CHAPTER 4

BASELINE ENVIRONMENTAL CONDITIONS: PHYSICAL, BIOLOGICAL, DEMOGRAPHIC AND SOCIO-ECONOMIC

4.1 INTRODUCTION

The field studies were carried out in and around the chosen locations for the 3 pipeline projects in TD Area, namely, 45 km long x 200 mm NB Baghjan–STF crude oil pipeline, 37 km long x 400 mm NB Baghjan-CGGS & OTP near W/50 gas pipeline and 23 km long x 100 mm NB Baghjan-Makum OCS crude oil pipeline, for a period of nearly 5 weeks from January 20 to February 22, 2009 for the Environmental Impact Assessment (EIA) studies to get necessary baseline data for the present environmental scenario in the study area.

4.2 SAMPLING/MONITORING LOCATIONS

Baseline primary data collection was carried out at following 8 villages in the study areas of 3 pipeline projects and some adjoining area in TD Area:

Sl. No.	Village	Circle	District	Population
1.	Chandmari Bongali Gaon	Tinsukia	Tinsukia	514
2.	Jaygu Khowa Gaon	Doom Dooma	Tinsukia	675
3.	Dighaltarang Gaon	Doom Dooma	Tinsukia	1046
4.	Baghjan Gaon	Doom Dooma	Tinsukia	3648
5.	Chuta Hapjan Gaon No.1	Doom Dooma	Tinsukia	2516
6.	Naoholia No. 3	Tengakhat	Dibrugarh	1149
7.	Tengapani TE316 Nlr Gt	Tinsukia	Tinsukia	1565
8.	Nagaajan Gaon	Tengakhat	Dibrugarh	1430

Camp Office was established at Tinsukia where automatic meteorological station was also installed. Baseline sampling/monitoring was carried out as per the details given below:

Parameter	Location
Meteorology	Tinsukia
Soil	Chandmari Bongali Gaon, Jaygukhowa Gaon, Dighaltarang Gaon, Baghjan Gaon, Chuta Hapjan Gaon, Naoholia No.3, Tengapani TE 316 Nlr Gt. and Nagaajan Gaon
Water	**Handpump:** Chandmari Bongali Gaon, Tengapani TE 316 Nlr Gt., Naoholia No. 3, Nagaajan Gaon, Baghjan Gaon and Chuta Hapjan Gaon **Tubewell:** Dighaltarang Gaon and Jaygukhowa Gaon **River:** Dibru River

Ambient Air	Chandmari Bongali Gaon, Tengapani TE 316 Nlr Gt., Naoholia No. 3, Nagaajan Gaon, Baghjan Gaon, Jaygukhowa Gaon, Dighaltarang Gaon and Chuta Hapjan Gaon
Noise	Chandmari Bongali Gaon, Tengapani TE 316 Nlr Gt., Naoholia No. 3, Nagaajan Gaon, Baghjan Gaon, Jaygukhowa Gaon, Dighaltarang Gaon and Chuta Hapjan Gaon

4.3 PHYSICAL ENVIRONMENT

4.3.1 Topography and Physiography

Physiographically the TD Area consists of a flat plain interspersed with Dibru and Dongari rivers and their tributaries as well as small ponds. TD Area villages and towns have no forest land (**Table 4.13**). Reconnaissance survey indicated that TD Area and surrounding area has many tea gardens and only few paddy fields. Dibru river flows in TD area. Baghjan-STF crude oil Pipeline, Baghjan-CGGS & OTP near W/50 gas pipeline and Baghjan-Makum OCS crude oil pipeline will cross Dibru river. River Dongari also flows through TD area in north western part of Baghjan OCS study area.

Area available for cultivation constitute nearly 84.07% of total village area but merely 1.75% of total culturable area has irrigation facilities and rest 98.25% depends on rains for irrigation (**Table 4.13**) which is quite heavy throughout the year except for the months of November to January (**Tables 4.2 and 4.3**).

4.3.2 Soils

The TD area has alluvium derived soils formed by deposition of sedimentary matter by flowing water within recent times. Light brown to dark brown in colour and sandy loam to loam in texture Alluvial soils found are rich in nutrients and are suitable for arable farming for growing paddy, maize, wheat, pulses, oilseeds, etc.

To understand the soil quality in the study area, soil samples were collected from 8 villages/towns covering the study and surrounding area in TD Area. The soil sampling locations are listed in **Section 4.2** and shown in **Fig. 4.1**. Composite soil sampling (10-15 cm depth) was carried out at each location.

The value of important physical and chemical parameters of these soil samples are given in **Table 4.1**. From the tabulated values, the following conclusions can be made about the physical and chemical characteristics of the soil samples.

A. Physical Parameters

The important physical characteristics of soils are bulk density, moisture content, water holding capacity and texture. The results of analysis are given in **Table 4.1** and brief summary of physical characteristics is given below:

Moisture Content: Moisture content of soils of the study area ranges from 2.64 to 4.24%.

Water Holding Capacity (WHC): Water holding capacity (WHC) of soil samples of the study area ranges between 44.5 to 54.5 percent and these soils are capable of retaining sufficient water quantity during irrigation/rainfall for facilitation of plant growth.

Bulk Density: Bulk density of soils in the study area is found to be in the range from 1.14 to 1.24 g/cm^3.

Texture: Soil samples from all eight locations are loam to sandy loam in texture.

