5.2	3.5	BDL	BDL	346
13.	W14	4.9	3.5	BDL	BDL	326

**Table 27: Concentration of Particulate Oxidisable Organic Carbon [POC]**

Sr. No.	Station	POC, [mg/m <sup>3</sup> ]
<b>Standard</b>		
<b>10 - 100</b>		
<b>JNP Harbor Area</b>		
1.	W1	810
2.	W2	687
3.	W3	617
4.	W4	756
5.	W5	687
6.	W6	772
7.	W7	803
8.	W10	455
9.	W9	569
<b>Nhava Creek Area</b>		
10.	W11	895
11.	W12	841
12.	W13	934
13.	W14	888

**Table 28: Benthic Fauna Recorded at JNP Harbor area and Nhava Creek**

Sr. No.	Station	Macro benthos	Percent Composition of Macro Benthos			
		[No/m²]	Foraminifera	Gastropods	Polychaeta	Chironomidae
JNP Harbour Area						
1.	W1	250	50	20	20	10
2.	W2	170	45	15	20	20
3.	W3	390	65	25	10	-
4.	W4	310	50	20	20	10
5.	W6	220	50	20	20	10
6.	W7	350	65	35	-	-
7.	W10	180	45	15	20	20
Nhava Creek Area						
8.	W13	250	70	20	10	-
9.	W14	210	60	20	5	15
Note: No sediment was found at W9, W8, W11 and W12						

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

Station Name	Ca <sup>2+</sup> , [mg/L]	Mg <sup>+</sup> , [mg/L]	K <sup>+</sup> , [mg/L]	Na <sup>+</sup> , [mg/L]	PO <sub>4</sub> <sup>3-</sup> -P, [mg/L]	NO <sub>3</sub> <sup>-</sup> -N, [mg/L]	NO <sub>2</sub> <sup>-</sup> -N, [mg/L]	SiO <sub>2</sub> <sup>2-</sup> , [mg/L]	SO <sub>4</sub> <sup>2-</sup> , [mg/L]
Standard	-	-	-	-	0.1 - 90	1.0 - 500	<125	10 - 5000	-
JNP HARBOUR AREA									
W1	654	1470	288	10400	125	450	<10	1812	3546
W2	770	1377	286	10300	135	460	<10	1815	2667
W3	654	1586	282	10200	114	480	<10	1815	3733
W4	577	1400	290	10600	116	470	<10	1800	2795
W5	577	1726	300	10300	108	470	<10	1650	3262
W6	577	1493	290	10400	118	510	<10	1642	3272
W7	693	1353	296	10300	122	330	<10	1612	2715
W10	500	1633	298	10300	111	400	<10	1760	2977
W9	654	1446	292	10600	99	510	<10	1814	3065
JNP NHAVA CREEK AREA									
W11	539	1446	288	10500	99	250	<10	1750	2847
W12	423	1516	292	10800	110	610	<10	1611	3343
W13	654	1493	300	11000	112	660	<10	1843	3230
W14	500	1486	298	10400	110	490	<10	1666	3530



Table 30: Concentration of Nutrients in Sediments at JNP Harbour area and Nhava Creek											
Station Name	Ca <sup>2+</sup> , [mg/kg]	Mg <sup>+</sup> , [mg/kg]	K <sup>+</sup> , [mg/kg]	Na <sup>+</sup> , [mg/kg]	PO <sub>4</sub> <sup>3-</sup> -P, [mg/kg]	NO <sub>3</sub> <sup>-</sup> -N, [mg/kg]	NO <sub>2</sub> <sup>-</sup> -N, [mg/kg]	SiO <sub>2</sub> <sup>2-</sup> , [mg/kg]	SO <sub>4</sub> <sup>2-</sup> , [mg/kg]		
Standard	-	-	-	-	-	-	-	-	-	-	-
JNP HARBOUR AREA											
W1	7200	632	260	6320	154	41	0.27	125		6582	
W2	6720	298	280	5240	126	46	0.34	196		6665	
W3	4400	365	390	5800	166	42	0.39	111		7004	
W4	3600	365	400	6400	142	56	0.52	123		6060	
W6	5200	146	410	5560	162	40	0.59	142		9816	
W7	3600	437	330	5840	100	43	0.20	123		8866	
W10	5200	243	360	6080	136	55	0.29	121		7076	
W9	Sample not found										
W5	Sample not found										
JNP NHAVA CREEK AREA											
W11	Sample not found										
W12	Sample not found										
W13	7200	243	420	5560	157	56	0.44	119		5809	
W14	4960	437	390	5800	129	44	0.58	135		8240	

### 3.4 DISCUSSION

#### 3.4.1 Water Quality: Biotic

In view of the need for conservation of environmental quality and biodiversity, study of biological environment is one of the most important components for ecological assessment. Ecological system shows inter relationship between biotic and abiotic components including dependence, competition and mutualism. Biotic component comprises of both plant and animal communities, which interact not only within and between them but also with the abiotic components viz., physical and chemical components of the environment.

Generally biological communities are the indicators of climatic conditions, dependent on environmental condition and resource of its distribution and survival. It may change if there is alteration in the environmental variables like temperature, humidity, rainfall, soil characteristics, topography etc., which are responsible for maintaining the homeostasis of the environment.

The species of flora and fauna in the environment are organized into natural communities with mutual dependencies and show various responses and sensitivities to anthropogenic influences. The changes in biotic community are studied in the pattern of distribution, abundance and diversity.

##### 3.4.1.a Primary Productivity

Primary production in the surface water is dependent on the photosynthesis of green plants principally of phytoplankton with a possible, minor contribution from very few species of green photosynthetic bacteria. The level of primary production is associated with the concentration of nutrients. As primary production results conversion of inorganic carbon to organic carbon with release of oxygen, it is usually determined by measuring the changes in oxygen concentrations in the water body.

Production is generally defined as the total mass of tissue elaborated within a stated interval and includes material which does not endure to the end of the period. It is therefore, a measure of the dynamic state of the biomass, the rate at which material is being gained or lost within a given time, and thus it is usually expressed as the mass per unit time. Production may be gross, that is including all energy assimilated, or net, that is the amount which contributes to tissue growth, the difference being the energy which is used in the metabolic processes which maintain life, principally respiration. Algal production is usually expressed in gross terms i.e. net photosynthetic activity added to respiratory activity.

Water samples from three different sampling points of various depths were collected both in a transparent and completely opaque (dark) high quality glass bottle. From each

sampling points two samples were collected in transparent bottles and the rest one was collected in dark bottle. Dark bottles were completely covered by a black cloth so as to avoid light penetration. The DO of one bottle was fixed on spot during the sample collection, while DO of other two light and dark bottles were fixed after a duration of six hours from sampling. DO of all the samples were analyzed using standard Sodium thiosulphate solution (**Standard Method, APHA 2005**).

