

CHAPTER 4 ENVIRONMENTAL IMPACTS

4.1 Introduction

This section identifies and predicts the probable impacts on different environmental parameters due to construction and operation of the proposed plant. After studying the existing baseline environmental scenario, monitoring environmental parameters, reviewing the process and related statutory norms, detailing the waste management measures, the major impacts can be identified during construction and operation phase.

4.2 Impact during Construction Phase

Construction Phase Activities

Construction phase starts from taking possession of the site. The work in this phase consists of sites clearing, land development, building of infra-structural facilities and all construction work till commissioning. Duration of this phase is dependent on many factors such as finance, size of the project, location and infrastructural support etc.

The total construction of the plant will take about 33 months.

Possession of Land and Displacement

The possession of land is the first major step in the project construction. This may cause acquiring people's land, displacing people from their residences and livelihood. This remains always a major impact for any large project.

The proposed project will be acquiring 990 acres of land out of which 79% of the land is private land. XIMB, Bhubaneswar is conducting the socio-economic study for the project. They are now involved in preparing the R & R plan for Project Affected People based on Government of Orissa's R & R policy. As homestead land in the identified land is negligible, there is no major displacement and

resettlement work. The exact quantum of resettlement will be known after the report on Socio-economic study. Exact number of persons to whom jobs have to be provided will be known after the report on Socio-economic study. The report is expected to be ready by 30th September, 2007 which will be submitted to Collector

However as described previously in **Chapter 3** that the land in this area is not good for agriculture and there is only one crop can be cultivated. Due to that agriculture is not the major livelihood of this area. A portion of the project land is being used for brick kiln and a part of the land is wasteland. So if proper compensation and rehabilitation is provided, the impact will not be significant.

Land use and Physiography

Land was in use for agriculture, brick kiln and for pasture. So the use of this land for constructing a power plant will have some impact on these present uses. There will be some impact on loss of pasture land for the local cattle. However with more industrialisation, this will be less significant in coming days. The new development will also have impact on local physiography changing the land topography.

Site Development

The site does not have significant vegetation or any ecologically sensitive area. So the clearance will not have any significant impact on the ecology. There will be requirement site gradation, some elevation at places etc. Runoff from the construction site is expected to be a source of water pollution. Such pollution may persist during the initial phase of construction period when site grading and excavation for foundation and back filling will be in progress. During this stage the rainwater runoff will carry more soil/silt than normal and this may cause silting problem in the receiving water bodies.

Civil & Structural Work

This work can be divided into two groups, foundation work and super-structural work. Certain foundation work may involve pile-driving rigs etc. These activities may generate noise pollution. Besides, foundation work will involve trench cutting, digging and concreting work. Dust pollution, especially during dry season, may cause problem. The super-structural work will involve steel and concrete work, masonry work etc. and will involve use of equipment like hoists, cranes, mixers, welding sets etc. There may be dust, noise and gaseous pollution from this work. Concreting work will need substantial amount of water. Water will be required for controlling dust pollution.

Mechanical and Electrical Erection

The mechanical erection work involves extensive use of mechanical equipment for storage, retrieval and erection, site fabrication etc. leading to considerable noise pollution and some air pollution. Electrical work, however, is less polluting.

Transport

Construction of a large project requires major transportation of materials and people. This involves large-scale movement of vehicles in a virgin area. The vehicle movement, especially heavy vehicles carrying construction materials and equipment can cause significant impact on air quality due to vehicular emission. The vehicle movement also affects local road condition and that may also cause significant air pollution.

Housing and Other Human Requirements

This activity covers the arrangement for housing and living requirements for the construction workers. Construction work is a labour intensive one and therefore a large number of workers will be working at a time. Many of them will be coming from outside. Their housing and other civic facilities should be provided otherwise this might have significant impact on local housing and civic facilities. In case the workers stay within the plant premises in temporary quarters, it will be ensured

that the workers are provided with proper housing with sanitation facilities. Otherwise local environment specially waterbodies may be polluted. Fuel requirements of the workers need to be met in a planned way by providing kerosene or cooking gas as possible otherwise local trees may be felt for the purpose.

Sources of Construction Materials

Stone chips, bricks and sand required for construction will be available locally. Cement and steel will be procured from market. There will be no appreciable impact on local environment for obtaining these construction materials.

