

## **CHAPTER – IV**

### **BASELINE ENVIRONMENTAL CONDITION**

1. In order to predict anticipated impacts due to any project, it is necessary to obtain baseline information of the environment, as it exists, which would serve as a datum. The interaction of baseline environment and the anticipated impacts are the basis for the environmental management plan for the activities of the proposed power plant.
2. Major activity for the proposed ultra mega power plant includes construction of foundations for steam turbines, storage areas, switchyards and other auxiliary structures for the establishment of proposed power project. This chapter includes existing scenario for various environmental components of the study area.

### **BASELINE DATA**

3. The baseline status of environmental quality in the vicinity of project expansion site serves as a basis for identification and prediction of impact. The baseline environmental quality status is assessed through field studies within the study area for various components of environment, viz, air, noise, water, land, biological and socio-economic. The baseline environmental quality of the study area of 10 km radius from the proposed project has been identified through network method. Also 25 km radius around the project site has been covered for general area of study. The cause -condition - effects are devised for the individual environmental components as well as overall impact.
4. Baseline data collection for each of the environmental components is based on the location of proposed project and anticipated distance of the significant impact. The study area is defined for each of the environmental components independently taking into consideration the vulnerability of the environmental component with respect to the activity of proposed expansion.

### **METHODOLOGY**

5. A general reconnaissance survey of the study area was done before the selection of sites for environmental monitoring. The area covered took into consideration was the accessibility to the sampling sites, topography of the area, major habitation and location of sensitive areas. Some of the recently generated data from secondary sources were also collected and used as baseline information.

### **PROJECT SITE**

6. PFC has identified a potential site for development of proposed coastal power project of 4,000 MW (Nominal) located at Mundra taluka, Kutch district, in Gujarat state. Alternative sites near Kandla Port was also selected but not considered because of a) Non-availability of the sufficient draft for handling 12 MT/annum of coal, b) inadequate coal handling facility and c) unsuitable land consists of salt pans and owned by private people.
7. CGPL intend to install a 4000 MW (Nominal) coal fired thermal power station at site in coastal area at Tundawand village to take advantage of available

habitated land, sea water, proximity to Mundra port (approximately 22 km) and other infrastructure required for the same. The layout map of the proposed power plant is presented in Figure III.1 in Chapter-III.

8. The site is located near Tundawand village at Mundra taluka, Kutch district of Gujarat Coastal area. The proposed project site is located at 22 km from Mundra port. The site is well connected with state Highway no. SH-50 (via Anjar) and SH-6 (via Gandhidham) and would be near to NH-8A (Delhi-Kandla).
9. The nearest railway station is Adipur and is 57 km away from the site. The railway station is well connected to multi-terminal Mundra port through broad gauge railway system owned by M/s. Adani Group. The nearest airport is Bhuj which is about 60 km from site. The site is about 2.5 km from the sea (Gulf of Kutch). The latitude and longitude of north-west corners are 22° 49' 48" N and 69° 30' 58" E respectively. The location of proposed site is shown in Figure II.1 in Chapter-II.
10. The seawater from Gulf of Kutch is the major source of water for the proposed power plant as there are no sources of sweet water. The location for intake water is identified at about 6.5 km from the plant site.
11. The 4000MW (Nominal) power plant is proposed to be located in a site near Tundawand village. The plant would be located considering CRZ regulations. The boundary of the main power plant is more than 500 m away from the High Tide Line (HTL). A satellite map indicating HTL and LTL is attached as Appendix-2. The land required for the power plant including ash disposal area is estimated to be 1242 Ha, and for housing colony about 182 Ha. The details of the land is given as under

S.No	Plant Facility	Village	Area (Ha)	Ownership
1.	Main Plant Area	Tunda/ Kandagara	88 12 218 169 130 Sub-Total 617	Govt. Waste Land, Govt. (Gaucher) MSEZ *(to be notified & allocated to UMPP) Private land Forest land to be allocated
2.	Ash Disposal (Ash corridor, ash dyke, dry ash collection system)	Kandagara	241	Govt. Waste land
3.	Colony	Nana Bhadiya	182	Govt. Waste Land
4.	MGR System	6. From Mundra Port to UMPP Site	100	Govt. Forest and MSEZ and Private Land
5.	Intake Outfall Channel		102	Govt. Land
		Total	1242 Ha	

12. Category wise (ownership) land breakup is shown as below:

S. No	Ownership	Area (Ha)
1.	Government Land	653
2.	MSEZ Land	218
3.	Private Land	169
	<b>Total</b>	<b>1040</b>

The land acquisition process is underway.

13. The site for the proposed unit is fairly graded with minimum undulation and would require nominal filling and grading of the plant to the proposed level of about 5 m MSL.
14. The power plant site is located in seismic Zone -V as per IS 1893 classification and therefore seismic factor of 1.5 will be considered for all designs.
15. The proposed site is remotely situated from major town or eco-sensitive spots including national park, wildlife sanctuary, biosphere reserve, historical and cultural sites and defence installation, places of historical, religious and cultural importance.
16. Provision of green belt has been kept within the premise of proposed power plant. For raising plantation adequate saplings would be planted covering about 33% of the total acquired area in side the power plant. The green belt would consist of native perennial green and fast growing trees. Trees would also be planted around the coal stockpile area and ash disposal area to minimise the dust pollution. Sanghi cement plant located at 145km from project site at Sanghipuram and cement plant proposed by M/s Adani and other industries has been considered as potential user of the ash generated from the power plant.
17. Separate housing colony for power plant staff is proposed near power plant within 5 km to accommodate 1200 persons. The area of the colony will be about 182 Ha.

### **PHYSIOGRAPHY AND DRAINAGE**

18. Due to gentle gradient towards the sea (Gulf of Kutch) most of the water flows in the sea within short span of time. The area is drained by several rivers and small tributaries, which are of dendritic pattern which remains dry in almost all the season. The seasonal rivers (rain fed) flowing through Mundra Taluka are River Nagmati, Bhukhi, Khari nadi and Phot, all in turn terminates to Gulf of Kutch. All rivers are dry most of time except for monsoon season. Khari nadi flows from North to South near Kandagara village, passes through Tundawand and terminates into the sea.
19. River Nagmati enters from NE and flows towards South and meets Gulf of Kutch near Jarpara village. River Bhukhi flows from North to South while Phot River flows from Village Bocha at North of Taluka and merge in the Gulf of Kutch, South of Taluka near Mundra. In Mandvi Taluka the seasonal rivers are Rukmavati, Kharod and Vantharadi. Mundra lies close to the Narmada Main Canal. The Narmada drinking water pipeline is passing close to the port and water is being tapped from Jarpara area.
20. The main source of water for the proposed power plant will be seawater. The seawater from Gulf of Kutch located at about 2.5 km from the site, will be utilized for the project, as there are no source of sweet water. Seawater would

be directly used for condenser cooling and the fresh water requirement would be met by installation of a desalination plant.

21. The surrounding area of the proposed project is studied for assessing the baseline environmental conditions. Site features and vicinity within 30 km radius from the study area is indicated in Figure IV.1.
22. The surrounding study-areas mainly consisting of rural conglomerates with very sparse population. Agricultural fields are covered with herbs and shrubby vegetation Soil at project location is silty sand. Vegetation of the study area can be categorized as Northern tropical Forest sub type C-I Desert Thorn Forest.
23. The study area within 10 km radius includes the villages from both Mundra and Mandvi Taluka.
24. There is no national park, biosphere reserve, sanctuary, and habitat for migratory birds, archaeological site, or airports within 10 km radius of the study area. However, few historical places are located within 25 km radius at Mandvi and Beraja. Naliya Grassland/ India Bustard Sanctuary (23°30'N, 68° 45'E) is located nearly 100 kms from the project location.

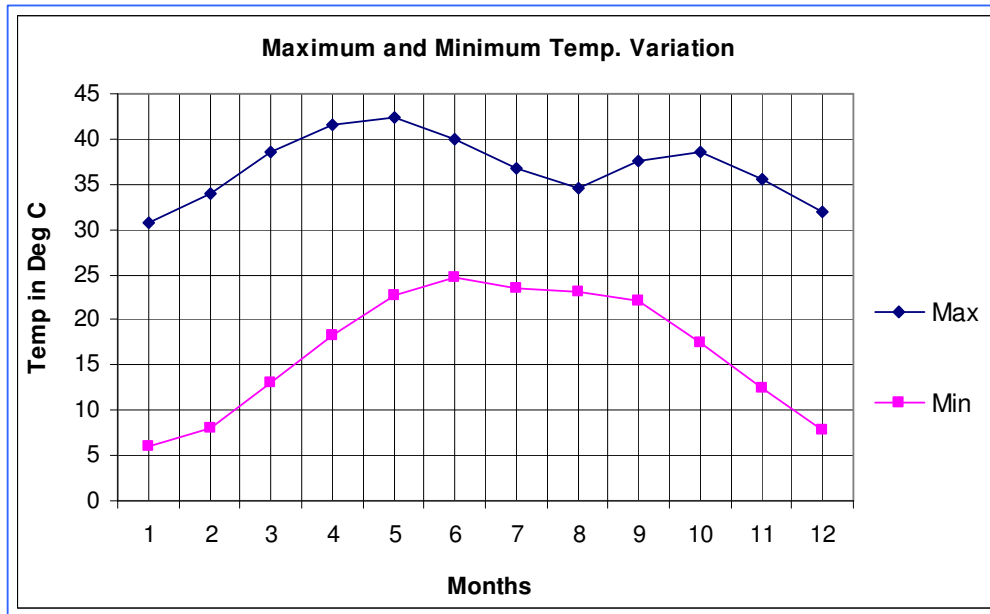
### **CLIMATE**

25. The climate of the study region in general is categorized by frequent draught and extreme temperature. The year may be divided into three seasons – summer (March to May), monsoon (June to September), post-monsoon (October to November) and winter (December to February). The region gets the rainfall from South West Monsoon. It is very erratic both in the extent and in duration. The weak monsoon rains and high rate of evaporation not only make the land area arid but also influence the seawater salinity to increase. Consequently, the region is relatively deficient on water resources.
26. The nearest meteorological station of Indian Meteorological Department (IMD) is at Bhuj located at 50 km. from the site. Data is also available from IMD Bhuj for last 30 years (Figure IV.2a, IV.2b and IV.2c). The meteorological data are also measured at Mundra Port (Figure IV.2 d, e and f). Mundra Port data shows that the mid November to February is the winter season of the year, December being the coldest month having an average minimum temperature of 9°C. Available mixing height data has been collected for Ahemdabad (23 04N Longitude: 72 38E Latitude), which is approximately 310 km (aerial distance) from the site.
27. Summer starts from March and continuous till May end. The air temperature varies from 5°C to 41°C. The relative humidity ranges from 80 to 90% during monsoon season. The sky is clear or lightly clouded except during monsoon period. Visibility is good throughout the period. However, average visibility of less than 1 km can be expected for a few days in winter month. The mean annual rainfall of Mundra and Mandvi talukas are 429 mm and 319 mm (from 1982-2002) respectively. The average number of rainy days in a year is only 14.

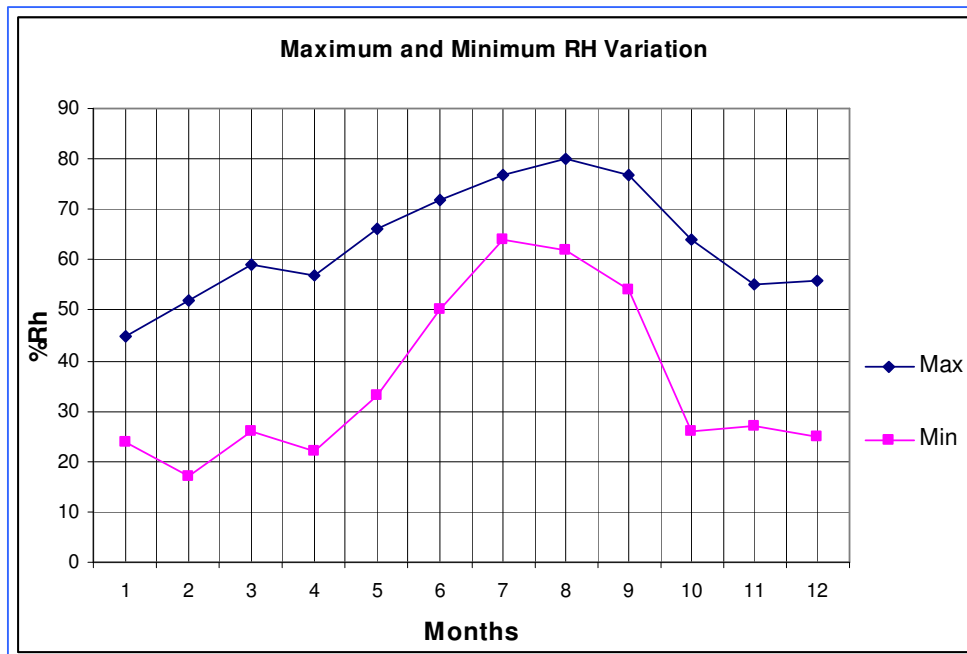
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**Figure IV.1**  
**Panoramic View of the Study Area with in 30 km Radius**

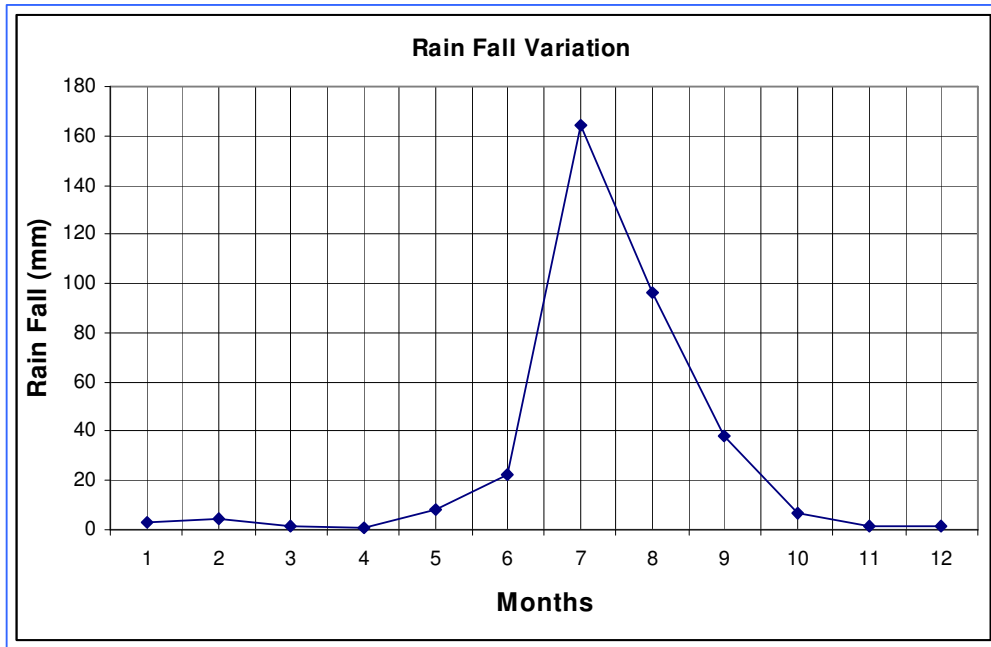
**Figure IV.2a**  
**Monthly Temperature Variation at IMD Bhuj**



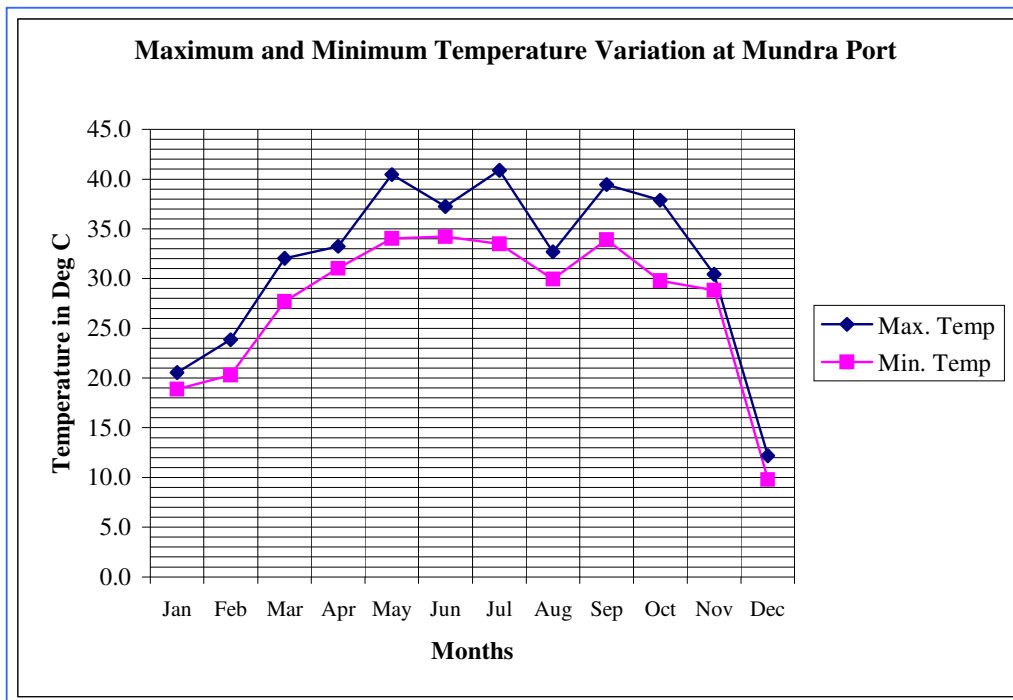
**Figure IV.2b**  
**Maximum and Minimum RH Variation at IMD Bhuj**



