CHAPTER 3
BASELINE ENVIRONMENT

3.1 SCOPE OF WORK

This section of the report gives description of the existing Environmental conditions within the project area, which constitutes the baseline for the study. Natural conditions are often critical when designing and constructing infrastructure works The assessment of baseline studies of the appropriate environmental parameters, which may be affected by the project implementation, is a pre-requisite for any Environmental Impact Assessment (EIA) study The purpose of describing the environmental settings in the study area is:

- To assess the existing environmental quality, as well as study the environmental impacts due to the proposed project
- To identify environmentally significant factors or geographical areas that could prelude any future development.

In order to investigate likely impacts due to commissioning of proposed project, the consultants, **M/s Fine Envirotech Engineers** carried out estimation of impacts based on data generated, secondary data as well as literature studies.

3.2 METHODOLOGY OF CONDUCTING STUDIES

M/s NETEL (India) Ltd., MoEF approved laboratory were engaged to carry out environmental monitoring and analysis. The monitoring surveys of the study area (project area) were carried out for one season i.e. from 4th September 2016 to 4th December 2016. Environmental monitoring data of J N port form Jan 2015 to September 2015 was collected and summarized for consideration. Field monitoring for meteorological conditions, ambient air quality, water quality, noise quality, etc. was carried out, which constitutes major portion of the baseline environmental studies

The impact due to the setting of incineration plant on existing baseline of environmental parameter will be restricted and of temporary in nature these are further controlled and minimized by adopting various mitigative measures. Even during operational phase the impact on environmental settings will be negligible and will be controlled by adopting proper environment management plan (EMP) These aspects have been studied with reference to the proposed project and baseline data has been presented in this chapter. These details have been given in the following sections.

EIA is often mandatory requirement for planning of infrastructure structures. The EIA determines the environmental consequences of the project prior to construction, assessment of environmental impact due to construction, its impact on existing baseline environmental parameters and also importantly on land use and socio-economic parameters. The entire data has been collected through actual physical surveys and observations, literature surveys, interaction with locals, government agencies and departments. This chapter describes the baseline environment settings in the area and will throw light, its effect on day-to-day environment.

3.3 BASELINE ENVIRONMENTAL STATUS

In order to assess the existing environmental status in the project area, primary and secondary data on various environmental attributes viz. air quality, noise levels, water quality, soil, ecology, land use etc. have been collected and presented in the following paragraphs.
The entire project area is divided in to various environmental segments in order to establish baseline environmental study.

The various parameters studied during environmental survey at above locations are indicated in the following **Table 3.1**

TABLE 3.1: ENVIRONMENTAL SETTINGS

Sr. No	**Parameters**	
1.	Air	PM_{10}, $PM_{2.5}$, SO_X, NO_X, CO etc
2.	Water(Marine)	Salinity, Temp, pH, BOD, COD, DO, etc.
3.	Noise	Noise levels
4.	Socio-economy	Socio-economy status, population, literacy etc.

The secondary data was collected by visits to MET department and through literature surveys The topography and meteorological conditions for the district has been discussed as whole while the environmental setting for air, water, noise and biodiversity studies were carried out for each part.

3.3.1 Location

JNP is located in the Mumbai estuary on the west coast of India at 18^o 56.43' N latitude and 72^o 56.24' E longitude in Sheva, Navi Mumbai, Maharashtra The location of JNP is shown in **Drawing I-514/JNPT/101.**

3.4 Meteorology

The data below is from the secondary sources.

3.4.1 Topography

The entire area near the site is almost barren with little vegetation along the slope. Land use classification of the project area and its surroundings was undertaken using digital satellite data of IRS IC, LISS III sensor The satellite data was procured from National Remote Sensing Agency (NRSA), Hyderabad and was processed at WAPCOS using image processing software. Ground truth verification studies were conducted in the month of April/May 2003, and the digital satellite data was processed for the land use classification.

3.4.2 Geology

The region is seaward part of the geology of the Deccan traps that formed by the eruptions to rapidly cover a large part of the Indian Peninsula (at present extends over 500,000 sq. kms.) the volcanic eruptions around the Mumbai area occurred in shallow lagoon conditions and thus most of the lava flows. Due to sub-aqueous eruptions of the lava, the basalt was converted to spilite, as a result of the metasomatic changes. Some of the lava flows developed pillow structure and some became brecciated to form volcanic breccia. Such sub-aqueous volcanic breccia may be described as Hyaloclastic There were intermediate and acid rocks formed as trachyte intrusive and rhyolie flows.

At the project site the soil profile was composed of gravely silty clay (murrum), sand, marine clay and boulders lying on the highly weathered tuff and berrica layers of intertrappean shale The rock type encountered out there is spilite with upper theolitic basalt The rock type encountered in the adjacent harbour area is hyaloclasite The area lies is seismic zone III.

3.5 METEOROLOGICAL CONDITIONS

The historical data collected from India Meteorological Department (IMD) and other secondary sources to represent the metrological conditions of the project area has been reviewed and presented below for various attributes such as Temperature, Wind, Cloud cover, Humidity, Rainfall, Cyclone, and Visibility The nearest IMD observatory to JNP is Mumbai, which is located at $18^{o}54'$ N latitude and 72^{o} 49' E longitude and details of the same are presented below.

3.5.1 Climate

The region experiences a tropical monsoon climate and has four distinct seasons as follows:

- Southwest monsoon season (June to September) - Main rainy season with very high humidity, low clouds and several spells of moderate to heavy rains.

- Post-monsoon season (October to November) - Frequency of severe cyclonic storms is the highest during this season.
- Winter season (December to February) - Fine weather and occasional morning mist or fog.
- Summer season (March to May) - A rise in air temperature with incidence of thunderstorms and cyclonic storms during the later part of the season.

3.5.2 Temperature

India Meteorological Department (IMD) records indicate that the area experiences tropical coastal climate The moderating effects of the nearby sea and the fairly high amount of relative humidity in the atmosphere have restricted the variability The seasonal variations of temperature follow closely the course of the sun. January is invariably the coldest month and May the warmest. With the onset of monsoon in early June there is a reversal of the temperature curve and the temperature during the period of monsoon remains very nearly uniform at about 27^0C The slight rise in temperature in October falls gradually till it reaches the coldest month in January.

The temperatures vary from 11.7^0C to 40.6^oC The mean daily maximum and minimum air temperatures along with the extremes for each month are as follows:

TABLE 3.2 MONTHLY MAXIMUM AND MINIMUM RECORDED TEMPERATURES

Month	**Recorded Temperature (^{o}C)**			
	Mean Daily Maximum	Mean Daily Minimum	Highest Maximum	Lowest Minimum
January	29.1	19.4	35.6	11.7
February	29.5	20.3	38.3	11.7
March	31.0	22.7	39.7	16.7
April	32.3	25.1	40.6	20.0
May	33.3	26.9	36.2	22.8
June	31.9	26.3	37.2	21.1
July	29.8	25.1	35.6	21.7
August	29.5	24.8	32.4	21.7
September	30.1	24.7	35.0	20.0
October	31.9	24.6	36.6	20.6
November	32.3	22.8	36.2	17.8
December	30.9	20.8	35.7	12.8

3.5.3 Wind

3.5.3.1 Offshore Wind

Latitude 15^o N to 20^o N and longitude 70^o E to 75^o E

Offshore wind data has been compiled by the IMD, based on ship observations in the area enclosed by ***Latitude 15^o N to 20^o N and longitude 70^o E to 75^o E*** for the period 1986 to 2001 The yearly wind rose diagram based on these observations is presented in figure below.

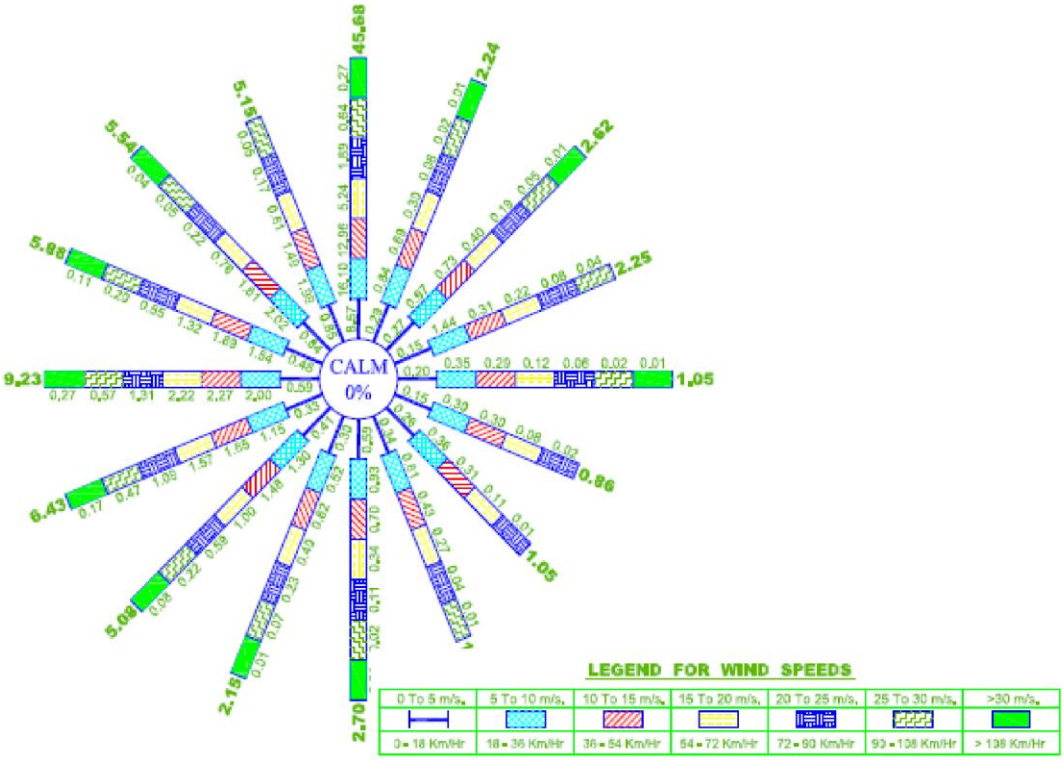


FIG. 3.1 WIND ROSE DATA OFFSHORE OF JNP FOR THE PERIOD 1986 TO 2001

From the above figure, it can be seen that the wind blows from the SW to N sector for 83% of the time and the predominant wind direction is north (45.7%) The wind speed is less than 15 m/s (54 km/hr) for 75% of the time and 20 m/s (72 km/hr) for 90% of the time The % of occurrence of wind speeds is as follows:

- 0 to 18 kmph - 14.6 %
- 18 to 36 kmph - 32.4 %
- 36 to 54 kmph - 27.5%
- 54 to 72 kmph - 15.0%
- 72 to 90 kmph - 7.0%
- 90 to 108 kmph - 3.5%

Latitude 18^o N to 19^o N and longitude 72.4^o E to 72.5 E

IMD have also made wind observations nearer to JNP and covering the location of the navigational channel in the area enclosed by ***Latitude 18^{o} N to 19^{o} N and longitude 72.4^{o} E to 72.5 E*** The observed data indicates that the wind blows from the sector SW to North for 92% of the time and the wind speed is less than 15 m/s (54 km/hr) for 87% of the time and 20 m/s (72 km/hr) for 95% of the time The wind occurs from SW to W for 37% of the time and W to N for 55% of the time The % of occurrence of wind speeds is as follows:

- 0 to 18 kmph - 48.6 %
- 18 to 36 kmph - 27.8 %
- 36 to 54 kmph - 11.1%
- 54 to 72 kmph - 7.0 %
- 72 to 90 kmph - 2.75%
- 90 to 108 kmph - 2.75%

The wind rose diagram offshore of JNP for various seasons is shown in **Drawing No. I-514/JNPT/102 (Annexure VI).**

3.5.3.2 Onshore Wind

Onshore wind data is based on observations at the meteorological station of the IMD located at Colaba, Mumbai The nearshore wind direction is as follows:

TABLE 3.3 ONSHORE WIND DIRECTION

Season	**Wind Direction**
SW monsoon (June-September)	WSW to NW. West in July and August
Post-monsoon (October-November)	NW to NE
Winter season (December – February)	ENE to NNW
Summer season (March to May)	NW to North

An analysis of the data for prevailing winds shows that the percentage of occurrence of various wind speed is as follows:

TABLE 3.4 ONSHORE WIND SPEEDS AND % OF OCCURRENCE

Speed (km/hr)	**% of Occurrence**
6	18.0 **%**
8	29.5 **%**
10	16.0 **%**
12	22.0 **%**
14	12.0 **%**

16	2.5 **%**

Prevailing wind speeds are higher in the afternoons than in the mornings. During short periods in a day, the wind speed exceeds prevailing wind speed The maximum wind speeds for various directions is presented in table below.

TABLE 3.5 MAXIMUM WIND SPEEDS AND DIRECTIONS FOR VARIOUS MONTHS (KMPH)

Month	**Direction**															
	N	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW
January	17	-	-	-	-	10	12	16	-	-	10	14	10	14	28	32
February	22	-	-	-	20	8	-	-	-	-	-	10	17	13	34	29
March	-	-	-	-	-	-	-	-	-	-	12	10	13	33	21	30
April	19	-	-	-	-	-	-	-	-	-	7	13	15	24	24	34
May	16	-	-	-	-	-	12	12	9	-	11	22	16	28	38	10
June	8	-	-	-	-	-	48	48	32	-	36	16	30	41	30	20
July	15	-	-	-	-	11	32	32	12	13	35	30	35	25	23	-
August	-	-	-	-	-	-	15	15	10	9	14	36	36	44	30	17
September	22	12	11	-	16	12	18	18	10	-	20	32	36	44	54	24
October	13	-	13	22	16	27	30	30	12	-	11	-	8	20	19	24
November	19	9	30	24	30	20	-	-	5	20	20	8	18	32	30	22
December	12	-	28	18	34	10	-	-	-	-	-	8	11	16	26	18

Maximum wind occurs from NW during September and the recorded speed is about 54 km/hr.