Employment

Construction work will provide employment to a number of people both directly and indirectly. About 500 people will work at the peak period. This will be beneficial to the local economy.

4.3 Impact Identification Matrix

The operation activities discussed above are likely to affect the environment in varying degrees. Relevant important aspects of environment are therefore selected which will be having impacts due to project activities. Environmental parameters are broadly classified into three groups.

1. Physical Environment
2. Biological Environment
3. Human Environment

The parameters selected for impact identification are site and project specific.

Physiography	PHYSICAL ENVIRONMENT
Hydrology	
Water quality	
Air quality:	
Noise and Odour	

Forest & Vegetation	BIOLOGICAL ENVIRONMENT
Fauna	
Aquatic Biology	
Agriculture	
Occupation	HUMAN ENVIRONMENT
Displacement	
Health	
Services	
Immigration	

Impact Identification Matrix for Construction Phase is presented in **Table 4.1**. The interaction between project activities and environmental parameters described above are shown in Identification Matrix (**Table 4.1**). The matrix points out each activity and its impact on specific environmental parameters. This is a qualitative work and does not assess the overall impact. Final assessment is done taking account of the operational phase and all pollution control measures to be implemented during project work. Some of the impacts are temporary & localized and some impacts have permanent effect. Thus the impacts are marked as T for temporary & P for permanent in the matrix.

4.4 Environmental Control Measures during Construction Phase

A number of probable negative impacts on environment due to construction activities have been identified previously. These impacts can be mitigated or neutralized if proper environmental control measures are undertaken. As construction phase is a shorter duration affair and different group of workers involved in different construction activities leave the place after a specific time span, environmental consequences of these activities are not properly assessed. It may be noted that there needs to be specific environmental clauses in the contract for construction work to ensure maintaining environmental quality. Following are the important control measures to be taken during this phase.

Dust Suppression: Dust will be a major pollutant during different project activities. Dust pollution, though temporary, may affect health of the construction workers and plant personals. Dust suppression methods, mainly sprinkling of water in dust prone activities like filling up by fly ash, transportation on unmetalled road, digging works, material handling etc will be taken up.

TPC will also interact with local authorities for maintenance of the local road so that the transportation activities do not cause air pollution in the vicinity.

Gaseous Pollution: Vehicles and machineries will be regularly maintained to conform to the emission standards stipulated under Environment (Protection), Rules 1986.

Noise: Noise levels of machineries used shall conform to relevant standards prescribed in Environment (Protection) Rules, 1986.

Water Pollution: Construction management will include the suitable steps to ensure that this problem is kept to absolute minimum. Site grading and excavation for foundation and back filling should be undertaken during dry season. If required, runoff water from unstabilised fill area, shall be channelled and routed to the receiving water body through a settling basin. Prior to construction a peripheral drain and settling pond will be provided to collect the rain runoff. This will prevent the loose soil getting washed away from the site. This is important as Puri canal bisects the site and any uncontrolled wastewater discharge may contaminate the canal water.

Special care will be taken to ensure that the construction work does not impact Puri canal water. No washing of vehicles or any other construction related equipment will be done near the canal and canal water will not be used for this purpose. There shall not be any wastewater outlet in the canal. No construction workers' accommodation, canteen etc should be built near the canal.

The other source of water pollution is expected from the sanitary waste coming from the temporary accommodation of the construction workers which is discussed below

The construction activity for this project is temporary in nature and not likely to have significant impact on the quality of ground water.

Workers' Colony and Sanitation: If workers stay within plant premises proper housing arrangements will be made for construction workers. It will be ensured by TPC that private contractors provide these arrangements. Approximately 500 temporary contractor workers are expected to be involved in construction phase. But most of the construction workers will be made available from the near by villages. The facilities presently available with the villages will continue to be used during construction activities and no major sanitation problem is expected during construction period.

The workers colony inside the plant premises will be provided with proper sanitation arrangement. The houses will have sanitary latrines to treat sanitary waste. This is an important step; otherwise a polluted colony may affect surroundings. Also without sanitation facilities, workers can pollute the locality. Sanitation is also important for women workers health and privacy.