**Figure IV.2c**  
**Monthly Rainfall Variation at IMD Bhuj**

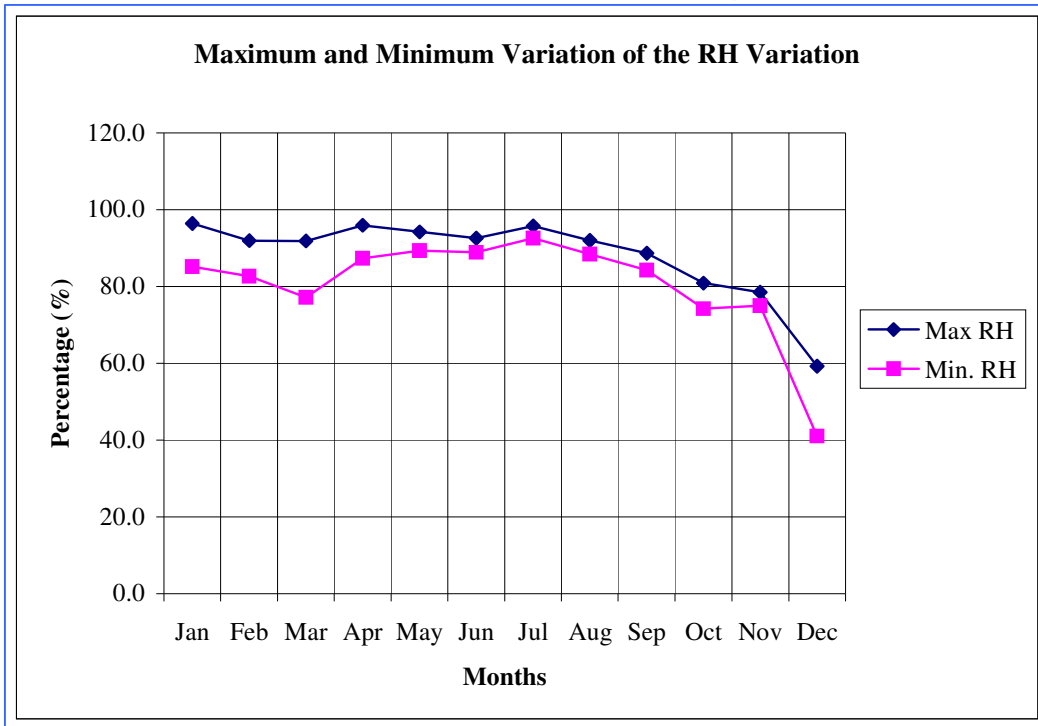


**Figure IV.2d**  
**Maximum and Minimum Temperature Variation at Mundra Port**



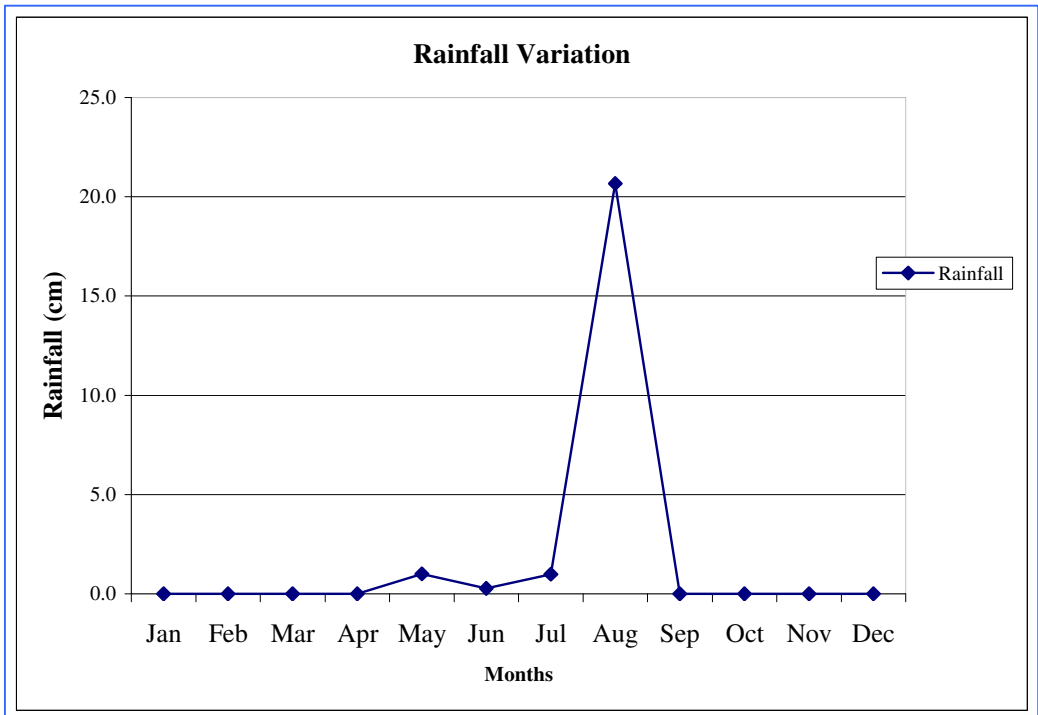
Source: Mundra SEZ

**Figure IV.2e**  
**Maximum and Minimum Variation of Relative Humidity at Mundra Port**



Source: Mundra SEZ

**Figure IV.2f**  
**Monthly Rainfall Variation at Mundra Port**



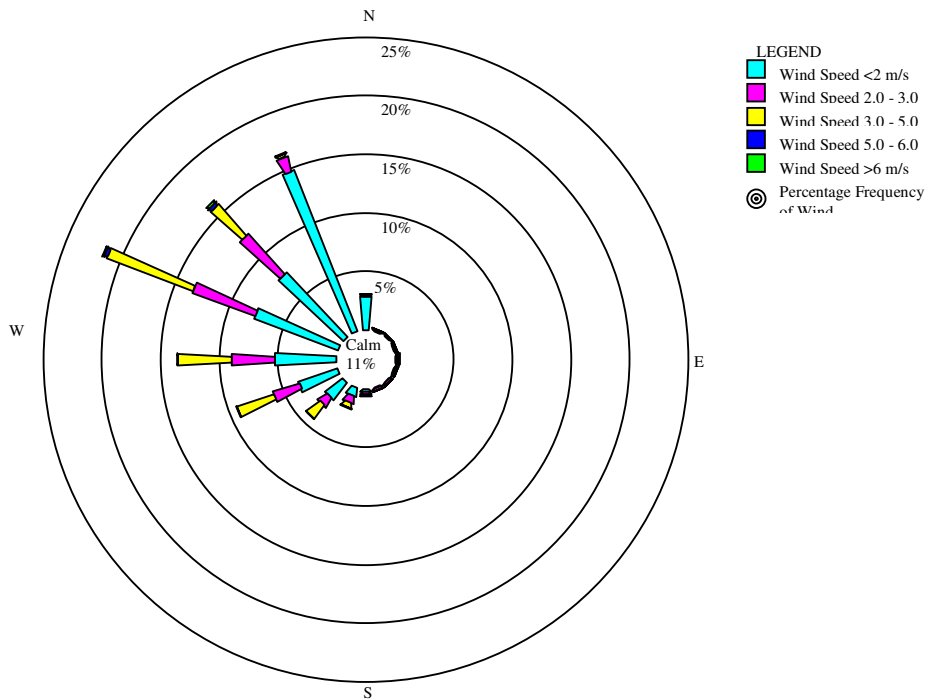
Source: Mundra SEZ



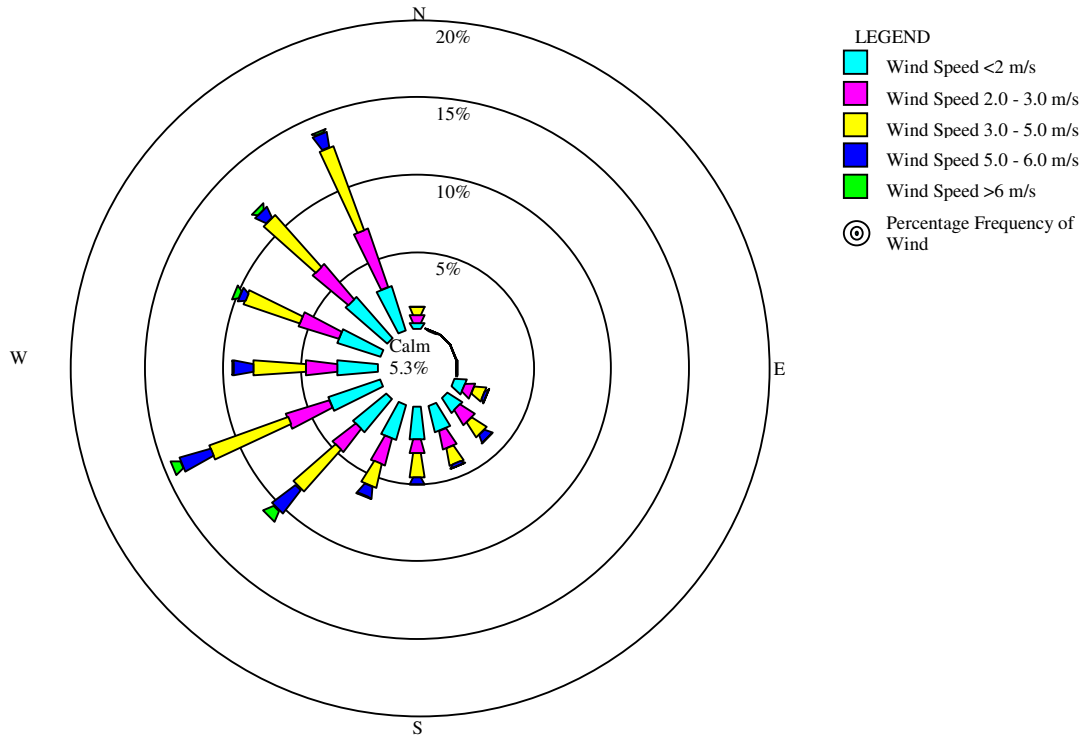
**METEOROLOGY**

28. Meteorological station was established at one of the centrally located site (Tundawand village) during the air-quality-monitoring period for three months in summer season. Photograph of the met station is shown in Appendix-3. The meteorological station was hindrance free and opens from all directions. Site-specific meteorological data were collected for wind speed, wind direction, ambient temperature, relative humidity (RH), and rainfall. The collected meteorological data for four seasons were analyzed on hourly basis.
29. The collected data on the wind speed and direction were analyzed and wind rose was drawn with the help of in-house developed software. The wind rose diagrams for each season are shown in Figure IV.3a, IV.3b, IV.3c and IV.3d, respectively. Wind rose diagram drawn for total study period is shown in Figure. IV.3e. The prevailing wind direction at site is from NW and NNW during summer season. For monsoon, the prevailing wind direction at site is from WSW and NNW. The prevailing wind direction at site is from W and WSW during post-monsoon season. The prevailing wind direction at site is from NNE during winter season. The prevailing wind direction at site is from WSW to NNW sector during the total study period.
30. The hourly variation of ambient temperature for each season is shown in Figure IV.4a-d. For summer, the mean daily maximum temperature goes up to 33.0°C and the highest temperature recorded was 40.2°C. Month of May is nearly as hot as April, and in these two months, the heat is oppressive. With the onset of monsoon in June, the weather becomes slightly cooler and continued to be so through out the monsoon period.
31. The annual maximum rainfall at Bhuj is recorded as 348.7mm whereas the maximum monthly rainfall was recorded to be 164mm during month of July. The heaviest 24 hour intensity of rainfall was recorded to be 467.9 mm during the rainy season.

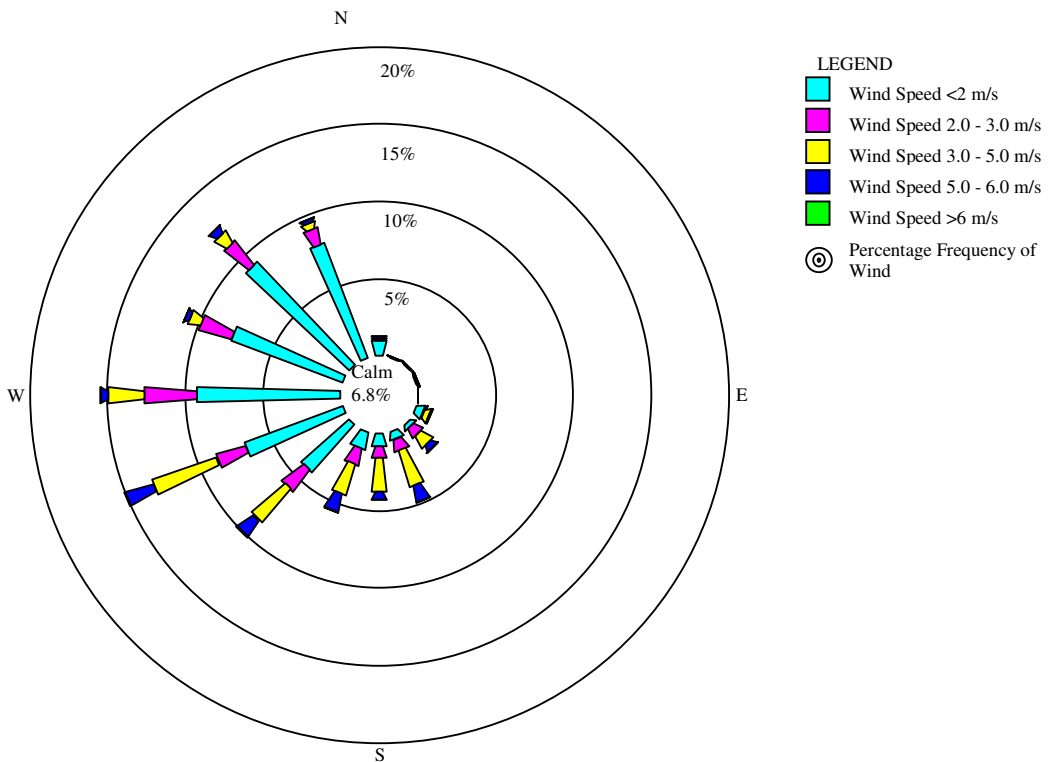
**Figure - IV.3a  
Wind-rose Diagram for summer (March to May) – 2006**



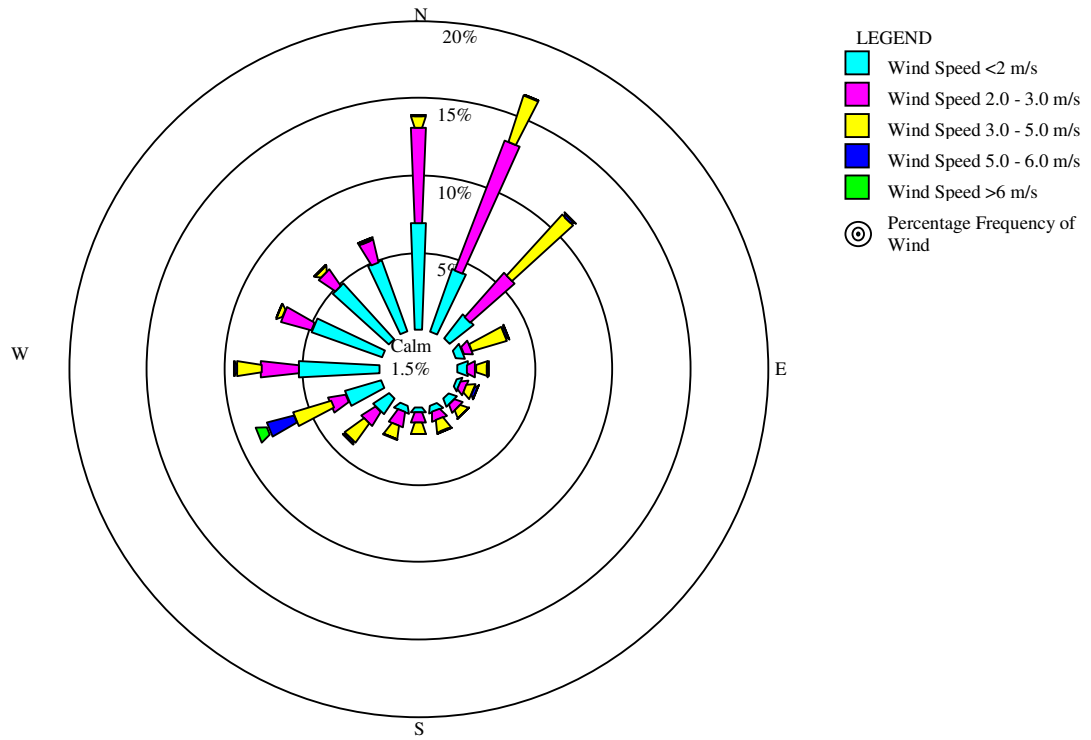
**Figure - IV.3b**  
**Wind-rose Diagram for Monsoon (June to September) – 2006**



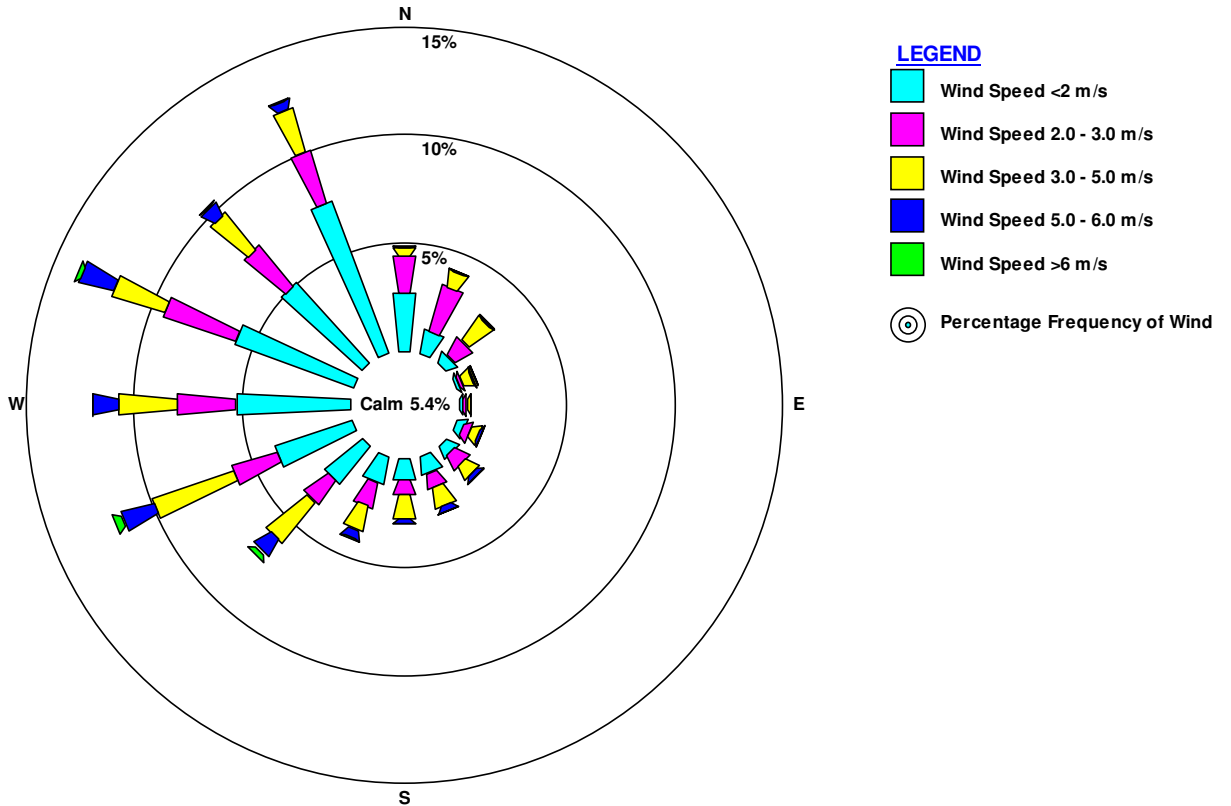
**Figure - IV.3c**  
**Wind-rose Diagram for Post-monsoon (October to November) – 2006**



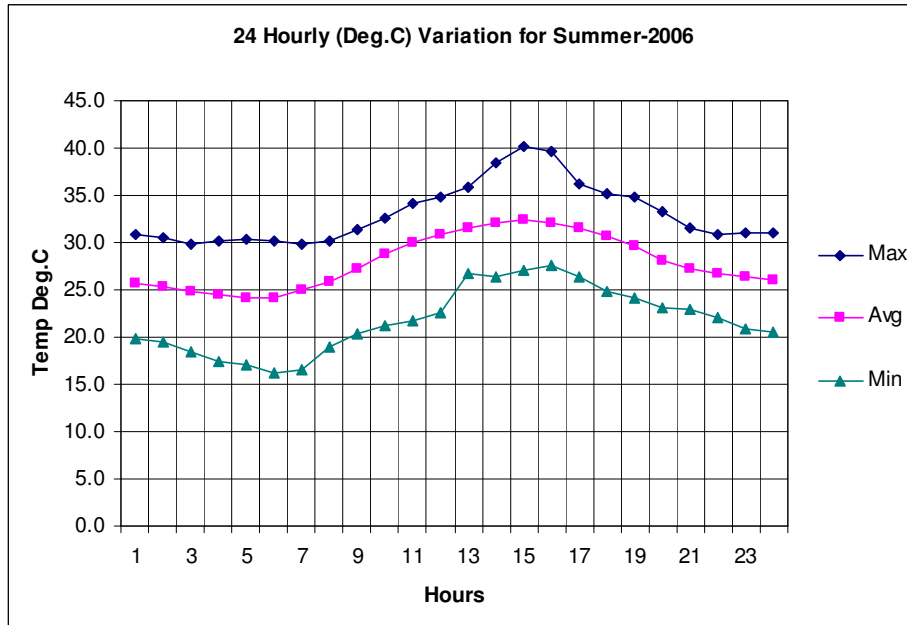
**Figure - IV.3d**  
**Wind-rose Diagram for winter (December 2006 to February 2007)**



