POSCO-INDIA PRIVATE LIMITED

RAPID ENVIRONMENTAL IMPACT ASSESSMENT

FOR

4 MTPY INTEGRATED STEEL PROJECT TO BE SET UP NEAR PARADIP IN ORISSA

VOLUME - I

TEXT

AUGUST 2006

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CONSULTING ENGINEERS
KOLKATA

VOLUME - I

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1 - INTRODUCTION

The long term goal of the national steel policy (2005) is that India should have a modern and efficient steel industry of world standards. The national policy establishes the fact that the country is poised for growth of present level of annual steel production from about 42 million tons per year (MTPY) to the tune of 110 MTPY by the year 2020. The policy focuses towards achieving global competitiveness, not only in terms of cost, quality and product mix, but also in terms of global benchmarks of efficiency and productivity. The liberalisation of industrial policy and other initiatives taken by the government have given a definite impetus for entry, participation and growth of the private sectors in the steel industry. In addition to expansion of existing steel plants, a large number of new/green field steel plants are coming up in the country.

Interest of Global Steel Majors in India

The global steel industry too appears to be in a race to invest in high growth zones such as India, China, Latin America and Eastern Europe. India has finally emerged as their favoured destination due to availability of basic raw materials, iron ore and coal, skilled manpower at an affordable rate and matured production base of steel industry.

Three States, namely, Orissa, Jharkhand and Chhattisgarh endowed with rich deposits of iron ore and coal are favoured locations of the private/foreign investors in setting up the mega scale steel plant in India.

India's biggest FDI Project

1 -Introduction (Cont'd)

In view of the above stated favourable factors and encouragement of the foreign direct investment (FDI) in the country, POSCO, a steel major of the Republic of Korea, have shown keen interest in setting up an integrated steel plant in India. In fact, POSCO was invited by the State Government of Orissa in early 1990s for setting up of 10 MTPY exported-oriented integrated steel plant in Orissa. However, due to global recession in the steel industry, this did not materialise.

On 22nd June 2005, POSCO, world's third largest steel producer have entered into a Memorandum of Understanding with the Government of Orissa for an eventual investment of around 11,576 million US Dollars (USD), around Rs 52,000 Crores for setting up of 12 MTPY integrated iron and steel plant with a dedicated port near Paradip in Jagatsinghpur district of Orissa in three phases, each of 4 MTPY production capacity. This will be the biggest FDI in India.

POSCO-India Private Limited **(Posco-India)** registered at Bhubaneswar, a subsidiary of their parent company, POSCO-South Korea, will set up and operate the proposed Paradip Steel Plant.

Project Highlights

Following are some of the highlights of the proposed steel project conceptualised by Posco-India:

? **Project aim** .. To set up 12 MTPY Integrated Steel Complex with a captive minor Port at an estimated investment of 11,576 million US Dollars (USD) in phases

? **Project implementation** .. In three phases -

Phase-I - 4 MTPY
Phase-II - 4 MTPY
Phase-III - 4 MTPY

1 -Introduction (Cont'd)

?	**Present Project**	..	**Phase-I - 4 MTPY**
?	**Site**	..	On the bank of Jatadharmohan River Creek located at about 12 km south of Paradip Port in Jagatsinghpur district of Orissa
?	**Process**	..	- 'FINEX' Process for Iron making - No traditional process route of Coke Ovens, Sinter Plant and Blast Furnace - Steel making by conventional BOF route
?	**Product Mix**	..	**Slabs (**870-2300 mm wide x 200-250 mm thick**)** - 1.5 MTPY **HR Coils (**850-1600 mm wide x 1-12 mm thick**)** - 2.5 MTPY
?	**Land Area required**	..	4,004 Acres (including port facility)
?	**Perennial Water Source**	..	Jobra barrage on the River Mahanadi near Cuttack at a distance of abt. 86 km from the Plant Site
?	**Other Infrastructure**	..	Captive Minor Port integrated with the Steel Plant, Road Network connecting the State Highway, Rail linkage from Paradip and Steel Township
?	**Expected direct Employment for Phase-I**	..	7,426
?	**Estimated Investment for Phase-I**	..	3,803 million USD (abt. 17,113 Crores), excluding mine development
?	**Completion Target for Phase-I**	..	December 2010
?	**Future provision**	..	To add 4 MTPY in respective phases, Phase-II and Phase-III, for making value added steel products

Project Status

Posco-India have carried out several site investigative studies comprising route survey of road linkage, water pipeline from Jobra

1 -Introduction (Cont'd)

barrage, railway linkage, electric power transmission from the State Power Grid. Posco-India have also submitted Forest Clearance Proposal through Industrial Development Corporation of Orissa (IDCO); CRZ and Environmental Clearance Proposal for the dedicated port to the Orissa Coastal Zone Management Authorities (OCZMA). The Project Report for 4 MTPY steel plant has also been prepared by POSCO's office in South Korea. The site acquisition progress is being monitored by the State Government of Orissa.

Environmental Clearance (EC)

Posco-India now await No Objection Certificate (NOC) from the Orissa Pollution Control Board (OPCB) for setting up of the steel plant for completion of Phase-I production facilities and EC from the Ministry of Environment & Forests (MoEF), Govt. of India to establish the project as required by the relevant provisions of Environment (Protection) Act, 1986 and the Rules thereunder as and when notified.

Posco-India being a subsidiary of POSCO-Korea have the same corporate responsibility for environment protection and social commitment as being practiced in their homeland, one of the highly developed Asian nations.

Authorisation

In view of the above stated regulatory requirements and corporate policy on environment, health, safety and social improvement, Posco-India have appointed M.N. Dastur & Company (P) Ltd, Consulting Engineers, Kolkata to undertake Rapid Environmental Impact Assessment (REIA) with suggested environmental management plan (EMP) of the proposed 4 MTPY integrated Steel Project under Phase-I implementation programme in accordance with Indian Regulations.

1 -Introduction (Cont'd)

Scope and Purpose of the Present Report

In order to have rapid assessment of environmental impacts, a short term baseline study has been conducted in and around the project site during the dry period of the year from December 2005 to February 2006.

Taking into consideration of the one-season baseline data and project concept as made available by Posco-India, a preliminary assessment of potential impacts is discussed in this Report. This Report also discusses suggested EMP to contain the adverse impacts as revealed during impact assessment. Associated environmental risks affecting community health and safety are also outlined in this Report.

Structure of the Report

This Report is presented in two Volumes; Volume-I - Text and Volume-II - Field Reports. The Volume-I Report is presented in 7 (seven) Chapters with Summary, relevant Tables, Appendices, Drawings and Figures. Following this Introduction Chapter, Site Selection is discussed in Chapter-2; Chapter-3 outlines the Project for which impacts on baseline needs to be assessed; Chapter-4 describes the Baseline status of the study area; Chapter-5 discusses Environmental Impacts; Chapter-6 proposes suggested Environmental Management Plan; and lastly, Chapter-7 outlines Environmental Risks and Emergency preparedness plan.

Acknowledgement

Consulting Engineers gratefully acknowledge the co-operation and assistance extended by Posco-India in preparing this Report. Consulting Engineers also record the co-operation of local people of Paradip, Kujang and Ersama in carrying out the field investigation work.

1 -Introduction (Cont'd)

References

References used for preparation of this Report are as follows:

i) Feasibility Study Report for Integrated Steel Works in India prepared by Posco-India (April 2006)

ii) Pollution Control Acts, Rules and Notifications Issued thereunder, CPCB Publication (January 2006)

iii) Report on CRZ delineation of present HTL and LTL of the Jatadharmohan River Creek and sea prepared by National Institute of Oceanography (NIO) - June 2006

iv) Forest Diversion Proposal prepared by Industrial Development Corporation of Orissa (IDCO) - March 2006

v) Field Investigation /Monitoring Reports for the period December 2005 to February 2006

vi) Towards Zero Discharge - Innovative methodology and technologies for process pollution prevention by Das TK - John Willey Publication, 2005

vii) Industrial Safety Management by LM Deshmkh - Tata McGraw Hill

Publication - 2006

viii) Corporate Brochure of POSCO-Korea

2 - SITE SELECTION

Selection of proper site in the state of Orissa is a major decision-making step for venturing into a mega steel project of ultimate capacity 12 MTPY. This Chapter presents extracts of the site selection study conducted by Posco-India for setting up their steel project.

Criteria for Site Selection

The site selection criteria in the state of Orissa for the proposed 12 million tons of integrated steel complex have been established considering the following major factors:

- Land availability of at least 4000 acres
- Availability of adjacent minor port
- Proximity to the iron ore belt
- Readiness of infrastructure like electric power, water, rail and road linkage, township etc
- Soil characteristics
- Minimum number of persons requiring relocation and rehabilitation
- Logistics of raw materials and product transportation
- Favourable environmental factors
- Scope for regional development

Description of Candidate Sites

In consideration to the above stated criteria, three prospective sites, namely, (i) Dhamra, (ii) Duburi and (iii) Paradip as shown in Fig. 2-1 on the next page were considered probable candidate locations. The brief features of each site are as follows:

2 - Site Selection (Cont'd)

i) Dhamra Site:

Dhamra is located in Chandbali tehsil of Bhadrak district of Orissa. The candidate site at Dhamra is about 8 km from the Dhamra fishing harbour. Approximate distance of the candidate site at Dhamra is about 65 km from NH-5.

2 - Site Selection (Cont'd)

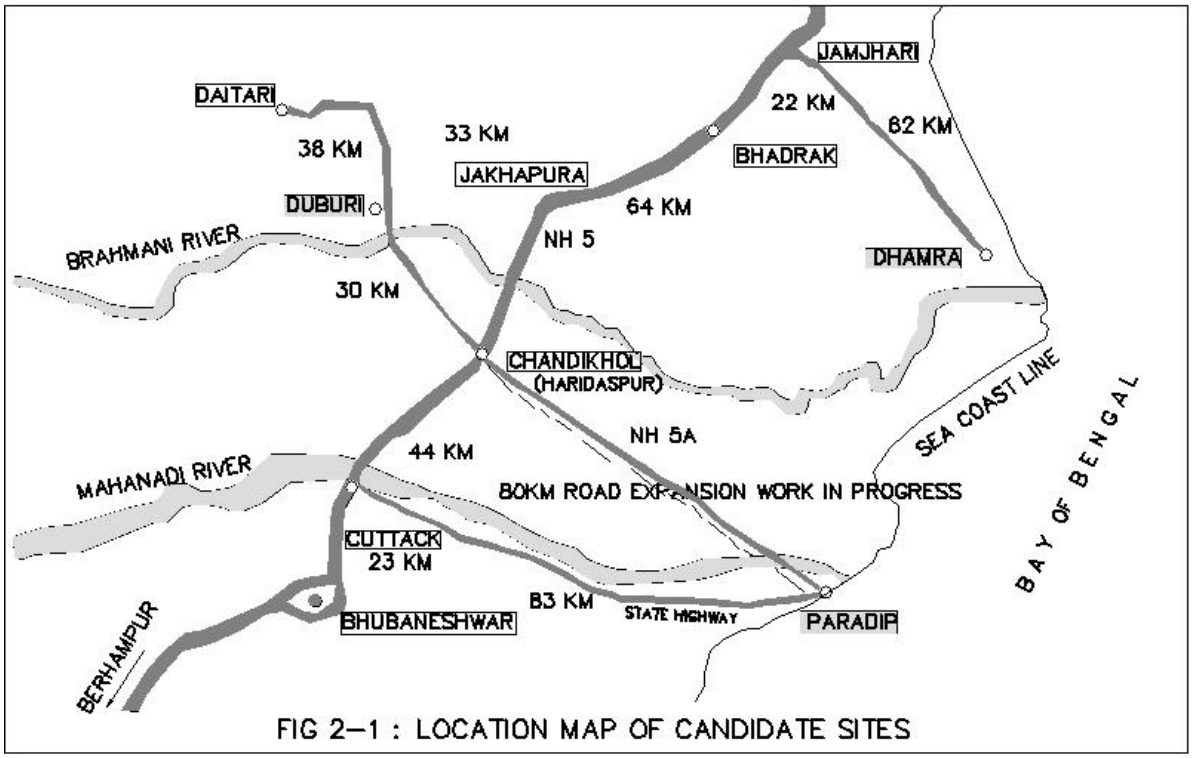


FIG 2–1 : LOCATION MAP OF CANDIDATE SITES

There is a small fishing port at Dhamra. Larsen & Toubro (L&T) and Tata Steel jointly are developing this port for cargo handling. Dhamra port after development will be of exclusive use by L&T and Tata Steel and no other private users are allowed.

In addition, Dhamra site is low lying and inundation prone during monsoon or high tides. Dhamra site also lacks the basic infrastructure for supply of fresh water to the project site on a sustained basis. The rivers of this region, namely, Baitarini, Salindi, Maritel etc do

2 - Site Selection (Cont'd)

not have any upstream impoundment of water. Therefore, the availability of water during lean season cannot be ensured.

2 - Site Selection (Cont'd)

Moreover, the water problem is further aggravated due to mixing of backwater of sea making the river water saline. The soil condition is also found to be unfavourable for steel plant construction.

In view of the above reasons, Dhamra site was not found suitable due to perennial water problem, flood prone area, non-availability of port facilities, unfavourable soil condition and lack of basic infrastructure.

ii) Duburi Site: Duburi area in Jajpur district of Orissa is located just next to Daitari-Paradip Expressway. It is approximately 30 km southeast of Daitari Ore Deposits. River Brahmani flows from west to east on the southern side of the candidate location. Duburi site has been converted to Industrial site and is known as Kalinganagar Industrial Complex (KIC). The nearest major port is Paradip port at a distance of around 140 km.

Posco-India may get 4000 acres of land area from the Industrial Development Corporation of Orissa (IDCO) but no further growth would be possible. KIC area will be congested with many other industrial installations, some of which have already been set up. Posco-India's Steel Complex will further add to environmental pollution problems. Selection of slag disposal area is difficult from logistic location point of view. Duburi site is not favourable due to its inland location for transportation of raw materials and products. The site

2 - Site Selection (Cont'd)

has to depend on Paradip port for export and import of raw materials and products. It requires double line railway linkage of about 86 km from Duburi via Jakhapura.

In view of these limitations, Duburi site was not found favourable.

iii) Jatadharmohan River Creek near Paradip: There is a major port at Paradip administered by Paradip Port Trust. This Port is under expansion. The chosen site on the western bank of Jatadharmohan River Creek for Posco-India at Paradip is about 12 km south of Paradip Port. Even with the expansion of Paradip Port, additional handling of cargo of the order of 25 to 30 million tons per year will be a difficult proposition. In addition, a separate transportation arrangement needs to be made to bring the materials from Paradip Port to Steel Plant and from the Plant to Port for export purpose.

In view of the above, it was decided to locate the site on the north western bank of Jatadharmohan River Creek nearly about 12 km south of Paradip Port. The site will be close to Indian Oil Corporation (IOCL)'s Paradip Refinery site. The villages within the selected site near Paradip are Polanga, Noliasahi, Govindpur, Dhinkia, Nuagaon, Bayanala Kanda, Jatadhar and Bhuinyapal, all in Kujang tehsil of Jagatsinghpur district. Of the 4,004 acres of land area required, it has been found that 3,566

2 - Site Selection (Cont'd)

acres (abt. 89%) is Government land; balance 11% private land.

Even at this selected site, there are limitations, which need to be taken into consideration for setting up of the project. These are (i) relocation and rehabilitation (R&R) of some of the village settlements, (ii) the area is cyclone prone, (iii) low lying area requiring filling, (iv) compliance with the CRZ regulations, and (v) forest clearance for the protected forest patch.

Thus, the selected site on the western bank of Jatadharmohan River Creek will require appropriate pre-engineering in locating the plant taking into consideration of the above site-specific limitations.

3 - PROJECT OUTLINE

This Chapter outlines the proposed green field integrated steel project of Posco-India to be set up near Paradip in Jagatsinghpur district, Orissa. The following description of the project forms the basis of environmental impact assessment (EIA).

Project aim

Posco-India intend to set up a green field integrated Steel Plant of total capacity 12 MTPY in phases along with a dedicated Port near Paradip in Orissa. The capacity will be built-up in three phases; each phase will be of 4 MTPY capacity. The first such implementation phase, that is, Phase-I is planned for setting up the facilities for 4 MTPY only to produce flat products like slabs and hot rolled coil (HRC). In subsequent phases, there is a plan to produce more value added diverse steel products.

Production plan for Phase-I

The annual production levels of intermediate and end products, that is, saleable steel as planned for Phase-I are presented in the Table 3-1 on the next page.

Project site

The proposed project will be sited near Paradip in Jagatsinghpur district of Orissa as shown in Location Map No. 10971-REIA-ENV-001. The site to be acquired is located at about 12 km south of Paradip on the north western bank of Jatadharmohan River Creek. On the north of the site, Paradip Port is located; on the east is Bay of Bengal; on the south is

3 - Project Outline (Cont'd)

Indian Oil Corporation's Refinery (under construction) and on the west, village settlements of Kujang and Ersama tehsils.

3 - Project Outline (Cont'd)

The site requires road linkage from the Highway NH-5 connecting Cuttack and Paradip. The nearest rail station is Paradip. The only airport in the State of Orissa is Bhubaneswar at a distance of around 140 km by road.

Table 3-1 - Annual production plan of Paradip Steel Plant

Products		Annual production with a variance of ± 5% '000 TPY	Tentative Product Specification
I. Intermediate products:			
? Hot Metal	..	4,364	C-43%; Si-0.8%; S-0.017%
? Liquid Steel	..	4,124	Low and medium carbon steel, micro alloy steel
II. Saleable products:			
? Slabs	..	1,500	900-2000 mm wide x 9-12 m long x 200-250 mm thick
? Hot Rolled Coil	..	2,463	800-2000 mm wide x 1.6-25 m thick

Manufacturing process

The manufacturing process of the proposed integrated steel plant comprises three principal process steps, namely, (i) iron making, (ii) steel making with continuous casting of liquid steel, and (iii) finishing mills of cast steel to produce desired finished steel products.

3 - Project Outline (Cont'd)

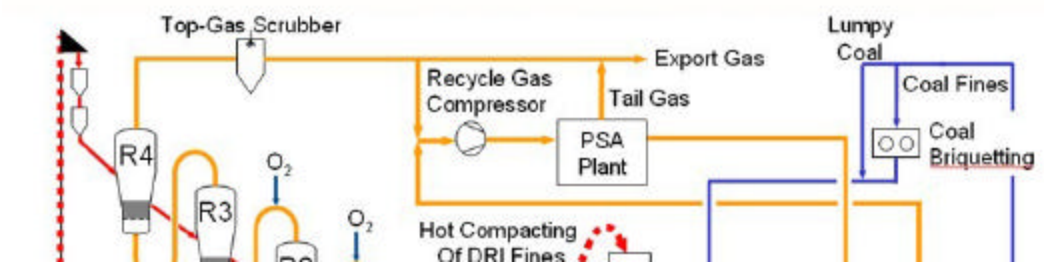
Iron making: Conventionally, iron is made by blast furnace (BF) process route, the upstream processes of which are coke making in coke ovens and sintering of iron ore fines, lime fines and coke breeze to produce sinter burdens of blast furnace.

In this particular project, these two traditional upstream processes are absent. Rather, a new type of smelting and reduction process of iron ore known as FINEX route of iron making has been considered. FINEX process does not require coke ovens and sintering.

The FINEX technology developed by POSCO-Korea and VAI-Austria is based on the direct reduction of iron ore fines in a series of fluidised bed reactor using FINEX off gas (FOG) as reductant. DRI so produced and lump ore together is smelted in the Melter Gasifier (MG), where coal is gasified with pure Oxygen. In the MG, hot metal by products, FOG and Slag are produced. Part of this FOG will be used as reductant gas for fluidised bed reactors and balance will be used for captive power generation.

POSCO-Korea in their Pohang Works is presently operating 800,000 TPY FINEX plant. A new FINEX plant of capacity 1.5 MTPY is nearing completion in the same Works.

A schematic process flow diagram of FINEX route of iron making is presented in Fig. 3-1.



Fine ore and fine additives (limestone and dolomite) are first dried and then conveyed and charged to the four-stage fluidised bed reactor system for initial reduction of iron ore by means of FOG and oxygen injection to control the bed temperature. Iron ore fines get progressively reduced to produce direct reduced iron (DRI) and calcine the fluxes. The hot DRI fines and partly calcined additives are compacted in double-roll compacting machine to get hot compacted iron (HCI). The HCI is then crushed into lumps and conveyed to the service bin of MG.

On the other hand, dried coal fines are briquetted in a briquetting machine. Lump coal, briquette coal, some amount of lump coke are fed to the MG.

In the MG, the coal and coke charge is gasified by pure oxygen to produce required energy for smelting of iron ore and generation of reductant gas. On the top of the MG, the lump iron ore and HCI get reduced first in the shaft reduction furnace before the final smelting

operation in the MG. In the MG, additional carbon requirement is met by the injection of dry coal powder, similar to powdered coal injection in conventional blast furnace route of iron making.

The FOG from the MG is first cooled by mixing of cold product gas of the CO_2 removal unit in the PSA (pressure swing adsorption) plant and then dedusted in a hot cyclone. The dust separated in the cyclone is recycled to the MG by means of oxygen dust burners. The carbon present in the dust is gasified by oxygen which produces the heat for melting and agglomeration of the non-combustible dust fraction. The used reducing gas leaving the fluidised bed reactor is quenched and cooled in the off gas scrubber. The cleaned FOG is used as plant fuel or for captive power generation after partial recovery of CO_2 in the PSA unit.

Steel making: Hot metal obtained from the MG of FINEX plant goes for steel making in BOF in conventional process route based on pure oxygen lancing as illustrated in Fig. 3-2. Hot metal undergoes desulphrisation, de-siliconisation etc pre-treatment steps before it gets charged to the steel converter BOF. Crude steel obtained from the converter after conditioning like de-carburising, vacuum degassing etc to make different grades of steel is continuously cast in the slab caster producing slabs of thickness 200/250 mm. The converter waste gas is cooled and cleaned by electrostatic precipitators (ESP) to get clean BOF gas of dust content below 30 mg/cu m for fuel use.

3 - Project Outline (Cont'd)

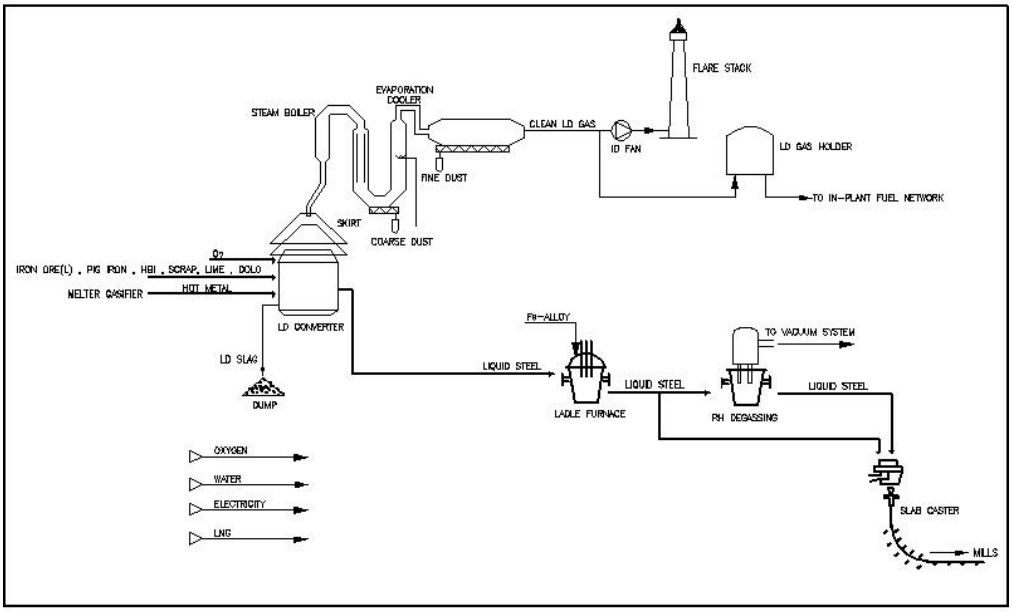


Fig. 3-2 - BOF Steel Making

Mini Flat Mill: The proposed mini flat mill (MFM) will produce thin slabs by continuous casting of liquid steel and thereafter further rolling in hot strip mill (HSM) to produce hot rolled coils (HRC). The continuously cast thin slabs will be heat soaked before it goes to roughing mill and then through HSM to produce hot rolled strips, coiled and packaged for despatch.

3 - Project Outline (Cont'd)

Other supporting production facilities

The other essential supporting production facilities are (i) Lime Calcination Plant, (ii) Air Separation Pant and (iii) Captive Power Plant.

Lime calcination: Burnt lime (CaO) and burnt dolomite (CaO/MgO) produced from limestone and dolomite respectively will be required as a fluxing material for iron making in FINEX Plant and also for Steel making in the BOF. Burnt lime will be produced in vertical twin shaft kiln and burnt dolomite will be produced in rotary kiln. A typical scheme of shaft kiln based lime plant is presented in Fig. 3-3.

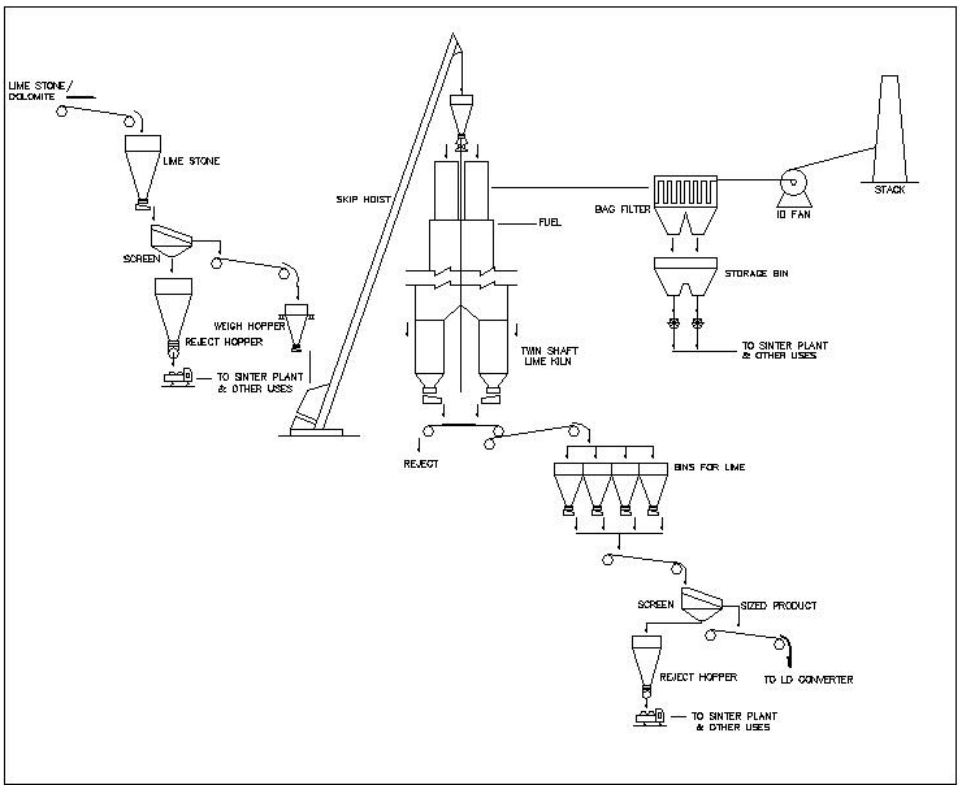


Fig. 3-3 - Typical Shaft Kiln based Lime Plant

Air separation plant/Oxygen plant: The FINEX as well as steel making would require 99.6% pure Oxygen. 99.99% pure Nitrogen and 99.99% pure Argon will be used in Steel Melt Shop including Continuous Caster.

The proposed Oxygen plant will have molecular sieve type air cleaning prior to feeding to the cryogenic unit for separation of liquid oxygen, nitrogen and argon.

Captive Power Plant: The by product FOG, BOF gas and liquified natural gas (LNG) will be used as fuel for captive power generation.

Raw materials and chemicals: The bulk consumption of raw materials is iron ore, non coking coal, limestone and dolomite. In addition, some amount of coke and hot briquetted iron (HBI) have also been considered as input raw materials. The chemicals required for water treatment are sulphuric acid, caustic soda and flocculent which are of insignificant quantities.

The average monthly consumption of bulk solid raw materials for 4 MTPY production level are indicated in Table 3-2 on the next page. The figures are estimated ones and may vary to some extent at the time of actual operation depending on the characteristics of raw materials and chemistry of steel desired.

Of the total consumption of raw materials, nearly 957,000 tons per month, nearly 45 per cent will come by ships berthing at the captive port of the steel plant and the balance will come by rail. The relative

distribution of iron ore, coal/coke and other sub-materials would be around 58 per cent ore, 25 per cent coal and 17 per cent sub-materials.

Some amount of sulphuric acid, caustic soda, flocculents, ion exchange resins will be required for water treatment.

Energy

The total energy requirement has been estimated at 25.2 Giga joules (GJ)/ton of steel, 22.9 GJ will be derived from coal and coke, 0.25 GJ from purchased electricity and the balance energy deficit of about 2 GJ will be met from LNG.

3 - Project Outline (Cont'd)

Table 3-2 - Estimated monthly consumption of major raw materials and chemicals

Incoming major raw materials/chemicals	Chemical composition	Monthly consumption	Mode of transport
	% w/w	'000 tons	
Lump Iron Ore (6 to 35 mm)	Fe - 64-66 Al_2O_3 - 1.5-2.2 SiO_2 - 1.1-1.5	132	Rail/Sea
Iron Ore fines (below 6 mm)	Fe - 60-62 Al_2O_3 - 1.5-5 SiO_2 - 1.1-1.3	409	Rail
Hot Briquetted Iron (HBI)	Fe_{Tot} - 90.5-92.0 Fe_{Met} - 84.2-84.8 C - 0.8-1.0	9.5	Sea
Non-Coking coal (Fines below 8 mm, Lump 8 to 63 mm)	Fe - 60-65 VM - 26-33 Ash - 8-26 S - 0.5-0.6	134	Rail/Sea
PCI Coal	Fe - 60-65 VM - 26-33 Ash - 8-26 S - 0.5-0.6	100	Rail/Sea
Coke (0.5 to 63 mm)	FC - 86-87 VM - 1-1.5 Ash - 11-12	13.3	Rail/Sea
Molasses	Glucose	6.0	Rail
Quartzite	SiO_2 - 94-96 Al_2O_3 - 2.8-3.2 K_2O - 0.5-0.7	16.7	Sea
Limestone (Lump & Fines)	CaO - 50-52 MgO - 3-3.5 SiO_2 - 1-1.05	82.4	Sea
Dolomite (Lump & Fines)	CaO - 30-32 MgO - 18-20	51.0	Sea

3 - Project Outline (Cont'd)

	SiO_2 - 1.2-1.3		
Ferro-Alloys	Fe - 28-32 Mn - 64-66 and Fe - 24-25 Si - 75-76 Al_2O_3 - 0.2-0.3%	3.2	Rail/Sea

Electricity

The annual electrical energy demand for the proposed production facilities has been estimated at 3,125 million units. With the use of available by-product fuel gases from the FINEX Plant and BOF Shop, abt. 2,859 million units of electric energy will be made available from the Captive Power Plant of capacity 400 MW. The deficit of electrical energy of the order of 266 million units/year will be purchased from the Orissa State Power Grid.