B. Chemical Parameters

The results of important chemical parameters of soils of the study area are also given in **Table 4.1** and a brief summary of chemical characteristics is given below:

pH: pH was determined by taking 1:5 ratio of soil and distilled water. pH of soils in the study area in a range of 7.5 to 7.8 is categorized to be slightly alkaline (7.5 to 8.5).

Calcium: Soluble calcium is a highly essential nutrient to plants and affects the activities of certain enzymes. The soluble calcium content as Ca in the soil samples of study area is found to be in the range of 7.2 to 12.8 mg/100g.

Magnesium: Soluble magnesium is used in plant growth in appreciable amount. It is also active in enzyme system and has a vital part in photosynthesis process. Soluble magnesium content as Mg in the soil samples of study area ranges from 6.8 to 8.3 mg/100g.

Chloride: The role of chloride in plant metabolism is not established but the presence of minute amount of chloride ion is essential. Soluble chloride content in soils of the study area is found to be in the range of 8.5 to 21.2 mg/100g.

Alkalinity: Total alkalinity as $CaCO_3$ of soil samples of the study area ranges from 40 to 110 mg/100g.

Available Phosphorous: Available phosphorous as PO_4 of soil samples of the study area is high and ranges from 4.4 to 11.0 mg/100g. Soils are rich in phosphorous. Phosphate is an essential nutrient for agricultural production.

Sulphate: Soluble sulphate content in soil samples of the study area as SO_4 is found in the range of 4.5 to 10.8 mg/100g.

Potassium: Potassium content as K in soil samples varies from 12.8 to 18.8 mg/100g and soil can be categorized to have high K (>11.1 mg/100g). Availability of potassium in soil is essential for agricultural production.

Total Kjeldahl Nitrogen (TKN): TKN concentration in soil samples varies in the range of 0.013 to 0.059%. Availability of nitrogen in soils is one of the main factor in agricultural production.

Total Organic Carbon (TOC): Total organic carbon content in soil samples of the study area is found to be in a range of 0.63 to 0.72% and is categorized as medium (0.5 to 0.75%).

Total Organic Matter (TOM): Total organic matter content in soil samples of the study area is found to be in the range of 1.09 to 1.24%. It may be noted that higher organic carbon content in soil shows higher microbial activities and higher availability of nutrients to crop.

Conclusions: Soils of the study area have good fertility and are suitable for cultivation.

4.3.3 WATER RESOURCES AND WATER QUALITY

4.3.3.1 Water Resources

Water resource of the study area are classified into following categories:

(i) Surface Water Resources: River, nadi, nullah, ponds, etc.
(ii) Ground Water Resources: Accumulation of water in deeper strata of ground.

The only source of recharging for surface water and ground water is from the atmospheric precipitation, which is in the form of rainfall.

4.3.3.2 Rainfall in the Study Area

The monthly rainfall data for last 10 years from 1999 to 2008 collected by the field team is presented in **Table 4.2** for Tinsukia and **Table 4.3** for Dibrugarh. Tabulated data shows that the annual rainfall for the period was as high as 2442.9 mm in 2000 at Tinsukia and 2660.4 mm in 2004 at Dibrugarh, and as low as 1371.9 mm at Tinsukia and 1883.3 mm at Dibrugarh both in 2001 with an average annual rainfall in last 10 years as 1994.3 mm at Tinsukia and 2185.7 mm at Dibrugarh. The study area generally receives good rainfall during April to September with heaviest rainfall in July followed by June. June and July together account for nearly 38.6 to 40.8% of average annual rainfall from south-west monsoon. Period from November to January has very low rainfall and accounts for only about 2.1 to 2.5% of average annual rainfall. The study area can be categorized as moderate to heavy rainfall area.

4.3.3.3 Surface and Ground Water Resources

Dibru and Dongari rivers along with many tributaries are the major surface water sources in the study area. Majestic river Brahamputra flows north of Dibrugarh and is far away from TD Area. Dibru and Dongari rivers are perennial sources of water and have sufficient water due to substantial rainfall in the TD Area throughout the year except during months of November to January. Other important source of surface water is the existence of large number of small ponds in the villages in TD Area.

Ground water availability in the study area is also good because of moderate to heavy rainfall in the TD Area and existence of perennial rivers and small ponds in the villages. Shallow ground water aquifers of sweet water exist at a

depth of 13 to 15 m in the study area. Tap water supply (river water) is available in about 11% villages for few hours in a day through common taps. In the absence of tap water supply villagers use water mostly from tubewell and well for drinking and other domestic use (**Table 4.20**).

4.3.3.4 Water Quality In Study Area

A. Water Sampling Locations

For assessing the water quality in the area, water samples were collected from nine locations described in **Sub-section 4.2** (1 surface and 8 ground water samples). The water quality sampling locations are shown in **Fig. 4.1** and listed in **Section 4.2**.