The highest estimated gross and net primary productivity was measured as 415 and 315 mgC/m<sup>3</sup>/d at station W7 [Table 20]. The estimated gross and net primary productivity values were usually low due to insufficient sunlight during monsoon. Compared with other coastal ecosystems, primary productivity of JNP Harbour area and Nhava creek was at a moderate level.

### **3.4.1.b Plankton**

Plankton are important component of ecosystem, which respond to ecosystem alterations rather rapidly. It is due to the fact that planktonic organisms, which react to different types of water pollution, play a key role in turnover of organic matter and energy through the ecosystem. This reaction is very rapid because of relatively short lifetime and high reproduction rates of the organisms. Since the phytoplankton play a key role of primary producer in aquatic environment, these are the first component in the trophic tier to be affected by pollution. Phytoplankton can grow rapidly and form massive blooms that can be regulated by environmental factors such as nutrients, availability of light and biotic interaction with grazers. Phytoplankton are passive drifters with the currents. Diatoms are a highly diverse and abundant group of phytoplankton in the aquatic environment. They are responsible for about 25% of global primary productivity and play a central role in the biogeochemical cycling of important nutrients such as carbon, nitrogen and silica. Most of the N is bound in organic compounds and its importance to phytoplankton bloom formation. If bloom formations take place in the water then it could significantly harm to these water bodies. Phytoplankton blooms decrease light penetration through the water column and can depress primary productivity. It may have diminished ecosystem integrity and the abundance and sustainability of living resources (e.g. fish and shrimp).

Similarly zooplankton, also a very important group in the aquatic ecosystem, act as the primary consumer and ultimately serve as the natural food source for many aquatic organisms, including fishes. Freshwater zooplankton show considerable variety comprising of members of almost every group from protozoa to chordate. Depending on seasons and environmental conditions, the plankton community shows pronounced variation in its character and composition.

For zooplankton, desired volume of waters were filtered through plankton net to represent all the available groups. The samples were fixed immediately with 5 %

buffered formalin. The S-R cell is a device commonly used for zooplankton counting because it is easily manipulated. The parameters studied were numerical count of individual species, groups and indices, as described hereunder. In view of this, studies were carried out towards distribution, diversity and other ecological aspects of phytoplankton and zooplankton from different sampling locations of JNP Harbour area and Nhava creek.



### Collection of Plankton from JNP Harbour Area

#### A] Phytoplankton:

**Count:** Phytoplankton counts, recorded at different sampling stations, are presented in **Table 21**. Total algal population varied between 150 and 590 algal cells/ml. Samples collected at station W13(B) and W7(S) showed lowest and highest counts respectively. Bacillariophyceae dominated all samples followed by Chlorophyceae. The phytoplankton population comprised of fifteen genera with 4 major groups, namely Bacillariophyceae, Chlorophyceae, Cyanophyceae and Chrysophyceae with seventeen different genera [**Table 22**]. Silicates count were less at the W7 might be cause of high Bacillariophyceae. High phosphate count was might be because of the high phytoplankton count in the respective station.

**Secchi Disk Transparency:** Secchi disk transparency refers to the depth to which the black and white Secchi disk can be seen in the water. Water clarity, as determined by a Secchi disk, is affected by two primary factors: algae and suspended particulate matter. Light penetration was measured in the JNP Harbour Area and Nhava creek with the help of Sechhi Disk (**Table 23**). Transparency varied between 40 & 50cm.

## B] Zooplankton:

Zooplankton counts, recorded at different sampling stations, are shown in Table 24. Since huge quantity of water was to be filtered through plankton net, middle and bottom samples could not be collected. Density of zooplankton varied between 210 and 390 N/m<sup>3</sup> at stations W5-W11 and W4-W3. Total eleven genera of zooplankton were recorded. Among zooplankton Copepoda and Cladocera group were dominant [Table 25]. Some stations in JNP Harbour area and NHAVA creek represent the distribution of Hydromedusae species like *Blackfordiavirginica* is an euryhaline species. This species is considered as backwater form but it may occasionally be found in coastal water also.

### 3.4.1.c Photosynthetic Pigments [Chlorophyll-a, Pheophytin-a]:

Chlorophyll is the green molecule in plant cells that carries out the bulk of energy fixation in the process of photosynthesis. Pheophytin (Pheo) is a chlorophyll derivative demodulated chlorophyll or simply chlorophyll without central Mg-atom. Pheophytin can be easily obtained during the extraction processes, due to the liability of magnesium in the chlorophyll molecule.

Standard method was followed to estimate chlorophyll-a and pheophytin of the water samples collected from different sampling points of JNP Harbour area and Nhava creek [Table 26]. For the estimation of chlorophyll-a and pheophytin-a, a certain volume of water sample was filtered through glass fiber filter paper and the filter paper was immersed in 5 ml of 90% acetone and grinded in tissue grinder and kept overnight at 40°C in dark for extraction of pigments. 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.

The algal biomass is the main source of food for the primary consumers and it was evaluated by chlorophyll-a method and its value is given in Table 26. In JNP harbor area, the range of algal biomass was found between 246 and 433 mg/m<sup>3</sup>. The minimum algal biomass was (246 mg/m<sup>3</sup>) found at W10 and maximum (433 mg/m<sup>3</sup>) was found at W7 station. The lowest and highest chlorophyll a levels from surface water sample varied from 2.7 at station W10 to 6.5 mg/m<sup>3</sup> at W7. High chlorophyll might be a cause of high primary productivity and phytoplankton at respective station. Pheophytin concentrations of many samples were below detectable limit [Table 26]. Based on values of Chlorophyll-a, these waters can be classified as mesotrophic, that is of medium quality.

### 3.4.1.d Particulate Organic Carbon [POC]:

The concentration of particulate oxidizable carbon [POC] is given in Table 27. In JNP harbour POC content was found to be between 455 - 810mg/m<sup>3</sup> with an average of 684



mg/m<sup>3</sup>. The minimum concentration of POC i.e. 455 mg/m<sup>3</sup> was found at W10 station and maximum concentration i.e. 810 mg/m<sup>3</sup> at W1 station. In Nhava creek the POC content was found to be between 841 - 934 mg/m<sup>3</sup> with an average of 889 mg/m<sup>3</sup>. The minimum concentration of POC i.e. 841 mg/m<sup>3</sup> was found at W12 station and maximum concentration i.e. 934 mg/m<sup>3</sup> was found at W13 station. The POC concentration was found to be higher than the prescribed standard range i.e. 10- 100 mg/m<sup>3</sup> at all stations in JNP Harbour region and Nhava Creek region. This may be due to detritus material originate from Mangrove swamps or detritus plankton. The higher values for POC were also reported in Tulaskar *et al* [Ind. J. Marine Sci., Vol. 21, 1992] for Rajapur and Vagathan estuaries (west coast of India).

