CHAPTER-5

BASELINE ENVIRONMENTAL STATUS

5.1 GEOLOGY

5.1.1 Regional Geology

Geologically, the sedimentaries of the area form a part of the Cretaceous – Tertiary sedimentary sequence that occupies the southern fringe of Meghalaya Plateau. The calcareous and calcarenaceous formations of the region belong to the Jaintia Group. The Jaintia Group, which is essentially a calcareous facies is divided into a lower Langpar Formation and an upper Shella Formation. Immediately overlying the Jaintia Formation is the Kopili Formation consisting mainly of shale, siltstone, sandstone and marl. It is the rocks of Kopili Formation for which the present mining project is confined to.

5.1.2 Local Geology

Although we designate the applied area as Shale area, in reality the formation consists of an alternation of Shale, Sandstone and Siltstone at varying extension both laterally and longitudinally. But in general this formation is popularly known as Kopili Shale. The local stratigraphic sequence in the Shella area is depicted below :

Local Stratigraphic Sequence in Shella West area

Age	Formation	Thickness (m)	Rock Type
Oligocene to Eocene	Kopili Formation	--	Light grey to yellowish brown shale and siltstone.
Upper Eocene to Middle Eocene	Prang Limestone	100-75	Hard, massive, fossiliferous grey limestone.
Lower Eocene	Narpuh Sandstone	20-22	Pinkish and brownish white friable, medium to coarse sandstone.
Lower Eocene	Umlatdoh Limestone	_	Pinkish white to grey, hard foraminiferal limestone associated with subordinate calcareous sandstone.

5.1.3 Lithological Description

The Kopili Formation is essentially an assemblage of non-calcareous sediments made up of a mixture of argillaceous and arenaceous sequence. It is primarily composed of shale, siltstone and an alternation of these two litho-units in different proportion. On the outcrops the shale is dark grey and brown in colour while the siltstone is of a lighter hue. When weathered the shale usually forms a very sticky clay.

5.1.4 Structure

The contact of Prang Limestone and the Kopili Formation is affected by a regional fault, which roughly runs in E-W direction. Because of the presence of this huge regional fault, the younger Kopili has been brought in juxtaposition with the older Prang Limestone. For the presence of this fault the strata in the vicinity of the fault on the down thrown side, has a higher dip varying in the range of 55^0 - 70^0, whereas further south down the dip side it is relatively shallow. This is probably due to the drag effect of this huge fault.

5.1.5 Exploration

Detail exploration for Kopili Shale-siltstone formation by drilling and chemical analysis was undertaken in part of one square kilometre area falling in Shella Darbar, East Khasi Hills district after prima facie suitability of the rocks was established as a corrective material for the cement raw mix.

A total of 21 boreholes were drilled along six N-S section lines at two hundred metres apart with northerly plunge drill holes varying from 45^0 to 55^0 exploring up to a depth of 40 m R.L. and chemical analysis of the core samples at 1.5 m interval and determination of their 13 radical constituents.

A total of around 50 million tonnes of insitu geological reserves of the mixed rock (shale, sandstone and siltstone) has been estimated in the area with the average quality of the three major and important constituents playing a vital role in determining the L.S.F. and Silica and Alumina modulii) varying within the range as shown below:

SiO_2 (%): 56.70 – 86.11

Al_2O_3 (%): 5.51 – 20.54

Fe_2O_3 (%): 2.67 – 9.56

5.1.6 Mining

From the nature of the deposit and the aerial extent of the proposed Mining area it is felt that the proposed mine / quarry would be grouped under ‘B’ category of mines.

5.2 SOIL

5.2.1 Introduction

As per the studies, there are three soil types viz., in crevices, from hill slopes and from foot hills. Soil is characterised as sandy clay loam in texture in the crevices and sandy loam in the foothills. The soil reaction is near neutral to alkaline in all three types. The soil in crevices is reported rich in organic carbon, total nitrogen and available phosphorus.

5.2.2 Soil Sampling and Analysis

Representative soil samples were collected from various locations during winter season (refer Exhibit-5.2.1) at sub surface level for studying soil characteristics and chemistry. The locations of the soil samples are provided in Table-5.2.1.

The above defined soil samples were collected from the cultivated areas, crevices at the site and hill slopes during winter season and results are given in Table 5.2.2. The results are compared with the standard soil classification provided in Table 5.2.3.

5.2.3 Presentation of Results

5.2.3.1 Limestone Mine Area

The soils at sampling locations, S7 and S8 have been reported to be loamy and sandy loam in texture . pH of soils varied from 6.8 to 7.9. Nitrogen content varied from 16.5 to 24.5 lbs/acre, falling under the category of very less. Similarly, the Potassium level varied from 83.1 to 85.0 lbs/acre, falling under the category very less. Phosphorus content varied from 17.5 to 18.5 lbs/acre, falling under the category of less. The levels of organic matter in the soil varied from 0.55 to 0.63% falling under the category of sufficient. Sulphates, Carbonates and Boron were found below detection limit.

5.2.3.2 Commercial Area

The texture of soil at Shella Bazar (S1 & S3) varied from loamy to sandy loam and pH value ranged between 5.1 to 6.5. Nitrogen content varied in the range of 13.5 to 59.5 lbs/acre to be under the category of less to very less. Similarly, the Potassium level varied from 90 to 94.5 lbs/acre to be under the category of low. Phosphorus was within the level of 19.3 to 20.5 lbs/acre to be under the category of an average less. The level of organic matter in the soil was observed in the range of 0.62 to 0.65% to be under the category of average sufficient. Sulphates, Carbonates and Boron were found below detection limit

5.2.3.3 Phlangkaruh River Bed

The soil at Phlangkaruh (S2) was collected from the bank of Phlangkaruh river and was observed to be sandy clay loam to sandy loam in texture & slightly acidic to

neutral in nature. Nitrogen content was 15.4 lbs/acre, and covered under the category of very less during winter season. Similarly, the Potassium level was 93.5 lbs/acre and covered under the category of low. Phosphorus level from 19.0 lbs/acre and covered under the category of less. The level of organic matter in the soil was observed to be 0.55% and covered under the category of on an average sufficient. Sulphates, Carbonates and Boron were found below detection limit.

5.2.3.4 Rural Surrounding

The soil at Nongwar and Mawryngkhong and Pyrkan (S4, S10 and S6) were collected to establish the rural soil quality of the region. Soil at all locations were found to be loamy and alkaline in nature. Nitrogen content ranged from 0 to 21.5 lbs/acre and covered under the category of very less. The Potassium level ranged from 91.5 to 96.3 lbs/acre and covered under the category of very less. Phosphorus was found to be in the range of 17.5 to 18.5 lbs/acre and covered under the category of less. The levels of organic matter in the soil was observed to be in the range of 0.5-0.65% and covered under the category of on an average sufficient, medium average to average sufficient. Sulphates, Carbonates and Boron were found below detection limit.

5.2.3.5 At Mawdet

The soil at Mawdet (S13) was observed to be sandy clay loam in texture and slightly alkaline to neutral in nature. Nitrogen was 11.5 lbs/acre. Potassium level was 96.7 lbs/acre and covered under the category of very less. Phosphorus level was 20.3 lbs/acre and covered under the category of less. The levels of organic matter in the soil was observed to be 0.72 %, covered under the category of sufficient. Sulphates, Carbonates and Boron were found below detection limit.

5.2.3.6 Cultivation Areas

The soil at Karda and Nonglait (S9 & S5) were reported to be sandy & loamy in texture and slightly alkaline in nature. Nitrogen level ranged from 0 to 9.5 lbs/acre. Potassium level varied between 85.1 to 92.5 lbs/acre, falling under the category of less. Phosphorus level was 18.7 lbs/acre, falling under the category of less. The levels of organic matter in the soil were reported in the range of 0.49 to 0.62%, falling under the category of sufficient. Sulphates, Carbonates and Boron were found below detection limit.

5.2.4 Observations

Soil of the area was reported to be sandy to loamy in texture containing high humus and with nature varying pH from slightly acidic to alkaline. The nitrogen levels were reported to be under the category of low except in certain cases. Similarly, the Potassium levels were also under the category of low. Whereas the levels of Phosphorus were reported to be in the category of less to medium. The levels of organic matter in the soils were reported to be in the category of medium to on an average sufficient. Sulphates, Carbonates and Boron were found below detection limit.

Table-5.2.1

Location of Soil Sampling Stations

Sample	Location
S1	Shella Bazar (lower), about 1.5 km east of the site
S2	Phlankaruh, about 1.0 km south of the site
S3	Shella Bazar (upper), about 1.5-2.0 km east of the site
S4	Nongwar, about 1.5-2.0 km east of the site
S5	Nonglait, about 3 km north east of the site
S6	Pyrkan, about 3 km west of the site
S7	Lime stone Mine area
S8	Lime stone Mine area
S9	Karda, about 4 km west- west south of the site
S10	Mawryngkhong, about 1km north east of the site
S11	Nongtrai (lower), about 2 km north east of the site
S12	Nongtrai (upper), about 2.5 km north east of the site
S13	Mawdet , about 6 km north west of the site

Table-5.2.2

Soil Quality of the Study Area

Parameters	Appearance	Texture	Gravel, %	Sand, %	Silt & Clay, %
Shella Bazar (lower)(S1)	Brownish	Loamy	10	74	16
Phlankaruh(S2)	Greyish Brown	Sandy Clay. Loam	39.5	22.2	38.5
Shella Bazar (upper (S3)	Greyish Brown	Sandy Loam	6.4	80.0	14.7
Nongwar(S4)	Buff Colour	Loamy	5.0	77.6	17.3
Nonglait(S5)	Light Yellowish	Loamy	13.0	79.6	7.5
Pyrkan(S6)	Dark Brown	Loamy	2.2	85.3	12.5
Lime Stone Mine area (S7)	Light Brown	Loamy	7.3	70.5	22.3
Lime Stone Mine area(S8)	Dark Brown	Sandy Loam	27.0	46.5	26.5
Karda(S9)	Brown	Sandy	2.1	85.4	12.5
Mawryngkhong(S10)	Greyish Brown	Loamy	9.5	80.0	10.5
Nongtrai (lower)(S11)	Greyish Brown	Sandy Loam	28.9	60.1	11.0
Nongtrai (upper)(S12)	Brownish	Sandy Loam	25.1	61.5	13.4
Mawdet (S13)	Blackish	Sandy Clay. Loam	39.5	22.0	38.5

Parameters	Organic Matter %	Plasticity Limit %	Bulk Density gm/cm^3	Moisture Retention Capacity	Wilting Coefficient	Nitrogen lbs/acre
Shella Bazar (lower)(S1)	0.65	8.5	1.1	36.0	23.5	59.5
Phlankaruh(S2)	0.55	12.4	1.3	42.5	20.7	15.4
Shella Bazar (upper) (S3)	0.62	25.8	1.1	44.2	24.3	13.5
Nongwar(S4)	0.5	28.1	1.5	36.5	17.1	12.6
Nonglait(S5)	0.49	11.6	1.5	42.5	20.5	Nil
Pyrkan(S6)	0.65	25.8	1.5	46.5	13.4	Nil
Lime Stone Mine area (S7)	0.55	33.5	1.1	55.5	37.5	16.5
Lime Stone Mine area(S8)	0.63	37.8	1.1	45.3	37.8	24.5
Karda(S9)	0.62	23.5	1.4	34.5	21.9	9.5
Mawryngkhong(S10)	0.64	21.8	1.5	44.1	18.7	21.5
Nongtrai (lower)(S11)	0.67	8.8	1.4	32.5	22.5	38.5
Nongtrai (upper)(S12)	0.68	25.5	1.5	24.6	24.5	11.5
Mawdet (S13)	0.72	16.8	1.3	37.5	15.7	11.5

Table-5.2.2 (contd)

Parameters	Phosphorus (lbs/acre)	Potassium (lbs/acre)	Sodium Absorption Ratio	pH (1:10 suspension)	Calcium as Ca, mg/gm	Magnesium as Mg, mg/gm
Shella Bazar (lower)(S1)	20.5	90.0	0.085	6.5	0.038	0.0234
Phlankaruh(S2)	19.0	93.5	0.15	6.6	0.092	0.0096
Shella Bazar (upper) (S3)	19.3	94.5	0.35	5.1	0.0015	0.005
Nongwar(S4)	17.9	94.5	0.044	6.3	0.0045	0.00183
Nonglait(S5)	18.7	85.1	0.028	6.8	0.0057	0.0025
Pyrkan(S6)	18.5	96.3	0.025	6.5	0.0048	0.0118
Lime Stone Mine area (S7)	18.5	85.0	0.011	6.8	0.395	0.0175
Lime Stone Mine area(S8)	17.5	83.1	0.0087	7.9	0.297	0.0261
Karda(S9)	18.7	92.5	0.0061	7.0	0.020	0.018
Mawryngkhong(S10)	17.5	91.5	0.0064	7.8	0.110	0.012
Nongtrai (lower)(S11)	18.0	92.5	0.0099	7.0	0.096	0.041
Nongtrai (upper)(S12)	20.5	92.0	0.0058	7.5	0.08	0.019
Mawdet (S13)	20.3	96.7	0.019	7.6	0.035	0.028

Parameters	Sodium as Na, mg/gm	Chlorides as Cl, %	Sulphates as SO4, %	Carbonates, %	Bicarbo-nates %	Total Alkalinity meq/100 gm
Shella Bazar (lower)(S1)	0.015	0.0036	BDL	BDL	0.26	0.493
Phlankaruh(S2)	0.035	0.0028	BDL	BDL	0.126	0.207
Shella Bazar (upper) (S3)	0.20	0.0043	BDL	BDL	0.0268	0.510
Nongwar(S4)	0.003	0.0024	BDL	BDL	0.0261	0.361
Nonglait(S5)	0.002	0.0031	BDL	BDL	0.0135	0.254
Pyrkan(S6)	0.002	0.0027	BDL	BDL	0.0244	0.345
Lime Stone Mine area (S7)	0.005	0.005	BDL	BDL	0.051	0.857
Lime Stone Mine area(S8)	0.006	0.0035	BDL	BDL	0.064	1.1
Karda(S9)	0.002	0.0035	BDL	BDL	0.014	0.171
Mawryngkhong(S10)	0.002	0.0030	BDL	BDL	0.0402	0.641
Nongtrai (lower)(S11)	0.003	0.0313	BDL	BDL	0.035	0.509
Nongtrai (upper)(S12)	0.001	0.0345	BDL	BDL	0.030	0.428
Mawdet (S13)	0.003	0.0036	BDL	BDL	0.020	0.215

Table-5.2.2 (contd)

Parameters	Iron as Fe, mg/gm	Copper as Cu mg/gm	Zinc as Zn mg/gm	Manganese as Mn, mg/gm	Boron as B, mg/gm
Shella Bazar (lower)(S1)	0.0165	0.00034	0.00093	0.000048	BDL
Phlankaruh(S2)	0.025	0.0020	0.00135	0.00018	BDL
Shella Bazar (upper) (S3)	0.198	0.00031	0.00096	0.00037	BDL
Nongwar(S4)	0.0207	0.00023	0.00092	0.00017	BDL
Nonglait(S5)	0.01	0.00020	0.00089	0.00020	BDL
Pyrkan(S6)	0.0145	0.00090	0.00106	0.00019	BDL
Lime Stone Mine area (S7)	0.0385	0.00117	0.00105	0.00020	BDL
Lime Stone Mine area (S8)	0.007	0.0110	0.0013	0.00019	BDL
Karda(S9)	0.015	0.0156	0.0010	0.00004	BDL
Mawryngkhong(S10)	0.020	0.00015	0.00108	0.000028	BDL
Nongtrai (lower)(S11)	0.0173	0.00030	0.00115	0.00030	BDL
Nongtrai (upper)(S12)	0.031	0.00034	0.00100	0.000027	BDL
Mawdet (S13)	0.015	0.00050	0.00084	0.00021	BDL

Table-5.2.3

Standard Soil Classification

Sl No	Soil Tests	Classification
1	pH	< 4.50 extremely acidic 4.51-5.00 very strongly acidic 5.01-5.50 strongly acidic 5.51-6.00 moderately acidic 6.01-6.50 slightly acidic 6.51-7.30 neutral 7.31-7.80 slightly alkaline 7.81-8.50 moderately alkaline 8.51-9.00 strongly alkaline 9.01 very strongly alkaline
2	Salinity Electrical Conductivity (mmhos/cm) (1 mmho/cm = 640 ppm)	upto 1.00 average 1.01-2.00 harmful to germination 2.01-3.00 harmful to crops (sensitive to salts)
3	Organic Carbon	upto 0.2 very less 0.21-0.4 less 0.41-0.5 medium 0.51-0.8 on an average sufficient 0.81-1.0 Sufficient >1.0 more than sufficient
4	Nitrogen (kg/ha)	Upto 50 very less 51-100 less 101-150 good 151-300 better above 300 sufficient
5	Phosphorus (kg/ha)	upto 15 very less 16-30 less 31-50 medium 51-65 on an average sufficient 66-80 sufficient above 80 more than sufficient
6	Potassium (kg/ha)	0 very less 120-180 less 181-240 medium 241-300 average 301-360 better above 360 more than sufficient

5.3 HYDROLOGY

5.3.1 Introduction

The hydrology of the area has been studied in order to assess the impact of the mining activities on the water quantity and water quality of the spring fed Phlangkaruh River. The techniques applied comprise the study of the hydrological patterns of the area by means of satellite imagery and the DEM in 1999 to study the hydraulic connectivity of various waters encountered, the interpretation of flow and discharge measurements, and the setting up of a water balance for the area.

