EXECUTIVE SUMMARY

An environmental management study was carried out in an area of about 40 km radius with Tentoi as centre in Angul and Dhenkanal districts in Orissa. The study was undertaken to assess the possibility of establishment of thirteen thermal power stations and supportive infrastructure and associate small and medium industries. The proposed development will also need opening of new mines and enhancement of the capacity of the existing coal mines in Talcher coalfield. The objectives were as given below.

- Assessment of present status of air, water, land use, bio-diversity and socio-economic components including noise.
- Identification and quantification of significant impacts due to the mining and other industrial operations (both existing and proposed) on various components of the environment and plan for the corrective measures.
- Prediction of impacts on different environmental components based on the existing and projected scenario.
- Preparation of an appropriate Regional Environmental Management Plan (REMP) based on the capacities of air, water and sub-systems outlining the control technologies to be adopted for mitigation of adverse impacts.
- Delineation of the post project environmental quality monitoring programme to be pursued by the mines and industrial owners and Government authorities in the region.

The Angul-Talcher-Meramundali area of Orissa has important natural resources, which include coal, forests, fertile land, minor minerals, ground and surface water, etc. and is only developed mainly in the coal bearing areas. Major industries operating in the area include aluminum smelter, thermal power plants, ferro alloy plant, coal mines, etc.

The area has a potential for large-scale industrial development due to availability of a large quantity of coal and other natural resources. There are proposals for establishing 13 thermal power plants with a total capacity of 14,770 MW in the next decade. In addition some other major industries may also be established. The daily demand of coal will be about 2,50,000 tonne.

The present industrial activities and those envisaged in future will impact all the components of the environment of the study area. This calls for devising measures for effective control and management of the environmental parameters while taking care of needs of the people and requirements for social and industrial development. Formulation of the present Regional Environmental Management Plan on the basis of the prevailing environmental scenario and taking into account the proposed industrial development is a step towards achieving this. For the development of the Plan the study covered the following aspects.

Land Environment	• Study of the general topography, development of the geological maps of the study area. • Defining land use pattern of the study area based on land use plan as well as remotely sensed data with adequate field

	verification. • Preparation of soil maps and soil quality data based on soil sampling and its subsequent analysis. • Assessment of existing and perspective mining areas. • Identification of the locations and characteristics of the urban agglomeration and transport and road network and future expansion plan. • Identification of the locations and characteristics of ecological sensitive areas.
Resource Accounting	• Assessment of coal availability and its consumption pattern. • Assessment of water availability, water demand, flow and consumption pattern. • Assessment of forest cover and plantation. • Study of flora and fauna including appropriate conservation plan of scheduled species. • Assessment of agriculture and horticulture pattern and products
Ambient Air Quality including noise	• Assessment of meteorological parameters. • Assessment of ambient air quality (SPM, RSPM, SO_2, NO_x, etc.) in the study area for summer, post-monsoon and winter seasons. • Assessment of ambient noise quality status at in industrial, commercial, residential as well as sensitive areas.
Water Quality	• Assessment of *surface water quality* of water available in rivers; reservoirs; and major ponds in four seasons as per existing norms. • Assessment of *ground water quality* in three seasons as per existing norms. • Assessment of seasonal variation and depletion of water table through existing hydrological maps and basic measurement of water level in well.
Socio-Economic Information	• Assessment of the socio-economic profile of the study area covering demography, health and food status, access to health care facilities, access to education, occupational pattern, income pattern, education, etc. • Assessment of the future socio-economic scenario on the basis of the proposed industrial and developmental activities.
Urban Activities	• Study of the urban development in combination with industrial development. • Present status as well as future requirement of drinking water and its management. • Present status of vehicular traffic at critical locations and management of the same in future on the basis of the planned

	mining and associated activities in the study area.
Assessment of existing environmental management measures and identification of environmental problems	• Preparation of an inventory of activity wise existing environmental management measures and assessment of their efficacy. • Identification of environmental problems (existing and proposed development in pipe line). • Modelling of environmental parameters. • Pollution indexing and development of Environmental Impact Matrix.
Development of Environmental Management Plan with recommendations for taking care of the components.	

ASSESSMENT OF EXISTING AND FUTURE ENVIRONMENTAL STATUS AND THEIR INDEXING

POPULATION

The total population of the two districts, i.e., Angul and Dhenkanal is about 22,00,000 and the growth of the population in future is anticipated to be as given below.

Angul district
In 2001 – 2011: 13,21,000 at 16% decennial growth rate
In 2011 – 2021: 15,33,000 at 16% decennial growth rate
In 2021 – 2031: 17,78,000 at 16% decennial growth rate

Dhenkanal district
In 2001 – 2011: 11,94,000 at 12% decennial growth rate
In 2011 – 2021: 13,38,000 at 12% decennial growth rate
In 2021 – 2031: 14,98,000 at 12% decennial growth rate

Hot spots (high population density/growth zones)

Villages and urban centres with projected 16% decennial growth rate and in-migration at 16% decennially have been identified. These have been designated as "hot spots" with respect to high population density and growth. The list of such villages and urban centres (about 15) is presented below.

Villages and Urban Centers	Hot spot[#] w.r.t population growth	Population as per 2001 census	Estimated Population in 2007[+]	Projected population in 2011[+]	Projected population in 2021[+]
GRID C16					
Chhendipada		4,904	5,453	5,688	6,598
Kosala		4,837	5,379	5,610	6,508

GRID D13					
Tukuda		3,488	3,879	4,046	4,693
Kanjara		3,220	3,851	3,735	4,332
Tubey		4,005	4,454	4,645	5,389
GRID G4					
Bijigol		3,123	3,473	3,622	4,202
Seepur		3,797	4,222	4,404	5,109
Tipo		4,133	4,596	4,794	5,561
GRID HI					
Gobara		3,298	3,667	3,825	4,437
Kangula		6,461	7,185	7,494	8,693
Balaramprasad		7,440	8,273	8,630	10,011
Kulad	Hot spot	4,184	5,121	5,522	7,290
Budhapanka		5,211	5,795	6,044	7,011
Gotamara	Hot spot	6,229	7,624	8,222	10,853
Nuahata	Hot spot	4,696	5,748	6,198	8,182
Kukudanga		3,340	3,714	3,874	4,494
Jarasingha	Hot spot	5,054	6,186	6,671	8,806
Turanga	Hot spot	3,952	4,837	5,216	6,885
Kumanda	Hot spot	5,337	6,532	7,044	9,299
Anugul (NAC*)	Hot spot	38,018	46,534	50,183	66,242
FCI Township (CT**)		7,058	7,848	8,187	9,497
TTPS Township (CT)	Hot spot	6,621	8,104	8,739	11,536
Dera Colliery T'ship (CT)	Hot spot	18,592	22,757	24,541	32,394
Ghantapada (CT)	Hot spot	15,593	19,086	20,582	27,169
Nalco (CT)	Hot spot	18,045	22,087	23,819	31,441
Talcher Municipality	Hot spot	34,998	42,838	46,197	60,980
GRID H5					
Kualo		3,942	4,384	4,572	5,304
Saranga		5,343	5,941	6,197	7,189
Badajhara		3,184	3,541	3,693	4,284
Barihapur		4,787	5,323	5,552	6,441
Kandarsingha		3,370	3,747	3,909	4,534
Parjang		3,613	4,018	4,191	4,861
Sanda		6,099	6,782	7,074	8,206
Kamalanga		3,370	3,747	3,909	4,534
Mangalpur	Hot spot	3,895	4,767	5,141	6,786
Kharagprasad	Hot spot	4,221	5,167	5,571	7,354
Balaramprasad	Hot spot	3,027	3,705	3,995	5274
GRID H9					
Indipur		4,335	4,821	5,028	5,833
Kamakshyanagar (NAC)		15,003	16,683	17,403	20,188

NAC* means Notified Area Council/ Committee

Cold spots (potential areas for urban development, R&R sites and Industrial development)

The Orissa Government has planned for massive industrial growth in the region by way of establishing a large number of thermal power plants, steel plants and other coal based industries, for which a large area of land and other human and natural resources will be required. Based on the existing land-use/ land-cover "cold spots" for industrial development are suggested. These are as given below.