Fuel

As stated earlier, the main fuel source would be coal and coke to be gasified by pure Oxygen in the MG of FINEX Plant. The balance fuel shortage will be met by purchasing LNG. It is estimated that nearly 22.7 tons of LNG per hour would be required for various heating, drying and calcining purpose. It is planned to have LNG connection from the IOCL's installation (under construction) adjacent to the proposed steel plant site.

Water source and requirement

River systems in the vicinity of the plant site are saline. A study was conducted by Posco-India to find a suitable water source which not only will sustain the ultimate production level of up to 12 MTPY in future but also the adequacy of water in that source is ensured through out the year.

3 - Project Outline (Cont'd)

In view of the above criteria for identification of suitable water source, Jobra barrage of Mahanadi River near Cuttack has been identified as the source of river water for the proposed Steel Plant. Jobra barrage is quite far away from the Steel Plant. Nearly 87 km long pipe length of 1400 mm dia needs to be laid for bringing water to the Steel Plant.

Presently, about 10 MGD (1895 cu m/hr) water including reservoir loss would be required of which Steel Plant alone would consume around 8.1 MGD (1535 cu m/hr), abt. 1.1 MGD for township and the balance 0.4 MGD for Captive Port.

The plant will have the reservoir for storing water for 3 days. The quality of the raw water of Mahanadi River to be transported by pipeline to the plant is as follows:

Temp. (^{0}C)	..	Ambient
pH	..	7.5-8.2
Turbidity	..	6-7 NTU
TSS	..	2.5 mg/l
TDS	..	115 mg/l
TH	..	57 mg/l
Conductivity	..	152
DO	..	7.9 mg/l
BOD	..	0.5-0.75 mg/l

Source: Posco-India.

3 - Project Outline (Cont'd)

This raw water will undergo conventional treatment of clari-flocculation to get industrial quality of water.

Other utilities

The other utilities and services required for operation of the proposed production facilities would be recovery of FINEX off gas, cleaning and partial enrichment of FOG by removal of CO_2 with the help of pressure swing adsorption (PSA) process, recovery of BOF gas, air separation for production of oxygen, nitrogen and argon, LNG distribution, pipeline transport of all fuel gases within the plant, compressed air, instrument grade air and chilled water for refrigeration purpose.

Infrastructure requirement

In order to set up the proposed Steel Plant on the western bank of Jatadharmohan River Creek, substantial investment would be made to develop the basic infrastructure. These are setting up of dedicated minor port as an integral part of the Steel Plant, construction of road linkage with the national highway, railway linkage, electric power supply from the state power grid and laying of water pipeline from Jobra barrage near Cuttack.

3 - Project Outline (Cont'd)

The dedicated port on the Jatadharmohan River Creek will have berthing facility for ships of size varying from 30,000 DWT to 100,000 DWT bringing raw materials and carrying finished steel products.

Main Plant and Facilities

The principal production facilities for 4 MTPY production level are summarised in Table 3-3 on the next page. The list, however, does not include water treatment plant, gas holders and other auxiliary facilities. The key production facilities as envisaged are FINEX plant having raw materials drying, compaction, fluidised bed reactors and melter gasifier, pressure swing adsorption (PSA) unit for partial removal of CO_2 from FINEX off gas, 2 Nos. 370 tons BOF converters with steel refining facility and continuous slab caster. The Mill area will have mini flat mill (MFM) of capacity 2.5 MTPY thin slabs and equivalent capacity Hot Strip Mill. The other supporting production facilities will be Calcination Plant and Power Plant of 400 MW.

Layout

Total land area needed for setting up of the proposed steel complex with future provisions for expansion is 4004 acres.

The present production facilities of 4 MTPY will come up within the earmarked area as conceptualised in preliminary layout drawing 10971-REIA-ENV-004. The planned use of land area to be acquired is depicted in Fig. 3-4 on page 3-13, which covers future expansion up to 12 MTPY.

Compliance with the Coastal Zone Regulations: As the proposed plant will be sited on the western bank of Jatadharmohan River Creek, the present production facilities will be set up beyond the coastal regulation zones (CRZ).

3 - Project Outline (Cont'd)

Table 3-3 - List of proposed principal production facilities

Sl. No.	Plant Unit/ Production facilities	Nos.	Unit Capacity	Special features
A.	**IRON MAKING (FINEX ROUTE)**			
a)	Coal Briquetting Units	4	60 tons/hr	Molasses will be the binder
b)	Coal Dryer	1	185 tons/hr	LNG fired
c)	Iron Ore Dryer	2	480tons/hr	LNG fired
d)	Hot Compactor	2	340 tons/hr	
e)	FB Reactors	2	180 tons/hr	Air tight reactors fitted with dust cyclones inside
f)	Melter Gasifier	2	230 tons/hr	Fitted with Reduction Shaft on top.
h)	PSA Unit	2	60,000 Ncum/hr	CO_2 separation
B.	**STEEL MAKING**			
a)	BOF Converter	2	370 tons	With secondary refining facilities
b)	Ladle Furnace	1	580 tons	
c)	2 Strands Slab Caster	1	1.5 MT slabs	Continuous slab caster
C.	**MILLS**			
a)	Mini Flat Mill	1	2.5 MT thin slabs	Near neat shaped slabs
b)	Hot Strip Mill	1	2.463 MT HR coils	
D.	**CALCINATION**			
a)	Lime Calcining Plant - Shaft kiln of capacity 300 tons/day	2	0.237 MT burnt lime	Vertical shaft kiln
b)	Dolo Calcining Plant - Rotary kiln of capacity 300 tons/day	2	0.021 MT burnt dolo	Rotary kiln
E.	**AIR SEPARATION PLANT**			

3 - Project Outline (Cont'd)

a)	Oxygen Plant	3	Oxygen - 90,000 N cu m/hr (~3100 TPD) Nitrogen - 0.16 N cu m/hr	Argon recovery
G. CAPTIVE POWER PLANT		4	100 MW	By product gas fired

Fig. 3-4 - Planned use of land area to be acquired

Source: Posco-India

Organisation and Manpower

Indian operations of POSCO for Paradip Integrated Steel Plant will be headed by the Chairman-cum-Managing Director (CMD), who will be assisted by a Deputy Managing Director (DMD) reporting to him. There will be seven divisions as shown in the organisation network in Fig. 3-5. Each Division will be headed by a Director. The seven Divisions as

planned will be (i) Management Support Division, (ii) Marketing Division, (iii) Manufacturing Division, (iv) Maintenance Division, (v) Engineering & Construction Division, (vi) Mining Division, and (vii) Port Division.

For the proposed production phase of 4 MTPY, total manpower requirement for all the seven divisions has been estimated at 7,426 personnel, of which Port Operation will require 19 personnel. Of the total 7,426 personnel, Managerial staff would be 240, Executives 560, Supervisory 752, Office administration 405 and Workmen 5,469.

It is also envisaged that when the proposed steel complex will attain 12 MTPY capacity in future, the total manpower would cross 18,000.

Construction

The essential infrastructure like electricity, telephone, water, road etc will be arranged one year in advance of actual construction work at the project site. The estimated construction volume involves 40,000 Nos. RCC piles, 73,000 steel piles, abt. 15 million cu m dredged sand filling, 1.17 million cum concrete of all grades, 111,825 tons of reinforcement steel, 136,800 tons of structural steel work, 323, 800 tons of equipment erection and 16,330 km cable work. The construction labour force requirement during peak period is estimated at about 17,000.

To execute such voluminous construction work, only resourceful contractor with adequate nos. of construction machineries would be deployed. Due to deployment of mostly local labourers and nearby Paradip Township, no separate labour camp has been felt necessary.

Construction period

3 - Project Outline (Cont'd)

Taking into consideration of the construction volume and delivery schedule of critical facilities, it is planned to construct 4 MTPY production facilities within a period of 36 months so as to start commercial production of Phase-I by the year 2010.

Environmental aspects

In consideration to the prevailing environmental regulations and corporate social responsibilities of Posco-India, the proposed project will be engineered with due concern for environment protection measures and social commitment as addressed in the EIA Report.

Project cost

The Project cost for the proposed 4 MTPY production facilities has been estimated at 3,803 million USD (abt. Rs 17,113 Crores).

3 - Project Outline (Cont'd)

Project 'Go-ahead'

As per terms of MoU with the State Govt. of Orissa in June 2005, Posco-India is interested to set up the proposed steel plant near Paradip. The ground breaking will commence as soon as the necessary statutory clearances are obtained from the concerned Regulating Authorities, both for the Port and the Steel Plant. The present target date for commencing the preliminary construction activities at the project site is April 2007.

4 - PRESENT ENVIRONMENTAL SETTING

The proposed integrated Iron and Steel project has been described in the earlier Chapter. In order to assess the environmental impacts due to the proposed project to be sited on the north western bank of Jatadharmohan River Creek, the present status of the environment prevailing at the project site and its surroundings has been ascertained. This Chapter outlines the present environmental setting of the project site and its surroundings.

Study Area

For the purpose of environmental impact assessment, the study area has been covered in two zones, namely,

- the core zone, the greenfield site, where the proposed project will be come up, and

- the buffer zone, covering an aerial coverage of around 10 km from the core zone periphery excluding the area falling within the sea.

Description of environmental setting of the Study Area

The following text gives a brief description of the present environmental setting as has been ascertained from the primary (monitored) data and partly from the secondary sources. The description covers four major environmental components, namely, (i) physico-chemical, (ii) biological, (iii) human and (iv) aesthetics.

Physico-Chemical aspects

4 - Present Environmental Setting (Cont'd)

The physico-chemical aspects of the present environmental setting cover land, water and air environment.

4 - Present Environmental Setting (Cont'd)

Land environment

Regional setting: The project site on the north western bank of Jatadharmohan River Creek shown in Location Map No. 10971-REIA-ENV-001 is within the jurisdiction of Kujang tehsil of Jagatsinghpur district of Orissa. The geographical location of the project site lies within $20^0 11'$ to $20^0 13'$ North latitude and $86^0 30'$ to $86^0 35'$ East longitude.

On the east of the site is Bay of Bengal and on the northwestern side, there are a number of villages such as Balitutha, Aligarh, Nuagaon, Gobindpur, Dhenkia etc. The only important locality within the region is Paradip port town at a distance of around 12 km north of the project site. Mahanga River flows past on the northwest of the project site. On the southwest of the project site the coast line further extents towards south and there are a number of rural settlements. Paradip area is gradually becoming a coast-based industrial belt of Orissa. Industries like Paradip Phosphate, Oswal Chemicals are in operation at Paradip. Indian Oil Corporation is setting up a refinery just adjacent to the proposed project site on northeast end.

The project site is presently accessible from Kujang on the Cuttack-Paradip State Highway (SH-12) via Baliatutha and Kujangarh. The road is partly metalled. The region *sensu stricto* has a predominant rural setting.

Topography: The study area being a part of Mahanadi delta is a flat land with hardly a relief. Topographic features of the study area is depicted in Survey of India's Topo Map 73 L/7, 8, 11 & 12 (1975 ed). Relevant topographic features of the study area may be seen from the Drg 10971-REIA-ENV-002. The general elevation of the study area varies

from 1m to about 5 m above mean sea level having a peak height of 10 m at the apex of Jatadharmohan River Creek catchment. A few stranded beach ridges in the form of low linear mounds form relatively high grounds of maximum height 6 m. Otherwise the landscape is featureless, an end product of sustained cultural modification of the fertile land of the Mahanadi delta. The topographic features of the study area also include an intricate network of tortuously meandering channels. Some of these channels are distributaries of the Mahanadi River. The landform elements of the southern part of the study area include such coast line features as prograding barrier beach-sand dune-sand spit-creek system separating the inland areas from open sea. The northern part of the Jatadharmohan is a sandy flat with subdued dune topography formed by the prograding and coalescing beach ridge complex of the open sea during the Holocene period.

Geology: The study area is floored by thick Quaternary sediment that is underlain in the sub-surface successively by rocks from early Cretaceous resting on metamorphic basement. The thickness of the Quaternary deposit are in excess of 500 m. It is built up by stacking of repeated sequences of sand, silt and clay beds.

On the surface the delta plain could be divided into two broad areas. The upper delta plain (UDP) lying beyond the tidal influence has been shaped by the fluvial action of the distributaries of the Mahanadi river system providing the landscape of point and channel bars, levee, back swamp, abandoned meander loops and undifferentiated flood plains.

On the seaward side of the UDP, the lower delta plain (LDP) represents a zone shaped by fluvial action, tides and the marine

4 - Present Environmental Setting (Cont'd)

processes. Therefore the geomorphology is variable with low levee on banks of the distributaries, inter-distributary marshes in between the distributaries, stranded beach ridges amidst flood plains, wide mud flats, lagoons, creeks, sand bars, barrier beach/sand spit and active dune-berm-beach face complex facing the open sea depicted in Fig. 4-1.

Details of sub-surface geology of the study area have been provided by wells drilled for exploration of oil and gas in the Mahanadi basin. The onshore part of the study area falling within the "Paradip Depression" (one of the many depressed areas in the basement of the Mahanadi on shore subsurface separated by palaeo-ridges) has a subsurface stratigraphy as given in the Table 4-1 on page 4-5.

4 - Present Environmental Setting (Cont'd)

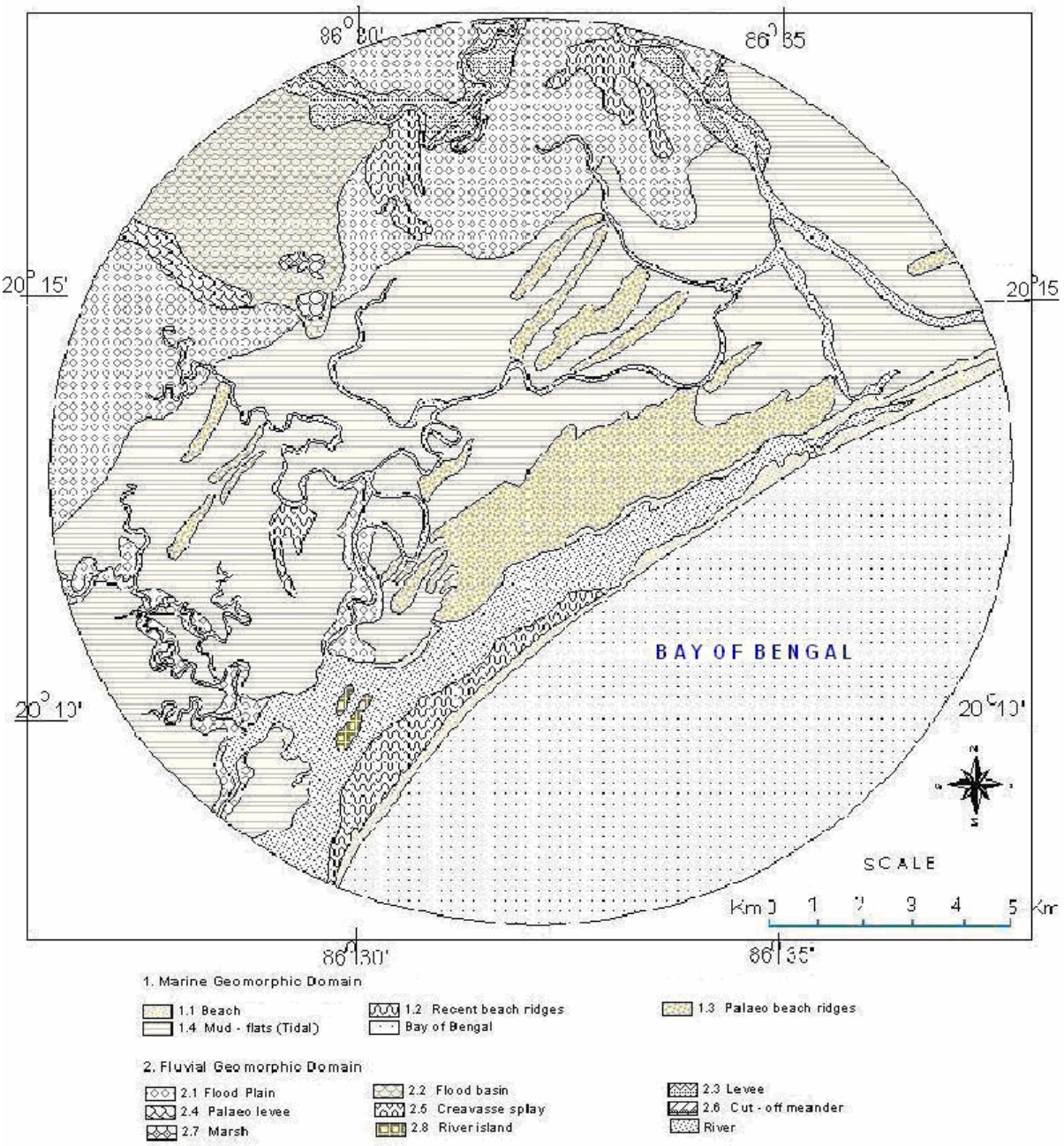


Fig. 4-1 - Geomorphological Map of the Study Area

4 - Present Environmental Setting (Cont'd)

Table 4-1 : Sub-surface stratigraphy in the Paradip Depression of Mahanadi onshore areas

Age	Lithology
Pleistocene to Recent	Unconsolidated sand and clay
Pliocene	Sandstone and claystone/clay
Late Miocene	-
Middle Miocene	Sandstone and claystone
Early Miocene	Sandstone and claystone with occasional coal streaks
Precambrian	Unconformity Metamorphics

According to Oil India Limited, who explored the area for hydrocarbon, the prospect of finding hydrocarbon in the off-shore Mahanadi basin could be rated as good, whereas that of the onshore is not so promising.

Seismology: As per IS:1893 (Part-1) : 2002 of Bureau of Indian Standards, the study area falls in seismic Zone III in a scale of Zone II to Zone V with Zone V being the highest risk zone. Although there is no historical record of significant intensity earthquake occurring in this part of Orissa coastal area, a number of sub-surface faults in the basement have been mapped during geophysical exploration revealing ridges and depressions in the sub-surface.

Drainage: The northern and eastern fringe of the study area is drained by the Mahanadi river and its distributary channel known as Chandpur river in the upstream part and Santra nadi in the downstream tidal reach. Excepting these fringes, tortuously meandering tributaries of

4 - Present Environmental Setting (Cont'd)

the Jatadharmohan nadi drain the study area. These tributaries are Harua nadi that joins the Mahanga River that in turn discharges into the Jatadharmohan Creek.

4 - Present Environmental Setting (Cont'd)

The creek joins into the Bay of Bengal flowing parallel to the coastline for more than 10 km. In the western part of the study area the major tributary stream that drains into the Jatadharmohan creek includes Tegaria nadi that is known as Akmul nadi after it is joined by Saulia nadi from the west. The river is tidal in the downstream stretch. In fact the part of the Mahanadi River falling within the study area is also influenced by tides along its entire stretch. All the coastal rivers and creeks including the Mahanadi river flow parallel to the coast for some distance before they meet the sea. For such stretches they are separated from the sea by beach-dune-bar complex developed through strong longshore current along the coast to the north. The mouths of such creeks and rivers often shift along the coast and are constricted by subaqueous to subaerial bars.

Soil: The soil cover of the study area is alluvial in nature. Typical characteristics of the soil are presented in Table 4-2 on the next page. From the Table, it may be observed that the soil cover is generally greyish in colour and sandy clay in texture. The soil is slightly alkaline to neutral in nature. The hydraulic conductivity is high (around 1.50 x 10^{-3} cu m/sec) due to high percentage of sand in the soil. The nutrient levels in the soil samples as recorded are found to be moderate and the soil appears moderately fertile. Salinity of soil in term of chloride concentration is between 100 and 180 mg/kg. Sodium absorption ratio is also moderate (around 0.5). Microbial population count is high (between 4.2 to 5.2 x 10^6 per gram of soil).

Landuse: The term 'landuse' used in this Report means landuse and land cover both. The landuse of the study area was carried out by utilising three principal resources, namely, (i) SOI Toposheet No. 73

4 - Present Environmental Setting (Cont'd)

L/12; (ii) IRS-P6 LISS III Satellite imageries without any cloud cover in FCC of scale 1:50,000 supplied by National Remote Sensing Agency, Hyderabad (NRSA); and (iii) ground validation for the interpretation of the FCC imagery. The landuse study report may be seen from the Section-I of Field Reports (Vol. II).

Relative distribution of land class units of the study area may be seen from the Fig. 4-2 on page 4-8.

Table 4-2 - Characteristics of Soil Quality in Paradip Study Area

Monitoring Location Map: 10971-REIA-ENV-008

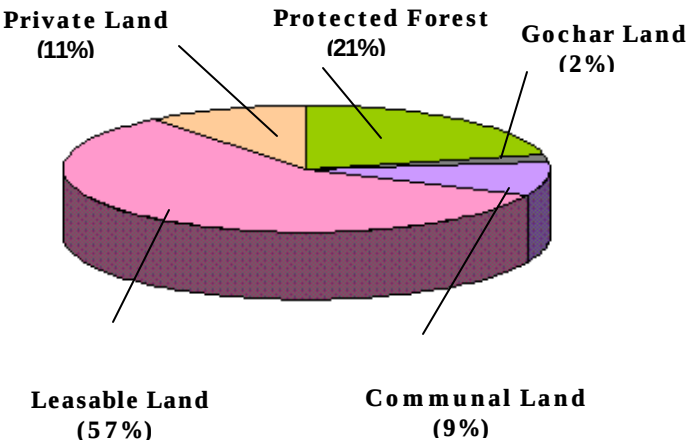
Monitoring Period: Dec'05 - Feb'06

	KUJANG (S1)	UCHANAGAR (S2)	IOCL (S3)
	(9.9.km N)	(4 km W)	(4.6 km NE)
Key Parameters			
Physical:			
Colour	Grayish	Grayish	Grayish
pH	7.1	7.05	7.08
Texture	Sandy clay	Sandy clay	Sandy clay
Alkalinity/Acidity	Very slightly basic	Very slightly basic	Very slightly basic
Sand(%)	50	52	55
Silt(%)	10	10	8
Clay(%)	40	38	38
Moisture(%)	22.15	13.51	22.13
Hydraulic conductivity (cm/sec.)	$1.45X\ 10^{-3}$	$1.48X10^{-3}$	$1.55X10^{-3}$
Bulk Density(gm/cc)	1.52	1.55	1.58
Porosity(%)	43	45	48
Chemical:			
Available Organic Carbon (gm/kg)	8.1	7.8	9.2
Available N_2 (mg/kg)	280	196	196
Available P_2O_5 (mg/kg)	245.27	258.69	260.8
Available K_2O (mg/kg)	65.2	58.5	42.8
Chloride (mg/kg)	184.1	97.46	108.29
Sulphate (mg/kg)	293.4	48.9	265.69
Sodium absorption rate (SAR)	0.58	0.42	0.45
Calcium (mg/kg)	4448.88	4448.88	4448.88
Magnesium (mg/kg)	6660	6660	6660
Iron (mg/kg)	87.2	100.45	112
Copper (mg/kg)	2.315	2.235	4.49
Lead (mg/kg)	1.9	2.15	2.65
Chromium (mg/kg)	bdl	0.125	1.95
Microbial Population (No./ gm)	5.2×10^6	4.8×10^8	4.2×10^6

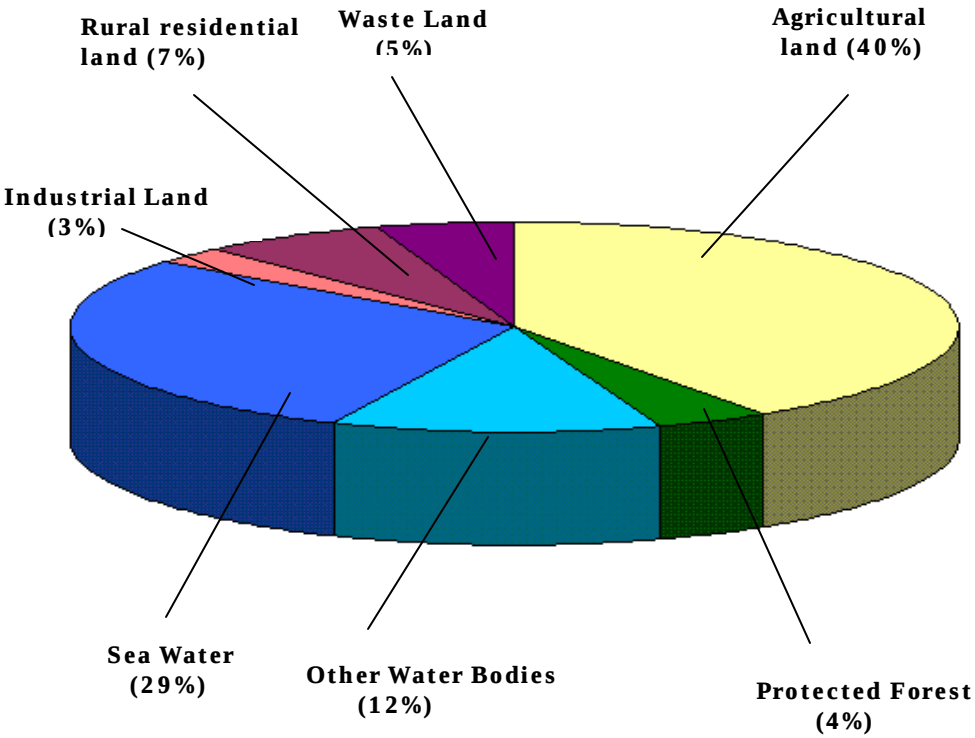
Note:

bdl- below detection limit

4 - Present Environmental Setting (Cont'd)



LANDUSE OF PROJECT SITE (abt 16.2 Sq km)
[AS PER GOVERNMENT LAND SCHEDULE]



LANDUSE OF THE STUDY AREA (Core & Buffer) (abt 314.0 Sq.km)
[AS PER SATTELITE IMAGERY]

Notes: Geographical setting of the study area :

$20^0 11'$ - $20^0 13'$ N Latitude; $86^0 30'$ - $86^0 35'$ E Longitude

Fig. 4-2 : Landuse Pattern of Paradip Study Area

The Core Zone land area occupies protected forest cover of around 341 hectares for which Posco-India have applied for Forest diversion. Betel vines in the study area constitute an important landuse category. Individual isolated plots of these gardens are of smaller dimensions and are not picked up by the ground resolution of 23.5 m x 23. 5 m of the used remote sensed data. Signatures of individual garden as well as clusters of gardens could be picked up in Google Earth Satellite data with ground resolution of 15 m x 15 m. Location of such gardens can be seen in the thematic map presented in Drg No. 10971-REIA-ENV-005.

Cashew plantation is another important landuse category, that is present especially within the Core Zone.

Water environment

Other than sea, the water environment of the study area comprises surface and ground water resources and their characteristics as studied during field investigation period (December 2005-February 2006).

Surface water resource: The study area is exclusively within the catchment of Jatadharmohan River Creek situated in between two major rivers, namely, Mahanadi river to the north and Devi to the south; the latter is beyond the study area.

As stated earlier, the water resource of Jatadharmohan River Creek will by no means be used in the project for catering make up water requirement. Make up water for the plant, township and port will be drawn from Jobra barrage of Mahanadi River near Cuttack at a distance of around 85 km.

4 - Present Environmental Setting (Cont'd)

Sediment transport by Jatadharmohan River Creek: However, Jatadharmohan River Creek being a significant drainage channel of the catchment area has been taken into consideration for sediment transport to the sea. The approximate length of Jatadharmohan River Creek is about 35.2 km. The catchment width is about 24 km at the seaward end. The total catchment area is 422 sq km. The peak discharge of Jatadharmohan River Creek works out around 3,500 cu m/sec. The bank full dominant discharge, which governs the morphological behaviour of the stream, may be assumed at 2.6% of the peak discharge, that is, 90 cu m/sec.

Considering the Musgrave equation (Source: Posco-India Project Report) with an average slope of Jatadharmohan River Creek 10 m in 35 km, and at a rainfall, say 150 mm/hr, the estimated sediment yield for 422 sq km catchment area is around 158,000 tons/year. Perhaps 90% or more of this sediment would be of clayey nature due to typical rural catchment and under equilibrium conditions would pass through the system. The sediment charge in the vicinity shows a range of values between 0.03 and 0.07 parts per 1000 cu m. Assuming a value of 0.07 and a discharge of 90 cu m/sec for say 100 days of the year, the sediments brought down the Jatadharmohan River Creek would be 50,000 to 60,000 tons/year.

Tidal Conditions of the Jatadharmohan River Creek: Tides at the sea front of the study area could be characterised from those observed in Paradip. Tides are mixed, semidiurnal type with an average spring tide range of 1.87 m and a neap tide range of 0.7 m (Paradip Port

4 - Present Environmental Setting (Cont'd)

Tide Table, 2005). Summarised data of tide characteristics during the tidal cycle period are given below:

Highest astronomical tide	..	HAT	+3.06 m
Mean high water spring	..	MHWS	+2.58 m
Mean high water neap	..	MHWN	+2.02 m
Mean sea level	..	MSL	+1.66 m
Mean low water neap	..	MLWN	+1.32 m
Mean low water spring	..	MLWS	+0.71 m
Mean lower low water spring	..	MLLS	+0.64 m
Chart Datum	..	CD	0.00 m

Water level variations of Jatadhar creek at Noliasahi on Jatadhar river is about 0.4 m. The change of tidal phase at Noliasahi was 2 hours later than at Paradip port.