5.3.2 Water Flow Routes and Water Quantity

Regional and local catchment areas have been defined on the basis of the satellite images and the DEM. On a regional scale, a number of large rivers drain the southern part of the Shillong Plateau and a large part of the Caenozoic to Tertiary sediment hills. The Umium catchment area at the mine site latitude has an acreage of approximately 358km^2. On the southern margin of the hills, between the lower basins of the larger rivers, a series of small, independent catchment areas form a separate drainage system. The Phlangkaruh basin is one of these sub-catchments. The catchment comprises approximately 5.2km^2.

5.3.3 Flow Routes

Apart from Phlangkaruh river, there is no clear surface water drainage pattern in the area. On the Nongtrai escarpment, some spring-fed river flows can be followed and these flows disseminate and dissolve as soon as the lower limestone area is entered. This indicates sinking streams. The precipitation on the karstified limestone forms no obvious surface drainage. Therefore, infiltration rates may be assumed to be very high or complete.

The water percolating into the limestone, will follow cavities along joints and bedding planes and form a kind of phreatic and highly variable (as well in time as location) “water-table”. The term water-table is not very correct in this context, as the system is highly anisotropic and no actual regional piezometric level exists. The subcutaneous flow will tend to follow the bedding dip and the strike of the joints. The flow direction is therefore generally south to south-easterly. Vertical movement of the water to greater depths occurs through 1. shaft flow, where open shafts or funnels connect to caves or larger cavities at greater depths; 2. vadose trickles, the water descend through solution widened joints and reach caves as fast drips of streamlets; and 3. vadose seepage, that feed slow drips in caves below and that may take months to respond to rainfall events. Vadose trickles and seepage were observed in the Twin Sinkhole caves.

The flow of water in the caves occurs in the form of cave rivers or streams. Flow velocities are comparable to those of surface streams. The cave streams may loose water to lower levels again through the same three vertical flow components as described above.

5.3.4 Flow and Discharge Measurement

In 1999, CSME have carried out flow and discharge measurements in Phlangkaruh river. The combined flow from the springs amounted to approximately $1m^3$/sec. At regular stations further downstream, the flow increased first to over $3m^3$/sec and to over $4m^3$/sec. This increase can easily be attributed to additional inflow from overland-flow and through-flow from the adjacent shale hills. However, the flow discharge increases sharply to over $16m^3$/sec. Considering the catchment area and considering the maximum 24 hours rainfall observed for the mine area and assuming 100% run-off, the additional water from run-off and through-flow from the adjecent shale hills could not explain this large increase.

The Rhodamine dye tracer test in one of the Nongtrai springs has indicated that the water from this source may follow a relatively deep route first through the limestone to the south, and being forced by the Kopili Formation to flow either west or east at a lower level. This indicates an additional inflow of water at a lower level than the springs. During the rainy season, this additional inflow is significantly higher than the spring flow. During the dry season, the flow increased from approximately 0.2 to $0.3m^3$/sec. The additional inflow of $0.1m^3$/sec was more than expected on the basis of the estimated dry season flow of the Nongtrai spring alone. Also other springs, like the ones occurring at a lower level at the escarpment contribute to this flow.

It should, therefore be concluded that the most significant inflow of water in Phlangkaruh river occurs at a lower level than the springs and that the springs have only a limited contribution to the river flow. The spring flow is most significant for the upper few hundreds of metres of the Phlangkaruh stream.

5.3.5 Water Balance

In order to quantify some aspects of the water flow and storage in the area, a water balance has been set up for the Phlangkaruh springs catchment area.

The following factors have been considered:

- Precipitation;
- Evapotranspiration;
- Surface run-on;
- Surface run-off;
- Spring flow; and
- Change in saturated storage volume.

Groundwater inflow and outflow into and out of the basin area has not been considered. To the south, the basin is bound by the relatively impervious Kopili Formation. To the north, all groundwater processes appear to occur in a level well above the study area as shown by the spring levels in the Nongtrai area. To the west and east, the area is bound by valleys, along which no significant springs were encountered.

The water balance has been set up using monthly figures for the precipitation. The monthly potential evapotranspiration has been calculated, from which the "actual" monthly evapotranspiration has been derived. The evapotranspiration has been calculated by the Priestly-Taylor method on the basis of the monthly figures for average temperature, average net radiation, the latent heat of water vaporisation, the gradient of the saturated water vapour pressure curve and the psychrometric constant. The actual evaporation has been estimated with the help of the Turc-equation for catchment areas. A check was made by applying the Blaney-Criddle equation. The figures from both methods matched very well. The calculated "actual" evapotranspiration also matched very well with the observed precipitation.

The water balance calculations indicated a water surplus for the area from the month of March till October. The largest surplus is found in June. During this period, first the saturated storage volume is recharged and the subsurface water flow increases. Spring flow will reach its maximum after the saturated storage volume has been fully recharged and all other water surplus is discharged through the springs. From November till February, the recharge is lower than the evapotranspiration and spring discharges combined. In this period, the saturated storage volume is depleted: the vadose zone water levels drop and the shallow rooting shrubs and plants wither.

The water balance calculations have been checked on the measured spring flow. The total spring flow then amounted to approximately 1,000 litres per second. The calculated average spring flow for August was, according to the water balance calculations approximately 850 litres per second. For September, this figure was 1,050 litres per second. The slight underestimation may be attributed to the fact that the water balance gives a monthly average and to the fact that it is quite common that the "actual" evapotranspiration is being over-estimated.

5.4 METEOROLOGY

5.4.1 Climate

The climate of the study area is sub-tropical type where seasons can be classified summer (March - April), premonsoon (May – mid June); peak monsoon (mid June - October); post monsoon (October – November) and winter (December - February).

The nearest India Meteorological Department (IMD) station is located at Cherrapunji (1313 m above mean sea level), which is about 15 km (crowfly) to the Northeast of the proposed mine site. The western, northern and eastern area has hilly topography whereas to the south of the mine site, the area is dominated by flood plains of Bangladesh. The data on surface meteorological parameters like wind speed, wind direction, temperature, rainfall, relative humidity, weather phenomena etc were procured from this IMD for 5-year period (1986-1990). Available Climatological data in Table-5.4.1 (1951 to 1980) for Cherrapunji has also been considered to understand the meteorology of the region.

The other nearest meteorological station is located in Bangladesh at Sylhet (11 m above mean sea level), which is about 40 km to the Southeast of the proposed mine site and data for various meteorological parameters were procured from Bangladesh Meteorological Department (BMD) for 10 years (1989 to 1999). The other available meteorological data (from an existing study) is for Sunamganj, Bangladesh, which is located at about 15 km to the south of the proposed mine site.

The summary of the meteorological information for Cherrapunji station is presented in Tables-5.4.1 and 5.4.2.

As per the 5-years data (1986 to 1990), the clouds at Cherrapunji are low which prevail in the area throughout the year. The Oktas of cloud cover ranging from 3 to 8 prevail in months of May to October. The low clouds (0 to 1000 m from surface) resulting into high foggy conditions during monsoon seasons i.e. May to September. The foggy conditions also prevail during non-monsoon i.e. October to March. The incidences of thunder prevail during April to September.

The average annual rainfall (1986 to 1990) at Cherrapunji station has been observed to be 15,818 mm. The heaviest 24 hours rainfall during this period has been observed to be 963.4 mm on 5 July, 1988. The average rainfall during 1951 to 1980 at Cherrapunji has been observed to be 11465.7 mm with the heaviest 24 hours rainfall of 985.5 mm observed on 13 September, 1974.

Meteorological Information for Sylhet Meteorological Station of BMD for 1989 to 1999 is presented in Table-5.4.3.

At Sylhet the foggy days prevail during winter i.e. from November to April. The average annual rainfall (1989 to 1999) observed is approx 4080 mm. The heaviest 24 hours rainfall of 290 mm occurred on 13 April 1998 during 1989 to 1999.

Meteorological Information for area near Sunamganj is presented in Table-5.4.4.

At Sunamganj, the annual rainfall observed is approx 4456 mm.

5.4.2 On Site Meteorology

Meteorological information has also been collected in the study area near the mine site during winter season. To collect the site-specific data, the meteorology station was established at Shella (near core zone). The methodology adopted for monitoring surface observations were as per the standard norms laid down by Bureau of Indian Standards (BIS) and IndianMeteorology Department (IMD).

Meteorological measurements were recorded at the selected station for monitoring of wind speed, wind direction, rainfall, ambient air temperature, relative humidity and cloud cover. On line weather monitoring system of Dyna lab make (model D2 2000) was installed at a central location in Shella Bazar, near ambient air quality (AAQ) station –A1 at top of a building height. Cloud cover was recorded by manual observation. Summary of meteorological data generated near the proposed mine site area is presented in Table-5.4.5.

Based on the site data, it may be concluded that the daily maximum and minimum temperatures recorded at site are mostly different than those recorded at Cherrapunji by IMD, however, these are more in line with that of Sylhet and Sunamganj locations in Bangladesh. The wind directions recorded at the site using continuous data logger, when compared with the Cherrapunji data, are found to be inconsistent.

The Cherrapunji being at an elevation of 1313 m amsl and the mine site area at an elevation of 20 to 140 m amsl, the meteorology of the area around the mine site is mostly different than that of Cherrapunji, however it is more in line with that of Sylhet and Sunjamganj which are at an elevation level of 11 to 15 m amsl. The rainfall recorded at the site is in concurrence with that recorded at Sylhet and Sunamganj.

This rainfall in the mine site area is more in concurrence with that of Sylhet and Sunamganj than with Cherrapunji.

Based on the above analysis, it is clear that the meteorology of the mine site area has least concurrence with that of Cherrapunji, however, it is more in line with that of Sylhet and Sunamganj.

Table-5.4.1

Meteorological Information* for Cherrapunji (Climatological Data 1951-80)

Month	Daily Temp (° C)		Relative Humidity (%)		Mean Wind Speed m/sec	Prevailing Wind Direction	Rainfall total
	Min	Max	Mor.	Eve.			(mm)
January	7.2	15.7	65	78	1.5	SW	19.8
February	9.1	17.5	64	71	2.1	SW	30.3
March	12.9	20.9	68	70	2.6	SW	228.0
April	14.9	22.4	80	81	2.8	SW	695.3
May	16.2	22.6	87	88	2.7	SW	1461.2
June	17.6	22.6	94	93	2.5	SW	2857.4
July	18.2	22.6	95	94	2.6	SW	2689.2
August	18.3	23.1	94	93	2.3	SW	1811.1
September	17.9	23.4	89	91	2.2	SW	1073.2
October	15.9	22.6	79	87	1.5	NE	527.0
November	12.4	20.0	71	82	1.3	NE	61.8
December	8.7	17.2	68	80	1.2	NE	11.4
Annual Avg.	14.1	20.9	80	84	2.1	-	-
Total Annual	-	-	-	-	-	-	11465.7

* Based on morning (0830 am) and evening (0530 pm) readings in a day except that of Rainfall.

Table-5.4.2

Meteorological Data for Cherrapunji (Lat 25°15'N; Long 91°44'E) for 1986-1990

Month Avg 1986-1990	Frequency of Foggy Days	Daily Temp (°C)		Relative Humidity (%)		Mean Wind Speed m/sec	Prevailing Wind Direction	Max Wind Speed m/sec
		Max	Min	Max	Min			
January	3	18.6	6.2	97	14	1.2	NE	3.8
February	2	19.6	7.2	98	26	1.6	SW	6.1
March	4	23.6	10.4	98	13	2.1	SW	11.1
April	3	23.6	11.4	100	30	2.8	SW	8.3
May	7	23.8	16.6	100	40	1.7	SW	6.1
June	12	28.8	16.8	100	54	1.7	SW	10.0
July	22	25.4	17.8	100	67	2.1	SW	11.1
August	18	26.2	17.8	100	57	1.7	SW	12.2
September	11	26.4	14.8	100	54	1.7	SW	10.0
October	4	25.8	14.8	100	31	1.3	NE	7.8
November	4	24.2	12.8	99	11	1.3	NE	9.5
December	2	19.0	6.8	100	18	1.2	NE	3.9
Annual Avg	92	23.8	12.8	99	35	1.7	-	8.3
Annual Total	-	-	-	-	-	-	-	-

Month	Monthly Rainfall in mm						
Avg 1986-1990	1986	1987	1988	1989	1990	Total Avg	Max 24 Hourly
January	12.3	41.2	23.4	56.1	19.0	30.5	42.1
February	0.0	20.2	89.8	235.0	73.0	83.6	113.6
March	55.8	288.2	174.1	34.0	186.0	147.6	68.3
April	323.3	822.7	418.2	2016.0	2059.3	1127.9	786.2
May	82.2	729.4	4967.8	1174.7	1428.1	1676.4	659.8
June	1614.0	3934.0	3045.9	3249.5	3277.4	3024.2	957.0
July	2264.8	5456.8	5219.1	6271.6	2850.5	4412.6	963.4
August	1619.8	2194.6	6172.3	1184.6	1125.3	2473.7	667.1
September	1195.2	2117.0	1918.7	1559.1	1649.5	1687.9	661.0
October	772.1	144.1	1102.1	1253.7	1386.0	931.6	642.8
November	257.7	70.3	406.6	58.0	29.5	164.4	209.1
December	2.8	76.4	201.2	5.0	1.9	57.5	201.2
Annual Avg	689.3	1324.6	1978.4	1424.75	1173.7	-	-
Annual Total	8272	15895	23740	17097	14085	15818	-

Table-5.4.2 (contd)

Month	Nos of Days with Total Cloud Cover (Oktas)				
Avg 1986-1990	0	1-2	3-5	6-7	8
January	12	7	10	2	0
February	0	1	14	0	13
March	9	5	9	6	2
April	3	4	11	7	5
May	0	6	12	10	5
June	0	2	5	11	12
July	0	0	3	8	20
August	0	1	6	10	14
September	0	1	6	11	13
October	5	7	9	6	4
November	9	7	10	3	1
December	14	6	8	3	0
Annual Avg	-	-	-	-	-
Annual Total	52	47	103	77	86

Table-5.4.3

Meteorological Data* for Sylhet (Lat 24°52'N; Long 91°53'E) for 1989-1999

Month Avg 1986-1990	Frequency of Foggy Days	Daily Temp (°C)		Relative Humidity (%)		Mean Wind Speed m/sec	Prevailing Wind Direction	Max Wind Speed m/sec
		Max	Min	Max	Min			
January	14	13.7	25.5	100	36	1.4	E	8.6
February	13	14.9	27.2	100	27.9	1.7	E	9.6
March	10	18.4	30.4	100	22.9	1.8	EW	10.1
April	8	21	31.3	100	34.6	1.9	E	17.7
May	3	22.8	31.1	100	47.6	1.9	E	22.8
June	2	24.4	31.2	100	54.5	1.6	E	17.7
July	1	25.1	31.5	100	54.3	1.4	E	14.2
August	1	25.2	3.2	99.8	55.1	1.4	ES	7.1
September	4	24.5	31.6	100	56.6	1.3	E	6.1
October	6	22.9	31.2	100	47.9	1.4	E	22.8
November	8	18.9	29.5	99.8	39.0	1.4	E	7.6
December	11	14.5	26.6	99.2	35.8	1.5	E	7.1
Annual Avg	81	20.5	29.9	99.9	42.7	1.6	-	12.6
Annual Total	-	-	-	-	-	-	-	-

Month	Rainfall in mm											Avg
Avg 1989-1999	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	1989-1999
January	6	2	10	0	35	23	10	2	1	7	0	9
February	33	45	55	55	149	43	29	76	27	15	0	48
March	11	176	60	172	96	514	80	257	111	239	49	160
April	312	574	405	129	261	326	176	252	170	548	207	305
May	453	546	1063	544	587	342	327	759	347	366	731	551
June	370	551	1203	661	1099	584	941	518	796	858	472	732
July	1342	596	351	901	1174	757	874	745	681	1245	775	858
August	665	582	437	374	471	573	832	745	486	665	503	576
September	1081	1023	781	549	702	227	423	379	946	313	253	607
October	524	216	173	203	153	145	79	281	31	90	344	204
November	34	40	3	3	2	4	102	0	23	42	0	23
December	1	3	79	0	0	0	0	0	18	0	0	9
Annual Avg	402.7	362.8	385	299.3	394.1	294.8	322.8	334.5	1818.5	365.7	277.8	-
Annual Total	4832	4354	4620	3591	4729	3538	3873	4014	3637	4388	3334	4083

* Based on morning (6 am) and evening (6 pm) readings in a day except that of rainfall.