B. Characteristics of Water Samples

The collected water samples were analyzed for selected physical and chemical parameters. **Table 4.4** gives the results of water quality analysis along with desirable limit and permissible limit if no alternate source of drinking water is available. Characteristics of water samples are summarized below:

Sl. No.	Parameter	Unit	Monitored Ranges
Essential Characteristics in Drinking Water			
1.	Colour	--	Colourless
2.	Odour	--	Unobjectionable
3.	Taste	--	Agreeable
4.	pH	--	6.5 to 7.6
5.	Total Hardness (as $CaCO_3$)	mg/l	50 to 90
6.	Iron	mg/l	0.09 to 0.14
7.	Chloride (as Cl)	mg/l	9.9 to 27.0
Desirable Characteristics in Drinking Water			
8.	Total Dissolved Solids	mg/l	100 to 156
9.	Calcium (as Ca)	mg/l	5.6 to 23.2
10.	Magnesium (as Mg)	mg/l	3.9 to 11.7
11.	Sulphate (as SO_4)	mg/l	7.3 to 10.5
12.	Nitrate (as NO_3)	mg/l	ND to 0.60
13.	Total Alkalinity (as $CaCO_3$)	mg/l	60 to 120
14.	Fluoride	mg/l	ND to 0.04
Other Characteristics (No Limits Specified in Drinking Water)			
15.	Silica	mg/l	1.40 to 2.58
16.	Phosphate (as PO_4)	mg/l	0.06 to 0.66
17.	Sodium (as Na)	mg/l	13 to 30
18.	Biological Oxygen Demand (BOD)	mg/l	8
19.	Chemical Oxygen Demand (COD)	mg/l	60

D. Conclusion

Water, both surface and ground, quality in the study and surrounding area in TD Area is extremely good because all parameter values for all water samples meet desirable limits wherever specified.

4.3.4 Climatology and Meteorology

4.3.4.1 Introduction

The meteorological parameters play a vital role in transport and dispersion of pollutants in the atmosphere. The collection and analysis of meteorological data, therefore, is an essential component of environmental impact assessment studies. The long-term and short-term impact assessments could be made through utilization and interpretation of meteorological data collected over long and short periods.
Since the meteorological parameters exhibit significant variation in time and space, meaningful interpretation can only be drawn through a careful analysis of reliable data collected very close to the site.

Climatological (long-term) data is obtained from the closest India Meteorological Department (IMD) station or from any other nearby station which has been collecting meteorological data for at least 10 years.

Dibrugarh meteorological station is the closest IMD station and is located at a distance of 45 km in eastern direction from Tinsukia town close to TD Area. Dibrugarh IMD station is collecting meteorological data since July 1901. Climatological data for Dibrugarh is obtained from India Meteorological Department, New Delhi, and is discussed in **Subsection 4.3.4.2**.

4.3.4.2 Climatological Data

Table 4.5 gives the climatological data from 1951 to 1980 for Dibrugarh IMD station.

A. Seasons

The TD area is characterized by a typical warm and humid climate with moderate to heavy rainfall mainly during southwest monsoon season. The area does not experience the extremes of summer season in a year and only December to February can be characterized as winter season having slightly lower temperatures with monthly mean of daily minimum and maximum temperature in ranges of 8.8 to 12.0^{0}C and 22.5 to 23.8^{0}C, respectively, and relatively low rainfall. June to August have relatively higher temperatures coupled with high rainfall.

It may be observed that the area cannot be characterized to have distinct summer and monsoon seasons and April to October can be considered as hot and rainy months.

B. Temperature

Table 4.5 gives the temperature at Dibrugarh IMD station. The hottest month is August and coldest month is January. The mean of the daily maximum temperature during August is 31.4^{0}C while mean of daily minimum

temperature is 24.6^0C. The mean of daily minimum temperature during January is minimum at 8.8^0C while mean of maximum temperature is 22.5^0C. The mean of daily maximum temperature remains in a narrow range of 22.5^0 to 31.4^0C and that of minimum temperature remains in a range of 8.8^0 to 24.6^0C throughout the year.

C. Atmospheric Pressure

Ambient atmospheric pressure at Dibrugarh is given in **Table 4.5**. Mean annual atmospheric pressures at 8:30 hour and 17:30 hour are 998.2 mb and 994.2 mb, respectively. Atmospheric pressure is higher by 3.6 to 4.2 mb at 8.30 hour as compared to 17.30 hour. Mean monthly atmospheric pressure is lowest during July (990.2 mb at 8:30 hour and 986.6 mb at 17:30 hour) and highest during December (1005.4 mb at 8:30 hour and 1001.5 mb at 17:30 hour).

D. Rainfall

Dibrugarh IMD station receives an average annual rainfall of 2588.7 mm (**Table 4.5**). This makes the region a heavy rainfall area. Nearly 76.78% of annual rainfall is received during May to September months with July showing the highest monthly rainfall of 516.9 mm and 21.6 rainy days with daily rainfall of 2.5 mm or more. Dibrugarh has 127.1 rainy days in a year with rainfall of 2.5 mm or more.

E. Humidity

Table 4.5 also gives the relative humidity (RH) data at Dibrugarh IMD station. Mean monthly RH is highest during July (88%) at 8:30 hour and October and November (84%) at 17:30 hour and lowest during March (71% at 8:30 hour and 64% at 17:30 hour). RH is higher at 8:30 hour as compared to 17:30 hour during January to September period but RH is lower at 8:30 hour as compared to 17:30 hour during October to December period.

F. Cloud Cover

Table 4.5 shows that June/July are the cloudiest months of the year with all clouds covering 7.3 octas at 8:30 hour in July and 5.9 octas and 17:30 hour in June. Cloudiness decreases to some extent during months of November to January with all clouds cover of 2.8 to 3.4 octas at 8:30 hour and 2.6 to 3.3 octas at 17:30 hour.

G. Visibility

Visibility is mostly 4 km and more for 328.7 days at 8:30 hour and 349.6 days at 17:30 hour (**Table 4.5**).