### 3.4.2 Sediment Quality: Biotic

**Benthos:** The organisms which inhabit the bottom of aquatic body are called benthos. Many of them are sessile; some creep over or burrow in mud and base of water body. The quality and quantity of animals found at the bottom is not only related to the nature of substrata but also to depth, the kind and the quality of aquatic plants present in such environment. Their number and distribution also depend upon physico-chemical properties of water and biological complexes, such as food and other factors.

The bottom mud was collected from various sampling points of JNP Harbour area and NHAVA creek Van veen grab sampler having the area 0.02 m<sup>2</sup>. The sediment was sieved through 500  $\mu$  mesh sieve and the organisms retained the sieve were preserved immediately with 5% buffered formalin. Subsequently, all the macro-benthic specimens were identified to the lowest possible level under a stereoscopic microscope. All unidentified specimens are referred to by their generic/family names and were considered in single taxonomic category.

A total of four macro-benthic groups were obtained from the sediment samples. *Foraminifera* were the most diverse group. Species like *Triloculina* and *Lagena* were dominant. *Forams* are abundant all over the ocean. They either live on the sea bottom (benthic) or float in the upper water column (planktonic). The size of the *foraminiferal* test typically ranges from 0.05mm to 0.5mm although some *forams* may be as large as several centimeters with a recorded maximum of 18cm in diameter. They not only provide surface for respiration, but also perform feeding, locomotion, test building, metabolite release, adhering, etc. Foods of the *foraminifera* are variable: dissolved free amino acids, bacteria, unicellular algae, and even metazoans, such as copepods. It was followed by Gastropods. Among the Gastropods, the dominant species were *Litiopa* & *Morula*. The highest count was 390 No/m<sup>2</sup> at station W3. As molluscs cell wall consumed the silica might be a cause for the minimum concentration of silica at this station. No sediment was found at stations W9, W8, W11 and W12.

**Trophic level of JNP Harbor area and Nhava creek:** In order to evaluate the trophic status of the lake the values of transparency, chlorophyll and phosphate were considered with available standards.. Since standards are not applicable to ecological parameters, Organization for Economic Co-Operation and Development (OECD) guidelines are recommended by US Environmental Protection Agency (USEPA) for evaluating status of surface water qualities. Accordingly, the values of transparency, chlorophyll-*a* & phosphorus were considered for assessing trophic status of one each JNP Harbor and Nhava creek water.

These guidelines are based on blooming of algae due to excessive nutrients, particularly phosphorus in water body. Based on values of Chlorophyll-*a* (**Table 29**), these waters can be classified as Mesotrophic that is of medium quality. It appears that transparency in these waters is less, not because of algal growth but due to turbidity. Further, phosphorus levels are also more due to discharge of wastes in creek and subsequent mixing with harbor water. Due to increase of turbidity, sunlight penetration is reduced, thereby hindering excessive growth of algae.

**Table 31:** *Trophic Status of JNP Harbor Water and NHAVA Creek Water with Reference to OECD Guidelines*

Status	Secchi Disk Depth (Transparency in m)	Chlorophyll- <i>a</i> (mg/m <sup>3</sup> )	Total Phosphorus (mg/L)
Oligotrophic	> 4	< 2	<0.01
Mesotrophic	1.6 to 4	2 to 10	0.01-0.03
Eutrophic	0.7 to 1.6	10 to 30	0.03 – 0.06
Hypereutrophic	< 0.7	> 30	>0.06
JNP Harbor area	0.4	4.2	0.453
NHAVA creek	0.4	4.9	0.108

### 3.4.3 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 depicted in **Table 29**. In harbor region the Phosphate was found to be 61µg/L – 156µg/L. In JNP harbor region, the Phosphate value was found above prescribed standard range [0.1 – 90µg/L] at most of the stations. Nitrate was found to be between 160µg/L – 520µg/L. The minimum value of Nitrate was found at W6 station and maximum at W8 station. The average concentration of Nitrate was found to be 350µg/L and overall Nitrate was found within range [1.0 to 500µg/L] at all stations except W8 station. 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 873 – 2232 µg/L with an average of 1631µg/L. The minimum concentration of silica was found at W4 station of JNP harbor region and the maximum concentration of silica was found at W8 station. The Sulphate was found between 3026 – 3310 mg/L, the minimum value recorded at W6 station and maximum at W3 station. The average concentration of Sulphate was found to be 3159 mg/L.

In Nhava Creek, Phosphate was found between 80µg/L – 128µg/L with an average 102µg/L which was above prescribed standard range [0.1-90µg/L]. Nitrate was found to be 540 – 640 µg/L with an average 588 µg/L. The silica content in Nhava creek was found to be 1145 – 1832 µg/L with an average of 1456 µg/L. The minimum silica content was found at station W13 station and maximum was found at W12 station. Sulphate was found between 2894 – 3268 mg/L with an average of 3051 mg/L. The minimum value for Sulphate was found at W11 station and maximum value at W13 station.

Overall in JNP harbor and creek region the values of all the nutrients were found to be within the recommended ranges, which are given in **Table 29**.

The nutrients in sediments at various stations in JNP harbor area and Nhava Creek area are given in **Table 30**. In harbor region the sediment found at eight locations out of nine. Phosphate was found between 126 – 213 mg/kg with an average of 162 mg/kg. The Nitrate was found minimum value at W1 station i.e. 34 mg/kg and maximum value at W3 station i.e. 60 mg/kg. The average concentration of Nitrate was found to be 49mg/kg. The Nitrite was found to be between 0.22 – 0.42 mg/kg with an average of 0.31 mg/kg. The minimum concentration of nitrite was found at W1 station and maximum value at W2 station. Silica in the form of silicate in JNP harbor sediments were found between 95 to 178 mg/kg with an average of 139 mg/kg. The minimum concentration of silica was found at W1 station and maximum value was found at W5 station. The Sulphate was found between 5032 to 7819 mg/kg, with

minimum value at W4 station and maximum value at W7 station. The average concentration of Sulphate was found to be 6630 mg/kg.

In Nhava Creek region the sediment found at two locations out of four. Phosphate levels were 142 and 187 mg/kg with an average of 165 mg/kg. Nitrate was found to be 53 and 52 mg/kg. The average concentration of Nitrate was found to be 52.5 mg/kg. The Nitrite was found to be 0.42 and 0.36 mg/kg. Silica in the form of silicate in JNP harbor sediments was found to be 110 to 113 mg/kg with an average of 112 mg/kg. The Sulphate was found to be 5282 and 7315mg/kg. The average concentration of Sulphate was found to be 6299 mg/kg.