Table-5.4.4

Meteorological Data* for Sunamganj

Month	Daily Temp (°C)		Relative Humidity (%)		Mean Wind Speed m/sec	Prevailing Wind Direction	Rainfall (mm)
	Min	Max	Max	Min			
January	13.4	25.1	93	67	4.6	SE	24
February	13.9	26.8	77	57	5.1	E	42
March	17.4	30.6	83	51	4.6	NE	65
April	21.8	32.8	87	63	7.6	NE	192
May	22.4	32.1	93	79	3.6	E	696
June	24.6	30.8	96	82	3.1	SE	1370
July	25.3	31.2	97	83	6.2	S	594
August	24.3	31.6	95	84	2.6	NE	531
September	24.6	30.8	95	85	4.6	NE	655
October	22.4	30.2	96	84	4.1	NE	274
November	17.1	28.7	93	75	4.1	E	7
December	14.1	26.4	95	73	2.6	NE	6
Annual Avg	20.1	29.8	93	75	4.4	-	371.4
Annual Total	-	-	-	-	-	-	4456

* Based on morning (6 am) and evening (6 pm) readings in a day except that of rainfall.

Table-5.4.5

Meteorological Data* for Site (Lat 25°12'N; Long 91°37'E)

Season	Daily Temp (°C)		Relative Humidity(%)		Mean Wind Speed m/sec	Prevailing Wind Direction	Max Wind Speed m/sec	Monthly Rain-fall in mm	
	Max	Min	Max	Min				Total	Max 24-Hourly
Winter	29.9	9.3	95	9	1.3	NE	4.2	6.0	4.0

* Based on hourly data collected round the clock during the study period.

5.5 LANDUSE

5.5.1 Landuse Pattern

The total geographical area of Mawsynram block is 523 square km, while that of Shella Bholaganj block is 578 square km. 47.53% of the land (including both the districts) is under cultivation or plantation. Most of the lands are natural rain fed while in some areas some irrigation through canals and bamboo connection are provided. The details of landuse of the study area as per satellite imagery IRS-1B data is given in Exhibit-5.51 and Table-5.5.1

Reportedly, there is no study being undertaken on the landuse pattern at the village level for the district and there are no records available on the land use pattern at the block level as well. In the district of East Khasi Hills most of the land belongs to the people and not to the state, the land tenure system are of different category. Re kyanti or the private land is the land which belongs exclusively to a person or persons (irrespective of how he/she and they got exclusively under his or their possession) and which has its boundaries as permanent stones, or boundary stones or stones marking the division of land or of trees, bamboos or rivers or of streams or of plant of definite marks.

Raid land is the land belonging to the community of the people of the Riad. Raid in the Khasi district is the administration of the village durbar by the person known as Bakhraw or Basan or the elders or headman appointed within the state, a section of the state, which is under the administration of the Bakhraw or Basans. This raid is called in Maharam state as Phra Kynbat in Shella and in Mawdan district as U Sande.

Ancestral land (Ri Nongtymmen) means the land inherited from the mothers or grandmothers, from uncle or elder brothers or from father or grandfather which is owned by those families who have descended from first owner.

In some Khasi states land is called Land of relatives (Ri Kur). In other villages this is named as the same land as the same borne (Ri Shyeing) or land of family (Ri RaiIng) and in other places this is called Ri Phirang

Lyngdoh land ie Ri Lyngdoh is the private land of the Lyngdoh Clan or of certain group of relatives where there is forest dedicated to religious purpose called Law Lyngdoh (Priest Forest). The Syiem Land (Ri Syiem) has three kinds :

- The private land of the Syiem family;
- The private lands which the Syiem family and some Basan and myntri (Ministers) use for their maintenance as in Maharam state and this is almost the same as the raid land or the Ri Raid;and
- Consecrated forests (Law Kyntang) are the forest consecrated or set apart purposely for religious performances of the village.

Reserve Forests (Law Adong) are forests purposely reserved for the need of the village or town. Priest forests (Law Lyngdoh) are the consecrated forests for the purpose of religious performances therein.

Land of families or clan (Ri riad Kur) is the private land of the families within the clan which is owned collectively by them. These types of lands are mostly found in Myelliem and Khyrim state.

The above mentioned land system was laid down by the forefathers to ensure both private and collective rights over the land and to provide land for every citizen according to the need. In course of time Riad land by means of Ri Dakhol and other similar means became the ri kyanti land. This has led an innovation of raid land. Ri dhakol is land over which a person has obtained Ri kyanti rights of purchase or winning a court case.

5.5.2 Agricultural Pattern

In Shella Bholaganj and Mawsynram, generally *kharif* (summer) crop is grown. Common *kharif* crops are maize, tejpatta, betel nuts and paddy. At times, *Rabi* (winter) crop is also taken in the plain and the plateau areas of the blocks. The main *rabi* crops is paddy, with occasional cultivation of fruits in some areas. In Mawyanram the cultivation is more towards the Jalor district, *Kharif* crops are grown in sandy soils and are mostly rainfed. The black and white pebber grows wild in the forests along with bay leaves. The usual harvesting season of these crops is early winter. In the foothills of the Khasi hills, there are numerous tree species including palm trees. Several varieties of bamboo grows in this area often wild or at times under nourishment of the villagers. These are sold in local markets as NTFP and also there is a good export market for bamboos in Bangladesh. Forest permits are obtained for trading bamboo and its produce with the adjoining border markets in Bangladesh. The area has rich orchards and fruits like banana, oranges, peach and pomegranate which grow well in this region. Banana grows wild in the foothills. The fruit orchards are usually located in the upper plateau region of the study area, likewise in the foothills some amount of paddy cultivation and plantation activities are practiced.

Most of the land in the upper regions of the Cherrapunjee plateau, which forms a significant portion of the study area and receives a significant amount of rainfall is naturally irrigated. This provides adequate water supply for the crops cultivated in the region. During the monsoon several natural water sources trickle down the valley which is used for watering the fields. Thus it was observed that most of the plantations are in the foothills. In the study area, the plantations include mostly betel nut, bamboo and bay leaf. Paddy is cultivated along the Bangladesh bordering villages comprising mainly the floodplains of river Umium of Shella Blolaganj district which is also famous for orchards including the oranges, peaches, guava etc. However the orchards are rapidly depleting due to the anthropogenic activities. The Mawsynram block also has a significant area under bamboo cultivation. Bamboo also grows wild and is collected as an important NTFP.

Table-5.5.1

Landuse based on IRS – 1B Data

Sl. No.	Landuse	Area (Sq km)	% Area
1	Settlement	5.42	1.72
2	Agriculture	82.63	26.3
3	Grass /Shrubs	14.61	4.65
4	Dense Vegetation	188.33	59.95
5	Sandy River Bed	1.82	0.58
6	Limestone	21.35	6.80

* Source : North-Eastern Hills University (NEHU)

5.6 WATER USE

5.6.1 Introduction

The main water use of the water from Phlangkaruh is the washing, bathing, cooking and drinking water supply for Phlangkaruh Village. The valley is too steeply incised to apply the water for irrigation of the fields on the valley slopes. Water is only abstracted for drinking water supply and cooking. Washing and bathing find place at various points in the river itself.

5.6.2 Domestic use

The average domestic water use may be estimated at 30 litres per capita per day for rural areas in India. The population of Phlangkaruh is estimated at 120 persons. This brings the downstream water use at 3600 liters per day. However, a major part of the water use is in-stream. Only a few litres per capita per day are abstracted for cooking and drinking. The amount of water abstracted can be estimated to be 5 litres per person per day, amounting to a total of approximately 600 litres per day.

A few scattered settlements are present in the shale hills. The people occupying these settlements abstract their water mainly from local seeps in the shale hills and not from Phlangkaruh.

5.6.3 Livestock Water Use

There is very little livestock present in the area. The livestock comprises a few heads of cattle, some goats and pigs. The average consumption of water by livestock can be estimated at 30 litres per head per day.

5.6.4 Agricultural use

Phlangkaruh river is too deeply incised to utilise its water for irrigation of the fields on the valley slopes or the beetle nut gardens without rams or pumps. Instead, the beetle nut gardens north of Phlangkaruh Village are irrigated by water from one of the springs on the Nongtrai escarpment. A system of plastic and bamboo pipelines is fed by the springs and transported by gravity to the beetle nut gardens over a distance of 2.0 to 2.4km. The fall in elevation is from approximately 275m RL at the spring to approximately 45m RL at the lowest point at the beetle nut gardens. The spring discharge was estimated not more than 20 litres per second during the dry season and approximately half was abstracted by the irrigation system. It may be assumed that at least half of the water is lost through leakages before it reaches the beetle nut gardens. This would yield approximately 400,000 litres per day for irrigation, which could support the irrigation of 20 to 40 hectares. The insignificant looking spring flow at the Nongtrai escarpment therefore contributes enormously to the dry season water supply of the agriculture in the Phlangkaruh area. This system is completely independent from the spring flow of the Phlangkaruh springs.

5.7 WATER QUALITY

5.7.1 Water Quality Monitoring

Reconnaissance survey was undertaken and monitoring locations were finalized based on :

- Location of water courses; and
- Location of residential areas representing different activities/likely impact areas.

The samples collected were examined for physio-chemical, heavy metals and bacteriological parameters in order to assess the effect of industrial and other activities on surface and ground water. The samples were collected and analysed as per the procedures specified in 'Standard Methods for the Examination of Water and Waste Water' published by American Public health Association (APHA) as per guidelines of Bureau of Indian Standards' IS:10500-1991 specifications.

Grab water samples were collected from 15 identified locations during the study period in winter season to assess the existing water quality in the study area. The details of the water sampling locations are shown in Table-5.7.1 and also marked in Exhibit-5.7.1.

The results of water quality in the area are summarized in Table-5.7.2.

5.7.2 Surface Water Quality

Umium River

Altogether 4 water samples (W3 to W6) were collected from Umium river at various locations upstream and downstream with respect to the proposed mine area.

It is observed from Table-5.7.2. that pH of the Umium river water was found to be in the range of 7.0 to 7.8. Fluorides are reported in all the water samples and the value ranges from 0.34 mg/l to 0.39 mg/l. The water samples collected from the Umium River reported no coliform contamination.

Fotsgnet Stream

One sample (W9) was collected and the results show that the pH was found to be 7.8. Fluorides were reported to be 0.34 mg/l.

Other Streams

The results of water quality analyses of the nalahs, streams and rivers (sampling locations W1, W2, W7, W8 and W10) show that the pH in the water samples collected from above said nalahs, stream and rivers range between 6.6 to 7.9. Bacteriological contamination was nil.

5.7.3 Springs Water Quality

Phlangkaruh Springs

As one of the sources of water for the Phlangkaruh River is the water springs coming out near the mine site. These streams meet together and form one stream that ultimately meets with Phlangkaruh River. One of the water sample (W11, W12, W13) were collected from stream 1, stream 2 and stream 3 while one water sample (W14) was collected from stream 4 (combined stream of stream 1, 2 & 3). Another water sample (W15) was also collected downstream from the meeting of stream 4 at Phlangkaruh River.

Water samples collected from sampling locations W11, W12, W13 and W14 are slightly alkaline in nature and pH values range between 7.3 to 8.0. PH was always higher in water sampling location W14. The pH of water sample (W15) from the downstream of the Phlangkaruh river was found to be 7.6 due to the dilution effect. Bacteriological contamination in all the samples was nil.

The levels of the Total Alkalinity (as $CaCO_3$) recorded at the origins and downstream of the Phlangkaruh river were found to be in the range of 90.5 to 100.5 mg/l, indicating that the waters are slightly alkaline. Fluorides (as F) have been recorded in all the water samples collected from the springs of Phalangkaruh river and values range between 0.31 to 0.39 mg/l.

5.7.4 General Observation

The overall study of the water samples collected from the study area reveals that none of the parameters tested are above the permissible standards of IS:10500 : Drinking Water Standards. The alkalinity of the water sample is on the higher scale in the nearby areas to the mining area.

Table-5.7.1

Details of Water Quality Monitoring Stations

Station	Approx Distance from the mine site (km)	Direction from mine site	Particulars
W1	4.5	NW	Mawsynram Nadi
W2	6.0	NE	Pryringithull Nala
W3	1.5	NE	Umium River, near Maweyngkong
W4	1.5	E	Upstream of Umium River, near Shella Bazar
W5	2.0	SE	Downstream of Umium river, near Shella Bazar
W6	3.5	S	Further downstream of Umium River, near Dalia
W7	2.5	SE	Nala near Jatap
W8	6.0	ESE	Nala near Ishamati
W9	1.0	NW	Fotsgnet stream water
W10	2.0	N	Nala near Nongtrai
W11	1.1	S	Stream 1 near 39 km milestone
W12	1.2	S	Stream 2 near 39 km milestone
W13	1.3	S	Stream 3 furlong ahead of 39 km milestone
W14	1.4	S	Stream 4 furlong ahead of 39 km milestone
W15	1.5	S	Downstream of Phlangkaruh river

Table-5.7.2

Water Quality of the Study Area

Sl.No	Parameter & Unit	W1	W2	W3	W4	W5
1	Colour Cobalt Unit	<10	<10	<10	<10	<10
2	Odour	Unob	Unob	Unob	Unob	Unob
3	Turbidity (NTU)	5	7	6	5	4
4	pH value	7.9	6.6	7.0	7.8	7.2
5	Total Hardness (mg/l as $CaCO_3$)	26.78	20.15	23.54	26.90	30.25
6	Iron (mg/l as Fe)	0.25	0.18	0.34	0.32	0.45
7	Chlorides as Cl (mg/l)	6.1	4.5	7.2	7.9	7.0
8	Residual Free Chlorine (mg/l)	<0.005	<0.005	<0.005	<0.005	<0.005
9	Total Suspended Solids (mg/l)	4.0	5.8	2.0	4.0	4.4
10	Dissolved Solids (mg/l)	40	34	45	48	40
11	Calcium as Ca (mg/l),	6.8	4.61	6.5	8.43	10.5
12	Magnesium (mg/l as Mg)	2.38	2.1	1.77	1.42	0.98
13	Copper (mg/l as Cu)	<0.05	<0.05	<0.05	<0.05	<0.05
14	Sulphate (mg/l as SO_4)	<1.0	<1.0	<1.0	<1.0	<1.0
15	Nitrate (mg/l as NO_3)	<0.01	<0.01	<0.01	<0.01	<0.01
16	Fluoride (mg/l as F)	0.36	0.31	0.39	0.34	0.34
17	Phenolic Compound as CaH_5OH (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001
18	Mercury (mg/l as Hg)	<0.001	<0.001	<0.001	<0.001	<0.001
19	Cadmium (mg/l as Cd)	<0.002	<0.002	<0.002	<0.002	<0.002
20	Selenium (mg/l as Se)	<0.01	<0.01	<0.01	<0.01	<0.01
21	Arsenic (mg/l as As)	<0.001	<0.001	<0.001	<0.001	<0.001
22	Cyanide (mg/l as CN)	<0.001	<0.001	<0.001	<0.001	<0.001
23	Lead (mg/l as Pb)	<0.001	<0.001	<0.001	<0.001	<0.001
24	Zinc (mg/l as Zn)	<0.001	<0.001	<0.001	<0.001	<0.001
25	Anionic detergents as MBAS (mg/l)	Nil	Nil	Nil	Nil	Nil
26	Chromium as $Cr^{+}6$ (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001
27	Polynuclear Aromatic Hydrocarbons as PAH (mg/l)	Nil	Nil	Nil	Nil	Nil
28	Mineral Oil (mg/l)	<0.5	<0.5	<0.5	<0.5	<0.5
29	Pesticides (mg/l)	Nil	Nil	Nil	Nil	Nil
30	Radioactive materials (Alpha emitters)	Nil	Nil	Nil	Nil	Nil
31	Radioactive materials (Beta emitters)	Nil	Nil	Nil	Nil	Nil
32	Alkanity as $CaCO_3$ (mg/l)	35	24.5	45.0	38.5	37.5
33	Aluminium as Al (mg/l)	<0.006	<0.006	<0.006	<0.006	<0.006
34	Manganese as Mn (mg/l)	<0.042	<0.042	<0.042	<0.042	<0.042
35	Boron as B (mg/l)	0.002	<0.002	<0.002	<0.002	<0.002
36	Total cliforms (MPN/100 ml)	Nil	Nil	Nil	Nil	Nil

Table-5.7.2 (contd)