Grid No	Land use/cover pattern	Hot spots/Cold Spots
3H/1	This grid lies almost in the heart of the study area. A major part falls in Angul district. Nandira jore and Nigra/Lingara nadi flows from west to east into Brahmani river. It has major urban centres, namely, Angul, Talcher, Banarpal, and Coal mining townships. The topography is mostly rolling with isolated hillocks Coal bearing formations exist on the northern side of Nandira jor. Major coal mining activities and other industries like NALCO and TTPS are present. The land use is dominated by agriculture followed by forest, settlements, mining area and barren land (gullied).	**Hot Spots**: Kulad Village, Gotamara Village, Nuahata Village, Jarasingha Village, Turanga Village, Kumanda Village, Angul (NAC), TTPS Township (CT), Dera colliery township, Ghanapada (CT), NALCO (CT), Talcher Municipility and active mining areas, both existing and proposed. **Cold Spots:** To the south of Banerpal (south of NH-42); and to north of Nigra/Lingara nadi, south of Khaliberana village. Barren and unused land lying on either side of NH-42.
73H/5	It falls in Dhenkanal district. Brahmani river flows from north to south-east with Gambharia jor and Nigra/Lingra nadi joining into it. The grid has Parajang and Meramandali towns and major industries , namely, Bhushan Steel, Nava Bharat Ferro Alloys, etc are present. The topography is mostly rolling with isolated hilly areas (RL varies from 60 to 300 m above MSL). Dominated by agriculture land followed by dense forest land and settlements	**Hot Spots:** Mangalpur village, Kharagprasad village, and Balaramprasad village **Cold Spots**: There is no major mining activity in the grid and as such a major area can be considered as cold spot except agriculture and forest lands.
73H/6	This grid lies to the south-eastern part from the centre (Tentuloi village) of the study area. It falls in Dhenkanal district. Bada jor flows from south to north-east into the Brahmani river. Includes Rasol town. The topography is partly hilly and partly plain (RL varies from 120 to 530 m above MSL). Dominated by agriculture land followed by dense forest land and barren land.	Grid number H-6 (north-west corner): north of Sanamunda village. The barren land area can be considered as **cold spots.**

73H/9	It falls in Dhenkanal district. Ramiala river flows from north into Brahmani river. Includes Kamakhyanagar town. The topography is partly hilly and partly plain (RL varies from 80 to 430 m above MSL). Dominated by agriculture land (fallow) followed by dense forest land and barren land.	**Hot Spots:** Indipur village, Kamakshyanagar (NAC). A small portion of this is coming within study area. However, the barren lands can be considered as **cold spots**.

Education

The studies indicated that the literacy rate in the study area is low. Among the total literates, only 9% have qualifications above class X, whereas overwhelming 70% respondents have qualifications below class V. The remaining 21% have qualifications between class V and X. Therefore, it is necessary to take measures for improving the educational facilities and motivate the people.

Employment and Income pattern

In the study it was observed that majority of the population of the area is dependent on agriculture for livelihood. While agricultural labour engaged in cultivation is 35.8% 47.04% are employed in industries. About 15.71% people do their own cultivation, whereas only 1.45% people have their own cottage/SSI units. The share of the income of the families from various sources was as given below.

- Cultivation of own land - 29.28%
- Agricultural labour - 22.17%
- Cottage and other industries - 42.63%
- Own business – 3.71%
- Fisheries and bee keeping - 2.21%

The average monthly income of the families was about Rs.2,000. Considering 5 members per family the per capita monthly income is about Rs 400 only. This indicates economic backwardness of the people living in the area specially in the villages.

Health & Medical facility

The study revealed an unhealthy life style of the people living in the region on account of addictions. They are addicted to smoking (31%), chewing beetle nuts and tobacco (62.54%), drinking alcohol (5.95%), and others using a local made tobacco based product (popularly known as GUDAKHU) (7.9%).

Water borne diseases are common ailment in the region (32.88%). Air borne, heart-related and eye diseases are also prevalent among the population. A large section of population (53.15%) suffers from malaria, tuberculosis, scabies, leprosy, acute respiratory infection, etc.

Probable future scenario and suggested strategy

The details of existing activities in the study area and projected level of industrialisation outlined earlier indicate that the resources available in the area will be exploited in near future. Since, coal is the major resource establishment of coal based industries, i.e., thermal power plants, steel plants, etc. is envisaged. The addition of these activities will stress all the components of prevailing environment. The anticipated impacts on the societal parameters are given below.

1. There will be a marked increase in the total population of the area.
2. The overall literacy of the area will increase with the establishment of the industries as well as due to implementation of Central and State governments social upliftment programs.
3. The surrounding areas of Angul-Talcher-Meramundali region has either dense forest lands or falls under the Mahanadi delta which is more suited for agriculture. The ensuing industrialization in the study area will lead to wide-scale mobility from rural to urban centres – thereby further stressing the environmental components, if appropriate planning with respect to development of infrastructure and civic facilities is not taken up urgently.
4. With the implementation of projected industrialisation some urban agglomerates will emerge around Angul, Kanhia, Talcher, Banarpal, Odapada blocks, etc. Hence, it is necessary to launch an effective regional planning with respect to spatial strategy, economy, housing and transportation around the development sites in the areas.
5. In the future scenario, as more industries will be set up in the region, migration of population from rural to urban areas/centers will take place. In order to maintain a balance between rural and urban settlements and population suitable measures shall be needed in the overall development planning.

In order to plan for future societal development of the study area with the addition of the planned coal based and associated industries the mining and other industries will be required to plan and implement all the measures required for the fulfillment of their '**Corporate Social Responsibility**' with a view to meeting the emotional, mental and physical needs of the society as well as an improvement in the quality-of-life commensurate with the level of economic activities. The following aspects need due attention.

1. Control of population development
2. Creating awareness among the society about the advantages and impacts of mining and associated coal based activities
3. Development of adequate infrastructure (roads, transport, communication, etc.)
4. Development of educational and medical facilities
5. Development of R&R packages and rehabilitation action plans
6. Development of overall community development plans
7. Optimization of impacts on the natural and manmade resources
8. Development of strategy for proper closure of the mines
9. Conservation and development of the manmade and natural resources other than minerals
10. Preservation of the entity of the areas in terms of social, religious, archeological and cultural significances
11. Any other need as per the typical features of the area

The corporate sector, i.e., mining and other companies responsible for the industrial development will be required to look into the following measures so as to be able to fulfill their **Corporate Social Responsibility.**

1. Agricultural development
2. Forest management
3. Overall land use management
4. Water resource management
5. Population control
6. Health, education and well being of the people
7. Promotion of agro-based cottage industries
8. Converting impacts into resources

LAND USE AND SOIL

Land-cover

The northern and southern parts of the study area are hilly and the rest of the area is having a number of fertile valleys. Almost all the hilly terrains (i.e., about 35%) of the study area are having forest cover. The remaining 65% of the study area is plain dominated by agricultural land (with frequent fallows) and other land-uses. Barren / waste lands with gullies (about 14% of the study area) exist throughout the study area. The terrain is undulating and accommodates a large number of human settlements and fertile lands as outlined earlier. The overall land use situation is as given below.

Sl no	Use	Percent of land
1	Mining area	0.61%
2	Human settlements	3.81%
3	Forest land including plantation	36.29%
4	Agriculture land	42.31%
5	Barren land/ waste land	14.13%
6	Water bodies	2.85

Soil resources

Typic Ustochrepts is the dominant (56.6%) soil type (soil sub-group), followed by Aeric Haplaquepts (13.4%) and Vertic Haplaquepts (13.1%) in the study area. These soils are slightly acidic and have high available water capacity. The dominant land-use associated with these soils is paddy cultivation.

Hot spots (areas having severe soil erosion and unacceptable soil quality)

About 150 sq km of barren land in Grid 73G/4 with a lot of gullies and ravines has been considered as hot spot from the point of view of severe soil erosion. As per 1973 Survey of India topographic sheets the area was covered by dense mixed Sal jungles. This forest land as per 2007 satellite imagery has been considerably eroded.

A number of power plants, mines, steel plants and their supporting ancillary industries are expected to come up in near future in this area. This will affect land use and soil quality of the area.

MINERAL RESOURCES

In terms of geographical distribution of mineral resources in Orissa, the Angul-Talcher-Meramundali area contributes to the state mainly in terms of power grade coal and fire clay although a few other non-metallic or industrial minerals like graphite, kyanite, quartz, quartzite and a few precious stones are also available in the region. The details of the resources and present scenario have been described earlier.

Future Scenario

Potentiality of Talcher Coalfield: The life of Talcher coalfield has been estimated to be 70 years. The present mineable reserve are estimated to be 1,373 Mt. Apart from the mines of Mahanadi Coalfields Limited a number of coal blocks have been allotted to the private sector for captive use mainly for power generation and sponge iron plants. The estimated geological reserves of these captive blocks are 7,418 Mt. The MCL has planned to produce about 3.6 Mt from the underground coal mines and the rest from the opencast mines in the future.

Solid Waste (overburden) generation

The stripping ratio of the existing mines is varying from 0.5 to 0.8. As estimated from the orientation and cross section of the coal seams the stripping ratio in future will not exceed 1.5. The mines will have to be planned in such a way that the overburden of one mine may be used to fill the void of another mine so that the mining craters are reclaimed properly. The projected volume of overburden to be generated by the mines through 2021-22 as 359.79 m^3.

FLORA AND FAUNA RESOURCES

Flora: As per Survey of India toposheet, 1972, the noticeable forest cover of the Angul-Talcher-Meramundali region was 2315.04 sq km (46.04 %). The satellite imagery of December 2007 shows forest cover as 1770.32 sq km (35.20 %). This reveals a decrease of 23.54 % forest cover since 1972.