#### **b. Cations:**

In harbor region water, the Calcium was found between 397 to 516 mg/L with an average of 450 mg/L given in **Table 29**. The Magnesium was found to be 1467 – 1540 mg/L, with maximum value at W1 station. The average concentration of Magnesium was found to be 1488.2 mg/L. Potassium in JNP harbor water was found between 284 to 302 mg/L with an average of 293.1 mg/L. The minimum concentration of Potassium was found at W1 station and maximum value W8 station. The Sodium was found between 10200 to 10700 mg/L with an average of 10477 mg/L. The minimum concentration of sodium was found at W3 station and maximum value of at W7station.

In Nhava Creek, Calcium concentration was found with an average 485.8 mg/L given in **Table 29**. Magnesium concentration was found to be 1371 – 1540 mg/L with an average of 1485.3 mg/L. The minimum value of Magnesium was found at W11 station and maximum value was found at W14 stations. The Potassium content in Nhava creek was found to be 1 – 300 mg/L with an average of 295 mg/L. Sodium minimum concentration was found to be 10300 mg/L at W11 and maximum of 11000 mg/L at W14.

In harbor region sediments, the Calcium was found to be 3760 to 8720 mg/Kg with an average of 4192 mg/Kg given in **Table 30**. The minimum Concentration of Calcium was found at W3 station and maximum concentration at W4 station. Magnesium was found to be 194 to 972 mg/Kg, with minimum value at W2 & w6 stations and maximum was recorded at W1 station. The average concentration of Magnesium was found to be 556.1 mg/Kg. Potassium in JNP harbor sediment was found to be 210 to 420 mg/Kg with an average of 311.1 mg/Kg. The minimum concentration of Potassium was found at W2 station and maximum value at W4 station. Sodium was found to be 4640 to 7200 mg/Kg with an average of 6013.3 mg/Kg. The minimum concentration of sodium was found at W9 station and maximum value at W7 station.

In Nhava Creek sediments, Calcium was found to be 3520 to 8320 mg/Kg with an average 5920 mg/Kg given in **Table 30**. Average magnesium was found to be 316

mg/Kg. Average potassium content in Nhava creek was found to be 420 mg/Kg. The minimum sodium value was found at W14 station and maximum value at W13.

### 3.5 OBSERVATIONS AND CONCLUSIONS

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

Sr. No.	Parameter	Criteria	Observations	Remarks	Mitigation Measures
1.	Net primary productivity	<1500 mgC/m <sup>3</sup> /day at surface	The observed values falls under 150 – 450 mgC/m <sup>3</sup> /day	Within Range	---
2.	Chlorophyll- <i>a</i>	< 4 mg/m <sup>3</sup> [Oligotrophic class] 4-10 mg/m <sup>3</sup> [Mesotrophic class] >10 mg/m <sup>3</sup> [Eutrophic class]	The observed values falls under 4.2 – 4.9 mg/m <sup>3</sup>	Majority stations follow Oligotrophic class of water	Does not require much remediation measures since the waters are either Oligotrophic or partially Mesotrophic
3.	Phosphate	0.1- 90 µg/L	Harbour area – 114 µg/L; Creek area – 101.8 µg/L	The nutrient acts as fertilizer. High level of nutrient from industrial waters from nearby mega cities may lead to excessive algal growth in aquatic ecosystem	Proper treatment of sewage and industrial wastes before discharging into the sea water by the concerned authority. Initiative may be taken towards this aspect.
4.	Nitrate	1.0- 500 µg/L	Harbour area – 350 µg/L; Creek area – 587.5 µg/L	Besides wastes from sewage / industries, the nutrient is also produced in natural water by decomposition of nitrogenous organic compounds. Moderate level of nitrate in the area.	Proper treatment to Sewage and Industrial waste into the sea water by the concerned authority.
5.	Nitrite	<125 µg/L	Harbour area – 27.7 µg/L & Creek area – <10 µg/L	A nutrient produced in natural water by decomposition of nitrogenous organic compounds. Moderate level of nitrite.	-----
6.	Particulate Organic Carbon	10 – 100 mg/m <sup>3</sup>	Harbour area – 684 mg/m <sup>3</sup> ; Creek area – 889 mg/m <sup>3</sup>	This may be due to detritus material originating from Mangrove swamps / detritus plankton, benthos, fish etc. / untreated sewage discharges from towns /villages around the area.	Natural Phenomenon regarding mangrove and other living organisms. Treatment of sewage and industrial wastes before discharging into the sea water by the concerned authority.

### ***Observations for the month of June:***

- ✓ *Construction of 4<sup>th</sup> Container Terminal on South side of JNPT:* Earth Filling work of 4<sup>th</sup> C.T. is underway.
- ✓ *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, 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 Seaduring June, 2015 except parameters like Particulate Organic Carbon, Nitrate and Phosphate.

The increased levels of POC, Phosphate and Nitrate, although not at alarming state, might be attributed to:

- ❖ 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 creek confluence, resulting in the direct impact on harbor water
- ❖ Thane creek is adjacent to Mumbai harbour bay. It is triangular mass of brackish water which widens out and opens to the Arabian Sea in the south. 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 creeks are 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
- ❖ The comparatively high values for POC might be due to detritus materials originating from Mangrove swamps due to tidal effects or enriched by detritus plankton & other organisms
- ❖ It may be mentioned that JN Port is not handling any dry bulk cargo containing Phosphate

### **Conclusion:**

Based on observations of the overall ecological parameters in JNP Harbour and Nhava Creek area, it can be inferred that the marine ecosystem is unlikely be adversely affected due to port operational activities. The undesirable levels of POC, Phosphate and Nitrate are the result of untreated discharges of sewage and industrial waste from the towns / villages around the area, like Navi-Mumbai, Thane, Panvel etc.

## 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 depicted below:

**Table 32: Description of Drinking Water Quality Monitoring Stations**

Sr. No.	Stations	Locations
<b>Outside the Port Area</b>		
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	DW08	Sector III
8	DW13	CISF Canteen
9	DW14	Custom Canteen
10	DW15	JNPT Guest House
<b>Inside the Port Area</b>		
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 eighteen stations ten stations were outside the port and eight stations were inside the port. All samples were collected from the port area of JNP on 08<sup>th</sup> June, 2015.

The water samples are analyzed for various parameters Colour, Odour, pH, Turbidity, Total Dissolved Solids, Aluminium as Al,  $\text{NH}_4^+$  - N, Barium as Ba, Boron, Calcium as Ca, Chloride as  $\text{Cl}^-$ , Copper as Cu, Fluoride, Free Residual Chlorine, Iron as Fe, Magnesium as Mg, Manganese as Mn, Oil & grease, Nitrate as  $\text{NO}_3^-$ , Phenolic compound, Selenium as Se, Silver as Ag, Sulphate as  $\text{SO}_4^{2-}$ , Total Alkalinity as  $\text{CaCO}_3$ , Total Hardness as  $\text{CaCO}_3$ , 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**.