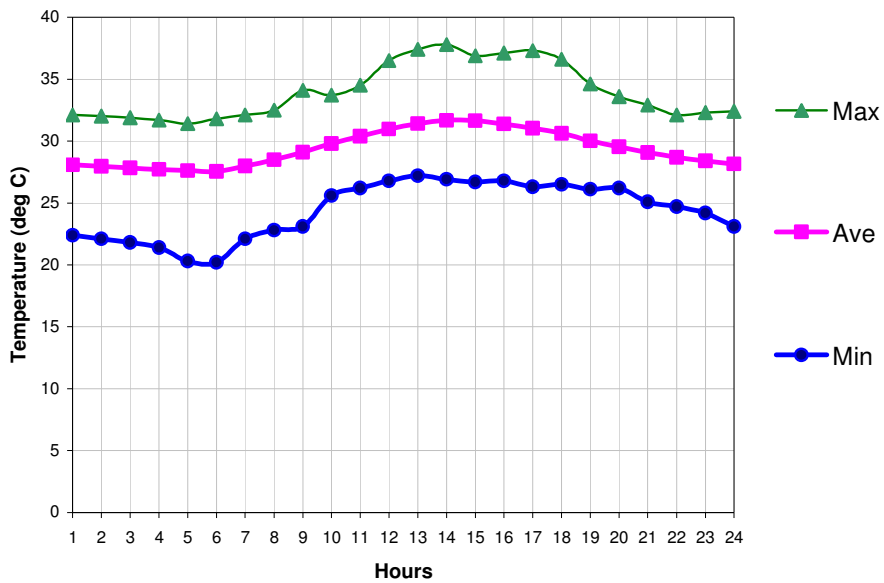
**Figure - IV.3e**  
**Annual Wind-rose Diagram (Period March '06 to February 07)**



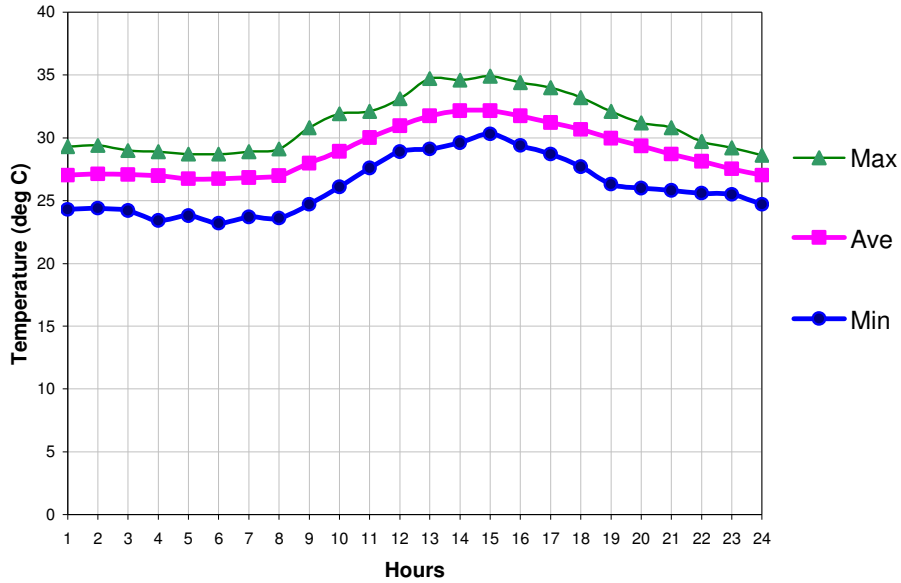
**Figure IV.4a**  
**Hourly Variation of Temperature at Tundawand Village for Summer – 2006**



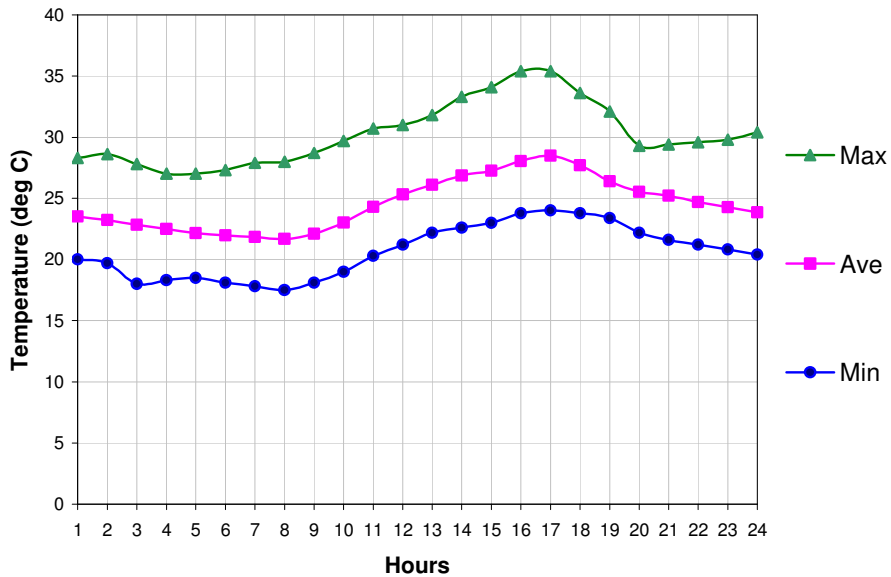
**Figure IV.4b**  
**Hourly Variation of Temperature for Monsoon 2006 at Tundawand Village**



**Figure IV.4c**  
**Hourly Variation of Temperature for Post-monsoon – 2006 at Tundawand Village**



**Figure IV.4d**  
**Hourly Variation of Temperature for Winter 2007 at Tundawand Village**



32. Summary of some important micro-meteorological parameter recorded at site is shown in Table IV.1.

**Table IV.1**  
**Summarised Meteorological Data at Tundawand Village**

<i>Sl.No.</i>	<i>Parameter</i>	<i>Max. Value</i>	<i>Avg-Value</i>	<i>Min. Value</i>
<b>Summer - 2006</b>				
1	Wind speed, m/s	9.0	2.2	0.0
2	Temperature, °C	40.2	28	16.2
<b>Post-monsoon - 2006</b>				
1	Wind speed, m/s	6.1	2.2	0
2	Temperature, °C	34.9	29.0	2
<b>Winter - 2007</b>				
1	Wind speed, m/s	6.9	2.4	0
2	Temperature, °C	35.4	24.6	17.5

#### **AMBIENT AIR ENVIRONMENT**

33. Reconnaissance survey of the study area covering 10 km radius was carried out before selection of sampling site for field environmental monitoring and secondary data collection. Sampling sites were finalized after the visit of study area for ambient air, noise, and soil and water quality monitoring stations.
34. Ambient Air Quality Monitoring Stations (AAQMS) were located considering MoEF guidelines pertaining up wind and down wind direction, quadrants, topography of the area, sensitive locations and major habitation, if there was any. Based up on the criteria mentioned in former line, eight AAQMS were selected for air quality monitoring.
35. The ambient air quality was monitored during all the seasons at all AAQMS. These monitoring locations are shown in Figure IV.5.



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**Figure IV.5**

**Location for AAQMS, Noise, Water and Soil Sampling Stations**

The details of AAQMS with direction and distance from the proposed source are given in Table IV.2.

**Table - IV.2**  
**Details of AAQMS**

<i>Sl. No.</i>	<i>Location</i>	<i>Distance From The Plant (km)</i>	<i>Direction W.R.T. Project Site</i>
1	Tunda village	0	Central
2	Jarpara	9	E
3	Desalpar	7	NNE
4	Mota Bhojapur	6	NE
5	Tragadi	6	W
6	Pipari	10	NW
7	Bidada	7	NNW
8	Kandagara	3	N

### **METHODOLOGY**

36. Samples were collected twice a week over a 52 week from March 2006 to February 2007. 24 hourly samples were collected for monitoring of SPM, RPM, SO<sub>2</sub> and NO<sub>x</sub>. One hourly sample was collected on each monitoring day for CO and HC. CEIA study is based on the ambient air quality data generated for the one year data.
37. Each sample was collected based on 24 hourly continuous sampling basis. The monitoring program was scheduled to cover all the days to get the representative concentration of the area. The analysis and methodology used for the monitoring was based on the procedure mentioned in the National Ambient Air Quality Standards (NAAQS) given by the Ministry of Environment and Forests (MoEF). Ambient air quality monitoring result for complete monitoring period is depicted in Appendix-4a-c. Locations for air quality monitoring stations are shown in Figure IV.5.
38. Analysis and measurement methods used for ambient air quality monitoring are shown in following Table IV. 3.



**Table IV.3  
Analytical / Measurement Methods**

POLLUTANTS	METHODS	BIS CODES
Suspended Particulate Matter ( SPM )	High Volume Air Sampler	5182 (Part - IV) - 1973
Respirable particulate Matter (RPM)	HVS with Cyclone Separator	5182 (Part - IV) - 1973
Sulphur Dioxide ( SO <sub>2</sub> )	West & Gaeke Method	5182 (Part - II) - 1973
Nitrogen Oxides ( as NO <sub>2</sub> )	Jacob and Hochheiser Method	5182 (Part - VI) - 1975
Carbon Monoxide (CO)	Flame Ionization Detector	IS: 5182 (Part X)
Hydrocarbon (HC)	Gas Chromatograph	IS: 5182(Part XVII)

39. The maximum, minimum, daily average and 98 percentile season wise monitored values at each location are shown in Table IV.4a-c. Overall summery of monitored ambient air quality data is given in Table IV.4d. The monitored ambient air quality at all AAQMS was compared with National Ambient Air Quality Standards (NAAQS) for residential and rural area. The National Ambient Air Quality Standards is given in Appendix – 5.

**Table - IV.4a  
Ambient Air Quality in the Study Area for Summer 2006**

Location		SPM ( $\mu\text{g}/\text{m}^3$ )	RPM ( $\mu\text{g}/\text{m}^3$ )	SO <sub>2</sub> ( $\mu\text{g}/\text{m}^3$ )	NOX ( $\mu\text{g}/\text{m}^3$ )	CO ( $\mu\text{g}/\text{m}^3$ )
Tunda village	Min	78	38	8.0	11.8	980
	Average	106.8	65	11.2	16.3	1543
	Max	138	96	16.2	23.4	2050
	98 Perc.	135	95	16.0	22.3	2015
Jalpara	Min	82	38	7.0	10.9	1000
	Average	110.6	65.5	10.9	16.6	1576.8
	Max	138	94	15.4	22.4	2000
	98 Perc.	138	93	15.1	22	1975
Desalpar	Min	84	42	8.4	13.5	900
	Average	113.11	71.4	11.2	18.4	1563.4
	Max	138	98	15.4	22.8	2010
	98 Perc.	138	96	14.9	22.6	2005
Mota Bhojapur	Min	84	38	7.6	11.2	1000
	Average	112.9	68.8	11.2	16.7	1576.2
	Max	136	98	18.4	23.8	2000

Location		SPM ( $\mu\text{g}/\text{m}^3$ )	RPM ( $\mu\text{g}/\text{m}^3$ )	SO <sub>2</sub> ( $\mu\text{g}/\text{m}^3$ )	NOX ( $\mu\text{g}/\text{m}^3$ )	CO ( $\mu\text{g}/\text{m}^3$ )
	98 Perc.	136	95.8	16.7	23.3	1946.0
Tragadi	Min	78	38.0	8.1	12.6	1000
	Average	108	66.3	10.6	17.0	1523.8
	Max	134	92	14.2	23.5	1900
	98 Perc.	132.6	89.6	13.8	23.3	1900
Pipari	Min	78	38	7.8	12.4	900
	Average	105.1	66.6	10.0	15.6	1348.5
	Max	134	96.0	13.0	22.0	2000
	98 Perc.	131.1	93.1	12.7	21.1	1980.8
Bidada	Min	82	34.0	8.9	14.9	1260.0
	Average	115.1	65.7	11.3	18.7	1700.8
	Max	142.0	98	15.9	22.8	1980.0
	98 Perc.	141.0	95.6	15.2	22.7	1958.4
Kandagra	Min	84	38	7.6	14.2	900
	Average	109.4	66.8	10.6	18.3	1425.7
	Max	134	96	16.4	22.8	1980.0
	98 Perc.	134	95	15.5	22.8	1941.6

**Table - IV.4b**  
**Ambient Air Quality In The Study Area For Post-Monsoon 2006**

Place		Ground Level Concentration				
		SPM	RPM	SO <sub>2</sub>	NO <sub>x</sub>	CO
		$\mu\text{g}/\text{m}^3$	$\mu\text{g}/\text{m}^3$	$\mu\text{g}/\text{m}^3$	$\mu\text{g}/\text{m}^3$	$\mu\text{g}/\text{m}^3$
Tunda village	Maximum	130.0	92.0	14.4	21.6	1845.0
	Minimum	82.0	42.0	8.4	11.5	1010.0
	Average	103.1	64.0	11.0	15.8	1451.8
	98 Perc.	127.4	90.2	14.1	21.2	1808.1
Jalpara	Maximum	138.0	92.0	16.8	22.8	1864.0
	Minimum	86.0	52.0	7.8	12.8	1298.0
	Average	111.1	70.9	11.9	17.2	1591.6
	98 Perc.	135.2	90.2	16.5	22.3	1826.7
Desalpar	Maximum	138.0	92.0	14.6	22.6	1945.0
	Minimum	88.0	48.0	9.0	12.2	1250.0
	Average	115.3	73.4	11.7	15.9	1594.1
	98 Perc.	135.2	90.2	14.3	22.1	1906.1
Mota Bhojapur	Maximum	142.0	98.0	16.4	24.8	1942.0
	Minimum	82.0	42.0	9.2	14.6	1245.0

Place		Ground Level Concentration				
		SPM	RPM	SO <sub>2</sub>	NO <sub>x</sub>	CO
		µg/m <sup>3</sup>	µg/m <sup>3</sup>	µg/m <sup>3</sup>	µg/m <sup>3</sup>	µg/m <sup>3</sup>
	Average	111.0	73.3	12.9	18.1	1640.7
	98 Perc.	139.2	96.0	16.1	24.3	1903.2
Tragadi	Maximum	124.0	84.0	14.6	20.4	1847.0
	Minimum	82.0	52.0	10.2	14.3	1289.0
	Average	107.3	63.5	12.1	16.8	1544.4
	98 Perc.	121.5	82.3	14.3	20.0	1810.1
Pipari	Maximum	116.0	88.0	16.2	21.2	1845.0
	Minimum	86.0	48.0	8.6	12.2	1463.0
	Average	100.8	69.5	11.5	15.8	1596.6
	98 Perc.	113.7	86.2	15.9	20.8	1808.1
Bidada	Maximum	142.0	94.0	16.8	22.1	1842.0
	Minimum	86.0	52.0	11.9	14.8	1489.0
	Average	113.3	71.0	14.0	18.8	1642.9
	98 Perc.	139.2	92.1	16.5	21.7	1805.2
Kandagra	Maximum	128.0	92.0	14.6	21.6	1946.0
	Minimum	86.0	46.0	8.4	13.5	1368.0
	Average	108.3	71.0	11.2	16.5	1572.8
	98 Perc.	125.4	90.2	14.3	21.2	1907.1

**Table - IV.4c**  
**Ambient Air Quality in the Study Area for Winter 2007**

Place		Ground Level Concentration				
		SPM	RPM	SO <sub>2</sub>	NO <sub>x</sub>	CO
		µg/m <sup>3</sup>	µg/m <sup>3</sup>	µg/m <sup>3</sup>	µg/m <sup>3</sup>	µg/m <sup>3</sup>
Tunda village	Maximum	129.0	85.0	14.3	20.1	1798.0
	Minimum	88.0	48.0	9.2	12.2	1124.0
	Average	106.7	63.6	10.9	15.2	1490.0
	98 Perc.	126.4	83.3	14.0	19.7	1762.0
Jalpara	Maximum	138.0	88.0	15.8	21.3	1872.0
	Minimum	87.0	52.0	9.2	14.2	1298.0
	Average	112.0	69.2	12.3	16.9	6195.3
	98 Perc.	135.2	86.2	15.5	20.9	1834.6
Desalpar	Maximum	139.0	93.0	15.2	21.1	1859.0
	Minimum	92.0	58.0	9.6	12.6	1356.0
	Average	117.7	74.3	12.4	16.2	1585.0

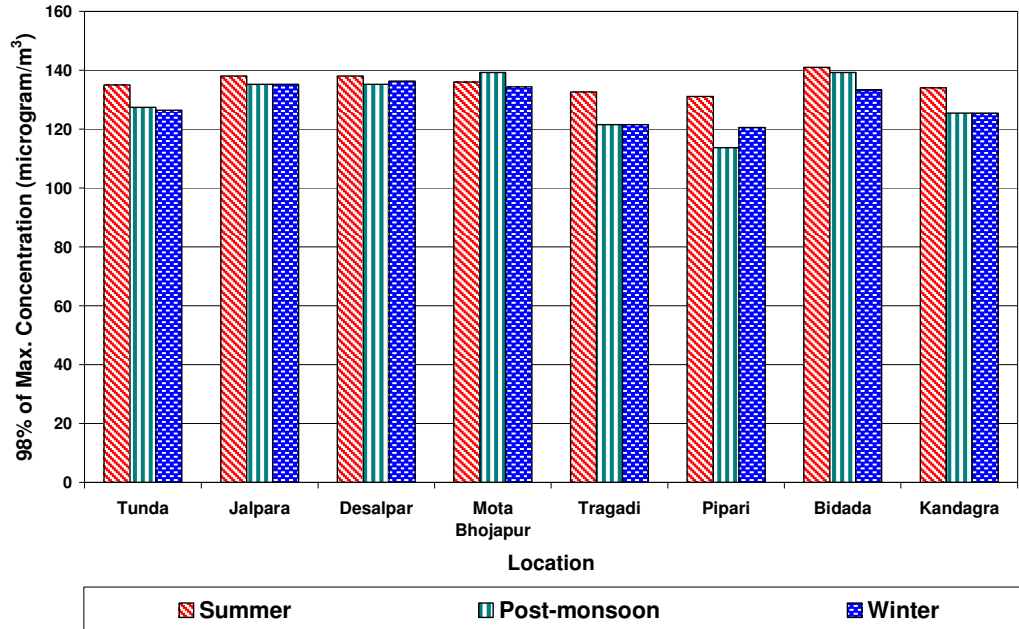
Place		Ground Level Concentration				
		SPM	RPM	SO <sub>2</sub>	NO <sub>x</sub>	CO
		µg/m <sup>3</sup>	µg/m <sup>3</sup>	µg/m <sup>3</sup>	µg/m <sup>3</sup>	µg/m <sup>3</sup>
	98 Perc.	136.2	91.1	14.9	20.7	1821.8
Mota Bhojapur	Maximum	137.0	94.0	16.8	21.2	1867.0
	Minimum	88.0	48.0	9.5	14.9	1277.0
	Average	113.3	67.7	12.7	17.2	1598.7
	98 Perc.	134.3	92.1	16.5	20.8	1829.7
Tragadi	Maximum	124.0	72.0	12.6	16.4	1795.0
	Minimum	92.0	52.0	8.9	12.2	1362.0
	Average	107.6	63.5	10.5	13.9	1564.3
	98 Perc.	121.5	70.6	12.3	16.1	1759.1
Pipari	Maximum	123.0	78.0	14.8	17.9	1843.0
	Minimum	92.0	52.0	8.9	11.8	1472.0
	Average	109.8	62.7	10.6	14.7	1607.0
	98 Perc.	120.5	76.4	14.5	17.5	1806.1
Bidada	Maximum	136.0	82.0	15.8	20.8	1836.0
	Minimum	89.0	61.0	12.1	13.3	1476.0
	Average	113.3	68.3	13.2	17.0	1617.0
	98 Perc.	133.3	80.4	15.5	20.4	1799.3
Kandagra	Maximum	128.0	78.0	12.8	17.6	1893.0
	Minimum	89.0	52.0	9.6	12.5	1352.0
	Average	111.0	65.3	11.0	15.1	1572.7
	98 Perc.	125.4	76.4	12.5	17.2	1855.1