Taking the mean spring tide as 1.87 m, estuary length as 12 km, and the mean width as 645 m at mean sea level, the tidal prism works out to 15.71 million cu m, or 1571 ha m.

The filling of the tidal prism of 1571 ha m in 6.2 hours, gives an average tidal inflow of about 700 m^3/s, with a maximum discharge of 1,000 cu m/s at mid-tide.

Comparing this value with the peak river discharge of 90 m^3/s it is seen that they are of the different order of magnitude, and hence the tidal flows govern hydrodynamics in the Jatadhar estuary.

Waves: Shallow water waves along the sea front of the study area as near Paradip approach the coast from directions ranging from ESE to

4 - Present Environmental Setting (Cont'd)

SW with predominance from southeast and south. Generally deep-water wave condition is moderate with waves coming from SW in the period from April to September and from NE in the period between October and December. The sea conditions are calm in the period between January to March.

The significant wave height off Paradip varies from 0.5 to 3.4 m with a maximum varying between 0.6 to 6.3 m. The wave periods vary from 8 to 15 second.

Currents: Off Paradip the currents are in the NE direction during January to September but they change to SW direction during October to December. Currents are weak during October to December. The current velocity is generally between 0.3 to 0.4 m/s but during southwest monsoon it reaches around 0.8 m/s. Wave-driven currents completely dominate in the surf zone while tidal currents are stronger in deeper water.

Long-shore sediment transport rates: The calculated annual littoral drifts south of Jatadhar river mouth are 1.12×10^6 m^3 per year as gross drift and 0.95×10^6 m^3 per year as net drift towards north. The estimated transport rates are comparable with measured drift rates at Paradip as coastline orientation near Paradip and that south of Jatadhar

River mouth is very similar. The region around the mouth of Jatadhar creek falls within the zone of wave divergence and is therefore in a depositional regime.

4 - Present Environmental Setting (Cont'd)

***Surface water quality*:** The quality of surface water within the study area as monitored during December 2005 to February 2006 is presented in Tables 4-3 & 4-4 on the following pages.

It may be seen from the Table that Mahanga River water near Bhuinyapal village on an average is having high concentration of total dissolved solid (1940 mg/l), chloride (855 mg/l) and sodium (415 mg). DO and BOD levels of the stream at this location are about 5.8 mg/l and 8.3 mg/l respectively. Mahanadi River water near IOCL has somewhat different chemical profile with comparatively low total dissolved solid (186 mg/l), chloride (67 mg/l) and sodium (31 mg/l), but DO. and BOD values remain at the same levels.

Water of the Jatadhari River at Noliasahi village on an average during the monitoring period has very high total dissolved solid (12608 mg/l) with corresponding high values of total hardness (2782 mg/l), chloride (6345 mg/l), sulphate (950 mg/l) and sodium (2300 mg/l).

The Harua River water near Garkujang and at a downstream point shows very high concentration of total dissolved solid (around 9000 mg/l). It has high concentrations of total hardness (between 1070 and 2405 mg/l), chloride (about 5000 mg/l), sulphate (around 1000 mg/l) and calcium (between 109 and 178 mg/l) and sodium (between 1948 and 3515 mg/l).

The Mahanga River near IOCL and further downstream has somewhat contrasting chemical profile. Water in the upstream location is having high concentration of total dissolved solid (4982 mg/l) compared to that in the downstream location (290 mg/l). Water of Mahanga River

4 - Present Environmental Setting (Cont'd)

shows the same difference between upstream and downstream samples in respect of the parameters on page 4-15.

Table 4-3 - Characteristics of Surface Water Quality

Monitoring Location Map: 10971-REIA-ENV-008

Frequency of monitoring :- Once a month

Monitoring Period :- Dec'05 - Feb'06

W_1 : Mahanga Nadi near Bhuinyapal Village (2.5 km W)
W_2 : Harua River near Garkujang (3.7 km W)
W_3 : Jatadhari River near Noliasahi village (Adjacent to W of project site)
W_4 : Mahanga Nadi near IOCL SPPL (1.2 km N)

Parameters	W_1	W_2	W_3	W_4
Physical+B37				
Odour(TON)	Odourless	Odourless	Odourless	Odourless
Temperature	25.83	27.50	26.33	27.67
Total Suspended Solids (mg/l)	62.10	68.33	51.67	110.50
Total Dissolved Solids (mg/l)	1939.33	9225.33	12608.00	4982.67
Chemical				
pH	7.14	7.07	7.47	7.49
Total Hardness (mg/l)	304.43	2405.07	2782.13	1391.30
Dissolved Oxygen (mg/l)	5.80	6.00	6.07	5.13
BOD . 3 days at 270C (mg./l)	8.33	6.33	6.67	13.33
CBOD. 3 days at 270C (mgl)	6.00	5.00	5.00	10.00
COD (mg./l)	39.73	27.64	34.73	61.03
Oil & Grease (mg./l)	NIL	NIL	NIL	NIL
Total Kjeldahl Nitrogen (mg/l)	1.88	1.33	1.30	1.64
Chloride (mg/l)	858.33	5721.69	6345.61	4063.37
Sulphates as SO4 (mg/l)	108.33	972.69	949.88	763.42
Bi-Carbonate (mg/l)	110.00	154.53	145.73	170.80
Phosphate (mg/l)	1.16	0.38	0.68	0.49
Calcium (mg/l)	54.66	178.52	217.23	157.22
Magnesium (mg/l)	40.52	470.08	535.43	239.90
Sodium (mg/l)	414.33	1948.67	2300.17	1490.42
Manganese (mg/l)	BDL	BDL	BDL	BDL
Zinc (mg/l)	0.09	0.06	0.11	0.09
Iron (mg/l)	1.04	1.08	1.11	1.08
Chromium (Total) (mg/l)	BDL	BDL	BDL	BDL
Chromium+6 (mg/l)	BDL	BDL	BDL	BDL
Arsenic (mg/l)	BDL	BDL	BDL	BDL
Mercury (mg/l)	BDL	BDL	BDL	BDL
Cadmium (mg/l)	BDL	BDL	BDL	BDL
Bacteriological (MPN/ 100 ml)				
Total Coliform	11.9×10^2	11.2×10^2	8.5×10^2	12.3×10^2
Faecal Coliform	9.6×10^2	8.5×10^2	6.4×10^2	9.2×10^2

f:\sj\p

Note:
(a) bdl - below detection limit

4 - Present Environmental Setting (Cont'd)

Table 4-4 - Characteristics of Surface Water Quality

Monitoring Location Map: 10971-REIA-ENV-008

Frequency of monitoring :- Once a month

Monitoring Period :- Dec'05 - Feb'06

W_5 : Mahanadi near IOCL Lockgate (10.0 km NE)

W_6 : Harua River (downstream) (3.5 km N)

W_7 :Mahanga River (downstream) (2.6 km N)

Parameters	W_5	W_6	W_7
Physical			
Odour (ton)	Odourless	Odourless	Odourless
Temperature	27.50	28.75	27.75
Total Suspended Solids (mg/l)	56.60	83.00	40.50
Total Dissolved Solids (mg/l)	186.67	8903.00	290.00
Chemical			
pH	7.32	7.01	7.23
Total Hardness (mg/l)	97.57	1071.15	111.00
Dissolved Oxygen (mg/l)	5.87	5.40	6.20
BOD , 3 days at 270C (mg./l)	7.33	13.50	5.00
CBOD, 3 days at 270C (mgl)	5.33	10.50	4.00
COD (mg./l)	31.23	56.84	21.56
Oil & Grease (mg./l)	NIL	NIL	NIL
Total Kjeldahl Nitrogen (mg/l)	1.08	1.75	0.87
Chloride (mg/l)	66.95	4900.61	82.65
Sulphates as SO4 (mg/l)	21.16	1045.80	17.02
Bi-Carbonate (mg/l)	117.93	146.40	122.00
Phosphate (mg/l)	0.21	0.89	0.29
Calcium (mg/l)	21.57	108.99	22.24
Magnesium (mg/l)	10.59	191.81	13.32
Sodium (mg/l)	31.17	3515.00	30.50
Manganese (mg/l)	BDL	BDL	BDL
Zinc (mg/l)	0.07	0.14	0.08
Iron (mg/l)	1.14	1.07	1.08
Chromium (Total) (mg/l)	BDL	BDL	BDL
Chromium+6 (mg/l)	BDL	BDL	BDL
Arsenic (mg/l)	BDL	BDL	BDL
Mercury (mg/l)	BDL	BDL	BDL
Cadmium (mg/l)	BDL	BDL	BDL
Bacteriological (MPN/ 100 ml)			
Total Coliform	1.4×10^3	7.8×10^2	9.3×10^2
Faecal Coliform	1.1×10^3	6.0×10^2	7.3×10^2

Note:

(a) bdl - below detection limit

4 - Present Environmental Setting (Cont'd)

Parameters	Upstream	Downstream
	mg/l	mg/l
Total hardness	1390	111
Chloride	4063	83
Sulphate	763	17
Calcium	157	22
Magnesium	240	13
Sodium	1490	30

The chemical quality of Mahanadi River water near IOCL Lock gate has a profile similar to that of Mahanga River (downstream).

Water samples from the surface streams show dissolved iron concentration varying between 1.04 and 1.14 mg/l. No traces of oil and grease and heavy metals (chromium, arsenic, mercury, cadmium etc) have been observed in any sample. The water is bacteriologically contaminated with high percentage of faecal coliform and can not be used for bathing.

Ground water resource: In order to ascertain the ground water potential in the study area, Geo-hydrological Study was taken up during the period 2005-06. The Geo-hydrological aspects of the study area are appended in Section II of Field Reports (Vol. II).

Sub-surface geology controls the occurrence and movement of ground water. As stated earlier, the area is undertaken by Quaternary sediments consisting of a succession of clay, silty clay, sand and sand

4 - Present Environmental Setting (Cont'd)

mixed gravel. Ground water occurs both under unconfined and confined conditions.

For example, ground water in the shallow sand, silty clay and clay zone occurs under unconfined conditions which in the deeper granular zones, is under confined condition.

4 - Present Environmental Setting (Cont'd)

There is a wide variation in the disposition of fresh and saline ground water bodies both in lateral and vertical directions. The upper aquifers are generally saline down to 40 to 60 m below ground and at places reversal of salinity profile is also present. A second system of fresh water aquifers is encountered in the depth range of 135 to 290 metres.

Piezometric surface was measured from hydrograph network stations of the month during December 2005 as well as in May 2006. During post-monsoon period, that is in the month of December, in the deeper zones [> 60 m below ground level (bgl)], the piezometric surface lies very close to surface. The depth to piezometric surface in that area was shallow ranging from 0.52 to 3.8 metres below ground level, while the depth to water (measured in dugwell) of the shallower aquifer zones (<60 m bgl) lies slightly at deeper level generally ranging between 0.7 to 3.45 m bgl. The deepest depth to water table in the shallower aquifer was also recorded at Garh Kujang. At the project site proper (Core Zone), the depth to piezometric surface ranges from 0.5 to 1.89 m bgl for deeper aquifer.

Similarly, in the pre-monsoon period, the piezometric surface of the confined aquifer system (>60 m bgl) was between 0.37 to 4.45 bgl, while the depth to water table of the shallow aquifer zones (<60 m bgl) was between 1.65 to 4.9 m bgl. At the project site, the depth to piezometric surface ranged between 1.2 to 2.85 m bgl.

Hydraulic characteristics like hydraulic conductivity, storativity and transmissivity are required for assessment for ground water potential. Field pumping test results of Geological Survey of India,

4 - Present Environmental Setting (Cont'd)

Central Ground Water Board in and around the study area record the hydraulic parameters as given in Table 4-5 on the next page.

The Hydrological Atlas of Orissa (1995) prepared by Central Ground Water Board reveals the area under investigation falls under high yield zone with yield greater than 40 litres per second.

4 - Present Environmental Setting (Cont'd)

Table 4-5 - Hydraulic Parameters of the Aquifers in the study area

Parameter	Machgaon		Ersama		Kujang	
	Saline	Fresh	Saline	Fresh	Saline	Fresh
Aquifer zone (m)	52-100 100-600	0-52	0-137 312-609	137-312	0-90 140-250	100-130
Hydraulic conductivity (m/day)	-	174	-	189	-	189
Trans-missivity (sq m/day)	935	5672	388	4721	388	4721
Storativity	-	$2.0x10^{-4}$	-	$2.0x10^{-4}$	-	$8.81x10^{-6}$
Yield (cu m/m)	3.334	5.448	3.334	5.448	3.334	5.448

Source: Central Ground Water Board

Ground water quality: The quality of ground water was recorded at selected three sites as presented in Table 4-6 on the next page for preliminary investigation. However, during geo-hydrological investigation of the study area, more data were generated in respect of shallow aquifer and deep aquifer water quality as presented in Table 4-7, 4-8 and 4-19 on pages 4-19, 4-20 and 4-21 respectively. From the ground water quality data generated during field investigation, the summary characteristics of the same are described below:

Quality of ground water in the shallow aquifer generally improves towards the sea. The ground water is neutral to mildly alkaline with pH ranging from 6.44 – 7.35. At places turbidity of the shallow aquifer is much higher than the permissible limit of the Indian drinking Water

4 - Present Environmental Setting (Cont'd)

Standard. The electrical conductance of shallow ground water is in the range of 420–1910 µs/cm. The total dissolved solids (TDS) are in the range of 285 – 1188 mg/L. The TDS concentrations are mostly above the desirable limit of Indian standard, but within the permissible limit. All major cations and anions are

4 - Present Environmental Setting (Cont'd)

Table 4-6 - Characteristics of Ground Water Quality

Monitoring Location Map: 10971-REIA-ENV-008

Frequency of monitoring :- Once a month

Monitoring Period :- Dec'05 - Feb'06

GW_1: Chatua Tubewell (6.6 km N)
GW_2 : Kujang Village (9.9 km N)
GW_3 : Paradeep Village (9.8 km NE)

Parameters	GW_1	GW_2	GW_3
Physical			
Odour (TON)	Odourless	Odourless	Odourless
Colour (Hazen)	1.33	1.00	1.67
Taste	Acceptable	Acceptable	Acceptable
Temperature (0C)	25.33	24.50	25.17
Turbidity (NTU)	12.33	3.67	2.67
Total Dissolved Solid (mg/l)	2604.67	204.00	346.00
Chemical (mg/l)			
pH	6.97	7.05	7.36
Alkalinity (mg/l)	213.33	96.67	213.33
Total Hardness (mg/l)	1118.37	125.83	267.83
Nitrate (mg/l)	1.28	0.83	0.91
Fluoride (mg/l)	bdl	bdl	bdl
Phenol (mg/l)	bdl	bdl	bdl
Total Nitrogen (mg/l)	2.09	1.57	1.37
Boron (mg/l)	bdl	bdl	bdl
Chloride (mg/l)	1523.99	33.30	69.49
Sulphate (mg/l)	114.98	18.13	26.59
Cyanide (mg/l)	bdl	bdl	bdl
Calcium (mg/l)	266.46	25.89	44.36
Manganese (mg/l)	0.11	0.10	0.15
Magnesium (mg/l)	109.52	14.69	36.82
Zinc (mg/l)	0.16	0.11	0.11
Aluminium (mg/l)	bdl	bdl	bdl
Iron (mg/L)	3.88	0.58	0.31
Chromium (mg/l)	bdl	bdl	bdl
Copper (mg/l)	bdl	bdl	bdl
Mercury (mg/l)	bdl	bdl	bdl
Cadmium (mg/l)	bdl	bdl	bdl
Sodium (mg/l)	498.40	13.43	23.23
Arsenic (mg/l)	bdl	bdl	bdl
Lead (mg/l)	bdl	bdl	bdl
Bacteriological (MPN/ 100 ml)			
Total Coliform	Nil	Nil	Nil
Faecal Coliform	Nil	Nil	Nil

Note:
bdl - below detection limit

Table 4-7 - Characteristics of Ground Water Quality of Shallow Aquifer (< 60 m depth)

Parameter	Location Numbers				
	C_3	C_{11}	C_{16}	C_{23}	C_{25}
Colour	Colourless	Colourless	Colourless	Colourless	Colourless
Odour	Odourless	Odourless	Odourless	Odourless	Odourless
Taste	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable
pH	7.35	7.25	6.44	7.13	7.2
Turbidity (NTU)	<5.0	<5.0	<5.0	8.0	15.0
EC (µs/cm at 25°C)	1910.0	900.0	420.0	890.0	1092.0
TDS (mg/l)	1188.0	598.0	285.0	586.0	670.1
Total Alkalinity (mg/l)	215.0	310.0	50.0	160.0	160.0
Total Hardness (mg/l)	448.0	304.0	116.0	100.0	147.0
Bicarbonate (mg/l)	262.3	378.2	61.0	195.2	195.2
Calcium (mg/l)	96.19	54.5	27.25	20.84	24.1
Magnesium (mg/l)	50.7	50.0	11.7	11.7	12.2
Sodium (mg/l)	295.0	115.0	52.0	182.01	185.0
Potassium (mg/l)	29.0	10.0	5.0	7.2	9.3
Chloride (mg/l)	560.0	140.0	90.0	210.0	220.0
Sulphate (mg/l)	50.9	29.3	24.4	48.9	44.1
Phosphorus (mg/l)	0.162	0.01	0.44	6.53	0.05
Nitrate (mg/l)	0.35	0.27	0.13	0.9	0.85
Fluoride (mg/l)	<0.01	<0.01	<0.01	0.75	0.33
Phenol (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001
Boron (mg/l)	<0.05	<0.05	<0.05	<0.05	<0.05
Iron (mg/l)	0.4	1.9	2.0	0.4	0.55
Arsenic (mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01
Selenium (mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01
Manganese (mg/l)	0.1	0.52	0.61	0.13	0.18
Aluminium (mg/l)	<0.03	<0.03	<0.03	<0.03	<0.03
Chromium (mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01
Cadmium (mg/l)	<0.005	<0.005	<0.005	<0.005	<0.005
Zinc (mg/l)	0.21	0.77	1.0	0.3	0.35
Lead (mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01

4 - Present Environmental Setting (Cont'd)

C_3 - Chatua Village
C_{11} - Kanaguli Village
C_{16} - Balitut Village
C_{23} - Partappur Village
C_{25} - Abhoychandipur

All villages are in Ersama Block of the study area.

Table 4-8 - Characteristics of Ground Water Quality of Deep Aquifer (> 60 m depth)

Parameter	Location Numbers				
	C2/2	C4/4	C8/8	C14/14	C15/15
Colour	Colourless	Colourless	Colourless	Colourless	Colourless
Odour	Odourless	Odourless	Odourless	Odourless	Odourless
Taste	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable
pH	7.4	7.55	7.45	7.1	6.83
Turbidity (NTU)	6.1	<5.0	8.0	<5.0	10.0
EC (µs/cm at 25°C)	1340.0	355.0	940.0	840.0	760.0
TDS (mg/l)	864.0	255.0	614.0	555.0	525.0
Total Alkalinity (mg/l)	255.0	125.0	250.0	289.0	295.0
Total Hardness (mg/l)	428.0	108.0	296.0	384.0	376.0
Bicarbonate (mg/l)	311.1	152.5	305.0	352.6	359.9
Calcium (mg/l)	54.5	30.46	54.5	63.8	60.92
Magnesium (mg/l)	72.3	7.8	39.1	10.8	30.1
Sodium (mg/l)	196.0	58.0	135.0	98.7	101.0
Potassium (mg/l)	25.0	2.5	4.0	7.9	9.0
Chloride (mg/l)	330.0	72.0	180.0	100.2	110.0
Sulphate (mg/l)	34.0	3.6	40.0	32.1	30.0
Phosphorus (mg/l)	0.015	0.379	0.02	0.35	0.44
Nitrate (mg/l)	0.07	0.17	0.19	0.19	0.17
Fluoride (mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01
Phenol (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001
Boron (mg/l)	<0.05	<0.05	<0.05	<0.05	<0.05
Iron (mg/l)	2.6	0.34	1.2	1.7	5.5
Arsenic (mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01
Selenium (mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01
Manganese (mg/l)	0.7	0.1	0.35	0.17	1.2
Aluminium (mg/l)	<0.03	<0.03	<0.03	<0.03	<0.03
Chromium (mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01
Cadmium (mg/l)	<0.005	<0.005	<0.005	<0.005	<0.005

4 - Present Environmental Setting (Cont'd)

Parameter	Location Numbers				
	C2/2	C4/4	C8/8	C14/14	C15/15
Zinc (mg/l)	1.1	0.25	0.89	2.1	1.8
Lead (mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01

C_2 - Arakhi Village of Kujang Block
C_4 - Nuagaon Village of Ersama Block
C_8 - Banipotkandha of Ersama Block
C_{14} - Delka Village of Ersama Block
C_{15} - Baratal Village of Ersama Block

Table 4-9 - Characteristics of Ground Water Quality of Deep Aquifer (> 60 m depth)

Parameter	Location Numbers				
	C18/18	C19/19	C25/25	C27/27	C28/28
Colour	Colourless	Colourless	Colourless	Colourless	Colourless
Odour	Odourless	Odourless	Odourless	Odourless	Odourless
Taste	Agreeable	Agreeable	Agreeable	Agreeable	Agreeable
pH	7.3	6.63	6.6	7.2	7.46
Turbidity (NTU)	<5.0	21.0	5.6	<5.0	<5.0
EC (µs/cm at 25°C)	1930.0	280.0	196.0	260.0	1990.0
TDS (mg/l)	1212.0	179.0	140.0	165.0	1210.0
Total Alkalinity (mg/l)	210.0	110.0	65.0	105.0	275.0
Total Hardness (mg/l)	588.0	100.0	64.0	100.0	176.0
Bicarbonate (mg/l)					
Calcium (mg/l)	89.78	30.46	19.23	32.1	32.06
Magnesium (mg/l)	88.77	5.84	3.9	4.84	23.41
Sodium (mg/l)	270.0	20.0	19.0	25.0	425.0
Potassium (mg/l)	18.0	2.5	1.3	3.2	25.0
Chloride (mg/l)	580.0	20.0	20.0	32.1	550.0
Sulphate (mg/l)	49.7	4.4	11.69	3.5	0.52
Phosphorus (mg/l)	0.03	0.064	0.3	0.06	0.014
Nitrate (mg/l)	0.35	0.13	0.8	0.15	0.053
Fluoride (mg/l)	<0.01	<0.01	0.47	<0.01	<0.01
Phenol (mg/l)	<0.001	<0.001	<0.001	<0.001	<0.001
Boron (mg/l)	<0.05	<0.05	<0.05	<0.05	<0.05
Iron (mg/l)	2.6	0.34	1.2	1.7	5.5
Arsenic (mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01
Selenium (mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01
Manganese (mg/l)	1.1	0.1	2.2	0.19	0.09
Aluminium (mg/l)	<0.03	<0.03	<0.03	<0.03	<0.03
Chromium (mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01
Cadmium (mg/l)	<0.005	<0.005	<0.005	<0.005	<0.005
Zinc (mg/l)	1.5	0.35	0.25	0.3	2.0
Lead (mg/l)	<0.01	<0.01	<0.01	<0.01	<0.01

C_{18} - Kankardia Village of Ersama Block
C_{19} - Ranipahar Village of Kujang Block
C_{25} - Abhoychandipur Village of Ersama Block
C_{27} - Gobindapur Village of Ersama Block
C_{28} - Jhimani Village of Kujang Block

4 - Present Environmental Setting (Cont'd)

within the permissible limit. It is important to note that the shallow ground water is free from heavy toxic metals likes Copper (Cu), Cadmium (Cd), Chromium (Cr), Lead (Pb), arsenic (As), Aluminium (Al) and Selenium (Se).

The quality of ground water of deeper aquifer indicates that the groundwater is neutral to mildly alkaline with pH ranging from 6.63 – 7.55. At places turbidity of this aquifer is much higher than the permissible limit of the Indian Drinking Water Standard. The electrical conductance is in the range of 260 – 1990 µs/cm, and the total dissolved solids (TDS) are in the range of 140– 1212 mg/L. The TDS concentrations are mostly above the desirable limit of Indian standard, but within the permissible limit.

The ground water in this region is generally moderately hard. Concentration of total hardness and alkalinity are within the permissible limits of IS:10500 : 1991. The deeper ground water is also free from heavy toxic metals likes Copper (Cu), Cadmium (Cd), Chromium (Cr), Lead (Pb), Arsenic (As), Aluminium (Al) and Selenium (Se) and all major cations and anions are within the permissible limit. Analysis of water samples through Piper's diagram [see Section II of Field Reports (Vol. II)] indicates that all the shallow and deep aquifer samples fall within the field where carbonate hardness (secondary alkalinity) exceeds 50% of all dissolved solids indicating water of carbonate type.

Suitability of ground water for irrigation in terms of the sodium absorption ratio (SAR) has been worked out as per Richards's method (1954). The analysis indicates that majority of the ground water samples belong to C2S1 – C3S1 which indicates that they are suitable for irrigation

4 - Present Environmental Setting (Cont'd)

without any hazard to crops. However, four shallow ground water sample locations fall in the medium salinity hazard class and one deep ground water sample location fall within high salinity hazard class.

4 - Present Environmental Setting (Cont'd)

Air environment status

The air environment in the study area was studied during the period from December 2005 to February 2006 as the dry months of the year. The observations are recorded as follows:

Climate: The regional climate at Paradip is humid tropical. Climatic Normals prepared by India Meteorological Department, Pune (IMD) indicate that the day temperature during the months of April to June ranges from 33 to 36 degree Celsius, whereas the minimum night temperature remains within 21 to 22 degree Celsius. The lowest temperature recorded was 12^0C as against highest temperature recorded was 41.4^0C in the month of May. The relative humidity (RH) is uniformly high of the order of 80 per cent throughout the year except during winter period (Dec/Jan) it becomes marginally lower to 70 per cent.

The annual average rainfall at Paradip area is around 1600 mm and nearly 50 per cent of the total rainfall takes place during the period from June to August due to strong monsoon conditions.

Normal wind speed ranges from 10 to 24 kmph; the area remains generally windy during April to June. The wind blows predominantly from SouthWest (SW) during the period from March to September and for rest part of the year wind generally blows from north and northeast directions as shown in monthly Windrose diagram in Fig. 4-3 on the next page.

Depressions, storms and cyclones: In the past 200 years, for the period 1804-2004, more than 100 cyclones/storms of different intensities have hit the Orissa Coast (Source: National Centre for Atmospheric Research). The formation of storms and depressions is negligible during January to March and very high during October and November months.

4 - Present Environmental Setting (Cont'd)

Monsoon depressions form in the head Bay and move towards Orissa Coast during SW monsoon season (May-August). The frequency of occurrence of cyclonic storms is highest during October. A total of 33 cyclonic storms have crossed the coast within a radius of 200 km from Paradip port during the period 1971 to 1995, of which 7 were cyclonic storms.

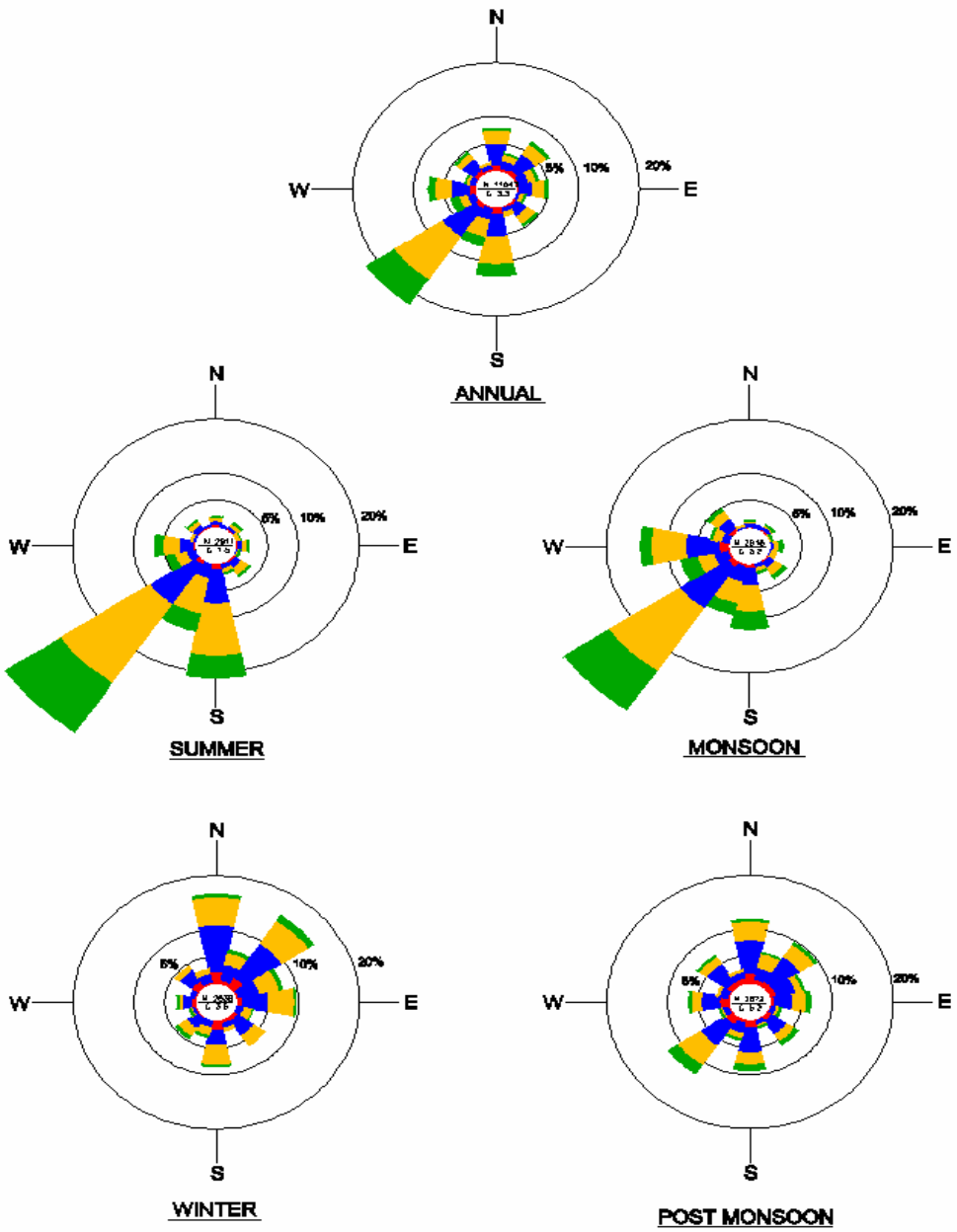


Fig. 4-3 - Windrose Diagram at Paradip, Orissa

The most destructive element associated with an intense cyclone is storm surge. Past history indicates that loss of life is significant when surge magnitude is 3 m or more. The severity of cyclone occurs when wind speed reaches 89 to 118 kmph, very severe cyclone when wind speed ranges in between 119 to 221 kmph and the wind speed due to Super Cyclonic storm exceeds 222 kmph.