Table 33: Results of Drinking water quality monitoring [Sample collected on Apr 2015]								
Parameter	Unit of Measurement	Station Name						Standards*
		DW1	DW2	DW3	DW4	DW5	DW6	
Colour	Hazen	<5	<5	<5	<5	<5	<5	5
Odour	-	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable
pH	-	7.49	7.27	7.46	7.40	7.43	7.94	6.5 to 8.5
Turbidity	NTU	<1	<1	<1	<1	<1	<1	1
Total Dissolved Solids	mg/L	89	94	87	86	88	93	500
Aluminium as Al	mg/L	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	0.03
NH <sub>4</sub> <sup>+</sup> - N	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.5
Barium as Ba	mg/L	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.7
Boron	mg/L	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	0.5
Calcium as Ca	mg/L	10	12	14	10	11	12	75
Chloride as Cl <sup>-</sup>	mg/L	10.1	9.6	9.6	10.1	9.6	9.6	250
Copper as Cu	mg/L	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.05
Fluoride	mg/L	<0.1	<0.1	<0.1	<0.1	0	<0.1	1.0
Free Residual Chlorine	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.2
Iron as Fe	mg/L	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	0.3
Magnesium as Mg	mg/L	5.6	3.5	3.0	6.1	3.9	4.9	30
Manganese as Mn	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.1
Oil and grease	mg/L	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.5
Nitrate as NO <sub>3</sub> <sup>-</sup>	mg/L	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2	45
Phenolic compound	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001
Selenium as Se	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01
Silver as Ag	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1
Sulphate as SO <sub>4</sub> <sup>-2</sup>	mg/L	3.2	2.9	2.4	2.1	2.4	3.1	200
Total Alkalinity as CaCO <sub>3</sub>	mg/L	41	39	41	40	37	45	200
Total Hardness as CaCO <sub>3</sub>	mg/L	48	44	46	51	43	51	200
Zinc as Zn	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	5
Cyanide	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05
Lead as Pb	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01
Mercury as Hg	mg/L	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.001
Molybdenum as Mo	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.07
Nickel as Ni	mg/L	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.02
Pesticides	mg/L	ND	ND	ND	ND	ND	ND	0.5
Total Arsenic as As	mg/L	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.01
Total Chromium as Cr	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05
Total Coliforms	MPN/100ml	Nil	Nil	Nil	Nil	Nil	Nil	Nil
E coli	-	Absent	Absent	Absent	Absent	Absent	Absent	Absent

\*: IS 10500:2012, Drinking Water - Specification



**Table 33: Results of Drinking water quality monitoring [Sample collected on Apr 2015]**

Parameter	Unit of Measurement	Station Name						Standard
		DW7	DW8	DW9	DW10	DW11	DW12	
Colour	Hazen	<5	<5	<5	<5	<5	<5	5
Odour	-	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable
pH	-	7.32	7.37	7.33	7.50	7.40	8.03	6.5 to 8.5
Turbidity	NTU	<1	<1	<1	<1	<1	2.42	1
Total Dissolved Solids	mg/L	84	88	85	88	87	580	500
Aluminium as Al	mg/L	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	0.03
NH <sub>4</sub> <sup>+</sup> - N	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.5
Barium as Ba	mg/L	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.7
Boron	mg/L	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	0.5
Calcium as Ca	mg/L	11	11	13	14	12	23	75
Chloride as Cl <sup>-</sup>	mg/L	10.1	9.6	10.1	9.6	10.1	201.5	250
Copper as Cu	mg/L	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.05
Fluoride	mg/L	0.4	<0.1	<0.1	0.1	0.1	1	1.0
Free Residual Chlorine	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.2
Iron as Fe	mg/L	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	0.3
Magnesium as Mg	mg/L	4.4	3.9	2.8	3.5	4.4	24.3	30
Manganese as Mn	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.1
Oil and grease	mg/L	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.5
Nitrate as NO <sub>3</sub> <sup>-</sup>	mg/L	<0.2	<0.2	<0.2	<0.2	<0.2	1	45
Phenolic compound	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001
Selenium as Se	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01
Silver as Ag	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1
Sulphate as SO <sub>4</sub> <sup>-2</sup>	mg/L	3.1	2.8	2.5	2.4	2.8	41.8	200
Total Alkalinity as CaCO <sub>3</sub>	mg/L	40	41	41	37	42	50	200
Total Hardness as CaCO <sub>3</sub>	mg/L	45	43	43	48	48	157	200
Zinc as Zn	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	5
Cyanide	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05
Lead as Pb	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01
Mercury as Hg	mg/L	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.001
Molybdenum as Mo	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.07
Nickel as Ni	mg/L	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.02
Pesticides	mg/L	ND	ND	ND	ND	ND	ND	0.5
Total Arsenic as As	mg/L	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.01
Total Chromium as Cr	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05
Total Coliforms	MPN/100ml	Nil	Nil	Nil	Nil	Nil	Nil	Nil
E coli	-	Absent	Absent	Absent	Absent	Absent	Absent	Absent

\*: IS 10500:2012, Drinking Water - Specification

Table 33: Results of Drinking water quality monitoring [Sample collected on Apr 2015]

Parameter	Unit of Measurement	Station Name						Standard
		DW13	DW14	DW15	DW16	DW17	DW18	
Colour	Hazen	<5	<5	<5	<5	<5	<5	5
Odour	-	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable
pH	-	7.50	7.49	7.50	7.46	7.42	7.64	6.5 to 8.5
Turbidity	NTU	2.43	<1	<1	<1	<1	<1	1
Total Dissolved Solids	mg/L	680	85	86	85	84	85	500
Aluminium as Al	mg/L	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	0.03
NH <sub>4</sub> <sup>+</sup> - N	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.5
Barium as Ba	mg/L	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.7
Boron	mg/L	<0.25	<0.25	<0.25	<0.25	<0.25	<0.25	0.5
Calcium as Ca	mg/L	19	13	14	12	12	12	75
Chloride as Cl <sup>-</sup>	mg/L	241.1	9.6	10.1	9.6	10.1	9.6	250
Copper as Cu	mg/L	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.05
Fluoride	mg/L	0.8	<0.1	0	<0.1	<0.1	0.4	1.0
Free Residual Chlorine	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.2
Iron as Fe	mg/L	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	0.3
Magnesium as Mg	mg/L	27.9	4.2	3.5	5.1	4.4	3.7	30
Manganese as Mn	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.1
Oil and grease	mg/L	<0.5	<0.5	<0.5	<0.5	<0.5	<0.5	0.5
Nitrate as NO <sub>3</sub> <sup>-</sup>	mg/L	1	<0.2	<0.2	<0.2	<0.2	<0.2	45
Phenolic compound	mg/L	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.001
Selenium as Se	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01
Silver as Ag	mg/L	<0.1	<0.1	<0.1	<0.1	<0.1	<0.1	0.1
Sulphate as SO <sub>4</sub> <sup>-2</sup>	mg/L	39.9	3.1	2.9	2.7	2.9	2.9	200
Total Alkalinity as CaCO <sub>3</sub>	mg/L	46	41	42	43	40	41	200
Total Hardness as CaCO <sub>3</sub>	mg/L	161	50	48	52	49	44	200
Zinc as Zn	mg/L	<0.005	<0.005	<0.005	<0.005	<0.005	<0.005	5
Cyanide	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05
Lead as Pb	mg/L	<0.01	<0.01	<0.01	<0.01	<0.01	<0.01	0.01
Mercury as Hg	mg/L	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	<0.0002	0.001
Molybdenum as Mo	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.07
Nickel as Ni	mg/L	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.02
Pesticides	mg/L	ND	ND	ND	ND	ND	ND	0.5
Total Arsenic as As	mg/L	<0.002	<0.002	<0.002	<0.002	<0.002	<0.002	0.01
Total Chromium as Cr	mg/L	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	0.05
Total Coliforms	MPN/100ml	Nil	Nil	Nil	Nil	Nil	Nil	Nil
E coli	-	Absent	Absent	Absent	Absent	Absent	Absent	Absent