**Table - IV.4d**  
**Overall Summary Of Ambient Air Quality Data**  
 (Period March'06 to February 07)

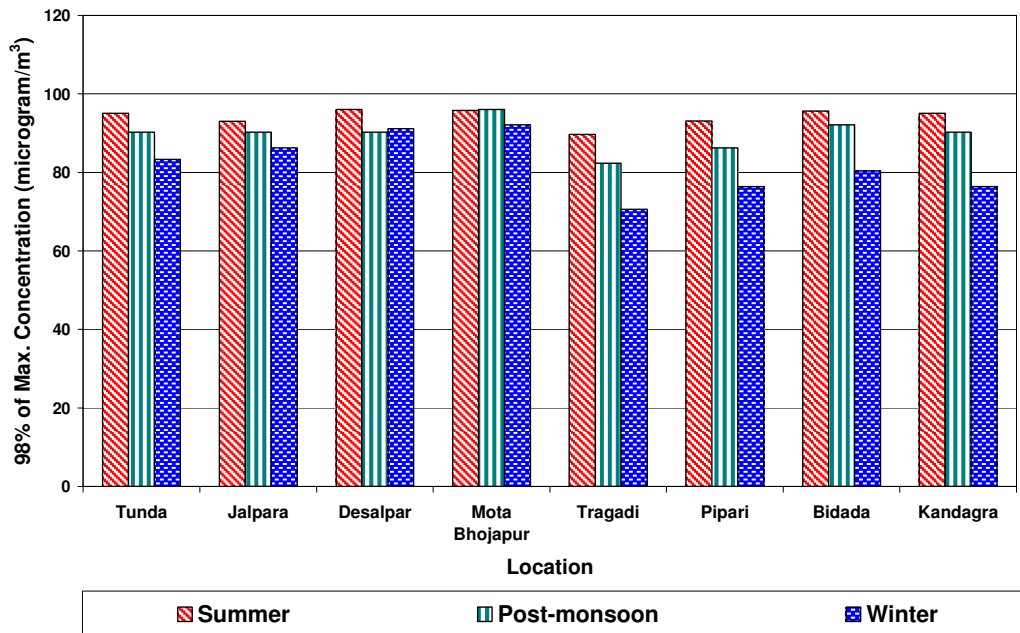
	SPM	RPM	SO <sub>2</sub>	NO <sub>x</sub>	CO
	µg/m <sup>3</sup>	µg/m <sup>3</sup>	µg/m <sup>3</sup>	µg/m <sup>3</sup>	µg/m <sup>3</sup>
Maximum	142.0	98.0	18.4	24.8	2050.0
Average	110.5	67.9	11.5	16.7	1560.9
Minimum	78.0	34.0	7.0	10.9	900.0
98 Percentile	138.0	94.0	15.9	22.8	1980.0

40. Monitored background concentrations of SPM , RPM, SO<sub>2</sub>, NO<sub>x</sub> and CO were compared for all the three seasons. The same has been compared which are shown in the following Figures. IV. 6a to IV.6e.

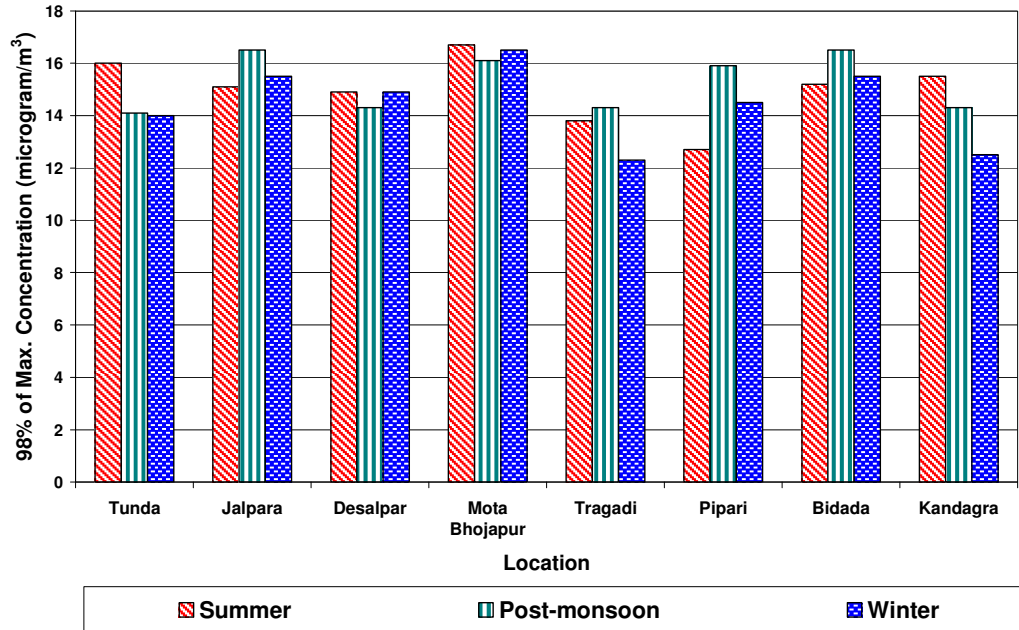
**Figure IV.6a**  
**Variation Of SPM Concentration In The Study Area**



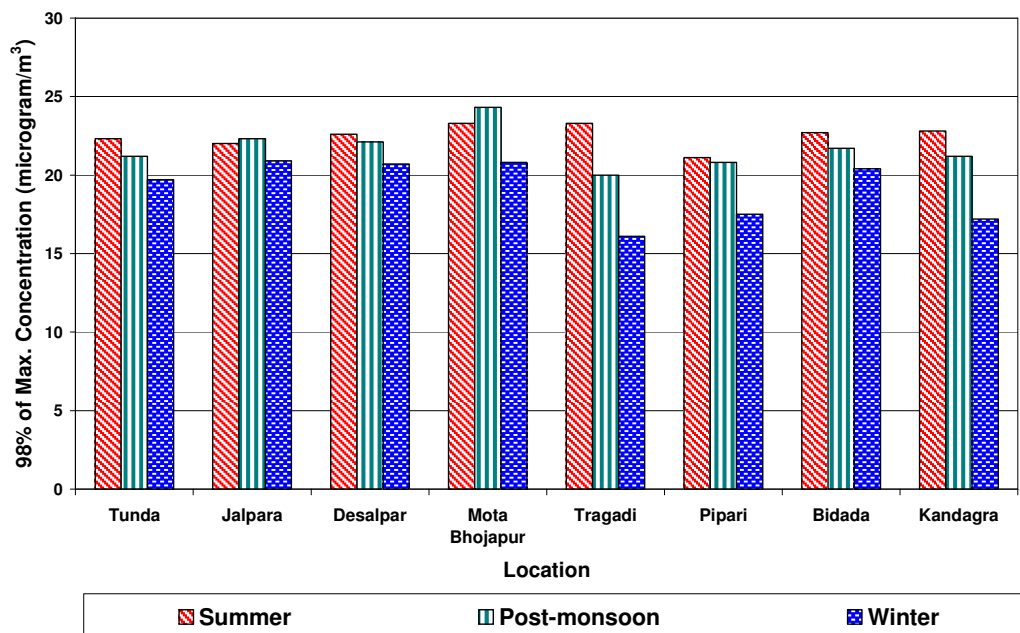
**Figure IV.6b**  
**Variation of RPM Concentration in the Study Area**



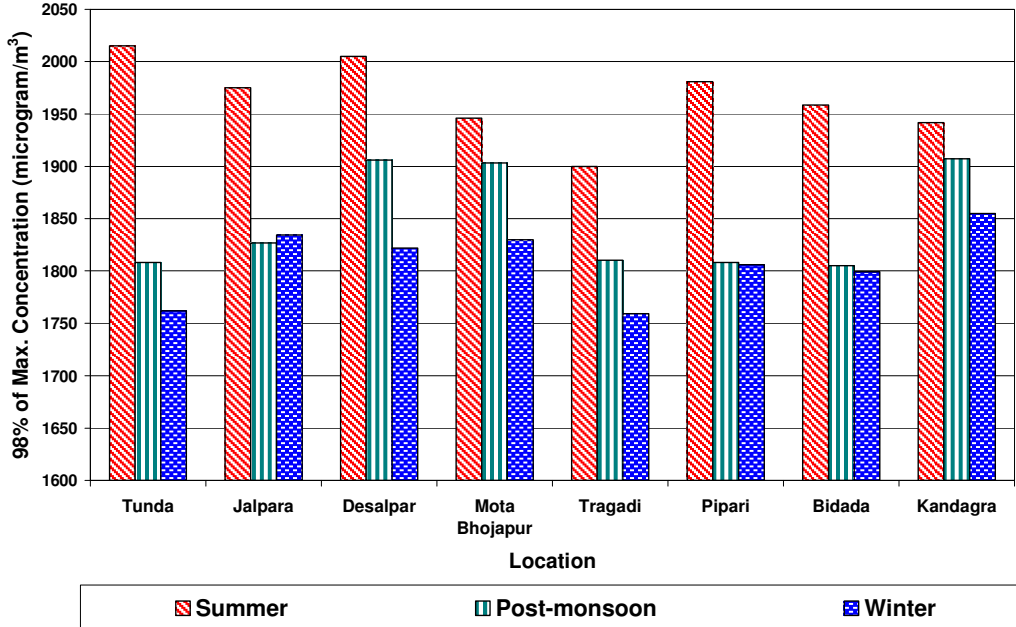
**Figure IV.6c**  
**Variation Of SO<sub>2</sub> Concentration In The Study Area**



**Figure IV.6d**  
**Variation Of No<sub>x</sub> Concentration In The Study Area**



**Figure IV.6e**  
**Variation Of CO Concentration In The Study Area**



41. The analysis results of monitored air quality indicate that SPM, RPM, SO<sub>2</sub>, and NO<sub>x</sub>, values are well within the stipulated NAAQ standards for residential and rural areas. CO concentration remained well below the standard of 2000 µg/m<sup>3</sup> for all collected samples.

**NOISE ENVIRONMENT**

42. The monitoring of noise was carried out at eight locations. Noise monitoring was carried out using precision noise level meter (make-Bruel & Kjar, model-2221, Made in Denmark, Digital type) on hourly basis for 24 hours. The locations of noise monitoring station (N1 to N8) are shown in Figure IV.5. The details of noise monitoring locations are shown in Table IV.5.

**Table - IV.5**  
**Details of Noise Monitoring Stations**

Sr. No.	Location	Distance (km)	Direction w.r.t. Plant Site
N1	Tunda village	0	Central
N2	Jarpara	9	E
N3	Desalpar	7	NNE
N4	Mota Bhojapur	6	NE
N5	Tragadi	6	W
N6	Pipari	10	NW
N7	Bidada	7	NNW
N8	Kandagara	3	N

43. Noise monitoring was carried out once during the summer season at all noise monitoring locations. Sound levels had been recorded for 24 hours continuously for the duration of fifteen (15) minutes at hourly intervals.
44. Noise monitoring data has been analyzed for each location. The equivalent noise levels for the period from March 2006 to February 2007 are shown in Table IV.6a-d. The results have been compared with the standard specified in Schedule III, Rule 3 of Environmental Protection Rules. The National Ambient Air Quality Standards (NAAQS) with respect to noise is given in Appendix – 6.

**Table - IV.6a**  
**Equivalent Noise Levels of the Study Area for Summer 2006**

Sr. No.	Location	Equivalent Noise Level (dB(A))		
		Day-Night (06.00 AM – 5.00 AM)	Day (06.00 AM – 10.00PM)	Night (10.00 PM – 6.00 AM)
1	Tunda village	50.8	50.9	50.6
2	Jarpara	59.2	61.2	45.7
3	Desalpar	54.8	53.5	55.9
4	Mota Bhojapur	54.7	54.8	54.5
5	Tragadi	54.6	53.8	55.9
6	Pipari	52.1	51.8	52.7
7	Bidada	53.7	53.1	54.4
8	Kandagara	54.2	52.1	56.4

**Table - IV.6b**  
**Equivalent Noise Levels of the Study Area for Monsoon 2006**

Sr. No.	Location	Equivalent Noise Level (dB(A))		
		Day-Night (06.00 AM – 5.00 AM)	Day (06.00 AM – 10.00PM)	Night (10.00 PM – 6.00 AM)
1	Tunda village	49.7	51.6	39.8
2	Jarpara	52.2	54.2	37.2
3	Desalpar	53.1	54.5	48.5
4	Mota Bhojapur	52.6	53.6	50.1
5	Tragadi	51.0	52.2	48.0
6	Pipari	50.5	52.0	45.6
7	Bidada	58.2	59.5	54.4
8	Kandagara	47.6	49.0	43.1



**Table - IV.6c**  
**Equivalent Noise Levels of the Study Area for Post-monsoon 2006**

Sr. No.	Location	Equivalent Noise Level (dB(A))		
		Day-Night (06.00 AM – 5.00 AM)	Day (06.00 AM – 10.00PM)	Night (10.00 PM – 6.00 AM)
1	Tunda village	49.9	51.7	40.6
2	Jarpara	52.3	54.2	41.6
3	Desalpar	55.0	56.7	48.6
4	Mota Bhojapur	57.5	59.3	49.2
5	Tragadi	50.5	52.2	44.4
6	Pipari	50.3	52.0	42.7
7	Bidada	58.2	59.5	54.4
8	Kandagara	49.7	51.3	44.2

**Table - IV.6d**  
**Equivalent Noise Levels of the Study Area for Winter 2006**

Sr. No.	Location	Equivalent Noise Level (dB(A))		
		Day-Night (06.00 AM – 5.00 AM)	Day (06.00 AM – 10.00PM)	Night (10.00 PM – 6.00 AM)
1	Tunda village	46.7	48.5	38.3
2	Jarpara	51.6	53.5	41.2
3	Desalpar	54.6	56.2	48.4
4	Mota Bhojapur	56.9	58.7	48.8
5	Tragadi	50.1	51.7	44.3
6	Pipari	49.4	51.1	41.7
7	Bidada	56.9	58.3	52.8
8	Kandagara	49.0	50.6	43.5

45. The monitored noise levels at all the locations coming under rural and residential areas are within the prescribed limit of National Ambient Air Quality Standards with respect to noise.

### **WATER ENVIRONMENT**

46. The surface water source for the proposed project is seawater from Gulf of Kutch located at about 2.5 km from project site. The seawater would be drawn to the plant boundary through an open channel excavated to a depth of about 3 m below lowest tide water level. The width of channel required would be about 100 m to draw an estimated cooling water flow of 5,94,200 m<sup>3</sup>/hr. The channel would be aligned southwards from the southwest corner of the plant site. An on shore pump house located within the plant boundary will house the cooling water pumps.

47. Sea water requirement is 594,175m<sup>3</sup>/hr as per following break up:

S. No.	Item	Estimated Quantity	
		Once Through Cooling	
		m <sup>3</sup> /hr	m <sup>3</sup> /day
1	Sea water for condenser cooling	588850	14132400
2	Sea water for desalination plant	5325	127800
	Total	594175	14260200
3	Fresh water	1072	25710

#### WATER QUALITY

48. Ground water sample collection is shown in Appendix – 7. The locations of water quality sampling stations are shown in Figure IV.5. The groundwater samples were collected from locations Kandagara, Navinal, Bhujpur Mota, Gundiya, Jarpara, Desalpar and Nana Bhadiya. These ground water samples were analyzed for various parameters and month-wise results are given in Appendix – 7a-k. Summary of the water quality results are given below:

#### **Summary of water quality during Summer -2006:**

pH Value	:	7.3	-	7.84
Conductivity mho	:	566	-	4901
Dissolved Solids, mg/l	:	335	-	3917
Total Hardness (as CaCO <sub>3</sub> ), mg/l	:	30.8	-	1304
Alkalinity , mg/l	:	37.9	-	116.8
Chloride (as Cl), mg/	:	69.3	-	2391
Calcium(as Ca), mg/l	:	5.6	-	236.3
Magnesium (as Mg), mg/l	:	4.1	-	173.4
Fluoride (as F), mg/l	:	0.086	-	1.087

#### **Summary of water quality during Monsoon -2006:**

pH Value	:	7.2	-	7.6
Conductivity mho	:	644	-	4867
Dissolved Solids, mg/l	:	356	-	3018
Total Hardness (as CaCO <sub>3</sub> ), mg/l	:	36.9	-	1284
Alkalinity , mg/l	:	49.3	-	215.3
Chloride (as Cl), mg/	:	75.6	-	1148
Calcium(as Ca), mg/l	:	6.9	-	214
Magnesium (as Mg), mg/l	:	4.8	-	179
Fluoride (as F), mg/l	:	0.102	-	1.128

#### **Summary of water quality during Post Monsoon -2006:**

pH Value	:	7.3	-	7.5
Conductivity mho	:	1352	-	5498
Dissolved Solids, mg/l	:	796.1	-	3342
Total Hardness (as CaCO <sub>3</sub> ), mg/l	:	62.2	-	1465
Alkalinity , mg/l	:	86	-	695
Chloride (as Cl), mg/	:	183.3	-	2230

Calcium(as Ca), mg/l	:	9.4	-	245.6
Magnesium (as Mg), mg/l	:	9.2	-	209.5
Fluoride (as F), mg/l	:	0.532	-	1.487

**Summary of water quality during Winter -2006:**

pH Value	:	7.2	-	7.6
Conductivity mho	:	1032	-	5238
Dissolved Solids, mg/l	:	634	-	3016
Total Hardness (as CaCO3), mg/l	:	61.4	-	1566
Alkalinity , mg/l	:	256	-	698
Chloride (as Cl), mg/	:	23.5	-	1869
Calcium(as Ca), mg/l	:	10.8	-	274
Magnesium (as Mg), mg/l	:	8.3	-	214.1
Fluoride (as F), mg/l	:	0.426	-	1.5

49. The water quality is assessed based up on the parameters specified for Indian standard IS 10500 (drinking water standards). The characteristics of water quality of ground water samples were agreeable with the permissible levels of the drinking water.

**SOIL ENVIRONMENT**

50. In order to assess the soil quality in the Plant site and study area, eight soil samples were collected from various locations during Summer, post monsoon and winter season. Details of soil sampling stations are given in Table IV.7.