Paradip and its adjoining areas in recent times faced super cyclones on 29th October 1999 having wind speed as high as 260 kmph and the radius of maximum wind was 10 to 15 km. While crossing the coast, the Super Cyclone produced 5.5 m storm surge above Chart Datum for above 6-7 hours duration, which inundated land up to about 30 km inland. This had a toll of nearly 9500 human lives and 10 million people got affected.

Tsunami

A tsunami hitting the eastern coast, including West Bengal and Orissa, on December 26, 2004 had not caused the devastation we now have come to associate with tsunamis after this disaster. The height of the waves was approximately one metre and its damage was minimal. However, there remains a possibility of an earthquake occurring in the east with its epicentre lying in the seabed off Chittagong coast, which is 'quake prone', and in its wake tidal waves hitting the Bengal and Orissa coasts.

Site-specific micro-meteorology: In order to determine the micro-meteorological conditions of the study area, a temporary continuous weather monitoring station was set up at Paradip and recording of monitoring data started from December 2005. This station had no

4 - Present Environmental Setting (Cont'd)

facilities for monitoring of atmospheric inversion. The site-specific summarised micrometeorological recordings from December 2005 to February 2006 (winter season) are presented in the Table 4-10 on the next page.

4 - Present Environmental Setting (Cont'd)

Table 4-10 - Summary of Micro-Meteorological Recordings of the Paradip Study Area

Monitoring site :
Location: Kujang
Lat/Long:
Elevation above MSL: 5 m

Climatic Normal:
Station: Paradip Port
Lat/Long: 20^{0}18' N/86^{0}41'E
Elevation above MSL: 8 m

Parameters	Winter		Summer		Monsoon		Post-monsoon	
	M	CN	M	CN	M	CN	M	CN
Max. DB Temp. (^{0}C)	37.0	29.1	-	33.1	-	32.7	-	32.0
Avg. DB Temp. (^{0}C)	21.8	23.1	-	28.7	-	28.9	-	27.8
Relative humidity (%)	72.6	74.5	-	81.6	-	85.0	-	80.0
Avg. wind speed, (kmph)	7.6	12.3	-	21.5	-	20.1	-	13.5
Predominant wind direction	N,NNW	N,NE	-	SW,S	-	SW,S	-	SW,S
Total rainfall (mm)	19.4	45.8	-	104.5	-	900.0	-	557.9

Notes: M-Monitored data – December 2005 to February 2006
CN - Climatic Normals (Source: IMD, Pune)

From the Table, it may be seen that wind speed recorded during the monitoring period is moderate which can facilitate effective dispersion of air borne pollutants. Fig.4-3 presents wind rose diagram based on historical data as made available by India Meteorological Department, Pune (IMD). The diagram depicts that most part of the year, wind blows from south/south-west except in winter, it blows from north/north-east.

Prevailing Ambient air quality (AAQ)

4 - Present Environmental Setting (Cont'd)

The study area is predominantly rural and the important locality is Paradip town. The principal road is Cuttack-Paradip State Highway terminating at Paradip port. The project site and its surroundings in that respect have no such road except narrow rural roads having less vehicular movement. There are no large industries as such.

For the present study, AAQ was ascertained from the 8 Nos. fixed AAQ monitoring stations on the following basis:

Basis of AAQ stations locations: The selection of the 8 AAQ monitoring locations was principally governed by the windrose pattern for the winter season and also the accessibility of the selected sites. Attempts
were made to locate the AAQ stations as shown in Drg. No. 10971-REIA-ENV-007 at reasonably right place to get a representative picture of the prevailing/baseline air quality, that are detailed below.

Station Code	Place	Aerial distance from the steel plant site		Justification
A_1	Eribina	7.0	km W	Rural residential area
A_2	Uchanugan	4.0	km W	Rural residential area
A_3	Chatua	6.2	km N	Rural residential area
A_4	Khuranta	2.6	km W	Rural Residential area
A_5	Paradip	9.3	km NE	Industrial area
A_6	IOCL (Ronaigarh)	4.6	km NE	Rural residential area to be converted to industrial area
A_7	Kujang	9.6	km N	Rural residential area
A_8	Badagapur	3.0	km N	Rural residential area

4 - Present Environmental Setting (Cont'd)

AAQ as recorded: Station-specific AAQ data as recorded during the period from December 2005 to February 2006 are summarised in Tables 4-11 and 4-12 on the following pages. Graphic representation of 98 percentile data of suspended particulate matter (SPM), respirable dusts below 10 microns (RD), Sulphur dioxide (SO_2) and Oxides of nitrogen (NOx) are presented in Fig. 4-4 & 4-5 on page 4-30 and 4-31 respectively.

It may be seen from the Figures that the recorded values of conventional air pollutants like SPM, RD, SO_2 and NOx lie well within the allowable limits of National Ambient Air Quality Standards (NAAQS) for the rural areas. As there is hardly any vehicular traffic load, Carbon monoxide

4 - Present Environmental Setting (Cont'd)

Table 4-11 - Ambient Air Quality at Paradip Study Area

Monitoring Location Map: 10971-REIA-ENV-008

MONITORING PERIOD : Dec'05 - Feb'06

Frequency of monitoring : Weekly Twice

Pollutants in mcg/cum

Station Code	Location	Monitored values	Max (8 hrs)	Min (8 hrs)	Average (24 hrs)	P_{98} (8hrs)	NAAQS
A1	Eribina (Rural Area) 7 km W	**RPM(<10 micron)**	68.2	24.6	41.0	61.6	**100**
		SPM	135.2	62.4	102.2	129.7	**200**
		SO2	6.9	2.0	2.8	6.3	**80**
		NO_x	34.6	7.2	13.8	31.0	**80**
		CO (8 hrs)	bdl				
A2	Uchanugan (Rural Area) 4 km W	**RPM(<10 micron)**	69.2	25.8	40.8	67.3	**100**
		SPM	135.5	62.1	99.5	131.8	**200**
		SO2	5.8	2.0	2.7	5.7	**80**
		NO_x	25.3	5.9	12.8	24.1	**80**
		CO (8 hrs)	bdl				
A3	Chatua (Rural Area) 6.2 km W	**RPM(<10 micron)**	54.2	24.2	39.2	52.1	**100**
		SPM	132.8	62.4	97.7	124.5	**200**
		SO2	5.8	2.0	2.5	5.5	**80**
		NOX	23.2	5.9	12.3	21.3	**80**
		CO (8 hrs)	bdl				
A4	Khurantha (Rural Area) 2.6 km W	**RPM(<10 micron)**	55.5	18.4	39.1	55.1	**100**
		SPM	140.3	62.4	97.5	138.1	**200**
		SO2	5.8	2.0	2.6	5.5	**80**
		NO_x	25.5	6.1	12.0	24.5	**80**
		CO (8 hrs)	bdl				

Notes:
(1) bdl - below detection limit
(2) Method of measurement - as per schedule VII of National Ambient Air Quality Standard (NAAQS of CPCB)

4 - Present Environmental Setting (Cont'd)

Table 4-12 - Ambient Air Quality at Paradip Study Area

Monitoring Location Map: 10971-REIA-ENV-008

MONITORING PERIOD : Dec'05 - Feb'06

Frequency of monitoring : Weekly Twice

Pollutants in mcg/cum

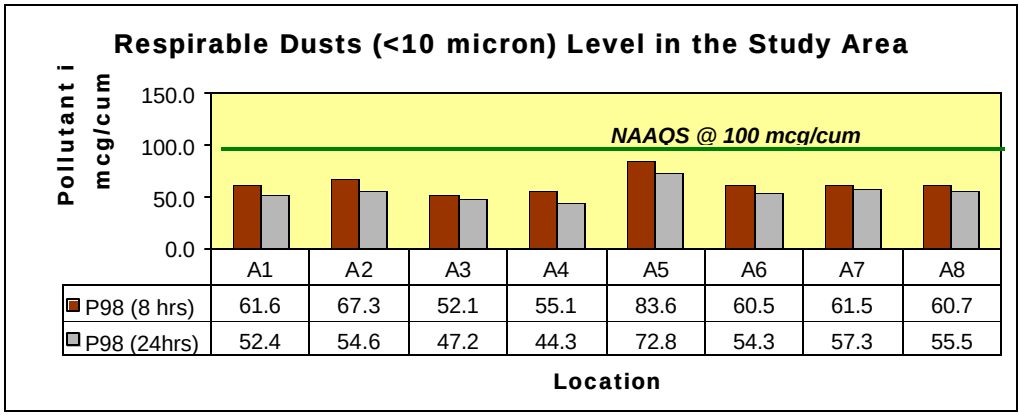
Station Code	Location	Monitored values	Max (8 hrs)	Min (8 hrs)	Average (24 hrs)	P_{98} (8hrs)	NAAQS
A5	Paradip (Industrial Area) 9.3 km NE	**RPM(<10 micron)**	91.2	35.1	58.4	83.6	**150**
		SPM	161.5	67.2	114.5	154.6	**500**
		SO2	18.3	2.0	7.9	15.9	**120**
		NOX	48.5	10.5	24.3	44.3	**120**
		CO (8 hrs)	500.0	250.0	347.7	500.0	**5000**
A6	IOCL (Roniagarh) (Rural Area) 4.6 km NE	**RPM(<10 micron)**	61.2	24.9	42.2	60.5	**100**
		SPM	168.5	58.2	106.7	150.1	**200**
		SO2	10.5	2.0	3.1	7.0	**80**
		NOX	32.6	6.5	15.7	32.1	**80**
		CO (8 hrs)	bdl				
A7	Kujang (Rural Area) 9.6 km N	**RPM(<10 micron)**	68.1	25.5	44.9	61.5	**100**
		SPM	157.3	61.4	105.6	145.3	**200**
		SO2	7.5	2.0	3.2	7.3	**80**
		NOX	35.5	6.2	18.1	32.5	**80**
		CO (8 hrs)	bdl				
A8	Badagapur (Rural Area) 3 km N	**RPM(<10 micron)**	61.4	24.1	43.3	60.7	**100**
		SPM	135.2	61.1	98.5	132.6	**200**
		SO2	7.1	2.0	3.1	6.7	**80**
		NOX	35.1	6.2	16.3	32.8	**80**
		CO (8 hrs)	bdl				

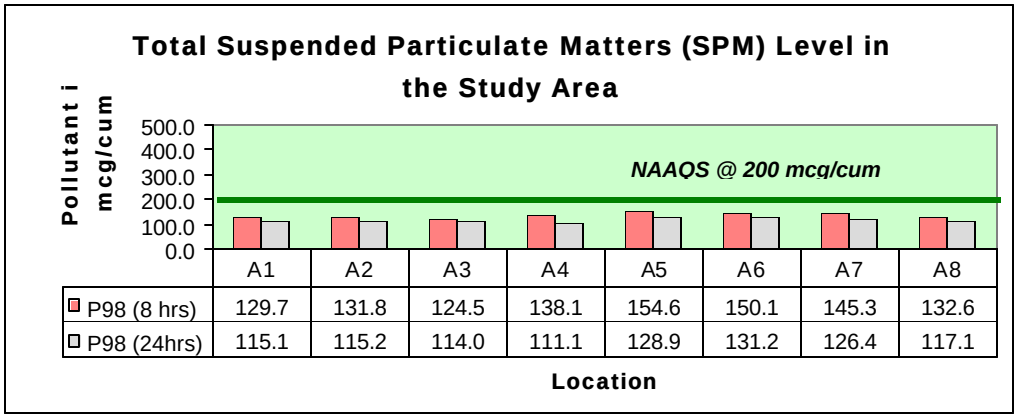
Notes:

(1) bdl - below detection limit

(2) Method of measurement - as per schedule VII of National Ambient Air Quality Standard (NAAQS of CPCB)

4 - Present Environmental Setting (Cont'd)





NOTES:

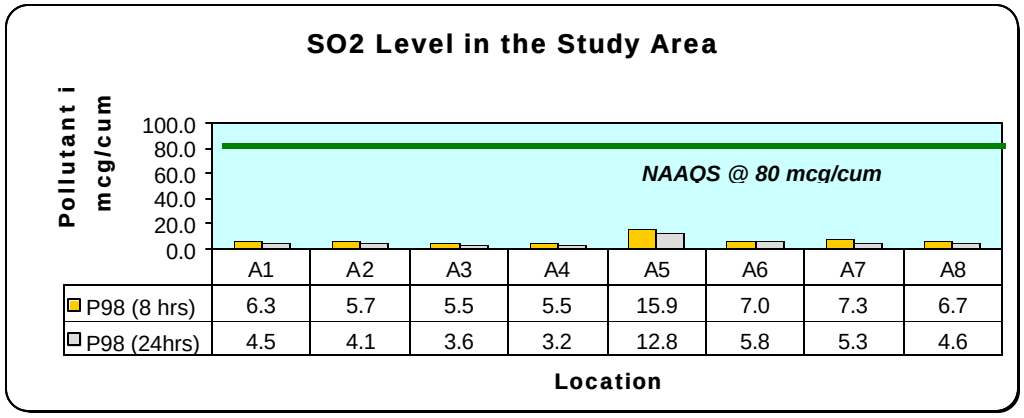
(a)

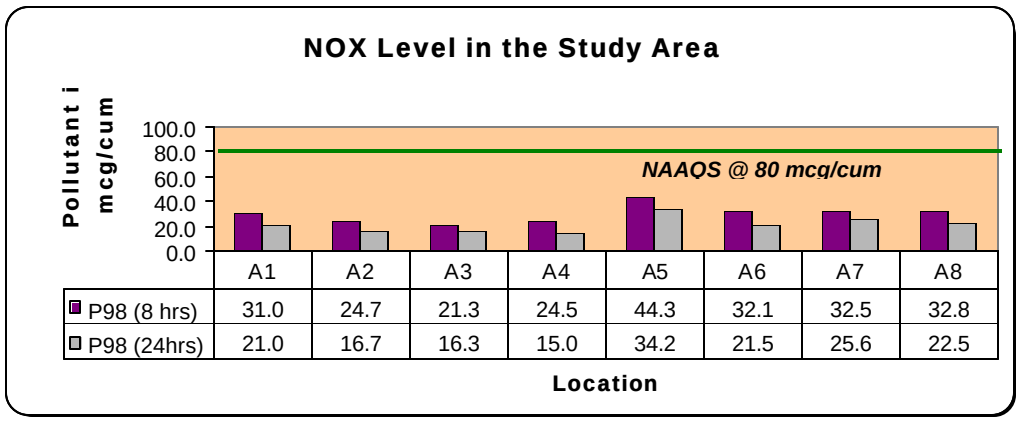
Station Code	Name	Approx. Diastance from the Project site
A1	ERIBINA	7 km W
A2	UCHANUGAN	4 km W
A3	CHATUA	6.2 km N
A4	KHURANTHA	2.6 km W
A5	PARADIP	9.3 km NE
A6	RONGIAGARH	4.6 km NE
A7	KUJANG	9.6 km N
A8	BADAGADPUR	3 km N

(b) NAAQS - National Ambient Air Quality Standard

Fig 4-4 : RD & SPM levels in the study area

4 - Present Environmental Setting (Cont'd)





NOTES:

(a)

Station Code	Name	Approx. Diastance from the Project site
A1	ERIBINA	7 km W
A2	UCHANUGAN	4 km W
A3	CHATUA	6.2 km N
A4	KHURANTHA	2.6 km W
A5	PARADIP	9.3 km NE
A6	RONGIAGARH	4.6 km NE
A7	KUJANG	9.6 km N
A8	BADAGADPUR	3 km N

(b) NAAQS - National Ambient Air Quality Standard

Fig 4 -5 : SO_2 & NOx levels in the study area

recording in all the places except Paradip were below detection limit of 2,000 mcg/cu m. Of all the locations within the study area, Paradip proper shows little higher values of all the pollutants due to industries and movement of commercial vehicles to the port complex. Otherwise, the ambient air of the study area may be categorised as clean and refreshing air.

Ambient noise

The ambient noise levels Leq during day time and night time were recorded in the study area. The recorded ambient noise levels presented in Table 4-13 indicate that the area is generally well within the acceptable noise level.

Table 4-13 - Ambient Noise Level (Leq) in Paradip, Orissa

Location	Category	Noise Level (Leq) day/night		Allowable Noise Level (Leq) dB(A) Day time/ Night time
		Day time	Night time	
Paradip Garh	Industrial	64.37	55.43	75/70
New PPL (Udavchanpur)	Industrial	67.92	60.83	75/70
Kujang Market	Commercial	62.97	53.47	65/55
Paradip Market	Commercial	63.09	54.86	65/55
Uchannagar	Rural	54.51	43.09	55/45
Iribina	Rural	54.55	44.25	55/45
Chatua (near School)	Rural/ Sensitive	55.89	43.92	50/40

4 - Present Environmental Setting (Cont'd)

Biological environment

In order to ascertain the baseline status of the biological environment comprising terrestrial and aquatic/marine ecology, field study was taken up in the months of December 2005 to February 2006. The report is available in Section III of Field Reports (Vol. II). Following text gives a brief description of the ecological status.

Terrestrial ecological status (TES): The study area forms a part of the Mahanadi delta plain on the east coast. Alluvial and fluvio tidal settlements cover the area. The soil cover in the study area is mostly alfisols and entisols formed in recent times. It has got moderate level of nutrients.

The percentage land cover with different types of vegetations in the study area is about 4 per cent. The vegetations include trees, as well as shrubs and herbs. Much of the natural vegetation cover has been extensively damaged from time to time due to natural calamities like cyclones, super cyclone in 1999, storm surge and inundation.

There are no protected areas of national ecological significance like Reserved Forests, National Park, Wild Life Sanctuary, Biosphere Reserves and Ramsar Site in the study area.

In the Core Zone of the study area, the dominant species is *Casuarina equisetifolia* (Jhau) and co-dominant species is *Anacardium Occidentale* (Bajan Cashew). In the Buffer Zone surveyed sites at Kujang, the dominant species found is *Albizia lebbeck* (Sirish) and co-dominant species found are again *Casuarina equisetifolia* (Jhau) and *Anacardium Occidentale* respectively. A total of 238 species have been recorded as

may be seen from the floristic checklist in Section III of Field Reports (Vol. II).

The vegetation community in the study area is found heterogeneous. Species diversity index is found medium indicating that the study area is characterised by diverse type of vegetations.

Attempt is being made to plant mangrove species on the coastal area far beyond the study area on the south west of the study area. Typical among them as observed is *Avicennia officinalis*, *Bruguiera gymnorrhiza*, *Ceriops decandra* etc. On the north western side of the project area near Bhuinyapal, patches of mangroves of initial stage have been observed.

Plant of Genetic and Economic Importance

A large number of plant species of the study area have economic utility like food, medicine, fuel wood, piper beetle leaf and cashew nut. Such plant species may be used for aforestation programme under "social forestry". It was also observed during the sample survey that none of the species could be considered as unique to this place, whose germplasm needs to be conserved in the region under ex-situ condition.

Rare and Endangered Plant species

As per IUCN 's "Red Data Book", none of the taxa are found in this region could be marked as rare or endangered plant species.

Medicinal Plant species

During the field survey of the study area, it was observed that the medicinal plant species occurred in a sporadic manner and only a few medicinal plant species could be identified. Some of the medicinal plant species as could be recorded are *Acalypha indica* (Muktajhuri). *Ocimum*

sanctum (Tulasi), *Eclipta prostrata* (Keshut), *Andrographis paniculata* (Kalmegh) etc are common varieties of medicinal plant species.

Regarding Avifauna, the common species like *Pycnonotus cafer* (Bulbul), *Alcedo* sp (Kingfisher), *Passer domesticus* (House Sparrow), *Tyto alba* (Barn Owl) etc are commonly sited.

Agricultural crop

The study area is under the agro ecological region of hot sub-humid to semi-arid eco region with coastal alluvium derived soils. The length of growing period of corps is 90–210 days. The normal annual rainfall is 1,600 mm. The soil is sandy clayey with medium nutrient level. The microbial population indicates that the soil is favourable for the growth of agricultural crops. The principal food crop is paddy followed by pulses, potatoes, oil seeds and vegetables etc. Fruit trees are – mango, jack fruit, guava, tamarind, banana etc. The garden vegetables are onion, cucumber, tomato, beans, pea, cabbage, cauliflower etc. Presently the degraded forest area is converted to cashew nut garden and *Piper betel* by the local people.

Terrestrial fauna

A faunistic checklist of the study area has been prepared that brings out that the study area is not a habitat for wild lives. The fauna species as observed during field survey and reported by the local people are mostly of Schedule IV and V categories such as *Funambulus pennanti* (Palm Squirrel), *Hystrix indica* (Procupine), *Bandicota bengalensis* (Bandicot rat), *Naja naja* (Indian Cobra), *Vipera* sp (Bora Snake) etc and are also commonly sited.

Aquatic Ecological Status (AES)

The land based water bodies in the study area occupy only 11.8 per cent comprising lakes/ponds, standing flood water and rivers/streams. The major water body is sea occupying nearly 29 per cent of the study area. Ecological status of the sea has been separately conducted by National Institute of Oceanography (NIO) in their Rapid EIA Report for the Captive Port of the proposed Steel Plant.

AES study was confined only to the main land based water bodies, that is, Jatadharmohan River Creek, upstream of the Creek during high tide and low tide, village pond and sea beach at Paradip Port area. The report on this AES is available in Section III of Field Reports (Vol. II).

The field investigations reveal that Jatadhari River of salinity in the range of 16 to 24 parts per thousand have reasonably good nutrient levels in respect of nitrogen (1.5 to 1.76 mg NO_3/ℓ) and phosphorus (0.3 to 0.87 mg PO_4/ℓ); silicate level varies from 3.5 to 8.5 mg/ℓ). This has led to satisfactory growth of aquatic vegetation. The total plankton count for

species like *Synedra* sp (Diatom), *Melosira* sp (Diatom), *Rivularia* sp (Cynophyta) etc, ten such species as recorded for Jatadharmohan River Creek is more within 14 to 21 x 10^3/cu m and Shanon-Weaver Index is around 2.0. The zooplankton count under groups Cladocera, Copepoda and Rotifera has been recorded in between 1540 to 2275 Nos. per cum with a Shanon Weaver Index in between 1.7 to 1.8. On the other hand, the pond water in Polang village does not favour growth of planktonic community due to lower level of nutrients; the coliform population is also quite low.

4 - Present Environmental Setting (Cont'd)

The aquatic avifauna and amphibian fauna in the study area is poor in terms of species diversity and population.

Benthic life forms in the study area are mainly gastropod, bivalve mollusca and crustacea reported during high tide and low tide. There are marshy and aquatic plant species too in the coastal zone of the study area.

Other than marine fishes like Prawn, Pomphret, Silver belly, Ribbon fish, Bombay duck, Jew fishes etc, there are other local varieties of fishes like Puti (*Barbus ticto*), Mrigel (*Cirrhina mrigala*), Phasa (*Setipinna phasa*) etc.

Human environment

In order to ascertain human environment of the study area, a general review of prevailing socio-economic aspects of the study area was taken up, which is available in Section-IV in Field Reports (Vol. II).

The prevailing status of human environment in the study area comprising demographic profile, infrastructure, socio-economic conditions and life style is presented in the following text:

Demographic profile: As per 2001 Census, the total population of the study area comprising 63 villages is around 69 thousands. The decadal growth is around 7 per cent from the last Census in 1991. A comparative statement of the demographic profile of last two Census, 1991 and 2001, is presented in Table 4-14 on the next page.

4 - Present Environmental Setting (Cont'd)

Table 4-14 - Demographic Profile of the Study Area

		Census Year	
		1991	2001
Total Population	..	40,360	69,163
Decadal growth (%)	..		71.4
Sex Ratio	..	989	955
No. of households	..	6,810	13,717
Literates (%)	..	56.5	66.9
Scheduled castes (%)	..	23.1	18.4
Scheduled tribes (%)	..	0.3	0.3
Total main workers (%)	..	27.5	24.6
Cultivators (%)	..	10.9	11.9
Agricultural labourers (%)	..	8.4	4.2
Marginal workers (%)	..	1.5	6.4
Non - workers (%)	..	71.0	68.5

Notes:

(1) The above stated population figures cover the total area of 314 sq km around the proposed Steel Plant of Posco-India near Paradip of Jagatsinghpur district, Orissa

(2) In the study area the entire population is residing in rural area

Source:

(1) Census of India 1991: Orissa- Primary Census Abstract: General Population Part II .1991

(2) Census of India 2001: Orissa- Primary Census Abstract: General Population Part II .2001

Percentage of non-workers marginally declined may be due to IOCL shift towards more contract labour in Paradip region. The study area lacks permanent employment opportunity as the scope of employment is limited and absence of required skill.

4 - Present Environmental Setting (Cont'd)

Land holding: From the sample survey in the study area, it is found that around 19%, that is around 122 households are landless. 40.4% (259 households) own land less than 1 hectare, 29.5% (189 households) own land in the range of 1 to 2 ha, 7.8% (50 households) own land in the range of 2-4 ha and the balance 3.3% (21 households) own land more than 4 ha. The percentage of landless families varies from 25% in case of villages located within 3 to 5 km from the project site and about 14% in case of villages within 1 km from the project site.

Village settlements of the Project Site: The proposed project requiring 4004 acres of land on the north western bank of Jatadharmohan River Creek will affect seven villages, namely, Polanga, Noliasahi, Govindpur, Dhinkia, Nuagon, Bayanala Kanda and Bhuinyapal affecting 200 families.

Employment potential and skill possession: In the sample survey of 3,278 persons in 641 households within the study area, it is observed that nearly 52% are adults in the age group of 18 to 60 which may be considered as potential workforce. Of this workforce 30% are having employment or in some other economic activities; balance 70% are unemployed.

Occupational pattern: Major skills possessed by the locals living in and around the project site is fish-net making, fish catch, masonry work, bamboo work and tailoring. In addition, owning of small eatery shops and grocery shops are also one of the occupations.

Industries: There are quite a few industries of medium scale located in Paradip region. These are Carbon India Ltd producing Dry Cell Carbon Anodes, Paradip Phosphate Limited producing phosphatic

fertilisers, Oswal Chemicals & Fertilisers Ltd producing fertilisers and chemicals, Kargil India producing edible oil. Indian Oil Corporation Limited (IOCL) is presently setting up a refinery at the south western side adjacent to the proposed project site of Posco-India.

Infrastructure

The State Highway (SH-12) of Paradip is the only major road connecting Paradip with Cuttack. The other metalled road under Rural Development Programme connects Kujang and Ersama. The rail linkage connects Paradip with Cuttack. Access road to the project site is presently from Kujang via Baliatut and Garkujang. The other access road from NH-5A to the project is via Dhinkia village. Paradip Port Town has got all the necessary infrastructure like electricity and water supply. Villages like Nuagaon, GarKujang, Baliatut etc also near the project site have the electricity under Rural Electrification Scheme. There is a major Port at Paradip, the only major port of Orissa.

Schools and colleges: There are 48 primary schools, 15 middle level schools and 14 high schools in 48 study villages. No colleges have been reported in those surveyed villages. The students depend on colleges at Kujang, Ersama or Paradip for higher education.

Community health: Anganwadi Centres spread over 47 villages out of 63 villages in the study area, cater the Child and Mother Care at the infant stage. Upgraded Primary Health Centres are limited. There is only one hospital at Paradip managed by Paradip Port Trust. Private Clinics and Community Health Centres are limited. Complicated medical cases are referred to Cuttack, about 130 km from Paradip.

4 - Present Environmental Setting (Cont'd)

Aesthetics: The present study area belongs regionally to the deltaic part of the Mahanadi river basin. The landscape is characterised by wide meandering and anastomosing network of distributaries of main Mahandi river and Jatadharmohan creek. In the upper part of the delta, vast agricultural land dotted with small to large villages with their characteristic orchards provides the scenic backdrop. These large villages are on threshold of becoming semi-urban settlements with gradual accretion of infra-structural facilities. Thus the idyllic setting of a rural landscape is slowly but perceptibly changing. In the lower delta area, the same landscape continues but a subtle change in land use is discernible.

Patches of beetle garden, stretches of protected forest, bare sand flats and minor plots of aquaculture ponds (along banks of the tidal stretches of the small rivers) make their appearances in the landscape along with the typical agricultural field and small to large villages.

Traces of ravages of 1999 super-cyclone could still be seen in the landscape of the coastal areas in the form of sand splays, destroyed forests of uprooted trees and pools of brackish water in low-lying areas.

Exquisitely beautiful scenic landscape could be seen along the coast comprising sand dunes, sandy beaches, sandy flats, mud flats, backwaters of creeks and the typical coastal vegetation of Casurina. Waves, with whitecaps on blue water, breaking near the sloping golden coloured beaches along the sea front of the study area provide a scenic landscape that is a treat to watch. In an otherwise serene ambience, the Paradip area presents a typical industrial landscape and skyline on the fringe of a rural area.

4 - Present Environmental Setting (Cont'd)

Dominant feature

The dominant feature of the study area is a typical deltaic landscape characterised by its flat topography with agricultural field, small patches of beetle gardens and protected forest. Surface water bodies in the form of perennial and tidal rivers are plenty that have high dissolved solid and very high bacterial count. Saline incursion in the ground water regime is present in the southern part of the area. The ambient air is fairly clean. Cyclones are regular visitors to the coastal area. The core zone does not have any settlement. Population density is on the lower side. The study area is essentially rural but is on the threshold of low order urbanization in some of the major rural settlements. The Paradip area is generally becoming industrialised and in the near future it may be a special economic zone and a coast-based industrial hub of Orissa.

5 - ENVIRONMENTAL IMPACT ASSESSMENT

The description of the proposed green field project for building up initial steel making capacity of 4 MTPY near Paradip, the prevailing environmental status of the project site and its surroundings have been described in earlier two Chapters. This Chapter discusses environmental aspects of the project and a broad assessment of environmental impacts considering no mitigation measures.