\*: IS 10500:2012, Drinking Water - Specification



### 4.3 DISCUSSION

**Table 33** provides the results for various parameters analyzed for drinking water collected at eighteen stations in and around the port's activity area. The observed results are compared with acceptable limits for various parameters of drinking water as prescribed in **IS 10500:2012** – Drinking Water Specification.

In collected drinking water, minimal variations of anion concentrations are found i.e. chlorides 9.6 to 241.1 mg/L; calcium 9.9 to 23.1 mg/L; magnesium 2.8 to 27.9 mg/L and sulphates 2.1 to 41.8 mg/L. The concentration of total dissolved solids is found to be between 84 to 680 mg/L and concentration of total hardness as CaCO<sub>3</sub> is found to be 43.2 to 161.3 mg/L. All parameters including the above mentioned, are well within the prescribed limits.

The color of all drinking water samples is < 5 Hazen unit and Odor of the samples is also agreeable. The turbidity values are below acceptable limits i.e. 1 NTU. The acceptable range for pH is 6.5 to 8.5, while the observed pH range is 7.27 to 8.03. The iron content and other parameters were found to be well within the acceptable limit.

Monitoring for total coliforms was used, in conjunction with other indicators, as part of a multi-barrier approach to producing drinking water of an acceptable quality. Coliform bacteria are a commonly used bacterial indicator of sanitary quality of foods and water. Some coliforms can cause serious illness in humans. Infection symptoms and signs include bloody diarrhea, stomach cramps, vomiting and occasionally, fever. The bacteria can also cause pneumonia, other respiratory illnesses and urinary tract infections<sup>1,2</sup>. Analysis of bacteriological parameter during **June'15** reported NIL.

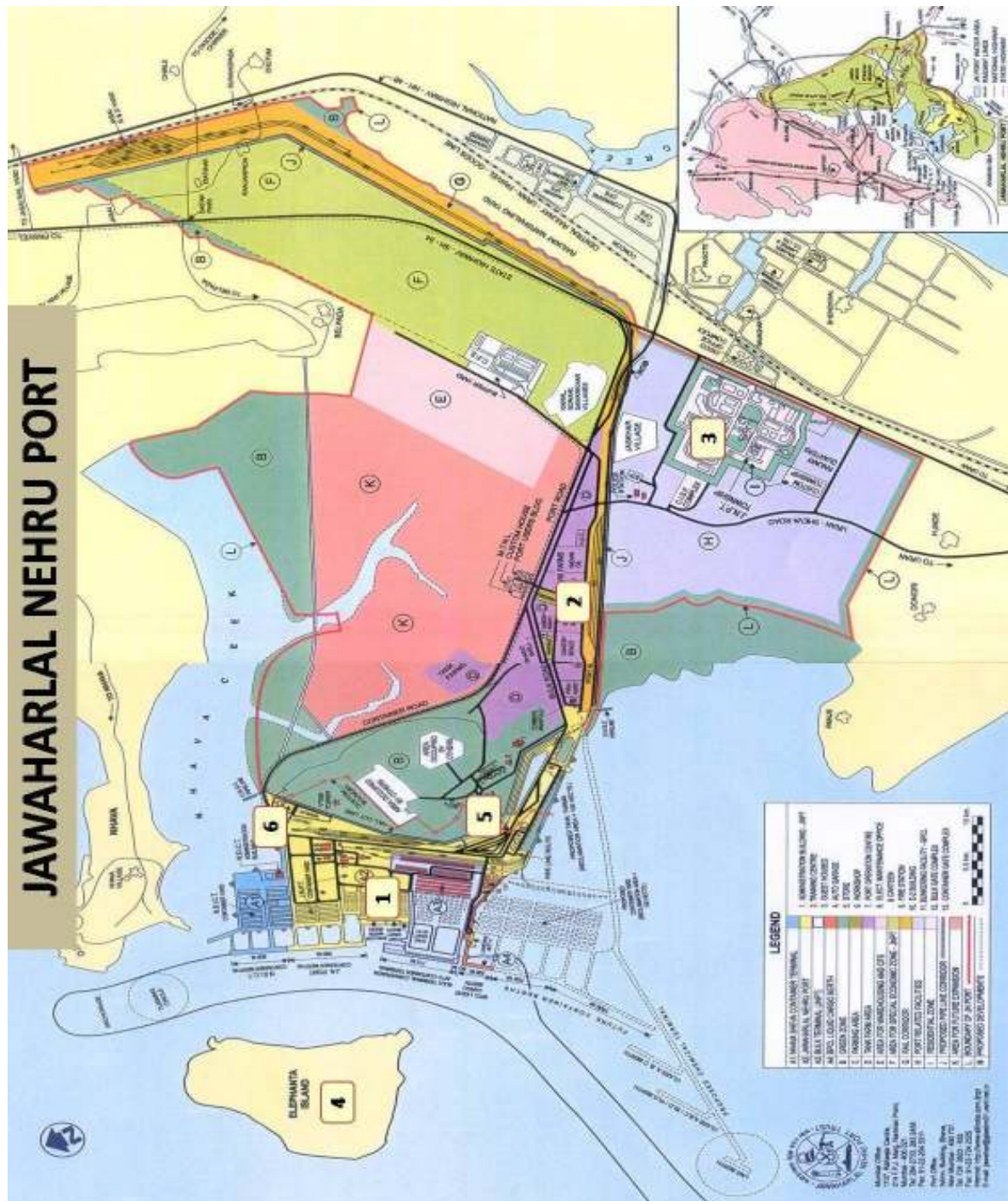
### 4.4 CONCLUSIONS

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.