Sl.No	Parameter & Unit	W6	W7	W8	W9	W10
1	Colour Cobalt Unit	<10	<10	<10	<10	<10
2	Odour	Unob	Unob	Unob	Unob	Unob
3	Turbidity (NTU)	8	8	9	5	9
4	pH value	7.0	7.5	6.7	7.8	7.3
5	Total Hardness (mg/l as $CaCO_3$)	27.37	40.20	14.22	30.5	14.22
6	Iron (mg/l as Fe)	0.47	0.25	0.18	0.34	0.35
7	Chlorides as Cl (mg/l)	3.5	8.5	6.2	4.25	2.0
8	Residual Free Chlorine (mg/l)	<0.005	<0.005	<0.005	<0.005	<0.005
9	Total Suspended Solids (mg/l)	5.5	6.5	7.0	2.0	9.0
10	Dissolved Solids (mg/l)	35	65	50	65	30
11	Calcium as Ca (mg/l)	7.5	4.0	3.55	7.55	3.5
12	Magnesium (mg/l as Mg)	2.1	7.9	1.2	2.5	Nil
13	Copper (mg/l as Cu)	<0.05	<0.05	<0.05	<0.05	<0.05
14	Sulphate (mg/l as SO_4)	3.5	<1.0	<1.0	<1.0	<1.0
15	Nitrate (mg/l as NO_3)	<0.01	<0.01	<0.01	<0.01	<0.01
16	Fluoride (mg/l as F)	0.36	0.41	0.32	0.43	0.31
17	Phenolic Compound	<0.001	<0.001	<0.001	<0.001	<0.001
18	Mercury (mg/l as Hg)	<0.001	<0.001	<0.001	<0.001	<0.001
19	Cadmium (mg/l as Cd)	<0.002	<0.002	<0.002	<0.002	<0.002
20	Selenium (mg/l as Se)	<0.01	<0.01	<0.01	<0.01	<0.01
21	Arsenic (mg/l as As)	<0.001	<0.001	<0.001	<0.001	<0.001
22	Cyanide (mg/l as CN)	<0.001	<0.001	<0.001	<0.001	<0.001
23	Lead (mg/l as Pb)	<0.001	<0.001	<0.001	<0.001	<0.001
24	Zinc (mg/l as Zn)	<0.001	<0.001	<0.001	<0.001	<0.001
25	Anionic detergents as MBAS (mg/l)	Nil	Nil	Nil	Nil	Nil
26	Chromium as $Cr^{+}6$ (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001
27	Polynuclear Aromatic Hydrocarbons as PAH (mg/l)	Nil	Nil	Nil	Nil	Nil
28	Mineral Oil (mg/l)	<0.5	<0.5	<0.5	<0.5	<0.5
29	Pesticides (mg/l)	Nil	Nil	Nil	Nil	Nil
30	Radioactive materials (Alpha emitters)	Nil	Nil	Nil	Nil	Nil
31	Radioactive materials (Beta emitters)	Nil	Nil	Nil	Nil	Nil
32	Alkanity as $CaCO_3$ (mg/l)	32.5	52.5	25.1	36.3	20.5
33	Aluminium as Al (mg/l)	<0.006	<0.006	<0.006	<0.006	<0.006
34	Manganese as Mn (mg/l)	<0.042	<0.042	<0.042	<0.042	<0.042
35	Boron as B (mg/l)	0.002	<0.002	<0.002	<0.002	<0.002
36	Total cliforms (MPN/100 ml)	2	1	Nil	Nil	4

Table-5.7.2 (contd)

Sl.No	Parameter & Unit	W11	W12	W13	W14	W15
1	Colour Cobalt Unit	<10	<10	<10	<10	<10
2	Odour	Unob	Unob	Unob	Unob	Unob
3	Turbidity (NTU)	7	9	10	9	7
4	pH value	7.3	7.5	7.4	8.0	7.6
5	Total Hardness (mg/l as $CaCO_3$)	83.60	79.40	92.16	83.31	85.55
6	Iron (mg/l as Fe)	0.22	0.31	0.18	0.20	0.23
7	Chlorides as Cl (mg/l)	5.67	6.95	3.50	5.67	5.95
8	Residual Free Chlorine (mg/l)	<0.005	<0.005	<0.005	<0.005	<0.005
9	Total Suspended Solids (mg/l)	7.0	9.0	11.0	9.0	7.0
10	Dissolved Solids (mg/l)	115	120	112	110	115
11	Calcium as Ca (mg/l)	19.5	23.57	30.71	28.25	27.50
12	Magnesium (mg/l as Mg)	8.5`	5.00	3.76	3.10	4.10
13	Copper (mg/l as Cu)	<0.05	<0.05	<0.05	<0.05	<0.05
14	Sulphate (mg/l as SO_4)	<1.0	<1.0	1.5	1.55	1.40
15	Nitrate (mg/l as NO_3)	<0.01	<0.01	<0.01	<0.01	<0.01
16	Fluoride (mg/l as F)	0.49	0.35	0.35	0.40	0.42
17	Phenolic Compound	<0.001	<0.001	<0.001	<0.001	<0.001
18	Mercury (mg/l as Hg)	<0.001	<0.001	<0.001	<0.001	<0.001
19	Cadmium (mg/l as Cd)	<0.002	<0.002	<0.002	<0.002	<0.002
20	Selenium (mg/l as Se)	<0.01	<0.01	<0.01	<0.01	<0.01
21	Arsenic (mg/l as As)	<0.001	<0.001	<0.001	<0.001	<0.001
22	Cyanide (mg/l as CN)	<0.001	<0.001	<0.001	<0.001	<0.001
23	Lead (mg/l as Pb)	<0.001	<0.001	<0.001	<0.001	<0.001
24	Zinc (mg/l as Zn)	<0.001	<0.001	<0.001	<0.001	<0.001
25	Anionic detergents as MBAS (mg/l)	Nil	Nil	Nil	Nil	Nil
26	Chromium as $Cr^{+}6$ (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001
27	Polynuclear Aromatic Hydrocarbons as PAH (mg/l)	Nil	Nil	Nil	Nil	Nil
28	Mineral Oil (mg/l)	<0.5	<0.5	<0.5	<0.5	<0.5
29	Pesticides (mg/l)	Nil	Nil	Nil	Nil	Nil
30	Radioactive materials (Alpha emitters)	Nil	Nil	Nil	Nil	Nil
31	Radioactive materials (Beta emitters)	Nil	Nil	Nil	Nil	Nil
32	Alkanity as $CaCO_3$ (mg/l)	90.5	100.5	98.5	90.5	96.5
33	Aluminium as Al (mg/l)	<0.006	<0.006	<0.006	<0.006	<0.006
34	Manganese as Mn (mg/l)	<0.042	<0.042	<0.042	<0.042	<0.042
35	Boron as B (mg/l)	0.002	<0.002	<0.002	<0.002	<0.002
36	Total cliforms (MPN/100 ml)	3	Nil	Nil	Nil	Nil

5.8 AMBIENT AIR QUALITY

5.8.1 Introduction

To make an assessment of baseline ambient air quality, air monitoring study was carried out during winter season. The locations of the ambient air quality monitoring stations were established after studying the predominant wind direction, topographical parameters, vegetation, receptors' sensitivity, etc in the study area and also the relative location of the core zone (mine site).

The locations of monitoring stations are depicted in Table-5.8.1 and the same are also shown in Exhibit-5.8.1.

5.8.2 Description of Sampling Locations

5.8.2.1 Location A1 : Shella Bazar

The location has been selected to assess the air quality levels in the core zone area of the proposed mine. As the site is an open non-arable fallow land, there are no residential buildings in the vicinity. The sampler was placed in the village located towards east of the proposed mining site at a distance of about 1.5 km on top of the terrace of two storey building and is free from any obstructions. The location is away from the village road and does not experience any frequent vehicular movement. The primary source of background levels of air pollutants could be the commercial and domestic activities.

Micro meteorological monitoring instrument and sensors as well as dust fall collection apparatus were also installed on top of the building.

5.8.2.2 Location A2 : Jatap

The village is located towards south east i.e. up wind direction of the proposed mining site at a distance of about 3.0 km from the core zone. The sampler was placed on the terrace of one storey building. The major activity in the adjacent areas of the village is lime kiln and the local limestone quarries. Cultivated land surrounds the location on one side. The village is very well connected to Cherrapunji and Shillong, by road.

5.8.2.3 Location A3 : Pyrkan

The village is located in the east south east (ESE) direction from the proposed mining site, at a distance of about 1.0 km. The site was just in the opposite to Shella Bazar on the right bank of river Umium. The sampler was placed on the top of a single storey building. There is no activity in the area barring trading of limestone and further up the hill there are some limestone quarries. The village is connected to Nongtrai, Mawsynram & Shillong by road. However, it is connected by boats to Shella.

5.8.2.4 Location A4 : Karda (Kyrdoh)

The village is located in the west and at a distance of about 4.5 kms from the proposed mining site. The sampler was placed on the top of a single storey building. There is no activity in the village except market days, once in every 4 days when petty business dealings occur. The village is well connected to state capital Shillong via Nongtrai, Mawsynram, by road.

5.8.2.5 Location A5 : Nonglait

Nonglait near Nongthymai was identified as one of the ambient air quality monitoring stations for crosswind direction. The sampler was placed on the top of a single storey building. The site is in the north west direction at a distance of approximately 3.5 km from the proposed mining site. The village has no major activity and is located on the highway joining Hat Mowdon to Mawsynram.

5.8.2.6 Location A6 : Nongtrai

The village is located towards north of proposed mining site at a distance of about 2.0 km. The sampler was placed on the top of a single storey building. The village is primarily residential and is located near the highway joining Hat Mowdon and Mawsynram.

5.8.2.7 Location A7 : Mawryngkhong

The village is located towards north east of the proposed mining site at a distance of about 1.5 km. The sampler was placed on the top of a single storey building. There is no major activity in the village.

5.8.2.8 Location A8 : Disong

Disong is very close to and in between Mawryngkhong and Shella Bazar. It is in the east east-north direction from the proposed mine site, at a distance of about 1.5 km. The sampler was placed on the top of a single storey building. The village has no major activity.

5.8.3 Sampling and Testing Methodology

The air samples were collected for the following air quality determinants :

- Suspended Particulate Matter (SPM)
- Respirable Suspended Particulate Matter (RSPM)
- Oxides of Nitrogen (NO_x)
- Sulphur Dioxide (SO_2)
- Carbon Monoxide (CO) and
- Hydrocarbon (HC)

5.8.3.1 Sampling Schedule :

24 hourly samples for SPM, RPM, SO_2, and NO_x were collected from each station, by continuously monitoring for 24 hours whereas CO and HC were analysed based on grab samples taken into the myller bags at a frequency of twice a week for four weeks.

The sampling and analysis of ambient air quality parameters was carried out as per the procedures detailed in relevant Parts of IS-5182 (Indian Standards for Ambient Air Quality Parameters). Brief of these testing procedures are given in Table-5.8.2.

5.8.3.2 Existing Ambient Air Quality

The summary of air quality during winter season is given in Table-5.8.3 and is being compared with the national ambient air quality standards prescribed by Central Pollution Control Board (CPCB) for industrial and residential, rural and other areas.

On perusal of the Table-5.8.3 it is evident that all monitored values are well within the stipulated limits presented by Central Pollution Control Board for residential, rural and other areas.

5.8.3.3 Suspended Particulate Matter (SPM)

The 24-hour average arithmetic mean values of SPM (Table-5.8.3) varied between 52.3 and 76.4 $\mu g/m^3$ (minimum observed at A4 and maximum observed at A3).

The 24-hour average 98-percentile values of SPM varied between 63.7 and 87.5 $\mu g/m^3$ (max observed at Station A3 and minimum observed at Station A4), well within the limit of 200 $\mu g/m^3$ stipulated for residential and rural areas as well as the standard of 500 $\mu g/m^3$ for industrial areas as per National Ambient Air Quality Standards (Table-5.8.3).

5.8.3.4 Respirable Particulate Matter (RPM)

The 24-hour average arithmetic mean values of RPM (Table-5.8.3) varied between 51.0 to 72.6 $\mu g/m^3$.

The 24-hour average 98-percentile values of RPM (max 82.5 $\mu g/m^3$ at Station A3 and min 60.8 $\mu g/m^3$ at Station A4) were very low and well within the limit of 100 $\mu g/m^3$ stipulated for residential and rural areas as well as the standard of 150 $\mu g/m^3$ for industrial areas (Table-5.8.3).

5.8.3.5 Sulphur Dioxide (SO_2)

The 24-hour average arithmetic mean values of SO_2 (Table-5.8.3) over the study area varied between 3.8 to 4.6 $\mu g/m^3$ with very little stationwise variation.

The 24-hour 98-percentile values of SO_2 (max 4.8 µg/m^3 at stations A1 and A2) were much below the permissible limit of 80 µg/m^3 for residential/rural areas.

5.8.3.6 Oxides of Nitrogen (NO_x)

The 24-hour average arithmetic mean values of NO_x (Table-5.8.3) over the entire area varied between 7.4 to 11.4 µg/m^3.

The 24-hour 98-percentile values of NO_x (max 12.7 µg/m^3 at station A1 and min 9.5 µg/m^3 at Station A4) were considerably lower than the permissible limit of 80 µg/m^3 for residential/rural areas.

5.8.3.7 Carbon Monoxide (CO)

The level of CO is uniform over all the study area. The range of values observed were between 393 to 540 µg/m^3.

5.8.3.8 Hydrocarbons (HC)

The levels of HC were observed to be low in all the monitoring stations. The range of values was observed between 133 to 197 µg/m^3.

5.8.4 Dust Fall

Dust fall measurements were also carried out at two locations, namely, Shella Bazar and Nongtrai as per IS:5182 part-I. The results of dust fall measurement are presented in Table-5.8.4. It is evident that dust fall is always higher at Nongtrai in comparison to Shella bazaar.

Table-5.8.1

Locations of Ambient Air Quality Monitoring Stations

Sl.No.	Locations	Station No.	Direction from Mining Area	Arial Distance from Mining Area
1	Shella Bazar	A1	East	1.5
2	Jatap	A2	South East	3.0
3	Pyrkan	A3	East East South	1.0
4	Karda (Kyrdoh)	A4	West	4.5
5	Nonglait	A5	North West	3.5
6	Nongtrai	A6	North	2.0
7	Mawryngkhong	A7	North East	1.5
8	Disong	A8	East East North	1.5

Table-5.8.2

Procedure for Determining Various Air Quality Parameters

Parameters	Testing procedure
RSPM	Gravimetric method using respirable dust sampler
SPM	Gravimetric method using respirable dust sampler IS:5182
NO_x	Absorption in dilute NaOH for colorimetric estimation with sulphanilamide and N (1-Napthyl Ethylene Diamine Dihydrochloride and Hydrogen Peroxide (IS:5182, 1975, Part V)
SO_2	Absorption in Sodium Tetra Chloromercurate followed by colorimetric estimation using p-Rosaniline Hydrochloride and Formaldehyde (IS:5182 Part II, 1969)
CO	GC-FID method IS:5182 (part XVII)
HC	GC-FID method IS:5182 (part X)

Table-5.8.3

Detailed Ambient Air Quality in the Study Area

	Shella bazaar (A1)	Jatap (A2)	Pyrkan (A3)	Karda (A4)	Nonglait (A5)	Nongtrai (A6)	Mawryn-gkhong (A7)	Disong (A8)
SPM Concentration								
Maximum	83.9	85.9	88.3	65.0	66.9	69.4	71.9	69.4
Minimum	54.3	47.9	62.5	39.8	53.7	55.6	46.7	40.4
Average	70.6	73.8	76.4	52.3	58.7	61.1	59.5	58.2
98%tile	83.0	85.6	87.5	63.7	66.3	68.6	71.2	68.7
RSPM Concentration								
Maximum	78.9	79.6	83.3	61.9	64.4	66.2	66.9	66.3
Minimum	51.1	46.7	61.2	39.8	51.7	51.8	45.5	39.1
Average	67.2	69.8	72.6	51.0	56.2	58.0	57.1	55.8
98%tile	78.1	79.5	82.5	60.8	63.7	65.6	66.5	65.7
SO_2 Concentration								
Maximum	4.8	4.8	4.7	4.3	4.3	4.4	4.3	4.3
Minimum	4.1	4.5	4,1	3.7	3.8	3.7	3.6	3.2
Average	4.5	4.6	4.4	4.0	4.1	4.1	4.0	3.8
98%tile	4.8	4.8	4.7	4.3	4.3	4.4	4.3	4.3
NO_x Concentration								
Maximum	12.7	12.7	12.0	9.5	11.4	11.4	11.4	12.1
Minimum	9.5	9.5	7.6	5.1	6.4	7.6	6.3	5.0
Average	10.9	11.4	10.5	7.4	9.0	9.4	9.3	8.3
98%tile	12.7	12.6	12.0	9.5	11.4	11.2	11.2	11.8
CO Concentration								
Maximum	540	525	511	494	518	528	501	435
Minimum	496	494	471	467	481	489	421	393
Average	519	510	493	480	498	509	479	419
98%tile	540	524	510	493	516	527	500	434
HC Concentration								
Maximum	197	169	192	146	172	193	172	170
Minimum	164	145	167	133	156	171	150	143
Average	181	158	180	140	164	184	162	160
98%tile	197	169	192	146	172	192	172	170

Table-5.8.4

Dust Fall near the Mine Area

	Shella bazaar	Nongtrai
Dust fall rate (MT/km2/month)	0.1264	0.1309
Heavy Metal	Nil	NIl

5.9 TERRESTRIAL ECOLOGY

5.9.1 Introduction

In the present context, ecological study forms the most important aspect of the impact assessment studies. The impact on ecological parameters *viz.* flora and fauna is a direct consequence of the mining activity. The primary objective of this study are as follows:

- To analyse the forest types both qualitatively and quantitatively;
- To prepare floristic checklist for core and buffer zone;
- To prepare list of rare and endangered plant species if any;
- To identify faunal checklist of core and buffer zone;
- To prepare list of rare and endangered animal species, if any;
- To evaluate wildlife habitat; and
- To evaluate impact of mining on flora and fauna, if any.

