Report on

Environmental Impact Assessment

of

Construction of Matarbari 600X2 MW Coal Fired Power Plant and Associated Facilities

Volume 1/2

Submitted By

Coal Power Generation Company of Bangladesh Limited

(An Enterprise of the People's Republic of Bangladesh)

Conducted By

Tokyo electric Power Services Co. Ltd (TEPSCO)
(Japan International Cooperation Agency Study Team)

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Index

Abbreviation

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AEZ	Agro-ecological Zone
BBS	Bangladesh Bureau of Statistics
BIWTA	Bangladesh Inland Water Transport Authority
BMCR	Boiler maximum continuous rating
BMD	Bangladesh Meteorological Department
BPDB	Bangladesh Power Development Board
BWDB	Bangladesh Water Development Board
CF	Capacity factor
CPGCBL	Coal Power Generation Company Bangladesh LTD
CT	Current Transformers
DAE	Department of Agricultural Extension
DCS	Distribution Control System
DOE	Department of Environment
ECA	Ecological Critical Area
ECC	Environmental Clearance Certificate
ECR	Environment Conservation Rules
EHS	Environmental, Health, and Safety
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
ESP	Electrostatic Precipitator
FGD	Flue Gas Desulphurization
FD	Forced draft
GCV	Gross Calorific Value
GOB	Government of Bangladesh
HEI	Heat Exchange Institute
HHV	Higher heating values
IFC	International Finance Corporation
IEE	Initial Environmental Examination
IESC	Important Environmental and Social Components
ID	Induced draft
JICA	Japan International Cooperation Agency
LA	Lighting Arrestors

MARPOL	International Convention for the Prevention of Pollution from Ships
Matarbari CFPP	Matarbari Coal- Fired Power Plant
MEAs	Multilateral Environmental Agreements
MHWS	Mean High Water Spring
NCS	National Conservation Strategy
NEMAP	National Environment Management Action Plan
NEP	National Environment Policy
PGCB	Power Grid Company of Bangladesh LTD
PT	Potential Transformers
PSMP	Power System Master Plan
RO	Reverse Osmosis
SCC	Site Clearance Certificate
SRDI	Soil Resource Development Institute
TOR	Terms of Reference
USC	Ultra-supercritical
WHO	World Health Organization

Terms of Reference

Government of the People's Republic of Bangladesh
Department of Environment
www.doe-bd.org
Head Office, E-16 Agargaon
Dhaka-1207

Memo No : DoE/Clearance/5222/2013/179 Date: 18/07/2013

Subject: Approval of Terms of Reference (ToR) for Environmental Impact Assessment (EIA) of the Proposed 2x600 MW Matarbari Coal Based Thermal Power Plant Construction Project at Matarbari, Moheshkhali, Cox's Bazar.

Ref: Your Application dated 17/06/2013.

With reference to your letter dated 17/06/2013 for the subject mentioned above, the Department of Environment hereby gives approval of TOR for Environmental Impact Assessment (EIA) for the proposed 2x600 MW Matarbari Coal Based Thermal Power Plant Project at Matarbari, Moheshkhali Upazila under Cox's Bazar District subject to fulfilling the following terms and conditions:

1. The project authority shall submit a comprehensive Environmental Impact Assessment (EIA) report considering the overall activity of the said Project in accordance with the TOR and time schedule indicated in the Initial Environmental Examination (IEE) Report.
2. The TOR of the EIA shall incorporate the following components/items :

I. Executive Summary

II. Introduction

II.1. Background
II.2. Purpose of the Study
II.3. Need of the Project
II.4. Importance of the Project
II.5. Scope of EIA Study
II.6. EIA Team

III. Legal and Legislative Framework, Regulations and Policy Considerations
Legislative, regulation and policy consideration (covering the potential legal, administrative, planning and policy framework within which the EIA will be prepared)

IV. Project Data Sheet

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IV.10. Transportation of primary Fuel

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V.2. Project Layout
V.3. Land Requirement
V.4. Fuel Requirement
V.5. Water Requirement
V.6. Technology Selection and Process Description
V.7. Description of Major Systems
V.8. Material Balance
V.9 Pollution Mitigation Measures (Units & Devices)

VI. Analysis of Suitability for Different Alternatives (this analysis shall be performed, among other approaches, in a GIS based Spatial Decision Support System (SDSS) presenting the suitability of different options for both the interventions)

VII. Detail description of the land cover/land use (with all the existing resource classes along with area coverages shall be shown in the respective maps derived from updated image of proper spatial and spectral resolution. Basic information (name of satellite, date and time of acquisition with atmospheric condition, spatial resolution, color composite etc.) of the image data to be used for making landuse/landcover maps shall be mentioned)

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VIII.3 Water availability
VIII.4 Sorbent availability
VIII.5 Hydrogeology
VIII.6 Meteorology
VIII.7 Ambient Air Quality
VIII.8 Ambient Noise Quality
VIII.9 Surface & Ground Water Quality
VIII.10 Aquatic Monitoring
VIII.11 Soil Quality
VIII.12 Ecology
    VIII.12.1 Forests
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VIII.13 Demography Profile and Occupational Pattern
VIII.14 Land use and Cropping Pattern
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IX.3.2 Impact on Landform
IX.3.3 Impact on Natural Resources
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IX.3.7 Impact on Water Bodies
IX.3.8 Impact on Soil
IX.3.9 Impact on Workers Health, Sanitation and Safety
IX.3.10 Impact on Key Point Installations & Others
IX.3.11 Solid Waste Disposal
IX.3.12 Impact due to transportation of raw materials

IX.4 Construction Stage Impact

IX.4.1 Impact on Landform
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IX.4.3 Impact on Eco-systems
IX.4.4 Impact on Ambient Air
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IX.4.9 Impact on Key Point Installations & Others
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IX.5.10 Impact due to Ash Disposal
IX.5.11 Ecology (Flora and Fauna)
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IX.5.15 Social Impact
IX.5.16 Impact on Tourism
IX.5.16 Impact due to transportation of primary fuels

X. Evaluation of Impacts

The impacts should be evaluated in terms of their local, regional and national importance. The impact should be assessed in terms of the magnitude, significance, frequency of the occurrence, duration and probability. The confidence level in the prediction must be stated. The judgment of significance of impacts can be based on one or more of the following, depending on the environmental factor being evaluated. These are :

i. comparison with laws, regulation or accepted national or international standards
ii. reference to pre-set criteria such as conservation or protected status of a site, feature or species
iii. consistency with pre-set policy objectives
iv. consultation and acceptability with the relevant decision makers, civil society, local community or the general public.

XI. Mitigation Of Impacts

Mitigation measures which may be of the following categories and coverages:

i. changing project layout, transport routes, disposal routes or locations, timing or engineering design
ii. introducing pollution controls, waste treatment, phased implementation and construction, engineering measures, monitoring, landscaping, social services or public education;
iii. rehabilitation, compensation to restore, relocate or provision of concession for damage

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- XII.1.1 Land Development
- XII.1.2 Location and Sources of Soil and Other Material for Development
- XII.1.3 Transport of Soil and Other Material
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- XII.3.6 Safety and Occupational Health

XII.4 Greenbelt Development
XII.5 Rain Water Harvesting Plan
XII.6 Rehabilitation and Resettlement Plan

XII.7 Thermal pollution management
XII.8 Coal Washery
XII.9 Coal Yard Mgt
XII.10 CDM Intent
XII.11 Budget for EMP
XII.12 Contingency Plans

The project authority shall:

a) Provide a conceptual contingency plan that considers environmental effects associated with operational upset conditions such as serious malfunctions or accidents;
b) Describe the flexibility built into the plant design and layout to accommodate future modifications required by any change in emission standards, limits and guidelines.

XIII. Risk Assessment

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- XIV.1.3 Meteorological Monitoring
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- XIV.1.5 Surface Water & Waste Water Monitoring
- XIV.1.5 Ground Water Monitoring
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- XIV.1.9 Community Health Monitoring
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- XIV.1.11 Monitoring and CSR Activities

XIV.2 Action During Abnormal Operating conditions
XIV.3 Budgets for Monitoring
XIV.4 Reporting

XV. Work Plan

XVI. Project Benefits with Benefit-Cost analysis that covers among others, Environmental and Social Cost

XVII. Public Consultation

Public Consultation both in Local and National Level should be carried out. The public participation process is critical in ensuring public review and input into the EIA process. Some of the authorities to be engaged include: Department of Environment, Forest Department, Water Development Board, BIWTA, Chittagong Port Authority, RHD, PWD, DPHE, Bangladesh Parjatan Corporation, Department of Fisheries, LGED, other national/local departments where deemed necessary, Local Administrations (DC, UNO, UP Chairman & Members), Community Based Organisations, Non-Governmental Organisations, Business Unions, Farmers' Unions, etc.

The project authority must provide a detailed Public Participation Plan, which shall include, but not be limited to the following: A timetable for communication, detailing who will be consulted and why; as a minimum, one public meeting should be held during the Scoping phase and one public meeting during the impact assessment phase (although this number might be increased due to the width of the study area). The timing of these meetings would be decided upon in conjunction with relevant stakeholders; ensure that the public participation process complies with the relevant EIA regulations; compile minutes of the meetings and send to all participants and organize appropriate feedback mechanisms for public comment.

XVIII. Conclusion & Recommendation

3. Without obtaining approval of EIA report by the Department of Environment, the project authority shall not be able to start the physical activity of the project and also not be able to open L/C in favor of importable machineries.
4. Rehabilitation of human settlement or compensation for any sort of activity which will incur damage or loss of public or private property shall be addressed as per Government of Bangladesh rules and regulations.
5. The project authority shall submit the EIA along with a filled-in application for Environmental Clearance in prescribed form, the feasibility report, the no objection certificate (NOC) from forest department (if it is required in case of cutting any forested plant/trees-private or public), NOCs from other relevant agencies and other necessary documents to the Chittagong Divisional Office of DOE at Chittagong with a copy to the Head Office of DOE in Dhaka.
6. A soft copy of the image data as well as the maps to be generated from the image shall be submitted to DOE Head Office along with the EIA.

(**Syed Nazmul Ahsan**)
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and
Member Secretary
Environmental Clearance Committee
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<u>Copy Forwarded to :</u>

1) Secretary, Ministry of Environment and Forests, Bangladesh Secretariat, Dhaka.
2) Secretary, Power Division, Ministry of Power, Energy & Mineral Resources, Bangladesh Secretariat, Dhaka.
3) Chairman, Bangladesh Power Development Board, Biddyut Bhaban, 1, Abdul Goni Road, Dhaka.
4) Director, Department of Environment, Chittagong Divisional Office, Chittagong.
5) Assistant Director, Department of Environment, Cox’s Bazar District Office, Cox’s Bazar.
6) Assistant Director, Office of the Director General, Department of Environment, Head Office, Dhaka.

Executive Summary

Executive Summary

Introduction

Development of a country largely depends upon its proper electricity service, as it influences the other sectors like industry, education, agriculture and so on. Power sector is considered one of the most vital sectors in Bangladesh. But at present, the generation of electricity is inadequate and shortage of electricity supply is occurred frequently that hampers the quality of electricity services for the nation. With a view to meet the said peak electricity demand, Coal Power Generation Company of Bangladesh (CPGCBL) is planning to construct a new power plant under the project "Construction of Matarbari 600X2 MW Coal-Fired Power Station and Associated Facilities”.

As a regulatory requirement set forth in the Environment Conservation Act 1995, a detailed environmental impact assessment (EIA) has been carried out for the proposed Coal Fired Power Station at Matarbari.

Government of Bangladesh has requested Government of Japan to conduct a Feasibility Study (F/S) regarding construction of a Coal Fired Power Station at Matarbari which will be the large scale power station in the south zone of Bangladesh.

The proposed power plant project is expected to be implemented with financial assistance from Japan International Cooperation Agency (JICA).

DESCRIPTION OF THE PROJECT

Overview

Basically, the project consists of a coal-fired thermal power plant with two units of 600 MW each and a circulating cooling water system, including proper intake and discharge tunnels, and a 275m high stack. The Power Plant will be designed in such a way so that the construction of future additional units is possible. A typical diagram of a coal based thermal power plant is shown in Figure 1.

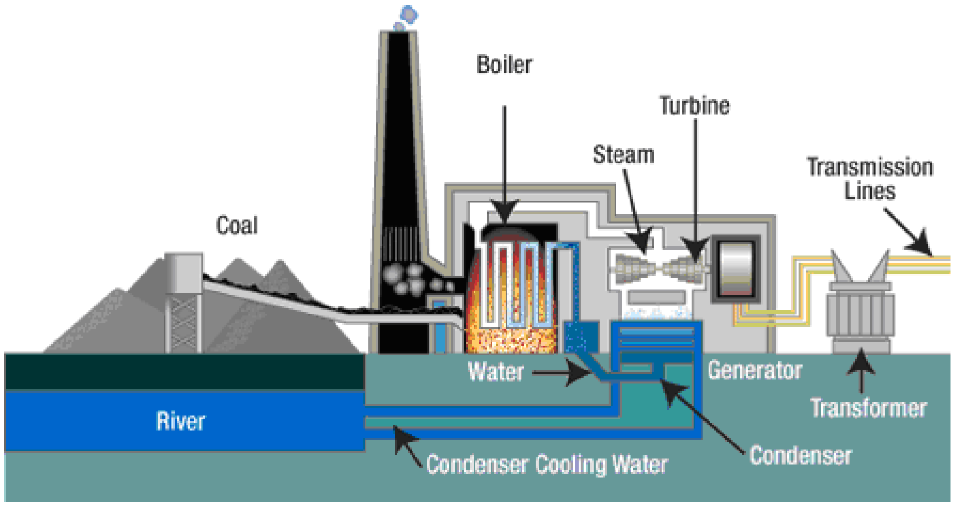

Figure 1: Typical diagram of a coal fired thermal power plant

The main project facilities are comprised of a power house and auxiliary facilities that include a switch yard, desalinization plant (Seas Water Reverse Osmosis), demineralization plant, circulating cooling water system, coal handling system (unloaders, stackers, reclaimers, conveyor belt and stockpiles), ash handling and disposal system, and a waste water treatment plant. Other project facilities that will be constructed by BPDB include an embankment along the sea shore. In addition, Flue Gas Desulphurization (FGD) and Electrostatic Precipitator (ESP) will be installed for flue gas treatment.

The proposed 600X2 MW (gross power output) ultra-supercritical (USC) bituminous pulverized coal plant will be constructed at a green field site. The turbine shaft configuration is a tandem compound design. The step up voltage level has been assumed as 400 KV as the capacity of the project will be 2 x 600 MW. The 400 KV double circuit line from Matarbari to Anowara will be built by Power Grid Company of Bangladesh LTD (PGCB), Bangladesh. The primary fuel of the plant will be sub-bituminous coal with a Gross Calorific Value (GCV) of 4700 Kcal/kg. The capacity factor (CF) for the plant is 80% without sparing of major train components. A summary of plant performance data for the USC plant is presented in Table 1 below.

Table 1: Basic plant information of the proposed coal based thermal power plant (estimated)

Component	Design Condition
Plant type	USC
Gross power output	1,200 MW (600X2 MW)
Primary fuel (type)	Sub-bituminous Coal having GCV of 4200-5200 kcal/kg and low Sulfur content (1.0 wt.% or less)
Coal flow (at 100% ECR)	12,800 ton/day
Annual coal requirement	3.73 mil. ton/year (considering 80% load factor)
Ash production	20%

Component	Design Condition
Temperature of flue gas at stack	75^{O}C
Flue Gas Flow	2 x 4.47 x 10^6 Nm^3/hr
Flue Gas Treatment System	Low NOx burner and over fire air, seawater FGD and electrostatic precipitator will be facilitated to reduce emissions and pollutions and to meet WHO standard for ambient on qualities
Maximum emission of SOx	Less than 820 mg/Nm^3
Maximum emission of NOx	Less than 460 mg/Nm^3
Particulate matter	50 mg/Nm^3 (from each unit)
Stack height	275 m
Water Intake	Necessity of water volume: 25(m^3 /sec/unit) × 2 units = 50(m^3/sec)
Water discharge after treatment	Into sea

Layout

In the plant layout, adequate space shall be kept for lay-down and pre-assembling activities of open stores, contractor's offices and stores, etc. Construction offices and storage sheds area shall be located close to the main approach road to the plant. The administrative building is proposed to be located outside the plant boundary near the main approach road. The total land requirement area (455 hectares) is shown in the above table, which does not include the access road, township, greenbelt and other use areas. The following major components shall be included in the layout plan, but it is not an all-inclusive list:

A: Industrial (plant area)

1. Main power plant (boiler, turbine, generator, workshop store, etc.)
2. Electrostatic precipitator, FGD as required, and chimney
3. Greenbelt and open space
4. Open air sub-station and network control room
5. Water treatment, sewerage treatment plant and sewerage channel
6. Coal terminal including jetty and coal conveyer belt
7. Ash handling control room, ash silo, ash disposal area
8. Coal stock yard (open and covered)
9. Port and harbor facilities

B: Township

10. Residential buildings, school, mosque, playground, community hall, rest house, dormitory, health center, club, etc.
11. New alternative road construction instead of the existing community road, administrative building, auditorium and parking area including cafeteria, and social building

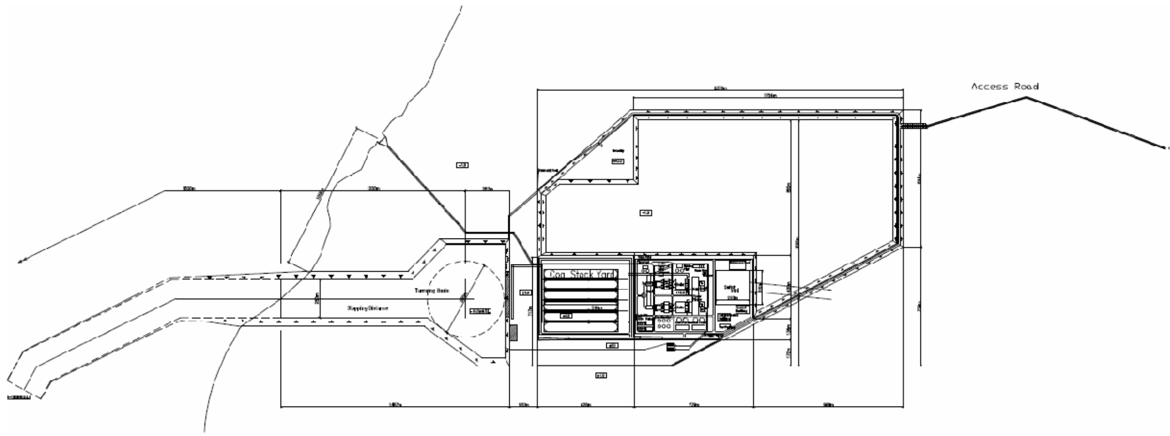

Figure 2: Plant layout plan

Administrative approval in connection with the acquisition of the required land will be obtained in the future. A land acquisition proposal (after necessary revision as per suggestions of the DC office) will also be submitted to the office of the DC, Cox's Bazar.

Project Activities

Pre-construction phase

a) Selection of candidate sites
b) Environmental and feasibility study
c) Selection of site
d) Land acquisition and site establishment

Construction phase

a) Dredging work and berth work
b) Civil construction and technological installation work
c) Post erection check and pre commissioning test
d) Monitoring of mitigation measures for environmental impact of the plant
e) Commissioning test
f) Reliability test run
g) Commercial operation of the plant
h) Overall project management
i) Alternative road

The existing road along the shoreline will be cut off by the construction of the power plant.
A new alternative road, instead of the existing road, shall be constructed and the route/ location of the alternative new road is planned between the east side of the harbor and the west side of the coal stock yard. Also, during the construction period, a temporary alternative road, instead of the existing road, will be used.

Operation phase

a) Commercial operation of the plant
b) Monitoring of EMP
c) Proper O&M for efficient running of the plant

Pollution Mitigation Measures

Air Pollution Control System

The boiler shall be designed for low NOx formation by adopting low NOx burners and over fire (two stage firing) system. High efficiency ESPs will be installed to limit the particulate emissions to 100mg/Nm^3. An FGD system will also be installed to reduce SO_2 to at least 90%. To facilitate wider dispersion of remaining particulates and gaseous pollutants (SO_2 and NOx), a chimney of 275 m height shall be used. To control emissions of fugitive dust within and around the coal handling plant and coal stockyard, a water spray system shall be installed. The chimney shall also be provided with facilities for online monitoring of stack emissions.

Noise Control

The major noise generating sources are the turbines, turbo-generators, compressors, pumps, fans and coal handling plant, etc., from where noise is continuously generated. Equipment will be designed to control the noise level to below 90 dB (A). Wherever it is not technically possible to meet the required noise levels at the work place, personnel protection and equipment, like ear plugs/ear mufflers, shall be provided to the workers. The buffer area around the plant, including the boundary wall around the project, shall dampen noise levels so that the nearby community will not experience significant noise.

Intent of Water Reuse

The entire water consumption and management system has been designed with the provision of water use facilities. A circulating water system has been designed for the cooling system, boiler water, ash disposal and handling system.

Effluent Treatment

A wastewater treatment plant has been planned to collect, treat and dispose of plant effluents. Liquid effluents shall be collected and treated/ recycled.

Thermal Pollution Control

About 180,000 m^3/hr cooling water will be discharged through the discharge tunnel, after the condenser, with a temperature increase of 6.6°C. The cooling water facilities will be designed so that the discharged water temperature will be not higher than 40°C which is the maximum temperature allowed in the wastewater quality standards of Bangladesh.

Waste Management

All kinds of solid waste to be generated at the power plant will be disposed on site maintaining

DOE's standards. Ash particles will be the major waste to be generated from the power plant and details of the ash management are described. Some waste will also be generated from the coal storage yard and belt conveyor facilities. To control flying coal dust, a water spraying system will be installed in the coal yard.

Water Intake Structure

Water supply from the intake point to the pump pit shall be provided with sufficient screening to filter out larger aquatic organisms like fish, etc. Drum screens shall be adopted in order to limit the entrainment of fish in the cooling water system.

Description of Existing Environment

Land Use

The land use of the project site is categorized in "Salt-Shrimp Area", according to the land use map of Maheshkhali Upazila, Cox's Bazar District.

Physical Environment

Climate

The climate in Bangladesh is divided into three seasons: summer from March to June with high temperatures and high humidity, the monsoon season from June to October with high winds, and winter from October to March with low temperatures and low precipitation.

The temperature in January is 19 - 21^{o}C, and then gradually rises toward April to 28 - 29^{o}C. The high temperature of 27 - 29^{o}C continues from April to October, while it is a little lower from July to October compared to April to June. The temperature is in decline in November and December, and the average temperature in December is 21 - 23^{o}C.

Northerly winds are dominant in January and February, and no significant high wind speed was observed in specific wind direction. Southerly winds become dominant from March, especially from April to September. In July and August, there is a tendency of slightly higher wind speed in southwesterly winds, otherwise no significant high wind speed was observed in any specific wind direction.

Topography

There are no structures in the project site. There are some fish and salt cultivation land and some temporary houses in the project site. And there are many water courses in the project site, made manually for the purpose of fish and salt cultivation. There are no features like electric poles, roads, etc, located anywhere in the boundary lines.

There is a long water course and the Kohelia River on the East side, the Bay of Bengal on the West side, a Homestead village of Nasir Mohammad Deil on the South side, and another Homestead on the North side of the project site.

Geology

The maximum depth of the boreholes at the project site is 33.0m from the existing ground surface. Mainly seven soil layers were observed in the studied site, i.e., very soft to medium stiff clay, loose to very dense silty fine sand, stiff clay, medium dense to very dense silty fine sand, very stiff silt, hard clay, and very dense silty fine sand.

Tidal

From all the current profiles, it is evident that almost 90% of the direction falls either from 0 to 90 degrees (Northeast direction) or from 180 to 270 degrees (Southwest direction). This happens because it represents the tide. When there is a flood tide the water goes towards shore/land, then it follows a southwest direction (180 to 270 degrees), whereas when there is an ebb tide the water goes towards the sea then it follows a northeast direction (0 to 90 degrees).

Flood

There are generally four types of floods in Bangladesh. “Storm Surges” in which the project site is located, is a type of flood mostly occurred along the coastal areas of Bangladesh which has a coast line of about 800km along the northern part of the Bay of Bengal. This coastal area is shallow and the coastal line in the eastern portion is conical in shape. Therefore, Storm Surges are likely to occur due to flood tides of cyclones and southwestern monsoon winds.

Cyclone

During the years 1960 to 2010, Bangladesh was hit by 53 severe cyclones, 32 of which were accompanied by storm surges. The height of the surges is limited to a maximum of 10 meters in the bay.

Tsunami

Cox’s Bazaar coast near the project site would be inundated during a Tsunami.
Tsunami height is considerably lower than the storm surge height in the range of 7-9m. Therefore, Tsunami conditions have not been included in the design of the power plant ground level.

Air Quality

The main industries of Matarbari Island are agriculture and fishery, and it is not an industrial area. The air quality survey results indicated overall that the air quality in the rainy season is clean, with a slightly high concentration of dust (SPM) and a low concentration of SOx and NOx.

Water Quality

Sea Water

In rainy season, the water temperature was in the range of 28.5 30.5^{o}C, with the tendency of higher temperatures near the surface layer and lowering towards the deeper layer. The salinity was in the range of 15.8 to 21.6, tending to be lower in the surface layer and becoming higher toward the deeper layer. SS (suspended solids) concentration is very high (640 910mg/L) due to the strong effects of river water. COD is also very high (160 197mg/L), while BOD is not at a high level (0.6 1.1mg/L) (the water quality standard for surface water is 2mg/L or less). Concentration of heavy metals, with the exception of a rather high concentration of Iron (Fe), was not high.

In dry season, the water temperature was in the range of 18.0 to 19.0^{o}C, and temperature differences by water depths were not observed. The salinity was in the range of 34.3 to 37.3 with no big difference between water depths, the same as the water temperature. Suspended solids ("SS") concentration is very high (46 – 329 mg/L) due to the strong effects of river water, especially at the bottom layer. COD is also very high (203 – 235 mg/L), while BOD is not at a high level (0.2 0.6 mg/L). Concentration of heavy metals, with the exception of a rather high concentration of Iron (Fe), was not high.

Surface Water

The results of the surface water quality survey indicate that the surveyed area has brackish water that is under the influence of sea water in the rainy season. SS (only in the rainy season) and COD showed high concentration levels similar to the sea water quality survey results. Environmental standards for surface water quality are determined by 6 criteria in Bangladesh, and the survey results satisfied even the highest criteria except DO.

Ground Water

The results of the ground water survey for both the rainy and dry seasons satisfied the drinking water standards of Bangladesh.

Noise

The noise measurement results indicated that the day time noise level was above the environmental standards for residential areas at one sampling point. Matabari Island is, as cited above, not an industrial area and therefore vehicles used for local transportation were the noise source. These vehicles are not used during the night.

Ecological Environment

Ecologically Valuable Habitats

Coral reef

According to the Chief Scientific Officer of the Bangladesh Fisheries Research Institute in Cox's Bazar, there is no coral reef habitat around the project site, and the closest coral reef to the project site is St. Martins Island located approximately 120km from the project site.

Seaweed

According to the Chief Scientific Officer of the Bangladesh Fisheries Research Institute in Cox's Bazar, seaweed does not grow around the project site because the transparency of the sea water is low.

Mangrove Forest

There are no mangrove forests around the proposed port facility site or along the coastline where the outlets for thermal effluents will be constructed. They are only scattered at the riverside of the Kohalia River, which flows between Matarbari and Maheshkhali Islands. There is a mangrove forest, which is large scale and artificially established, at the south side of Matarbari Island and its opposite bank is Maheshkhali Island.

Mud Flats

The coastline of Matarbari Island is a long sandy beach, and the sea side of the project site, where a port facility and outlets for thermal effluents will be constructed, is also part of the beach. The slope of the sandy beach is steep, and the area of its inter-tidal zone is relatively small. On the other hand, a sand bar and shallow sea area lie in the estuary of the Kohalia River located south of Matarbari Island due to sedimentation.

Marine Organisms

Phyto-plankton

In rainy season, fifteen species of phyto-plankton were observed, and Diatom was the largest in number of species. *Thalassiothrix* sp. was the species that emerged most frequently, followed by *Biddulphia* sp. The emergence of Pleurosigma sp., which is a freshwater species, indicates the strong influence of river water inflow in the sea front area of the power plant site. In dry season, eight species of phyto-plankton were observed, and Diatom was the largest in number of species. *Biddulphia* sp. and *Thalassiothrix* sp. were the species that emerged most frequently, followed by *Coscinodiscus* sp. and *Rhizosolenia* sp.

Zoo-plankton

In rainy season, eleven species of zoo-plankton were observed, and ARTHROPODA was the largest in number of species. Copepoda was the species that emerged most frequently, followed by *Sagitta* sp. In dry season, twelve species of zoo-plankton were observed, and ARTHROPODA was the largest in number of species. Copepoda was the species that emerged most frequently, followed by *Sagitta* sp.

Benthos (Sea bottom)

In rainy season, the population was scarce with only 3 individuals /m^2 in sampling point 1, and 16 to 18 invidiuals/m^2 in sampling point 2 to 4. On the other hand, 306 invidiuals/m^2 of Bivalvia and

30 invidiuals/m^2 of Gastropod were observed in sampling point 5. In dry season, a lot of Bivalvia was observed in sampling point 5 during the rainy season, but was not observed in the dry season.

Benthos (Mudflat)

In rainy season, the bottom sediment of each sampling points was sand and only a small population was observed. Twenty eight individuals per m^2 were observed in Dhalghata, which is 2/3 of Sonadia, in the sea front area of the power plant site. The dominant species were different in Sonadia and Dhalghata, and no dominant species was observed in Kutubdia. In dry season, 115 invidiuals/m^2 of Benthos was observed in Dhalghata in the sea front area of the power plant, which was more than the number of individuals observed in Kutubdia and Sonadia. Many kinds of Mollusk species such as Gastropoda and Bivalve were observed in Dhalghata, but only a few or even none of Mollusk was observed in Kutubdia and Sonadia.

Fish and Nekton

In rainy season, the highest number of species was observed at the sampling point in Sonadia, which had 22 species, followed by 21 species in Dhalghata and 20 species in Matarbari where the proposed power plant will be located and 14 species in Kutubdia. The only common species observed in all of the 4 sampling points was “*Loligo* sp.” under DECAPODIFORMES.

The dominate species in the 2 sampling points near the power plant site were different from the dominate species in Sonadia and Kutubdia; the dominate species near the power plant site were “*Metapenaeus monoceros*” and “*Exopalaemon styliferus*” under DECAPODA, “Stolephorus tri” under Engraulidae, “*Glossogobius giuris*” and “*Odontamblyopus rubicundus*” under Gobiidae and “Terapon jarbua” under Terapontidae; whereas, in Sonadia and Kutubdia, “*Squilla* sp.” under STOMATOPODA, “*Acetes* sp.” under DECAPODA, “*Charybdis natator*” under BRACHYURA and “*Harpadon nehereus*” under Synodontidae were the dominate species.

In dry season, the highest number of species was observed at the sampling point in Matarbari, which had 29 species, followed by 26 species in Dhalghata, 25 species in Kutubdia, and 17 species in Sonadia. The only common species observed in all of the 4 sampling points was “*Acetes* sp.” under DECAPODA and “*Cynoglossus cynoglossus*” under Cynoglossidae.

The dominate species near the power plant site were “*Metapenaeus monoceros*” under DECAPODA, “*Harpadon nehereus*” under Synodontidae, “*Coilia dussumier*” under Engraulidae, “*Johnius argentatu*” under Sciaenidae, and “*Otolithoides pama*” under Sciaenidae; whereas, in Sonadia and Kutubdia, “*Metapenaeus brevicornis*” and “*Metapenaeus lysianassa*” under DECAPODA were the dominate species.

Terrestrial Wildlife

Flora

Humans have impacted much of the land area of the Power Plant site, particularly by shifting shrimp farming and salt pans to the area over several generations. The project area now has species generally associated with secondary and pioneer communities, secondary scrubs, grasslands, poor vegetation cover, and little cash crop in its fringe areas. In all, 77 species in the rainy season and 71 species in the dry season were recorded at the power plant site, the majority of which are angiosperms. No threatened species, as designated by IUCN status declaration of 2012, were recorded. Three species (*Calamus guruba* Buch-Ham, *Trihosanthes cordata* Roxb, and *Lepisanthes rubiginosa*) which are considered as threatened species under local status by scientist groups in Bangladesh were recorded, but these species have wide distributions and are common in the region (Biologist-group's views of Chittagong University).

Fauna

Insects

A total of 23 species of 22 families under 10 orders in the rainy season and 22 species of 20 families under 9 orders in the dry season were recorded in the proposed project area. All of these species have Not Threatened (NO) status as per the IUCN status declaration of 2012.

Amphibians

A total of 4 species of 2 families under 1 order in the rainy season and 5 species of 2 families under 1 order in the dry season were recorded in the proposed project area, all of which are Not Threatened (NO) status by IUCN.

Reptiles

A total of 13 species of 7 families under 2 orders in the rainy season and 9 species of 5 families under 2 orders in the dry season were recorded in the study area. Among these reptiles, 1 Turtle species (*Eretmochelys imbricate*) was identified as being designated as Critically Endangered (CR) as per the IUCN Red list category.

Three Turtles species (*Geoclemys hamiltonii*, *Chelonia mydas*, and *Caretta caretta*) were identified as being designated as Endangered (EN) and another Turtle species (*Lepidochelys olivacea*) was identified as being designated as Vulnerable (VU) as per the IUCN Red list category. Five species (*Calotes versicolor*, *Mabuya mabuya*, *Gekko gecko*, *Panghura tentoria*, and *Naja naja*) which are considered as threatened species under local status by scientist groups in Bangladesh were recorded, but these species have wide distributions and are common in the region (Biologist-group's views of Chittagong University).

Birds

A total of 77 species of birds in the rainy season and 103 species of birds in the dry season were recorded in the proposed project area. No threatened species, as designated by the IUCN status declaration of 2012, were recorded. Two species (*Arachnothera magna*, *Ketupa zeylonensis*) which are considered as threatened species under local status by scientist groups in Bangladesh were recorded, but these species have wide distributions and are common in the region (Biologist-group's views of Chittagong University).

Mammals

A total of 11 species of 8 families under 4 orders in the rainy season and 8 species of 6 families under 4 orders in the dry season were recorded in the proposed project area. All of these species have Not Threatened (NO) status as per the IUCN status declaration of 2012. (The results of the dry season will be added to the Final Report)

Socio-Economic Environment

Social Environment

A household survey targeting over 300 household heads as well as focus group discussions targeting women, children, salt workers and shrimp workers were conducted in December 2012 for comprehensive apprehension of the socio-economic profile of the project affected people. The project site is home to the local residents over generations. The maximum length of time found among them reached 300 years. The household size typically found at the site is 6 people, and over 70% of the interviewed household heads were illiterate or could only write their own names. 35% of the interviewed households received between 10,000 and 20,000 taka, and the average household monthly income was approximately 26,500 taka, 45.5% of the households spent between 10,000 and 20,000 taka per month, and the average household monthly expenditure was approximately 18,000 taka. Based on the incidence of poverty by the cost of basic needs (CBN) method defined by the Bangladesh Bureau of Statistics, 9% of them were categorized as poor households on income basis, and 13% on expenditure basis.

Most of the land in the power plant site is used for salt cultivation during the dry season (November to April), and shrimp cultivation during the rainy season (May to October).

There are mainly four kinds of people involved in salt and shrimp cultivations: cultivator, laborer, mazi, and businessman. Among the households interviewed at the project site in December 2012, cultivators were comprised of over 30% among them, are the owners of salt field of shrimp field (by owning or leasing the land). They invest money for cultivation. Laborers are those people who sell their labor under the instruction given by the cultivators. They prepare and make the salt bed, for instance. They receive wages from cultivators. Due to the fact that their households have not been financially privileged, they do not have sufficient opportunities for education. Many of them have to drop out of school while they were children even before they completed primary education. They have fewer job opportunities because of their low education and literacy levels. They also shared around 30% in the interview survey. Maziz, comprised of 10% among the interviewed households, coordinate between cultivators and laborers. They find laborers and allocate them at salt/shrimp fields that belong to the owners or lessees who need laborers. Businessmen, around 10% as well, are those who are involved in purchasing salt (or shrimp) from the field and local market, and sell them at markets in Chittagong, Dhaka or Narayanganj. One of the salt factories located within the site has 70 to 80 workers throughout the year, 20 to 30 of whom live together in a terrace house. Laborers come from other districts for shrimp cultivation during the rainy season. All salt taken at the site is sent to Chittagong as there is no salt market in Cox's Bazar.

Fishery

Fisherman's village in Maheshkhali Upazila is located along the coast line and Kohalia River, and the number of fisherman's households is estimated to be 3000 to 4000. The average annual income by fishing activities is about 10,000 to 15,000 per household. There are four main fishing zones in the Bay of Bengal, and the nearest fishing zone from the proposed power plant site is South Patches, located at south of Sonadia Island. Therefore, it can be noted that the sea side of the proposed power plant site is not the main fishing ground.

Environmentally Sensitive Areas of Special or Unique Scientific, Socio-economic or Cultural Value

Under the Environmental Conservation Act (ECA), ecologically sensitive and precious areas are designated as ECAs (Ecologically Critical Areas) by Department of Environment in Bangladesh in cases where an ecosystem or biodiversity area is considered to be threatened to reach a critical state. On the other hand, protected areas such as national parks and protected forests are designated by Department of Forest under the Wildlife Order and Forest Act.

ECAs focus more on the importance and diversity of species and ecosystem and target any ecologically sensitive areas except for the protected areas designated by Department of Forest.
Along with the ECAs declaration, each ECAs has notifications declared by Department of Environment in which specific activities to be restricted in that ECA are specified.

The closest ECA to the project site is Sonadia ECA located 15km from the project site. The area of Sonadia ECA is 49.2km^2.

Potential Environmental Impacts and Mitigation

Construction Phase

Air Quality

Watering the access road and construction site, especially in the dry season, and using cover sheets on trucks for the transportation of soil will be undertaken to reduce dust generation. Periodic maintenance and management of all the construction machinery and vehicles will be conducted to reduce exhaust gas discharged from construction machinery and vehicles.

Water Quality

A wastewater treatment facility for workers, such as a septic tank and an oil separator for oily run-off water, will be installed in the worker's camp and construction area. Oil and chemical materials will be stored in an appropriate storage site to prevent permeation into the ground. These measures will minimize the impact of contamination of sea water, river water and！ underground water.

Wastes

Separating waste collection, recycling and reuse of waste will be promoted and non-recyclable waste will be disposed at appropriate sites according to related regulations. Hazardous waste will be treated under the related regulations. To reduce the amount of solid waste discharged from the workers during the construction work, efforts will be taken to employ local workers wherever possible, so that the amount of household waste at the plant will be minimized. These measures will be taken to ensure that water pollution or sanitary problems resulting from waste will not arise.

Noise

Noise level generated by construction activities is 23.0 ↛ 70.3dB(A) at the boundary of the power plant site and discharge facility and 36.4 ↛ 55.4dB(A) at the nearest residence (1 point at north of the site and 2 points at south of the site.). The noise levels at all points in residential areas exceed the day-time noise level standard of Bangladesh, but satisfy IFC/WB guideline. Noise impact caused by construction activities will be mitigated by managing the construction schedule in order to level out the construction amount and scale as well as introducing up-to-date low-noise equipments. Monitoring on noise levels will also be necessary.

Protected Areas

Sonadia ECA has been designated pursuant to the Environmental Protection Law in Bangladesh, and it is located 15km south of the proposed project site. Environmental impact of air pollution, water turbidity, noise and other environmental impact during construction will be mitigated through appropriate countermeasures and the extent of any impact will be limited. Consequently, the impact to Sonadia ECA will be insignificant.

Ecosystem

The project site consists of land used for salt farms and other purposes, and not primeval forests or tropical rain forests. A sandy beach is located in front of the proposed project site; however there are no mangrove forests or tidal flats.

The area is the presumed habitat of birds, dolphins, and sea turtles on the IUCN Red list (endangered species, etc.), and construction work may have a possible impact on the rare species and ecosystem. Very few trees will be cut down due to the construction work, and the environmental impact of air pollution, water turbidity, noise and other environmental impact during construction will be minimized through appropriate countermeasures.

As for precious species of animals designated by IUCN, one Turtle species (*Eretmochelys* *imbricate*) classified as CR (Critically Endangered), three Turtles species (*Geoclemys hamiltonii, Chelonia mydas, Caretta caretta*) classified as EN (Endangered) and one Turtle species (*Lepidochelys olivacea*) classified as VU (Vulnerable) were observed within the project site and the front beach. There were no other precious species of insects, amphibians, reptiles, mammals or birds designated by IUCN observed.

Spawning takes place at nighttime when human activity is low, however the light and noise of any nighttime construction may have adverse effects on these species. Consequently, night construction activity in the spawning season should be avoided as much as possible, and should be conducted under minimum light. Lighting colors that do not affect the spawning (e.g., red or yellow) should be selected. The careful monitoring of spawning status is necessary.

Land Acquisition

It is expected that the approximately 20 households currently living on the site without permission will have to vacate their homes due to the land acquisition for the construction of the power plant. Land owners will lose their land. Employers/ employees of salt farms, shrimp farms, and fishermen will lose their means of livelihood. Those people who run business, employers or employees at salt farms, shrimp farms and fishermen in the site will lose their livelihood means. Note that the site selection was reconsidered to the present site from the previous one (2 km south), where large settlements were found on private land, in order to avoid a large-scale resettlement.

267 households and 1,588 people will be affected by the construction of the power plant and the port facility. Besides, there are 76 households living or make a living around the project area and will be indirectly affected by the project. LARAP (Land Acquisition and Resettlement Action Plan) that includes not only a compensation plan but also a livelihood restoration program for affected people shall be established.

Deterioration of Local Economy such as Losses of Employment and Livelihood Means/

Land Use and Utilization of Local Resources

About 70% of the heads of 343 households that will be directly or indirectly affected are working in salt or shrimp farms. Although the number of salt and shrimp farms will decrease due to the construction of the power plant, employment opportunities will increase for various subcontract work of the construction. Local people will be given priority in employment. However, approximately 70% of heads of household are illiterate or can only write their signatures, so they can only be engaged in very simple tasks due to their lack of skills. Livelihood restoration measures will be established, including job training for those who want it.

Disturbance to Existing Social Infrastructure and Services

As material and equipment transportation will be mainly conducted by vessels, increased marine traffic may disturb existing marine traffic including fishing boats. Additionally, vehicles transporting commuting workers may cause increased traffic and traffic jams around the project area.

In regard to vessels, water routes shall be determined after consultation with the related authorities. Marking buoys will be set around the construction area for marine safety. The schedule of vessels shall be announced to fishermen, etc. And in regard to vehicles, bus use will be promoted to reduce increasing the number of vehicles on the roads. The bus schedules shall be managed in consultation with related organizations and shall be communicated to people in the surrounding villages.

Social Institutions such as Social Infrastructure and Local Decision-making Institutions
The Deputy Commissioner's Office of Cox's Bazar District will officially take responsibility for initiatives to conduct local consultations concerning compensation. In consideration of changing emotions of local residents over the course of negotiations with office staff, LARAP preparations should be carried out in consultation with the local people.

A number of consultations with local residents have been conducted in preparing the draft LARAP in this feasibility study. Laws of Bangladesh stipulate the need to conduct public consultations in land acquisition processes. In the resettlement process, personnel responsible for responding to complaints or suggestions from local residents will work at the power plant office.

Children's Rights

Labor contracts between the construction industry and children shall be prohibited. Regular patrols to check for child workers shall be conducted.

Infectious Diseases such as HIV/AIDS

Local people should be recruited for simple work as much as possible so to minimize the risk of infectious diseases being transmitted from external workers. Pre-employment and periodic medical check-ups should be conducted for external workers (technical workers, etc).

Work Environment (Including Work Safety)

Construction companies should establish work safety plans and submit them to CPGCBL to obtain approval. Work safety plans should stipulate mitigation measures on soft aspects (safety training, etc.) and hard aspects (provide workers with appropriate protective equipment, etc.).

Cross-boundary Impact and Climate Change

CO_2 will be produced by the construction work. Periodic maintenance and management of all construction machinery and vehicles will be conducted.

Operation Phase

Air Quality

A flue gas desulphurization (FGD) system using marine water, an electrostatic precipitator (EP), and low-NOx burning method (multi phase burning) will be adopted in this project, and exhaust concentrations will be kept below the Bangladesh emission standards and the guideline values of the IFC/WB EHS guidelines. Predicted concentration of pollutants from exhaust gases, taking into account the background concentration, will satisfy the ambient air quality standards of Bangladesh as well as IFC/WB EHS guidelines and environmental standards of the EU etc. A cover will be installed on the conveyor for coal and ash transportation, and watering coal storage and the ash pond will be conducted to keep the surface wet.

Water Quality

Water used in the power plant will have intake at low speed (0.2m/s) from low-temperature seawater in the deep layer at the water inlet located in the port using the curtain wall method. Thermal effluent will be discharged at low speed (0.3m/s) from the water discharge outlet located 1km north of the port in order to prevent recirculation. The temperature of thermal effluent will be discharged within ΔT 8^{o}C compared to the water temperature of the intake water and will be less than 40^{o}C. Therefore the temperature of the thermal effluent is within the discharge water regulation (40^{o}C).

According to the simulation result for diffusion model of thermal effluent, thermal effluent is diffused at a fast speed due to the fast current; therefore, the range of water temperature increase by more than 3^{o}C is limited to the surrounding area of the discharge outlet. The range of water temperature increase by more than 2^{o}C is up to 200m from the discharge outlet in case of NNE current and not reached to the coastal area of the island. On the other hand, in case of SSW current, the range of water temperature increase is up to 200m from the discharge outlet and not reached to the coastal area of the island.

Wastewater from each facility will collect in the central wastewater treatment system. The wastewater treatment system will consist of neutralization, coagulating sedimentation, and a filtration and oil separator. Wastewater will be managed and treated appropriately to comply with water quality of Bangladesh regulations and IFC/EHS Guideline values for thermal power plants. Treated wastewater will be mixed and diluted with a large volume of thermal effluents.

Leakage from the bottom of the ash pond will be prevented by using an impermeable layer, such as high density polyethylene (HDPE) sheet or silt layer. Wastewater will be managed and treated appropriately by neutralization and sedimentation to comply with water quality of Bangladesh regulations and IFC/WB EHS Guideline values for thermal power plants. The above measures will be taken to ensure that the impact on the water quality will be insignificant.

Wastes

Separating waste collection, recycling and reuse of waste will be promoted and non-recyclable waste will be disposed at appropriate sites according to the related regulations. Hazardous waste will be treated under the related regulations. An ash disposal pond (183 ha) will be built at the project site. The nominal capacity of the ash disposal pond is calculated based on the total volume of the ash to be accumulated for the duration of 25 years operation with 80% load factor. The total capacity is estimated to be 20,250,000 ton. The above measures will be taken to ensure that water pollution or sanitary problems resulting from waste do not arise.

Noise

Noise level generated by power plant operation is 10.6⇸ 43.3dB (A) at the boundary of the power plant site and discharge facility and 30.2 ⇸ 41.2 dB (A) at the nearest residence (1 point at north of the site and 2 points at south of the site). The noise levels at all the points in residential areas satisfy the day-time noise level standard of Bangladesh. The noise level at 1 point in the residential areas exceeds the night-time noise level standard of Bangladesh; however, the range of the noise levels exceeding the night-time standard is only limited to the surrounding area of the power plant, and the noise level at the whole village satisfies the night-time standard. IFC/WB guideline is satisfied at all the points. Maintenance of equipment will be conducted and low noise type equipment and adequate enclosures will be installed.

Ecosystem

The project site consists of land used for salt farms and other purposes, with no primeval forests or tropical rain forests. A sandy beach is located in front of the proposed project site, but there are no mangrove forests or tidal flats.

The area is the presumed habitat of birds and sea turtles of the IUCN Red list (endangered species, etc.), and construction work may impact the rare species and ecosystem. Environmental impact of air pollution, water turbidity, and noise, etc., during the operation phase will be mitigated through appropriate countermeasures, as described above, and results of simulations also indicate that environmental standards will be met. The water intake and discharge of cooling water used in the power plant will be carried out at a flow rate much lower than the current in the surrounding ocean, and the water flow in the surrounding sea will not be affected.

In addition, smaller fish in the sea area have sufficient swimming ability in comparison to the flow rate of water intake, and it is considered they will not be affected as a consequence. The diffusion area of thermal effluents with increased temperature of 2 ºC or higher is limited to a certain surface layer and fish can easily bypass this area.

It is highly likely that the spawning of four IUCN precious species of sea turtles takes place on the sea coast, and a detailed survey should be conducted. Light and noise of nighttime construction may have adverse effects on the sea turtles. Consequently, night construction activity in the spawning season should be avoided as much as possible, and should be conducted under minimum light. Lighting color that does not affect spawning (e.g., red or yellow) will be selected. Low-noise equipment shall also be installed. The careful monitoring of spawning status is necessary.

Deterioration of Local Economy such as Losses of Employment and Livelihood Means/ Land Use and Utilization of Local Resources

Local people should be employed to work at the power plant and related facilities to the maximum extent possible according to their skills. Livelihood restoration means shall be conducted including job training for those who want it. Services (e.g., laundry, catering services, etc.) and products offered by the local community should be used by the power plant as much as possible.

Disturbance to the Existing Social Infrastructure and Service

Traffic volume and traffic jams will increase in the surrounding roads during the operation phase. Mitigation measures to decrease traffic volume shall be conducted, such as the promotion of bus use. The management of schedules of project vehicles will be conducted in cooperation with related organizations, and the schedules will be announced to local people living in surrounding villages. Additionally, an access road, community road and road around the power plant boundary shall be built. These roads will be built with sufficient height so that they can be used even in the rainy season, in order to enable public access to markets and social services.

In addition, a school and medical facility constructed within the power plant site shall be open to all local people for the improvement of their lives.

Children's Rights

There is a possibility that children may be forced to work and not attend school. Labor contracts between the subcontractors and children shall be prohibited. Regular patrols to check for child workers shall be conducted.

Work Environment (Including Work Safety)

Work accidents involving workers may occur at the power plant site. CPGCBL shall establish a work safety plan. The work safety plan shall stipulate mitigation measures on soft aspects (safety training, etc.) and on hard aspects (provide workers with appropriate protective equipment, etc.).

Cross-boundary Impact and Climate Change

CO_2 will be produced by the operation of the power plant. Ultra supercritical (USC) technology will be adopted at the power plant, producing less CO_2 of approximately 566 thousand tons/year compared to a sub-critical coal-fired power plant.

Environmental Management and Monitoring

The main objective of the environmental management plan and environmental monitoring plan is to ensure implementation of the mitigation measures planned to reduce the environmental impact by the implementation of the power plant project, and to verify and record the environmental impact.

Construction Phase

At the construction phase, CPGCBL shall carefully consider all construction activities with the supervision consultant, and encourage the contractor to fully understand the necessary mitigation measures and to implement them. In this regard, an environmental management unit shall be organized prior to construction activity and an expert environmental management administrator shall be employed. The unit will discuss and prepare mitigation measures with the supervision consultant and the contractor prior to the construction activity.

During the construction activity, in which a large inflow of workers and vehicles is predicted, the CPGCBL shall encourage the understanding of the surrounding community about the contents and schedule of the construction activity and mitigation measures, and shall obtain local people's opinions and change the mitigation measures as appropriate.

In order to confirm the implementation of the environmental management and to consider further mitigation measures, the contractor should submit regular reports to the supervision consultant and environmental management unit on the implementation status of the management plan.

The environmental management administrator shall regularly hold explanation sessions with the local people and submit reports to the Department of Environment, JICA and other relevant organizations about the implementation status of the environmental management, in addition to the environmental monitoring.

Operation Phase

The power plant is responsible for organizing an unit in charge of environmental management to develop and implement the environmental management plan as mitigation measures. An expert environmental management administrator shall be employed so that the environmental management plan is appropriately implemented. The environmental management administrator shall encourage the understanding of the environmental management plan to the project staff prior to plant operation, and continue regular education of the staff during the operation phase.

The environmental management unit shall also function as a grievance organization to understand and address any grievances from local people during the operation phase, and conduct appropriate mitigation measures.

The basic policy of the environmental management plan is to liaise with local community, and sufficient explanation of the positive mitigation measures to local people is very important.

The administrator shall report the contents and implementation status of the environmental management plan and the environmental monitoring plan described below to the director of the plant, with the director taking final responsibility. The environmental management administrator shall regularly provide explanations to the local people and submit reports to the Department of Environment, JICA and other relevant organizations about the implementation status of the environmental management, in addition to the environmental monitoring.

Public Consultation

In accordance with JICA Guidelines for Environmental and Social Consideration, the first stakeholder meeting for the power plant was held at the scoping stage of the Feasibility Study of the Coal-fired Power Plant Development Project (600X2 MW) at Matarbari, Cox's Bazar. The project owners, the Coal Power Generation Company Bangladesh LTD. (CPGCBL) for the power plant hosted the meetings assisted by the JICA Study Team. At the meeting, a power-point presentation was given to the local participants in their local language (Bengali), with a full explanation of the project and environmental impacts in addition to the mitigation measures to be taken, to allow the audience to fully understand the project and contribute valuable comments.

Conclusion and Recommendation

Conclusions

The study suggests that most of the adverse impacts on the physic-chemical environment are of low to moderate in nature and therefore, could be offset or minimized if the mitigation measures are adequately implemented. From the social environmental point of view, people welcomed the proposed power plant project at Matarbari. However, they recommended installing a plant of good quality, which will be able to keep anticipated air, water and noise pollution to a minimum level.

Some adverse impact during the operation phase of the plant will come from pollutants, emission from the power plant. However, modeling study suggests that the predicted concentration of pollutants from exhaust gases, taking into account the background concentration, will satisfy the ambient air quality standards of Bangladesh as well as IFC/WB EHS guidelines and environmental standards of the EU etc.

Cooling Water used in the power plant will have intake in the deep layer at the water inlet located in the port using the curtain wall method. Thermal effluent will be discharged at outlet located 1km north of the port in order to prevent recirculation. The temperature of thermal effluent will be discharged within ΔT 8^{o}C compared to the water temperature of the intake water and will be less than 40^{o}C as the discharge water regulation.

According to the simulation result for diffusion model of thermal effluent, thermal effluent is diffused at a fast speed due to the fast current; therefore, the range of water temperature increase by more than 3^{o}C is limited to the surrounding area of the discharge outlet. The range of water temperature increase by more than 2^{o}C is up to 200m from the discharge outlet and not reached to the coastal area of the island.

Waste water from each facility will be managed and treated appropriately to comply with water quality of Bangladesh regulations and IFC/EHS Guideline values for thermal power plants. Treated wastewater will be mixed and diluted with a large volume of thermal effluents. Noise level has been identified as significant potential impact of the proposed power plant during both the

construction and operation phases. The noise generated from construction activities during the construction phase might become a source of annoyance at the residential Area to the project site. However, the noise level is expected to come down to tolerable levels within residential area
The area is the presumed habitat of birds and sea turtles of the IUCN Red list (endangered species, etc.), and construction work may impact the rare species and ecosystem. Environmental impact of air pollution, water turbidity, and noise, etc., during the operation phase will be mitigated through appropriate countermeasures. The diffusion area of thermal effluents with increased temperature of 2 ºC or higher is limited to a certain surface layer and fish can easily bypass this area.

It is highly likely that the spawning of four IUCN precious species of sea turtles takes place on the sea coast, and a detailed survey should be conducted. Light and noise of nighttime construction may have adverse effects on the sea turtles. The careful monitoring of spawning status is necessary.

The approximately 20 households currently living on the site will have to vacate their homes due to the land acquisition for the construction of the power plant. Land owners will lose their land. Employers/ employees of salt farms, shrimp farms, and fishermen will lose their means of livelihood. LARAP (Land Acquisition and Resettlement Action Plan) that includes not only a compensation plan but also a livelihood restoration program for affected people shall be established. During public consultations carried out as a part of the EIA study, people welcomed the proposed power plant project at Matarbari. However, they recommended installing a plant of good quality, which will be able to provide uninterrupted power and will be able to keep anticipated air and noise pollution to a minimum level.

Recommendations

The environmental assessment carried out for the proposed coal fired power plant at Matarbari,! suggests low to moderate scale of adverse impacts, which can be reduced to acceptable level through recommended mitigation measures as mentioned in the EMP. It is therefore recommended that the proposed power plant may be installed, provided the suggested mitigation measures are adequately implemented. It is also recommended that the environmental monitoring plan be effectively implemented in order to identify any changes in the predicted impacts and take appropriate measures including LARAP to off-set any unexpected adverse effects.

Apart from risks associated with emissions, noise generation, solid waste, hazardous waste and wastewater disposal as a result of construction and operation activities, the coal fired power plant put human beings and the environment inside and outside of the plant to a certain degree of risk of accident and sometime loss of life. A risk analysis for the proposed power plant has been developed listing various actions to be performed in a very short period of time in a pre-determined sequence if it is to deal effectively and efficiently with any emergency, major accident or natural disaster.

Chapter 1

Introduction

Chapter 1

Introduction

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1.1 Background of the Study

Electricity is the key to all development activities. Sustainable power supply is a major precondition for the socio-economic development of Bangladesh. Access to electricity is now being recognized as a fundamental right. Notwithstanding the medium growth rate of GDP of Bangladesh, the per capita electricity generation, only 254 kW (BPDB; Bangladesh Power Development Board, 2012), is very meager. At present, 50% of the total population has access to electricity but reliable and quality power generation and supply is still a far away. The Government assigns top priority to the development of power sector realizing its importance in economy, industrial and social development of the country. To this end, the government has set the goal of providing electricity to all citizens by 2020. The present installed generation capacity is 8,315 MW including 3,771 MW from private sector and electricity demand growth 10% per annum. Government forecasts that the maximum electricity demand would be 13,000MW in 2017 and 34,000 MW in 2030. To meet up this, the Government of Bangladesh (GOB) has formulated a Power System Master Plan (2010). Taking consideration of high dependency on natural gas (67%) of power generation comes from natural gas based units), Power System Master Plan (PSMP 2010) recommends diversification of fuel used for electricity generation because present primary energy i.e natural gas supply will decrease after 2017 and opt coal as a prime energy for electricity generation. The Master plan, targets composition of power supply as of 2030 set at 50% for domestic and imported coal, 25% for domestic and imported (in the form of LNG) natural gas and 25% for other sources such oil, nuclear power and renewable energy. The coal based generation is the least cost option in consideration to present economy.

In this situation, Japan International Cooperation Agency (JICA) implemented PSMP 2010 The study covered strategy to expand coal-fired power generation focusing on utilizing imported coal and developing domestic coal. Based on the results of the PSMP 2010, GOB has requested the Japanese government to conduct a study to inquire into possibility of receiving support from Japan for imported coal power development. JICA implemented “Data collection survey on coal power master plan follow-up survey”. After the follow-up survey, JICA has implemented “The preparatory survey on the Chittagong area coal-fired power plant development project”. Then BPDB plans for establish Coal Power Generation Company Bangladesh LTD (CPGCBL) and installation of Matarbari Coal-Fired Power Plant (Matrbari CFPP; 2 x 600 MW) at Matarbari island under Maheshkhali Upazila, Cox’s Bazar District (Figure 1.1-1).

The proposed power plant area is situated within Matarbari and Dhalghata Union under Maheshkhali Upazila (Figure 1.1-1). The proposed power plant will cover an area of about 455 hectare.

As stipulated in the Environment Conservation Acts, 1995, no project shall be established without obtaining Environmental Clearance from the Department of Environment (DOE) and the detail procedure and steps have been described in the Environment Conservation Rules, 1997. The proposed project falls under the Red category of industrial classification made under the Environment Conservation Rules (ECR), 1997 which requires Site Clearance Certificate (SCC) and Environmental Clearance Certificate (ECC) from DOE. As such, for obtaining these aforementioned clearance certificates from DOE, JICA Study Team on behalf of CPGCBL has conducted Initial Environmental Examination (IEE) and Environmental Impact Assessment (EIA) study for the proposed coal-fired thermal power plant. Table 1.1-1 shows the distance of the important locations from the project site. Figure 1.1-2 shows the aerial distance of important locations from the project site.

Note: The center of location is 21 42'15" N, 91 53'16" E

(Source: http://www.in2bangla.com/upazilaMap.php?id=293)

Figure 1.1-1 Location map of the proposed power plant site in Matarbari

Table 1.1-1 Aerial distance of different point of interest from the site

Location	*Distance (km) (center to center)*
Chittagong city	*67*
Cox's Bazar city	*33*
Cox's Bazar airport	*31*
Sonadia Island	*24*
Sonadia ECA	*15 (center to boundary of ECA)*
The crossing of National road No. 1 and the district road No. 177 (Chakaria)	*20*

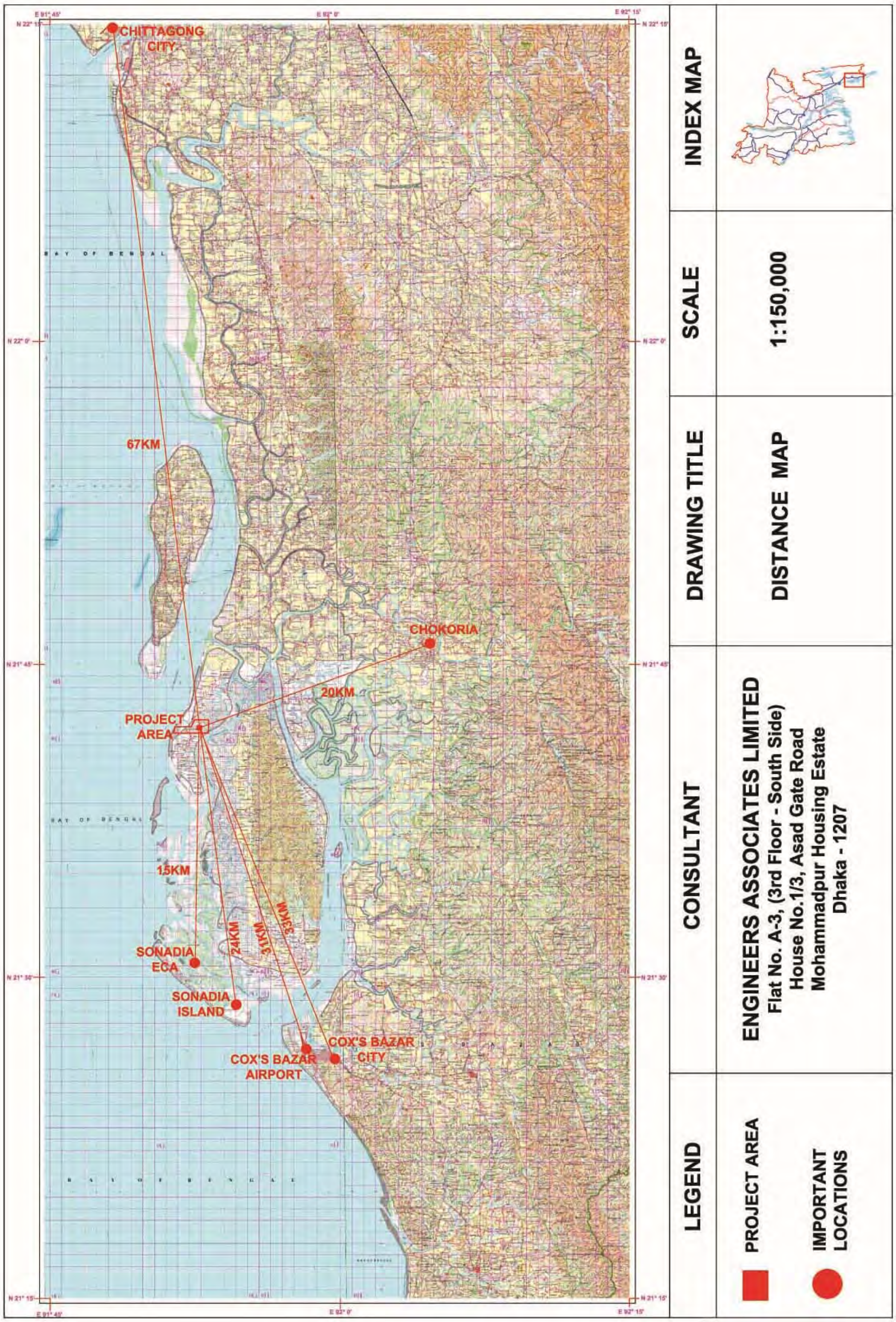


Figure 1.1-2 Aerial Distances of important locations from the proposed power plant site

1.2 Purpose of the study

The project falls under the red category defined by DOE which requires EIA to obtain SCC and ECC from DOE as per Environmental Conservation Rules, 1997.

This study will identify and evaluate the potential environmental and socio-economic impacts due to construction of the coal-fired power plant providing detail Environmental Management Plan (EMP) to mitigate the project oriented negative impacts. It is expected that the study will facilitate the planning and design of the proposed power plant in the way of mitigating the potential negative impacts and enhancing the project benefits.

Given the vision of obtaining site clearance certificate the specific objectives of the study are:

- Selection of alternative sites
- Identification of national and international legal environmental requirements
- Identification of potential environmental and socio-economic impacts
- Identification of occupational risk and hazard
- Identification of mitigation and abatement measures
- Delineation of Environmental Management Plan (EMP)

According to EIA guidelines for Industries of DOE, Bangladesh, Power Plant, Transmission line and gas pipeline, distribution, construction /re-construction/ extension fall under the Red category (Category-D). Red category projects require EIA.

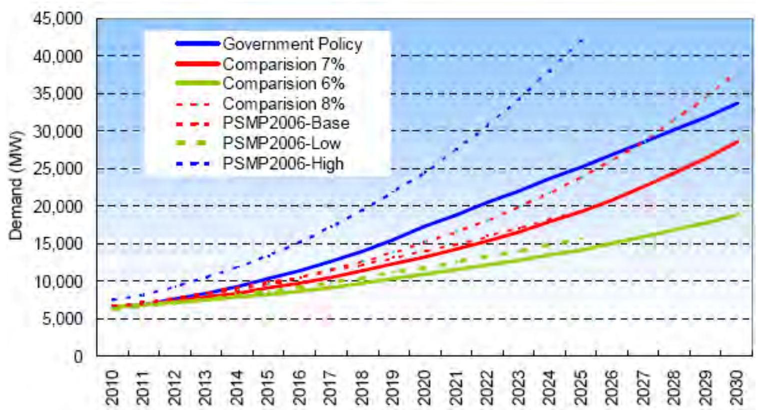
This project falling under the red category is therefore required to undertake EIA which is a precondition for giving go-ahead clearance by the DOE.

Hence, JICA study Team on behalf of CPGCBL carried out EIA to fulfill the requirement of the DOE. The main objectives of the EIA study were:

- Describing the existing environment of the area;
- Assessment of the potential environmental impacts, including residual impact of the proposed project;
- Identifying mitigation measures to minimize the impact;
- Preparing an Environmental Monitoring Program etc.

1.3 Need of the project

At present a total number of 79 Power Plants having total capacity of 7613 MW generate 4,000 MW to 5500 MW on an average. Against this generation, the daily average demand at the generation end varies about 5,100 - 6,000 MW. In accordance to an unofficial calculation, the average shortfall is about 2,000 MW per day. The demand of power is rising with the economic development of the country. MoPEMR, has forecast power demand growth in line with the desired economic growth of the country under PSMP, 2010. As per the forecast, with government policy scenario the power demand will reach 17,000 MW in 2017 and 34,000MW by 2030. The PSMP also forecasts the demand as per different GDP growth rate. Figure 1.3-1 shows power demand forecasts of PSMP, 2010 up to 2030.



(Source: PSMP, 2010)

Figure 1.3-1 Power demand forecast for different scenarios

The present electricity crisis is hindering the national economic development by discouraging the foreign investment, disturbing the national industrial production and dropping the quality of living standard (Mozumdaer and Marathe, 2007). A research on electricity consumption and GDP growth reveals that Bangladesh loses industrial production worth $1 billion per year that reduces 0.5% of the GDP due to power outage. To mitigate the prevailing crisis of electricity demand as well as to achieve the desirable overall development of the country, the BPDB/GOB has adopted a power generation increase plan up to 2016 in line with the PSMP (2010). The summary of the plan is shown in the Table 1.3-1.

Table 1.3-1 Summary of the power generation increase plan

(Unit: MW)

Type	2012	2013	2014	2015	2016	Total
Public	632	1467	1660	1410	750	5919
Private	1354	1372	1637	772	1600	6735
Power Import	---	500	---	----	---	500
Total	1986	3339	3297	2182	2350	13154

(Source: BPDB)

Taking consideration of national gas reserves which is the primary energy of power generation of the country at present (67% of total power generation from gas based units), the PSMP recommends diversification of fuel for electricity generation and opts coal based power generation as least cost option to reduce the dependency on natural gas. In this line, Government has taken initiatives to install Matarbari CFPP (2 x 600 MW)at Matarbari island.

1.4 Importance of the project

The proposed power plant will add 1,200MW electricity to the national grid that will improve the present electricity generation significantly and as well as trigger the national economic development. Not only that, industrial development will be initiated after implementation. Additionally, it will create employment opportunity to the local people and improve transportation system in the project area, which will ultimately play an important role in poverty reduction and develop social safety net condition. Moreover, this coal based power plant will thereby play an important role in fuel diversification in electricity generation and reduce pressure on natural gas reserve.

1.5 Scope of Study

The scope of works includes mainly execution of EIA and detail scope of works is as follows:

1.5.1 Environmental and Social Impact Assessment

The scope of services under the ESIA study is as follows:

a) Carry out environmental and social impact assessment identifying Matarbari CFPP (2 x 600 MW) that will satisfy the applicable environmental requirements, including the laws and bylaws of Bangladesh and JICA guideline.
b) Carry out hydrological investigation; in order to design the appropriate port facility.
c) Elaborate project description and design and the activities at pre-construction, construction and post-construction phases.
d) Establish environmental and social baseline condition in respect of water resources, land resources, agriculture, fisheries, ecology and socio-economic condition.
e) Carry out meteorological, noise level and air quality investigations for the proposed power plants and the necessary additional transmission lines.
f) Select environmental and social components likely to be impact by the proposed coal-fired power plants.
g) Identify suitable control measures to minimize CO_2, Dust, SOx, and NO_x. emissions from the power plants.
h) Identify exhaust stack requirements (275 meters as per DOE rules) applicable to the plant so that concentration of SO_2 and particulate matter in the surrounding area is uniform and minimum.
i) Thermal plume modelling will be completed considering the proposed power plant including nearby industrial installations (if any).

j) Ability for the developers of the power generation projects to satisfy all national regulatory requirements and international obligations related to health and human safety and the environment in the construction, operation, and maintenance of imported coal projects of the anticipated size at the identified sites.
k) Ability to dispose efficiently and in a manner that complies with all national regulatory requirements and international obligations related to the ash generation by the power generation facilities (and the development of a recommended plan for doing so).
l) Social/infrastructure facilities to be required.
m) Assess and evaluate the ability of each of the projects (and any expansion projects at the site) to comply with all health and safety and environmental laws of Bangladesh and the requirements of the JICA guideline. Identify any restriction that should reasonably be imposed on the developers of the power generation projects to ensure that expansion projects can be designed, constructed and operated in compliance with all such laws, regulations and requirements and also international obligations.
n) Evaluate the impact on environment in line with Bangladesh and/or JICA guideline requirement for the coal power plant to ensure that the power generation facilities and transmission facilities can be designed, constructed and operated in compliance with all applicable environmental requirements.
o) Preparation of EMP, which shall include mitigation measures, enhancement and contingency measures and compensation.
p) As per TOR approved by the DOE, produce an EIA report which shall form the basis of obtaining environmental clearance from the DOE for implementation of the coal-fired thermal power generation facilities.
q) Study of prevention measures for dust particles from coal to the air.
r) Study of siltation problem and migration of soil/sand in the proposed area.
s) Study of the township development of the area.
t) Study of salinity of the area.

1.5.2 Topographical and Engineering Survey

a) Carry out Benchmark pillar from nearest established Benchmark Pillar
b) Establishment of 5 numbers of Benchmark and 10 numbers of Reference Pillars (2 reference pillars for each BM)
c) Total station survey on 455 hector area
d) Producing maps of topographical information and features
e) Detail contour survey by taking spot levels at 20 Meter intervals constructing Bench mark, reference pillars and grid pillars of approved specifications at 100 meter grid points of the area surveyed.

1.5.3 Geotechnical Investigations

a) Execution of minimum 6 numbers of exploratory borings depth up to 40 meters, recording of sub-soil stratification and position of ground water table.
b) Execution of standard penetration test (SPT) at an interval of 1.5 m depth with collection of disturbed soil samples up to the final depth of exploration of each boring.
c) Carry out laboratory test of required engineering properties of sub soil.

1.6 The EIA Team

JICA Study Team has formed a multidisciplinary team of EIA experts of having experience of conducting Environmental Impact Assessment of large scale industrial and infrastructural development projects. The name of the professionals' involved in the study is as below:

Japanese expert list and its role of work are as follows:

● Team Leader/ Power Plant System Planning A	Shigeru SAITO
● Deputy Team Leader/ Power Plant System Planning B	Yoichiro KUBOTA
● Power Plant Construction Planning	Shinji OUCHI
● Implementation Plan and Estimation	Sachio KOSAKA
● Civil	Mitsuaki SHIMADA
● Mechanical	Hideki ASAYAMA
● Electrical and I&C	Yoshihide KANAI
● Port Planning	Mitsunobu ABE
● Port Engineering	Ryo KONDO
● Power System Analysis	Atsushi YUIHARA
● Transmission	Satoshi KOBAYASHI
● Substation	Tomio ICHIKAWA
● Fuel Supply Planning	Hajime ENDO
● Fuel Transportation Planning	Genshiro KANO
● Operation & Maintenance Management A	Kiyoshi KATAOKA
● Operation & Maintenance Management B	Mayo YONEYAMA
● Human Resource Administration	Keiichi FUJITANI
● Economy and Financial Analysis	Yasuhisa KURODA
● Organization Structure	Noboru SEKI
● Project Operation	Atsumasa SAKAI
● Environmental A	Tadashi NAKAMURA
● Environmental B	Shigeki WADA
● Environmental Impact Evaluation	Norihiko FUKAZAWA
● Fauna &Flora	Kenzo UTSUGI
● Environmental & Social Consideration	Tadashi MIYAGI
● Social Consideration	Junko FUJIWARA
<Access Road Unit>	
● Access Route Selection/Road /Foundation	Kiyoshi WATANABE
● Road Planning	Toshiyuki KOBAYASHI
● Road Construction Plan/Cost Estimate	Takeo MOGAMI

- Natural Condition (Foundation/Geology/Hydrology) Yoshiyuki AKAGAWA
- Bridge/Structure Design Makoto IIDA
- Environmental & Social (Land Acquisition and Resettlement Action Plan
Osamu NAKAZAWA
- Environmental & Social 8Social Survey and Ecosystem
Jiro OTSUBO
- Environmental & Social (EIA) Kazuhiro YOSHIDA
- Economic Analysis Hiroaki YAMAGISHI

Bangladeshi expert list and its role of work are as follows:

Sl. No.	Name of Professionals	Position Assigned
1.	Syed Bahar Uddin	Electrical Engineer & Local Team Leader
2.	Rama Nath Roy	Environmental Specialist
3.	Dr. Khairul Bashar	Geological Expert
4.	AKM Anisur Rahman	Mechanical Engineer
5.	Mohammad Muslem Uddin	Fisheries Specialist
6.	Dr. Nazmun Nahar	Water Resources Engineer
7.	Mohammad Omar Faruque	Flora Specialist
8.	Mohammad Abdul Wahed Chowdhury	Wildlife Specialist
9.	Mizanur Rahman Khan	Socio-Economist
10.	Md. Mahbubul Islam	Geologist
11.	Md. Mohsin Patwary	Morphologist
12.	S.M. Andalib	Environmental Law Specialist

Chapter 2

Legal and Legislative Framework, Regulations and Policy Consideration

Chapter 2

Legal and Legislative Framework, Regulations and Policy Consideration

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2.1 Environmental Regulation

Details of the environmental standards applicable in Bangladesh are described in the Environmental Conservation Rules (ECR). Regulated areas cover all industries, and regulated items are air quality, water quality (surface water, drinking water), noise (boundary, source), emissions from motor vehicles or ships, odor, sewage discharge, waste from industrial units and industrial effluents or emissions. Items and standards, which are related to the construction and operation of coal-fired power plants, are listed below. Tables and annotations of environmental regulations are described as textual descriptions of ECR.

