



## MONITORING OF ENVIRONMENTAL PLAN FOR JN PORT ENVIRONMENTAL MONITORING REPORT

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## 1. AMBIENT AIR QUALITY MONITORING

### 1.1 INTRODUCTION

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

*Table 1: Description of Ambient Air Monitoring Stations*

Station No.	Station	Location	Selection Criterion
1.	POC	At Port Operational Centre	Main Port Activity Location
2.	IMC	At IMC compound in Liquid Chemical Terminal Area	Major industrial activity centre
3.	RC	At JNP residential township	Impact on human population, receptor oriented
4.	EC	At Elephanta Caves	Impact on 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 of ambient air samples are carried out as per CPCB Guidelines for Ambient Air Quality Monitoring, Volume-I, 2012. The monitoring is carried-out as per 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, while at NGC and SGC it is once a week. However, monitoring at Elephanta Caves is once a month as per schedule of EMP of JNPT.

In all above stations, 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 are used for a period of 24 hours to obtain one sample each 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 November, 2015 are given in **Tables 2, 3 & 4** respectively. The ambient air quality monitoring data for EC and two movable stations, NGC&SGC are given in **Tables 5, 6 & 7** respectively.

Table 2: Results of Air Pollutant Concentration at POC Station of JNP Area during the month of November, 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> ]	
			100 µg/m <sup>3</sup> 24 hr	60 µg/m <sup>3</sup> 24 hr	79 24 hr	60 µg/m <sup>3</sup> 24 hr	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	02.11.2015 To 03.11.2015	14:00 to 22:00					28		56		22	
		22:00 to 06:00	212	79			29	28.9	60	57.0	26	23.9
		06:00 to 14:00					30		55		24	
POC-2	05.11.2015 To 06.11.2015	14:00 to 22:00					29		57		16	
		22:00 to 06:00	132	71			32	30.2	60	58.9	23	19.4
		06:00 to 14:00					30		60		19	
POC-3	09.11.2015 To 10.11.2015	14:00 to 22:00					39		18		27	
		22:00 to 06:00	277	76			41	38.8	25	21.5	31	28.3
		06:00 to 14:00					37		21		28	
POC-4	12.11.2015 To 13.11.2015	14:00 to 22:00					3		71		29	
		22:00 to 06:00	260	112			5	3.2	75	72.5	35	32.3
		06:00 to 14:00					2		72		33	
POC-5	16.11.2015 To 17.11.2015	14:00 to 22:00					38		19		30	
		22:00 to 06:00	276	103			40	38.8	25	22.4	35	32.2
		06:00 to 14:00					39		23		32	
POC-6	19.11.2015 To 20.11.2015	14:00 to 22:00					4		62		28	
		22:00 to 06:00	268	84			8	<10	69	65.0	32	30.0
		06:00 to 14:00					7		64		30	
POC-7	23.11.2015 To 24.11.2015	14:00 to 22:00					31		55		26	
		22:00 to 06:00	106	44			34	32.4	58	55.4	29	27.6
		06:00 to 14:00					33		54		28	
POC-8	26.11.2015 To 27.11.2015	14:00 to 22:00					32		37		25	
		22:00 to 06:00	273	112			35	33.0	42	39.3	28	26.3
		06:00 to 14:00					33		39		26	
Average Standard Dev			226	85				29.3		49.0		27.5
			69	23				12.2		19.1		4.3

**Table 2: Results of Air Pollutant Concentration at POC Station of JNP Area during the month of November, 2015**

Sampling Period	Date	Time, [hrs]	O <sub>3</sub> , [µg/m <sup>3</sup> ]	8 hr	Pb, [µg/m <sup>3</sup> ]	24 hr	As, [ng/m <sup>3</sup> ]	24 hr	Ni, [ng/m <sup>3</sup> ]	24 hr	5 µg/m <sup>3</sup>	8 hr	BaP, [ng/m <sup>3</sup> ]	24 hr	CO, [ng/m <sup>3</sup> ]	Grab Sampling 4 mg/m <sup>3</sup>	CO <sub>2</sub> , [ppm]	Grab Sampling
NAAQMS				100 µg/m <sup>3</sup>	1.0 µg/m <sup>3</sup>	6 ng/m <sup>3</sup>	20 ng/m <sup>3</sup>	1 ng/m <sup>3</sup>										
POC-1	02.11.2015 To 03.11.2015	14:00 to 22:00																
		22:00 to 06:00		14	<0.01	<1	<1	<0.5	<1	<1	<1	<1	<0.5	<0.5	15	15	238	
POC-2	05.11.2015 To 06.11.2015	14:00 to 22:00																
		22:00 to 06:00		10	<0.01	<1	<1	<0.5	<1	<1	<1	<1	<0.5	<0.5	09	09	215	
POC-3	09.11.2015 To 10.11.2015	14:00 to 22:00																
		22:00 to 06:00		7	<0.01	<1	<1	<0.5	<1	<1	<1	<1	<0.5	<0.5	17	17	219	
POC-4	12.11.2015 to 13.11.2015	14:00 to 22:00																
		22:00 to 06:00		42	<0.01	<1	<1	<0.5	<1	<1	<1	<1	<0.5	<0.5	14	14	269	
POC-5	16.11.2015 to 17.11.2015	14:00 to 22:00																
		22:00 to 06:00		11	<0.01	<1	<1	<0.5	<1	<1	<1	<1	<0.5	<0.5	14	14	284	
POC-6	19.11.2015 to 20.11.2015	14:00 to 22:00																
		22:00 to 06:00		18	<0.01	<1	<1	<0.5	<1	<1	<1	<1	<0.5	<0.5	21	21	212	
POC-7	23.11.2015 to 24.11.2015	14:00 to 22:00																
		22:00 to 06:00		15	<0.01	<1	<1	<0.5	<1	<1	<1	<1	<0.5	<0.5	20	20	239	
POC-8	26.11.2015 to 27.11.2015	14:00 to 22:00																
		22:00 to 06:00		16	<0.01	<1	<1	<0.5	<1	<1	<1	<1	<0.5	<0.5	06	06	244	
Average Standard Dev				17														
				13														

Table 3: Results of Air Pollutant Concentration at IMC Station of JNP Area during the month of November, 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 100 µg/m <sup>3</sup>	24 hr 60 µg/m <sup>3</sup>	24 hr 77	8 hr 20	24 hr (Avg) 80 µg/m <sup>3</sup>	8 hr 74	24 hr (Avg) 80 µg/m <sup>3</sup>	8 hr 15	24 hr (Avg) 400 µg/m <sup>3</sup>	8 hr 15	24 hr (Avg) 400 µg/m <sup>3</sup>
IMC-1	02.11.2015 To 03.11.2015	15:00 to 23:00											
		23:00 to 07:00	199		77	22	21	66	70.6	22	18.0	22	18.0
		07:00 to 15:00				20		72		17		17	
IMC-2	05.11.2015 To 06.11.2015	15:05 to 23:05											
		23:05 to 07:05	141		70	23	25	95	99.1	53	55.0	58	55.0
		07:05 to 15:05				25		98		54		54	
IMC-3	09.11.2015 To 10.11.2015	15:10 to 23:10											
		23:10 to 07:10	478		168	31	33	51	54.9	19	21.5	24	21.5
		07:10 to 15:10				33		56		21		21	
IMC-4	12.11.2015 to 13.11.2015	14:50 to 22:50											
		22:50 to 06:50	464		72	29	30	105	105.2	22	24.5	27	24.5
		06:50 to 14:50				30		104		25		25	
IMC-5	16.11.2015 to 17.11.2015	15:00 to 23:00											
		23:00 to 07:00	289		126	25	27	49	52.4	18	20.8	24	20.8
		07:00 to 15:00				30		55		20		20	
IMC-6	19.11.2015 to 20.11.2015	15:00 to 23:00											
		23:00 to 07:00	145		63	28	29.2	8	39.7	19	20.1	21	20.1
		07:00 to 15:00				31		13		20		20	
IMC-7	23.11.2015 to 24.11.2015	15:00 to 23:00											
		23:00 to 07:00	97		28	22	24.1	38	39.7	14	14.5	15	14.5
		07:00 to 15:00				26		42		15		15	
IMC-8	26.11.2015 to 27.11.2015	15:00 to 23:00											
		23:00 to 07:00	168		69	30	30.8	14	17.5	17	17.6	19	17.6
		07:00 to 15:00				32		22		18		18	
Average Standard Dev			248		84		27.5		59.9		24.0		24.0
			149		43		4.0		30.2		12.9		12.9

Table 3: Results of Air Pollutant Concentration at IMC Station of JNP Area during the month of November, 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> ]	24 hr	24 hr	24 hr	8 hr	24 hr	24 hr	CO <sub>2</sub> , [ppm]
NAAQMS			100 µg/m <sup>3</sup>	1.0 µg/m <sup>3</sup>	6 ng/m <sup>3</sup>	20 ng/m <sup>3</sup>	5 µg/m <sup>3</sup>	1 ng/m <sup>3</sup>	Grab Sampling 4 ng/m <sup>3</sup>	Grab Sampling		
IMC-1	02.11.2015 To	15:00 to 23:00										
		23:00 to 07:00	12	<0.01	<1	<1	<1	<0.5	1.3	293		
IMC-2	03.11.2015 To	07:00 to 15:00										
		15:05 to 23:05	11	<0.01	<1	<1	<1	<0.5	1.4	288		
IMC-3	06.11.2015 To	07:05 to 15:05										
		15:10 to 23:10	12	<0.01	<1	<1	<1	<0.5	1.1	274		
IMC-4	09.11.2015 To	23:10 to 07:10										
		07:10 to 15:10	17	<0.01	<1	<1	<1	<0.5	1.7	234		
IMC-5	12.11.2015 to	14:50 to 22:50										
		22:50 to 06:50	20	<0.01	<1	<1	<1	<0.5	1.1	281		
IMC-6	13.11.2015 to	06:50 to 14:50										
		15:00 to 23:00	9	<0.01	<1	<1	<1	<0.5	2.3	289		
IMC-7	16.11.2015 to	23:00 to 07:00										
		07:00 to 15:00	17	<0.01	<1	<1	<1	<0.5	2.4	225		
IMC-8	17.11.2015 to	15:00 to 23:00										
		23:00 to 07:00	13	<0.01	<1	<1	<1	<0.5	2.0	256		
Average Standard Dev	20.11.2015 to	07:00 to 15:00										
		15:00 to 23:00	16						1.7	268		
	23.11.2015 to	23:00 to 07:00	7						0.5	26		
		07:00 to 15:00										