4.5 Impact during Operation Phase

The operation of the proposed Plant will generate some liquid, solid and gaseous effluents. The generations of these effluents from various sources and their management have been discussed in **Chapter 2**. These effluents may have impact on several environmental parameters. An impact identification matrix can be developed for operational phase in the same way that has been done for construction phase activities. Though, environmental parameters are same as in construction phase, here the impacts are continuous and therefore have a permanent effect. Therefore the impact has just been marked in the matrix without showing any other category. **Table 4.2** shows the Impact Identification Matrix for

Operation Phase. Probable impacts on different environmental parameters are discussed below.

4.5.1 Physical Environment

Water Resources

Local water resources include the river Mahanadi, Puri canal emanating from the Naraj barrage on Mahanadi, the local ponds and waterbodies in the villages and groundwater.

Water will be obtained from river Mahanadi. The nearest barrage is at Naraj from where Puri Canal emanates. The barrage is also source of water supply to the Cuttack city. The total requirement of raw water make-up is of the order of 40 cusecs (21 MGD) for the 1000 MW power plant capacity. Duly considering evaporation losses in the raw water storage pond, an allocation of 46 cusecs is being sought from the Irrigation authorities. As per a separate study report conducted by an independent agency, adequate quantity of river water is available throughout all seasons of the year and for all the years to come. The extract of the report is annexed.

So it can be inferred that this withdrawal will not affect any other water user.

There will be no direct impact on local water resources for operation of this plant, as it does not draw any water from any of the local water resources.

As there will be no extraction of ground water, there will be no impact on local ground water resources.

Water Quality

Present water qualities of the surface water sources –upstream and downstream of Mahanadi River and Puri Canal, local waterbodies and ground water sources have been analyzed and results have been discussed in **Sec 3.6**.

Water quality of local water bodies can be affected by the discharge of liquid effluent from the plant in river. It has been discussed in details in **Sec 2.10** that

there will be no wastewater discharge from ash water pond or ash pond directly or any other effluent from the plant. Only treated wastewater from CMB will be discharged in the Mahanadi River upstream of the intake. Water quality of this discharge will meet the required norms. Thus there is less possibility of polluting the surface water sources. There will be no discharge in the Puri Canal and therefore there is no possibility of impacting the canal water.

Ash pond bottom will be lined by compacting clay making an impervious layer. Though possibility of leaching of metals from ash water is very low, still for this there will be no pollution of groundwater. There is also no storage of toxic waste and thus there is also no scope of polluting ground water sources by seepage or leaching.

Air Quality

Existing status of the background air quality of the area has been discussed in details in **Section 3.5**. The air quality of the area is generally good. Only suspended particulate level and respirable particulate level during the monitoring period few results were high at the urban areas of Cuttack. The ambient levels of SO₂ remained very low. NO_x level was also moderate and well within limit for the residential zone limit.

The present plant will emit some air pollutants, mostly suspended particulates, sulphur dioxide and nitrogen oxides. The types and modes emission and their control have been discussed in details in **Section 2.10**. The gaseous wastes are disposed through a number of high stacks and those disperse in the atmosphere. The following section discusses the impact of dispersion of gaseous pollutants.

Dispersion of Gaseous Pollutants: The emissions from stationary source are subjected to transport and diffusion process which is together termed as dispersion. The following processes govern the atmospheric dispersion of pollutants.

- a) An initial vertical rise called the plume rise due to initial thermal buoyancy and momentum of discharge.
- b) Transport by wind in its direction.
- c) Diffusion by turbulence.
- d) A number of physico-chemical processes such as gravitational settling, dry and wet deposition which includes deposition on vegetation, chemical reactions, transformations and decomposition, adsorption on deposited vapours, coagulation of particles etc.