Most of the Angul-Talcher-Meramundali region is covered with tropical deciduous forests of different types. Forty-six plant families with 115 species are thriving in the entire area.

Shorea robusta was maximum in number as per quadrat analysis undertaken in the study area. Next dominating species was *Buchanania lanzan*, *Madhuca indica* and *Butea monosperma*. The structure and function of tropical deciduous forests in Angul-Talcher-Meramundali region is dominantly controlled by *Shorea robusta*. The study area represented different communities in terms of species composition. The diversity index revealed that the forests were moderate in species richness and lower in stem density and basal area.

Aquatic and Terrestrial Fauna: Fishes, amphibians and water snakes are the major aquatic fauna. The terrestrial fauna includes common invertebrates and vertebrates. It is pertinent to mention that wild animals, like Bear, Boer, Tiger, Leopard and Elephants are not seen in the site. Elephants and Bears are the only migratory mammals in the area coming from distant

places. However, it is not a common migratory route for wild animals. Among the amphibians, *Rana tigrina* is a threatened species and in reptiles V*aranus* is threatened.

Livestock: As per 2001 livestock census the cattle population of Angul district is 5,72,619 out of which 5,30,867 are indigenous and 41,752 are crossbreed. The buffalo population is 43,616, which are of indigenous type. The sheep, goat, pig, poultry population is 63,951; 2,38,663; 3,047; and 3,63,830 respectively as per 2001 livestock census. The sheep available are mostly of local non-descript type. Goats are reared mostly in hilly areas.

Hot spots (protected forests, areas having rich bio-diversity, endangered species, degraded forest areas and loss of prime agriculture land)

Extensive mining, urbanisation and population growth in the area has triggered increase in the number of urban and rural settlements, degradation of forest area and loss of prime agricultural land. Decrease in agricultural land in the study area may be attributed to the shift in occupation by the people from cultivation to the lucrative mining jobs and also due to lack of improvement in irrigation facilities. Deforestation due to various reasons has also triggered an increase in barren land and subsequent loss of soils. Ecological hot spots are given below.

Category of hot spots	Status at present	Anticipated status
Degraded protected forests	About 145 and 75 sq km of forest land has been degraded to barren land in Grids 73G/4 and 73H/6 respectively since 1973 to 2007. There is also a marked decrease in forest land in Grids 73C/16, 73D/14, 73H/2, 73G/8, 73H/5 and 73D/13	The satellite imagery clearly depicts how the forest cover in the study area has degraded over a span of 34 years. This trend is likely to continue in view of the anticipated growth of population, increased coal mining and setting up of more and more industries, which will require large areas of land. Obviously either the forest land or agricultural land shall be used for this purpose.
Loss of prime agricultural land	About 80 and 50 sq km of prime agricultural land has been degraded to barren land in Grids 73C/6 and 73D/13 respectively since 1973 to 2007. There is also a decrease in prime agricultural land in Grids 73H/1, 73H/9 and 73G/12	
Areas having rich Biodiversity	Wildlife habitats, namely, Satakosia Gorge Sanctuary, Malyagiri, Bulajhar, Panchadhara and Mahanadi river systems lie in and around the study area. These are fragile and have biologically diverse habitats. 146 different species of trees, 3 of Bamboos, 59 of shrubs, 46 of herbs, 24 of perennial grasses, 8 of annual grasses and 57 of climbers are thriving in the region. Thus, the area has considerable variation in plant diversity. The diversity index revealed that the forests were moderate in	The industrialisation and urbanisation of the area will impact the forest cover of the area, which is a habitat to a number of birds and animals, thereby threatening their existence.

	species richness. Fishes, amphibians and water snakes are major aquatic fauna. The terrestrial fauna includes common invertebrates and vertebrates. Details are given in Chapter 3.	
Endangered species	Among the amphibians, *Rana tigrina* is a threatened species and in reptiles V*aranus* is threatened.	

WATER RESOURCES

The area under study has all the three types of geological formations, i.e., sedimentary, metamorphic and igneous rocks. The coal and other deposits are available only in the sedimentary formations. The area has both surfaced and underground sources of water.

Brahmani River basin

The Angul-Talcher-Meramundali area falls in the "Brahmani River Basin", which is an inter-state river basin. It is spread across the states of Chhattisgarh, Jharkhand and Orissa. The Central Water Commission (CWC) has estimated the annual renewable water resources of the basin as 21,920 million cubic meters. This includes surface and ground water resources. The annual renewable groundwater recharge has been assessed as 5,171 million cubic meters. Out of this, a recharge of 4,395 million cubic meters is considered utilizable for irrigation.

Surface water resource in the study area

The Central Water Commission has estimated the annual renewable water resources of the Brahmani river basin as 21,920 million cubic meters (MCM). This includes surface and groundwater. Out of this, it is estimated that 16,618 MCM of water (about 75%) would continue to flow to the sea, indicating that the basin would not have any water shortage.

The average rainfall in the study area in 2007 was 1,111 mm. The rainfall in the area during the last 10 years varied between 896 and 1,744 mm. It is estimated that the total surface runoff in the study area in 2007 was 5,589 MCM. Annually about 1,029 MCM (about 18%) is recharged as groundwater.

There are more than 1,000 ponds (covering an area of about 28 sq km), 4 small reservoirs (covering an area of 3.6 sq km) and Brahmani River and its first and second order streams (covering an area of 111.5 sq km) in the study area, which hold a significant quantity of surface water. The ponds and reservoirs hold about 111 MCM and the rivers and drains can hold 390 MCM water. Thus, the total water holding capacity of the study area is 501 MCM.

Groundwater

The study area is blessed with rich groundwater availability in the sedimentary and metamorphic rock regions. The annual renewable groundwater recharge has been assessed as 5,171 MCM in the entire Brahmani river basin. The annual renewable groundwater resource in

Angul and Dhenkanal districts is about 1,029 MCM as given below.

District	Basin area (km^2)	Gross recharge 10^6 m^3	Utilizable recharge (85%) of gross recharge 10^6 m^3
Angul	4,235	547.18	465.10
Dhenkanal	3,969	481.53	409.30

Source CWC

The water sources both surface and underground, are impacted by both opencast and underground mining. The impacts are remarkable up to a distance of about 1.0-1.5 km beyond the boundary of the mines depending upon the characteristics of the mines.

Water demand in Angul-Talcher industrial area

The area is fast emerging as an important source of coal, aluminum and thermal power in the country. About 711 km^2 area forms the core industrial zone. Water of Brahmani river and its tributaries cater to the industrial/domestic need of this fast growing complex. The major part of the area forms the plains of river Brahmani and its tributaries like Nandira Jhor, Singada Jhor and Tikra River.

Raw water to the extent of about 86 million cubic meters/annum is drawn from the river for industry/ mining activity, apart from other surface and ground withdrawals (36 million cubic meters/annum) . The water consumption and wastewater generation by major existing industrial users and some of the proposed industries are as given below.

(Figures in thousand litres/day)

Name of the Industry	Products	Water consumption	Wastewater generation
A) Existing Industries			
National Aluminum Company-Smelter Unit	Aluminum	5,066	4,900
National Aluminum Company – Captive Power Plant	Electric Power	1,35,000	90,000
ORICHEM Ltd.	Chemicals	170	10
Talcher Thermal Power	Electric Power	13,227	6,483
Talcher Super Thermal Power Plant NTPC, Kaniha	Electric Power	1,37,099	52,080
Miscellaneous	---	45,883	16,608
Total		**3,36,445**	**1,70,081**
B) Proposed Industries			
MESCO Iron Steel Ltd. Duburi	1.0 MT, Iron	84,840	40,078
MESCO Kalinga Steel Ltd. Duburi	4.5 MT, Steel	1,93,200	91,268
Bhusan Steel Ltd.	3.0 MT Iron & Steel	2,29,200	1,08,274
Neelachal Steel Ltd.	2.5 MT, Iron & Steel	1,75,200	82,764
Brahmani Steel, Duburi	1.0 MT, Iron & Steel	84,840	40,078
ORIND Steel Ltd.	1.0 MT, Iron & Steel	16,800	7,936
Other Steel Plants	3.0 MT Iron & Steel	2,88,000	1,36,051

Ancillary Industries		45,840	21,655
Kalinga Power	4 x 250 MW	3,36,000	1,58,726
Total		**14,53,920**	**6,86,832**

Water scenario of mining

Talcher coalfield has both the opencast and underground mines and as is well known both the methods of mining severely impact the surface and ground water sources.

Impacts of opencast mines

- The first and second order streams and sometimes the third order streams on the surface are severely affected due to alterations in the surface topography by way of formation of the mine, overburden dumps, soil stacks, and other supporting services of the mines.
- By removing the overlying rock mass the water table and the aquifers lying over the coal beds are cut across and hence get damaged. In many situations it has been noticed that due to this the availability of water from these sources is affected due to draw down up to a distance of about 0.50 to 1.50 km.