3.5.4 Humidity

The humidity is moderate to high throughout the year with the mornings being more humid than evenings The mean relative humidity for each month in a year measured during mornings and evenings is as tabulated below:

TABLE 3.6 MEAN MONTHLY RELATIVE HUMIDITY

Month	**Mean Relative Humidity (%)**	
	Morning (0830 hrs)	**Evening (1730 hrs)**
January	71	63
February	72	62
March	72	63
April	73	66

May	73	68
June	80	78
July	85	85
August	85	84
September	85	80
October	80	74
November	73	67
December	70	64

The mean relative humidity during the non-monsoon season varies from 70-73% in the morning and 62-68% in the evening. With the onset of the southwest monsoon, there is a marked increase in the humidity which remains around 80-85% till October The humidity is less during December to February which is about 70% in the morning and 62% in the evening.

3.5.5 Cloud Cover

The average number of days in each month with clear and overcast skies, the mean cloud amount and the mean number of hours of bright sunshine per day for each month of the year are as follows:

TABLE 3.7 MONTHLY AVERAGE CLOUD COVER

Month	Average Cloudiness		Mean cloud cover (Okta)	Mean No. of hrs of bright sunshine per day
	Clear days	Overcast days		
January	15	0	1.2	9.2
February	16	0	0.9	9.6
March	17	0	1.1	9.3
April	10	0	1.7	9.4
May	3	1	3	9.3
June	0	10	5.6	5.6
July	0	18	7.2	2.3
August	0	15	6.8	2.7
September	0	8	5.6	4.9
October	5	2	3	8.2
November	9	1	2	9.1
December	12	1	1.4	9.1

The skies are clear and lightly clouded from December to March with a gradual increase in cloudiness thereafter till May. With the arrival of the southwest monsoon in June, there is a sharp

increase in cloudiness and skies are overcast for 12 days in a month on an average. This condition continues till September.

3.5.6 Rainfall

Monsoon generally sets in around the second week of June and continues till late September. July and August are the wettest months all over the region. There is hardly a day without rain, in these two months. Towards the later part of the season, there are breaks in between, when the oppressive hot weather is associated with high humidity along the coast. The average annual rainfall in the region is about 1800 mm. The month-wise distribution of the average rainfall recorded for each month in a year is as follows:

TABLE 3.8 MONTHLY AVERAGE RAINFALL INTENSITY

Month	Average Rainfall (mm)	Average No. of Rainy Days	Heaviest rainfall recorded in 24 hours (mm)
January	4.1	0.3	49.3
February	2.0	0.1	41.7
March	1.5	0.1	34.3
April	1.5	0.1	37.3
May	18.3	0.8	126.2
June	464.8	14.2	408.2
July	613.4	22.2	304.8
August	328.9	18.2	287.0
September	286.0	12.6	548.1
October	64.5	3.0	148.6
November	17.5	0.8	122.7
December	2.3	0.3	24.4
Total	1804.8	**72.7**	-

The rainfall during southwest monsoon season accounts for about 94% of the annual rainfall The onset of the southwest monsoon is generally around 1 week of June. On an average, there are 73 rainy days in a year, out of which about 67 days occur during the southwest monsoon season. Maximum rainfall occurs in the month of July (613.4 mm) and the number rainy days are about 22.

3.5.7 Visibility

The visibility in the project area is generally good throughout the year, except for a few days during the winter season and during periods of heavy rain. On an average, the visibility is less than 4 km for about 18 days in a year.

Sea-level Atmospheric Pressure

The sea-level atmospheric pressure ranges from 1001 Mb to 1013 Mb. The monthly variations in sea-level atmospheric pressure during mornings as well as evenings are as follows:

TABLE 3.9 MONTHLY AVERAGE SEA-LEVEL ATMOSPHERIC PRESSURE

Month	Sea-Level Atmospheric Pressure (In Millibars)	
	Morning (0830 hrs)	Evening (1730 hrs)
January	1013.2	1010.4
February	1012.2	1009.4
March	1010.7	1007.6
April	1009.1	1005.8
May	1006.9	1004.0
June	1003.6	1001.4
July	1003.1	1001.6
August	1004.7	1002.9
September	1007.2	1004.8
October	1009.7	1006.7
November	1011.7	1008.9
December	1013.2	1010.3

Depressions and Cyclonic Storms

India Meteorological Department has classified the storm systems as follows:

- Depressions : Winds from 18-33 knots (33-61 kmph)
- Cyclonic storms : Winds from 34-47 knots (62-87 kmph)
- Severe cyclonic storms : Winds above 48 knots (88 kmph)

Based on the records of IMD from 1891 to 1994 (104 years), it is observed that a number of storms have crossed close enough to the study area affecting the area with strong winds, heavy rains and also moderate to high sea wave conditions.

There have been 47 such storms during this period with 32 depressions, 6 cyclonic storms and 9 severe cyclonic storms. Season-wise distribution of cyclonic storms is as follows:

TABLE 3.10 SEASON-WISE DISTRIBUTION OF CYCLONIC STORMS

Season	Months of Occurrence	No. of Cyclones	Cyclonic system
Pre-monsoon	April & May	6	3 depressions

			and 3 severe cyclonicstorms
SW monsoon	June & September	18	13 depressions, 2 cyclonic storms and 3 severe cyclonic storms
Post-monsoon	October & November	23	16 depressions, 3 cyclonic storms and 4 severe cyclonic storms

Wind speeds usually reach speeds of 30 - 40 knots (55-75 kmph) and during severe storms wind speeds reach upto 60 knots (110 kmph).

3.6 Oceanographic Information

3.6.1 Waves

The wave climate in the region has been established based on the studies carried out by the CWPRS The findings of these studies are summarised hereunder The complete reports are available for reference with JNPT.

3.6.1.1 Offshore Wave Climate

The offshore wave climate for normal wave conditions has been determined based on analysis of IMD's ship observed wave data (1968 to 2000) in the area enclosed between Lat. 15^{o}N to 20^{o} N and Long 70^{o} E to 75^{o} E The IMD data was analysed to arrive at the percentage of wave heights from different directions and the wave rose based on this analysis is shown in figure below.

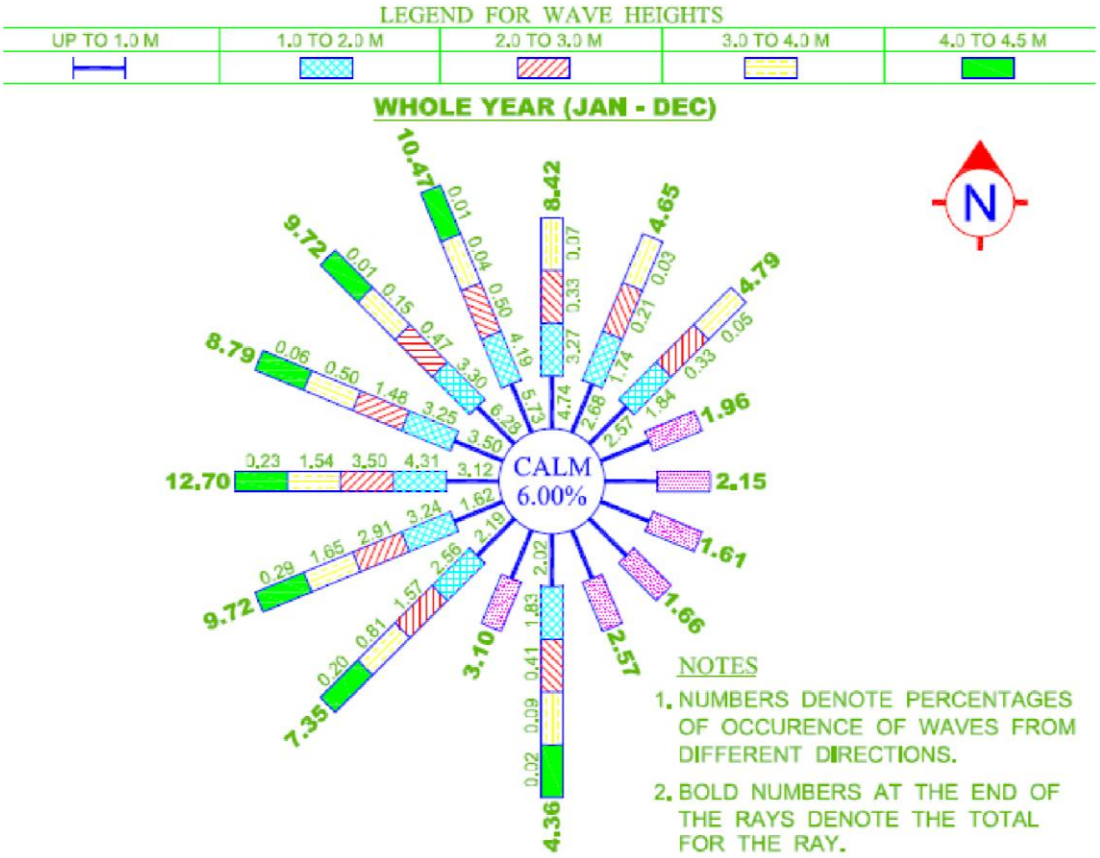


FIG. 3.2 WAVE ROSE DATA OFFSHORE OF JNP FOR THE PERIOD 1968 TO 2000

The directions of predominant waves in the deep sea are from SW (32.87% of the time) and NW (37.4% of the time) The % of occurrence of wave heights in a year is as follows:

- 0 to 1 m - 53.5 %
- 1 to 2 m - 29.5 %
- 2 to 3 m - 11.7%
- 3 to 4 m - 4.5%
- 4 to 4.5 m - 0.8%

The wave height is less than 2 m for 83% of the time and the predominant wave period is 10 seconds The wave rose diagram offshore of JNP for various seasons is shown in **Drawing I-514/JNPT/103 (Annexure VII).**

3.6.1.2 Nearshore Wave Climate

The nearshore zone is taken east of the 20 m contour, which is aligned roughly in the N-S direction at Long. 72^{o} 39'E.

Normal Wave Conditions

Wave rose diagram of the near shore climate is as follows:

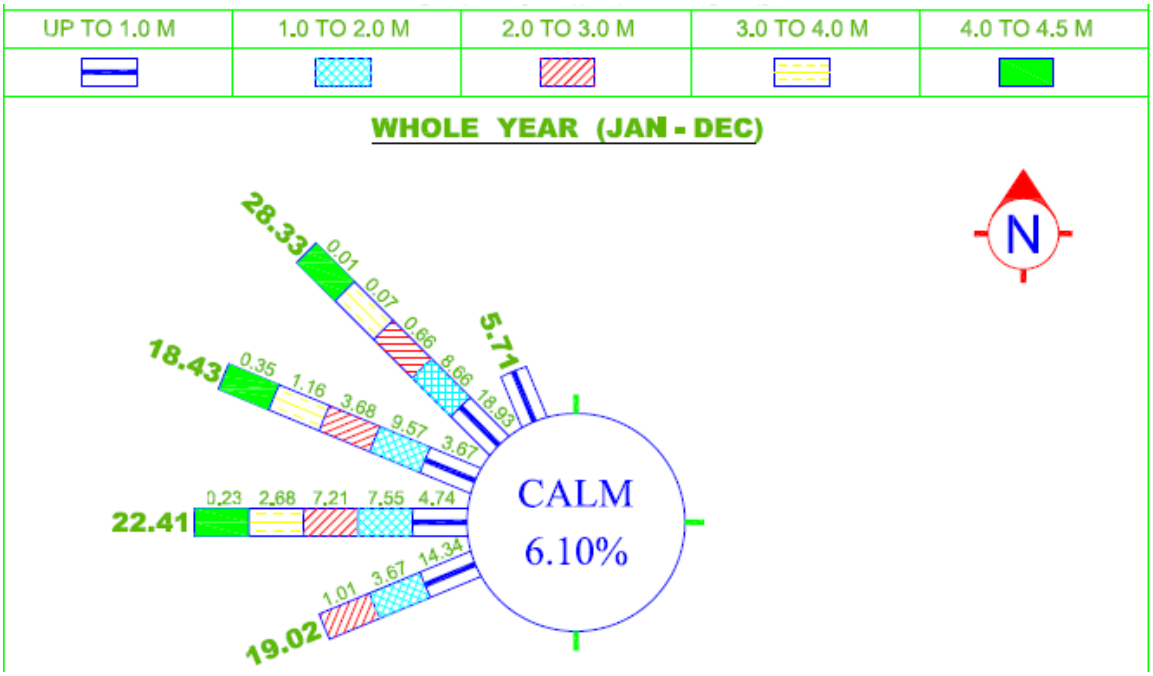


FIG. 3.3 WAVE ROSE DIAGRAM OF THE NEARSHORE CLIMATE

The predominant directions of normal waves in the nearshore zone are from the WSW, W, WNW, NW The wave rose diagram nearshore of JNP for various seasons is shown in **Drawing I-514/JNPT/104 (Annexure VIII) The** % of occurrence of wave heights in a year is as follows:

- 0 to 1 m - 53.5 %
- 1 to 2 m - 29.5 %
- 2 to 3 m - 12.5%
- 3 to 4 m - 3.9%
- 4 to 4.5 m - 0.6%

Extreme Wave Conditions

The extreme waves are from the WSW direction and extreme nearshore wave conditions are as follows:

TABLE 3.11 EXTREME NEARSHORE WAVE CONDITIONS

Return Period (Years_	**Significant Wave Height**	Average Zero Crossing Period 'Tz'

	'Hs' (m)	(seconds)
5	4.3	9.0
10	4.4	9.0
25	4.5	11.0
50	5.1	12.0
100	5.4	12.5

Wave Conditions inside the Navigational Channel

CWPRS have carried out model studies to determine the significant wave height in different sections (S1 through S12) along the approach channel by using the nearshore wave data (20 m contour), both normal and extreme conditions, as input The various sections of the approach channel are as shown in **Drawing I514/JNPT/105.** Location S1 corresponds to the 16m contour.