ECR is currently in the process of amendment. There is a possibility that the environmental regulations of the following items will be amended, but the current regulations are applicable until the amendment process is completed.

In addition to ECR, this project will also comply with IFC (International Finance Corporation) EHS (Environmental, Health and Safety) Guideline “General”, “Thermal power” and “Transmission and Distribution”.

(1) Air quality

Table 1.1-1 shows the air quality standards in Bangladesh. Air quality standards adhere to WHO guidelines, also mentioned in the table below.

Table 2.1-1 Standards for air quality in Bangladesh [1]

No.	Parameter	Concentration (mg/m^3)		Exposure Time
		ECR	IFC Guideline (General: 2007)*	
a)	Carbon Mono-oxide	10	-	8 hours
		40	-	1 hour
b)	Lead (Pb)	0.5	-	Year
c)	Nitrogen Oxide	0.1	0.04	Year
		-	0.2	1 hour
		-	0.2	1 hour
d)	Suspended Particulate Matter (SPM)	0.2	-	8 hours
e)	Particulate Matter 10μm (PM_{10})	0.05	0.02	Year
		0.15	0.05	24 hours
f)	Particulate Matter 2.5μm ($PM_{2.5}$)	0.015	0.01	Year
		0.065	0.025	24 hours
g)	Ozone	0.235	-	1 hour
		0.157	0.160	8 hours
h)	Sulfur Dioxide	0.08	-	Year
		0.365	0.125	24 hours

Notes: * Air quality standard of IFC Guideline is quated from WHO Guideline.

(Source: Bangladesh Gazette July 19, 2005, IFC Environmental Health and Safety Guidelines 2007

[1] Not exceed one time per year

Table 2.1-2 shows gas emission standards for industrial facilities in Bangladesh, and Table 2.1-3 shows gas emission standards for industrial boilers in Bangladesh.

Table 2.1-2 Gas emission standards for industrial facilities

No.	Parameter	Unit	Standard Limit
1	Particulates		
	a) Electric Power plants of 200 Megawatts and above	mg/Nm^3	150
	b) Electric Power plants less than 200 Megawatts	mg/Nm^3	350
2	Chlorine	mg/Nm^3	150
3	Hydrochloric Acid gas & mist	mg/Nm^3	350
4	Total Fluoride (F)	mg/Nm^3	25
5	Sulfuric Acid mist	mg/Nm^3	50
6	Lead particles	mg/Nm^3	10
7	Mercury particles	mg/Nm^3	0.2
8	Sulfur Dioxide		
	a) Sulfuric Acid manufacture (DCDA process)	kg/ton	4
	b) Sulfuric Acid manufacture (SCSA process) Minimum Stack height for Sulfuric Acid emissions	kg/ton	10
	Lowest height of stack for dispersion of sulfuric acid a) Coal Fired Electric Power plants		
	i) 500 Megawatts & above	m[2]	275
	ii) 200-500 Megawatts	m	220
	iii) Below 200 Megawatts	m	$14\ (Q)^{0.3}$ [3]
	b) Boilers		
	i) For Steam up to 15 tons/hour	m	11
	ii) For steam above 15 tons/hour	m	$14\ (Q)^{0.3}$
9	Nitrogen Oxides		
	a) Nitric Acid manufacture	kg/ton	3
	b) Gas Fired Electric Power plants		
	i) 500 Megawatts & above	ppm	50
	ii) 200-500 Megawatts	ppm	40
	iii) Less than 200 Megawatts	ppm	30
	c) Metal Treatment Furnace	ppm	200
10	Soot & Dust Particles		
	a) Air Ventilated Furnaces	mg/Nm^3	500
	b) Brick-fields	mg/Nm^3	1000
	c) Cooking Furnaces	mg/Nm^3	500
	d) Limestone Furnaces	mg/Nm^3	250

(Source: The Environmental Conservation Rules, 1997)

Table 2.1-3 Gas emission standard for industrial boiler

No.	Parameters	Standard for presence in a unit of mg/Nm^3
1	Soot and particulates (fuel based)	
	a) Coal	500
	b) Gas	100

[2] Lowest height of stack is defined
[3] Q=SO_2 emission in kg/hour

No.	Parameters	Standard for presence in a unit of mg/Nm^3
	c) Oil	30
2	Oxides of Nitrogen (fuel based)	
	a) Coal	60
	b) Gas	15
	c) Oil	30

(Source: The Environmental Conservation Rules, 1997)

A coal-fired power plant utilizes coal (main fuel) and oil (auxiliary fuel for startup). Since the planned output of the power plant is 600MW, the emission standard limit of particulates is $150mg/Nm^3$. For Sulfur Dioxide, if a stack of 275m height is installed, there are no standard limits of emissions densities and amount limits. The emission standard limit of Oxides of Nitrogen shown in Table-3 is 600 mg/Nm^3 in the case of coal-firing and 300 mg/Nm^3 in the case of oil firing.

It is common to set emission standards to SO_2 based on global standards. Table 2.1-4 shows a comparison of the flue gas emission standards of Bangladesh to the World Bank (IFC). A new coal-fired power plant should consider these world standards.

Table 2.1-4 Comparison of flue gas emission standards between Bangladesh and IFC

Parameters	Bangladesh Standard	IFC Guidelines (Thermal Power: 2008)
SO_2	- [4]	$850mg/m^3$ [5]
NO_x	600 mg/m^3	510 mg/m^3
Particulate Matter (PM)	$500mg/m^3$	$50mg/m^3$
Dry Gas , Excess O_2 Content	-	6%

(Source: The Environmental Conservation Rules 1997, IFC Environmental Health and Safety Guidelines 2008)

(2) Water quality

Table 2.1-5 shows ambient water quality standards (inland surface water), Table 2.1-6 shows environmental water quality standards (drinking water), and Table 2.1-7 shows waste water standard parameters in Bangladesh. For drinking water standards and waste water standards, WHO standards are also stated in the tables below for comparison. World Bank (IFC) guidelines stipulate monitoring necessary heavy metals according to the characteristics of each thermal power plant.

[4] Lowest height of stack is defined
[5] As the high limit in non-degraded airsheds

Table 2.1-5 Ambient water quality standards (inland surface water)[6]

No.	Best Practice Based Classification	pH	BOD mg/1	Dissolved Oxygen (DO), mg/l	Total Coliform Bacteria quantity/ml
a)	Potable water source supply after	6.5-8.5	2 or less	6 or above	50 or less
b)	Water used for recreation	6.5-8.5	3 or less	5 or above	200 or less
c)	Potable water source supply after	6.5-8.5	3 or less	6 or above	5000 or less
d)	Water used for pisci-culture	6.5-8.5	6 or less	5 or above	5000 or less
e)	Industrial use water including chilling & other processes	6.5-8.5	10 or less	5 or above	
f)	Water used for irrigation	6.5-8.5	10 or less	5 or above	1000 or less

(Source: The Environmental Conservation Rules,1997)

Table 2.1-6 Environmental water quality standards (drinking water)

No.	Parameter	Unit	Standard Limit	WHO Guidelines
1	Aluminum	mg/l	0.2	0.2
2	Ammonia (NH_3)	mg/l	0.5	-
3	Arsenic	mg/l	0.05	0.01
4	Barium	mg/l	0.01	0.7
5	Benzene	mg/l	0.01	0.01
6	BOD_5 20^{O}C	mg/l	0.2	-
7	Boron	mg/l	1.0	0.5
8	Cadmium	mg/l	0.005	0.003
9	Calcium	mg/l	75	-
10	Chloride	mg/l	150-600	-
11	Chlorinated Alkanes			-
	Carbon Tetrachloride	mg/l	0.01	-
	1.1 Dichloroethylene	mg/l	0.001	-
	1.2 Dichloroethylene	mg/l	0.03	-
	Tetrachloroethylene	mg/l	0.03	-
	Trichloroethylene	mg/l	0.09	-
12	Chlorinated Phenols			-
	Pentachlorophenol	mg/l	0.03	-
	2.4.6 Trichlorophenol	mg/l	0.03	-
13	Chlorine (residual)	mg/l	0.2	-
14	Chloroform	mg/l	0.09	0.3
15	Chromium (hexavalent)	mg/l	0.05	-
16	Chromium (total)	mg/l	0.05	0.05
17	COD	mg/l	4	-
18	Coliform (fecal)	n/100 ml	0	-
19	Coliform (total)	n/100 ml	0	-
20	Color	Huyghens unit	15	-
21	Copper	mg/l	1	-
22	Cyanide	mg/l	0.1	-
23	Detergents	mg/l	0.2	-
24	DO	mg/l	6	-
25	Fluoride	mg/l	1	1.5
26	Hardness (as $CaCO_3$)	mg/l	200-500	-
27	Iron	mg/l	0.3-1.0	-

[6] Textual annotations are as follows.
(1) Maximum amount of ammonia presence in water is 1.2 mg/l (as nitrogen molecule) which is used for pisciculture.
(2) For water used in irrigation, Electrical Conductivity-2250 micro mho/cm (at 25oC). Sodium less than 26 mg/l, Boron less than 2 mg/l

No.	Parameter	Unit	Standard Limit	WHO Guidelines
28	Nitrogen (Total)	mg/l	1	-
29	Lead	mg/l	0.05	0.01
30	Magnesium	mg/l	30-35	-
31	Manganese	mg/l	0.1	0.4
32	Mercury	mg/l	0.001	0.006
33	Nickel	mg/l	0.1	0.07
34	Nitrate	mg/l	10	3
35	Nitrite	mg/l	Less than 1	-
36	Odor		Odorless	-
37	Oil & Grease	mg/l	0.01	-
38	pH		6.5-8.5	-
39	Phenolic compounds	mg/l	0.002	-
40	Phosphate	mg/l	6	-
41	Phosphorus	mg/l	0	-
42	Potassium	mg/l	12	-
43	Radioactive Materials (gross alpha	Bq/l	0.01	-
44	Radioactive Materials (gross beta	mg/l	0.1	-
45	Selenium	mg/l	0.01	-
46	Silver	mg/l	0.02	-
47	Sodium	mg/l	200	-
48	Suspended particulate matters	mg/l	10	-
49	Sulfide	mg/l	0	-
50	Sulfate	mg/l	400	-
51	Total dissolived solids	mg/l	1000	1000
52	Temperature	Ⅲ	20-30	-
53	Tin	mg/l	2	-
54	Turbidity	JTU	10	-
55	Zinc	mg/l	5	-

(Source: The Environmental Conservation Rules 1997, Guidelines for Drinking-water Quality WHO 2008)

Table 2.1-7 Wastewater Discharge Standards [7]

No.	Parameter	Unit	Inland Surface Water	Public Sewer at Secondary Treatment plant	Irrigated Land	IFC Guideline (Thermal power: 2008)
1	Ammoniacal Nitrogen (N molecule)	mg/l	50	75	75	-
2	Ammonia (free ammonia)	mg/l	5	5	15	-
3	Arsenic (As)	mg/l	0.2	0.05	0.2	0.5

[7] Textual annotations are as follows.
(1) These standards shall be applicable to industrial units or projects other than those given under Quality Standards for Classified Industries (Schedule 12).
(2) These quality standards must be ensured at the moment of going into trial production for industrial units and at the moment of going into trial production for industrial units and at the moment of going into operation for other projects.
(3) The value must not exceed the quality standard during spot checks at any time; if required, the quality standards may be stricter to meet the environment terms in certain areas.
(4) Inland Surface Water shall mean drains, ponds, tanks, water bodies or water holes, canals, rivers, springs and estuaries.
(5) Public sewer shall mean sewers connected with fully combined processing plant including primary and secondary treatment.
(6) Irrigated land shall mean appropriately irrigated plantation areas of specified crops based on quantity and quality of waste water.
(7) Inland Surface Quality Standards (Schedule 13) shall be applicable for any discharge taking place in public sewers or land not defined in Notes 5

No.	Parameter	Unit	Inland Surface Water	Public Sewer at Secondary Treatment plant	Irrigated Land	IFC Guideline (Thermal power: 2008)
4	BOD_5 20°C	mg/l	50	250	100	-
5	Boron	mg/l	2	2	2	-
6	Cadmium (Cd)	mg/l	0.05	0.5	0.5	0.1
7	Chloride	mg/l	600	600	600	-
8	Chromium (total Cr)	mg/l	0.5	1.0	1.0	0.5
9	COD	mg/l	200	400	400	-
10	Cr^{6+} (hexavalent Cr)	mg/l	0.1	1.0	1.0	-
11	Copper (Cu)	mg/l	0.5	3.0	3.0	0.5
12	Dissolved Oxygen (DO)	mg/l	4.5-8	4.5-8	4.5-8	-
13	Electrical Conductivity	micro mho/cm	1200	1200	1200	-
14	Total Dissolved Solids	mg/l	2,100	2,100	2,100	-
15	Fluoride (F)	mg/l	7	15	10	-
16	Sulfide (S)	mg/l	1	2	2	-
17	Iron (Fe)	mg/l	2	2	2	1
18	Total Kjeldahl Nitrogen (N)	mg/l	100	100	100	-
19	Lead (Pb)	mg/l	0.1	1.0	0.1	0.5
20	Mangaense (Mn)	mg/l	5	5	5	-
21	Mercury (Hg)	mg/l	0.01	0.01	0.01	0.005
22	Nickel (Ni)	mg/l	1.0	2.0	1.0	-
23	Nitrate (N molecule)	mg/l	10.00	Undetermined	10	-
24	Oil & grease	mg/l	10	20	10	10
25	Phenol compounds(C_6H_5OH)	mg/l	1.0	5	1	-
26	Dissolved Phosphorus (P)	mg/l	8	8	10	-
27	Radioactive Materials.	As determined by Bangladesh Atomic Energy Commission				-
28	pH		6-9	6-9	6-9	6-9
29	Selenium	mg/l	0.05	0.05	0.05	-
30	Zn (Zn)	mg/l	5.0	10.0	10.0	1
31	Total Dissolved solid	mg/l	2,100	2,100	2,100	-
32	Temperature	Centigrade	40	40	40-Summer	-
			45	45	45-Winter	-
33	Total Suspended Solid (TSS)	mg/1	150	500	200	50
34	Cyanide (CN)	mg/1	0.1	2.0	0.2	-

(Source: The Environmental Conservation Rules 1997. IFC Environmental Health and Safety Guidelines 2008)

(3) Noise and Odor

In regards to noise, the standard limit is set for every category of zone class. Table 1.1-8 shows the noise standards in Bangladesh.

Table 2.1-8 Standards for Noise[8]

<table>
<tr><th rowspan="3">No</th><th rowspan="3">Zone Class</th><th colspan="4">Limits in dBA</th></tr>
<tr><th colspan="2">ECR</th><th colspan="2">IFC Guideline
(General: 2007)</th></tr>
<tr><th>Day</th><th>Night</th><th>Day</th><th>Night</th></tr>
<tr><td>a)</td><td>Silent Zone</td><td>45</td><td>35</td><td rowspan="2">55</td><td rowspan="2">45</td></tr>
<tr><td>b)</td><td>Residential Zone</td><td>50</td><td>40</td></tr>
<tr><td>c)</td><td>Mixed Zone (this area is used combining residential, commercial and industrial purposes)</td><td>60</td><td>50</td><td rowspan="3">70</td><td rowspan="3">70</td></tr>
<tr><td>d)</td><td>Commercial Zone</td><td>70</td><td>60</td></tr>
<tr><td>e)</td><td>Industrial Zone</td><td>70</td><td>70</td></tr>
</table>

(Source: The Environmental Conservation Rules, 1997 IFC Environmental Health and Safety Guidelines 2008)

Ammonia is used in SCR, which is possible to be introduced for the purpose of nitrogen oxide reduction. Including ammonia, Table 1.1-9 shows the odor emission standards in Bangladesh.

Table 1.1-9 Standards for Odor[9]

Parameter	Unit	Standard Limit
Acetaldehyde	ppm	0.5 – 5
Ammonia	ppm	1 – 5
Hydrogen Sulfide	ppm	0.02 – 0.2
Methyl Disulfide	ppm	0.009 – 0.1
Methyl Sulfide	ppm	0.01 – 0.2
Styrene	ppm	0.4 – 2.0
Trim ethylamine	ppm	0.005-0.07

(Source: The Environmental Conservation Rules 1997)

[8] Textual annotations are as follows.
(1) Day time is considered from 6 a.m. to 9 p.m. and night time is from 9 p.m. to 6 a.m.
(2) From 9 at night to 6 in the morning is considered night time.
(3) Areas within 100 meters of hospitals, education institutions, educational institutions or government designated / to be designated / specific institution / establishments are considered Silent Zones. Use of motor vehicle horns or other signals and loudspeaker are forbidden in Silent Zones.

[9] Textual annotations are as follows.
(1) Following regulatory limits shall be generally applicable to emission/exhaust outlet pipes of above 5 meter height: Q = 0.108 x He2Cm (Where Q = Gas Emission rate Nm3/hour)
He = Height of exhaust outlet pipe (m)
Cm = Above mentioned limit (ppm)
(2) In cases where a special parameter has been mentioned, the lower limit shall be applicable for warning purposes, and the higher limit shall be applicable for prosecution purposes or punitive measures.

(4) Electric and magnetic fields

IFC EHS Guideline (Electric Power Transmission and Disgtribution; 2007) recommends the following methods for managing EMF (Electric and magnetic fields) generated by transmission line.

- Evaluating potential exposure to the public against the reference levels developed by the International Commission on Non-Ionizing Radiation Protection (ICNIRP). Average and peak exposure levels should remain below the ICNIRP recommendation for General Public Exposure (Table 2.1-10).
- Considering siting new facilities so as to avoid or minimize exposure to the public. Installation of transmission lines or other high voltage equipment above or adjacent to residential properties or other locations intended for highly frequent human occupancy, (e.g. schools or offices), should be avoided;
- If EMF levels are confirmed or expected to be the recommended exposure limits (Table-10), application of engineering techniques should be considered to reduce the EMF produced by power lines, substations, or transformers. Examples of these techniques include:
    - o Shielding with specific metal alloys
    - o Burying transmission lines
    - o Increasing height of transmission towers
    - o Modifications to size, spacing, and configuration of conductors

Table 2.1-10 Recommended exposure limits for general public exposure to electric and magnetic fields
(IFC Guideline: “Transmission and Distribution”, 2007)

Frequency	Electric Field (V/m)	Magnetic Field (μT)
50 Hz	5,000	100
60 HZ	4,150	83

Source: International Commission on Non-Ionizing Radiation Protection (1998): “Guidelines for limiting exposure to time-varying electric, magnetic, and electromagnetic fields (up to 300 GHz).

2.2 Protected areas and environmentally controlled areas

Classification of protected areas and environmentally-controlled areas in Bangladesh are shown in Table 2.2-1. These areas are declared as National Parks, Wildlife Sanctuaries, Game Reserves, Botanical Gardens and Eco-parks under the Wildlife (Preservation) Order, Reserved Forests and Protected Forests under the Forest Act and Ecologically Critical Areas (ECA) notified under the Environmental Conservation Act.

Table 2.2-1 Classification of protected areas and environmentally controlled areas

Classification		Competent Authority	Governing law
A	National Parks	Department of Forest	Wildlife (Preservation) Order
B	Wildlife Sanctuaries		
C	Game Reserves		
D	Botanical Gardens, Eco-parks		
E	Reserved Forests, Protected Forests		Forest Act
F	Ecologically Critical Areas	Department of Environment	Environmental Conservation Act

(Source: Power System Master Plan 2010

There are fifteen national parks, thirteen wildlife sanctuaries, five botanical gardens and eco-parks in Bangladesh classified under the Wildlife (Preservation) Order, having a total area of 2,702.2 km^2. A list of the protected areas and environmentally-controlled areas declared under the Wildlife (Preservation) Order are shown in Table 2.2-2.

There are nine ECAs with a total area of 8,063.2 km^2 excluding the Gulshan–Banani-Baridhara Lake in Dhaka. Table-13 shows a list of ECA designated areas under the Bangladesh Environmental Conservation Act (BECA). BECA provides for ECA declarations by the Director General of the Department of Environment in cases where an ecosystem or biodiversity area is considered to be threatened to reach a critical state. Along with the ECA declaration, each ECA has notifications declared in which specific activities to be restricted in that ECA are specified.

Table 2.2-2 List of protected areas and environmentally controlled areas

Item	No	Name	Place	Size (km^2)
A	1	Bhawal National Park	Gazipur	50.2
	2	Modhupur National Park	Tangail/ Mymensingh	84.4
	3	Ramsagar National Park	Dinajpur	0.3
	4	Himchari National Park	Cox's Bazar	17.3
	5	Lawachara National Park	Moulavibazar	12.5
	6	Kaptai National Park	Chittagong Hill Tracts	54.6

Item	No	Name	Place	Size (km^2)
	7	Nijhum Dweep National Park	Noakhali	163.5
	8	Medha Kachhapia National Park	Cox's Bazar	4.0
	9	Satchari National Park	Habigonj	2.4
	10	Khadim Nagar National Park	Sylhet	6.8
	11	Baraiyadhala National Park	Chittagong	29.3
	12	Kuakata National Park	Patuakhali	16.1
	13	Nababgonj National Park	Dinajpur	5.2
	14	Shingra National Park	Dinajpur	3.1
	15	Kadigarh National Park	Mymensingh	3.4
B	1	Rema-Kalenga Wildlife Sanctuary	Hobigonj	18.0
	2	Char Kukri-Mukri Wildlife Sanctuary	Bhola	0.4
	3	Sundarban (East) Wildlife Sanctuary	Bagerhat	312.3
	4	Sundarban (West) Wildlife Sanctuary	Satkhira	715.0
	5	Sundarban (South) Wildlife Sanctuary	Khulna	369.7
	6	Pablakhali Wildlife Sanctuary	Chittagong Hill Tracts	420.9
	7	Chunati Wildlife Sanctuary	Chittagong	77.6
	8	Fashiakhali Wildlife Sanctuary	Cox's Bazar	32.2
	9	Dudh Pukuria-Dhopachari Wildlife Sanctuary	Chittagong	47.2
	10	Hazarikhil Wildlife Sanctuary	Chittagong	29.1
	11	Sangu Wildlife Sanctuary	Bandarban	57.6
	12	Teknaf Wildlife Sanctuary	Cox's Bazar	116.2
	13	Tengragiri Wildlife Sanctuary	Barguna	40.5
D	1	National Botanical Garden	Dhaka	0.8
	2	Baldha Garden	Dhaka	-
	3	Madhabkunda Eco-Park	Moulavibazar	2.7
	4	Sitakunda Botanical Garden and Eco-park	Chittagong	8.1
	5	Dulahazara Safari Parks	Cox's Bazar	6.0

(Source: http://www.bforest.gov.bd/conservation.php, accessed January 2011)

Table 2.2-3 List of Environmental Critical Areas

Item	No	Name	Place	Size (km^2)
F	1	The Sundarbans	Bagerhat, Khulna, Satkhira	7,620.3
	2	Cox's Bazar (Teknaf, Sea beach)	Cox's Bazar	104.7
	3	St. Martin Island	Cox's Bazar	5.9
	4	Sonadia Island	Cox's Bazar	49.2
	5	Hakaluki Haor	Moulavi Bazar	183.8
	6	Tanguar Haor	Sumamganj	97.3
	7	Marjat Baor	Jhinaidha	2
	8	Gulshan-Banani-Baridhara Lake	Dhaka	-
	9	Rivers (Buriganga, Turag, Sitalakhya and Balu) around Dhaka city	Dhaka	-

(Source: Biodiversity National Assessment and Programme of Action 2020, DOE Bangladesh, 2010)

Chapter 3

Project Data Sheet

Chapter 3

Project Data Sheet

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3.1 Project Proponent: Basic Concept

The project includes first experience items for Bangladesh such as large size high efficiency coal-fired power plant, coal import and deep sea port development. In addition, it is the first step for future development.

Concerning the importance of the Project in Bangladesh, in this study, the following 5 items are configured as “Basic Concept”, and the study was conducted in order to achieve them.

- 1st Unit with State-of-art Technology
- Environmental Friendly
- Power System Stability
- Expansion Potential in the Future
- Social Community Development

According to the power development scenario, a specific coal power development plan was formulated. Regarding domestic coal, it is assumed that it will take time for domestic coal development progress. On the other hand, import coal could be considered soon. However, in considering coal imports, the problem is that it is almost shallow around the Bay of Bengal. To achieve efficient coal imports, the direct approach of large scale coal ships should be necessary. However, there is only a small area in the southeast of Bangladesh with a deep sea. Therefore, at an early stage, a power station with a deep sea port should be developed at the site in the south east area, after that the site will be developed into a “coal center”, and the coal transportation system from the coal center will be formulated. This system will make the stable coal supply.

In the PSMP2010 power development scenario, operations of the first imported coal fired power plant are slated to start in 2016. However, it is impossible to build a port that can dock large-scale vessels until 2016. Therefore, until the completion of a large-scale port and coal center by 2020, it is planned to have the coal transportation vessels anchor offshore and from there, small-size barges will shuttle coal to the power plants. However, the Matarbari Coal Fired Power Station is not scheduled to begin operations until 2023. Given this extended period of time, it is possible to develop a port that would be able to accommodate large-scale vessels. This would allow the vessels to dock directly and thus it would be unnecessary to have the vessels anchor offshore. That is why this project is the first step of coal-fired power development in Bangladesh. In the future, by developing an import coal power station in other areas (inland areas) and establishing a coal center, the power station can serve as a hub of coal supply.

In addition, the Deep Sea Port Project, whose implementation was planned to take place at Sonadia Island by the Ministry of Shipping in Bangladesh, is not progressing as this island has been designated as an Environmental Critical Area. To sum up, the port being developed by this project would be the first Deep Sea Port in Bangladesh. Once completed, this port has the possibility to contribute to not only coal imports but also the large-scale commercial development of the Matarbari area.

3.2 Comparison of Energy Option for Generation

From various points of views, coal has its advantages except as an environment load. It means that, as the future stable energy for Bangladesh, it would be the best solution to apply coal by considering countermeasures to reduce environmental load.

Table 0 Comparison of Fuel Option for Thermal Power Generation for Bangladesh

	Natural Gas ↖ LNG, Shale Gas↗	Oil	Coal
Price Stability	Fluctuate per the world situation. (dominantly synchronized with oil prices) No experience in importing Shale Gas	Fluctuate per the world situation.	Stable. Cheaper than LNG
Supply Flexibility	Production area is limited. Reserve 58.6 years Currently shale gas is in the USA	Production area is limited to the Middle East Reserve 46.2 years	Everywhere Reserve 118 years Solid biomass fuel can be accepted.
Easiness of Market Entry	Difficult to join	Possible to extend current imports	Easy to join
Facility Investment	Large port Storage (tank) vaporizer	Large port Storage (tank) (Refinery)	Large port Coal storage and transportation facility
Environment Load	Low (Low CO2 emissions No sulfur)	Middle (Middle CO2 emissions Little sulfur (depends on production area)	High (High CO2 emissions Sulfur (depends on production area)
CO_2 Emission Factor(*1)	56.1 t-CO_2/TJ (58% for Coal)	73.3 t-CO_2/TJ (76% for Coal)	96.1 t-CO_2/TJ (100)
Others	High demand in the residential/commercial sectors	High demand in the residential/commercial sectors	Only for the power sector

(*1): 2006 IPCC Guidelines for National Greenhouse Gas Inventories

3.3 Unit Capacity

It is important to determine the unit capacity during the development of the new power station. Generally, equipment with bigger unit size has the advantage of scale so that the construction costs can be decreased. However such equipment has a big impact to the whole of the power grid in case it stops due to trouble. Therefore, the optimum unit capacity should be determined via a comparison of the related items taking in account the stability of the power grid.

For a decision of the unit capacity of this project, the following 3 candidate types were compared.

Table 0 Case for Comparison

	Case 1	Case 2	Case 3
Unit Capacity	300MW	600MW	800MW
Steam conditions	16.6MPa	24.1MPa	24.1MPa
	566Ⅲ/566Ⅲ	566Ⅲ/566Ⅲ	566Ⅲ/566Ⅲ
Unit construction costs	1,690USD/kW	1,600USD/kW	1,500USD/kW
Efficiency (LHV)	42.0%	43.8%	43.8%
Auxiliary power ratio	7.0%	7.0%	7.0%
Forced outage rate	8%	8%	8%

* Forced outage rate = (Annual forced outage time) / (8760 hour – Annual planned outage time)

(Source: JICA Study Team)

For the above, one candidate would be selected by comparing the following five points. The “Economy” and the “Possibility of a system collapse” are given special consideration.

- Economy
- Possibility of a system collapse
- Reliability level
- Environment (CO_2)
- Operations and maintenance

Generally, for the comparison of a newly installed generation facility, the economy is the important point. However, in this case, as mentioned later, the unit capacity is the issue of having an impact for the stability of the whole power system, so the possibility of a system collapse is also an important point.. Therefore, these 2 points should be made compared weighing their respective areas of importance.

For each point, the comparison is conducted. In this comparison, the economy and possibility of a system collapse should be weighed. Regarding the economy, 600MW or 800MW should be chosen because of the size and difference of type, and regarding possibility of a system collapse, the risk of 800MW is higher than 600MW. Considering that the level of the economy is almost the same, in this comparison, 600MW should be chosen by weighing the risk of a system collapse.

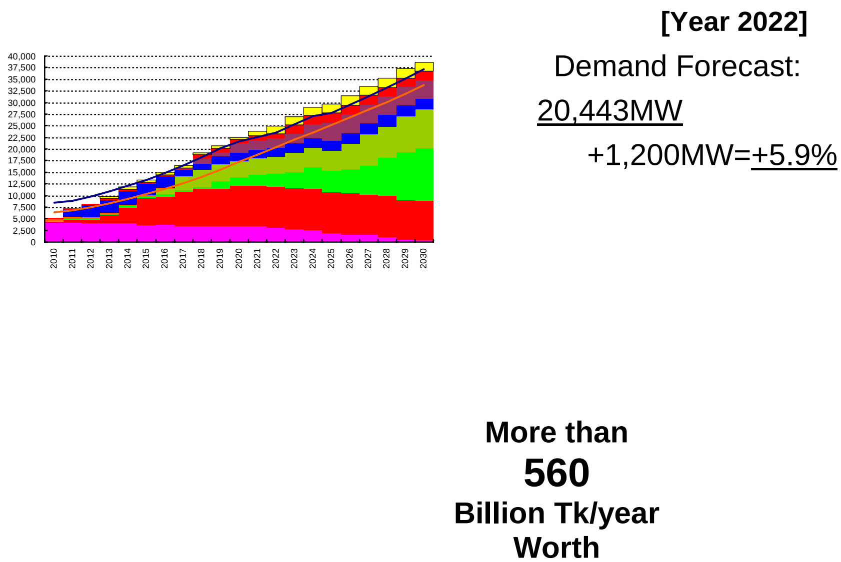
It is true that the larger the size, the more economical it is. Therefore, in the future, in case demand increases, the possibility of a system collapse could become lower. So in the future, the adoption of an 800MW unit or a 1,000MW unit could be considered.

3.4 Economic Effect brought by the Project

By implementing this project, not only will power supply be increased in Bangladesh, but other various associated effects can also be expected. Many type of economic effects could be estimated, the following shows some simple examples.

(1) Impact to GDP

The target of the elasticity of the power demand to the GDP is 1.4. Here "the elasticity" refers to the ratio between the electric energy consumption growth ratio (power demand growth ratio) and the economic growth ratio (GDP growth ratio). Suppose that the GDP growth is 5%, the GDP in 2022 when the project starts commercial operations would be Tk 13,468.9 billion. If the power demand at that time is 20,443MW, which is the same as the forecast, and if the increase of the 2 x 600MW = 1,200MW demand occurs via the newly started power plant (actually a part of the capacity is not an increase because some rental power plant would stop operations instead), the demand growth ratio is equal to about 1,200/ 20,443=5.9%. In case the elasticity is 1.4 at that time, it is equivalent to about 4.2% of GDP growth. It means that, the impact of the project to the GDP would be about Tk 13,468.9 billion * 4.2%=Tk 565.6 billion.



Source: JICA Study Team

Figure 3.4 Image of Impact to GNP

(2) Impact to the power sector's finances

Currently, in order to mitigate power shortage, the power sector relies on rental power facilities even though the unit costs are high. In that situation, by installing a large scale coal-fired power plant whose generation costs are low, rental power facilities could be decreased so that total generation costs would be reduced. It means that, from a BPDB side, because the unit price of procurement is low, the procurement costs become low. For example, as an objective for comparison, the HFO-fired rental power plant with the same size (1,200MW) is concerned. According to Chapter 11, the current cost (procurement costs of BPDB) of the HFO-fired rental power plant is Taka 15.61 /kWh, while the price of the Project is Taka 7.04 /kWh. It means there is a difference of Taka 8.57/kWh in the procurement costs. By using 80% of the plant factor (annual power amount is 1,200MW * 24hours * 365days * 80% = 8,409GWh↗ , as a result, it could be said that, the procurement costs of BPDB will decrease to more than Taka 70 billion /year.

3.5 Selection of Suitable Site

The study areas are Cox Bazaar district, Chittagong district, zone for transmission line, Chittagong city in Bangladesh and coal producing countries. A and B of the aerial photograph of Figure 3.5 are the main study areas.

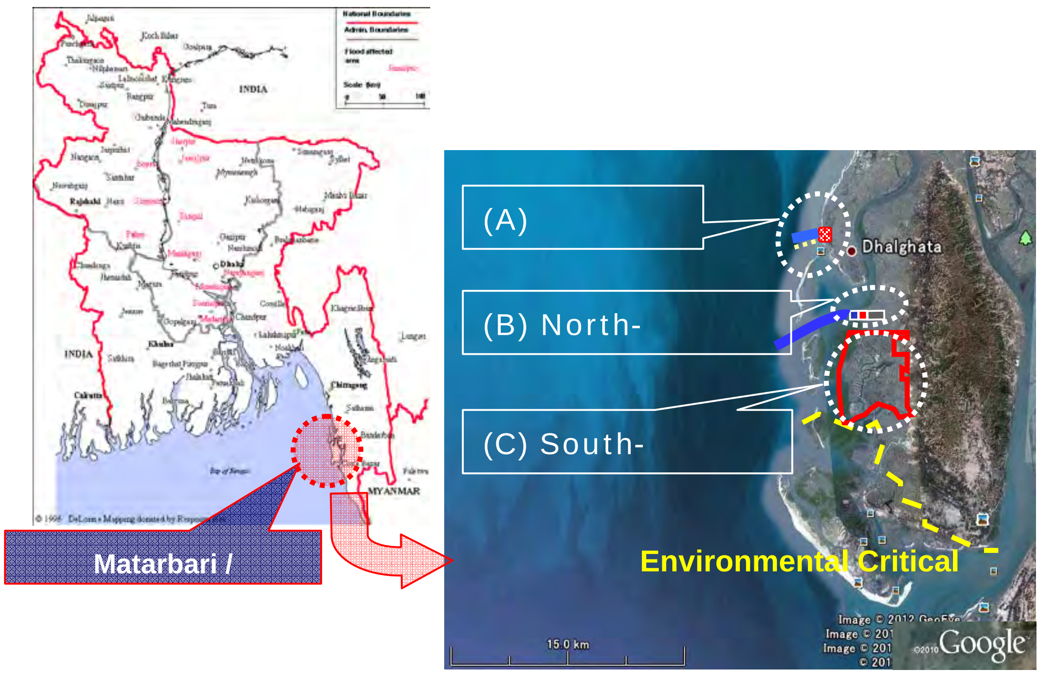


Figure 3.5 : The Study Areas

As the result of the Follow-up Survey, two candidate sites were selected and surveyed. As a first step of the Study, one candidate site should be selected for further detail study. The candidate sites which were selected on the Follow-up Survey were as follows.

According to the result of the Follow-up Survey, Matarbari has an advantage from the viewpoint of environmental issue. After the Follow-up Study, GOB and JICA signed the Minutes of Discussion which says that, Matarbari site would be considered on a priority basis over North-Maheskhali but in-depth examination and further consideration will be required. As the first step of the Study, the confirmation of the suitability of the candidate site is conducted by detail including site survey and numerical simulation etc.

3.6 Design Condition

3.6.1 Flow Chart of the Study

The flow of the Study is shown in Figure 3.6.1

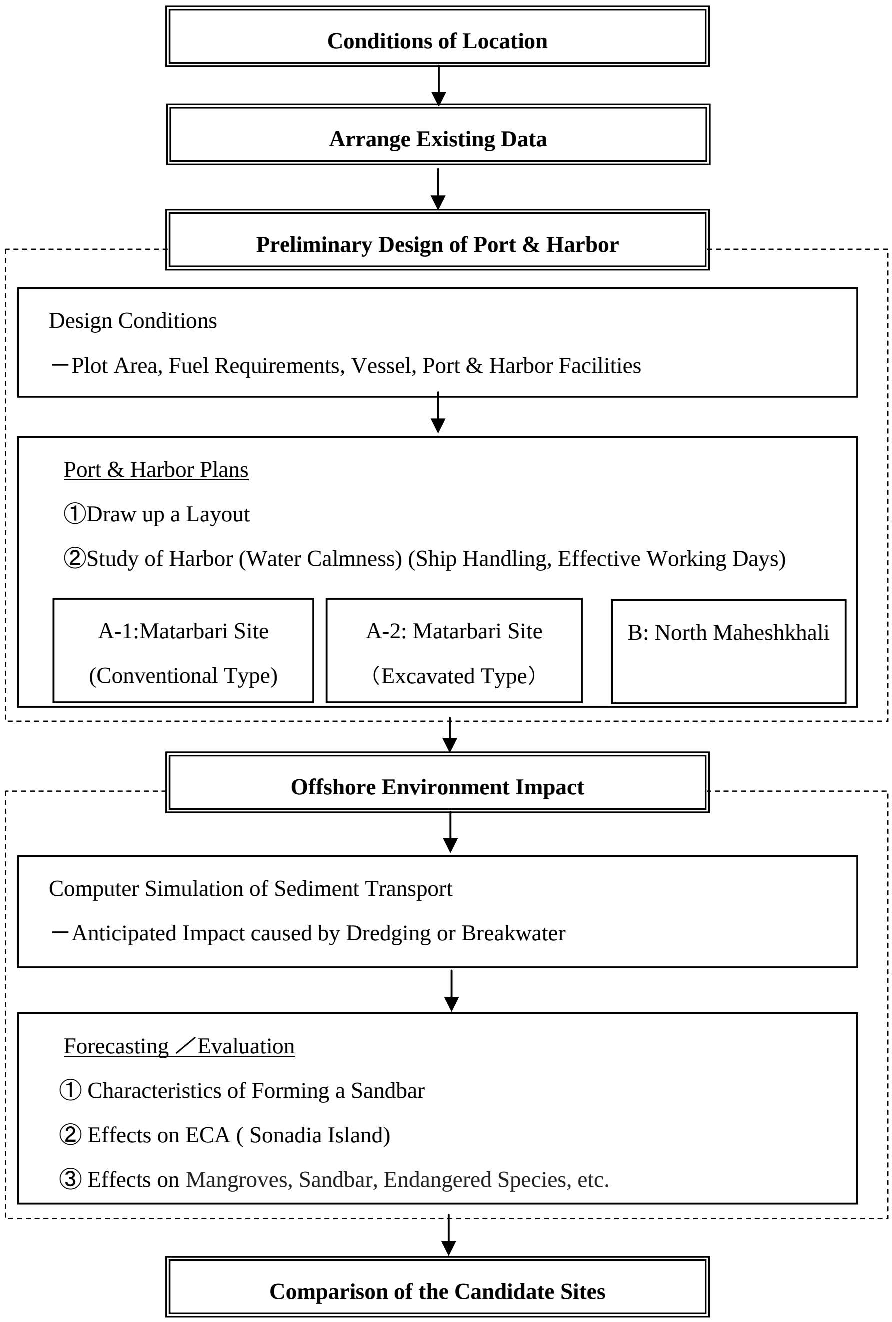


Figure 3.6.1 Flow Chart of the Study

3.6.2 Site Selection

(1) Proposed candidate site

On the basis of the results thus far, the JICA Study Team of port and harbor engineering has concluded that the Matarbari Site should have higher priority than the Maheshkhali Site. The comparative table is as shown below.

- ! The site conditions are based on field studies
- ! Maintenance dredging is based on the computer simulation of sediment transport results
- ! Operability is based on the calmness analysis results
- !

The expansion of port and harbor is based on the land–use planning with the related surrounding circumstances.

Table 3.6.2.1 Site Selection Result (from the viewpoint of port and harbor engineering)

Items	Matarbari Site	Maheshkhali Site
Site Conditions	It is possible to plan a power plant at this site.	It is possible to plan a power plant at this site.
Maintenance Dredging	Need maintenance dredging, but less than the Maheshkhali Site (approx. 600m in length).	Need continuous maintenance dredging throughout the channel (7 km in length).
Operability of Coal Vessels	Channel and mooring basin are calm because of the breakwater or the artificially excavated land, so there is no impact on cargo handling. (reduce wave length height about from 30% to 80% at port entrance)	Ship handling demands extreme care through the restricted channel on account of several dipper dredgers working on the channel (7 km in length).
Expansion of Port & Harbor	Can expand port and harbor, with little effect on coastal change.	To expand port and harbor increases risk of negatively impacting mangroves.
Results	**Candidate site for a Power Plant**	Unsuitable

Natural Environment Conditions

(1) Background

To get up-to-date information about the natural environment surrounding each project site, the JICA Study Team has conducted interviews with environmental specialists who have been working as nature commentators on site (Sonadia Island) and held a meeting with some environmental specialists at Cox's Bazar Field Office of the Bangladesh Government Department of Environment (DoE).

Environmental specialists have emphasized the importance of the protection of mangrove vegetation, sand dunes, beaches, sandy shoals, and mudflats in and around Sonadia Island (including Maheshkhali areas), as saying that they provide an excellent wintering ground for migratory waterfowl and shorebirds, and a nursing and feeding ground for fish and shrimp species, especially the sand dunes provide nesting grounds for marine turtles.

(2) Number of preliminary alternative sites to have been assessed of their relative merits

The JICA Study Team has adopted three preliminary alternative sites, in which two sites have been considered as candidate project sites by the "Study for the Master Plan (2010)," and the additional site has been added at the stage of this Preparatory Survey (2012) from the perspective of avoiding risks to the mudflats and its ecosystem.

(3) Results of evaluations on Matarbari and Maheshkhali

a) Result of 1st field survey conducted by the JICA Study Team

Table 3.6.2.2 shows a comparison of the Matarbari and Maheshkhali sites from the viewpoint of the natural environment based on the 1st field survey conducted by the JICA Study Team. Both the Matarbari and Maheshkhali sites have poor vegetation and a limited number of animals were observed on land, thus there is no difference between the two sites as a better project site. However, the Maheshkhali site has a huge mangrove forest and sandbar at the sea side of the site; therefore, it is predicted that the mangrove forest and sandbar may be affected during the construction and operation phase of the power plant, if the Maheshkhali site is selected as the project site.

Table 3.6.2.2 Comparison of Matarbari & Maheshkhali from Natural Environment Conditions

Items	Matarbari	Maheskhali
Vegetation	- Site: Poor - Forest: There are few trees place on the nearest residence area - Mangrove: No Mangrove	- Site: Poor - Forest: There are few trees place on the nearest residence area - Mangrove: There are huge mangrove forests offshore.
Animal	- Site: Sedentary birds observed -Surrounding area: Sedentary birds observed	- Site: Sedentary birds observed - Surrounding area: Sedentary birds are observed over the mangrove forests
Endanger species	- Site: Not observed - Surrounding area: Not observed	- Site: Not observed - Surrounding area: Not observed
Habitat condition surrounding the site	- Corral reef: Not observed - Seaweed bed: Not observed - Sandy beach: Observed Mudflat: Observed - Sandbar: Not observed	- Corral reef: Not observed - Seaweed bed: Not observed - Sandy beach: Not observed - Mudflat: Observed Sand bar: There is a sandbar in estuarine region around 4km away from the site

a) Simulation of Waves and Currents

To evaluate the effects of some main activities planned in each project site on the surrounding natural environment of alternative project sites, the following types of simulations have been conducted.

i. Simulation of wave-height and its effects on geological conditions offshore

ii. Simulation of tidal currents and its effects on geological conditions offshore

iii. Simulation of dredging and its effects on geological conditions offshore

Table3.6.2.3 shows the main results of simulation on environmental issues (project sites) caused by dredging activity.

Table 3.6.2.3 Main results of simulation on environmental issues (project sites)

Project sites / Items	Matarbari	Maheshkhali
Wave-height	A little (almost negligible) ✓ A little change on the mud-sediment around the dredging site	Notable ✓ Mud-erosion around dredging site covered with mangroves
Tidal current	None	Notable ✓ Mud-sediment around dredging site covered with mangroves Mud-erosion around dredging site covered with mangroves
Dredging	A little ✓ Periodical dredging is needed but less frequently than Alternative III	Notable ✓ Periodical dredging covering a wide area is needed

a) Comparison of the Matarbari and Maheshkhali sites

Both the Matarbari and Maheshkhali sites have been compared to each other by rating in the degree of environmental impact. The rating using a quantifiable method for the natural environment is not established as an academic discipline yet, therefore, numbers (from 0 to -3) are used to evaluate the natural environment of alternative sites, just as a qualitative tendency.

0: *No impact*

-1: *A small impact but not serious*

-2: *Serious impact but not irreversible*

-3: *Irreversible impact*

From a comparison of the two project sites, the negative points of each alternative site is as below (Table 3.6.2.4).

Matarbari: -2

Maheshkhali: -10

The Maheshkhali site receives a larger negative point and there are impacts on the surrounding mangrove forest, which is an ecologically sensitive area. From the viewpoint of environmental consideration, the Maheshkhali site is not recommended.

Table 3.6.2.4 Comparison of project alternative sites

Impact		**Matarbari**		**Maheshkhali**	
Impact on mudflats		(By wave, a little -1)	-1	(By wave, serious -2) (By current, serious -2)	-4
Impact on sea bottom		(By dredging, serious-2)	-2	(By dredging, serious-2)	-2
Impact on sand beach		(By drifting, serious-2)	-2	(By drifting, a little-1)	-1
Impact to flora and fauna	Impact on migratory birds	None	0	None	0
	Impact on sea turtles	None	0	(By dredging near turtle habitat, a little -1)	-1
	Impact on dolphins	None	0	None	0 [1]
	Impact no young fish	None	0	None	0
	Impact on mangroves	None	0	(By wave, serious -2) (By current, serious -2)	-4 [2]
	Impact on benthos[3]	(By dredging, a little -1)	-1	(By dredging, a little-1)	-1
Distance to Sonadia ECA		None	0	None	0
Evaluation			**-6**		**-13**

Note) 0[1] : There is some apprehension regarding impact on dolphins by dredging with 7Km front to offshore, but no information or data available

-4[2] : There is no direct impact of cutting down mangrove vegetation, but deterioration of habitat by losing mudflats near its root would cause many harsh consequences, such as mangroves falling down

Benthos[3] : Including sea grass and

Social Environment

(2) Overview of each site

The overview of each site is summarized in the tables below. Unlike the evaluation for the natural environment conditions, Alternatives I and II have been examined together as the design difference in this case will not likely have a large impact on the social environment. The Matarbari site includes at least Sairer Dail village and the Maheshkhali site includes Kalaghagir Para village. As it is not easy at this moment to identify all villages where alternative sites are located, a complete comparison of the two sites stays at the same level (Table 3.6.2.5).

Table 3.6.2.5 Specifications of Located Unions

Project sites / Items		Matarbari	Maheshkhali
Located Union		Matarbari Union* (Note) Part of Dhalghata Union may be included as the site is located at the union border.	Hoanak Union
1	Area	6,682 acres (approximately 2,704 ha)	9,165 acres (approximately 3,721 ha)
2	Population	8,168 households (44,937 people) living in 21 villages of the union.	9,373 households (51,587 people) living in 28 villages of the union.
3	Population density	1,661 people per square km	1,386 people per square km
4	Land use	Cultivated land: 600 ha Rice production: 2,328 metric ton	Cultivated land: 1,150 ha Rice production: 4,450 metric ton
5	Employment status	6,944 are employed out of 19,436 aged 7 and above not attending school	9,498 are employed out of 22,689 aged 7 and above not attending school
6	Field of activity	Agriculture: 75.6%, industry: 3.2%, service: 21.3%	Agriculture: 90.1%, industry: 1.7%, service: 8.1%
7	Source of drinking water	Tap: 0.2%, tube well: 95.0%, other: 4.8%	Tap: 0.2%, tube well: 91.3%, other: 8.5%
8	Literacy rate	27.7% (male: 26.1%, female: 29.4%)	29.9% (male: 28.8%, female: 31.1%)
9	Type of house structure	Permanent: 4.4% Semi-permanent: 4.8% Mud / bamboo: 71.7% Temporary: 19.1%	Permanent: 1.4% Semi-permanent: 3.4% Mud / bamboo: 93.8% Temporary: 1.3%
10	Toilet facility	Sanitary (water-sealed): 2.2% Sanitary (non water-sealed): 36.6% Non-sanitary: 49.6% None: 11.6%	Sanitary (water-sealed): 1.4%% Sanitary (non water-sealed): 21.7% Non-sanitary: 69.6% None: 7.3%

Source: Population Census 2011, data provided at the Agricultural Division of Maheshkhali Upazila Nirbahi Office.

Conclusion

Table 3.6.2.6 provides the total assessment results of the study. The Matarbari site is considered to be more advantageous than the Maheshkhali site. Therefore, the JICA Survey Team suggests the Matarbari site to the CPGCBL as the project site.

Table 3.6.2.6 Results of the Site Selection

Impact	Matarbari Site		Maheshkhali Site
Technical and economic aspects (port engineering)	- A channel will be necessary for continuous maintenance dredging but to a lesser extent than the Maheshkhali site. - The Matarbari site has greater potential for expansion.	↬	- A channel will be necessary with continuous maintenance dredging throughout the channel, 7 km in length. The maintenance dredging work will be a financial burden. - There is no real opportunity for expansion of the port and harbor because of increased risks of negatively impacting the mangrove forest.
Natural environment	- There is no mangrove forest near the Matarbari site, and the site will not be affected during the construction and operation phase of the power plant, since the amount of dredging soil will be less than the Maheshkhali site.	↬	- The Maheshkhali site has a huge mangrove forest and sandbar at the seaside of the site, therefore, it is predicted that the mangrove forest and sandbar may be affected during the construction and operation phase of the power plant.
Social environment	- Local residents of the small disaster-stricken area will be forced to vacate. - Local residents will lose their private lots, standing crops, shrimps and fish that are their principal source of income.	↪	-The Maheshkhali site has no local residents to vacate. - Local people will lose their private lots, standing crops, shrimps and fish that are their principal source of income as is the case of the Matarbari site. - This case will not likely have a large impact on the social environment.

In conclusion, Matarbari site is more superior as a project site from the viewpoint of technical, economical and natural environmental aspects, but not superior from the social environmental point of view. The impacts to the affected people will be mitigated through appropriately preparing and implementing Land Acquisition and Resettlement Action Plan (LARAP). Therefore, the over-all evaluation concludes Matarbari site to be more superior as a project site.

3.7 Project Overview

Basically, the project consists of a coal-fired thermal power plant with two units of 600 MW each and a circulating cooling water system, including proper intake and discharge tunnels, and a 275m high stack. The Power Plant will be designed in such a way so that the construction of future additional units is possible. A typical diagram of a coal based thermal power plant is shown in Figure 3.7.1.

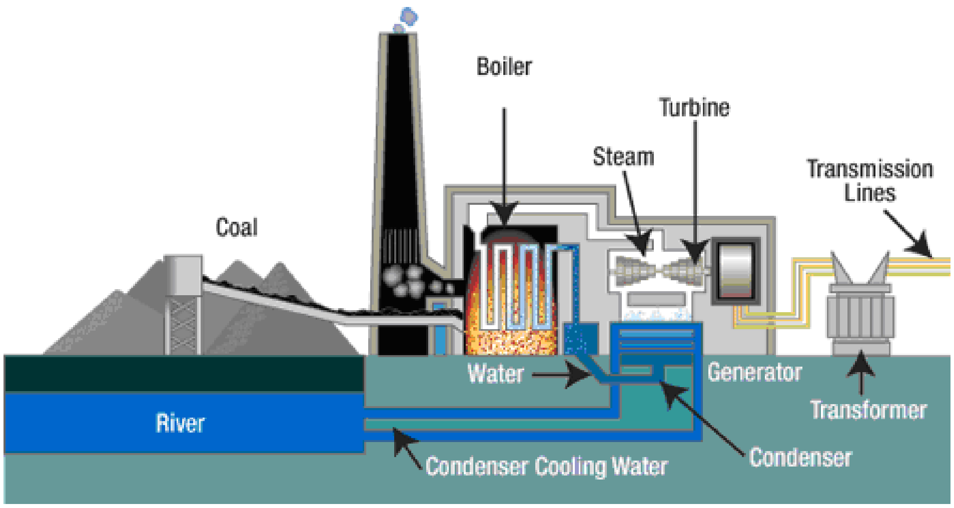


Figure 3.7.1: Typical diagram of a coal fired thermal power plant

The main project facilities are comprised of a power house and auxiliary facilities that include a switch yard, desalinization plant (Seas Water Reverse Osmosis), demineralization plant, circulating cooling water system, coal handling system (unloaders, stackers, reclaimers, conveyor belt and stockpiles), ash handling and disposal system, and a waste water treatment plant. Other project facilities that will be constructed by BPDB include an embankment along the sea shore. In addition, Flue Gas Desulphurization (FGD) and Electrostatic Precipitator (ESP) will be installed for flue gas treatment.

The proposed 2 x 600 MW (gross power output) ultra-supercritical (USC) bituminous pulverized coal plant will be constructed at a greenfield site. The turbine shaft configuration is a tandem compound design. The step up voltage level has been assumed as 400 KV as the capacity of the project will be 2 x 600 MW. The 400 KV double circuit line from Matarbari to Anowara will be built by Power Grid Company of Bangladesh LTD (PGCB), Bangladesh. The primary fuel of the plant will be bituminous coal with a Gross Calorific Value (GCV) of 4700 Kcal/kg. The capacity factor (CF) for the plant is 80% without sparing of major train components. A summary of plant performance data for the USC plant is presented in Table 3.7.1 below.

Table 3.7.1: Basic plant information of the proposed coal based thermal power plant (estimated)

Component	Design Condition
Plant type	USC
Gross power output	1,200 MW (2 x 600 MW)
Primary fuel (type)	Sub-bituminous Coal having GCV of 4200-5200 kcal/kg and low Sulfur content (1.0 wt.% or less)
Coal flow (at 100% ECR)	12,800 ton/day
Annual coal requirement	3.73 mil. ton/year (considering 80% load factor)
Ash production	20%
Temperature of flue gas at stack	$75^{O}C$
Flue Gas Flow	2 x 4.47 x 10^6 Nm^3/hr
Flue Gas Treatment System	Low NOx burner and over fire air, seawater FGD and electrostatic precipitator will be facilitated to reduce emissions and pollutions and to meet WHO standard for ambient on qualities
Maximum emission of SOx	Less than 820 mg/Nm^3
Maximum emission of NOx	Less than 460 mg/Nm^3
Particulate matter	50 mg/Nm^3 (from each unit)
Stack height	275 m
Water Intake	Necessity of water volume: 25(m^3 /sec/unit) × 2 units = 50(m^3/sec)
Water discharge after treatment	Into sea

3.8 Project Design and Construction

3.8.1 Design

The project is being designed in accordance with the international standards for USC steam power plants. The design of support facilities and associated works is in accordance with appropriate national and international standards. The plant design will cope with local seismic conditions.

The design life of the plant will be at least 25 years. Civil works structures and foundations will be designed for a life exceeding 45 years.

3.8.2 Construction

The port and harbor facilities for the arrival of coal vessels shall be excavated through the land. Dredging channel work, excavation work and berth work shall be the main construction work of the port and harbor facilities. The dredging work shall be performed working toward the land from the ocean, and the dredged soil shall be sent by a discharge pipe and stored in a temporary depot.

The power plant site must be a raised height for the prevention of flood damage caused by cyclones. The dredged sand shall be used as part of site renovation.

The site requires filling and grading to establish the final landform. Site soil will consist of sandy to sandy loam topsoil and subsoil, which will require that excavation be undertaken with bulldozers and excavators. Site leveling will use all excess soil produced from excavation with additional soil (if necessary) brought onto the site from outside sources.

Civil works will involve the construction of the main power plant and auxiliary facilities and buildings, and the water supply pipeline from the nearest source. Mechanical and electrical works will include both on-site and off-site fabrication, assembly, installation, and erection of power plant equipment, pollution control equipment including FGD units and the chimney structure, demineralization plant, control system, power system, and various utility systems.

Construction will require between approximately 4,000 and 8,000 skilled and unskilled workers. Construction workers will be engaged by contractors responsible for different construction packages. Construction water will be sourced through authorized vendors and from ground water sources prior to the operation of the plant water supply pipeline.

3.9 Project layout

A detailed layout plan of the proposed project shall be developed by the feasibility study team considering the tentative capacity of the proposed power plants with related auxiliary facilities. However, a land allocation plan for a coal based power plant and port and harbor of different capacity is given below.

Table 3.9.1: Important features of the Matarbari coal-fired Power Plant

Sl No.	Component	Land Requirement (tentative)
01.	Coal based power plant 2 × 600 MW = 1,200 MW	40 hectares
02.	Ash pond	183 hectares
03.	Coal stock yard	33 hectares
04.	Port and harbor	77 hectares
05.	400 KV switch yard	122 hectares
06.	Others(Township, Embankment, Intake etc.	122 hectares
Total potential capacity: 1,200 MW		Total land: 455 hectares (848 acres)

In the plant layout, adequate space shall be kept for lay-down and pre-assembling activities of open stores, contractor’s offices and stores, etc. Construction offices and storage sheds area shall be located close to the main approach road to the plant. The administrative building is proposed to be located outside the plant boundary near the main approach road. The total land requirement area (455 hectares) is shown in the above table, which does not include the access road, township, greenbelt and other use areas. The following major components shall be included in the layout plan, but it is not an all-inclusive list:

A: Industrial (plant area)

1. Main power plant (boiler, turbine, generator, workshop store, etc.)
2. Electrostatic precipitator, FGD as required, and chimney
3. Greenbelt and open space
4. Open air sub-station and network control room
5. Water treatment, sewerage treatment plant and sewerage channel
6. Coal terminal including jetty and coal conveyer belt
7. Ash handling control room, ash silo, ash disposal area
8. Coal stock yard (open and covered)
9. Port and harbor facilities

B: Township

10. Residential buildings, school, mosque, playground, community hall, rest house, dormitory, health center, club, etc.
11. New alternative road construction instead of the existing community road, administrative building, auditorium and parking area including cafeteria, and social building

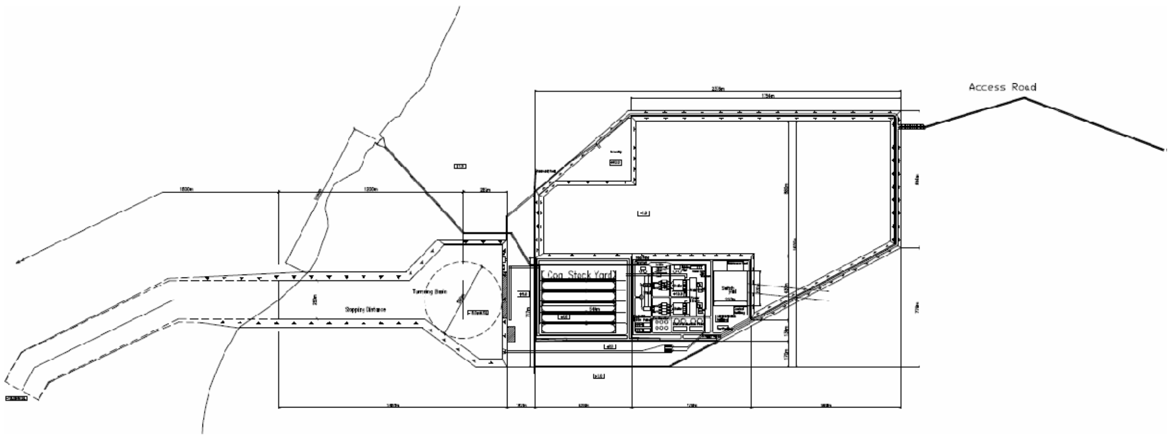


Figure 3.9.1 Plant layout plan

Administrative approval in connection with the acquisition of the required land will be obtained in the future. A land acquisition proposal (after necessary revision as per suggestions of the DC office) will also be submitted to the office of the DC, Cox's Bazar.

3.10 Project Activities

Pre-construction phase

a) Selection of candidate sites
b) Environmental and feasibility study
c) Selection of site
d) Land acquisition and site establishment

Construction phase

a) Dredging work and berth work
b) Civil construction and technological installation work
c) Post erection check and pre commissioning test
d) Monitoring of mitigation measures for environmental impact of the plant

e) Commissioning test
f) Reliability test run
g) Commercial operation of the plant
h) Overall project management
i) Alternative road
j)

The existing road along the shoreline will be cut off by the construction of the power plant. A new alternative road, instead of the existing road, shall be constructed and the route/ location of the alternative new road is planned between the east side of the harbor and the west side of the coal stock yard. Also, during the construction period, a temporary alternative road, instead of the existing road, will be used.

Operation phase

a) Commercial operation of the plant
b) Monitoring of EMP
c) Proper O&M for efficient running of the plant

3.11 Fuel Requirement

The main fuel to be used for generating electricity will be coal. Based on the estimations of the Feasibility Study, the daily coal requirement for generation of 1,200 MW power by operating 2 x 600 MW power plants shall be 3.7 million ton per year considering 80% plant load factor at ECR. In addition, light diesel fuel oil will also be used for boiler start up, flame stabilization and low-load operation. Annual light diesel fuel oil consumption is estimated to be 40,000 m^3.

3.12 Water Requirement and Source

Water will be required for steam generation, condenser cooling, coal management and domestic purposes. It is estimated that 180,000 m^3/hr water will be required for meeting total demand and approximately 2500 m^3/day water will be required for steam generation. This water will be collected from the nearby sea. The project will adopt the Reverse Osmosis Process for desalinization of saline water to meet the sweet water requirement.

After use (consumptive and non-consumptive) of intake water, 350 m^3/day will be discharged after treatment through effluent treatment and monitoring sump.

3.13 Resources and Utility Demand

The proposed project shall provide employment opportunities for unskilled, semi-skilled and skilled categories of employment. Employment potential shall increase with the start of construction activities. During the operation phase there will also be employment opportunities, mainly in the service sector.

3.14 Process Description of Individual Project Components

3.14.1Power Generation

The power plant consists of 2 x 600 MW units. Each unit will have steam-based, pulverized coal-fired boiler units of USC type, steam turbines and generators. Each boiler unit will comprise a boiler proper, regenerating type air heater, and 2 forced draft (FD) fans and 2 induced draft (ID) fans. In addition to coal, light diesel fuel oil will be used for start-up as well as flame stabilization during low-load operation.

3.14.2 Boiler and Auxiliaries

The boilers shall both be pulverized coal firing, radiant, reheat, and variable pressure operation once through boilers for outdoor installation. The boilers shall be designed for low NOx emission by employing low NOx burners and over fire air (two stage firing) systems.

The main parameters of the boilers will be as follows:

Table 3.14.2 Boiler parameters

Parameter	Measures
Type	Radiant reheat, variable pressure operation, once-through boiler (outdoor installation)
Quantity	2 units
Main steam flow	1.760 t/h
Reheat steam flow	1.490 t/h
Main steam pressure	25.4 MPa(g) at superheater outlet
Main steam temperature	604ºC at superheater outlet
Reheat steam temperature	602ºC at reheater outlet
Firing system	Pulverized coal firing with low NOx burners and two stage firing and light oil (30% capacity) for unit start up and low load operation
Draft system	Balanced draft

3.14.3 Firing System

The coal firing system will comprise of coal mills of vertical spindle type which include bowl mills, roller mills, balls and race mills or any approved equivalents. The number and capacities of the mills shall be selected so that they can fire the worst and design coals at boiler maximum continuous rating (BMCR) without using the one standby mill.

Start-up, warm up and low load carrying shall be done by light oil. Boilers will be so designed that oil firing for flame stabilization will not be required beyond any loads higher than 30% maximum continuous rating.

3.14.4 Soot Blowing System

A fully automatic, sequentially controlled, microprocessor based steam soot blowing system, complete with provision for individual operation of any soot blower pair, operation and facility to bypass any soot blower, will be provided.

3.15.5 Electrostatic Precipitator

Each boiler will be equipped with an ESP with parallel gas paths. The ESP will have a dust collection efficiency of not less than 99.8% while firing coal with the highest ash content of 15% to meet particulate emission to IFC standard value (i.e., 50 mg/Nm^3).

3.14.6 Flue Gas Desulphurization System

Provision of the FGD system will be installed in the plant, based on the sulfur content in the coal, to meet the ground level SO_2 concentration standards of Ministry of Environment & Forest.

3.14.7 Turbine and its Auxiliaries

The scope of each turbine unit of the 2 x 600 MW power plants shall broadly cover the Steam Turbines along with its integral systems and auxiliaries, like lube oil system, control-fluid system, condensers, condenser air evacuation system, HP & LP Bypass system, complete regenerative feed heating system, condensate pumps and drives, boiler feed water pumps and drives, automatic control system, instruments, turbine protection and interlock system, automatic turbine testing system and turbine hall overhead crane.

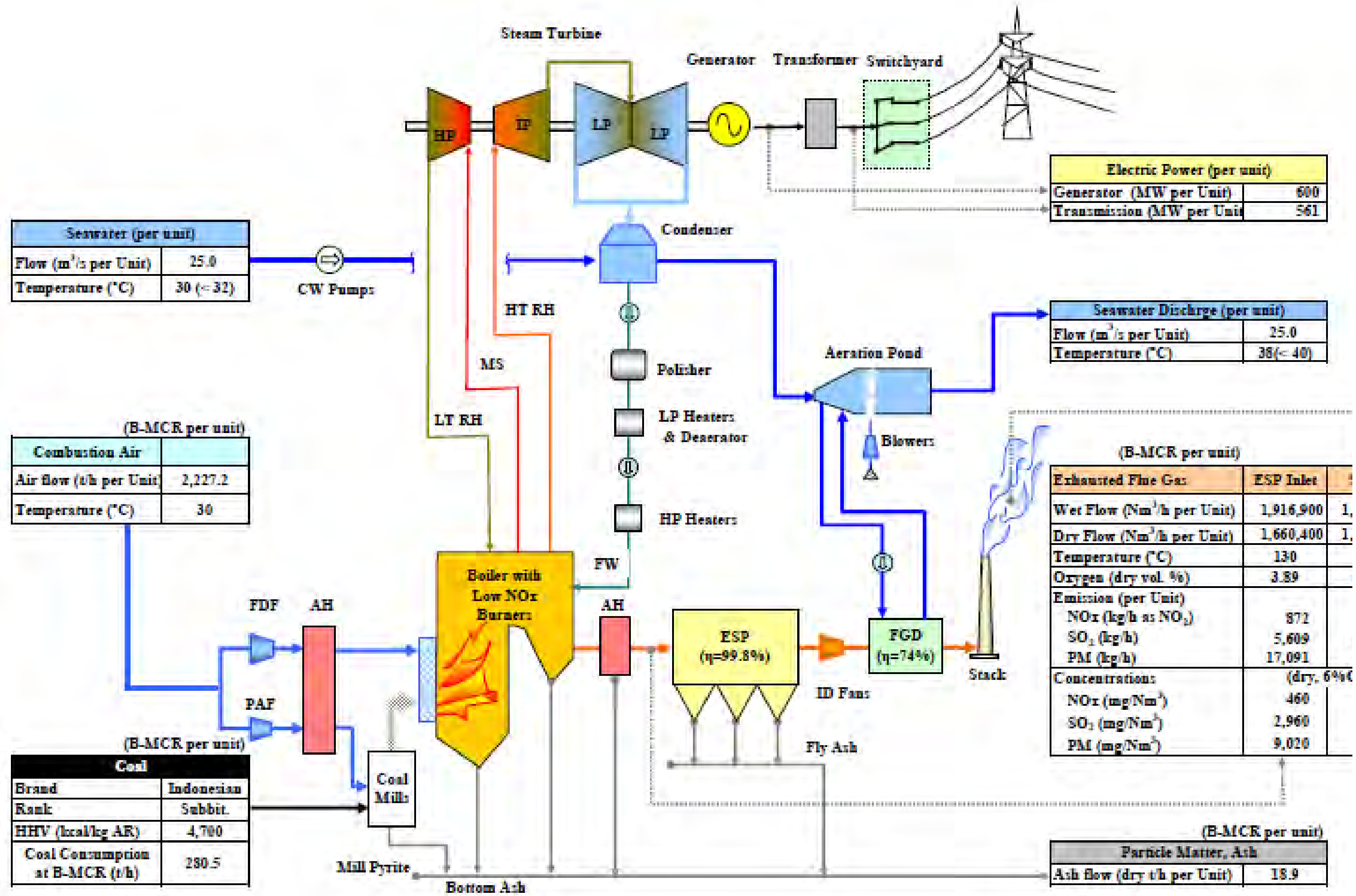


Figure 2.8-1: Process flow diagram

3.14.8 Condenser

The purpose of a surface condenser is to condense the exhaust steam from a steam turbine into cycle water (steam condensate) so that it is reused in the boiler as boiler feed water. A single pass-one division of tube and shell circuit schematics is preferable, even for condenser types for large-sized turbines, being based on the Heat Exchange Institute (HEI) standard.

Based on the data of a similar power plant with the same capacity and same steam conditions, and adding an appropriate amount of bearing cooling water, etc., the total required amount of cooling water was estimated at 50 m^3/s for two units. Chlorination system will be adopted to avoid adhesion of organism.

3.14.9 Coal Source and Transportation System

BPDB has conducted a detailed study on coal sourcing, transportation and handling to attain a sustainable solution taking into consideration the environmental safety of the project surrounding environment.

(1) Coal specification and requirements

Considering the safety of the surrounding ecosystem, public health and safety, the specifications of the coal have been selected. The specifications define the sulphur content lower than 1.0%, total moisture content maximum 25%, and a target of higher heating values (HHV) 4,700 kcal/kg with the allowable range of 4,200 - 5,200 kcal/kg. Since the power plant shall be equipped with coal-mixing facilities between the coal storage yard and the coal bunkers, some deviation of coal quality from these specifications may be acceptable for each imported coal.

Table 3.14.2 Tentative Quality of the Coal Available in Selected Source Country

Items	Min - Max
Total moisture (As received %)	18.3 - 38.0
Inherent moisture (Air dry %)	10.2 - 25.0
Ash (Air dry %)	3.0 - 15.1
Sulfur (Air dry %)	0.1 - 1.0
Gross Caloric Value (As received kcal/kg)	4,200 – 5,200

Coal requirement depends on the calorific value of used coal, the operating loads and numbers of units, and the generation heat rate of units. The annual coal requirement of 2 x 600 MW units shall be about 3.7 million tons based on HHV of 4,700 kcal/kg, plant capacity factor of 80%, and gross generation efficiency of 41.29% (unit heat rate of 2,082.5 kcal/kWh).

Coal requirements have been estimated using the formula:

Annual Coal Requirement: {(2 x 600,000 kW) x 24 hours/day x 365 days/year x 859.85kcal/kWh x 80%} / (41.29% x 4,700 kcal/kg) = 3.726 million tonnes

Where, 859.85 kcal/kWh is the conversion factor of energy from kWh to kcal.

(2) Coal sources

Considering suggested coal specification, availability, cost of coal, cost of transportation and reliability to supply coal, it has been judiciously planned to import coal from Indonesia, Australia and South Africa under long term/short term agreements with coal producers and suppliers. In such case, good quality Sub-bituminous coal can be imported from Indonesia and Bituminous coal can be imported from South Africa and Australia. In this case of multiple sources, GCV of average 4,700 (GCV 4,200 - 5,200 as received basis) kcal/kg to be achieved through blending of different coals of different grades has been considered for planning purposes.

BPDB will engage third parties to supply coal and transport coal to the project site under Coal Supply Agreement and Coal Transportation Agreements with outsourced agencies.

(3) Coal transportation

The required amount of coal, maritime routes, transport options, chartering terms and conditions, voyage times, freight costs and navigational aids are the key parameters for deciding the mode of maritime coal transportation. After studying all the parameters in the Feasibility study phase, the mode of transport of coal shall be selected. The mode of transportation of coal from the sea port of the potential coal sourcing countries to Bangladesh (Maheshkhali project site) will all be the same.

3.14.10 Coal Handling and Storage

(1) External coal handling system

The proposed sea port may be used for unloading coal from mother vessels throughout the year as there will be no draught problems. The coal received from the vessels shall be unloaded through rail mounted continuous bucket type unloaders and shall be conveyed to the plant end by parallel double stream high capacity through conveyors via a series of transfer points.

(2) Internal coal handling system

The coal as received from the port end through parallel conveyors shall drop onto two dedicated sets of screening feeders and crushers. An independent coal handling plant is proposed to cater to each of the two units of the 600 MW power plants. The coal handling plant will have an optimum capacity coal conveying system (with 100% standby parallel stream) along with stackers/ reclaimers, etc., moving to the boiler.

The coal shall be conveyed to the stock yard through parallel stream conveyors and shall be stocked in the stock yard by the stackers.

Further reclaimers are proposed to convey the coal to boiler bunkers by means of one set of parallel double stream belt conveyors (one working and one stand by). An interconnection is also to be used to convey coal directly to the boiler bunker, and Figure 2.8-2 shows an indicative flow diagram of the coal handling system. The overall operation hours of the coal handling plant shall be 18 hours spread over three shifts per day. The proposed coal handling plant shall cater to the peak daily requirement of coal for the plant in five bunker filling cycles in 12 hours effective operation. All chutes will be lined to ensure smooth flow and discharge of coal, and the longer operating life of the chutes. All junction towers and the crusher house will have floor cleaning chutes. Motorized travelling trippers shall be provided to feed crushed coal into the raw coal bunkers of the boilers.

Coal stock for 60 days is envisaged. In practice this amount might be changed. Stock requirements will be decided based on forecasts of maximum numbers of days for which port operation is possible in a year and the continuous periods when the operation is likely to be affected due to unfavorable weather. In the layout plan, there is space provision for two months storage of coal.

A centralized main coal handling plant control room shall be provided to control and monitor the operations of the entire coal handling system.