Underground mines

- Underground mining of coal seams either with caving or with backfilling causes subsidence movements on the surface, which results in the modification of surface topography. The alterations in the topography affect the nature and flow characteristics of first and second order streams.
- The water table and the aquifers overlying the coal seams get damaged due to subsidence movements because of the disturbance caused in the overlying rock mass. The impacts are more severe in the underground mines planned with caving. In these situation also the water availability from underground sources is affected due to draw down and this affect may be up to a distance of about 1.00km.

Water Balance (in the study area)

Based on the available data, a broad outline of water budget of the study area has been drawn for the year 2007. In addition, water budget for the years 2011, 2016 and 2021 has also been projected as given below.

Figures in million Cu.m

Sl. no		**2007**	**2011**	**2016**	**2021**	**Remarks**
1.	**Input** Rainfall (1111 mm annual) (available as total surface runoff in peak period within the study area)	5589	5589	5589	5589	No change is considered for future years
2.	**Means ofStorage**					
a)	Ground water recharge (includes wells)	1029	1029	1029	1029	No change is considered for future years

Sl. no		2007	2011	2016	2021	Remarks
b)	Retained by ponds and reservoirs in peak season	111	111	111	111	No change is considered for future years
c)	Retained by rivers and drains in peak season	390	390	390	390	No change is considered for future years
	Sub-Total	**1530**	**1530**	**1530**	**1530**	
3.	**Consumers**					
a)	Rural population (from wells) @ 70 LPCD	28.9 (11.30 lakhs)	29.7 (11.64 lakhs)	31.2 (12.22 lakhs)	32.8 (12.83 lakhs)	Considering 1% growth/year
b)	Urban population @ 140 LPCD	9.1 (1.78 lakhs)	10.0 (1.96 lakhs)	11.0 (2.16 lakhs)	12.1 (2.37 lakhs)	Considering 2% growth/year
c)	Livestock: - Cattle & Buffalos – (estimated 10 lakhs) @ 50 LPCD	18.3	18.8	19.7	20.7	Considering 1% growth/year
d)	Other live stock: - pigs, sheep, goats, etc. @ 10% of livestock	1.83	1.88	1.97	2.07	Considering 1% growth/year
e)	Agriculture (irrigation) (2128 sqkm) @ 200 mm per Ha	425	425	425	425	No growth considered
f)	Forests and other vegetation (1825.2 sqkm) @ 400 mm per Ha	730	730	730	730	No growth considered
g)	Industrial use	122	653	653	653	No growth considered after 2011
	Sub-Total	**1335.13**	**1868.38**	**1871.87**	**1875.67**	
4.	**Water Loss**					
a)	Return flow from industries (waste water - 50% of industrial use)	62	313	313	313	Can be utilised by recycling
b)	Runoff into Sea (73%)	4059	4059	4059	4059	Can be tapped for utilisation
	Sub-Total	**4121**	**4372**	**4372**	**4372**	
5.	**Balance (2-3)**	**(+)194.87**	**(-)338.38**	**(-)341.87**	**(-)345.67**	
6.	**Gross Balance: Water loss + Balance (4+5)**	**(+)4315.87**	**(+)4033.62**	**(+)4030.13**	**(+)4026.33**	

Ground water table fluctuation

There was considerable fluctuations in seasonal water table as outlined hereunder.

Pre-monsoon season : 1.74 to 10.92 m
Monsoon season : 0.6 to 8.3 m
Post monsoon seasons: 1.3 to 9.1 m
Winter season : 1.7 to 9.1 m

The variations in water table were due to intensive mining and other activities. The mining area and an area up to a distance of about 1.0 – 1.5 km around mines experienced ground water table depletion due to mining and associated activities.

Surface water quality

The assessment of the quality of water available from surface sources was done by analyzing the water quality parameters of the composite samples for four seasons from 26 locations. Water quality of various rivers, streams and Jhors of the study area was of medium to good category in all four seasons. Derjang reservoir and a few Ponds (Pond water near Manapur, Turang, Kumanda, Kandasaar villages) had bad water quality in post monsoon season by having slightly acidic nature (pH: 5-6), low DO concentration and high coliforms. The quality of pond water of Manapur and Turang villages was bad during summer season due to the presence of coliforms and organic matter.

Pollution of ground water

The assessment of quality of ground water available from different sources was done by analyzing the water quality parameters of composite samples for three seasons from 24 locations. As per annual average of the seasonal water quality index the overall quality of ground water ranged from poor to very good. Out of 24 locations, ground water quality at four locations, namely, Nuasahi open well, Tulsipal open well, Longipeda tube well and Gadrakhai open well was in poor category mainly due to the proximity of the smelter. The data indicates that water available from these sources was conforming to the parameters defined in IS 10,500 except for fluoride concentration, which was on the higher side. At other locations the water quality was in good category.

Floods

The study area has rain fall as the main source of surface water and sometimes due to heavy rains there may some flooding**.** During floods, river Brahmani turns into a large turbulent channel posing potential threat to the life and properties in the basin. The highest flood level in the river was recorded on 20 August, 1975. There is a history of frequent floods in the study area until the development of Rengali Multipurpose Project, which is located to the north of the study area. As per available literature, areas on both sides of Brahmani river are prone to floods. The probable flood zone extends from either banks of Brahmani river to the area covered by the 60 to 70 m RL contour, covering an area of about 261 sq km.

AIR ENVIRONMENT

The exiting status of air quality in the study area and the anticipated air quality in future are as given below.

Existing Air Quality

Ambient air quality monitoring for SPM, RPM, SO_2 and NO_x was done at 51 locations in the study area during summer, post-monsoon and winter seasons as per CPCB guide lines. Fluoride concentration (both in particulate and gaseous forms) was monitored at 9 locations around NALCO Smelter. The Air Quality Index (AQI) with respect to SPM, RPM, SO_2 , NO_x and fluoride revealed the following status.

- The opencast mines, i.e., Lingaraj, Bhubaneswari, Ananta and Jagannath, had moderately polluted status with AQI ranging from 4 to 6.
- Frequent vehicular movement through Dera Chowk, Sharma Chowk and Banerpal Junction was the main reason for moderately pollution status of these areas with the index ranging from 4 to 6.
- Other monitoring locations had low pollution status with index ranging from 1 to 3.
- Grid 73 H/1 had low to moderate air quality status while Grids 73 H/5, 73 G/4, 73 C/16 and 73 D/13 had low pollution status.
- The fluoride concentration in Kuladh and Girang villages was on the higher side as a result of the discharges from NALCO smelter.

In the overall analysis the ambient air quality of the study area was moderately good.

Anticipated Air Quality

The anticipated air quality, with the addition of the proposed thermal power plants and other industries as well opening of new mines and reorganization of the existing mines, was computed with the help of a model. The exercise was carried out to assess the air quality status in the years 2007-08, 2011-12, and 2016-17.

Suspended Particulate Matter		
1	**Existing Status in 2007-08**	The predicted SPM concentration due to operating ***coal mines***, reveal the following: • Maximum concentration zone was confined to Ananta and Jagannath mines. • Ananta OCP (A9) and surrounding locality had SPM concentration from 207 to 311 µg/m^3. • Dera Chowk (A36), Mukundnali village (A50), situated in close vicinity of Ananta and Jagannath mines and Ananta Guest House (A48) had SPM concentration from 103.6 to 207.0 µg/m^3. • In rest of the area SPM concentration was <103 µg/m^3. The predicted SPM concentration due to operating ***thermal power plants/industries*** revealed the following: • NALCO commercial area (A25), Turang village (A29),Khandasar (A28),Kuladh village (A26),Girang village (A27)Gotamara (A24) had maximum SPM concentration of 29.1 to 32.6 µg/m^3. • Banarpal Junction (A38) had SPM concentration of 11.6 to 15.0 µg/m^3. • Rest of the locality had SPM concentration <11.6 µg/m^3. The predicted SPM concentration of ***integrated activities including road***