The nearshore normal wave conditions used as input in the model studies are as follows:

TABLE 3.12 INPUT NEARSHORE NORMAL WAVE CONDITIONS

Wave Direction (^{o}N)	**Wave Height (m)**
247.5º (WSW)	3.0
270.0º(W)	4.0
292.5º(WNW)	3.0

The average wave period of high waves ranged between 8 to 14 seconds The extreme conditions given in **Extreme Nearshore Wave Conditions** are used as input in the model studies. Based on this data, the significant wave heights at various locations along the approach channel for various incident normal wave directions, with and without wind effect are tabulated in tables below.

TABLE 3.13 SIGNIFICANT WAVE HEIGHTS INSIDE THE APPROACH CHANNEL FOR NORMAL WAVE CONDITIONS

Location inside the channel	**Significant Wave Height (m)**					
	WNW		**W**		**WSW**	
	Without Wind	**With 20 m/s Wind from WSW**	**Without Wind**	**With 20 m/s Wind from WSW**	**Without Wind**	**With 20 m/s Wind from WSW**
S1	3.0	3.0	4.1	4.0	3.0	3.0
S2	2.5	2.6	3.6	3.7	2.8	2.8
S3	2.2	2.3	3.1	3.4	2.5	2.6

S4	2.0	2.1	2.9	3.2	2.4	2.5
S5	1.3	1.4	1.6	1.9	1.5	1.6
S6	1.4	1.7	1.2	1.7	1.4	1.7
S7	0.4	1.0	0.3	1.0	0.3	0.9
S8	0.2	1.0	0.2	1.0	0.2	1.0
S9	0.2	1.1	0.2	1.0	0.2	1.0
S10	0.2	0.8	0.2	0.8	0.2	0.8
S11	0.2	0.6	0.2	0.6	0.2	0.6
S12	0.2	0.5	0.2	0.5	0.2	0.5

TABLE 3.14 SIGNIFICANT WAVE HEIGHTS INSIDE THE APPROACH CHANNEL FOR EXTREME WAVE CONDITIONS

Location inside the channel	**Significant Wave Height along the Channel for WSW waves (Metres)**				
	Return Period (Years)				
	5	10	25	50	100
S1	4.3	4.4	4.5	5.1	5.4
S2	4.3	4.4	4.5	5.1	5.4
S3	4.3	4.4	4.5	4.8	5.4
S4	4.1	4.1	4.2	4.4	5.0
S5	2.4	2.4	2.3	2.6	2.6
S6	1.5	1.5	1.5	1.5	1.5
S7	1.0	1.0	1.0	1.0	1.0
S8	1.0	1.0	1.0	1.0	1.0
S9	0.9	0.9	0.9	1.0	0.9
S10	0.8	0.8	0.8	0.8	0.8
S11	0.6	0.6	0.6	0.6	0.6
S12	0.6	0.6	0.6	0.6	0.6

3.6.2 Currents

The currents in the navigational channel are predominantly tidal currents with their directions aligned with the channel, except when the flow pattern is altered by runoffs from rivers and Creeks during the southwest monsoon period.

In February 2000, CWPRS have measured current velocities and directions at 4 locations in JNP harbour (marked P1, P2, P3 and P4 in **Drawing I-514/JNPT/105**).

The results of the measurements are presented in table below.

Table 3.15 Current Velocity and Direction in JNP Harbour

Location	Current Velocity (Knots) and Directions (wrt N)			
	Sprint Tide		Neap Tide	
	Flood	Ebb	Flood	Ebb
P1	2.31 (70^{o})	1.30 (254 ^{o})	0.99(68 ^{o})	0.76 (241 ^{o})
P2	1.59 (28 ^{o})	0.76 (213 ^{o})	0.67 (34 ^{o})	0.49 (220 ^{o})
P3	2.10 (39 ^{o})	0.64 (335 ^{o})	0.87 (38 ^{o})	0.72 (200 ^{o})
P4	2.43 (17 ^{o})	1.92 (203 ^{o})	0.51 (17 ^{o})	0.76 (199 ^{o})

CWPRS have carried out model studies (Technical Report No. 3887, May 2002) to establish the current for the entire navigational channel, using current data provided in **Table 2.14** The current velocities and directions were extracted at 12 selected locations along the channel (marked S1 to S12 in **Drawing I514/JNPT/105**) and the same are presented in table below.

TABLE 3.16 PEAK CURRENT VELOCITIES AND BEARINGS ALONG THE NAVIGATIONAL CHANNEL BASED ON MATHEMATICAL MODEL STUDIES

Location Inside the Channel	Peak Current Velocities and Bearings			
	Sprint Tide		Neap Tide	
	Flood	Ebb	Flood	Ebb
S1	1.80 (2^{O}- 4 ^{O})	2.0 (181^{O} – 184 ^{O})	1.01 (2^{O} -5 ^{O})	0.72 (182 ^{O} -185 ^{O})
S2	1.20 (17^{O} -21^{O})	1.52 (194^{O}-200^{O})	0.80 (18^{O}-24 ^{O})	0.56 (200 ^{O} -210^{O})
S3	1.13 (40^{O}-45^{O})	1.40 (200^{O}-210^{O})	0.76 (36 ^{O} -43 ^{O})	0.56 (213 ^{O} -225 ^{O})
S4	1.30 (53 ^{O} -57 ^{O})	1.34 (218 ^{O} -226)	0.82 (46 ^{O} -54 ^{O})	0.66 (231 ^{O} -240 ^{O})
S5	1.92 (45 ^{O} -52 ^{O})	1.90 (223 ^{O}-226 ^{O})	1.22 (45 ^{O} -54 ^{O})	0.93 (225 ^{O} -230 ^{O})
S6	2.02 (29 ^{O} -31 ^{O})	2.40 (207 ^{O}-210 ^{O})	1.40 (30 ^{O} -33 ^{O})	1.15 (207 ^{O} -209 ^{O})
S7	2.10 (39 ^{O}-43 ^{O})	1.92(223 ^{O}-227 ^{O})	1.44 (38 ^{O} -42 ^{O})	0.95 (225 ^{O} -230 ^{O})
S8	2.04 (55 ^{O} -57 ^{O})	1.80(227 ^{O}-230^{O})	1.44 (55 ^{O} -60 ^{O})	0.87 (227 ^{O} -230 ^{O})
S9	1.42 (70 ^{O} -74 ^{O})	0.95 (243 ^{O}-250 ^{O})	1.44 (67 ^{O} -70 ^{O})	0.93 (243 ^{O} -250 ^{O})
S10	1.40 (54 ^{O} -58 ^{O})	1.63 (227 ^{O}-230 ^{O})	1.07 (55 ^{O} -59 ^{O})	0.95 (227 ^{O} -230 ^{O})
S11	1.75 (22 ^{O} -24 ^{O})	1.73 (202 -205 ^{O})	1.34 (22 ^{O} -24 ^{O})	1.09 (203 ^{O} -205 ^{O})
S12	1.87 (17 ^{O} -21 ^{O})	1.81 (200 ^{O}-205 ^{O})	1.44 (18 ^{O} -20 ^{O})	1.18 (200 ^{O} -205 ^{O})

3.6.3 Tides

The tides in the region are semi-diurnal in character, exhibiting two high and two low waters in a period of 24 hours and 25 minutes. Duration of each tidal cycle is between 5 to 7 hours (theoretically 6 hours and 12 minutes). Tidal levels are recorded extensively at three locations in

the region, viz. Apollo Bandar, Mora and Trombay, for many years The tidal levels recorded at Apollo Bandar (Lat. 18° 55'N; Long 72°50’E) have been used in the design of approach channel since Apollo Bandar is geographically the most relevant location for the project area The recorded tidal levels with reference to Chart Datum are presented in table below.

TABLE 3.17 RECORDED TIDAL LEVELS AT MBP AND JNP'S HARBOR WITH REFERENCE TO CD

Highest High Water Recorded	+5.38 m
Highest High Water Springs (HHWS)	+4.96 m
Mean High Water Springs (MHWS)	+4.42 m
Highest High Water Neaps (HHWN)	+3.88 m
Lowest High Water Springs (LHWS)	+3.86 m
Mean High Water Neaps (MHWN)	+3.30 m
Lowest High Water Neaps (LHWN)	+2.74 m
Mean Sea Level (MSL)	+2.51 m
Lowest High Water (LHW)	+2.48 m
Highest Low Water Neaps (HLWN)	+2.40 m
Mean Low Water Neaps (MLWN)	+1.86 m
Highest Low Water Springs (HLWS)	+1.30 m
Lowest Low Water Neaps (LLWN)	+1.30 m
Mean Low Water Springs (MLWS)	+0.76 m
Lowest Low Water Springs (LLWS)	+0.12 m

Chart Datum	+0.00 m
Lowest Low Water Recorded	-0.44 m

Based on the tidal levels the highest, mean and lowest tidal ranges for both spring and neap tides are given in table below.

TABLE 3.18 TIDAL RANGE

Tides	**Range (m CD)**		
	Highest	Mean	Lowest
Spring	4.86 m	3.66 m	2.56 m
Neap	2.58 m	1.44 m	0.34 m

3.6.4 Bathymetry

M/s Fugro have carried out the post-dredging bathymetry survey of approach channel and the surrounding areas in May 2015 and details of the same are given in table below and **Drawing I-514/JNPT/106A to Drawing I-514/JNPT/106J**.

TABLE 3.19 BATHYMETRY DETAILS OF JNP NAVIGATIONAL AREAS

Sr. No	**Channel Section**	**Length (m)**	**Width (m)**	**Current Dredged Levels (m CD)**
1	AB	9775	800	-14.3 to -15.5
2	BC	4680	370	-14.6 to -14.9
3	CD	7980	370	-14.3 to -15.0
4	DE	4365	370	-14.0 to -15.0
5	EF	6690	400 to 500	-13.1 to -18.5
6	Berth Pockets & emergency Anchorage	-	-	-16.5

3.7 ENVIRONMENTAL BASELINE

3.7.1 Methodology for studies undertaken

Air quality

a) Selection of Monitoring Stations

The locations for the monitoring were selected considering the distance of the location from the site.

b) Monitoring Methodology

Monitoring of ambient air quality was carried out as per CPCB guidelines.

The techniques used for measurement of pollutants may be summarized as under:

TABLE 3.20 MEASUREMENT TECHNIQUES

Sr.	Pollutant	Code Of Practice	Methods Of Measurement	Minimum Detectable Limit
1	Sulphur Dioxide (SO_2)	IS-5182 (Part-II):2001 & CPCB Guidelines	Improved West and Geake	3 µg/m^3
2	Nitrogen Dioxide (NO_2)	IS-5182 (Part-VI): 2006 & CPCB Guidelines	Modified Jacob & Hochheiser (Na-Arsenite)	3 µg/m^3
3	Particulate Matter (size less than 10 µm) or PM_{10}	IS-5182 (PART-23):2006 & CPCB Guidelines	Gravimetric	4 µg/m^3
4	Particulate Matter (size less than 2.5 µm) or $PM_{2.5}$			4 µg/m^3
5	Ozone (O_3)	IS-5182 (Part-IX):1974 & CPCB Guidelines	Spectrophotometric Method	1 µg/m^3
6	Carbon Monoxide (CO)	IS: 5182 (Part-X) & CPCB Guidelines	Non Dispersive Infra Red (NDIR) spectroscopy	0.01 mg/m^3
7	Ammonia (NH_3)	APHA, (Method-401) & CPCB Guidelines	Indophenol blue method	6 µg/m^3
8	Benzene (C_6H_6)	IS-5182 (Part-XI):2006 & CPCB Guidelines	Gas Chromatography	0.5 µg/m^3
9	Benzo (a) Pyrene (BaP) – particulate phase only,	IS-5182 (Part-XII):2004 & CPCB Guidelines	Solvent extraction followed by HPLC analysis	0.5 ng/m^3

Sr.	Pollutant	Code Of Practice	Methods Of Measurement	Minimum Detectable Limit
10	Lead (Pb)	USEPA/625/R-96/0109/IO-3.1& 3.2 & CPCB Guidelines	AAS method	0.01 µg/m^3
11	Arsenic (As)			1 ng/m^3
12	Nickel (Ni)			1 ng/m^3

Ambient Air Quality Standards stipulated by CPCB are presented in **Table 3.21.**

TABLE 3.21: NATIONAL AMBIENT AIR QUALITY STANDARDS (CPCB)

Pollutant	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural and other areas	Ecologically Sensitive areas notified by Central Government
Sulphur Dioxide (SO_2) ($\mu g/m^3$)	Annual Average* 24 hours**	50 80	20 80
Oxides of Nitrogen (NOx) ($\mu g/m^3$)	Annual Average* 24 hours**	40 80	30 80
Particulate Matter (PM_{10}) ($\mu g/m^3$)	Annual Average* 24 hours**	60 100	60 100
Particulate Matter ($PM_{2.5}$) ($\mu g/m^3$)	Annual Average* 24 hours**	40 60	40 60
Carbon Monoxide (CO) (mg/m^3)	8 hours** 1 hour	02 04	02 04
Lead (Pb) ($\mu g/m^3$)	Annual Average* 24 hours**	0.50 1.0	0.50 1.0
Ozone (O3) $\mu g/m^3$	8 hours** 1 hour**	100 180	100 180
Ammonia (NH3) $\mu g/m^3$	Annual* 24 hours**	100 400	100 400

Pollutant	Time Weighted Average	Concentration in Ambient Air	
		Industrial, Residential, Rural and other areas	Ecologically Sensitive areas notified by Central Government
Benzene (C6H6) $\mu g/m^3$	Annual*	05	05
Benzo(a)Pyrene (BaP) – particulate phase only, ng/m^3	Annual*	01	01
Arsenic (As) ng/m^3	Annual*	06	06
Nickel (Ni), ng/m^3	Annual*	20	20

3.7.2 AIR ENVIRONMENT:

As a part of the study, the secondary data available on ambient air quality was collected and suitably incorporated in the EIA STUDY. The monitoring is being continuously done by various institutions like, CESS, IIT Bombay, Ultratech lts, Detox. in the Jawaharlal Nehru port area JNPT. The findings of the survey conducted during Jan 2015 to August 2016 are summarized in Table no **3.22.** Ambient air quality monitoring carried out for the period 4th Sep 2016 to 4th December 2016 is given in the subsequent tables.