Table 4: Results of Air Pollutant Concentration at RC School Station of JNP Area during the month of November, 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> ]		
			100 µg/m <sup>3</sup>	24 hr	60 µg/m <sup>3</sup>	24 hr	8 hr	24 hr (Avg)	8 hr	24 hr (Avg)	8 hr	24 hr (Avg)	
RC-1	02.11.2015 To 03.11.2015	15:30 to 23:30					2		38			10	
		23:30 to 07:30		252	62	5	<10	43		<10		15	12.7
		07:30 to 15:30				4		41			13		
RC-2	05.11.2015 To 06.11.2015	15:30 to 23:30					9		20			9	
		23:30 to 07:30		96	52	13	11	27		23.1		15	12.5
		07:30 to 15:30				11		22			13		
RC-3	09.11.2015 To 10.11.2015	15:30 to 23:30					5		7			17	
		23:30 to 07:30		91	69	10	<10	15		11.9		24	19.8
		07:30 to 15:30				6		13			19		
RC-4	12.11.2015 to 13.11.2015	15:30 to 23:30					11		27			20	
		23:30 to 07:30		327	105	14	13	35		32.0		29	23.9
		07:30 to 15:30				13		34			23		
RC-5	16.11.2015 to 17.11.2015	15:30 to 23:30					10		11			16	
		23:30 to 07:30		316	126	15	13	15		12.9		22	19.1
		07:30 to 15:30				13		13			19		
RC-6	19.11.2015 to 20.11.2015	15:30 to 23:30					12		4			24	
		23:30 to 07:30		330	83	16	14	11		<10		27	24.6
		07:30 to 15:30				13		7			24		
RC-7	23.11.2015 to 24.11.2015	15:30 to 23:30					7		11			12	
		23:30 to 07:30		143	28	9	<10	15		13.1		16	14.2
		07:30 to 15:30				8		13			14		
RC-8	26.11.2015 to 27.11.2015	15:30 to 23:30					5		6			25	
		23:30 to 07:30		288	100	9	<10	13		<10		29	27.3
		07:30 to 15:30				8		10			28		
Average			230	78				12.4			18.6		19.3
Standard Dev			104	32				13			8.8		5.7

Table 4: Results of Air Pollutant Concentration at RC Station of JNP Area during the month of November, 2015																		
Sampling Period	Date	Time, [Hrs]	O <sub>3</sub> , [µg/m <sup>3</sup> ]	Pb, [µg/m <sup>3</sup> ]	24 hr	24 hr	As, [ng/m <sup>3</sup> ]	24 hr	Ni, [ng/m <sup>3</sup> ]	20 ng/m <sup>3</sup>	8 hr	24 hr	BaP, [ng/m <sup>3</sup> ]	1 ng/m <sup>3</sup>	CO, [mg/m <sup>3</sup> ]	Grab Sampling	CO <sub>2</sub> , [ppm]	Grab Sampling
NAAQMS			100 µg/m <sup>3</sup>	1.0 µg/m <sup>3</sup>	6 ng/m <sup>3</sup>	20 ng/m <sup>3</sup>	5 µg/m <sup>3</sup>	1 ng/m <sup>3</sup>	4 mg/m <sup>3</sup>									
RC-1	02.11.2015 To 03.11.2015	15:30 to 23:30	28	<0.01	<1	<1	<1	<0.5	2.2								278	
		23:30 to 07:30																
RC-2	05.11.2015 To 06.11.2015	15:30 to 23:30	6	<0.01	<1	<1	<1	<0.5	1.5								292	
		23:30 to 07:30																
RC-3	09.11.2015 To 10.11.2015	15:30 to 23:30	4	<0.01	<1	<1	<1	<0.5	2.3								234	
		23:30 to 07:30																
RC-4	12.11.2015 to 13.11.2015	15:30 to 23:30	10	<0.01	<1	<1	<1	<0.5	2.2								221	
		23:30 to 07:30																
RC-5	16.11.2015 to 17.11.2015	15:30 to 23:30	18	<0.01	<1	<1	<1	<0.5	2.9								298	
		23:30 to 07:30																
RC-6	19.11.2015 to 20.11.2015	15:30 to 23:30	33	<0.01	<1	<1	<1	<0.5	1.4								236	
		23:30 to 07:30																
RC-7	23.11.2015 to 24.11.2015	15:30 to 23:30	10	<0.01	<1	<1	<1	<0.5	2.4								288	
		23:30 to 07:30																
RC-8	26.11.2015 to 27.11.2015	15:30 to 23:30	7	<0.01	<1	<1	<1	<0.5	2.3								274	
		23:30 to 07:30																
Average Standard Dev			13						2.2		1.3					2.2	265	
			9						0.5		0.2					0.5	30	

**Table 5: Results of Air Pollutant Concentration at EC Station monitored during November, 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> ]		NH <sub>3</sub> , [µg/m <sup>3</sup> ]	
			24 hr	24 hr	24 hr	24 hr	8 hr	24 hr (Avg)	8 hr	24 hr (Avg)	8 hr	24 hr (Avg)
NAAQMS			100 µg/m <sup>3</sup>	60 µg/m <sup>3</sup>	-	80 µg/m <sup>3</sup>	-	80 µg/m <sup>3</sup>	-	80 µg/m <sup>3</sup>	-	400 µg/m <sup>3</sup>
EC	04.11.2015 To 05.11.2015	14:00 to 22:00			1.0		18		9			
		22:00 to 06:00	64	33	3.9	<10	49	35.5	12	10.1		
		06:00 to 14:00			2.9		39		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> ]	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]
			8 hr	24 hr	24 hr	24 hr	8 hr	24 hr	24 hr	Grab Sampling
NAAQMS			100 µg/m <sup>3</sup>	1.0 µg/m <sup>3</sup>	6 ng/m <sup>3</sup>	20 ng/m <sup>3</sup>	5 µg/m <sup>3</sup>	1 ng/m <sup>3</sup>	4 mg/m <sup>3</sup>	-
EC	04.11.2015 To 05.11.2015	14:00 to 22:00								
		22:00 to 06:00	6	<0.01	<1	<1	<1	<0.5	0.5	237
		06:00 to 14:00								

Table 6: Results of Air Pollutant Concentration at NGC Station of JNP Area during the month of November, 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> ]		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>	8 hr	24 hr (Avg)	8 hr	24 hr (Avg)	8 hr	24 hr (Avg)
NG-1	05.11.2015 To 06.11.2015	14:30 to 22:30					7		49		8	
		22:30 to 06:30	128		55		12	<10	58	53.5	12	9.9
		06:30 to 14:30					8		54		9	
NG-2	12.11.2015 To 13.11.2015	14:30 to 22:30					13		25		17	
		22:30 to 06:30	235		88		15	14.1	29	27.3	24	19.7
		06:30 to 14:30					14		27		18	
NG-3	19.11.2015 to 20.11.2015	14:30 to 22:30					13		53		18	
		22:30 to 06:30	227		75		22	18.6	60	56.6	23	20.3
		06:30 to 14:30					20		57		20	
NG-4	26.11.2015 to 27.11.2015	14:30 to 22:30					11		46		5	
		22:30 to 06:30	300		111		20	16.4	53	49.1	10	7.1
		06:30 to 14:30					18		48		6	
Average			223		82			16.4		46.6		14.2
Standard Dev			71		23			2.2		13.2		6.7

Table 6: Results of Air Pollutant Concentration at NGC Station of JNP Area during the month of November, 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> ]		Ni, [µg/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>	24 hr	1 ng/m <sup>3</sup>	Grab Sampling	4 mg/m <sup>3</sup>	Grab Sampling	
NG-1	05.11.2015 To 06.11.2015	14:30 to 22:30														
		22:30 to 06:30	9		<0.01		<1		<1	<1	<0.5		1.6		229	
		06:30 to 14:30														
NG-2	12.11.2015 To 13.11.2015	14:30 to 22:30														
		22:30 to 06:30	26		<0.01		<1		<1	<1	<0.5		1.0		278	
		06:30 to 14:30														
NG-3	16.11.2015 to 17.11.2015	14:30 to 22:30														
		22:30 to 06:30	9		<0.01		<1		<1	<1	<0.5		1.6		244	
		06:30 to 14:30														
NG-4	26.11.2015 to 27.11.2015	14:30 to 22:30														
		22:30 to 06:30	4		<0.01		<1		<1	<1	<0.5		0.8		287	
		06:30 to 14:30														
Average			19										1.3		260	
Standard Dev			13										0.4		28	

Table 7: Results of Air Pollutant Concentration at SGC Station of JNP Area during the month of November, 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 100 µg/m <sup>3</sup>	8 hr 60 µg/m <sup>3</sup>	24 hr 60 µg/m <sup>3</sup>	8 hr 60 µg/m <sup>3</sup>	24 hr (Avg) 80 µg/m <sup>3</sup>	8 hr 80 µg/m <sup>3</sup>	24 hr (Avg) 80 µg/m <sup>3</sup>	8 hr 80 µg/m <sup>3</sup>	24 hr (Avg) 400 µg/m <sup>3</sup>	8 hr 400 µg/m <sup>3</sup>
SG-1	02.11.2015 To 03.11.2015	14:30 to 22:30					6		55	5		
		22:30 to 06:30	215		61		11		62	11		
		06:30 to 14:30					9		58	7		
SG-2	09.11.2015 To 10.11.2015	14:30 to 22:30					4		62	14		
		22:30 to 06:30	271		88		10		72	22		
		06:30 to 14:30					8		67	19		
SG-3	16.11.2015 to 17.11.2015	14:30 to 22:30					6		63	17		
		22:30 to 06:30	308		93		10		69	24		
		06:30 to 14:30					8		65	21		
SG-4	23.11.2015 to 24.11.2015	14:30 to 22:30					11		58	15		
		22:30 to 06:30	116		38		20		61	17		
		06:30 to 14:30					18		60	16		
Average			228		70				9.9		62.5	
Standard Dev			84		26				4.4		4.4	