The ground level concentration (GLC) of pollutants due to emissions from stationary elevated sources is computed using dispersion models, which are mathematical relations between the source strength and concentration and involves parameters related transport and diffusion. The empirical Gaussian model is the widely used model in practice which assumes that the parameters governing the transport and diffusion do not change in space and time. In reality attention may have to be given to several factors namely, existence of different stability classes at different heights, change of terrain characteristics, change in the stability characteristics with time, existence of free convection regions and strong wind sheers. Cognizance of these factors was taken in the best possible way to suit the circumstances and the best possible estimates were obtained. The basic Gaussian equation represents an ideal steady state of homogeneous meteorological conditions, idealized plume geometry, uniform flat terrain, complete conservation of mass and exact Gaussian dispersion, which never occurs in real situations. The equation is as follows:

$$C(x,y,z) = \frac{Q}{\pi \cdot u \cdot \sigma_y \cdot \sigma_z} \cdot \exp\left(-\frac{y^2}{2\sigma_y^2}\right) \cdot \exp\left(-\frac{(z-H)^2}{2\sigma_z^2}\right) \cdot \exp\left(-\frac{(z+H)^2}{2\sigma_y^2}\right)$$

where, C = Concentration of pollutant in g/cu m at a point (x,y,z)

Q = Source strength in g/s (rate of pollutant release)

u = Horizontal wind speed in m/s at the source level

σ_y & σ_z = horizontal crosswind and vertical distance in m from the plume centre line to the receptors respectively

H = The effective stack height which means the sum of stack height and plume rise above the stack.

The coordinate system is such that the origin (0,0,0) is at the source, X-axis is in the mean downwind direction, Y-axis is in horizontal crosswind direction and Z-axis is in the vertical. The quantities σ_y and σ_z are the standard deviations of the distribution of concentrations at 'x' in horizontal crosswind and vertical directions respectively. The quantity σ_y and σ_z increase with increasing downwind distance 'x', signifying that the dilution increases with distance. The rate at which σ_y and σ_z increases with distance depends upon the turbulence intensity and hence the stability of atmosphere. The concentration at any point downwind of the source is given by the equation.

Based on the above equations a number of mathematical models are in use. Because of some difference in the calculation of plume rise wind speed, stability classifications, results of some of the models vary significantly. Central Pollution control Board (CPCB) has recently published Guidelines for Conducting Air Quality Modelling (PROBES/70/1557-58). It follows dispersion equations as stated above only specifying the equations and conditions to be followed for different parameters e.g. use of Pasquill-Gifford's stability classes, Briggs' equation for effective stack height calculation and use of Irwin's formula to extrapolate measured wind speed to the higher altitudes.

Industrial Source Complex Short Term, version 3 (ISCST3) (1999) dispersion model of Environment Protection Agency of USA is similar to CPCB's suggested model and has been used in the present study. This is a quite advanced model which can take account of complex terrain, building downwash, dry deposition, pollutant decay etc. It takes meteorological input for every hour and calculates concentration at each receptor for one hour average. The desired average e.g 24-hour average or monthly averages can be obtained based on the hourly averages. The model does not consider any factor for one hour average though the basic dispersion co-efficients are for 3-15 minutes average. There are different

empirical factors suggested for correcting this base average concentration. In absence of any suggestion in CPCB's guideline, the correction suggested by Turner (1970) has been included in the model. Mixing height which determines the dispersion of the plume changes with the hours of the day and season. The summer time mixing height for the region from CPCB's publication has been considered in the model.

It should always be considered that Gaussian plume dispersion models provide approximate results because of number of assumptions and empirical equations being involved in the computation. The models would predict results which are mainly a guide for air quality decision.

Results and Discussions

Emission data from the stack and the stack details have been given in **Table 2.6**.

Hourly meteorological data for April - May 2007 monitored during the EIA study have been used for the present computation, to represent summer season.

Figures 4.1, 4.2 and 4.3 show the isopleths for highest 24 hour GLC for Suspended Particulate Matters, Sulphur Dioxide and Nitrogen Dioxide. The summary of the findings is given below in **Table 4.3**. Detailed output is given in **Annexure VI**.

Table 4.3

Predicted Maximum Increase in 24 hour GLC due to Emission from Stack

Pollutant	Max Increase in GLC ($\mu\text{g}/\text{m}^3$)	Distance from Stack	Background level at ($\mu\text{g}/\text{m}^3$)	Overall max level ($\mu\text{g}/\text{m}^3$)
SPM	2.4	5 Km to NW	112	114.4
SO ₂	39.6		5.4	45
NO ₂	9.1		32.6	41.7

It shows that maximum increase in GLC of SPM is very low. With this, there will be no dust pollution outside. SO₂ will increase, however even with this increase the overall level of SO₂ will be much within residential and industrial limit. NO₂ increase will also be marginal. The maximum probable 24 hour increase of SO₂ in the impact zone has been shown in **Figure 4.4**.