Observation on ambient SO_2 levels

The So_2 levels at various stations covered under the ambient air quality monitoring survey ranged from 22 to 48 µg/m^3 which is well below the permissible limits (120 µg/m^3) specified for industrial areas by CPCB as per the Gazette notification of April 1984.

Observation on ambient NO_x levels

The NOx levels at various stations covered under the ambient air quality monitoring survey ranged from 14 to 29 µg/m^3 which is well within the permissible industrial area (120 µg/m^3) as specified by CPCB in the Gazette notification of April 1984.

TABLE 3.22: RESULT OF AIR POLLUTANT CONCENTRATION AT VARIOUS STATIONS OF JNP AREA (From Jan 2015 to Aug 2016) (in µG/M^3)

Station	PM10	PM 2.5	NOx	SO_2	NH_3	O3	pb	C6H6	CO	CO2
At port Operational Centre	179	59	24	40	23	21	0.08	1.78	1.63	272
IMC	198	70	26	39	23	19	0.09	1.63	1.69	275

compound										
Near North gate complex	190	58	24	40	20	23	0.11	1.6	1.58	278
Near south gate complex	188	62	26	37	21	17	0.13	1.77	1.68	275
Residential colony township	197	58	21	30	20	17	0.1	1.58	1.7	277
Elephanta caves	117	33	18	30	16	15	0.11	1.64	1.43	269

TABLE 3.23: RESULT OF AIR POLLUTANT CONCENTRATION AT VARIOUS STATIONS OF JNP AREA (Sep 2016) (in µG/M^3)

Station	PM10	PM 2.5	NOx	SO_2	NH_3	O3	pb	C6H6	CO	CO2
At port Operational Centre	175	62	23	39	22	15	0.05	1.66	1.65	278
IMC compound	193	75	21	41	20	18	0.08	1.62	1.64	274
Near North gate complex	185	57	22	42	18	21	0.12	1.5	1.54	268
Near south gate complex	175	65	25	36	23	15	0.15	1.78	1.69	269
Residential colony township	192	55	19	28	24	12	0.1	1.54	1.71	274
Elephanta caves	120	32	15	22	12	12	0.14	1.68	1.45	265

TABLE 3.24: RESULT OF AIR POLLUTANT CONCENTRATION AT VARIOUS STATIONS OF JNP AREA (Oct 2016) (in µG/M^3)

Station	PM10	PM 2.5	NOx	SO_2	NH_3	O3	pb	C6H6	CO	CO2
At port Operational Centre	175	65	22	36	24	18	0.07	1.54	1.65	268

IMC compound	199	78	22	45	23	21	0.06	1.63	1.62	266
Near North gate complex	178	58	23	46	19	24	0.15	1.62	1.59	251
Near south gate complex	172	68	28	37	24	16	0.18	1.79	1.64	268
Residential colony township	195	58	21	25	23	15	0.2	1.62	1.75	272
Elephanta caves	119	35	16	23	15	16	0.06	1.66	1.48	269

TABLE 3.25: RESULT OF AIR POLLUTANT CONCENTRATION AT VARIOUS STATIONS OF JNP AREA (4th Nov 2016 to 4thDec 2016) (in µG/M^3)

Station	PM10	PM 2.5	NOx	SO_2	NH_3	O3	pb	C6H6	CO	CO2
At port Operational Centre	178	66	23	35	26	17	0.05	1.55	1.62	264
IMC compound	195	79	21	42	23	22	0.03	1.72	1.63	169
Near North gate complex	174	59	25	48	18	23	0.11	1.63	1.54	256
Near south gate complex	178	66	29	39	23	12	0.14	1.82	1.69	271
Residential colony township	195	57	20	26	21	13	0.19	1.69	1.66	268
Elephanta caves	123	34	14	22	12	12	0.07	1.64	1.41	252

3.7.3 Noise studies

The noise level monitoring has been carried out at all the 8 stretches of the river and creeks.
The ambient noise levels were monitored at the selected location within the study area during day and nighttime Equivalent noise level is a scale for measurement of long-term noise exposure and has been accepted by International Standard Organization.

The main objective of Noise Pollution Impact Assessment in the study area is to assess the impact of the total noise generated by the existing activity on the human settlements The main objectives of the study conducted are:

- Assessment of background noise levels.
- Identification and monitoring the major noise sources of the existing activity.
- To assess the impact of noise of general population

At each ambient noise monitoring station, Leq. Noise level has been recorded at hourly intervals for 24 hours.

TABLE 3.26: PERMISSIBLE NOISE LEVEL (CPCB STANDARDS)

Area	Category of Area	Permissible Limit	
		L_{eq} Day time	L_{eq} Night time
A	Industrial Area	75	70
B	Commercial Area	65	55
C	Residential Area	55	45
D	Silence Zone	50	40

TABLE 3.27 RESULT OF NOISE LEVELS AT VARIOUS STATIONS OF JNP AREA (Sep 2016)

Station Code	Noise Monitoring Location	Category of Area/ Zone	Average noise levels in dB		CPCB Limits in dB (A)	
			Leq(day)	Leq(night)	Day	Night
N1	GTICT Container Berth	Industrial	85.1	77	75	70
N2	JNP Container Berth	Industrial	77.9	71.4	75	70
N3	NSICT Container Berth	Industrial	82.4	77.1	75	70
N4	Container yard near shift office	Industrial	75.3	67.6	75	70
N5	Container yard opp to Ct	Industrial	80.2	71	75	70

	canteen					
N6	J. M. Bakshi	Industrial	61.3	61.3	75	70
N7	ICD 1-5	Industrial	69.8	61.5	75	70
N8	ICD 6&8	Industrial	77.3	71.5	75	70
N9	Port Craft Jetty	Industrial	65.7	64.4	75	70
N10	North Gate Complex	Industrial	73.2	70.1	75	70
N11	Navratna Canteen	Industrial	82.5	73.8	75	70
N12	CFS Gate	Industrial	81.9	74.1	75	70

Table 3.28 RESULT OF NOISE LEVELS AT VARIOUS STATIONS OF JNP AREA (Oct 2016)

Station Code	**Noise Monitoring Location**	**Category of Area/ Zone**	**Average noise levels in dB**		**CPCB Limits in dB (A)**	
			Leq(day)	**Leq(night)**	**Day**	**Night**
N1	GTICT Container Berth	Industrial	70.2	67.9	75	70
N2	JNP Container Berth	Industrial	70.1	67.6	75	70
N3	NSICT Container Berth	Industrial	68.8	67.5	75	70
N4	Container yard near shift office	Industrial	66.6	64.4	75	70
N5	Container yard opp to Ct canteen	Industrial	68.8	64.1	75	70
N6	J. M. Bakshi	Industrial	62.9	59.2	75	70
N7	ICD 1-5	Industrial	67.8	63.3	75	70
N8	ICD 6&8	Industrial	64.8	63.5	75	70
N9	Port Craft Jetty	Industrial	63.6	63.4	75	70
N10	North Gate Complex	Industrial	70.4	62.5	75	70
N11	Navratna Canteen	Industrial	69.7	68	75	70
N12	CFS Gate	Industrial	68.9	63.3	75	70

TABLE 3.29 RESULTS OF NOISE LEVELS AT VARIOUS STATIONS OF JNP AREA (4th Nov 2016 to 4th Dec 2016)

Station Code	**Noise Monitoring Location**	**Category of Area/ Zone**	**Average noise levels in dB**		**CPCB Limits in dB (A)**	
			Leq(day)	**Leq(night)**	**Day**	**Night**
N1	GTICT Container Berth	Industrial	71.1	68.2	75	70
N2	JNP Container Berth	Industrial	71.0	68.1	75	70
N3	NSICT Container Berth	Industrial	67.7	68.0	75	70
N4	Container yard near shift office	Industrial	66.8	64.2	75	70
N5	Container yard opp to Ct Canteen	Industrial	68.9	64.0	75	70
N6	J. M. Bakshi	Industrial	63.0	60.0	75	70
N7	ICD 1-5	Industrial	68.1	62.9	75	70
N8	ICD 6&8	Industrial	65.0	64.1	75	70
N9	Port Craft Jetty	Industrial	64.1	62.9	75	70
N10	North Gate Complex	Industrial	71.2	63.1	75	70
N11	Navratna Canteen	Industrial	60.8	67.0	75	70
N12	CFS Gate	Industrial	69.1	64.0	75	70

The monitoring for noise level was carried out for 24 hours using a portable sound level meter. Noise levels were recorded at a 1 hour interval The L equivalent (L eq) was calculated for the day and night time readings The noise monitoring was carried out for twelve different locations and the results obtained were compared to the standards prescribed by the Noise Pollution (Regulation and Control) Rules, (Year 2000). In the month of September the levels were found to exceed the prescribed limits at some locations. All the noise monitoring results were found to be within the acceptable limits for the month of October and November for all the locations.

3.7.4 MARINE WATER QUALITY

The cleaning and maintenance of the waterways is an activity that will directly affect the water quality. Thus physico-chemical properties of the creeks and rivers were studies to understand the water quality of the region. This would also help to adopt the mitigation measures during the project activities The procedures adopted for analysis of water are as per APHA and IS The details of the procedure is given as below:

TABLE 3.30 METHODOLOGY ADOPTED FOR WATER ANALYSIS

Sr. No.	Parameter	units	Method
1.	**pH**	–	IS:3025(Part 11)
2.	**Turbidity**	NTU	IS:3025(Part 10)
3.	**Electrical Conductivity**	mS/cm	APHA 2510-B
4.	**Dissolved Oxygen (DO)**	mg/l	APHA4500 -O -B
5.	**Chemical Oxygen Demand (COD)**	mg/l	APHA 5220-B
6.	**Biochemical Oxygen Demand (BOD)**	mg/l	APHA 5210 - B
7.	**Total Suspended Solids (TSS)**	mg/l	APHA 2540 - D
8.	**Total Dissolved Solids (TDS)**	mg/l	APHA 2540-C
9.	**Sulphate**	mg/l	APHA 4500 SO_4- E
10.	**Nitrate**	mg/l	IS:3025(Part 34)
11.	**Total Hardness**	mg/l	IS:3025 (Part 21)
13.	**Salinity**	ppt	IS:3025 (Part 32)
14.	**Oil & Grease**	mg/l	APHA 5520-B
15.	**Mercury (Hg)**	mg/l	APHA 3030-F
16.	**Copper (Cu)**	mg/l	APHA 3030-F
17.	**Zinc (Zn)**	mg/l	APHA 3030-F
18.	**Nitrite**	mg/l	APHA 4500 N-C
19.	**Phosphate**	mg/l	IS:3025(Part 31)
20.	**Silicates**	mg/l	APHA 4500 SiO_2- F

Water studies- Physicochemical properties

Detailed marine ecological survey was conducted as a part of EIA study during 4th Sep 2016 to 4th December 2016 to establish the existing status of the marine water around the proposed project site. The survey included the analysis of physico-chemical and biological characteristics of marine water and sediment samples. Keeping in view the proposed project location, the sampling was done at fourteen locations as outlined in **Table 3.31** three sampling station were selected around the JNPT jetty and another four sampling location were fixed in the navigation channel. Samples were also collected from the existing and proposed dumping sites for the dredged material.