**Table - IV.7  
Details of Soil Sampling Locations**

<b>Sample</b>	<b>Location</b>	<b>Type of Land</b>
S1	Nani Khakhar	Agricultural Land
S2	Desalpar	Agricultural land
S3	Nana Bhadiya	Agriculture Land
S 4	Bidada	Agricultural Land
S5	Kandagra	Agricultural Land
S6	Wand	Agricultural Land
S7	Jarpara	Agricultural Land
S8	Bhojpur	Agricultural Land
S9	Gundiyali	Agricultural Land
S10	Navinal	Agricultural Land

51. The soil of the area varies from dark brown to light brown in color. Soil pH plays an important role in the availability of nutrients for microbial activities and growth of plants.. Electrical conductivity (EC) is a measure of the soluble salts and ionic activity in the soil. The collected soil samples have normal conductivity.
52. Soil Samples are analyzed for various chemical parameters. In the tested soil samples, available N, P & K values varies from low to high. Soil samples collected from agriculture land have medium organic carbon content while soil sample of proposed site indicated low content of organic carbon.

53. Micronutrients play a vital role in the growth and development of plants. Most micronutrients, like Zn, Fe, Mn and Cu are constituents of many enzymes and they play key role in metabolic activities such as chlorophyll synthesis, photosynthesis, respiration, protein synthesis, nitrogen fixation, assimilation of nitrates and sulphate, etc. Soil micronutrient can be employed as a tool for predicting the deficiency of a nutrient and the profitability of its application. The critical limit of micronutrient in a soil is the content of nutrient at which plantation produce a significant response to its application.
54. The detailed soil investigation was carried out for study area. Soil samples were collected from eight locations once in a season during the complete study period. The locations of soil sampling stations are shown in Figure IV.5. Physico-chemical analysis of soil samples was carried out to assess the quality of soil. Their results are shown in Appendix–8a-c. summary of soil sampling results during summer'06, post monsoon'06 and winter06 are given in Table 7a-c below:

**Table IV.7a**  
**Summary Of Soil Quality During Summer 2006**

pH (1 :10 suspension)	6.9 – 7.9
Electric conductivity ms/cm	0.084 – 2.320
Sand, %	14.6 - 33.3
Silt,%	27.6 - 58.6
Clay,%	26.8 – 40.5
Organic Matter%	0.179 – 1.030
Nitrogen, mg/gm	0.019 – 0.038
Phosphorus mg/gm	0.29 – 0.60
Potassium %	0.2593 – 0.9240
Sodium Adsorption Ratio	0.00792 – 0.289

**Table IV.7b**  
**Summary of Soil Quality During Post Monsoon 2006**

pH (1 :10 suspension)	7.0 – 7.5
Electric conductivity ms/cm	0.169 – 1.961
Sand, %	16.9 – 30.4
Silt,%	29.3 – 51.6
Clay,%	29.6 – 42.1
Organic Matter%	0.583– 1.213
Nitrogen, mg/gm	0.041 – 0.216
Phosphorus mg/gm	0.319 – 0.55
Potassium %	0.2163 – 0.7631
Sodium Adsorption Ratio	0.0059 – 0.71

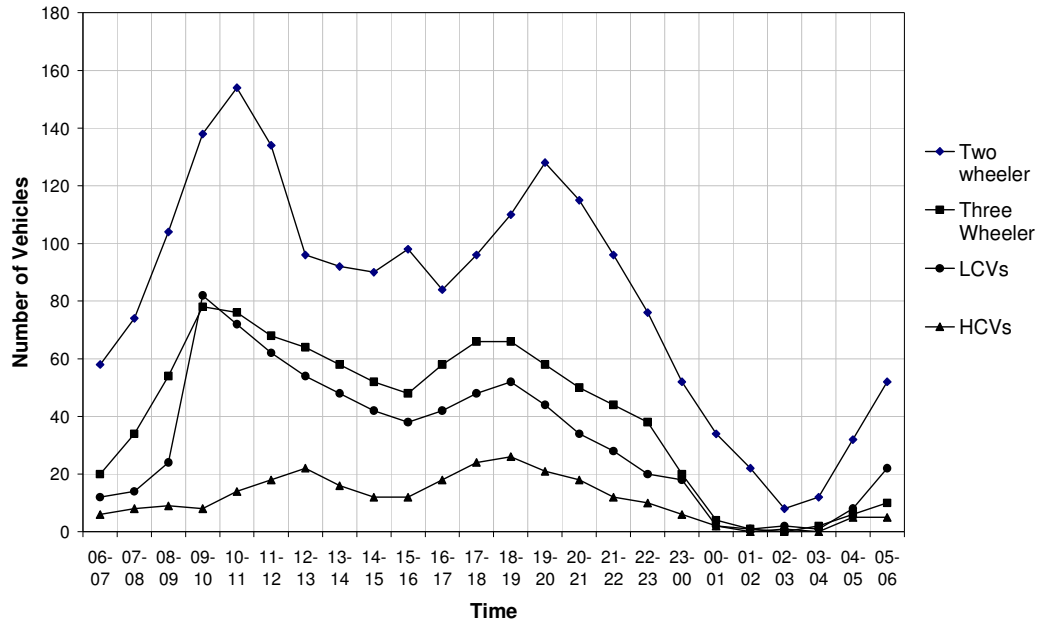
**Table IV.7c  
Summary of Soil Quality During winter 2006**

pH (1 :10 suspension)	7.1 – 7.4
Electric conductivity ms/cm	0.176 – 1.813
Sand, %	19.3 – 30.1
Silt,%	28.8 – 50.4
Clay,%	30.3 – 44.7
Organic Matter%	0.626– 1.191
Nitrogen, mg/gm	0.045 – 0.198
Phosphorus mg/gm	0.326 – 0.513
Potassium %	0.224 – 0.7819
Sodium Adsorption Ratio	0.050 – 0.635

#### **TRAFFIC AND TRANSPORT**

55. The Plant site is linked with a good network of rail and roadways.. The project site is located at 22 km from Mundra port. The site is well connected with state Highway no. SH-50 (via Anjar) and SH-6 (via Gandhidham) and would be near to NH-8A (Delhi-Kandla).
56. The nearest railway station is Adipur (57 km), which is 57 km away from the site. The railway station is well connected to multi-terminal Mundra port through broad gauge railway system owned by M/s. Adani Group. The nearest airport is Bhuj which is about 60 km from site. The site is about 2.5 km from the sea (Gulf of Kutch).
57. Heavy weight carrying vehicles (HCVs), Light weight carrying vehicles (LCVs), two wheelers and three wheelers are plying frequently on adjoining high way. Traffic pattern at Bhojpur, Bidada, Kandagra, Desalpur Highways for four types of vehicles were recorded during the Summer, post-monsoon and winter 2006. The traffic patterns of the adjoining highways are shown in following Figures IV.7a-h.

**Figure IV.7a**  
**Traffic Trend In Bhojpur Highway During Post-Monsoon 2006**



**Figure IV.7b**  
**Traffic trend in Bidada Highway during Post-monsoon 2006**

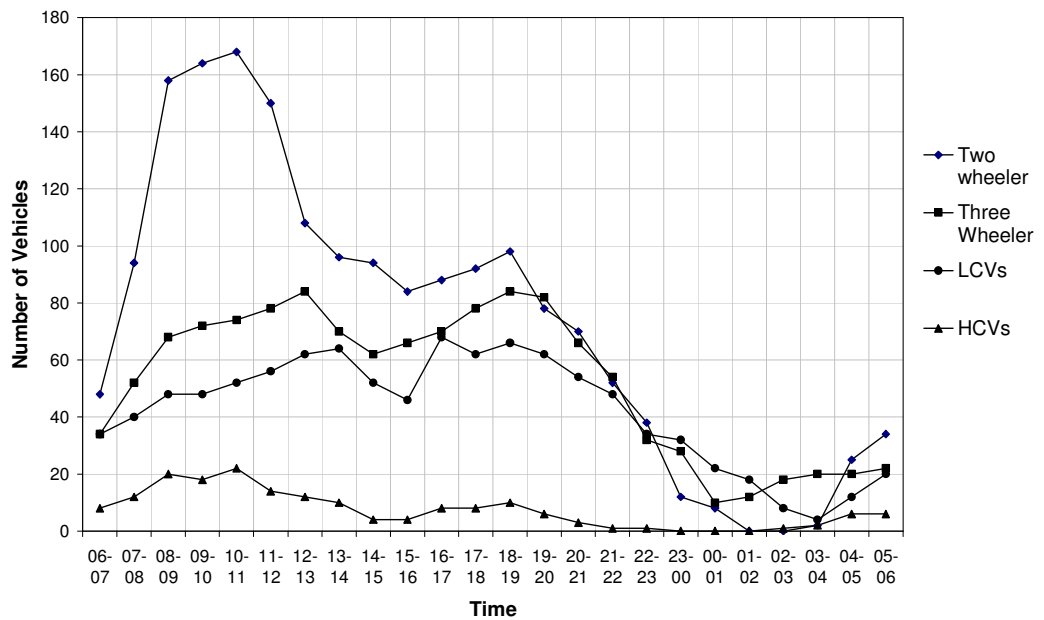


Figure IV.7c

Traffic Trend In Kandagra Highway During Post-Monsoon 2006

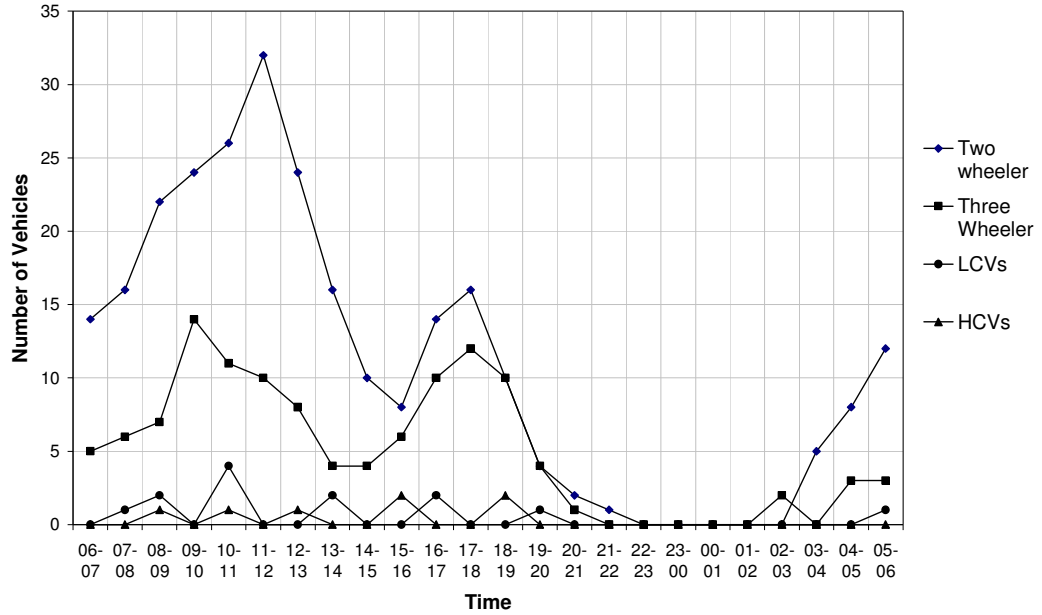


Figure IV.7d

Traffic Trend In Desalpur Highway During Post-Monsoon 2006

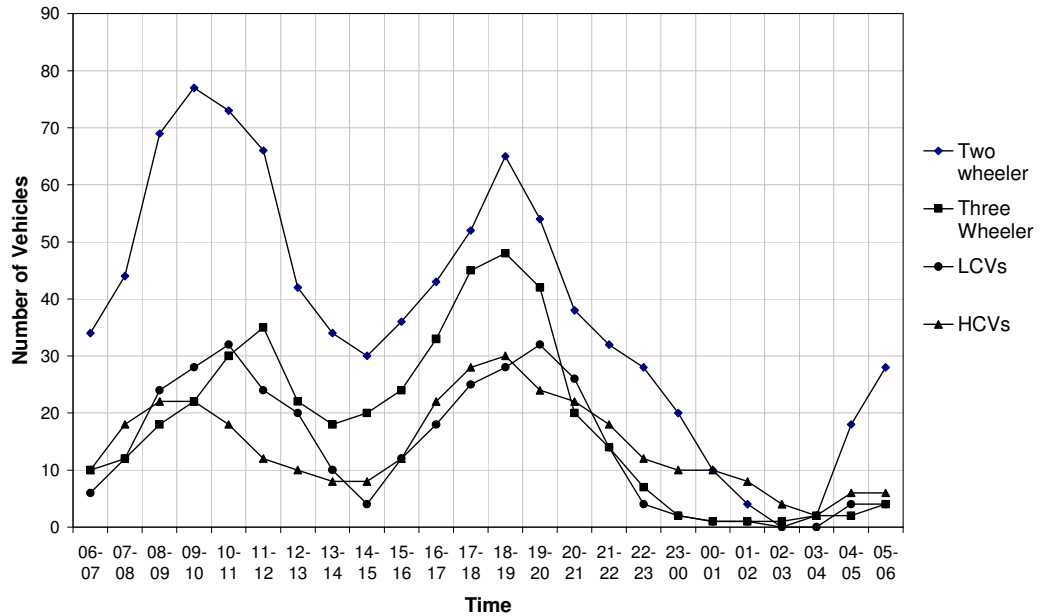


Figure IV.7e

Traffic Trend In Bhojpur Highway During Winter 2006

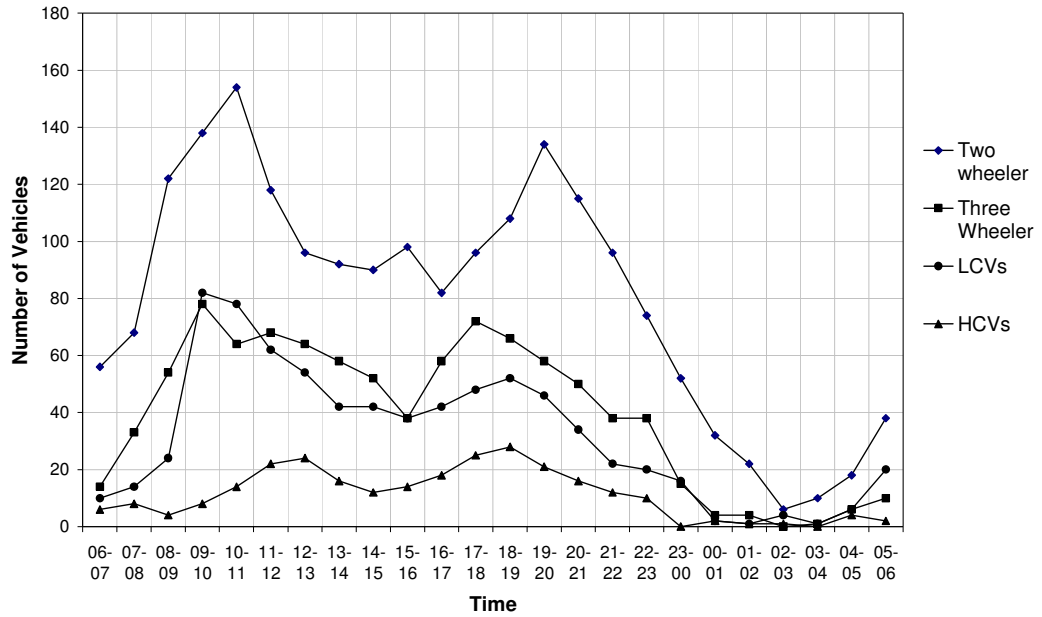


Figure IV.7f

Traffic Trend In Bidada Highway During Winter 2006

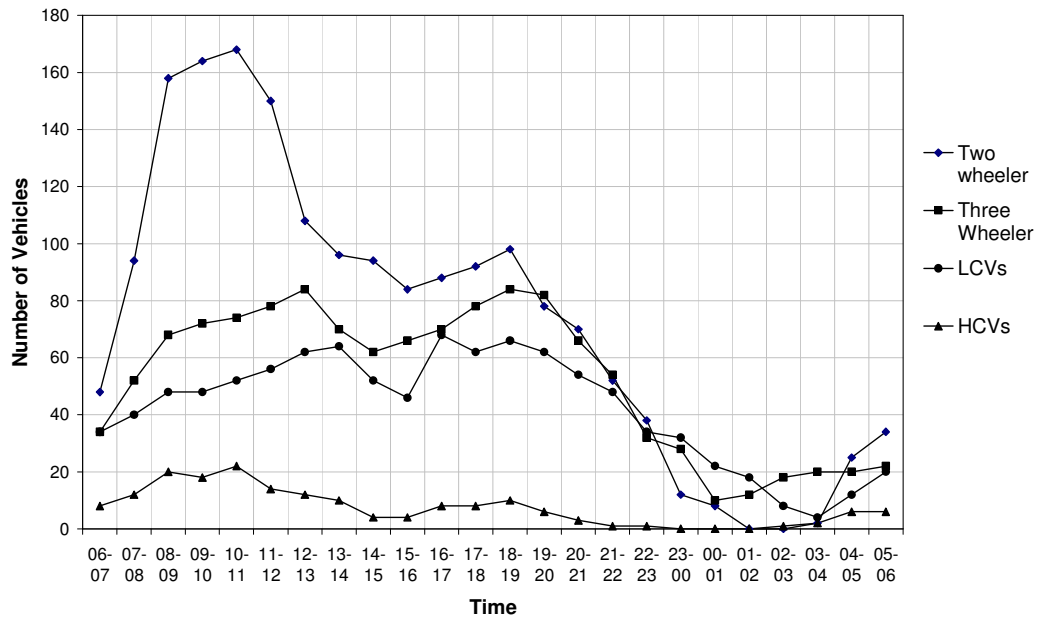




Figure IV.7g

Traffic Trend in Kandagra Highway During Winter 2006

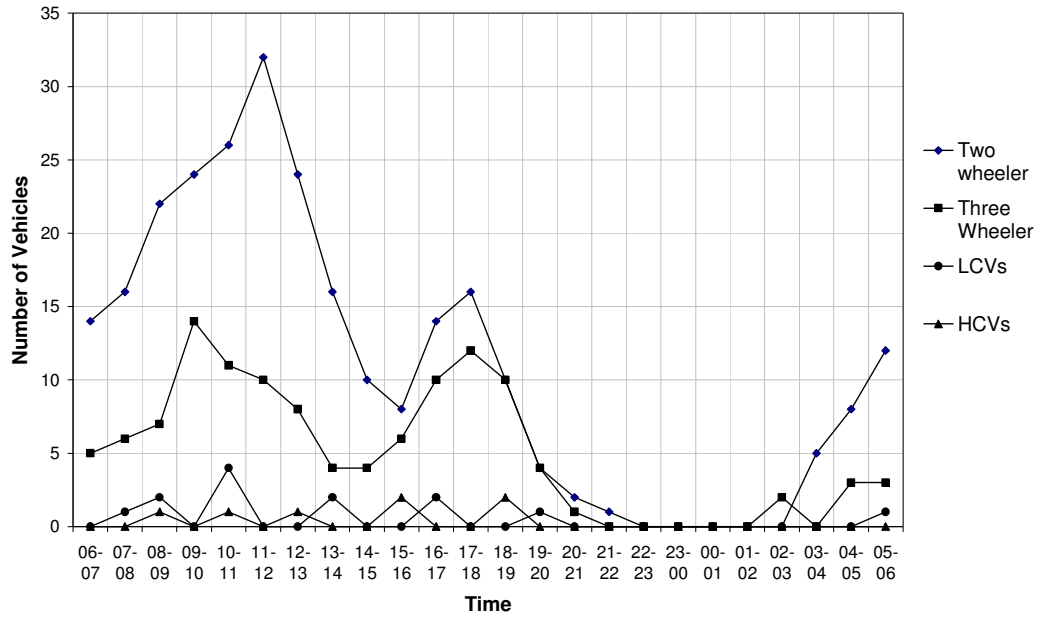
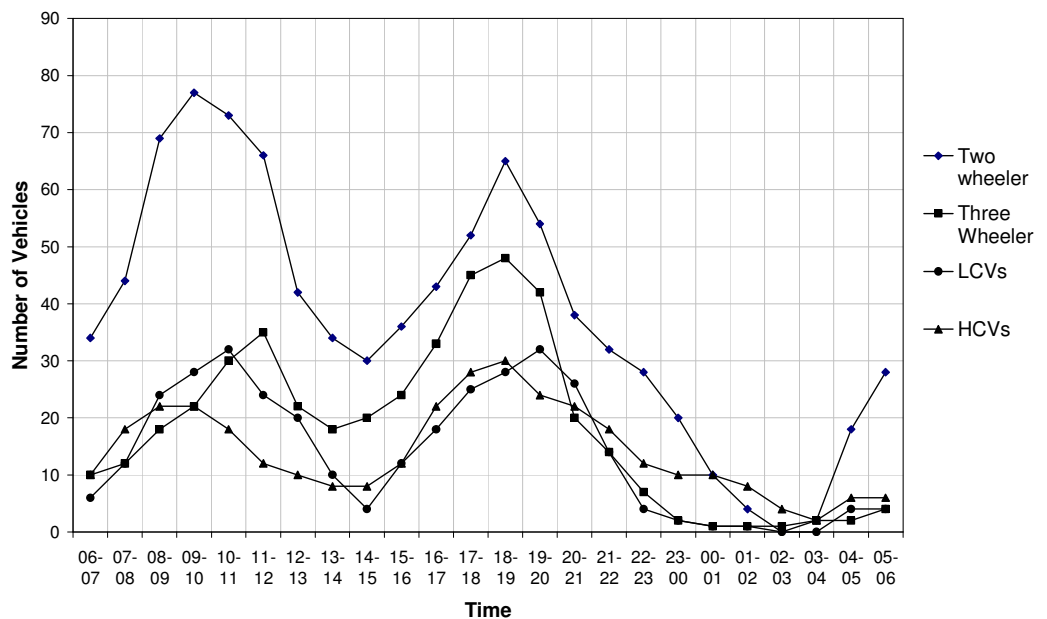