Table 7: Results of Air Pollutant Concentration at SGC Station of JNP Area during the month of November, 2015

Sampling Period NAAQMS	Date	Time, [Hrs]	O <sub>3</sub> , [µg/m <sup>3</sup> ]		Pb, [µg/m <sup>3</sup> ]		As, [µg/m <sup>3</sup> ]		Ni, [ng/m <sup>3</sup> ]		BaP, [µg/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>	8 hr 1.0 µg/m <sup>3</sup>	24 hr 1.0 µg/m <sup>3</sup>	8 hr 6 ng/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 4 mg/m <sup>3</sup>	Grab Sampling 4 mg/m <sup>3</sup>	Grab Sampling 4 mg/m <sup>3</sup>	Grab Sampling 4 mg/m <sup>3</sup>	Grab Sampling 4 mg/m <sup>3</sup>
SG-1	02.11.2015 To 03.11.2015	14:30 to 22:30														
		22:30 to 06:30	14													
		06:30 to 14:30														
SG-2	09.11.2015 To 10.11.2015	14:30 to 22:30														
		22:30 to 06:30	14													
		06:30 to 14:30														
SG-3	16.11.2015 to 17.11.2015	14:30 to 22:30														
		22:30 to 06:30	9													
		06:30 to 14:30														
SG-4	23.11.2015 to 24.11.2015	14:30 to 22:30														
		22:30 to 06:30	18													
		06:30 to 14:30														
Average			14													
Standard Dev			4													

## 1.4 DISCUSSION

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

**Table 8:** Monthly Average Values of Air Pollutants at Various Stations in JNP Area during November, 2015

STATION	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> ]	O <sub>3</sub> , [μg/m <sup>3</sup> ]	Pb [μg/m <sup>3</sup> ]	C <sub>6</sub> H <sub>6</sub> , [μg/m <sup>3</sup> ]	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	226 ± 69	85 ± 23	29.3±12.2	49.0±19.1	27.5±4.3	17 ± 13	<0.01	1.4 ± 0.3	1.5 ± 0.5	240 ± 26
IMC	248±149	84 ± 43	27.5±4.0	59.9±30.2	24.0±12.9	16 ± 07	<0.01	1.4 ± 0.4	1.7 ± 0.5	268 ± 26
NG	223±71	82 ± 23	16.4±2.2	46.6±13.2	14.2 ± 6.7	19 ± 13	<0.01	<1	1.3 ± 0.4	260± 28
SG	228 ± 84	70 ± 26	9.9±4.4	62.5±4.4	15.7 ± 5.7	14 ± 4	<0.01	<1	1.5 ± 0.5	272± 26
<b>RESIDENTIAL AREA</b>										
RC	230± 104	78 ± 32	12.4±1.3	18.6±8.8	19.3 ± 5.7	13 ± 9	<0.01	1.3± 0.2	2.2 ± 0.5	265± 30
<b>ECO-SENSITIVE AREA</b>										
EC	64	33	<10	35.5	10.1	6	<0.01	<0.5	0.5	237

During the monitoring period, the overall Ambient Air Quality of the port area was found to be well within the desired levels for various pollutants. Daily average pollutant levels are presented in **Tables 2** through **7**. However, the concentrations obtained for particulate matter PM<sub>10</sub> and PM<sub>2.5</sub> at all stations were found to be exceeding the prescribed CPCB limits. All other pollutants were recorded well below the prescribed limits.

Results for the air quality parameters at Elephanta Caves [EC] station during 04<sup>th</sup> November'15 to 5<sup>th</sup> November'15 are represented in **Table 5**. **Tables 6 & 7** provide the results for NGC and SGC air monitoring stations respectively.

In November '15, gaseous pollutants were well within the prescribed limits, set for industrial as well as sensitive areas.

## 1.5 OBSERVATIONS AND CONCLUSIONS

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

### *Observations for the month of November'15:*

- ✓ All the public and community buildings in residential complex / township are under renovation. Being temporary activity; it will not affect ambient air quality in long run. Existing Ambient air Quality of RC station is well within CPCB permissible limits except for PM<sub>10</sub> and PM<sub>2.5</sub>, which are higher than the prescribed CPCB standard.
- ✓ *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: The transportation of soil and earth shall be considered a vital part as it is potential source of particulates. The overall ambient air quality around the Port area shows no adverse effect. Increase in the PM<sub>10</sub> and PM<sub>2.5</sub> Concentration at South Gate may be attributed to the earth filling activity of 4<sup>th</sup> C.T. where the Dumpers carrying earth filling materials were ferrying without any tarpaulin cover and heavy traffic movement at SGC.
- ✓ *Construction of NSIGT Yard is underway to the North side of JNPT:* The nearest Ambient Air Monitoring location is North gate Complex. The overall values of gaseous parameters are well within the CPCB limits except for PM<sub>10</sub> and PM<sub>2.5</sub> Concentration which are found exceeding the CPCB limits. The development of yard for NSIGT and heavy vehicular movement causing the elevated values of PM<sub>10</sub> and PM<sub>2.5</sub> Concentration at NGC.
- ✓ *Vehicular Traffic at three gates:* The monitoring of ambient air Quality at South and North gate complexes has been done once a week. The location is covered by large control sections and dense tree cover accounting as pollutant trap. 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 November'15 for the Rail over bridge. Nearest location i.e. RC

does not show any adverse impact due to this activity. All the AAQM parameters are well within the prescribed CPCB limits except the values of PM<sub>10</sub> and PM<sub>2.5</sub>. 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.

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

#### Conclusion:

From the results obtained for the month of November, 2015 it can be concluded that overall Ambient Air quality of the JN Port is within CPCB limits, except the levels of PM<sub>10</sub> and PM<sub>2.5</sub>, which are higher at all locations due to port development activities.



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

### 2.1 INTRODUCTION

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

### 2.2 MARINE WATER QUALITY MONITORING METHODOLOGY

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

**Harbor Water Quality Monitoring** – Three samples from the surface, mid depth and bottom are collected during spring and neap tidal cycle. The samples are taken after 1<sup>st</sup>, 3<sup>rd</sup> and 5<sup>th</sup> hour of the tide from eight fixed and one moving stations and composited from each harbor water quality monitoring station. 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 composited 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 presented in **Table 10** along with parameters 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.	4 <sup>th</sup> November, 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	4 <sup>th</sup> November, 2015
3.	W3	Identified by the green buoy no. <u>FG2 Green</u> of JNPT approach channel and lies near the landing jetty.	5 <sup>th</sup> November, 2015
4.	W4	Located at Uran Patch Beacon (lighthouse on concrete platform) near the Butcher Island filling platform.	5 <sup>th</sup> November, 2015
5.	W5	W5 is near to the guide bund and others are along Nhava creek upto Belpada. These are selected to examine the impact of neighboring Nhava Villages and Belpadato the creek water quality.	4 <sup>th</sup> November, 2015
	W11 to W14		6 <sup>th</sup> November, 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.	4 <sup>th</sup> November, 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.	5 <sup>th</sup> November, 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	5 <sup>th</sup> November, 2015
9.	W8/W10	Located near proposed chemical berth. These stations are variable and selected to examine the impact of proposed chemical terminal and IVth Container terminal activities on water quality.	5 <sup>th</sup> November, 2015

**Table 10: List of Parameters Monitored for Marine Water Quality**

Marine Water Quality Parameters [Harbor Area & Creek Area]
<b>A] Physical parameters 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 are presented in **Table 11** for Physico-chemical parameters, **Table 12** for Bio-chemical parameters and **Table 13** for Sediment samples collected at these nine locations. The creek water quality data for four Nhava creek water quality monitoring stations are reported in **Table 14** for Physico-chemical parameters, **Table 15** for Bio-chemical parameters and **Table 16** for Sediment samples, collected at these locations.

**Table 11: Results of Physical parameters of Water Samples Collected from JNP Harbor Area during November, 2015**

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	-	-	-	-	-
W1	SS	13.0	27.1	7.19	32.2	10	29940	102	30042
	SM		27	7.28	29.9	8	30010	106	30116
	SB		26.8	7.29	30.5	8	30140	156	30296
	NS	12.5	28.5	7.27	31.6	10	30210	85	30295
	NM		28.4	7.35	29.9	7	30240	120	30360
	NB		28.6	7.26	31.0	5	30310	168	30478
W2	SS	4.5	27.3	7.36	32.2	2	29950	95	30045
	SM		27.1	7.28	29.3	4	29920	111	30031
	SB		26.9	7.23	31.0	8	30110	115	30225
	NS	4.0	28.4	7.38	30.5	5	30250	78	30328
	NM		28.3	7.35	29.9	3	30330	108	30438
	NB		28.3	7.36	31.0	6	30270	123	30393
W3	SS	7.5	28.2	7.11	31.6	4	30310	88	30398
	SM		28	7.60	30.5	8	30260	57	30317
	SB		27.9	6.91	31.0	2	30350	63	30413
	NS	7.0	29	7.41	29.9	5	30380	104	30484
	NM		28.5	7.03	32.2	8	30180	94	30274
	NB		28.7	7.62	31.6	7	30170	118	30288
W4	SS	10.5	28.1	7.43	31.0	2	30190	45	30235
	SM		28	6.86	31.6	4	30220	113	30333
	SB		28	7.31	30.5	5	30250	88	30338
	NS	10.0	28.4	6.87	32.2	8	30240	131	30371
	NM		28.5	7.41	32.7	3	30280	103	30383
	NB		28.4	7.33	29.9	4	30090	119	30209
W5	SS	13.0	27.9	7.49	31.0	10	29970	126	30096
	SM		27.8	7.55	31.6	16	29840	106	29946
	SB		27.8	7.48	29.9	18	29950	84	30034
	NS	12.5	28	7.58	30.5	10	29980	82	30062
	NM		28.1	7.48	31.6	18	29990	101	30091
	NB		28.2	7.36	31.0	4	30080	91	30171