Objective

The objective of undertaking a rapid EIA of the project under consideration at the selected site is to identify the probable impact areas on the various attributes of the present environment. This gives a first-hand assessment of the likely impact areas and its degree of impact caused by the project activities at different stages from acquisition of site to commercial production. From the rapid assessment of impacts, it can be judged to what extent the potential impacts are likely to occur and if so, to what level it needs to be minimised by implementing environmental management plan (EMP) from the site acquisition stage itself.

Scope of the present EIA

The present EIA being a rapid one is based on the project concept as being planned and short term baseline data gathered at the project site. It reviews the manufacturing process from environmental angle, scoping and assessment of impacts. A summary of potential impacts as found out is indicated at the end for ready reference for the purpose of drawing suitable EMP.

Evaluation of the steel making process

The basic process for steel making from the iron ore is to produce hot metal first by reduction of oxide ore with carbonaceous reductant like coal or coke or reformed natural gas in presence of fluxes to produce iron either in the form of solid, that is, directly reduced iron (DRI) or in the molten form as hot metal. The hot metal containing carbon nearly about 4 to 6 per cent by weight requires oxidation of carbon by oxygen to produce desired quality of steel. For DRI too, the same along with scrap will be converted to steel by electric smelting. The entire process chemistry works at an elevated temperature at about 1,500 degree Celsius for which steel making is known to be a pyro-metallurgical process.

Based on this principle, there are two traditional process routes of iron and steel making, although variations and combinations of two exist. These two traditional integrated processes of iron and steel making are (i) blast furnace-basic oxygen furnace (BF-BOF) route and (ii) DRI-Electric Arc Furnace (DR-EAF) route. There are other process routes like COREX, FINEX, Direct Iron Ore Smelting (DIOS) etc, some of which are seeing light of the day.

The proposed project will adopt FINEX process route for iron making and not conventional BF route. The FINEX process has been described earlier in Chapter 3.

Review of pollution potential of FINEX Process: The unique feature of the FINEX Process for the proposed Steel Plant is that it does not require two upfront process units, that is, Coke Ovens for coke

5 - Environmental Impact Assessment (Cont'd)

making and Sinter Plant unlike traditional BF route of iron making. The FINEX Process is based on smelting of iron ore fines by coal gasification.

A comparison of the pollution potential of FINEX and traditional BF process can be seen from the Figure 5-1 on the next page.

From the Figure, it may be seen that FINEX route of iron making is cleaner than BF route due to absence of up front processes like coking and sintering. In the FINEX, the sulphur present in coal and ore gets fixed as CaS in the slag and NOx emission is substantially reduced due to use of oxygen in the melter gasifier whereas BF route uses generally hot blast air.

5 - Environmental Impact Assessment (Cont'd)

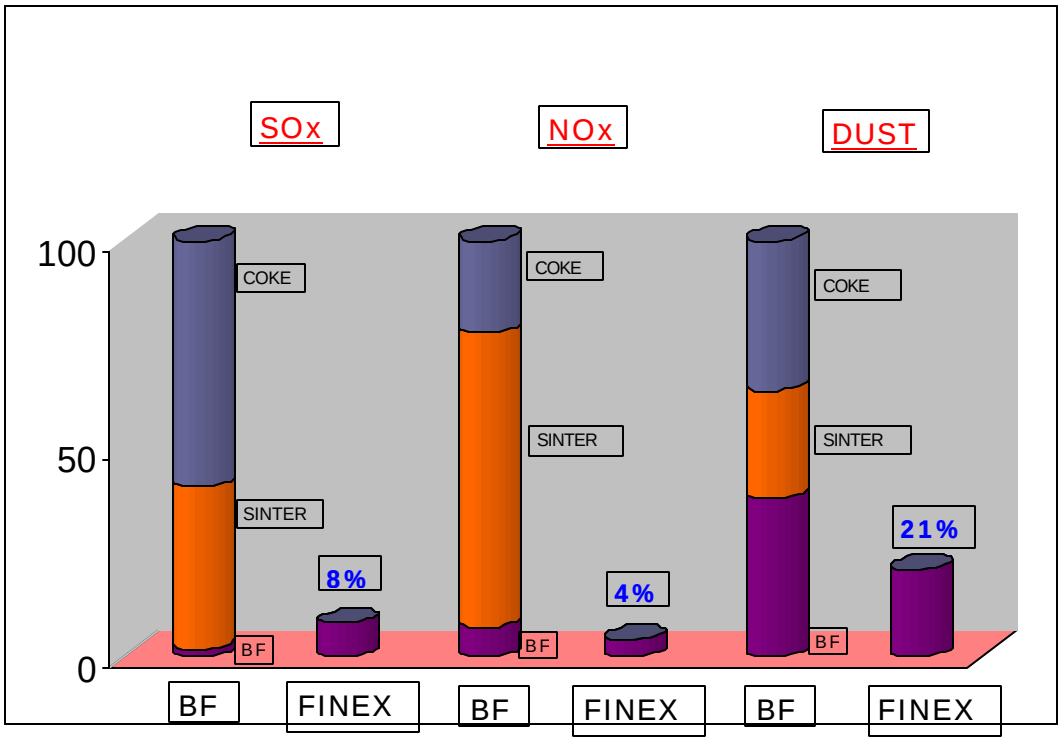


Fig. 5-1 - Comparison of pollution level for BF and FINEX route of iron making

Process	SO_2	NOx	Dust
	g/t	g/t	g/t
Blast Furnace			
BF	28.5	102.7	136.0
Sinter	800.0	986.3	93.0
Coke	1200.0	308.2	127.0
FINEX	171.5	61.6	75.0

The other form of environmental pollution from the proposed project activities are presented in Table 5-1 for crude steel making and Table 5-2 for making finished steel from crude steel. The predominant environmental pollution would be the air pollution due to dust emissions

and water pollution from the wastewater of gas cleaning plants, mill effluent and plant sanitary effluent. However, none of the pollutants can be categorised as eco-toxic as there is total absence of ammonia, phenolic compounds, thio-cyanates and toxic metallic compounds.

Table 5-1 - Sources and types of environmental pollution for making Crude Steel

Section/ Units	Feed & Fuels	Operation	Pollutants	Receptor	Form of pollution
I. Construction Stage					
Stockpiling in open air	Construc-tion materials	Construc-tion work	- Dusts	Air	Air pollution
			- Noise		
			- Construc-tion washings	Jatadhar mohan River/Sea	Water pollution
II. Operation Stage					
Raw materials Storage / stock piling in open air	All types of solid raw materials	Mechani-cal handling	- Dusts	Air	Air pollution
Raw materials processing	Iron Ore and Coal	Drying, Screening and Conveying	- Dusts - SO_2 - NOx	Air	Air pollution
			- Noise	Air	Air pollution
Iron making by FINEX Process Units	Iron Ore, Coal briquette s, Fluxes and Oxyge n	Direct reduction, Compaction, Coal gasifica-tion in Melter Gasifier	- Heat - Dusts	Air	Air pollution
			- Noise	Air	Air pollution
			- Sludge Water	Plant	Water

5 - Environmental Impact Assessment (Cont'd)

				Drain to Jatadhar mohan River/Sea	pollution
Steel Melt Shop (SM) (with Slab Caster)	Hot Meal, Fluxes, additives and Oxygen	Steel conversion, refining and continuous casting of liquid steel to slabs	- Heat - Dusts	Air	Air pollution
			- Noise	Air	Air pollution
			- Wastewater containing SS and Oil & Grease	Jatadhar mohan River/Sea	Water pollution

5 - Environmental Impact Assessment (Cont'd)

Table 5-2 - Sources and types of Pollution for making Finished Steel and other supporting production facilities

Section/ Units	Feed & Fuels	Operation	Pollutants	Receptor	Form of pollution
Mini Flat Mill and Hot Strip Mill	Liquid Steel LNG Fuel	Casting & Rolling	- Heat - NOx - Noise	Air	Air pollution
			- Millscale wastes	Jatadhar mohan River/Sea	Water pollution
Lime Calcining	Limestone / Dolomite LNG Fuel	Calcina-tion	- Heat - Dusts - NOx - Noise	Air	Air pollution
Captive Power Plant	FINEX Off Gas and BOF Gas	Combined Cycle power generation	- NOx - CO - Noise	Air	Air pollution
			- Backwash of DM Water Plant	Jatadhar mohan River/Sea	Water pollution
Plant Sanitary	-	-	Suspended Solids, BOD, Faecal Coli	Jatadhar mohan River/Sea	Water pollution

In addition to air and water pollution, there would be generation of solid by-products like FINEX slag, BOF slag, millscales, dusts, etc and some amount of hazardous wastes like oily wastes.

Inventories of uncontrolled emissions to air

5 - Environmental Impact Assessment (Cont'd)

Uncontrolled emissions to air from the proposed production facilities are grouped under two categories, namely (i) fugitive emissions from non-point sources such as raw materials handling section (RMHS), raw materials processing units, FINEX Cast House and BOF Shop, and (ii) point source emissions such as combustion stacks of power plant and other production units.

Estimated inventories of uncontrolled emissions to air environment are presented in Table 5-3 on the next page. From the Table, it may be seen that the major emissions would be contributed by dusts, both from the non-point as well as from some of the point sources. Fugitive dust emissions, when wind-borne, would increase the suspended particulate matter (SPM) and respirable dust (RD) load in the ambient air outside the plant boundary. Fugitive dusts in closed workzone area will also make dusty environment. This needs to be prevented and controlled.

Noise pollution

The noise would be mostly of fluid noise type due to operation of rotary equipment and machines like fans, turbo blowers, turbo generators, pumps, compressors, etc. The intermittent noise pollution in the workzone would arise due to impact noise caused by mechanical handling of slabs, hot rolled coils and scrap handling. Short duration of high rise noise may occur due to venting of steam. The workzone noise level at some locations may be as high as 100-103 dB (A).

Inventories of wastewater

The steel making process even being a pyro-metallurgical process, requires extensive both for direct and indirect cooling. Due to FINEX

process route of iron making, there would not be any coke oven effluent having phenolic and cyanogenic compounds. The effluent would contain mainly suspended solids with at best floating oil and grease to some extent. The untreated process effluent streams and plant sanitary effluents as would be generated in the proposed facilities are summarised in Table 5-4 on page 5-8.

From the Table 5-4, it may be seen that there would be six effluent streams generating from the sections, namely, (i) Raw materials stockyard, (ii) FINEX Gas Cleaning Plant, (iii) BOF Caster, (iv) Mini Flat Mill, (v) DM Water Plant, and (vi) Plant Sanitary. These effluents, if not treated and released to the Creek water, will not only add make up water consumption but also pollute the Creek/Sea water.

5 - Environmental Impact Assessment (Cont'd)

Table 5-3 - Inventories of uncontrolled emissions to air

Production Unit / Section	Combined Emission Stream No.	Source	Source type	Estimated release of pollutants, kg/hr		
				SPM	SO_2	NOx
Raw Materials Handling Section (RMHS)	ES-1	Stockpiles, conveyor transfer points and screening	Non-point/ fugitive	500	-	-
FINEX Plant	ES-2	Feed to dryers, compactors, briquetting, handling etc	Non-point/ fugitive	4000-5000	-	-
	ES-3	Cast House	Non-point/ fugitive	3000-4000	-	-
BOF Shop	ES-4	Secondary dust/fume of BOF and continuous casting	Non-point/ fugitive	4000-4500	-	-
Lime /Dolo Calcining	ES-5	Screens & Bins	Non-point/ fugitive	90-100	-	-
FINEX Plant Dryers	ES-6	Ore dryers & Coal dryers	Point	48	105	210
Mills	ES-7	Tunnel Furnaces	Point	9.0	18.0	36.0
Lime Calcining Plant	ES-8	Kiln Furnaces	Point	8.0	7.02	25.0

5 - Environmental Impact Assessment (Cont'd)

Power Plant	ES-9	Combined Stack	Point	13.5	45.0	90.0
Incinerator	ES-10	Hazardous waste incinerator	Point	1.4	4.0	8.0
Estimated Total Uncontrolled Emissions			..	11600-14000	178	369

Table 5-4 - Inventories of wastewater from the production facilities

Production Unit/ Section	Effluent Stream No.	Source	Approx. quantity	Principal pollutants
			cu m/hr	mg/l
Raw materials stockyard	WW_1	Raw materials stockyard	400-600	TSS = 800-1200
FINEX Plant	WW_2	Gas cleaning plant	22000-23000	TSS = 1000-2500
Continuous Caster of Steelmelt Shop	WW_3	Scale Pit	1500-1700	TSS = 1000-2000
Mini Flat Mill (include Hot Strip Mill)	WW_4	Scale Pit	4500-5000	TSS = 1500-2500 Oil & Grease = 50-60
DM Water Plant of Power Plant	WW_5	Back wash	20-30	TSS = 100 Free Alkali = 200-300
Plant Sanitary	WW_6	Canteen, Toilets etc	18-20	TSS, BOD and COD

Inventory of solid wastes generation

The solid wastes, which in many cases can be made reusable, are grouped under two broad categories, namely, (a) non-hazardous and (b) hazardous.

The non-hazardous solid wastes which will be produced from the production facilities are FINEX Slag, BOF Slag, millscales and dusts from

5 - Environmental Impact Assessment (Cont'd)

the different dust extraction (DE) system, which are free from the toxic metals like chromium, nickel etc or even if present they are within allowable limits. Generation of hazardous solid wastes such as oily wastes would be of marginal quantity.

Table 5-5 indicates inventory of solid wastes presently estimated for the proposed production facilities.

Table 5-5 - Inventory of solid wastes generation at 4 MTPY production level

Solid wastes	Expected generation TPD	Indicative Characteristics (% w/w)
A. Non-Hazardous Wastes		
1. FINEX Slag	3600-3700	50% Granulated 50% slowly air cooled Al_2O_3 - 18022 MgO - 10-12 FeO - 0.5-1.0 CaO/SiO_2 - 1.15-1.2
2. BOF Slag	1100-1200	Lumps Fe(T) - 35-40 CaO - 25-36 Al_2O_3 - 3-4 P_2O_5 - 3.5-4.5
3. Sludge	1100-1200	Muck Fe(T) - 40-50 Zn - 0.03 - 0.11
4. Dusts from DE Systems	600-700	Fine Dusts Fe(T) = 30-40 CaO = 5-6 C = 30-40 SiO_2 = 8-10

5 - Environmental Impact Assessment (Cont'd)

5.	Millscales	60-80	Solid fluxes Fe(T) - 70-80 Oil - 10-12
6.	Used Refractory/ Debris	50-60	Solid sintered
	B. Hazardous Wastes		
7.	Oily Wastes, Plastics, Flammable Wastes	8-10	Flammable wastes

Environmental Impacts

In view of the pollution potential of the project described in the foregoing text, the probable impacts on the present environment are discussed in the following text:

Scoping of impacts: A checklist of probable impacts on environment since the land acquisition stage is presented in Appendix 5-1. While scoping the impacts relative importance of impacts in respect of environmental baseline has been qualitatively assessed under three broad categories, namely, ***insignificant/no impact, adverse*** and ***beneficial***, depending on the nature and scale of impacts.

From the Appendix, a summarised list of concerned areas of impact, which need to be addressed to, is given below.

- Impact due to Site acquisition
- Impact on Land environment
- Impact on Water environment
- Impact on Air environment
- Impact on Human environment

and

- Impact on Aesthetics of the area

Impact due to Site acquisition: As stated earlier, the proposed project requires 4,004 acres of land on the north western bank of Jatadharmohan River Creek as shown in the Drg No. 10971-REIA-ENV-006. The site encompasses seven villages, namely, Polanga, Noliasahi, Govindpur, Dhenkia (Part), Nuagaon (Part), Bayanala Kanda and Bhuinyapal. The acquisition of site will affect the following:

- loss of protected forest cover of 341.14 hectares mostly of Casuarina trees
- relocation of 471 families
- loss of some of the privately owned betel vines

The site is cyclone prone with storm surge. Other than relocation of 471 Nos. families from the project site, which is a social issue, the acquisition of site as such is not going to cause adverse impact on the environment. The protected forest cover can be regenerated elsewhere by adopting compensatory afforestation. The betel vines too can be planted elsewhere. One favourable aspect of the project site is that private land ownership is marginal acquiring nearly 437 acres; rest is Government land. Thus, acquisition of private land having homesteads and ownership may have adverse impact on the landowners, if they are not properly compensated.

Impacts during construction period

Though the construction period of 36 months will be of temporary nature, the impacts on environment cannot be ruled out. Considering the volume of construction activities outlined earlier in Chapter-3, the

potential impacts on water environment will arise due to discharge of washings of construction materials stockpiled, washings of concrete batching plant and discharge of untreated sewage of the construction labourers.

Similarly, potential impacts on air environment will arise due to emissions of fugitive dusts, vehicular emissions and noise at the construction site.

Mitigation measures will be required to minimise the adverse impacts on water and air environment.

The ***beneficial*** impacts during construction period will, however, be on the local people due to job prospects and opportunities for local traders, suppliers and service providers.

Impact on land environment: The project site and its surroundings within the study area are not a developed one. The only developed area is Paradip port site located at about 12 km north of the project site. Paradip proper in Jagatsinghpur district has been developed due to establishment

of a major port and based on which a few industries have come up. But beyond that, there has been no major economic development of Jagatsinghpur district as a whole.

The project site is a low lying hinter land, affected by cyclonic depressions and storm surge. The land cover does not produce adequate economic value except some part covered with non-irrigated agricultural activities, income from betel vines and manual fishing. If the selected site is maintained as of prevailing status, the area will have no scope for development in the near future. In consideration to this, if the proposed project comes up in this hinter land, the land will have more gainful use inviting large investment, infrastructure development in the area and above all a boost in the regional development of the area. The land environment will thus have ***moderately beneficial*** impact due to setting up of the proposed project at the selected site.

Impact on Water environment: An integrated steel plant with captive power plant requires enormous quantity of water mainly for cooling and gas cleaning purpose. The proposed steel plant facilities alone would require around 80,000 to 82,000 cu m/hr (abt 433 MGD). This, however, excludes cooling water requirement of the captive power plant, which has been planned to have once-thru seawater cooling; otherwise, the above stated cooling water load would have increased further.

In order to conserve water, the steel plant uses recycling of water. In this project too, nearly 96% recycling of water has been considered so as to bring down the make up water consumption to around 1,500 cu m/hr (abt. 8 MGD) or say 3.3 cu m/ton of steel well

within the figure of 7 cu m/ton of flat steel products as required by the corporate responsibility of environment protection (CREP) for the Steel Industry.

This make up water requirement will not be met from the nearby surface streams like Mahanga River or Harua River etc within the study area as these streams are saline due to tidal effect. The water source will be Mahanadi River near Cuttack about 85 km away from the plant site. Thus, there would be ***no impact*** on the surface water resource within the study area. The availability of water at Jobra barrage of Mahanadi River near Cuttack has been examined and separate study has been made by the project proponent prior to planning of the project. Posco-India have also obtained necessary permission from the Government of Orissa to withdraw 16.5 MGD of water during Phase-I.

There would be no impact on ground water resource as water source for the project will by no means be dependent on ground water withdrawal.

Impact due to Plant wastewater discharge: The receiving body of plant wastewater will be either Jatadharmohan River Creek, where the steel plant harbour will be constructed or the sea, that is, Bay of Bengal. Untreated wastewater, the inventory of which has been indicated in Table 5-4, if released to the sea/creek, there would be ***significantly adverse*** impact of the water body. In such case, this will cause marine pollution due to discharge of suspended solids, oil and grease, acids/alkalis etc, though, no toxic metal compounds like chromium, mercury, lead etc are envisaged in the untreated effluent.

5 - Environmental Impact Assessment (Cont'd)

Impact on ambient air quality: As indicated earlier in Table 5-3 for inventory of uncontrolled emissions to air, there would be appreciably high rate of dust emissions unless it is arrested. Emission due to SOx and NOx in that respect would be much less as the FINEX technology emits less NOx due to use of pure oxygen and sulphur present in charge-raw materials get fixed in the slag. The only significant emissions due to fugitive dusts and point source dusts would cause ***significant adverse*** impact on air environment.

During operational stage, there would be noise from the plant and machineries. The ambient noise level at the plant boundary gate would not rise above the present ambient noise level as plant area is spread over an area of 9.1 km x 1.5 km. The most noise prone equipment like compressors, turbo-generators, mills etc would separately be housed to attenuate the noise. There would be workzone noise for which workzone

noise environs at localised places may have ***moderately adverse*** impact on the operational and maintenance people attending those noise prone installations.

Impact on biological environment: The biological environment of the study area, that is, Core zone (plant site proper) and Buffer Zone (beyond the plant site) comprises terrestrial, aquatic and marine environment. The acquisition of Core Zone will have ***moderately adverse*** impact on the terrestrial ecology due to diversion of 341.14 hectares (843 acres) of protected forest cover of Casuarina trees and to some extent agricultural land cover. In the Buffer Zone, there would be no impact on the prevailing terrestrial ecological status.

5 - Environmental Impact Assessment (Cont'd)

The aquatic ecology of Jatadharmohan River Creek and marine ecology of the sea may have ***significantly adverse*** impact if the untreated wastewater with temperature high above sea water surface temperature, suspended solids, oil and grease, etc are released to these water bodies.

Impact on human environment

The human environment of the study area covers project affected families, infrastructure, employment generation, economy, safety and community health.

Impact on project affected families (PAFs): In order to acquire the project site on the northwestern bank of Jatadharmohan River Creek, around 471 rural families of total population around 1,500 need to be relocated. Displacement of families/homesteads without proper resettlement, rehabilitation and adequate compensation for the displacement leads to ***significantly adverse*** impact on their living, occupation and community bondage.

Impact on infrastructure: At present, in such remote area, basic infrastructure facilities cannot be expected. However, when a mega project like the proposed one will be sited, infrastructure in respect of road, rail linkage, telecommunication links etc will get developed. This will lead to ***significant beneficial*** impact on the prevailing infrastructure of the study area.

Impact on employment: An integrated steel complex requires substantial manpower to operate and maintain the steel plant. For the proposed 4 MTPY Steel Complex, the estimated direct employment for the steel plant alone will be around 7,426. This, however, excludes Mining Division, which will require additional direct employment of around 126.

5 - Environmental Impact Assessment (Cont'd)

The projection of total manpower for direct employment has been estimated at 18,052 when the project reaches 12 MTPY capacity in future.

For the present plant capacity of 4 MTPY under Phase-I programme, out of total direct employment of 6,100, nearly 60 per cent will be the workmen of different categories. There will be a great opportunity for the engineers, technical hands, and efficient administrative staff available in the State of Orissa. In addition, there will be scope for indirect employment opportunity of the local people and from adjoining districts of Orissa due to outsourcing of many work activities of the project. Usually, for such steel complex, 1:1.2 outsourcing is required. In view of this high potential of employment generation from the proposed project under consideration, there would be ***significantly beneficial*** impact on the employment generation.

Impact on economy: Posco-India has a plan to invest around 11,576 million USD (abt. Rs 52,100 Crores) to set up their proposed Steel Complex, its dedicated port and mine development in the State of Orissa. This will be the largest foreign direct investment in the country.

For the present Phase-I project of 4 MTPY, the estimated investment would be 3,803 million USD (abt. Rs 17,113 Crores).

This project will not only provide an enormous capital asset to the State but also will provide numerous economic benefits by way of various taxes, duties, Cess earned by the Central and State Governments. Due to sheer size of the project, the construction related taxation revenues for Central and State Governments are expected to exceed Rs 7,000 Crores and

Rs 3,400 Crores respectively. During the 30-year operation period, based on current rate, Central and State Governments will earn revenues in the tune of Rs 89,000 Crores and Rs 59,000 Crores respectively.

In addition, the State of Orissa is likely to witness an enhancement in its industrial output by nearly 23% and improvement in its Net State Domestic Product by 8.5% with the implementation of total project of 12 MTPY capacity.

Impact on economic development due to the proposed project may be considered ***significantly beneficial***.

Impact on Regional development: When a big industrial unit is set up, many other development activities take place centering around the mother unit. In this case too, when proposed steel complex is set up in such hinter land, several large, medium and small industrial complexes will come up in Paradip area.

Posco-India envisage the regional industrial development at Paradip based on their steel plant will accommodate auto industry, ship building complex and other allied industrial complexes as depicted in Fig. 5-2 on the next page. The proposed project will thus have ***beneficial*** impact on the regional development vis-à-vis development of the State.

Impact on Safety: This is an essential aspect during the operation and maintenance stage. During operational stage, exposure to heat, splashing of molten metal, exposure to carbon monoxide, electrical short circuits etc unsafe operation and maintenance may lead to serious consequences, if adequate safety measures are not adopted. In

5 - Environmental Impact Assessment (Cont'd)

consideration to this, if safety aspects of the plant during operation are not given due consideration, from the design stage itself, the impact on human environment may be ***significantly adverse.***

5 - Environmental Impact Assessment (Cont'd)

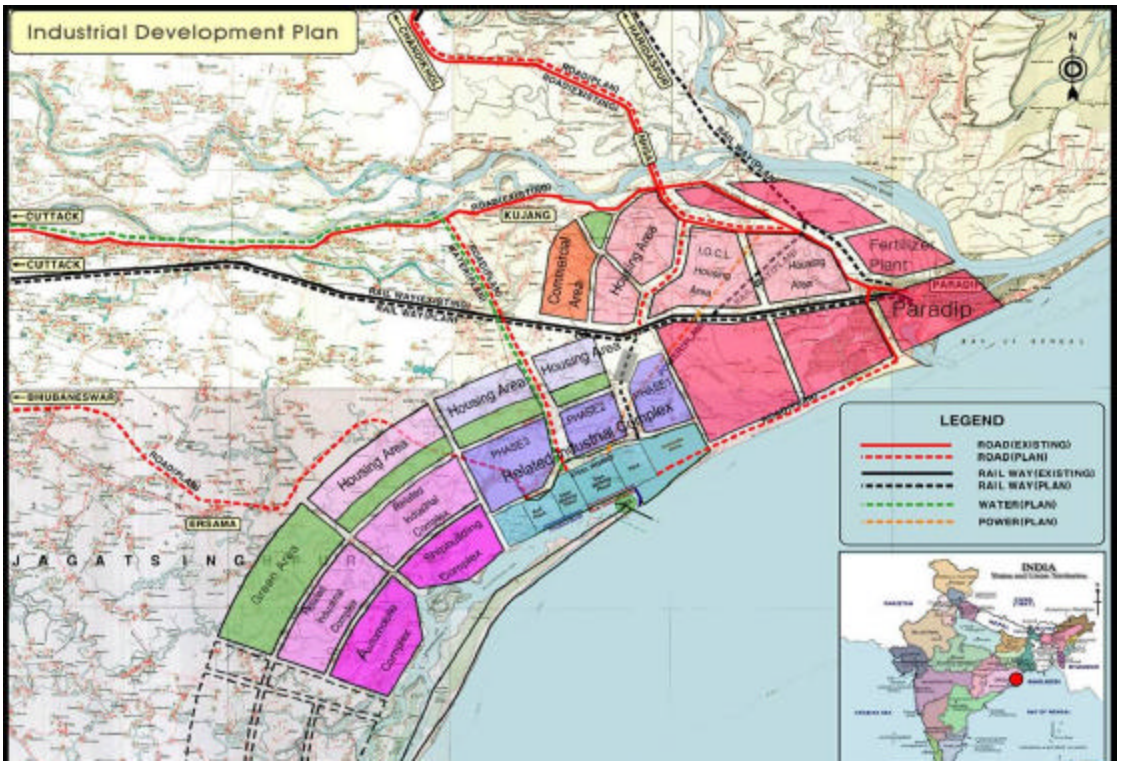


Fig.5-2 - Command Area Development

Source: Posco-India

Impact on community health: The impact on community health arises from the breathing of polluted air due to industrial emissions, traffic emissions, poor sanitation systems and allied unhealthy environment affecting the local community. The common disease generally encountered in the community living within the study area of the steel plant are acute respiratory tract infection, chest infection, skin allergy, loss of hearing, and other occupational health related problems of the plant people. The impact on community health may have ***moderately adverse*** impact.

5 - Environmental Impact Assessment (Cont'd)

Impact on aesthetics: A virgin rural coastal site when gets industrialised will lose its serenity to some extent unless adequate green cover and reasonably clean environment are maintained.

5 - Environmental Impact Assessment (Cont'd)

Impact Summary

In the foregoing text, several impacts, both adverse and beneficial have been discussed which have major bearing on the environment baseline status of the study area due to proposed project activities.

A summary of all these impacts without any mitigation measures is presented in Table 5-6. In order to understand the relative degree of impacts, a subjective scale has been considered as follows:

0 - No impact/insignificant; **1** - Marginal;
2 - Moderate; **3** - Significant; and **4** - Irreversible;
(+)ve means Beneficial and **(-)**ve means Adverse

From the Table, it may be seen that to make the proposed steel project environmentally less adverse, certain specific areas like water environment, air environment, ecology, human environment require mitigative measures from the site acquisition and design stages itself. These suggested mitigation measures are outlined in the next Chapter on Environmental Management Plan (EMP).

Table 5-6 – Summary of environmental impact assessment for the proposed 4 MTPY green field steel project to be set up near Paradip

Environmental attributes within the study area	Project Stage: Construction	Project Stage: Operation
Duration ..	36 months	On sustained basis
I. Physico-Chemical		
Land environment (after acquisition) ..	..	**-2 +2**
Surface water resource ..	0	0
Surface water quality ..	**-3**	**-2**
Ground water resource ..	0	0
Ground water quality ..	0	0
Creek/Sea water quality ..	**-2**	**-2**
Workzone air quality ..	**-2**	**-3**
Ambient air quality ..	**-2**	**-2**
Ambient noise ..	0	0
Workzone noise ..	**-3**	**-2**
II. Biological		
Terrestrial ecology ..	**-2**	0
Aquatic ecology ..	**-2**	**-2**
Marine ecology ..	**-2**	**-2**
III. Human		
Displacement of Human settlements ..	..	**-3 -3**
Infrastructure ..	**+3**	**+3**
Employment generation ..	**+3**	**+3**
Economy ..	**+2**	**+3**
Regional development ..	0	**+3**
Safety ..	**-3**	**-2**
Community health ..	0	**-2**
Aesthetics ..	0	**-1**

Legend:
1 – Marginal**; 2 –** Moderate**; 3 –** Significant**; (+)** ve **–** Beneficial**; (-)** ve **–** Adverse**.**

5 - Environmental Impact Assessment (Cont'd)

6 - ENVIRONMENTAL MANAGEMENT PLAN

The potential impacts discussed in earlier Chapter reveals that the proposed coast based green field steel project requires environment protection measures in several areas, such as physical, biological and human environment of the project site and its surroundings within the study area. This Chapter proposes environmental management plan (EMP), which will be an integral part of the project for minimising the adverse impacts.