Figure IV.7h

Traffic Trend in Desalpur Highway During Winter 2006



58. From Figures IV.7a-h indicated that maximum traffic was observed during daytime. Frequency of two wheelers and three wheelers was maximum followed by, LCV's and HCV's. Minimum traffic was observed in night time during the period from 11.00 PM to 4.00 AM. Bidada Highway is exposed to more number of vehicles especially two wheelers. Kandagra Highway is having very less number of vehicles. Moreover, there is no significant difference in number of vehicles between post-monsoon period and winter during 2006.

### **INDUSTRIES**

59. There is no major industry within 10km radius of the project area.

### **SOCIO ECONOMIC ENVIRONMENT**

60. Socio-economic study of the area is a part of environmental impact assessment study for the proposed power project. Socio-economics, a component of environment includes description of demography, available basic amenities like housing, health care services, transportation, education and cultural activities. Information on the above said parameters has been collected to define the socio-economic profile of the study area (10-km radius).
61. A reconnaissance survey of the study area was conducted during the study period considering the socio-economic condition of the study area. Socio-economic assessment of the study area was carried out by survey team. List of survey nos. in the main plant area is enclosed in Appendix-9. Visits were made to Taluka office and district head offices for collection of data on population and land use pattern. Census data for the year 2001 was collected in CD form from the available source. Census handbook for the year 1991 was also referred for analysis of socio-economic data. The information on socio-economic aspects collected from various secondary sources including government offices has been analyzed and compiled. Information was also collected from local villagers. A detailed socio-economic study of the surrounding area with impacts and conclusion is enclosed as Enclosure – 1.
62. A list of villages falling within the study area with details of population characteristics and land use pattern is shown in Appendix – 10,11,12,13. The summary of population characteristics, literacy and occupational pattern for the year 2001 of the study area is provided in Table IV.8:

**Table IV.8  
Summary of Demographic Details within 10 Km Radius of the Study Area**

<b>Demographic Parameters</b>	<b>1991</b>	<b>2001</b>
No. of Households	7811	10161
Total Study Area, Ha	36489	36489
Total Population	43272	53452
Total Male	21429	26897
Total Female	21843	26555
Population Density (No./Ha)	1.19	1.46

Demographic Parameters	1991	2001
Female per 1000 Male	1019	987
Family size	5.5	5.3
Percentage of Population below 6 Years	18.0	16.2
Total Schedule Caste	5816	7269
Total Schedule Tribe	1249	2025
No. of Literates	18658	28946
No. of Illiterates	24614	24506
Female literacy	7310	12073
Total Workers Population	16424	20938
Total Male workers	11025	14232
Total Female Workers	5399	6706
Main Workers	14860	15924
Marginal Workers	1744	5014
Non-Workers	26134	32514
Main Cultivator Population	5885	4496
Main Female Cultivator Population	1451	737

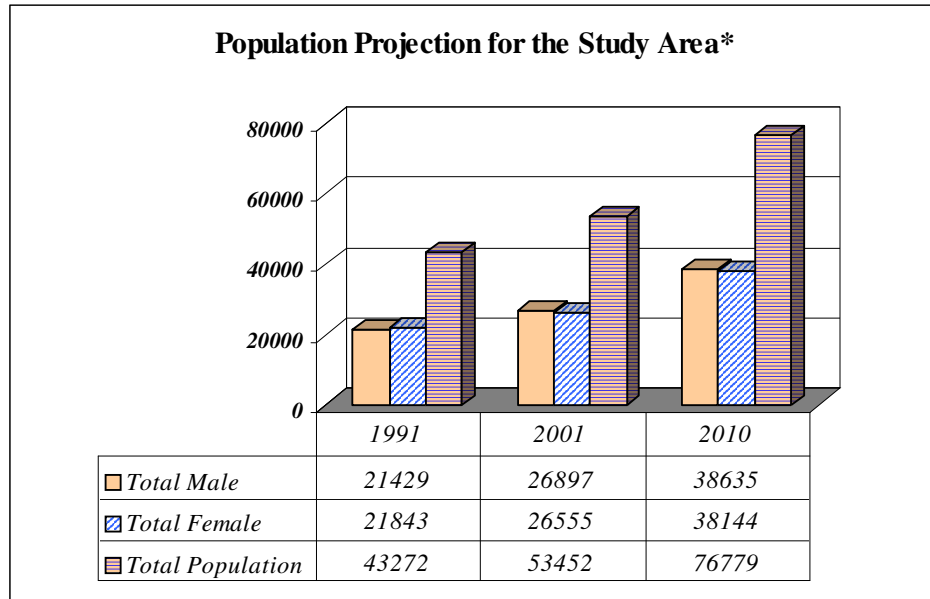
§Source: District Census Handbook 1991, Census 2001

63. Legends used for demographic profiles are as follows:

M:	Male	ST:	Scheduled Tribes
F:	Female	HH:	House Hold
Tot_M:	Total Male	CL:	Cultivator
Tot_F:	Total Female	OT:	Other Workers
P_06:	Population within 6 years	Work:	Workers
P:	Population	Marg:	Marginal
SC:	Scheduled Caste	Lit:	Literates
AL	Agricultural Labourer	ILL:	Illiterates

64. According to the results of Population Census 2001, the population of the study area is reported as 43272. The study area falls under SEZ, therefore, the region will have fast growing population. The population growth rate in 1991-2001 was 43%. The projected population in 2010 would be 76779 as per geometric progression method [Figure IV.8a].

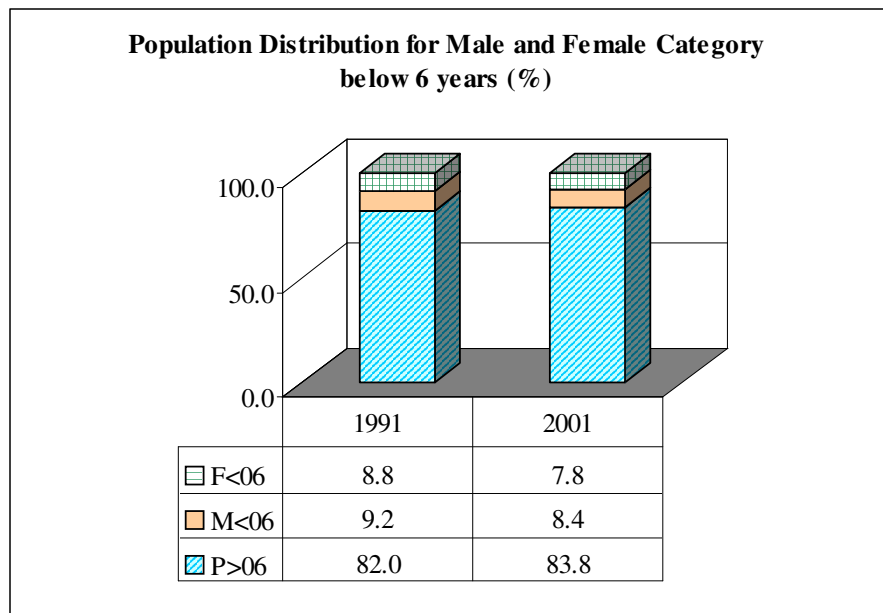
**Figure IV.8a  
Population Projection for Year 2010**



\*Population projection by Geometric Progression Method (within 10 km radius)  
Source: District Census Handbook 1991 and Census 2001

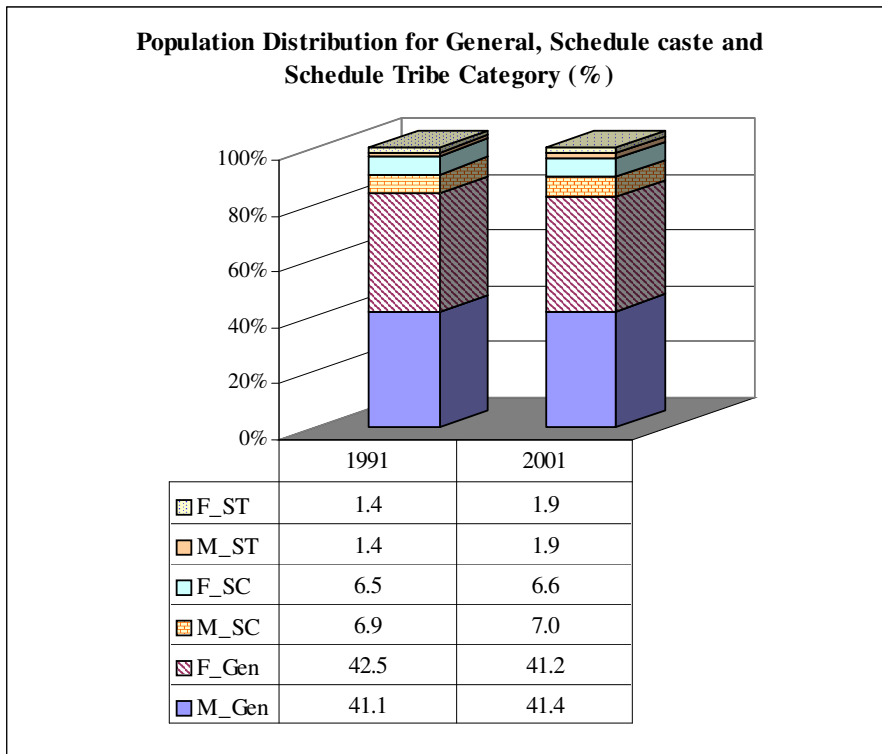
65. The contribution of 0-6 year children to over all population has reduced significantly from 18% (1991) to 16.2 % (2001) as shown in Figure IV.8b. Figure IV.8c indicates that the contribution of scheduled caste and scheduled tribes populations to overall population are 13.6% and 3.8%, respectively in 2001. The analysis result indicated that percentage of schedule tribe population was less as compared to scheduled caste population.

**Figure IV.8b  
Population Distribution for 0-6 Year Age Group**



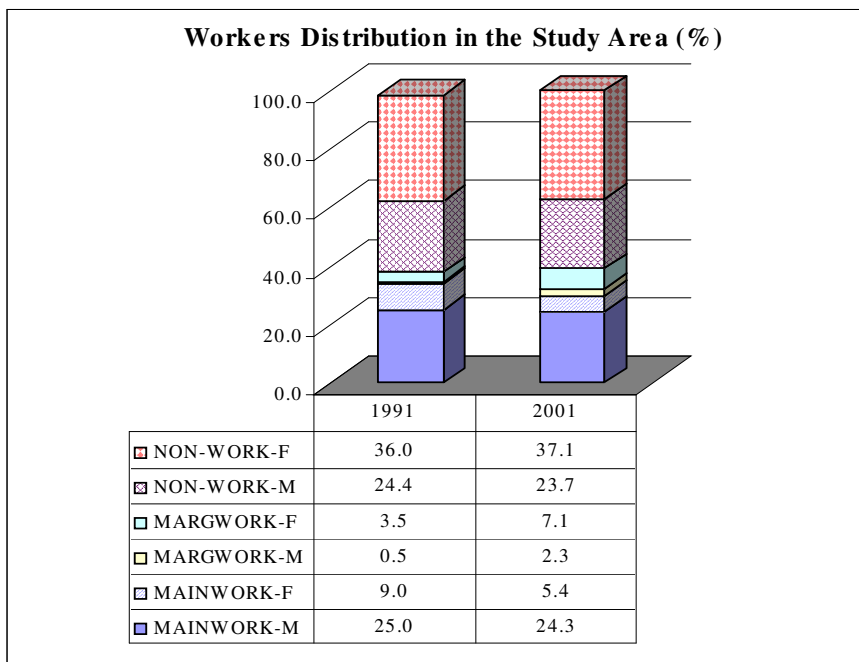
Source: District Census Handbook 1991 and Census 2001

**Figure IV.8c**  
**Population Distribution for SC and ST**

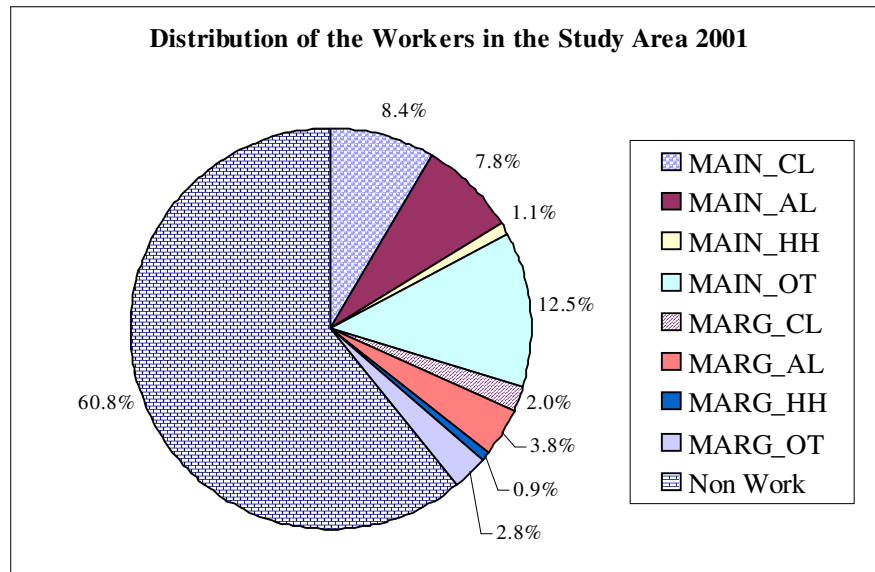


66. Considerable portion about 39.2% of the total population falls under workers categories. Distribution of various categories of workers is shown in Figure IV.9 a & b.

**Figure IV.9a**  
**Workers Distribution Pattern**



#### IV.9b Distribution of Workers (2001)

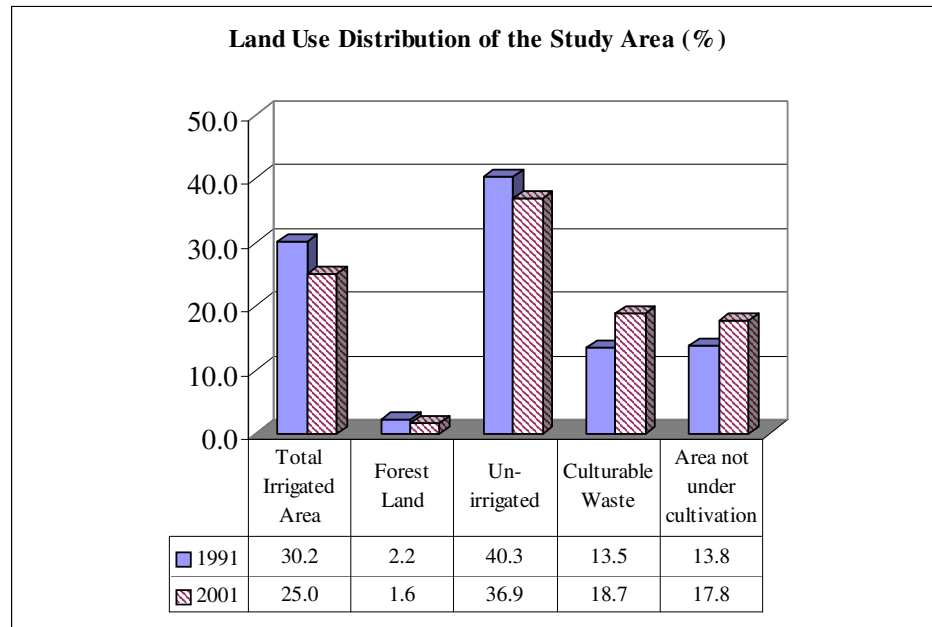


67. The summary Table IV.8 indicated that population of non-workers was highest of 60.8% followed by 39.2% of total workers, (34.0 % main workers and 4.0 % marginal workers). Non worker population cover all persons, who are engaged in unpaid home duties and do not know other work or have not done any work at all during the last one year. The main worker is a person, who works for major part of the year. Marginal worker is a person who works for a period of less than 6 months in a year. A detailed village wise workers distribution pattern is shown in Appendix – 11. Population wise distribution of workers is shown in Figure IV.9a & b.
68. Production of Coal from wood is typical activity carried out by specialized population, which is means of income for them. (Appendix-14).
69. The 4000MW (Nominal) power plant is proposed to be located in a site near Tundawand village in Mundra taluka, Kutch district of Gujarat Coastal area. No major displacement of the people is required which may affect their livelihood. However, a separate socio-economic study had been carried out through the questionnaire and field survey. A separate socio-economic study report has been prepared for the consideration of the issues to be dealt for social aspects

#### LAND USE PATTERN

70. The total study area for this the project is around 36489 Ha. Forest area is 1.6% of the total area of the villages falling within 10 km radius of the study area. There is no forest reserve within the plant boundary. The detail of landuse pattern for the study area is shown in Appendix –12. The following Figure IV.10 shows the agriculture land use pattern in the study area.