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, [ppt]	Turbidity, [NTU]	TDS, [mg/L]	TSS, [mg/L]	TS, [mg/L]
Standard		-	-	6.5 - 9.0	-	-	-	-	-
W6	SS	12.5	27.1	7.42	32.2	6	30110	104	30214
	SM		27	7.53	31.6	5	30180	82	30262
	SB		27	7.26	31.0	4	30090	71	30161
	NS	12.0	28.4	7.51	29.9	5	30160	77	30237
	NM		28.2	7.46	30.5	3	30210	104	30314
	NB		28.3	6.90	31.0	7	30240	112	30352
W7	SS	8.5	28	7.32	31.6	2	30310	127	30437
	SM		27.8	7.52	29.9	2	30280	227	30507
	SB		27.7	7.46	30.5	4	30270	58	30328
	NS	7.5	28.2	7.63	29.9	3	30180	152	30332
	NM		27.9	7.59	31.6	8	30190	138	30328
	NB		28	7.46	31.0	17	30280	359	30639
W8	SS	13.0	27.9	7.52	31.0	3	30340	79	30419
	SM		27.6	7.61	29.9	4	30250	186	30436
	SB		27.6	7.59	31.6	6	30270	154	30424
	NS	12.5	28.3	7.63	32.2	3	30260	78	30338
	NM		28	7.41	31.6	4	30310	131	30441
	NB		28.1	7.41	30.5	14	30280	225	30505
W9	SS	19.5	28.1	7.38	32.2	27	30180	96	30276
	SM		27.9	7.52	31.6	26	30370	122	30492
	SB		27.8	7.61	31.0	37	30350	123	30473
	NS	19.0	28.1	7.60	30.5	14	30280	132	30412
	NM		27.9	7.65	29.9	12	30250	68	30318
	NB		28.1	7.60	31.0	40	30210	123	30333

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 November, 2015**

Sample Name		DO, [mg/L]	COD, [mg/L]	BOD, [mg/L]	NH <sub>3</sub> -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#		-	-	-	-	2	110	2
	SS	5.4	40	<2	<0.1	<0.01			
	SM	5.3	44	-	-	-			
	SB	5.1	36	-	-	-			
	NS#			-	-	-	1	56	<2
	NS	6	28	<2	<0.1	<0.01			
	NM	5.8	32	-	-	-			
	NB	5.9	20	-	-	-			
W2	SS#						<1	69	4
	SS	5.8	32	<2	<0.1	<0.01			
	SM	5.7	24	-					
	SB	5.5	36	-					
	NS#						3	<30	8
	NS	5.6	40	<2	<0.1	<0.01			
	NM	5.7	44	-					
	NB	5.7	28	-					
W3	SS#		-	-	-	-	2	130	80
	SS	6	40	<2	<0.1	<0.01			
	SM	5.8	44	-	-	-			
	SB	5.7	28	-	-	-			
	NS#			-	-	-	1	84	4
	NS	5.8	36	<2	<0.1	<0.01			
	NM	5.6	32	-	-	-			
	NB	5.6	48	-	-	-			
W4	SS#		-	-	-	-	1	64	50
	SS	6.2	48	<2	<0.1	<0.01			
	SM	5.7	28	-	-	-			
	SB	5.9	32	-	-	-			
	NS#			-	-	-	1	<30	11
	NS	5.8	44	<2	<0.1	<0.01			
	NM	5.7	40	-	-	-			
	NB	5.8	36	-	-	-			
W5	SS#		-	-	-	-	3	88	26
	SS	5.9	44	<2	<0.1	<0.01			
	SM	6	40	-	-	-			
	SB	5.9	48	-	-	-			
	NS#		-	-	-	-	2	48	<2
	NS	5.8	24	<2	<0.1	<0.01			
	NM	5.4	28	-	-	-			
	NB	5.6	32	-	-	-			

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>3</sub> -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	42	4
	SS	5.5	48	<2	<0.1	<0.01	-	-	-
	SM	5.3	28	-	-	-	-	-	-
	SB	5.2	32	-	-	-	-	-	-
	NS <sup>#</sup>		-	-	-	-	2	89	11
	NS	5.6	24	<2	<0.1	<0.01	-	-	-
	NM	5.4	36	-	-	-	-	-	-
W7	NB	5.4	40	-	-	-	-	-	-
	SS <sup>#</sup>		-	-	-	-	<1	<30	11
	SS	5.6	48	2.2	<0.1	<0.01	-	-	-
	SM	5.7	36	-	-	-	-	-	-
	SB	5.5	44	-	-	-	-	-	-
	NS <sup>#</sup>		-	-	-	-	2	56	4
	NS	5.8	32	<2	<0.1	<0.01	-	-	-
W8	NM	5.6	40	-	-	-	-	-	-
	NB	5.7	28	-	-	-	-	-	-
	SS <sup>#</sup>		-	-	-	-	2	92	8
	SS	5.7	36	<2	<0.1	<0.01	-	-	-
	SM	5.6	44	-	-	-	-	-	-
	SB	5.5	32	-	-	-	-	-	-
	NS <sup>#</sup>		-	-	-	-	2	<30	2
W9	NS	5.8	40	<2	<0.1	<0.01	-	-	-
	NM	5.7	48	-	-	-	-	-	-
	NB	5.6	28	-	-	-	-	-	-
	SS <sup>#</sup>		-	-	-	-	2	<30	26
	SS	6	46	2.4	<0.1	<0.01	-	-	-
	SM	5.9	42	-	-	-	-	-	-
	SB	5.8	50	-	-	-	-	-	-
W9	NS <sup>#</sup>		-	-	-	-	1	<30	8
	NS	5.8	37	<2	<0.1	<0.01	-	-	-
	NM	5.4	33	-	-	-	-	-	-
	NB	5.6	29	-	-	-	-	-	-

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 Nov., 2015**

Station Name	Organic Matter		Total Carbon		Inorganic Phosphate mg/kg
	mg/g	%	mg/g	%	
W1	Sample Not Found				
W2	Sample Not Found				
W3	96.6	9.7	56.0	5.6	220
W4	134.5	13.5	78.0	7.8	150
W5	Sample Not Found				
W6	125.7	12.6	72.9	7.3	240
W7	124.1	12.4	72.0	7.2	220
W8	Sample Not Found				
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	4.5	27.4	7.70	29.9	4	30140	72	30212
	SM		27.2	7.75	29.3	4	30180	68	30248
	SB		27.2	7.73	30.5	5	30190	75	30265
	NS	4.0	28.1	7.70	31.0	3	30210	75	30285
	NM		27.9	7.73	31.6	5	30240	80	30320
	NB		27.8	7.06	30.5	5	30270	105	30375
W12	SS	4.0	27.6	7.60	31.6	3	30280	152	30432
	SM		27.5	7.74	32.2	5	30320	95	30415
	SB		27.5	7.72	31.0	73	30410	49	30459
	NS	3.5	28	7.69	29.9	5	30430	64	30494
	NM		28	7.79	29.3	6	30250	83	30333
	NB		27.8	7.68	32.7	4	30220	98	30318
W13	SS	3.5	27.6	7.73	30.5	6	30150	132	30282
	SM		27.6	7.58	29.9	4	30160	110	30270
	SB		27.5	7.80	31.0	6	30180	84	30264
	NS	3.5	28	7.81	31.6	2	30230	81	30311
	NM		27.9	7.76	29.9	7	30240	122	30362
	NB		27.7	7.75	30.5	4	30310	112	30422
W14	SS	3.5	27.7	7.74	31.0	4	30190	114	30304
	SM		27.6	7.73	32.2	6	30220	138	30358
	SB		27.5	7.02	30.5	4	30240	98	30338
	NS	3.0	27.8	7.70	32.2	6	30250	102	30352
	NM		27.6	7.72	29.3	4	30320	151	30471
	NB		27.6	7.75	32.2	4	30360	110	30470

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 <sub>3</sub> -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	5.6	37	<2	<0.1	<0.01	2	30	9
	SM	5.5	33	-	-	-	-	-	-
	SB	5.4	42	-	-	-	-	-	-
	NS	5.7	46	<2	<0.1	<0.01	1	48	2
	NM	5.6	29	-	-	-	-	-	-
	NB	5.6	50	-	-	-	-	-	-
W12	SS	5.8	46	<2	<0.1	<0.01	2	189	7
	SM	5.7	29	-	-	-	-	-	-
	SB	5.6	33	-	-	-	-	-	-
	NS	5.5	37	<2	<0.1	<0.01	2	78	<2
	NM	5.6	42	-	-	-	-	-	-
	NB	5.7	25	-	-	-	-	-	-
W13	SS	5.8	50	<2	<0.1	<0.01	3	52	33
	SM	5.7	33	-	-	-	-	-	-
	SB	5.8	37	-	-	-	-	-	-
	NS	5.8	42	<2	<0.1	<0.01	2	<30	4
	NM	5.7	46	-	-	-	-	-	-
	NB	5.6	29	-	-	-	-	-	-
W14	SS	5.8	37	<2	<0.1	<0.01	2	221	22
	SM	5.6	42	-	-	-	-	-	-
	SB	5.7	29	-	-	-	-	-	-
	NS	5.6	46	<2	<0.1	<0.01	2	80	11
	NM	5.7	50	-	-	-	-	-	-
	NB	5.6	33	-	-	-	-	-	-

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 Nov., 2015**

Sample Name	Organic Matter		Total Carbon		Inorganic Phosphate
	mg/g	%	mg/g	%	
W11	Sediment not found				
W12	Sediment not found				
W13	113.3	11.3	65.7	6.6	200
W14	90.5	9.1	52.5	5.2	170

## 2.4 DISCUSSION

**Tables 17 and 18** present concentration ranges of various parameters for Harbor and Nhava regions respectively. 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	26.8 – 29.0	°C	-
2	pH	6.86– 7.65	-	<b>6.5 - 9.0</b>
3	Salinity	29.3-32.7	ppt	-
4	Turbidity	2-40	NTU	-
5	TDS	29840 – 30380	mg/L	-
6	TSS	45-359	mg/L	-
7	TS	29946-30639	mg/L	-
8	DO	5.2 – 6.2	mg/L	<b>3.0 mg/L(min.) or 40% of saturation value</b>
9	COD	24-50	mg/L	-
10	BOD	<2-2.4	mg/L	<b>5 (max.)</b>
11	NH <sub>3</sub> -N	<0.1	mg/L	-
12	Phenol	< 0.01	mg/L	-
13	Oil & Grease	<1– 3	mg/L	<b>10 (max.)</b>
14	Total Plate Count	<30 - 130	CFU/ml	-
15	Fecal Coliforms	<2-80	MPN/100 mL	<b>500 (max.)</b>

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

Sr. No.	Parameter	Observed Range	Unit	Prescribed Limits
1	Temperature	27.2– 28.1	°C	-
2	pH	7.02– 7.81	-	<b>6.5 - 9.0</b>
3	Salinity	29.3-32.7	ppt	-
4	Turbidity	2-73	NTU	-
5	TDS	30140-30430	mg/L	-
6	TSS	49-152	mg/L	-
7	TS	30212-30494	mg/L	-
8	DO	5.4 – 5.8	mg/L	<b>3.0 mg/L(min.) or 40% of saturation value</b>
9	COD	25-50	mg/L	-
10	BOD	< 2.0	mg/L	<b>5 (max.)</b>
11	NH <sub>3</sub> -N	< 1.0	mg/L	-
12	Phenol	< 0.01	mg/L	-
13	Oil & Grease	1 – 3	mg/L	<b>10 (max.)</b>
14	Total Plate Count	<30 -221	CFU/ml	-
15	Fecal Coliforms	<2 -33	MPN/100 mL	<b>500 (max.)</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 November, 2015 are within the prescribed limits. Also, the concentration ranges observed for various parameters for water samples collected from Nhava Creek area during November, 2015 are also within prescribed limits.