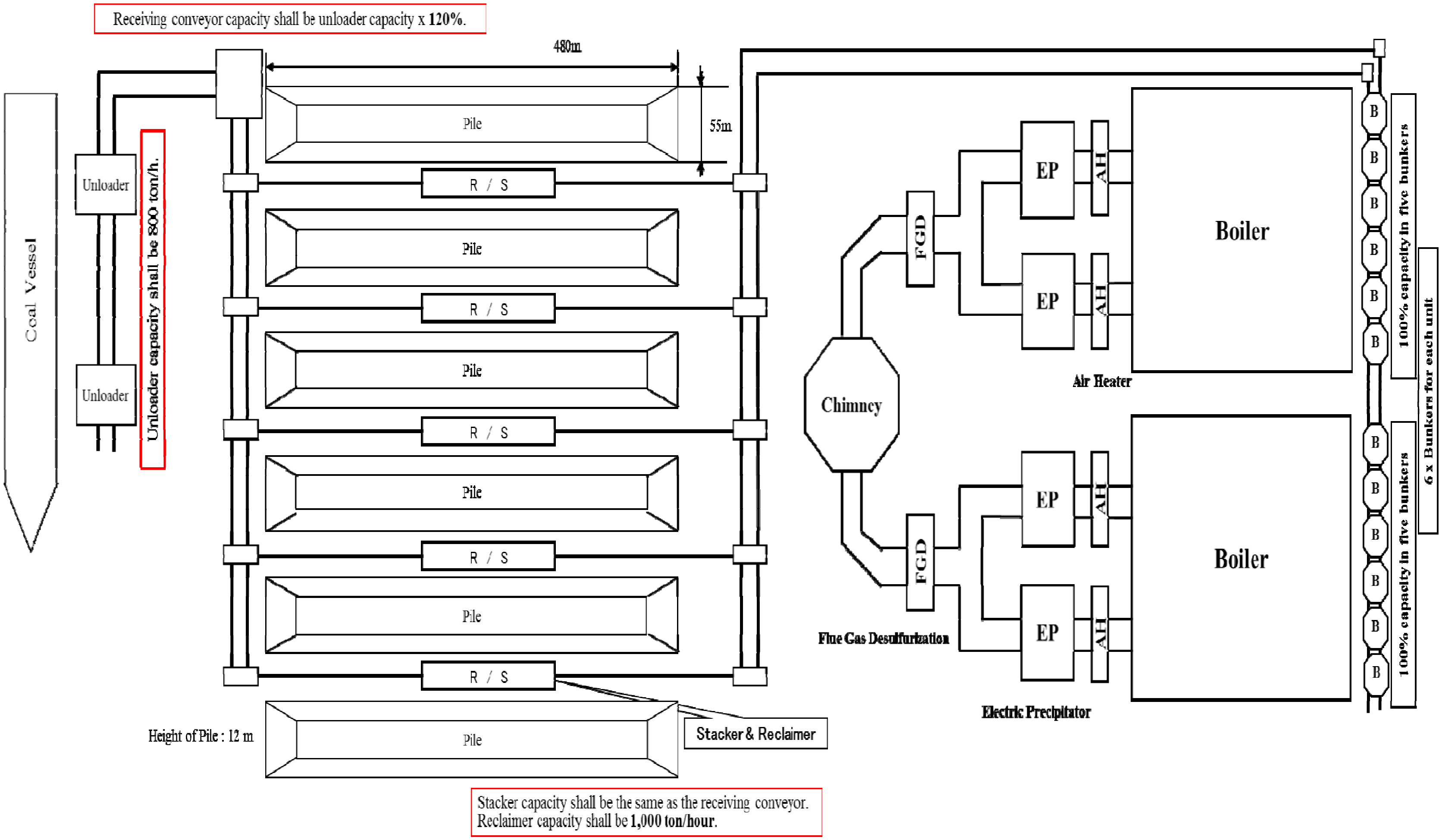


Figure 3.14.2 Indicative flow diagram of internal coal handling system

3.14.11 Fuel Oil Transport, Unloading and Storage

A fuel oil unloading and storage system shall be designed to handle light oil to be used for unit startup and low load operation of the steam generator. The capacity of the light oil firing system shall be 30% unit load.

3.14.12 Chimney

The DOE rules of maintaining a minimum stack height of 275 m for power plants over 500 MW capacity under ECR, 1997, has been considered in the design conditions.

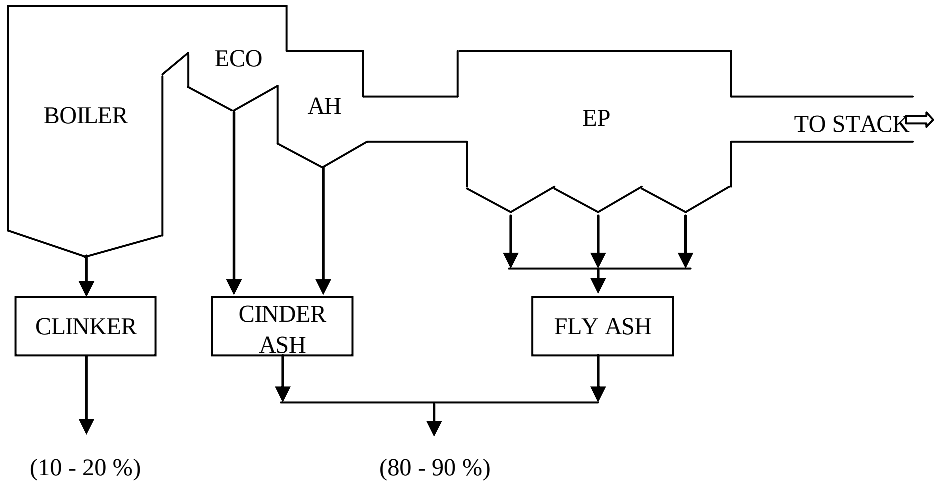
3.14.13 Ash Handling and Transportation System

In general, ash in coal is captured in various parts in the flue gas flow (outlined below) in the course of the combustion of coal in the boiler until the flue gas is discharged from the stack.

㉺ Ash which is melted by the coal combustion falls to the bottom hopper of the boiler furnace and is captured. This is called clinker. About 10 - 20% of the amount of all ash is captured in this way.

㉺ Part of the combustion ash which floats in the flue gas falls to the bottom hopper of the economizer and the air heater in the downstream of flue gas and is captured. This combustion ash is called cinder ash. 5% or less of the amount of all ash is captured here.

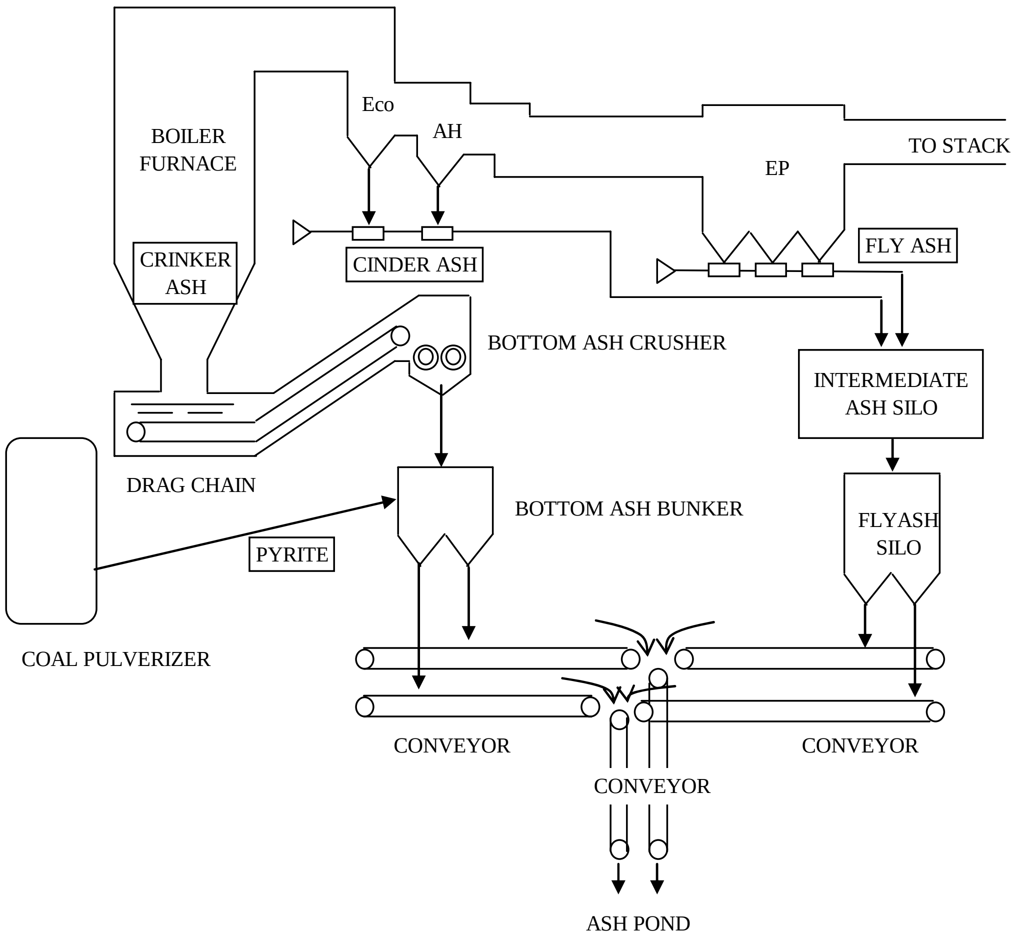
㉺ The combustion ash which is captured by the electrostatic precipitator is caught in the bottom hopper of the electrostatic precipitator. It is called fly ash. In general, 80 - 90% of the amount of all ash is captured here.



The collected coal ash is generally transported and processed through ash handling systems that may be roughly categorized into two systems.

㉠ The first system handles clinker that falls to the bottom hopper of the boiler and the pyrite exhausted from the coal pulverizer.

㉡ The second system handles the cinder ash and fly ash that falls to the bottom hopper of the economizer, air heater and electrostatics precipitator.



(1) Bottom Ash handling system

Bottom ash handling systems are classified into typical types, such as the water sealed drag chain system and the air sealed drag chain system. The air sealed system is superior to the water sealed system, because there is no discharge of wastewater. However, the air sealed system has only been recently developed and there is limited experience using this system. The boiler sealed system is very important for the reliable operation of boilers. For the purposes of this study, the most popular type, the water sealed drag chain system, is described.

The water sealed drag chain system handles clinker ash that falls to the bottom hopper of the boiler and the pyrite exhausted from the coal pulverizer. The clinker that falls to the bottom hopper of the boiler is collected using the water sealed conveyor and is dehydrated for transport to a bottom ash bunker for temporary storage. The pyrite flows into the bottom of the ash bunker. The clinker ash and pyrite are transported to the ash disposal pond by belt conveyer in order to keep the power station roads clean.

(2) Fly ash handling system

Fly ash handling systems are classified into the vacuum system, pneumatic system and vacuum - pneumatic system. The vacuum system is superior to the pneumatic system, because the ash does not disperse if the piping is damaged. However, the vacuum system can only be adopted for short distance transportation. Therefore, the vacuum - pneumatic system is often adopted in large scale power plants. For the purposes of this study, the most popular type, the vacuum – pneumatic system is described.

The vacuum – pneumatic system handles the cinder ash and fly ash that falls to the bottom hoppers of the economizer, air heater and electrostatic precipitator. The cinder ash and fly ash are transported to intermediate ash silos using a vacuum, and then transported from intermediate ash silos to the fly ash silos for temporary storage using compressed air. Finally, the fly ash is transported to the ash disposal pond by belt conveyer in order to keep the power station roads clean.

(3) Ash utilization

Various studies have been conducted regarding effective utilization of coal ash produced in large quantities in boilers, and the following uses have proven practical.

➢ Clinker
✓ Road bed material
➢ Fly ash
✓ Material for cement
✓ Concrete aggregate
✓ Road pavement
✓ Fertilizer

The JICA Study Team was informed that ash produced in power plants cannot be utilized for the cement industry and it is therefore imported from India by train, since its usage has not been signed into law. If the ash can be utilized effectively, the ash disposal area will be smaller than the study result and rest of the area will be utilized for other activities of the project keeping environmental consideration as top priority.

(4) Ash slurry disposal system

The ash disposal site (ash pond) of Matarbari CFPP will be located to the north east of the power plant site. In order to sufficiently preserve the environment around the power plant area, the ash disposal area shall be a controlled type, taking into account the environmental aspects of the surrounding area so that any ash, rain water and wastewater, etc., will not be leaked directly to the outside area.

The ash pond shall be coffered with soil banking, and ash will be disposed into the pond. The nominal capacity of the ash disposal pond is calculated based on the total volume of the ash to be accumulated for the duration of 25 years operation with 80% capacity factor of the two units.

3.14.14 Water Treatment System

(1) Desalination plant

The Reverse Osmosis ("RO") process is planned to be adopted for the desalination of sea water. The desalination system shall be equipped with a water pre-treatment section, such as clarification, and chemical dosing as per the standard practice of the suppliers. Service water produced by the desalination plant will be utilized as the source of demineralized water for boiler make-up, cooling water for bearing of equipment, ash disposal and firefighting water, etc.

(2) Demineralization plant

Following the desalination process, a demineralized water plant will be required for feeding into the closed cooling water, as well as boiler feed water for power cycle make up. The demineralization plant has been designed based on the latest cost effective ion exchange technique of counter current regeneration. Wastewater from the plant produced during the regeneration of resins will be neutralized in a neutralization pit.

(3) Conceptual schematic diagram of water treatment system

Figure 3.14.3 shows the conceptual schematic diagram of the water treatment system. Figure 3.14.4 shows an Estimated Water Balance Diagram.

3.14.15 Wastewater Treatment System

The general treatment concepts of the various effluent streams are as follows:

i) The process wastewater shall be treated in the wastewater treatment plant, after which it shall be discharged into the cooling water discharge line with quality levels meeting IFC Guidelines as well as the Bangladesh Environment standards for effluents. The process wastewater includes waste streams from plant oily waste, drains, and other miscellaneous streams. Wastewater sample points shall be provided in the plant.

ii) Boiler blowdown shall be directed to the boiler blowdown tank with quenching by cooling water, after which it shall be directed into the boiler sump pit.

iii) Oil-contaminated effluents shall be treated in an oil/water separator, after which the effluents shall be routed into the wastewater storage pit.

iv) In no case shall the untreated effluent be discharged either directly or indirectly into any surface or ground water source.

v) Sanitary wastewater from buildings in the plant shall be routed directly to an on-site sewage treatment plant.

vi) Roof drain, storm water and water tanks overflow shall be conveyed into a check pit and discharged into the cooling water discharge line after checking water quality (at least pH value and oil content).

vii) Coal yard rainwater shall be treated separately using the coagulation and filtration method.

viii) Wastewater from the coal conveyer cleaning system shall be treated separately using the coagulation and sedimentation method. Concentrated coal slurry shall be returned to the coal yard.

ix) Ash pond wastewater shall be treated separately using the sedimentation and neutralization method.

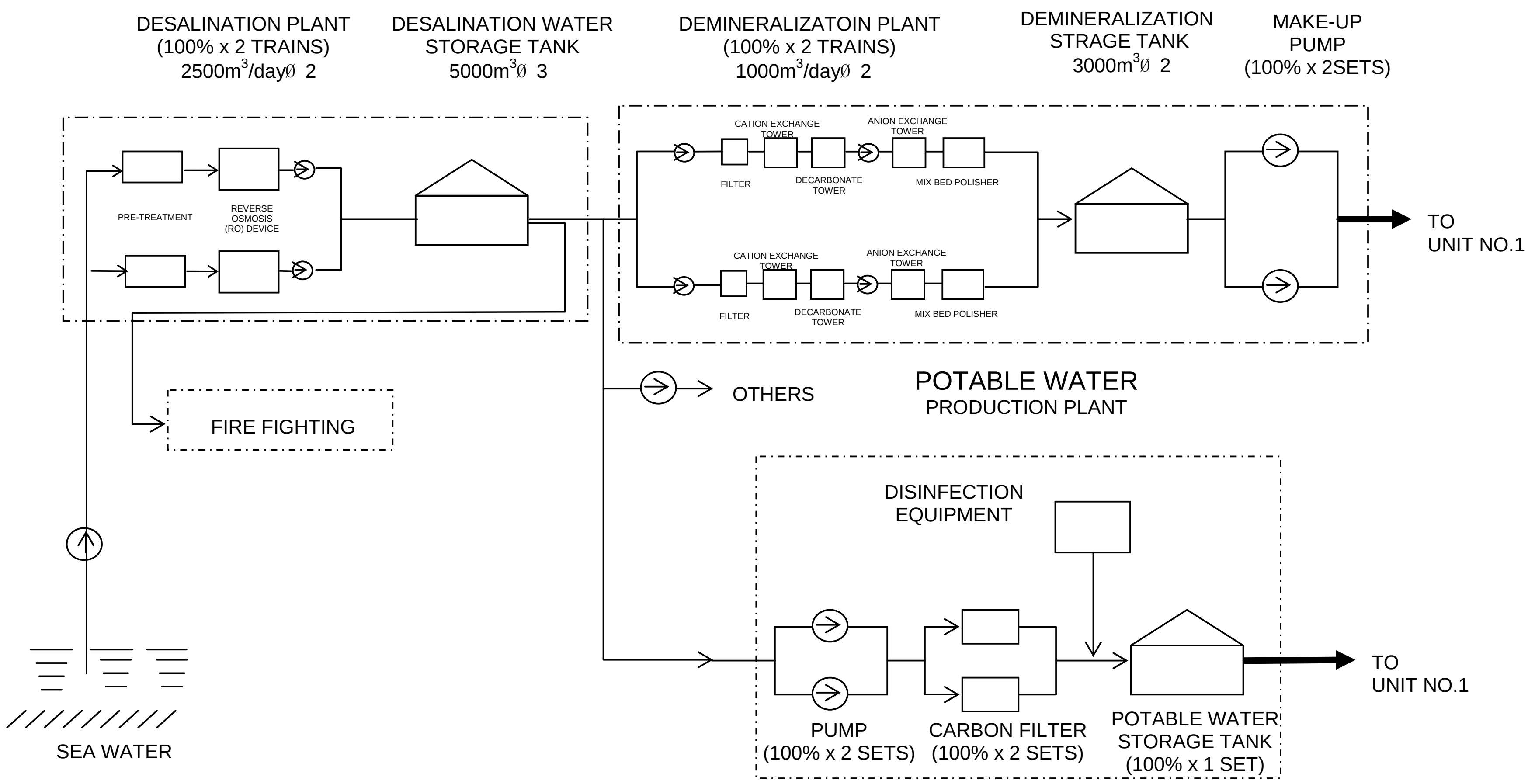


Figure 3.14.3 Conceptual Schematic Diagram of Water Treatment System

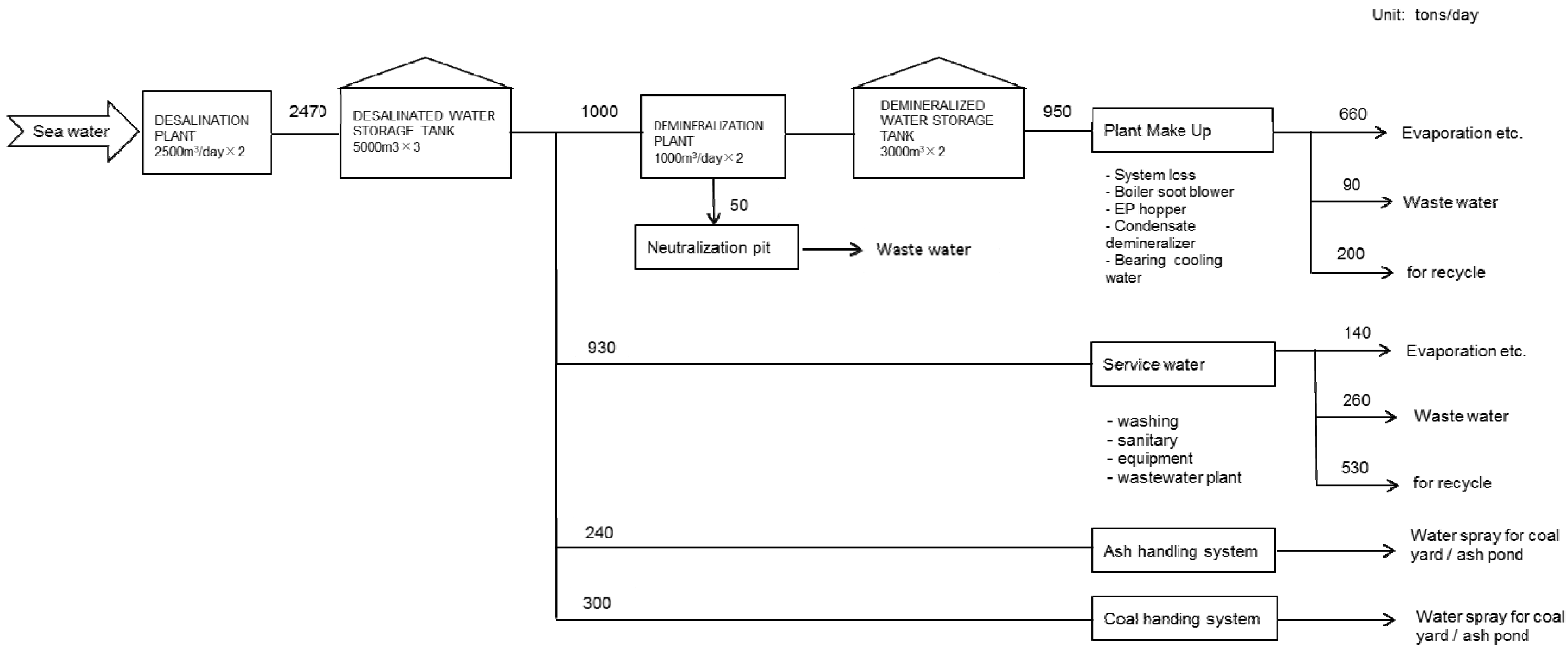


Figure 3.14.4 Estimated Water Balance Diagram

3.14.16 Waste Management

Dredging work will be carried out in the channel for vessels and for port construction. Some sediment will be spread into the ocean during the dredging work. Water turbidity will be the major waste to be generated into the ocean and the details of water pollution control are described here.

As a preventative measure against causing water pollution into the sea, a nonproliferation membrane shall be installed. Moreover, water quality will be constantly monitored to assure proper levels. Sludge collected by the wastewater treatment plant shall be transferred to an appropriate disposal site.

3.14.17 Electrical System

(1) Power evacuation

400 kV and 230 kV transmission systems are planned to be adopted together with the proposed power plant. PGCB will design and implement the necessary transmission systems. Power generated from each 600 MW unit will be stepped up to the evacuation voltage level through a suitably rated Generator Step Up Transformer. In the end, this power shall be distributed to the consumer end through different grid and distribution substations.

(2) Start-up power requirements

The startup power of the plant has been envisaged to be drawn from the nearby available grid line by constructing the required inter connection transmission line. The availability of the 400 kV Double Circuit line interconnection from the nearby substation needs to be ensured that it meets the project start up power schedule.

(3) Auxiliary power supply scheme

The plant auxiliary power supply scheme has been evolved along with suitably rated unit auxiliary transformers and station auxiliary transformers associated with each unit.

(4) Generator

The main parameters of the generator are as follows:

a)	Nominal rating	600 MW
b)	Rated output	750 MVA
c)	Power factor	0.80 (lag) - 0.95 (leading)
d)	Rated Voltage	As per manufacturer’s standard (in the range of 18-25 kV)
e)	Speed	3000 rpm
f)	Short Circuit ratio	Not less than 0.50

(5) High voltage switchyard and power distribution

A 400 kV air insulated switchyard shall be installed in this power plant with the required number of buses and incoming outgoing feeders. As per the power purchase agreement, the evacuated power from the plant generated by the project will be sold to distribution companies owned by the Government of Bangladesh. The main components of the switchyard are two generator step up transformer circuits, two station auxiliary transformer circuits, two transmission lines, the required number of circuit breakers as per requirements and design along with Current Transformers (CT), Potential Transformers (PT), Lighting Arrestors (LA), and communication equipment, etc.

3.14.18 Central Control and Monitoring

One central control room for two units in the operating floor along with a control equipment room will be installed. The boilers, turbine and generators along with their associated auxiliaries will be controlled and monitored from the central control room by the Distribution Control System (DCS). To achieve environmental efficiency, SOx, NOx, O_2, CO_2, CO and dust emission measurements shall be provided.

3.14.19 Civil Structure and Urban Facilities

A large numbers of civil structures and facilities are planned with the project. Possible civil and urban facilities to be constructed are listed below:

- Infrastructure and civil structures
    - Site establishment
    - Office building
    - Dozer maintenance shed
    - Workshop, permanent stores
    - Steel foundation for the plant
    - Ash storage facility
    - Water treatment, drainage and sewerage network
    - Security fencing
    - Coal terminal
    - Coal corridor
    - Coal handling, storage and transportation facilities

- Residential facilities
    - Rest house
    - Officials quarters

- Staff quarters
- Guard shed
- Canteen

- Township
  - School
  - Mosque
  - Medical centre
  - Officers club
  - Sports complex, playground, fitness center, etc.
  - Police camp
  - Social facilities-community center, club, auditorium, bank, post office, shopping center, etc.
  - Transportation facilities-transport center, petrol pump
  - Community centre for workers/ labors

- Pollution mitigation facilities
  - Greenbelt around the power plant
  - Eco-park
  - Water treatment plant
  - Central effluent monitoring basin
  - Chimney of 275m height

- Road network
  - Access road - double lane bituminous access road
  - Necessary bridges, culverts, sluices, etc.
  - Patrol road, internal road network, etc.

3.15 Pollution Mitigation Measures

3.15.1 Air Pollution Control System

The boiler shall be designed for low NOx formation by adopting low NOx burners and over fire (two stage firing) system. High efficiency ESPs will be installed to limit the particulate emissions to 100mg/Nm3. An FGD system will also be installed to reduce SO_2 to at least 90%. To facilitate wider dispersion of remaining particulates and gaseous pollutants (SO_2 and NO_x), a chimney of 275 m height shall be used. To control emissions of fugitive dust within and around the coal handling plant and coal stockyard, a water spray system shall be installed. The chimney shall also be provided with facilities for online monitoring of stack emissions.

3.15.2 Noise Control

The major noise generating sources are the turbines, turbo-generators, compressors, pumps, fans and coal handling plant, etc., from where noise is continuously generated. Equipment will be designed to control the noise level to below 90 dB (A). Wherever it is not technically possible to meet the required noise levels at the work place, personnel protection and equipment, like ear plugs/ear mufflers, shall be provided to the workers. The buffer area around the plant, including the boundary wall around the project, shall dampen noise levels so that the nearby community will not experience significant noise.

3.15.3 Intent of Water Reuse

The entire water consumption and management system has been designed with the provision of water use facilities. A circulating water system has been designed for the cooling system, boiler water, ash disposal and handling system.

3.15.4 Effluent Treatment

A wastewater treatment plant has been planned to collect, treat and dispose of plant effluents. Liquid effluents shall be collected and treated/ recycled as described in Section 3.14.15.

3.15.5 Thermal Pollution Control

About 180,000 m^3/hr cooling water will be discharged through the discharge tunnel, after the condenser, with a temperature increase of 6.6°C. The cooling water facilities will be designed so that the discharged water temperature will be not higher than 40°C which is the maximum temperature allowed in the wastewater quality standards of Bangladesh.

3.15.6 Waste Management

All kinds of solid waste to be generated at the power plant will be disposed on site maintaining DOE’s standards. Ash particles will be the major waste to be generated from the power plant and details of the ash management are described in Section 3.14.13. Some waste will also be generated from the coal storage yard and belt conveyor facilities. To control flying coal dust, a water spraying system will be installed in the coal yard.

3.15.7 Water Intake Structure

Water supply from the intake point to the pump pit shall be provided with sufficient screening to filter out larger aquatic organisms like fish, etc. Drum screens shall be adopted in order to limit the entrainment of fish in the cooling water system.

3.15.10 Post Operation Monitoring Program

Regular monitoring of pollutants in different environmental disciplines like air, stack emission, wastewater, etc., shall be conducted and the data shall be submitted to the DOE regularly following the EMP proposed under this study. The monitoring locations will be finalized in consultation with the DOE. Monitoring stations will be equipped with all necessary apparatus and manpower for ensuring effective monitoring.

The environmental monitoring officer shall monitor the EMP implementation and submit quarterly reports to the said department. In addition, an annual monitoring report with quarterly monitoring data shall be submitted to the DOE for renewing the ECC. Two trainings per year at the plant shall be planned for safety professionals.

Chapter 4

Environmental Background Analysis and Detailed Description

Chapter 4

Environmental Background: Analysis and Detailed Description

Table of Contents

4.1 Environmental Base Maps

The proposed coal-fired power plant (Matarbari CFPP; 2 x 600MW, “Power Plant”) is located in the Matarbari Union and Dhalghata Union in Maheshkhali Upazila in Cox’s Bazar District, in the south-east area of Bangladesh (Figure 4.1.1).

Note: The location is 21 42’15” N, 91 53’16” E

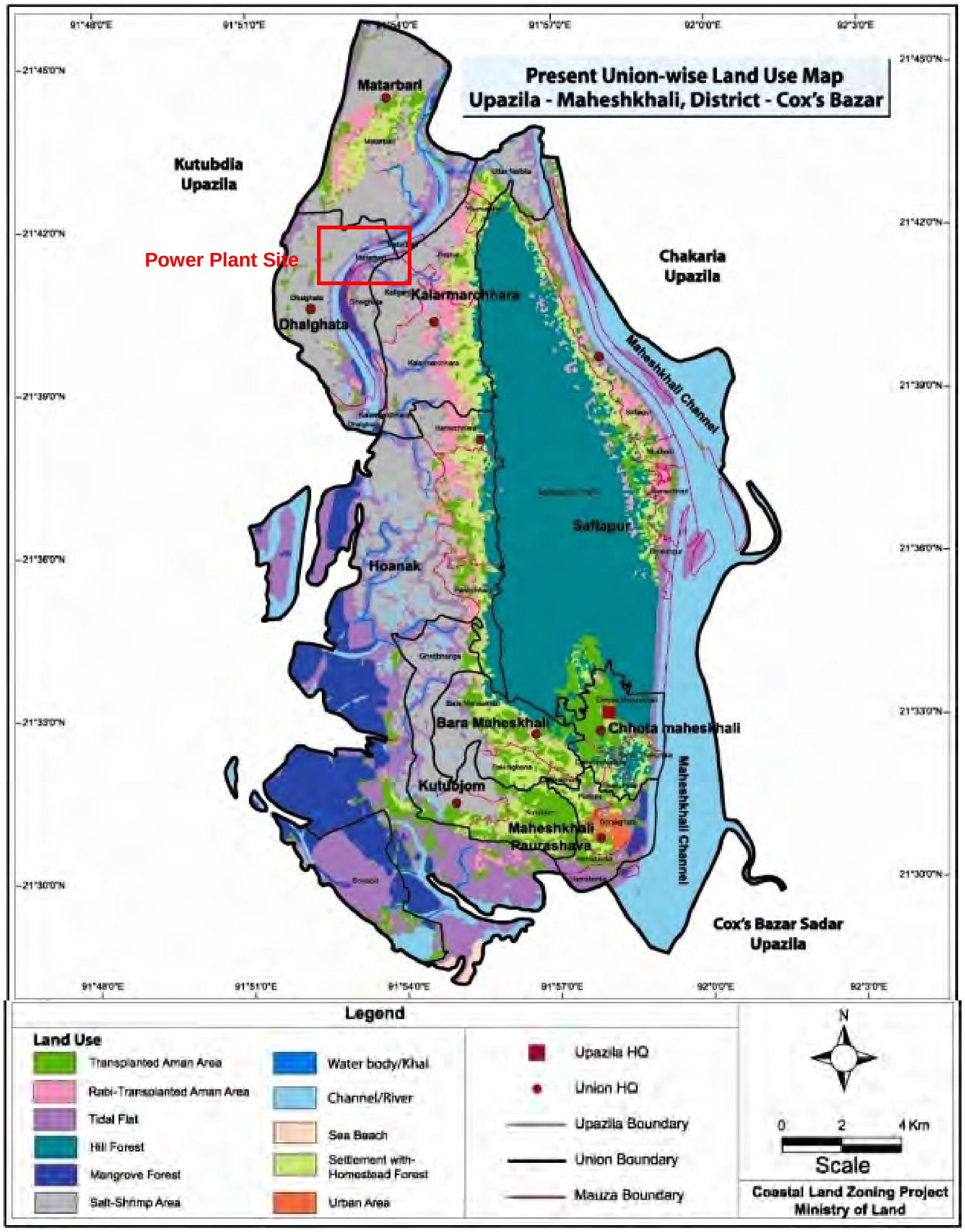
(Source: http://www.in2bangla.com/upazilaMap.php?id=293)

Figure 4.1.1 Location of the Power Plant

4.2 Description of the Following Features

4.2.1 Land Use

Land use map of Maheshkhali Upazila, Cox's Bazar District is shown in the figure below. The land use of the project site is categorized in "Salt-Shrimp Area" (Figure 4.2.1.1).



Note: Locations of potential sites for power plant on the map are marked by the Survey Team.
(Source: http://www.landzoning.gov.bd/ZoneMaps/Maheshkhali.jpg (accessed in August 2012))

Figure 4.2.1.1 Land Use Map of Maheshkhali Upazila, Cox's Bazar District

4.2.2 Natural Physical Resources

(1) Climate

The climate in Bangladesh is divided into three seasons: summer from March to June with high temperatures and high humidity, the monsoon season from June to October with high winds, and winter from October to March with low temperatures and low precipitation.

The meteorological observatories in the project area are Kutubdia Observatory, 10km north of the project site, and Cox's Bazar Observatory, 30km south of the site. The local meteorological observation results from 2000 to 2011 are shown below (Figure 4.2.2.1).

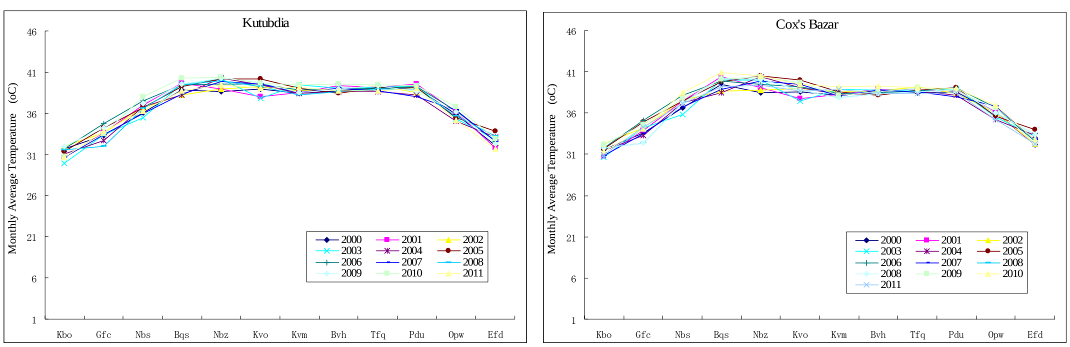
(Source: JICA Study Team)

Figure 4.2.2.1 Location of meteorological observatories

a) Temperature

The monthly average temperatures in Kutubdia and Cox's Bazar are shown in Figure 4.2.2.2. Climate fluctuations are stable every year in both areas in view of seasonal temperature change. The temperature in January is 19 - 21^{o}C, and then gradually rises toward April to 28 - 29^{o}C. The high temperature of 27 - 29^{o}C continues from April to October, while it is a little lower from July to October compared to April to June. The temperature is in decline in November and December, and the average temperature in December is 21 - 23^{o}C.

The maximum monthly average temperatures were 29.4°C in Kutubdia observed in May 2010, and 29.9^{o}C in Cox's Bazar observed in April 2010. The minimum monthly average temperatures were 18.9^{o}C in Kutubdia and 19.6^{o}C in Cox's Bazar, both recorded in January 2003.

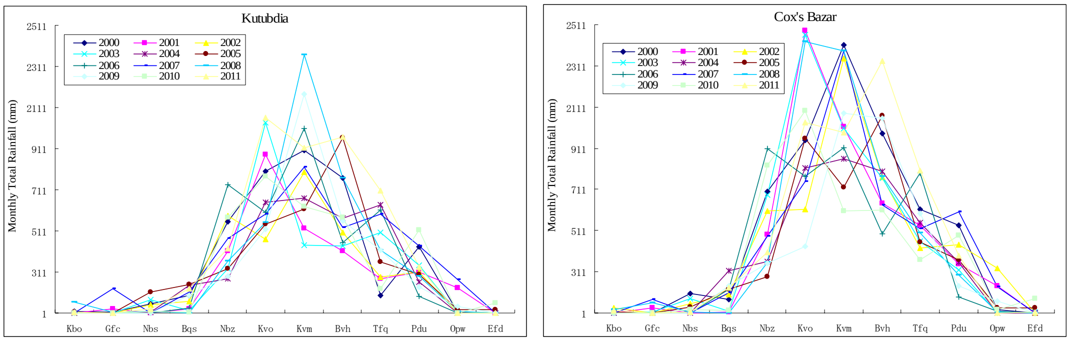


(Prepared based on the data of the meteorological observatories)

Figure 4.2.3 Monthly average temperatures

b) Rainfall

The monthly total rainfall in Kutubdia and Cox's Bazar is shown in Figure 4.2.2.3. The total annual rainfall is 4,321 - 5,905mm in Kutubdia, and 5,286 - 6,707mm in Cox's Bazar. Rainfall is concentrated between May and October; while very little or no rain is recorded from November to April. In this way, there is a definite difference of rainfall between the rainy season (monsoon season) and other seasons.

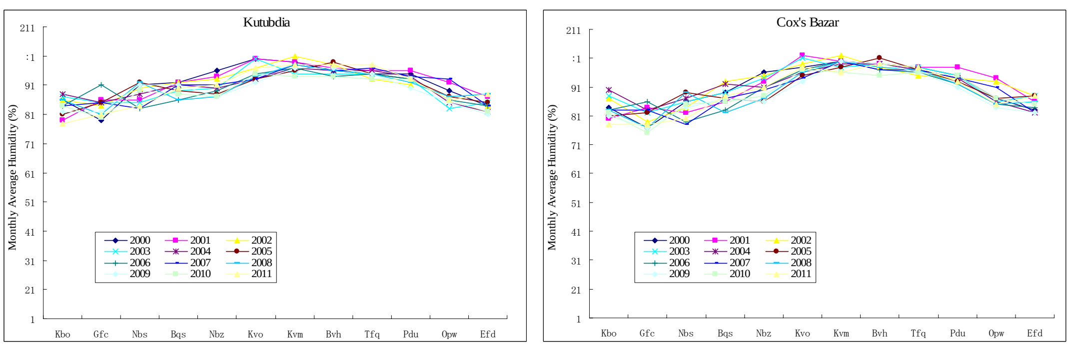


(Prepared based on the data of the meteorological observatories)

Figure 4.2.2.3 Monthly total rainfall

c) Humidity

The monthly average humidity in Kutubdia and Cox's Bazar is shown in Figure 4.2.2.4. Humidity fluctuations are stable every year in both areas in view of seasonal humidity change. The difference in the average humidity between respective months is rather small, in a range of 65 - 90%, while the average is 75 - 90% in the rainy season of May to October and 65 - 85% from November to April where little rain falls.

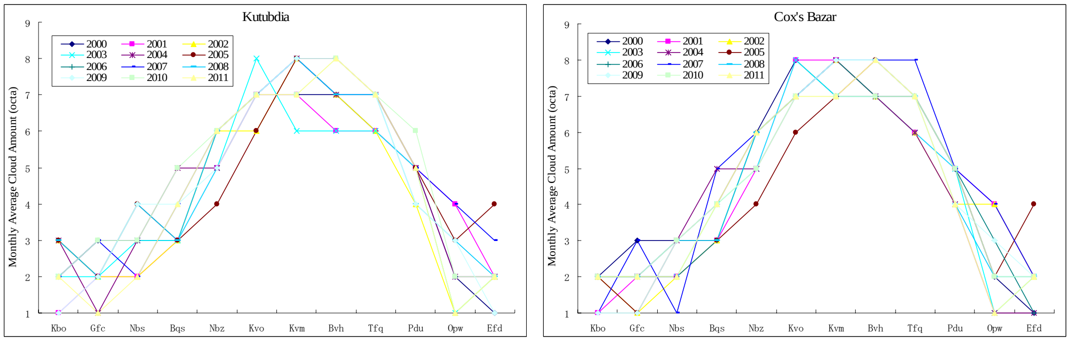


(Prepared based on the data of the meteorological observatories)

Figure 4.2.2.4 Monthly average humidity

d) Cloud amount

The monthly cloud amount in Kutubdia and Cox's Bazar is shown in Figure 4.2.2.5. Cloud amount fluctuations are stable every year in both areas in view of seasonal change in cloud amounts. The cloud amount is larger in the rainy season of May to October compared to November to April where little rain falls.

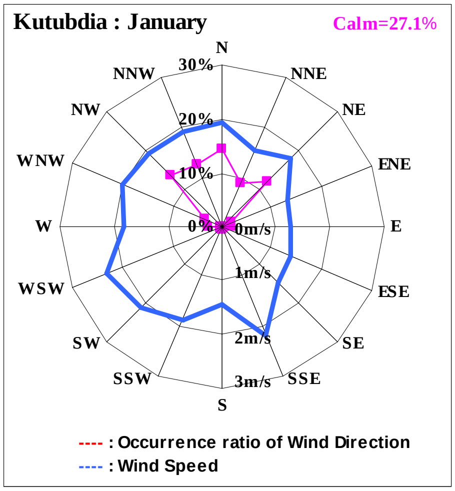


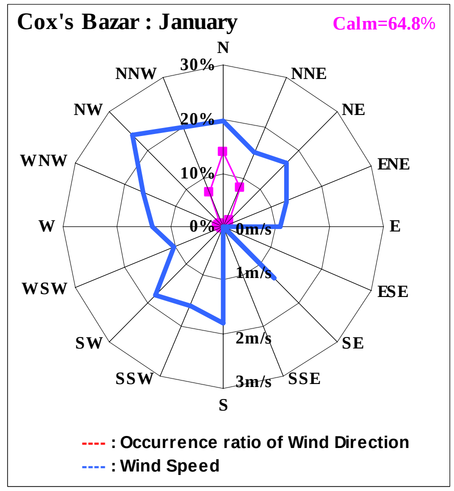
(Prepared based on the data of the meteorological observatories)

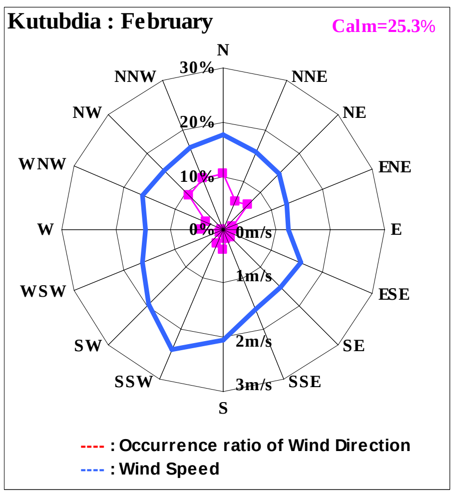
Figure 4.2.2.5 Monthly average cloud amount

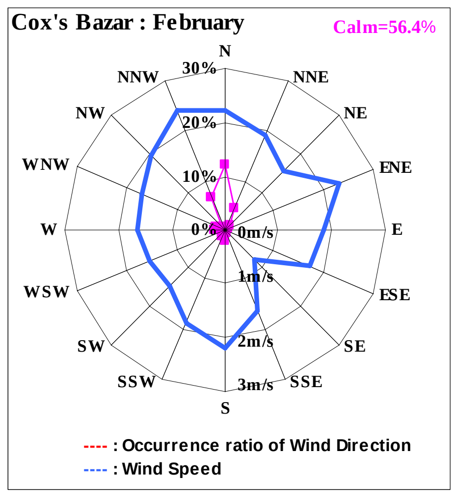
e) Wind

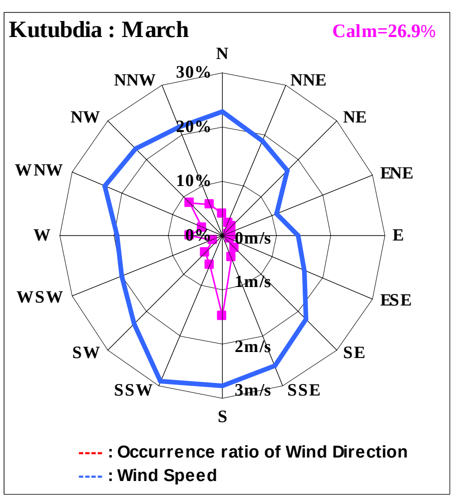
Figure 4.2.2.6 indicates the monthly frequency ratio of wind direction and the average wind speed for each wind direction in Kutubdia and Cox’s Bazar. The data was missing in Kutubdia for 2006. In Cox’s Bazar, “Calm (wind speed 0.5m/sec and lower)” occurs most frequently, accounting for more than 50% from September to March. Except for this difference, the wind directions in both areas show similar tendencies. Northerly winds are dominant in January and February, and no significant high wind speed was observed in specific wind direction. Southerly winds become dominant from March, especially from April to September. In July and August, there is a tendency of slightly higher wind speed in southwesterly winds, otherwise no significant high wind speed was observed in any specific wind direction. Wind direction shifts from southerly winds to northerly winds in October, and there is a tendency of high wind speed of southwesterly winds. Northerly winds are dominant in November and December, but high wind speed tends to occur in southwesterly winds.

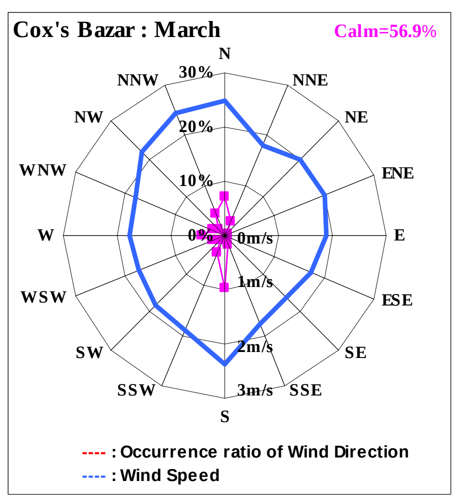

Kutubdia : January
Calm=27.1%
N
NNE
NE
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW
30%
20%
10%
0%
0m/s
1m/s
2m/s
3m/s
---- : Occurrence ratio of Wind Direction
---- : Wind Speed

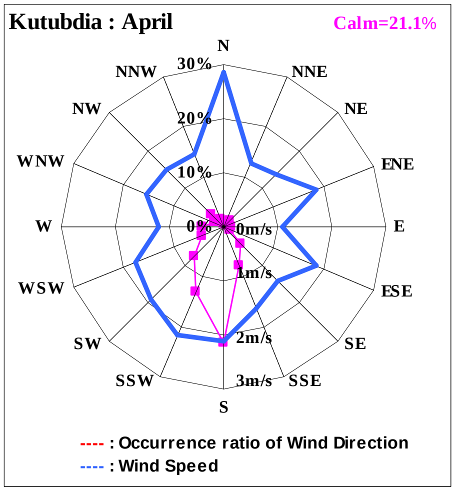

Cox's Bazar : January
Calm=64.8%
N
NNE
NE
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW
30%
20%
10%
0%
0m/s
1m/s
2m/s
3m/s
---- : Occurrence ratio of Wind Direction
---- : Wind Speed

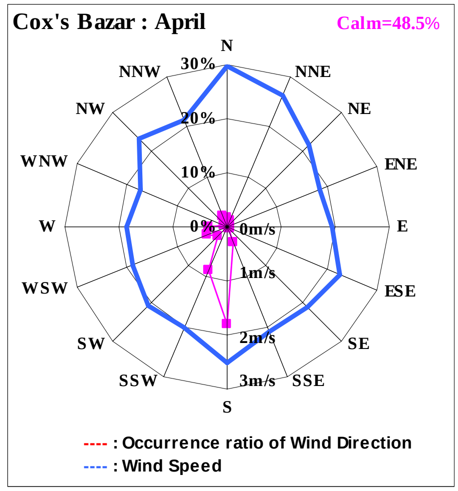

Kutubdia : February
Calm=25.3%
N
NNE
NE
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW
30%
20%
10%
0%
0m/s
1m/s
2m/s
3m/s
---- : Occurrence ratio of Wind Direction
---- : Wind Speed

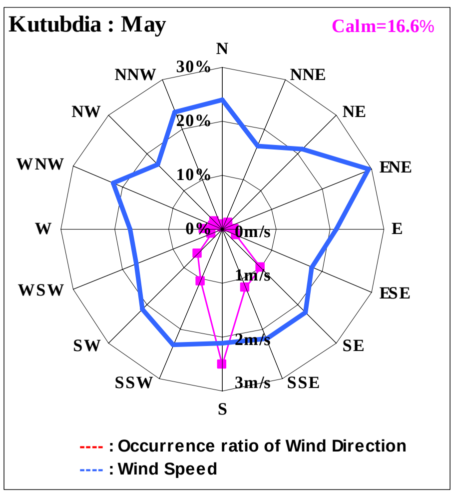

Cox's Bazar : February
Calm=56.4%
N
NNE
NE
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW
30%
20%
10%
0%
0m/s
1m/s
2m/s
3m/s
---- : Occurrence ratio of Wind Direction
---- : Wind Speed

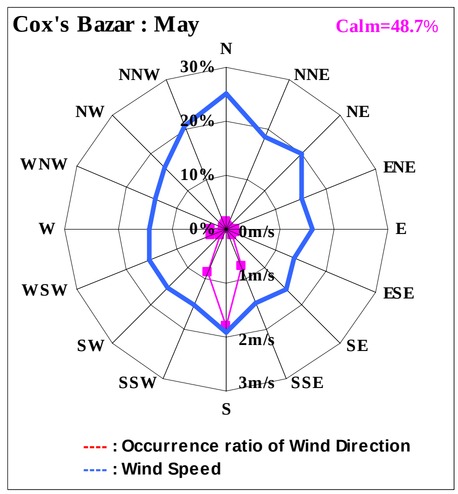

Kutubdia : March
Calm=26.9%
N
NNE
NE
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW
30%
20%
10%
0%
0m/s
1m/s
2m/s
3m/s
---- : Occurrence ratio of Wind Direction
---- : Wind Speed

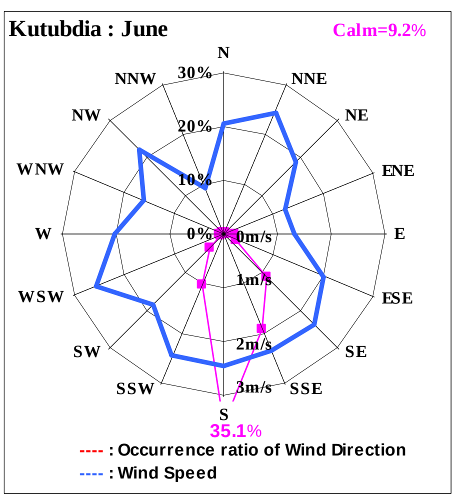

Cox's Bazar : March
Calm=56.9%
N
NNE
NE
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW
30%
20%
10%
0%
0m/s
1m/s
2m/s
3m/s
---- : Occurrence ratio of Wind Direction
---- : Wind Speed

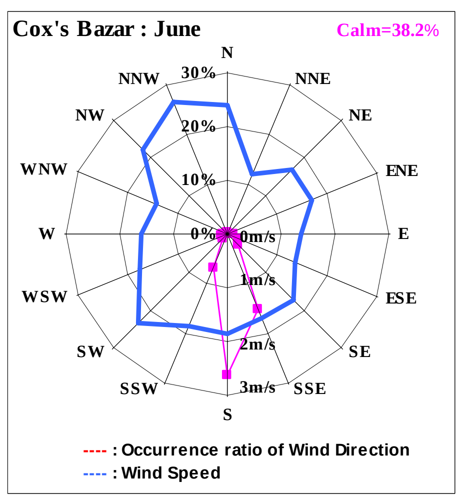

Kutubdia : April
Calm=21.1%
N
NNE
NE
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW
30%
20%
10%
0%
0m/s
1m/s
2m/s
3m/s
---- : Occurrence ratio of Wind Direction
---- : Wind Speed

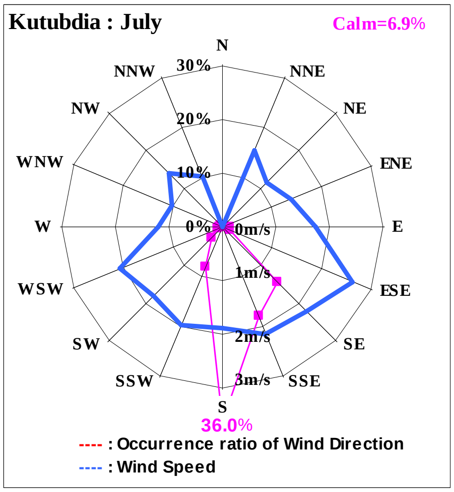

Cox's Bazar : April
Calm=48.5%
N
NNE
NE
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW
30%
20%
10%
0%
0m/s
1m/s
2m/s
3m/s
---- : Occurrence ratio of Wind Direction
---- : Wind Speed

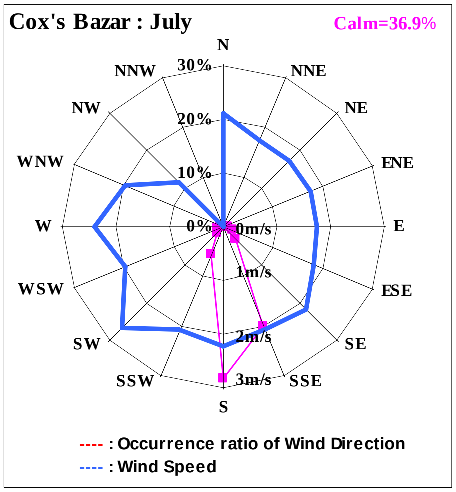

Kutubdia : May
Calm=16.6%
N
NNE
NE
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW
30%
20%
10%
0%
0m/s
1m/s
2m/s
3m/s
---- : Occurrence ratio of Wind Direction
---- : Wind Speed

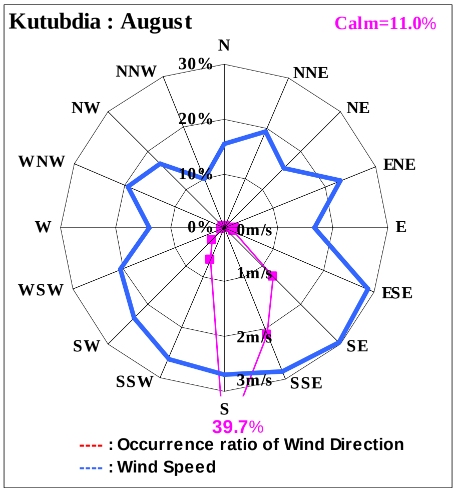

Cox's Bazar : May
Calm=48.7%
N
NNE
NE
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW
30%
20%
10%
0%
0m/s
1m/s
2m/s
3m/s
---- : Occurrence ratio of Wind Direction
---- : Wind Speed

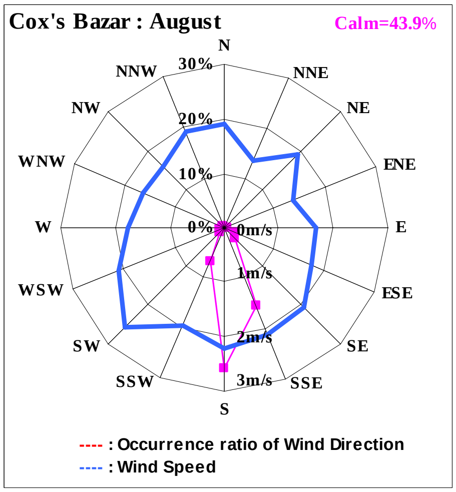

Kutubdia : June
Calm=9.2%
N
NNE
NE
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW
30%
20%
10%
0%
0m/s
1m/s
2m/s
3m/s
35.1%
---- : Occurrence ratio of Wind Direction
---- : Wind Speed

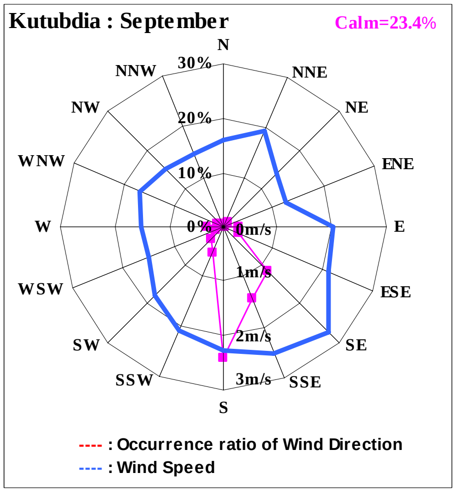

Cox's Bazar : June
Calm=38.2%
N
NNE
NE
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW
30%
20%
10%
0%
0m/s
1m/s
2m/s
3m/s
---- : Occurrence ratio of Wind Direction
---- : Wind Speed

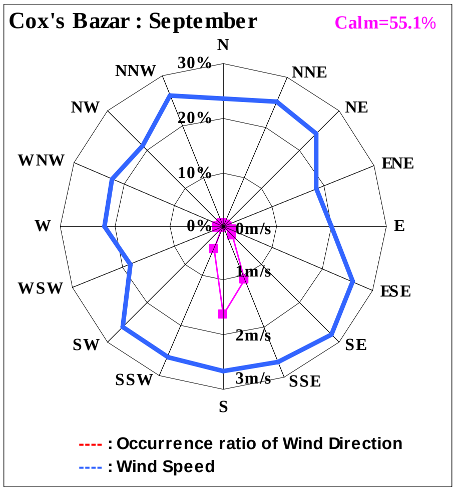

Kutubdia : July
Calm=6.9%
N
NNE
NE
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW
30%
20%
10%
0%
0m/s
1m/s
2m/s
3m/s
36.0%
---- : Occurrence ratio of Wind Direction
---- : Wind Speed

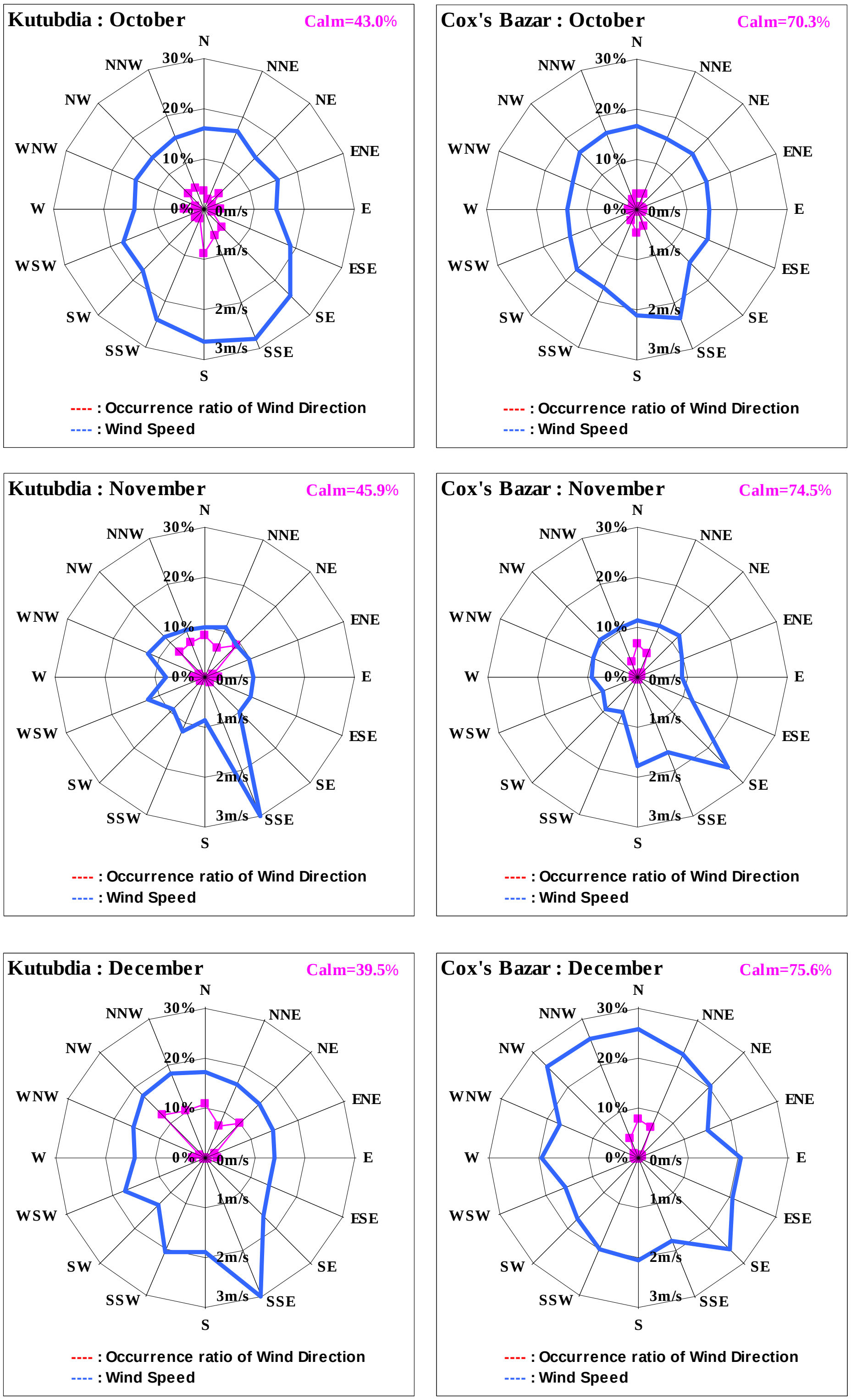

Cox's Bazar : July
Calm=36.9%
N
NNE
NE
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW
30%
20%
10%
0%
0m/s
1m/s
2m/s
3m/s
---- : Occurrence ratio of Wind Direction
---- : Wind Speed


Kutubdia : August
Calm=11.0%
N
NNE
NE
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW
30%
20%
10%
0%
0m/s
1m/s
2m/s
3m/s
39.7%
---- : Occurrence ratio of Wind Direction
---- : Wind Speed


Cox's Bazar : August
Calm=43.9%
N
NNE
NE
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW
30%
20%
10%
0%
0m/s
1m/s
2m/s
3m/s
---- : Occurrence ratio of Wind Direction
---- : Wind Speed


Kutubdia : September
Calm=23.4%
N
NNE
NE
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW
30%
20%
10%
0%
0m/s
1m/s
2m/s
3m/s
---- : Occurrence ratio of Wind Direction
---- : Wind Speed


Cox's Bazar : September
Calm=55.1%
N
NNE
NE
ENE
E
ESE
SE
SSE
S
SSW
SW
WSW
W
WNW
NW
NNW
30%
20%
10%
0%
0m/s
1m/s
2m/s
3m/s
---- : Occurrence ratio of Wind Direction
---- : Wind Speed



(Prepared based on the data of the meteorological observatory)

Figure 4.2.2.6 Monthly wind rise

(2) Topography

-Features of the project site

There are no structures in the project site.

There are some fish and salt cultivation land and some temporary houses in the project site. And there are many water courses in the project site, made manually for the purpose of fish and salt cultivation.

There are no features like electric poles, roads, etc., located anywhere in the boundary lines.

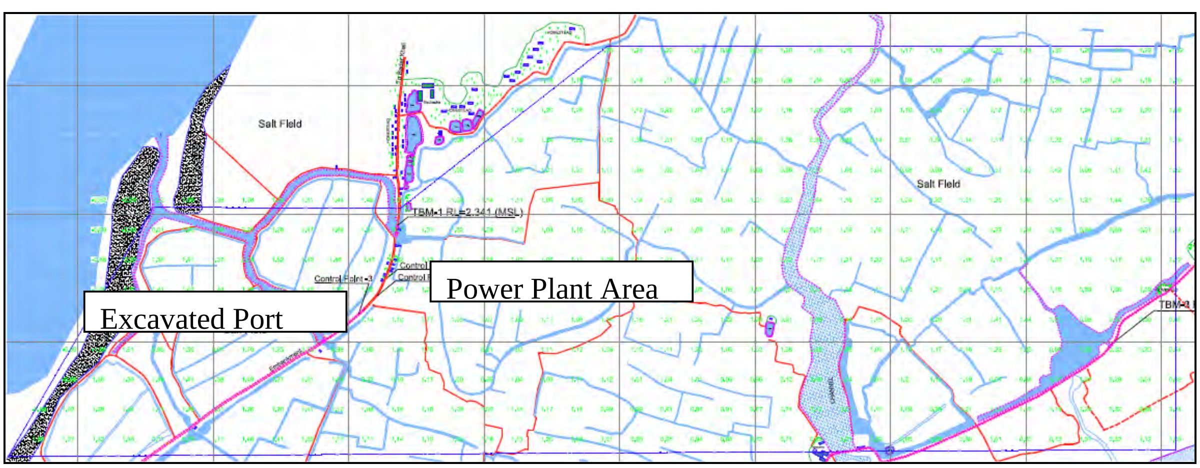
-Surrounds of the project site

There is a long water course and the Kohelia River on the East side, the Bay of Bengal on the West side, a Homestead village of Nasir Mohammad Deil on the South side, and another Homestead on the North side of the project site.

-Existing ground level

On the basis of the Topographical Map (refer to appendix C01-01), the existing ground level should be set based on the average level of the existing ground as follows:

㉺Existing ground level: +1.0m M.S.L.



(The numbers in this figure show the elevation (M.S.L.) of the site.)

Figure 4.2.2.7 Drawing of a topographical map of the project site

(3) Geology

The JICA Study Team carried out a detailed soil investigation of the Matarbari area. Ground investigation work is a main feature in the designing foundation of important structures in an intelligent, economic and satisfactory way. It provides necessary information of strength and compressibility characteristics of the sub-soil to the design engineers to enable the selection of suitable depths and types of foundation for the proposed structures.

The investigation work included the execution of nine borings from the existing ground level and execution of an SPT test, collection of disturbed samples at specified depths under consideration, and a record of ground water levels, etc. All of these items of the field investigation have subsequently been followed up by the performance of laboratory tests.

a) Boring points

The drilling implementation was determined on the basis of the power plant area and formation of a port.
A drawing of the boring points is shown in Figure 4.2.2.8.

b) Field Investigation

Core drilling was conducted in 9 boreholes with a total depth of 696 m. The deepest hole was 100 m and the shallowest was 30 m. Information about those boreholes, comprising the borehole numbers, location, coordinates and elevation are shown in Table 4.2.2.1 below, including the related Bore Logs.

Table 4.2.2.1 Pilling List

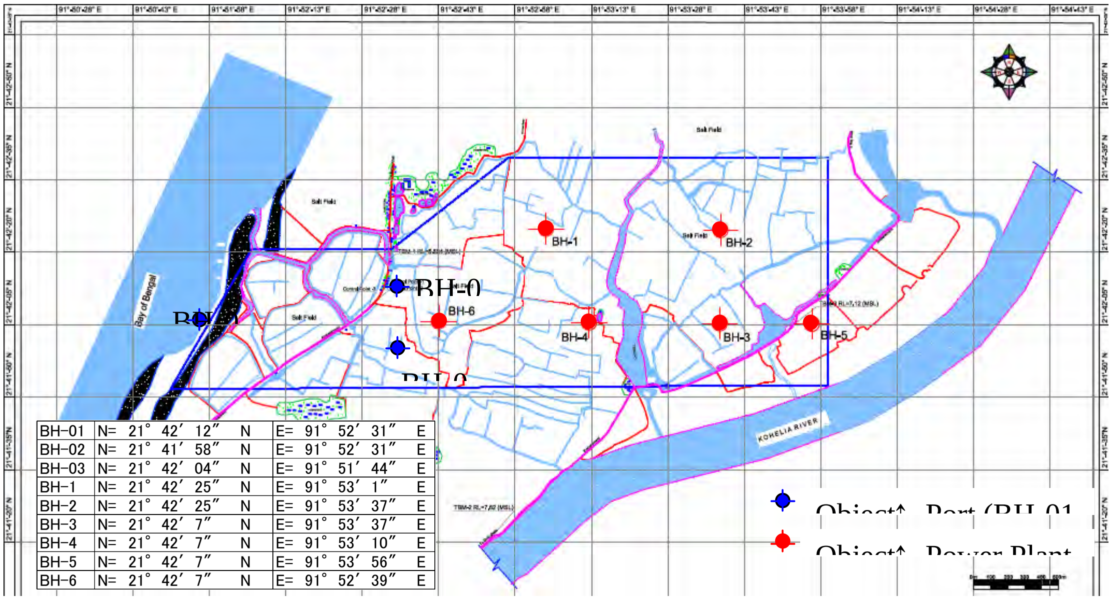
Bore No.	Coordinate		Depth	Loction	Ground Elevation	Bore Log
BH-01	N= 21° 42′ 12″ N	E= 91° 52′ 31″ E	33m	port	4.88mMSL	figure5.2.4-4
BH-02	N= 21° 41′ 58″ N	E= 91° 52′ 31″ E	33m	port	4.70mMSL	figure5.2.4-5
BH-03	N= 21° 42′ 04″ N	E= 91° 51′ 44″ E	30m	channel	3.68mMSL	figure5.2.4-6
BH-1	N= 21° 42′ 25″ N	E= 91° 53′ 1″ E	100m	Plant	-	figure5.2.4-7
BH-2	N= 21° 42′ 25″ N	E= 91° 53′ 37″ E	100m	Plant	-	figure5.2.4-8
BH-3	N= 21° 42′ 7″ N	E= 91° 53′ 37″ E	100m	Plant	-	figure5.2.4-9
BH-4	N= 21° 42′ 7″ N	E= 91° 53′ 10″ E	100m	Plant	-	figure5.2.4-10
BH-5	N= 21° 42′ 7″ N	E= 91° 53′ 56″ E	100m	Plant	-	figure5.2.4-11
BH-6	N= 21° 42′ 7″ N	E= 91° 52′ 39″ E	100m	Plant	-	figure5.2.4-12

c) Geological survey results

The subsurface geology of the proposed project site has been revealed using BH-01 BH-03 borehole logs of the project site. The maximum depth of the boreholes is 33.0m from the existing ground surface. Mainly seven soil layers were observed in the studied site, i.e., very soft to medium stiff clay, loose to very dense silty fine sand, stiff clay, medium dense to very dense silty fine sand, very stiff silt, hard clay, and very dense silty fine sand. The stratigraphy of the project site is given in the table below.

Table 4.2.2.2 The stratigraphy of the project site

Lithology	Average Thickness (m)
Unit-1: CLAY. It is very soft to medium stiff, grey to dark grey in color, medium to high plastic in nature.	8.0
Unit-2: Silty fine SAND. It is loose to very dense, grey to light grey in color with trace of mica.	4.0
Unit-3: CLAY. It is stiff, grey in color, medium plastic in nature.	2.0
Unit-4: Silty fine SAND. It is medium dense to very dense, light grey in color with traces of mica.	5.0
Unit-5: SILT. It is very stiff, light grey in color, non-plastic in nature.	2.0
Unit-6: CLAY. It is hard, grey spotted brown in color, medium plastic in nature.	4.0
Unit-7: Silty fine SAND. It is very dense, yellowish brown to reddish brown in color with traces of mica.	8.0



BH−01	N= 21°	42′	12″	N	E= 91°	52′	31″	E
BH−02	N= 21°	41′	58″	N	E= 91°	52′	31″	E
BH−03	N= 21°	42′	04″	N	E= 91°	51′	44″	E
BH−1	N= 21°	42′	25″	N	E= 91°	53′	1″	E
BH−2	N= 21°	42′	25″	N	E= 91°	53′	37″	E
BH−3	N= 21°	42′	7″	N	E= 91°	53′	37″	E
BH−4	N= 21°	42′	7″	N	E= 91°	53′	10″	E
BH−5	N= 21°	42′	7″	N	E= 91°	53′	56″	E
BH−6	N= 21°	42′	7″	N	E= 91°	52′	39″	E

The details of the bore logs are shown in appendix C04-02.

Figure 4.2.2.8 Drawing of boring points

(4) Tidal

a) Tidal level

Water level was collected for one month from 29th September to 28th October. The location of the water level is shown in Figure 4.2.2.9.

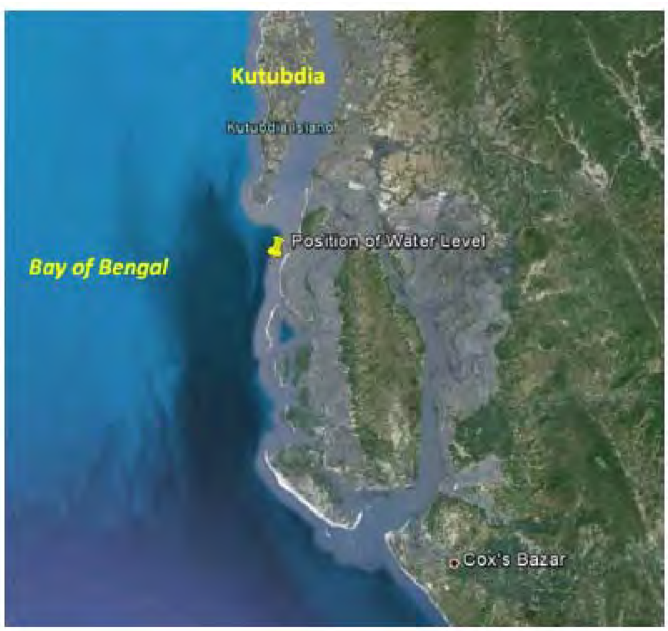


Figure 4.2.2.9 Location of water level station

-Design of Tidal Level (prediction of water level using harmonic analysis)

Harmonic analysis is the transformation of tidal observations from the time domain to the frequency domain. The tidal variations can then be given by the sum of the harmonic constituents, which period is associated with the period of the tide generating forces. The periods fall into three tidal species (long-period, lunar and semi- lunar). Each tidal species contains groups of harmonics, which can be separated by analysis of a month of observations. In turn each group contains constituents, which can be separated by analysis of a year of observations. Third lunar, fourth lunar and higher species of harmonics are generated by shallow water effects.

Normally long tidal records are needed to determine amplitude and phase for a larger number of constituents with high accuracy. Here we analyzed 30 days data and the calculated harmonic constituents are provided in Table 4.2.2.3. The water level of 2012 was predicted using these tidal/harmonic constituents and compared with the measured data.

Table 4.2.2.3 Component Tide

Component Tide	M2	S2	N2	K2	K1	O1	P1	M4	Ms4	Z0
Amplitude	1.34m	0.61m	0.27m	0.13m	0.17m	0.05m	0.05m	0.01m	0.006m	0.45m

- Nearly Highest High Water ⊗ ↖ M2 + S2 + K1 + O1 ↗ above M.S.L

⊗ 2.2 m above M.S.L

- Nearly Lowest Low Water ⊗ ↖ M2 + S2 + K1 + O1 ↗ below M.S.L

⊗ 2.2 m above M.S.L

- Lowest Low Water Level ⊗↖ M2 + S2 + N2 + K2 +K1 + O1 + P1 + M4 + MS4↗below M.S.L！！！！！！！！

⊗ 2.6 m above M.S.L

▽ Nearly Highest High Water = 2.2m above M.S.L. H.W.L =+2.2m M.S.L.

Mean Sea Level (M..S.L) M.S.L = E.L.±0.0m

▽ Nearly Lowest Low Water =2.2 m below M.S.L. L.W.L.=-2.2m M.S.L.

▽ Lowest Low Water Level = 2.6m below M.S.L L.L.W.L.=-2.6m M.S.L

* The Chart Datum (CD) is 2.69m below M.S.L at SONADIA

The details of the investigation data are shown in appendix C04-03.

Figure 4.2.2.10 Tidal Conditions at Matarbari

b) Tidal current

Current speed data was collected for 15 days for four selected locations. The four locations are provided in Figure 4.2.2.11.

Of the four locations, three locations are almost close but location 3 is more towards the sea. It is evident from the results of the investigation that the current speed varies from 0.03 m/s to 1.26 m/s (location 1), and 0.025 m/s to 1.5 m/s (locations 2 and 3), and the dominant direction follows 0 to 90 degrees and 180 to 270 degrees (locations 1,2 and 3). In addition, it was found that the current speed of location 4 varies from 0.06 m/s to 1.88 m/s and the dominant direction is 0 to 90 degrees.

From all the current profiles it is evident that almost 90% of the direction falls either from 0 to 90 degrees (Northeast direction) or from 180 to 270 degrees (Southwest direction). This happens because it represents the tide. When there is a flood tide the water goes towards shore/land, then it follows a southwest direction (180 to 270 degrees), whereas when there is an ebb tide the water goes towards the sea then it follows a northeast direction (0 to 90 degrees).