**Figure IV.10  
Land use Pattern**



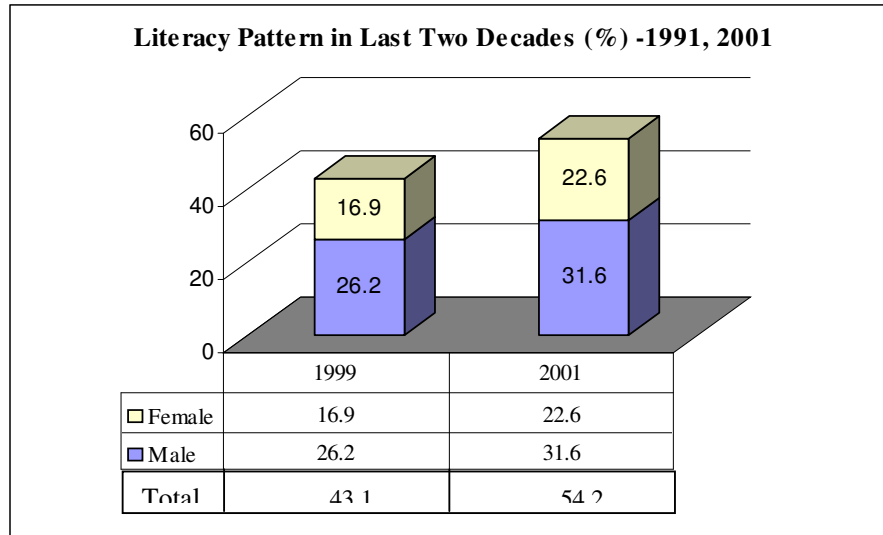
§Source: Census 2001, Census Handbook 1991

71. The figure indicated that only 25% of land area is coming under irrigation as compared to 36.9% of land area has no irrigation facility. Out of total land area 18.7 % land is culturable waste and 17.8 % of land is not used for any type of cultivation.
72. Major portion of the land area is coming under un-irrigated land category. However, nearly one fourth of land area comes under irrigated land category. This is an indication that surrounding population is depending on source of income other than agriculture also. Agriculture is mainly depending upon monsoon rain.

**LITERACY STATUS**

73. Educational status of population of the study area is not good as only 54.2% of population is literate. However, female literacy rate is 22.6%, which is comparatively poor. As per 2001 census data 67 % of the population was literate and remaining 33% population comes under illiterate category. A detailed literacy pattern of the study area is included in Appendix -13 Distribution pattern of literacy rate for all category of population is shown in following Figure IV.11. The Education facilities with in 10km radius of the study area is given in Table IV.9.

**Figure IV.11  
Literacy Pattern In The Study Area**



Source: Census Handbook, 1991 and Census 2001.

**Table IV.9  
Education Facilities within 10 km Radius of the Study Area**

<i>Educational Facility</i>	<i>1991</i>	<i>2001</i>
Primary or Elementary School	27	42
Middle School	1	0
Secondary or Matriculation School	2	4
Higher or Senior Secondary School	0	1
College	0	0
Industrial School	0	0
Training School	1	0
Adult Literacy Class/Centre	26	0
Other Educational Institutions	4	0

Source: Census Handbook, 1991 and Census 2001.

74. The predicted total number of persons required for the proposed project during construction and operation phase is as follows:

<b>Item</b>	<b>Company's</b>	<b>Contractor's</b>	<b>Total</b>
<b>During construction</b>	100	4000	4100
<b>During operation</b>	1850	150	2000

AGRICULTURE AND AMENITIES

75. Economic resources of the area include agriculture, irrigation, livestock and animal husbandry, forest, industries, transport and communication, medical and public health. All villages are electrified and medical facilities are adequate.



76. Amenities of the villages falling within 10km radius of the study area are shown in Appendix –15.
77. The land has been classified according to the different uses of rural areas. The land has been classified into irrigated, un-irrigated, culturable waste, area not available for cultivation and forestland type. The land use pattern of the study area is shown in Figure IV.10.
78. The dominant source of income is agriculture. The percentage of irrigated land is 12% of the total land area. The medical facilities present in study area are given in Table IV.10.

**Table IV.10**  
**Medical Facilities within 10km of the Study area**

<i>Medical Facilities</i>	<i>1991</i>	<i>2001</i>
Allopathic Hospital	2	1
Ayurvedic Hospital		0
Unani Hospital		0
Homeopathic Hospital		1
Allopathic Dispensary	7	9
Ayurvedic Dispensary		2
Unani Dispensary		0
Homeopathic Dispensary		0
Maternity and Child Welfare	1	2
Maternity Home	2	1
Child Welfare Centre	6	4
Health Centre	0	1
Primary Health Centre	8	2
Primary Health Sub Centre	0	2
Family Welfare Centre	4	3
T.B. Clinic	1	1
Nursing Home	1	1
Registered Private Medical Practitioners	14	9
Subsidized Medical Practitioners	1	0
Community Health workers	18	18
Other medical facilities	1	0

79. Wheat, pulses, castor seeds, guvar, bajri, groundnut, maize, mug, jowar are the some of major commodities manufactured in the 10km radius area. Apart from these, cotton, kharek (Dates), isabgul and chikko cultivation are also major source of revenue generation. The major commodities manufactured in respective villages within 10 km radius are shown in Appendix –15a.
80. In Mundra the fodder crop dominated the cultivation. In Mandvi, major crops such as cereals and pulses are uniformly distributed. Cotton cultivation is also concentrated in areas of Mundra and Mandvi. Per hectare yield of the selected crops are shown in Table IV.11.

**Table IV.11**  
**Average Yield of Crops Per Hectare**

Principal Crops	Average yield kg per hectare
Bajri	844
Jowar	447
Wheat	1971
Ground Nut	1010
Cotton	452

Source: Directorate of Agriculture –1990

### CONNECTIVITY

81. There are one National highway (NH-8A Extension upto Mandvi through MSEZ) and three state highways (SH-6, SH-47 (Bhuj) and SH-48 (Bhuj)) passing through the study area. The site is accessible by road with State Highway No. SH-50 (via Anjar) and SH-6 (via Gandhidham) and National Highway No. NH-8A (Delhi Kandla). The site is 280 km from Rajkot and 350km from Ahmedabad.
82. The nearest railway station is Adipur (57km). A broad gauge rail network is also operational connecting Mundra with National rail network. The nearest airport is at Bhuj, which is about 60 km from the site. An in-zone airstrip is also being constructed within Mundra-SEZ. There is also Mandvi airstrip about 40km from Mundra port and 15 km from the Western boundary of Mundra SEZ. The proposed site is located at 22 km from Mundra port and 2.5 km away from Gulf of Kutch.
83. The means of transport is by bus, two-wheelers, bullock carts and camel carts. “Chhakada”, a vehicle combination of motorcycle and cart that can carry more than six people at a time, is a basic local transportation. (Appendix-15b )

### LIVESTOCK POPULATION

84. Cattle wealth occupies a pivotal place in the rural economy of any of the area. Bullocks & cows, buffalo, sheep, goats, horses, mules, donkeys, camels, pigs and poultry are the livestock reported. Livestock density of the area varies from 50 to 75 per square kilometer. Average density (per square kilometer) for buffalo, cattle, goat, and sheep varies from 10 – 20, 30 – 50, 10 – 20, and below 5, respectively. The cattles (cow and buffaloes) are normally taken to open land for natural manuring of the land. There are various dairy farms (Gau shalas) in the study region that are also important source of earning for village people.

Livestock	Average Density/sq km
Buffalo	<10
Cattle	20-30
Goat	20-30
Sheep	20-30

Source: ENVIS website, 2006

## WATER BODIES

85. The seasonal rivers flowing through Mundra Taluka are River Nagmati, Bhukhi, Khari nadi and Phot, all in turn terminates to Gulf of Kutch. . In Mandvi Taluka the seasonal rivers are Rukmavati, Kharod and Vantharadi. In Mandvi and Mundra there are medium surface water structures namely Don and Kalaghogha respectively. Taluka wise surface water storage and irrigation potential is summarized in Table IV.12. Table shows that the Mandvi ranks poorer in terms of the storage but demonstrates better irrigation capability.

**Table IV.12**

### **Taluka wise Surface water storage and irrigation Potential**

Taluka	CCA(Ha)	UIP (Ha)	GS (MCM)
Mundra	7197	4999	37.42
Mandvi	13409	8803	66.44

*CCA- Culturable command area; UIP- Ultimate irrigation Potential, GS- Gross Storage*

*Source: GIDE, 2000.*

86. Mundra falls under “dark” category as groundwater development is between 85-100%. Mandvi is categorized as “OE” meaning the ground water is overexploited to the extent of development above 100% (GIDE, 2000).

## **SATELITE DATA COLLECTION, ANALYSIS AND INTERPRETATION**

87. Details of study including methodology adopted for the study is described in the Appendix – 16. Chapter 2.0. Chapter 3.0 describes the field observations and Global Positioning System (GPS) made from ground survey. Chapter 4.0 explains the dominant and representative ground features showing the digital photographs. Chapter 5.0 gives the satellite images, which include classified land use/land cover thematic maps.
88. Satellite image analysis was carried out for the generation of land use/ land cover map of the study region. The study region, is located the district of Kuchhch, Gujarat. The approach for satellite data analysis adopted the well-proven Image processing procedures. The analysis was preceded with a ground survey, which comprised of data collection of ground features along with the respective geographical position in terms of latitudes and longitudes. The interpretation of the satellite data was supplemented by these ground truth studies. The satellite data used has the below specifications:
- Satellite and Sensor: IRS P-6, LIS III (L-3)
  - Date on which the image was taken: 26-November-05
89. The said time period of acquisition of the satellite data has been judiciously chosen to depict the vegetation and other ground features at its best, as also avoid the cloud cover over the satellite data.
90. The image processing software used is the professional version of ERDAS IMAGINE 8.4 under Windows NT. A Pentium 1V based computing machine

with high processing speed and graphic facilities under the operating system of Windows NT is used for the image processing and interpretation.

91. The landuse-landcover in the region comprises of various types, referred as classes. The features derived from the satellite image after validation by the ground observations, have been presented as nine classes and are given below. These classifications types are as per the 'level classification' categories followed by National Remote Sensing Agencies (NRSA), -
- a) Cultivated Land
  - b) Fallow Land
  - c) Built-up Area
  - d) Water Bodies
  - e) Barren Area
  - f) Marshy Land / Low Land
  - g) waste land
  - h) Forest Cover
  - i) Sparse Forest
92. Satellite data from IRS-P6 (November 26, 2005) has been used. The approach used for analysis is given at the Chapter 2.0 of Appendix -16.
93. In order to understand the land use and land features covering the entire study region, both False Composite and classified images have been derived. FCC images depict the land features such as the coastal boundaries, while the classified images show different land use classes listed above. The coverage statistics, the area covered by each land use class, are also derived through satellite data analysis and given below in different Tables-2 included in Appendix – 16.
94. FCC Images for 5, 10, and 30 km from the project site is shown as Figure 1, 2 and 3, respectively. Similarly, classified images for 5, 10 and 30 km from the project site is shown as Figure 4, 5 & 6 in attached Appendix-16.

### **BIOLOGICAL ENVIRONMENT**

95. Environmental Impact Assessment studies needs monitoring of each and every environmental component. Apart from other environmental components, biological environment is an important and integral part of EIA study, as whatever changes due to industrial activities takes place in the surrounding environment, affects both living and non-living component of environment. Assessment of terrestrial ecosystem concentrates on the tree and herbaceous layer vegetation because these are relatively conspicuous and easy to identify.
96. Since the study area belongs to the coastal region and project activities are not limited to land but to marine ecosystem also. Therefore, marine environment is an important component that may be affected due to industrial activity, if proper control measure would not be adopted.
97. Baseline data for flora and fauna has been collected, which includes information on both flora and fauna communities. In present study, information has been collected on existing plant and animal species through survey and field studies. The information on distribution pattern of tree species has been collected to establish the interrelationship between species for prevailing environmental factors for post-development monitoring and management.

98. Plants and its surrounding environment are closely related and interdependent on each other. Plants compete themselves for the need of nutrient and light and adjust by adaptation or by modifying the surrounding environmental conditions. Thus they develop some sort of tolerance / resistance to overcome the adverse conditions. Plant population in a community varies from habitat to habitat that plays a fundamental role in determining the type of community over a period of time. Each constituent species within a community has a large measure of its structural and functional individualism along with more or less different ecological amplitude. Therefore, the dimension, population size and diversity of the species are more significant biological element of an ecosystem.
99. Plant communities are not static but always a dynamic entity. The vegetation cover may reflect the changes, which occurs in its structure, density, and composition. The most important characteristics of a community are its quantitative relationship between abundant and rare species. Characteristics of community in any ecosystem include the composition, structure, species diversity and growth trend of succession and other characteristics of the community, which is applied for the concept and realization of land management. To meet the objective of bio-diversity conservation with temporal & spatial changes, the monitoring of vegetation of an area is a necessary step.
100. A reconnaissance survey of the study area was planned during the study period Summer 2006 to establish the existing baseline ecological condition of the study area. The information about forestland area of the villages was collected from District Census Hand Book Part II – Land use. *Prosopis juliflora* is the dominant species of the terrestrial ecosystem of the study area.

### **ECOLOGICAL STUDY OF PROPOSED POWER PLANT AT MUNDRA**

#### **THE STUDY AREA**

101. (Study area: Village Tunda-Wand and the region within 10 km radius from this village; Period of Observation: Pre-monsoon period, Third week of May 2006). Ecological study has also been carried out for MGR system extended from power plant boundary to Adani port at Mundra.
102. Separate study on terrestrial ecology of MGR system and proposed service road has been carried out during first week of December'06. Separate terrestrial ecology report has been submitted to MOEF, New Delhi before second MOEF expert committee meeting held on 09.01.2007. This report includes impacts and finding of ecological study for MGR system. The same is enclosed with this report as Enclosure - 2.
103. Village Tunda-wandh is situated in Mundra taluka of Kuchchh district of Gujarat state. Geographically it is situated on the northern coast of Gulf of Kuchchh. The study area comprises following villages:
- a) Coastal villages: Jarpara, Navi Nall, Dhrab, Borana, Siracha, Tunda-Vandh, Gundhiali, Maska
  - b) Villages away from the coast: Tragdi, Nani Khakar, Mota Khakar, Nana Bhadiya, Mota Bhadiya, Bag, Pipri, Bidada, Desalpar, Bhojpar, Khandagra,
  - c) Town Mundra and Mandvi fall just out side the study area.

### VEGETATION COMPOSITION

104. Vegetation of the study area falls under “VI – B Northern Tropical Forest “ – sub – type C-I Desert Thorn Forest - (VI – Kachchh, Saurashtra, Gujarat). A coastal area of the study area has small patches of mangrove forest also in its coastal belt. View of barren project site area without tree and habitation is shown in Appendix - 17. Typical open scrub forest mainly constitutes thorny, stout species of *Prosopis juliflora*, *Accasia* spp., *Ephorbia* spp. *Cassia auriculiformis*. A typical scrub vegetation of the study area is shown in Appendix - 18 Sand dunes were also recorded very close to coast area. A typical photograph of sand dune around the species of *Prosopis juliflora* is shown in Appendix-19.
105. The geographical area of Kuchchh is 19,478.96 sq.km and consists 949 villages. The average rainfall of the district is 300-400mm only. The forest cover is 1,83,600 hectares, irrigated land is 71,000 hectares, non-irrigated land is 6,62,600 hectares. Town Mundra and Mandvi fall just out side the study area.
106. The main crops of the District are Bajra, Jowar, Wheat, Coconut, Kharik, Sugarcane and pulses. The geographical area of Mundra taluka is 888.1 sq. m. and consists 60 villages.
107. Marine Impact Assessment is based on the analysis of the baseline data and other available source of information in the study region. The attempt has been made to evaluate the existing environmental condition of the region. If any fragile condition exists it will be identified and addressed. Various parameters inter relationship with each other, possible positive/adverse impacts has been evaluated and enlisted. In case of any negative impacts the possible way of mitigative measures for reducing the impacts, available, alternatives and other suitable mitigation measures will be formulated and presented.
108. Marine Environmental Management Plan is based on the studies, the various marine management plans for the proposed activities during construction and operation phase has been prepared and included in chapter environmental management plan.

### BIOLOGICAL CHARACTERISTICS: AND ANALYSIS OF VARIOUS PARAMETERS

109. Phytoplanktons including all drifting or floating aquatic plants. Usually, these plants are single celled and autotrophic. Phytoplankton, as primary producers, contributes appreciably to the total production within the aquatic system.
110. Primary productivity is the rate at which the sun's radiant energy is stored by photosynthetic activity of producer organisms in the form of chemical energy. The primary productivity is thus the basis of whole metabolic cycle in natural aquatic ecosystems; the remainder is consumption and decay. The consumers inhabiting the system utilize the organic matter synthesized by primary producers.

111. All the material synthesized by the producers, however, is not available to consumers (all other forms except producers). The producers themselves utilize part of it in their maintenance (respiration) whereas some part of it is wasted and is use by the decomposers (non-photosynthetic bacteria, fungi, etc.) and the remainder is consumed by the herbivores (organisms using plant material as food). Herbivores transfer some amount of energy to the carnivores (organisms using living animal material as food). The accumulation of biomass in all other organisms except in producers is referred as secondary production. There are four successive steps of production process:

Gross Primary Production (GPP)

112. It is the rate of photosynthesis, and includes the organic matter used up in the respiration during the measurement period.

Net Primary Production (NPP)

113. It is the rate of storage of organic matter in plant tissue in excess of the respiratory utilization by the producers during the period of measurement.

Net Community Production (NCP)

114. It is the rate of organic matter not used by heterotrophs (i.e. NPP - heterotrophic consumption) during the period under observation.

Secondary Productivity (SP)

115. It is the rate of energy storage at consumer level.
116. Primary productivity studies are of paramount interest in understanding the effect of pollution on systems efficiency. High rates of production both in natural and cultural ecosystems occur when physicochemical factors are favourable. Pollution of water in the long run leads to a reduction in primary productivity. Pollution also affects the production (P)/respiration (R) ratio, a proper level of which is very essential for the sustenance of the system. In non-polluted water, the P usually exceeds R but in organically polluted systems R exceeds P and no organic material is left available for the bioactivity of the system leading to system's impairment.
117. Zooplanktons include small animals of weak swimming ability or without swimming ability that are free floating or drifting biota. The Zooplanktons have their importance in the aquatic food web by being an initial consumer of energy fixed by the Phytoplankton, and by them providing a link between primary production and higher trophic levels. Thus, measurements of species richness, species composition and species diversity indices could be used to evaluate the baseline status of the aquatic zone. In the same way the secondary productivity too gives a good idea about the present status of the aquatic environment and also of the impact of a particular development in the sense that if the secondary productivity is more then the physicochemical factors prevailing in the study area are favorable and vice versa.

METHODOLOGY

Sampling

118. Sampling was carried out in the whole study area of 10 km during the month of May 2006. Topographic feature of the area covered for marine ecological study is shown in Appendix -20.



119. The study area is divided into 4 transects. The distribution of transects were done based on the reconnaissance at the beginning of the project as well as the considering the detailed project activity and secondary information on the surrounding areas of water body and the prevalent activity.
120. The samples were collected at inter tidal region and up to a distance of about 3 km, (Radial) into the sea at 4 sampling points.
121. Surface water samples and sediment samples were collected for the selected sampling locations for low tide as well as high tide. Plankton samples were collected using plankton net. Sediment samples were collected using Ekman's grab while the water samples were collected from surface directly. The boats used for sampling is shown as Appendix- 21.
122. The Phytoplankton samples were preserved using Lugol's solution whereas 5% Formalin solution was used for the preservation of Zooplanktons.

### Analysis

123. The samples were analyzed within 24 hours from the time of collection using the standard methods of analysis as stated under.