This report has been prepared based on extensive field investigations as well as review of data available with BSI and ZSI.

5.9.2 Methodology

The ecological status survey was undertaken in December 2000. The primary data relating to flora and fauna of the area was generated on site. Secondary data were obtained from Botanical Survey of India (Shillong Regional office), Zoological Survey of India (Shillong Regional office), Divisional forest offices (Territorial, Silviculture, Social Forestry and Wildlife), District Agriculture office of East Khasi Hills district, Meghalaya, through intensive interactive sessions with the above.

Both Terrestrial Ecosystem and Aquatic Ecosystem were investigated in depth during survey period. The analysis of terrestrial ecosystem covers the forest type analysis, floral analysis, faunal analysis and assessment of agriculture and livestock, etc.

5.9.3 Terrestrial Flora

5.9.3.1 Forest Types of Meghalaya

Since the works published by Hooker (1854), it became known that vegetation cover of North-East region, particularly Meghalaya region is rich and diverse. Rao (1968, 74), Bor (1942), Joseph (1968), Balakrishnan (1981), Baishya and Rao (1928), Haridasan and Rao (1985) and Haridasan (1999), surveyed the flora of Meghalaya and reported more than 3000 plant species from 22,549 Sq. km area. Broadly, the forecast of Meghalaya can be grouped under Tropical and Temperate forest on the basis of their climatic association and species composition. Further, Tropical forests are classified as "Tropical moist" and "Dry deciduous", "Tropical semi-evergreen", "Tropical evergreen" and "Grassland" types.

5.9.3.2 Tropical Moist and Dry Deciduous Forest

This type of forests occurs at the lower elevation of the hills in Meghalaya. The dominant upper canopy forming species are *Tectona grandis, Terminalia myriocarpa, Sterculia villosa, Lagerstroemia parviflora* and *Gmelina arborea,* both as natural and as plantation; while species like *Schima wallichii, Salmalia malabaricum, Albizia odontossima, Terminalia balerica* and *Amoora wallichi* are found in natural forest. The second story is composed of small trees and shrubs. The dominant species are C*areya arborea, Bridelia retusa, Grewia disperma, Holarrhena antidysenterica, Flemmingia macrophylla, Zizyphous mauritianus, Eupatorium odoratum* and *Lantana camara*. Climbers and lianas are also very abundant; they are represented by *Combretum roxburghii, Holbolia latifolia, Ichinocarpus fruticens, Mikenea scandens* and *Derris elliptica*. There are abundance of bamboo species, viz. *Dendrocalamus hamiltonii, Bambusa tudla, Bambusa pallida* and *Arundinaria intermedia*.

5.9.3.3 Tropical Semi-everygreen Forest

This type of forest is found at an elevation of 900-1200 m. The dominant species of the upper canopy are as follows: *Elaeocarpus floribundus, Dillenia pentagyna, Dillenia indica, Symplocos racemosus, Garcinia indica* and *Careya arborea*. The second story of small trees and shrubs layer is not very dense. It is composed of *Ficus* spp*., Clerodendron infortunatum, Hypericum japonicum* and *Thysanolena maxima.*

5.9.3.4 Tropical Evergreen Forest

These forests are found in upper hill zone with high rainfall. The upper canopy is composed of dominant species like *Mesna ferra, Castanopsis indica, Terminalia belerica, laeocarpus floribundus, Pterospermum acerifolium* and *Lennaea coromandelia*. The second storied is composed of species like *Grasinia indica, Ficus racemosa, Saraca indica, Sterculia villosa* and *Mangifera indica*. The shrubs and small trees form the third storied. The dominant species are *Ficus reticulata, Justicia gendarusa* and *Dracaena elliptica*. Like semievergreen forest, this zone is also having wood climber viz. *Thunbergia grandilfora* and *Combretum roxenburghii* and the epiphytes like *Hoya parasitica*, species of *Dendrobium* and *Pothos scandens* are most frequent. The stream corridors have dominant trees like *Duabanga grandiflora*.

5.9.3.5 Grasslands

Grassland is found in hill slope after forest clearance by jhuming or in exposed river - beds. The dominant species are *Saccharunm spontaneum, Chrysopogon aciculatum, Imperata cylindrica, Eriocaulon chinensis* and *Paspalum dilatatum*.

5.9.3.6 Temperate Forests

These forests are located in high mountain zone (>above 1000 m) outside the present study area. The dominant species are *Quercus semiserrata, Alnus nepalensis, Castanopsis kuezii, Achima wallichi* and *Elaeocarpus acuminata*. The shrub layer is represented by *Mahonis pycnophylla, Daphne papyracea, Virubrum foetidum* and *Polygala arillata*. This region is also rich in epiphytic flora and climbers. In some places, the temperate flora is dominated by Pine forest, which is mostly planted.

A number of sacred groves are found in temperate zone. In a recent report, about 31 sacred grooves in east Khasi Hills district are recorded but almost all of them are located in upper hilly region outside the present study area.

5.9.3.7 Plantation and Orchards

In and around village settlements, there is frequent commercial plantation of Betelnut palm with *Piper nigrum*, pine apple, lemon grass, banana, turmeric and ginger and fruit trees like mango, guava, peach, pear and cherry. A few timber yielding species are also grown around the village orchards. Except road-side planting, plantation (in blocks) under social forestry schemes is not seen in the surveyed areas.

5.9.3.8 Riparian Forest

The dominant species of riparian vegetation are *Homonya riparia, saccharum spontaneum, Calotropis procera, Eupatorium odoratum, Holarrhena antidysenterica, Hyptis suaveolens, Zyziphus mauritianus* and isolated trees like *Alstonia scholaris, Duabauga gradiflora* and *Sizygium cumini*.

5.9.3.9 Trends in the Area

In general much of the original forests of the East Khasi Hills area and of the state itself have declined in past years due to jhuming or shifting agriculture and fuelwood/ timber extraction. As most of the forest area is privately owned, there are few significant efforts for forest conservation or afforestation.

5.9.4 Vegetation of Surveyed Area

The survey was carried out by using grids in both core zone i.e. mine area and buffer zone i.e. within 10 km radius around the mine area. No Reserve forest, Wildlife sanctuary, National Park or Biosphere Reserve exists within the core or buffer area. The results of primary survey are given below.

Vegetation cover of Core Zone

Trees such as *Terminalia arjuna, Terminalia bellerica, Terminalia myriocarps, Alstonia scholaris, Ficus glomerata, Gmelina arborea, Bauhinia acuminata, Ailanthus grandis, Duabanga grandiflora* and *Sterculia villosa* are very frequent in this area. The dominant shrubs of this area are *Eupatorium odonatum*, *Zizyphus muritinum* and *Clerodendron infortunatum, Saccharum spontaneum; Thysanolaena maxima* are abundant in exposed places. There are quite a good number of herbs in comparatively exposed areas. The dominant forms are *Sida cordifolia, Sida acuta, Urena lobata, Amaranthus viridis, Ageratum conyzoides* and *Bidens pillosa.* Climbers are fairly abundant. The most predominant forms are *Mikenia scandense* and *Combretum roxburghii*. Wild *Musa sapiantum* occurs in the lower elevation.

However no endemic or endangered plant species was found in the core zone area according to the primary survey and quadrants that were used for the same.

Vegetation Cover of Buffer Zone

As the site sits at the divide between mountains and plain, this zone extends from upper hills (>1000 m) to river- bed and swampy paddy fields and is very diverse. There are a good number of village settlements with orchards and plantation areas. Thus the buffer zone shows different types of forests including Tropical evergreen, Tropical semi-evergreen, Tropical moist and Dry deciduous, Grassland and plantations forest.

Almost all households in the villages have homeland to grow crops like turmeric, ginger, banana, vegetables, betelnut or fruit trees.

The canopy cover of the upper hill forests ranges between 20-30% while that of village orchards ranges from 10-15%. The ground cover in grassland is fairly dense. Timber and fuel wood extraction from the forest is a continued process. The grazing in forest area is fairly low except in the areas around the village settlement.

The primary survey indicates that there are no endangered or endemic species in the buffer area, and that this is corroborated by a secondary data review.

5.9.4.1 Flora

Meghalaya and East Khasi hills are floristically fairly rich areas. The study area (core and buffer zone) extends from near sea level elevation to an elevation of about 800 m. The buffer zone extends from hilly subtropical regions in the north and in the eastern part, to plains and swamp land in the south. As such it has floristic components of tropical, subtropical, riparian and grassland zones.

The floral checklist was prepared on the basis of intensive study and field observations in the project core area and also extensive study in the buffer zone during December 2000.

In the floristic checklist (Table-5.9.1), both forest species (wild and planted) and cultivated orchard species are included. A good number of species are commercially cultivated in orchards, a few of which have medicinal values. Though in Meghalaya there are a number of endemic plant species reported earlier, none of the species was observed in the study area. A total of 71 trees, 34 shrubs, 21 climbers and epiphytes and about 48 common herb species is listed here from our field observation during the study period

5.9.4.2 Endangered Plant Species

According to the report of Haridasan and Rao (1985) and Haridasn (1999), 89 plant species are recorded as “Endangered” from the entire state of Meghalaya; among the endangered species *Nepenthes khasiana* is most widely known but was never recorded in the study area. For *in-situ* conservation of endangered flora and fauna, natural habitats at Nokrek, Balphakhram and other protected areas (Wildlife Sanctuary, etc.) have already been established specially in Garo Hills.

However from the field survey records and observations made during the present study it appears that none of the endangered plant species exist in the study area.

5.9.4.3 Cryptogamic Flora

The study area, specially Buffer zone, shows different species of ferns including tree fern, lihens and wood decaying fungi. The most common ferns belong to the gerera viz. *Diplazium, Pteris, Adiantum, Lygodium, Nephrolepis, Cyanthera, Argiopteris* and *Asplenium*. The dominant wood fungi are species of *Polyporus, Ganoderma, Lentinus* and *Schizophyllum*. The lichens are also fairly abundant in this area. The most common forms are Crantose and Foliose. In upper elevation of buffer zone, species of *Lycopodium* and *Selaginella* along with moss and liverwarts were observed particularly in moist places.

5.9.4.4 Phytosociology

For quantitative analysis of floristic components in different zones of core and buffer region, quadrates (20 m x 20 m) were laid in a linear grade. A total of ten quadrate sampling was performed for quantitative assessment of plant types in the core and buffer zone. The details are given in Table-5.9.2.

There is no endangered or rare species (as per Red Data Book published by BSI) observed during this study.

5.9.4.5 Agriculture

In the proposed mine site, currently there is no agricultural activity, as the area is highly fractured. However in the buffer zone, there is considerable agricultural activity (comprising about 26% of the total land area). Buffer zone includes blocks viz. Mawsynram and Shella-Bhilaganj. The common crops grown are rice, pulses, oil seeds, chilly, ginger, tapioca, potato, sweet potato, banana and papaya. In addition there is extensive cultivation of betel nut, fruit trees like jack fruit, orange, peach and guava.

5.9.5 Fauna and Wildlife

The fauna of Meghalaya has been documented by Zoological Survey of India (State fauna Series 4, 1995). Of the vertebrates, 139 species of mammals are recorded from the state of which, 69 species are known from East Khasi Hill district. Herpetofauna consists of 44 species of Reptiles and 54 species of Amphibia.

The study area was, in the historic past, a favourable habitat of wildlife; elders of the local community clearly identified a number of species, when coloured plates of the same were shown. These included Himalayan Black Bear, Barking Deer, Leopard, Wild Boar, Porcupine, etc. All these species have totally disappeared from the study area due to extensive hunting pressure from local communities. Hunting being an age old tradition in the area, the pressure obviously increased with expanding population.

The present study as such reveals a rather poor profile of higher vertebrates, especially mammalian fauna. Frugivorous bats and small rodents and legomorphs remain the major representative both in the Core zone and in the Buffer zone (Table-5.9.3). None of the mammalian species could be identified as Rare and Endangered. The avian fauna observed totals 57 species. No separate record was available from Eastern Regional Centre of ZSI. Most of the bird species recorded in the study area are widespread in distribution in Meghalaya and Eastern Himalayas. None of the bird species is considered "Endangered or Rare" as per schedule of IWPA, 1972 and its amendment version (Table 5.9.4).

The Herpetofaunal records from the study area indicate the possible occurrence of Rusells Viper and King Cobra in the past. A survey undertaken by ZSI in Meghalaya (published 1995) however, did not find these species. During the present study at most eight species of snakes and lizards (Table-5.9.5) and two species of Amphibia, could be recorded (in the aquatic ecosystem). None has been listed as “Endangered or Rare” in the IWPA. Of the vertebrates, Pisces (Fishes) have been dealt under Aquatic Ecosystem.

According to normal biodiversity studies, Butterflies are recorded as being of significant ecological value (besides Birds and Flowering Plants). Survey records in Eastern Regional Station of ZSI, Shillong indicate occurrence of 22 species belonging to Pieridae, Danaudae, Papillionidae. None of these species is considered “Rare and Endangered” (Table-5.9.6).

Table-5.9.1

Floral Checklist of Surveyed Area

S.N	Scientific Name	Local/ Common Name
Trees		
1.	*Aegle marmelos*	Heikhagok
2.	*Ailanthes grandis*	Ganmathai
3.	*Albizia lucida*	Siris
4.	*Albizia odoratisima*	Haya
5.	*Albizia procera*	Dumkol
6.	*Alstonea scholaris*	Chaton
7.	*Amoora walichi*	Agachi, Akshi
8.	*Areca catechu*	Betelnut Palm
9.	*Artocarpus chaplasa*	Dewa-sali
10.	*Artocarpus integrifolia*	Jackfruit
11.	*Arundinaria intermedia*	Perinypk
12.	*Azadirachta indica*	Baigaina
13.	*Bambusa pallida*	Shken
14.	*Bambusa tulda*	Shkong
15.	*Bauhinia acuminata*	Chingthrou
16.	*Bauhinia purpurea*	Chingthao-angauba
17.	*Bixa orellana*	Annatto
18.	*Bridelia retusa*	Geio
19.	*Buddeja macrostachya*	Tipoka-moli
20.	*Careya arborea*	Gemble
21.	*Caryota urens*	Tamak
22.	*Cassia fistula*	Haunaruaraung
23.	*Castanopsis indica*	Khashi badam
24.	*Chikrasia tabularis*	-
25.	*Cinnamomum bejolghota*	Ashokhyphum
26.	*Cinnamomum tamala*	Lapynriang
27.	*Cocos nucifera*	Coconut
28.	*Dalbergia sissoo*	Sisoo
29.	*Dendrocalamus giganteus*	Wa
30.	*Dendrocalamus hamiltonii*	Choya bans
31.	*Dillenia indica*	Heigri
32.	*Dillenia pentagyna*	Agachi, Akshi
33.	*Duabanga grandiflora*	Luaipap
34.	*Elaeocarpus floribundus*	Koying
35.	*Erythrina arborecens*	Hieto
36.	*Ficus bengalensis*	Bar
37.	*Ficus glomerata*	-
38.	*Ficus hispida*	Takpiang
39.	*Ficus religiosa*	Aliot
40.	*Ficus reticulata*	Fig
41.	*Garuga pinata*	Bonkung-esing
42.	*Glochidion lanceolarium*	-

Table-5.9.1(contd)

S.N	Scientific Name	Local/ Common Name
43.	*Gmelia arborea*	-
44.	*Grevillea robusta*	Kabulia
45.	*Grewia sapida*	Brbe
46.	*Kydia calycina*	Anisep
47.	*Lagerstomea parviflora*	Jarul
48.	*Lelnnea coromandelia*	-
49.	*Lichi chinensis*	Dieng-soh-manir
50.	*Macaranga peltata*	-
51.	*Mangifera indica*	Am, Chillujak
52.	*Mesua ferra*	Karai
53.	*Phoneix sylvestris*	Datepalm
54.	*Prunus persica*	Chumberi
55.	*Psidium guajava*	Ambak
56.	*Pterospermum acerifolium*	-
57.	*Quercus semiserrata*	Kara
58.	*Salmalia malabaricum*	Semulu
59.	*Sapindus mukorossi*	Haitaguti
60.	*Spondias pinnata*	Ambithong
61.	*Sterculia villosa*	Chikaung-araung
62.	*Symplocos ramossisima*	Kharane
63.	*Syzygium cumini*	Golpai
64.	*Tamarindus indica*	Maunge
65.	*Tectona grandis*	Teak
66.	*Terminalia arjuna*	Arjuna
67.	*Terminalia belerica*	Bahera
68.	*Toona ciliata*	Poma
69.	*Trema orientalis*	Pampak
70.	*Trewia nudiflora*	Wangbhop
71.	Zizyphus mauritiana	Soh-broi
Shrubs		
1.	*Acacia intsia*	Ragre
2.	*Cajanus cajan*	Rahban
3.	*Calamus erectus*	Rue
4.	*Calotropis gigantea*	Akon
5.	*Capparis spinosa*	Koura
6.	*Carica papaya*	Awthabi
7.	*Coix lacrymajobi*	Chening
8.	*Costos speciosus*	Akotenarmg
9.	*Desmodium pulchellum*	Pangaug
10.	Eupatorium odoratum	Samalmari
11.	*Flemingia macrophylla*	Charaiaw
12.	*Holarrhena antidysenterica*	Bolmatra
13.	*Homonya riparia*	-
14.	*Hyptdis suaveolense*	Bantulsi
15.	*Hypericum japonicum*	Aaeemilang