Objectives of EMP

The objectives of the proposed EMP are aimed towards meeting three basic requirements, namely, (i) environmental mitigation measures in compliance with the environment protection regulations; (ii) schemes for minimising adverse impacts; and (iii) to fulfil the corporate responsibility on environment protection (CREP).

Applicable regulations

Following regulations have been considered in formulating this EMP:

- Orissa Resettlement and Rehabilitation Policy-2006
- Coastal Zone Regulations Notification (S.O. 114E) dated 19th February 1991 as amended till 24th July 2003
- Section 21 of the Air (Prevention and Control of Pollution) Act, 1981
- Sections 25 and 26 of the Water (Prevention and Control of Pollution) Act, 1974
- The Manufacture, Storage and Import of Hazardous Chemicals Rules, 1989
- The Hazardous Waste Management Handling Rules, 2000

Scope of EMP

6 - Environmental Management Plan (Cont'd)

In order to meet with the above stated objectives, the proposed EMP outlines (i) social mitigation measures at the time of site acquisition; (ii) environmental mitigation measures at the time of detailed design and engineering of the plant; and (iii) EMP during construction and operational stages of the plant and facilities.

Social Mitigation Measures at the time of site acquisition

The present project site will affect eight villages, namely, (i) Dhinkia, (ii) Gobindapur, (iii) Nuagaon, (iv) Polanga, (v) Bhuyanpal, (vi) Bayanal Kandha, (vii) Noliasahi and (viii) Jatadhar. Of the total 4,004 acres of land area to be acquired, the private land is nearly 437 acres; balance is Government land with pockets of unauthorised encroachment. Private land acquisition involves displacement of 471 families affecting their loss of land holding, betel gardens and cashew plants.

In order to have proper resettlement and rehabilitation of those project affected families (PAFs), Posco-India will abide by the R & R policy-2006 of the Government of Orissa. In addition, Posco-India of their own have commissioned Tata Institute of Social Science (TISS), Mumbai to assist them in the R & R and peripherial social development for the project area. The Rehabilitation-cum-Periphery Development Advisory Committee (RPDAC) formed by the Government of Orissa will monitor the implementation of R & R.

The Committee Members of the RPDAC also include local NGOs who may understand better the needs of the PAFs.

One-time monetary compensation to the PAFs covered in the R & R package does not necessarily meet the desired goal of their economic stability. It is suggested that a Trust may be formed among the

6 - Environmental Management Plan (Cont'd)

representatives of the PAFs, which will maintain an Inviolate Corpus fund for investment in the securities, bonds, Post Office deposits etc to get a steady monthly dividend disbursable among the resettled PAFs.

Posco-India have taken initiatives to set up a Training Centre in Paradip for the skill development of the local people who later on may be employed in the industry or may find a better scope for self employment.

It also needs to be considered in respect of site acquisition that implementation of R & R package alone may not solve the social disturbance among the PAFs effectively. In any displacement, there may be social trauma among the PAFs due to loss of their traditional homesteads, living style, loss of age-old social bondage developed by neighbourhood relationships.

In view of this, it is suggested that the project proponent shall form a counselling group having NGOs and representatives of different stakeholders. Counselling will be required for the PAFs to help them in adjusting to the new settlements and acceptance of their changed occupational livelihood. This counselling will be more appropriate particularly for the vulnerable section among the PAFs, such as aged, infirmed, windows, orphans and women members.

To monitor the effectiveness of the resettlement, a Peer Group from the representatives of the PAFs may be formed to have continuous dialogue with the R & R Cell of the Project proponent for their day to day living problems at the initial stage.

In brief, it needs to be stated that implementation of R & R plan for the PAFs is not one time activity during site acquisition; rather, it has to be monitored till each of the PAFs is found to be reasonably satisfied with their new resettlement and congenial rehabilitation.

Diversion of Protected Forests due to site acquisition

The other issue related to environmental mitigation measures at the time of site acquisition will be loss of protected forest cover of Casuarina trees. In this context, it may be noted that much of the

protected forest cover has been destroyed due to natural calamities. The proposed project siting requires diversion of 341.14 ha of protected forest cover. Posco-India will provide necessary fund to the Government of Orissa for compensatory afforestation as required by Forest Conservation Act and Rules thereunder. Industrial Development Corporation of Orissa (IDCO), on behalf of Posco-India, have made the Forest Diversion Proposal in March 2006 and this is under active consideration by the CCF, Orissa. Posco-India, of their own, will try to restore green cover afresh by peripherial greenbelt development within the plant and their township. Local people need to be involved in the development of social forestry.

Environmental Mitigation Measures at Design Stage

Technological improvements: The proposed FINEX process of iron making is no doubt a technological improvement over the traditional BF-route of iron making. As stated earlier, FINEX route does not require upfront process units like coke ovens and sinter plant. FINEX process is a closed cycle air tight direct reduction-cum-smelting of iron ore fines and part lumps, where pure oxygen will be used for coal gasification to produce desired reducing gas and energy for smelting. The FINEX route though based on low ash coal will require coke to some extent. Low ash coke will be procured from other sources.

Other than FINEX, following are the key areas where technological improvements will be incorporated for arresting pollution, enhancing water conservation, energy recovery and solid wastes management.

- fugitive dust emission control by dry fogging and high efficiency dust extraction systems
- extraction of electric power from FINEX and BOF off gases

6 - Environmental Management Plan (Cont'd)

- reuse /recycling of wastewater
- recovery of metallics from the solid wastes, collected dusts and pelletising the same for reuse in the FINEX plant
- use of low sulphur fuel for drying and heating

The technological improvements incorporated at the design stage are not only aimed for productivity improvement but also ensuring environmentally clean process without affecting the economic viability of the project.

6 - Environmental Management Plan (Cont'd)

Mitigation measures for land environment: The land is low lying of elevation around 4.7 m from chart datum (CD) of the sea. Considering tidal range, wave height, storm surge, it has been planned to raise the site level to +6.5 m above CD; one metre reserved height for storm surge due to cyclone as shown in Fig. 6-1.

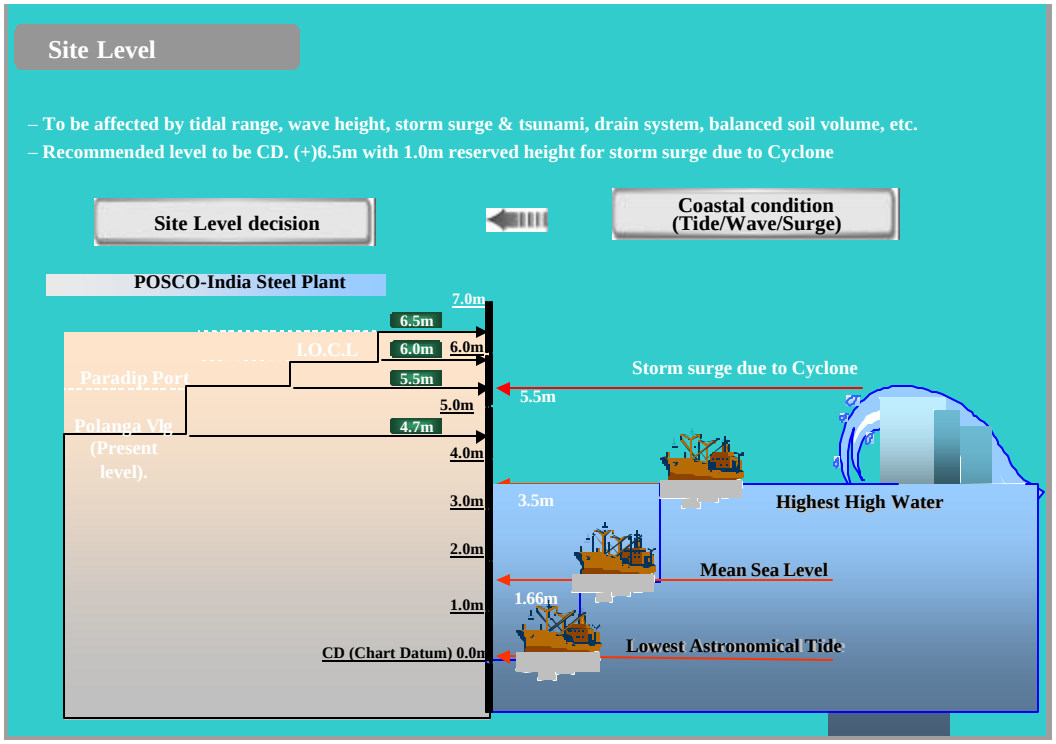


Fig. 6-1 - Site level decision

Source: Posco-India

In order to raise the elevation of the site, the fill material will be dredged sand from the navigation channel and turning basins of the dedicated port.

The layout of the present production facilities will not encroach the CRZ area. The proposed production facilities of 4 MTPY will be set up at a distance of 150 m away from the HTL of Jatadharmohan River Creek

and 500 m away from the HTL of sea. The bank of Jatadharmohan River Creek beyond the berthing line will have protection measures to consolidate the land. Similar protection measures will be taken up for sea shore protection on the south western edge.

The land to be acquired will be broadly divided into six zones as shown in Fig. 3-4 in Chapter 3. The Disposal Area will be earmarked for slag dump, waste recycling, effluent treatment plant, incineration etc for non-production use. The land ward plant boundary will be protected with earth bank using sand material and filter layer to protect erosion of the earthen bank. In addition, all along the property line, 50 m wide green belt coverage will be developed to consolidate the earth as well as to serve as a barrier for the wind borne dusts and ameliorate the temperature.

Mitigation measures for water environment: During design stage, mitigation measures for water environment protection will address two major aspects, that is, (i) conservation of water and (ii) treatment of wastewater and reuse/recycling of wastewater within the plant so as to have marginal discharge of treated wastewater to the sea.

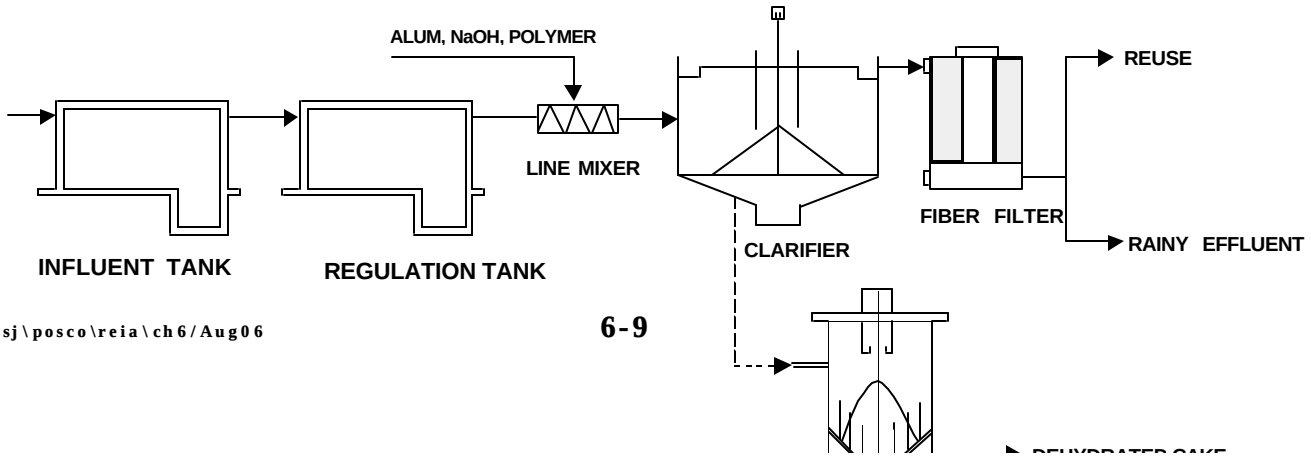
The design basis for make up water consumption for flat steel products is presently 7 cu m/ton of steel as required by the CREP stipulations. The proposed production facilities envisage make up water consumption in the tune of 1,500 cu m/hr (that is, abt. 8 MGD), which includes water consumption for 400 MW Captive Power Plant. This in other words, the steel plant will require approximately 3.3 cu m/ton of steel much lower than CREP recommendations as explained in earlier Chapter. A substantial quantity of make up water will be saved by

adopting FINEX technology, recycling of treated wastewater and above all use of once-thru sea water cooling for the power plant.

The planned water balance diagram of the plant as envisaged is presented in Fig. 6-2 on page 6-33. Nearly 82,000 cu m/hr of water will remain in circulation.

Wastewater treatment, recycling and disposal: While discussing the inventories of wastewater generation in earlier Chapter, it has been indicated that there would be six wastewater streams, WW_1 to WW_6. The total generation quantity of wastewater has been estimated in the tune of 28,000 to 30,000 cu m/hr (Table 5-4). Basically, the process wastewater can be categorised under two broad quality groups, namely (i) wastewater containing suspended solids, and (ii) wastewater containing both suspended solids and floating oil and grease. Each shop/facility will therefore be provided with its independent treatment plant.

Treatment of wastewater containing suspended solids: The wastewater containing suspended solids originating from the raw materials yard and gas cleaning plants only will be treated in clarifier-thickener as shown below in Fig. 6-3 and Fig. 6-4 on the next page respectively. The clarified water after filtering through fabric filter will get recycled again with addition of make up water. The thickener sludge



will be dewatered and the same will be used in the plant as a raw materials feed stock.

Fig. 6-3 - Treatment of Material Yard Wastewater

Treatment of wastewater containing suspended solids as well as oil and grease: The wastewater will originate from the scale pits of Caster and Mini Flat Mill. In the scale pit the separation of coarse millscales and floating oil get separated first. The clarified water free from coarse millscales and floating oil will pass through filtering unit before it gets recycled to the direct cooling system through cooling tower as shown in Fig. 6-5 on the next page.

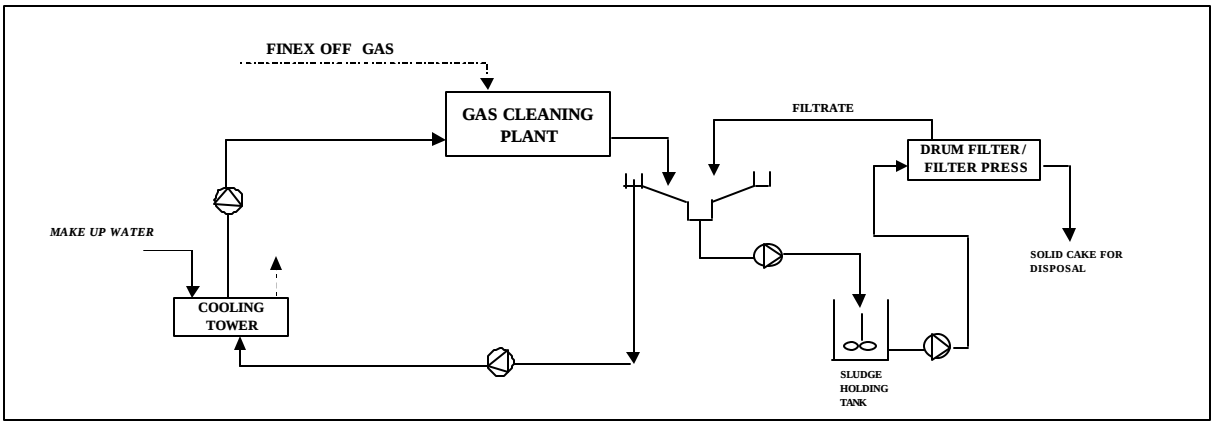


Fig. 6-4 - Schematic Flow Diagram Of A Typical Gas Cleaning Plant

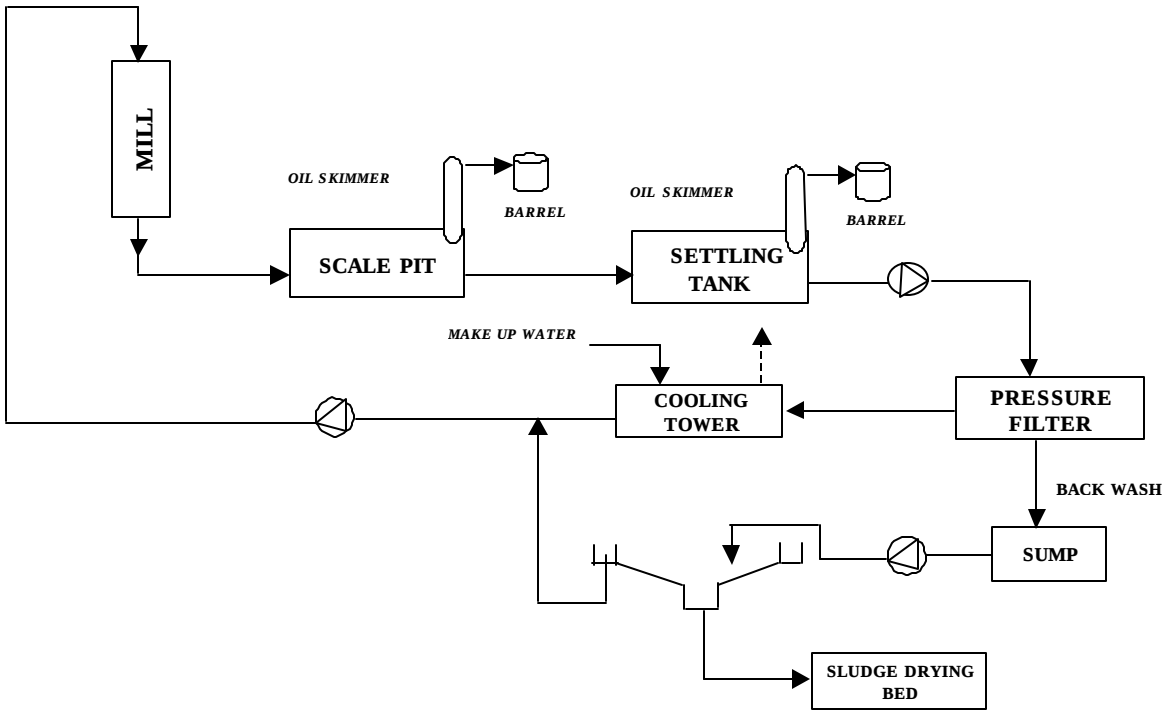


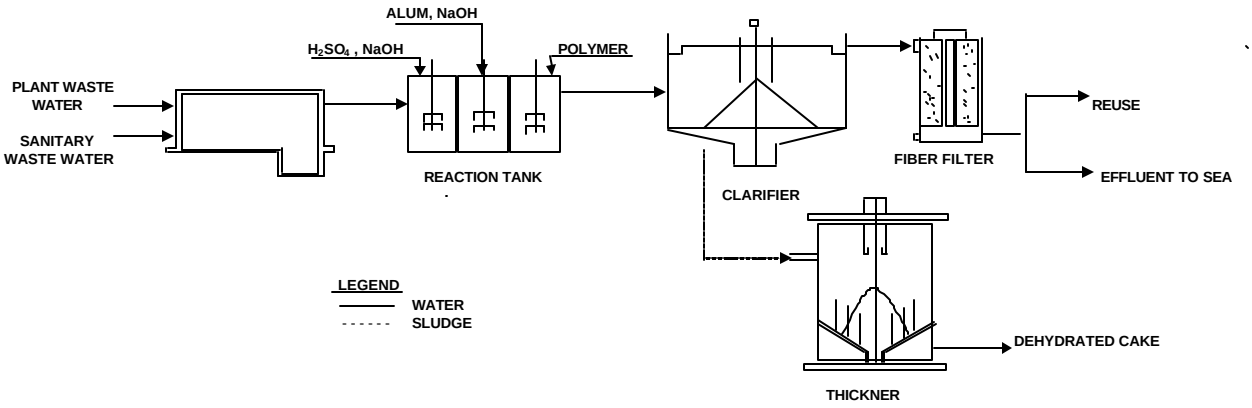
Fig. 6-5 - Schematic Flow Diagram of Mill Effluent Treatment

Treatment of Power Plant effluent: The power plant effluent will be the backwash of DM water plant. This effluent will be free from suspended solids and oil, thus requiring pH adjustment in the neutralising pit.

Treatment of plant sanitary effluent: The sanitary wastewater will be treated in a modular sewage treatment plant having regulation, aeration and settling. The settled treated effluent will be further treated in common effluent treatment plant (CETP).

6 - Environmental Management Plan (Cont'd)

Common effluent treatment: A common effluent treatment plant has been envisaged in the project to take care of all the remaining untreated process effluents and treated plant sanitary wastewater. The CETP will have physico-chemical as schematically shown in Fig. 6-6 to arrive at the desired characteristics of the treated effluent to be discharged into deep sea. The treated wastewater of CETP after partial use in green belt and plant landscape maintenance will be let into the sea by submarine pipeline at 18 to 20 metres depth by jet diffusion. At the time of detailed design and engineering of the plant, discharge



arrangement to the sea may be finalised in consultation with National Institute of Oceanography, Goa.

Fig. 6-6 - A Typical Scheme of CETP

6 - Environmental Management Plan (Cont'd)

Use of cooling tower blowdowns: Except power plant where once-thru cooling by seawater will be adopted, the cooling tower blowdowns will be utilised partly as make up water to direct contaminated water cooling tower and the balance for slag cooling and miscellaneous non-productive use.

'Zero' discharge concept: The water management of plant has been considered at bare minimum discharge from the plant to the receiving body of wastewater, that is, sea. It has been planned to recycle 97% of treated wastewater and about balance 3%, that is to say of the order of 47 cu m/hr will be let into the deep sea by pipeline.

Design characteristics of treated wastewater from the CETP to sea: Considering the prevailing regulations of discharge to the sea, the following principal characteristics of the treated effluent of CETP and once-thru sea water for cooling will be monitored prior to discharge to the sea.

Colour and odour	..	No visible colour and offensive odour
Temperature	..	Not exceeding 5^0C above the surface temperate of sea
pH	..	5.5 to 9.0
Suspended solids	..	100 mg/l (max)
BOD for 3 days at 27^0C	..	30 mg/l (max)
C.O.D	..	250 mg/l (max)
Oil and grease	..	10 mg/l (max)
Total Kjeldahl Nitrogen	..	100 mg/l (max)

6 - Environmental Management Plan (Cont'd)

Total Chromium	..	2.0 mg/l (max)
Hexavalent Chromium	..	1.0 mg/l (max)
Cyanides (as CN^-)	..	0.2 mg/l (max)

(as per CPCB regulations on the discharge of treated wastewater to sea)

The Harbour Water quality shall be maintained at the following characteristics:

Colour and odour	..	No visible colour and offensive odour
pH	..	6 to 9
Floating materials like oil, grease and scum	..	10 mg/l
Faecal coliform	..	500/100 (MPN)

(as per CPCB regulations on the quality of Harbour water)

Summary of proposed wastewater treatment schemes

In view of the above stated mitigation measures required for wastewater treatment and disposal for the production facilities, a summarised list of wastewater treatment plants is presented in Appendix 6-1.

Mitigation measures for air environment protection at design stage

The estimated inventories of uncontrolled emissions to air have been indicated in Table 5-3 of Chapter-5. The design consideration for air pollution abatement of the production facilities will be as follows for minimising the adverse impacts on air environment of the plant and its surroundings within the study area.

6 - Environmental Management Plan (Cont'd)

Fugitive dust emissions control of raw materials handling section (RMHS): To control the fugitive dust emissions at the stockpiles on the ground, stacker reclaimer, conveyor transfer points, vibrating screens etc which would be major source of fugitive dusts, both water sprinkling and dry fogging (DF) will be adopted for suppression of wind borne dusts in order to keep open workzone air environment clean. The DF system as shown in Fig. 6-7 on the next page will be adopted specially for conveyor transfer points, sizing plants, stacker reclaimer for effective suppression of dusts.

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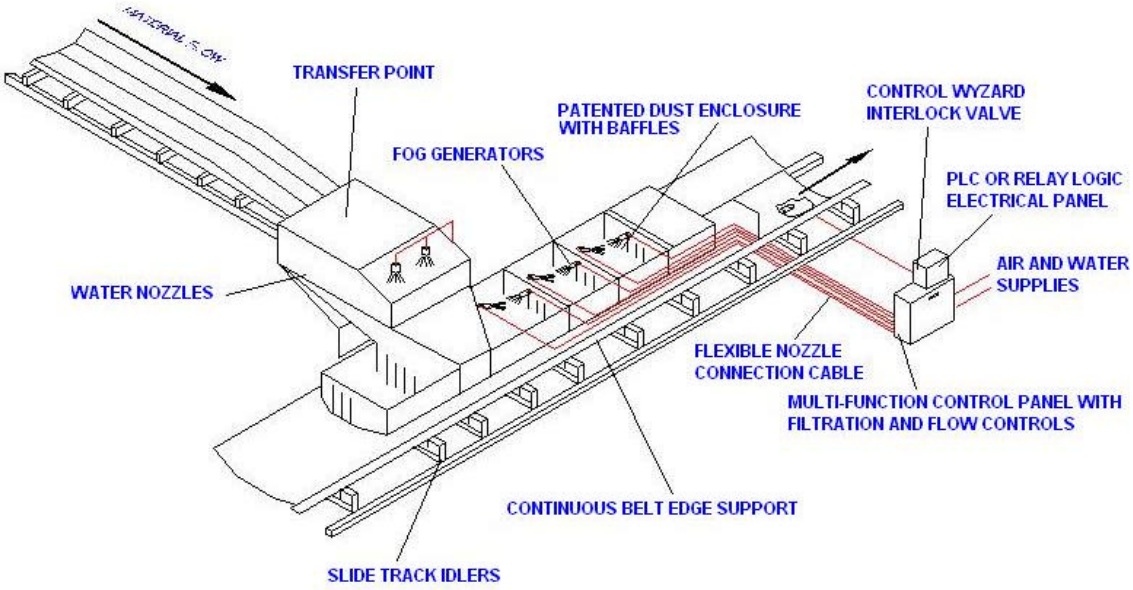

Fig. 6-7 - Fugitive Emission Control by Dry Fogging System

The DF system will work on the principle of wet scrubber and fabric filter with appropriate baffles in the spraying nozzle. It will generate a layer of fine water droplets (fog) that a dust particle cannot pass through without colliding with water droplet. It will not use any chemicals as dust suppressant agent. DF requires only compressed air and water pressure for atomisation through specially designed nozzles. DF will be adopted for handling of iron ore, coal, coke etc, which are non-reactive with water. For lime dust abatement, the facilities will be provided with fabric filter based dust extraction system.

Dust extraction (DE) system: The design of the production facilities will incorporate 25 to 30 DE systems of different capacities based on fabric filters and partly by electrostatic precipitators (ESP). These DE systems will cover FINEX plant, cast house fume extraction of

6 - Environmental Management Plan (Cont'd)

FINEX plant and secondary emissions of BOF shop during charging and tapping of BOF converters. There would be DE systems for flux and ferro-alloys handling system in the BOF Shop. Similar fume extraction system will be planned for steel refining units. All these fugitive emissions control devices will be considered at the detailed design stage so as to eliminate visible emissions from the steel complex. The non-point fugitive dusts and fume emission control scheme of the BOF shop may be seen in Fig. 6-8.

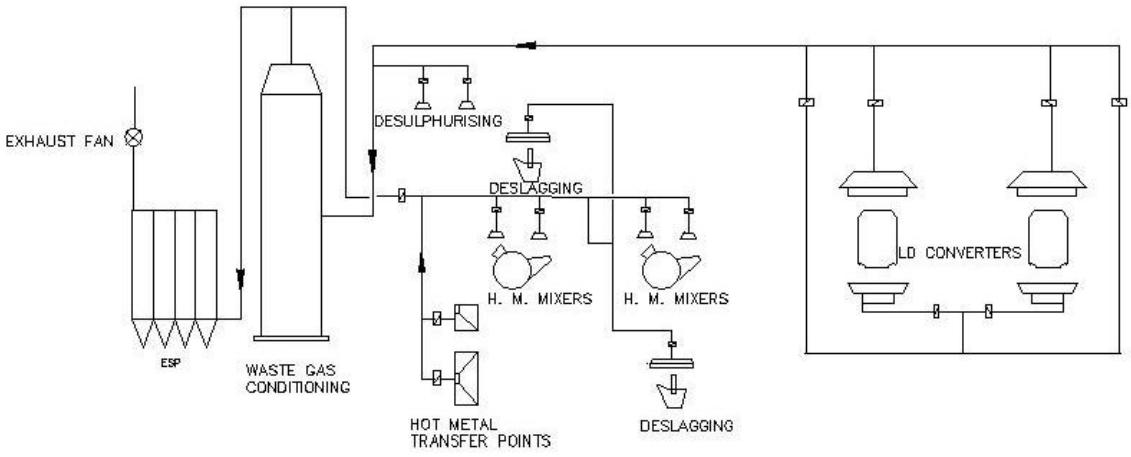

Fig. 6-8 - A Typical Scheme of BOF Secondary Emission Control

Dust handling: It is a common source of intermittent puff emissions of dusts while collecting the dusts from the dust collectors of DE System. The plant design features will incorporate covered conveyor system in case of transportation of dry raw materials, pugmilling of collected dusts and transportation of same in covered trucks/other means of transport to the site for further processing.

Point source dust emission control: Wherever there is gas fired combustion like captive power plant and mill furnaces, no dust emission

control devices are envisaged. In the case of Melter Off Gas of FINEX plant, wet scrubbing has been planned. The primary emission of BOF will be cleaned by dry method, that is, evaporative cooling followed by ESP unlike conventional gas cleaning of BOF by wet scrubbing.

SO_2 emission control: The FINEX technology as such reduces SO_2 emission by fixing sulphur present in coal and coke having sulphur level below 0.5% (w/w) as calcium sulphide in the slag while reacting with fluxes like limestone and dolomite. The fuel to be used other than reductant coal and coke will be the sweet LNG. The captive power plant will use FINEX off gas and BOF gas almost free from sulphur compounds. Hence, emission of SO_2 through combustion stacks to the ambient air would be ***insignificant.***

NOx emission control: A substantial part of thermal NOx emission will be reduced due to use of pure oxygen in the melter gasifier of FINEX plant instead of using blast air as in the case of blast furnace. Thus, the FINEX off gas to be used for in-plant fuel will have practically no free nitrogen. Thermal NOx emission from the captive power plant and combustion furnaces will be provided with efficient burning system with recycling of waste gas in the combustion process so as to minimise use of secondary air. No special de-noxification scheme has been envisaged for the present facilities.