Observed salinity values for Harbor and Creek water samples in the month of November, 2015 varied from 28.9-33.7 ppt and 29.4-33.1 ppt respectively [**Tables 11&14**]. The earth filling activity for the development of 4<sup>th</sup> Container Terminal and Dredging works in the region does not seem to be affecting on Marine water Quality as Turbidity values and TSS values are decreased as compared to August month's data. During August, 2015 sampling the sea was rough whereas during current month Calm conditions were observed. The ranges observed for COD values in mg/L are 28 – 52 and 16-52 respectively for Harbor and Creek water samples. The DO levels were found between 5.7 & 6.4 mg/L and 5.8 & 6.2 mg/L for water samples collected from Harbor and Creek areas respectively. The concentrations of Phenol and NH<sub>3</sub> - N were found to be very less in both Harbor and Creek water samples. Bacteriological parameters were 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 JNP Harbor samples. The values obtained for Organic Matter, Total Organic Carbon and Inorganic Phosphate varied from 9 – 20%, 5 – 12% and 83 – 183mg/kg, respectively. **Table 16** shows the values for Organic Matter, Total Organic Carbon and Inorganic Phosphate as 17 to 20 %, 10 to 12 % and 103– 168mg/kg, respectively in Nhava Creek sediments during November, 2015.

## 2.5 OBSERVATIONS AND CONCLUSION

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

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

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**Conclusion:**

Considering the activities in the Harbor area and the results obtained for the month of November, 2015 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 [W8/W10] are identified. At Nhava creek 4 fixed stations [W11 to W14] are identified. All above mentioned stations are selected for studying aquatic flora and fauna as well as benthic fauna. The description of stations is presented in **Table 9**. The location map of various Marine ecology monitoring stations along with direction of towing are depicted in **Annexure-IV**.

#### 3.2 MARINE ECOSYSTEM MONITORING METHODOLOGY

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

**Marine Ecology Monitoring** –Monitoring of marine ecology was carried out on the levels of high & low water of spring and neap tides at twelve fixed stations and one moving station in Port's water limit. Phytoplankton and Zooplankton samples were collected during spring and neap tides from all the 12 fixed [W1 to W7, W9 and W11 to W14] and one moving [W8/W10] water quality monitoring stations.

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

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

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 **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	315	275
2.	W2	515	475
3.	W3	375	315
4.	W4	415	375
5.	W5	315	275
6.	W6	415	375
7.	W7	315	275
8.	W9	375	315
9.	W10	415	375
<b>JNP Nhava Creek Area</b>			
10.	W11	375	215
11.	W12	375	215
12.	W13	415	375
13.	W14	415	325

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

Sr. No.	Sampling station	Sample Location	Phyto-plankton [No/ml]	Percent Composition of Algal		
				Bacillario-phyceae	Chloro-phyceae	Cyano-phyceae
JNP Harbour Area						
1	W1	Surface	425	50	30	20
		Bottom	370	65	20	15
2	W2	Surface	515	50	20	30
		Bottom	475	65	25	10
3	W3	Surface	320	45	35	20
		Bottom	275	60	20	20
4	W4	Surface	475	50	20	30
		Bottom	380	60	20	20
5	W5	Surface	510	55	25	20
		Bottom	425	45	35	20
6	W6	Surface	470	60	20	20
		Bottom	315	50	30	20
7	W7	Surface	490	60	20	20
		Bottom	370	50	30	20
8	W9	Surface	425	55	25	20
		Bottom	370	70	20	10
9	W10	Surface	360	50	20	30
		Bottom	290	50	40	10
JNP Nhava Creek						
10	W11	Surface	410	40	30	30
		Bottom	370	50	20	30
11	W12	Surface	510	60	20	20
		Bottom	475	50	30	20
12	W13	Surface	465	65	20	15
		Bottom	390	60	20	20
13	W14	Surface	500	60	20	20
		Bottom	460	50	30	20

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

Sr. No.	Bacillariophyceae	Chlorophyceae	Cyanophyceae
1.	<i>Navicula</i> sp.	<i>Closterium</i> sp.	<i>Gloeocapsa</i> sp.
2.	<i>Nitzschia</i> sp.	<i>Cosmarium</i> sp.	<i>Oscillatoria</i> sp.
3.	<i>Fragillaria</i> sp.	<i>Scenedesmus</i> sp.	<i>Anabaena</i> sp.
4.	<i>Surirella</i> sp.	<i>Ulothrix</i> sp.	<i>Aphanocapsa</i> sp.
5.	<i>Gyrosigma</i> sp.	-	-
6.	<i>Skeletonema</i> sp.	-	-
7.	<i>Pleurosigma</i> sp.	-	-

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

Sr. No.	Station	Secchi Depth [cm]
<b>JNP Harbour Area</b>		
1.	W1	30
2.	W2	25
3.	W3	30
4.	W4	30
5.	W5	25
6.	W6	20
7.	W7	15
8.	W9	30
9.	W10	25
<b>JNP Nhava Creek Area</b>		
10.	W11	15
11.	W12	15
12.	W13	10
13.	W14	10



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

Sr. No.	Towing between Stations	Zoo-plankton, [No/m³]	Percent Composition of Zooplankton Groups			
			Copepoda	Cladocera	Foraminifera	Rotifera
JNP Harbour Area						
1.	W1-W2	315	60	20	10	10
2.	W2-W5	375	50	20	10	20
3.	W5-W1	356	45	25	25	5
4.	W5-W6	425	40	20	20	20
5.	W6-W2	350	55	25	20	-
6.	W4-W3	315	45	20	5	30
7.	W3-W7	380	55	25	-	20
8.	W7-W10	430	60	20	10	10
9.	W10-W3	355	50	25	15	10
10.	W9-W3	400	50	20	10	20
JNP Nhava Creek						
11.	W5-W11	250	50	20	20	10
12.	W11-W12	390	65	25	10	-
13.	W12-W13	350	50	20	10	20
14.	W13-W14	420	45	25	20	10

**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>Rotalia</i> sp.
2.	-	<i>Brachionus</i> sp.	<i>Moina</i> sp.	-

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

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	3.5	2.5	0.5	BDL	233
2.	W2	3.9	2.6	BDL	BDL	260
3.	W3	4.1	2.4	BDL	BDL	273
4.	W4	2.5	1.5	BDL	BDL	166
5.	W5	2.7	1.6	BDL	BDL	180
6.	W6	4.3	2.8	BDL	BDL	286
7.	W7	3.8	2.5	BDL	BDL	253
8.	W9	2.9	1.4	BDL	BDL	193
9.	W10	2.0	1.6	BDL	BDL	133
Nhava Creek Area						
10.	W11	2.5	1.8	BDL	BDL	166
11.	W12	3.5	2.3	BDL	BDL	233
12.	W13	2.6	1.5	BDL	BDL	173
13.	W14	2.5	1.2	BDL	BDL	166

**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	510
2.	W2	677
3.	W3	642
4.	W4	976
5.	W5	879
6.	W6	756
7.	W7	659
8.	W8	466
9.	W9	703
<b>Nhava Creek Area</b>		
10.	W11	818
11.	W12	906
12.	W13	923
13.	W14	853

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

Sr. No.	Station	Macrobenthos [No/m²]	Percent Composition of Macrobenthos			
			Gastropods	Polychaeta	Foraminifera	Chironomidae
JNP Harbour Area						
1.	W3	225	50	20	30	-
2.	W4	175	40	30	30	-
3.	W6	190	45	25	20	10
4.	W7	150	50	30	20	-
JNP Nhava Creek Area						
5.	W13	105	40	30	20	10
6.	W14	210	50	20	30	-

Note: No sediment was found at W1, W2, W5, W9, W10, 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]	SO <sub>4</sub> <sup>2-</sup> , [mg/L]
Standard	-	-	-	-	0.1 - 90	1.0 - 500	<125	10 - 5000
JNP HARBOUR AREA								
W1	437	1419	158	10300	33	485	<10	1542
W2	595	1275	162	10400	139	410	<10	1520
W3	516	1516	184	10200	103	520	<10	1597
W4	476	1516	210	10600	68	510	<10	1541
W5	437	1516	194	10200	103	422	40	1558
W6	516	1467	185	10500	46	370	<10	1644
W7	635	1492	178	10600	48	545	36	1635
W8	516	1516	198	10700	67	495	<10	1595
W9	476	1612	190	10500	35	545	<10	1527
JNP NHAVA CREEK AREA								
W11	476	1588	186	10400	100	515	11	1555
W12	556	1492	188	10800	69	495	<10	1532
W13	595	1467	192	10500	46	460	<10	1548
W14	437	1443	197	10300	65	480	<10	1568

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	Sample not found								
W2	Sample not found								
W3	4594	193	311	5123	360	15	0.17	22	5688
W4	4673	289	305	4792	250	16	0.14	34	5681
W5	Sample not found								
W6	5306	289	304	5079	380	6	0.09	96	6845
W7	4118	337	298	5117	300	22	0.08	33	4762
W9	Sample not found								
W10	Sample not found								
JNP NHAVA CREEK AREA									
W11	Sample not found								
W12	Sample not found								
W13	4752	385	318	5300	240	8	0.09	85	4142
W14	5227	289	282	4634	250	11	0.11	56	6522

### 3.4 DISCUSSION

#### 3.4.1 Water Quality: Biotic

##### 3.4.1.a Primary Productivity

The highest estimated gross and net primary productivity was measured as 515 and 475 mgC/m<sup>3</sup>/d at station W2 [Table 20]. Compared with other coastal ecosystems, primary productivity of JNP Harbour area and Nhava creek was at a moderate level. The dredging activity near W7 location does not seem to be affecting the primary productivity.