The basic equation of photosynthesis is:



124. Hence, to measure primary productivity one can measure the carbon uptake as well as the oxygen production, or the formation of the organic compounds or the gain of chemical energy of the system. In aquatic ecosystems, the primary productivity is mainly due to Phytoplankton and aquatic macrophytes. The methodology adopted for determining the primary productivity is the *Chlorophyll method (APHA, 1989)*.

### Chlorophyll Method for Primary Productivity

125. The Phytoplanktons were collected from the by grab sampling method and centrifuged in order to collect the settled mass. These were washed with tap water, then with distilled water and dried with blotting paper. Accurately weighed 1gm. sample was crushed properly with the help of mortar and pestle in 80% acetone medium so as to get a homogenate. A pinch of MgCO<sub>3</sub> is added to remove of the unnecessary acids. The contents are finally diluted to 100ml.
126. The absorbance is measured at 630nm, 645nm and 663nm for each sample and the chlorophyll content is calculated by applying the following formula:  
 Chlorophyll a = (11.64 x O.D at 663nm) - (2.6 x O.D at 645nm) + (0.1 x O. D. at 630nm)  
 Thus, the primary productivity is determined in terms of chlorophyll content.

### Phaeophytin

127. The contents in the cuvette used for the analysis of chlorophyll a are acidified with 0.1ml of 0.1 M HCl in order to remove the interference of chlorophyll a. The optical densities are read at 664nm and 665nm respectively.



Phaeophytin is estimated by using the formula:

$$\text{Phaeophytin a} = \frac{26.7 [1.7 (665\text{nm}) - 884\text{nm}] \times V1}{V2}$$

- 128. **Zooplankton** were analyzed for the species diversity, standing stock and biomass using microscopic examination with the aid of identification keys from the literature available, photoplates, etc.
- 129. Benthic communities were microscopically examined for identification of species.

**OBSERVATIONS AND DISCUSSIONS:**

**Phytoplankton**

- 130. The phytoplankton pigments were measured at the surface. The results for the same are given in **Table IV.13** and **IV.14**.

**Table IV.13**  
**Average of Phytoplankton Pigments at study area (surface)**

Sampling Location	Chlorophyll a (mg/m <sup>3</sup> )		Phaeophytin (mg/m <sup>3</sup> )	
	High Tide	Low Tide	High Tide	Low Tide
S1	2.4	2.7	1.4	1.8
S2	2.3	2.8	1.2	1.6
S3	2.1	3.0	0.8	1.0
S4	1.9	3.1	0.5	1.0

- 131. The average chlorophyll values of 2.17m<sup>3</sup> and 2.9 mg/m<sup>3</sup> during high tide and low tide suggest moderately high primary production potential. Phaeophytin values are mostly lower than chlorophyll a indicating a healthy condition.
- 132. The productivity values also reveal less primary and secondary consumers as compared to the primary producers. The reason for which is a matter of extensive study.

**Table IV.14**  
**Primary Productivity at various sampling locations.**

Sampling Location	Gross (MgC/m <sup>3</sup> /hr)		Net (MgC/m <sup>3</sup> /hr)	
	High Tide	Low Tide	High Tide	Low Tide
S1	1.86	2.55	1.09	1.81
S2	1.95	2.62	1.21	1.91

Sampling Location	Gross (MgC/m <sup>3</sup> /hr)		Net (MgC/m <sup>3</sup> /hr)	
	High Tide	Low Tide	High Tide	Low Tide
S3	1.91	2.87	1.11	1.57
S4	1.97	2.91	1.17	1.80

133. Phytoplankton in the study area are principally composed of one-celled diatoms, cyanophytes, coccolithophorids, chlorophytes and dinoflagellates (**Table IV.15**). Other Phytoplanktons includes blue-green algae.

**Table IV.15**

**Phytoplankton diversity at various sampling locations (surface)**

Sampling Point	Cell count (no x 10 <sup>3</sup> /l)		Total genera		Composition (Major Groups)
	High*	Low*	High*	Low*	
S1	117	119	4	4	Bacteriastrum, Rhizosolenia, Navicula, Anabaena spiroides
S2	119	121	5	4	Bacteriastrum, Rhizosolenia, Navicula, Thalassiosira, Cosmarium
S3	120	118	4	6	Bacteriastrum, Rhizosolenia, Navicula, Microsystis
S4	112	125	5	6	Coscinodiscus, Navicula, Bacteriastrum, Tribonema

\* - Tide

Phytoplankton population is found to be moderately high in almost all the samples. The species diversity found is also fairly good in all the samples.

Zooplankton

134. The predominant groups of Zooplanktons in the study area include copepods, Sagitta, Mysids, Naupilli besides larval forms of gastropods, polychaetes, radiolarians, and others (**Table IV.16**). The standing stock and the biomass found in the samples (sampling points S1 to S4) is moderate with moderate species diversity. However, the trend can be generalized as increasing from S1 to S4. The reasons for the above mentioned trend can be attributed to those similar to that for the Phytoplankton.

**Table IV.16**  
**Zooplankton diversity at various sampling locations (surface)**

Sampling Point	Biomass (ml/100m <sup>3</sup> )		Population Density (no x 10 <sup>3</sup> /100m <sup>3</sup> )		Faunal group (no.)	Major group
	High*	Low*	High*	Low*		
S1	6.97	7.07	106	117	13	Copepods (Cyclops), Trichocerca spp, Sagitta
S2	5.48	6.99	83	92	8	Copepods, fish eggs, Mysids, Naupilli
S3	5.67	5.88	119	134	16	Copepods (Cyclops), Moina, Sagitta, Mysids, Cercaria larva
S4	6.92	8.15	132	146	16	Cyclops, fish eggs, Sagitta Mysids, Cercaria larva

\* - Tide

Biomass of zooplankton is fairly high. The major group classifications include rotifers, cladocerans and copepods besides some fish eggs and schools of larval fish.

#### Benthos

135. Intertidal macrobenthic biomass is very high, 134 g/m<sup>2</sup>. Group diversity was also moderately high with an average of 21 groups. The intertidal organisms include a diverse *Katelysia*, *Meretrix*, *Murex*, *Cyprea*, *Balanus* etc.

#### Fishes

136. Fishing is the major source of income in the study area. Lot of fishermen go out in their indigenous boats, some have mechanized trawlers. The area has good fish population. Gujarat, in the northwest coast, is dominated by demersals such as sciaenids, cuttlefishes and non-penaeid prawns. The major commercial varieties of fish that are caught are Jew fish, Bombay duck, Prawn, Lobster, Squid, Cuttle fish, Silver bar, Hilsa, Shark, Catfish, Mulletts, Ribbon fish, Shrimps, Sear fish and Croakers. In addition, the Gulf of Kutch has favorable conditions for the growth and sustenance of different types of Oysters, Shellfish and Seaweeds. Trawl catch rate indicates good potential 25 – 35 kg/h with an average species diversity of 34. Gill nettings show average rates of 7.6 kg/h.

### Birds

137. The Gulf area, which has many saltpans, Islands and inter-tidal coastal system with mangroves, offer favourable conditions for feeding, breeding and shelter to a variety of birds. A recent study reveals high avifaunal diversity at Mundra region and 140 species have been documented. Some of the birds sighted during the present study are Grey herons, Pond herons, large and small Egrets, Black Ibis etc. Birds seen at Mandvi beach are shown in Appendix-22.

### Water quality

138. Hydro chemically, the study area shows properties typical of a shallow semi enclosed sea in an arid region with the little or no freshwater input. The annual variation of water temperature is between 24 and 30°C though localised higher temperatures upto 35°C can result in isolated water pools formed in shallow intertidal depressions during low tide.
139. **pH** of the Gulf water is fairly constant (7.8-8.0) and is within the range expected for the coastal tropical seas (**Table IV.17**).
140. **Salinity** is higher than that of the typical seawater. This is particularly because the area experiences low precipitation and high evaporation.
141. **DO** is fairly high (4 -5 ml/l) which indicates good mixing of oxygen thus favourable conditions for organisms. Near homogeneity, absence of stratification and large tidal amplitudes coupled with turbulence render the entire Gulf vertically well-mixed resulting in high dissolved oxygen at or over its saturation point.

**Table IV.17**  
**Water Quality of study area**

Sampling Location	Parameters							
	pH	D.O. ml/L	TSS mg/L	NO <sub>2</sub> -N mg/L	NO <sub>3</sub> -N mg/L	PO <sub>4</sub> <sup>-3</sup> mg/L	B.O.D. ml/L	Salinity (‰)
W1	8.0	4.2	120	0.001	0.098	0.028	0.88	36
W2	7.8	4.8	179	0.001	0.086	0.019	1.2	37
W3	7.8	5.1	83	0.002	0.092	0.010	0.92	38
W4	7.9	4.3	143	0.001	0.122	0.031	0.96	38

142. The concentrations of heavy metals such as chromium, manganese, cobalt, nickel, copper, zinc and lead were studied **Table IV.18**.

**Table IV.18**  
**Metal concentrations in water samples from study area**

Sampling Location	Metal Concentration $\mu\text{g/g}$							
	Cd	Cr	Co	Cu	Mn	Ni	Pb	Zn
W1	0.02	BDL	0.07	0.35	0.09	0.86	0.07	0.12
W2	0.01	BDL	0.05	0.24	0.12	0.79	0.04	0.17
W3	BDL	BDL	0.08	0.32	0.12	0.92	0.03	0.13
W4	0.02	BDL	0.06	0.17	0.11	0.88	0.03	0.16

\*BDL : Below Detection Level

143. **BOD** is low (0.88-1.2 ml/l) indicating good oxidizing conditions. The organic load in the water column is expected to be effectively oxidized aerobically.
144. **Suspended Solids** (83 – 179 mg/L) vary spatially as well as temporally, and largely result from the dispersion of fine sediment from the bed and the intertidal mudflat, by tidal movements.
145. **PO<sub>4</sub><sup>-3</sup>** concentrations were in a favourable range and more or less uniformly distributed. The network of creeks sustains high natural concentrations of nutrients perhaps due to high regeneration rates.
146. **NO<sub>2</sub>-N, NO<sub>3</sub>-N** concentrations were also in a favourable range and more or less uniformly distributed with slight variation.
147. **Metal** concentration of the water samples were found to be relatively low, indicating that the water is yet not contaminated to alarming levels.
148. The overall quality of water is excellent. Marginal degradation in water quality in localized areas around industrial and urban centre is possible. But such changes are subsided by semi – diurnal tidal flushings associated with moderate to strong tidal currents.

#### Sediment quality

149. The near shore sediment, which consists of light grey silt and clay with patches of fine to coarse sand in-between. The major source of this sediment is considered to be the shore material and the load transported by the Indus River. A view of beach located close to project site is shown in Appendix- 23.
150. The concentrations of heavy metals such as chromium, manganese, cobalt, nickel, copper, zinc and lead were studied **Table IV.19**. The metal concentrations indicate natural background levels and there is no evidence of Gross sediment contamination.

Table IV.19

## Metal concentration in sediments from the study area

Sampling Location	Metal Concentration $\mu\text{g/g}$							
	Cd	Cr	Co	Cu	Mn	Ni	Pb	Zn
S1	15.2	10.2	18.3	32.2	23.0	14.0	27.2	46.2
S2	12.8	18.3	20.2	30.9	19.7	17.3	36.1	73.4
S3	8.3	15.8	16.1	27.4	21.2	15.9	24.7	69.7

**LAND BASED SURVEY- VEGETATION ANALYSIS****AGRICULTURAL VEGETATION DIVERSITY**

151. There happens to be a significant diversity of crops in the study area. Among cereals, Bajra (*Pennisetum typhoides*) and Jowar (*Sorghum bicolor*) are mainly cultivated in this region. Proportionately Wheat (*Triticum vulgare*) is cultivated in lesser quantity. In pulses Mung and Mungphali (*Arachis hypogaea*) were observed. Kharik Palm (*Phoenix dactylifera*), Chiku (*Achras sapota*), Coconut (*Cocos nucifera*) Mango (*Mangifera indica* var. Kesar) were the main cash crops cultivated in orchards. Of these Kharik Palm, Chiku were the predominant in the coastal villages.
152. However in inner villages the Coconut and Mango has reduced their majority significantly. Papita or Papaya (*Carica papaya*) was also observed in few orchards. Erand (*Ricinus communis*) was observed to be cultivated for its oil yielding seeds. In vegetable crops Dudhi, and members of Cucurbitaceae family were observed along with Brinjal. In homestead areas Khatti and Mithi imli (*Tamarindus indicus* and *Pithecolobium dulce*), Jamun (*Syzygium cumini*) and Ber (*Zizyphus mauritiana*) were very common. Very few numbers of *Artocarpus heterophyllus* were also been observed.

**MANGROVE VEGETATION**

153. The intertidal region in the study area is though under influence of tide, possesses sandy substratum and hence is devoid of mangrove vegetation. Mangroves show a very dwarf appearance in the creeklets such as "kutri"(local name creek, which is at least 2.5 km. away from the actual project site. *Avicennia marina* is the dominant species with *Suaeda* as a major associate mangrove. *Denis indica* and *Salvadora persica* are the other associated species were recorded during the study period. Physical feature of the dominant mangrove species *Avicennia marina* is shown in Appendix -24.
154. Mangroves, locally famous as "Cheriyā" in this region and the mangrove areas are called "Cheriyā vistar". *Avicennia marina*, *Salvadora perciaca*, *Seuda* were very common in this area. According to information available from local forest office, few years back, *Rhizophora mucronata* and *Ceriops tagal* had been introduced in this region. The mangrove vegetation is seen from Mundra port up to Tunda-Vandh coast. However, in Tunda-Vandh, the *Prosopis* and *Acacia* spp. were predominantly observed just above the high tide line.

### VEGETATION OF WILD HABITATS

155. This region receives very small amount of rain, in addition the soil texture is also sandy. Hence, the vegetation in this region is typically “scrub” vegetation. The trees and shrubs of *Prosopis* and *Acacia* are predominantly occurs in non-cultivated lands. Also members of Euphorbiaceae namely *E. nivula* and *E. tirucalli* were very commonly observed. *Aloe vera* was also observed at few places. The profusely grown *Ficus benghlensis* were observed near a dry water tank in Navinal village. Among the evergreen species Neem (*Azadirachta indica*) is the only species observed significantly in the study area. In shrubs- *Cassia auriculiformis*, locally called “Avar” is also observed predominantly along with *Calotropis*. In tress species, *Eucalyptus*, *Casuarina*, *Delonix*, *Peltophorum*, *Nerium*, *Polyalthia*, *Thevetia* were observed to be cultivated in homestead areas. A list of flora recorded in the study area is shown in the following Table IV.20

**Table IV.20**

**List of plants recorded from the study region**

No.	Name of Plant	Family	Habit	Vernacular Name
1.	<i>Acacia auriculiformis</i>	Mimosaceae	T	
2.	<i>Acacia leucociphala</i>	Mimosaceae	T	Hermo baval
3.	<i>Acacia nilotica sub-species indica</i>	Mimosaceae	T	Babhul
4.	<i>Acacia senagal</i>	Mimosaceae	T	Gorad
5.	<i>Acrus sapota</i>	Sapotaceae	T	Chiku
6.	<i>Agave ingens</i>	Agavaceae	H	
7.	<i>Aloe vera</i>		H	
8.	<i>Arachis hypogaea</i>	Papilionaceae	H	Mungphali
9.	<i>Artocarpus heterophyllus</i>	Moraceae	T	
10.	<i>Avicennia marina</i>	Avicenniaceae	T	Cheriyā
11.	<i>Azadirachta indica</i>	Meliaceae	T	Nimda, Limdo, Neem
12.	<i>Bougainvillea spectabilis</i>	Nyctaginaceae	C	
13.	<i>Butea monosperma</i>	Fabaceae	T	Kesudo
14.	<i>Calotropis gignentia</i>	Asclepiadaceae	S	Dholo Akado
15.	<i>Calotropis procera</i>	Asclepiadaceae	S	Nano Akado
16.	<i>Carica papaya</i>	Carricaceae	T	Papita, Papaya
17.	<i>Cassia auriculiformis</i>	Caesalpiniaceae	S	Avar
18.	<i>Casuarina equisetifolia</i>	Casuarinaceae	T	Suru
19.	<i>Cocos nucifera</i>	Arecaceae	T	Nariyal

No.	Name of Plant	Family	Habit	Vernacular Name
20.	<i>Cordia dichotoma</i>	Boraginaceae	T	Moto Gundo
21.	<i>Cordia gharaf</i>	Boraginaceae	S	Liyar, Gundi,
22.	<i>Cynodon dactylon.</i>	Poaceae	HG	
23.	<i>Cyperous spp.</i>	Cypereceae	H	
24.	<i>Delonix regia</i>	Caesalpinaceae	T	Gul Mohar
25.	<i>Derris indica</i>	Fabaceae	T	
26.	<i>Eucalyptus Spp.</i>	Myrtaceae	T	Nilgiri
27.	<i>Euphorbia nivulia</i>	Euphorbiaceae	S	Thor
28.	<i>Euphorbia tirucalli</i>	Euphorbiaceae	T	Kharsani, Thor
29.	<i>Ficus benghalensis</i>	Moraceae	T	
30.	<i>Ficus recemosa L.</i>	Moraceae	T	
31.	<i>Ficus religiosa L.</i>	Moraceae	T	Pipal
32.	<i>Ipomea fistulosa</i>	Convolvulaceae	S	Akari
33.	<i>Ipomoea sp.</i>	Convolvulaceae	C	
34.	<i>Leptadenia pyrotechnica</i>	Asclepiadaceae	S	Khip
35.	<i>Leucaena leucocephala</i>	Mimosaceae	T	
36.	<i>Mangifera indica L</i>	Anacardiaceae	T	Aam
37.	<i>Mimosops hexandra</i>	Sapotaceae	T	Rayan
38.	<i>Nerium odoratum</i>	Apocynaceae	S	Kanher
39.	<i>Peltophorum pterocarpum</i>	Caesalpinaceae	T	
40.	<i>Pennisetum typhoides</i>	Poaceae	HG	Bajra
41.	<i>Phaseolus aureus</i>	Fabaceae	H	Mung
42.	<i>Pheonix dactylifera</i>	Arecaceae	T	Kharik Palm
43.	<i>Pithecolobium dulce</i>	Mimosaceae	T	
44.	<i>Polyalthia longifolia</i>	Annonaceae	T	
45.	<i>Portulaca indica</i>	Portulacaceae	H	
46.	<i>Prosopis chilensis</i>	Mimosaceae	S	Gando Baval
47.	<i>Prosopis chilensis</i>	Mimosaceae	T	Khijdo
48.	<i>Prosopis stephaniana</i>	Mimosaceae	S	Khijdi
49.	<i>Ricinus communis L.</i>	Euphorbiaceae	S	Erand
50.	<i>Samanea saman</i>	Mimosaceae	T	



No.	Name of Plant	Family	Habit	Vernacular Name
51.	<i>Solanum melanogena</i>	Solanaceae	H	Baingan
52.	<i>Sorghum bicolor</i>	Poaceae	HG	Jowar
53.	<i>Syzygium cumini</i>	Myrtaceae	T	Jamun
54.	<i>Tamarindus indicus L.</i>	Caesalpiniaceae	T	
55.	<i>Terminalia catapa</i>	Combretaceae	T	
56.	<i>Thevetia peruviana</i>	Apocynaceae	S	
57.	<i>Typha angustata</i>		H	Panj
58.	<i>Zizyphus mauritiana</i>	Rhamnaceae	S	Ber