H. Special Weather Phenomena

Maximum thunder storms are observed in August (13.2 d) followed by April (12.5 d). Thunder storms are minimum during December (0.6 d). Dibrugarh observes dust storm for 0.6 d in a year with March having 0.3 d. Fog is observed maximum in December (11.9 d) followed by January (9.0 d) and only July has no foggy day.

I. Wind Direction and Wind Speed

Table 4.6 shows that the winds at 8:30 and 17:30 hours are mostly from NE-E sector towards SW-W sector throughout the year. Calm period at 17:30 hour during October to January prevails for 82 to 94% of total time.

Annual average wind speed is 4.1 kmph with March showing the highest average wind speed of 6.2 kmph. Lowest wind speed of 2.3 kmph is observed in November and December.

4.3.4.3 Meteorological Observations at Site (Tinsukia)

IMD data recorded only at 8:30 and 17:30 hours for only eight wind directions with wind speeds over widely spaced ranges is not of much use in dispersion modelling. Because of these limitations a meteorological station was set up by the Envirotech Field Team at Tinsukia in TD Area for meteorological measurements in winter season (January 20 to February 22, 2009).

The meteorological data, such as, wind speed and direction was collected every hour, dry bulb and wet bulb temperatures and relative humidity were measured at 8:30 and 17:30 hours, and maximum and minimum temperatures were recorded every day during the study period. Automatic wind monitor was established at a height of nearly 10 m. The summary of the same is presented in **Table 4.6** and discussed in the following sub-sections:

A. Temperature

Table 4.6 presents the highest, lowest and average values of maximum and minimum temperatures recorded at Tinsukia during the study period. From the tabulated data it may be noted that the highest maximum temperature of 29.0^0C and lowest minimum temperature of 14.0^0C are observed during the study period. The average daily maximum and minimum temperatures are observed to be respectively 26.6^0C and 16.8^0C during the study period.

During the study period at 8:30 hour, average dry bulb temperature is 21.4^0C and varies in a range of 20.0 to 23.5^0C. At 17:30 hour, average dry bulb temperature is 23.0^0C and varies in a range of 20.0 to 25.5^0C. During the study period average wet bulb temperature is 18.4^0C and varies in a range of 17.0 to 20.0^0C at 8:30 hour, and at 17:30 hour average wet bulb temperature is 19.4^0C and varies in a range of 18.0 to 20.5^0C.

B. Relative Humidity

The relative humidity recorded at 8:30 and 17:30 hours at Tinsukia during the study period is also given in **Table 4.6**. From tabulated data it is observed that highest relative humidity value is recorded as 80% at 8:30 hour and 78% at 17:30 hour while lowest relative humidity is recorded as 65% at 8:30 hour and 65% at 17:30 hour. Average RH value is 70.2% at 8:30 hour and 69.4% at 17:30 hour during the study period.

C. Atmospheric Pressure

Table 4.6 gives the barometric pressure recorded at Tinsukia during the study period. From tabulated data it is observed that at 8:30 hour average barometric pressure is 1004 mb and varies from 1003 to 1005 mb while at 17:30 hour, average atmospheric pressure to 1000 mb and varies from 999 to 1001 mb.

D. Wind Speed

Average wind speed during the study period is 3.6 kmph. Highest average day-, night- and day + night-time wind speeds are respectively 8.1, 5.5 and 6.4 kmph while their respective lowest values are 2.9, 1.2 and 2.0 kmph, and their respective average values are 4.4, 3.0 and 3.6 kmph.

E. Wind Pattern

Table 4.7 and **Fig. 4.2** present the wind pattern data for the study period (January 20 to February 22, 2009) at Tinsukia during day-, night- and day + night time.

- **Day Time**

Predominant winds from E direction are observed for 15.45% of the total time with wind speeds and frequencies in the range of >3.6-7.2 kmph (8.64%), >1.8-3.6 kmph (5.45%) and >7.2-14.4 kmph (1.36%).

Other directions and percentage frequencies are (in decreasing order of frequency) from ENE (12.27%), NE (11.36%), ESE (10.00%), NNE (6.82%) and N (6.36%). Winds in other directions have frequencies less than 5% each.

The most predominant wind speed is >3.6-7.2 kmph (54.09%) followed by >1.8-3.6 kmph (27.73%), >7.2-14.4 kmph (8.18%) and >14.4-28.8 kmph (0.45%). Calm period is observed for 9.55% of the total time.

- **Night Time**

Predominant winds from E direction is observed for 14.51% with wind speeds and frequencies in the range of >3.6-7.2 kmph (9.26%), >1.8-3.6 kmph (4.63%) and >7.2-14.4 kmph (0.62%).

Other directions and percentage frequencies are (in decreasing order of frequency) from ENE (11.73%), NE (8.02%) and ESE (6.17%). Winds in other remaining direction have frequency less than 5% each.

The predominant wind speed is >3.6-7.2 kmph (32.41%) followed by >1.8-3.6 kmph (30.86%), >7.2-14.4 kmph (2.78%) and >14.4-28.8 kmph (0.31%). Calm period prevails for 33.64% of the total time.

- **Combined (Day + Night) Time**

Predominant winds from E direction are observed for 14.89% of the total time with wind speed and frequencies in the range of >3.6-7.2 kmph (9.01%) and >1.8-3.6 kmph (4.96%) and >7.2-14.4 kmph (0.92%).

Other directions and percentage frequencies are (in decreasing order of frequency) from ENE (11.95%), NE (9.37%), ESE (7.72%) and NNE (5.33%). Winds in other directions have frequency less than 5% each.