Table 4.2.2.4 Tidal Current Observation Point/Line

SL	NAME/ID	LAT (WGS84)	LON (WGS84)	EASTING (UTM)	NORTHING (UTM)	REMARKS
1	TC-01	21°42' 20"N	91°51' 35"E	382048	2400946	at -5m depth
2	TC-02	21°41' 45"N	91°51' 18"E	381526	2399615	at -5m depth
3	TC-03	21°41' 45"N	91°50' 49"E	380699	2399600	at -15m depth
4	TC-04	21°38' 39"N	91°53' 21"E	385033	2393849	RIVER END

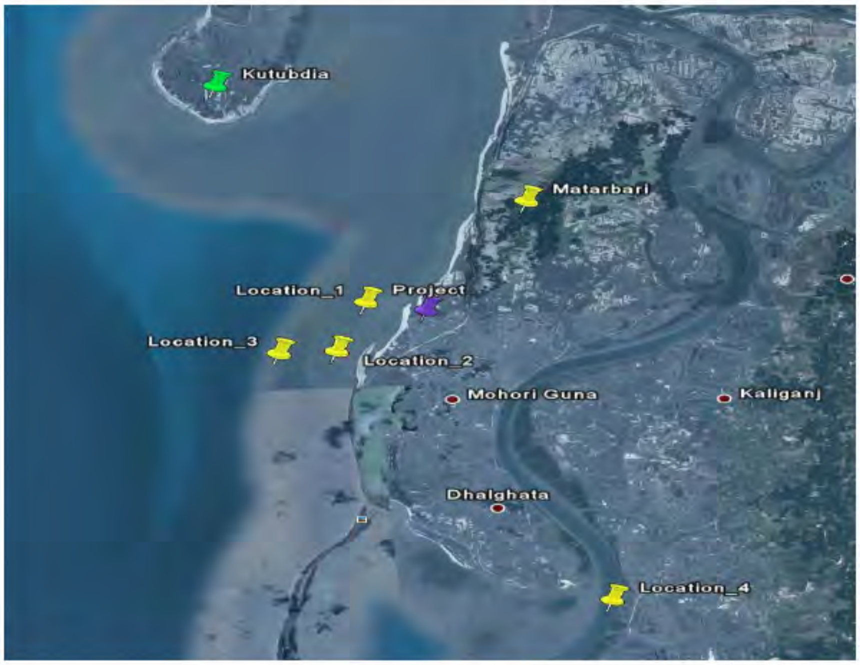


Figure 4.2.2.11 Point Map

(5) Wave

a) Water Depth

The water depth as charted by the hydrographic chart applies to the sea area of the candidate site. The hydrographic chart is shown in the next page.

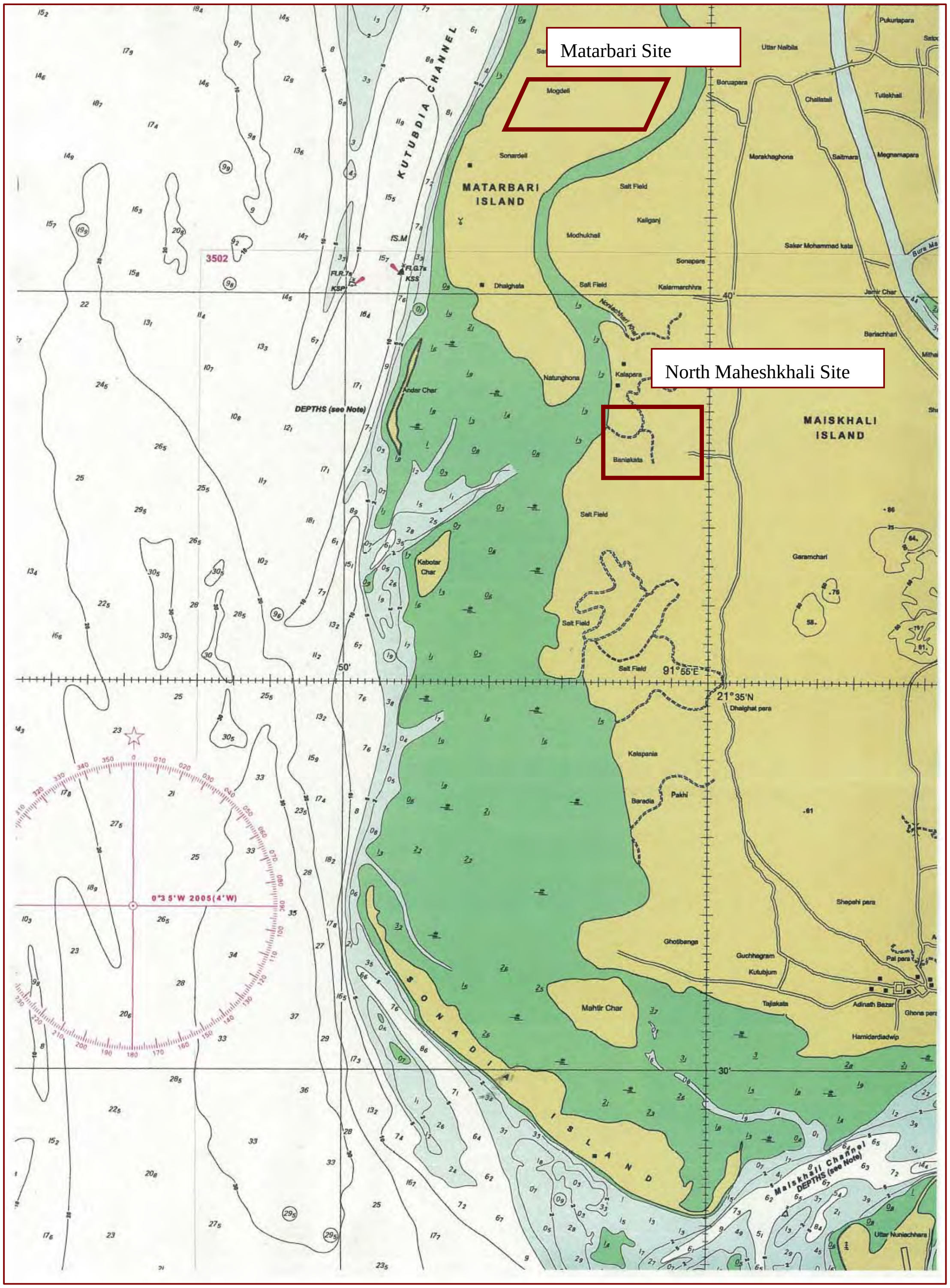


Figure 4.2.2.12 Hydrographic Chart (Candidate Area)

b) Ordinary Deepwater Waves

a. Outline of Estimated Global Wave Database

An estimated global wave database has been calculated using the Wave Estimation Model "JWA3G" developed by the Japan Weather Association, based on the objectively analyzed sea surface wind values of the European Center for Medium-Range Weather Forecasts (ECMWF) as input conditions.

Model JWA3G is the most advanced model for estimating irregular waves approaching from various directions based on the spectral method

b. Deepwater Waves Data

▪	Period	:	2006.1.1～2010.12.31
▪	Extraction Point	:	Long. 91°30' E, Long. 20°30' N
▪	Time Interval	:	1 hour
▪	Data Elements	:	Significant wave height, period and direction

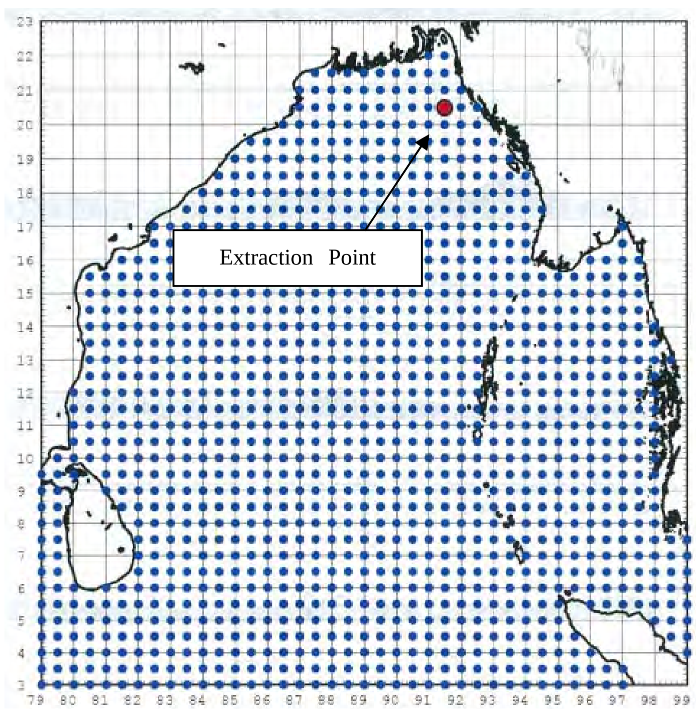


Figure 4.2.2.13 Area of wave forecasting data

Statistical analysis of ordinary deepwater waves has been carried out based on wave estimation data. The composite occurrence frequency table and chart of significant wave height, period and direction are indicated respectively in Table 4.2.2.5 and Figure 4.2.2.14.

Table 4.2.2.5 (1) Composite frequency of significant wave height and period (deepwater, annually)

Point : E91.5 , N20.5
Term : 2006.1.1 ～ 2010.12.31

Wave Direction : ALL

Height (m) \ Period (s)	～ 2.9	3.0 ～ 3.9	4.0 ～ 4.9	5.0 ～ 5.9	6.0 ～ 6.9	7.0 ～ 7.9	8.0 ～ 8.9	9.0 ～ 9.9	10.0 ～ 10.9	11.0 ～ 11.9	12.0 ～ 12.9	13.0 ～ 13.9	14.0 ～ 14.9	15.0 ～	Sum	Total amount
～ 0.49			18 (0.0)	75 (0.2)	187 (0.4)	323 (0.7)	378 (0.9)	346 (0.8)	131 (0.3)	17 (0.0)					1475 (3.4)	1475 (3.4)
0.50 ～ 0.99		6 (0.0)	255 (0.6)	948 (2.2)	1729 (3.9)	2533 (5.8)	3765 (8.6)	3280 (7.5)	1734 (4.0)	484 (1.1)	189 (0.4)	19 (0.0)	13 (0.0)		14955 (34.1)	16430 (37.5)
1.00 ～ 1.49			186 (0.4)	590 (1.3)	1089 (2.5)	2579 (5.9)	2952 (6.7)	1929 (4.4)	1389 (3.2)	917 (2.1)	350 (0.8)	110 (0.3)	18 (0.0)		12109 (27.6)	28539 (65.1)
1.50 ～ 1.99				144 (0.3)	1295 (3.0)	2644 (6.0)	2617 (6.0)	1209 (2.8)	609 (1.4)	122 (0.3)	61 (0.1)	70 (0.2)	4 (0.0)		8775 (20.0)	37314 (85.1)
2.00 ～ 2.49				14 (0.0)	765 (1.7)	1560 (3.6)	1158 (2.6)	462 (1.1)	129 (0.3)	67 (0.2)	42 (0.1)				4197 (9.6)	41511 (94.7)
2.50 ～ 2.99					267 (0.6)	681 (1.6)	369 (0.8)	173 (0.4)	28 (0.1)	13 (0.0)	26 (0.1)				1557 (3.6)	43068 (98.3)
3.00 ～ 3.49					13 (0.0)	256 (0.6)	128 (0.3)	13 (0.0)	1 (0.0)	13 (0.0)					424 (1.0)	43492 (99.2)
3.50 ～ 3.99						131 (0.3)	36 (0.1)	9 (0.0)							176 (0.4)	43668 (99.6)
4.00 ～ 4.49						34 (0.1)	35 (0.1)	6 (0.0)							75 (0.2)	43743 (99.8)
4.50 ～ 4.99						2 (0.0)	17 (0.0)	10 (0.0)							29 (0.1)	43772 (99.9)
5.00 ～ 5.49							13 (0.0)	4 (0.0)	2 (0.0)						19 (0.0)	43791 (99.9)
5.50 ～ 5.99							6 (0.0)	7 (0.0)	4 (0.0)						17 (0.0)	43808 (100.0)
6.00 ～ 6.49								5 (0.0)	5 (0.0)						10 (0.0)	43818 (100.0)
6.50 ～ 6.99									6 (0.0)						6 (0.0)	43824 (100.0)
7.00 ～															0 (0.0)	43824 (100.0)
Sum	0 (0.0)	6 (0.0)	459 (1.0)	1771 (4.0)	5345 (12.2)	10743 (24.5)	11474 (26.2)	7453 (17.0)	4038 (9.2)	1633 (3.7)	668 (1.5)	199 (0.5)	35 (0.1)	0 (0.0)	43824 (100.0)	
Total amount	0 (0.0)	6 (0.0)	465 (1.1)	2236 (5.1)	7581 (17.3)	18324 (41.8)	29798 (68.0)	37251 (85.0)	41289 (94.2)	42922 (97.9)	43590 (99.5)	43789 (99.9)	43824 (100.0)	43824 (100.0)		

upper : frequency , (lower) : ratio

Table 4.2.2.5 (2) Composite frequency of significant wave height and direction (deepwater, annually)

Point : E91.5 , N20.5
Term : 2006.1.1 ~ 2010.12.31

Direction / Height (m)	NNE	NE	ENE	E	ESE	SE	SSE	S	SSW	SW	WSW	W	WNW	NW	NNW	N	Sum
~ 0.49	10 (0.0)	1 (0.0)	1 (0.0)		1 (0.0)	3 (0.0)	66 (0.2)	890 (2.0)	375 (0.9)	52 (0.1)	19 (0.0)	23 (0.1)	17 (0.0)	12 (0.0)	3 (0.0)	2 (0.0)	1475 (3.4)
0.50 ~ 0.99	55 (0.1)	3 (0.0)	1 (0.0)	2 (0.0)		7 (0.0)	37 (0.1)	2921 (6.7)	8670 (19.8)	1486 (3.4)	288 (0.7)	251 (0.6)	239 (0.5)	317 (0.7)	389 (0.9)	289 (0.7)	14955 (34.1)
1.00 ~ 1.49	15 (0.0)					7 (0.0)	39 (0.1)	816 (1.9)	8201 (18.7)	1781 (4.1)	182 (0.4)	105 (0.2)	92 (0.2)	138 (0.3)	424 (1.0)	309 (0.7)	12109 (27.6)
1.50 ~ 1.99						11 (0.0)	40 (0.1)	532 (1.2)	6711 (15.3)	1396 (3.2)			2 (0.0)	3 (0.0)	28 (0.1)	52 (0.1)	8775 (20.0)
2.00 ~ 2.49						12 (0.0)	86 (0.2)	353 (0.8)	2906 (6.6)	838 (1.9)	2 (0.0)						4197 (9.6)
2.50 ~ 2.99						1 (0.0)	74 (0.2)	125 (0.3)	847 (1.9)	508 (1.2)	2 (0.0)						1557 (3.6)
3.00 ~ 3.49							17 (0.0)	73 (0.2)	258 (0.6)	76 (0.2)							424 (1.0)
3.50 ~ 3.99							33 (0.1)	22 (0.1)	80 (0.2)	41 (0.1)							176 (0.4)
4.00 ~ 4.49							22 (0.1)	5 (0.0)	35 (0.1)	13 (0.0)							75 (0.2)
4.50 ~ 4.99							5 (0.0)	9 (0.0)	15 (0.0)								29 (0.1)
5.00 ~ 5.49							7 (0.0)	6 (0.0)	6 (0.0)								19 (0.0)
5.50 ~ 5.99								7 (0.0)	10 (0.0)								17 (0.0)
6.00 ~ 6.49								6 (0.0)	4 (0.0)								10 (0.0)
6.50 ~ 6.99								1 (0.0)	5 (0.0)								6 (0.0)
7.00 ~																	0 (0.0)
Sum	80 (0.2)	4 (0.0)	2 (0.0)	2 (0.0)	1 (0.0)	41 (0.1)	426 (1.0)	5766 (13.2)	28123 (64.2)	6191 (14.1)	493 (1.1)	379 (0.9)	350 (0.8)	470 (1.1)	844 (1.9)	652 (1.5)	43824 (100.0)

upper : frequency , (lower) : ratio

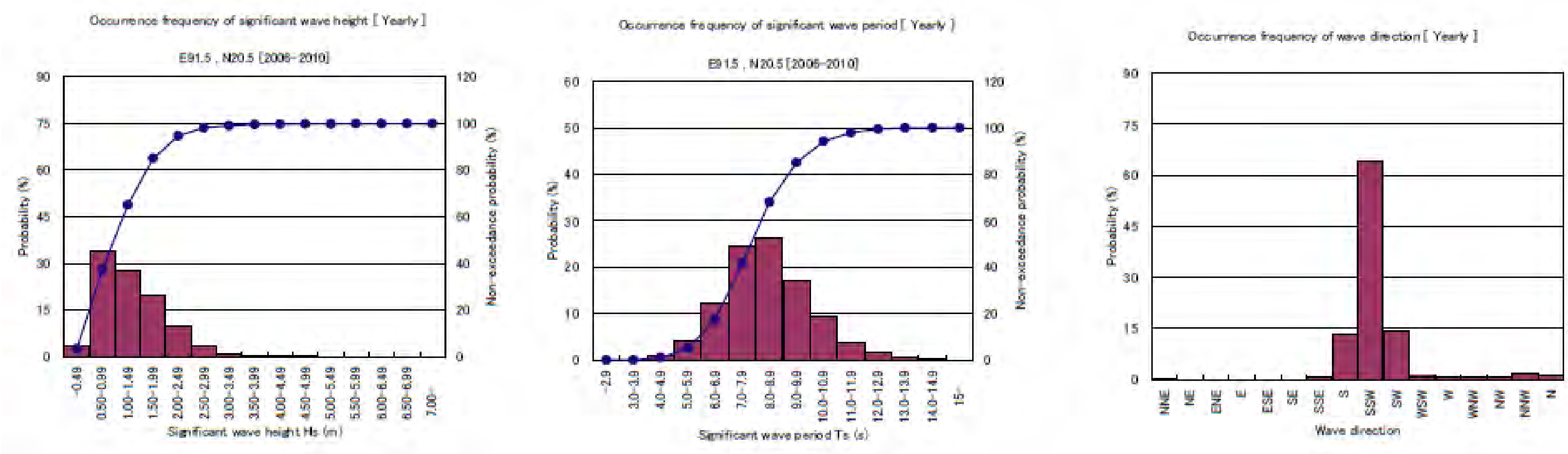


Figure 3.2.2-14 (1) Frequency of significant wave height and direction (deepwater, annually)

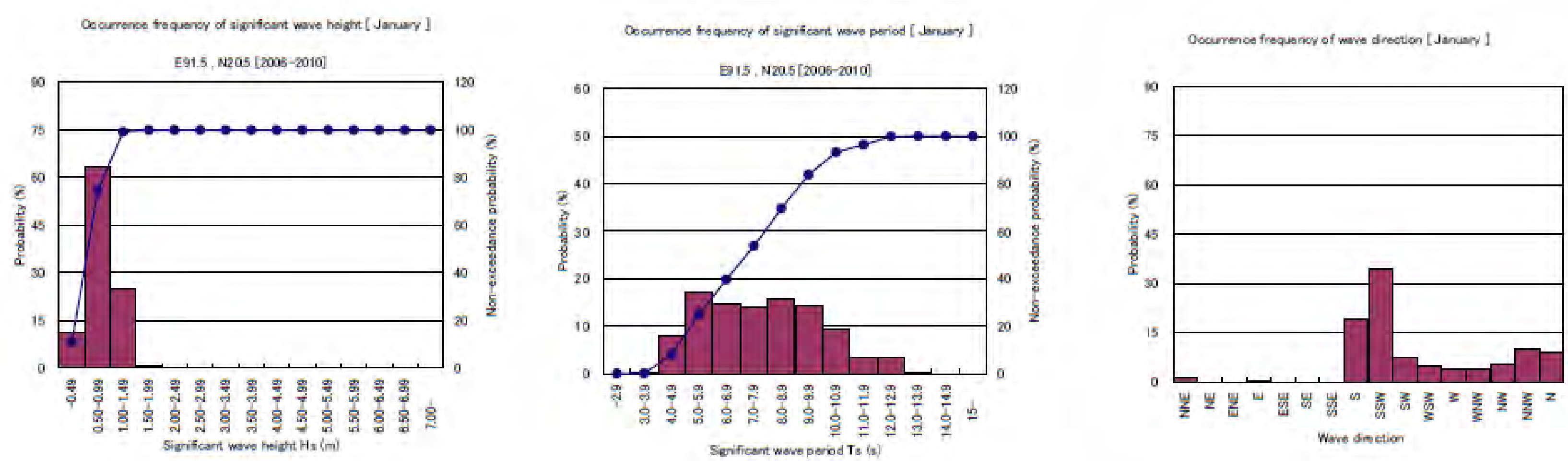


Figure 4.2.2.14 (2) Frequency of significant wave height and direction (deepwater, Jan.)

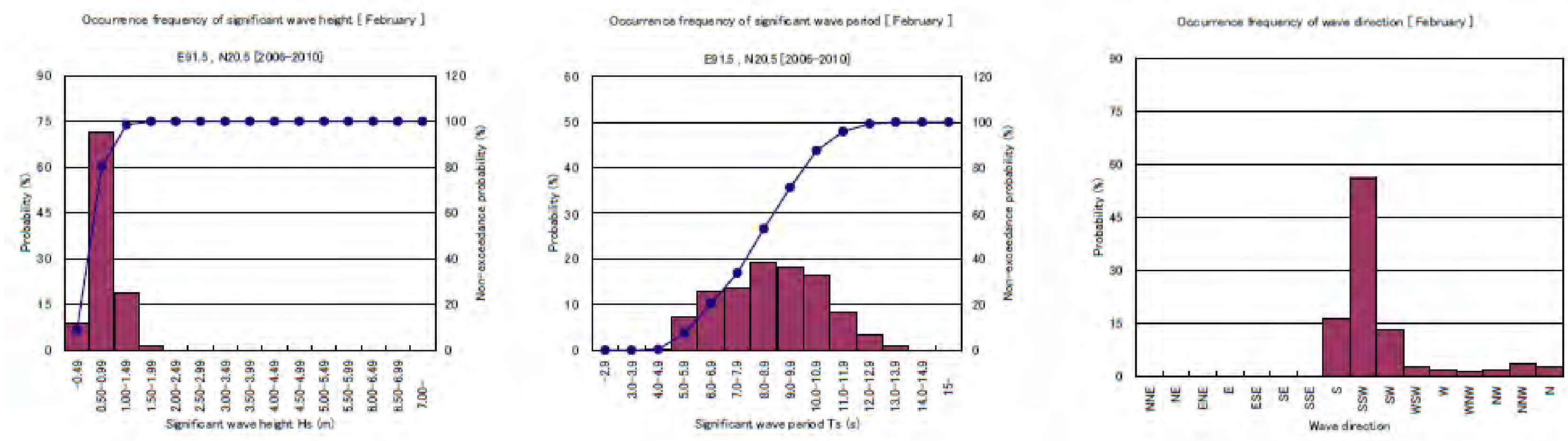


Figure 4.2.2.14 (3) Occurrence frequency of significant wave height and direction (deepwater, Feb.)

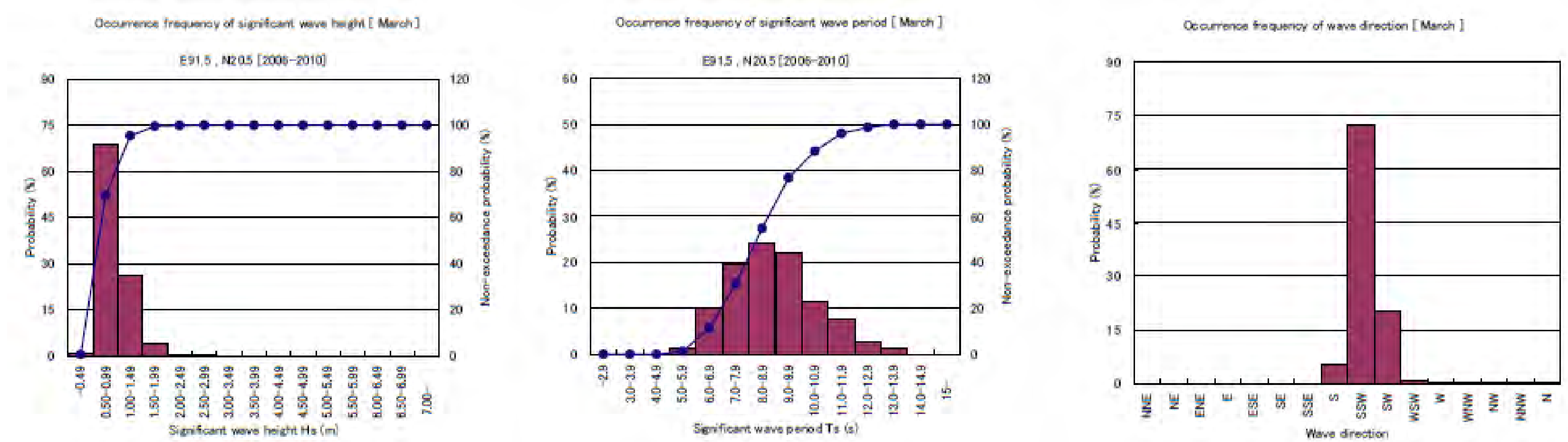


Figure 4.2.2.14 (4) Frequency of significant wave height and direction (deepwater, Mar.)

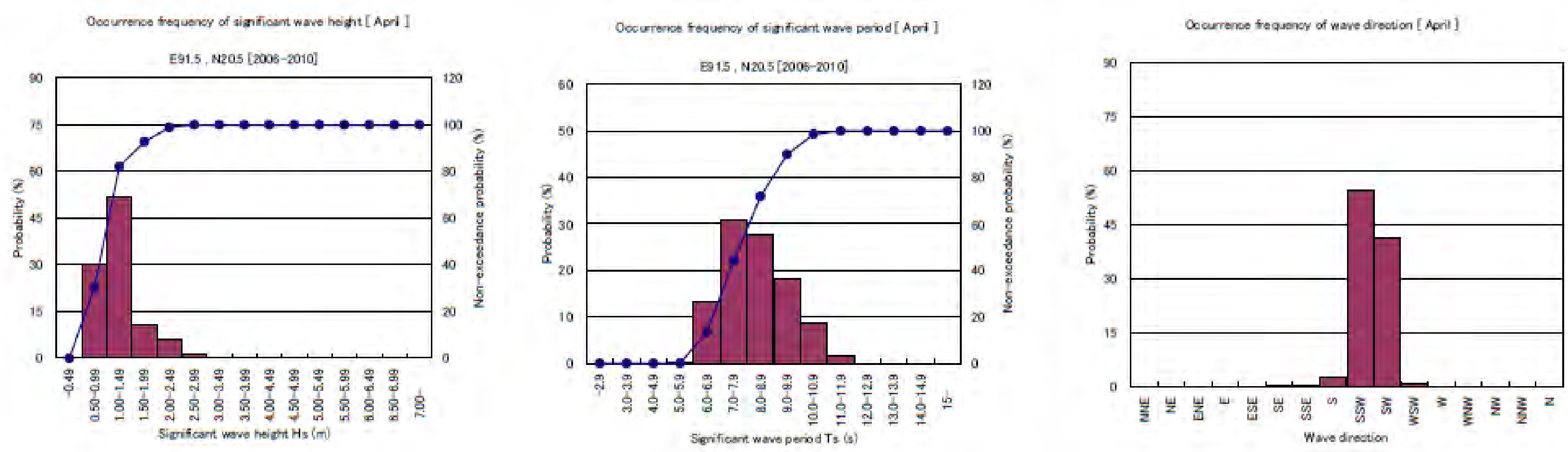


Figure 4.2.2.14 (5) Frequency of significant wave height and direction (deepwater, Apr.)

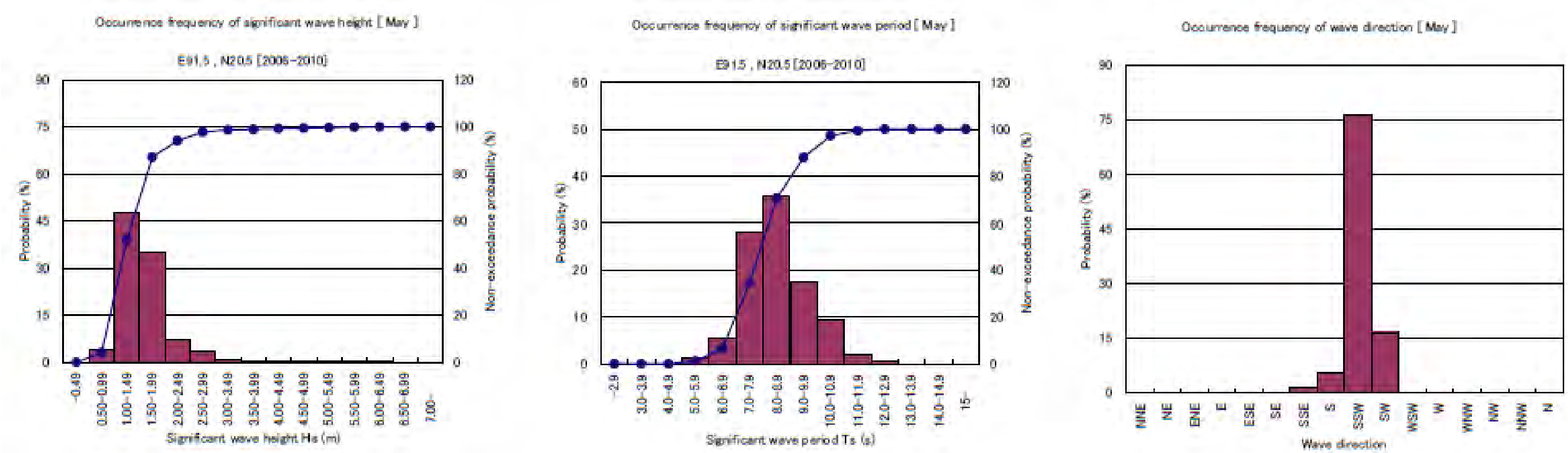


Figure 4.2.2.14 (6) Frequency of significant wave height and direction (deepwater, May)

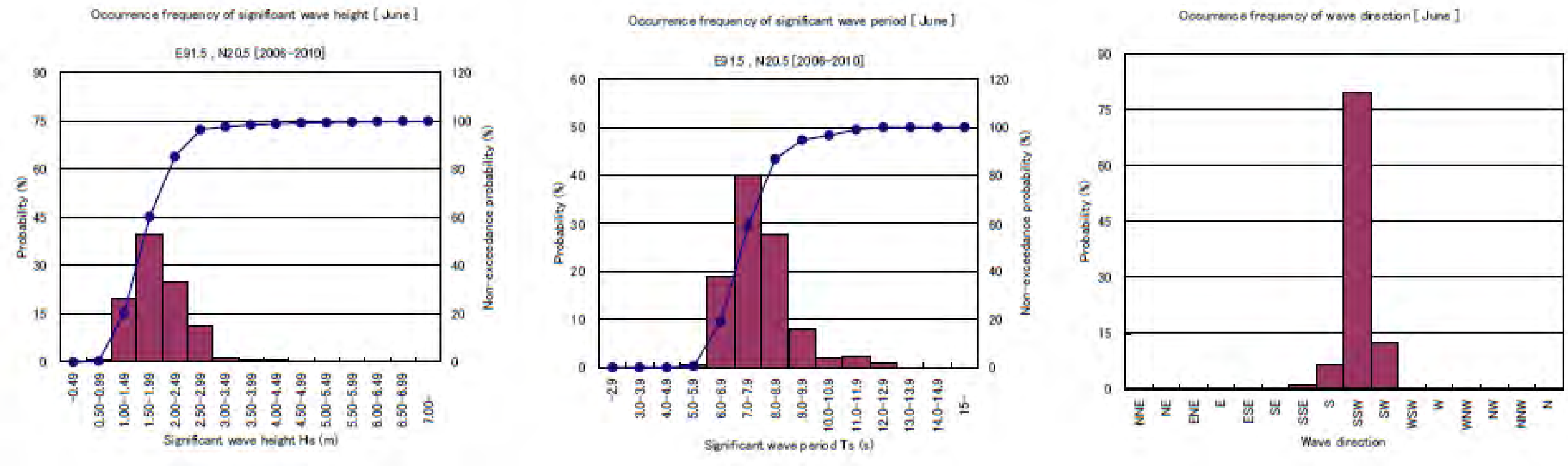


Figure 4.2.2.14 (7) Frequency of significant wave height and direction (deepwater, Jun.)

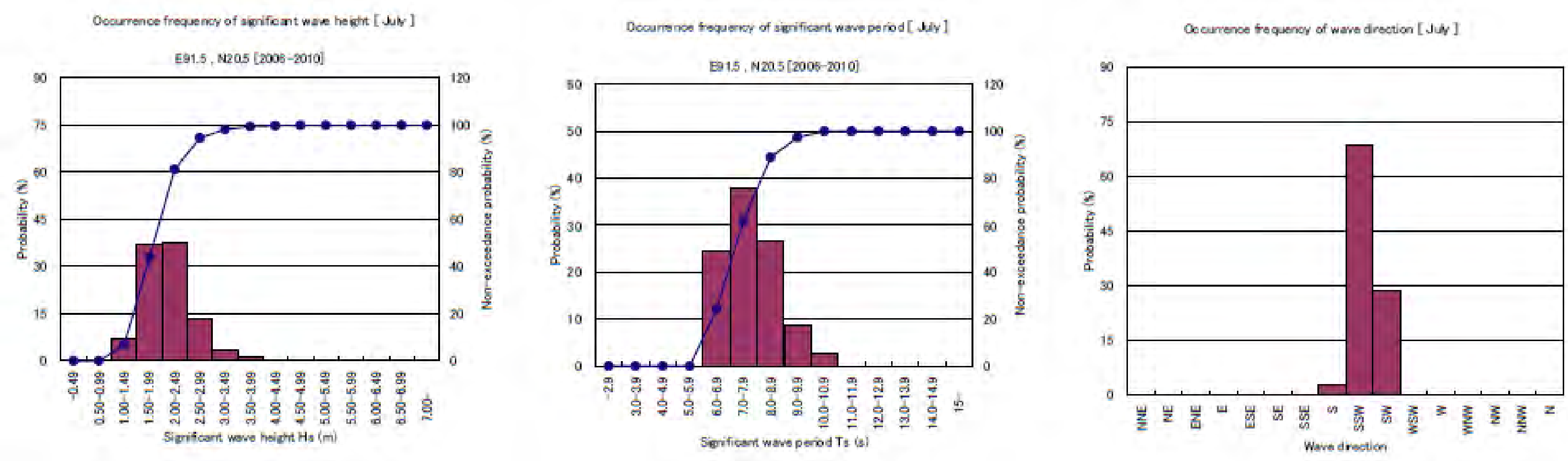


Figure 4.2.2.14 (8) Frequency of significant wave height and direction (deepwater, Jul.)

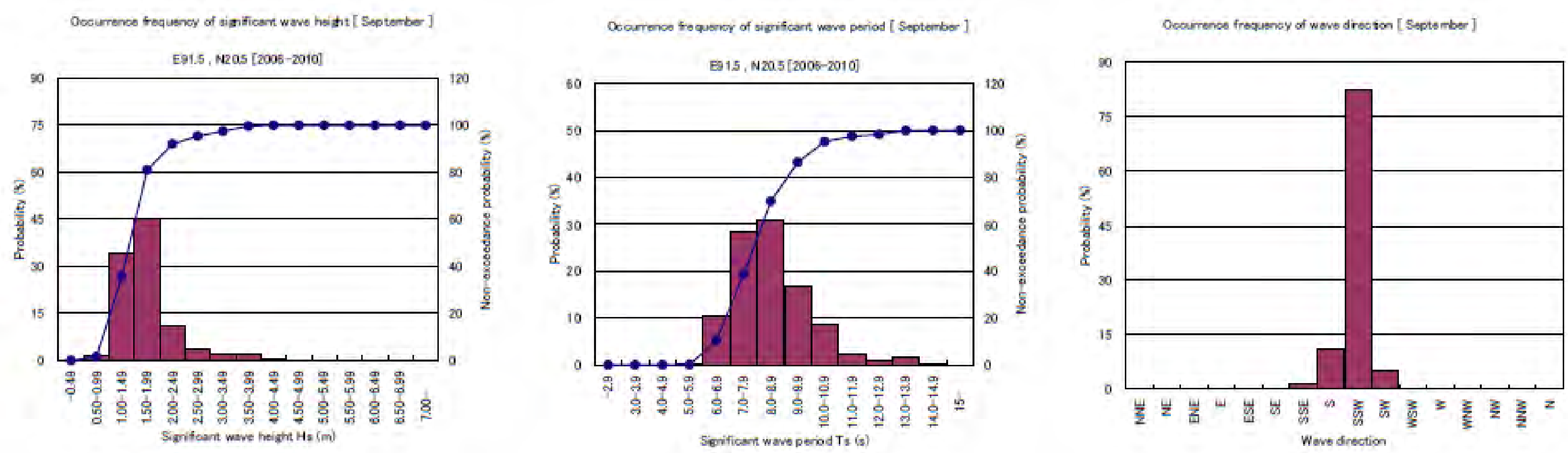


Figure 4.2.2.14 (9) Frequency of significant wave height and direction (deepwater, Aug.)

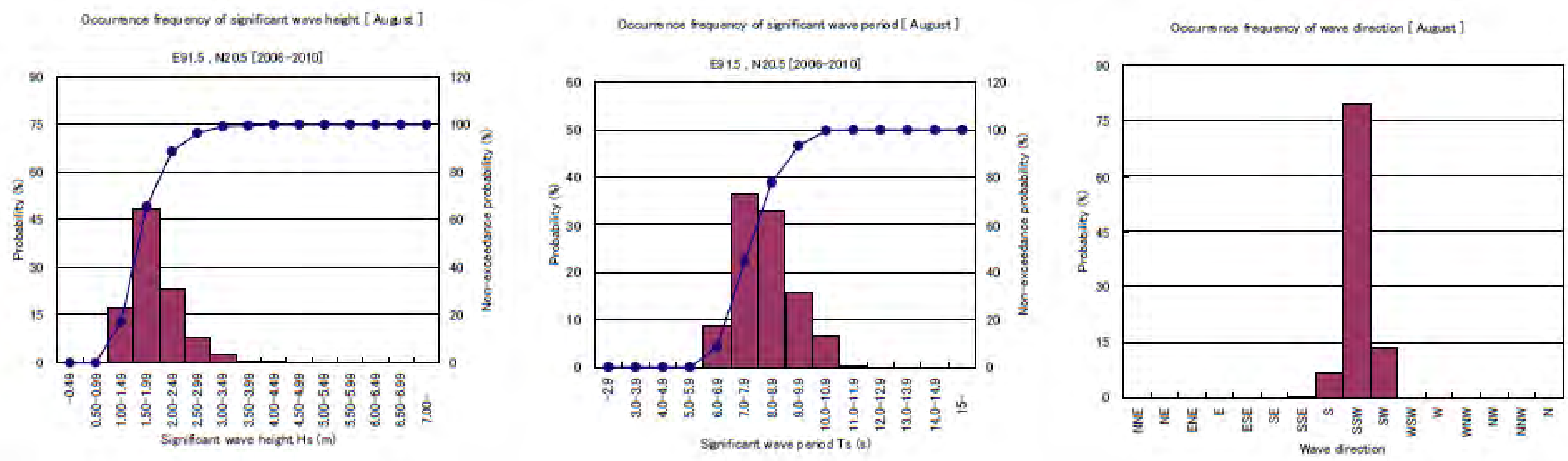


Figure 4.2.2.14 (10) Frequency of significant wave height and direction (deepwater, Sep.)

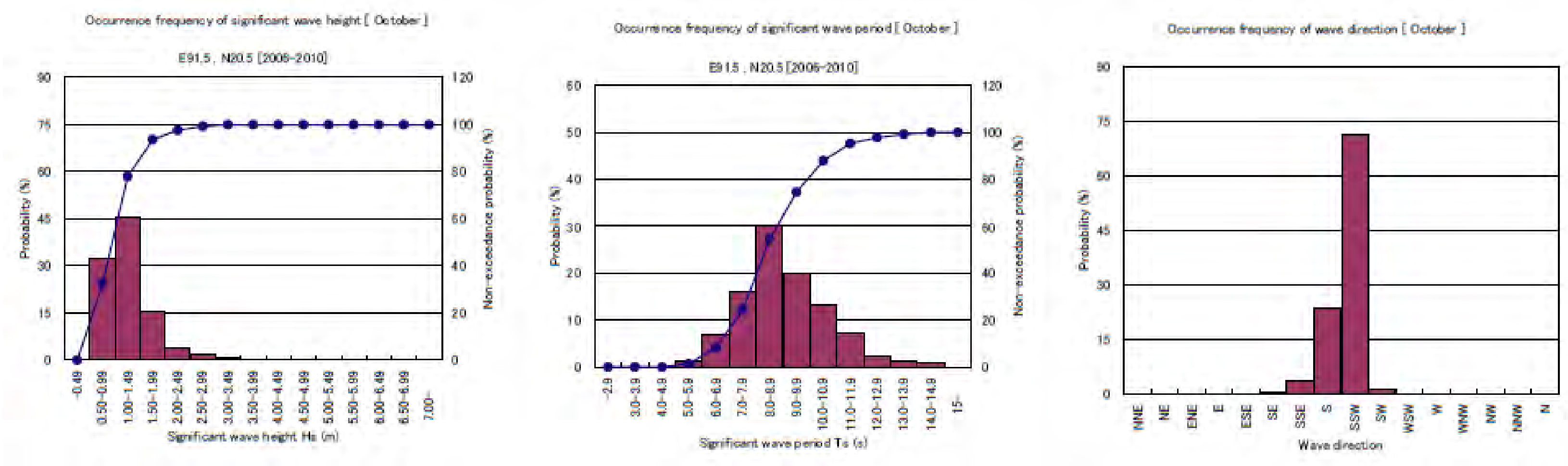


Figure 4.2.2.14 (11) Frequency of significant wave height and direction (deepwater, Oct.)

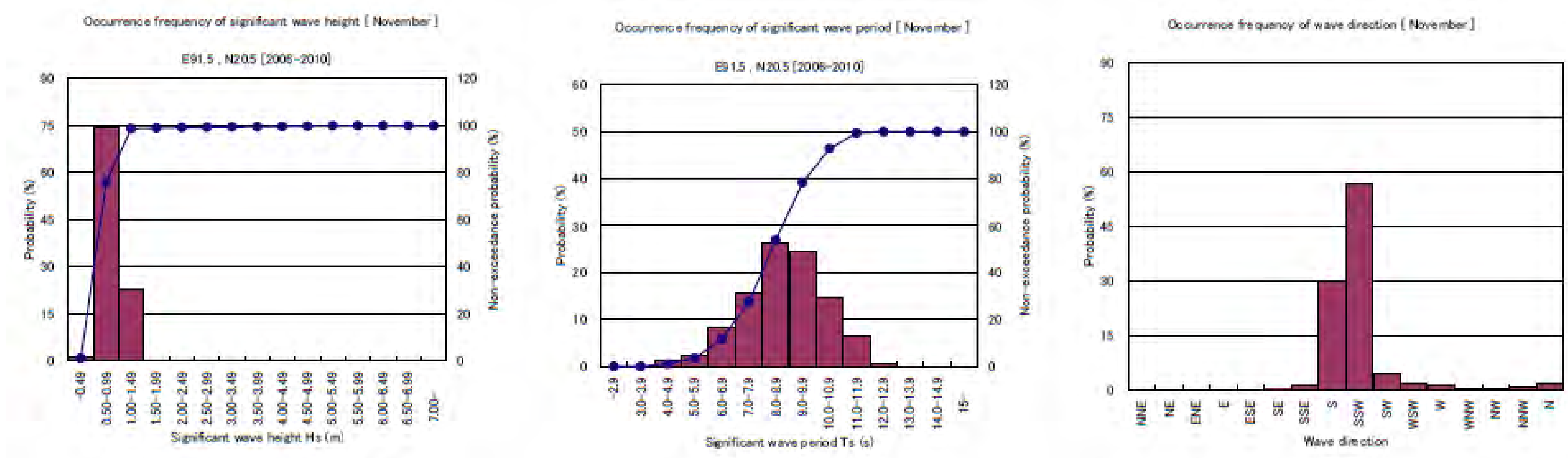


Figure 4.2.2.14 (12) Frequency of significant wave height and direction (deepwater, Nov.)

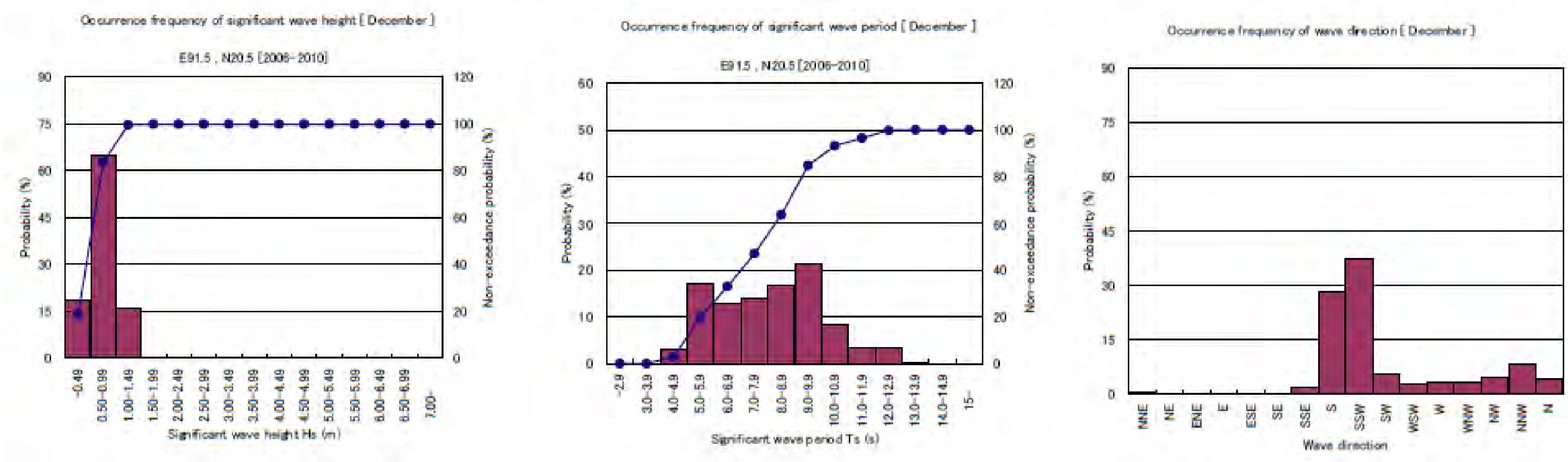


Figure 4.2.2.14 (13) Frequency of significant wave height and direction (deepwater, Dec.)

c) Current

Table 4.2.2.6 Current around Sonadia Island

(m/s)

Flood		Ebb	
Velocity	Direction	Velocity	Direction
1.45	NNE	1.20	SSW

Source: based on current observation data (unreliable data source)

d) Tidal Levels

Table 4.2.2.7 Tidal Levels of Sonadia Island

H.W.L	M.S.L	L.W.L
+1.94	±0.00	-2.08

Source: based on tidal observation data (unreliable data source)

(6) Flood types

There are generally four types of floods in Bangladesh[1] (Figure 4.2.2.15).

Normal Floods: This type of flood generally occurs in the Gangetic deltas where natural drainage systems are deteriorating due to amounts of rainfall that are larger than drainage capacity. They also occur in towns where natural drainage systems have been disturbed because of human interference, mainly due to construction of unplanned rural roads and illegal occupation of river courses.

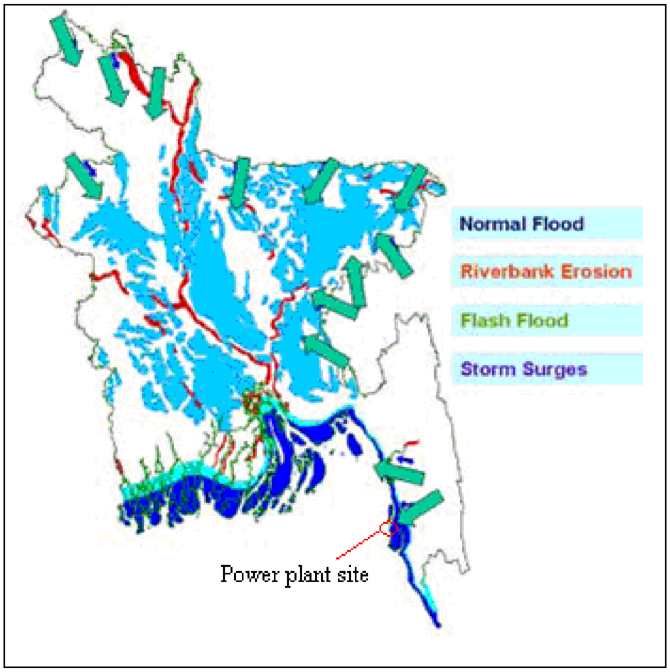
Riverbank Erosion: This type of flood is the most common phenomenon in the country from time immemorial. They normally occur in the monsoon season along the river. In the case of extreme floods, 50~70% of the country are inundated extending into areas far beyond the riverbanks.

Flash Floods: This type of flood is characterized by a rapid rise and fall in water levels. Flash floods occur mostly in the northern area, north-central part, northeastern part and southeastern part of the country.

Storm Surges: This kind of flood mostly occurs along the coastal areas of Bangladesh which has a coast line of about 800km along the northern part of the Bay of Bengal. This coastal area is shallow and the coastal line in the eastern

[1] World Meteorological Organization, 2003: Integrated Flood Management Case Study; BANGLADESH, FLOOD MANAGEMENT

portion is conical in shape. Therefore, Storm Surges are likely to occur due to flood tides of cyclones and southwestern monsoon winds. The power plant site is located in this Storm Surges area.



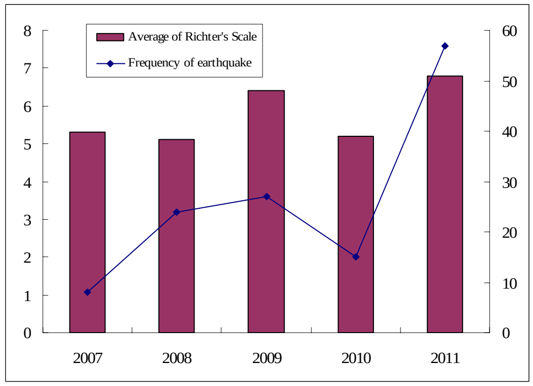
(Source: World Meteorological Organization, 2003)

Figure 4.2.2.15 Areas of four flood types

(7) Seismic coefficient

Earthquakes which have occurred in Bangladesh and the surrounding area since 2007 are recorded by the Bangladesh Meteorological Department (only major earthquakes that caused serious damage had been recorded prior to 2007). Eight earthquakes were recorded in 2007, while 24 to 27 earthquakes were recorded from 2008 to 2009. Fifteen earthquakes were recorded in 2010, while the number increased to 81 in 2011. The number recorded in 2011 included earthquakes with remote epicenters, of which 57 had been recorded prior to 2011 (Figure 4.2.16).

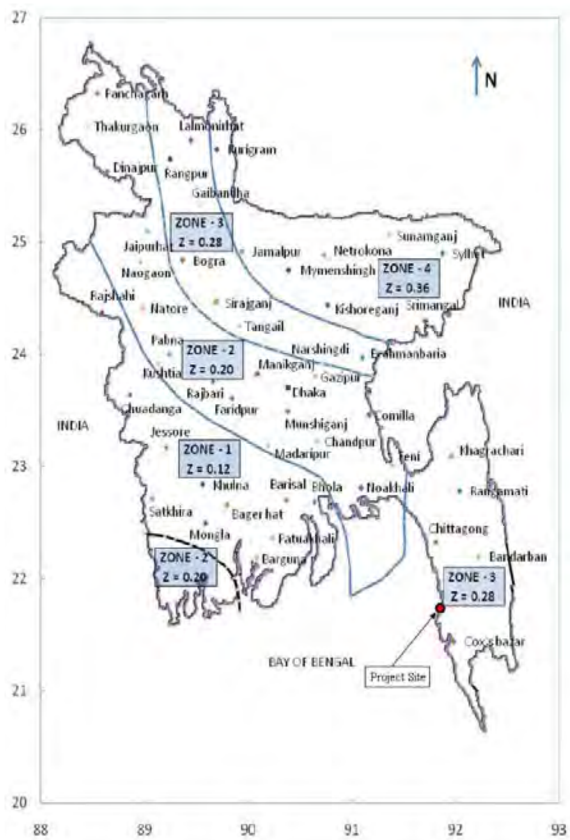
Regarding the intensity of earthquakes as indicated by the Richter Scale, the records of yearly maximums on the Richter scale show that strong earthquakes occurred more often in 2009 and 2011 than in the other 3 years between 2007 and 2011 (Figure 4.2.17).



(Prepared based on the data of Bangladesh Meteorological Department)

Figure 4.2.17 Frequency of earthquakes and maximums on the Richter Scale

Bangladesh is divided into four seismic zones, and the design strength of buildings is stipulated in each seismic zone. The project site is located in Zone -3, the same as Chittagong, where moderate levels of strength designs for buildings will be necessary (Figure 4.2.2.17).



(Source: Bangladesh National Building Code)

Figure 4.2.2.17 Seismic Zone Map of Bangladesh

The seismic coefficient shall be determined from the following relation by the BANGLADESH NATIONAL BULDING CODE 2006.

$$k = k = \frac{Z \cdot I \cdot C}{R}$$

where, k = Seismic coefficient

Z = Seismic zone coefficient given in Table 4.2.2.8

I = Structure importance coefficient given in Table 4.2.2.9

R = Response modification coefficient for structural systems given in Table 4.2.2.11

C = Numerical coefficient given by the relation;

$$C = \frac{1.25S}{T^{2/3}}$$

S = Site coefficient for soil characteristics as provided in Table 4.2.2.10

T = Fundamental period of vibration in seconds

Table 4.2.2.8 Seismic Zone Coefficients (Z)

Seismic Zone	Zone Coefficient
1	0.12
2	0.20
3	0.28
4	0.36

(Source: Bangladesh National Building Code)

Table 4.2.2.9 Structure Importance Coefficients (I)

Structure Importance Categories	Structure Importance Coefficients	
	I	I'
Essential facilities	1.25	1.50
Hazardous facilities	1.25	1.50
Special occupancy structures	1.00	1.00
Standard occupancy structures	1.00	1.00
Low-risk structures	1.00	1.00

Table 4.2.2.10 Site Coefficient (S)

Site Soil Characteristics		Coefficient, S
Type	Description	
S_1	A soil profile with either : a) A rock-like material characterized by a shear-wave velocity greater than 762 m/s or by other suitable means of classification, or b) Stiff or dense soil condition where the soil depth is less than 61 metres	1.0
S_2	A soil profile with dense or stiff soil conditions, where the soil depth exceeds 61 metres	1.2
S_3	A soil profile 21 metres or more in depth and containing more than 6 metres of soft to medium stiff clay but not more than 12 metres of soft clay	1.5
S_4	A soil profile containing more than 12 metres of soft clay characterized by a shear wave velocity less than 152 m/s	2.0

Note : (1) The site coefficient shall be established from properly substantiated geotechnical data. In locations where the soil properties are not known in sufficient detail to determine the soil profile type, soil profile S_3 shall be used. Soil profile S_4 need not be assumed unless the building official determines that soil profile S_4 may be present at the site, or in the event that soil profile S_4 is established by geotechnical data.

Table 4.2.2.11 Response Modification Coefficient for Structural Systems (R)

Basic Structural System(1)	description of Lateral Force Resisting System	$R^{(2)}$
a. Bearing Wall System	1. Light framed walls with shear panels	
	i) Plywood walls for structures, 3 storeys or less	8
	ii) All other light framed walls	6
	2. Shear walls	
	i) Concrete	6
	ii) Masonry	6
	3. Light steel framed bearing walls with tension only bracing	4
	4. Braced frames where bracing carries gravity loads	
	i) Steel	6
	ii) Concrete (3)	4
	iii) Heavy timber	4
b. Building Frame System	1. Steel eccentric braced frame (EBF)	10
	2. Light framed walls with shear panels	
	i) Plywood walls for structures 3-storeys or less	9
	ii) All other light framed walls	7
	3. Shear walls	
	i) Concrete	8
	ii) Masonry	8
	4. Concentric braced frames (CBF)	
	i) Steel	8
	ii) Concrete (3)	8
	iii) Heavy timber	8
c. Moment Resisting Frame System	1. Special moment resisting frames (SMRF)	
	i) Steel	12
	ii) Concrete	12
	2. Intermediate moment resisting frames (IMRF), concrete (4)	8
	3. Ordinary moment resisting frames (OMRF)	
	i) Steel	6
	ii) Concrete (5)	5
d. Dual System	1. Shear walls	
	i) Concrete with steel or concrete SMRF	12
	ii) Concrete with steel OMRF	6
	iii) Concrete with concrete IMRF (4)	9
	iv) Masonry with steel or concrete SMRF	8
	v) Masonry with steel OMRF	6
	vi) Masonry with concrete IMRF (3)	7
	2. Steel EBF	
	i) With steel SMRF	12
	ii) With steel OMRF	6
	3. Concentric braced frame (CBF)	
	i) Steel with steel SMRF	10
	ii) Steel with steel OMRF	6
	iii) Concrete with concrete SMRF (3)	9
	iv) Concrete with concrete IMRF (3)	6
e. Special Structural Systems	See Sec 1.3. 2, 1. 3. 3, 1.3.5	

Notes : (1) Basic Structural Systems are defined in Sec 1.3.2, Chapter 1.
(2) See Sec 2.5.6.6 for combination of structural systems, and Sec 1.3.5 for system limitations.
(3) Prohibited in Seismic Zone 3.
(4) Prohibited in Seismic Zone 3 except as permitted in Sec. 2.5.9.3.
(5) Prohibited in seismic Zones 2 and 3. Sec 1.7.2.6.

A seismic coefficient was calculated using each coefficient above.

In addition, the shear wave velocity and the natural period of each structure can be calculated as needed.

(8) Cyclone

During the years 1960 to 2010, Bangladesh was hit by 53 severe cyclones, 32 of which were accompanied by storm surges. Table 4.2.2.12 lists the disasters with particular reference to the wind speed, surge height, and loss of life. The height of the surges is limited to a maximum of 10 meters in the bay.

Table 4.2.2.12 List of Major Cyclonic Storms from 1960 to 2011

Date of Landfall	Nature of Phenomenon	Landfall Area	Maximum Wind Speed in kph	No. of Deaths	Surge Height
11.10.1960	S.C.S	Chittagong	160	3,450	6.0m
31.10.1960	S.C.S	Chittagong	193	5,149	6.6m
09.05.1961	S.C.S	Chittagong	160	11,468	5.0m
30.05.1961	S.C.S	Chittagong (Near Feni)	160	-	2.0 - 4.55m
28.05.1963	S.C.S	Chittagong- Cox's Bazar	200	11,520	6.0m
11.05.1965	S.C.S	Chittagong -Barisal Coast	160	19,279	3.7m
05.11.1965	S.C.S	Chittagong	160		6.1 - 7.6m
15.12.1965	S.C.S	Cox's Bazar	210	873	2.4 - 3.6m
23.09.1966	S.C.S	Noakhali coast	139	850	6 - 6.67m
07.12.1966	S.C.S	Cox's Bazar	81	-	-
08.11.1967	C.S	Khulna (Sundarban)	111 (sandheads)	1000 (India)	-
23.10.1967	S.C.S	Near Cox’s Bazar	107(cox’s) 145(M.mar)	51	-
23.10.1970	S.C.S of hurricane intensity	Bangladesh -West Bengal coast	163	300	4.7 m
12.11.1970	S.C.S with a core of hurricane winds	Chittagong	224	3,00,000	3 - 10m
8.05.1971	C.S	Chittagong	81	-	2.4 - 4.24m
29.09.1971	S.C.S	Sundarban coast	97-113	-	0.6m
6.11.1971	S.C.S	Chittagong- Noakhali coast	-	-	-
18.11.1973	S.C.S	Chittagong	102	-	-
30.05.1974	C.S	Patuakhali	74-83	-	-
28.11.1974	S.C.S	Chittagong- Cox's Bazar coast	163	20	3.0 - 5.1m
10.12.1981	C.S	Khulna	120	72	2.12 - 4.55m
15.10.1983	C.S	Chittagong	93	43	-
09.11.1983	S.C.S	Chittagong -Cox's Bazar coast	136	300	1.5m
24.05.1985	S.C.S	Chittagong	154	4,264	4.55m
29.11.1988	S.C.S with a core of hurricane winds	Khulna coast	160	5,683	4.4m
18.12.1990	Cyclonic Storm (crossed land as a depression)	Cox's Bazar Coast	115	-	-
29.04.1991	S.C.S with a core of hurricane winds	Chittagong	225	1,38,882	6-7.6m
31.05.1991	C.S	Noakhali coast	83	--	2.5m
02.05.1994	S.C.S with a core of hurricane winds	Cox's Bazar-Teknaf Coast	200-250	184	3.64-4.85m
25.11.1995	S.C.S	South of Cox's Bazar	55	---	---

Date of Landfall	Nature of Phenomenon	Landfall Area	Maximum Wind Speed in kph	No. of Deaths	Surge Height
26.10.1996	C.S	Sundarban coast	70	09	1.5-2.0m
19.05.1997	S.C.S with a core of hurricane winds	Sitakundu	232	155	4.55 m
27.09.1997	S.C.S with a core of hurricane winds	Sitakundu	150	67	3.0-4.55m
20.05.1998	S.C.S with core of hurricane winds	Chittagong Coast near Sitakunda	173	14	0.9m
17.10.1999	S.C.S of hurricane intensity	Orissa Coast	-	-	-
25.10.1999	S.C.S of hurricane intensity	Orissa Coast	-	-	-
28.10.2000	Deep Depression (probably Cyclonic Storm)	Sundarban coast near Mongla	50-60	3	0.6-1.2m
16-10.2001	S.C.S	Andhra coast	65-85	-	-
12.11.2002	C.S	Sundarban coast near Raimangal river	65-85	2	1.5-2.1m
20.5.2003	C.S	Myanmar coast	65-85	-	0.9-1.5m
16.12.2003	S.C.S	Andhra coast	98-115	-	-
19.05.2004	C.S	Cox's Bazar & Akyab Coast	65-90	---	0.6-1.2m
28.10.2005	C.S	Andhra coast near Ongole.	-	-	-
10.12.2005	Cyclonic Storm (crossed land as a depression)	Tamilnadu coast near Nagapattnam.	-	-	-
29.04.2006	S.C.S with a core of Hurricane **"Mala"**	Arakan coast of Myanmar between Akyab & Sandoway	-	-	-
15.05.2007	C.S **"AKASH"**	Ctg- Cox's Bazar. Coast near	83	-	-
15.11.2007	S.C.S **"SIDR"** with a core of hurricane winds	Khulna-Barisal coast near Baleshwar river	223	3,363	4.6-6.1m
02.05.2008	S.C.S **"NARGIS"** with a core of hurricane winds	Myanmar coast near Bassein	-	-	-
26.10.2008	C.S **"Rashmi"**	Khulna-Barisal coast near Patharghata	-	---	1.5-2.1m
27.11.2008	C.S **"Nisha"**	Tamilnadu coast near Nagapathnam.	-	-	-
17.04.2009	C.S **"BIJLI"**	Chittagong-Cox'sBazar coast near Ctg.	90	---	---
25.05.2009	C.S **"AILA"**	West Bengal-Khulna (Bangladesh) coast near Sagar inland of India.	92	190	2.1-2.4m
20.05.2010	S.C.S **"LAILA"**	NE Andhra coast of India	-	-	-

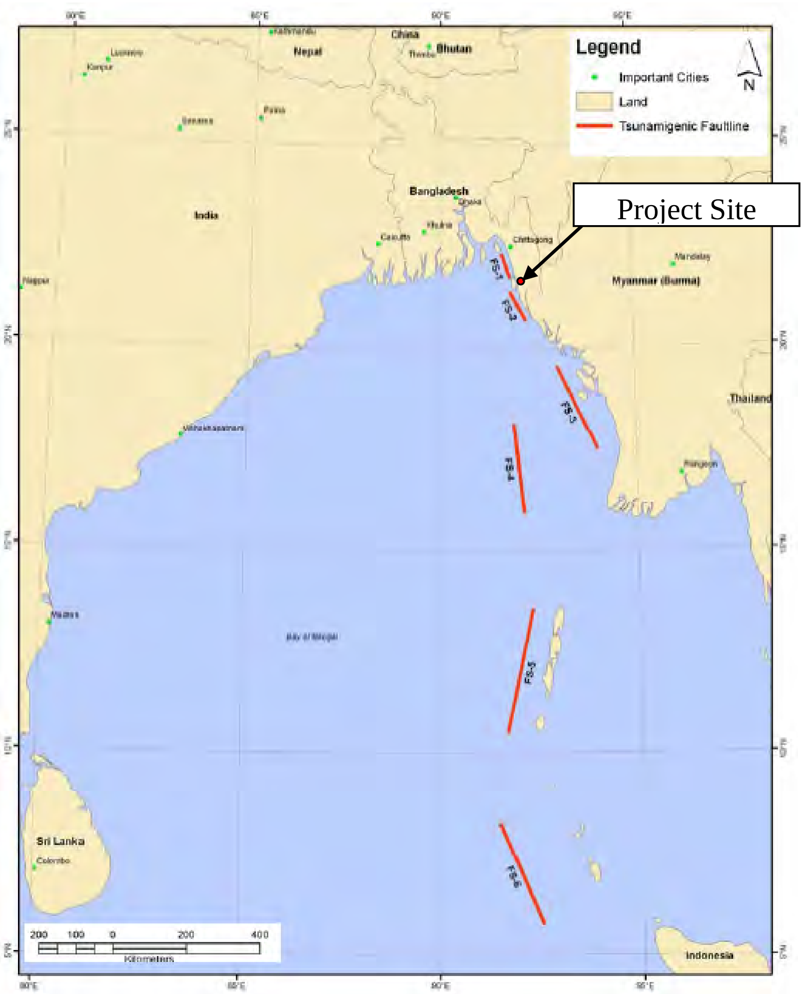
S.C.S⇕ Severe Cyclonic Storm, C.S⇕ Cyclonic StormRefer to 4.1.2 Environmental Situation, (3) Cyclonic Storm Surges.

(9) Tsunami

A literature survey was carried out on the data concerning Tsunami.

Tsunamigenic Fault Source

Based on a report of the Ministry of Food and Disaster Management, a potential fault source map of the Bay of Bengal has been prepared and presented in Figure 4.2.2.18.
It shows six potential tsunamigenic fault sources.



(Source: Use Existing Data on Available Digital Elevation Models to prepare Useable Tsunami and Storm Surge Inundation Risk Maps for the Entire Coastal Region Final Report 2009)

Figure 4.2.2.18 Potential Tsunamigenic faut-source map

Inundation Risk Map

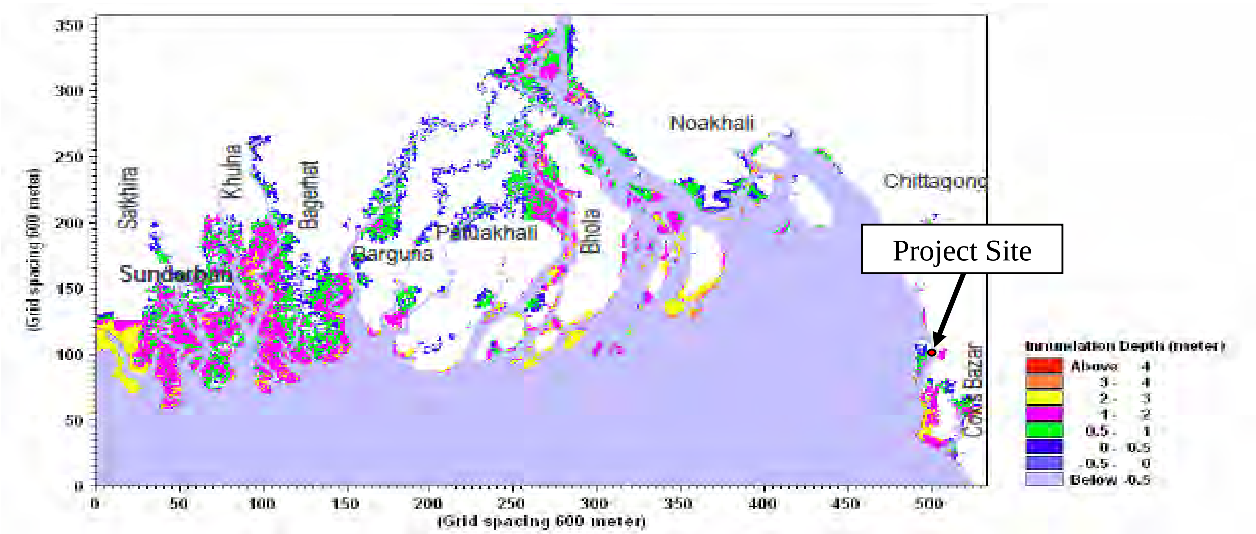
Based on a report of the Ministry of Food and Disaster Management, an Inundation Risk Map has been prepared and presented in Figure 4.2.2.19.

A tsunami model was developed for the Indian Ocean, the Arabian Sea, the Bay of Bengal and the coastal region of Bangladesh using the MIKE21 model system of DHI (Water Environment Health). The model was calibrated with the tsunami of December 26, 2004, which occurred on the West Coast of Sumatra due to an earthquake. The model was applied to simulate a tsunami propagation and inundation from its sources to the coast of Bangladesh.

An inundation risk map for the coastal region of Bangladesh was prepared based on six scenarios of tsunamis originating from six potential sources of earthquakes in the Bay of Bengal. Initially all the tsunamis generated from the potential sources were simulated using the MIKE 21 model system. Maximum inundation maps for all of the tsunamis were generated from the simulation results under Mean High Water Spring (MHWS) tide conditions. Finally, the inundation risk map was generated based on the maximum inundation maps using GIS tools.

The inundation risk map for tsunamis shows that the Cox's Bazaar coast near the project site would be inundated during a tsunami. Maximum inundations have been found Cox's Bazar coast near the project site in the range of 1-3 m.

For reference, it was found that in the 2004 Sumatra case that first tsunami after the earthquake arrived within 2.2 hours with a maximum height of 31 cm at St. Martin Island.



(Source: Use Existing Data on Available Digital Elevation Models to prepare Useable Tsunami and Storm Surge Inundation Risk Maps for the Entire Coastal Region Final Report 2009)

Figure 4.2.2.19 Maximum Inundation Map for Tsunamis

Tsunami Conditions

Based on a report of the Ministry of Food and Disaster Management, which gives detailed descriptions of related tsunamigenic fault sources and tsunami simulations, a tsunami height of 1 - 3m is predicted.

As a result of this, tsunami height is considerably lower than the storm surge height in the range of 7 - 9m. Therefore, tsunami conditions have not been included in the design of the power plant ground level.

(10) Air quality

a) Sampling points

The residential areas within the site and in the north and the site were selected as sampling points for air quality and noise measurement. The survey was conducted in the rainy season (19 to 20 of October 2012) and in the dry season (29 to 30 of January 2013) to reflect the influence of precipitation in the fluctuation of air quality.

Sampling Point	Latitude (North)	Longitude (East)
AN-1	21°43'19"	91°53'03"
AN-2	21°43'56"	91°53'28"
AN-3	21°42'28"	91°52'43"

(Source: JICA Study Team)

Figure 4.2.2.20 Sampling points of air quality survey and noise measurement

b) Results

The main industries of Matarbari Island are agriculture and fishery, and it is not an industrial area. The air quality survey results indicated overall that the air quality in the rainy season is clean, with a slightly high concentration of dust (SPM) and a low concentration of SOx and NOx (Table 4.2.2.13).

Table 4.2.2.13(1) Results of air quality survey

(Rainy season: 19 20/October/2012)

Parameter	Unit	Results			Ambient Air Quality Standards	IFC EHS Guideline (General: 2007)
		AN1	AN2	AN3		
SPM	μg/m^3	54	56	42	200 (8hr) PM_{10}: 150 (24hr) PM_{10}: 50 (year)	SPM: - PM_{10}: 150 (24hr) PM_{10}: 70 (year)
SO_2	μg/m^3	3.2	3.4	3.0	365 (24hr) 80 (year)	500 (10min) 125 (24hr)
NO_2	μg/m^3	6.2	6.5	6.0	100 (year)	200 (1hr) 40 (year)

(Source: JICA Study Team)

Table 4.2.2.13 (2) Results of air quality survey

(Dry season: 29 30/January/2013)

Parameter	Unit	Results			Ambient Air Quality Standards	IFC EHS Guideline (General: 2007)
		AN1	AN2	AN3		
SPM	μg/m^3	59	62	45	200 (8hr) PM_{10}: 150 (24hr) PM_{10}: 50 (year)	SPM: - PM_{10}: 150 (24hr) PM_{10}: 70 (year)
SO_2	μg/m^3	4.0	4.1	3.0	365 (24hr) 80 (year)	500 (10min) 125 (24hr)
NO_2	μg/m^3	7.4	7.6	5.0	100 (year)	200 (1hr) 40 (year)

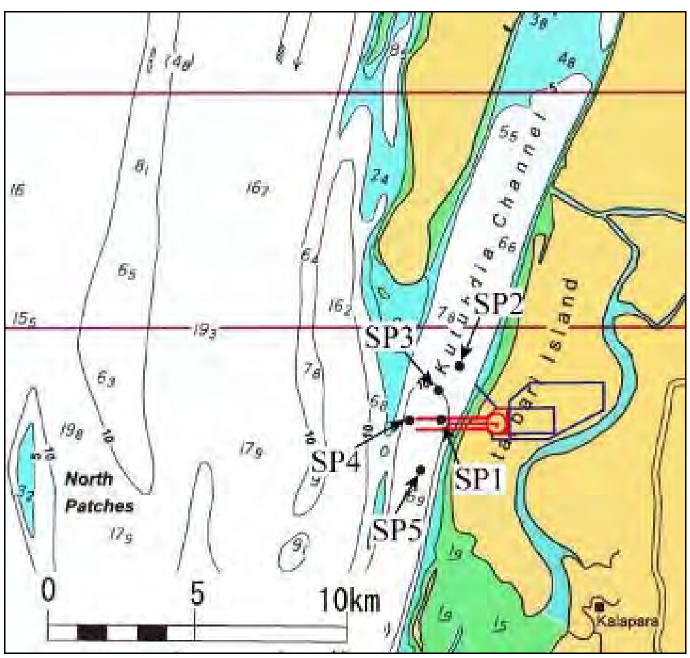
(Source: JICA Study Team)

(11) Water quality

a) Sea water

a. Sampling points

Five sampling points were selected in the sea front area of the power plant site in consideration of the discharge outlet of thermal wastewater and dredging the canal. The sampling was conducted in three layers, Surface (0.5m), Middle (1/2 depth), and Bottom (1m up from the bottom) in consideration of submerged discharge of thermal wastewater. Also, the survey was conducted in the rainy season (19 to 20 of October 2012) and in the dry season (29 of January 2013) to reflect the wide seasonal fluctuation of precipitation in Bangladesh.



Sampling Points	Latitude (North)	Longitude (East)
SP1	21°41'58.92”	91°51'04.99"
SP2	21°43'00.57”	91°51'32.44”
SP3	21°42'33.74”	91°51'08.55”
SP4	21°41'56.99”	91°50'29.11”
SP5	21°40'56.65”	91°50'43.90”

(Source: JICA Study Team)

Figure 4.2.2.21 Sampling points of the sea water quality survey

b. Results

<Rainy season>

The water temperature was in the range of 28.5 - 30.5 °C, with the tendency of higher temperatures near the surface layer and lowering towards the deeper layer. The salinity was in the range of 15.8 - 21.6, tending to be lower in the surface layer and becoming higher toward the deeper layer. It should be noted that, according to the database of the Japan Oceanographic Data Center[2], salinity in the surface layer in the sea areas of 21 - 22°N and 91 - 92°E are within the range of 23.95 - 31.93. The salinity in the sea front area of the project site is assumed to be influenced by the Padma River and other rivers. SS (suspended solids) concentration is very high (640 - 910mg/L) due to the strong effects of river water. COD is also very high (160 - 197mg/L), while BOD is not at a high level (0.6 - 1.1mg/L) (the water quality standard for surface water is 2mg/L or less). Concentration of heavy metals, with the exception of a rather high concentration of Iron (Fe), was not high.