TABLE 3.31: LOCATION OF MARINE WATER QUALITY SAMPLING STATIONS

Sr. No.	Station	Description
1	W1	Between Elephanta and Nhava Islands
2	W2	Denoted by buoy no.FG2 RED of JNPT channel. It is near the Elephanta Island, and opposite to Port Craft Jetty
3	W3	Identified by the green buoy no. FG2 Green of JNPT approach channel and lies near the landing jetty.
4	W4	Located at Uran Patch Beacon (lighthouse on concrete platform) near the Butcher Island filling platform.
5	W5 W11 to W14	W5 is near to the guide bund and others are along Nhava creek upto Belpada. These are selected to examine the impact of neighboring Nhava Villages and Belpada to the creek water quality
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.
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.
8	W10	Located near proposed chemical berth. These stations are variable and selected to examine the impact of proposed chemical terminal and IV Container terminal activities on water quality.
9	W9	Located in between GTI and Liquid Cargo Jetty. This station is selected to examine the impact of terminal activities on water qualities

TABLE 3.32: PHYSICO-CHEMICAL CHARACTERISTIC OF MARINE WATER SAMPLES (Jan 2015-Aug 2016 Average)

Location	Temp., [°C]	pH	Salinity, [ppth]	Turbidity, [NTU]	TDS, [mg/L]	TSS, [mg/L]	TS, [mg/L]	DO, [mg/L]	COD, [mg/L]
W1	26.4	7.4	32.54	22.73	29678.04	137.4968	30226.37	6.1	46.5
W2	26.1	7.5	33.12	30.33	29552.59	179.6907	30374.95	6.0	48.4
W3	25.8	7.5	32.84	20.68	28515.39	141.1071	29027.57	5.5	49.6
W4	25.5	7.5	32.83	24.14	28586.82	159.1071	28986.18	5.6	45.1
W5	26.1	7.5	32.77	20.18	28494.14	106.0479	29149.18	5.8	50.2
W6	26.5	7.4	32.41	21.74	28805.76	112.8217	29376.54	5.6	45.4
W7	26.3	7.4	32.24	20.25	28651.93	102.845	29114.71	5.6	44.8
W8	26.3	7.4	34.6	19.24	30606.09	102.8636	31365.32	5.4	47.1
W9	26.2	7.5	32.53	18.43	28884.67	114.8333	29467.71	5.5	44.3
W10	27.3	7.4	29.3	28.6	28084.8	132.2	29993.0	5.9	60.5
W11	27.1	7.4	29.2	27.9	25977.8	142.0	27414.6	5.7	64.2
W12	26.5	7.6	28.6	29.2	26174.6	125.4	28326.0	5.6	53.8
W13	26.7	7.4	30.1	27.3	25907.6	112.3	27973.4	5.4	46.1
W14	26.4	8.7	31.78	23.90	28301.55	128.3658	29291.96	5.7	49.7

Location	BOD, [mg/L]	NH4+-N, [mg/L]	Phenol, [mg/L]	O&G, [mg/L]	TPC, [CFU/mL]	Fecal Coliforms [MPN/100 mL]
W1	<2	<0.1	<0.01	1.6	80	18
W2	<2	<0.1	<0.01	2	83	21
W3	<2	<0.1	<0.01	1.3	102	18
W4	<2	<0.1	<0.01	1.6	121	17
W5	<2	<0.1	<0.01	1	78	15

W6	<2	<0.1	<0.01	2	90	21
W7	<2	<0.1	<0.01	1.5	150	20
W8	<2	<0.1	<0.01	2.7	88	20
W9	<2	<0.1	<0.01	2	120	23
W10	<2	<0.1	<0.01	2.0	164	41
W11	<2	<0.1	<0.01	3.0	137	46
W12	<2	<0.1	<0.01	1.0	160	43
W13	<2	<0.1	<0.01	1.2	169	34
W14	<2	<0.1	<0.01	1.7	119	26

TABLE 3.33: PHYSICO-CHEMICAL CHARACTERISTIC OF MARINE WATER SAMPLES (Sep 2016)

Location	Temp., [°C]	pH	Salinity, [ppth]	Turbidity, [NTU]	TDS, [mg/L]	TSS, [mg/L]	TS, [mg/L]	DO, [mg/L]	COD, [mg/L]
W1	26.2	7.4	32.5	22.4	29688.0	137.5	30236.4	6.1	46.4
W2	26.3	7.5	33.14	30.25	29552.4	179.8	30374.0	5.9	48.2
W3	25.7	7.4	32.75	20.68	28615.4	141.1	29047.4	5.4	49.6
W4	25.5	7.5	32.84	24.16	28686.8	159.1	28996.2	5.6	45.1
W5	26.2	7.6	32.75	20.18	28484.1	106.2	29249.2	5.7	50.3
W6	26.4	7.4	32.44	21.75	28825.8	113.8	29476.6	5.8	45.3
W7	26.3	7.5	32.24	20.24	28641.9	102.9	29113.7	5.4	44.7
W8	26.3	7.4	34.6	19.21	30606.1	102.7	31364.2	5.3	47.3
W9	26.4	7.5	32.56	18.54	28885.7	114.7	29467.7	5.4	44.7
W10	27.2	7.6	29.4	28.5	28088.8	132.3	29945.0	5.8	60.1
W11	27.2	7.4	29.4	28.3	25978.8	144.0	27411.4	5.2	65.1
W12	26.5	7.6	28.6	29.4	26173.6	125.3	28426.0	5.4	54.2
W13	26.7	7.4	30.1	28.1	25907.6	112.3	27873.4	5.2	45.9
W14	26.3	8.6	31.78	23.8	28301.1	128.6	29491.2	5.6	48.9

Location	BOD, [mg/L]	NH4+-N, [mg/L]	Phenol, [mg/L]	O&G, [mg/L]	TPC, [CFU/mL]	Fecal Coliforms [MPN/100 mL]
W1	<2	<0.1	<0.01	1.5	81	20
W2	<2	<0.1	<0.01	2.1	84	22
W3	<2	<0.1	<0.01	1.2	104	19
W4	<2	<0.1	<0.01	1.5	120	16
W5	<2	<0.1	<0.01	1.1	78	15
W6	<2	<0.1	<0.01	2.1	97	22
W7	<2	<0.1	<0.01	1.4	160	21
W8	<2	<0.1	<0.01	2.4	91	21
W9	<2	<0.1	<0.01	2.1	133	24
W10	<2	<0.1	<0.01	1.9	164	47
W11	<2	<0.1	<0.01	3.1	140	45
W12	<2	<0.1	<0.01	1.2	155	43
W13	<2	<0.1	<0.01	1.4	170	35
W14	<2	<0.1	<0.01	1.4	119	25

TABLE 3.34: PHYSICO-CHEMICAL CHARACTERISTIC OF MARINE WATER SAMPLES (Oct 2016)

Location	Temp., [°C]	pH	Salinity, [ppth]	Turbidity, [NTU]	TDS, [mg/L]	TSS, [mg/L]	TS, [mg/L]	DO, [mg/L]	COD, [mg/L]
W1	26.1	7.4	32.54	22.41	29677.0	138.5	30256.4	6.1	46.4
W2	26.2	7.4	33.41	30.45	29542.4	178.7	30474.5	6.1	47.2
W3	25.7	7.5	32.54	20.68	28615.1	141.7	29037.5	5.4	48.9
W4	25.4	7.6	32.85	23.15	28586.8	158.2	28996.2	5.5	45.2
W5	25.9	7.6	32.66	20.16	28444.4	105.1	29150.5	5.7	51.2

W6	25.5	7.5	32.45	22.54	28205.6	112.8	29374.6	5.7	44.9
W7	26.8	7.5	32.54	20.54	28451.9	104.8	29214.5	5.6	45.2
W8	27.1	7.4	34.23	20.12	31606.1	102.8	31355.4	5.4	47.1
W9	26.4	7.5	32.53	19.32	28484.7	114.8	29457.7	5.4	44.3
W10	27.3	7.4	29.3	28.3	28184.8	134.2	29993.0	5.8	61.2
W11	27.2	7.6	29.1	28.31	26977.8	144.0	27444.6	5.6	65.1
W12	26.4	7.8	28.6	29.1	26184.5	124.4	28346.0	5.7	53.8
W13	26.1	7.9	31.2	28.1	25977.2	112.3	27873.4	5.4	47.3
W14	26.1	7.2	32.68	23.45	28401.5	127.4	29892.0	5.8	50.1

Location	**BOD, [mg/L]**	**NH4+-N, [mg/L]**	**Phenol, [mg/L]**	**O&G, [mg/L]**	**TPC, [CFU/mL]**	**Fecal Coliforms [MPN/100 mL]**
W1	<2	<0.1	<0.01	1.5	81	19
W2	<2	<0.1	<0.01	2.1	84	22
W3	<2	<0.1	<0.01	1.5	101	19
W4	<2	<0.1	<0.01	1.4	141	16
W5	<2	<0.1	<0.01	1.1	79	15
W6	<2	<0.1	<0.01	2.2	91	22
W7	<2	<0.1	<0.01	1.5	151	21
W8	<2	<0.1	<0.01	2.1	89	20
W9	<2	<0.1	<0.01	1..9	121	24
W10	<2	<0.1	<0.01	1.8	165	43
W11	<2	<0.1	<0.01	3	138	15
W12	<2	<0.1	<0.01	1.5	164	44
W13	<2	<0.1	<0.01	1.6	170	35
W14	<2	<0.1	<0.01	1.9	120	28

TABLE 3.35: PHYSICO-CHEMICAL CHARACTERISTIC OF MARINE WATER SAMPLES (4th November 2016 to 4th December 2016)

Location	Temp., [°C]	pH	Salinity, [ppth]	Turbidity, [NTU]	TDS, [mg/L]	TSS, [mg/L]	TS, [mg/L]	DO, [mg/L]	COD, [mg/L]
W1	26.5	7.4	32.45	22.15	29548.1	132.6	30426.7	5.9	46.4
W2	26.3	7.4	33.14	31.12	29453.5	180.1	30384.2	6.1	46.9
W3	25.4	7.6	31.94	21.56	28715.6	139.8	28827.5	5.4	50.1
W4	25.5	7.4	32.45	23.15	28626.2	160.2	28186.2	5.5	46.1
W5	26.3	7.4	32.66	21.21	28445.1	108.2	29249.4	5.6	51.2
W6	26.8	7.5	33.12	22.14	28795.8	114.2	29476.6	5.6	45.7
W7	26.4	7.6	32.89	21.86	28451.9	102.8	29414.4	5.7	43.9
W8	26.3	7.4	35.1	20.12	30656.2	102.7	31435.5	5.3	47.6
W9	26.5	7.6	33.54	19.32	28984.6	116.2	29657.4	5.4	45.1
W10	28.2	7.4	29.6	28.61	28074.8	140.6	29493.0	5.8	61.2
W11	28.1	7.4	30.1	28.32	25847.8	144.6	27465.6	5.6	63.8
W12	26.4	7.6	29.5	30.1	26546.3	145.2	28626.0	5.6	54.8
W13	26.8	7.4	31.2	28.4	25607.4	113.2	27873.4	5.5	47.2
W14	26.3	8.5	32.12	24.3	28441.8	129.4	29382.0	5.8	49.8

Location	BOD, [mg/L]	NH4+-N, [mg/L]	Phenol, [mg/L]	O&G, [mg/L]	TPC, [CFU/mL]	Fecal Coliforms [MPN/100 mL]
W1	<2	<0.1	<0.01	1.5	82	20
W2	<2	<0.1	<0.01	2.2	85	22
W3	<2	<0.1	<0.01	1.5	110	20
W4	<2	<0.1	<0.01	1.4	138	17
W5	<2	<0.1	<0.01	1.2	81	15

W6	<2	<0.1	<0.01	2.1	90	21
W7	<2	<0.1	<0.01	1.6	162	22
W8	<2	<0.1	<0.01	1.9	85	21
W9	<2	<0.1	<0.01	2	119	23
W10	<2	<0.1	<0.01	1.9	166	42
W11	<2	<0.1	<0.01	3.1	140	16
W12	<2	<0.1	<0.01	1.4	165	43
W13	<2	<0.1	<0.01	1.5	175	36
W14	<2	<0.1	<0.01	1.8	121	29

PHYSICO-CHEMICAL CHARACTERISTIC OF WATER

pH

The marine water in the project area is slightly alkaline. The pH value in the surface and sub-surface water samples ranged from 6.98 to 8.70. The pH values did not show any spatial variations. The pH values of sub-surface and surface water samples at all the stations were more or less same. This could be due to the continuous mixing of the water columns.

Salinity;

The salinity varied from 28.6 to 34.23 ppt in sub-surface water samples.. The salinity in sub-surface water samples was observed to be marginally higher than surface water samples at all the stations.

Biochemical Oxygen Demand (BOD)

The BOD levels observed at various sampling stations are less than 2.0 mg/lit. The index of organic pollution as reflected by the BOD values was found to be slightly high in the stations adjacent to the harbor.

Heavy metals

The concentration of heavy metals in surface and bottom water samples was determined by an Atomic Absorption Spectrophotometer. The concentration of copper, zinc, magnesium, nickel, lead and mercury observed throughout study period in the surface and sub-surface water samples is detailed in above tables.

The investigation of the heavy metals, both in the water column and sediments, exhibit station wise variation, giving fairly high concentration. However, the levels of zinc, Copper and Lead in both compartments were found to be higher compared to the other metals The water samples

collected from JNPT showed the values of 15.2 to 69.5 mg/l for copper, 25.4 to 72.3 mg/l for zinc, 20.5 to48.2 mg/l for cadmium, less than 1.0 mg/l for Nickel, less than 0.05mg/l for Lead and 0.06 to 0.60 mg/l for mercury. The concentration of tress metals in these regions has revealed fluctuations and also varies with the place and time of sampling, nature of pollutants and the chemical characteristic of water body. Moreover, many trace metals such as Copper, Zink, Lead and Cadmium get rapidly fixed to particulate matter and are ultimately carried to the bottom sediments.

3.7.5 SEDIMENTS CHARACTEISRICS

In a water body, there is a close relationship between the type of sediments with physico-chemical and biological parameters of water. Similarly the activities in the area also have a profound effect on the sediment composition, Hence, an understanding of the physico-chemical and biological characteristics of the sediment is essential. With this in view, the sediment samples from various stations were collected and their physico-chemical and biological characteristic were analyzed.