<sup>1</sup>Todar, K. "Pathogenic *E. coli*". Online Textbook of Bacteriology. University of Wisconsin-Madison Department of Bacteriology. Retrieved 2007-11-30

<sup>2</sup>"*Escherichia coli*". CDC National Center for Emerging and Zoonotic Infectious Diseases. Retrieved 2012-10-02

## 5. ANNEXURES



*Annexure-I: Location map for Ambient Air Monitoring Stations*

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 <sub>2</sub> ), µg/m <sup>3</sup>	Annual*	50	20	-Improved West and Gaeke
		24 hours**	80	80	-Ultraviolet fluorescence
2.	Nitrogen Dioxide (NO <sub>2</sub> ), µg/m <sup>3</sup>	Annual*	40	30	-Modified Jacob & Hochheiser (Na-Arsenite)
		24 hours**	80	80	-Chemiluminescence
3.	Particulate Matter (size less than 10µm) or PM <sub>10</sub> , µg/m <sup>3</sup>	Annual*	60	60	-Gravimetric
		24 hours**	100	100	-TOEM -Beta attenuation
4.	Particulate Matter (size less than 2.5µm) or PM <sub>2.5</sub> , µg/m <sup>3</sup>	Annual*	40	40	-Gravimetric
		24 hours**	60	60	-TOEM -Beta attenuation
5.	Ozone (O <sub>3</sub> ), µg/m <sup>3</sup>	8 hours**	100	100	-UV photometric
		1 hour**	180	180	-Chemiluminescence -Chemical Method
6.	Lead (Pb), µg/m <sup>3</sup>	Annual*	0.5	0.5	-AAS/ICP method after sampling on EPM 2000 or equivalent filter paper
		24 hours**	1.0	1.0	-ED-XRF using Teflon filter
7.	Carbon Monoxide (CO), mg/m <sup>3</sup>	8 hours**	02	02	-Non Dispersive Infra Red (NDIR)
		1 hour**	04	04	spectroscopy
8.	Ammonia (NH <sub>3</sub> ), µg/m <sup>3</sup>	Annual*	100	100	-Chemiluminescence
		24 hours**	400	400	-Indophenol blue method
9.	Benzene (C <sub>6</sub> H <sub>6</sub> ), µg/m <sup>3</sup>	Annual*	05	05	-Gas chromatography based continuous analyzer -Adsorption and Desorption followed by GC analysis
10.	Benzo(a)Pyrene (BaP) – particulate phase only, ng/m <sup>3</sup>	Annual*	01	01	-Solvent extraction followed by HPLC/GC analysis
11.	Arsenic (As), ng/m <sup>3</sup>	Annual*	06	06	-AAS/ICP method after sampling on EPM 2000 or equivalent filter paper
12.	Nickel (Ni), ng/m <sup>3</sup>	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

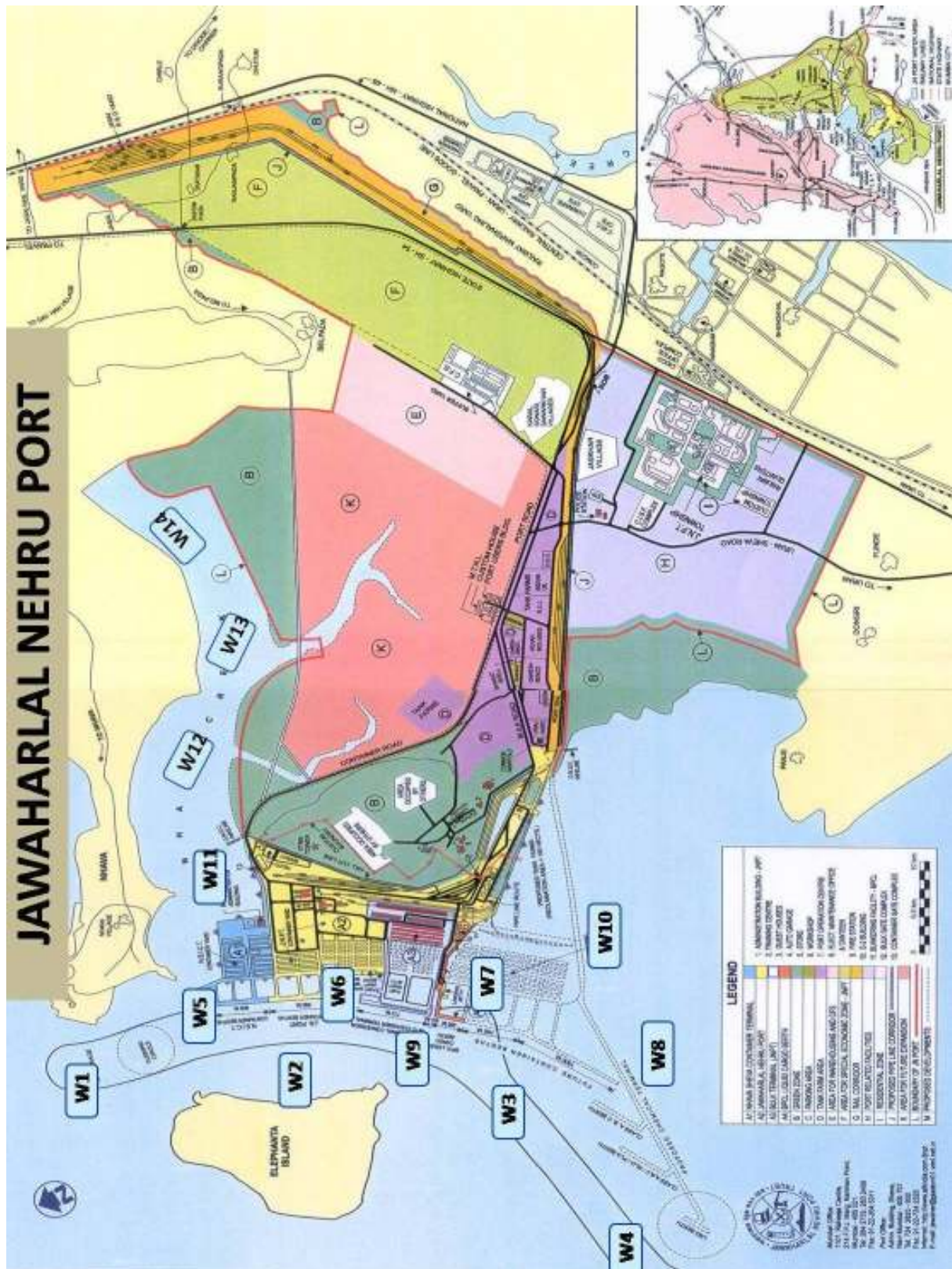
\*\* 24 hourly or 08 hourly or 01 hourly monitored values, as applicable, shall be compiled with 98% of the time in a year.