Table 4.2.2.14 (1) Results of sea water quality survey

(Rainy season: 6 7/October/2012)

Parameter	Unit	SP-1			SP-2			SP-3		
		Surface	Middle	Bottom	Surface	Middle	Bottom	Surface	Middle	Bottom
Depth	M	0.5			0.5			0.5		
Temperature	°C	30.0	28.8	29.0	30.0	29.0	28.5	30.5	29.5	28.5
Salinity	-	15.8	17.5	18.5	16.5	18.0	18.5	16.3	16.5	17.2
pH	-	8.19	8.26	8.11	7.90	8.10	8.00	8.13	8.10	8.12
DO	mg/L	5.4	5.3	5.0	5.5	5.3	5.1	5.6	5.4	5.1
BOD	mg/L	1.0	0.7	0.6	1.0	0.8	0.7	0.8	0.7	0.6
COD	mg/L	180	182	160	184	182	182	178	180	180
Oil & Grease	mg/L	5.5	3.0	0.5	5.4	3.1	0.5	4.5	3.0	0.5
SS	mg/L	782	641	834	780	640	835	776	688	795
T-Cr	mg/L	0.011	0.014	0.057	0.019	0.023	0.050	0.009	0.010	0.016
Cu	mg/L	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1	0.1
Fe	mg/L	2.24	4.59	60.50	13.30	21.60	51.90	2.50	4.10	8.72
Zn	mg/L	0.1	0.1	0.13	0.1	0.1	0.11	0.1	0.1	0.1
Pb	mg/L	0.01	0.01	0.018	0.01	0.01	0.019	0.01	0.01	0.01
Cd	mg/L	0.001	0.001	0.002	0.001	0.001	0.001	0.001	0.001	0.001
Hg	mg/L	0.003	0.002	0.006	0.002	0.003	0.005	0.004	0.005	0.005
As	mg/L	0.005	0.008	0.010	0.007	0.005	0.009	0.005	0.008	0.005

[2] http://www.jodc.go.jp/index_j.html

Parameter	Unit	SP-4			SP-5			Average		
		Surface	Middle	Bottom	Surface	Middle	Bottom	Surface	Middle	Bottom
Depth	M	0.5			0.5			-	-	-
Temperature	^oC	29.0	28.5	30.0	30.5	30.5	29.0	30.0	29.3	29.0
Salinity	-	19.6	20.1	20.2	20.8	21.2	21.6	17.8	18.7	19.2
pH	-	8.15	8.00	8.20	8.18	8.15	7.95	8.11	8.12	8.08
DO	mg/L	5.4	5.2	4.9	5.4	4.9	4.6	5.5	5.2	4.9
BOD	mg/L	1.1	0.8	0.7	1.1	0.8	0.8	1.0	0.8	0.7
COD	mg/L	191	193	193	196	197	195	186	187	182
Oil & Grease	mg/L	4.4	3.0	0.5	5.5	3.0	0.5	5.1	3.0	0.5
SS	mg/L	770	752	883	782	761	910	778	696	851
T-Cr	mg/L	0.012	0.015	0.027	0.013	0.017	0.017	0.013	0.016	0.033
Cu	mg/L	0.1	0.1	0.23	0.1	0.1	0.1	0.10	0.10	0.13
Fe	mg/L	5.00	10.20	25.70	5.17	10.60	11.60	5.64	10.22	31.68
Zn	mg/L	0.1	0.1	1.21	0.1	0.1	0.1	0.10	0.10	0.33
Pb	mg/L	0.01	0.01	0.130	0.01	0.01	0.01	0.010	0.010	0.037
Cd	mg/L	0.002	0.002	0.001	0.001	0.001	0.002	0.001	0.001	0.001
Hg	mg/L	0.003	0.004	0.008	0.005	0.003	0.004	0.003	0.003	0.006
As	mg/L	0.019	0.005	0.037	0.014	0.014	0.005	0.010	0.008	0.013

(Source: JICA Study Team)

<Dry season>

The water temperature was in the range of 18.0 - 19.0^{o}C, and temperature differences by water depths were not observed. The salinity was in the range of 34.3 - 37.3 with no big difference between water depths, the same as the water temperature. The salinity in the sea front area of the project site is assumed to be influenced by the Padma River and other rivers. Suspended solids ("SS") concentration is very high (46 - 329 mg/L) due to the strong effects of river water, especially at the bottom layer. COD is also very high (203 - 235 mg/L), while BOD is not at a high level (0.2 - 0.6 mg/L). Concentration of heavy metals, with the exception of a rather high concentration of Iron (Fe), was not high.

Table 4.2.2.14 (2) Results of sea water quality survey

(Dry season: 29/January/2013)

Parameter	Unit	SP-1			SP-2			SP-3		
		Surface	Middle	Bottom	Surface	Middle	Bottom	Surface	Middle	Bottom
Depth	M	0.5	5.0	9.0	0.5	5.0	9.0	0.5	4.5	8.0
Temperature	^oC	19.0	19.0	19.0	18.0	18.0	18.0	18.0	18.0	18.0
Salinity	-	35.3	35.8	35.3	35.2	36.2	35.7	35.0	35.8	34.9
pH	-	8.03	8.01	7.91	7.86	7.91	8.02	8.00	7.82	7.85
DO	mg/L	6.0	5.8	5.4	6.1	5.9	5.4	6.2	6.0	5.8
BOD	mg/L	0.2	0.4	0.6	0.2	0.4	0.5	0.2	0.3	0.5
COD	mg/L	207	209	226	205	211	231	205	208	230
Oil&Grease	mg/L	4.4	3.0	0.5	4.3	3.1	0.5	4.2	3.0	0.5
SS	mg/L	52	73	281	49	84	293	51	81	308

T-Cr	mg/L	0.035	0.050	0.050	0.105	0.061	0.052	0.035	0.048	0.037
Cu	mg/L	0.1	0.11	0.31	0.1	0.58	0.54	0.1	0.30	0.31
Fe	mg/L	4.17	10.8	27.2	25.4	28.6	18.1	18.3	25.8	26.1
Zn	mg/L	0.05	0.10	0.18	0.05	0.16	0.12	0.05	0.11	0.14
Pb	mg/L	0.01	0.01	0.02	0.01	0.03	0.06	0.01	0.02	0.017
Cd	mg/L	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Hg	mg/L	0.016	0.022	0.018	0.018	0.029	0.014	0.018	0.021	0.009
As	mg/L	0.005	0.005	0.007	0.007	0.010	0.005	0.006	0.005	0.008

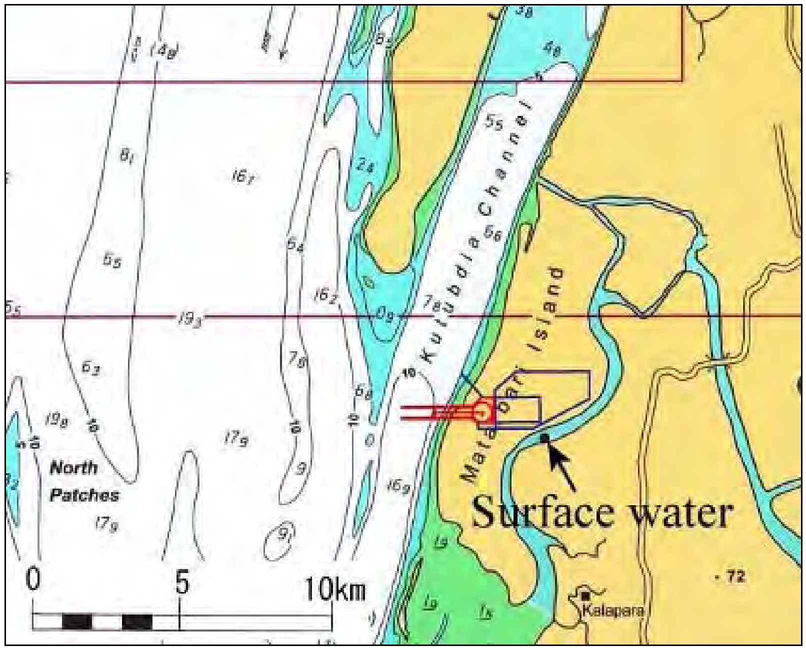
Parameter	Unit	SP-4			SP-5			Average		
		Surface	Middle	Bottom	Surface	Middle	Bottom	Surface	Middle	Bottom
Depth	M	0.5	7.8	14.6	0.5	7.8	14.6	-	-	-
Temperature	^{o}C	18.0	18.0	18.0	18.0	18.0	18.0	18.2	18.2	18.2
Salinity	-	34.4	35.4	34.3	34.4	34.7	34.8	35.3	35.6	35.0
pH	-	7.95	8.02	7.84	7.85	7.86	8.01	7.94	7.92	7.93
DO	mg/L	6.4	6.1	5.8	6.2	6.0	5.7	6.2	6.0	5.6
BOD	mg/L	0.2	0.3	0.5	0.3	0.4	0.6	0.2	0.4	0.5
COD	mg/L	205	211	223	203	212	235	205	210	229
Oil&Grease	mg/L	4.2	3.1	0.5	4.0	3.0	0.5	4.2	3.0	0.5
SS	mg/L	48	79	312	46	81	329	49	80	305
T-Cr	mg/L	0.021	0.027	0.057	0.019	0.039	0.055	0.043	0.045	0.050
Cu	mg/L	0.1	0.17	0.38	0.1	0.28	0.12	0.10	0.29	0.33
Fe	mg/L	3.25	3.88	45.2	2.97	32.1	25.0	10.82	20.24	28.32
Zn	mg/L	0.05	0.08	0.18	0.05	0.21	0.12	0.05	0.13	0.15
Pb	mg/L	0.01	0.01	0.02	0.01	0.018	0.01	0.010	0.018	0.025
Cd	mg/L	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001	0.001
Hg	mg/L	0.008	0.007	0.011	0.005	0.007	0.007	0.013	0.017	0.012
As	mg/L	0.005	0.005	0.012	0.005	0.009	0.007	0.006	0.007	0.008

(Source: JICA Study Team)

b) Surface water

a. Sampling point

The river water quality of the river (Koheli River) near the power plant site was surveyed. The survey was conducted in the rainy season (7 of October 2012) and in the dry season (30 of January 2013) to reflect the seasonal changes of surface water, as is the case for sea water quality.



Sampling Point	Latitude (North)	Longitude (East)
Surface water	21^{o}41'35"	91^{o}53'17"

(Source: JICA Study Team)

Figure 4.2.2.22 Sampling point of the surface water quality survey

b. Results

The results of the surface water quality survey are shown in Table 4.2.2.15. The value of salinity suggests that the surveyed area has brackish water that is under the influence of sea water in the rainy season. SS (only in the rainy season) and COD showed high concentration levels similar to the sea water quality survey results.

Environmental standards for surface water quality are determined by 6 criteria in Bangladesh, and the survey results satisfied even the highest criteria except DO.

Table 4.2.2.15 Results of the surface water quality survey

Parameter	Unit	Results		Standards for Inland Surface Water					
		Rainy season: 7/Oct/2012	Dry season: 30/Jan/2013	A	B	C	D	E	F
Depth	M	0.5	0.5	-	-	-	-	-	-
Temperature	^{o}C	30.6	18.0	-	-	-	-	-	-
Salinity	-	9.8	35.8	-	-	-	-	-	-
pH	-	7.82	8.00	6.5-8.5	6.5-8.6	6.5-8.7	6.5-8.8	6.5-8.9	6.5-8.9
DO	mg/	5.5	5.8	6 or	5 or	6 or	5 or	5 or	5 or

Parameter	Unit	Results		Standards for Inland Surface Water					
		Rainy season: 7/Oct/2012	Dry season: 30/Jan/2013	A	B	C	D	E	F
	L			above	above	above	above	above	above
BOD	mg/ L	0.8	0.4	2 or less	3 or less	3 or less	6 or less	10 or less	10 or less
COD	mg/ L	97	241	-	-	-	-	-	-
Oil&Grease	mg/ L	4.2	-	-	-	-	-	-	-
SS	mg/ L	613	-	-	-	-	-	-	-

Notes: Category of water body is as below.
A: Potable water source supply after bacteria freeing only
B: Water used for recreational purposes
C: Potable water source supply after conventional processing
D: Water used for pisciculture
E: Industrial use water including chilling and other processes
F: Water used for irrigation

(Source: JICA Study Team)

c) Ground water

a. Sampling point

The water quality of well water around the power plant site was surveyed. The river water quality of the rivers near the power plant site was also surveyed. The survey was conducted in the rainy season (7 of October 2012) and in the dry season (30 of January 2013) to reflect the seasonal change of well water quality, as in the case of sea water quality.

Sampling Point	Latitude (North)	Longitude (East)
Ground water	21°42'42"	91°52'50"

(Source: JICA Study Team)

Figure 4.2.2.23 Sampling point of the ground water quality survey

b. Results

The results of the ground water quality survey are shown in Table 4.2.2.16. The results of both the rainy and dry seasons satisfied the drinking water standards of Bangladesh.

Table 4.2.2.16 Results of the ground water quality survey

Parameter	Unit	Results		Standards for Drinking Water
		Rainy season 7/October/2012	Dry season 30/January/2013	
Temperature	°C	29.7	20.1	20 – 30
pH	-	7.48	7.20	6.5 8.5
Chloride	mg/L	167	167	150 – 600
NH_3	mg/L	0.04	0.04	0.5
Iron (Fe)	mg/L	0.92	0.92	0.3 1.0
Hardne	mg/L	164	164	200 – 500
Arsenic (As)	mg/L	0.01	0.01	0.05
DO	mg/L	3.5	4.7	6.0
BOD	mg/L	0.4	0.2	0.2
COD	mg/L	0	0	4.0
SS	mg/L	0.2	-	10
Coliform	N/100mL	0	-	0
Salinity	-	0.3	0.7	-

(Source: JICA Study Team)

(12) Noise

a) Sampling points

The residential areas within the site and in the north and south of the site were selected as the sampling points for the noise survey, as is in the case of air quality. The survey was conducted in the rainy season (19 and 20 of October 2012) and in the dry season (29 to 30 of January 2013) to reflect the seasonal changes of noise levels.

b) Results

The noise measurement results indicated that the day time noise level was above the environmental standards for residential areas at one sampling point. Matarbari Island is, as cited above, not an industrial area and therefore vehicles used for local transportation were the noise source. These vehicles are not used during the night.

Table 4.2.2.17 Results of the noise measurement survey

(Unit: dBA)

Survey phase	Results			Standards for Noise				
	St.1	St.2	St.3	A	B	C	D	E
Rainy season 19 20/October/2012	57.0	57.3	49.5	Day (6AM-9PM): 45 Night (9PM-6AM): 35	Day: 50 Night: 40	Day: 60 Night: 50	Day: 70 Night: 60	Day: 70 Night: 70
Dry Season 29 30/January/2013	56.0	57.0	45.3					

Notes: Category of areas is as below.

A: Silent zone

B: Residential area

C: Mixed area (mainly residential area, and also simultaneously used for commercial and industrial purposes)

D: Commercial area

E: Industrial area

(Source: JICA Study Team)

Reference: IFC/EHS guidelines

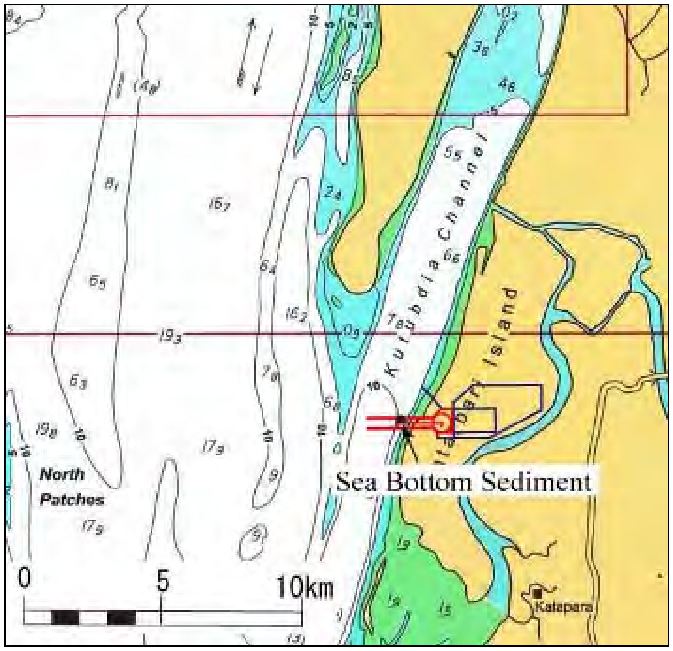
Receptor	Day 07:00-22:00	Night 22:00-07:00
Residential, institutional, educational area	55	45
Industrial, commercial area	70	70

(Source: IFC/EHS General Guidelines, 2007)

(13) Sea bottom sediment (heavy metals)

a) Sampling point

The sampling point for the sea bottom sediment survey was established on the coastal side of SP-1 for the water quality survey, in consideration of sediment contamination resulting from dredging of the canal.



Sampling Point	Latitude (North)	Longitude (East)
Sea bottom sediment	21°41'59.00”	91°51'20.52"

(Source: JICA Study Team)

Figure 4.2.2.24 Sampling point of the sea bottom sediment survey

b) Results

There are no standard values for heavy metals contained in sea bottom sediment in Bangladesh. Globally, ERL (Effects Range-Low) and ERM (Effects Range-Median) are proposed by the NOAA (National Oceanic and Atmospheric Administration, U.S.) as the guidelines to help categorize the range of concentrations of heavy metals and organic chloride compounds in sediment which affect benthic organisms.

In a series of data of ascending levels of contaminants and their toxicity effects, the 10th percentile and the 50th percentile (median) of the effects database were identified for each substance. The 10th percentile values were named the “Effects Range-Low” (ERL), indicative of concentrations below which adverse effects rarely occur. The 50th percentiles values were named the “Effects Range-Median” (ERM) values, representative of concentrations above which various effects frequently occur.

The measurement results indicated that ERL was not exceeded in any of the parameters except for mercury (Hg), and even then it did not exceed ERM.

Table 4.2.2.18 Results of the sea bottom sediment survey (Heavy metals)

Parameter	Unit	Results		Guideline of NOAA	
		15/October /2012	28/January /2013	ERL	ERM
Hg	mg/kg	0.142	0.456	0.15	0.71
Cd	mg/kg	0.032	0.05	1.2	9.6
Pb	mg/kg	11.6	3.39	46.7	218
As	mg/kg	4.45	2.91	8.2	70
Cu	mg/kg	23.8	3.75	34	270
Zn	mg/kg	63.7	20.2	410	410
Fe	mg/kg	27,400	11,183	-	-

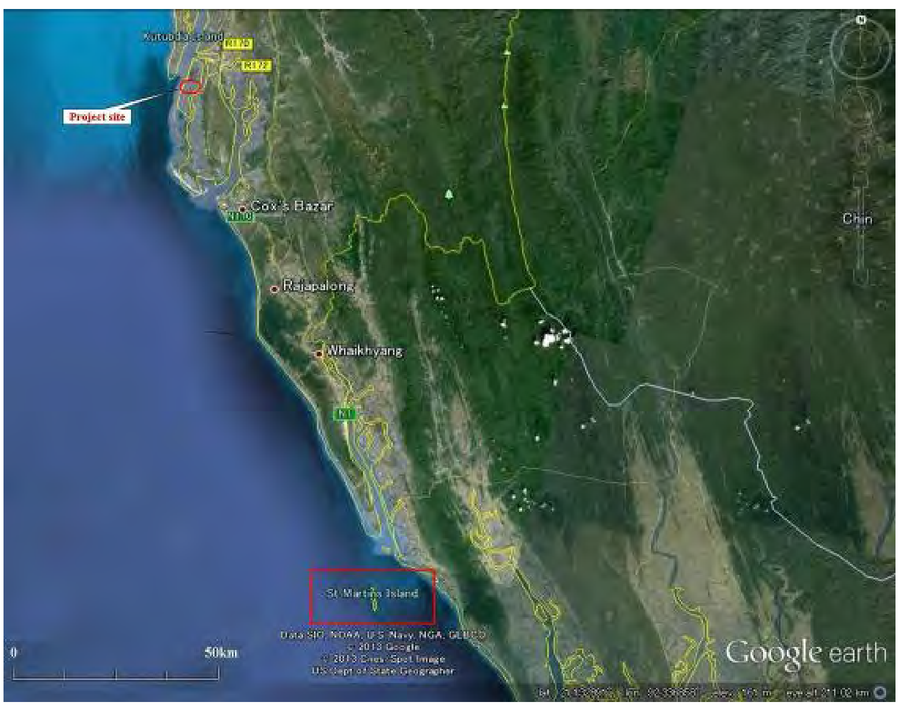
(Source; JICA Study Team)

4.2.3 Natural Biological Resources (including Forests)

(1) Ecologically valuable habitats

a) Coral reef

According to the Chief Scientific Officer of the Bangladesh Fisheries Research Institute in Cox's Bazar, there is no coral reef habitat around the project site, and the closest coral reef to the project site is St. Martins Island located approximately 120km from the project site (Figure 4.2.3.1).



(Source: Google earth)

Figure 4.2.3.1 Project Site and St. Martins Island

b) Seaweed

According to the Chief Scientific Officer of the Bangladesh Fisheries Research Institute in Cox's Bazar, seaweed does not grow around the project site because the transparency of the sea water is low.

c) Mangrove forest

There are no mangrove forests around the proposed port facility site or along the coastline where the outlets for thermal effluents will be constructed. They are only scattered at the riverside of the Kohalia River, which flows between Matarbari and Maheshkhali Islands. There is a mangrove forest, which is large scale and artificially established, at the south side of Matarbari Island and its opposite bank is Maheshkhali Island.

d) Mud flats

The coastline of Matarbari Island is a long sandy beach, and the sea side of the project site, where a port facility and outlets for thermal effluents will be constructed, is also part of the beach. The slope of the sandy beach is steep, and the area of its inter-tidal zone is relatively small.

On the other hand, a sand bar and shallow sea area lie in the estuary of the Kohalia River located south of Matarbari Island due to sedimentation.

(2) Marine organisms

a) Phyto-plankton

a. Sampling points

The phyto-plankton survey was conducted at five sampling points similar to the water quality survey (Figure 4.2.2-23), at three water layers, Surface (0.5m), Middle (1/2 depth), and Bottom (1m up from the bottom), as in the case of the sea water quality survey.

b. Method

Water samples from different depths (pre-selected) were collected by using Nenson bottles and were immediately transferred to 15 commercially available plastic bottles as is the recommended method by Sourna (1978) to obtain an accurate depiction of the quantitative composition of phyto-plankton.

The collected samples were preserved with 3% neutralized formalin. Immediately after collection, the bottles were labeled and transferred to a laboratory for further analysis.

c. Results

<Rainy season>

Fifteen species of phyto-plankton were observed, and Diatom was the largest in number of species (Table 4.2.3.1(1)). *Thalassiothrix* sp. was the species that emerged most frequently, followed by *Biddulphia* sp. The emergence of Pleurosigma sp., which is a freshwater species, indicates the strong influence of river water inflow in the sea front area of the power plant site, as described above in the results of the sea water quality survey.

Table 4.2.3.1(1) Results of the phyto-plankton survey

(Rainy season: 6 7/October/2012) (Unit: cells/L)

Species	SP.1			SP.2			SP.3		
	Surface	Middle	Bottom	Surface	Middle	Bottom	Surface	Middle	Bottom
Depth (m)	0.5	4.5	8.0	0.5	6.5	12.0	0.5	6.5	12.0
CYANOPHYTA									
1 *Nostoc* sp.	200								
DINOPHYTA									
2 *Ceratium* sp.		25			100				
HETEROKONTOPHYTA									
3 *Diatoma* sp.									
4 *Skeletonema* sp.								50	
5 *Coscinodiscus* sp.		50	75			50	125		1,400
6 *Rhizosolenia* sp.				750	1,075			25	600
7 *Biddulphia* sp.	1,725	300	300	200	950	625	400	625	2,050
8 *Ditylum* sp.									
9 *Thalassiothrix* sp.	1,675	1,475	3,000	2,550	6,100	1,875	1,725	1,300	5,650
10 *Flagillaria* sp.			300	150		350	50		500
11 *Thalassionema* sp.				300	225				
12 *Nitzchia* sp.			500	200	125	250		125	500
13 *Pleurosigma* sp.							50		
HAPTOPHYTA									
14 *Coccolith* sp.		50					100		
PROCHLOROPHYTA									
15 *Tetraedron* sp.		25					50		
N. of species	3	6	5	6	6	5	7	5	6
Total	3,600	1,925	4,175	4,150	8,575	3,150	2,500	2,125	10,700

Species	SP.4			SP.5			Average		
	Surface	Middle	Bottom	Surface	Middle	Bottom	Surface	Middle	Bottom
Depth (m)	0.5	8.5	16.0	0.5	6.5	12.0	-	-	-
CYANOPHYTA									
1 *Nostoc* sp.							40		
DINOPHYTA									
2 *Ceratium* sp.								25	
HETEROKONTOPHYTA									

Species		SP.4			SP.5			Average		
		Surface	Middle	Bottom	Surface	Middle	Bottom	Surface	Middle	Bottom
3	*Diatoma* sp.						50			10
4	*Skeletonema* sp.						100		10	20
5	*Coscinodiscus* sp.	175	100	250	50	3,200		70	670	355
6	*Rhizosolenia* sp.	1,800	650	500				510	350	220
7	*Biddulphia* sp.	1,825	750	2,400	4,175	450	1,900	1,665	615	1,455
8	*Ditylum* sp.	50						10		
9	*Thalassiothrix* sp.	1,650	4,200	2,750	4,250	200	1,625	2,370	2,655	2,980
10	*Flagillaria* sp.	200	200	100	325			145	40	250
11	*Thalassionema* sp.		200					60	85	
12	*Nitzchia* sp.		100	475		325	225	40	135	390
13	*Pleurosigma* sp.	150						40		
HAPTOPHYTA										
14	*Coccolith* sp.					50		20	20	
PROCHLOROPHYTA										
15	*Tetraedron* sp.							10	5	
N. of species		7	7	6	4	5	5	12	11	8
Total		5,850	6,200	6,475	8,800	4,225	3,900	4,980	4,610	5,680

(Source: JICA Study Team)

<Dry Season>

Eight species of phyto-plankton were observed, and Diatom was the largest in number of species (Table 4.2.3.1(2)). *Biddulphia* sp. and *Thalassiothrix* sp. were the species that emerged most frequently, followed by *Coscinodiscus* sp. and *Rhizosolenia* sp.

Table 4.2.3.1(2) Results of the phyto-plankton survey

(Dry season: 29/January/2013) (Unit: cells/L)

Species		SP.1			SP.2			SP.3		
		Surface	Middle	Bottom	Surface	Middle	Bottom	Surface	Middle	Bottom
Depth (m)		0.5	5.0	9.0	0.5	5.0	9.0	0.5	4.5	8.0
CHLOROPHYTA										
1	*Cosmarium* sp.									
CYANOPHYTA										
2	*Nostoc* sp.	50								
HETEROKONTOPHYTA										
3	*Coscinodiscus* sp.	250	150	225	50		100	200	175	225
4	*Rhizosolenia* sp.	150	650	675		125	150	675	575	475
5	*Biddulphia* sp.	700	2,725	8,375	775	650	450	6,475	3,875	425
6	*Thalassiothrix* sp.	1,100	1,575	825	400	950	1,425	1,575	875	1,250
7	*Nitzchia* sp.		325	350						
8	*Surirella* sp.							100		
N. of species		5	5	5	3	3	4	5	4	4
Total		2,250	5,425	10,450	1,225	1,725	2,125	9,025	5,500	2,375

Species		SP.4			SP.5			Average		
		Surface	Middle	Bottom	Surface	Middle	Bottom	Surface	Middle	Bottom
Depth (m)		0.5	7.8	14.6	0.5	7.8	14.6	-	-	-
CHLOROPHYTA										
1	*Cosmarium* sp.						25			5
CYANOPHYTA										
2	*Nostoc* sp.							10		
HETEROKONTOPHYTA										
3	*Coscinodiscus* sp.	50	125	225	300	125	150	155	150	165
4	*Rhizosolenia* sp.	175	75	925	175	75	325	385	320	340
5	*Biddulphia* sp.	600	1800	2025	1925	700	1350	2,115	2,195	2,260
6	*Thalassiothrix* sp.	1175	4400	1550	1575	1025	1975	1,160	1,875	1,300
7	*Nitzchia* sp.								65	70
8	*Surirella* sp.							20		
N. of species		4	4	5	4	4	4	6	5	6
Total		2,000	6,400	4,725	3,975	1,925	3,825	3,845	4,605	4,140

(Source: JICA Study Team)

b) Zoo-plankton

a. Sampling points

The zoo-plankton survey was conducted at five sampling points similar to the water quality survey (Figure 4.2.2.23), at two water layers, between 5m depth and the Surface (0.5m), and between the Bottom (1m up from the bottom) and 5m depth.

b. Method

Zoo-plankton samples were collected from the subsurface water using a Zooplankton net with mesh size 300µm and metallic circular frame with a 25cm mouth opening. A flow meter (FMC-0.3) was used at the mouth of the net to record the quantity of the water filtered through the net. Precaution was taken for clearing the net and bucket before every sampling to avoid any possible contamination. After collecting the samples, they were put into 200ml plastic jars and preserved with 5% formalin.

c. Results
<Rainy season>
Eleven species of zoo-plankton were observed, and ARTHROPODA was the largest in number of species (Table 4.2.3.2(1)). Copepoda was the species that emerged most frequently, followed by *Sagitta* sp.

Table 4.2.3.2(1) Results of the zoo-plankton survey

(Rainy season: 6 7/October/2012)) (Unit: Individual/m^3)

Species		SP.1		SP.2		SP.3	
		0 <- 5	5 <- B+1	0 <- 5	5 <- B+1	0 <- 5	5 <- B+1
COELENTERATA							
1	*Pleurobrachia* sp.	1		4	2	1	
MOLLUSCA							
2	Bivalve larvae		1			40	
ANNELIDA							
3	*Sagitta* sp.	57	153	160	282	42	14
ARTHROPODA							
4	Copepoda	120	600	560	520	140	154
5	Caridea	30					
6	*Acetes* sp.		38				
7	Lucifer	5		12			
8	Shrimp larvae			7	28	2	5
9	Crab Zoea		1	1	5	4	
10	Mysidae						3
VERTEBRATA							
11	Fish larvae			12		3	
N. of species		5	5	7	5	7	4
Total		213	793	756	837	232	176

Species		SP.4		SP.5		Average	
		0 <- 5	5 <- B+1	0 <- 5	5 <- B+1	0 <- 5	5 <- B+1
COELENTERATA							
1	*Pleurobrachia* sp.	2	2	2	1	2	1
MOLLUSCA							
2	Bivalve larvae					8	
ANNELIDA							
3	*Sagitta* sp.	27	68	48	96	67	123
ARTHROPODA							
4	Copepoda	320	308	1,060		440	316
5	Caridea					6	
6	*Acetes* sp.	4	18	17	20	4	15
7	Lucifer	6		6	1	6	
8	Shrimp larvae	3		34		9	7
9	Crab Zoea	1	2	1	326	1	67
10	Mysidae		21		15		8
VERTEBRATA							
11	Fish larvae					3	
N. of species		7	6	7	6	10	7
Total		363	419	1,168	459	546	537

(Source: JICA Study Team)

<Dry season>

Twelve species of zoo-plankton were observed, and ARTHROPODA was the largest in number of species (Table 4.2.3.2(2)). Copepoda was the species that emerged most frequently, followed by *Sagitta* sp.

Table 4.2.3.3.2(2) Results of the zoo-plankton survey

(Dry season: 29/January/2013) (Unit: Individual/m^3)

Species		SP.1		SP.2		SP.3	
		0 <- 5	5 <- B+1	0 <- 5	5 <- B+1	0 <- 5	5 <- B+1
MOLLUSCA							
1	Gastropod					1	
2	Sepia Larvae						
ANNELIDA							
3	*Sagitta* sp.	36	120	124	135	8	85
ARTHROPODA							
4	Copepoda	406	683	1,216	760	934	458
5	*Acetes* sp.	1		5		17	
6	Daphnia	124	17	44		3	8
7	Lucifer			10	2	11	
8	Shrimp larvae		37	25	32	22	39
9	Lobster larvae						
10	Crab zoea		9	3	3	7	4
VERTEBRATA							
11	*Cynoglossus* larvae						4
12	Fish larvae		7	2			4
N. of species		4	6	8	5	8	7
Total		567	898	1,429	994	1,003	602

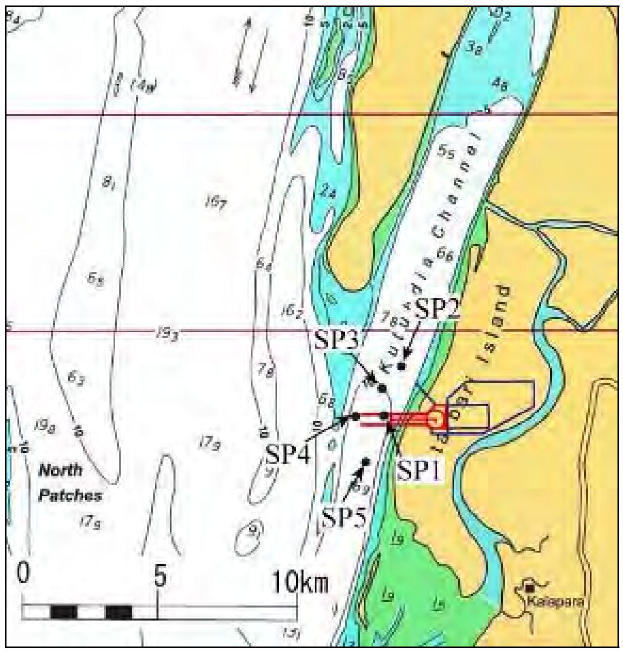
Species		SP.4		SP.5		Average	
		0 <- 5	5 <- B+1	0 <- 5	5 <- B+1	0 <- 5	5 <- B+1
MOLLUSCA							
1	Gastropod						
2	Sepia Larvae	1				0	
ANNELIDA							
3	*Sagitta* sp.		87	312	210	96	127
ARTHROPODA							
4	Copepoda		927	4,976	248	1,506	615
5	*Acetes* sp.					5	
6	Daphnia		13	82	28	51	13
7	Lucifer			37	2	12	1
8	Shrimp larvae	6	8	6	10	12	25
9	Lobster larvae	3				1	
10	Crab zoea		6	7	2	3	5
VERTEBRATA							
11	*Cynoglossus* larvae						1
12	Fish larvae		3	5	2	1	3
N. of species		3	6	7	7	6	6
Total		12	1,058	5,425	507	1,687	812

(Source: JICA Study Team)

c) Benthos (Sea bottom)

a. Sampling points

The macros-benthos survey was conducted at one sampling point similar to the sea bottom sediment survey and at four other sampling points similar to the sea water quality survey (Figure 4.2.3.2).



Sampling Point	Latitude (North)	Longitude (East)
SP-1	21°41'59.00”	91°51'20.52"
SP-2	21°43'00.57”	91°51'32.44”
SP-3	21°42'33.74”	91°51'08.55”
SP-4	21°41'56.99”	91°50'29.11”
SP-5	21°40'56.65”	91°50'43.90”

(Source: JICA Study Team)

Figure 4.2.3.2 Sampling points of macro-benthos on the sea bottom

b. Method

For macro-benthos, samplings were collected at the selected points for bottom sediments. Samples for macro benthos for bottom sediments were collected randomly using a grab sampler of 20cm × 20cm with 10cm depth.

The collected sediments were then placed in plastic buckets and washed through a sieve of mesh size 0.5mm and 0.25 mm to retain all benthic fauna. The fauna from the sieves were preserved in a pre-labeled plastic container containing 5% formaline.

c. Results

<Rainy season>

The population was scarce with only 3 individuals/m^2 in SP-1, and 16 to 18 invidiuals/m^2 in SP-2 to SP-4. On the other hand, 306 invidiuals/m^2 of Bivalvia and 30 invidiuals/m^2 of Gastropod were observed in SP-5 (Table 4.2.3.3(1)).

Table 4.2.3.3(1) Results of the macro-benthos survey on the sea bottom

(Rainy season: 15/October/2012) (Unit: Individuals/m^2)

	Group	SP-1	SP-2	SP-3	SP-4	SP-5	Total
1	Gastropoda		2			30	6
2	Bivalvia	2	5	14	2	306	66
3	Polychaeta		10	2	14		5
4	Crustacea	1		2		2	1
	Total	3	17	18	16	338	78

(Source: JICA Study Team)

<Dry season>

A lot of Bivalvia was observed in SP-5 during the rainy season, but was not observed in the dry season (Table 4.2.3.3(2)).

Table 4.2.3.3(2) Results of the macro-benthos survey on the sea bottom

(Dry season: 28/January/2013) (Unit: Individuals/m^2)

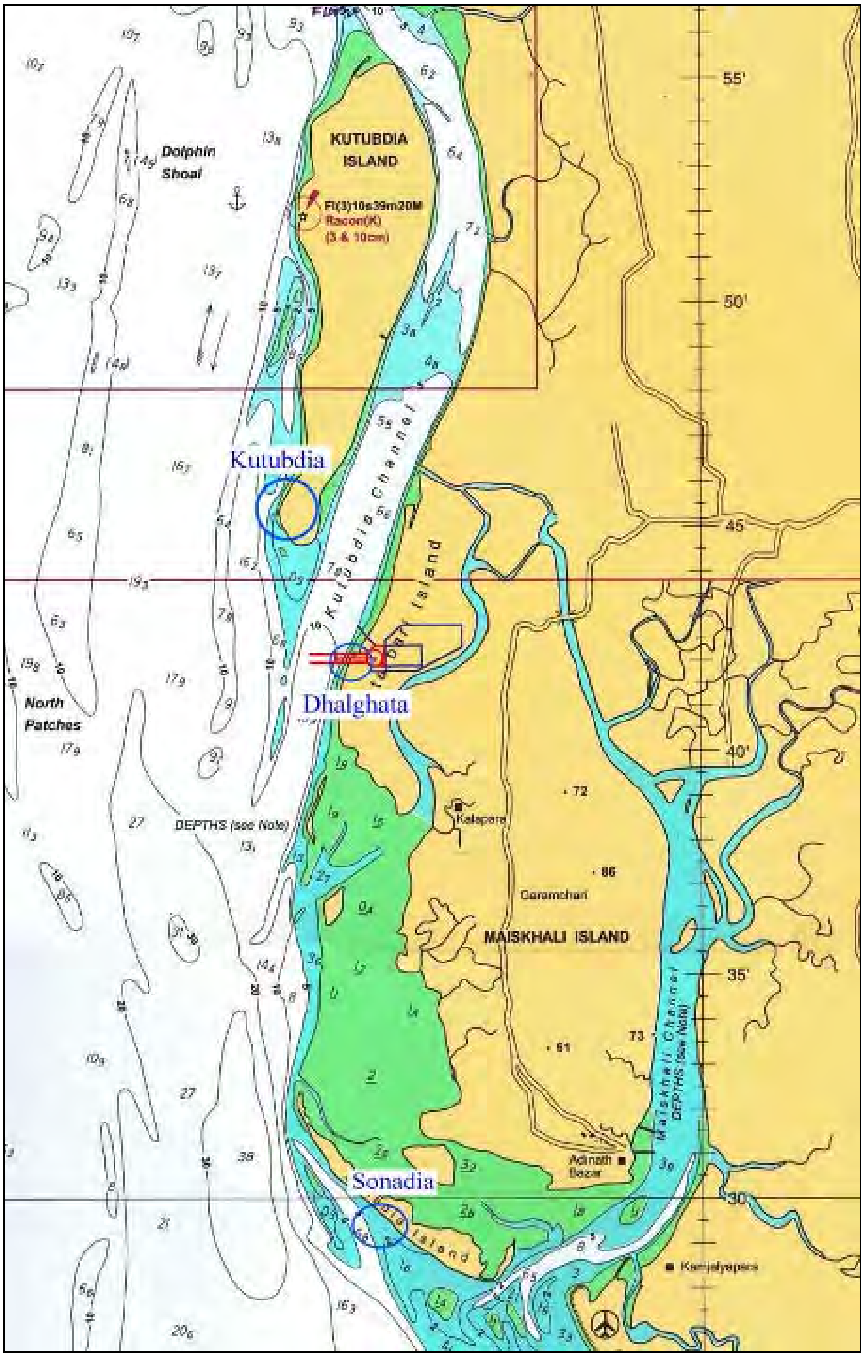
	Species	SP-1	SP-2	SP-3	SP-4	SP-5	Total
Gastropoda							
1	*Mactra* sp.				2	1	1
Polychete							
2	*Duplex* sp.	5					1
3	*Nematode* sp.	1				89	18
4	*Lumbrineris* sp.		14	22	43		16
	Total	6	14	22	45	90	35

(Source: JICA Study Team)

d) Benthos (Mudflat)

a. Sampling point

The sampling of benthos of the intertidal mudflats was conducted at Sonadia Island, in the sea front area of the power plant site and the surrounding sea (Figure 4.2.3.3).



(Source: JICA Study Team)

Figure 4.2.3.3 Sampling point of macro-benthos of the intertidal mudflats

b. Method

For macro-benthos, samplings were carried out at the selected study stations for intertidal mudflats. A permanent plot with an area of 50m × 50m was selected at the two sampling stations for the collection of macro benthos. During the visit, samples for macro benthos were collected randomly from the permanent plot using a quadrate with an area of 20cm × 20cm with 10cm. For macro benthos of intertidal mudflats, one square meter quadrate was used with 25cm depth. Macro benthos was collected manually from 10cm depth of sediment.

The collected sediments were then placed in plastic buckets and washed through a sieve of mesh size 0.5mm and 0.25 mm to retain all benthic fauna. The fauna from the sieve were preserved in a pre-labeled plastic container containing 5% formaline.

c. Results

<Rainy season>

The bottom sediment of each sampling points was sand and only a small population was observed. Twenty eight individuals per m^2 were observed in Dhalghata, which is 2/3 of Sonadia, in the sea front area of the power plant site. The dominant species were different in Sonadia and Dhalghata, and no dominant species was observed in Kutubdia (Table 4.2.3.4(1)).

Table 4.2.3.4(1) Results of the macro-benthos survey of the intertidal mudflats

(Rainy season: November/2012) (Unit: Individuals/m^2)

Group	Species	Area		
		Kutubdia	Dhalghata	Sonadia
Nematoda	Nematoda	1		
Gastropoda	*Umbonium vestiarium*		3	
	Batillaria angulifera	1		
	Batillaria sp.			1
	Cerithidea cingulata	1		23
	Cerithidea quadrata	1		
	Nodilittorina thocchridos			1
	Polinices sp.		1	
	Oliva carneola		1	
	Heliacus areola			1
	Atrina sp.		13	
Bivalve	*Mactra* sp.		2	1
	Barbatia bistrigata	1		
	Anadara antiquate		1	
	Anadara nodifera	1		
	Scapharca pilula	1		
	Anadara scapha		1	
	Atrina vexillum	1		
	Apolymetis edentula	1		
	Apolymetis identula		1	
	Donax carinatus		1	

Group	Species	Area		
		Kutubdia	Dhalghata	Sonadia
	Tellina tenuis		1	
	Sanguinolaria acuminata			1
	Dosivia variegate	1		
	Unidentified			4
Polycheta	*Lumbrinereis* sp.	1		
	Unidentified		3	10
Number of species		11	11	8
Total		11	28	42

(Source: JICA Study Team)

<Dry season: January/2013>

In the dry season, 115 invidiuals/m^2 of Benthos was observed in Dhalghata in the sea front area of the power plant, which was more than the number of individuals observed in Kutubdia and Sonadia. Many kinds of Mollusk species such as Gastropoda and Bivalve were observed in Dhalghata, but only a few or even none of Mollusk was observed in Kutubdia and Sonadia (Table 4.2.3.4 (2)).

Table 4.2.3.4(2) Results of the macro-benthos survey of the intertidal mudflats

(Dry season: January/2013) (Unit: Individuals/m^2)

Group	Species	Area		
		Kutubdia	Dhalghata	Sonadia
Gastropoda	*Umbonium vestiarium*		16	
	Pythia sp.		2	
	Cerithium sp.		22	
	Thais sp.		1	
	Bullia sp.		6	
	Telescopium sp.		4	
Bivalve	*Cerithudea cingulata*	9		
	Donax carinatus		23	
	Mactra sp.		28	
	Tellina tenuis		10	
	Barbatia bistrigata		2	
	Pholas sp.		1	
Polychaete	*Nematode* sp.	14		37
Number of species		2	11	1
Total		23	115	37

(Source: JICA Study Team)

<Dry season: March/2013>

During the surveyed period, 452 invidiuals/m2 of Benthos were observed in Sonadia, which was more than the number of individuals observed in Kutubdia and Dhalgata. Species of

Gastropod and Bivalve were observed most often in Dhalgata, on the other hand, species of Polychete was observed at most in Sonadia. Larva of cuttlefish was also observed in Sonadia (Table 4.2.3.4 (3)).

Table 4.2.3.4(3) Results of the macro-benthos survey of the intertidal mudflats

(Dry season: March/2013) (Unit: Individuals/m^2)

Group	Species	Area		
		Kutubdia	Dhalghata	Sonadia
Gastropod	*Rhinoclavis* sp.		45	
	Batillaria sp.		1	
	Umbonium vestiarium	3	8	
	Unidentified gastropod larvae			2
Bivalve	*Dosinia* sp.		2	
	Trachycardium sp.	8	1	
	Scapharsa sp.		2	
	Mactra sp.	6	1	
	Tellina sp.		15	
	Donax sp.	5	2	
Polychete	*Lycastoneries indica*			32
	Nereis sp			66
	Lumbrineris sp.	68		284
	Unidentified species			31
Sipuncula	Unidentified species			62
Arthropoda	Sepia larvae			6
Number of species		5	9	7
Total		90	77	452

(Source: JICA Study Team)

e) Fish and Nekton

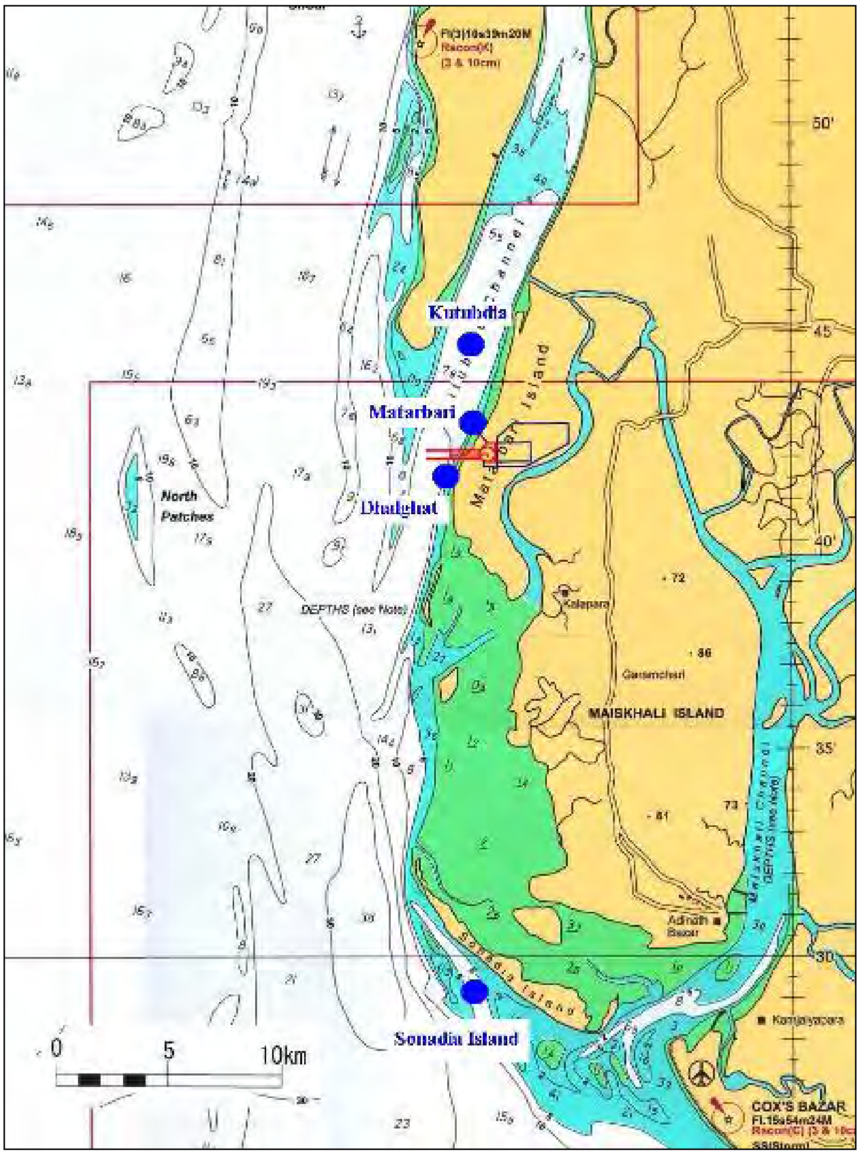
a. Sampling points

The fish samples for assessment were collected from set bag nets of the Kutubdia channel, Sonadia Island and Dhalghata Union of Matarbari Island. One sample was collected from a local fish farm (Ghona) of Matarbari Island. A brief introduction of the sampling areas is as below (Figure 4.2.3.4):

Kutubdia Channel: The Kutubdia Channel is situated in the south eastern part of the Bay of Bengal. It lies between 21º45´ N to 21º55´ N latitude and 91º53´ E to 91º55´ E longitude. Kutubdia Channel is an important spawning and nursery ground for several species of fin fish and shrimps.

Project site: Matarbari Island is situated in the north western part of Maheshkhali Island. Many parts of this island are at stake because of unplanned shrimp farming and natural disasters. This island is rich in shrimp farming and solar salt pans. There are also many fish farms (local name: *ghona*) scattered on this island. The island lies between 21º41´ N to 21º44´ N latitude and 91º46´ E to 91º52´ E longitude. The survey in front of the project site was conducted at 2 sampling points (Matarbari and Dhalghata).

Sonadia Island: Sonadia Island is an island situated in the northern part of Maheshkhali Island. It lies between 21º23´ N to 21º28´ N latitude and 91º48´ E to 91º52´ E longitude. Sonadia Island is a biodiversity hotspot and a proposed area for a future deep sea port of Bangladesh.

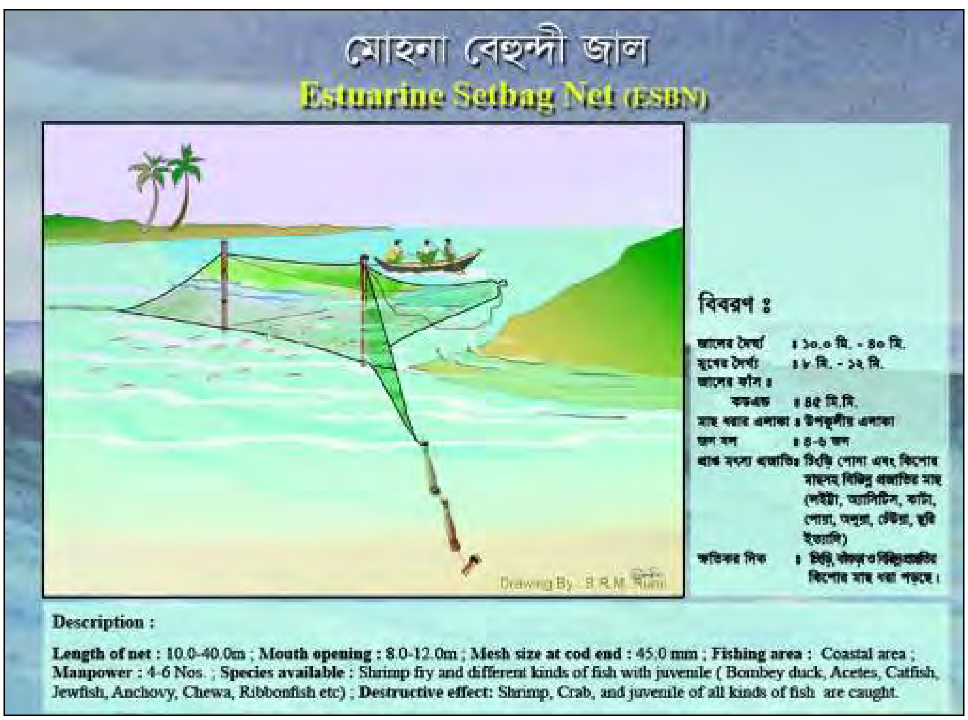


(Source: JICA Study Team)

Figure 4.2.3.4 Sampling points of fish and nekton

b. Method

The sampling gear of fish was an estuarine set bag net, locally known as "*Behundi Jal*" (Figure 4.2.3.5). The set bag net is a fixed tapering net, resembling a trawl net, set in the tidal stream by attaching it to hold-fasts. It has a rectangular mouth kept open by two vertical bamboo poles. The net is held in a fishing position against the current by linking the extended sides of the net (wing tips) to hold-fasts by means of long bamboo poles and steel wires. The hold-fasts are two wooden stakes embedded some distance apart in the sea bed, so that the net is parallel to the direction of the current. The set bag net catches species of fish which drift with the current or do not swim fast enough to stem the current and maintain a fixed position in relation to the sea bed. At each slack water period, the net comes to the surface (by means of the bamboo poles used for opening of the net, the bamboos serving as sweep lines) when it is emptied; it is then reversed in the opposite direction ready for fishing. The survey was conducted from high tide in one evening up to high tide in the morning of the following day. Set bad nets at every sampling point were set up at depths of 8 to 12 meters.



(Source: http://www.fisheries.gov.bd/album_details/507)

Figure 4.2.3.5 Estuarine set bag net

c. Results

<Rainy season>

For fish and nekton, the highest number of species was observed at the sampling point in Sonadia, which had 22 species, followed by 21 species in Dhalghata and 20 species in Matarbari where the proposed power plant will be located and 14 species in Kutubdia. The only common species observed in all of the 4 sampling points was "*Loligo* sp." under DECAPODIFORMES.

The dominate species in the 2 sampling points near the power plant site were different from the dominate species in Sonadia and Kutubdia; the dominate species near the power plant site were "*Metapenaeus monoceros*" and "*Exopalaemon styliferus*" under DECAPODA, "Stolephorus tri" under Engraulidae, "*Glossogobius giuris*" and "*Odontamblyopus rubicundus*" under Gobiidae and "Terapon jarbua" under Terapontidae; whereas, in Sonadia and Kutubdia, "*Squilla* sp." under STOMATOPODA, "*Acetes* sp." under DECAPODA, "*Charybdis natator*" under BRACHYURA and "*Harpadon nehereus*" under Synodontidae were the dominate species.

Table 4.2.3.5 (1) Results of the fish and nekton survey

(Rainy season: 16/November/2012) (Unit: N=Individuals/haul, W=g/haul)

Species		Dhalghata		Matarbari		Sonadia		Kutubdia	
		N	W	N	W	N	W	N	W
DECAPODIFORMES									
1	*Sepia* sp.	2	24.96			8	99.84		
2	*Loligo* sp.	5	16.35	2	3.27	65	212.55	1	3.27
STOMATOPODA									
3	*Squilla* sp.	17	13.09			357	274.89	148	113.96
DECAPODA									
4	*Solenocera* sp.					68	992.80		
5	*Metapenaeus lysianassa*			30	42.60	65	95.36	10	14.20
6	*Metapenaeus monoceros*	61	100.65	68	112.20				
7	*Parapenaeopsis sculptilis*							98	230.30
8	*Acetes* sp.					424	42.01	616	141.68
9	*Exopalaemon peliferus*							61	59.78
10	*Exopalaemon styliferus*	187	287.98	213	328.02	14	9.55		
BRACHYURA									
11	*Matuta planipes*					8	3.04		
12	*Charybdis natator*					166	141.10	14	11.90
13	*Scylla* sp.			1	14.55				
14	*Acanthopotamon martensi*	7	28.08	11	55.88				
OSTEICHTHYES									
15	*Pisodonophis boro*	1	7.97	1	7.97	1	7.97		
16	*Harpadon nehereus*					785	2,001.75	362	923.10
17	*Coilia dussumieri*					10	10.21		

Species		Dhalghata		Matarbari		Sonadia		Kutubdia	
		N	W	N	W	N	W	N	W
18	*Coilia peliferus*							5	17.00
19	*Setipinna phasa*							1	26.04
20	*Stolephorus tri*	100	150.00	3	4.50	30	16.62		
21	*Liza* sp.	4	29.96	7	52.43				
22	*Valamugil speigleri*	1	10.70	2	21.40				
23	*Strongylura strongylura*			6	11.52				
24	*Ambassis* sp.			1	3.98				
25	*Boleophthalmus viridis*	2	6.26						
26	*Eleutheronema tetradactylum*	1	7.61						
27	*Glossogobius giuris*	24	96.48	15	60.30				
28	*Lates calcarifer*			2	110.06				
29	*Lepturacanthus savala*					17	242.25	2	28.50
30	*Lutjanus johnii*	1	0.86	1	0.86	26	22.36		
31	*Odontamblyopus rubicundus*	14	78.96	1	5.64	2	1.44		
32	*Pampus argenteus*					1	1.50		
33	*Polynemus paradiseus*							3	45.42
34	*Scatophagus argus*			1	23.66				
35	*Sillago domina*							1	17.69
36	*Trypauchen vagina*	7	19.32	9	24.84	1	2.70		
37	*Pseudapocryptes elongates*	1	9.12	2	18.24				
38	*Terapon jarbua*	35	573.65	11	180.29				
39	*Cynoglossus cynoglossus*	1	3.32						
40	*Cynoglossus lingua*					1	1.88		
41	*Paraplagusia bilineata*	1	8.48			4	54.20		
42	*Arius* sp.					1	2.70	3	40.72
43	*Syngnathoides* sp.	4	5.72						
44	*Chelonodon patoca*					6	13.58		
Total		476	1,479.52	387	1,082.21	2,060	4,250.30	1,325	1,673.56
Number of species		21		20		22		14	

(Source: JICA Study Team)

<Dry season: January/2013>

The highest number of species was observed at the sampling point in Matarbari, which had 29 species, followed by 26 species in Dhalghata, 25 species in Kutubdia, and 17 species in Sonadia. The only common species observed in all of the 4 sampling points was "*Acetes* sp." under DECAPODA and "*Cynoglossus cynoglossus*" under Cynoglossidae.

The dominate species near the power plant site were "*Metapenaeus monoceros*" under DECAPODA, "*Harpadon nehereus*" under Synodontidae, "*Coilia dussumier*" under Engraulidae, "*Johnius argentatu*" under Sciaenidae, and "*Otolithoides pama*" under Sciaenidae; whereas, in Sonadia and Kutubdia, "*Metapenaeus brevicornis*" and "*Metapenaeus lysianassa*" under DECAPODA were the dominate species.

Table 4.2.3-5 (2) Results of the fish and nekton survey

(Dry season: 17/January/2013) (Unit: N=Individuals/haul, W=g/haul)

Species		Dhalghata		Matarbari		Sonadia		Kutubdia	
		N	W	N	W	N	W	N	W
DECAPODIFORMES									
1	*Sepia* sp.	10	152.77	2	7.85			4	61.11
2	*Histioteuthis celelaria pacifica*					14	30.73		
3	*Loligo* sp.	3	25.45	17	168.42	2	13.96		
OCTOPODIFORMES									
4	*Octopus* sp.	3	25.22						
STOMATOPODA									
5	*Orantoskuilla inornata*	6	20.87	112	371.99				
6	*Squilla* sp.							42	292.22
DECAPODA									
7	*Solenocera melantho*			61	87.84				
8	*Solenocera* sp.					10	3.83		
9	*Penaeus affinis*	2	0.29	11	1.97				
10	*Penaeus merguiensis*	1	11.46						
11	*Penaeus semisulcatus*			10	13.10				
12	*Penulirus* sp.							17	3.58
13	*Metapenaeus brevicornis*					2	0.98	14	56.70
14	*Metapenaeus lysianassa*					24	8.65	70	72.10
15	*Metapenaeus monoceros*	103	232.75					51	23.29
16	*Metapenaeus tenuipes*	11	25.80	12	5.48				
17	*Trachypenaeus* sp.					43	28.02		
18	*Acetes* sp.	243	27.86	5,020	379.85	254	19.22	3,720	281.48
19	*Panulirus ornatus*	1	0.44	3	2.01				
BRACHYURA									
20	*Matuta planipes*			117	226.55	15	11.15	16	11.89
21	*Scylla olivacea*			56	10.64			29	5.51
22	*Portunus sanguinolentus*	28	213.83						
OSTEICHTHYES									
22	*Gymnothorax punctatus*							1	357.00
23	*Congresox talabonoides*							1	0.39
24	*Muraenesox bagio*							1	1.24
25	*Thyrsoidea macruna*			6	3.01				
26	*Harpadon nehereus*	7	48.51	71	272.78			9	13.96
27	*Pellona dichella*	20	107.79						
28	*Sardinella fimbriata*							6	12.68
29	*Sardinella melanura*			19	9.69			1	0.49
30	*Tenualosa megaloptera*			1	1.60	5	11.71		
31	*Coilia dussumieri*	74	295.65	14	13.55			4	8.78
32	*Ilisha filigera*					9	15.88		
33	*Setipinna taty*	2	24.09					1	4.79
34	*Tenualosa ilisha*							1	3.79
35	*Thryssa purava*			153	96.90			25	15.83
36	*Mugil cephalus*	1	1.86						
37	*Johnius argentatus*	57	65.45	7	9.76			2	1.83
38	*Butis butis*			2	0.76	2	0.51		
39	*Drepane punctata*	1	3.85	2	2.35				

Species		Dhalghata		Matarbari		Sonadia		Kutubdia	
		N	W	N	W	N	W	N	W
40	*Lates calcarifer*			1	2.42	1	1.28		
41	*Odontamblyopus rubicundus*	1	7.21	13	12.39			5	4.77
42	*Apocryptes dantatus*			16	32.20				
43	*Otolithoides pama*	25	58.80	72	44.78				
44	*Pampus argenteus*	2	11.63			6	26.56	1	2.56
45	*Pampus chinensiss*			1	0.45				
46	*Secutor ruconius*	8	16.04	3	4.94	14	23.04		
47	*Sillago domina*	1	6.00	1	0.39				
48	*Lepturacanthus savala*			52	576.59	4	13.45	18	60.53
49	*Trichiurus haumela*	12	91.70						
50	*Cynoglossus cynoglossus*	11	82.56	22	169.76	2	1.38	5	37.53
51	*Torquigener oblongus*	7	11.20			2	0.85	1	1.60
Total		640	1,569.08	5,877	2,530.02	409	211.20	4,045	1,335.65
Number of species		26		29		17		25	

(Source: JICA Study Team)

<Dry season: March/2013>

The highest number of species was observed at the sampling point in Matarbari, which had 24 species, followed by 23 species in Dhalghata, 21 species in Sonadia, and 16 species in Kutubdia. The common species observed in all of the 4 sampling points were "Squilla sp." under STOMATOPODA, "Acetes sp." under DECAPODA, "Stelopherus tri" under Engraulidae, and "Lepturacanthus savala" under Trichiuridae.

"Acetes sp." was the dominate species in all the 4 sampling points. Other than "Acetes sp.", the dominant species near the power plant site were "Coilia desumeri" under Engraulida and "Harpadon nehereus" under Synodontidae, whereas, in Sonadia, "Squilla sp." and "Thryssa hamiltoni" under Engraulidae were the dominate species (Table 4.2.3.5(3)).

Table 4.2.3.5 (3) Results of the fish and nekton survey

(Dry season: March/2013) (Unit: N=Individuals/haul, W=g/haul)

Species		Dhalghata		Matarbari		Sonadia		Kutubdia	
		N	W	N	W	N	W	N	W
DECAPODIFORMES									
1	*Sepia* sp.	3	9.84	1	67.62				
2	*Loligo* sp.	2	22.73	2	4.67	11	44.40		
OCTOPODIFORMES									
3	*Octopus* sp.	2	7.38			1	1.97	1	6.16
STOMATOPODA									
4	*Squilla* sp.	9	58.67	9	64.83	228	4.70	4	4.65
DECAPODA									
5	*Solenocera* sp.	2	5.35	14	24.59				
6	*Penaeus monodon*			9	51.67				
7	*Metapenaeus affinis*	5	43.31			3	2.29		

Species		Dhalghata		Matarbari		Sonadia		Kutubdia	
		N	W	N	W	N	W	N	W
8	*Metapenaeus lysianassa*					13	4.98	5	1.17
9	*Parapenaeopsis hardwickii*			14	24.58			7	28.43
10	*Acetes* sp.	55	21.49	347	95.08	234	77.41	457	178.53
11	*Alpheus* sp.	2	0.68	3	2.59			1	3.71
BRACHYURA									
12	*Matuta planipes*	14	163.41	3	15.00			2	6.99
13	*Scylla olivacea*					21	22.01	99	18.03
14	*Acthopotamon* sp.			55	9.00				
OSTEICHTHYES									
15	*Gymnothorax punctatus*			5	28.07				
16	*Lamnostoma orientalis*	1	10.79	2	13.63				
17	*Coilia desumeri*	16	35.83	23	75.34			7	30.57
18	*Thryssa hamiltoni*					34	61.71		
19	*Setipinna phasa*			2	16.77				
20	*Setipinna taty*	1	22.63			2	10.58	1	17.54
21	*Stelopherus tri*	2	9.94	15	26.90	2	2.59	9	14.78
22	*Surdinella gibbosa*					12	47.96		
23	*Securicola gora*					10	12.22		
24	*Harpodon neherus*	47	79.64	4	15.94			53	22.88
25	*Valamugil* sp.	1	4.18						
26	*Sillago domina*	1	3.34	1	4.91				
27	*Atropus atropas*			3	18.48	8	39.38		
28	*Lutjanus johnii*					3	2.11		
29	*Johnius argentatus*	2	3.01					6	18.60
30	*Otolithoides pama*			30	41.78			68	94.69
31	*Drepane punctata*							6	1.03
32	*Boleophthalmus boddarti*					1	1.06		
33	*Glossogobius* sp.					2	3.17		
34	*Odontamblyopus rubicundus*	4	6.59						
35	*Parapocryptes batoides*	6	6.70						
36	*Lepturacanthus savala*	7	34.54	3	22.30	10	98.38	2	10.43
37	*Scambaromorus guttatus*			1	2.64				
38	*Rastrelliger* sp.			1	5.10				
39	*Cynoglossus cynoglossus*	2	11.26			3	17.71		
40	*Cynoglossus lingua*	3	11.96	1	3.74				
41	*Chilondon patoca*	1	6.45	2	12.08	7	47.27		
42	Unidentified sp.1					46	45.03		
43	Unidentified sp.2					1	1.34		
Total		188	579.70	550	647.31	652	548.27	728	458.18
N.of species		23		24		21		16	

(Source: JICA Study Team)

(3) Terrestrial wildlife

The aim of the survey is to provide information on fauna and flora for the preparation of the EIA report in connection with the Coal-Fired Thermal Power Plant Construction Project and its transmission (power) line extension areas (PLA). The information should cover the issues of threatened species including critically endangered (CR), endangered (EN), and vulnerable species (VU) listed in the Red list. Every potential impact on and risk to those species has to be mentioned in the report. If the impacts are seriously negative, and the risks are quite high, appropriate countermeasures should be taken to minimize those impacts and risks.

The survey was conducted twice during different seasons of the rainy season (September to October, 2012) and the dry season (middle of January, 2-13)

a) Location of Power Plant

The power plant site will be located at the middle part of Matarbari Island. The site is a low lying area with facilities of salt cultivation in the winter season and shrimp cultivation in the rainy season. There is the Bay of Bengal on the West of the site, Kohelia River on the East, Dhalghata Union on the South, and Sairiar Dail fishermen village on the North of the site.

b) Location of Survey Points

Four survey points were identified by the JICA Study Team to survey the flora and fauna of the area. The survey points are as follows (Figure 4.2.3.6):

1. Southern part of Kutubdia Island
2. Inside the power plant area
3. Mouth of Matarbari Channel (Kohelia River)
4. Sonadia Island

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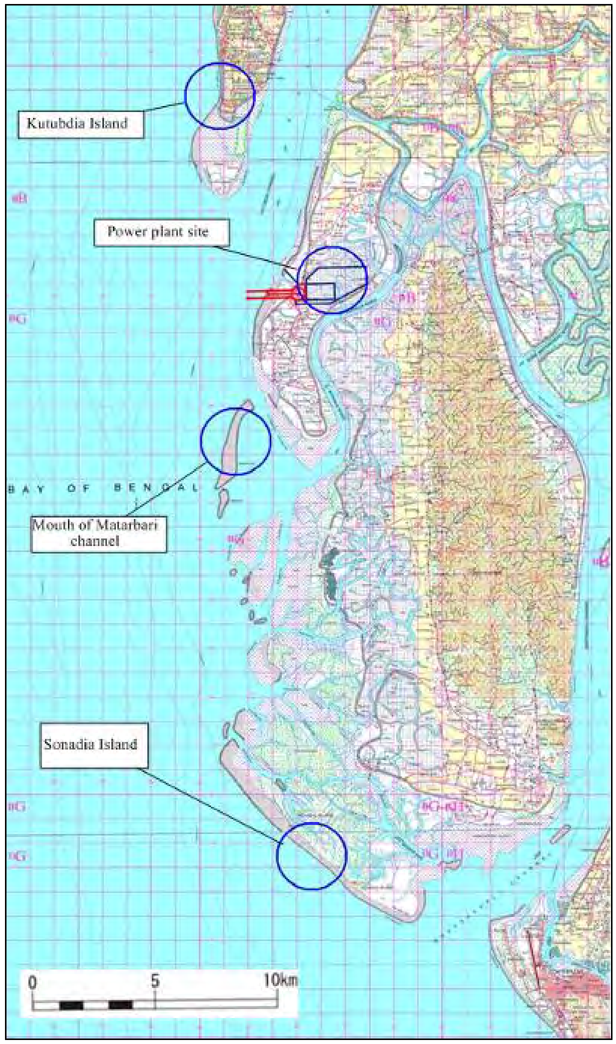


(Source: JICA Study Team)

Figure 4.2.3.6 Map showing the location of the survey points

c) List of Flora and Fauna identified by the survey

A list of flora and fauna identified during the rainy and dry seasons at the 4 survey points is provided in the Annex-2.

d) Results

a. Flora

Humans have impacted much of the land area of the Power Plant site, particularly by shifting shrimp farming and salt pans to the area over several generations. The project area now has species generally associated with secondary and pioneer communities, secondary scrubs, grasslands, poor vegetation cover, and little cash crop in its fringe areas.

In all, 77 species in the rainy season and 71 species in the dry season were recorded at the power plant site, the majority of which are angiosperms. No threatened species, as designated by IUCN status declaration of 2012, were recorded. Three species (*Calamus guruba* Buch-Ham, *Trihosanthes cordata* Roxb, and *Lepisanthes rubiginosa*) which are considered as threatened species under local status by scientist groups in Bangladesh were recorded, but these species have wide distributions and are common in the region (Biologist-group's views of Chittagong University).

b. Fauna

<Insects>

A total of 23 species of 22 families under 10 orders in the rainy season and 32 species of -27 families under 13 orders in the dry season were recorded in the proposed project area. All of these species have Not Threatened (NO) status as per the IUCN status declaration of 2012.

<Amphibians>

A total of 4 species of 2 families under 1 order in the rainy season and 5 species of 2 families under 1 order in the dry season were recorded in the proposed project area, all of which are Not Threatened (NO) status by IUCN.

<Reptiles>

A total of 13 species of 7 families under 2 orders in the rainy season and 10 species of 5 families under 2 orders in the dry season were recorded in the study area.

Among these reptiles, 1 Turtle species (*Eretmochelys imbricate*) was identified as being designated as Critically Endangered (CR) as per the IUCN Red list category.

Three Turtles species (*Geoclemys hamiltonii*, *Chelonia mydas*, and *Caretta caretta*) were identified as being designated as Endangered (EN) and another Turtle species (*Lepidochelys olivacea*) was identified as being designated as Vulnerable (VU) as per the IUCN Red list category.

Five species (*Calotes versicolor*, *Mabuya mabuya*, *Gekko gecko*, *Panghura tentoria*, and *Naja naja*) which are considered as threatened species under local status by scientist groups in Bangladesh were recorded, but these species have wide distributions and are common in the region (Biologist-group's views of Chittagong University).

<Birds>

A total of 77 species of birds in the rainy season and ~~103~~ 147 species of birds in the dry season were recorded in the proposed project area. Among these birds, 1 species (*Eurynorhynchus pygmeus*, Spoon-billed Sandpiper) was identified as being designated as Critically Endangered (CR) by the IUCN status declaration of 2012. ~~No threatened species, as designated by the IUCN status declaration of 2012, were recoded.~~ Two species (*Arachnothera magna*, *Ketupa zeylonensis*) which are considered as threatened species under local status by scientist groups in Bangladesh were recorded, but these species have wide distributions and are common in the region (Biologist-group's views of Chittagong University).

<Mammals>

A total of 11 species of 8 families under 4 orders in the rainy season and 8 species of 6 families under ~~4~~ 5 orders in the dry season were recorded in the proposed project area. All of these species have Not Threatened (NO) status as per the IUCN status declaration of 2012. ~~(The results of the dry season will be added to the Final Report)~~

c. Threatened Species

<Threatened Species listed on the IUCN List>

From the results of the survey on flora and fauna which was carried out during the rainy and dry seasons, a total of 6 species of 1 bird and 5 reptiles were identified as designated threatened species as CR, EN and VU on the IUCN Red List of 2012.

Except for these 6 species of reptiles, there were no other threatened species of flora and fauna observed in both project sites.

Table 4.2.3.6 Threatened species observed in project areas

Taxa	No.	Scientific Name	Season		Conservation Status	Remarks
			Rainy	Dry	IUCN (2012)	
Bird	1	*Eurynorhynchus pygmeus* (Spoon-billed sandpiper)		O	CR	During the weekly survey in the month of December 7 to March 30, 2013, only 3 days in project site and at most 2 individuals in one day were identified in project site.

Taxa	No.	Scientific Name	Season		Conservation Status	Remarks
			Rainy	Dry	IUCN (2012)	
Reptile	1	*Geoclemys hamiltonii* (Spotted Pond Turtle)	**O**		VU	One individual found. It may have strayed into the salt pan as its main habitat is in fresh water ponds, rivers, and marshlands beside salt pans.
	2	*Lepidochelys olivacea* , (Olive Ridley Turtle)	-	**O**	VU	One strayed individual (*Lepidochelys olivacea*) found at a salt pan far from the sea coast. All other 3 species were observed at the adjoining sandy coast of the power plant project site. The numbers of these turtles landing at this coast for laying eggs was 15 individuals over 18 days, approximately one turtle landing per night. A more detailed survey to understand these turtles' nesting distributions has been carried out beginning March, 2013. Effective measures to mitigate for these turtles will be confirmed in the Final Report based on the current detailed survey.
	3	*Caretta caretta* (Logger head turtle)	-	O	EN	
	4	*Chelonia mydas* (Green turtle)	-	O	EN	
	5	*Eretmochelys Imbricate* (Hawksbill turtle)	-	O	CR	
Total	5		↖ 1↗	↖ 4↗		

Notes: CR - Critically Endangered, EN - Endangered, VU - Vulnerable

(Source: JICA Study Team)

Spoon-billed Sandpiper (*Eurynorhynchus pygmeus*)

According to the survey conducted for the month of December 7 till March 30' 2013 it can be confirmed that migration behavior somehow controls the study area to be the wintering ground, that is during winter the Spoon billed Sandpiper come to ashore of the sandy beach of the project front site but it is extremely small compared to nearby coastal offshore, Sonadia Island which is also supported by other's finding in different sites.

During the weekly survey in the month of December 7 to March 30, 2013, only 3 days in project site and 11 days in the southern front of Sonadia were observed flying there respectively, and at most 2 individuals in one day were identified in project site which is about 15% whereas 13 individuals were identified in the southern front of Sonadia in one day (Annex-2).

So, the availability frequency of Spoon billed Sandpiper as a wintering ground to the Matabari Peninsula is comparatively very poor in comparison with that in the nearby offshore island, Sonadia. According to all those previous survey results point out that Matabari Peninsula beach is not main migratory habitat for the migratory bird especially for

Spoon billed Sandpiper in Bangladesh which was also supported by other experts and reports (eminent-ornithology-group's views of Bangladesh) (Annex-2).

Sea Turtle

The survey which aims to grasp the numbers of landing sea turtle for laying eggs at sandy beaches of Matarbari Island and its adjacent beach and one nearby offshore island is to be carried out and following items will be cleared and provided by present survey:

- The numbers of landing sea turtles.
- The name of species of landing sea turtles.
- The nesting behaviors of landing sea turtles.
- The record of hearing results on landing sea turtles from concerned people or authorities
-* The ecological document data on landing sea turtles from scientists

The survey results for 40 days of March 5th to 24 and April 1 to 20' 2013 have been tabulated and Turtles landed confirmed by the survey for the duration aforesaid in the total study area were 34 individuals of 4 species of Olive ridley turtle (*Lepidochelys olivacea*), Loggerhead turtle (*Caretta caretta*), Green turtle (*Chelonia mydas*), and Hawksbill turtle (*Eretmochelys imbricate*).