Carbon monoxide emission control: Recovery of by-product fuel gases of FINEX and BOF will be designed with leak proof gas supply system. In addition, there will be CO detection and alarm devices so as to prevent any leakage of carbon monoxide to the air environment.

6 - Environmental Management Plan (Cont'd)

Combustion of this by-product fuel gas in the furnaces will be designed to have 100 per cent combustion in presence of excess oxygen.

On-line stack monitoring: At the design stage itself, on-line stack monitoring for all the major stacks for real time recording of emission load in respect of dusts, SO_2 and NOx and centralised data logging of the same. Portable CO monitoring will be an added-provision in the design stage.

Noise emission control: At the design specification stage, it has been planned to select low noise prone equipment particularly, fans and blowers. In addition, the high noise prone equipment like compressors, turbines etc will be housed separately with remote operation facility. The vibrations of the rotary equipment will be dampened with proper grouting on the foundations.

6 - Environmental Management Plan (Cont'd)

Design target of APC System

In view of the above stated design considerations for air pollution prevention and control of the proposed production facilities, the following standards will be binding on the design and engineering of the facilities:

?	open area dust load in ambient air of the work zone	-	below 600 mcg/cu m
?	dust load in the closed workzone	-	below 5 mg/cu m above ambient dust load
?	dust outlet of the fabric filters and ESPs	-	= 50 mg/cu m
?	expected overall dust emission load	-	within 1 kg/ton of steel
?	expected SO_2 emission load	-	within 0.5 kg/ton of steel
?	expected NOx emission load	-	within 1 kg/ton of steel
?	workzone noise level (Leq for 8 hrs)	-	85 dB(A) at 3 m distance from the noise source

Summary of proposed APC measures

A summarised list of proposed APC measures to be considered at the design stage as mitigation measures is presented in Appendix 6-2. However, at the time of detailed design, the APC systems presently envisaged need to be reviewed for ensuring clean air environment.

Prediction of ground level concentrations (glcs)

In consideration to the above stated design aspects of air pollution mitigation measures for total suspended particulates (TSP), that is, dusts, SO_2 and NOx, the prediction of glcs of stack emissions including DE stacks at the time of operation, has been made based on air dispersion modelling of multi-source emissions from the plant facilities.

6 - Environmental Management Plan (Cont'd)

Three principal pollutants, namely, respirable dusts (RD), SO_2 and NOx, have been taken into consideration for assessing the impacts of the same on the ambient air quality prevailing in the study area near Paradip.

The estimated quantities of design emission load from respective stacks are presented in the Stack Schedule in Appendix 6-3. From this Appendix, the gross controlled emissions to air environment is indicated in the Table 6-1.

Table 6-1 - Estimation of gross controlled emissions from the proposed 4 MTPY production facilities

Parameters	Nos.	Emission volume '000 N cu m/hr	Estimated controlled emissions, kg/hr TSP	SO_2	NOx
? Major DE Stacks	21	4,082	204	-	-
? Combustion stacks	13	1,873	84	178	369
Total ..	34	5,955	288	178	369

(see Stack Schedule in Appendix 6-3)

In order to predict the glcs of particulate matters of size below 10 microns (PM_{10}), that is, RD, SO_2 and NOx respectively from the design figures of controlled emission is indicated in Table 6-2, the site-specific meteorological data as recorded have been taken into consideration for air dispersion modelling. The software used for air dispersion modelling is BREEZE ISC Suite (ISC-3) and the relative disposition of 34 major

stacks of the proposed facilities is presented in Stack Location Map, Drg. 10971-REIA-ENV-007. 100 per cent of TSP has been considered as RD as a worst scenario.

The model run gives the following predicted values of glcs at different zones from the property boundary of the plant in Table 6-2 on the next page.

The relative isopleths of RD below 10 microns, SO_2 and NOx are presented in Fig. 6-9 to 6-11 on page 6-18, 6-19 and 6-20 respectively. This prediction is however based on five (5) months site-specific meteorological recordings during the period December 2005 to April 2006.

Table 6-2 - Predicted range of incremental glcs (mcg/cu m) over the baseline AAQ

Zone	RD	SO_2	NOx
0.5 km outside the plant boundary	13	14	15-22
0.5 to 2 km	7-13	8-11	15-22
2 km to 5 km	7-13	3-6	8-15
Beyond 5 km	7	3	8

It may be observed that due to adaptation of clean technology, use of clean fuel LNG and design consideration of APC measures, the ambient air quality would hardly get polluted with RD, SO_2 and NOx.

Energy conservation measures: Energy conservation measures consideration at the design stage will be given equal importance as of pollution mitigation measures. Energy will be recovered from FINEX off

gas and BOF gas for generation of electric power. Energy saving measures have also been taken into consideration by selection of continuous casting of liquid steel to produce saleable steel, thus, avoiding intermediate heating steps, except in the case of hot strip mill. Office illumination will be optimally designed and use of low wattage compact fluorescent lamps will be preferred.

Corrosion protection and colour aesthetics: The coastal belt of India in general has got higher corrosion rate above 30 mils per year. All steel structure and equipment will require suitable corrosion resistant painting with proper colour schemes, both for corrosion protection and identification purposes.

Air conditioning and ventilation: The plant design will provide best practicable congenial work environment from occupational health care point of view. The controlled rooms, pulpits and control cabins will require chilled water based air conditioning facility. The room inside temperature will be maintained at 25$\pm$ 2^{0}C and relative humidity at 55$\pm$ 5%.

6 - Environmental Management Plan (Cont'd)

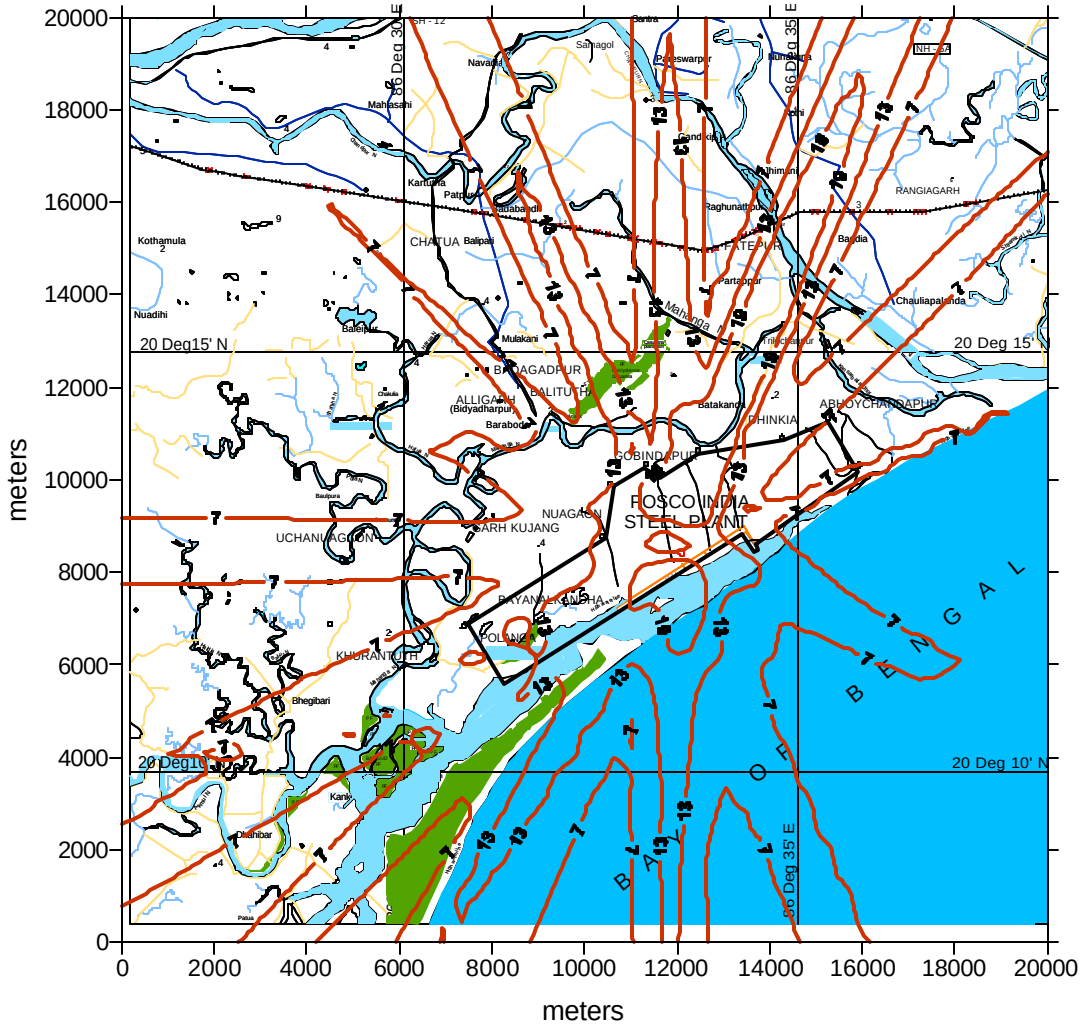

Fig.6-9 Predicted 24 - hrly average glcs of RD in mcg/cum from the proposed 4 MTPY Steel Plant near Paradip

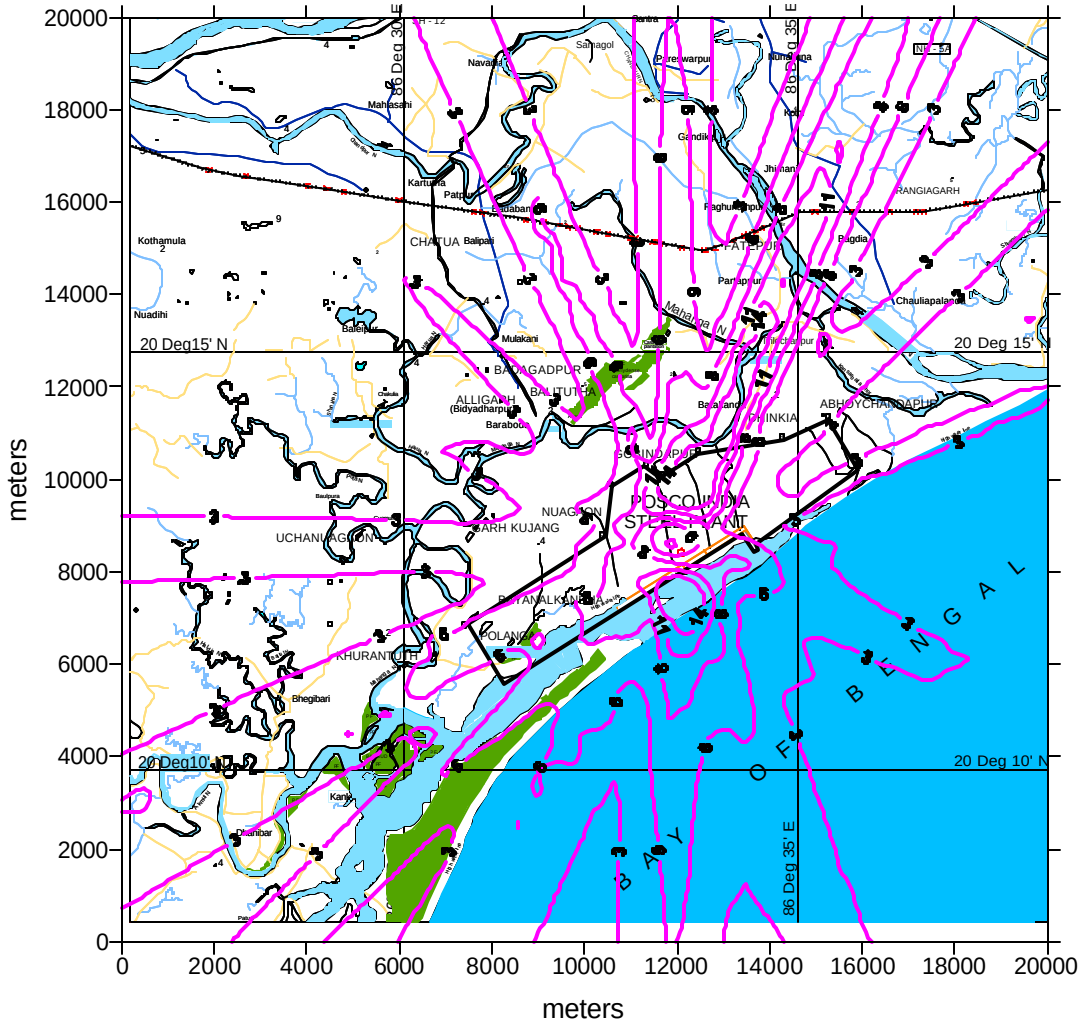

Fig.6-10 Predicted 24 - hrly average glcs of SO2 in mcg/cum from the proposed 4 MTPY Steel Plant near Paradip

6 - Environmental Management Plan (Cont'd)

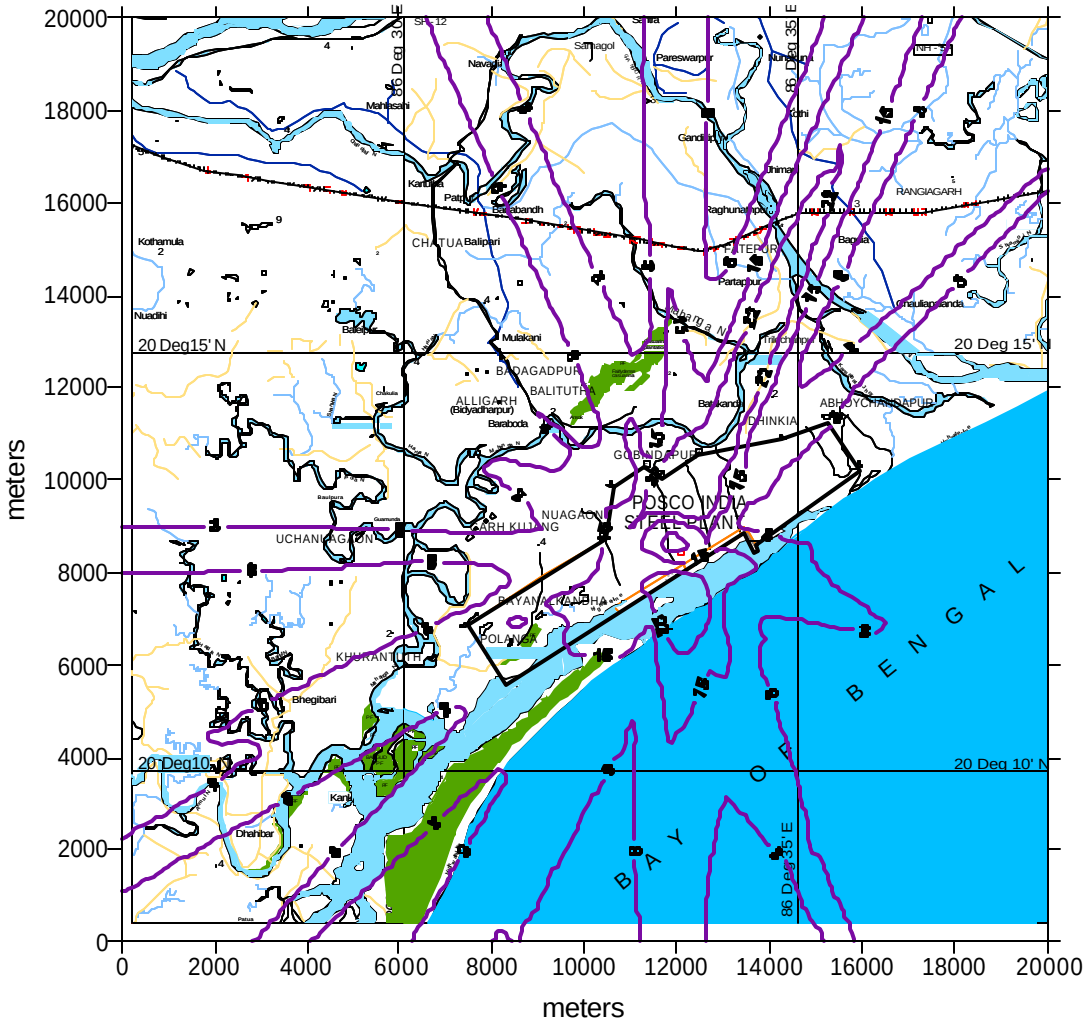

Fig.6-11 Predicted 24 - hrly average glcs of NOx in mcg/cum from the proposed 4 MTPY Steel Plant near Paradip

6 - Environmental Management Plan (Cont'd)

Window Coolers/Split Air Coolers, if considered, will use only those types of refrigerants, which by no means shall be ozone depleting substances.

The production shops having roof cover will be designed with adequate natural ventilation. The additional heat load within the shop floor will be ventilated by forced supply of washed air.

Landscaping: While freezing the Plant General Layout with judicious utilisation of available land area, the vacant areas for future expansion will be provided with grass cover. The unpaved areas will either have black top/cemented or will have grass lawns cover to prevent wind borne fugitive dust emissions. In addition to peripherial greenbelt, each production zone will be provided with open land area by the sides of the access road for beautification purpose with fountains and colourful flower garden.

Environmental management measures (EMM)

EMM is required both during construction and operation stages.

EMM during construction stage: Considering the fact that the site to be acquired is a low lying coastal area, adequate precautions need to be considered during construction in preventing contamination of Jatadharmohan River Creek and sea with construction debris and wastes. A group of persons will be made responsible to monitor the construction activities from environment and safety point of view. The following measures for environment management during construction period need to be considered:

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- preparation and follow-up of construction manual for environmental safeguards and safety compliance at the construction site
- development of own Nursery for growing plant species
- commencement of peripherial greenbelt along the property line
- the entire site needs to be divided into several construction zones; environment and safety aspects will be monitored for respective zones
- dredged sand and other earth material required for site levelling will be stockpiled and contained within the temporary bundwall so as to prevent any ingress of same to the water bodies
- similar containment will be provided for stockpiling of construction materials like sand and gravel
- bringing the construction material by rail/ship; at the time of unloading water sprinkling will be provided to arrest fugitive dusts
- construction will be carried out with mechanical machineries
- batching plant washings will be drained only after passing through settling basins
- all construction personnel will be given safety training and shall use compulsorily safety helmets, gum boots, goggles and dust masks
- safety surveillance on each day and administrative control for avoiding unsafe practices
- no child labourers will be deployed
- labour hutments, if constructed, shall have sanitation facilities and other entertainment facilities
- cleaning of site after completion of construction and erection activities at respective construction zone

6 - Environmental Management Plan (Cont'd)

- the construction wastes will be disposed of in an isolated site within the steel plant boundary till its safe disposal is completed

EMM during operation stage: EMM during operation stage requires formation of suitable organisational network for monitoring planning and implementation of environment, health and safety aspects of the plant in operation.

EHS Organisation: It is planned to have a strong organisation at network of EHS with 200 personnel with different responsibilities. Fig. 6-12 on the next page depicts a scheme of EHS organisation during full scale operation of the plant.

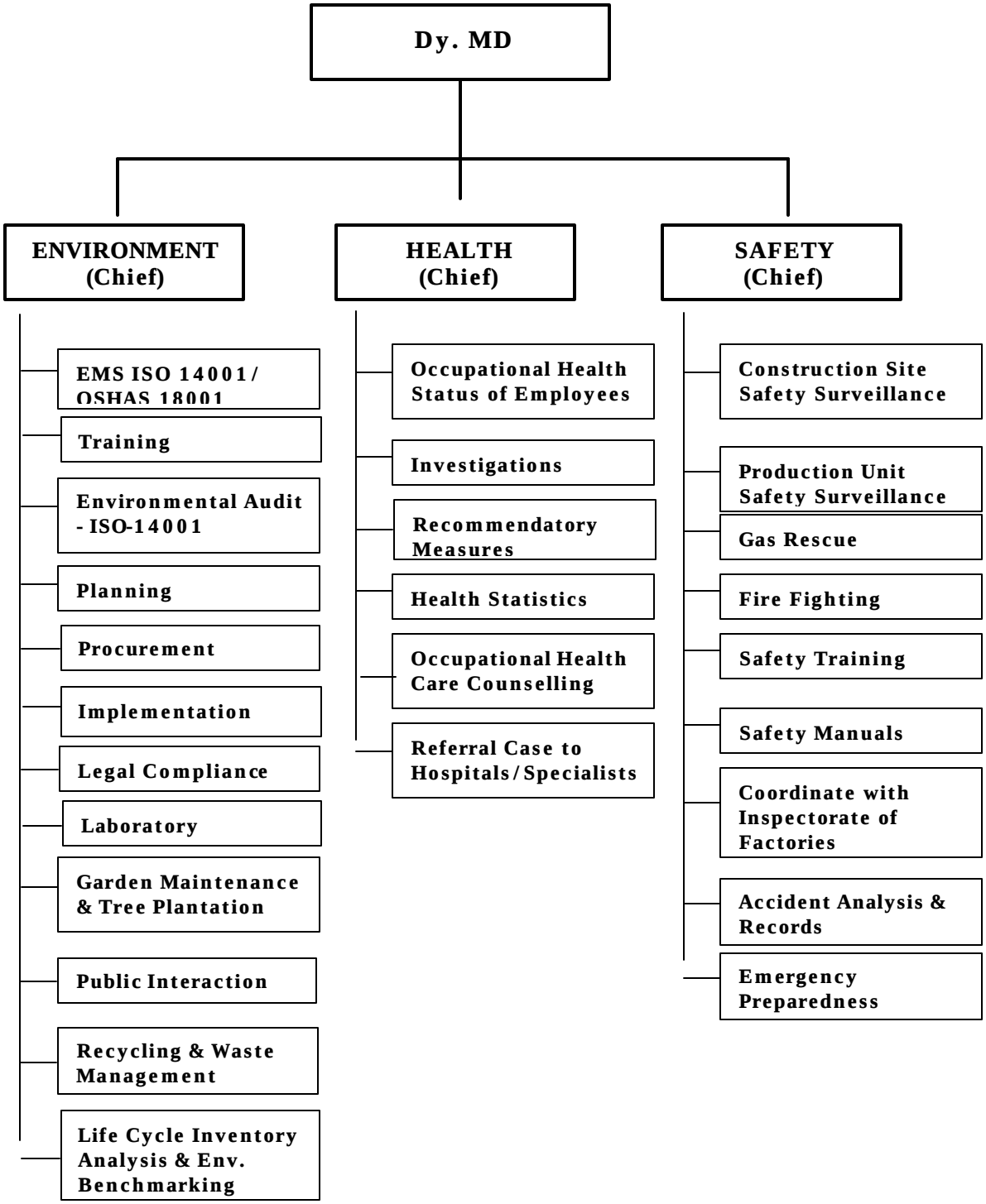


FIG. 6-12 - INDICATIVE ORGANSIATION STRUCTURE OF THE PROPOSED EHS DEPARTMENT OF PARADIP STEEL PLANT

The EHS organisation will be an integral part of the manufacturing division and will be under direct administrative control of Dy. Managing Director of the Steel Plant and Port.

The main responsibilities of EHS will cover the following:

- witnessing the environmental performance (EP) test of pollution control equipment/systems
- monitoring the EP of the pollution control equipment/systems on daily basis
- environmental data compilation and monthly report preparation
- implementation of corrective measures as and when required
- dealing with the stake holders on the desired EP of the plant
- occupational health monitoring and implementation of occupational health care programme
- safety surveillance, safety audit and conducting HAZOP study
- training of operation and maintenance personnel

The plant operation will be brought under comprehensive environmental management system (EMS) and occupational health care system in accordance with ISO-14001:2004 and OSHAS-18001-1999 as amended.

Solid waste management at the operational stage

At full scale operation of 4 MTPY Steel Plant, the estimated quantity of solid waste will be of the order of 6,500 to 7,000 TPD as indicated in Table 5-5 in Chapter 5. Of this much quantity of solid

6 - Environmental Management Plan (Cont'd)

wastes, FINEX Slag will be nearly 52 per cent; BOF Slag 17 per cent and the balance 31 per cent accounts for sludge, dusts, mill scales etc.

It is planned to utilise maximum practicable quantities of solid wastes within the plant, part for other gainful use and the balance will require dumping within the Steel Plant boundary for future use.

In consideration to this, a tentative scheme of solid waste disposal as of current planning is presented in the Table 6-3.

Table 6-3 - Proposed management scheme for solid wastes disposal

No.	Solid wastes	Expected generation TPD	Disposal plan
1.	FINEX Slag	3600-3700	Abt. 16% will be used within the plant; rest 84% will go to cement plant
2.	BOF Slag	1100-1200	Abt. 50% reuse within the plant; balance 50% will be used for railway ballast, road subgrade preparation and other construction aggregates
3.	Millscales	60-80	50% reuse within the plant and 50% to be sold out for ancillary industries
4.	Sludge	1100-1200	90-95% reuse within the plant; balance to be dumped
5.	Dusts	600-700	30-35% reuse within the plant; balance to be dumped
6.	Used refractory, debris	50-60	100% for miscellaneous civil construction work like site grading, road construction etc

From the Table 6-3, the expected dumping of solid wastes will be nominal, not even 10 per cent of the total generation. Land area measuring around 900 acres has been earmarked for dumping of these unused solid wastes.

Planned utilisation of solid wastes

Under solid waste management scheme, the following schemes have been envisaged:

FINEX Slag: Fifty per cent of FINEX Slag will be granulated for use by the cement industries. The balance 50% will be slowly air cooled to make stone like construction material for use in the road pavement, harbour maintenance and many other on going civil work.

Steel Melt Shop (SMS) Slag: To recover effectively Fe resource from all sorts of SMS Slag like converter slag, caster etc, there will be a waste recycling plant (WRP). In the WRP, the BOF Slag and Caster Slag will be batched separately. The Crusher will crush the big lumps followed by screening to separate out separate sized aggregates. The skulls will be processed in skull cutting equipment. By magnetic separation, the metallics will be isolated from the sized fraction and the same will be recycled to the FINEX plant. The balance amount of slag sized to desired fraction will be used as aggregate for in-plant railway ballast, road sub-grade preparation and other miscellaneous aggregates for construction purpose.

Millscale: The mill scale from the caster and mill will be used as the material for Cold Bonded Pelletising (CBP) plants. The millscales, which cannot be used in the CBP, will be sold out.

Sludge and dust: The proposed CBP facility has been envisaged for utilisation of sludge of the Gas Cleaning Plants and dusts recovered from dust extraction systems. The sludge and dusts, which cannot be processed in the CBP, will be dumped for future construction purpose.

Cold Bonded Pelletising (CBP) facility: The CBP facility will be provided with silos, mixer, disk pelletiser and dryer. The schematic flow diagram of CBP is presented in Fig. 6-13 on the next page. In this plant

6 - Environmental Management Plan (Cont'd)

solid wastes like millscales, dusts, sludge having Fe content of appreciable amount will get pelletised. The pellets will be recycled to the FINEX plant.

Hazardous wastes disposal

The proposed production facilities will produce hazardous wastes (HW) in the tune of 10 to 20 tons per day. The HW will contain oil muck, cotton wastes, packaging materials, discarded flammable materials and part of township wastes.