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.

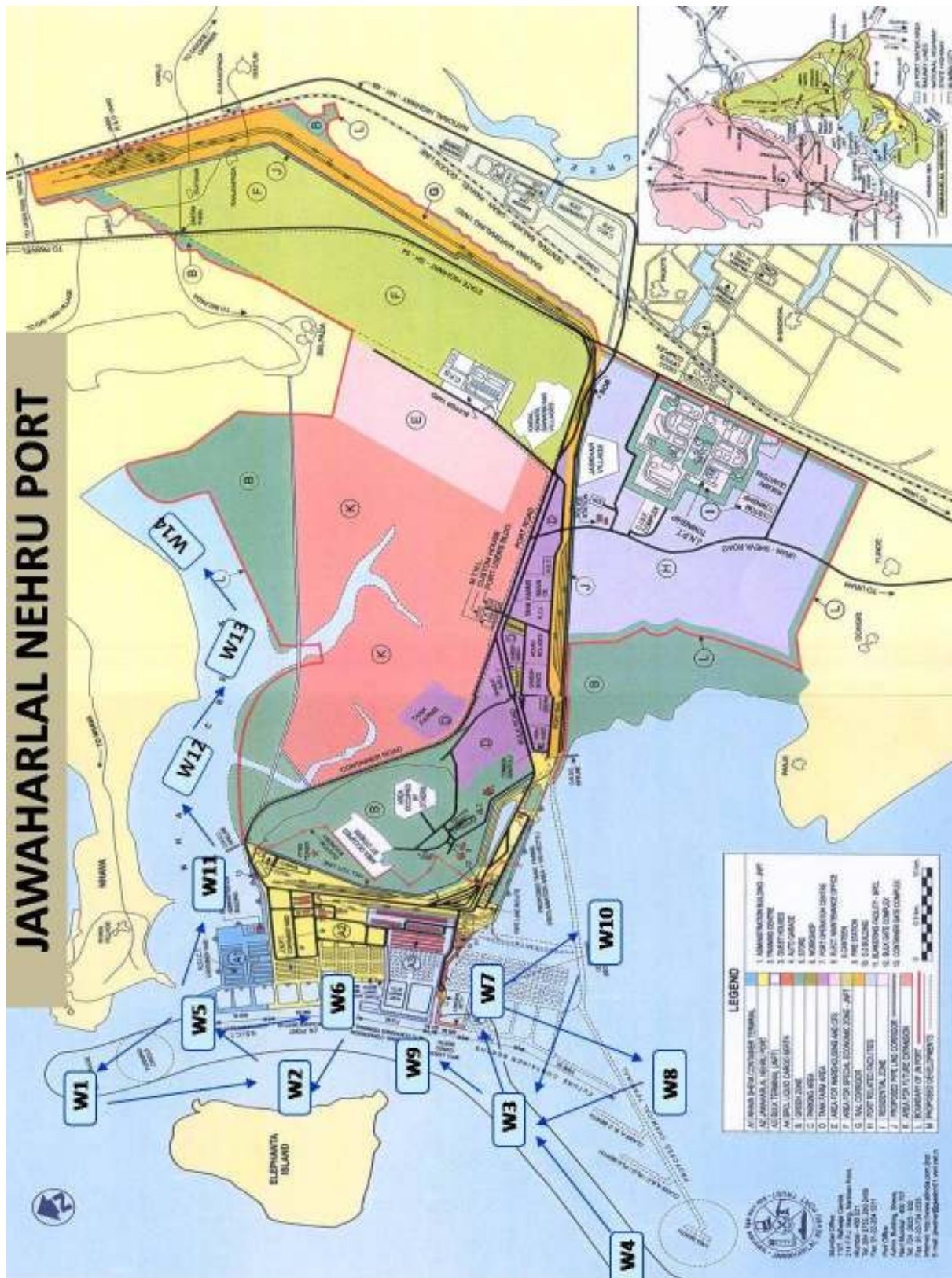
## Annexure-II: National Ambient Air Quality Monitoring Standard





### ***Annexure-III: Location map for Marine Water Monitoring Stations***





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 (5 days at 20°C)	5 mg/L	To maintain water relatively free from the pollution caused by sewage and other decomposable wastes.

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

Sr. No.	Parameter	Criteria	Rationale/Remarks
1.	Net primary productivity	<1500 mgC/m <sup>3</sup> /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 <sup>3</sup> 4-10 mg/m <sup>3</sup> >10 mg/m <sup>3</sup>	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 hemoglobin 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 <sup>3</sup>	POC is directly related to primary productivity. High concentration of POC represents the region of high productivity.
7.	Silicate (SiO <sub>2</sub> )	10-5000 µg/L	Nucleic acid synthesis and skeletal formation of Diatoms.

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

**Annexure-VII: Drinking Water - Specifications (IS 10500:2012)**

Parameter	Unit	Standards*
Colour	Hazen	5
Odour	-	Agreeable
pH	-	6.5 to 8.5
Turbidity	NTU	1
Total Dissolved Solids	mg/L	500
Aluminium as Al	mg/L	0.03
NH <sub>4</sub> <sup>+</sup> - N	mg/L	0.5
Barium as Ba	mg/L	0.7
Boron	mg/L	0.5
Calcium as Ca	mg/L	75
Chloride as Cl <sup>-</sup>	mg/L	250
Copper as Cu	mg/L	0.05
Fluoride	mg/L	1
Free Residual Chlorine	mg/L	0.2
Iron as Fe	mg/L	0.3
Magnesium as Mg	mg/L	30
Manganese as Mn	mg/L	0.1
Oil and grease	mg/L	0.5
Nitrate as NO <sub>3</sub> <sup>-</sup>	mg/L	45
Phenolic compound	mg/L	0.001
Selenium as Se	mg/L	0.01
Silver as Ag	mg/L	0.1
Sulphate as SO <sub>4</sub> <sup>-2</sup>	mg/L	200
Total Alkalinity as CaCO <sub>3</sub>	mg/L	200
Total Hardness as CaCO <sub>3</sub>	mg/L	200
Zinc as Zn	mg/L	5
Cyanide	mg/L	0.05
Lead as Pb	mg/L	0.01
Mercury as Hg	mg/L	0.001
Molybdenum as Mo	mg/L	0.07
Nickel as Ni	mg/L	0.02
Pesticides	mg/L	0.5
Total Arsenic as As	mg/L	0.01
Total Chromium as Cr	mg/L	0.05
Total Coliforms	MPN/100ml	Nil
E coli	-	Absent