Table-5.9.1(contd)

S.N	Scientific Name	Local/ Common Name
16.	*Jatropa cureas*	Wa-kege
17.	*Justicia gendarusa*	-
18.	*Lantana camara*	Soh-pang-khlieh
19.	*Clerodendrum infortunatum*	Akalbiti
20.	*Manihot esculenta*	Tapioca
21.	*Melastoma malabathricum*	Akayoanyi
22.	*Morinda citrifolia*	Ach
23.	*Morus alba*	Sanukimbu
24.	*Musa paradisica*	Athiakol
25.	*Nyctanthes arbor-tristis*	Sephalika
26.	*Pandanus fasciculatum*	Keheki
27.	*Phyllanthes uranaria*	-
28.	*Ricinus communis*	Dalda grass
29.	*Saccharum spontaneum*	Kahibon
30.	*Solanum torvum*	Bako
31.	*Streblus asper*	Bulat
32.	*Thysanoaena maxima*	Holjaru
33.	*Urena lobata*	Bhatekuru
34.	*Woodfordia fruticosa*	-
Climbers and Epiphytes		
1.	*Abrus plecatorius*	Lalgadi
2.	*Aristolochia cathartii*	Baro-nirkhut
3.	*Asclepias racemosus*	-
4.	*Bauhinia vahlii*	Bhorla
5.	*Combretum roxburghii*	Arkeng-rikang
6.	*Dendrobium dinsiflorum*	Balgto
7.	*Derris elliptica*	Hiru rikang
8.	*Dioscorea alata*	Eugin
9.	*Dioscorea belophylla*	Ban-tarul
10.	*Dioscorea hamiltonii*	Ban-tarul
11.	*Holboellia latifolia*	Mezutsuk-moli
12.	*Hoya parasitica*	-
13.	*Ichnocarpus frutescens*	Jorakuchare
14.	*Lablab purpureus*	Tohi
15.	*Mikenia scandanse*	German-pula
16.	*Piper nigrum*	Jaluk
17.	*Pothos scandens*	-
18.	*Smilax zeylanica*	-
19.	*Thunbergia gradiflora*	Nungnung
20.	*Tinospora cordifolia*	Amaslota
21.	*Vanda teosellata*	Akhasi-gos
Herbs		
1.	*Achyranthes aspera*	Minamkachi
2.	*Ageratum conyzoidas*	Imchenriza

Table-5.9.1 (contd)

S.N	Scientific Name	Local/ Common Name
3.	*Alternanthera sessilis*	-
4.	*Amaranthus viridis*	-
5.	*Ananus squamosus*	Alipiong
6.	*Andrographis paniculata*	-
7.	*Bidens pillosa*	Bana
8.	*Blumea lacera*	Janya
9.	*Boerhavia repens*	-
10.	*Calamintha umbrosa*	-
11.	*Carex filicina*	Dimba lapia
12.	*Centella asiatica*	Atina
13.	*Chenopodium ambrosoides*	Chisik-bot
14.	*Curcuma zedoaria*	Amada
15.	*Cymbopogon nurdas*	Citronella
16.	*Cynodon dactylon*	Dubari
17.	*Cyperus griffithi*	Bajran
18.	*Desmodium laxiflorum*	Bhutu-ham
19.	Drymeria cordata	Achhamena
20.	*Echinochloa crus-galli*	-
21.	*Eleusive indica*	Bobosaben
22.	*Eragrostis tenella*	-
23.	*Eriocanton luzulaefolium*	-
24.	*Euphorbia lutra*	-
25.	*Fimbristylis falcata*	Arza
26.	*Hedychium aurantiacum*	-
27.	*Imperata cylindrica*	Altong
28.	*Isachne albens*	-
29.	*Mimosa pudica*	-
30.	*Ocimum basilium*	-
31.	*Oxalis corniculata*	Chota tengeri
32.	*Paedaria foetida*	Bhedailota
33.	*Pennisetum americanum*	Yangpah
34.	*Polygonum molle*	Borbung
35.	*Polygonum orientale*	Agasom
36.	*Pouzozia hirta*	Akhle
37.	*Scoparia dulcis*	Butburi
38.	*Sida acuta*	Barphum
39.	*Sida cordifolia*	Barial
40.	*Solanum nigrum*	-
41.	*Sonchus asper*	Akatsu
42.	*Strobilanthus orientalis*	Barcha
43.	*Themeda villosa*	Kahinwon
44.	*Tridax procumbens*	-
45.	*Triumfelta rhomboidea*	Sli-sko
46.	*Vinca rosea*	-
47.	*Xanthium strumarium*	Agra
48.	*Zingiber officinale*	Ada

Table-5.9.2

Phytosociological Analysis of Forest Zones

Type of Forest with Location	S. N	Species	Frequency	Density	Abundance
A. Core zone					
i) Upper elevation, semi-evergreen forest patch	1	Sterculia villosa	60	6.0	10.0
	2	*Chikrasia tabularis*	20	1.0	20.0
	3	*Saraca indica*	10	1.0	10.0
	4	*Ficus glomerata*	20	8.0	2.5
	5	*Terminalia belerica*	20	4.0	5.0
	6	*Terminalia myriocarpa*	20	3.0	6.6
	7	*Alstonea scholaris*	40	8.0	5.0
	8	*Eupatorium odaratum*	100	10.0	10.0
	9	*Lantana camara*	50	6.0	8.3
	10	*Musa sapientum*	80	8.0	10.0
	11	*Toona ciliata*	20	2.0	10.0
	12	*Clerodendron infortunatum*	30	3.0	10.0
ii) Lower elevation, mix semievergreen & deciduous forest patch	1	*Duabanga grandiflora*	40	4.0	10.0
	2	*Alstonea scholaris*	30	5.0	6.0
	3	*Zyzyphus mautianus*	40	8.0	5.0
	4	*Terminalia belerica*	30	5.0	6.0
	5	*Terminalia arjuna*	20	5.0	4.0
	6	*Ficus glomerata*	30	6.0	5.0
	7	*Gmelina arborea*	30	5.0	6.0
	8	*Bauhinia acuminata*	40	8.0	5.0
	9	*Ailanthes grandis*	10	2.0	5.0
	10	*Eupatorium odoratum*	80	8.0	10.0
	11	*Musa sapientum*	80	8.0	10.0
	12	*Lantana camara*	40	8.0	8.0
	13	*Saccharum spontaneum*	50	5.0	10.0
	14	*Clerodendron infortunatum*	40	5.0	8.0
	15	*Thysanolaena maxima*	30	6.0	5.0
B. Buffer zone					
i) Evergreen forest patch	1	*Terminalia belerica*	30	6.0	5.0
	2	*Terminalia myriocarpa*	20	5.0	4.0
	3	*Castanopis indica*	20	4.0	5.0
	4	*Pterospermum acerifolium*	20	5.0	4.0
	5	*Sterculia villosa*	40	6.0	6.6
	6	*Ficus recemosa*	20	4.0	5.0
	7	*Gracinia indica*	10	5.0	2.0

Table-5.9.2 (contd)

Type of Forest with Location	S. N	Species	Frequency	Density	Abundance
	8	*Daubanga grandiflora*	20	6.0	3.3
	9	*Mangifera indica*	10	5.0	2.0
	10	*Mesua ferra*	20	4.0	5.0
ii) Semi-evergreen deciduous forest patch	1	*Dillenia pantagyna*	30	6.0	5.0
	2	*Symlocos recemosus*	20	5.0	4.0
	3	*Carya arborea*	10	2.0	5.0
	4	*Erythrina arborescense*	20	5.0	4.0
	5	*Clerodendron infortunatum*	40	8.0	5.0
	6	*Ficus glomerata*	20	5.0	4.0
	7	*Thysanolaena maxima*	20	4.0	5.0
	8	*Sterculia villosa*	30	6.0	5.0
	9	*Alstonia scholaris*	30	5.0	6.0
	10	*Hypericum japonicum*	20	5.0	4.0
iii) Grassland Patch	1	*Saccharum spontaneum*	60	6.0	10.0
	2	*Impamta cylindrica*	50	5.0	10.0
	3	*Paspalum dilatatum*	40	8.0	5.0
	4	*Calotropis gigantea*	30	6.0	5.0
	5	*Eupatorium odoratum*	60	10.0	6.0
	6	*Lantana camara*	40	8.0	5.0
	7	*Capparis spinosa*	10	2.0	5.0
	8	*Zyziphus nimularius*	20	5.0	4.0
	9	*Holarrhena antidysenterica*	60	6.0	10.0
iv) Village Orchard Patch (Shella)	1	*Areca catechu*	60	6.0	10.0
	2	*Litchi chinensis*	20	5.0	4.0
	3	*Mangifera indica*	30	6.0	5.0
	4	*Phyllanthes emblica*	10	2.0	5.0
	5	*Sizyzium cumini*	20	5.0	4.0
	6	*Cinnamomum tamala*	20	4.0	5.0
	7	*Dendrocalamus hamiltoni*	20	5.0	4.0
	8	*Tectona grandis*	20	6.0	3.3
	9	*Alstonea grandis*	20	5.0	4.0
	10	*Gmelina arborea*	30	6.0	5.0
	11	*Musa paradisiaca*	40	5.0	8.0
	12	*Artocarpus integrifolia*	30	6.0	5.0
v) Village Orchard Patch II (Durbar)	1	*Mangifera indica*	30	6.0	5.0
	2	*Musa paradisiaca*	40	8.0	5.0
	3	*Ficus glomerata*	30	6.0	5.0

Table-5.9.2 (contd)

Type of Forest with Location	S. N	Species	Frequency	Density	Abundance
	4	*Morus alba*	20	5.0	4.0
	5	*Cinnamomum tamala*	20	6.0	3.3
	6	*Artocarpus integrifolia*	20	4.0	5.0
	7	*Areca catechu*	60	6.0	10.0
	8	*Albizia odontosima*	40	8.0	5.0
	9	*Tonna ciliata*	20	2.0	10.0
	10	*Psidium guajava*	20	5.0	4.0

Table-5.9.3

Checklist of Mammalian Species

Sl. No.	**Scientific Name**	Common Name	**Local Status**	**IWPA**
1.	*Bandicota bengalensis*	Indian Mole Rat	Common	V
2.	*Bandicota indica*	Bandicoot Rat	Common	V
3.	*Cannomys badius*	Bamboo Rat	Sporadic	V
4.	*Cynoptarus sphinx*	Shortnosed Fruit Bat	Common	V
5.	*Dremomys lokriah*	Himalayan Squirrels	Common	-
6.	*Lepus nigricollis*	Indian Hare	Rare	-
7.	*Mus booduga*	Indian Field Rat	Common	-
8.	*Scotophilus heathi*	Common yellow Bat	Common	-
9.	*Vulpes bengalensis*	Indian Fox	Sporadic	II

Table-5.9.4

Checklist of Bird Species

Sl. No.	Scientific Name	Common Name	Local Status	IWPA
1.	*Columba livia*	Blue Rock Pigeon	Common	IV
2.	*Streptopelia chinensis*	Spotted Dove	Common	IV
3.	*Psittacula krameri*	Roseringed Parakeet	Sporadic	IV
4.	*Psittacula alexandria*	Indian Redbreasted Parakeet	Rare	IV
5.	*Loriculua verhalis*	Lorikeet	Rare	IV
6.	*Cuculus canorus*	Cuckoo	Sporadic	IV
7.	*Cuculus micropterus*	Hawk Cuckoo	Sporadic	IV
8.	*Clamator coromandus*	Redwinged Crested Cuckoo	Rare	IV
9.	*Eudynamys scolopacea*	Koel	Common	-
10.	*Centropus sinensis*	Koel	Sporadic	-
11.	*Strix leptogrammica*	Brown Wood Owl	Rare	IV
12.	*Hemiprone longipennis*	House Swift	Common	-
13.	*Cypsiurus parvus*	Palm swift	Common	-
14.	*Caprimulgus asiaticua*	Common Indian Nitghtar	Sporadic	IV
15.	*Merops leschenaulti*	Chestnutheaded Bee-eater	Common	-
16.	*Merops orientalis*	Small Green Bee-eater	Common	-
17.	*Coracias garrulus*	Roller	Rare	IV
18.	*Upupa epops*	Hoopoe	Rare	IV
19.	*Megalaima haemacephala*	Coppersmith	Common	IV
20.	*Megalaima rubricapilla*	Crimsonthroated Barbet	Common	IV
21.	*Chyrysocolaptes festivus*	Indian Goldenbacked Woodpecker	Sporadic	IV
22.	*Dinopium bengalensis*	Lesser Goldenbacked Woodpecker	Sporadic	IV
23.	*Megalaima asiatica*	Blue throated Barbet	Common	IV
24.	*Pitta nipalensis*	Bluenaped Pitta	Common	IV
25.	*Galerida cristata*	Crested Lark	Rare	IV
26.	*Lanius cristatus*	Brown Shrike	Common	-
27.	*Oriolus oriolus*	Golden Oriole	Common	IV
28.	*Oriolus xanthornus*	Lackheaded Oriole	Common	IV
29.	*Dicrurus adsimilis*	Black Drongo	Sporadic	IV
30.	*Dicrurus aeneus*	Brown Drongo	Rare	IV
31.	*Acridotheres tristis*	Indian Myna	Sporadic	IV
32.	*Acridotheres ginginianus*	Bank Myna	Sporadic	IV
33.	*Sturus contra*	Pied Myna	Sporadic	IV
34.	*Dendrocitta vagabunda*	Tree Pie	Rare	IV
35.	*Corvus splendens*	House Crow	Rare	V
36.	*Corvus macrorhynchos*	Jungle Crow	Sporadic	V
37.	*Hemipus picatus*	Pied Flycatcher	Common	IV
38.	*Pericrocotus erythropygius*	Whitebellied Minivet	Common	IV
39.	*Pericrocotus roseus*	Rosy Minivet	Common	IV

Table-5.9.4 (contd)

Sl. No.	**Scientific Name**	Common Name	**Local Status**	**IWPA**
40.	*Chloropsis cochinchinensis*	Goldmantled Chloropsis	Common	IV
41.	*Pycnonotus atriceps*	Blackheaded Bulbul	Common	IV
42.	*Pycnonotus cafer*	Redvented Bulbul	Common	IV
43.	*Pellorneum ruficeps*	Spotted Babbler	Sporadic	IV
44.	*Alsippe poioicephala*	Quaker Babbler	Sporadic	IV
45.	*Gampsorhynchus rufulus*	Whiteheaded Babbler	Sporadic	IV
46.	*Turdoides striatus*	Jungle Babbler	Rare	IV
47.	*Garrulax maniligerus*	Necklaced Laughing Thrus	Sporadic	IV
48.	*Muscicapa mutti*	Brown-breasted Flycatcher	Sporadic	IV
49.	*Orthotomus mtorius*	Tailor Bird	Common	-
50.	*Copsychus saularis*	Magpie Robin	Rare	-
51.	*Dicacum erythrohynchos*	Thickll's Flowerpecker	Common	IV
52.	*Dicacum ignipeetus*	Firebreasted Flowerpecker	Sporadic	IV
53.	*Acthopyga siparaja*	Yellowbacked Sunbird	Common	IV
54.	*Nectarine asiatica*	Purple Sunbird	Common	IV
55.	*Passer domesticua*	House Sparrow	Common	-
56.	*Ploceus philippinus*	Baya Weaver Bird	Rare	IV
57.	*Lanchura mallaca*	Blackheaded Munia	Sporadic	IV
58.	*Milvus migrans*	Pariah Kite	Common	IV

Table-5.9.5

Checklist of Reptiles

S. N.	Scientific Name	Common Name	Local Status	IWPA
1.	*Ahaectulla nasutus*	Common Green Whip Snake	Common	-
2.	*Calotes jerdoni*	Eastern Green Calotes	Rare	-
3.	*Calotes versicolor*	Common garden Lizard	Common	-
4.	*Hemidactylus flaviviridis*	House Gecko	Common	-
5.	*Mabuya carinata*	Common Skink	Sporadic	-
6.	*Macropisthodon plumbicolor*	Green Keelback	Common	-
7.	*Varanus bengalensis*	Common Indian Monitor	Sporadic	II
8.	*Xenochrophis piscator*	Checkered Keelback	Common	II

Table-5.9.6

Checklist of Lepidoptera

S.N	Scientific Name	Common Name
1.	*Argynnis hyperbius*	Indian Fritillary
2.	*Catopsilia pomona*	-
3.	*Danaus chrysippus*	Plain Tiger
4.	*Danaus genutia*	Common Tiger
5.	*Danaus melissa*	-
6.	*Delius acalis*	Red-Breasted jezebel
7.	*Euploea mulciber*	-
8.	*Euploea mulciber*	Striped Blue Crow
9.	*Eurema blanda*	Three Spot Grass Yellow
10.	*Eurema hecabe*	Common Grass Yellow
11.	*Eurema laeta laeta*	Spotless Grass Yellow
12.	*Hypolimnas bolina*	-
13.	*Lamproptera eurius*	-
14.	*Pantoporia perius*	Common Sergeant
15.	*Papilio polytes*	Common Mormon
16.	*Precis almera*	Peacock Pansy
17.	*Precis atlites*	Grey Pansy
18.	*Precis iphita*	Chocolate Pansy
19.	*Precis lemonius*	Lemon Pansy
20.	*Symbrenthia hippoelus*	Himalayan Jester
21.	*Vanessa cardui*	-
22.	*Zemeros flegyas*	Punchinello

5.10 AQUATIC ECOLOGY

5.10.1 Introduction

The surveyed area is located in the water shed between the Umium river on the east and the Khasimarg river on the west. Several seasonal rivulets, nallahs and gullies dissect the surface, which result in the formation of spurs. The Umium river flows southwards; and has tributaries like Phlangkaruh river. In addition there are bill, swamp area in the south east part of Shella region.