		traffic, revealed the following: • Ananta mine (A9) registered SPM concentration of 303.5 to 346.7 µg/m^3. • Mukundnali village (A50) and Dera chowk (A36) had maximum concentration 173.8 to 260.0 µg/m^3. • Ananta Guest House (A48) registered SPM concentration of 130.0 to 173.8 µg/m^3. • Kalinga township (A12), situated in close vicinity of Hingula OCP, Talbera village (A44),Ekgharai village (A46), had SPM concentration of 87.0 to 130.6 µg/m^3 whereas Raghunathpur village (A17), Bharatpur colony (A11), and Rakash village (A49) had SPM concentration of 44.0 to 87.0 µg/m^3.
2	**Anticipated Status in 2011-12**	The predicted SPM concentration due to operating ***coal mines***, revealed that the maximum SPM profile (776 to 876 µg/m^3) will shift to Chendipada, Utkal and Gopalprasad villages and surrounding areas as the proposed mines are expected to come in these areas. There will be some reduction in SPM concentration in 2011-12 compared to the present situation, i.e., 2007-08 even when the number of mines as well as production levels will increase. This can be attributed to an increase in the aerial extent of the new mines. The predicted SPM concentration due to ***operating thermal power plants/industries***, revealed the following: • Dera chawk (A36) will have maximum SPM concentration of 26.03 to 30.1 µg/m^3. • Kuladh village (A26) and Girang village (A27) will have SPM concentration of 22.0 to 26.1 µg/m^3. • NALCO commercial area (A25), Gotamara (A24), Banarpal junction (A38),Bonda village (A30) will have maximum concentration in 18.0 to 22.0 µg/m^3. • Rest of the locality will have SPM concentration <17.97 µg/m^3. The predicted SPM concentration due to ***integrated activities including road traffic***, revealed the following: • Ananta Guest House (A48),Kalimga Township (A12),Raghunathpur village (A17),Gopal Prasad village (A14),Rakash village (A49),Turang village (A29),Mukundnali village (A50),Dera Chawk (A36) will have maximum concentration 60.3 to 80.0 µg/m^3. • Rest of the locality will have SPM concentration < 60.3 µg/m^3.
3	**Anticipated Status in 2016-17**	The predicted SPM concentration due to ***operating coal mines***, revealed the following: • Maximum SPM profile (708 to 796 µg/m^3) will shift to Chendipada, Utkal and Gopalprasad villages and surrounding areas as new proposed mines are expected to come to their vicinity. • Chendipada (A13) will have maximum SPM concentration of 354 to 442 µg/m^3

		• Raghunathpur village (A17) will have maximum SPM concentration of 88 to 177 µg/m^3. • Rest of the area will have SPM concentration < 88 µg/m^3. The predicted SPM concentration due to operating ***thermal power plants/industries*** in 2016-17 will be same to that of 2011-12 as number of thermal power plants as well as SPM emission will remain the same. The predicted SPM concentration of **integrated activities including road traffic**, revealed the following: • Chendipada (A13) will have the maximum SPM concentration of 441 to 496 µg/m^3. • Raghunathpur village (A17) will have the maximum SPM concentration of 111.0 to 166.0 µg/m^3. • Gopal Prasad village (A14), Utkal village (A15), Dera Chawk (A36) and most of the other localities will have the maximum SPM concentration of 56.0 to 111.0 µg/m^3.
Oxides of nitrogen (NOx)		
1	**Existing Status 2007-08**	The predicted NOx concentration due to existing ***thermal power plants/industries*** revealed the following: • The entire study area had NO_x concentration < the permissible limit of 80 µg/m^3. • Gotamara village (A24) had NOx concentration of 17.9 to 21.3 µg/m^3. • Banarpal junction (A38), NALCO commercial area (A25), Kuladh village (A26), Girang village (A27) had NOx concentration of 14.6 to 17.9 µg/m^3. • Karadih village (A1) and NTPC Kaniha-CISF camp (A2), NTPC Kaniha main gate (A3), Executive engineer office near Samal barrage (A6) had NOx concentration of 11.3 to 14.6 µg/m^3. • Kalinga Township (A12), Ananta Guest House (A48), Ananta OCP(A9), Raghunathpur village (A17), Bhubaneswari mines (A8), Dera Chawk (A8), Mukundnali (A50), Rakash village (A49), and Talbera (A44) had maximum NOx concentration of 8.0 to 11.0 µg/m^3. • Rest of the locality had NOx concentration < 11.0 µg/m^3. The predicted NOx concentration of ***integrated activities including road traffic*** revealed the following: • Gotamara village (A24), Banarpal junction (A38) and Bonda village (A30) had maximum NOx concentration within 15.0 to 17.0 µg/m^3. • Kuladh village (A26), Girang village (A27), Tentuli village (A19) and NALCO commercial area (A25) had NOx concentration within 11.5 to 13.5 µg/m^3.

		• Karadih village (A1), NTPC Kaniha-CISF camp (A2), NTPC Kaniha main gate (A3), Executive Engineer Office near Samal Barrage (A6), and Ekgharia village (A46) had maximum NOx concentration within 9.4 to 11.5 µg/m^3. • Rest of the locality had NOx concentration < 9.4 µg/m^3.
2	**Anticipated Status in 2011-12**	The predicted NOx concentration due to ***thermal power plants/industries*** (2011-12 as well as 2016-17), revealed the following: • Takua village (A4), Vikashnagar (A 47), and Turang village (A29) will have maximum NOx concentration of 34.0 to 40.0. • Tentuli village (A19), Lingraj OCP (A7), Sharma Chawk (A35), Talcher Guest House (A20), Jagannathpur village (A22), Bhubaneswari mines (A8), Angul Township (A32), Notified area council (A33), Bonda village (A30) and Fire station (A37) will have maximum NOx concentration of 28.1 to 34.0 µg/m^3. • Donnara village (A16), Raghunathpur village (A17), Ananta Guest House (A48), Ananta OCP (A9), Bharatpur village (A11), Mukundnali village (A50), Rakash village (A49), Dera Chawk (A36) and Talbera village (A44) will have maximum NOx concentration of 22.2 to 28.1. • Rest of the locality had NOx concentration < 22.2 µg/m^3. The predicted NOx concentration of ***integrated activities including road traffic*** reveal the following: • Banarpal junction (A38) will have maximum NOx concentration of 41.6 to 46.2 µg/m^3. • Kuladh village (A26), Girang village (A27), Vikashnagar (A47), RSPCB office (A31), Angul Township (A32), Notified area council (A33), Khandasar (A28), NALCO commercial area (A25), and Turng village (A29) will have maximum concentration of 32.3 to 37.0 µg/m^3. • Tentoi village (A19), Bhubaneswari mines (A8), Sharma Chawk (A35), Talcher Guest House (A20) and Jagannathpur village (A22) will have maximum NOx concentration of 27.7 to 32.3 µg/m^3. • Rest of the locality had NOx concentration < 22.16 µg/m^3.
3	**Anticipated Status in 2016-17**	All the proposed ***thermal power plants*** will be commissioned by 2011-12. Therefore there will be practically no addition of NOx to the ambient air pollution load. The status (due to thermal power plants) can be expected to be the same as that in 2011-12. The anticipated NOx profile for ***integrated activities including road traffic*** revealed the following: • Banarpal junction (A38) will have maximum NOx concentration of 41.6 to 46.2 µg/m^3. • Kuladh village (A26), Girang village (A27),Vikashnagar (A47), RSPCB office (A31), Angul Township (A32), Notified area council (A33), Khandasar (A28), NALCO commercial area (A25), and Turng village (A29) will have maximum concentration of 32.3 to 37.0 µg/m^3. • Tentoi village (A19), Bhubaneswari mines (A8), Sharma Chawk

		(A35), Talcher Guest House (A20) and Jagannathpur village (A22) will have maximum NOx concentration of 27.7 to 32.3 µg/m^3. • Rest of the locality had NOx concentration < 22.16 µg/m^3.
Sulfur-di-oxide (SO_2)		
1	**Existing Status in 2007-08**	The predicted SO_2 concentration due to ***thermal power plants/industries*** revealed the following. • The entire study area had SO_2 concentration less than the permissible limit of 80 µg/m^3. • Banarpal junction (A38), Dera Chawk (A36) and Gotamara (A24) will have maximum SO_2 concentration of 40.0 to 52.0 µg/m^3. • Kalinga Township (A12), Donnara village (A16), Lingraj OCP (A7), Talcher Guest House (A20), Talcher Residential area (A21), Tentuli village (A19) and NALCO Commercial area (A25) will have maximum SO_2 concentration of 27.8 to 40.0 µg/m^3. • Bonda village (A30), RSPCB office (A31) and Angul Township (A32), Notified Area Council (A33), Vikashnagar (A47), Fire station (A37), Kuladh village (A27), Girang village (A26), Gopal prasad village (A14), Donnara village (A16), Kalamchui village (A45), Raghunathpur village (A17), Ananta Guest House (A48), Rakash village (A49) and Ananta OCP (A9) will have maximum SO_2 concentration of 15.7 to 27.8 µg/m^3. • Rest of the locality SO_2 had concentration < 0.65 µg/m^3. The predicted SO_2 concentration of ***integrated activities including road traffic*** revealed the following: • NTPC Kaniha main gate (A3) and Executive engineering office near Samal barrage (A6), NTPC Kaniha-CISF camp (A2), Karadih village (A1) and Ekgharia village (A46) will have maximum SO_2 concentration within 38.5 to 44.4 µg/m^3. • Tentuli (A19) will have maximum SO_2 concentration within 32.7 to 38.6 µg/m^3. • Ananta OCP (A9), Rakash village (A49), Ananta Guest House (A48), and Raghunathpur village (A17) will have maximum SO_2 concentration within 21.0 to 26.0 µg/m^3. • Sharma Chawk (A35), Talcher Guest House (A20) and Bhubaneswari mines (A8)) will have maximum SO_2 concentration within 26.0 to 32.0 µg/m^3. • Rest of the locality SO_2 had concentration < 26 µg/m^3.
2	**Anticipated Status in 2011-12**	The SO_2 concentration due to ***thermal power plants/industries*** (2011-12 as well as 2016-17), revealed the following: • Takua village (A4), RSPCB office (A31) and Angul Township (A32), Notified Area Council (A33), Bonda village (A30), Vikashnagar (A47),NALCO commercial area (A25), Kuladh village (A26) and Girang village (A27), Banarpal junction (A38) and Fire station (A37) will have maximum SO_2 concentration of 125 to 142 µg/m^3. • Tentuli village (A19), Lingraj OCP (A7), Bhubaneswari (A8),