The most predominant wind speed is >3.6-7.2 kmph (41.18%) followed by >1.8-3.6 kmph (29.60%), >7.2-14.4 kmph (4.96%) and >14.4-28.8 kmph (0.36%). Calm period prevails for 23.90% of the total time.

4.3.5 Ambient Air Quality

4.3.5.1 Introduction

Suspended particulate matter (SPM), respirable particulate matter (RPM), sulphur dioxide (SO_2), oxides of nitrogen (NOx), carbon monoxide and hydrocarbons are the only air pollutants which may be emitted in small amounts during operation of 3 pipeline line projects in TD Area due to vehicular movement, combustion of natural gas/HSD during operation of crude oil dispatch pumps and gas compressor/boosters.

4.3.5.2 Methodology of Monitoring and Analysis

Eight AAQM stations were set up to study the background ambient air quality of the study area as discussed in **Section 4.2**. The AAQM stations were selected keeping in mind the study areas of the proposed new development projects as well as major settlements and their locations within and around the study area in TD Area. 24-hourly monitoring was carried out for a period of four consecutive days at each of eight locations. **Fig. 4.1** shows the AAQM locations.

One Respirable Dust Sampler (RDS) manufactured by Envirotech Instruments Pvt. Ltd. (APM 451) was deployed for ambient air quality monitoring (AAQM). The RDS has been located on concrete slab rooftops of single storey houses wherever possible (Jaygukhowa Gaon, Baghjan Gaon, Chuta Hapjan Gaon and Naoholia No. 3) and at ground level (Chandmari Bongali Goan, Dighaltarang Gaon, Tengapani TE 316 Nlr Gt., and Nagaajan Gaon) because of non-availability of suitable single storey houses. At each station 24-hourly

air sampling was carried out for SPM, RPM, SO_2 and NOx measurements. One grab sample from each of eight locations was also collected for analysis of Carbon Monoxide, Methane and Total Hydrocarbons including other VOCs (as CH_4) using gas Chromatography. Non-Methane Hydrocarbons including other VOCs (as CH_4) are computed by difference.

Bureau of Indian Standards Code IS 5182 parts 2, 4, 6 and 14 are followed for collection and analysis of samples.

4.3.5.3 Monitored Ambient Air Quality

The results of 24-hourly SPM, RPM SO_2 and NOx concentrations and grab sample concentrations of CO, CH_4, Total Hydrocarbons including other VOCs (as CH_4) and Non-Methane Hydrocarbons including other VOCs (as CH_4) measurements during the study period are given in **Table 4.8**. National ambient air quality standards for RPM, SPM, SO_2, NOx and CO are given in **Table 4.9**. On the basis of tabulated results following observations can be made.

A. Suspended Particulate Matter (SPM)

The 24-hourly SPM concentration at all AAQM locations varies in a range from 53 to 398 $\mu g/m^3$. Highest 24-hourly SPM concentration of 398 $\mu g/m^3$ is observed at Naoholia No. 3 and lowest 24-hourly SPM concentration of 53 $\mu g/m^3$ is observed at Nagaajan Gaon. Average SPM concentration is highest at Chandmari Bongali Gaon (259 $\mu g/m^3$) followed by Tengapani TE 316 Nlr Gt. (225 $\mu g/m^3$), Chuta Hapjan Gaon (191$\mu g/m^3$), Naoholia No. 3 (163 $\mu g/m^3$), Dighaltarang Gaon (157 $\mu g/m^3$), Jaygukhowa Gaon (147 $\mu g/m^3$), Baghjan Gaon (84 $\mu g/m^3$) and Nagaajan Gaon (82 $\mu g/m^3$)

B. Respirable Particulate Matter (RPM)

The 24-hourly RPM concentration at all AAQM locations varies in a range from 41 to 219 $\mu g/m^3$. Highest 24-hourly RPM concentration of 219 $\mu g/m^3$ is observed at Chandmari Bongali Gaon and lowest 24-hourly RPM concentration of 41 $\mu g/m^3$ is observed at Nagaajan Gaon. Highest average RPM concentration of 192 $\mu g/m^3$ is observed at Chandmari Bongali Gaon followed by Tengapani TE 316 Nlr Gt. (148 $\mu g/m^3$), Chuta Hapjan Gaon (110 $\mu g/m^3$), Dighaltarang Gaon (105 $\mu g/m^3$), Naoholia No. 3 (81 $\mu g/m^3$), Jaygukhowa Gaon (78 $\mu g/m^3$), Baghjan Gaon (59 $\mu g/m^3$) and Nagajan Gaon (55 $\mu g/m^3$).

C. Sulphur Dioxide (SO_2)

The 24-hourly concentration of SO_2 at all AAQM locations is low and varies in a range of 4.2 to 15.5 $\mu g/m^3$. Highest average SO_2 value of 11.3 $\mu g/m^3$ is observed at Chandmari Bongali Gaon followed by Baghjan Gaon (10.0 $\mu g/m^3$), Chuta Hapjan Gaon (9.3 $\mu g/m^3$), Jaygukhowa Gaon (7.7 $\mu g/m^3$), Naoholia No. 3 (7.6 $\mu g/m^3$), Tengapani TE 316 Nlr Gt. (6.4 $\mu g/m^3$), Nagaajan

Gaon (6.3 μg/m^3) and Dighaltarang Gaon (5.7 μg/m^3).