TABLE 3.36 CONCENTRATIONS OF HEAVY METALS IN SEDIMENT SAMPLES IN THE PROJECT AREA (Sep 2016)

Sr. no	Heavy Metals	Units	Station 1	Station 2	Station 3	Station 4	Station 5	Station 6	Station 7	Station 8	Station 9	Station 10	Station 11
1	Copper	µg/l	17.4	24.5	21.3	38.0	34.0	29.0	24.90	34.5	41.0	55.0	68.0
2	Zink	µg/l	45.8	52.3	48.2	29.0	25.0	31.0	26.0	39.0	45.0	62.0	71.00
3	Cadmium	µg/l	25.6	20.5	22.5	29.0	24.0	25.30	32.7	30.00	38.00	31.0	47.0
4	Nickel	µg/l	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
5	Lead	µg/l	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
6	Mercury	µg/l	0.20	0.60	0.50	0.40	0.10	0.30	0.50	0.60	0.50	0.60	0.50

TABLE 3.37 CONCENTRATIONS OF HEAVY METALS IN SEDIMENT SAMPLES IN THE PROJECT AREA (Oct 2016)

Sr. no	Heavy Metals	Units	Station 1	Station 2	Station 3	Station 4	Station 5	Station 6	Station 7	Station 8	Station 9	Station 10	Station 11
1	Copper	µg/l	15.2	24.3	20.4	38.6	34.2	29.5	25.9	34.8	42.3	53.2	69.5
2	Zink	µg/l	45.8	55.2	47.6	29.5	25.4	32.5	27.3	35.9	46.8	63.2	72.3
3	Cadmium	µg/l	25.3	21.8	22.8	28.9	23.9	26.4	33.2	29.4	37.6	32	45.2
4	Nickel	µg/l	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
5	Lead	µg/l	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
6	Mercury	µg/l	0.15	0.55	0.49	0.34	0.09	0.29	0.47	0.59	0.48	0.52	0.48

TABLE 3.38 CONCENTRATIONS OF HEAVY METALS IN SEDIMENT SAMPLES IN THE PROJECT AREA (4th November 2016 to 4th December 2016)

Sr. no	Heavy Metals	Units	Station 1	Station 2	Station 3	Station 4	Station 5	Station 6	Station 7	Station 8	Station 9	Station 10	Station 11
1	Copper	µg/l	16.2	22.6	19.2	39.5	33.6	28.3	25.3	33.6	43.2	52.6	68.2
2	Zink	µg/l	43.2	58.2	45.3	31.2	29.3	31.3	26.4	32.1	45.2	62.8	69.3
3	Cadmium	µg/l	26.5	20.6	21.5	27.6	22.5	25.3	31.2	30.1	38.2	33.1	48.2
4	Nickel	µg/l	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0	<1.0
5	Lead	µg/l	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05	<0.05
6	Mercury	µg/l	0.18	0.45	0.45	0.4	0.06	0.21	0.35	0.49	0.52	0.42	0.45

Textural Analysis

The texture of sediments of the area to be dredged was silty marine clay. The texture observed in the sediment samples collected from the JNP area indicates the limited inputs of fresh water.

Heavy metals

The concentration of heavy metals throughout study period is detailed in above tables. It may be seen that there is a good correlation between the heavy metal concentration in sediments and that in water.

3.7.6 Marine biodiversity study

Biodiversity and community structures are recognized to be important determinants of ecosystem functioning. Monitoring of species diversity is a useful technique for assessing damage to the system and maintenance of good species diversity is a positive management objective.

The productive of an area is determined by the biological characteristics. As a part of the study, phytoplankton, zooplankton and benthic organisms were studied along each transect The sample for phytoplankton was preserved in Lugol's solution The sample was concentrated by decantation and the sample was screened under the microscope and species diversity was noted The phytoplankton cell count was done using Sedgwick rafter slide.

Zooplankton was collected and stored in plastic bottles They were preserved in 4% buffered formaldehyde The qualitative and quantitative analysis was carried out under microscope.

The benthic studies were carried out in a square of 1 x 1 mt. Large shells were identified and their number was noted The sand and soil where every possible was sieved by a fine mesh The organisms were fixed in Rose Bengal and preserved in 4% formaldehyde.

Biological parameters are very important in the aquatic ecosystem since they determine the productivity of a water body , Primary productivity is an important indicator of pollution level an any aquatic ecosystem and the primary productivity depends upon the presence of phytoplankton and zooplanktons. Fish production dependent on the phytoplankton production or primary productivity. All these are related to Physico-chemical characteristic of the water.

As mentioned earlier, detailed marine ecological survey was conducted in the project area in the month of September 2016 , to understand the existing status of marine ecology The biological parameters like abundance and density of zooplanktons and phytoplankton, chlorophyll, phaeophytin, primary productivity, abundance and density of benthic organism were monitored and the results are presented in the following section

Phytoplankton and Zooplankton

Phytoplankton have long been used as indicator of water quality. Some species flourish in highly atrophic waters while others are very sensitive to organic and/or chemical waste. Phytoplankton from the pastures of the sea These organisms are atrophic in nature The growth and multiplications of phytoplanktons primarily depends on solar illuminations, temperature, silicates, trace elements etc.. Phytoplankton are suspended in the euphotic zone and from season to season and this variation is responsible for the organic production The productivity of phytoplankton is directly responsible for the growth of zooplanktons in the water.

3.7.6.1 PHYTOPLANKTON

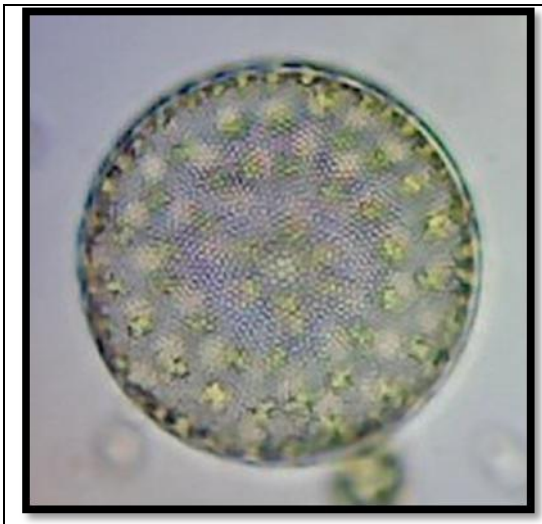
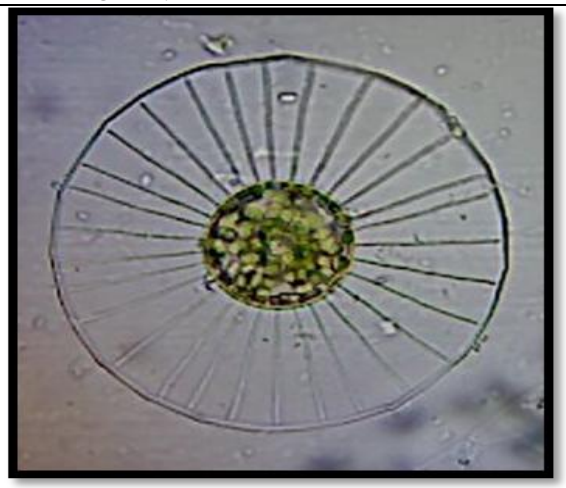
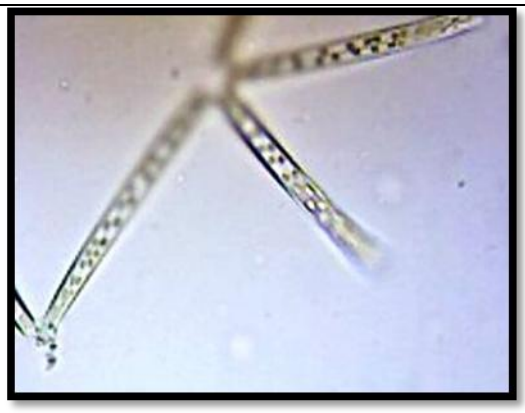
The population density of phytoplankton ranged from 53 to. 70 cells/lit The phytoplankton maximum population density (70cells/l) was observed at station-7 and minimum at station 2 and station 6 (53cells/l) The phytoplankton density at station10 which is the present disposal site indicates that the once disposal is stopped at a particular site, the nutrients in the sediments and tranquil conditions enable sufficient productivity in the area.

A total of 17 species of phytoplankton was recorded from the study area. amongst them 12 species of Diatoms , three species of Dinoflaggilateds and two species of blue green algae were recorded. Neelam ramaiah and Ramaiah (1998) have recorded the presence of 37 species of phytoplanktons (33 diatoms and 4 dinoflagellates). The reduction in the number of species suggests that this could be due to anthropogenic influences.

In the present investigation, the diatoms were found to be the dominant group. Amongst the diatoms, the *Thalassiosira sp, Planktonella sp.* and *Coscinodiscus sp* were observed at all the stations. Neelam ramaiah and Ramaiah (1998) observed the *Thalassionema sp*. *Coscinodiscus sp*. and *Nitzschia sp* were most common in polluted Bombay harbour- Thana-Bassain creek estuarine complex. Harrison et at (1991) reported that the rapid proliferation of Skeletonema in nutrient rich areas is due to the input of organic waste. Indiscriminate disposal of sewage and industrial waste have been the major cause for the nutrient enrichment in coastal waters leading to reduction in diversity but with increase in total biomass, promoting some opportunistic algal species to dominate and suppress others (Dedegren,1992 and Kimor,1991).

In the project area *Thalassiosira sp* were observed at all the stations. The species of *Thalassiosira* are known to bloom in areas affected by sewage pollution (Stocker et al 1979 and Raman and prakash 1989). In generally the primary productivity, chlorophyll 'a', pheophytin, density and total biomass of phytoplankton was found to be fairly high and sustained with healthy phytoplankton biomass in the sea and is responsible for the photosynthesis. Among the 11 stations sampled at JNPT, the station- 7 was found to show a fairy good phytoplankton number, Primary productivity, density and total biomass followed by station- 3. The chlorophyll 'a' was found to be high at station- 11 and pheophytin observed below detectable level in all the stations.

FIG. 3.4: PHYTOPLANKTON OF PROJECT SITE

	
Coscinodiscus sp.	*Pleurosigma sp.*
	
Ceratium furca	Planktiniella sp.
	
Nitzschia sp.	*Thalassiothrix sp.*

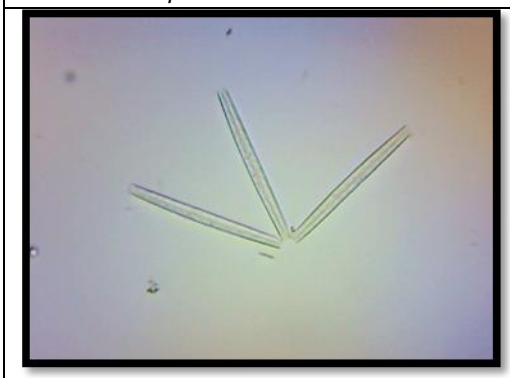
	
Rhizosolenia sp.	*Navicula sp.*
	
Peridinium sp.	*Thallasiosira sp.*
	
Thalassionema sp.	*Pleurosigma sp.*

TABLE 3.39 ABUNDANCE AND DENSITY(CELLS/L) OF PHYTOPLANKTON IN THE PROJECT SITE

sr. no.	Name of the organism/Species	Station 1	Station 2	Station 3	Station 4	Station 5	Station 6	Station 7	Station 8	Station 9	Station 10	Station 11
	Dinoflagellates											
	Class : Dynophyceae											
	Order : Gonyaulac											
	Family : Ceratiaceae											
1	*Ceratium furca*	4	2	5	2	2	2	4	2	6	4	3
2	*Ceratium tripose*	5	2	6	4	5	5	6	1	4	5	5
	Family : Peridiniaceae											
3	*Peridinium sp*	6	2	1	2	2	2	5	6	1	6	1
	Dinoflagellates total units/L	**15**	**6**	**12**	**8**	**9**	**9**	**15**	**9**	**11**	**15**	**9**
	Diatoms											
	Class : Bacillariophyceae											
	Order: Thalassiosirales											
	Family : Thalassiosiraceae											
1	*Thalassiosira sp*	15	10	16	9	8	12	11	11	10	15	14
2	*Planktonella sp.*	10	7	8	11	7	8	9	9	8	10	5
	Order: Coscinodiscales											
	Family :											

	Coscinodiscaceae											
3	*Coscinodiscus sp*	7	10	14	15	9	5	10	9	8	8	7
4	*Coscinodiscus gigas*	6	8	4	9	5	0	0	6	5	2	1
	Order: Naviculales											
	Family : Naviculaceae											
5	*Navicula sp.*	0	4	2	0	6	5	4	8	2	1	5
	Family : pleurosigmataceae											
6	*Pleurosigma sp.*	1	1	0	0	0	1	2	0	1	0	1
	Family Bacillariaceae											
7	*Nistzschia sp*	0	1	3	4	2	1	2	1	2	0	1
8	*Nistzschia closterium*	0	1	2	0	1	2	1	0	3	0	1
	Family : Fragilariaceae											
9	*Thalassionema sp*	1	1	2	0	3	0	2	2	1	2	3
10	*Thalassiothrix*	0	1	1	2	3	1	3	0	1	2	0
	Family: Solenoidae											
11	*Rhizosolenia sp*	4	1	5	2	2	0	1	3	2	1	2
	Family : Lithodesmiaceae											
12	*Triceracium sp*	0	0	0	1	0	2	1	2	1	1	0
	Diatoms total unit/L	**44**	**45**	**57**	**53**	**46**	**41**	**54**	**51**	**44**	**42**	**40**
	Blue-Green algae											
	Class: Cynophyceae											
	Order: Stigonematales											

	Family: Stigonemaaceae											
1	*Stigonema sp*	0	2	0	1	1	1	0	0	0	0	1
	Order: Nostocales											
	Family: Oscillatoriaceae											
2	*Oscillatoria sp.*	1	0	0	0	1	2	1	1	2	0	0
	Blue green algae total units/L	**1**	**2**	**0**	**1**	**2**	**3**	**1**	**1**	**2**	**0**	**1**
	Total Phytoplankton Units/L	**60**	**53**	**69**	**62**	**57**	**53**	**70**	**61**	**57**	**57**	**50**

3.7.6.2 ZOOPLANKTON

The zooplankton density ranges from 65 to 118 Numbers /l In the total study The minimum was observe at station-5 and the maximum was observed at station-2, followed by station-9. The station 11 is located at one of the proposed sites selected for deposal. The station shows better productivity as compared to the other station which are located in area with heavy ship movement and subjected regular maintenance dredging as well.