		Dera Chawk (A35),Talcher Gust House (A20) and Jagannathpur village (A22) will have NOx concentration of 108 to 125 µg/m^3. • Rest of the locality will have SO_2 concentration < 108 µg/m^3. The predicted SO_2 concentration of ***integrated activities including road traffic*** revealed the following: • Dera Chawk will have maximum SO_2 concentration of 148.3 to 164.7 µg/m^3. • Gotamara village (A24),), RSPCB office (A31) and Angul Township (A32), Notified Area Council (A33), Bonda village (A30), Chargaria village (A42), Fire Station (A37), Turang village (A29), NALCO Township (A23), Khandasar (A28) and District library (A34) will have maximum SO_2 concentration of 132.0 to 148.3 µg/m^3. • Takua village (A4), Girang village (A27), Kuladh village (A26) and Khandasar village (A28) will have maximum SO_2 concentration of 115.0 to 132.0 µg/m^3. • Rest of the locality will have SO_2 concentration <115.0 µg/m^3.
	Anticipated Status in 2016-17	As per the information available all the proposed ***thermal power plants*** will installed and commissioned by 2011-12. Therefore, there will be practically no addition of SO_2 to the ambient air pollution load. The status can be expected to be the same as that in 2011-12. In similar manner, the SO_2 profile for ***integrated activities including road traffic*** will be same to that of 2011-12. This is because all the power plants will be commissioned by 2011-12. As such, there will not be any additional SO_2 emission. There will be an increase in number of operating mines and frequency of vehicles plying over the roads. But these activities will have almost negligible contribution to overall SO_2 load.

NOISE ENVIRONMENT

The status of the existing noise environment in different types of locations in the study area was as given below. It may be mentioned here that the overall noise situation in general was within the permissible norms.

Industrial Area: The average Leq levels in the six industrial areas, namely, Kaniha STPP surrounding area, Jagannath OCP locality, Ananta locality, TTPS surrounding area, CPP NALCO surrounding area and NALCO Smelter surrounding area were within the range of 62.3 to 65.7 dB(A) during day time and 51.5 to 55.5 dB(A) during night time respectively. As such, both the day and night time noise levels (Leq) were within permissible norms of 75 and 70 dB(A) respectively. The average background levels, i.e., L_{90} were within the range of 52.1 to 57.9 and 44.2 to 49.4 dB(A) for day and night time respectively.

Commercial Area: The average Leq levels in different commercial areas (Dera Chowk, Sharma Chowk, Angul District Library locality, NALCO commercial area, Banerpal Junction and Angul Town junction point) were within the range of 49.3 to 62.3 dB(A) during day and 42.3 to 53.1 dB(A) during night time. Both day time and night time Leq levels were within the permissible standard of 65 and 55 dB(A) respectively. The average background levels, i.e., L_{90} were within the range of 44.1 to 55.1 and 39.1 to 47.8 dB(A) for day and night time respectively.

Residential Areas: The average Leq levels for all the residential areas were in the range of 47.1 to 53.9 dB(A) during day time and 40.5 to 46.6 dB(A) during night time respectively. Both day time and night time Leq levels were more or less within the norms of 55 and 45 dB(A) respectively. The average background levels, i.e., L_{90} were within the range of 40.3 to 48.9 and 37.1 to 44.5 dB(A) for day and night time respectively.

Sensitive Area: The average Leq levels for all the sensitive areas were in the range of 42.9 to 62.9 dB(A) during day time and 40.1 to 48.3 dB(A) during night time respectively. Both Leq, day [62.9 dB (A)] and Leq, night [48.3 dB(A)] at SDM Court locality were exceeding the norms of 50 and 40 dB(A) respectively. Similarly Leq levels of both day and night time at Angul Govt. Hospital, Central Hospital, Govt. College, Angul were slightly more than the permissible standards. The average background levels were within the range of 39.2 to 53.2 and 37.1 to 42.3 dB(A) for day and night time respectively.

The proposed industrialization and developments may increase the noise situation manifolds unless suitable control measures are not taken.

OVERALL ENVIRONMENTAL EVALUATION

The existing environmental status as well as that anticipated in 2011-12 and 2016-17 were indexed using BEES methodology. The assessed indices are given below. It can be noted that even with the protection measures the overall environmental quality will deteriorate. For taking care of the overall environmental status measures have been suggested in the recommendations.

(Total weightage = 1,000)

Parameters	**Assigned Importance (PIU)**	**(2007-08) (EIU)**	**After proposed development**	
			EIU 2011-12	**EIU 2016-17**
Ecology	**200**	140	110	105
Environmental Pollution	**450**	360	285	265
Aesthetics	**100**	75	65	60
Human Interest	**250**	130	170	200
Total	**1,000**	**705**	**630**	**630**

RECOMMENDATIONS

The studies indicated that for maintaining proper environmental status in the area with the existing industrial activities as well as the activities planned to be developed in near future certain mitigative measures will be required to be taken. The steps required to be taken with respect to various components of environment are recommended in brief hereunder.

MINING		
1	Optimization of land requirement for mining and its associated activities in opencast and underground mines	*Opencast mines* • Design of optimum pit slopes taking characteristics of the overlying rock mass into consideration • Design of mines with concurrent reclamation • Design of external soil stacks and overburden dumps with least possible land requirement • Selection of land for associated activities in such a manner that there is least possible impact on land use *Underground mines* • Optimisation of land requirement for the development of surface infrastructure around shafts, inclines and other entries • Anticipate subsidence movements and incorporate subsidence management measures • Measures for continued use of land even when subsidence is taking place
2	Overall mine planning for underground and opencast mines	• The *underground* mines should be planned for minimum possible impacts on the environmental components on the surface by optimizing subsidence movements and their impacts. • The running and closure of the *underground* mines should be effectively directed towards continued use of land for the purposes/economic activities all the times. • At the time of closure of underground mines care should be taken that the resources required for the uses are adequately developed and that there are no chances of any risks/hazards related with mining activities. • As far as possible the opencast mines should be planned with concurrent reclamation. In the situations where it is not possible the mines should be planned for post mining reclamation. *In fact no opencast mine should be planned without reclamation.* • The surface topography for reclamation in the opencast mines should be planned taking into consideration the quantum of overburden and soils available and the intended uses of land. • While undertaking reclamation care should be taken to develop the resources which are required for the success of desired land uses after reclamation. Also it should be ensured that there are no chances of any risks/hazards for the population living in the area during and after mining.

3	Removal of flora from the area designated for mining and associated activities and development of a flora bank	• In the opencast mines it is necessary to remove all flora from the area designated for use of mining and associated activities before the removal of soils. • The typical flora of the areas should be preserved in flora banks and, if feasible, the trees, etc. to be removed should be re-planted in suitable areas.
4	Removal, management and preservation of soils	• The top soil and sub soil should be removed and stacked separately • The soils should be removed by dozing and should not be blasted • In the formation of soil stacks and preservation of the characteristics of the soils the guidelines should be properly followed • Before relaying the soils in the process of reclamation suitable amendments to improve the nutrition status should be taken
5	Management of overburden rock mass	• The design of dumps should be made to ensure safety against failure while taking into account the characteristics of the rock mass • The overlying rock mass having potential for creating mine fires and acid mine drainage should be selectively removed and handled. These rocks should be suitably placed in the central portion along the bottom. The rocks having potential for acid mine drainage should be treated with lime powder • In the mines designed with concurrent reclamation only the minimum possible quantity of the overburden should be stored outside the mine
6	Management of noise and vibrations due to blasting in opencast mines including fly rocks, air over pressure, etc.	• For the management of the impacts of blasting standard practices along with the parameters designed on the basis of the trials of blasting in the mine should be followed
7	Management of rock mass having potential for the development of mine fires and acid mine drainage	• The overlying rock mass having potential for creating mine fires and acid mine drainage should be selectively removed and handled. These rocks should be suitably placed in the central portion along the bottom. The rocks having potential for acid mine drainage should be treated with lime powder
8	Management of	• In the coal mining areas the surface and ground water regime