D. Nitrogen Oxide (NOx)

The 24-hourly concentration of NOx at all AAQM locations is low and varies in a range of 7.4 to 43.4 μg/m^3. Highest average NOx value of 35.2 μg/m^3 is observed at Chandmari Bongali Gaon followed by Chuta Hapjan Gaon (17.0 μg/m^3), Tengapani TE 316 Nlr Gt. (16.1 μg/m^3), Baghjan Gaon (15.1 μg/m^3), Jaygukhowa Gaon and Naoholia No. 3 (13.8 μg/m^3), Nagaajan Gaon (13.1 μg/m^3) and Dighaltarang Gaon (10.0 μg/m^3).

E. Carbon Monoxide (CO)

Concentration of grab samples of CO for all AAQM locations is quite low and varies in a range of 710 to 1220 μg/m^3. Highest CO concentration of 1220 μg/m^3 is observed at Chandmari Bongali Gaon followed by Naoholia No. 3 (1080 μg/m^3), Jaygukhowa Gaon (930 μg/m^3), Tengapani TE 316 Nlr Gt. (900 μg/m^3), Nagaajan Gaon (880 μg/m^3), Chuta Hapjan Gaon (810 μg/m^3), Baghjan Gaon (740 μg/m^3) and Dighaltarang Gaon (710 μg/m^3).

G. Methane (CH_4)

Concentration of grab samples of CH_4 for all AAQM locations is low and varies in a range of 1.8 to 2.9 ppmv. Highest CH_4 concentration is observed at Chandmari Bongali Gaon (2.9 ppmv) followed by Naoholia No. 3 (2.8 ppmv), Jaygukhowa Gaon (2.6 ppmv), Tengapani TE 316 Nlr Gt. (2.2 ppmv), Baghjan Gaon (2.1 ppmv), Chuta Hapjan Gaon (1.9 ppmv) and Dighaltarang Gaon and Nagaajan Gaon (1.8 ppmv each).

E. Total Hydrocarbons Including Other VOCs (as CH_4)

The concentration of total hydrocarbons including other volatile organic compounds (as CH_4) in the study area is low and varies in a range of 1.9 to 3.3 ppmv. Highest total hydrocarbons concentration including other VOCs (as CH_4) is observed at Chandmari Bongali Gaon (3.3 ppmv) followed by Naoholia No. 3 (3.1 ppmv), Jaygukhowa Gaon (2.8 ppmv), Baghjan Gaon (2.4 ppmv), Tengapani TE 316 Nlr Gt. (2.3 ppmv), Chuta Hapjan Gaon and Nagaajan Gaon (2.0 ppmv each) and Dighaltarang Gaon (1.9 ppmv).

F. Non-Methane Hydrocarbons Including Other VOCs (as CH_4)

The concentration of non-methane hydrocarbons including other volatile organic compounds (as CH_4) varies in a range of 0.1 to 0.4 ppmv. Highest non-methane hydrocarbons including other volatile organic compounds (as CH_4) is observed at Chandmari Bongali Gaon (0.4 ppmv) followed by Naoholia No. 3 and Baghjan Gaon (0.3 ppmv each), Jaygukhowa Gaon and Nagaajan Gaon, (0.2 ppmv each) and Chuta Hapjan Gaon, Dighaltarang Gaon and Tengapani TE 316 Nlr Gt. (0.1 ppmv each).

4.3.5.5 Ambient Air Quality Status

National ambient air quality standards for SPM, RPM, SO_2, NOx and CO are given in **Table 4.9**.

National 24-hourly ambient air quality standards for residential/rural area are always met for SO_2 and NOx at all 8 AAQM locations during the monitoring period and for SPM at only Baghjan Gaon and Nagaajan Gaon and for RPM at only Nagaajan Gaon but these are not always met for SPM and RPM at other locations. Concentration of grab samples for CO are well below the 1-hourly limit in residential and rural area for CO (4000 $\mu g/m^3$) at all 8 locations. National ambient air quality standards do not specify any limits for hydrocarbons in ambient air. However, in urban air Methane concentration normally varies from 1.2 to 15 ppmv and Total Hydrocarbons concentration from 1.22 to 17.37 ppmv (**Table 4.10**). Therefore, monitored grab concentrations of CH_4 and Total Hydrocarbons at all 8 locations appear to be quite low and reasonable even though the TD Area already has 50 wells drilled and also has many crude oil production, storage and transportation facilities. Discussions given above indicate that Chandmari Bongali Gaon has the worst ambient air quality in the study area probably because it has a Bowser Unloading Station in regular operation resulting in regular movement of road tankers and unloading of crude oil from road tankers and its transportation to storage tanks.

4.3.6 Ambient Noise Level

4.3.6.1 Introduction

Noise can be defined as an unwanted sound. It interferes with speech and hearing. If intense enough, it can damage hearing, or is otherwise annoying. The definition of noise as unwanted sound implies that it has an adverse effect on human beings and their environment. Noise can also disturb natural wildlife and ecological system.

4.3.6.2 Methodology

To understand the noise environment in the study area, 24-hourly measurements were carried out at two location, Baghjan Gaon and Jaygukhowa Gaon and for 8 to 10 hours during day-time at remaining six locations using Sound Level Meter 2031 manufactured by Cygnet Systems. **Fig.4.1** shows the noise monitoring locations.

4.3.6.3 Ambient Air Quality Standards in Respect of Noise

Ministry of Environment & Forests, Government of India, has notified the ambient standards in respect of noise. **Table 4.11** gives these standards in respect of noise.