The biological resources of aquatic systems were either collected or observed and analysed both qualitatively and quantitatively during the field survey. The major components are as follows :

- Producers : Plankton (Phyto); Macrophytes; Benthos
- Consumers: Plankton (Zoo); Fish; Amphibia; Water birds;Aquatic mammals

5.10.2 Planktons

These are microscopic life forms belonging to either Phytoplankton (algae) or Zooplanktons (Protozoa or rotifers, etc.) categories. They form the lowest trophic level of the aquatic ecosystem. Water samples were collected from three surface flowing sources, filtered through plankton net for collection of planktons. Then samples were processed and preserved for microscopic analysis. The species density is presented in Table-5.10.1.

5.10.3 Macrophytes

The swamps and freshwater beels area reveal a number of macrophytes. They constitute a major component of aquatic ecosystems. A checklist is presented in Table-5.10.2.

On the whole, it appears that except *Euryle ferox* (Katapadum), none of the aquatic forms appears to be rare. It is also important to note the fact, these water bodies were located in the peripheral part of the buffer zone and some may extend to Bangladesh region. None of the aquatic forms could be considered as endangered. No macrophyte was recorded in the Phlangkarauh river.

5.10.4 Benthic Forms

A few benthic filamentous algal forms were observed and collected from river bed and stagnant water pool. These are species of *Spirogyra, Zygnema, Oedogonium, Pithophora, Oscillatoria* and *Lyngbia*.

The above mentioned plants viz. planktons (phyto), benthos and macrophytes form the producer trophic order of the aquatic ecosystem.

5.10.5 Fishes

A total of 42 species of hill stream fishes have been recorded in the Shella and around by Zoological Survey of India, Shillong. In addition, records of fresh water pond fish could be noted in the literature and from the information obtained from local people. These are listed in Table-5.10.3.

5.10.6 Amphibia

In spite of the fact that N.E. Indian region has more than 50 species of amphibia, only two species are recorded by Zoological Survey of India from the study area. No frogs and toad were seen during the survey due to the cold climate (Table-5.10.4).

5.10.7 Aquatic Birds

A total of 12 species of aquatic birds have been reported (Table-5.10.5) in the buffer zone.

5.10.8 Conclusion

The survey has thus found that there are no endangered or locally endemic flora or fauna within the core and buffer area, as revealed both by extensive literature review as well as field studies (10 quadrates). While other dominant fauna did exist in the past, hunting pressure and habitat destruction by local people appears to have eliminated most species, especially large and medium mammals.

Table-5.10.1

Plankton Load (No./100 litre)

S. N	Species	Phlangkaruh	Shella	Tollyp
A. Phytoplankton				
1.	*Volvox* sp.	-	100	300
2.	*Cosmarium* sp.	50	100	100
3.	*Formedia* sp.	100	100	200
4.	*Chlamydomonas* sp.	100	50	100
5.	*Navicula* sp.	400	200	50
6	*Euglena* sp.	-	200	600
7.	*Pediastrum* sp.	200	600	-
8.	*Eudorina* sp.	100	50	-
B.Zooplankton				
1.	Rotifers	40	30	50
2.	Cladocera	30	40	-
	TOTAL :	1020	970	1400

Table-5.10.2

Checklist of Macrophytes

Sl. No.	Species (Scientific Name)	Growth Form	Occurrence
1.	*Cardenthera diformis*	Amphibious	F
2.	*Eichhornea crassipes*	Floating	C
3.	*Euryle ferox*	Rooted at bottom but leave on surface	R
4.	*Hydrilla verticillata*	Submerged	C
5.	*Hydrolea zyylanica*	Amphibious	F
6.	*Ipomea aquatica*	Amphibious	F
7.	*Lemna minor*	Floating	F
8.	*Ludwigia perviflora*	Amphibious	F
9.	*Naja naja*	Submerged	F
10.	*Nymphea naucheli*	Rooted at bottom but leave on surface	C
11.	*Plantago ovata*	Submerged	F
12.	*Potamogeton minor*	Floating	F
13.	*Utricularia racemosa*	Submerged	C
14.	*Vallisnaria spiralis*	Submerged	C
Note:	*C = Common; R = Rare; F = Frequent*		

Table-5.10.3

Checklist of Fishes

Sl. No.	Scientific Name	Local Name (Khasi)
1.	*Acanthocobitis botia*	-
2.	*Acanthopthalmus pangia*	-
3.	*Ailia coila*	Kha tungkra
4.	*Amblypharyngodon mola*	Kha muka
5.	*Anabas testudineus*	Kha Koi
6.	*Anabas testudineus*	-
7.	*Badis badis*	Kha snoing
8.	*Barilius barna*	Kha ilong
9.	*Barilius bendelisis*	Kha ilong
10.	*Batasio batasio*	-
11.	*Batasio teggana*	-
12.	*Catla catla*	-
13.	*Chana orientalis*	-
14.	*Chana stewartii*	-
15.	*Chanda nama*	Kha snad
16.	*Clarias batracus*	Kha Magur
17.	*Colisa fasciatus*	Kha snoing
18.	*Danio devario*	Shylynnai
19.	*Glossogobius giuris*	-
20.	*Gudusia chapra*	Kha Chapila
21.	*Heteropneustes fossilis*	Kha Singi
22.	*Labeo gonius*	Kha ski
23.	*Labeo pangusia*	Kha bah
24.	*Labeo rohita*	Kha bah
25.	*Laguvia ribeiroi*	-
26.	*Lepidocephalus guntea*	Sher Syngkai
27.	*Monopterus cuchia*	-
28.	*Mystus bleekeri*	Kha tynkara
29.	*Mystus montanus*	-
30.	*Nandus nandus*	Kha aniang
31.	*Olyra horai*	-
32.	*Osteobrama cotio cotio*	-
33.	*Parambassis rauga*	-
34.	*Pseudeutropius atherinoides*	Kha tyngkara
35.	*Puntius chola*	Shalynnai
36.	*Puntius sophore*	Shalynnai
37.	*Puntius ticto*	Kha shalynnai
38.	*Sarmostoma baccila*	-
39.	*Schistura savona*	-
40.	*Securicula gora*	Kha ilong
41.	*Somileptes gongota*	Doh Sher
42.	*Tetraodon cucutia*	-

Table-5.10.4

Checklist of Amphibian

S. N	Scientific Name	Common Name
1.	Rana cyanophlyetis	Skipping Frog
2.	Rana limnocharis	Cricket Frog

Table-5.10.5

Checklist of Aquatic Birds

Sl. No.	Scientific Name	Common Name	Occurrence	Status in IWPA
1.	*Alcedo atthis*	Small Blue Kingfisher	Sporadic	IV
2.	*Amaurornis phoenicurus*	Whitebreasted Water Hen	Rare	IV
3.	*Ardeola grayii*	Pond Heron	Sporadic	IV
4.	*Charadrius alexandrius*	Little Ringed Plover	Sporadic	IV
5.	*Egretta grazetta*	Little Egret	Rare	IV
6.	*Fulica atra*	Coot	Sporadic	IV
7.	*Gallinago stenura*	Common Snipe	Sporadic	IV
8.	*Halcyon smyrnensis*	Whitebreasted Kingfisher	Sporadic	IV
9.	*Motacilla alba*	White Wagtail	Common	IV
10.	*Phalacrocorax carbo*	Little Cormorant	Rare	IV
11.	*Tachybaptus ruficollis*	Little Grebe	Rare	IV
12.	*Tringa hypoleucos*	Common Sandpiper	Sporadic	IV

5.11 DEMOGRAPHY AND SOCIOECONOMICS

5.11.1 Introduction

The socio-economic profile of the study area is based on the site visit, group discussions with the villagers and the secondary data available from various concerned agencies and offices. Demographic profile, landuse pattern and infrastructural facilities, etc, have been sourced from District Census Book, East Khasi Hills District, 1991; Basic Statistics of Meghalaya, 1991 and interviews and discussions with the local authorities and the villagers. A survey was conducted and the total respondents were 137 households. Agricultural economics have also been worked based on the information collected from Agricultural Department and discussions held with the villagers at site. The study area villages have been categorised based on the radial distance from the exploration site. The categories taken for studying the socio-economic profile are 0-3 km (hereinafter referred to as Grid I), 3-7 km (hereinafter referred to as Grid II) and 7-10 km (hereinafter referred to as Grid III). The shale mine area is the private land owned by the individuals of Shella village and the process of transfer (by way of purchase or lease) is underway.

5.11.2 Study Area

5.11.2.1 Administrative Jurisdiction

The study area encompasses 56 villages within two CD blocks: Mawsynram and Shella Bholaganj. Each village has a village Durbar, which is the lowest administrative unit at the village level. The site is located in the Shella village of the East Khasi Hills area of East Khasi Hills district. The shale mine site falls in Shella Confederacy.

5.11.2.2 Social Setting

The study area essentially comprises of agriculture and unreserved private/community forest dominated land in the region. The social setting is however, very different and typical of the region. Most of the villages are along the slope of the hills and are built on community land of the village. The agricultural fields are outside the village along other hill slopes. The agricultural lands either belong to the community or are private lands. The private lands are locally known as *Ri-Kynti* whereas the community lands are known as *Ri-Raid.* The mainstay of the people of the region is agriculture. From our discussion with the local population, we understand that timber trade was an important and lucrative source of income of the villages, however, the ban on timber trading in the year 1996 had hurt the economy of certain families. Principal crop in the study area is pepper (*kali mirch*). Major crops cultivated in the region include betel leaves and nuts, bay leaves (*Tejpatta),* bajra, maize, vegetables (for self-consumption) and fruits. Second to agriculture, Limestone mining is the other occupation of the people in the area. Animal husbandry is practiced for self-consumption. Major livestock of the study area consists of pigs, goat, hens and cows.

5.11.3 Demography

The population density per sq km is very thin due to the unutilised vast tracts of land in the study area. Comparatively study area under the CD Block Shella Bholaganj is more populated than Mawsynram CD block. Over 80% of the population belong to the Khasi tribe and its subtribes. The majority of the population within the study area is inhabited by War Khasis with agriculture as the main occupation. A segment of the Garo ethnic group and the Bengali migrants from Bangladesh form the rest 20% of the population. There is a small segment of population from the other states of India, also mainly engaged in the limestone quarries and commercial activities. The War Khasis are primarily involved in agriculture and plantation activities while the Boro and the Garo population is generally hunters or daily wage working class. As per the law of the land no non-khasi community can own land in the area.

The sex ratio of the rural population in the CD blocks reveal that the number of female per thousand males is 954 in Shella while 964 in Mawsynram. The neighbouring block of Pynursla has a strong female dominance of 1009 females per thousand males. Village Nongtrai is mainly inhabited by tribal *Khasi C*hristians community.

The total population in the study area stands at 17556 with 10.3%, 41% and 48.7% of the total inhabiting villages within the Grid I, Grid II and Grid III areas respectively. The number of females for every 1,000 males in the study area is around 938.

Scheduled Castes and Scheduled Tribes

There are segmented schedule caste population residing within the study area, however this population is mainly migrated from the other Indian states and neighbouring Bangladesh.

In Meghalaya, over 17 tribes have been recognized as scheduled tribes as per the Scheduled Caste and Scheduled Tribe Orders (Amendment) Act 1976 and the Constitution (Scheduled Tribes) Order Amendment Act 1987.

In the study area the predominant scheduled tribe population is the Khasi followed by the Boro Kacharis and Garos. Each of these tribes has several sub-tribes that are also considered as scheduled tribe population as per the Indian regulation.

Khasi tribe comprises of a matriarchal family system, where lands belong to the female members of the family and the land is used to transfer in the name of the female members of next generation.

5.11.4 Occupational Pattern

Worker and Non-Worker Population

The main working class segment comprises of persons engaged in plantation and orchards. The cultivators and the agricultural activity is very minimal, usually the cultivation class is from the Khasi community. Some of the village of Mawrynkhong, Nongtrai and Shella are engaged in limestone quarries and lime kilns.

Boro villages mainly comprise of marginal workers, who either work in the plantations of the Khasi community or collect non-timber forest products (NTFP). Some of these people also work as daily wagers in the limestone quarries and with the State government for building roads and bridges.

5.11.5 Agricultural Productivity and Economics

According to information provided by the forest officer, Shillong, the study area is renowned for the betel nut cultivation and the variety grown in the foothills has the distinction of producing good varieties of betel nuts. The floodplains are cultivated for turmeric and among the productive areas of the district.

5.11.6 Animal Husbandry

There are no census records on the livestock population of the district. During our study it was observed that almost all the local residents in the Mawsynram and Shella Bholaganj have livestock. No Government owned animal husbandry programme are available within the East Khasi hills district. As can be gauged from the survey below, the poultry farming is the main husbandry operation and comprise of 50 % of the livestock, excluding dogs and goats. The next highest category of animal is the pigs, which forms nearly 30% of the total livestock population. It is found during the study that Khasi villagers generally do not rear goats and cows, Boro villagers rear goats and almost every house of Phlangkaruh and Desong villages has cows . Mawsynram has a veterinary hospital. Most of these units are lacking the infrastructure support and basic facilities.

5.11.7 Infrastructural Facilities

Infrastructure facilities are very poor in the district. However, in comparison to Mawsynram block, Shella Bholaganj is better equipped with these facilities. Specific details of these facilities are listed below in Table-5.10.3.

5.11.7.1 Education

The literacy rate in Shella is 49.61% (51.56% male literacy and 47.54% female literacy) compared to 45.91% (48.92% male literacy and 42.77% female literacy) in Mawsynram.

Female education is comparatively higher than that in other Indian states, due to the influence of Christian missionary society.

Educational facilities available within the study area are primary school, middle school, high school and adult literacy centre. Most of the villages (about 70%) have primary level educational facility. Some of the large villages have secondary education facillities as well. Rest of the villages have education facility within 5 to 10 km. Within Grid I, 6 villages out of 9 villages (66%) have primary schools, with 2 middle schools and 1 adult literacy centre. Nongtrai has a middle school and a secondary school. The nearest higher secondary school is at Lawbah, while on the other side the higher secondary school is at Cherrapunji. The Boro and the Garo

population within the study area is less educated, it is primarily due to the economic pressure and lack of amenities. However the primary education among this population is gradually increasing. The villages Lawbah, Maphlong and those near to the major cities of Mawsynram and Cherrapunji are being provided with better education facilities.

5.11.7.2 Medical & Public Health

There are a total of 26 government medical institutions including Family Welfare Sub-centres (FWSC) in both districts. Out of these, 15 are in Shella Bholaganj which includes 12 FWSC. Medical facilities are better in Shella Bholaganj compared to Mawsynram.

The medical facilities available within the study area are dispensaries, hospital, maternity home, child welfare centers, family planning centers, primary health sub center, community health center and other similar facilities. It has been reported that 144 villages of the total 159 villages in the Mawsynram district and 168 villages of the total 180 villages in CD block of Shella Bholaganj do not have adequate medical facilities.

Medical facilities in the study area are very poor, nearly 31% villages have the facility within 5-10 km ; 25% villages have the facility at more than 10 km distance . In Grid I, only 2 (22%) villages have medical facility in their village. Nongterai has one primary health sub-centre (PHS) and Shella Bazar has one dispensary. Village Phlankaruah has a facility available at a distance of 25 km. The medical facilities available in these units are also very poor. Once in a week the Ramkrishna Mission Charitable Society, located at Cherrapunji, in mobile vans provide medical facilities in the remote villages.

5.11.7.3 Drinking Water

Most of the villages obtain drinking water from the adjoining springs and rivers. Dug wells have been developed along the riverbanks in Disong village and in some other villages, in the plain to obtain fresh drinking water. Reportedly, there is no scarcity of water, however the quality is often non-potable due to bacteriological source contamination.