According to the survey results it be confirmed that tidal behavior somehow controls the spawning of both species that is during neap tide the turtles come to ashore to spawn on to the sandy beach is extremely small compared to spring tide which is also supported by other's finding in different sites.

The landing frequency has been decreasing in almost all sites from March to April. These results agreed with the findings of different papers published in MTN (Marine Turtles Network) by Marine Life Alliance survey for Saint Martin's island and Sonadia Island of the sane coast.

In 2011, a study of 2009-2010, 192 individuals per year was confirmed landing in the Sonadia island. Additionally, landing of 19 individuals was confirmed in one day and night in the same investigation (Islam et al 2011) conducted by the MarineLife Alliance survey.
On the other hand, only 34 individuals in 40 days of observation have been confirmed to land in and Matabari Peninsula. The frequency of nesting is very poor in comparison with their nesting frequency in the nearby offshore island, Sonadia (eminent-reptile-group's views of Bangladesh) (Annex-2).

For the sea turtles, available mitigation measures such as controlling levels of lighting, noise and vibrations caused by construction work may be needed as the sandy coast adjacent to the project site appears to be their nesting and egg-laying sites.

Spotted Pond Turtle (*Geoclemys hamiltonii*)

This species was observed at the salt pans in the project site, although it did not appear to use these salt pans for its displacement and access to feeding, breeding and reproduction in view of its ecological features, so that there is no need to take special countermeasures to protect it besides capturing and replacing it into its original environment.

<Threatened Species that may be treated as rare species by Bangladesh scientist groups in the project areas and effective measures to mitigate the impacts on them>

During the site survey on fauna and flora in both project sites of the Power Plant and transmission line, 11 rare species which are not yet listed in the IUCN Red List of 2012 as threatened species, but are being evaluated as threatened species by Bangladesh scientist groups have been recorded.

Table 4.2.3.7 Threatened Species proposed by Bangladesh scientist groups

Taxa	No.	Scientific name	English name
Flora	1	*Calamus guruba Buch.-Ham.*	Cane
	2	*Trichosanthes cordata Roxb.*	Snake guard
	3	*Lepisanthes rubiginosa*	Rusty sapindus
	3		
Reptile	1	*Calotes versicolor*	Garden lizard
	2	*Mabuya mabuya*	Skink
	3	*Gekko gecko*	Tokay Gecko
	4	*Pangshura tentoria*	Median Roofed Turtle
	5	*Naja naja*	Bicled Cobra
	5		
Bird	1	*Arachnothera magna*	Streaked Spiderhunter
	2	*Ketupa zeylonensis*	Broun Fish Owl
	3	*Vanellus duvaucelii*	River Lapwing
	3		
Total	**11**		

(Source: JICA Study Team)

<Other>

According to “Data collection survey on coal power master plan follow-up in the People's Republic of Bangladesh: final report”, there are some endangered species in and around Sonadia Island. Therefore, an investigation of endangered species was conducted.

- Spotted green shanks (*Tringa guttifer*) (EN the IUCN Red List of 2012)

From the results of the survey on birds which was carried out during the rainy and dry seasons in the Power plant site and the Transmission line, none of this species was recorded.

- Great knotd (*Calidris tenuirostris*) (VU the IUCN Red List of 2012)

From the results of the survey on birds which was carried out during the rainy and dry seasons in the Power plant site and the Transmission line, none of this species was recorded.

- Indo-Pacific Finless Porpoised (*Neophocaena phocaenoides*) (VU the IUCN Red List of 2012)

From the results of the survey on dolphin which was carried out during the rainy and dry seasons in the canals, shores and offshore areas of the Power plant site and Sonadia Island, none of this species was recorded.

- Irrawaddy Dolphins (*Orcaella brevirostris*) (VU the IUCN Red List of 2012)

From the results of the survey on dolphins which was carried out during the rainy and dry seasons in the canals, shores and offshore areas of the Power plant site and Sonadia Island, none of this species was recorded.

4.2.4 Socio-Economic Status

(1) Social environment

A household survey targeting over 300 household heads as well as focus group discussions targeting women, children, salt workers and shrimp workers were conducted in December 2012 for comprehensive apprehension of the socio-economic profile of the project affected people. The project site is home to the local residents over generations. The maximum length of time found among them reached 300 years. The household size typically found at the site is 6 people, and over 70% of the interviewed household heads were illiterate or could only write their own names. 35% of the interviewed households received between 10,000 and 20,000 taka, and the average household monthly income was approximately 26,500 taka, 45.5% of the households spent between 10,000 and 20,000 taka per month, and the average household monthly expenditure was approximately 18,000 taka. Based on the incidence of poverty by the cost of basic needs (CBN) method defined by the Bangladesh

Bureau of Statistics, 9% of them were categorized as poor households on income basis, and 13% on expenditure basis.

Most of the land in the power plant site is used for salt cultivation during the dry season (November to April), and shrimp cultivation during the rainy season (May to October). Shrimp laborers often come from Matarbari Island: Saliari Dail, Mogdai Bazar, Sardar Para, Honsho Meage Para, and Nasir Mohammaddhil villages. Salt laborers are mainly collected at the labor market in Santair Bazar, and also come from Natur Bazar, Puran Bazar, Rajghat, Matarbari, Saliari Dail, Mogdai Bazar, Nutur Para, Sardar Para, Honsho Meage Para, Nasir Mohammaddhil, and Uttar Hohoraghora.

(Source: Taken by the JICA Study Team)

Figure 4.2.4.1 Power plant and Port facility site

There are mainly four kinds of people involved in salt and shrimp cultivations: cultivator, laborer, mazi, and businessman. Among the households interviewed at the project site in December 2012, cultivators were comprised of over 30% among them, are the owners of salt field of shrimp field (by owning or leasing the land). They invest money for cultivation. Laborers are those people who sell their labor under the instruction given by the cultivators. They prepare and make the salt bed, for instance. They receive wages from cultivators. Due to the fact that their households have not been financially privileged, they do not have sufficient opportunities for education. Many of them have to drop out of school while they were children even before they completed primary education. They have fewer job opportunities because of their low education and literacy levels. They also shared around 30% in the interview survey. Maziz, comprised of 10 % among the interviewed households, coordinate between cultivators and laborers. They find laborers and allocate them at salt/shrimp fields that belong to the owners or lessees who need laborers. Businessmen, around 10 % as well, are those who are involved in purchasing salt (or shrimp) from the field and local market, and sell them at markets in Chittagong, Dhaka or Narayanganj.

One of the salt factories located within the site has 70 to 80 workers throughout the year, 20 to 30 of whom live together in a terrace house. Laborers come from other districts for shrimp cultivation during the rainy season. All salt taken at the site is sent to Chittagong as there is no salt market in Cox's Bazar.

(Source: Taken by the JICA Study Team)

Figure 4.2.4.2 Power plant and Port facility site (East edge)

Almost all the interviewed households used firewood for cooking, and majority of them used kerosene for lighting. All of them depended on tube wells for water. Local residents used alum (phitkari) for purifying water instead of boiling water. They have to travel to the nearest market to see quack doctors and other sources for medical and health treatment. They often suffer from general fever, respiratory infection (such as cold), diarrhea and stomachache.

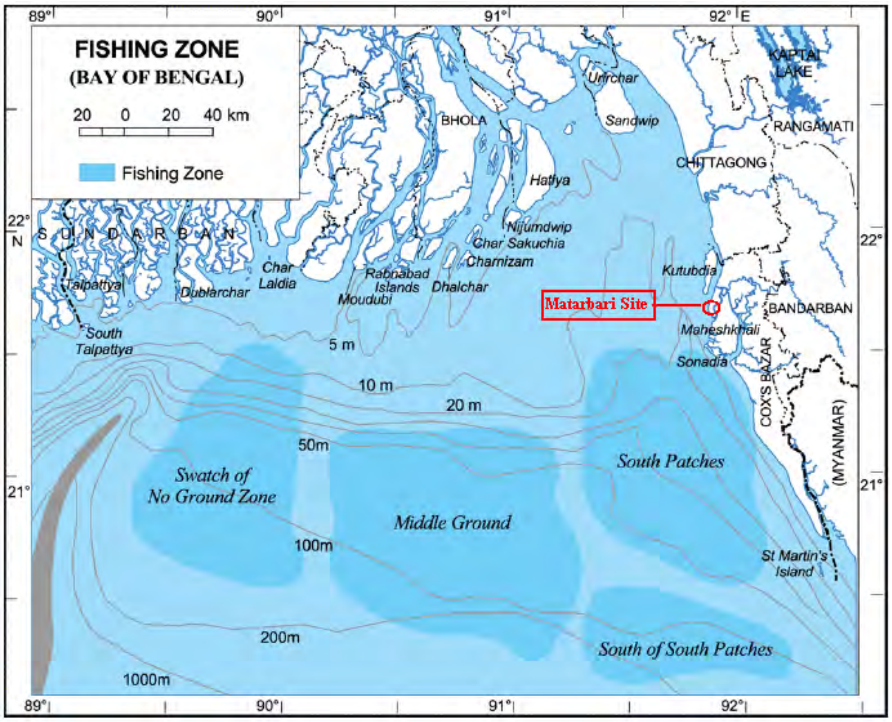
Not many of them collect information from TV or radio as they do not have these items at home. They often listen to radio or watch TV at tea stands or in the local markets for collecting information, apart from which they hear news from neighbors and friends.

The survey details and results are found in the Land Acquisition and Resettlement Action Plan as attached in the Annex-5.

(2) Fishery

Information on fishery was collected and confirmed at Maheshkhali Upazila Office. Fisherman's village in Maheshkhali Upazila is located along the coast line and Kohalia River, and the number of fisherman's households is estimated to be 3000 to 4000. The average annual income by fishing activities is about 10,000 to 15,000 per household. There are four main fishing zones in the Bay of Bengal as described in Figure 4.4.4.3. The nearest fishing zone from the proposed power plant site is South Patches, located at south of

Sonadia Island. Therefore, it can be noted that the sea side of the proposed power plant site is not the main fishing ground.



(Source: http://www.banglapedia.org/httpdocs/HT/B_0361.HTM (accessed August 2012))

Figure 4.2.4.3 Main fishing zone in Bengal Bay

4.2.5 Environmentally Sensitive Areas of Special or Unique Scientific, Socio-economic or Cultural Value

Under the Environmental Conservation Act (ECA), ecologically sensitive and precious areas are designated as ECAs (Ecologically Critical Areas) by Department of Environment in Bangladesh in cases where an ecosystem or biodiversity area is considered to be threatened to reach a critical state. On the other hand, protected areas such as national parks and protected forests are designated by Department of Forest under the Wildlife Order and Forest Act as shown on Table 4.2.5.1.

Table 4.2.5.1 Protected Areas in Bangladesh

Classification		Competent Authority	Governing Law
A	National Parks	Department of Forest	Wildlife (Preservation) Order
B	Wildlife Sanctuaries		
C	Game Reserves		
D	Botanical Gardens, Eco-parks		
E	Reserved Forests, Protected Forests		Forest Act
F	Ecologically Critical Areas	Department of Environment	Environmental Conservation Act

ECAs focus more on the importance and diversity of species and ecosystem and target any ecologically sensitive areas except for the protected areas designated by Department of Forest.

Along with the ECAs declaration, each ECAs has notifications declared by Department of Environment in which specific activities to be restricted in that ECA are specified.

ECAs are actually a new category of Protected Area in Bangladesh and not formally acknowledged in Bangladesh law, in reality all the ECA management enforcement could become ineffective[3]. According to Department of Environment, enforcement of laws and regulations regarding ECAs are not clearly scheduled at this moment.

The closest ECA to the project site is Sonadia ECA located 15km from the project site (Figure 4.2.5.1). The area of Sonadia ECA is $49.2km^2$. The following is a list of restricted activities specified in the notification of Sonadia ECA[4]:

- Natural forest and tree felling and harvesting
- Wildlife or game killing
- Catching or collecting corals, bivalves, turtles and other wild life
- Destruction or alteration of habitats for flora and fauna
- Any activities that relate to the destruction of the natural characteristics of land and water
- Establishment of industries that might pollute the land, water, air and make sound pollution
- Any activity that might harm fish and other aquatic lives

[3] Sonadia Island ECA Conservation Management Plan -DRAFT-, 2006.
[4] Ibid

(Source: Sonadia Island ECA Conservation Management Plan -DRAFT-, 2006.)

Figure 4.2.5.1 Project Site and Sonadia ECA boundary

Chapter 5

Primary Fuel Sources and Transportation

Chapter 5

Primary Fuel Source and Transportation

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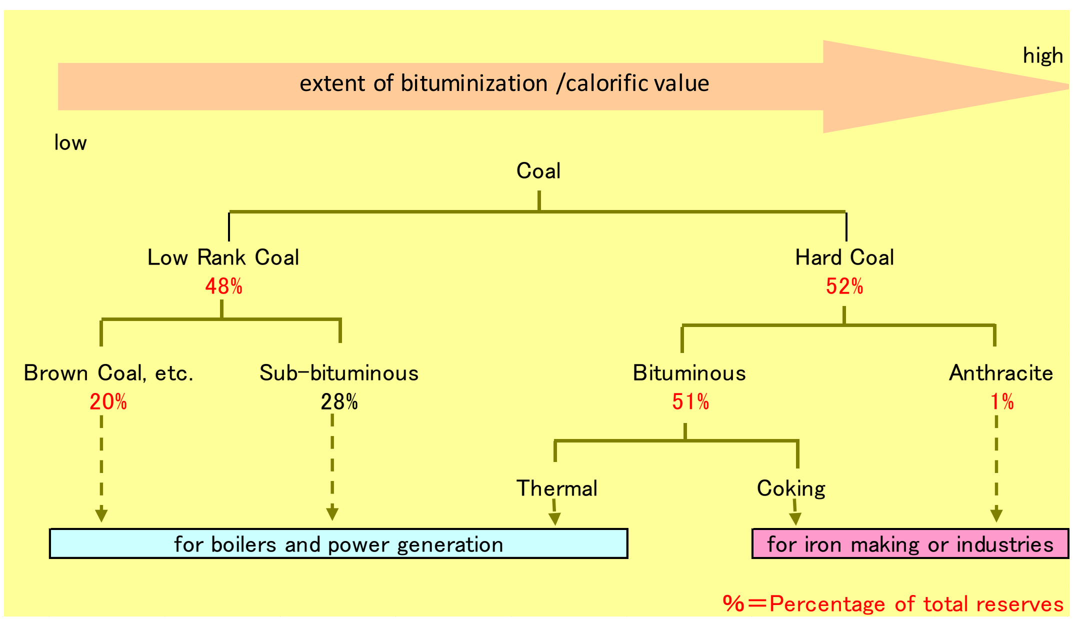
5 Fuel Supply Plan

5.1 Amount of coal resources

5.1.1 Classification of coal

Coal is roughly divided into three types according to the progress of coalification shown in Figure 5.1.1. They are brown coal including peat and lignite, bituminous coal, and anthracite in ascending order according to coalification. Because coalification is the process of the increasing carbon content, the quality of coal rises from brown coal to anthracite. At each intermediate stage in the coalification process, there is matter called peat (the lower grade of lignite), sub-bituminous coal (the lower grade of bituminous) and semi-anthracite etc. Young coal which has high oxygen content requires careful handling due to the likelihood of spontaneous combustion.

In addition, depending on how it is used, coal can be classified as coking coal for iron making and thermal coal for power generation.



Source: The Study Team

Figure 5.1.1 Classification of coal

5.1.2 Proven reserves of coal in the world

According to BP statistics, the world's proven reserves of coal are 861 billion tones as shown in Table 5.1.1. The reserve-production ratio is about 118 years. Coal has the longer R/P ratio than oil or gas, and has a wider global dispersion rate. The United States has the biggest reserves, Russia the second, and China the third, followed by Australia, India and so on.

Table 5.1.1 Proven reserves of coal in the world

(million tonnes)

	Anthracite/ Bituminous	Sub-bituminous/ Brown Coal	Total
USA	108,501	128,794	237,295
Russia	49,088	107,922	157,010
China	62,200	52,300	114,500
Australia	37,100	39,300	76,400
India	56,100	4,500	60,600
Germany	99	40,600	40,699
Ukraine	15,351	18,522	33,873
Kazakhstan	21,500	12,100	33,600
South Africa	30,100	–	30,100
Columbia	6,366	380	6,746
Canada	3,474	3,108	6,582
Indonesia	1,520	4,009	5,529

Source：BP Statistical Review of World Enrgy 2011

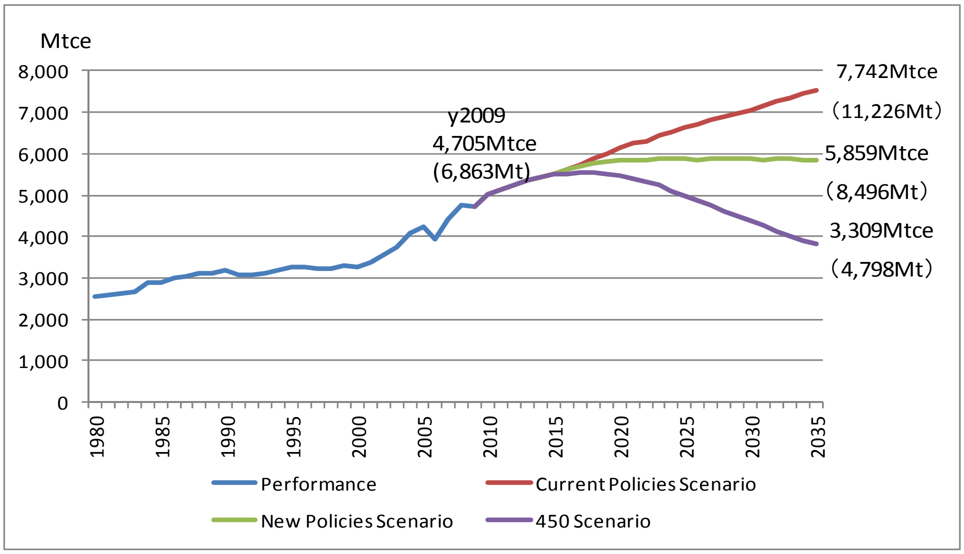
5.2 Demand and supply situation of imported coal in the international market

5.2.1 Global coal demand

Figure 5.2.1 shows the result of world coal demand through 2010 and the IEA's prediction until 2035. The predicted scenario shows three via a national approach towards climate change, which are the Current Policies Scenario, New Polices Scenario and the 450 Scenario[1]. World coal production in 2009 was 6.8 billion tons and the demand for coal should continue the current policy remains will reach 11.2 billion tons in 2035. However, it is said that it is possible to reduce the consumption of coal by 8.5 billion tons per the New Polices Scenario and 4.8 billion tons per the 450 Scenario.

Coal demand has been increasing rapidly since 2002 and coal prices have been rising as a result. The period of stable demand applied not only to stable coal prices but also to situations where rapidly increasing coal demand in Non-OECD countries in recent years. The tight supply has caused a coal price increase and uncompetitive coal resources will allow the mining of coal and an increase in coal supply as a result. Therefore, the future price of coal is expected to rise until the balance between supply and demand is stabilized.

[1] 450 scenario is the scenario to hold down CO_2 density to 450ppm



(Sources: IEA World Energy Outlook11)

Figure 5.2.1 World Coal Demand Forecast

About 90↓ of the world's coal consumption is thermal coal, so global coal demand trends can basically be considered to be global thermal coal demand trends.

According to the "World Energy Outlook 2011" by IEA, global coal demand in 2009 was 4.7 billion tons and occupied a 27% share of primary energy demand. From 2000 to 2010, the estimated global coal demand growth was 4.4% per annum, and that figure was far more than the 1.1↓ growth in oil demand and 2.7% growth in natural gas demand. As a result, coal contributed to a little less than half the level of primary energy demand growth over the 10- year period. The main use of coal is for power generation. About two-thirds of the demand for coal is for power generation, and 20% is for industrial purposes. During power generation, the proportion of coal is about less than half, so coal can be the main fuel.

In terms of future demand trends, the global coal demand is expected to increase by 1.9% per the annum growth rate from 4.7 billion tones in 2009 to 7.7 billion tones in 2035 under the current policy scenario. Even under the new policy scenario[2,] the demand is expected to remain unchanged from 2020, but reach 5.9 billion tones in 2035.

Concerning regional demand growth, whereas OECD countries are almost flat, non-OECD

[2] New policy scenario is a scenario which is considered the planning and pledge released by the countries for energy security or no environment problems, and it is not a forecast.

countries especially China and India are expected to experience large demand growth as shown in Table 5.2.1. Under the current policy scenario, the growth in coal demand in China and India is expected to account for three quarters of global coal demand growth by 2035. So the growth of coal imports of both countries is projected to have a major impact on the coal trade.

Table 5.2.1 Coal demand by region and scenario

【Coal demand by region and scenario】

(Mtce)

			Current Policies Scenario		New Policies Scenario	
	1980	2009	2020	2035	2020	2035
OECD	1,380	1,476	1,609	1,588	1,494	1,146
United States	*537*	*693*	*751*	*773*	*705*	*599*
Europe	*663*	*415*	*431*	*400*	*383*	*264*
Japan	*85*	*145*	*165*	*156*	*158*	*115*
Non-OECD	1,179	3,229	4,699	6,154	4,339	4,713
China	*446*	*2,179*	*3,069*	*3,709*	*2,863*	*2,820*
India	*75*	*399*	*699*	*1,148*	*619*	*883*
Russia	*NA*	*136*	*173*	*203*	*166*	*168*
World	2,560	4,705	6,308	7,742	5,833	5,859

Source：IEA "World Energy Outlook 2011"

5.3 Global coal production

According to BP statistics, global coal production in 2010 was 7.3 billion tons, an increase of 6.3 percent. Per country, production in China is overwhelming in comparison to other countries and its volume accounts for more than 40% of the total world coal production followed by the United States, India, and Australia as shown in Table 5.3.

Table 5.3 Global coal production

(million tonnes)

China	3,240
USA	985
India	570
Australia	424
Russia	317
Indonesia	306
South Africa	254
Germany	182
Poland	133
Kazakhstan	111

Source：BP Statistical Review of World Enrgy 2011

5.4 Thermal coal export countries

Countries with a higher export volume of coal are Indonesia, Australia, and then Russia as shown in Table 5.4. In high-volume production countries such as China, the United States and India, coal is essentially devoted to domestic consumption and exports are minimal. China has recently become a net importer.

Table 5.4 Countries with a higher export volume of coal

(million tonnes)

Indonesia	285
Australia	143
Russia	95
Columbia	68
South Africa	68
Kazakhstan	33
USA	23
China	19

Source：IEA “Coal Information 2011”

5.5 Thermal coal import countries

Top coal importers are mainly East Asian Countries such as Japan, China, Korea, India, and Taiwan as shown in Table 6.2-4. In addition, European countries are also importers. Although China occupies only about 4 % of the imports in domestic coal production, China is already ranks as one of the top importing counties. Given the significant increase in coal demand in India and China in the future, Chinese and Indian influence is expected to increase in the area of seaborne trade of coal.

Table 5.5 Top coal importers

(million tonnes)

Japan	135
China	129
Korea	91
India	60
Taiwan	58
Germany	38
Russia	23

Source：IEA “Coal Information 2011”

5.6 Possibility of coal supply to the Matarbari CFPP

For coal supply and demand forecasts of countries that can export to Bangladesh, coal production was examined country by country. In order to study the coal supply and demand forecast for 2030, Indonesia, Australia, South Africa and Mozambique will be considered as possible coal-producing countries for the sea transport distances to Bangladesh. Table 5.6 shows freight rate and navigation days in 2012.

Table 5.6 Freight Rate and Navigation Day

Shipping Country！ to Chittagong	Loading Port	Freight Rate (US$/t)	Navigation mile	Navigation Days (port to port, 13 knot/hr)
Indonesia (South Sumatra)	Palembang	$13	1,842	6
Indonesia (South Kalimantan)	Taboneo	$14	2,268	8
Indonesia (East Kalimantan)	Bontang	$15	2,963	9
South Africa	Richards Bay	$18	4,979	16
Australia (NSW)	Newcastle	$22	5,767	19
Canada (West coast)	Westshore	$28	8,584	28
USA (West coast)	Long Beach	$31	9,190	30
Colombia (Atlantic coast)	Puerto Bolivar	$33	11,726	38
USA (Gulf)	New Orleans	$38	13,223	42

In addition, in terms of coal reserves and future production possibilities, the neighboring countries of Bangladesh, Myanmar and Laos are being considered. But stable exports would still take time. Thailand has also been producing coal but it cannot be expected that their coal has a high sulfur content, considering the fact that domestic consumption is limited. And, since China becomes an import coal country, China is out of all those countries.

The coal production situation in Australia, Indonesia, South Africa, and Mozambique are described here.

5.6.1 Australia

According to the "Australian energy projections to 2034–35" released by BREE[3] in December, 2011, production of black coal[4] is expected to increase at an annual rate of 2.8% from 300 million tons (9,004 petajoules) in FY2008/09 to 623 million tons in FY2034/35 (18,676 petajoules) as shown in Table5.6.1 and Figure 5.6.1. Since domestic coal demand is expected to become lower than present levels, the export volume should increase along with the expansion of production. Construction of infrastructure for coal development and coal exports is promoted

[3] The Bureau of Resources and Energy Economics, a research body of the commonwealth of Australia,
[4] Bituminous coal of both steam and coking coal, etc.

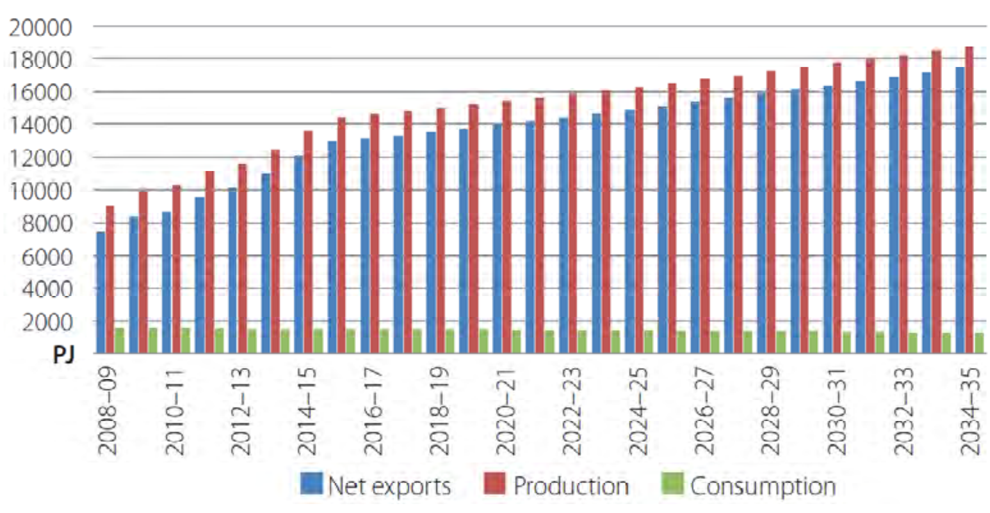
in the State of New South Wales and the State of Queensland, and it is expected that the volume of coal exports will continue to expand at an annual rate of 3.3% towards FY2034/35 from 247 million tons (7,411 petajoules) to 581 million tons (17,415 petajoules) (black coal alone).

Table 5.6.1 Australian Coal Supply and Demand Outlook

		2008/09		2019/20		2034/35	
		(million tons)	(PJ)	(million tons)	(PJ)	(million tons)	(PJ)
Production	Black Coal	300	(9,004)	506	(15,185)	623	(18,676)
	Brown Coal	66	(647)	66	(647)	29	(281)
		366	(9,651)	572	(15,832)	651	(18,957)
Domesiti Consamption	Black Coal	53	(1,593)	49	(1,460)	42	(1,260)
	Brown Coal	66	(647)	66	(647)	29	(281)
		119	(2,240)	115	(2,107)	71	(1,541)
Exports	Black Coal	247	(7,411)	458	(13,725)	581	(17,415)
	Brown Coal	0	(0)	0	(0)	0	(0)
		247	(7,411)	458	(13,725)	581	(17,415)

Source: Prepared by JICA study team based on the “Australian energy projections to 2034–35, December 2011” of BERR

In the “BREE’s list of major minerals and energy projects, April 2012” made public by BREE on its own Web site in April, 2012, 46 projects to expand existing coal mines (16 under construction) and 48 new development projects (5 under construction), totaling 94 projects (21 under construction), are listed in Table 6.3-3.



Source: The “Australian energy projections to 2034–35, December 2011” of BERR

Figure 5.6.1 Australian Black Coal Supply and Demand Outlook

If the coal supply capacity that can be added by such coal production increase projects listed here in and after 2012 is accumulated, Australia can will be able to add a total of 570 million tons of coal supply capacity in 2017, of which steam coal is 400 million tons and 170 million tons is coking coal as shown in Table 5.6.3. BREE says that 348 million tons of coal (coal products minus lignite) was actually produced in 2011 and the simple addition of this value to added coal supply capacity yields 920 million tons as of 2017. BREE expects coal production (coal products minus lignite) in 2019/20 to be 506 million tons and, if the production increase projects shown in the "BREE's list of major minerals and energy projects, April 2012" are implemented smoothly, it seems that the supply capacity will be sufficient enough to satisfy the expected value even if some of the existing mines are closed due to coal reserve depletion. Since coal production can be expanded as mentioned above, it is assumed to be quite possible to achieve the outlook for 2019/20 coal exports. According to BREE, Australia exported 281 million tons of coal in 2011, of which 133 million tons 47% of this amount was steam coal and 148 million tons or 53% of this amount was coking coal.5 This means that, if the above ratio is applied, as shown in Table 5.6.4, the volume of steam coal exports will swell to 241 million tons in 2019/20 and to 305 million tons in 2034/35, while the volume of coking coal exports will increase to 217 million tons in 2019/20 and to 275 million tons in 2034/35.

Table 5.6.2 Number of Australian Coal Projects

	NSW	QLD	West Australia	Total
Expansion	25 (9)	21 (7)	0 (0)	46 (16)
New Project	8 (1)	39 (4)	1 (0)	48 (5)
Total	33 (10)	60 (11)	1 (0)	94 (21)

Source: Prepared by JICA study team based on the "BREE's list of major minerals and energy projects, April 2012" of BERR

[5] BREE's Web site-contained information "Resources and Energy Statistics—December Quarter 2011—Commodity Historical Data Tables"

Table 5.6.3 Australian Coal Production Increase Plan

(million tons)

		2012	2013	2014	2015	2016	2017-
NSW		12.0	33.3	23.6	15.5	14.0	44.4
	Steam Coal	9.0	20.7	16.1	15.5	3.5	41.7
	Coking Coal	3.0	12.7	7.5	0.0	10.5	2.8
QLD		13.2	54.3	146.6	72.6	18.0	120.9
	Steam Coal	3.2	19.2	101.9	70.6	5.0	92.5
	Coking Coal	10.0	35.1	44.7	2.0	13.0	28.5
West Australia		0.0	0.0	2.5	0.0	0.0	0.0
	Steam Coal	0.0	0.0	2.5	0.0	0.0	0.0
	Coking Coal	-	-	-	-	-	-
Total		25.2	87.6	172.7	88.1	32.0	165.3
	Steam Coal	12.2	39.9	120.5	86.1	8.5	134.1
	Coking Coal	13.0	47.8	52.2	2.0	23.5	31.2
Cumulative Total		25.2	112.8	285.5	373.6	405.6	570.9
	Steam Coal	12.2	52.1	172.6	258.7	267.2	401.3
	Coking Coal	13.0	60.8	113.0	115.0	138.5	169.7

(Source: Prepared by JICA study team based on the "BREE's list of major minerals and energy projects, April 2012" of BERR)

Table 5.6.4 Australia's By-Coal Type Coal Exports Outlook

(million tons)

		2011 Actual	2019/20	2034/35
Exports	Steam Coal	148	241	305
	Coking Coal	133	217	275
		281	458	581

Note: Actual values are based on BERR statistics.

(Source: Prepared by JICA study team)

5.6.2 Indonesia

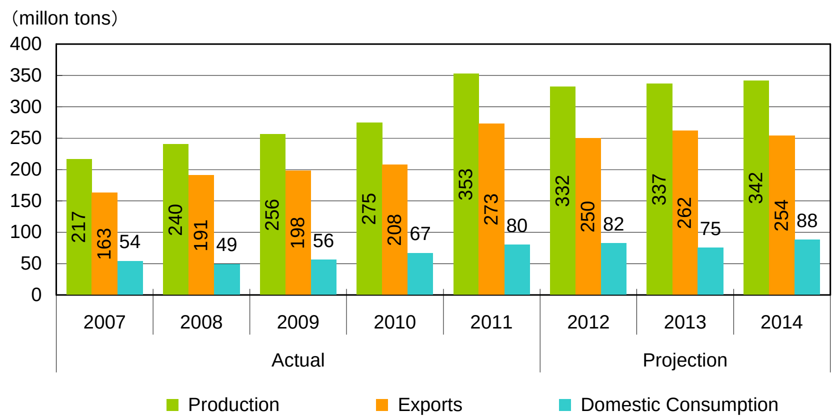
According to the presentation6 made by Mr. Wibowo, Directorate General of Mineral and Coal, the Ministry of Energy and Mineral Resources as shown in Figure 5.6.2.1, in the medium runs both production volume and export volume of coal fail to maintain such expansion as was achieved before and hit their ceilings. Furthermore, according to the presentation7 made by Mr. Kamandanu from the Indonesian Coal Mining Association as shown in Figure. 5.6.2.2, it is expected that, in the long term, coal production will continue to expand. It is, however, assumed that since domestic coal demand is expected to increase, exports will remain in the range from

[6] The "Coal Policy and The New Mining Law No. 4/2009 in Indonesia" at the "Clean Coal Day in Japan 2012 International Symposium" held on September 4 and 5, 2012,

[7] The "Indonesian Coal Mining Outlook" at the IEA workshop "Coal Market's Outlook" held in China on April 14, 2011,

240 million tons to 260 million tons and fail to maintain such expansion as was achieved before.

Table 5.6.2.1 shows a compilation8 of projects for the production increase at existing coal mines and new coal mine development cited in an information magazine9 between last year and this year, indicating that the supply capacity that can be added between 2012 and 2014 reaches 121 million tons (107 million tons of steam coal and 14 million tons of coking coal). As shown in Figure. 5.6.2.1, in the medium run, since no increase in coal production is expected between 2011 and 2014, 121 million tons of supply capacity to be added becomes the reserve supply capacity as is. In other words, Indonesia ends up having some 100 million tons-worth reserve coal export capacity.



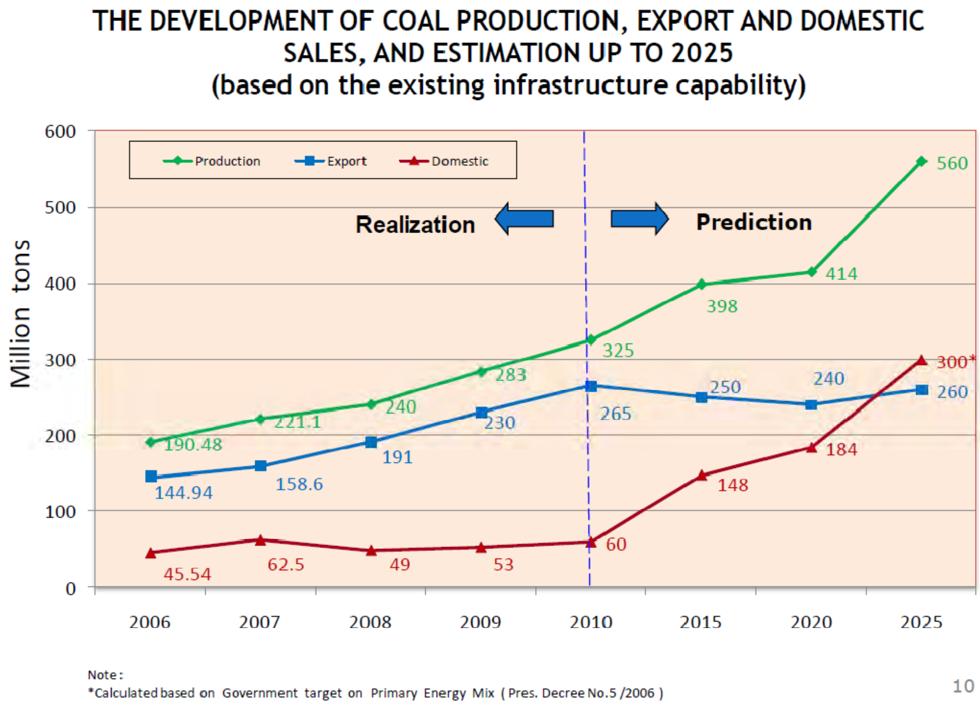
(million tons)

	Actual					Projection		
	2007	2008	2009	2010	2011	2012	2013	2014
Production	217	240	256	275	353	332	337	342
Exports	163	191	198	208	273	250	262	254
Domestic Consumption	54	49	56	67	80	82	75	88

(Source: Prepared by JICA study team based on lecture materials of the "Clean Coal Day in Japan 2012 International Symposium" held on September 4, 2012)

Figure 5.6.2.1 Indonesian Medium-Term Coal Supply and Demand Outlook

[8] Does not cover all of Indonesia's projects for production increase and new development.
[9] TEX Report (released by The TEX Report Ltd., http://www.texreport.co.jp/xenglish/index.html)



(Source: Lecture materials of IEA workshop "Coal Market's Outlook" held on April 14, 2011)

Figure 5.6.2.2 Indonesian Long-Term Coal Supply and Demand Outlook

Table 5.6.2.1 Indonesia's Coal Production Increase Plan

(million tons)

		2012	2013	2014	2015	2016	2017-
Total		33.8	45.0	42.0	13.5	3.0	6.0
	Steam Coal	29.3	35.5	42.0	0.0	0.0	6.0
	Coking Coal	4.5	9.5	0.0	13.5	3.0	0.0
Cumulative Total		33.8	78.8	120.8	134.3	137.3	143.3
	Steam Coal	29.3	64.8	106.8	106.8	106.8	112.8
	Coking Coal	4.5	14.0	14.0	27.5	30.5	30.5

Note: Does not cover all of Indonesia's projects for production increase at existing coal mines and new coal mine development.
(Source: Prepared by JICA study team)

With regards to the outlook breakdown for coal exports, in Indonesia, the coking coal demand for domestic usage is scarce and it is assumed that the coking coal supply capacity to be added will be all applied to exports. Therefore, although Indonesia exported about 1 to 2 million tons of coking coal in the 2000s[10], it becomes possible to expand this to around 20 million tons in 2015. Assuming that the coking coal supply capacity to be added is entirely applied to exports,

[10] The "Coal Information 2012" of IEA

the by-coal type outlook for coal exports prepared in line with long-term coal supply and demand outlook (Figure. 5.6.2.2) will be as shown in Table 6.3-7.

Table 5.6.2.2 Indonesia's By-Coal Type Coal Exports Outlook

（million tons）

		2011 Actual	2015	2020	2025
Exports	Steam Coal	272	230	220	240
	Coking Coal	1	20	20	20
		273	250	240	260

(Source: Prepared by JICA study team)

5.6.3 South Africa

Regarding South Africa and Mozambique describing later, nothing like the above-given coal supply-demand outlook released such as by a government agency is available but the coal supply capacity that can be added is identified from the projects for production increase at existing coal mines and the new coal mine development contained in an information magazine to infer the volume of coal that can be exported.

First, with regards to South Africa, a compilation11 of 6 new coal mine development projects placed in an information magazine12 between last year and this year is shown in Table 5.6.3.1. During and after 2012, the supply capacity that can be added by 2015 is 36 million tons (18 million tons of steam coal and 18 million tons of coking coal). Since the coal production in 2011 is 253 million tons13, the supply capacity expands to as much as about 290 million tons in 2015, assuming that the production will not drop due to coal mine closure etc. As for the added coal supply capacity, it is assumed that the coking coal will be entirely applied to exports and, 80% of the steam coal will be applied to the exports. However, the steam coal supply capacity of 10 million tons to be added in 2014 is excluded because it is for domestic use. Table 5.6.3.2 shows the coal export volume outlook based on this assumption.

Table 5.6.3.1 South Africa's Coal Production Increase Plan

（million tons）

		2012	2013	2014	2015
Total		0.8	6.2	12.1	0.0
	Steam Coal	0.8	5.2	12.1	0.0
	Coking Coal	0.0	1.0	0.0	0.0
Cumulative Total		0.8	6.9	19.0	19.0
	Steam Coal	0.8	5.9	18.0	18.0
	Coking Coal	0.0	1.0	1.0	1.0

[11] Does not cover all of South Africa's projects for production increase and new development.
[12] TEX Report (released by The TEX Report Ltd.)
[13] The "Coal Information 2012"of IEA

Note: Does not cover all of South Africa's projects for production increase at existing coal mines and new coal mine development.

(Source: Prepared by JICA study team)

Table 5.6.3.2 South Africa's By-Coal Type Coal Exports Outlook

(million tons)

		Actual					Projection			
		2007	2008	2009	2010	2011*	2012	2013	2014	2015
Exports	Steam Coal	66.1	56.6	51.4	65.6	71.6	72.2	76.3	78.0	78.0
	Coking Coal	0.9	1.3	0.6	0.8	0.2	0.2	1.2	1.2	1.2
		67.0	57.9	52.0	66.4	71.7	72.3	77.4	79.1	79.1

Note: Actual values are based on "Coal Information 2012" of IEA and 2011 values are prospective.

(Source: Prepared by JICA study team)

5.6.4 Mozambique

As for Mozambique, a compilation14 of 5 new coal mine development projects placed in an information magazine15 between last year and this year is shown in Table 5.6.4.1. The supply capacity that can be added between 2012 and 2015 is 44 million tons (14 million tons of steam coal and 30 million tons of coking coal). Since, according to the "Coal Information 2012" released by IEA, the coal production in 2011 is below 0.1 million tons, the supply capacity of 44 million tons that can be added by 2015 remains as is the amount that can be produced. Assuming that the added coal supply capacity will be entirely applied to coking coal and 70% of steam coal will be applied to exports, the coal exports outlook will be as shown in Table 5.6.4.2.

Table 5.6.4.1 Mozambique's Coal Production Increase Plan

(million tons)

		2012	2013	2014	2015
Total		6.3	10.5	17.4	9.6
	Steam Coal	1.9	3.1	3.4	5.2
	Coking Coal	4.3	7.5	13.9	4.4
Cumulative Total		6.3	16.8	34.1	43.7
	Steam Coal	1.9	5.0	8.4	13.6
	Coking Coal	4.3	11.8	25.7	30.1

Note: Does not cover all of Mozambique's projects for production increase at existing coal mines and new coal mine development.

(Source: Prepared by JICA study team)

Table 5.6.4.2 Mozambique's By-Coal Type Coal Exports Outlook

(million tons)

		Actual					Projection			
		2007	2008	2009	2010	2011*	2012	2013	2014	2015
Exports	Steam Coal	0.02	0.03	0.03	0.03	0.01	1.3	3.5	5.9	9.5
	Coking Coal	0.00	0.00	0.00	0.00	0.00	4.3	11.8	25.7	30.1
		0.02	0.03	0.03	0.03	0.01	5.7	15.3	31.6	39.7

14 Does not cover all of Mozambique's projects for production increase and new development.

15 TEX Report (released by The TEX Report Ltd.)

Note: Actual values are based on the “Coal Information 2012” of IEA and 2011 values are prospective.
(Source: Prepared by JICA study team)

5.7 Coal Supply Plan to Matarbari CFPP

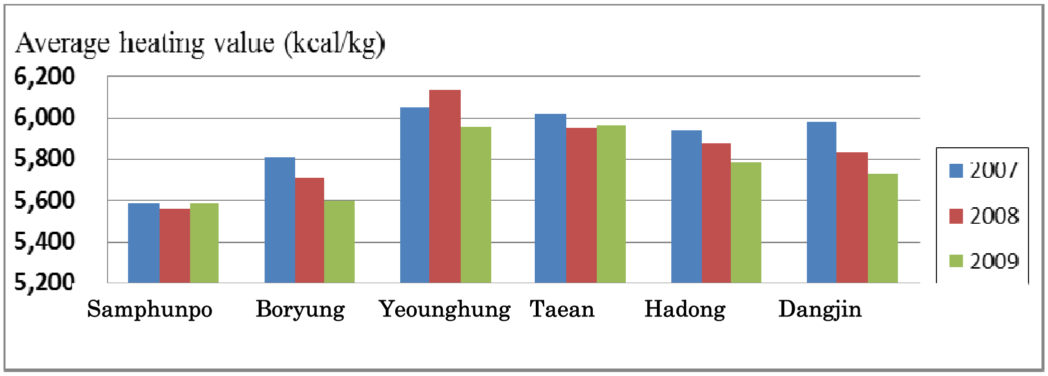
5.7.1 The calorific value of import coal and summary of imported coal

(1) Determination of the calorific value

When the calorific value of coal imported by Bangladesh is considered from the viewpoint of the importation of coal available in terms of future stability, the circumstances described below are examined.

- An extra 6,000 kcal/kg for the average demand has already been decided in developed countries and it is difficult to import this high calorie coal to the new market of Bangladesh.
- In terms of the boiler design, to use the higher calorific value becomes a smaller investment amount and better efficient combustion but when calorific value is below the design specifications of the imported coal from the supply problems in the future, it will cause significant operational problems. It is often seen in cases of new power plants in developing countries. Conversely, if the calorific value is greater than the design specifications, it is a minor problem.
- As an example of the current power plant in Korea in Figure. 6.4-1, the existing power station also tends to degrade the calorific value of coal in terms of securing a stable supply of coal.

From the above situation, the information of Japanese trading companies and the site investigations conducted in Indonesia and Australia, the range and amount of heat from 4,200 kcal/kg to 5,200 kcal/kg and the average calorific value of 4,700 kcal/kg of imported coal is reasonable and determined. It has been confirmed that the quantity of coal in this calorific value necessary for 600Mw x two units is sufficient for long-term stable supply through an investigation as from 3.5 to 4 million tons. In addition, more information about the details of the design coal is described later.



(Source: JICA study team)

Figure 5.7.1 Actual Use of Low-grade Coal at Coal-fired Power Stations in South Korea

(2) Summary of import coal

As a result of this study, Indonesia will be main country of import coal for Matarbari CFPP and 70% of the entire amount of import coal will be from Indonesia. And the rest will be imported from Australia. South Africa and Mozambique will be in addition to Australia in the future. The summary of these coals is as followings.

1) Indonesian coal

ⓔ Though Indonesian coal has normally low ash content at around 2% -15%, the range of the total moisture is wide at around 11% - 40%.

ⓔ There is much coal with a sulfur content of less than 1%, but, sometimes, there may be much available coal of high calorific value with high sulfur levels.

ⓔ In general, the high moisture coal can easily self-ignite. The examination of spontaneous combustion and the adjustment of the coal reserve period in the coal stock pile are necessary.

ⓔ Due to insufficient quality controls at some coal mines, special attention is particularly necessary for the coal from coal mines of small and medium size scale.

2) Australian coal

ⓔ! Generally, Australian coal has a stable coal quality, and their coal quality control management is thorough.

ⓔ! Australian coal is available for blend use with Indonesian low grade coal, when high quality coal of Australian coal appears in spot market.

3) South African and Mozambican coal

ⓔ! South African coal is high-grade coal and can be used for blends like Australian coal.

ⓔ! The Mozambican coal will be expected in the near future, too, but the economic infrastructure situation involving such factors as the port facilities and transportation becomes a problem.

5.7.2 Coal quality of design coal

(1) Candidate for design coal

Based on a determination of the calorific value of imported coal in 6.4.1, the main factor of coal quality of the candidate for design coal that can be supplied stably for the long term in Matarbari CFPP is shown in Table 6.4-1. The coal data painted in blue shows for single brand and coal data painted in yellow shows for blending use in the table.

Table 5.7.2.1 Candidate for design coal

No	Country	Sample No.	total moisture (AR)	Inherent moisture (AD)	Ash (AD)	Sulfur (AD)	GAR (Kcal/kg)
1	South Africa	18	9.0	4.1	15.6	0.82	6,010
2	Indonesia	9	19.0	11.5	8.0	1.00	5,860
3	Australia	13	12.5	7.0	11.5	0.40	5,830
4	Australia	16	17.0	8.0	9.5	0.60	5,800
5	Australia	15	10.5	3.5	21.0	1.00	5,750
6	Indonesia	8	19.0	14.0	5.2	1.60	5,630
7	Australia	14	10.0	2.5	22.0	0.60	5,630
8	South Africa	19	8.0	3.5	23.1	0.74	5,400
9	Indonesia	10	26.0	15.5	7.0	1.00	5,200
10	Indonesia	1	26.0	12.0	6.0	0.60	5,100
11	Indonesia	6	26.0	18.0	4.5	0.99	4,960
12	Indonesia	4	31.0	16.0	6.0	1.00	4,600
13	Indonesia	11	35.0	15.0	6.0	0.80	4,440
14	Indonesia	2	38.0	25.0	7.0	0.60	4,200
15	Indonesia	5	35.0	22.0	4.5	0.10	4,200
16	Indonesia	25	35.0	22.0	3.5	0.10	4,200
17	Indonesia	26	35.0	21.0	4.0	0.15	4,200
18	Indonesia	28	34.0	18.4	7.0	0.60	4,140
19	Indonesia	24	38.0	25.0	3.0	0.15	4,100
20	Indonesia	3	40.0	27.0	2.0	0.15	4,000
21	Indonesia	12	39.0	14.1	4.9	0.13	3,800

(Source: JICA study team)

(2) Summary of single brand

The summary of single brand that is used as only one brand of coal for Matarbari CFPP is shown in table 6.4-2.

Table 5.7.2.2 Summary of single brand

Country	Total moisture (Ar.%)	Inherent moisture (Ad.%)	Ash (Ad.%)	Sulfur (Ad.%)	GAR (Ar.%)
Indonesia	26.0 - 38	12 - 25	3.5 – 7.0	0.1 – 1.0	4,200-5,200

(Source: JICA study team)

(2) Summary of blending coal

When securing of coal of single brand is difficult, use of blending coal is necessary for stabilization of the fueling, the efficiency driving of the boiler, reduction of the fuel cost. In the blend coal, a combination of Australian and South African high calorific coal and Indonesian low calorific coal is examined. They show the coal painted by yellow color in Table 5.7.2.1. In this case, the calorific value after the blend aims 4,900kcal/kg from 4,500kcal/kg in consideration of fluctuation of the coal quality and Table 5.7.2.3 shows coal quality of blending coal.

Table 5.7.2.3 Summary of blending coal

Country	Total moisture (Ar.%)	Inherent moisture (Ad.%)	Ash (Ad.%)	Sulfur (Ad.%)	GAR (Ar.%)
Indonesia Australia South Africa	18.3 – 33.7	10.2 – 23.1	3.0 – 15.1	0.23 – 1.0	4,500-4,900

(Source: JICA study team)

5.8 Transportation and Loading Port for the Coal

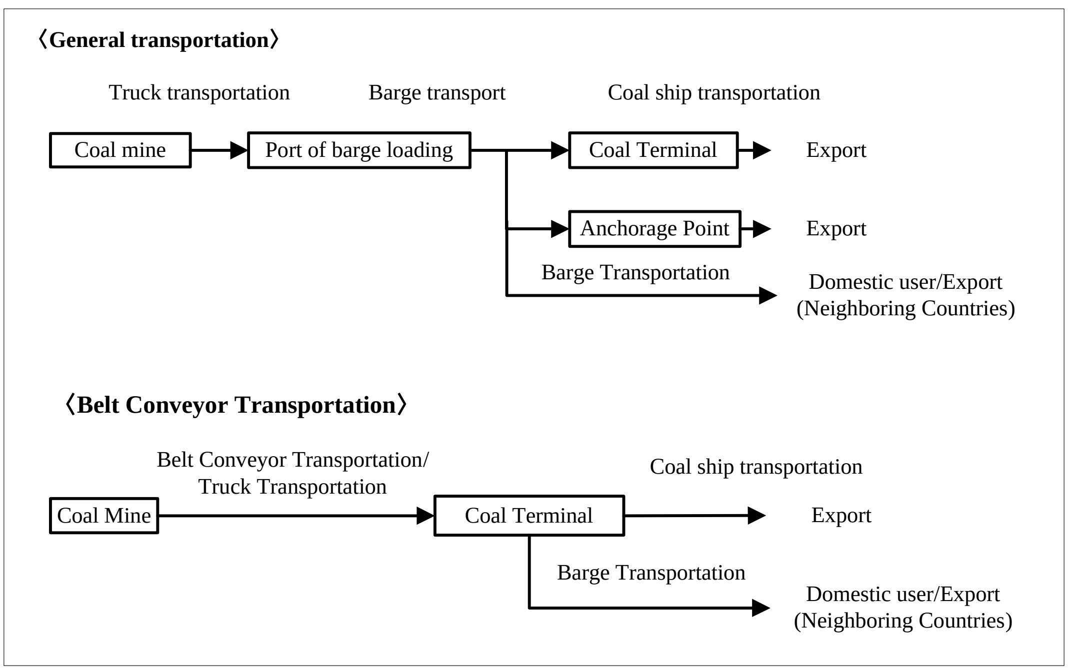
This Study shows that from the perspective of transportation and production prospects, Indonesia, Australia, South Africa and Mozambique have the potential to export coal to Bangladesh. Among the countries, Indonesia and Australia have the most potential.

(2) Indonesia: Kalimantan Island

Regarding the amount of coal mines in Indonesia in 2010, accessible coal reserves are 104,900 million tons and the estimated amount of coal reserves are 19,000 million tons. The specifications of the Indonesian coal are that most of the coal is thermal coal, not coking coal. The ash content and sulfur content of the Indonesian coal is low so that the calorific value of most of the coal in Indonesia is comparatively low. In Indonesia, there is abundant coal in Sumatra Island and Kalimantan Island, and a small amount of coal in the Java Island, Sulawesi Island, Maluku Islands and the Papua area. Coal production in Indonesia was 376 million tons in 2011 (IEA Coal information 2012). Of particular mention is that the proven reserves of coal in Kalimantan Island are approximately 460 million tons. Currently, coal production is conducted primarily in Kalimantan Island.

1) Coal Transportation

In Indonesia, coal production is implemented mainly in Sumatra Island and Kalimantan Island. Given that there are no train facilities in Sumatra Island and Kalimantan Island and a large river runs nearby the coal mine, two measures for coal transportation are used; one is the truck delivery from the coal mine to the ship, the other is a river barge.

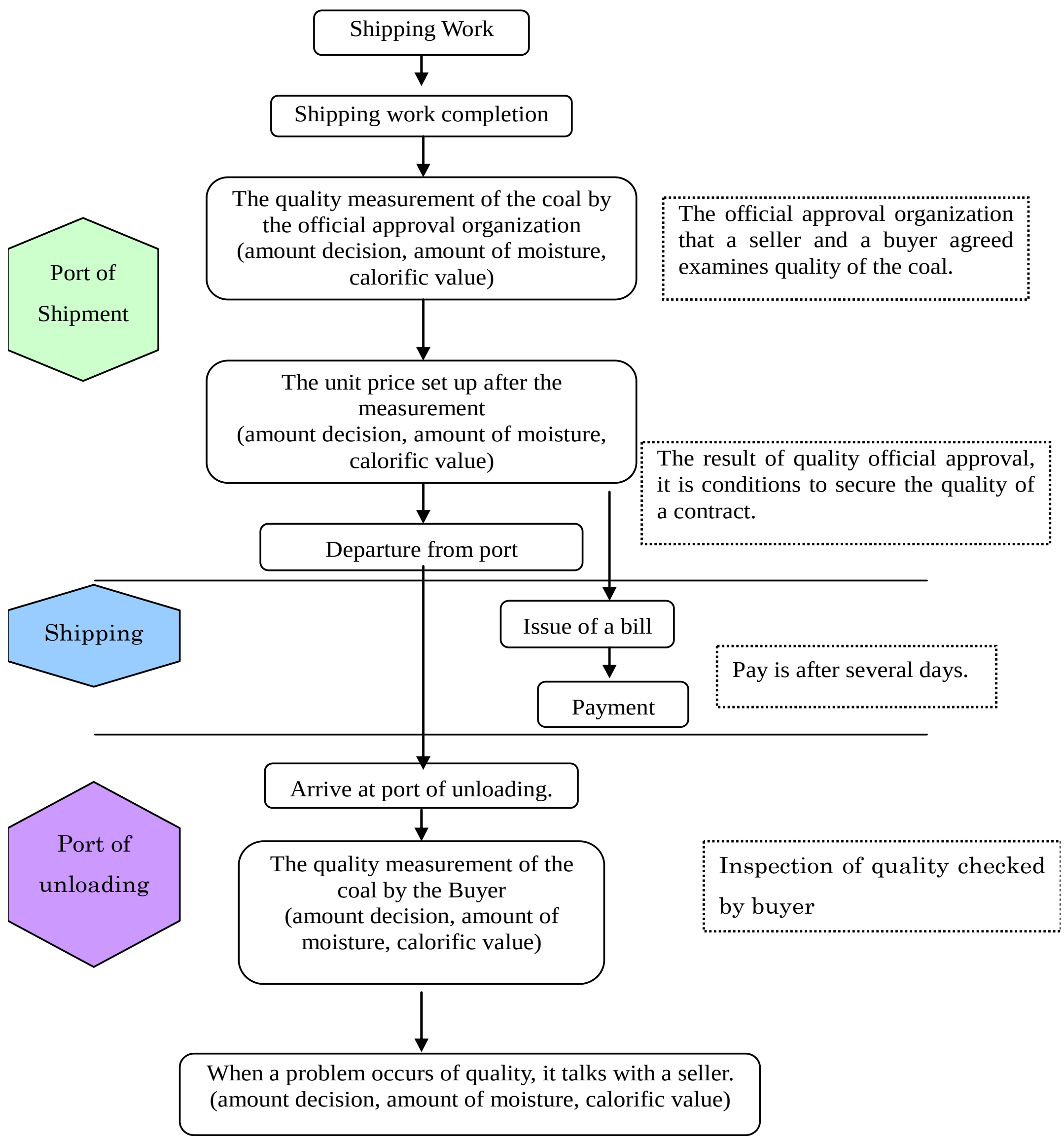


(Source: JICA Study Team)

Figure 5.8.1 Coal Transportation in Indonesia

5.8.1 Coal quality management at coal mine

The general workflow from coal shipping to coal loading in Australia is shown in the following figure.



(Source: JICA Study Team)

Figure 5.8.1 Work Flow of Coal Shipping

5.8.2 Type of transport ships

In Japan, power utilities for coal transportation enter into a special shipping vessel contract with the shipping companies.

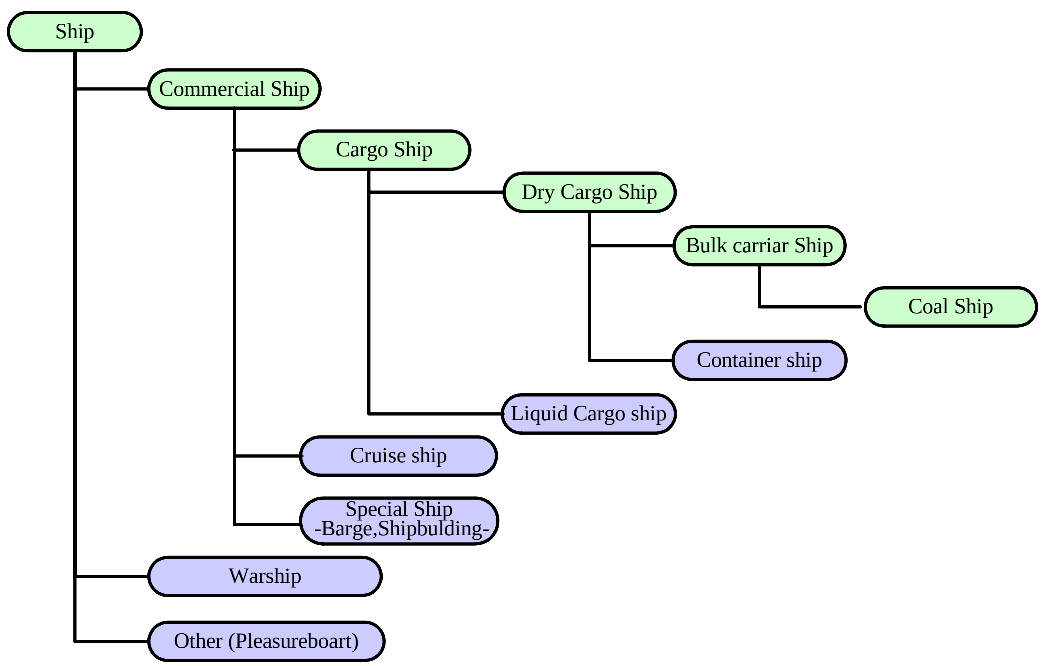
In consideration of the coal procurement risks and quantity change, it is necessary to decide a proper transportation mode and contract amongst the long/short-term contracts or spot chartering.

Most of the steel manufacturing companies use special shipping vessels. For example, 60-70% of steel factories in China consign their special vessels to Japanese shipping companies, and the others enter into spot contracts.

5.8.3 Type of ships

1) Types of ships by cargo

The following figure shows the types of ships by cargo.



(Source: JICA Study Team)

Figure 5.8.3.1 Types of Ships by Cargo

The types of ships by cargo are divided into three types: Dry Cargo, Liquid Cargo and the others. Dry Cargo can be classified into bulk carriers and container ships.

The bulk carrier ships deal with general merchandise, machineries and steel materials. The container ships carry the container freight 20 feet by 40.

The bulk carrier ships are classified into standard bulk carrier and special bulk carrier. The distinguishing characteristics of standard bulk carrier ships are their handy size, panamax size and cape size.

The various special ships are bulk coal carriers, ore coal carriers, chip carriers, car carriers and reefer carriers.

Liquid cargo ships are divided into oil tankers, product carriers, chemical tankers, and liquefied natural gas carriers.

The oil tankers are for oil, product carriers are for petroleum products (naphtha, diesel oil, heavy oil, kerosene, gasoline), chemical tankers are for liquid chemical products(benzene, toluene, wine, milk and others), and liquefied natural gas carriers are for LNG and LPG.

In the above figure, the "Others (Pleasure boat)" refer to passenger boats, cruise passenger boats, ferry boats, fishing boats, tugboats and naval escort ships.

2) Size of bulk carriers

The size of carriers depends on the weight of the freight such as the fuel, lubricating oil, passengers and food items.

The loading capacity of a carrier is shown in tons. The unit of the "DWT (deadweight)" is used as tonnages in explanation of the number of cargo ships and tankers. The size of the bulk carriers are specified into 4 types such as a (i) Small Handy, (ii) Supramax Handy, (iii) Panamax and (iv) Cape Size. The typical size of the bulk carriers is described in the following table.

Table 5.8.3.1 Typical Size of Bulk Carriers

Item	Small Handy	Supermax Handy	Panamax	Cape size
DWT(Dead weight)	32,000	55,000	70,000	170,000
LOA(Length over all)	170	190	225	280
Beam(m)	27	32.2	32.2	47
Full draft(m)	12.5	12.5	13.7	17.8
Number of Hold	5	5	7	9
Hold Capacity (m^3)	41,000	69,000	102,000	195,000

(Source: NYK Presentation material)

The Handy size vessels are those bulk carriers whose loading capacity is 18,000-55,000DWT.

Their fairly compact size allows for easy entry and departure at most of the world's ports.
Among the various Handy sizes, the Small Handy are those bulk carriers whose loading capacity is less than 28,000DWT, and the Super Max are those bulk carriers whose loading capacity is 45,000DWT-55,000DWT.

The word "Panamax" is a compound word combining "Panama" and "maximum". The size of the ship is the maximum size that would allow for passage through the Panama Canal. The length is 900 feet (approximately 274m) or less, and the width is 106 feet (approximately 32.31⇛) or less. The loading capacity is a 70,000DWT-75,000DWT class. The Panamax is utilized for not only tankers, but also bulk carriers, or carriers and container ships.

For the coal transportation at the Matarbari coal-fired power station it is recommended that Panamax-size ships be used. These Panamax size ships will raise the efficiency of coal procurement. The Cape size is larger than the Panamax size. The Cape size ships whose loading capacity is 150,000DWT-170,000DWT class are too large to allow for easy passage through the Panama Canal, so they need to go around the Cape of Good Hope in the African Continent.

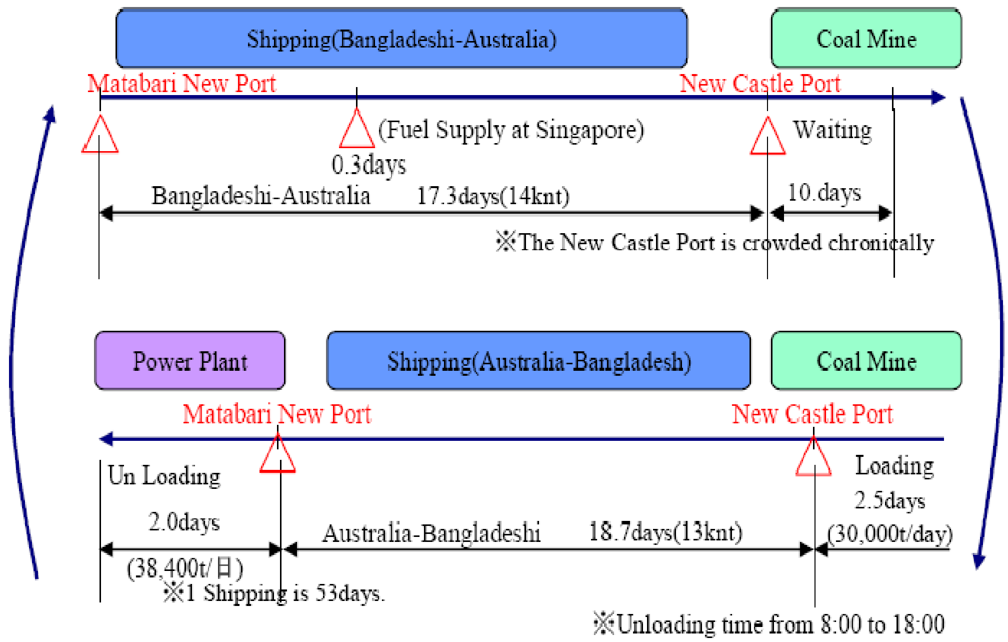
3) Transportation from Australia to Matarbari in Bangladesh

The navigation period from New Castle Port in Australia to the newly developed Matarbari Port in Bangladesh is estimated in Figure 5.8.3.2.

The transportation route from Australia to Matarbari is shown in Figure 5.8.3.2.

The conditions of the transportation are the estimated loading capacity of 75,000 tons, an estimated distance of 5,824 miles, a transportation speed of 13knt(25.3km/h). In the route via Australia, refueling is planned to take place at the Singapore Port due to passage through the Strait of Malacca.

The navigation period from New Castle Port in Australia to Matarbari Port in Bangladesh is 53 days. According to past data, if 20 days are to be regarded as non-operation days due to bad weather, the remaining days in the year for operation will be 345 days, and coal transportation can be conducted 7 times a year.



(Source: JICA Study Team)

Figure 5.8.3.2 Transportation Route of Australia to Matarbari in Bangladesh

4) Transportation from Indonesia to Matarbari Port in Bangladesh

The navigation period from Tarakan Port of East Kalimantan Island in Indonesia to the newly developed Matarbari Port in Bangladesh is estimated in Figure 5.8.3.3.

The transportation route is shown in Figure 5.8.3.3.

The conditions of the transportation is the estimated loading capacity of 75,000 tons, an estimated distance of 2,837 miles, a transportation speed of 13knt (25.3km/h). In the route via Australia, refueling is planned to take place at the Singapore Port due to passage through the Strait of Malacca.

The navigation period from Tarakan Port in Indonesia(Anchored type port) to Matarbari Port in Bangladesh is 32 days, and coal transportation can be conducted 11 times a year.

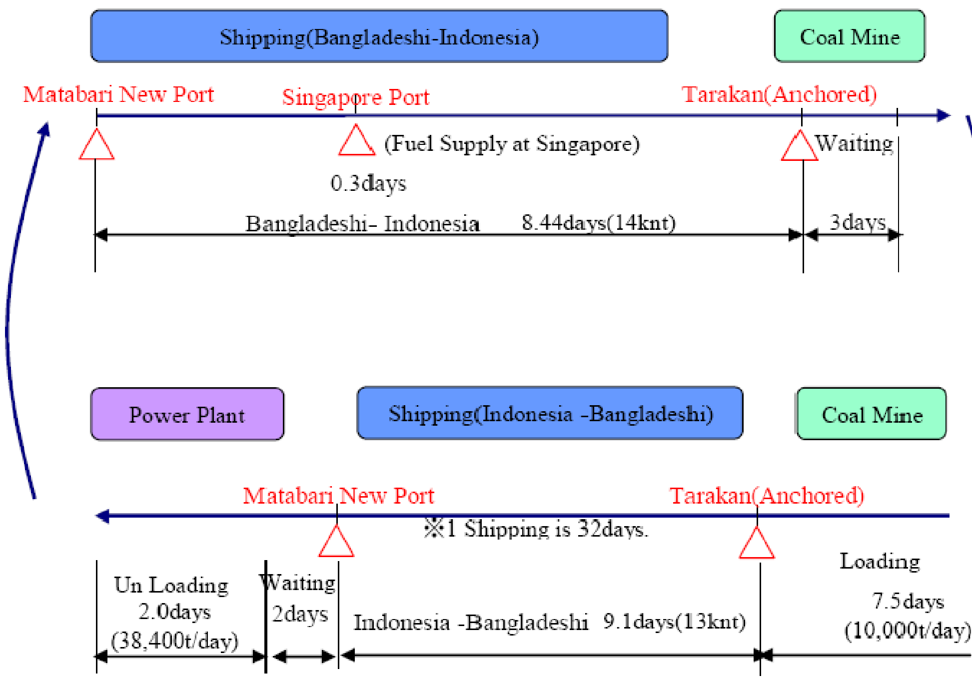


Figure 5.8.3.3 Transportation Route from Tarakan in Indonesia to Matarbari Port in Bangladesh

Table 5.8.3.2 Navigation Days from the Main Port in Australia and Indonesia

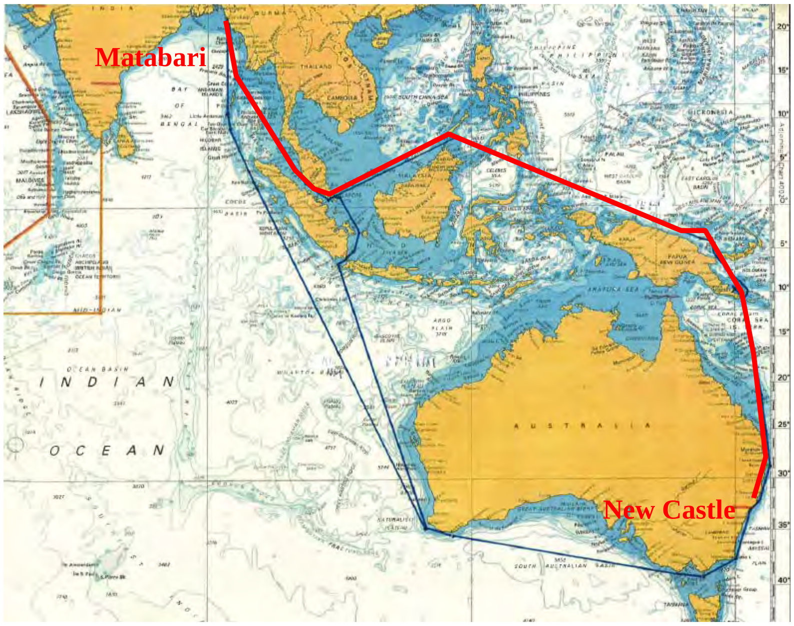
Estimation of navigation days from the main port in Australia and Indonesia to Matarbari in Bangladesh
ウReview Conditionsエ
ﾐTarget vessel: PANAMAX type (DWT76,000)
ﾐPrecondition of sailing speed
㋪Outward: 14knt, (27.2km/h)
㋪Homeward: 13knt, (25.3km/h)
! ﾐShipping port
! ! ! ㋪Australia: New Castle Port in NSW
! ! ! ㋪Indonesia: East Kalimantan Island

Item	**Representative Port**			
Loading Port	**Australia**	**Indonesia**		
	NEWCASTLE (Jetty)	**TARAKAN (Anchored)**	**SAMARINDA (Anchored)**	**TANJUNG BARA(Jetty)**
Expectation of cargo Weight (t)	75,000	74,500	75,000	75,000
ウBoundエ	!	!	!	!
Distance of Shipping (Mile)Via Singapore	5,824	2,837	2,647	2,716
Navigation Days↖ day↗	17.33	8.44	7.88	8.08
Time of Fuel Supply at Singapore (day)	0.3	0.3	0.3	0.3
Waiting days of Loading on offing(day)	10	3	3	3
Loading Capacity of one day (t/day)	30,000	10,000	17,000	35,000
	!	!	!	!
The total number of loading days (day)	2.5	7.5	4.4	2.1
ウReturnエ	!	!	!	!
Distance of Shipping (Mile)Via Singapore	5,824	2,837	2,647	2,716
Navigation Days↖ day↗	18.67	9.09	8.48	8.71
Waiting days of Unloading(day)	2	2	2	2
Unloading Capacity of One day (t/day)	38,400	38,400	38,400	38,400
The total number of Unloading days (day)	2.0	2.0	2.0	2.0
The total number of navigation days(day↗	52.8	32.2	28.0	26.2
The number the annual shipping (Shipping/year)	7	11	12	13
ﾐAnnual Operation Days:345days ﾐIt is 20th non-operation days by bad weather				
ウReferenceエQuantity of annual procurement coal (t/year)	490,500	797,895	923,250	998,600

Source: JICA Study Team

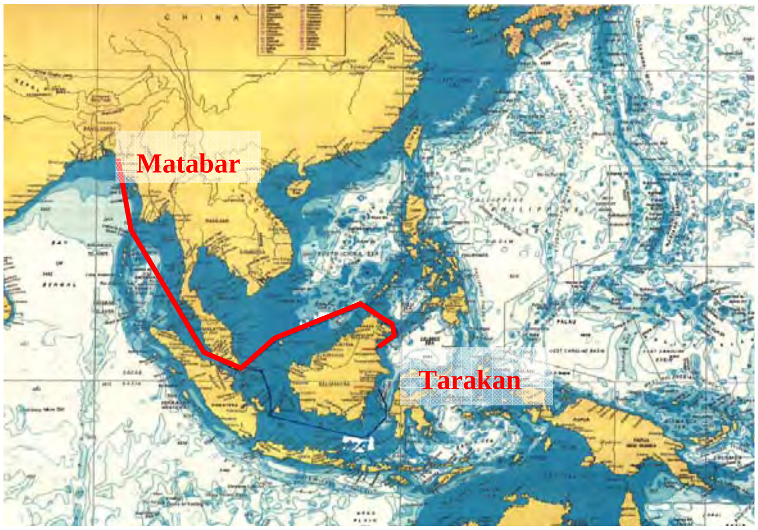
5) Marine Transportation Route

The marine transportation route between Matarbari area in Bangladesh and New Castle Port in Australia is shown in Figure 5.8.3.4, and the route between the Matarbari area and Tarakan Port in Kalimantan Island, Indonesia is shown in Figure 5.8.3.5.



(Source: JICA Study Team)

Figure 5.8.3.4 Transportation Route from Australia



(Source: JICA Study Team)

Figure 5.8.3.5 Transportation Route from East Kalimantan Island, Indonesia

Chapter 6

Environmental Impact Assessment

Chapter 6

Environmental Impact Assessment

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6 Summary of Environmental and Social Impact Assessment

The results of environmental impact assessment are summarized in Table 6.1 to 6.2.