4.3.6.4 Noise Level Status

Envirotech Consultants field team carried out noise measurements at 8 locations as discussed in **Section 4.2** noise monitoring locations are shown in **Fig. 4.1**. The hourly Leq values of recorded noise levels at these locations are given in **Table 4.12** which also gives Lday and Lnight values for Baghjan Gaon and Jaygukhowa Gaon where 24-hourly noise monitoring could be carried out close to the existing facilities. At other 6 locations only 8-hourly value in day-time (8:00 to 16:00 hours) where noise monitoring could be carried out only for 8 to 10 hours during day-time since noise monitoring was not possible during night-time.

At Baghjan Gaon and Jaygukhowa Gaon where 24-hourly noise monitoring was carried out Lday value is found to be respectively 61.0 dB(A) and 59.0 dB(A) and Lnight value is found to be 52.0 dB(A) and 48.0 dB(A). At other six locations where 8 to 10 hour noise monitoring was carried out 8 to 10-hourly day-time value varies from 52.3 to 59.6 dB (A).
Residential area Lnight limit of 45 dB(A) and Lday limit of 55 dB(A) are not met at both Baghjan Gaon and Jaygukhowa Gaon 8 to 10-hourly day-time noise level is highest at 59.6 dB(A) at Chandmari Bongali Gaon because of the movement of vehicles in connection with OIL's other E&P activities in the area.

4.3.7 Land Use

4.3.7.1 Land Use: Scope and Limitations

In census records, major land use classifications are: (a) forests, (b) culturable land, (c) culturable waste land and (d) area not available for cultivation. Culturable land is further classified as: irrigated and unirrigated. Area not available for cultivation includes habited areas, pastures, area under water bodies, hills, rocky land and area used for roads and buildings.

4.3.7.2 Land Use Pattern in 2001

Land use pattern for 156 villages of the study and surrounding area as per 2001 Census records is presented in **Table 4.13:** 2001 Census does not give land use pattern for 6 towns and one village in the study and surrounding area. The following observations can be made from tabulated data:

- Total land area of the 156 villages of the TD area is 26541.27 ha or nearly 265.41 sq. km as against the geographical area of 204.1 sq. km for the chosen study area.
- There is no forest area.
- Culturable area is 22313.58 ha or 84.07% of the total village area.
- Irrigated area is only 1.75% and unirrigated area is 98.25% of the total culturable area.
- Culturable waste area is 1288.07 ha or 4.85% of the total village area.
- Area not available for cultivation is 2939.62 ha or 11.08% of the total village area.

Therefore, the study and surrounding area is essentially a flat plain with no forest land area and with negligible irrigation facility in culturable land area in view of moderate to heavy rainfall spread over 9 months in a year.

4.4 BIOLOGICAL ENVIRONMENT

4.4.1 Introduction

The structure and type of vegetation depends on climatic conditions and physiography as well as the requirements of the local inhabitants of an area. Climatic conditions of the study area are warm humid eco-region with moderate to heavy rainfall and large moisture availability. It, therefore, can have a good vegetation cover. But since the TD area is a flat plain, it is used mostly for growing tea leaves in tea gardens and to a limited extent for cultivation of paddy. Trees, shrubs and climbers can, however, be observed in good numbers near villages, adjoining the roads, boundaries of agricultural fields, community places and even backyard of houses in the TD area.

The trees and shrubs are helpful in reducing the pollution and soil erosion and improving rainfall and visual environment. Leaf canopy of the trees acts as an efficient interceptor for the dust and other air pollutants. **Table 4.14** gives a list of trees, shrubs and climbers found in Bherjan-Padumoni-Borajan Wild Life Sanctuary (WLS) and some of these species can be observed in the study area/TD Area.

Non-availability of dense vegetation cover of large size in the study area/TD Area does not provide good habitat for rich and diverse array of wildlife and mostly commonly found fauna in habited area is observed in the area.

It has been pointed out in **Section 1.4** in **Chapter 1** that Dibru-Saikhowa National Park is also situated within 5 km radius study area of Baghjan OCS (**Fig. 1.3** in **Chapter 1**). **Table 4.15** gives a list of mammals and birds found in Bherjan-Padumoni-Borajan WLS. **Table 4.16** gives list of mammals and birds found in Dibrugarh district.

4.4.2 Cropping Pattern

Winter paddy is the dominant crop in the area. Paddy is also sown in autumn and summer seasons to a limited extent. In addition to paddy, pulses, oil seeds, vegetables, tuber crops and spices are also sown in the area. **Table 4.17** gives information on area, production and productivity of major crops in Dibrugarh district.

4.5 DEMOGRAPHIC AND SOCIO-ECONOMIC ENVIRONMENT

4.5.1 DEMOGRAPHIC ENVIRONMENT

4.5.1.1 Introduction

Baseline environmental scenario in the study area with respect of demographic condition has been discussed in the following sub-sections. Data on number of villages and towns with the number of households, population of males and females, scheduled castes, scheduled tribes and literacy rate in the study area has been obtained from Soft Copy (CD) of Primary Census Abstract, Census of India 2001 of Dibrugarh and Tinsukia districts.

As per 2001 Census, the study area has a total of 157 villages (142 villages in Tinsukia district and 15 villages in Dibrugarh district). There are 6 towns in the study area (all 6 towns in Tinsukia district). Out of 142 villages in Tinsukia district 7 villages are uninhabited. Demographic details of these villages/towns are given in **Table 4.18** as per Census 2001.