A total of 22 species of zooplankton were recorded from the study area out of them 12 species of Copepods, 3 species of tintinids, 2 decapods species , a single species of arrow worm and 4 species of larvae were found in the area.

The present study also reveals that the Copapoda were the dominant groups compared to other zooplankton groups. Amongs the copepods *Acrocalanus sp. Centropages sp Acartia sp* were observed at all the station covered in the marine ecological survey The present investigation showed that larval forms were recorded at various stations monitored during the field survey The density of larval forms varied from 5 to 15 no/l at various station in the dredging channel The larval density in the area proposed for disposal of dredge material is 8no/l (station 10) and 5 no/l (station11) .

FIG. 3.5: ZOOPLANKTON OF PROJECT SITE

	
Zoea larvae	*Sagitta sp.*
	
Copepoda	*Lucifer sp.*
	
Bivalve larvae	*Nauplius larvae*

TABLE 3.40: ABUNDANCE AND DENSITY (N/L) OF ZOOPLANKTON IN THE PROJECT SITE

Name of the organism/Species	Station 1	Station 2	Station 3	Station 4	Station 5	Station 6	Station 7	Station 8	Station 9	Station 10	Station 11
Copepodes											
Sub Class : Copepoda											
Order : Calanoida											
Family : Paracalanidae											
Acrocalanus sp.	12	10	9	14	8	10	10	13	15	9	9
Parvocalanus sp	1	1	0	1	0	0	0	0	2	1	0
Bestiolina sp	0	2	1	0	1	1	0	0	0	0	1
Paracalanus sp	0	2	2	2	0	1	1	0	0	0	1
Family : Eucalandae											
subeuccalanus sp	5	6	5	5	0	1	4	6	5	4	4
Family ;Clausocalanidaeae											
Clausocalanus sp	0	2	1	1	1	0	2	6	2	0	1
Family: Acartiidae											
Acartia sp	4	5	2	3	3	1	6	2	1	2	4
Family: Centropagidae											
Centropages sp	5	6	1	4	5	3	2	5	6	4	2
Acartiella sp	1	2	5	0	5	5	0	6	3	0	1
Order : Cyclopoida											
Family: Oithonidae											
Oithona sp.	2	1	4	2	2	3	1	3	1	0	2
Family:Corycaeidae											
Corycaeus sp	4	5	2	6	2	3	1	3	2	1	0
Order : Harpacticoida											
Family: Euterpinidae											

Euterpina sp.	1	0	0	0	0	0	2	0	0	0	0
Copepods total N/L	35	42	32	38	27	28	29	44	37	21	25
Tintinids											
Class : Spirotrichea											
Order: Tintinnida											
Family : Codonellidae											
Tintinopsis gracilis	30	52	23	25	16	26	24	25	38	39	30
Tintiniopsis acuminata	10	5	9	8	6	8	6	9	9	4	10
Family : Codonellopsidae											
Codonellopsis sp	2	1	1	1	3	0	0	0	0	1	0
Tintinnids total N/L	**42**	**58**	**33**	**34**	**25**	**34**	**30**	**34**	**47**	**44**	**40**
Decapoda											
Class : Malacostraca											
Order: Decapoda											
Family : Penaeidae											
Metapenaeus sp	1	0	1	0	1	1	3	0	1	1	1
Family : Luciferidae											
Lucifer sp	5	4	4	6	2	0	1	6	1	2	3
Decapods Total N/L	**6**	**4**	**5**	**6**	**3**	**1**	**4**	**6**	**2**	**3**	**4**
Arrow worms											
Class : Sagittoidae											
Order: Aphragmophora											
Family : Sagittidae											
Sagitta sp.	1	1	2	0	1	0	1	1	1	0	0
Larval forms											
Crustacean Larvae											
Class: Copepoda											
Nauplius larva of Copepods	6	10	10	9	8	9	6	4	12	5	2

Brachyuran Larvae											
Class: Decapoda (Brachyura)											
Zoea larvae	1	2	2	2	1	2	3	0	1	1	1
Molluscan Larvae											
Molluscan larvae	0	1	0	0	0	0	1	1	1	1	1
Bivalve larvae	0	0	0	0	0	1	1	1	1	1	1
Larval forms total N/L	**7**	**13**	**12**	**11**	**9**	**12**	**11**	**6**	**15**	**8**	**5**
Total zooplankton N/L	**91**	**118**	**84**	**89**	**65**	**75**	**75**	**91**	**102**	**76**	**74**

3.7.6.3 Primary productivity

It is the rate at which new organic matter is added to the exiting phytoplankton standing crop. primary productivity depends on the chlorophyll pigments which absorbs the light and produces energy through the process of photosynthesis. Therefore, the estimation of these pigments is prominent to ascertain the productivity of the aquatic environment. The details of primary productivity in the project area are given in table no 3.41. The Gross Primary Productivity (GPP) ranged from 50 to 115. The maximum GPP was observed at station8 and station- 10. The Net Primary productivity (NPP) from 112.5 to 187.5 at various sampling stations covered in the marine ecological survey. The maximum productivity was observed at station-2 and the minimum was at station-3 and station-8. Primary productivity values shows that the low to moderate productive. The area to be dredged has significant ship movement and is also dredged regular as a part of the maintenance dredging activities, all of which attribute to low to moderate productivity.

TABLE 3.41 BIOLOGICAL CHARACTERISTICS OF MARINE WATER IN AND AROUND JNPT AREA

Sr. no.	Biological Parameters	**Station 1**	**Station 2**	**Station 3**	**Station 4**	**Station 5**	**Station 6**	**Station 7**	**Station 8**	**Station 9**	**Station 10**	**Station 11**
1	Primary productivity (PP) (mg/Cm3/hr)											
1.1	Gross productivity	102	112	50	100	75	78	100	112.5	75	112.5	75
1.2	Net Productivity	175	187.5	112.5	175	175	162.5	162.5	150	112.5	150	150
2	Chlorophyll 'a' (mg/m3)	1.431	1.518	1.518	1.139	1.478	1.022	1.209	1.681	1.533	0.887	1.941
3	Pheophytin (mg/m3)	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL	BDL
4	Algal Biomass	95.87	101.71	102.78	76.31	99.03	68.47	81	112.63	102.71	59.43	130.05
5	Phytoplankton											
	Population density (Cells/l)	**60**	**53**	**69**	**62**	**57**	**53**	**70**	**61**	**57**	**57**	**50**
6	Zooplankton											
	Population density (N/l)	**91**	**118**	**84**	**89**	**65**	**75**	**75**	**91**	**102**	**76**	**74**

BDL: below detectable level

Chlorophyll 'a' (mg/m^3)

Chlorophyll 'a' value varied from 0.887 to 1.941 mg/m^3. The maximum density 1.941 mg/m^3 was observed at station-11 and the minimum at station.-10 The variations of chlorophyll 'a' was associated with the numerical abundance of diatoms individuals

Phaeophytin (mg/m^3)

The phaeophytin level is below detectable level in all the stations

The variation of Chlorophyll 'a' was associated with the numerical abundance of phytoplankton The biological process which influence spatial distribution of chlorophyll are phytoplankton production, cellular senescence and zooplankton grazing The chemical environment associated with the zooplankton digestive system is capable of stoichiometrically converting chlorophyll 'a' in to phaeophytin and then to phaeophorbide 'a' The elevated level of phaeophytin may indicate the enhanced zooplankton grazing activity

3.7.6.4 Benthic fauna

Benthos is a collective term referred to the organism lying in or associated with aquatic sediment comprising plants and animals from almost all phylla. Benthic animals are generally described on the basis of their position in the sediment. Benthic fauna have been found to play a significant role in the trophic chain, as they utilize all forms of food materials available in the sea bed or estuarine base form an important link in the pollution on the standing crop and productivity.

Benthic environment is a unique ecological system being designed and regulated by a wide range of physico-chemical and biological factor down from planktons, mud-water interface and sediment realms. Sediments samples were collected from various stations using Peterson;s dredger having a biting area of 16 x 17 cm^2 The sediment obtained was sieved through required meshes to separate macro-fauna (>100µ) and meo-fauna. Each group of organisms were individually identified and a quantitative qualitative analysis has been done.

TABLE 3.42: BENTHOS OBSERVED AT VARIOUS SAMPLING STATIONS IN AND AROUND JNPT AREA

Sr. no.	Name of the organism/Species	Station 1	Station 2	Station 3	Station 4	Station 5	Station 6	Station 7	Station 8	Station 9	Station 10	Station 11
	Polychaetes											
	Family : Nereidae											
1	*Nereis sp.*	25	20	19	23	25	20	21	20	16	25	20
	Family: Phyllodocidae											
2	*Phyllodocidae sp*	5	2	6	1	6	4	2	2	1	1	0
	Family : Amphinomidae											
3	*Amphinomie sp*	15	15	10	10	5	6	10	14	12	12	12
	Bivalves											
4	*Placenta Placenta*	0	1	2	0	0	0	1	0	5	0	2
5	Crustacea	0	0	1	2	0	0	0	0	0	0	0
6	*balanus sp.*	0	2	0	0	0	0	0	1	1	0	
7	*Tibia curta*	1	2	3	4	1	2	2	1	2	2	2
8	*Phalium sp.*	0	0	0	0	0	1	0	0	0	0	0
9	*Cancellaria sp*	0	1	1	0	0	0	0	0	0	0	0
	Amphipods											
10	*Corophium sp*	5	10	2	2	2	2	0	0	1	0	12

3.7.6.5 Mangroves

Mangroves are various types of trees up to medium height and shrubs that grow along the intertidal zone of coast or estuaries in the tropics and subtropics mainly between latitudes 25° N and 25° S (Giri et al 2011; Zhang et al 2007) They have special physiological adaptations to frequently inundation by the tides (Lewis III 2005). Numerous studies on mangrove habitats have demonstrated the high biological productivity and rich biodiversity of these ecosystems in tropical and sub-tropical regions (Lindegarth & Hoskin 2001; Valiela et al 2001; Ashton & Macintosh 2002; Macintosh et al 2002). Despite the physical and biological fragility of these coastal ecosystems, they provide a wide range of ecological services such as: (1) improve water quality by filtering and assimilating pollutants; (2) stabilize and improve the soil and protect shorelines from erosion; (3) maintain biodiversity and genetic resources; (4) provide feeding, reproductive, shelter and nursery sites to several terrestrial and aquatic species; (5) regulate important processes of estuarine chemical cycles and (6) capture carbon dioxide (Ronnback 1999; Sydenham & Thomas 2003; Kathiresan & Rajendran 2005). Mangroves formerly occupied ~75% of tropical coasts and inlets (Farnsworth & Ellison 1997), but today they only line ~25% of the world's tropical coastlines (World Resources Institute 1996). For the Asia-Pacific region an annual deforestation rate of 1% is considered to be a conservative measure (Ong 1995). More than 50% of the loss in mangrove area can be attributed to conversion into shrimp pond aquaculture. Other factors influencing the global decline of mangrove systems are widespread urban agricultural, and industrial development, as well as pollution and overfishing (Macintosh 1996; Valiela et al 2001) These mangrove losses have resulted in a reduction in biodiversity and the abundance of macrofauna, particularly seafood. In fact, the ecological basis for economic value of seafood production is supported by mangrove ecosystems (Ronnback 1999). Mangroves play a vital role in the energy budget of tropical coastal areas by providing significant nutrient supplies to adjacent benthic and pelagic food webs (Kieckbusch et al 2004; Alfaro 2006). However, the pathways and mechanisms by which this primary productivity is transferred to higher trophic levels and its ability to support secondary productivity can be difficult to identify.