	water resources including steps required for augmentation of water availability	is damaged leading to decrease in the water availability in and around the mine. The water from the underground sources finds way into the mines and this is pumped out of the mines. This should be suitably treated for use on the surface. • During reclamation planning of the opencast mines provisions should be made for the formation of surface and, if feasible, underground water bodies for augmenting the water quantity. • The subsided areas can also be used for the formation of surface water bodies.
9	Reclamation and rehabilitation of land disturbed by underground mining	• In the underground mines the subsided surface areas should be suitably reclaimed by designing proper drainage and controlling the soil erosion for various uses. The subsided land can be used for agriculture, formation of water bodies, constructions, etc. with suitable amendments.
10	Reclamation and rehabilitation of land disturbed by opencast mining	• Reclamation planning of the mined out opencasted areas involves the design of surface based on the availability of overburden rock mass and anticipated post mining use. Invariably the reclaimed areas are used in agriculture with proper provisions for drainage and control of soil erosion. The land can also be used for other purpose, e.g., building construction, development of surface water bodies, etc.
11	Post mining land use assessment and development of resources for these uses	• Invariably the post use of reclaimed land is agriculture, plantation and afforestation. In most situation surface water bodies can also be developed. The surface resources required for these end uses are basically fertile soils and water with precautions for controlling the soil erosion.
WATER MANAGEMENT		
1	Assessment of water requirement for the mines, industries, household activities, commercial activities, agriculture, etc.	• Assess the quality and quantity of water required for the current activities and those planned in future. • Water being an important resource all care should be taken in optimizing the requirements of various components of the mines and industries. • There should be, as far as practicable, a provision for recycling of water/effluents in all the activities.
2	Identification of sources of water and assessment of	• Assess the availability of water and it's quality in different seasons from all the sources, both underground and surface.

	availability from these sources	• The assessment should also include the availability of water from rains and measures taken for rain water harvesting.
3	Development of water resources in the process of underground and opencast mining, rain water harvesting and water shed management	• It is well known that both opencast and underground mining damage the surface as well underground water sources. This causes a marked reduction in the water availability. To take care of such impacts both the underground and opencast mines should be planned with the provisions of development of surface and underground water bodies. • In all the developmental and industrial activities taking place presently in the area an assessment should be made for the development of rain water harvesting. • All new mining, industrial and other developmental activities should be planned with rain water harvesting as an integral part. • To augment the water availability on the surface efforts should be made for developing small and medium size surface water bodies utilising the water shed of various streams in the area.
4	Effluent management from mines, industries, commercial activities, agriculture, households, etc.	• The effluents being discharged from various activities should be treated according to the characteristics and the requirements in the nature of uses after treatment. • Wherever possible the use of water in the activities should in the form of closed circuit with treatment as required. • Before discharging the effluents in to the surface water bodies and on the soils the impacts of such discharges on the quality of the sinks should be assessed and only in the cases where the impacts are not harmful the discharge should be planned.
5	Water treatment for household and other uses	• The most important part of water management in the industrial areas is meeting the requirements of quality and quantity of water to the household for human consumption. Hence, this aspect should be given proper attention. On an average the domestic water availability should be 120-150 litre/head/day. • To the extent possible the domestic effluents should also be recycled.
6	Treatment and management of waters/effluents containing fluoride	• The water containing fluoride available from various surface and underground sources as well as the fluoride containing effluents should be adequately treated. • Time to time the efficacy of the fluoride treatment system should be assessed for its effectiveness.
7	Management of water logging and floods	• The mining and industrial planning should be assessed for the changes in the surface topography due to which the area may become prone to water logging and floods from internal and external sources.
8	Water balance	• An exercise of water balancing should be undertaken on yearly basis. Hence, provision should be made for this purpose in the planning of all the mining, industrial and developmental activities.

LAND USE MANAGEMENT		
1	Existing land use and the impacts of the current activities on the land use	• The current status of land use in the area under consideration and from this the impacts that have taken place from the existing activities should be assessed. • The measures being taken for mitigating the impacts and their efficacy should be assessed. Wherever necessary, precautionary/remedial/management measures should be refined/re-planned.
2	Land use changes anticipated as a result of the current activities	• The mining, industrial and developmental activities that are taking place in the area should be assessed for their impacts on land use in future. • Wherever necessary, the impacts should be minimised and also should be mitigated by incorporating suitable measures in the planning of the activities.
3	Identification of the area's most suitable for the development of future industries	Based on the existing land-use/ land-cover of the area, the following areas are being suggested for industrial development in near future. 1) Grid number H-1 (south-east corner): to the south of Banarpal (south of NH-42); and to north of Nigra/ Lingara nadi, south of Khaliberana village. 2) Grid number H-5 (south-west corner): around Meramundali (west and south of NH-42), between Brahmani river and NH-42; North of Brahmani river to south of Kumasi village; North of Brahmani river and south and west of Bhirenia village; and More broadly on either side of Brahmani river preferably to the south. 3) Grid number H-6 (north-west corner): north of Sanamunda village. 4) Barren and unused land lying on either side of NH-42 in Grid number H-1 and H-5. 5) Other available barren lands
4	Anticipated impacts on land use due to future activities	• The locations suitable for establishment of the planned activities from the standpoint of overall environmental management in future have been identified as given above. • In addition to the impacts of the current activities the land in the study areas will be impacted in future due to opening of new mines, augmentation of coal production from the existing mines, establishment of the thermal power plants and other industrial activities, and increase in the population. • Suitable mitigation and management measures should be incorporated in planning of the activities for taking care of the impacts on the land.

5	Post mining and during mining land use management including subsidence management and reclamation of mined out areas	• The underground mines, both the existing ones and those planned for future, should have measures for the management of subsidence movements and their impacts in the mine plans. These measures should address the needs of taking care of the dangers of the impacts on the underground workings; undesirable changes in the surface topography; damage to surface, sub-surface and underground properties; etc. • As stated earlier no opencast mine should be planned without proper reclamation of the mined out areas and also the areas where it becomes necessary due to impacts of other activities. • As far as possible the opencast mines should be planned with concurrent reclamation. • The design of the surface topography to be obtained after reclamation should be designed for the intended land uses during and after the closure of the mines. • The reclamation planning should also take care of drainage pattern of the area as well as minimization of erosion potential.
6	Soil management	• Top soil and sub-soils are important natural sources. Hence, adequate provisions should be made in the planning of the mines and other industrial and developmental activities for preservation and management of these soils.
7	Design of surface topography in mines	• The quantum of solids and soils available in the opencast mines for reclamation are seldom adequate for restoring the surface topography. Hence, in almost all the situation it becomes necessary to re-design surface topography. • While designing care should be taken to ensure the following aspects. 1. The designed surface topography should merge with the surrounding topography. 2. There should not be any chance of undesired water logging or flooding from nearby sources. 3. The drainage should carefully designed for minimizing the erosion potential. 4. Special attention should be given to the management of rock masses capable of causing problems of mine fires and acid mine drainage. 5. The surface topography should be suitable for intended land uses at different stages.

AIR QUALITY MANAGEMENT		
1	Current air quality management measures and their efficacy in mines and industries	• The analysis of three season data revealed the following. 1. The area in and around the opencast mines had moderately polluted status. 2. Frequent vehicular movement through Dera Chowk, Sharma Chowk and Banerpal Junction was the main reason for moderately polluted status of these areas. 3. Other monitoring locations had low pollution status. 4. The area in grid 73 H/1 registered low to moderate air quality status while that in grids 73 H/5, 73 G/4, 73 C/16 and 73 D/13 had low pollution status. The management measures currently being taken in the mines and industries are more or less adequate.
3	Control of SO_2 from thermal power plants, both existing and planned for future	***Current status*** The entire study area had SO_2 concentration less than the permissible limit of 80 µg/m^3. ***Anticipated future status (2011-12 and 2016-17)*** • Dera Chowk will have maximum SO_2 concentration in the range of 148.3 to 164.7 µg/m^3. • Gotamara village (A24),), RSPCB office (A31) and Angul Township (A32), Notified Area Council (A33), Bonda village (A30), Chargaria village (A42), Fire Station (A37), Turang village (A29), NALCO Township (A23), Khandasar (A28) and District library (A34) will have maximum SO_2 concentration between 132.0 and 148.3 µg/m^3. • Takua village (A4), Girang village (A27), Kuladh village (A26) and Khandasar village (A28) will have maximum SO_2 concentration of 115.0 to 132.0 µg/m^3. • The remaining areas will have SO_2 levels within the permissible limit. In view of the above it will be necessary to incorporate measures for cleaning of flue gases from thermal power plants to maintain the concentration of SO_2 within the permissible range. The new thermal power plants should be designed accordingly. Domestic and local uses of coal should be minimized and efforts should be made for using clean fuels, e.g., LPG, etc.
4	Fluoride management in the air quality related to NALCO smelter	• Kuladh and Girang villages near NALCO Smelter registered high fluoride concentrations in both particulate and gaseous forms. The problem should be investigated in details and based on the findings measures for control should be adopted.