##### 3.4.1.b Plankton

###### A] Phytoplankton:

**Count :** Phytoplankton counts, recorded at different sampling stations, are presented in Table 21. Total algal population varied between 290 and 515 algal cells/ml. Samples collected at stations W10(B) and W2(S) showed lowest and highest counts respectively. Bacillariophyceae dominated all samples followed by Chlorophyceae. The most common genera found were *Navicula*, *Oscillatoria*, *Fragillaria*, *Gyrosigma*, etc. The phytoplankton population comprised of fifteen genera with 3 major groups, namely Bacillariophyceae, Chlorophyceae and Cyanophyceae [Table 22]. At location W2, turbidity decreases might be cause of higher algal count. In periods when turbidity is low, algal numbers can increase due to deeper light penetration and by uptake of nutrients in the water.

As the dredging activities going on around W7, since it may not be affected on the plankton count. Planktonic organisms respond quickly to environmental changes. Thus, the counts are quickly affected during dredging; they recover in a short time after dredging because the effects of dredging in the pelagic environment, although intensive, are generally short-lived.

**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 Secchi Disk (Table 23). Transparency varied between 15-30 cm. In periods when turbidity is low, algal numbers can increase due to deeper light penetration and by uptake of nutrients in the water.

###### 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 250 and 430 N/m<sup>3</sup> at stations W5-W11 and W7-W10. Total six genera of zooplankton were recorded. Copepoda dominated all the samples [Table 25].

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

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 133 and 300 mg/m<sup>3</sup>. The minimum algal biomass was (133 mg/m<sup>3</sup>) found at W10 and maximum (300 mg/m<sup>3</sup>) was found at W2 station. The lowest and highest chlorophyll *a* levels from surface water sample varied from 2.0 mg/m<sup>3</sup> at station W10(S) to 4.5 mg/m<sup>3</sup> at W2(S). Pheophytin concentrations of many samples were below detectable limit [**Table 26**]. Based on values of Chlorophyll-*a*, these waters can be classified as mostly oligotrophic, that is of good 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 466 and 976 mg/m<sup>3</sup> with an average of 697 mg/m<sup>3</sup>. The minimum concentration of POC i.e. 466 mg/m<sup>3</sup> was found at W8 station and maximum concentration i.e. 976 mg/m<sup>3</sup> at W4 station. In Nhava creek the POC content was found to be from 818 - 923 mg/m<sup>3</sup> with an average of 875 mg/m<sup>3</sup>. The minimum concentration of POC i.e. 818 mg/m<sup>3</sup> was found at W11 station and maximum concentration i.e. 923 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 and Nhava Creek regions. This may be due to detritus material originated 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 Vagothan estuaries (west coast of India).

## 3.4.2 Sediment Quality: Biotic

### Benthos:

A total of four macrobenthic groups were obtained from the sediment samples. Gastropod are abundant. Among the Gastropods, the dominant species were *Litiopa* sp., *Littorina* sp., *Morula* sp. and *Oliva* sp. The highest count was 225 No/m<sup>2</sup> at station W3 while lowest (105 No/m<sup>2</sup>) was found at station W13. No sediment was found at stations W1, W2, W5, W9, W10, W11 and W12. Generally, distribution of macrobenthos was not homogenous among sampling station. Presence of comparatively less number of macrobenthos around sampling station W3 may be attributed to rocky bottom and abundance of predators in this region.

### 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 presented in **Table 29**. In harbor region the Phosphate was found to be 33µg/L – 139µg/L. The average concentration of Phosphate was found to be 71µg/L in JNP harbor region, the Phosphate values are within the prescribed standard range [0.1 – 90µg/L] except at W2, W3 and W5. Nitrate was found to be between 370µg/L – 545µg/L. The minimum value of Nitrate 370µg/L was found at W6 station and maximum value 545µg/L at W7 station. The average concentration of Nitrate was found to be 478µg/L. At locations W3, W4, W7 & W9 the Nitrate concentration was found to be above prescribed standard range [1.0 to 500 µg/L]. Silica is another important nutrient in seawater. The requirement of silica by diatoms is however, entirely limited to skeletal formation and has particular importance in coastal upwelling region where diatoms form a dominant part of phytoplankton. Silica in the form of silicate in JNP harbor water was found between 1520 – 1644 µg/L with an average of 1573µg/L. The minimum concentration of silica was found at W2 station of JNP harbor region and the maximum concentration of silica was found at W6 station. The values of silica were observed to be well within the prescribed limits. The Sulphate was found between 1919 – 3417 mg/L, the minimum value recorded at W1 station and maximum at W9 station. The average concentration of Sulphate was found to be 2899 mg/L.

In Nhava Creek, Phosphate was found between 46µg/L – 100µg/L with an average 70µg/L which is within the prescribed standard range [0.1-90µg/L] except at W11. The minimum value was recorded at W13 and maximum at W11 location. Nitrate was found to be 460 (at W13) – 515 µg/L (at W11) with an average 488 µg/L. The silica content in Nhava creek was found to be 1532 – 1568 µg/L with an average of 1551 µg/L. The minimum silica content was found at station W12 station and maximum was found at W14 station. The values of silica were observed to be well within the prescribed limits. Sulphate was found between 2887 – 3585 mg/L with an average of 3203 mg/L. The



minimum value for Sulphate was found at W14 station and maximum value at W11 station.

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 was found at seven out of nine locations. Phosphate was found between 250 – 380 mg/kg with an average of 323 mg/kg. The minimum value of 250mg/kg was found at W4 location while maximum value (380mg/kg) was found at W6. The Nitrate was found minimum value at W6 station i.e. 6 mg/kg and maximum value at W7 station i.e. 22mg/kg. The average concentration of Nitrate was found to be 15mg/kg. The Nitrite was found to be between 0.08 – 0.17 mg/kg with an average of 0.12 mg/kg. The minimum concentration of nitrite was found at W7 station and maximum value at W3 station. Silica in the form of silicate in JNP harbor sediments were found between 22 and 96 mg/kg with an average of 46mg/kg. The minimum concentration of silica was found at W3 station i.e. 22mg/kg and maximum value was found at W6 station i.e. 96mg/kg. The Sulphate was found between 4762 and 6845 mg/kg, with minimum value i.e. 4762 mg/kg at W7 station and maximum value i.e. 6845 mg/kg at W6 station. The average concentration of Sulphate was found to be 5744 mg/kg.

In Nhava Creek region the sediment found at three locations out of four. Phosphate levels were 240 and 250 mg/kg with an average of 245 mg/kg. Nitrate was found to be 8 and 11 mg/kg. The average concentration of Nitrate was found to be 10 mg/kg. The Nitrite was found to be 0.09 and 0.11 mg/kg. The average concentration of Nitrite was found to be 0.10 mg/kg. Silica in the form of silicate in JNP harbor sediments was found to be 56 to 85 mg/kg with an average of 71 mg/kg. The Sulphate was found to be 4142 and 6522mg/kg. The average concentration of Sulphate was found to be 5332mg/kg.

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

In harbor region water, the Calcium was found between 437 to 635mg/L with an average of 512 mg/L given in **Table 29**. The minimum value for Calcium i.e. 437mg/L was found at W1 & W5 location whereas the maximum value i.e. 635mg/L was found at W7 location. The Magnesium was found to be 1275 – 1612 mg/L, with minimum value i.e. 1275mg/L at W2 location whereas maximum value i.e. 1612 was found at W9 stations. The average concentration of Magnesium was found to be 1481 mg/L. The minimum concentration of Potassium 158 mg/L was found at W1 location and maximum concentration 210 mg/L at W4 location with an average of 184 mg/L. The Sodium was found between 10200 to 10700 mg/L with an average of 10444 mg/L. The minimum concentration of sodium i.e. 10200 mg/L was found at W3 & W5 stations and maximum value i.e. 10700 mg/L of at W8 station.

In Nhava Creek, Calcium concentration was found with an average 516 mg/L given in **Table 29**. The minimum value 437 mg/L was found at W14 and maximum 595 mg/L at W13 station. Magnesium concentration was found to be 1443 – 1588 mg/L with an

average of 1498 mg/L. The minimum value i.e. 1443 mg/L of Magnesium was found at W14 station and maximum value 1588 mg/L was found at W11 stations. The Potassium content in Nhava creek was found to be 186mg/L at W11 – 197 mg/L at W14 station with an average of 191 mg/L. Sodium minimum concentration was found to be 10300 mg/L at W14 and maximum of 10800 mg/L at W12. The average concentration of sodium was found to be 10500 mg/L.

In harbor region sediments, the Calcium was found to be 4118 to 5306 mg/Kg with an average of 4673 mg/Kg given in **Table 30**. The minimum Concentration of Calcium 4118 mg/kg was found at W7 station and maximum concentration 5306 mg/kg at W6 station. Magnesium was found to be 193 to 337 mg/Kg, with minimum value 193 mg/kg at W3 station and maximum 337 mg/kg was recorded at W7 station. The average concentration of Magnesium was found to be 277 mg/Kg. Potassium in JNP harbor sediment was found to be 298 to 311 mg/Kg with an average of 304 mg/Kg. The minimum concentration of Potassium 298 mg/kg was found at W7 station and maximum value 311 mg/kg at W3 station. Sodium was found to be 4792 to 5123 mg/Kg with an average of 5028 mg/Kg. The minimum concentration of sodium 4792 mg/kg was found at W4 station and maximum value 5123 mg/kg at W3 station.