However the above results are for **maximum 24 hour** GLC, which can occur on a specific day. If a **maximum monthly average** is considered, the GLC reduces significantly. The maximum monthly average for SO₂ will be 13.4 µg/m³ only.

Table 4.4 shows the maximum increase in monthly average

Table 4.4

Predicted Maximum Increase in Monthly Average GLC due to Emission from Stack

Pollutant	Max Increase in GLC (µg/m³)	Distance from Stack	Background level at (µg/m³)	Overall max level (µg/m³)
SPM	0.8	4 Km to	112	113
SO ₂	13.4	NE	5.4	19
NO ₂	3.1		32.6	36

Thus no significant impact on air quality is expected though there will be some rise in overall back ground level of SO₂.

Noise

Background noise level around the plant site was monitored and has been presented in **Section 3.8**.

The noise level reduces with distance and also with attenuation by physical barriers and vegetation

Reduction of Noise level with distance can be calculated as

$$L_2 = L_1 - 20\log(d_2/d_1)$$

L₂ = Sound level at a distance d₂

L_1 = Sound level at a distance d_1

Considering that noise level at the working zone will be within 90 dB(A) when measured at a distance of 1m from the source and any work zone will be at least within 100 m from the plant boundary, the additional noise level there will be 50 dB(A). Considering background noise level of 56 dB(A), at present, and adding the 50 dB(A) noise level, the total noise level will be 57 dB(A) only, hardly any increase at all.

So the plant noise will not have any impact on the local noise level.

Solid Waste

Ash is the major solid waste from the coal-fired power plant. Ash management has been discussed in details in **Section 2.10**. It has been proposed that fly ash will be collected dry, stored in silos and will be used for brick making, in cement plant and mine backfilling. Bottom ash which will be removed hydraulically will be disposed in the ash pond. The ash pond will be surrounded by plantation and there will be a cover of water to prevent any dispersion of ash from ash pond. Ash will also finally be excavated and reused for road making, landfilling etc. There is no chance of disposing ash in the vicinity of the plant. So there is no possibility of impact on local environment.

Other solid wastes like water treatment sludge will be disposed in ash pond. Coal mill wastes will be stored inside the plant. Metallic junks will be stored and sold periodically.

Hazardous wastes like spent oil etc will be sold to the dealers

So as there is no direct disposal of solid waste. No impact on local environment is expected.

Land Environment

As mentioned before there will be change in land use but that it not have significant impact on local livelihood and will cause minor displacement. There

will be also no direct impact on the land outside the plant premises. Other source of impact for land environment can be the disposal of solid wastes from the plant. As described above no solid waste will be disposed on outside land. As no outside land will be impacted for other solid waste disposal, it can be concluded that there will not be any impact on the land environment.

4.5.2 Biological Environment

The surrounding area has substantial vegetation in the form of village orchards, roadside trees and agriculture. The impact zone has a number of reserve forests including wildlife sanctuaries. There is a major river close to the site. Thus the biological environment in the impact zone surrounding the proposed plant site is quite important

Impact on Vegetation

Suspended particulates can have detrimental impact on the vegetation by covering plant surfaces. Sulphur dioxide can injure plant by causing injury to chlorophyll pigments. Nitrogen oxides at higher level can damage plant cells and affect the metabolic process

It has been shown above that the impact on air quality due to the operation of the plant units is expected to be low. Increase in suspended particulates will be practically nil and therefore will not have any consequence on the forest areas within the study zone. Increase in oxides of nitrogen is also insignificant. Only there will be some increase in background level of sulphur dioxide for some specific days of some season at some places depending upon the season. As overall background level will not be much impacted (experience from different thermal power plants in India show that sulphur dioxide level in the ambient air has not increased much), no significant impact on the forest vegetation will be affected.

There will be intensive plantation of trees in the plant site. All these measures ensure no significant impact on the local vegetation from the proposed plant.