4.5.1.2 Population

The study area sustains a total population 2,48,486 in 157 villages and 6 towns in the study area. The rural population in 157 villages is 1,36,296 while urban population in 6 towns is 1,12,190.

The male population constitutes nearly 53.30% and female population is 46.70% in the study area.

4.5.1.3 Population Density

From data given in **Tables 4.13 and 4.18**, it is observed that population density in the 157 villages of the study area is nearly 514 persons/km^2.

4.5.1.4 Sex Ratio

Census records define sex ratio as the number of females per 1000 males. As per 2001 Census, sex ratio for the study area is nearly 876, nearly 928 for rural population in 157 villages and nearly 817 for urban population in 6 towns.

4.5.1.5 Scheduled Castes and Scheduled Tribes

As per Census 2001, 4.46% of total population belongs to scheduled castes (4.50% amongst males and 4.41% amongst females) and 0.82% of total population belongs to scheduled tribes (0.85% amongst males and 0.79% amongst females).

4.5.1.6 Literacy

As per 2001 Census records, 57.14% population of the study area (64.38% amongst males, and 48.88% amongst females) is literate.

4.5.2 Employment Pattern

The employment pattern in the area is an indicator of number of persons employed in various sectors. It also indicates the various categories of employment flourishing in the area. The employment pattern in villages/towns of the study area is given in **Table 4.19** as per the Census 2001.

The total main workers account for 31.31% of total population in the study area consisting of 46.06% of male and 14.48% of female population whereas marginal workers account for 5.65% of total population consisting 5.77% of male and 5.50% of female population, and non-workers account for 63.04% of total population consisting of 48.17% of male and 80.02% of female population as per the Census 2001. Since total main workers account for only 31.31% of total population, it is clear that there is not enough employment opportunity either in agriculture or elsewhere in the study area.

Out of the total main workers, cultivators account for 6.15% (6.65% males and 4.33% females), agricultural workers account for 2.17% (1.78% males and 3.57% females), household industry workers account for 1.67% (1.48% males and 2.38% females) and other workers account for 90.01% (90.09% males and 89.72% females). It is, therefore, clear that agriculture, either as cultivator or as agricultural labourer, is not the main occupation of the population in the study area because only 8.32% of total main workers are engaged in agricultural activities as against 90.09% engaged as other workers probably as workers in tea gardens within and outside the study area/TD Area. It is also likely that some of the other workers may also be engaged in exploration and production activities for oil and gas in TD and surrounding area.

4.5.3 Living Standards and Infrastructure

In India it is not possible to set up a primary standard of living because of wide variations in terms of income, economic condition, social custom, employment opportunity, pattern of spending, etc. However, availability of amenities like education, medical, water supply, communication, road network, electricity, etc. significantly reflects the level of development of an area. Information on available amenities in the study area is extracted from Census 2001 of Tinsukia and Dibrugarh districts. Details of amenities available in the villages of study area are presented in **Table 4.20** as per Census 2001. On the basis of the tabulated data, the status of the available amenities is discussed in following sub-sections.

4.5.3.1 Education Facilities

As per Census 2001, out of 150 inhabited villages, 113 villages have one or more primary schools. 25 villages have middle schools and 7 have secondary schools. 37 villages do not have even a primary school and children have to travel 5 km or more even for primary education.

4.5.3.2 Medical Facilities

As per 2001 Census, out of 150 inhabited villages, only 34 villages have some medical facilities and no medical facility exists in 116 inhabited villages in the study area. Villagers of these villages have to travel 5 to 10 km or more than 10 km to avail medical facilities. Study area has 4 primary health centres, 8 primary health sub-centres, 1 health centre, 18 allopathic hospital and 1 allopathic dispensary.

Tables 4.21 and **4.22** respectively give O.P.D. treatment of diseases for 2008 for primary health centre at Makum and L.G.B. Civil Hospital at Tinsukia. Tabulated data shows that fever, respiratory, gastric and nutritional disease occur most commonly in the study area.

4.5.3.3 Drinking Water Supply

As per 2001 census all the inhabited villages in the study area have drinking water facilities. 16 villages have tap water supply. In the absence of tap water, water from tube wells and wells in most of the villages and from handpumps, tanks and rivers is used in some of the villages for drinking purpose. It may be noted that the surface and ground water of the study area is of very good quality.

4.5.3.4 Post and Telegraph

As per 2001 Census, out of 150 inhabited villages, 19 villages have post office, and 36 villages have phone facility. Remaining villages in the area can have access to these facilities within a distance of 5 to 10 km.

4.5.3.5 Communication and Transport

The main mode of public transport available in the study area is by bus but only 64 villages have bus stop. Only 4 villages have railway station. Villagers of other villages have to travel 5 to 10 km to avail bus facility.

4.5.3.6 Approach to Village

As per 2001 Census, out of 150 inhabited villages, 109 villages can be approached by pucca roads. Remaining villages of the area can be approached only by mud roads (142 villages) and foot paths (3 villages).

4.5.3.7 Power Supply

As per 2001 Census, out of 150 inhabited villages, power is available in 140 (93.33%) villages out of which in 108 villages have power supply only for domestic purpose and 32 villages have for all purposes.

4.5.3.8 Industrial and Commercial Activities

The TD area is primarily a rural area having little industrial or commercial activity of significance except for tea gardens. In last few decades, however, extensive efforts are being made for undertaking exploration and production of hydrocarbons (gas and oil) in and around the TD area. **Table 4.23** gives the list of important industries found in Tinsukia district in TD Area.