Table 6.1: Results of Environmental Impact Assessment for the Power Plant

Item	No.	Impact	Assessment of Scoping		Assessment of survey results		Results
			Pre/ construction Phase	Operation Phase	Pre/ construction Phase	Operation Phase	
Pollution Control	1	Air Quality	B-	A-	B-	B-	**Construction phase:** - Prevention measures for dust dispersion will be taken by spraying water. - Maintenance of machinery will be conducted regularly, resulting in reducing exhaust gas emissions. **Operation phase:** - Concentration of pollutants in emission gas will meet emission gas standards by adopting low-NOx combustion methods, electrostatic precipitators (around 99.8% efficiency: 7,707 mg/m^3 -> 50 mg/m^3) and flue gas desulphurization equipment (around 70% efficiency: 2,526 mg/m^3 -> 820 mg/m^3). - Ground concentration of pollutants caused by emission gas will meet ambient air quality standards. - Prevention measures for dust dispersion will be taken at coal storage and ash disposal sites.
	2	Water Quality	A-	A-	B-	B-	**Construction phase:** - Turbid water, such as rainwater run off, will be treated with precipitation processes. - Wastewater containing oil will be treated with oil-water separator. **Operation phase:** - Plant wastewater will be treated at a wastewater treatment facility in order for pollutants in the water to meet wastewater quality standards. - The outlet for intake of cooling water and the outlet for discharge of thermal effluent are designed to be located far away from each other. The diffusion of the increase of water temperature will occur only in the surface layer. - Wastewater discharged from coal storage and ash disposal sites will be treated at the wastewater treatment facility.
	3	Waste	B-	B-	B-	B-	**Construction phase:** - Construction waste and general waste will be re-used, recycled or disposed following relevant laws and regulations. **Operation phase:**

Item	No.	Impact	Assessment of Scoping		Assessment of survey results		Results
			Pre/ construction Phase	Operation Phase	Pre/ construction Phase	Operation Phase	
							- Sludge from the wastewater treatment facility, waste oil from machine inspections and general waste will be re-used, recycled or disposed following relevant laws and regulations. - All fly ash and bottom ash will be disposed of inside the power plant site.
	4	Noise and Vibration	B-	A-	B-	B-	**Construction phase:** - Construction machinery and vehicles will be regularly maintained. - Low-noise/ low-vibration machinery will be used. - Noise levels generated from construction machinery will meet noise level standards at the nearest residential area (Max 114dB -> 70.3dB). **Operation phase:** - Construction machinery and vehicles will be regularly maintained. - Low-noise/ low-vibration machinery will be used. - Noise levels generated from construction machinery will meet noise level standards at the nearest residential area (Max 108dB -> 43.3dB).
	5	Subsidence	C-	C-	D	D	**Construction and Operation phases:** - Ground water will not be used during construction and operation phases.
	6	Odor	B-	B-	B-	B-	**Construction and Operation phases:** - General waste will be re-used, recycled or disposed following relevant laws and regulations.
	7	Soil	B-	B-	B-	B-	**Construction phase:** - Wastewater containing oil will be treated with oil-water separator. - Oil and chemical substances will be appropriately stored. **Operation phase:** - Ash disposal site will be designed to prevent seepage. - Storage for oil and chemical substances will be designed to prevent seepage.
	8	Sediment	B-	B-	B-	B-	**Construction and Operation phases:** - Wastewater and waste will be appropriately treated and disposed.
Natural Environ -ment	9	Protected Areas	C-	C-	D	D	**Construction and Operation phases:** - Sonadia ECA has been designated pursuant to the Environmental Protection Law in Bangladesh, located 15km south of the proposed project site. - Air quality, water quality and noise levels during both

Item	No.	Impact	Assessment of Scoping		Assessment of survey results		Results
			Pre/ construction Phase	Operation Phase	Pre/ construction Phase	Operation Phase	
							construction and operation phases will meet environmental standards, and the impacts will not reach Sonadia ECA.
	10	Ecosystem	A-	A-	A-	B-	**Construction phase:** - Impact of air pollution, water turbidity and noise, etc., during the operation phase will be mitigated through appropriate countermeasures, as described above. - The Spoon billed Sandpiper, listed in the IUCN Red list, was observed at the beach in front of the power plant. However, Matabari Peninsula beach is not the main migratory habitat for migratory birds, particularly the Spoon billed Sandpiper in Bangladesh. For the purpose of protecting the species, construction workers will be instructed to strictly comply with hunting and capturing restrictions prescribed by law. - Four species of sea turtle species listed in the IUCN Red list, spawn at the sea front area of the power plant. Mitigation measures will be taken, especially night-time lighting and lowering noise levels. Monitoring will also be conducted. - Other fauna species designated as valuable by biologists of Bangladesh have been observed, but these species are generally observed widely around the area. **Operation phase:** - Impact of air pollution, water turbidity and noise, etc., during the operation phase will be mitigated through appropriate countermeasures, as described above, and the results of simulation also indicate that environmental standards are met. - The frequency with which this species uses the Matabari Peninsula as a wintering ground is relatively very low in comparison with the nearby offshore island of Sonadia. Many previous survey results point out that Matabari Peninsula beach is not a main migratory habitat for migratory birds, especially the Spoon billed Sandpiper in Bangladesh; this is also supported by other experts and reports. However, for the purpose of protecting the species, construction workers will be instructed to strictly comply with hunting and capturing restrictions prescribed by law. - Four kinds of sea turtle species listed in the IUCN Red list spawn at the sea front area of the power plant. Mitigation measures will be taken, especially night-time lighting and lowering noise levels. Monitoring will also be conducted.

Item	No.	Impact	Assessment of Scoping		Assessment of survey results		Results
			Pre/ construction Phase	Operation Phase	Pre/ construction Phase	Operation Phase	
							- Other fauna species designated as valuable by biologists of Bangladesh have been observed, but these species are generally observed widely around the area.
Social Environ-Ment	11	Land Resettlement	A-	D	A-	D	**Pre-construction phase:** - 343 households and 2,031 people will be affected by the construction of the power plant and the port facility. LARAP (Land Acquisition and Resettlement Action Plan), that includes not only a compensation plan but also a livelihood restoration program for affected people, shall be established.
	12	Disturbance to Poor People	A-/B+	A-/B+	A-/B+	A-/B+	**Pre-construction and Construction phases:** - The employment of local people will be promoted for increased employment opportunities for various subcontract work resulting from the power plant construction activity. - Livelihood restoration measures will be established including job training for those who want it. **Operation phase:** - Poor people who currently have deteriorated living standards without proper facilities will have better access to social services throughout the year if roads are improved along with the construction of the power plant, especially access during the rainy season.
	13	Disturbance to Ethnic Minority Groups and Indigenous People	D	D	D	D	- There were no ethnic and indigenous people found on or around the project site.
	14	Deterioration of Local Economy such as Losses of Employment and Livelihood Means	A-	A-/B+	A-	A-/B+	**Pre-construction and Construction phases:** - The employment of local people will be promoted for increased employment opportunities for various subcontract work resulting from the power plant construction activity. - Livelihood restoration measures will be established including job training for those who want it. **Operation phase:** - The employment of local people will be promoted for increased employment opportunities for various subcontract work resulting from the power plant construction activity. - Livelihood restoration measures will be established including job training for those who want it.

Item	No.	Impact	Assessment of Scoping		Assessment of survey results		Results
			Pre/ construction Phase	Operation Phase	Pre/ construction Phase	Operation Phase	
							- Services, such as laundry and catering services, and products provided by the local community will be preferentially used to the extent possible.
	15	Land Use and Utilization of Local Resources	A-	A-	A-	A-	**Pre-construction, Construction, and Operation phases:** - The employment of local people will be promoted for increased employment opportunities for various subcontract work resulting from the power plant construction activity. - Livelihood restoration measures will be established including job training for those who want it.
	16	Disturbance to Water Usage, Water Rights, etc.	A-	B-	B-	B-	**Construction phase:** - Wastewater will be treated, and monitoring of groundwater will be conducted. **Operation phase:** - Plant water used during the operation phase will be taken from sea water through a desalinating process, so that no impact to river and ground water is anticipated.
	17	Disturbance to the Existing Social Infrastructure and Services	B-	B-/B+	B-	B-/B+	**Construction phase:** - For vessels, a water route will be determined after consultation with related authorities. - For vehicles, bus use will be promoted to reduce increasing the number of vehicles used. - Bus schedules will be managed in consultation with related organizations. **Operation phase:** - Bus use will be promoted - An access road, community road and road around the power plant boundary will be built. - A school and medical facility constructed within the power plant site will be open to all local people for the improvement of their lives.
	18	Social Institutions such as Social Infrastructure and Local Decision-making Institutions	B-	D	B-	D	**Pre-construction phase:** - Regulations of Bangladesh stipulate that public consultation must be held in the land acquisition process. In the resettlement process, personnel responsible for responding to complaints or suggestions from local residents will work at the power plant office.
	19	Misdistribution of Benefits and Compensation	B-	B+	B-	B-/B+	**Pre-construction phase:** - Equality of compensation shall be assured as there is a possibility of unequal compensation between local residents. **Operation phase:**

Item	No.	Impact	Assessment of Scoping Pre/ construction Phase	 Operation Phase	Assessment of survey results Pre/ construction Phase	 Operation Phase	Results
							- The access road, school and medical facility constructed within the power plant site will be open to all local people.
	20	Local Conflicts of Interest	B-	B-/B+	B-	B-/B+	**Preconstruction phase:** - Regulations of Bangladesh stipulate that public consultation must be held in the land acquisition process. In the resettlement process, personnel responsible for responding to complaints or suggestions from local residents will work at the power plant office. **Construction phase:** - Local people will be employed to the maximum extent possible, and foreign workers will be taught to respect local customs in order to facilitate good relationships with local people. Lodgings of project workers will be equipped with sufficient living facilities keeping order that workers remain at the project site as much as possible. **Operation phase:** - Lodgings of project workers will be equipped with sufficient living facilities keeping order that workers remain at the project site as much as possible. - The access road, school and medical facility constructed within the power plant site will be open to all local people.
	21	Cultural Heritage	D	D	D	D	- There are no historical, cultural and archaeological properties or heritage sites in or around the site.
	22	Landscape	D	D	D	D	- There is no picturesque scenery in or around the site.
	23	Gender	B-/B+	B+	B-/B+	B+	**Pre-construction and Construction phases:** - There are women among those to be resettled and/or lose their livelihood means. They currently have low living standards and lack proper facilities; they will have better access to social services throughout the year. However, wives of those men who lose their land or jobs may suffer from adverse effects on their household economy. - Livelihood restoration measures will be established for improving life quality. **Operation phase:** - The access road, school and medical facility constructed within the power plant site shall be open to all local people to the maximum extent possible for the improvement of their lives. - Job opportunities will be open to them according to their qualification.
	24	Children's Rights	B-	B-/B+	B-	B-/B+	**Pre-construction and Construction phases:** - Labor contracts between the construction industry and

Item	No.	Impact	Assessment of Scoping		Assessment of survey results		Results
			Pre/ construction Phase	Operation Phase	Pre/ construction Phase	Operation Phase	
							children shall be prohibited. Regular patrols to check for child workers will be conducted. **Operation phase:** - Labor contracts between the construction industry and children shall be prohibited. Regular patrols to check for child workers will be conducted.
	25	Infectious Diseases such as HIV/AIDS	B-	D	B-	D	**Construction phase:** - Local people will be recruited for simple work as much as possible and there is a low risk of infectious diseases transmitted from external workers. Pre-employment and periodic medical check-ups will be conducted for external workers (technical workers, etc).
	26	Work Environment (Including Work Safety)	B-	B-	B-	B-	**Construction and Operation phases:** - The construction company shall establish a work safety plan and submit it to CPGCBL to obtain approval. The work safety plan shall stipulate mitigation measures on soft aspects (safety training, etc.) and on hard aspects (provide workers with appropriate protective equipment, etc).
Other	27	Accidents	B-	B-	B-	B-	**Construction phase:** - For land traffic, observation of traffic regulations, installation of traffic signs and training and education on safe driving will be conducted. - For marine traffic, marking buoys will be set up around the construction area for marine safety. - Schedule of vessels will be announced to fishermen, etc. **Operation phase:** - Observation of traffic regulations, installation of traffic signs, and training will be conducted. - Education on driving safety shall be carried out for land traffic vehicles. - For ocean navigation, water routes will be determined after consultation with related authorities, and course buoys shall be set on navigation channel for marine safety. - For fire prevention, regular watering of the coal storage site, installation of fire protection equipment in the power plant, and organization of fire-fighting teams and fire-fighting training shall be carried out.
	28	Cross-boundary Impact and Climate Change	B-	B-	B-	B-	**Construction phase:** - Periodic maintenance and management of all construction machinery and vehicles will be conducted. **Operation phase:** - CO_2 will be produced by plant operation. Ultra supercritical

Item	No.	Impact	Assessment of Scoping		Assessment of survey results		Results
			Pre/ construction Phase	Operation Phase	Pre/ construction Phase	Operation Phase	
							(USC) technology will be adopted at the power plant, which compared to a sub critical coal-fired power plant will produce less CO_2 of approximately 555,400 tons /year.

Notes: A+/-: Significant positive/negative impact is expected.
B+/-: Positive/negative impact is expected to some extent.
C+/-: Extent of positive/negative impact is unknown. (Further examination is needed, and the impact may be clarified as the study progresses.)
D: No impact is expected.

(Source: JICA Study Team)

Table 6.2: Results of Environmental Impact Assessment for the Port Facility

Item	No.	Impact	Assessment based Scoping		Assessment based survey results		Results
			Pre/ construction Phase	Operation Phase	Pre/ construction Phase	Operation Phase	
Pollution Control	1	Air Quality	B-	B-	B-	B-	**Construction phase:** - Prevention measures for dust dispersion will be taken by spraying water. - Maintenance of machinery will be conducted regularly, resulting in reducing exhaust gas emissions. **Operation phase:** - Air pollution caused by exhaust gas generated from the vessels using the port is predicted. - Dust dispersion, generated from loading-unloading of coal, is also predicted.
	2	Water Quality	A-	A-	B-	B-	**Construction phase:** - Grab dredgers or pump dredgers will be used and anti-diffusion membrane will be installed to prevent diffusion of turbidity. - When excavating the land area, steel sheet piles will be installed for enclosure on the marine side before any excavation work. - Turbid water from the land will be treated with a precipitation system. **Operation phase:** - Dredging method and equipment will be selected to minimize turbidity. - The number of days that coal vessels enter and leave the port is about 50 days per year, which is relatively few.
	3	Waste	A-	A-	B-	B-	**Construction phase:** - Sand and silt from dredging work of the navigation channel and the port will be re-used for land preparation of the plant and disposed of into the ash pond. **Operation phase:** - Dredged materials generated by maintenance of the port will be reused to the maximum extent around the project and residual material will be disposed of within the project site.
	4	Noise and Vibration	B-	B-	B-	B-	**Construction phase:** - Construction machinery and vehicles will be maintained regularly. - Low-noise/ low-vibration machinery will be used. - Noise levels generated from construction machinery will meet noise level standards at the nearest residential area

Item	No.	Impact	Assessment based Scoping		Assessment based survey results		Results
			Pre/ construction Phase	Operation Phase	Pre/ construction Phase	Operation Phase	
							(Max 119dB -> 73.2dB). **Operation phase:** - Construction machinery and vehicles will be maintained regularly. - Low-noise/ low-vibration machinery will be used. - Noise levels generated from construction machinery will meet noise level standards at the nearest residential area (101dB -> 43.3dB).
	5	Subsidence	C-	C-	D	D	**Construction and Operation phases:** - Ground water will not be used during construction and operation phases.
	6	Odor	D	D	D	D	**Construction and Operation phases:** - No expected use of substances that may be a potential source of bad odors.
	7	Sediment	D	D	D	D	**Construction and Operation phases:** - No hazardous waste will pollute the sediment.
Natural Environ-Ment	8	Protected Areas	C-	C-	D	D	**Construction and Operation phases:** - Sonadia ECA has been designated pursuant to the Environmental Protection Law in Bangladesh, located 15km south of the proposed project site. - Air quality, water quality and noise levels during both the construction and operation phases will meet environmental standards, and the impacts will not reach Sonadia ECA.
	9	Ecosystem	A-	A-	A-	B-	**Construction phase:** - Impact of air pollution, water turbidity and noise, etc., during the operation phase will be mitigated through appropriate countermeasures, as described above. - The frequency with which this species uses the Matabari Peninsula as a wintering ground is relatively very low in comparison with the nearby offshore island of Sonadia. Many previous survey results point out that Matabari Peninsula beach is not a main migratory habitat for migratory birds, especially the Spoon billed Sandpiper in Bangladesh; this is also supported by other experts and reports. However, for the purpose of protecting the species, construction workers will be instructed to strictly comply with hunting and capturing restrictions prescribed by law. - Four species of sea turtle species listed in the IUCN Red list spawn at the sea front area of the power plant. Mitigation measures will be taken, especially night-time lighting and

Item	No.	Impact	Assessment based Scoping		Assessment based survey results		Results
			Pre/ construction Phase	Operation Phase	Pre/ construction Phase	Operation Phase	
							minimizing noise levels. Monitoring will also be conducted. - Other fauna species designated as valuable by biologists of Bangladesh have been observed, but these species are generally observed widely around the area. **Operation phase:** - Impact of air pollution, water turbidity and noise, etc. during the operation phase will be mitigated through appropriate countermeasures, as described above, and the results of simulations also indicate that environmental standards will be satisfied. - The frequency with which this species uses the Matabari Peninsula as a wintering ground is relatively very low in comparison with the nearby offshore island of Sonadia. Many previous survey results point out that Matabari Peninsula beach is not a main migratory habitat for migratory birds, especially the Spoon billed Sandpiper in Bangladesh; this is also supported by other experts and reports. However, for the purpose of protecting the species, construction workers will be instructed to strictly comply with hunting and capturing restrictions prescribed by law. - Four kinds of sea turtle species listed in the IUCN Red list spawn at the sea front area of the power plant. Mitigation measures will be taken, especially night-time lighting and minimizing noise levels. Monitoring will also be conducted. - Other fauna species designated as valuable by biologists of Bangladesh have been observed, but these species are generally observed widely around the area.
	10	Hydrology	B-	B-	B-	B-	**Construction and Operation phases:** - The impact of the port facility on changes in ocean currents will be limited and not considered significant, because the proposed port facility is an excavated type port.
	11	Topography and Geology	B-	B-	B-	B-	**Construction and Operation phases:** - The impact of the port facility and sedimentation on changes in topography will be limited and not considered significant, because the proposed port facility is an excavated type port.
Social Environ-ment	12	Disturbance to the Existing Social Infrastructure and	B-	B-	B-	B-	**Construction and Operation phases:** - For vessels, a water route will be determined after consultation with the related authorities.

Item	No.	Impact	Assessment based Scoping		Assessment based survey results		Results
			Pre/ construction Phase	Operation Phase	Pre/ construction Phase	Operation Phase	
		Social Services					
	13	Work Environment (Including Work Safety)	B-	B-	B-	B-	**Construction and Operation phases:** - The construction company shall establish a work safety plan and submit it to CPGCBL to obtain approval. The work safety plan shall stipulate mitigation measures on soft aspects (safety training, etc.) and hard aspects (provide workers with appropriate protective equipment, etc).
Other	14	Accidents	B-	B-	B-	B-	**Construction phase:** - Marking buoys will be set around the construction area for marine safety. - Schedules of vessels will be announced to fishermen, etc. **Operation phase:** - The water route of large coal transport vessels will be determined after consultation with related authorities. - Course buoys will be set on navigation channel for marine safety.
	15	Cross-boundary Impact and Climate Change	D	D	D	D	**Construction phase:** - CO_2 will be produced from construction work, but no impact on climate change is expected. **Operation phase:** - CO_2 will be produced by entry and departure of vessels, but no impact on climate change is expected.

Note: A+/-: Significant positive/negative impact is expected.

B+/-: Positive/negative impact is expected to some extent.

C+/-: Extent of positive/negative impact is unknown. (Further examination is needed, and the impact may be clarified as the study progresses.)

D: No impact is expected.

(Source: JICA Study Team)

Chapter 7

Environmental Management and Mitigation Plan

Chapter 7

Environmental Management and Mitigation Plan

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7 Environmental Management and Mitigation Plan

7.1 Power Plant and Port Facility

(1) Power Plant

1) Implementation system

a) Construction phase

At the construction phase, the Project Implementation Unit (PIU) of CPGCBL shall carefully consider all construction activities with the supervision consultant, and encourage the contractor to fully understand the necessary mitigation measures and to implement them.

For this purpose, an environmental management unit (EMU) shall be organized prior to construction activity and an expert environmental management administrator in the EMU shall be employed. The unit will discuss and prepare mitigation measures with the supervision consultant and the contractor prior to the start of construction.
We anticipate a large inflow of workers and vehicles once construction begins. The EMU shall also function as a grievance organization to understand and address any grievances from local people during the construction phase, and conduct appropriate mitigation measures.

The EMU shall improve the understanding of the surrounding community regarding construction details, the schedule and mitigation measures, and shall obtain local input from people and change the mitigation measures as appropriate.

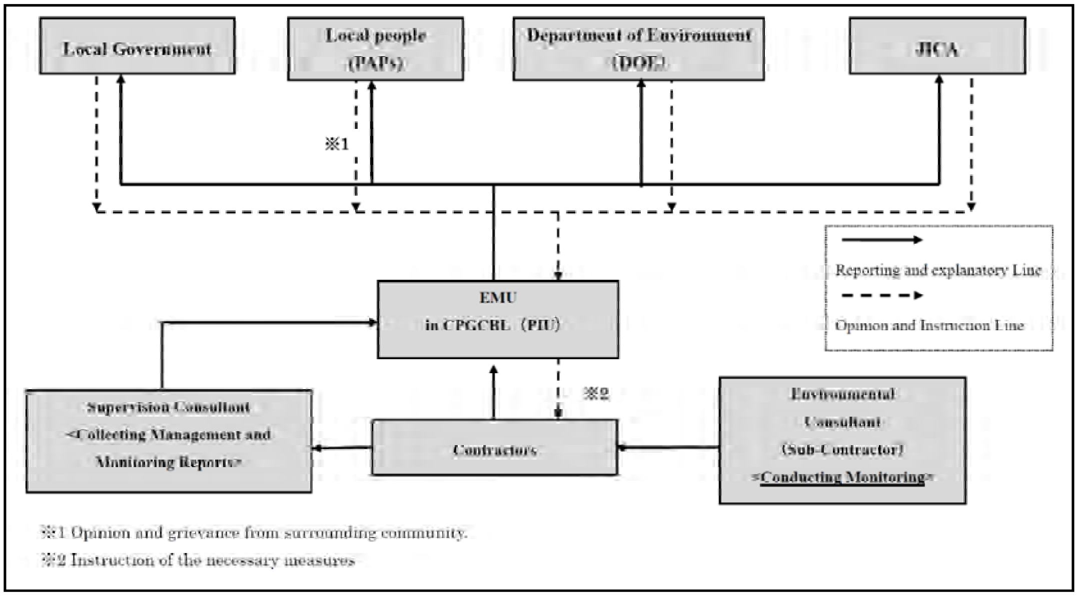
In order to confirm the implementation of environmental management and to consider further mitigation measures, the contractor should submit regular reports to the supervisory consultant and the EMU on the implementation status of the management plan.

The administrator of the EMU shall regularly hold explanation sessions with the local community, continuously listen to their grievances, submit reports to the Department of Environment, JICA and other relevant organizations regarding those grievances, as well as the implementation status of environmental management and environmental monitoring (described hereinafter).

If environmental problems occur due to construction work, the EMU shall confirm the cause with the contractor as soon as possible.

In order to resolve these problems, the administrator of the EMU shall instruct the contractor and consultant regarding necessary measures. If the problem is serious, the PIU may order the contractor to halt construction work until the problem is resolved.

Figure 7.1.1 outlines the environmental management and monitoring implementation structure in accordance with the reporting flow during the construction phase.



(Source: JICA Study Team)

Figure 7.1.1 Environmental Management and Monitoring Implementation Structure in the Construction Phase for the power plant and port facility

b) Operation phase

The power plant is responsible for organizing the EMU in a manner that allows it to develop and implement an environmental management plan that includes mitigation measures.! An expert environmental management administrator at the EMU shall be employed to ensure the environmental management plan is appropriately implemented. The administrator shall encourage the project staff to familiarize themselves with the environmental management plan prior to the start of plant operation, and shall regular educate those regarding ongoing matters during the operation phase.

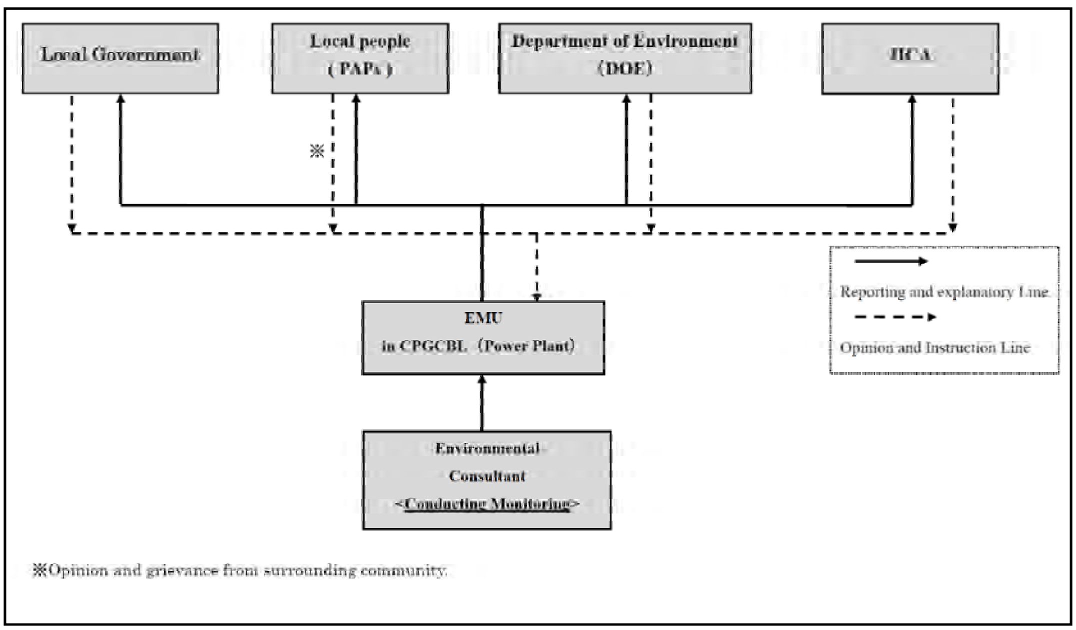
The EMU shall also function as a grievance organization and will strive to understand and address any grievances from the local people during the operation phase, and undertake appropriate mitigation measures.

The basic function of the environmental management plan is to lease with the local community, and to provide them with sufficient explanations based on positive mitigation measures, which is very important.

The administrator shall report on the contents and implementation status of the environmental management plan and environmental monitoring plan described below to the director of the plant, with the director taking final responsibility.

The administrator of the EMU shall regularly hold explanation sessions with the local community, continuously listen to their grievances, submit reports to the Department of Environment, JICA and other relevant organizations regarding those grievances, as well as on the implementation status of environmental management and environmental monitoring activities (described hereinafter).

Figure 7.1.2 describes the environmental management and monitoring implementation structure with the reporting flow during the operation phase.



(Source: JICA Study Team)

Figure 7.1.2 Environmental Management and Monitoring Implementation Structure in Operation Phase for the power plant and port facility

2) Mitigation Measures

The major environmental impact, mitigation measures, responsible organization, and expenses for each environmental item during the construction and operation phases for the power plant and port facility are listed in Table 7.1.1 and Table 7.1.2.

Table 7.1.1 Environmental Management Plan (Power Plant)

No	Potential Impact to be Managed	Sources of Potential Impact	Standard of Impact	Objectives	Management Effort	Management Location	Period of Management	Management Institution	Cost
Pre-construction Phase									
1	Land acquisition	1) Loss of private land 2) Loss of salt fields, shrimp farms and fishing ground for push net 3) Loss of residential/ commercial structures 4) Loss of trees, home gardens, fish ponds and fruit	1) - 4) - The Acquisition and Requisition of Immovable Property Ordinance of 1982 - JICA Guideline (2010)	1) Consideration for land owners 2) Consideration for persons losing their homes 3), 4) Consideration for persons losing their property	1) - 4) - Developing an appropriate "land acquisition and resettlement action plan" - Land acquisition should be conducted in compliance with the relevant laws and regulations - The cost related to relocation will be given to relocated residents - Employ local residents, especially loss of salt fields, shrimp farms, and fishing ground for push net as much as possible	1) - 4) - At the site	1) - 4) - During land acquisition process	- Office of the Deputy Commissioner - CPGCBL	Expenses to be paid by CPGCBL - Total cost relating to land acquisition: 3,864,045,082 Tk.
2	Disturbance to poor people	- Poor households among those who are to be resettled.	- JICA Guideline (2010)	- Consideration for burden on vulnerable groups	- Developing "livelihood restoration program", including job training programs to persons who want the training.	- At the site	- Prior to start construction	- Office of the Deputy Commissioner - CPGCBL	Expenses to be paid by CPGCBL - Job training programs: 120,000 Tk./ 20person∈20day
3	Social Institutions such as Social Infrastructure and Local Decision-	- Changing peoples' thinking through interacting with local government officers, local	-----	- Consideration to affected peoples' emotions	- Developing an appropriate "land acquisition and resettlement action plan"	- At the site	- Prior to start construction	- Office of the Deputy Commissioner - CPGCBL	Expenses to be paid by CPGCBL

No	Potential Impact to be Managed	Sources of Potential Impact	Standard of Impact	Objectives	Management Effort	Management Location	Period of Management	Management Institution	Cost
	making Institutions	residents and others in the land acquisition procedure							
4	Misdistribution of Benefits and Compensation	- It can occur among residents, workers, government officers and local politicians	-----	- Consideration for uneven distribution of benefits and losses	- Implement the same mitigation measures as those outlined in "Social infrastructure"	- At the site	- Prior to start construction	- Office of the Deputy Commissioner - CPGCBL	Expenses to be paid by CPGCBL
5	Local Conflicts of Interest	- It can occur among residents, workers, government officers and local politicians	-----	- Consideration to affected peoples' emotions	- Implement the same mitigation measures as those outlined in "Poor people"	- At the site	- Prior to start construction	- Office of the Deputy Commissioner - CPGCBL	Expenses to be paid by CPGCBL
Construction Phase									
1	Air Quality	1) Dust resulting from construction work 2) Exhaust gas from construction machinery and vehicles used for mobilization of equipment 3) Air pollution arising from incineration of construction	1) - 3) - Ambient Air Quality Standard - IFC guideline value for ambient air quality (General/ 2007)	1) - 3) - Prevention of air pollution in the surrounding area	1) Dust prevention - Watering access road and construction site, especially in the dry season - Using cover sheets on trucks for the transportation of soil 2) Gas emission prevention - Periodic maintenance and management of all the construction machinery and vehicles 3) Waste management - Prohibit open burning	1) - 3) - Construction area	1) - 3) - During construction phase	- Implementation: Contractor/ Environmental Consultant - Supervisor: CPGCBL/ Supervision Consultant	Expenses included in contract cost by Contractor

No	Potential Impact to be Managed	Sources of Potential Impact	Standard of Impact	Objectives	Management Effort	Management Location	Period of Management	Management Institution	Cost
		materials and waste							
2	Water Quality	1) Run off water from construction area 2) Domestic wastewater of workers 3) Inappropriate disposal of waste 4) Leakage oil and chemical materials from construction activity	1) - 4) - Wastewater standards	1) - 4) - Prevention of water pollution in the surrounding area	1) Run off water - Excavate channels, ditches and temporary settling pond around construction area - Install oil separator for treatment of oily wastewater - Construct silt basin 2) Domestic wastewater - Install wastewater treatment facility for workers such as septic tanks 3) Waste management - Prohibit illegal dumping 4) Oil and chemical materials leakage - Storage of oil and chemical materials in an appropriate storage site and appropriate method to prevent permeation into ground	1) - 4) - Construction area	1) - 4) - During construction phase	- Implementation: Contractor/ Environmental Consultant - Supervisor: CPGCBL/ Supervision Consultant	Expenses included in contract cost by Contractor
3	Waste	1) Construction waste from construction work 2) Domestic waste from workers 3) Hazardous	1) - 3) - Waste Management Rule	1) - 3) - Prevention of inappropriate waste disposal	1), 2) Construction and domestic waste - Conduct separate waste collection and promote recycling and reuse - Appropriate disposal of non-recyclable waste	1) - 3) - Construction area	1) - 3) - During construction phase	- Implementation: Contractor/ Environmental Consultant - Supervisor: CPGCBL/ Supervision Consultant	Expenses included in contract cost by Contractor

No	Potential Impact to be Managed	Sources of Potential Impact	Standard of Impact	Objectives	Management Effort	Management Location	Period of Management	Management Institution	Cost
		waste such as dry batteries, etc.			according to rules 3) Hazardous waste - Hazardous waste should be treated under the related regulations				
4	Noise and Vibration	1) Noise and vibration caused by construction machinery 2) Noise caused by vehicles used for mobilization of equipment and workers	1), 2) - Noise level standards - IFC guideline values for noise (General/ 2007)	1), 2) - Reduction of noise levels from construction activities	1) Construction machinery - Optimizing construction schedule - Performing construction work during daytime, especially piling work - Using low-noise/ low vibration equipment as much as possible 2) Mobilization - Transportation of material and equipment for construction by shipping - Determine a traffic control plan including route-setting - Limit truck speed especially around residential areas	1), 2) - Construction area	1), 2) - During construction phase	- Implementation: Contractor/ Environmental Consultant - Supervisor: CPGCBL/ Supervision Consultant	Expenses included in contract cost by Contractor
5	Odor	- Domestic wastewater of workers	- Wastewater standards	- Prevention of generating odor	- Taking appropriate measures for handling general waste - Prohibit illegal waste disposal	- Construction area	- During construction phase	- Implementation: Contractor/ Environmental Consultant - Supervisor: CPGCBL/ Supervision Consultant	Expenses included in contract cost by Contractor.
6	Soil	1) Leakages of oil and chemical	1), 2) - Drinking water	1), 2) - Prevention of	1) Leakages of oil and chemical materials	1), 2) - Construction	1), 2) - During	- Implementation: Contractor/	Expenses included in contract cost by

No	Potential Impact to be Managed	Sources of Potential Impact	Standard of Impact	Objectives	Management Effort	Management Location	Period of Management	Management Institution	Cost
		materials from construction activity 2) Inappropriate disposal of waste	quality standards	water and soil pollution in the surrounding area	- Storage of oil and chemical materials in an appropriate storage site and method to prevent permeation into the ground 2) Waste management - Prohibit illegal dumping	area	construction phase	Environmental Consultant - Supervisor: CPGCBL/ Supervision Consultant	Contractor
7	Sediment	1) Run off water from construction area 2) Domestic wastewater of workers 3) Inappropriate disposal of waste 4) Leakages of oil and chemical materials from construction activity	1) - 4) - Wastewater standards	1) - 4) - Prevention of water pollution in the surrounding area	1) - 4) - Implement the same mitigation measures as those addressed in "Water quality"	1) - 4) - Construction area	1) 4) - During construction phase	- Implementation: Contractor/ Environmental Consultant - Supervisor: CPGCBL/ Supervision Consultant	Expenses included in contract cost by Contractor
8	Ecosystem	1) Existence of endangered species 2) Spawning of sea turtles	1), 2) - Bangladesh Wild Life (Preservation) (Amendment) Act, 1974 - JICA Guideline (2010)	1), 2) - Protection of endangered species	1) Existence of endangered species - Prohibit disturbance, harassment, and hunting, especially of the Spoon billed Sandpiper, by workers - Replace to nearby site, if needed 2↗ Spawning of sea turtles	1) Construction area 2) Construction site adjoining sand beach	1), 2) - During construction phase	- Implementation: Contractor/ Environmental Consultant - Supervisor: CPGCBL/ Supervision Consultant	Expenses included in contract cost by Contractor

No	Potential Impact to be Managed	Sources of Potential Impact	Standard of Impact	Objectives	Management Effort	Management Location	Period of Management	Management Institution	Cost
					- Turning off unnecessary lights during the nesting season - Using a smaller number or lower wattage of lights - Using red, yellow lights (as sea turtles are less affected by these colors) - Using low noise machinery - Planning construction activities to minimize adverse effects during the nesting season				
		- Potential impact due to water pollution caused by construction activities	- Wastewater standards	- Prevention of water pollution in order to reduce negative impact on marine organisms	- Implement the same mitigation measures as those addressed in "Water quality"	- Construction area			
9	Deterioration of Local Economy such as Losses of Employment and Means of Livelihood	- Increase in employment and business opportunities	- Number of employment opportunities for local residents and number of businesses around the construction area	- Improvement of the local economy - Improvement of living standards of local residents - Consideration to local residents' feelings	- Employ local residents as much as possible - Use the services (i.e., laundry and catering services, etc.) and products offered by the local community. - Developing "livelihood restoration program", including job training programs to persons who want the training.	- Villages near the site	- During construction phase	- Implementation: Contractor/ Environmental Consultant - Supervisor: CPGCBL/ Supervision Consultant	Expense is included in contract cost by Contractor - Hire local residence: 1,000Tk./person-day

No	Potential Impact to be Managed	Sources of Potential Impact	Standard of Impact	Objectives	Management Effort	Management Location	Period of Management	Management Institution	Cost
10	Land Use and Utilization of Local Resources	- Changing the traditional land use patterns and utilization of local resources	-----	- Consideration to local residents' feelings	- Implement the same mitigation measures as those addressed in the "Local economy"	- Villages near the site	- During construction phase	- Implementation: Contractor/ Environmental Consultant - Supervisor: CPGCBL/ Supervision Consultant	Expenses included in contract cost by Contractor
11	Disturbance to Water Usage, Water Rights, etc.	1) Adverse impact due to water pollution 2) Usage of underground water	1) Water pollution - Same as those addressed in "Water quality" 2) Ground water - Drinking water quality standards	1) Water pollution - Same as those addressed in "Water quality" 2) Ground water - Consideration to local residents' living	1) Water pollution - Implement the same mitigation measures as those addressed in "Water quality" 2) Ground water - Monitoring of water levels and water quality at wells in residential areas	1), 2) - Construction area	1), 2) - During construction phase	- Implementation: Contractor/ Environmental Consultant - Supervisor: CPGCBL/ Supervision Consultant	Expenses included in contract cost by Contractor
12	Disturbance to Existing Social Infrastructure and Services	1) Increased marine traffic may disturb the existing marine traffic including fishing boats 2) Traffic jams caused by increased number of vehicles during construction 3) Closure of the existing road along the	1) - 3) -Traffic volume around the construction site	1) - 3) - Mitigation of traffic jams	1) Marine traffic - Consulting with related authorities on the schedules of vessels - Determining water routes after consultation with related authorities 2), 3) Land traffic - Making inappropriate vehicle schedules - Reducing the number of vehicles used by using buses - Consulting with related authorities on bus	1) Sea area near the site 2), 3) Roads near the construction area	1) - 3)During construction phase	- Implementation: Contractor/ Environmental Consultant - Supervisor: CPGCBL/ Supervision Consultant	Expenses included in contract cost by Contractor

No	Potential Impact to be Managed	Sources of Potential Impact	Standard of Impact	Objectives	Management Effort	Management Location	Period of Management	Management Institution	Cost
		shoreline			schedules				
13	Local Conflicts of Interest	- Conflicts between local residents and external workers	- Change in local customs	- Consideration of the attitudes of local residents to the project	- Employ local residents as much as possible - Promote communication between external workers and local people (e.g., join in local events)	- Villages near the site	- During construction phase	- Implementation: Contractor/ Environmental Consultant - Supervisor: CPGCBL/ Supervision Consultant	Expenses included in contract cost by Contractor
14	Children's Rights	- Child labor	-----	- Banning child labor	- Prohibit labor contracts between subcontractor and children - Patrolling periodically to check for any child labor	- Construction area	- During construction phase	- Implementation: Contractor/ Environmental Consultant - Supervisor: CPGCBL/ Supervision Consultant	Expenses included in contract cost by Contractor
15	Infectious Diseases such as HIV/AIDS	- Temporary influx of migrant labor during construction may increase risk of infection	-----	- Consideration for sanitation for local residents	- Implementation of periodic medical check-ups by temporary medical team - Education and training on health care of workers	- Construction area	- During construction phase	- Implementation: Contractor/ Environmental Consultant - Supervisor: CPGCBL/ Supervision Consultant	Expenses included in contract cost by Contractor - Medical checkups: 22,500Tk./ person (Full Medical Checkup) - Safety education and training: 75,000Tk./ 20 person
16	Work environment (including work safety)	1) Labor accidents 2) Diseases caused by air pollutants, water pollutants, and noise by construction	1) Labor accidents - Handling heavy loads - Working at heights	1), 2) - Prevention of labor accidents and health problems	1) Labor accidents - Prepare a manual for labor accident prevention including safety education and training - Provide workers with	1), 2) - Construction area	1), 2) - During construction phase	- Implementation: Contractor/ Environmental Consultant - Supervisor: CPGCBL/ Supervision	Expenses included in contract cost by Contractor - Protective equipment: 5,000Tk./ person

No	Potential Impact to be Managed	Sources of Potential Impact	Standard of Impact	Objectives	Management Effort	Management Location	Period of Management	Management Institution	Cost
		work	- Electric shocks 2) Environment pollution - Ambient Air Quality Standards - Noise level standards - Waste management rules - IFC guideline values for ambient air quality and noise (General/ 2007)		appropriate protective equipment, such as helmets - Install fire extinguishers in fire handling places - Inspect and ensure that any lifting devices, such as cranes, are appropriate for expected loads - Keep lifting devices well maintained and perform maintenance checks as appropriate during the construction period - Use equipment that protects against electric shocks 2) Environment pollution - Observe related standards and provide workers with appropriate equipment, such as masks, ear plugs, etc.			Consultant	
17	Accidents	- Traffic accidents	1) Marine traffic 2) Land traffic	1), 2) - Traffic accidents	1) Marine traffic - Marking buoys around the construction area for marine safety - Informing vessel schedules to local fishermen, etc. 2), 3) Land traffic - Informing bus schedules to the surrounding villages - Determining a traffic	1) Sea area near the site 2) Roads near the construction area	1), 2) - During construction phase	- Implementation: Contractor/ Environmental Consultant - Supervisor: CPGCBL/ Supervision Consultant	Expenses included in contract cost by Contractor - Making buoys: 5,000Tk./ unit

No	Potential Impact to be Managed	Sources of Potential Impact	Standard of Impact	Objectives	Management Effort	Management Location	Period of Management	Management Institution	Cost
					control plan - Training safe operation of vehicles				
18	Cross-boundary impact and climate change	- CO_2 will be produced by construction work	-----	- Reduce CO_2 emissions as much as possible	- Periodic maintenance and management of all construction machinery and vehicles	- Construction area	- During construction phase	- Implementation: Contractor/ Environmental Consultant - Supervisor: CPGCBL/ Supervision Consultant	Expenses included in contract cost by Contractor
Operational Phase									
1	Air Quality	1) Exhaust gas from the stacks 2) Dust from ash disposal activity 3) Exhaust gas from vehicles used for mobilization of equipment and workers 4) Dust from coal handling activities at jetty and coal yard	1) - 4) - Emission gas standards - Ambient air quality standards - IFC guideline values for ambient air quality (General/ 2007) and gas emission (Thermal power plant/ 2008)	1), 3) - Prevention of air pollution in the surrounding area 2) Appropriate handling of ash 4) Appropriate coal handling during stock and unloading activities	1) Power plant operational activities: - To reduce PM emissions, Electrostatic Precipitator (EP; around 99.8% efficiency) will be installed - To reduce NO_2 emissions, firing system will use low combust technology - To reduce SO_2 emissions, sea water FGD equipment (FGD; around 70% efficiency) will be installed - For stack design, the height is 275m - Duct will be provided with CEMS (Continuous Emission Monitoring System) with the supported infrastructure as required under the gas emission	1) Stack 2) Ash pond 3) Villages near the site 4) Coal stock yard	1) - 4) During operation of power plant	CPGCBL	- Flue gas treatment facilities: 319 million US$ - Flue gas duct and stack: 114 million US$ - Coal handling and transportion facilities: 182 million US$ - Re-greening: 100Tk./ m^2 (50ha) (Expenses included in contract cost by Contractor)

No	Potential Impact to be Managed	Sources of Potential Impact	Standard of Impact	Objectives	Management Effort	Management Location	Period of Management	Management Institution	Cost
					standards and IFC guideline 2) Ash handling - Shifting the fly ash and the bottom ash to the ash pond using air sealed conveyer - Watering in ash pond as required for the dry season - Re-greening especially along the boundary of the plant site, surrounding ash pond with domestic plants according to local climate conditions 3) Gas emissions from vehicles - Periodic maintenance and management of vehicles 4) Coal handling - A cover will be installed for the conveyor for coal transportation to coal yard - Unloading of coal will be minimized (e.g., reduce the frequency of activity, etc.) during times of high speed winds - Spraying water in coal yard to keep the surface wet and prevent wind from blowing coal and dust - Installation of a dust				

No	Potential Impact to be Managed	Sources of Potential Impact	Standard of Impact	Objectives	Management Effort	Management Location	Period of Management	Management Institution	Cost
					control fence - Re-greening especially along boundary of plant site, surrounding coal yard with domestic plants				
2	Water Quality	1) Thermal effluents from cooling system 2) Wastewater from plant process 3) Rainwater drainage from ash pond and coal yard 4) Leakages of oil and chemical materials	1) - 3) - Wastewater standards - IFC guideline values for wastewater (Thermal power plant/ 2008)	1) - 4) - Prevention of sea water pollution	1) Thermal effluents - Thermal effluents are discharged to north side far from the intake point of cooling water to reduce the impact on surrounding area 2) Wastewater - Installation of wastewater treatment system by neutralization, settling and oil separation so any wastewater produced complies with wastewater standards and IFC guideline 3) Run off water - Run off water is collected in the pond and discharged after appropriate treatment - The bottom of the ash pond shall have an impermeable layer (less than 10^{-6}cm/sec) such as impermeable geo-membrane, sheet and clay 4) Oil and chemical materials leakage - Storage of oil and chemical	1) - 4) - Power plant, especially at discharge of thermal effluents and wastewater treatment system	1) - 4) During the operation of power plant	CPGCBL	- Wastewater treatment system: (Expenses included in contract cost by Contractor)

No	Potential Impact to be Managed	Sources of Potential Impact	Standard of Impact	Objectives	Management Effort	Management Location	Period of Management	Management Institution	Cost
					materials in an appropriate tank with retaining wall and method to prevent permeation into ground				
3	Waste	1) Fly ash and bottom ash 2) Sludge from wastewater treatment and waste oil from equipment, etc. 3) Sewage and garbage from workers	1) - 3) - Waste management rules	1) Appropriate handling of coal ash 1) 3) - Management of waste, especially hazardous waste - Prevention of inappropriate waste disposal	1) Ash pond is designed with capacity of 25 years operation 2), 3) Waste management - Waste management program consisting of reduction, reuse, and recycling of materials - Systematic collection and protected storage - Waste disposal at appropriate location - Hazardous waste shall be treated under the related regulations - Prohibition of dumping any contaminating materials	1) Ash pond 2), 3) - Power plant	- During the operation of power plant	CPGCBL	- Ash handling facilities: 114 million US$ (Expenses included in contract cost by Contractor)
4	Noise and vibration	1) Noise and vibration from steam turbines, generators, and pumps, etc. 2) Noise by ash disposal activity 3) Noise caused by vehicles used for mobilization of	1) - 4) - Noise standards - IFC guideline values for noise (General/ 2007)	1) - 4) - Mitigation of noise generated by the power plant	1) - 4) - Maintenance of equipment - Installation of low noise/ low vibration type equipment - Adequate basis of equipment to reduce vibration - Adequate enclosure of equipment to reduce noise	1) - 4) - Power plant	1) - 4) - During the operation of power plant	CPGCBL	- Buildings housing boiler and turbine generator (Expenses included in contract cost by Contractor)

No	Potential Impact to be Managed	Sources of Potential Impact	Standard of Impact	Objectives	Management Effort	Management Location	Period of Management	Management Institution	Cost
		equipment and workers 4) Noise from coal handling activity at jetty and coal yard							
5	Odor	- Domestic wastewater of workers	- Wastewater standards	- Prevention of generating odors	- Taking appropriate measures for handling general waste - Prohibit illegal waste disposal	- Power plant	- During the operation of power plant	CPGCBL	Expenses by CPGCBL
6	Soil	1) Seepage from ash disposal site 2) Leakages of oil and chemical materials	1), 2) - Ground water (Drinking water quality standards)	1), 2) - Prevention of soil and water pollution in the surrounding area	1) Seepage - The bottom of the ash pond should have an impermeable layer (less than 10^{-6}cm/sec) such as impermeable geo-membrane, sheet and clay 2) Oil and chemical materials leakage - Storage of oil and chemical materials in an appropriate tank with retaining wall and method to prevent permeation into ground	1) Ash pond 2) Power plant	1), 2) - During coal unloading activity	CPGCBL	Expenses by CPGCBL
7	Sediment	1) Wastewater from plant process 2) Run off water from ash disposal site and coal yard 3) Leakages of oil	1) - 3) - Wastewater standards - IFC guideline values for wastewater	1) - 3) - Prevention of sea water pollution	1) Wastewater - Installation of wastewater treatment system by neutralization, settling and oil separation so any wastewater produced	1) - 3) - Power plant, wastewater treatment system	1) - 3) - During the operation of power plant	CPGCBL	Expenses by CPGCBL

No	Potential Impact to be Managed	Sources of Potential Impact	Standard of Impact	Objectives	Management Effort	Management Location	Period of Management	Management Institution	Cost
		and chemical materials	(Thermal power plant/ 2008)		complies with wastewater standards and IFC guideline 2) Run off water - Run off water is collected in the pond and discharged after appropriate treatment 3) Oil and chemical materials leakage - Storage of oil and chemical materials in an appropriate tank with retaining wall and method to prevent permeation into ground				
8	Ecosystem	1) Existence of endangered species 2) Spawning of sea turtles	1), 2) - Bangladesh Wild Life (Preservation) (Amendment) Act, 1974 - JICA Guideline (2010)	1), 2) - Protection of endangered species	1) Existence of endangered species - Prohibit disturbance, harassment, and hunting, especially of the Spoon billed Sandpiper, by workers 2) Spawning of sea turtles - Turning off unnecessary lights during the nesting season - Using a smaller number or lower wattage of lights - Using red and yellow lights (as sea turtles are less affected by these colors) - Using low noise machinery	1) Power plant 2) Power plant adjoining sand beach	1), 2) - During the operation of the power plant	CPGCBL	Expenses by CPGCBL
		- Negative impact	- Emission gas	- Prevention of air	- Implement the same	- Power plant			

No	Potential Impact to be Managed	Sources of Potential Impact	Standard of Impact	Objectives	Management Effort	Management Location	Period of Management	Management Institution	Cost
		due to air pollutants, noise, and waste management	standards - Ambient air quality standards - Wastewater standards - Noise standards - Waste management rules - IFC guideline values for ambient air quality (General/ 2007) and gas emissions (Thermal power plant/ 2008)	pollution, water pollution, noise, and inappropriate waste treatment	mitigation measures as those addressed in air quality, water quality, noise, and waste				
9	Disturbance to Poor People	- Improved road along with the power plant	-----	- Access to social services	- Construction of the access road, community road, and road around the power plant boundary - These roads will be built with sufficient height that they can be used even in the rainy season	- Villages near the site	- During the operation of power plant	CPGCBL	Expenses by CPGCBL
10	Deterioration of Local Economy such as Losses of Employment and Means of Livelihood	- Increase in employment and business opportunities	- Number of employment opportunities for local residents and number of businesses around the	- Improvement of the local economy - Improvement of living standards of local residents - Consideration of	- Employment of local residents as much as possible - Use of services (i.e., laundry and catering services, etc.) and products offered by the local	- Villages near the site	- During the operation of power plant	CPGCBL	Expenses by CPGCBL

No	Potential Impact to be Managed	Sources of Potential Impact	Standard of Impact	Objectives	Management Effort	Management Location	Period of Management	Management Institution	Cost
			power plant	local residents' feelings	community				
11	Land Use and Utilization of Local Resources	- Changing traditional land use patterns and utilization of local resources	-----	- Consideration of local residents' feelings	- Implement the same mitigation measures as those addressed in "Local economy"	- Villages near the site	- During the operation of power plant	CPGCBL	Expenses by CPGCBL
12	Disturbance to Water Usage, Water Rights, etc.	- Adverse impact due to water pollution	- Same as those addressed in "Water quality"	- Same as those addressed in "Water quality"	- Implement the same mitigation measures as those addressed in "Water quality"	- Power plant	- During the operation of power plant	CPGCBL	Expenses by CPGCBL
13	Disturbance to the Existing Social Infrastructure and Services	1) Traffic jams caused by increased vehicles 2) Improved roads along with the power plant 3) Improved social infrastructure along with the power plant	-----	1) Traffic volume will increase 2) Access to social services 3) Improvement of living standards of local residents	1) Traffic volume - Minimizing traffic volume by using buses for employees 2) Access to social services - Construction of the access road, community road, and road around the power plant boundary - These roads can be used even in the rainy season. 3) Improvement of living - New service facilities, such as school and medical center, are made available to local residents, as required - Electrification of surrounding area will be examined	1), 2) Villages near the site 3) Power plant	1) 3) During the operation of power plant	CPGCBL	Expenses by CPGCBL

No	Potential Impact to be Managed	Sources of Potential Impact	Standard of Impact	Objectives	Management Effort	Management Location	Period of Management	Management Institution	Cost
14	Misdistribution of Benefits and Compensation	- It can occur among residents, workers, government officers and local politicians	-----	- Consideration to affected peoples' emotions	- Developing an employment plan that is fair to every affected person	- Villages near the site	- During the operation of power plant	CPGCBL	Expenses by CPGCBL
15	Local Conflicts of Interest	- Conflict between local residents and workers	- Change in local customs	- Consideration of the attitudes of local residents to the project	- Employ local residents as much as possible - Promote communication between workers and local people (e.g., join in local events)	- Villages near the site	- During the operation of power plant	CPGCBL	Expenses by CPGCBL - Hire local residence: 1,000Tk./person-day
16	Gender	- Improved road along with the power plant	-----	- Access to social services and markets	- Implement the same mitigation measures as those outlined in "Poor people"	- Villages near the site	- During the operation of power plant	CPGCBL	Expenses by CPGCBL
17	Children's Rights	1) Child labor 2) Improved road along with the power plant	-----	1) Banning child labor 2) Access to schools	1) Child labor - Prohibit labor contracts between subcontractor and children - Patrolling periodically to check for any child labor 2) Improved roads - Construction of the access road, community road, and road around the power plant boundary - These roads will be built with sufficient height so that they can be used even in the rainy season	1), 2) - Power plant	1), 2) - During the operation of power plant	CPGCBL	Expenses by CPGCBL

No	Potential Impact to be Managed	Sources of Potential Impact	Standard of Impact	Objectives	Management Effort	Management Location	Period of Management	Management Institution	Cost
18	Work environment (including work safety)	1) Labor accidents 2) Diseases caused by air pollutants, water pollutants, and noise from the operation of the power plant	1) Labor accidents - Handling heavy loads - Working at heights - Electric shocks 2) Environment pollution - Ambient air quality standards - Noise standards - Waste management rules - IFC guideline values for ambient air quality and noise (General/ 2007)	1), 2) - Prevention measures against labor accidents and health problems	1) Labor accidents - Prepare a manual for labor accident prevention including safety education and training - Provide workers with appropriate protective equipment - Inspect and ensure that any lifting devices, such as cranes, are appropriate for expected loads - Keep lifting devices well maintained and perform maintenance checks as appropriate - Use equipment that protects against electric shock 3) Environment pollution - Observe related standards and provide workers with appropriate facilities	1), 2) - Power plant	1), 2) - During the operation of power plant	CPGCBL	Expenses by CPGCBL - Safety education and training: 75,000Tk./ 20person - Protective equipment: 5,000Tk./ person
19	Accidents	1) Traffic accidents 2) Fire 3) Cyclones and tidal surge	1) Traffic accidents - Marine traffic - Land traffic 2) Fire 3) Cyclones and tidal surge	1) Prevention of traffic accidents 2) Prevention of fire 3) Prevent floods caused by cyclones	1) Traffic accidents - Determining water routes and setting course buoys on navigation channel for safety - Informing vessel schedules to local fishermen, etc. - Observation of traffic regulations, installation of	1) Villages near the site 2) Power plant	1), 2) During the operation of power plant	CPGCBL	Expenses by CPGCBL - Course buoys: 5,000Tk./ unit - Fire extinguisher: 60,000Tk./ set (Consist of 6 pcs)

No	Potential Impact to be Managed	Sources of Potential Impact	Standard of Impact	Objectives	Management Effort	Management Location	Period of Management	Management Institution	Cost
					traffic signs, and education on safe driving - Informing bus schedules to the surrounding villages 2) Fire - Installing fire extinguishers in fire handling places - Installing fire fighting system - Spraying water in coal yard - Developing fire fighting organization and implementing fire drills 3) Cyclones and tidal surges - Construction of embankment along navigation channels and revetment in the port to prevent floods caused by cyclones.				
20	Cross-boundary impact and climate change	- CO_2 emission	- Amount of CO_2 emission	- Reduce CO_2 emissions per electric generate (kW)	- Use of USC of high efficiency for power generation	- Power plant	- During the operation of power plant	CPGCBL	Expenses by CPGCBL - Boiler and auxiliaries: 433million US$

(Source: JICA Study Team)

Table 7.1.2 Environmental Management Plan (Port Facility)

No	Potential Impact to be Managed	Sources of Potential Impact	Standard of Impact	Objectives	Management Effort	Management Location	Period of Management	Management Institution	Cost
Construction Phase									
1	Air Quality	1) Dust resulting from construction work 2) Exhaust gas from construction machinery and vehicles used for mobilization of equipment 3) Air pollution arising from incineration of construction materials and waste	1) - 3) - Ambient Air Quality Standard - IFC guideline values for ambient air quality (General/ 2007)	1) - 3) - Prevention of air pollution in the surrounding area	1) Dust prevention - Watering access road and construction site, especially in the dry season - Using cover sheets on trucks for the transportation of soil 2) Gas emission prevention - Periodic maintenance and management of all the construction machinery and vehicles 3) Waste management - Prohibit open burning and illegal dumping	1) - 3) - Construction area	1) - 3) - During construction phase	- Implementation: Contractor/ Environmental Consultant - Supervisor: CPGCBL/ Supervision Consultant	Expenses included in contract cost by Contractor
2	Water Quality	1) Dredging 2) Landfill for land preparation	1), 2) - Wastewater standards for industrial activity	1), 2) - Prevention of water pollution in the surrounding coastal area	1) Dredging - Conducting dredging at sea area with pump dredger or grab dredger and setting film preventing the diffusion of contamination - When dredging terrestrial area, firstly driving steel sheet pile at the sea side	1) Dredging area 2) Power plant site	1) During the dredging activities 2) During landfill activities	- Implementation: Contractor/ Environmental Consultant - Supervisor: CPGCBL/ Supervision Consultant	Expenses included in contract cost by Contractor

No	Potential Impact to be Managed	Sources of Potential Impact	Standard of Impact	Objectives	Management Effort	Management Location	Period of Management	Management Institution	Cost
					and dredging with pump or grab after sea water penetrates the land 2) Landfill - Treating turbid water from land, such as rainwater run off, with precipitation process and discharging the remaining water into the excavated part of the port				
3	Waste	- Dredging material for the channel	- Waste Management Rules	- Prevention of inappropriate waste disposal	1) Dredging material - Sand: Use for leveling the site - Silt: Dispose in the ash pond (7,500,000m^3)	1) Dredging area 2) Power plant site	- During construction phase	- Implementation: Contractor/ Environmental Consultant - Supervisor: CPGCBL/ Supervision Consultant	Expenses included in contract cost by Contractor
4	Noise and Vibration	- Noise and vibration caused by construction machinery	- Noise level standards - IFC guideline values for noise (General/ 2007)	- Reduction of noise levels from construction activities	- Optimizing construction schedule - Perform construction work during daytime, especially piling work - Using low-noise/ low vibration equipment as much as possible	- Construction area	- During construction phase	- Implementation: Contractor/ Environmental Consultant - Supervisor: CPGCBL/ Supervision Consultant	Expenses included in contract cost by Contractor
5	Ecosystem	1) Existence of endangered species 2) Spawning of sea turtles	1), 2) - Bangladesh Wild Life (Preservation) (Amendment) Act, 1974 - JICA Guideline	1), 2) - Protection of endangered species	1) Existence of endangered species - Prohibit disturbance, harassment, and hunting, especially the Spoon billed Sandpiper, by workers - Replace to nearby sites if	1) Construction area 2) Construction site adjoining sand beach	1), 2) - During construction phase	- Implementation: Contractor/ Environmental Consultant - Supervisor: CPGCBL/ Supervision Consultant	Expenses included in contract cost by Contractor

No	Potential Impact to be Managed	Sources of Potential Impact	Standard of Impact	Objectives	Management Effort	Management Location	Period of Management	Management Institution	Cost
			(2010)		needed. 2) Spawning of sea turtles - Turning off unnecessary lights during the nesting season - Using a smaller number or lower wattage of lights - Using red and yellow lights (as sea turtles are less affected by these colors) - Using low noise machinery - Planning construction activities to minimize adverse effects during the nesting season				
6	Disturbance to the Existing Social Infrastructure and Social Services	- Increase the number of construction vessels	- Interference to other tankers, barges, and fishing boats	-----	- Consulting with related authorities on vessel schedules - Determining water routes after consultation with related authorities	- Sea area around construction area for port facility	-During construction phase	- Implementation: Contractor/ Environmental Consultant - Supervisor: CPGCBL/ Supervision Consultant	Expenses included in contract cost by Contractor
7	Work environment (including work safety)	1) Labor accidents 2) Diseases caused by air pollutants, water pollutants, and noise by construction	1) Labor accidents - Handling heavy loads - Working at heights - Electric shocks 2) Environment pollution	1), 2) - Prevention of labor accidents, traffic accidents, and health problems	1) Labor accidents - Prepare a manual for labor accident prevention including safety education and training - Provide workers with appropriate protective equipment - Inspect and ensure that any	1), 2) - Construction area	1), 2) - During construction phase	- Implementation: Contractor/ Environmental Consultant - Supervisor: CPGCBL/ Supervision Consultant	Expenses included in contract cost by Contractor

No	Potential Impact to be Managed	Sources of Potential Impact	Standard of Impact	Objectives	Management Effort	Management Location	Period of Management	Management Institution	Cost
		work	- Ambient Air Quality Standards - Noise level standards - Waste management rule - IFC guideline values for ambient air quality and noise (General/ 2007)		lifting devices, such as cranes, are appropriate for expected loads - Keep lifting devices well maintained and perform maintenance checks as appropriate during the period of construction - Use equipment that protects against electric shock 2) Environment pollution - Observe related standards and provide workers with appropriate facilities				
8	Accidents	- Traffic accidents	- Marine traffic accidents	- Prevention of traffic accidents	- Setting marking buoys around the construction area for marine safety - Informing vessel schedules to local fishermen, etc.	- Sea area around construction area for port facility	- During construction phase	- Implementation: Contractor/ Environmental Consultant - Supervisor: CPGCBL/ Supervision Consultant	Expenses included in contract cost by Contractor
Operational Phase									
1	Air Quality	1) Dust from coal handling activity at port 2) Exhaust gas from vessels	1) Coal handling - Ambient air quality (No.41/199) - IFC guideline for ambient air quality (General/ 2007) 2) MALPOL 73/78 treaty	1) Appropriate coal handling during coal unloading activity 2) Prevention of air pollution caused by vessels	1) Coal handling - A cover will be installed on the conveyor for coal transportation to coal yard - Unloading of coal will be minimized (e.g., reduce the frequency of activity, etc.) during times of high speed winds - Spraying water in coal	1), 2) - Port facility	1), 2) - During coal unloading activity	CPGCBL/ Environmental Consultant	Expenses by CPGCBL/ Vessel owners

No	Potential Impact to be Managed	Sources of Potential Impact	Standard of Impact	Objectives	Management Effort	Management Location	Period of Management	Management Institution	Cost
			(Annex VI)		handling area to keep the surface wet and prevent wind from blowing coal and dust 2) Gas emission from vessels - Hire vessels compliant to MARPOL 73/78 treaty - Stop engines in the port				
2	Water Quality	- Dredging material for the maintenance of the navigation channel	- Regulations relating to dredging	- Minimization of water pollution by dredging	- To choose dredging method and equipment that will minimize turbidity	- Dredging area	- During the dredging activities	CPGCBL/ Environmental Consultant	Expenses by CPGCBL
		1) Operation of the port may cause a coal spillage, and as a result, water pollution will occur 2) Leakages of oil from oil tankers 3) Wastewater from vessels will cause water pollution	1) ---- 2), 3) - MALPOL 73/78 treaty (Annex I-V) 3) Wastewater from vessels - International Convention for the control and management of Ships' Ballast Water and Sediments (BWM), 2004	1) Appropriate coal handling during coal unloading activity 2), 3) Prevention of water pollution caused by vessels	1) Operation of the port - Cover installation on conveyor for coal transportation to coal yard 2) Leakages of oil from oil tankers - Installation of oil fence 3) Wastewater from vessels - Prohibition of dumping any contaminated materials - Hire vessels compliant to MARPOL 73/78 treaty and BWM - Any waste will be treated by the port facility	1) - 3) - Port facility	1) - 3) - During coal unloading activity		Expenses by CPGCBL/ Vessel owners
3	Waste	- Dredging material for the maintenance of	- Waste management rules	- Prevention of inappropriate waste disposal	- Sand: To use for construction material - Silt; To dispose in ash	- Dredging area	- During the dredging activities.	CPGCBL	Expenses by CPGCBL

No	Potential Impact to be Managed	Sources of Potential Impact	Standard of Impact	Objectives	Management Effort	Management Location	Period of Management	Management Institution	Cost
		the channel			pond (365,000m^3/year)				
		- Waste from vessels	- Waste management rules - MALPOL 73/78 treaty (Annex I-V)	- Appropriate waste management	- Prohibition of dumping any contaminated materials - Hire vessels compliant to MARPOL 73/78 treaty - Any waste will be treated by the port facility	- Port facility	- During coal unloading activity		Expenses by CPGCBL / Vessel owners
4	Noise and Vibration	- Noise from coal handling activity at the port	- Noise standards - IFC guideline values for noise (General/2007)	- Mitigation of noise generated by the unloading activity	- Maintenance of equipment. - Installation of low noise type equipment - Optimizing coal unloading schedule	- Port facility	- During coal unloading activity	CPGCBL	Expenses by CPGCBL
5	Ecosystem	1) Existence of endangered species 2) Spawning of sea turtles	1), 2) - Bangladesh Wild Life (Preservation) (Amendment) Act, 1974 - JICA Guideline (2010)	1), 2) - Protection of endangered species	1) Existence of endangered species - Prohibit disturbance, harassment, and hunting, especially of the Spoon billed Sandpiper, by workers 2) Spawning of sea turtles - Turning off unnecessary lights during the nesting season - Using a smaller number or lower wattage of lights - Using red and yellow lights (as sea turtles are less affected by these colors) - Using low noise machinery	- Around the port facility	- During the operation of the power plant	CPGCBL	Expenses by CPGCBL
		1) Operation of the port may cause	1) ---- 2), 3)	1) Appropriate coal handling	1) Operation of the port - Cover installation on	1) - 3) - Port facility	1) - 3) - During coal		Expenses by CPGCBL/ Vessel

No	Potential Impact to be Managed	Sources of Potential Impact	Standard of Impact	Objectives	Management Effort	Management Location	Period of Management	Management Institution	Cost
		a coal spillage, and as a result, water pollution will occur 2) Leakage oil from oil tanker 3) Wastewater from vessels will cause water pollution	MALPOL 73/78 treaty (Annex I-V) 3) Wastewater from vessels International Convention for the control and management of Ships' Ballast Water and Sediments (BWM), 2004	during coal unloading activity 2). 3) Prevention of water pollution caused by vessels	conveyor for coal transportation to coal yard. 2) Leakages of oil from oil tankers - Installation of oil fence 3) Wastewater from vessels - Prohibition of dumping any contaminated materials - Hire vessels compliant to MARPOL 73/78 treaty and BWM - Any waste will be treated by the port facility		unloading activity - During oil storage activity		owners
6	Hydrology	- Potential impact to tidal currents caused by construction of the port facility	- Tidal currents	- Minimization of change of tidal currents	- Conducting tidal current simulation to assess any changes in tidal currents	- Sea area port facility	- During operation of the port facility	CPGCBL	Expenses by CPGCBL
7	Topography and Geology	- Potential impact on coastal line caused by changing tidal currents	- Coastal line	- Minimization of change of coastal line	- Conducting tidal current simulation to assess the change of drift sand movement	- Sea area around construction area for port facility	- During operation of the port facility	CPGCBL	Expenses by CPGCBL
8	Disturbance to the Existing Social Infrastructure and Social Services	- Increase in the number of vessels	- Interference to other tankers or barges	-----	- Setting water routes after consultation with related authorities	Sea area around port facility	During coal unloading activity	CPGCBL	Expenses by CPGCBL
9	Work Environment (Including	1) Labor accidents 2) Diseases	1) Labor accidents - Handling heavy	1), 2) Prevention of labor accidents	1) Labor accidents - Prepare a manual for labor accident prevention	1), 2) Port facility	1), 2) - During coal unloading	CPGCBL	Expenses by CPGCBL

No	Potential Impact to be Managed	Sources of Potential Impact	Standard of Impact	Objectives	Management Effort	Management Location	Period of Management	Management Institution	Cost
	Work Safety)	caused by air pollutants and noise by coal unloading activity	loads - Working at heights 2) Environmental pollution - Ambient air quality standards - Noise standards - Waste management rules - IFC guideline values for ambient air quality and noise (General/ 2007)	and health problems	including safety education and training - Provide workers with appropriate protective equipment - Inspect and ensure that any lifting devices, such as cranes, are appropriate for expected loads - Keep lifting devices well maintained and perform maintenance checks as appropriate 2) Environment pollution - Observe related standards and provide workers with appropriate equipment		activity		
10	Accidents	- Traffic accidents	- Marine traffic	- Prevention of traffic accidents	- Consulting with related authorities on vessel schedules - Determining water routes after consultation with related authorities - Setting course buoys around navigation channel area for marine safety - Informing operation schedule to local fishermen etc.	- Sea area around port facility	- During coal unloading activity	CPGCBL	Expenses by CPGCBL

(Source: JICA Study Team)

7.2 Proposed Mitigation or Management Measures for Threatened Species

Biological repercussions to nesting turtles do not always occur.
Any impact is dependent upon the level of physical disturbance caused by noise and lighting adjacent to the sand beach coast.

When the levels of physical disturbance appears to be high, effective mitigation measures described in the table below should be discussed.

Table 7.2.1 Proposed Mitigation or Management Measures on Threatened Species

<table>
<tr><th></th><th>Scientific
(English)</th><th>IUCN</th><th>Proposed Mitigation or Management Measures</th></tr>
<tr><td>1</td><td>Eurynorhynchus pygmeus
(Spoon-billed Sandpiper)</td><td>CR</td><td>For the purpose of protecting the species, workers will be instructed to strictly comply with hunting and capturing restrictions prescribed by law.</td></tr>
<tr><td>2</td><td>Geoclemys hamiltonii
(Spotted Pond Turtle)</td><td>VU</td><td>Feed on fish, invertebrates, and floating aquatic plants. There are no ponds or waterways which provide them with such foods in the project site. Prohibit disturbance, harassment, and hunting by project workers or contractors while working, traveling by vehicles or residing in the project field accommodation and encourage workers to quickly place them into nearby fresh ponds or rivers if they encounter the creatures.</td></tr>
<tr><td>3</td><td>Lepidochelys olivacea ,
(Olive Ridley Turtle)</td><td>VU</td><td rowspan="4">Sensitive to light and noise, so noise and use of flashlights on the coast at night can cause nesting females to halt their nesting.
Measures available to mitigate these impacts should be taken:
➢ Turning off unnecessary lights during the nesting season
➢ Using a smaller number or lower wattage of lights
➢ Shielding, redirecting and repositioning lights
➢ Using red, yellow, and low-pressure sodium-vapor lights (as sea turtles are less affected by these colors)
➢ Using low-level noise heavy machinery (concrete mixing, excavation machinery, etc.)
➢ Planning construction activities to minimize adverse effects during the nesting season
➢ Avoiding tall structures creating shade on the coast to maintain nest temperatures
➢ Control the introduction of non-native plants which may lead to impenetrable root mats
(The optimal use of any one of these measures depends upon the results of the current sea turtle survey)</td></tr>
<tr><td>4</td><td>Caretta caretta
(Logger head turtle)</td><td>EN</td></tr>
<tr><td>5</td><td>Chelonia mydas
(Green turtle)</td><td>EN</td></tr>
<tr><td>6</td><td>Eretmochelys Imbricate
(Hawksbill turtle)</td><td>CR</td></tr>
</table>

The protection measures outlined in Table 7.2.2 shall be considered when dealing with the 11 species indicated by the Bangladeshi scientist groups.