5	Control of air pollution anticipated due to enhancement of the number of vehicles plying on the roads in the study area	• The increase in density of vehicular movement on the road network in the study area can be expected to increase the pollution level significantly. This can be controlled by improving the condition of the roads as well as by proper maintenance of the vehicles, especially diesel driven heavy vehicles.
6	Road and industrial noise management	• Presently noise pollution along the roads and in the industrial areas was within permissible limits. The proposed industrialization and developments can be expected to increase vehicular traffic manifolds. This will further stress the noise environment. The following measures will be required to be taken. • Adaptation of industry/ activity specific noise control measures. • Controlling the noise situation along roads in locations close to sensitive areas by erecting suitably designed measures including erection of barriers, etc.
7	Green belt development for arresting air borne dust and attenuation of noise	The development of green belts (with suitable species and width), wherever feasible around the pollution causing sources as well as the residential locations can be expected to help in air and noise pollution control and management
SOLID WASTE MANAGEMENT		
1	Minimisation of fly ash generation	• The coals having higher ash content then the requirements of the boilers of thermal power plants should be properly treated/ washed/ cleaned/ blended to lower the ash content. • The middlings and tailings produced in the processes of coal beneficiation should be effectively used in fluidised bed plants and the solid wastes generated from these sources should be used in reclamation of the mined out areas.
2	Use of ashes in reclamation of opencast mines and for backfilling of underground cavities	• The ashes generated in the thermal power plants should be used for the reclamation of the opencast mines. • The ashes can also be used for backfilling and stowing of underground mine workings.
3	Use of fly ash in the reclamation of subsided land	• In some situations it becomes necessary to reclaim the areas which have experienced subsidence. Fly ash as it is and also blended with other solids/soils can be used in this reclamation.

5	Use of fly ash in road and embankment construction	• Fly ash and bottom ash have been effectively used in the construction of roads and embankments. Such uses should be encouraged.
6	Use of fly ash in manufacture of cement, bricks, and tiles	• Fly ash and bottom ash can also be used for the manufacture of cement, bricks, tiles, etc.
7	Use of fly ash in agriculture and amendment of soils	• The top soils in the agricultural areas can be amended with the use of fly ash. Some experiments done in the country have yielded encouraging results.
8	Overburden management in backfilling of the mined out areas and reclamation	• The overburden rock mass in the opencast mines should be treated as a resource as it can be used in the reclamation of these mines. The reclamation planning should take into consideration the characteristics of the available rock mass.
9	Management of solid wastes from industries other than mines and thermal power plants	• The solid wastes available from the industries should be used in reclamation, road making, etc. depending on their characteristics.
10	Management of municipal solid wastes	• The usual practices for the management of domestic solid wastes of land fill, value addition by segregating and planning for obtaining the useful components should be planned.
11	Management of hazardous wastes	• The directives contained in the relevant legislation should be followed for the management of hazardous wastes.
SOCIO-ECONOMIC DEVELOPMENT MANAGEMENT		
1	Population management	• In the industrial areas the management of population is an important measure for the overall improvement in the quality of life. An account of the increase in the population of the area as per the installation of the new industrial units should be developed.
2	Development of social infrastructure	• The social infrastructure, i.e., housing, water supply, electricity, sanitation, roads, communication, marketing, etc., should be planned taking into consideration the expected increase in the population with provisions for accommodating the annual increase.
3	Development of educational, medical	• As with social infrastructure, the educational, medical and health care facilities should also be developed for taking

	and health care facilities	care of the anticipated population.
4	Development of income generating activities	• The study area may have income generation schemes under various Central and State Governments initiatives, which invariably are not adequate. Therefore, it is necessary to plan for income generation schemes in the areas based on the local resources, skills of the people, and their emotional, mental and physical needs. These programs should be designed for affecting an improvement in the quality-of-life of the families.
5	Measures for the benefit of the community at large	• The community facilities, i.e., clubs, market places, cinema, water treatment plants, sewerage treatment plants, etc. should be developed for the anticipated population with due regards to their needs.
6	Development of community resources other than the minerals	• The development of community resources, i.e., reclaimed land, surface and underground water bodies, agricultural development, irrigation facilities, etc. should be realistically planned to meet the requirement of the anticipated population.
7	Rehabilitation and resettlement of project affected families (PAFs)	• Special attention should be given to the development and implementation of the rehabilitation and resettlement packages for the PAFs. The package should be aimed at to treat the PAFs with dignity and honour and meeting their needs. The development of the package and its implementation should be done with active participation of the PAFs.
8	Quality of life based societal development planning	• The overall societal development of the industrial and surrounding areas should be planned for improving the quality of life of the families commensurate with the increase in the level of the economic activities due to establishment of the industries.
9	Societal implications of mine closure as well as closure of other industries	• It is generally anticipated that when an industry/mine is closed the in any area the population of the area decreases drastically and only the people dependent on the other resources in these areas remain. Therefore, for the long term planning due attention should be given to societal implications of the closure of the mines and industries.

ECOLOGICAL MANAGEMENT		
1	Conservation of flora by way of developing *flora banks* as well as re-plantation	• The typical flora should be suitably preserved. This can be done by replanting the species in the areas for the development of green belts, plantation, forestry, etc. In addition flora banks can be developed for preserving the species so that later on after reclamation of the mining areas these can be used for improving the ecological status.
2	Compensatory afforestation for the forest land diverted for non-forest uses	• The work of compensatory afforestation either on new or degraded forest land should be aimed at the development of flora akin to the forests so that when fully developed the fauna may find it suitable for their habitat.
3	Development of green belts	• For improving the aesthetics of the surrounding areas of the mines and the industries it is appropriate to develop green belts of adequate widths with suitable species range. The width of these belts should be about 50 m and in no case less than 30 m.
4	Development of existing forests	• The denudation and encroachment of the existing forest areas in and around the mines and industries should not be allowed. All efforts should be made to protect the forests and the forest authorities should be consulted for improving the status of the forests.
5	Reclamation of forest land damaged due to mining and associated activities	• The forest land damaged due to mining and other industries should be properly reclaimed so that efforts can be taken for the development of real forests on this land.
6	Conservation of prime agricultural land	• In no situation the prime agricultural land should be diverted for other purposes. In the situations, where it becomes essential efforts should be made to reclaim this land properly to restart agricultural activities with improved land status.
7	Minimization of impacts of noise, vibration, air and water pollution on fauna	• The impacts of noise and air pollution on the flora and fauna can only be minimized by minimizing the generation of the pollutants in the mining and industrial activities.
8	Care and management	• The various provisions concerning the care and

	of endangered species of flora and fauna, if any	management of flora and fauna in The Wild Life Protection Act should be suitably used.
9	Rehabilitation and resettlement of tribal people	• Special attention should be given to the development and implementation of the rehabilitation and resettlement packages for the PAFs, specially the tribal people. The package should be aimed at to treat the PAFs with dignity and honour and meeting their needs. The development of the package and its implementation should be done with active participation of the PAFs. The typical character of the tribes and their culture should be duly preserved.

ENVIRONMENTAL QUALITY MONITORING PROGRAMME

The environmental quality assessment given earlier indicates that although the present environmental status is satisfactory and it is expected to remain the same with the suggested measures. The overall efforts in the area should be to improve the environmental status as much as possible. The efficacy of the management measures for various components of environment will need careful monitoring to assess the effects of the measures as well as for taking corrective measures. The suggested environmental quality monitoring program for the study area is as given below.

Areas/Components	Monitoring
1. Ecology	• Status of compensatory afforestation in the forest land and also in the non-forest land • Development of green belts • Status and development of flora bank • Status and care measures for endangered species • Tribal welfare measures • Measures for the protection for terrestrial and aquatic fauna
2. Environmental Pollution	• Land use changes • Land capacity assessment for agriculture and afforestation • Soil management • Reclamation of land areas affected by mining and industrial activities • Management of solid wastes including fly-ash and bottom-ash • Management of hazardous and bio-medical wastes • Water quality monitoring • Water treatment efficacy

	• Water balance • Efforts for augmentation of water availability • Development of surface and underground water bodies in the mining areas • Industrial and mining effluent management • Sewerage and domestic effluent management • Ambient air quality monitoring • Assessment of efficacy of air pollution control measures for SPM, RPM, SO_2, NO_x and fluoride. • Efficacy of noise control measures, especially due to road traffic.
3. Aesthetics	• Design and development of surface topography • Reclamation planning to merge with the surrounding and to take care of water logging and surface drainage • Rehabilitation of reclaimed and other categories of land affected by the mining and industrial activities • Design and planning of surface layouts for the mining and industrial activities and their supporting services and colonies • Avenue plantation • Development of agricultural land
4. Human Interest	• Management of population dynamics • Discharge of Corporate Social Responsibility • Rehabilitation and resettlement of Project Affected Families with adequate improvements in their quality-of-life • Development of educational and medical facilities • Development of civic and infrastructure facilities • Care of the families of tribal people and also the families living below poverty limit