In Nhava Creek sediments, Calcium was found to be 4752 mg/kg at W13 and 5227 mg/Kg at W14 locations, with an average 4990 mg/Kg given in **Table 30**. Average magnesium was found to be 337 mg/Kg. The minimum concentration of magnesium was found at W14 location i.e. 289 mg/kg, whereas maximum concentration was observed at W13 location with value 385 mg/kg. The minimum concentration of potassium 282 mg/kg was observed at W14 and maximum concentration 318 mg/kg was observed at W13 station. Average potassium content in Nhava creek was found to be 300 mg/Kg. The minimum sodium value 4635 mg/kg was found at W14 station and maximum value 5300 mg/kg at W13. The average concentration of sodium was found to be 4967mg/kg.

### 3.5 OBSERVATIONS AND CONCLUSIONS

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

- ✓ *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.
- ✓ *Construction of NSIGT Yard is underway to the North side of JNPT.*
- ✓ *Plying of Ferry Boats:* There were large numbers of ferry boats plying in the area from Gateway of India to Elephanta.

It is seen from the data, as reported in **Tables 20 to 29** and subsequently discussed in above paragraphs, the major parameters comply with recommended ranges of the ecological parameters for Arabian Sea during November, 2015 except parameters like Particulate Organic Carbon and Nitrate.

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 and Panvel creek confluence, resulting in direct impact on harbor water
- ❖ The creek is narrow at Northern end, where it is fed partially by River Ulhas. Along the east and west sides of the creek, many industrial units have come up. Thane and Panvel creek is the ultimate recipient of all the liquid discharges from these industries and mostly untreated sewage discharges. The discharges into the creek on its western side are dominated by Mumbai city sewerage and wastes from petrochemical, fertilizer and thermal plants at Chembur, besides the pharmaceutical and chemical complexes at Vikhroli, Bhandup and Mulund.
- ❖ The comparatively high values for POC might be the offshoot of detritus materials originating from Mangrove swamps due to tidal effects or enriched by detritus plankton & other organisms, coming from the creeks located on the Northern side of the Port.
- ❖ It may be mentioned that JN Port is not handling any dry bulk cargo containing Phosphate

Based on observations of the overall ecological parameters in JNP Harbour and Nhava Creek area, it can be inferred that the marine ecosystem is not affected due to port operational activities. The undesirable levels of POC 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. Accordingly certain mitigation measures, corresponding to parameters, are recommended in **Table 31**.

**Table 31:** Suggested mitigating measures for the Ecological parameters

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 215 – 475 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 2.0 – 4.5 mg/m <sup>3</sup>	Stations follow mostly Oligotrophic class of water	Does not require since the values fall under Oligotrophic class of water
3.	Phosphate	0.1- 90 µg/L	Harbour area – 71 µg/L; Creek area – 70 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 – 478 µg/L; Creek area – 488 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 authorities like BMC, TMC, Panvel Municipal Corporation etc.
5.	Nitrite	<125 µg/L	Harbour area – 38 µg/L & Creek area – <10µg/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 – 697 mg/m <sup>3</sup> ; Creek area – 875 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 authorities.
7.	Silicate (SiO <sub>2</sub> )	10-5000 µg/L	Harbour area – 1573 µg/L; Creek area – 1551 µg/L	Nucleic acid synthesis and skeletal formation of Diatoms.	Within Range

## 4. DRINKING WATER QUALITY MONITORING

### 4.1 INTRODUCTION

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

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

Sr. No.	Stations	Locations
<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 18 stations, 10 are in outside the port while 8 are inside the port. All samples were collected from the port area of JNP on 11<sup>th</sup> November, 2015.

The water samples are analyzed for various parameters, viz. Colour, Odour, pH, Turbidity, Total Dissolved Solids, Aluminium as Al, NH<sub>3</sub> - N, Barium as Ba, Boron, Calcium as Ca, Chloride as Cl<sup>-</sup>, Copper as Cu, Fluoride, Free Residual Chlorine, Iron as Fe, Magnesium as Mg, Manganese as Mn, Oil & grease, Nitrate as NO<sub>3</sub><sup>-</sup>, Phenolic compound, Selenium as Se, Silver as Ag, Sulphate as SO<sub>4</sub><sup>-2</sup>, Total Alkalinity as CaCO<sub>3</sub>, Total Hardness as CaCO<sub>3</sub>, 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 November, 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	-	6.93	7.66	7.10	7.09	7.61	7.37	6.5 to 8.5
Turbidity	NTU	<1	<1	<1	<1	<1	<1	1
Total Dissolved Solids	mg/L	148	150	89	94	98	94	500
Aluminium as Al	mg/L	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	0.03
NH <sub>3</sub> - 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	16	16	13	11	12	12	75
Chloride as Cl <sup>-</sup>	mg/L	14	13	11	13	13	12	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	<0.1	<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	5	1	4	5	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	<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	16	8	5	5	7	5	200
Total Alkalinity as CaCO <sub>3</sub>	mg/L	38	39	35	36	36	35	200
Total Hardness as CaCO <sub>3</sub>	mg/L	59	58	39	43	50	42	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	<2	<2	<2	4	<2	2	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 November, 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	-	7.30	7.71	7.34	7.13	7.05	7.35	6.5 to 8.5
Turbidity	NTU	<1	<1	<1	<1	<1	<1	1
Total Dissolved Solids	mg/L	128	93	98	97	142	92	500
Aluminium as Al	mg/L	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	0.03
NH <sub>3</sub> - 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	10	10	16	13	75
Chloride as Cl <sup>-</sup>	mg/L	9	8	9	9	12	10	250
Copper as Cu	mg/L	<0.02	<0.02	<0.02	<0.02	<0.02	<0.02	0.05
Fluoride	mg/L	0.2	<0.1	<0.1	<0.1	<0.1	0	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	3	4	4	4	2	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	0.8	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	6	6	5	5	5	6	200
Total Alkalinity as CaCO <sub>3</sub>	mg/L	38	32	36	36	35	35	200
Total Hardness as CaCO <sub>3</sub>	mg/L	43	41	42	43	56	41	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	<2	<2	<2	<2	<2	<2	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 November, 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	-	7.18	7.35	7.28	7.45	7.32	7.27	6.5 to 8.5
Turbidity	NTU	<1	<1	<1	<1	<1	<1	1
Total Dissolved Solids	mg/L	104	86	92	96	83	92	500
Aluminium as Al	mg/L	<0.03	<0.03	<0.03	<0.03	<0.03	<0.03	0.03
NH <sub>3</sub> - 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	10	11	10	10	10	75
Chloride as Cl <sup>-</sup>	mg/L	12	10	11	9	9	9	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	0.2	<0.1	<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	4	5	4	4	5	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	0.9	<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	5	5	6	6	6	5	200
Total Alkalinity as CaCO <sub>3</sub>	mg/L	38	35	36	35	36	38	200
Total Hardness as CaCO <sub>3</sub>	mg/L	43	47	45	43	45	39	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	<2	<2	<2	<2	<2	<2	Nil
E coli	-	Absent	Absent	Absent	Absent	Absent	Absent	Absent

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



### 4.3 DISCUSSION

**Table 33** provides the observed results for various parameters analyzed for drinking water samples collected from eighteen stations in and around the port's activity during the monitoring period of November, 2015 are compared with acceptable limits as prescribed in **IS 10500:2012** – Drinking Water Specification. It is seen from the analysis data that during the study period the water was safe for human consumption at all drinking water monitoring stations in and around the port.

The colour of all drinking water samples was < 5 Hazen unit and odour of the samples was also agreeable. The values of turbidity, Iron as Fe and Ammonia as  $\text{NH}_3\text{-N}$  were observed to be below detection limits of measurement i.e. <0.1 NT, <0.03 mg/L and <0.1 mg/L respectively. Apparently these parameters are not at alarming levels.

Values observed for TDS for all the samples were in the range of 83 to 150 mg/L which are well below the acceptable standard limits (500 mg/L). pH values of all the samples were in the range of 6.93 to 7.71 which is within the permissible standard 6.5 to 8.5. Total Hardness as  $\text{CaCO}_3$  values of all the eighteen samples were found to be in the range of 39 to 59 mg/L and found to be within the acceptable limit (200 mg/L).

Concentration levels observed for Chlorides as  $\text{Cl}^-$  and Sulphate as  $\text{SO}_4^{2-}$  were in the range of 8.0 to 13.5 mg/L, 5.0 to 16.0 mg/L respectively. The observed values for these parameters are well within the acceptable standard limits.

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

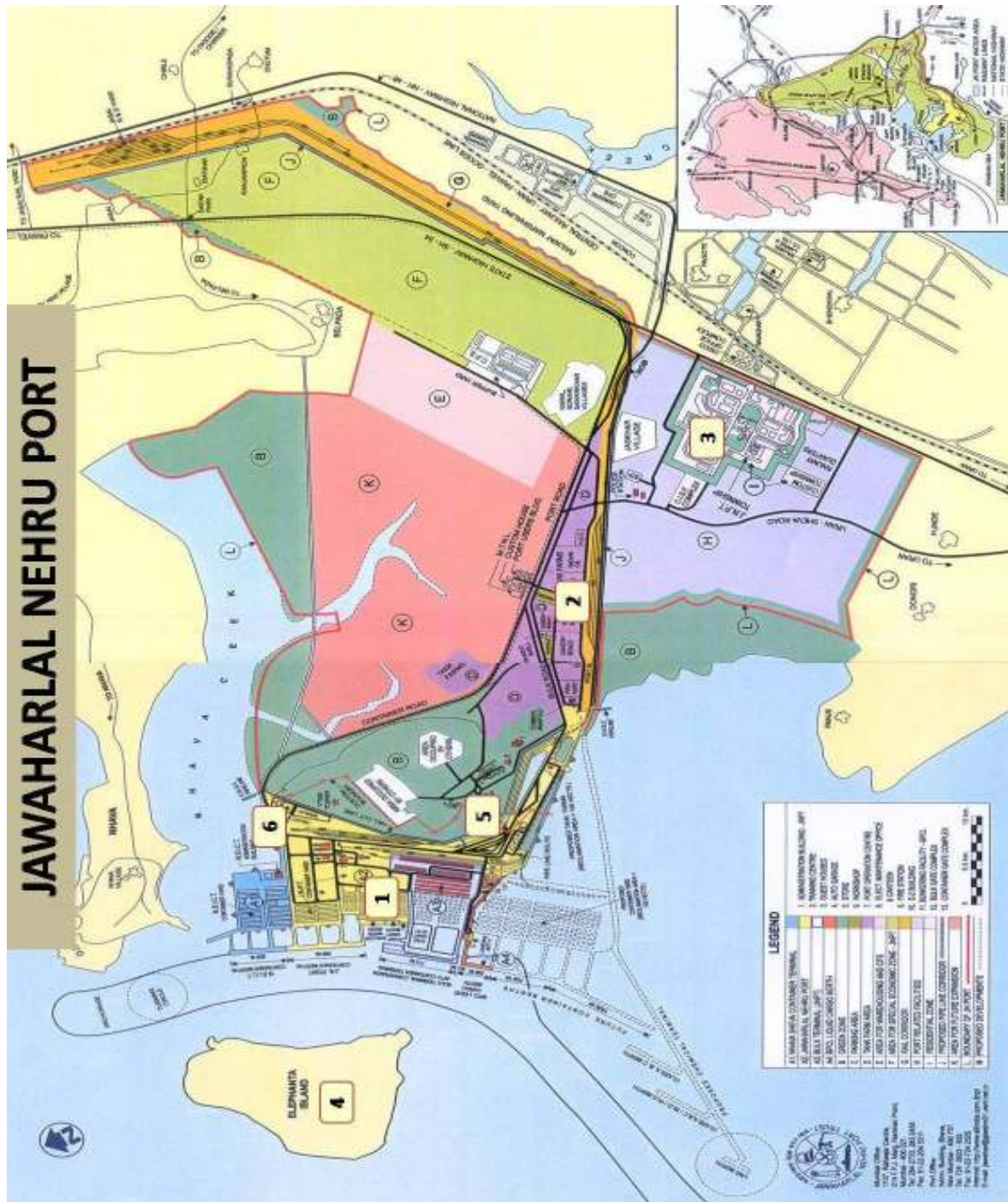
### 4.4 CONCLUSIONS AND MITIGATION MEASURES:

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

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

## 5. ANNEXURES

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



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

Sr. No.	Pollutant	Time Weighted Average	Concentration in Ambient Air		
			Industrial, Residential, Rural and Other Area	Ecologically Sensitive Area (notified by Central Government)	Methods of Measurement
1.	Sulphur Dioxide (SO <sub>2</sub> ), µg/m <sup>3</sup>	Annual*	50	20	-Improved West and Geake
		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 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

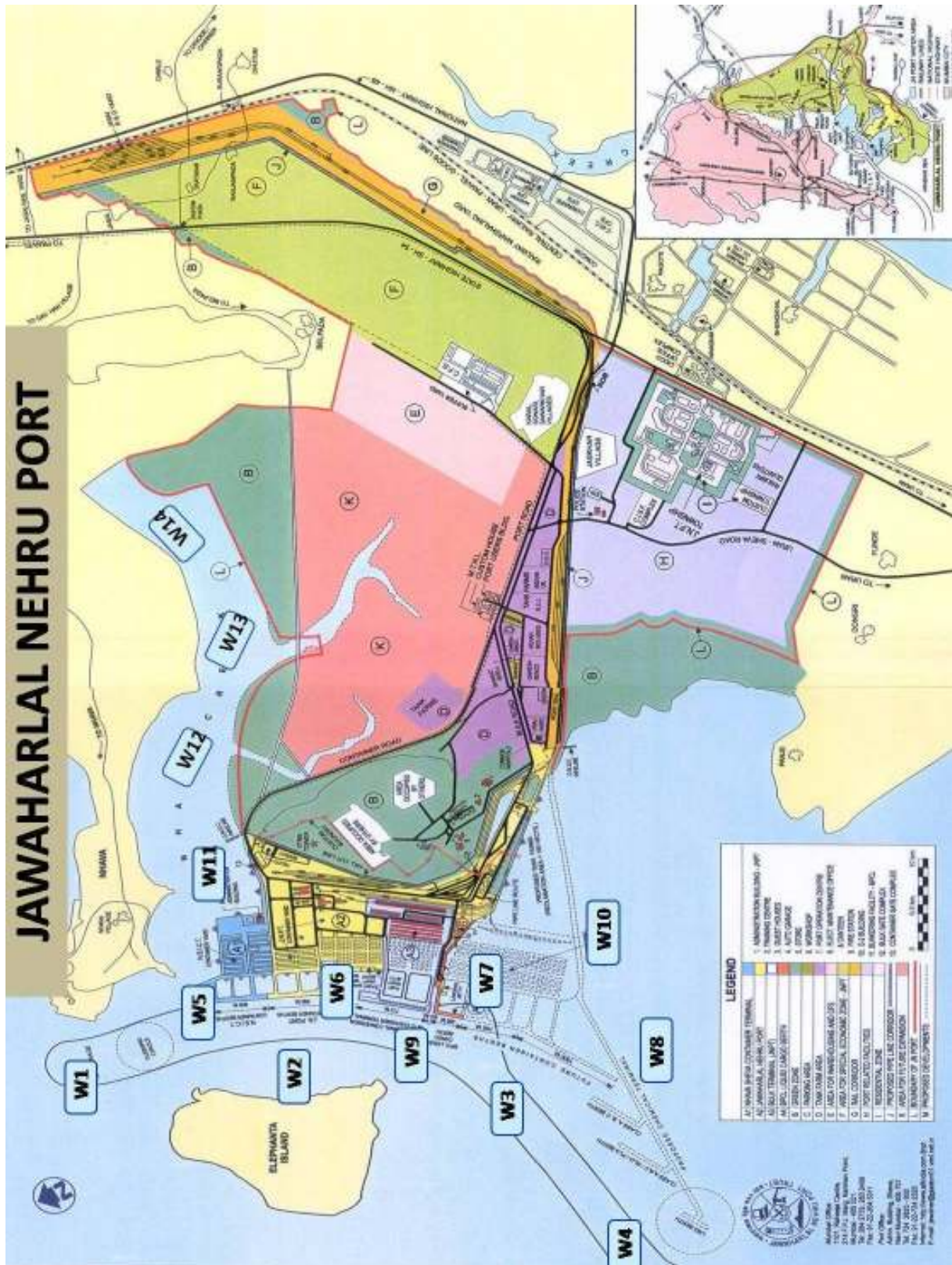
\*\* 24 hourly or 08 hourly or 01 hourly monitored values, as applicable, shall be compiled with 98% of the time in a year.

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.

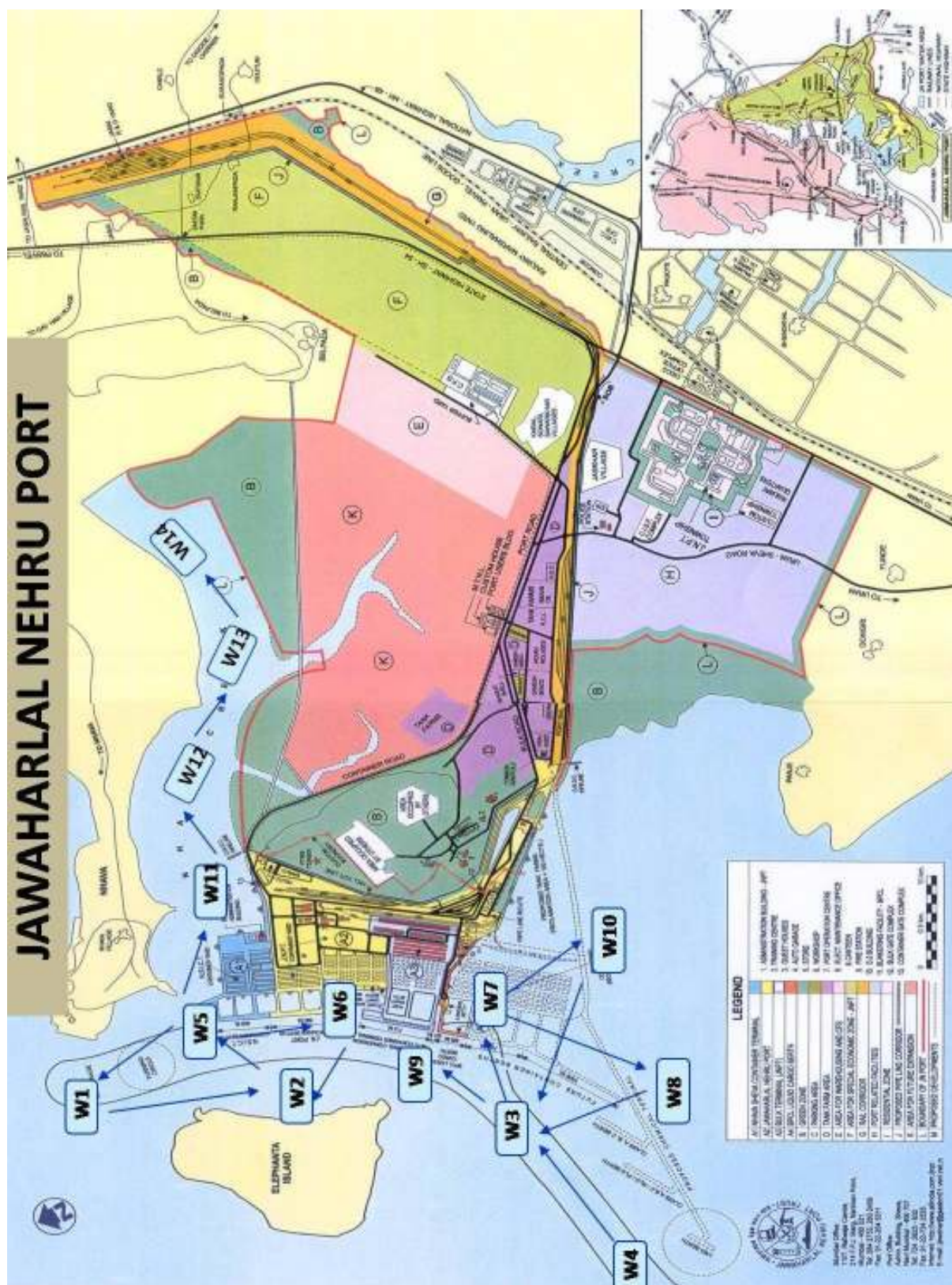


**Annexure-III: Location map for Marine Water Monitoring Stations**





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



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

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

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

Sr. No.	Parameter	Criteria	Rationale/Remarks
1.	Net primary productivity	<1500 mgC/m <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.