Census shows that only 20% villages have only one type of drinking water source in the study area. Water supply lines are provided to some of the villages in upper plateaus. The water is treated and supplied to the villages through PWD supply lines.

5.1.7.4 Post and Telegraph

Only 3 of the villages are connected with telegraph within the study area. Some efforts of solar telephone booths were tried in some of the villages. Reportedly, most of these are at present non-functional. The nearest telephone facility available at site is at Shella Bazar. Within the Grid I, only 3% of the villages in the study area have post and telegraph (P/T) facilities. Recently telegraph posts have been installed in the Mawsynram village.

Nearly 27% and 20% villages have P/T facilities (Post Office) in their villages in the Grid II and Grid III respectively. 47% and 32% villages within the 3-5 km and 5-15 km radial distance have P/T facility within 5 km and remaining at more than 5 km distance, respectively.

5.11.7.5 Communications

Apart from P/T services, transport is the main communication linkage in the study area. For long distances people mainly depend on the bus service, which is in general available within a distance of 10 km or more. There are two main hill tracts within the site area. One from Shillong to Hat Mowdon and other from Shillong to Cherrapunjee. Villagers mainly use their cycles as a transportation means. 31% of the villages are communicated by buses in the study area.

5.11.7.6 Road Network

Most of the villages, are located along the main roads. However the internal roads leading to the village or from the village to the main roads are not well defined. Often, they are hilly tracts and are non-motorable roads. Villages in Grid II and Grid III are provided with road facilities which are asphalt topped. Only 6% and 13% are connected with pucca road in Grid II and Grid III respectively.

No national highways fall within the study area . The two main routes within this hilly terrain are: (1) Shillong – Mawphlang- Mawsynram- Balat- Maheshkola- Baghmara route which connects Shillong with the border areas and (2) The other important routes are Shillong- Pynursala- Dawki route, Shillong-Mawphlang- Weiloi route extended to Mawsynram and Balat in one direction and Mawkyrwat in another. For the local transport, villagers walk along the hilly tracts, the village across the hills provide shortcuts and are very commonly used and provide very unique mode of communication. In the Ishamati and Shella bazar area the river of Umium and Ishamati canal are also used for plying.

5.11.7.7 Power and Electricity

The CD blocks have 57% of the villages with power supply, while the availability of power in Shella Bholaganj CD block is 41.1%. With the introduction of Rural Electrification Scheme in East Khasi Hills district, more villages are anticipated to be electrified. Some of the villages have been provided with solar heaters and lighting systems.

5.11.7.8 Industries and Labour

Due to lack of adequate infrastructure, very few large industries are found in the districts. The only dominant industrial activity observed within the study area is the excavation of limestone and other minerals and stone from the hills. At some places very thin coal seams were found under excavation by the local people. By and large limestone is the most important and easily available mineral, which is exported by water channels to Bangladesh and also to the main towns like Cherrapunji and Shillong. There are also several lime kilns in the region. There are some limestone

quarries in the east and northeast direction which are actively engaged in limestone extraction.

Cottage industries like carpentry, pottery, bamboo works, weaving, manufacturing, rope-making, indigenous confectionery, brick manufacturing etc. are also reported in both the districts. Fishing and hunting with collection of NTFPs from the adjoining forests is one of the major activities.

Labour in the study area is cheaply available. Labour is mainly employed in the agricultural fields, during monsoon season (4 months). Mostly, landless people (in particular, people belonging to Boro & Garo community) are employed as agricultural labourers. During the discussion with the villagers, daily wages for the labourers is Rs.70.00 per day for male and Rs 60.00 per day for female in addition to food.

5.11.8 Social Setup around the Project Area

People of Shella belong to Khasi tribe and are residing in this village for more than 20 years. It is one of the oldest settlements in the area. Most people are followers of Christianity. The population has considerable mix of Presbyterian, Church of God and Catholics. There are few persons who are the followers of indigenous Khasi faith.

The literacy rate in the village is 66.44% (as per the survey conducted). Majority of the school going students discontinues their studies after completion of lower primary and middle level education due to lack of motivation and financial constraint. The area shows considerably high level of female literacy, up to 47 % compared to the male literacy rate of 53.2%. Table 5.11.4 provides information on the percentage of educated population in the Mawsynram CD Block.

The primary occupation of the villagers of Shella is agriculture and plantation. The working population includes primarily agricultural labourers and landowners and workers in other commercial activities.

Reportedly, there are few government service holders and local traders.

The plantation of betel nut and leaf in the slopes of the hills is an important income generating source. Some paddy and maize cultivation in the plains is also carried out. Other produces include Bay leaf, wild pepper, brooms, oranges and other NTFPs. Until recently timber trade was one of the major income generation source of the village, however with the ban on timber trade, this is no longer practised. Most of the respondents are engaged in agriculture/plantation. Table-5.11.5 provides the estimate of the various crops and vegetation that is grown by the agricultural cultivation.

5.11.8.1 Income Sources

The survey among the respondents reveals that the annual income of the people is, on an average, less than Rs 30,000, the primary source being the agriculture. There are two limekilns in the vicinity of the village. Some illegally operated quarries are also located within the village premises. Usually the Khasi households have pigs and hens

as main husbandry while none of the houses were reported to have any goat or cattle population.

5.11.8.2 Administrative Set Up

Each confederacy has an elected candidate as Chief (Wardhar). Under the Wardhar, there are village chiefs or headmen. The headmen is elected by the village council and the village council has two committees:

- Special affairs committee relating to boundary dispute
- Local affairs committee relating to Governmental Schemes and methods of implementation.

The village council selects two prominent members for the Wardhar Durbar. Maintenance of law and order and settlement of land disputes are the two main functions of the village council. Each village also has a village defence party, which plays vital role in maintaining social tranquillity.

5.11.8.4 Culture and Festivals

Khasi society is a society in which all groups are considered equal. It is the woman who inherit the property and is the legal owner of the property. In some of the War area of the south khasi hills, males also own property. Although female is the owner of the property, they are not part of the village administration, the administrative decision making is the exclusive right of their male counterparts. In the villages the market day that rotates in the region over week is an important occasion and so is the day when the village Durbar meets. Khasis commemorate this day with archery practised by the village youth.

Another popular celebration is Shad Suk Mynseim (the dance of contentment or happiness) – an expression of thanksgiving for the blessings of prosperity that the people have enjoyed during the year. Another important festival is the Shad Nongkrem (Nongkrem dance).

Due to large dominance of Christian population, Easter and Christmas are also celebrated with great pomp and show.

Table-5.11.1

Villages in the study area

CD Block	Grid I	Grid II	Grid III
Mawsynram	2	12	9
Shela Bhlolaganj	3	14	16
Total	**5**	**26**	**25**

Table-5.11.2

Administrative Structure

	Mawsynram Block		Shella Bholaganj Block	
	CD Block	Study Area	CD Block	Study Area
Area in sq km (approx)	523	NA	578	NA
Durbar	151	-	180	-
Villages	159	23	187	33
Inhabited Villages	151	23	180	33
Population	38194	7005	38022	10047
Sex Ratio (per 1000 males)	954		964	

Table-5.11.3

Infrastructural Facilities in the Study Area (Based on 1991 Census Data)

Study Area Distance from the Site		**0 - 3**	**3 - 7 km**	**7 – 10 km**	**0-10 km**
Total No. of Villages in the Study Area		**5**	**26**	**25**	**56**
Infrastructural Facility	**At the Distance**				
Education	**In the village**	4	15	20	*70% villages in the total study area have educational facilities in their villages, while remaining villages have to access these outside their villages. Most of these villages have Primary level education. Only one village in 3 km area have primary educational facility, while 37.5% and 45% villages in Grid II and Grid III area have primary level educational facility, respectively.*
	-[5]	1	5	5	
	-[5-10]	0	1	0	
Medical	**In the village**	0	3	4	*13% villages in the study area have medical facility in their villages. Though most of them (25%) have access to these at the distance of 5-10 km from their villages,in the 3 km radial distance, no villages have medical facility (PHS & Dispensary). 20% and 20% villages have medical facilities (PHS and Dispensary) available in their villages in Grid II and Grid III, respectively.*
	-[5]	4	9	11	
	-[5-10]	0	4	3	
	-[10+]	1	6	7	
Drinking Water Availability (Types of Sources)	**#1 (T)**	5	12	18	*All the villages have only tap water as drinking water in the study area. Maximum number of villages are dependent on tap water, followed by surface water sources. 55% of villages in 5 km distance have only one source of drinking water. 85% and 62% villages have 2 or more sources of drinking water (tubewell/tap/tank /river) in Grid II and Grid III, respectively. Drinking water facilities increase as we move farther to site.*
	#2 (W)	0	3	2	
	#3 (S)	2	12	12	
	#4 (0)	0	2	0	
	#5 (R)	3	2	4	
Post & Telegraph	**In the village**	1	3	6	*18% of the villages in the study area have post and telegraph (P/T) facilities. 20% of the villages have P/T facilities (Post office & Phone) in Grid I. Near l2% and 30% villages have P/T facilities (Post Office) in their villages in the Grid II and Grid III. 46% and 60 % villages in the Grid II and Grid III have P/T facility at distance of 5 km from villages; and remaining at more than 5 km distance.*
	-[5]	4	12	15	
	-[5-10]	0	3	2	
	-[10+]	0	3	2	

Study Area Distance from the Site		0 - 3	3 - 7 km	7 – 10 km	0-10 km
Communications	**In village**	1 BS	5 BS	8	*37% of the villages are communicated by buses in their villages in the study area. Within Grid I, one village is having communication services (bus) till 5 km distance. Nearly 39% villages have bus facility in their villages in 5-10 km radius.*
	-[5]	3	9	10	
	-[5-10]	0	5	3	
	-[10+]	1	2	4	
Approach to village	**N A**	0	0	0	*24% of the villages do not have road connection in their villages in the study area. Only 33% villages have access to Kuchha road in Grid I. 27% and 19% villages do not have road facility in their villages in Grid II and Grid III. Most of the villages are connected by kuchha road. Only 6% and 13% are connected with pucca road in Grid II and Grid III.*
	Kuchha Road (KR)	1	1	6	
	Pucca Road (PR)	1	7	7	
	Footpath (FP)	4	19	22	
Power Supply (Types of sources)	**#1 ED**	5	9	17	*20% villages in the study are have power supply in their villages. 35% villages do not have any type of power supply (ED, EAG) in the study area. All the villages have power supply in their villages in Grid I.*
	#2	0	0	0	
	Not Available	0	12	8	

Note: The distance for the infrastructure facilities is as per the approach road, from the subject village.

Table-5.11.4

Education Rate

Education level	CD block of Mawsynram (in %)
Primary	49.63%
Secondary	30.30%
College	12.34%

Table-5.11.5

Percentage of Agricultural Cultivation

Sl No	Crops	% of total agriculture
1	Paddy	12.19
2	Black Pepper	59.75
3	White Pepper	34.14
4	Betel Leaf	65.85
5	Betel Nut	87.80
6	Bamboo	1.21
7	Tejpatta	52.43

5.12 Noise

5.12.1 Introduction

Noise in general is sound, which is composed of many frequency components of various loudness distributed over the audible frequency range. The most common and universally accepted scale is the A Weighted Scale which is measured as dB(A). This is more suitable for audible range of 20 to 20,000 Hz.

5.12.2 Investigation Criteria

A preliminary reconnaissance survey has been undertaken to identify the major noise generating sources in the area. Noise levels were recorded for 10 minutes in every clock hour for a continuous 24-hour period at 15 locations during winter season in the study area. The environment setting of noise monitoring locations are described in Table-5.12.1 and depicted in Exhibit-5.12.1

5.12.3 Assessment Criteria

Leq is the equivalent continuous sound level that is equivalent to the same sound energy as the actual fluctuating sound measured in the same period. This is necessary because sound from noise source often fluctuates widely during a given period of time. This is calculated from the following :

L_{day} is defined as the equivalent noise level measured over a period of time during day (6 am to 10 pm).

L_{night} is defined as the equivalent noise level measured over a period of time during night (10 pm to 6 am).

A noise rating developed by Environment Protection Agency, USEPA for specification of community noise from all the sources is the Day-Night Sound Level (L_{dn}).

Day-Night Sound Level (L_{dn})

The noise rating developed for community noise from all sources is the Day-Night Sound Level (L_{dn}). It is similar to a 24 hr equivalent sound level except that during night time period (10 pm to 6 am) a 10 dB(A) weighting penalty added to the instantaneous sound level before computing the 24 hr average

$$L_{eq} = 10 \log \frac{1}{T} \sum_{I=1}^{N} Ti\,(10)^{Li/10}$$

Where T = Total time of sampling
Ti = Time duration of ith phase
N = Number of phases, and
Li = (L_{eq}) for the ith phase

This night time penalty is added to account for the fact that noise during night when people usually sleep is judged as more annoying than the same noise during the day time.

The L_{dn} for a given location in a community may be calculated from the hourly $L_{eq's}$ by the following equation.

(L_{dn} =10 log {1/24[16($10^{Ld/10}$) + 8 ($10^{(Ln/10)}$)]}

Where, L_d is the equivalent sound level during the day time (6 am to 10 pm) and L_n is the equivalent sound level during the night time (10 pm to 6 am).

5.12.4 Existing Noise Environment

The noise level monitored during winter season are given in Table-5.12.2 in the form of L_{day}, L_{night}, and L_{dn} and compared with the standard prescribed by CPCB.

It would be seen from Table-5.12.2 that maximum L_d was observed to be 68.9 dB(A) at Shella Bazar while minimum noise L_d was observed to be 61.7 (N13) dB(A) at Thamtham (N4). Maximum L_n was observed to be 51.5 dB(A) at Jatap (N5) while minimum noise L_n was observed to be 42.6 dB(A) at Kyrdoh (N3). Noise level variation and exceeded values are mainly attributed to the local domestic activities.

Table-5.12.1

Details of Noise Level Monitoring Locations

Sl. No.	Locations	Direction wrt Plant Site	Distance wrt Plant site, km	Details of the surroundings
1	Phlankaruh	S	1-1.5	The location has been selected to assess noise levels near the mine site in residential areas.
2	Nongtrai	N	2	The location has been selected to assess noise levels near the mine site in residential area.
3	Kyrdoh	W	4.5	The location has been selected to assess noise levels in the residential area.
4	Tham Tham	S	3.0	The location has been selected to assess noise levels in a residential area with light vehicular movement. Monitoring point is selected near the market area characterised with heavy vehicular traffic and crowd.
5	Jatap	SE	3.0	The location has been selected to assess noise levels in the traffic area and mining activities.
6	Nonglait	NW	3.5	The location has been selected to assess noise levels in the residential area. The location has been selected to assess noise levels near a hospital. A village road passes nearby.
7	Mustoh	ENE	2.5	The location has been selected to assess noise levels in the residential area.
8	Pyrkan	EES	1.0	The location has been selected to assess noise levels in the residential area.
9	Mawryngkhong	NE	1.5	The location has been selected to assess noise levels in a residential area.
10	Hat Mawdon	WWS	5	The location has been selected to assess noise levels in a residential area with light vehicular movement.
11	Disong	EEN	1.5	The location has been selected to assess noise levels in a residential area with light vehicular movement.
12	Nongwar	NE	3.5	Residential houses surround the monitoring point with vehicular movement along the highway.
13	Shella Bazar	E	1.5	The location has been selected to assess the noise levels in the commercial area. The monitoring pt is located near the state highway and shops during market day.
14	Shella Bazar	E	1.5	The location has been selected to assess the noise levels in the area without commercial activities.
15	Mine Area	Core	0.0	The location has been selected to assess the noise levels in the mining area and thereby determine a baseline status.

Table-5.12.2

Equivalent Noise Levels in the Study Area

S.N	Station	Day Time L_{eq} (L_d) (dBA)	Night Time L_{eq} (L_n) (dBA)	Day-Night Time L_{eq} (L_{dn}) (dBA)
1	Phlangkaruh (N1)	64.2	49.9	62.3
2	Nongtrai (N2)	63.9	47.9	62.4
3	Kyrdoh (N3)	64.9	42.6	63.0
4	Thamtham (N4)	61.7	46.6	60.3
5	Jatap (N5)	64.7	51.5	63.7
6	Nonglait (N6)	64.2	49.5	62.9
7	Mustoh (N7)	63.6	48.4	62.1
8	Pyrkan (N8)	67.4	48.8	65.6
9	Mawryngkhong (N9)	63.9	50.8	62.9
10	Hatmawdan (N10)	68.6	51.0	66.9
11	Disong (N11)	63.4	48.9	62.1
12	Nongwar (N12)	64.5	49.9	63.2
13	Shella Bazar (Mkt day)(N13)	68.9	47.5	67.0
14	Mine Site (N14)	64.4	49.1	63.0
15	Shella Bazar (N15)	67.4	50.2	65.8

CPCB norms L_{eq} (dBA)

	Industrial Area	Commercial Area
Day time :	75	65
Night Time :	70	55