Impact on Terrestrial Fauna

There is no significant wild life in the immediate vicinity of the plant site. The forest lands with wildlife are all several kilometres away from the plant. The plant activities in no way will affect their habitat, their breeding zones, the water holes or their movement corridors. As mentioned above the gaseous emission will not be significant to have any impact on the wild life. The major wildlife of the area is represented by the elephants and an elephant sanctuary lies towards south west of the plant site. The plant activities will not anyway involve the sanctuary zone or its vicinity. In fact the unplanned development in the area is causing the human-nature conflict; the planned development can avoid that benefiting both.

Impact on Aquatic ecology

As described before that wastewater after meeting the desired norms will be discharged in the Mahanadi River. It is expected there will not be any impact on the river ecology for this. As there will not be any discharge in the Puri canal, the aquatic ecology of that will not be impacted any way.

4.5.3 Socio-Economic Environment

Any development project has the potential to have impacts on socio-economic environment of the area which may be adverse or beneficial. Most of the project land is private land. The owners will be properly compensated. The land being not much productive, the compensation package is expected to be beneficial to the people. There will be a few displacement and they would be rehabilitated in accordance with the requirements of Government of Orissa. These provisions are expected to be beneficial to the local economy

The project will offer some employment potential during construction phase and during operation phase which will have beneficial impact to the local people. Besides there will be secondary employment opportunities for providing different kinds of services involving the operation of the power plant. There will be more demand for markets, transports, different civic services, education, housing etc and these will benefit the local economy.

It is also expected that more generation of electricity will be beneficial to the society in different ways.

4.6 Summary of the Impacts

Finally it is to sum up the study, quantify the impact and to arrive at an overall assessment. Final assessment is somewhat subjective depending on the bias of the assessor. This cannot be totally avoided however the attempt for quantification reduces the proportion of subjectivity. Here the environmental parameters are first assessed individually and then as a part of an overall environment. After studying, the probable environmental impacts discussed above, considering the control measures.

Environmental impacts have been identified above by checklist matrix method which is a qualitative approach. The present trend is to quantify the impact using a common unit of measurement. This methodology called weighing-scaling checklist method has been developed by a number of groups. This consists of assigning relative importance weights to environmental factors and impact scales for each alternative activity relative to each factor. The basic concept can be expressed as

$$EIV = \sum_{i=1}^m \sum_{j=1}^n (IS)_i (PI)_j$$

Where,

EIV = Environmental Impact Value

(IS)_i = Impact Scale value for ith activity

(PI)_j = Parameter importance value for jth environmental parameter

m = No. of activities

n = No. of environmental parameters

Battele Environmental Evaluation System (BEES) was earlier developed in USA for this kind of impact quantification. It was specifically developed for water resources project. It considered 78 environmental parameters, all of which were

assigned importance values totaling to 1000. Impact scaling for all the parameters was done by developing functional relationship values which is called Environmental Quality (EQ). EQ curves were developed for all parameters based on objective and subjective decisions of a panel of experts. Application of BEES in Indian environmental assessment is problematic because EQ's are dependent on local subjective decisions and local environmental regulations. Also the large number of environmental parameters in BEES needs detailed database for quantitative evaluation.

BEES approach is, therefore, adopted to develop a simplified quantitative impact evaluation system. The impact matrices used earlier as identification matrices are again considered, only each environmental parameter are given some weightage values totaling 100. The weightage values are subjective but arrived after inter-disciplinary exchanges and literature references.

Impacts of the activities have been marked positive (+) or negative (-) depending on its beneficial or adverse effects on the environment. The impact scale has been assessed

Insignificant = 0 – 0.5 May be significant 0.5-1 ; Significant = 1-2 ;
Appreciable = 2-3 ; Considerable = 3-4 ; Major = >4 ;

Based on these values **Table 4.5** shows the quantitative environmental impact evaluation. A summary is presented **Table 4.6**.

Table 4.6
Summary of Quantitative Environmental Impact Evaluation

	ENVIRONMENT			
	Physical	Biological	Human	Total
Weightage	30	40	30	100
Impact Value	-31	-40	22.5	-48.5
Degree of Impact	-1.03	-1	+0.75	-0.485
Remarks	Adverse significant	Adverse May be significant	Beneficial May be significant	Adverse Insignificant

It is evident from this evaluation that if the environment management plan is properly implemented there will be insignificant adverse impact. However as mentioned before that the impact zone around the site has ecological importance, the implementation of environment management plan discussed in **Chapter 6** will be the key for maintaining environmental quality.

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