Ecological Importance of Mangroves

Mangrove trees are an indigenous species to Florida and a major contributor to the state's marine environment. The mangrove tree is a halophyte, a plant that thrives in salty conditions. It has the ability to grow where no other tree can, thereby making significant contributions that benefit the environment. Their coverage of coastal shorelines and wetlands provides many diverse species of birds, mammals, crustacea, and fish a unique, irreplaceable habitat. Mangroves preserve water quality and reduce pollution by filtering suspended material and assimilating dissolved nutrients. The tree is the foundation in a complex marine food chain and the detrital food cycle. The detrital food cycle was discovered by two biologists from the University of Miami, Eric Heald & William Odum, in 1969. As mangrove leaves drop into tidal waters they are colonized within a few hours by marine bacteria that convert difficult to digest carbon compounds into nitrogen rich

detritus material. The resulting pieces covered with microorganisms become food for the smallest animals such as worms, snails, shrimp, mollusks, mussels, barnacles, clams, oysters, and the larger commercially important striped mullet. These detritus eaters are food for carnivores including crabs and fish, subsequently birds and game fish follow the food chain, culminating with man. Many of these species, whose continued existence depends on thriving mangroves, are endangered or threatened. It has been estimated that 75% of the game fish and 90% of the commercial species in south Florida rely on the mangrove system. The value of red mangrove prop root habitat for a variety of fishes and invertebrates has been quantitatively documented. Data suggest that the prop root environment may be equally or more important to juveniles than are sea grass beds, on a comparable area basis. Discovery of the importance of mangroves in the marine food chain dramatically changed the respective governmental regulation of coastal land use and development. Despite increasing awareness regarding value and importance, the destruction of mangrove forest continues to take place in many parts of the world under a variety of economic as-well-as political motives. In some areas, mangroves are protected by law but a lack of enforcement coupled with the economic incentive to reclaim land can result in deliberate destruction. Escalating pressure on mangrove populations and increasing quantities of pollutants reaching coastal and intra-coastal waters has brought new interest in the importance of mangroves to a healthy marine ecology.

TABLE 3.43 MANGROVES SP. OBSERVED IN JNPT AREA

Sr. no	Family	No. of genus	No. of species
1	Avicenniaceae	1	2
2	Acanthaceae	1	1
3	Euphorbiaceae	1	1
4	Mycrinaceae	1	1
5	Rhizophoraceae	1	3
6	Sonneratiaceae	2	2
Total	6	7	10

A total of 10 species were recorded in and around JNP area. *Avicennia marina* was found to be the most dominant species followed by *Acanthus illicifolius* , other species be insignificant in this region The dominance of *Avicennia marina* is due to its wide range of tolerance to the extreme environment The production of seeds, their survival rate, germination establishment and growth is altogether found to be more than the other species.

Terrestrial biodiversity were also carried out near JNP area. major findings are as follows

3.7.6.6 Floral Diversity

Vegetation study was undertaken to document diversity of herb, shrub, climber and tree species prevalent at JNPT and nearby area. Background information on floristic/vegetation diversity

from literature survey was used to create a detailed account of local vegetation that may not have been encountered during the study. a total of 40 floral species were recordedas trees-19, Shrubs-4, Herbs- 12, Climbers-5. list of observed floral species is listed as follows

TABLE 3.44 FLORAL DIVERSITY OBSERVED IN & NEAR JNPT AREA

Sr. no	Scientific name	Common name	Family	Habit
1	*Abelmoschus manihot (Linn.) Medicus*	Raanbhendi	Malvaceae	Shrub
2	*Acanthus ilicifolius L.*	Holly mangrove,muramdo	Acanthaceae	Shrub
3	*Achyranthes aspera L.*	Aghada	Amaranthaceae	Herb
4	*Alternanthera paronychioides St. -Hill.*	Smooth chaff flower	Amaranthaceae	Herb
5	*Apluda mutica L.*	Mauritian grass	Poaceae	Herb
6	*Avicennia officinalis L.*	Tivar	Avicenniaceae	Tree
7	*Avicennia marina (Forssk.) Vierh.*	Tavir, Grey Mangrove	Avicenniaceae	Tree
8	*Azadirachta indica A. Juss.*	Kaduneem	Meliaceae	Tree
9	*Barleria cristata L.*	Vajra danti	Acanthaceae	Herb
10	*Basela alba L.*	Velbendi	Basellaceae	Herb
11	*Blumea lacera (Burm.f.) DC.*	Burando	Asteraceae	Herb
12	*Bombax ceiba L.*	Kate savar	Bombacaceae	Tree
13	*Bridelia spinosa Willd.*	Asana	Euphorbiaceae	Tree
14	*Cajanus scarabaeoides (L.) Thouars*	Showy Pigeonpea	Fabaceae	Herb
15	*Calotropis gigantia(L.)Dryand*	Rui	Asclepiadaceae	Shrub
16	*Carissa carandas L.*	Karvand	Apocynaceae	Shrub
17	*Celosia argentea L.*	Kurdu	Amaranthaceae	Herb
18	*Ceriops tagal (Perr.) C. B. Rob*	Tagal mangrove	Rhizophoraceae	Tree
19	*Coccinea grandis (L.) Voight*	Tondli	Cucurbitaceae	Climber
20	*Cocculus hirsutus (L.) Diels*	Vasanvel	Menispermaceae	Climber
21	*Cordia dichotoma Forst.f.*	Bhokar	Boraginaceae	Tree
22	*Crateva religiosa G. Forst.*	Vayavarna	Capparaceae	Tree
23	*Cressa cretica L.*	Rudravanti	Convolvulaceae	Herb
24	*Cynodon dactylon (L.) Pers.*	Doorva	Poaceae	Herb
25	*Derris trifoliata Lour.*	Kaaranj vel	Leguminoceaae	Climber
26	*Erythrina stricta Roxb.*	Pangara	Fabaceae	Tree
27	*Ficus benghalensis L.*	Vad	Moraceae	Tree
28	*Ficus religiosa L.*	Pimpal	Moraceae	Tree

29	*Grewia asiatica L.*	Phalsa	Tiliaceae	Tree
30	*Hyptis suaveolens (Linn.) Poir*	Bush mint , Jungli Tulas	Lamiaceae	Herb
31	*Leucaena leucocephala (Lamk.) De Wit.*	Subabhul	Mimosaceae	Tree
32	*Momordica charantia Linn.*	Karela	Cucurbitaceae	Climber
33	*Morinda pubesence Sm.*	Bartondi	Rubiaceae	Tree
34	*Mucuna pruriens (L.) DC. Prodr.*	Khaj-kuili	Fabaceae	Climber
35	*Parkinsonia aculeata L.*	Vilayati kikar	Leguminoceaae	Tree
36	*Peltophorum pterocarpum (DC.) Bk.exHyn*	Sonmohar	Caesalpiniaceae	Tree
37	*Pongamia pinnata L. Pierre.*	Karanj	Fabaceae	Tree
38	*Psidium guajava Linn.*	Peru	Myrtaceae	Tree
39	*Scoparia dulcis L.*	Sweet Broom Weed	Scrophulariaceae	Herb
40	*Zizyphus mauritiana Lamk.*	Ber	Rhamnaceae	Tree

3.7.6.7 Faunal diversity

To study faunal diversity, random sightings/search and sampling points on predetermined transects were used. For reptiles, we searched by stone lifting, looking at rock crevices and wall space of structures in the samping locations. Amphibians were searched near the stagnant water pools and small streams. Insects were observed on underside of leaves, nests, rock crevices, bushes and other places. Birds were studied by point sampling method and mammal diversity assessment was based on indirect evidences and random interviews with the local human community. During survey total 70 faunal sp. were recorded of which 46 were birds, 23 insect, 2 reptiles and a species of spider were observed, list of observed faunal species is listed in following table.

TABLE 3.45 FAUNAL DIVERSITY OBSERVED IN & NEAR JNPT AREA

Sr.no	Scientific name	Common name	Family	Group	IUCN
1	Common myna	*Acridotheres tristis*	Sturnidae	Bird	Least Concern
2	Common sandpiper	*Actitis hypoleucos*	Scolopacidae	Bird	Least Concern
3	White-breasted waterhen	*Amaurornis phoenicurus*	Rallidae	Bird	Least Concern
4	Openbill stork	*Anastomus oscitans*	Ciconiidae	Bird	Least Concern
5	Great egret	*Ardea alba*	Ardeidae	Bird	Least Concern
6	Cattle egret	*Bubulcus ibis*	Ardeidae	Bird	Least Concern

7	Little ringed plover	*Charadrius clubius*	Charadriidae	Bird	Least Concern
8	Purple sunbird	*Cinnyris asiaticus*	Nectariniidae	Bird	Least Concern
9	Black drongo	*Dicrurus macrocercus*	Dicruridae	Bird	Least Concern
10	Tawny-bellied babbler	*Dumetia hyperythra*	Timaliidae	Bird	Least Concern
11	Little egret	*Egretta garzetta*	Ardeidae	Bird	Least Concern
12	Asian koel	*Eudynamys scolopaceus*	Cuculidae	Bird	Least Concern
13	White-throated kingfisher	*Halcyon smyrnensis*	Halcyonidae	Bird	Least Concern
14	Black-winged stilt	*Himantopus himantopus*	Recurvirostridae	Bird	Least Concern
15	Brown-headed gull	*Larus brunnicephalus*	Laridae	Bird	Least Concern
16	Little cormorant	*Microcarbo niger*	Phalacrocoracidae	Bird	Least Concern
17	White-cheeked barbet	*Psilopoganviridis*	Megalaimidae	Bird	Least Concern
18	Red vented bulbul	*Pycnonotus cafer*	Pycnonotidae	Bird	Least Concern
19	Red-wiskered bulbul	*Pycnonotus jocusus*	Pycnonotidae	Bird	Least Concern
20	Pied starling	*Sturnus contra*	Sturnidae	Bird	Least Concern
21	Yellow-footed green pigeon	*Treron Phoenicopterus*	Columbidae	Bird	Least Concern
22	Wood sandpiper	*Tringa glareola*	scolopacidae	Bird	Least Concern
23	Common greenshank	*Tringa nebularia*	Scolopacidae	Bird	Least Concern
24	Marsh sandpiper	*Tringa stagnatilis*	Scolopacidae	Bird	Least Concern
25	Common redshank	*Tringa totanus*	Scolopacidae	Bird	Least Concern
26	House crow	*Corvus splendens*	Corvidae	Bird	Least Concern
27	Spot-billed duck	*Anas poecilorhyncha*	Anatidae	Bird	Least Concern
28	Grey heron	*Ardea cinerea*	Ardeidae	Bird	Least Concern
29	Indian pond heron	*Ardeola grayii*	Ardeidae	Bird	Least Concern

30	Rock pigeon	*Columba livia*	Columbidae	Bird	Least Concern
31	Jungle crow	*Corvus macrorhynchos*	Corvidae	Bird	Least Concern
32	Asian palm swift	*Cypsiurus balasiensis*	Apodidae	Bird	Least Concern
33	Brahminy kite	*Haliastur indus*	Accipitridae	Bird	Least Concern
34	Grey hornbill	*Ocyceros birosteis*	Bucerotiformes	Bird	Least Concern
35	Long-tailed shrike	*Lanius schach*	Laniidae	Bird	Least Concern
36	Black-tailed godwit	*limosa lapponica*	Scolopacidae	Bird	Least Concern
37	Green bee-eater	*Merops orientalis*	Meropidae	Bird	Least Concern
38	Black kite	*Milvus migrans*	Accipitridae	Bird	Least Concern
39	Chestnut - shouldered petronia	*Petronia xanthocollis*	Passeridae	Bird	Least Concern
40	Plain prinia	*Prinia inornata*	Cisticolidae	Bird	Least Concern
41	Ashy prinia	*Prinia socialis*	Cisticolidae	Bird	Least Concern
42	Rose ringed Parakeet	*Psittacula krameri*	Psittaculidae	Bird	Least Concern
43	White-throated fantail	*Rhipidura albicollis*	Truerhipidhuridae	Bird	Least Concern
44	Indian Robin	*Saxicoloides fulicatus*	Muscicapidae	Bird	Least Concern
45	Spotted dove	*Spilopelia chinensis*	Columbidae	Bird	Least Concern
46	Red wattled lapwing	*Vanellus indicus*	Charadriidae	Bird	Least Concern
47	Gram blue	*Euchrysops cnejus*	Lycaenidae	Insect	no category
48	Common indian crow	*Euploea core*	Nymphalidae	Insect	no category
49	Common pierrot	*Castalius rosimon*	Lycaenidae	Insect	no category
50	Common emigrant	*Catopsilia pomona*	Pieridae	Insect	no category
51	Small salmon arab	*Colotis amata*	Pieridae	Insect	no category
52	Plain tiger	*Danaus chrysippu*	Nymphalidae	Insect	no category

53	Striped Tiger	*Danaus genutia*	Nymphalidae	Insect	no category
54	jezebel	*Delias eucharis*	Pieridae	Insect	no category
55	Common grass yellow	*Eurema hecabe*	Pieridae	Insect	no category
56	Tawny coster	*Acraea terpsicore*	Nymphalidae	Insect	no category
57	Psyche	*Leptosia nina*	Pieridae	Insect	no category
58	Common Sailor	*Neptis hylas*	Nymphalidae	Insect	no category
59	Common rose	*Pachliopta aristolochiae*	Papilionidae	Insect	no category
60	Glassy tiger	*Parantica aglea*	Nymphalidae	Insect	no category
61	White orange tip	*Ixias marianne*	Pieridae	Insect	no category
62	Peacock pansy	*Junonia almana*	Nymphalidae	Insect	no category
63	Lemon pansy	*Junonia lemonias*	Nymphalidae	Insect	no category
64	Pea blue	*Lampides boeticus*	Lycaenidae	Insect	no category
65	Antlion	*Distoleon tetragrammicus*	Myrmeleontidae	Insect	no category
66	Banded pearl moth	*Sameodes cancellalis*	Crambidae	Insect	no category
67	Ditch jewel	*Brachythemis contaminata*	Libellulidae	Insect	no category
68	Field cricket	*Gryllodes sp*	Gryllidae	Insect	no category
69	Carpenter bee	*Xylocopa auripennis*	Apidae	Insect	no category
70	Garden lizard	*Calotes versicolor*	Agamidae	Reptile	no category
71	Brahminy Skink	*Mabuya carinata*	Scincidae	Reptile	no category
72	Funnel web Spider	*Hippasa sp*	Hexathelidae	Spider	no category