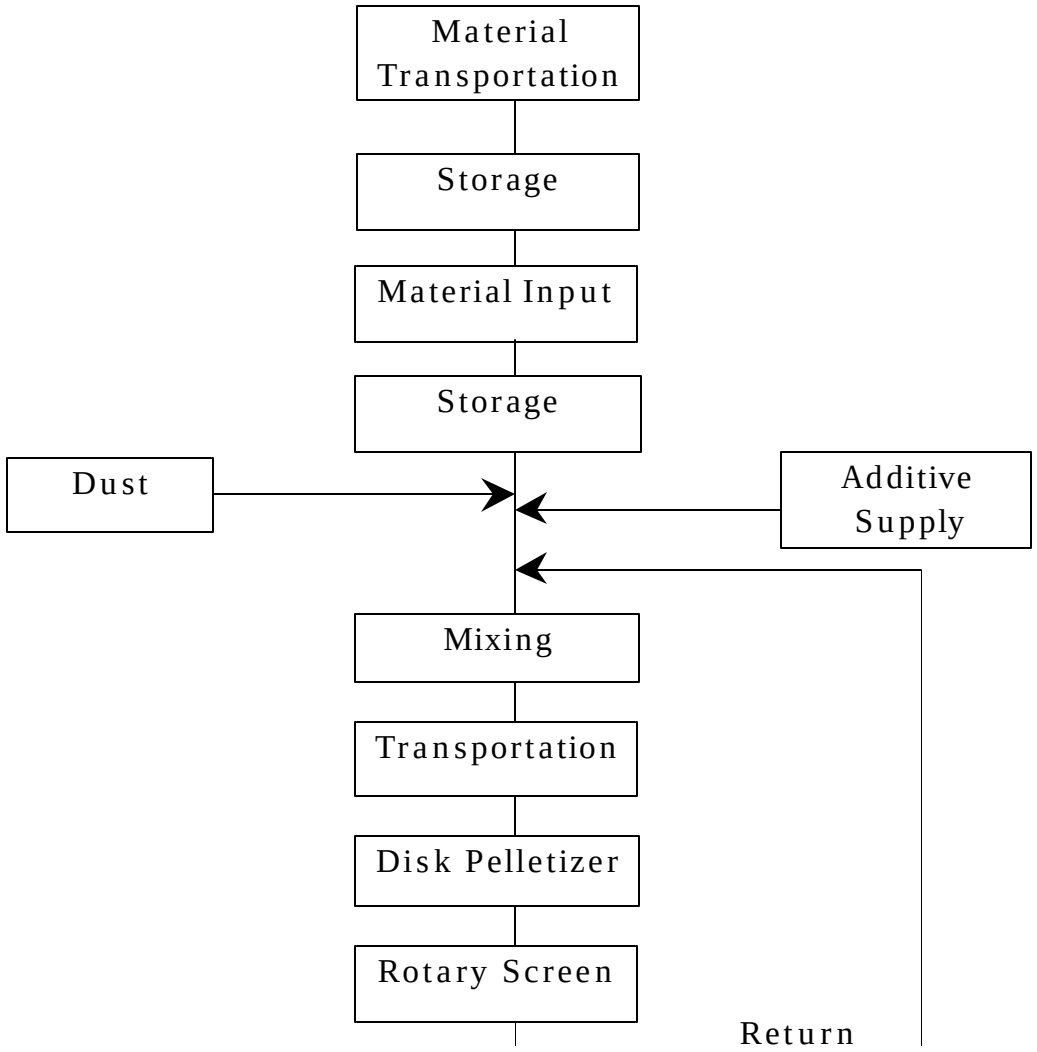
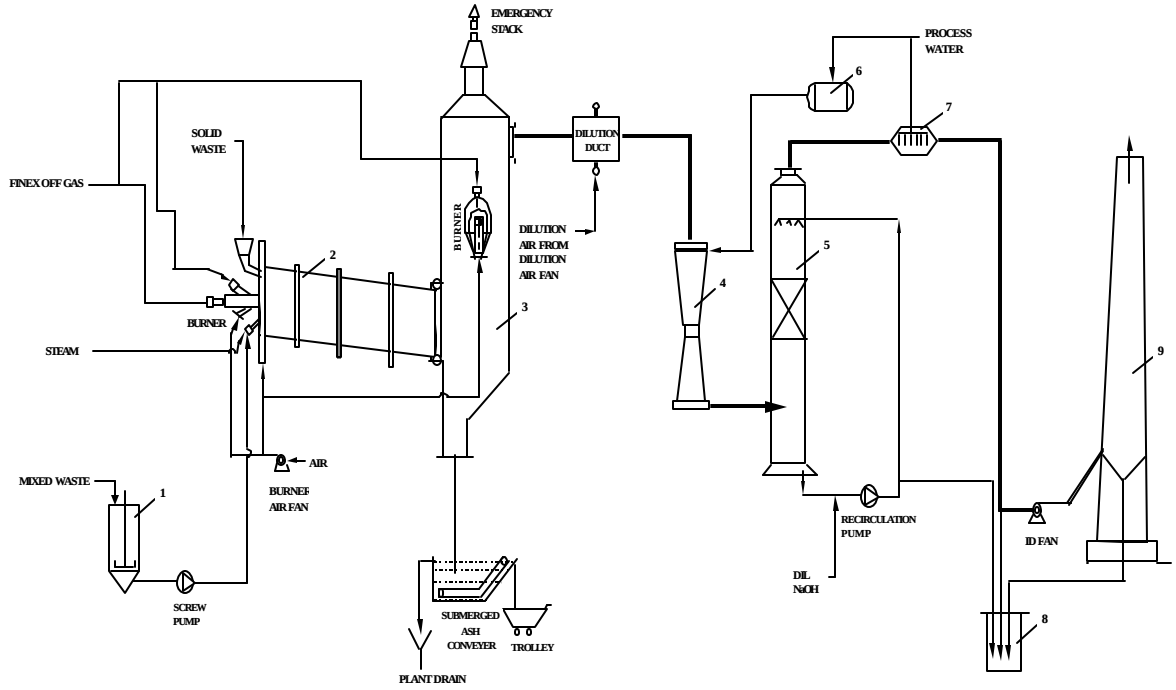


Fig. 6-13 - Flow Sheet for Cold Bonded Pelletising

The incineration will be of rotary type with post-combustion facility and lime slurry-scrubbing facility for venting clean gas to atmosphere. The non-toxic ash collected will be dumped in the containment area. The schematic flow diagram of incineration facility is presented in Fig. 6-14 on the next page. The fuel for the incinerator will be LNG.



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LEGENDS:

1	SLUDGE TANK	6	EMERGENCY OVERHEAD TANK
2	ROTARY KLIN	7	MIST SEPARATOR
3	SECONDARY CHAMBER	8	SEAL POT
4	VENTURI SCRUBBER	9	STACK
5	PACKED COLUMN		

Fig. 6-14 - A Typical Scheme for Oily Waste Incineration

Safety surveillance

The steel making process is a high temperature bulk solids processing operation. This requires significant amount of thermal and electrical energy, water, handling of fuel gases, handling of molten metal in ladles, mechanical handling and processing of bulk solids, product handling, operation of large capacities of electrical motors, cranes etc. The Steel Plant, therefore, requires best operational practice of safety not only in accordance with the Factories Act and Regulations, but also to minimise the production loss and accidents. Some of the key areas requiring routine safety surveillance are listed below:

- Electrical installation, cabling and tripping devices
- Fuel gas and LNG storage and distribution network
- Smoke detection alarms and operation of automatic fire extinguisher devices

- Pressure in fire hydrant mains
- Workers personal safety measures
- Safety training

A full fledged safety department as shown in the EHS organisation headed by Chief Safety Officer will look after the overall safety aspects of the Steel Plant and its supporting facilities.

Environmental monitoring

In addition to provisions for on-line stack monitoring of major stacks, air pollution level within the plant and outside the plant boundary including township will be monitored on daily basis. It is proposed to have six to eight fixed ambient air quality monitoring stations spreading over 5 km aerial belt (other than sea) from the plant boundary. In addition, there will be one permanent meteorological station, which will record real time data on temperature, humidity, barometric pressure, wind speed, wind direction, rainfall and weather phenomena.

A mobile van having necessary instruments to record air quality and water quality will be utilised for random checking of environmental quality outside the plant boundary on weekly basis.

The recorded data will be centrally stored in a computer by telemetry displayed on the board for information to the local public about the daily status of environment.

Occupational health care

The operation of an integrated steel plant is associated with occupational hazards due to exposure to heat, dusts, noise, gas leaks, acids and alkalis. The occupational risk group personnel need to be identified and they would be brought under occupational health care

6 - Environmental Management Plan (Cont'd)

monitoring programme to diagnose their ailments and provide necessary treatment. It is proposed that the Steel Plant would be covered under comprehensive occupational health services as required by international standard of occupational health and safety administration system OHSAS-18001-1999.

6 - Environmental Management Plan (Cont'd)

Training

The Posco-India HRD Centre will be established to provide technically qualified manpower. The Centre will focus on possessing the state-of-the art training facilities with the assistance of qualified and experienced faculties with modern training modules and learning environment.

In order to ensure world class training, the Company will adopt methods of training and expertise from Posco-Korea as suitable in Indian context. The aim of training is to form a core team of experienced and younger qualified personnel having gained experience in the intricacies of FINEX technology and environmental challenges to be encountered. This training has been planned prior to commissioning of the plant. In addition, there will be routine training modules for upgradation of the knowledge base in the plant operation, environment, health and safety.

Social upliftment

A world famous corporate organisation like Posco, working on six-Sigma principle, will pass on the same practice of social commitment policy to their Indian subsidiary, Posco-India.

Other than implementation of R&R plan as discussed earlier, Posco-India proposes to undertake peripherial social upliftment programme in many ways. The first priority is to open a Training Centre to educate and train the local people for their skill development depending on their aptitude. These trained local people will be utilised in the development of the project. In addition to vocational training of the locals, the other social upliftment programme include sinking of tubewells in the villages, fish culturing, social forestry, child education, primary health care, small business entrepreneurship development.

6 - Environmental Management Plan (Cont'd)

6 - Environmental Management Plan (Cont'd)

Environmental Management Cost

For implementation of proposed environmental mitigation measures described earlier, Posco-India have considered CAPEX of the order of 361 million USD (abt. Rs 1,625 Crores). The major CAPEX heads under environmental mitigation are as given below.

			million USD
?	R & R Compensation	-	95.0
?	Compensatory Afforestation	-	8.0
?	Air Pollution Control Systems	-	146.8
?	Water Conservation, Wastewater Treatment	-	62.5
?	Solid Wastes Recycling Plant and Treatment	-	33.5
?	Greenbelt Development	-	6.7
?	Peripherial Development / Assistance for Training Centres, Health Centres, Sinking Tubewells etc	-	8.5
	Total	..	**361 million USD (~ Rs 1,625 Crores)**

Environmental Impact Statement (EIS)

Taking into consideration of the proposed environmental management measures for the project outlined in the foregoing text and the present practice of environmental management, a matrix of net environmental impacts due to proposed management measures is presented in Table 6-4 on the next page.

From the Table it may be seen that with the proposed environmental management measures, the project under consideration

6 - Environmental Management Plan (Cont'd)

would not cause significant adverse impact on the present environment of the study area; rather the proposed project will lead to significant development of Paradip region.

6 - Environmental Management Plan (Cont'd)

Table 6-4 - Environmental impact statement of the proposed project

Environmental attributes		Impact on baseline: Project without EMP	Impact on baseline: Project with EMP
Duration	..		
I. Physico-Chemical			
Land environment (after acquisition)	..	**+2**	**+3**
Surface water resource	..	0	0
Surface water quality	..	**-2**	0
Ground water resource	..	0	0
Ground water quality	..	0	0
Creek/Sea water quality	..	**-2**	0
Workzone air quality	..	**-3**	0
Ambient air quality	..	**-2**	0
Ambient noise	..	0	0
Workzone noise	..	**-2**	**-1**
II. Biological			
Terrestrial ecology	..	0	**+1**
Aquatic ecology	..	**-2**	0
Marine ecology	..	**-2**	0
III. Human			
Displacement of Human settlements	..	**-3**	0
Infrastructure	..	**+3**	**+3**
Employment generation	..	**+3**	**+3**
Economy	..	**+3**	**+3**
Regional development	..	**+3**	**+3**
Safety	..	**-2**	0
Community health	..	**-2**	0
Aesthetics	..	**-1**	**+1**

Legend:
1 – Marginal**; 2 –** Moderate**; 3 –** Significant**; (+)** ve **–** Beneficial**; (-)** ve **–** Adverse**.**

7 – ENVIRONMENTAL RISK ASSESSMENT

It is presumed that the proposed greenfield steel plant at Paradip would be designed and engineered with all possible safety measures and standard codes of engineering practices. Inspite of this, there may be some design deficiency or accidental events during operation and maintenance, which may cause damage to the environment, life and property. This Chapter presents an overview of environmental risks associated with the production facilities, suggested remedial measures and a model outline of the emergency preparedness plan.

Objectives

The objectives of environmental risk assessment are governed by the following, which excludes natural calamities:

a) to identify the potential hazardous areas so that necessary design safety measures can be adopted to minimise the probability of accidental events.

b) to identify the potential areas of environmental disaster which can be prevented by proper design of the installations and its controlled operation.

c) to manage the emergency situation or a disastrous event, if any, from the plant operation.

Managing a disastrous event will obviously require prompt action by the operators and the crisis management personnel using all their available resources like alerting the people and other Plant personnel remaining inside, deployment of fire fighting equipment, operation of emergency shut off valves, opening of the escape doors, rescue etc.

Minimising the immediate consequences of a hazardous event include cordoning off, evacuation, medical assistance and giving correct information to the families of the affected persons and local public for avoiding rumours and panic.

Lastly, an expert committee is required to probe the cause of such events and the losses encountered, and suggest remedial measures for implementation so that in future such events or similar events do not recur.

Definition of environmental risks

The following terms related to environmental risks are defined before reviewing the environmental risks:

- Harm : Damage to the person, property or environment.
- Hazard : Something with the potential to cause harm; this could be a characteristic of material being processed or malfunctioning of the equipment. An environmental hazard is thus going to be a set of circumstances, which leads to the direct or indirect degradation of environment and damage to the life and property.
- Risk : The probability of the harm or likelihood of harmful occurrence being released and its severity. Environmental risk is a measure of the potential threats to the environment, life and property.

7 - Environmental Risk Assessment (Cont'd)

- Consequence : Effect due to occurrence of the event, which may endanger the environment permanently or temporarily and, or, loss of life and property.

- Environmental disaster : The consequence is so severe that it can extensively damage any one or all the four components of the environment, namely, (i) physico-chemical, (ii) biological, (iii) human and (iv) aesthetics.

7 - Environmental Risk Assessment (Cont'd)

Identification of hazards

The hazards are attributable due to raw materials and chemicals used in steelmaking and the Plant operation. A list of major raw materials used in the Plant and the process units with their hazard potential is presented in Table 7-1.

Table 7-1 – Hazard Identification of the proposed steel plant

Sl. No.	Group	Item	Hazard potential	Probable consequence
I.	**Raw materials and Products**	Iron ore	None	-
		Coal	Moderate	Fire
		Other fluxing minerals	None	-
		Product steel	None	-
		Acids/Alkalis	Major	Bio corrosive
		Lube oil	Moderate	Flammable
II.	**Processing**			
	- Drying	Dusts and fumes	Moderate	Air pollution
	- Ironmaking in FINEX Plant	FINEX off gas	Major	Flammable and CO pollution
		Hot Metal	Major	Personnel injury & fire
		Molten Slag	Major	Personnel injury & fire
	- Steelmaking in BOFs	BOF/LD gas	Major	Flammable and CO pollution
		Liquid steel	Major	Personnel injury & fire
		Molten Slag	Major	Personnel injury & fire
	- Rolling Mills	Gas firing	Major	Fire
		Mill machinery	Minor	Personnel injury
III.	**Utilities**			
	- LNG	Leaks/vapour cloud	Major	Fire /explosion

7 - Environmental Risk Assessment (Cont'd)

- Fuel gas distribution	Gas leaks	Major	Fire and CO pollution
- Electric power supply	Short circuit	Major	Fire
- Effluent treatment	Untreated effluent discharge	Moderate	Water pollution

From the Table, it may be observed that major on-site emergency situation may occur from coal storage and handling, fuel gas handling, molten metal and slag handling, acids and alkali storage and handling, electrical short-circuit and malfunctioning of effluent treatment plant. The off-site environmental disaster may occur if large-scale fire and explosion occurs, the effect of which extends beyond the plant boundary. The off-site environmental disaster may occur due to significant environmental degradation for a sustained period.

Environmental risk evaluation

From environmental hazards point of view for the raw materials and consumable chemicals and processing of the same in various production units, relative risk potential analysis is made on the following three factors:

- likelihood of occurrence
- likelihood of detection
- severity of consequence

Each of these factors is graded and compiled to determine the risk potential. The factors governing the determination of relative risk potentials are presented in the Table 7-2.

Table 7-2 – Determination of Risk Potential

(A) Likelihood of occurrence		(B) Likelihood of detection		(C) Severity of consequence	
Criteria	**Rank**	**Criteria**	**Rank**	**Criteria**	**Rank**
Very High	**5**	Very High	**1**	None	**2**
High	**4**	High	**2**	Minor	**4**

7 - Environmental Risk Assessment (Cont'd)

Moderate	**3**	Moderate	**3**	Low	**6**
Low	**2**	Low	**4**	Moderate	**8**
Very Low	**1**	Very Low	**5**	High	**10**

RISK POTENTIAL (RP) = (A + B) x C

Based on the above stated criteria for assessing the risk, each probable event has been evaluated by addressing several questions on the probability of event occurrence in view of the in-built design features detection response, operational practice and its likely consequence. A summarised list of environmental risk potential for the likely events is presented in Table 7-3 on the next page.

This evaluation has been done with the presumptions of common events as observed from the past experience in the operation of an integrated iron and steel plant and best practicable designs for the proposed Project. The present risk potential evaluation is primarily based on human errors or faulty operation or failure of the control systems.

From the Table 7-3, it appears that some events carry risk potential above 50. These events will be considered as risk prone hazardous events and need adequate safe design operation and maintenance in order to reduce the risk.

HAZOP Study

It is suggested to have HAZOP Study for the fuel gas distribution network and LNG handling facilities prior to commissioning for last minute corrections in the design of the systems from fail safe angle.

Risk management measures

The risk management measures for the proposed project activities require adoption of best safety practice at the respective construction zones within the Works boundary. In addition, the design and engineering of the proposed facilities would take into consideration of the

7 - Environmental Risk Assessment (Cont'd)

proposed protection measures for air and water environment as outlined in earlier Chapter. The Environment Department of the plant shall keep close vigil on the efficient performance of air pollution control units, shop-wise effluent treatment plant and quality of final discharge of treated wastewater from the common effluent treatment plant.

7 - Environmental Risk Assessment (Cont'd)

Table 7-3 - Environmental Risk Potential Evaluation

Sl. No.	Event	Rank Likelihood of occurrence	Likelihood of detection	Severity of consequence	Risk potential
i)	Fire at the coal stockyard	Very low (1)	High (2)	High (10)	**30**
ii)	LNG handling and pipe work	Moderate (3)	Low (3)	High (10)	**70**
iii)	Fuel gas leaks from the pipe line/valves	High (4)	Low (4)	High (10)	**80**
iv)	Collapsing of Gas Holders	Very low (1)	High (2)	High (10)	**30**
v)	Splashing of molten metal and slag	Very low (1)	Very High (1)	High (10)	**20**
vi)	Uncontrolled dust emissions/failure of emission control system	High (4)	Moderate (3)	Moderate (8)	**56**
vii)	Release of untreated wastewater to Coast/ Creek	High (4)	Low (4)	Moderate (8)	**64**
viii)	Collapsing of acid/ alkali storage tanks	Very low (1)	High (2)	High (10)	**30**
ix)	Leakage of acids / alkalis	Low (2)	Very low (5)	Moderate (8)	**56**
x)	Occurrence of static electricity/electric spark in the Mill Cellar Room	Very low (1)	Very low (5)	High (10)	**60**
xi)	Failure of Gas Cleaning Plant/ Fume Extraction System	Moderate (3)	High (2)	High (10)	**50**
xii)	Unsafe disposal of oily wastes of Rolling Mills	High (4)	Low (4)	Moderate (8)	**64**

7 - Environmental Risk Assessment (Cont'd)

xiii)	Wet scrubbers running dry	Low (2)	Moderate (3)	High (10)	**50**
xiv)	Oil wastes/ oil sludge handling	Low (2)	High (2)	High (10)	**40**

7 - Environmental Risk Assessment (Cont'd)

Electrical safety: Adequately rated and quick response circuit breakers, aided by reliable and selective digital or microprocessor based electro-magnetic protective relays would be incorporated in the electrical system design for the proposed Project. The metering and instruments would be of proper accuracy class and scale dimensions. A centralised supervisory control of data acquisition (SCADA) system exists in the Plant. The proposed facilities would require integration with this system.

Fire prevention: In addition to the yard fire water hydrant system, each individual shop will be provided with fire and smoke detection alarm systems. Typical applications of such systems are as follows:

Location and Coverage	Required Systems
Cable basement/Cellar, HT Switchgear rooms, Electrical control rooms	Fire and smoke detection alarm system
Main Transformers	High velocity water spray with FDA system
All production shops/utility facilities	Wall mounted internal hydrants with valves, hoses and hose boxes
All areas of plants, buildings with possibility of fire hazards	Portable dry type fire extinguishers

Fire detection system will have interlock with the automatic water sprinklers and other process interfacings.

On-site emergency plan

The on-site emergency plan relates to the laid-down and well-practised procedure after taking care of all design based precautionary

7 - Environmental Risk Assessment (Cont'd)

measures for risk control. This plan is aimed for tackling any emergency situation, if arises.

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Posco-India plans to adopt on-site-emergency control in their Indian operation similar to their Korean Plant as schematically represented in Fig. 7-1.

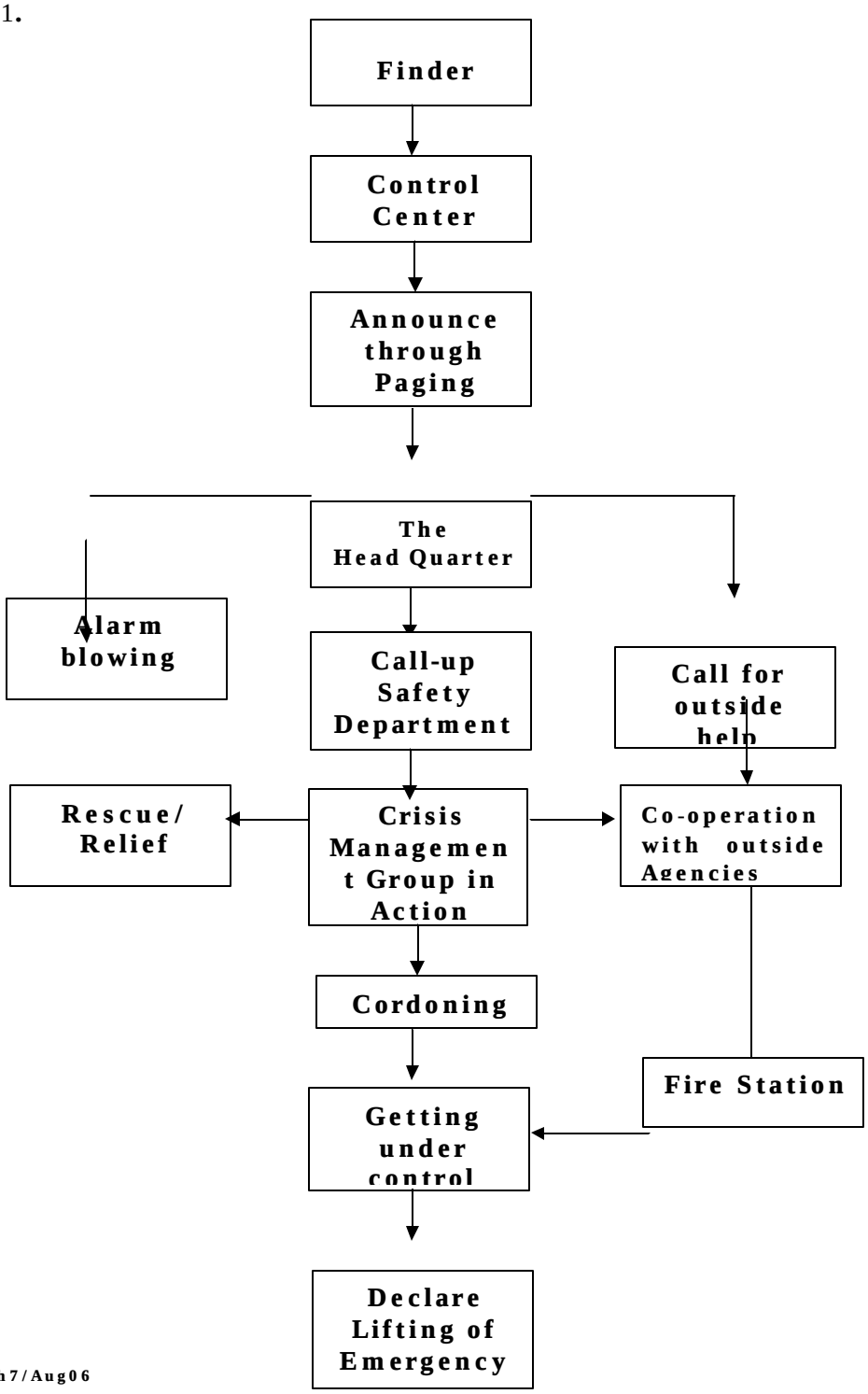

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Fig. 7-1 - Proposed Procedure for Accident Control

7 - Environmental Risk Assessment (Cont'd)

There will be a Plant Disaster Control Cell (PDC) for the proposed facilities under Safety Department. The Organisation of PDC as shown in Fig. 7-2 will be formed in the proposed Steel Plant. In case of any emergency, the PDC immediately will take the task of emergency control.

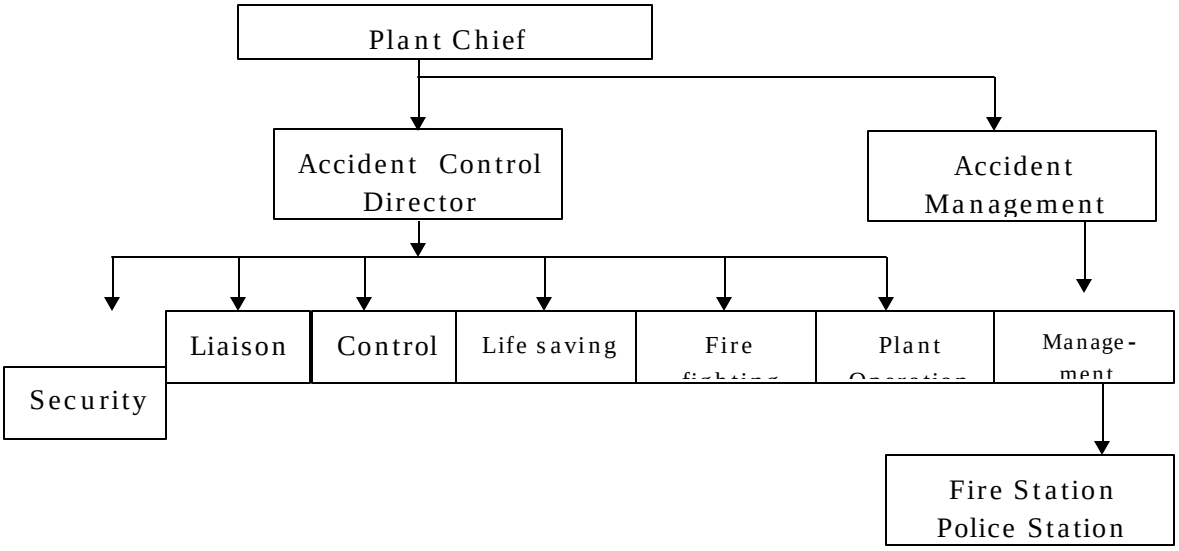

Fig. 7-2 - Model Organisation of Safety

The important contract Nos. need to be displayed at the entry points of respective production unit, on the plant road crossings and at the Main Gate so that during emergency, no time is lost in mobilising the resources. After major emerging situation comes under control, this will be announced.

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On-site emergency planning rehearsals need to be carried out from time to time. It requires monitoring by experienced persons from other similar factories or by senior officials from the State Inspectorate of Factories and/or the Directorate of Fire Services, who can help in updating the emergency plan procedure.

Accident statistics

The PDC will record the accidental events, be it minor or major, listing all the details such as place of event, date and time of event, duration, probable cause of event, extent of damage, personnel affected, man-hours lost, medical assistance provided etc so as to analyse these data for drawing up necessary corrective measures.

Accident Statistics of POSCO's Kwangyang Steel Plant presented below indicate the extent of safety management practice adopted by POSCO. It is expected that in their Indian operation, the same trend or improvement over it will be maintained:

Year		Mandays lost
2001	..	42
2002	..	112
2003	..	227
2004	..	84
2005	..	35

The mandays lost in Korean Steel Plant stated above is quite low in comparison to our similar plant in India where mandays lost varies from 1500 to 2000.

Off-site emergency planning

Off-site emergency planning is normally under the jurisdiction of the district administration. The designated official of the Steel Plant is required to have co-ordination with

7 - Environmental Risk Assessment (Cont'd)

the district administration for responsive action in off-site emergency planning.

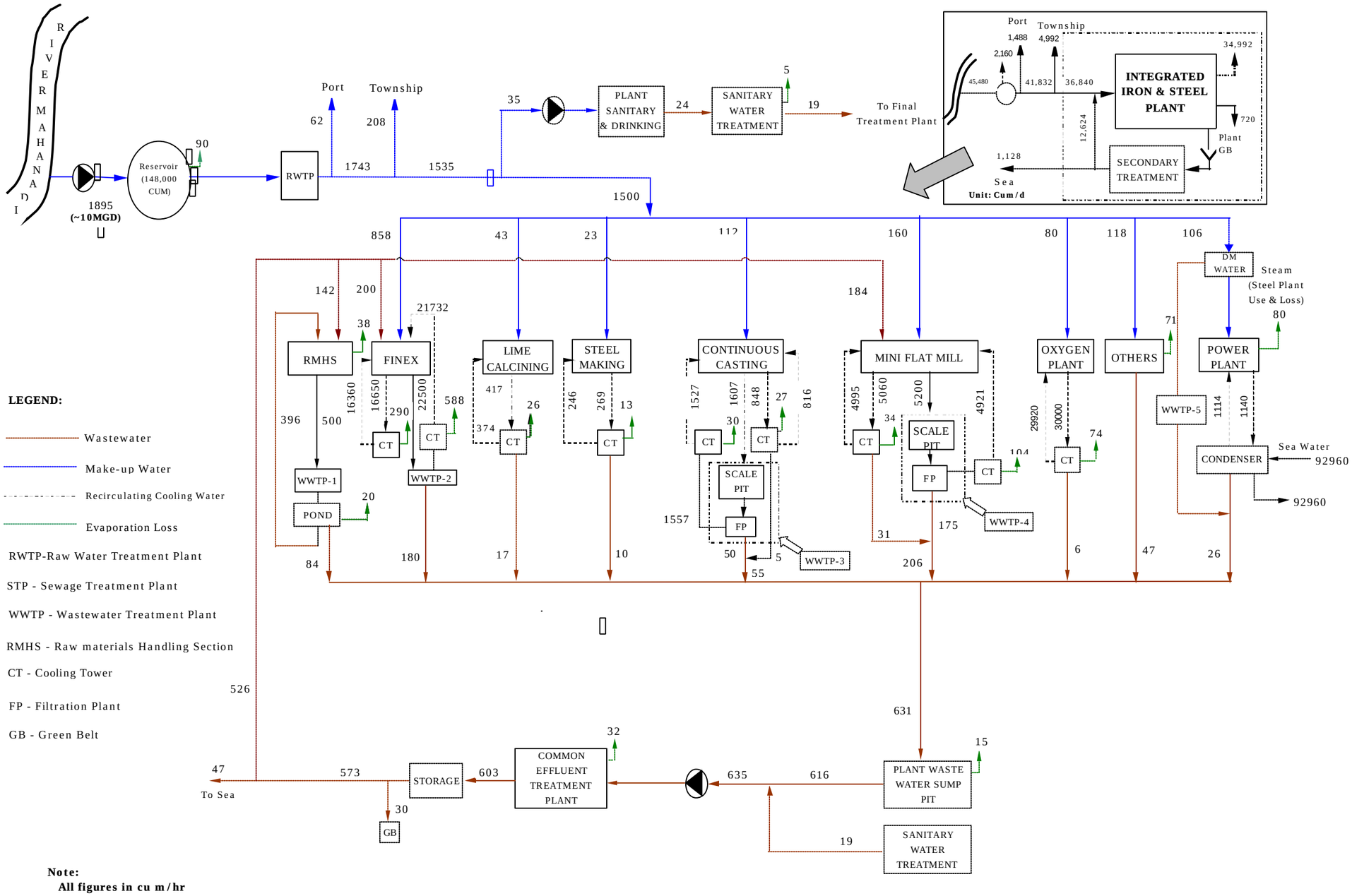

Fig. 6-2 : Water Balance Diagram for Proposed Steel Plant at Paradip, Orissa