Table 7.2.2 Threatened Species proposed by Bangladesh Scientist Groups

Taxa	No.	Scientific Name	English Name	Available Mitigation Measures
Flora	1	*Calamus guruba Buch.-Ham.*	Cane	➢ Transfer to similar sites to the project area And if impossible to transfer: ➢ Collection of seeds or adoption of cuttings
	2	*Trichosanthes cordata Roxb.*	Snake guard	
	3	*Lepisanthes rubiginosa*	Rusty sapindus	
	3			
Reptile	1	*Calotes versicolor*	Garden lizard	➢ Prohibit disturbance, harassment, killing or possession of these species by project workers or contractors while working.
	2	*Mabuya mabuya*	Skink	
	3	*Gekko gecko*	Tokay Gecko	
	4	*Pangshura tentoria*	Median Roofed Turtle	
	5	*Naja naja*	Bicled Cobra	
	5			
Bird	1	*Arachnothera magna*	Streaked Spiderhunter	(These species can easily fly away from the disturbed habitat and find other suitable habitats) ➢ Prohibit illegal hunting by project workers or contractors while working.
	2	*Ketupa zeylonensis*	Broun Fish Owl	
	3	*Vanellus duvaucelii*	River Lapwing	
	3			
Total	**11**			

Chapter 8

Risk Management

Chapter 8

Risk Management

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8 Risk Management

8.1 Identification of Risks

The implementation of a large scale infrastructure project involves many complex and diverse risks. The identification and allocation of those risks is critical in structuring the financing facility for such a project. The project finance which is the technology widely used by internationally established financial institutions for infrastructure projects thoroughly analyzes the risks associated and constructs appropriate measures for mitigation. Unlike the project financed under a commercial basis, the project formulated under the government sector relies upon the credibility of the government in arranging financing for implementation. For the project financed by ODA assistance, in particular, the project is implemented by the Executing Agency (Project Company) with support of the government who bears the eventual and ultimate risk for debt servicing while the provider of assistance remains keen on the debt servicing with the view to the achievement and continuation of successful operations and sustainability of the project. The concern of the provider of ODA assistance centers on the smooth implementation of the project, the efficient operation and materialization of the output, and the effect and impact is achieved as has been designed. The technology used for project finance in identifying and allocating the risks and establishing the safeguarding measures, however, remains valid and reflective in enabling the government and the Executing Agency to tightly control the project. In general, a large infrastructure project is conceived to be associated with the following materially significant risks:

- ✓ Political risk,
- ✓ Capability of the executing agency for implementation,
- ✓ Natural calamities, etc.,
- ✓ Occurrence of fatal accident,
- ✓ Project completion,
- ✓ Social and environmental risk,
- ✓ Economic and financial viability,
- ✓ Availability and stable supply of fuel,
- ✓ Related infrastructure such as the transmission lines, and
- ✓ Others

8.2 Analyses of Risks

The risks listed above are reviewed and the mitigation measures to be taken are described in the following table for each of the risks mentioned;

Table 8.2.1 Identification of Risks by Causes (Prior to COD)

Risk Category	Sub-category	Profile of Risk	Risk Born by			Contract for Risk Covering	Mitigating Measures	Possible Impact from Non-Mitigated Risks
			GOVT/ BPDB	CPG CBL	SHAR ED			
Political risk	War or civil commotions, etc.	Suspension or destruction during the implementation phase.	X (GOB)					㋪Suspension, postponement of the project and/or destruction of the plant under construction.
	Seizure by government	Seizure of the Project resulting in disruption or deterioration of the efficiency	X (GOB)			㋪Implementation Agreement (IPP)		㋪same as above
	Foreign exchange control	Change in the exchange control	X (GOB)			㋪Implementation Agreement (IPP)		㋪same as above
	Law, policy or taxation change	Changes in Power Sector Policy, Coal Policy, taxation, etc.	X (GOB)			㋪Implementation Agreement (IPP)		㋪same as above
	Socio-economic instability	Riot, strikes, social unrest, etc.	X (GOB)			㋪Implementation Agreement (IPP)		㋪same as above
	Concession or operational right	Revocation of license or changes in the business rights	X (GOB)			㋪Implementation Agreement (IPP)		㋪same as above
Capability of sponsor risk	Managerial incapability	Unsophisticated management causing delay, over-run cost		X			㋪Recruitment of capable staff and employment of capable consultants	

Risk Category	Sub-category	Profile of Risk	Risk Born by			Contract for Risk Covering	Mitigating Measures	Possible Impact from Non-Mitigated Risks
			GOVT/ BPDB	CPG CBL	SHAR ED			
	Financial incapability	Failure to attain healthy financial conditions for, timely provision of paid-up capital and funding support for covering the cost over-run.		X			ⓔRecruitment of capable staff	
	Cyclone				X	ⓔInsurance	ⓔDesign standard (raising the ground level by 10m) and insurance	
	Tidal wave				X	ⓔInsurance	ⓔDesign standard (raising the ground level by 10m) and insurance	
Natural calamities, etc.	Earthquake				X	ⓔInsurance	ⓔDesign standard (aseismatic structure) and insurance	
	Tsunami				X	ⓔInsurance	ⓔDesign standard (raising the ground level by 10m) and insurance	
	Others	Lightening, Storm, Tornado, Radioactive contamination, Fire, Epidemics, etc.			X	ⓔInsurance	ⓔDesign standard (various), insurance and other appropriate measures.	
Occurrence of fatal accident	Occurrence of accident	Disruption and delay in construction due to accident investigation and introduction of countermeasures				ⓔInsurance	ⓔContinuous training for safety management and insurance coverage	

Risk Category	Sub-category	Profile of Risk	Risk Born by			Contract for Risk Covering	Mitigating Measures	Possible Impact from Non-Mitigated Risks
			GOVT/ BPDB	CPG CBL	SHAR ED			
Plant Completion (incl. access road, port and coal unloading facilities, etc.)	Insufficient capability of the consultants			X		㉫Consulting Contract	㉫Technical assessment and screening through prequalification	
	Insufficient capability of the EPC contractor			X		㉫Construction Contract	㉫Technical assessment and screening through prequalification	
	Poor Performance or defaults of sub-contractors			X		㉫Construction contracts	㉫Performance management by prime contractors and supervision by consultant	
	Delay in Govt approvals in planning, development and operation		X (MPEMR)			㉫Shareholder's Agreement	㉫Effective and timely management by CPGCBL for total project	
	Delay in progress and completion	Failure to complete the project as has been planned and designed. Along with the Project, related infrastructure required for the Project needs to be completed.		X		㉫Construction Contract	㉫Construction management by sponsor, consultant and EPC contractor	
	Increase in the cost of plant and material	Insufficiency of funds due to cost increase.		X		㉫Construction Contract	㉫Contingency	

Risk Category	Sub-category	Profile of Risk	Risk Born by			Contract for Risk Covering	Mitigating Measures	Possible Impact from Non-Mitigated Risks
			GOVT/ BPDB	CPG CBL	SHAR ED			
	Failure in procurement of the fuel for plant testing	Discontinuation or disruption of plant testing operation due to the shortage of fuel.		X		㋪Fuel Supply Contract (Coal, Gas & Oil) ㋪Government Guarantee for Supply of Gas (IPP)	㋪Mobilization of trading firms for procurement↖ to be funded by GOB or by JICA↗	
Social and environmental risk	Non-acceptance of the Project by the local government	Failure or delay in starting construction of the plant	X (MPEMR)			㋪Implementation Agreement (IPP)	㋪Consultation	
	Failure or delay in acquisition of the land	Failure or delay in starting construction of the plant	X (MPEMR)			㋪Land Lease Agreement	㋪Consultation	
	Failure in resettlement	Failure or delay in starting construction of the plant	X (MPEMR)			㋪Land Lease Agreement	㋪Consultation	
	Resistance by local inhabitants	Failure or delay in starting construction of the plant	X (MPEMR)				㋪Consultation	
	Failure or delay to obtain dredging permit	Failure or delay in starting construction of the plant	X (MPEMR)			㋪Implementation Agreement (IPP)		
	Congestion in surface transport	Delay in construction schedule	X (MPEMR)				㋪Construction of access road	
	Identification of the rare species (animals or plants)	Disruption or suspension of project implementation	X (MPEMR)				㋪Environmental Impact Assessment	

Risk Category	Sub-category	Profile of Risk	Risk Born by			Contract for Risk Covering	Mitigating Measures	Possible Impact from Non-Mitigated Risks
			GOVT/ BPDB	CPG CBL	SHAR ED			
	Contamination/ pollution to the site environment			X			ⓔCompliance with environmental protection guidelines	
	Deficiency financing risk	Temporary deficiency in cash flow (delay in budget execution, etc.)		X		ⓔBorrowing Facilities from Banks ⓔShareholder's Support (Agreement)	ⓔFinancial assistance by GOB or BPDB	
	Budgeting and financing	Purchasing of fuel for plant testing and working capital required prior to COD		X		ⓔBorrowing Facilities from Banks ⓔShareholder's Support (Agreement)	ⓔPreparation of budget and fund raising for budget implementation	
	Fluctuation of exchange rate	Unexpected cost increase in construction cost, etc. and insufficiency of funds due to exchange loss.		X		ⓔBorrowing Facilities from Banks ⓔShareholder's Support (Agreement)	ⓔContingency	
	Increase in inflation	Unexpected cost increase in construction cost, etc. and insufficiency of funds due to cost increase.		X			ⓔContingency	
	Insurance risk	Availability of specific coverage and/or fluctuation of insurance premium		X		ⓔInsurance contract	ⓔConsultation with insurance broker or company	
	Non-compliant bids	Delay in project implementation		X		ⓔInvitation for Bidding, Conditions for Pre-qualification and Specifications	ⓔQuality enhancement of cost estimation	

Risk Category	Sub-category	Profile of Risk	Risk Born by			Contract for Risk Covering	Mitigating Measures	Possible Impact from Non-Mitigated Risks
			GOVT/ BPDB	CPG CBL	SHARED			
Transmission lines	Failure in acquisition of the right of way	Delay in construction of the transmission lines	X (MPEMR)			㋪Implementation Agreement (IPP)	㋪Consultation	
	Delay in completion of the inter- linked transmission lines	Non-readiness for trial run	X (MPEMR, PGCB)			㋪Implementation Agreement (IPP)	㋪Formulation of the Project without relying on the other transmission lines	

(source) JICA Study Team

Similarly, the risks listed for the phase after the commissioning date are reviewed and the measures to be taken for mitigation are described in the following table for each of the risks mentioned;

Table 8.2.2 Identification of Risks by Causes (Post COD)

Risk Category	Sub-category	Profile of Risk	Risk Born By			Contract for Risk Covering	Mitigating Measures	Possible Impact from Non-Mitigated Risks
			GOVT/ BPDB	CPG CBL	SHA RED			
Political risk	War or civil commotions, etc.	Suspension or destruction during the implementation phase.	X (GOB)			㋪Implementation Agreement (IPP) ㋪Power Purchase Agreement		㋪Suspension, postponement of the project and/or destruction of the plant under operation
	Seizure by government	Seizure of the Project resulting in disruption or deterioration of the efficiency	X (GOB)			㋪Implementation Agreement (IPP) ㋪Power Purchase Agreement		㋪same as above
	Foreign exchange control	Change in the exchange control	X (GOB)			㋪Implementation Agreement (IPP) ㋪Power Purchase Agreement		㋪same as above
	Law, policy or taxation change	Changes in Power Sector Policy, Coal Policy, taxation, etc.	X (GOB)			㋪Implementation Agreement (IPP) ㋪Power Purchase Agreement		㋪same as above
	Socio-economic instability	Riot, strikes, social unrest, etc.	X (GOB)			㋪Implementation Agreement (IPP) ㋪Power Purchase Agreement ㋪Insurance		㋪same as above
	Concession or operational right	Revocation of license or changes in the business rights	X (GOB)			㋪Implementation Agreement (IPP) ㋪Power Purchase Agreement		㋪same as above

Risk Category	Sub-category	Profile of Risk	Risk Born By			Contract for Risk Covering	Mitigating Measures	Possible Impact from Non-Mitigated Risks
			GOVT/ BPDB	CPG CBL	SHA RED			
Capability of sponsor risk	Managerial incapability	Unsophisticated management causing operational inefficiency		X			Recruitment of capable staff and Incentive system	
	Financial incapability	Failure to attain healthy financial conditions for, timely provision of working capital.		X				
	Operational and maintenance incapability	Increase in accidents, maintenance cost, and inefficiency in operation		X			Training system for operational staffs and incentive system	
	Incapability of the outsourced company	Failure to achieve the targeted level of performance under contract		X		㋪Outsourcing Contract	Enhancement of training system and employment of foreign engineers	
Natural calamities, etc.	Cyclone	Continuous non-accessibility period for berthing by the coal carriers			X	㋪Insurance	Design standard (coal storage for 60 days) and insurance	
	Tidal wave				X	㋪Insurance	Design standard (raising the ground level by 10m) and insurance	
	Earthquake				X	㋪Insurance	Design standard (a seismically strong structure) and insurance	
	Tsunami				X	㋪Insurance	Design standard (raising the ground level by 10m) and insurance	

Risk Category	Sub-category	Profile of Risk	Risk Born By			Contract for Risk Covering	Mitigating Measures	Possible Impact from Non-Mitigated Risks
			GOVT/ BPDB	CPG CBL	SHA RED			
	Others	Lightening, Storm, Tornado, Radioactive contamination, Fire, Epidemics, etc.			X	ⓔInsurance	Design standard (various), insurance and other appropriate measures.	
Occurrence of fatal accident	Occurrence of a major scale of accident	Long term disruption in plant operation		X		ⓔInsurance	Preventing maintenance and insurance	
Plant Completion (incl. access road, port and coal unloading facilities, etc.)	Failure to achieve the designed capacity performance	Less revenue due to reduction of output		X		ⓔConstruction Contract	Extension of warranty period	
	Unexpected deterioration in operational performance	Increased consumption of fuel due to inefficiency or less revenue due to reduction of output		X		ⓔConstruction Contract	Periodical maintenance	
Social and environmental risk	Negative impact on fishery	Suspension in plant operation or reduction in operating ratio			X	ⓔInsurance	Reconsideration on warm water discharge	
	Traffic congestion on surface transport				X		Construction of access road	
	Contamination/pollution to the site environment			X			ⓔCompliance with environmental protection guidelines	
	Malfunctioning and/or deterioration of environmental devices	Suspension in plant operation or reduction in operating ratio		X		ⓔManufacturer's Warranty ⓔInsurance	Periodical maintenance and insurance	
Economic and financial viability risk	Sales and collection risk	Sales price in short of cost recovery and/or slow collection		X		ⓔPower Purchase Agreement		

Risk Category	Sub-category	Profile of Risk	Risk Born By			Contract for Risk Covering	Mitigating Measures	Possible Impact from Non-Mitigated Risks
			GOVT/ BPDB	CPG CBL	SHA RED			
	Delay and/or insufficiency in tariff adjustment				X	㋪PPA	Good operational performance, close monitoring and adjustment of tariff	
	Deficiency financing risk	Unexpected shortfall of funds for expenditure and/or debt servicing		X		㋪Borrowing Facilities from Banks ㋪Escrow Account ㋪Shareholder's Support (Agreement)	Parental funding support by BPDB	
	Budgeting and financing	Failure in financial management for O&M, in particular, the fund shortage for periodical maintenance		X		㋪Borrowing Facilities from Banks ㋪Shareholder's Support (Agreement)	Incorporation of sufficient budget for periodical maintenance↗	
	Fluctuation of foreign exchange	Unexpected cost increase in fuel cost and O&M and insufficiency of funds due to exchange loss.		X		㋪Power Purchase Agreement ㋪Borrowing Facilities from Banks ㋪Shareholder's Support (Agreement)		
	Insurance risk	Availability of specific coverage and/or fluctuation of insurance premium		X		㋪Insurance contract	㋪Consultation with insurance broker or company	

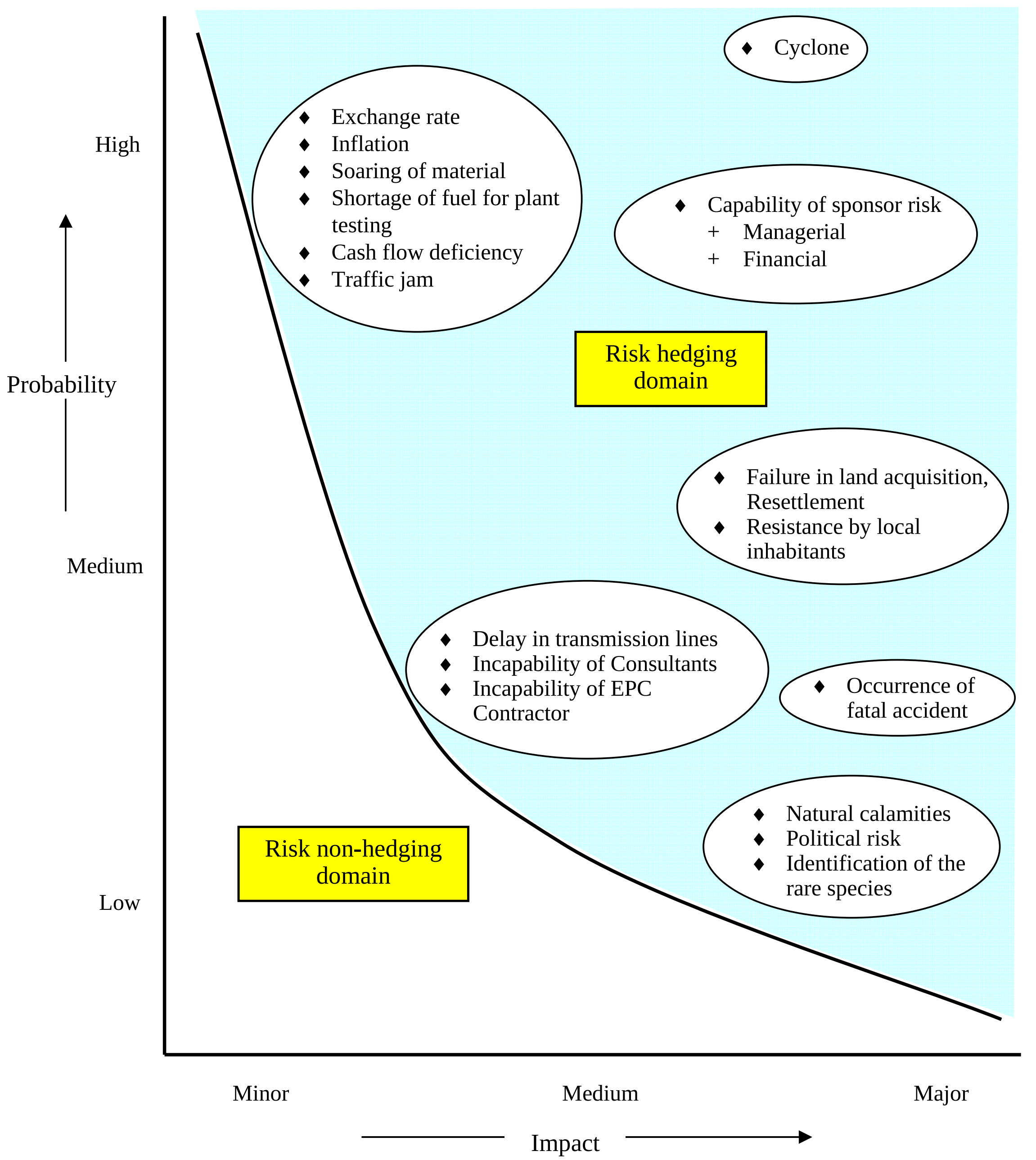
Risk Category	Sub-category	Profile of Risk	Risk Born By			Contract for Risk Covering	Mitigating Measures	Possible Impact from Non-Mitigated Risks
			GOVT/ BPDB	CPG CBL	SHA RED			
	Aggravation of inflation	Unexpected cost increase in fuel cost and O&M and insufficiency of funds due to cost increase.		X		㋪Power Purchase Agreement ㋪Borrowing Facilities from Banks ㋪Shareholder's Support (Agreement)		
Availability and stable supply risk of fuel	Non-availability of Fuel and other materials	Occurrence of shortfall in fuel coal and/or other materials		X		㋪Coal Supply Contract	㋪Diversification of supply sources ㋪Sufficient stocks maintained	
	Non-availability of coal-carrying vessel	Occurrence of shortfall in fuel coal		X		㋪Charter-hire contract	㋪Medium term charter contract of spot hire contract diversified ㋪Sufficient stocks maintained	
	Long term contract risk	Discontinuation or disruption of stable operation due to the shortage of fuel while Binding obligation for purchase for the contract term and/or take-or-pay obligation		X		㋪Coal Supply Contract	Diversification of contract terms	
	Volatile market price	Instability in the import cost of fuel resulting in the loss of economic/financial viability		X		㋪Power Purchase Agreement		

Risk Category	Sub-category	Profile of Risk	Risk Born By			Contract for Risk Covering	Mitigating Measures	Possible Impact from Non-Mitigated Risks
			GOVT/ BPDB	CPG CBL	SHA RED			
	Unbalanced qualities of fuel coal	Inharmonious quality for mixing		X		㋪Coal Supply Contract	Construction of a reserve mills for coal of low calorific value	
	Non-availability of start-up fuel	Inability to start-up the plant		X		㋪Fuel Supply Contract ㋪Government Guarantee for Fuel (Gas or Oil) Supply (IPP)	Sufficient storage of fuel	
Transmission lines	Troubles at transmission lines	Inability to transmit the power causing the suspension of plant operation	X (PGCB)			㋪Power Purchase Agreement ㋪Implementation Agreement (IPP)		
Others	Sluggish increase in power demand	No dispatch instruction to the plant	X (MPEMR)			㋪Power Purchase Agreement ㋪Implementation Agreement (IPP)		
	Development of low cost gas field and/or procurement of LNG (provision of lower price gas)	Dispatch instruction to the coal fired plant becomes subordinate to other fuel and the coal fired plant to be operated as the middle-load system	X (MPEMR)			㋪Power Purchase Agreement ㋪Implementation Agreement (IPP)		

(source) JICA Study Team

It should be noted that in the two tables given above, it shows that the risk categories as well as the sub-categories appear similar in many of the risk items but the profiles are described distinctively different as the risks surrounding the Project may appear in a different manner between the two phases of the Project.

The risks are then analyzed in terms of their probability of occurrence and the impacts associated. In order to distinguish the risks that should be safeguarded or mitigated from the ones that should be left unattended, an attempt is herein made to draw a curve and plot each of the risks in a figure above or below the mitigation curve. The mitigation curve distinguishes the sphere for mitigation from the one for non-mitigation. For the risks plotted above the mitigation curve, appropriate measures for mitigation should be deliberated and introduced as their products of the probability multiplied by the impact becomes substantial. Meanwhile, the risks below the mitigation curve will be left without mitigation as the products of the probability multiplied by the impact will be less substantial. The following figure is one that describes the analysis for the phase prior to the commissioning date;



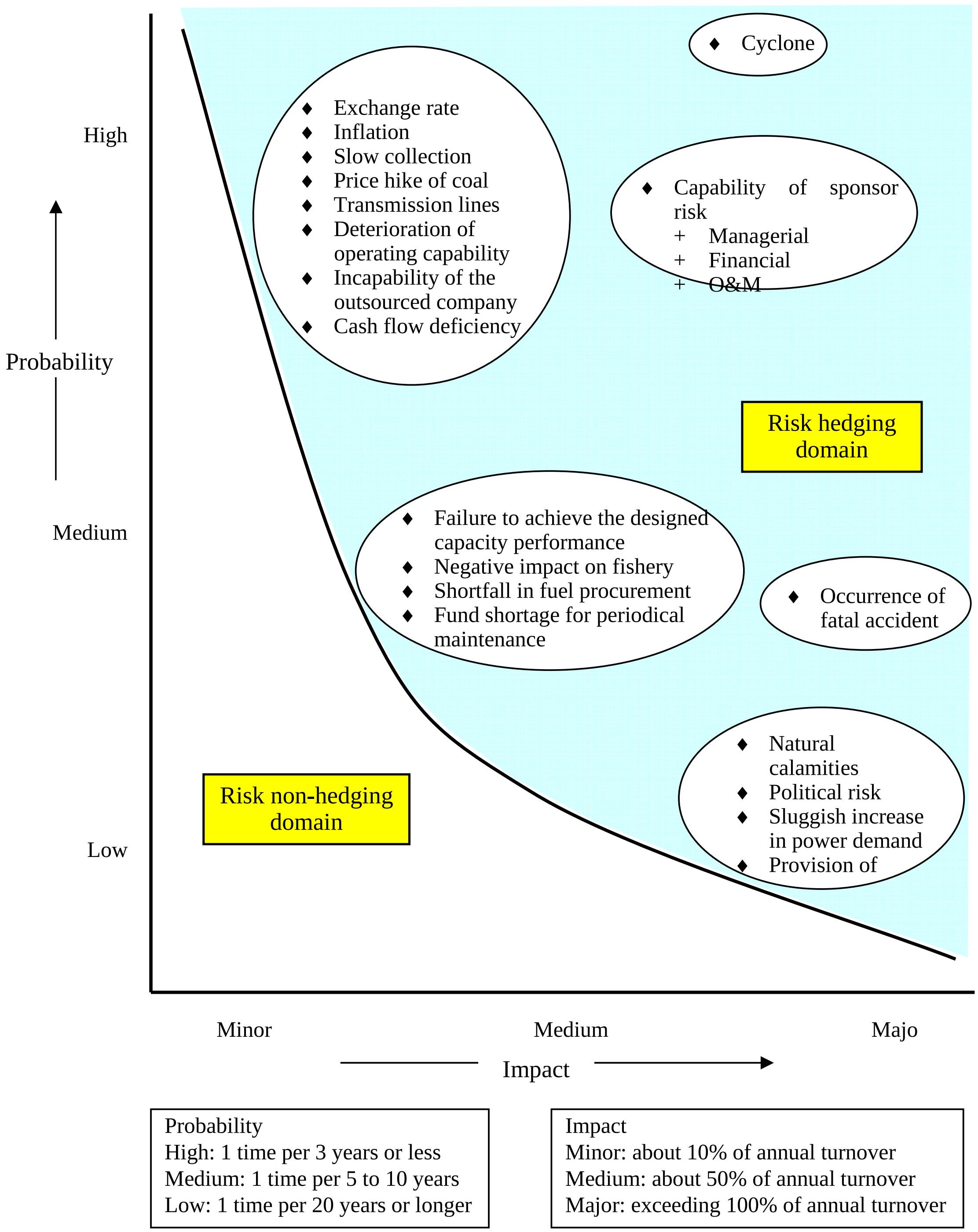
Probability
High: 1 time per 3 years or less
Medium: 1 time per 5 to 10 years
Low: 1 time per 20 years or longer

Impact
Minor: several months of delay in construction or about 10% increase in construction cost
Medium: approximately 2 years of delay in construction or about 50% increase in construction cost
Major: cancellation of the Project or more than 100% increase of construction cost

(source) JICA Study Team

Figure 8.2.1 Identification of Risks by Causes↖ prior to COD↗

Similarly, the following figure depicts the risks analyzed for the period after the commissioning date;



(source) JICA Study Team

Figure 8.2.2 Identification of Risks by Causes (post COD)

Chapter 9

Environmental Monitoring Plan

Chapter 9

Environmental Monitoring Plan

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9 Monitoring plan

9.1 Power Plant and Port Facility

An Environmental Monitoring Plan will be prepared to provide guidelines for environmental management plan during the construction and operation phases of the Coal-fired Power Plant. The environmental components that will be monitored are those that will be positively or negatively affected, or expected to be affected, by construction activity. Environmental management is a sustainable way of planning, arranging, supervising, organizing, and developing the environment for the maintenance of the preservation of natural resources and the prevention or reduction of damage to the environment.

(1) Power Plant

The major environmental impact, monitoring method, responsible organization, and expense for each environmental item in the construction and operation phases for the power plant are listed in Table 9.1.

(2) Port Facility

The major environmental impacts, monitoring methods, responsible organizations, and expenses for each environmental item in the construction and operation phases for the power plant are listed in Table 9.2.

Table 9.1 Environmental Monitoring Plan (Power plant)

No	Significant Impact to be Monitored	Source of Significant Impact	Monitored Parameter	Purpose of the Monitoring	Monitoring Method			Responsible Organization	Cost
					Method of Collecting and Analyzing Data	Location	Duration and Frequency		
Pre-Construction									
1	Land acquisition	1) Loss of private land 2) Loss of salt fields, shrimp farms and fishing sites 3) Loss of residential/ commercial structures 4) Loss of trees, home gardens, fish ponds and fruit plants	1) - 4) - The Acquisition and Requisition of Immovable Property Ordinance of 1982 - JICA Guideline (2010)	1) - 4) - Confirmation of compensation process	1) - 4) - Attendance at compensation payment - Record of compensation agreements	1) - 4) - Areas eligible for compensation	1) - 4) - During land acquisition process	- Office of the Deputy Commissioner - CPGCBL	Expenses by CPGCBL - Witness: 6,500Tk./ person・day
2	Disturbance to poor people	1) Poor households among those who are to be resettled 2) Loss of salt fields, shrimp farms and fishing sites	1), 2) - JICA Guideline (2010)	1), 2) - Same as those addressed in “Land acquisition”	1), 2) - Interviewing affected people	1), 2) - Affected people	1), 2) - Once a year	- Implementation: Contractor/ Environmental Consultant - Supervisor: CPGCBL/ Supervision Consultant	Expenses by CPGCBL - Interviewer: 5,500Tk./ person・day
3	Social Institutions such as Social Infrastructure and Local Decision-making Institutions	- Changing peoples` thinking through interacting with local government officers, local residents and others in the land acquisition procedure	-----	- Confirmation of affected peoples’ feelings	- Interviewing affected people	- Affected people	- Once a year	- Implementation: Contractor/ Environmental Consultant - Supervisor: CPGCBL/ Supervision Consultant	Expenses by CPGCBL
4	Misdistribution of Benefits and Compensation	- It can occur among residents, workers, government officers and	-----	- Same as those addressed in “Land acquisition”	- Same as those addressed in “Land acquisition”	- Same as those addressed in “Land	- Same as those addressed in “Land	- Implementation: Contractor/ Environmental	Expenses by CPGCBL

No	Significant Impact to be Monitored	Source of Significant Impact	Monitored Parameter	Purpose of the Monitoring	Monitoring Method			Responsible Organization	Cost
					Method of Collecting and Analyzing Data	Location	Duration and Frequency		
		local politicians				acquisition”	acquisition”	Consultant - Supervisor: CPGCBL/ Supervision Consultant	
5	Local Conflicts of Interest	- It can occur among residents, workers, government officers and local politicians	-----	- Same as those addressed in “Land acquisition”	- Same as those addressed in “Land acquisition”	- Same as those addressed in “Land acquisition”	- Same as those addressed in “Land acquisition”	- Implementation: Contractor/ Environmental Consultant - Supervisor: CPGCBL/ Supervision Consultant	Expenses by CPGCBL
Construction Phase									
1	Air Quality	1) Dust resulting from construction work 2) Exhaust gas from construction machinery and vehicles used for mobilization of equipment 3) Air pollution arising from incineration of construction materials and waste	1) - 3) **PM_{10}** - Ambient Air Quality Standard - IFC guideline values for ambient air quality (General/ 2007) **- Meteorological Condition (Temperature, Moisture, Wind)**	1) - 3) - Evaluation of effect of the mitigation measures towards air pollution	1) - 3) - Collecting samples and analyzing at a lab - Measuring meteorological data	1) - 3) **- 3 points** Residential area around the power plant	1) - 3) - Once every three months	- Implementation: Contractor/ Environmental Consultant - Supervisor: CPGCBL/ Supervision Consultant	Expenses included in contract cost by Contractor - Sampling: 50,000Tk./ sample - Analyzing: 45,000Tk./ sample

No	Significant Impact to be Monitored	Source of Significant Impact	Monitored Parameter	Purpose of the Monitoring	Monitoring Method			Responsible Organization	Cost
					Method of Collecting and Analyzing Data	Location	Duration and Frequency		
2	Water Quality (Soil) (Sediment)	1) Run off water from construction area 2) Domestic wastewater of workers 3) Inappropriate disposal of waste 4) Leakages of oil and chemical materials from construction activity	1) - 4) **pH, BOD, TSS, Oil, Coliforms, etc.** - Wastewater standards - Ambient water quality standards (inland surface water) - Ground water (Drinking water quality standards)	1) - 4) - Evaluation of effect of the mitigation measures towards water pollution	1) - 4) - Collecting samples and analyzing at a lab	1) - 4) - **1 point:** Foreside of the drain outlet - **1 point:** Surface water near the construction area - **1 point:** Ground water from existing wells - **5 points:** Sea water near the construction area	1) - 4) - Once every three months	- Implementation: Contractor/ Environmental Consultant - Supervisor: CPGCBL/ Supervision Consultant	Expenses included in contract cost by Contractor - Sampling: 50,000Tk./ sampling - Analyzing: 100,000Tk./ all sample
3	Wastes (Odor) (Sediment)	1) Construction waste from construction work 2) Domestic waste from workers 3) Hazardous waste such as dry batteries, etc.	1) - 3) - Waste Management Rules	1) - 3) - Evaluation of effect of the mitigation measures for waste	1) - 3) - Record of kinds and quantity of waste, and the disposal method	1) - 3) - Construction area	1) - 4) - Continuous records	- Implementation: Contractor/ Environmental Consultant - Supervisor: CPGCBL/ Supervision Consultant	Expenses included in contract cost by Contractor
4	Noise and Vibration	1) Noise and vibration caused by construction machinery 2) Noise caused by vehicles used for mobilization of equipment and workers	1), 2) **Noise level** - Noise level standards - IFC guideline values for noise (General/ 2007)	1), 2) - Evaluation of effect of the mitigation measures towards noise levels	1), 2) - Measurement using noise level meter	1), 2) - **3 points:** On the border of the site near the residential areas	1), 2) - Once every three months	- Implementation: Contractor/ Environmental Consultant - Supervisor: CPGCBL/ Supervision Consultant	Expenses included in contract cost by Contractor - Measurement: 50,000Tk./ session

No	Significant Impact to be Monitored	Source of Significant Impact	Monitored Parameter	Purpose of the Monitoring	Monitoring Method			Responsible Organization	Cost
					Method of Collecting and Analyzing Data	Location	Duration and Frequency		
5	Ecosystem (Endangered Species)	1) Existence of endangered species 2) Spawning of sea turtles	1), 2) **Species, Number** - Bangladesh Wild Life (Preservation) (Amendment) Act, 1974 - JICA Guideline (2010)	1) Evaluation of existence of endangered species 2) Evaluation of spawning of sea turtles	1), 2) - Observation	1) Endangered species **- 1 point:** Construction area 2) Sea turtle **- 2 lines:** Beach in front of the site and the sandbar	1) Endangered species - Bird: Once a week in migration season - Others: Twice a year in dry and rainy seasons 2) Every 3 days in spawning season	- Implementation: Contractor/ Environmental Consultant - Supervisor: CPGCBL/ Supervision Consultant	Expenses included in contract cost by Contractor - Observation: 400,000Tk./ researcher・year
	Ecosystem (Marine Biota)	1) Potential impact due to the degradation of water quality caused by civil engineering work 2) Domestic wastewater of workers 3) Inappropriate disposal of solid waste	1) - 3) **Species, Number** - Phyto and Zoo Plankton - Benthos (Sea bottom)	1) - 3) - Evaluation of effect of the mitigation measures towards water pollution - Confirming the population and change in types of marine organisms	1) - 3) - Collecting samples at the site, analyzing at a lab	1) - 3) **- 5 points:** Sea area in front of construction area	1) - 3) - Twice a year in dry and rainy seasons		Expenses included in contract cost by Contractor - Sampling & analyzing: 200,000Tk./ season (Same as “water quality”)
	Ecosystem (Mud Flat, Fish & Nekton)	1) - 3) Ditto	1) - 3) **Species, Number, Weight** - Benthos (Mud flat) - Fish and Nekton	1) - 3) Ditto	1) - 3) - Collecting samples at the site, analyzing at a lab	1) - 3) **- 1 point:** In front of the site	1) - 3) - Twice a year in dry and rainy seasons		Expense is included in contract cost by Contractor - Sampling & analyzing: 200,000Tk./ season

No	Significant Impact to be Monitored	Source of Significant Impact	Monitored Parameter	Purpose of the Monitoring	Monitoring Method: Method of Collecting and Analyzing Data	Monitoring Method: Location	Monitoring Method: Duration and Frequency	Responsible Organization	Cost
6	Deterioration of Local Economy such as Losses of Employment and Means of Livelihood	- Increase in employment and business opportunities	- Number of employment opportunities for local residents and number of businesses around the construction area	- Improvement of the local economy - Improvement of living standards of local residents - Consideration to local residents' feelings	- Information from related institutions - Interviewing residents	- Related institutions - Villages near the site	- Once a year	- Implementation: Contractor/ Environmental Consultant - Supervisor: CPGCBL/ Supervision Consultant	Expenses included in contract cost by Contractor - Interviewer: 5,500Tk./ researcher (Same as "Poor people")
7	Land Use and Utilization of Local Resources	- Changing the traditional land use patterns and utilization of local resources	- Same as those addressed in "Local Economy"	- Same as those addressed in "Local Economy"	- Same as those addressed in "Local Economy"	- Same as those addressed in "Local Economy"	- Same as those addressed in "Local Economy"	- Implementation: Contractor/ Environmental Consultant - Supervisor: CPGCBL/ Supervision Consultant	Expenses included in contract cost by Contractor
8	Disturbance to Existing Social Infrastructure and Services	1) Increase in the number of vessels 2) Increase in the number of cars	1), 2) - Traffic volume by construction	1), 2) - Evaluation of effect of construction schedule	1), 2) - Record of numbers of vessels and cars being used	1), 2) - Project site	1), 2) - Continuous records	- Implementation: Contractor/ Environmental Consultant - Supervisor: CPGCBL/ Supervision Consultant	Expenses included in contract cost by Contractor
9	Local Conflicts of Interest	- Conflict between local residents and external workers	- Change in local customs	- Confirmation of the attitudes of local residents to the project	- Interviewing residents	- Villages near the site	- Once a year	- Implementation: Contractor/ Environmental Consultant - Supervisor: CPGCBL/ Supervision	Expenses included in contract cost by Contractor - Interviewer: 5,500Tk./ researcher (Same as "Poor

No	Significant Impact to be Monitored	Source of Significant Impact	Monitored Parameter	Purpose of the Monitoring	Monitoring Method			Responsible Organization	Cost
					Method of Collecting and Analyzing Data	Location	Duration and Frequency		
								Consultant	people")
10	Gender	1) Gender among those who are to be resettled 2) Loss of salt fields, shrimp farms and fishing sites	1), 2) -----	1), 2) - Same as those outlined in "Poor people"	1), 2) - Same as those outlined in "Poor people"	1), 2) - Same as those outlined in "Poor people"	1), 2) - Same as those outlined in "Poor people"	- Implementation: Contractor/ Environmental Consultant - Supervisor: CPGCBL/ Supervision Consultant	Expenses included in contract cost by Contractor
11	Children's Right	- Child labor	-----	- Evaluation of effect of banning child labor	- Checking the labor contracts between subcontractor and workers - Patrolling construction area for child labor	- Construction area	- Once a year	- Implementation: Contractor/ Environmental Consultant - Supervisor: CPGCBL/ Supervision Consultant	Expenses included in contract cost by Contractor
12	Infectious Diseases such as HIV/AIDS	- Temporary influx of migrant labor during construction may increase risk of infection	-----	- Evaluation of sanitation for labor	- Labor health records	- Related institutions	- Once a year	- Implementation: Contractor/ Environmental Consultant - Supervisor: CPGCBL/ Supervision Consultant	Expenses included in contract cost by Contractor
13	Work Environment (Including Work Safety)	- Labor accidents	- Handling heavy loads - Working at heights - Electric shock	- Evaluation of effect of the work safety plan	- Record of accidents	- Contractor's office	- Continuous records	- Implementation: Contractor/ Environmental Consultant - Supervisor: CPGCBL/	Expenses included in contract cost by Contractor

No	Significant Impact to be Monitored	Source of Significant Impact	Monitored Parameter	Purpose of the Monitoring	Monitoring Method: Method of Collecting and Analyzing Data	Monitoring Method: Location	Monitoring Method: Duration and Frequency	Responsible Organization	Cost
								Supervision Consultant	
14	Accidents	- Traffic accidents	- Marine traffic - Land traffic	- Evaluation of effect of traffic schedules	- Record of accidents	- Contractor's office	- Continuous records	- Implementation: Contractor/ Environmental Consultant - Supervisor: CPGCBL/ Supervision Consultant	Expenses included in contract cost by Contractor
15	Cross-boundary Impact and Climate Change	- CO_2 will be produced by construction work	-----	- Efforts to reduce CO_2	- Record of machinery maintenance	- Contractor's office	- Continuous records	- Implementation: Contractor/ Environmental Consultant - Supervisor: CPGCBL/ Supervision Consultant	Expenses included in contract cost by Contractor
Operation Stage									
1	Air Quality	1) Exhaust gas from the stacks 2) Dust from ash disposal activity 3) Exhaust gas from vehicles used for mobilization of equipment and workers 4) Dust from coal handling activity at jetty and coal yard	1) - 4) **SO_2, NO_2, PM_{10}** - Emission gas standards - Ambient air quality standards - IFC guideline values for gas emission (Thermal power plant/ 2008) and ambient air quality (General/ 2007)	1) - 4) - Evaluation of effect of the mitigation measures towards air pollution	1) Exhaust gas - CEMS (Continuous Emission Monitoring System) 1) - 4) - Collecting samples at the site, analyzing at a lab - Measuring the meteorological	1) Stack outlet 1) - 4) - **3 points:** Residential area around the power plant	1) Continuous measure-ment 1) - 4) - Once every 3 months	- CPGCBL/ Environmental Consultant	- CEMS (Expenses included in contract cost by Contractor) Expenses by CPGCBL - Sampling: 50,000Tk./ staff - Analyzing: 45,000Tk./ sample

No	Significant Impact to be Monitored	Source of Significant Impact	Monitored Parameter	Purpose of the Monitoring	Monitoring Method			Responsible Organization	Cost
					Method of Collecting and Analyzing Data	Location	Duration and Frequency		
			2) - 4) **Meteorological Condition (Temperature, Moisture, Wind)**		data				
2	Water Quality (Soil) (Sediment)	1) Thermal effluents from cooling system 2) Wastewater from plant process 3) Rainwater drainage from ash pond and coal yard 4) Leakages of oil and chemical materials	1) - 4) **Water temperature, pH, DO, SS, oil, BOD, COD, Heavy metals** - Wastewater standards - IFC guideline values for wastewater (Thermal power plant/ 2008) - Ground water (Drinking water quality standards)	1) - 4) - Evaluation of effect of the mitigation measure towards water pollution	1) Thermal effluents - Measuring vertical sea water temperature profile with CTD meter 2) - 4) - Collecting samples at the site, analyzing at a lab - Continuous measurement using a sensor	1), 4) - **5 points:** Sea area around thermal water discharge point - **1 point:** Ground water from existing well 2), 3) - **2 points:** Drain outlet of the wastewater treatment facility	1), 4) - Once every 3 months 2), 3) - Sampling and analyzing: **SS, Oil, BOD, Heavy metal etc.(as necessary)** - Continuous measure-ment: **pH**	- CPGCBL/ Environmental Consultant	- Continuous sensor (Expenses included in contract cost by Contractor) Expenses by CPGCBL - CTD: 20,000 US$ - Sampling: 50,000Tk./ staff - Analyzing: 100,000Tk./ sample
3	Waste (Odor) (Sediment)	1) Fly ash and bottom ash 2) Sludge from wastewater treatment and waste oil from equipment, etc. 3) Sewage and garbage from workers	1) – 3) - Waste management rules	1) - 3) - Evaluation of effect of the handling of coal ash, sludge, and garbage	1) Coal ash - Record of the amount of coal ash generation and disposal 2), 3) - Record of the amount of sludge and garbage	1) - 3) - Power plant office	1) - 3) - Continuous records	- CPGCBL/ Environmental Consultant	Expenses by CPGCBL
4	Noise and Vibration	1) Noise and vibration from steam turbines, generators, and pumps, etc.	1) – 4) **Noise level** - Noise standards - IFC guideline values	1) - 4) - Evaluation of effect of the mitigation measures towards	1) - 4) - Measurement using noise level meter	1) - 4) - **3 points:** On the border of the site near the	1) - 4) - Once every 3 months	- CPGCBL/ Environmental Consultant	Expenses by CPGCBL - Measurement: 100,000Tk./

No	Significant Impact to be Monitored	Source of Significant Impact	Monitored Parameter	Purpose of the Monitoring	Monitoring Method			Responsible Organization	Cost
					Method of Collecting and Analyzing Data	Location	Duration and Frequency		
		2) Noise from ash disposal activity 3) Noise caused by vehicles used for mobilization of equipment and workers 4) Noise from coal handling activity at jetty and coal yard	for noise (Thermal power plant/ 2008) (General/2007))	noise levels		residential areas			session
5	Ecosystem (Endangered Species)	1) Existence of endangered species (migration bird) 2) Spawning of sea turtles	1), 2) **Species, Number** - Bangladesh Wild Life (Preservation) (Amendment) Act, 1974 - JICA Guideline (2010)	1) Evaluation of existence of endangered species (migration bird) 2) Evaluation of spawning of sea turtles	1), 2) - Observation	1) Endangered species (migration bird) - **1 point:** Ash pond 2) Sea turtles - **2 lines:** Beach in front of the site and the sandbar	1) Once a week in migration season 2) Every 3 days in spawning season	- CPGCBL/ Environmental Consultant	Expenses by CPGCBL - Observation: 200,000Tk// researcher
	Ecosystem (Marine Biota)	1) Potential impact due to the degradation of water quality caused by civil engineering works 2) Domestic wastewater of workers 3) Inappropriate disposal of solid waste	1) - 3) **Species, Number** - Phyto and Zoo Plankton - Benthos (sea bottom)	1) - 3) - Evaluation of effect of the mitigation measure towards water pollution - Confirming the population and change in types of the marine organisms	1) - 3) - Collecting samples at the site, analyzing at a lab	1) - 3) - **5 points:** Sea area in front of the site	1) - 3) - Twice a year in dry and rainy seasons		Expenses by CPGCBL - Sampling & Analyzing: 300,000Tk./ all sample
	Ecosystem (Mud Flat, Fish & Nekton)	1) - 3) Ditto	1) - 3) **Species, Number, Weight**	1) - 3) Ditto	1) - 3) - Collecting samples at the site,	1) - 3) - **1 point:** In front of the site	1) - 3) - Twice a year in dry and		Expenses by CPGCBL - Sampling &

No	Significant Impact to be Monitored	Source of Significant Impact	Monitored Parameter	Purpose of the Monitoring	Monitoring Method			Responsible Organization	Cost
					Method of Collecting and Analyzing Data	Location	Duration and Frequency		
			- Benthos (mud flat) - Fish and nekton		analyzing at a lab		rainy seasons		Analyzing: 300,000Tk./ all sample
6	Disturbance to Poor People	- Improved road along with the power plant	-----	- Evaluation of access to social services	- Information from related institutions - Interviewing residents	- Related institutions - Villages near the site	Once a year	- CPGCBL/ Environmental Consultant	Expenses by CPGCBL - Interviewer: 5,500Tk./ researcher
7	Deterioration of Local Economy such as Losses of Employment and Means of Livelihood	- Increase in employment and business opportunities	-----	- Evaluation of increase in employment and business opportunities	Ditto	Ditto	Ditto	- CPGCBL/ Environmental Consultant	Expenses by CPGCBL
8	Land Use and Utilization of Local Resources	- Changing traditional land use patterns and utilization of local resources	-----	- Confirmation of local residents' feelings	- Interviewing residents	- Villages near the site	- Once a year	- CPGCBL/ Environmental Consultant	Expenses by CPGCBL - Interviewer: 5,500Tk./ researcher (Same as "Poor people")
9	Disturbance to the Existing Social Infrastructure and Services	1) Increase in the number of vessels 2) Increase in the number of cars	1), 2) - Traffic volume	1), 2) - Evaluation of effect of traffic schedules	1), 2) - Record of numbers of vessels and cars being used	1), 2) - Project site	1), 2) Continuous records	- CPGCBL/ Environmental Consultant	Expenses by CPGCBL
10	Misdistribution of Benefits and Compensation	- It can occur among residents, workers, government officers, and local politicians	-----	- Same as those addressed in "Land use"	- Same as those addressed in "Land use"	- Same as those addressed in "Land use"	- Same as those addressed in "Land use"	- CPGCBL/ Environmental Consultant	Expenses by CPGCBL
11	Local Conflicts of Interest	- Conflict between local residents and workers	-----	- Same as those addressed in "Land	- Same as those addressed in "Land	- Same as those addressed in	- Same as those addressed in	- CPGCBL/ Environmental	Expenses by CPGCBL

No	Significant Impact to be Monitored	Source of Significant Impact	Monitored Parameter	Purpose of the Monitoring	Monitoring Method			Responsible Organization	Cost
					Method of Collecting and Analyzing Data	Location	Duration and Frequency		
				use”	use”	“Land use”	“Land use”	Consultant	
12	Gender	1) Loss of salt fields, shrimp farms and fishing sites 2) Improved road along with the power plant	-----	1), 2) - Same as those addressed in “Poor people”	1), 2) - Same as those addressed in “Poor people”	1), 2) - Same as those addressed in “Poor people”	1), 2) - Same as those addressed in “Poor people”	- CPGCBL/ Environmental Consultant	Expenses by CPGCBL
13	Children’s Rights	1) Child labor 2) Improved road along with the power plant	1) Child labor 2) -----	1) Evaluation of effect of banning child labor 2) Same as those addressed in Poor people	1) Child labor - Checking labor contracts between subcontractor and workers - Patrolling construction area for child labor 2) Same as those addressed in “Poor people”	1) Working area 2) Same as those addressed in “Poor people”	1), 2) Once a year	- CPGCBL/ Environmental Consultant	Expenses by CPGCBL
14	Work Environment (Including Work Safety)	- Labor accidents	- Labor accidents - Handling heavy loads - Working at heights - Electric shocks	- Evaluation of effect of the work safety plan	- Record of accidents	-Power plant	- Continuous records	- CPGCBL/ Environmental Consultant	Expenses by CPGCBL
15	Accidents	1) Traffic accidents 2) Fire	1) Traffic accidents - Land traffic - Marine traffic 2) Fire - Record	1), 2) - Evaluation of effect of the work safety plan	1), 2) - Record of accidents and fire	1), 2) - Power plant	- Continuous records	- CPGCBL/ Environmental Consultant	Expenses by CPGCBL
16	Cross-boundary Impact and Climate Change	- CO_2 emissions	- Amount of CO_2 emissions	- Efforts to reduce CO_2	- Calculate the CO_2 emissions from fuel consumption	- Power plant	- Once a year	- CPGCBL/ Environmental Consultant	Expenses by CPGCBL

(Source: JICA Study Team)

Table 9.2 Environmental Monitoring Plan (Port Facility)

No	Significant Impact to be Monitored	Source of Significant Impact	Monitored Parameter	Purpose of the Monitoring	Monitoring Method: Method of Collecting and Analyzing Data	Monitoring Method: Location	Monitoring Method: Duration and Frequency	Initiator Supervisor	Cost
Construction Phase									
1	Air Quality	1) Dust resulting from construction work 2) Exhaust gas from construction machinery and vehicles used for mobilization of equipment 3) Air pollution arising from incineration of construction materials and waste	1) - 3) - Same as those addressed in “Air quality” of the power plant	1) - 3) - Same as those addressed in “Air quality” of the power plant	1) - 3) - Same as those addressed in “Air quality” of the power plant	1) - 3) - Same as those addressed in “Air quality” of the power plant	1) - 3) - Same as those addressed in “Air quality” of the power plant	- Implementation: Contractor/ Environmental Consultant - Supervisor: CPGCBL/ Supervision Consultant	Expenses included in contract cost by Contractor
2	Water Quality (Waste)	1) Dredging 2) Landfill for land-reparation	1), 2) **TSS, etc.** - Wastewater standards for industrial activity	1), 2) - Evaluation of effect of the mitigation measure towards water pollution	1), 2) - Collecting samples and analyzing at a lab	1), 2) - **2 points:** Sea water near the construction area	1), 2) - Once every three months	- Implementation: Contractor/ Environmental Consultant - Supervisor: CPGCBL/ Supervision Consultant	Expenses included in contract cost by Contractor - Sampling: 25,000Tk./ staff (Same as “Power plant”) - Analyzing: 15,000Tk./ sample
3	Noise and Vibration	- Noise and vibration caused by construction machinery	- Same as those addressed in “Noise” of the power plant	- Same as those addressed in “Noise” of the power plant	- Same as those addressed in “Noise” of the power plant	- Same as those addressed in “Noise” of the power plant	- Same as those addressed in “Noise” of the power plant	- Implementation: Contractor/ Environmental Consultant - Supervisor: CPGCBL/ Supervision	Expenses included in contract cost by Contractor

No	Significant Impact to be Monitored	Source of Significant Impact	Monitored Parameter	Purpose of the Monitoring	Monitoring Method: Method of Collecting and Analyzing Data	Monitoring Method: Location	Monitoring Method: Duration and Frequency	Initiator Supervisor	Cost
								Consultant	
4	Ecosystem (Endangered Species)	1) Existence of endangered species 2) Spawning of sea	1), 2) - Same as those addressed in "Ecosystem (Endangered species)" of the power plant	1), 2) - Same as those addressed in "Ecosystem (Endangered species)" of the power plant	1), 2) - Same as those addressed in "Ecosystem (Endangered species)" of the power plant	1), 2) - Same as those addressed in "Ecosystem (Endangered species)" of the power plant	1), 2) - Same as those addressed in "Ecosystem (Endangered species)" of the power plant	- Implementation: Contractor/ Environmental Consultant - Supervisor: CPGCBL/ Supervision Consultant	Expenses included in contract cost by Contractor
	Ecosystem (Marine Biota)	1) Potential impact due to the degradation of water quality caused by civil engineering works 2) Domestic wastewater of workers 3) Inappropriate disposal of solid waste	1) - 3) - Same as those addressed in "Ecosystem (Marine biota)" of the power plant	1) - 3) - Same as those addressed in "Ecosystem (Marine biota)" of the power plant	1) - 3) - Same as those addressed in "Ecosystem (Marine biota)" of the power plant	1) - 3) - Same as those addressed in "Ecosystem (Marine biota)" of the power plant	1) - 3) - Same as those addressed in "Ecosystem (Marine biota)" of the power plant		
	Ecosystem (Mud Flat, Fish & Nekton)	1) - 3) Ditto	1) - 3) - Same as those addressed in "Ecosystem (Mud Flat, Fish & Nekton)" of the power plant	1) - 3) - Same as those addressed in "Ecosystem (Mud Flat, Fish & Nekton)" of the power plant	1) - 3) - Same as those addressed in "Ecosystem (Mud Flat, Fish & Nekton)" of the power plant	1) - 3) - Same as those addressed in "Ecosystem (Mud Flat, Fish & Nekton)" of the power plant	1) - 3) - Same as those addressed in "Ecosystem (Mud Flat, Fish & Nekton)" of the power plant		
5	Disturbance to Existing Social Infrastructure and Services	- Increase in the number of vessels	- Traffic volume from construction	- Evaluation of effect of construction schedule	- Record of numbers of vessels	- Contractor's office	- Continuous records	- Implementation: Contractor/ Environmental Consultant - Supervisor:	Expenses included in contract cost by Contractor

No	Significant Impact to be Monitored	Source of Significant Impact	Monitored Parameter	Purpose of the Monitoring	Monitoring Method			Initiator Supervisor	Cost
					Method of Collecting and Analyzing Data	Location	Duration and Frequency		
								CPGCBL/ Supervision Consultant	
6	Work Environment (Including Work Safety)	- Labor accidents	- Same as those addressed in "Work environment" of the power plant	- Same as those addressed in "Work environment" of the power plant	- Same as those addressed in "Work environment" of the power plant	- Same as those addressed in "Work environment" of the power plant	- Same as those addressed in "Work environment" of the power plant	- Implementation: Contractor/ Environmental Consultant - Supervisor: CPGCBL/ Supervision Consultant	Expenses included in contract cost by Contractor
7	Accidents	- Traffic accidents	- Marine traffic	- Evaluation of operation schedule of vessels	- Record of accidents	- Contractor's office	- Continuous records	- Implementation: Contractor/ Environmental Consultant - Supervisor: CPGCBL/ Supervision Consultant	Expenses included in contract cost by contractor
Operation Stage									
1	Air Quality	1) Dust from coal handling activity at port 2) Exhaust gas from vessels	1) Coal handling **PM_{10}** - Ambient air quality (No.41/199) - IFC guideline for ambient air quality (General/ 2007) 2) Exhaust gas from vessels- - MALPOL 73/78 treaty (Annex VI)	1), 2) - Evaluation of effect of the mitigation measure towards air pollution	1) Coal handling - Collecting samples at the site, analyzing at a lab 2) Exhaust gas from vessels - Record of vessels' logs	1) Coal handling - Same as those addressed in "Air quality of the power plant" 2) Exhaust gas from vessels - Port office	1) Coal handling - Same as those addressed in "Air quality of the power plant" 2) Exhaust gas from vessels Once a year	- CPGCBL/ Environmental Consultant	Expenses by CPGCBL - Sampling: 25,000Tk./staff - Analyzing: 20,000Tk./ sample (Same as "Power plant")

No	Significant Impact to be Monitored	Source of Significant Impact	Monitored Parameter	Purpose of the Monitoring	Monitoring Method: Method of Collecting and Analyzing Data	Monitoring Method: Location	Monitoring Method: Duration and Frequency	Initiator Supervisor	Cost
2	Water Quality	- Dredging material for the maintenance of the navigation channel	**TSS** - Wastewater standards - IFC guideline values for wastewater (Thermal power plant/ 2008)	- Evaluation of effect of the mitigation measures towards water pollution	- Collecting samples at the site, analyzing at a lab	- **2 points:** Around the dredging area	- During dredging activity	- CPGCBL/ Environmental Consultant	Expenses by CPGCBL - Sampling: 25,000Tk./ staff - Analyzing: 15,000Tk./ sample
		1) Operation of the port may cause a coal spillage and as a result, water pollution will occur 2) Leakages of oil 3) Wastewater from vessels will cause water pollution	1) ---- 2), 3) - MALPOL 73/78 treaty (Annex I-V) 3) - International Convention for the control and management of Ships' Ballast Water and Sediments (BWM), 2004	1) - 3) - Evaluation of effect of the mitigation measures towards water pollution	1), 2) - Record of coal spillages and oil leakages 3) - Record of vessels' logs	1) - 3) - Port office	1) - 3) - Once a year		
3	Waste	- Waste from vessels	- Waste management rules - MALPOL 73/78 treaty (Annex I-V)	- Evaluation of effect of waste management	- Record of the amount of waste from vessels	- Port office	- Once a year	- CPGCBL/ Environmental Consultant	Expenses by CPGCBL
4	Noise and Vibration	- Noise from coal handling activity at the port	- Same as those addressed in "Noise" of the power plant	- Same as those addressed in "Noise" of the power plant	- Same as those addressed in "Noise" of the power plant	- Same as those addressed in "Noise" of the power plant	- Same as those addressed in "Noise" of the power plant	- CPGCBL/ Environmental Consultant	Expenses by CPGCBL
5	Ecosystem (Endangered Species)	1) Existence of endangered species 2) Spawning of sea turtle	1), 2) - Same as those addressed in	1), 2) - Same as those addressed in	1), 2) - Same as those addressed in	1), 2) - Same as those addressed in	1), 2) - Same as those addressed in	- CPGCBL/ Environmental Consultant	Expenses by CPGCBL

No	Significant Impact to be Monitored	Source of Significant Impact	Monitored Parameter	Purpose of the Monitoring	Monitoring Method: Method of Collecting and Analyzing Data	Monitoring Method: Location	Monitoring Method: Duration and Frequency	Initiator Supervisor	Cost
			"Ecosystem (Endangered species)" of the power plant	"Ecosystem (Endangered species)" of the power plant	"Ecosystem (Endangered species)" of the power plant	"Ecosystem (Endangered species)" of the power plant	"Ecosystem (Endangered species)" of the power plant		
	Ecosystem (Marine Biota)	1) Operation of the port may cause a coal spillage, and as a result, water pollution will occur 2) Leakages of oil from oil tankers 3) Wastewater from vessels will cause water pollution	1) - 3) - Same as those addressed in "Ecosystem (Marine biota)" of the power plant	1) - 3) - Same as those addressed in "Ecosystem (Marine biota)" of the power plant	1) - 3) - Same as those addressed in "Ecosystem (Marine biota)" of the power plant	1) - 3) - Same as those addressed in "Ecosystem (Marine biota)" of the power plant	1) - 3) - Same as those addressed in "Ecosystem (Marine biota)" of the power plant		
	Ecosystem (Mud Flat, Fish & Nekton)	1) - 3) Ditto	1) - 3) - Same as those addressed in "Ecosystem (Mud Flat, Fish & Nekton)" of the power plant	1) - 3) - Same as those addressed in "Ecosystem (Mud Flat, Fish & Nekton)" of the power plant	1) - 3) - Same as those addressed in "Ecosystem (Mud Flat, Fish & Nekton)" of the power plant	1) - 3) - Same as those addressed in "Ecosystem (Mud Flat, Fish & Nekton)" of the power plant	1) - 3) - Same as those addressed in "Ecosystem (Mud Flat, Fish & Nekton)" of the power plant		
6	Disturbance to Existing Social Infrastructure and Social Services	- Increase in the number of vessels	- Traffic volume	- Evaluation of effect of traffic schedule	- Record of numbers of vessels and cars being used	- Port office	- Continuous records	- CPGCBL/ Environmental Consultant	Expenses by CPGCBL
7	Work Environment (Including Work	- Labor accidents	- Labor accidents - Handling heavy loads - Working at heights	- Evaluation of effect of the work safety plan	- Record of accidents	- Port office	- Continuous records	- CPGCBL/ Environmental Consultant	Expenses by CPGCBL

No	Significant Impact to be Monitored	Source of Significant Impact	Monitored Parameter	Purpose of the Monitoring	Monitoring Method			Initiator Supervisor	Cost
					Method of Collecting and Analyzing Data	Location	Duration and Frequency		
	Safety)		- Electric shocks						
8	Accidents	- Traffic accidents	- Marine traffic	- Evaluation of vessel schedules	- Record of accidents	- Port office	- Continuous records	- CPGCBL/ Environmental Consultant	Expenses by CPGCBL

(Source: JICA Study Team)

Chapter 10

Work Plan

Chapter 10

Work Plan

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10 Project Construction Plan

10.1 Project Implementation Schedule

CPGCBL is now intending to proceed with the implementation of the Matarbari CFPP Project with the financial assistance of a Japanese ODA Loan in order to meet the increasing power demand in Bangladesh.

The ultimate schedule of this project is construction of 2 x 600 MW coal fired power generating units.

CPGCBL will acquire an area of at least approximately 350 ha, which is planned for the construction of this project.

The Project Implementation Schedule that the JICA Study Team has assumed is shown in Figure 10.1 "Tentative Project Implementation for Matarbari CFPP Project and Transmission Line Project".

(1) Site Survey and Collection of Data related to site and surrounding areas

The consulting engineer for ES-I and II selected by CPGCBL will carry out a site survey and collect the necessary data for the project, and will review and study the Feasibility Study Report together with CPGCBL.

(2) Phase I (Pre-Construction Stage)

The consulting engineer will conduct the following work.

a. Preparation of Basic Design Report
b. Preparation of Prequalification and Bidding Documents
c. Prequalification of Bidders
d. Technical and Financial Evaluation of Proposals submitted by Bidders
e. Contract Negotiations with successful Bidder

(3) Phase II (Manufacturing and Construction Stage)

After the contract has been awarded to each successful contractor, CPGCBL/Consultant will hold kick-off meetings to start the project, and indicate the project management systems and procedures. At the design stage, the Consultant will review and approve the design documents, drawings and calculation sheets submitted by the Contractor. Also, the Consultant will organize design review meetings among CPGCBL, the Consultant and each of the Contractor periodically to settle any discrepancies in design or schedules.

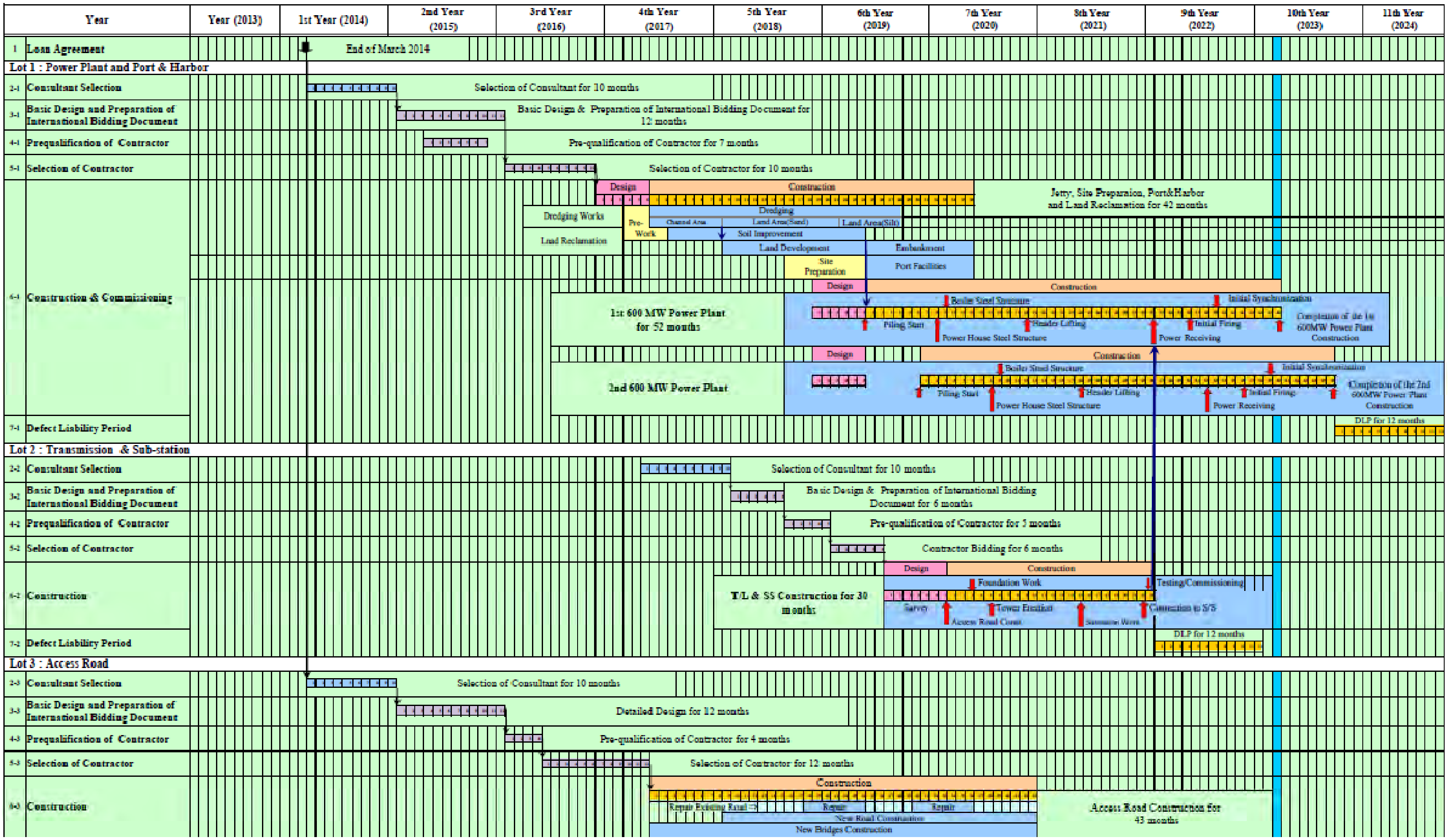

Figure 10.1 Tentative Project Implementation for Matarbari CFPP Project and Transmission Line Project

(Source: JICA Study Team)

To ensure the quality control of manufacturing, CPGCBL and the Consultant will conduct factory inspections and witness the manufacturing conditions of major equipment in accordance with the factory test schedule and approved QA/QC Inspection, and Test Plans and their related procedures, submitted by the Contractor at this stage.

At the construction stage, coordination and supervision related to all construction work, including civil work, shall be made by the Consultant. The Consultant will hold weekly construction schedule meetings to check the schedules, including the management of the labor force, and arrangements for construction equipment, tools and materials.

At the commissioning stage, the Consultant will check and approve the schedules and procedures for testing and commissioning of individual auxiliary equipment and facilities.
CPGCBL and the Consultant will witness the tests of mechanical and electrical equipment and confirm important items and test results.

The performance and acceptance tests shall be carried out under the supervision of the Consultant and the Consultant will judge the results and report them to CPGCBL.

CPGCBL will issue Taking Over Certificates (TOC) for the Contractor after the results are confirmed and approved by CPGCBL.

In the warranty period, the Consultant will inspect the conditions of each equipment and facility periodically. After the warranty period, CPGCBL will issue Final Acceptance Certificates (FAC) for the Contractor.

Chapter 11

Financial and Economic Analysis

Chapter 11

Financial and Economic Analysis

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11 Financial and Economic Analysis

The Project is to be assessed by calculating the economic internal rate of return to determine economic viability and the financial internal rate of return to determine financial viability. The following are the major areas that will be analyzed in order for the JICA Study Team to determine the final evaluation and assessment.

11.1 Project Costs

11.1.1 Basic calculation method

The total construction costs of the plant were calculated in the following way.

1) Total plant construction costs

   Plant construction costs, consulting expenses, contingency plans, spare parts required in the initial two years, and the interest rates during the construction period are included in the total construction costs of the plant.

2) Plant construction costs

   Concerning the plant construction costs, except for the materials which are procurable locally, materials are to be imported from overseas.

3) The following are not included in the total cost of construction of the plant.
   (1) Power plant site, site preparation, and maintenance costs
   (2) Costs of clerical work facilities related to operation management
   (3) Costs of dwelling facilities for power plant staff and costs of related services facilities
   (4) Costs of electric power for construction and costs for water involved in the engineering work
   (5) Allotment costs related to power plant construction
   (6) Removal costs of existing facilities (if any)

4) Base currency and exchange rates

   The standard official currency is assumed to be the Japanese yen, and the exchange rates are shown below.

   US$ 1.0 = ￥ 94.8
   US$ 1.0 = TK 79.5
   TK 1.0 = ￥ 1.20

5) Escalation rates (including Consultant)

   Foreign Currency Portion: 1.3% p.a.
   Local Currency Portion: 3.5% p.a.

6) Base year for construction costs

   Construction costs are based on the prices of December 2012.

7) Import duties

   Import duties shall be exempted.

11.2 Financial and Economic Evaluation

11.2.1 Basic assumptions

(1) Key Project Design and Assumptions

The key project design and assumptions for financial modeling are shown in the following Table 11.2.1 and Table 11.2.2;

Table 0 Essential Framework of the Project

Category	Sub-category	Dimension
Generation Plants	Rated Capacity	600 MW X 2 Units
	Plant Load Factor	80%
	Thermal Efficiency	41.29%
	Auxiliary Consumption	6.5%
	Plant Life	25 years
Start-up & Completion	Consulting Service	Start-up: Feb. 2015
	Unit 1	Construction to start: Jun. 2019 Completion: Oct. 2023
	Unit 2	Construction to start: Jun. 2019 Completion: Apr. 2024
Plant Lives of Other Components	Transmission Lines	40 years
	Port & Harbor	25 years
	Coal Unloading Facilities	25 years
	Access Road	30 years
Depreciation	Depreciation Method	Straight Line Method
	Residual Value	10% of gross fixed assets
Estimated Cost	Generation	Refer to the respective Chapters of the Report.
	Transmission	Same as above
	Port & Harbor	Same as above
	Coal Unloading	Same as above
	Access Road	Same as above

(source) JICA Study Team

Table 0 Key Assumptions

Category	Sub-category	Dimension
Financing	Financing Sources	Donor Loan: 80%, and Government funding: 20% (equity 60%: loan 40%)
	Donor Loan (subsidiary loan from GOB to executing agencies)	Interest rate: 0.01% p.a., Repayment period: 34 years, and Grace period: 10 years
	Government Loan	Interest rate: 3.0% p.a., Repayment period: 20 years, and Grace period: 10 years
	Government Equity	No written obligation and assumed to be exempt from dividend payment and redemption. (*)
Fuel Cost	Indonesian Coal	Refer to the Chapter 6 of the Report.
	Australian Coal	Same as above
	Other Coals	Same as above

Category	Sub-category	Dimension
O&M	O&M Expense	Refer to Chapter 13 of the Report
Overhead	Administrative Overhead	Refer to Chapter 13 of the Report
Taxes	Corporate Income Tax	37.5%
	VAT	5%
	VAT for EPC Contractor & Consultant	10.5%
	Custom Duties	5%
	VAT on imports	5%
Return on Equity	ROE before Tax	12% on paid-up equity
Exchange Rate		US$ 1=Tk 79.50; US$ 1=JPY 94.80

(note) Under the on-going practices of GOB, the outlay from the government budget is documented in the approval letter of ECNEC for the amount of equity and loan. Neither the conditions for equity redemption nor the terms and conditions of loans are committed in written documents. In the power sector, there exists no precedence of equity redemption while dividend is paid out by PGCB and DESCO based on the declaration of the companies..

(source) JICA Study Team

The assumptions listed above are prepared for the purpose of construction of the financial model only and the specific data and/or information are of preliminary nature. The succeeding analysis on financial simulation as well as the economic and financial evaluation shall be updated accordingly.

a. Project Cost

The cost of the Project has been analyzed previously, the gist of which is taken here for the sake of the financial analysis of the Project. The following table summarizes the overall cost of the Project;

Table 0 Total Cost of the Project (before tax)

Project Component	Total Cost (JPY million)	Breakdown		
		Foreign Currency (JPY million)	Local Currency (Tk million)	JPY Equivalent of local currency portion (JPY million)
Power Generation				
EPC Contract	236,668	177,513	49,609	59,155
Land cost	5,075	-	4,256	5,075
Community	624	-	523	624
Others	77	69	7	8
Consultant	4,733	3,550	992	1,183
Contingency				
Physical *1	23,904	17,929	5,010	5,975
Price	34,309	17,307 *2	14,259 *3	17,002
Sub-total	305,390	216,368	74,656	89,022
Transmission				
EPC Contract	4,033	3,064	813	969

Project Component	Total Cost (JPY million)	Breakdown		
		Foreign Currency (JPY million)	Local Currency (Tk million)	JPY Equivalent of local currency portion (JPY million)
Land cost	4	-	3	3
Others.	3		3	4
Consultant	154	154	-	-
Contingency				
Physical *1	411	314	81	97
Price	538	281 *2	215 *3	257
Sub-total	5,139	3,813	1,851	1,326
Port & Harbor				
EPC Contract	37,920	15,168	19,080	22,752
Land cost				
Consultant	758	303	382	455
Contingency				
Physical *1	3,830	1,532	1,927	2,298
Price	5,527	1,055 *2	3,751 *3	4,472
Sub-total	48,035	18,058	25,140	29,977
Access Road				
Bridge	1,899	436	1,463	1,463
Road	1,498	344	1,154	1,154
Land Cost	18		15	18
Consultant	308	205	86	103
Contingency				
Physical *1	355	88	266	267
Price	563	54 *2	509 *3	509
Sub-total	4,623	1,127	3,478	3,496
E. Total	363,187	239,366	104,402	123,821
F. L/C Opening Charge	3,310	-	2,775	3,310
G. Adm. Overhead *4	6,345		5,329	6,345
H. Coal for Trial Run *5	23,834	23,834	-	-
I. HSD for Trial Run *5	770	-	646	770
J. Grand Total	397,446	263,200	107,823	134,246

Note) *1) Physical contingencies are calculated at; 10% for the plant cost and civil work; 5% for consulting services

*2) Price contingencies for foreign currency portion are calculated at 1.3% p.a.

*3) Price contingencies for local currency portion are calculated at 3.5% p.a.

！！！！ *4) Administrative overhead is calculated at 2% of the total eligible component.

*5) The fuel for trial run of the plants are counted for 6 months of operation. The amount spent for the procurement of the fuel for trial run will be reimbursed by the single buyer, BPDB, when the commercial run of the plants will start. The amount to be paid by BPDB will be sufficient enough for CPGCBL to purchase the fuel for future operation. For CPGCBL, the one cycle of coal purchasing will be approximately six months, i.e. two and half months for shipment and storage, half a month for generation and three months for bill collection, counting from the payment for import till bill collection.

*6) Exchange rates applied are; US$ 1 = BDT 79.50; US$ 1 = JPY 94.80; BDT 1 = JPY 1.192.

b. Power Production

The Project plans to install two power generator units with a rated capacity of 600MW each. The expected annual power output will be 8,410 GWh via a plant load factor of 80%. Per the auxiliary consumption of 6.5%, the net power production, which can be available for sales, will be 7,863GWh. The parameters have been established in the following background and technological theory;

1) Plant Factor

The plant factor is the ratio of the total amount of energy (GWh) produced during a period of time to the amount of energy (GWh) the plant would have produced if the plant had been operating at the rated capacity;

Annual plant factor (%) = annual actual output (MWh) / {rated capacity (MW) x 8,760 (h/year)} x 100 (%)

The project assumes to be operated non-stop at the rated capacity with exception of the periodical inspection and maintenance which will last approximately one and half a month every year. Under such operative condition, the plant factor is calculated theoretically as 87.5% but the plant factor may be reduced subject to the factors such as central dispatch instructions, mechanical maladjustment, etc. and in consideration of such, the Study Team has established the plant factor for the Project to be at 80%.

2) Thermal Efficiency

Thermal efficiency is the ratio of the electricity output the plant produces, to the fuel heat input the plant consumes. The difference of dimensions of heat and electricity requires a conversion factor to derive the thermal efficiency as in the following formula;

$\eta p = (MW \times 860) / (F \times HHV)$ ······Ⓓ

ηp : thermal efficiency of a plant (%)

MW: electricity output (kWh)

860 : factor for converting kWh to kcal (kcal/kWh)

F : volume of coal consumption (kg/hr)

HHV : calorific value of coal (kcal/kg)

The thermal efficiency of the Project, 41.29%, has been established by the Study Team in consideration of the design specifics of the USC power plant which is 24.5MPa x 600°C / 600°C, the higher heating value of the fuel coal from Indonesia which is 4,700kcal/kg, the climatic conditions of Bangladesh including the ambient air temperature 30°C and the sea water temperature 30°C, etc.

3) Auxiliary Consumption

Auxiliary power consumption is the volume of electric power consumed by the auxiliary equipment and facilities in a power plant and is expressed in the percentage of the gross power output. The auxiliary power ratio of the Project, 6.5%, has been estimated by the Study Team taking the conditions of the Project into consideration and comprising the power consumption by all the unit auxiliaries as well as the common station requirement such as station lighting, air conditioning, etc.

c. Project Implementation Period

The Project implementation period, from consulting services till the commercial operation date (COD), is assumed to be nine years.

d. Depreciation

In Bangladesh, depreciation is generally treated in a flexible manner. Power entities are allowed to select the straight line or the declining balance method. In this study, it is assumed that the straight line depreciation will be adopted. Also the residual value is expected to be 10% of the gross amount of fixed assets.

e. Funding

For the total funds required, 88% of the investment cost for the Project is assumed to be financed by debt, including ODA loans and domestic loans. The ODA Yen Loan will be lent to the government of Bangladesh (GOB) from JICA and be on-lent from GOB to CPGCBL, PGCB and appropriated to RHD. The ODA Yen Loan may be granted to cover 100% of the eligible portion of the total project cost while the non-eligible portion shall not be financed. Assuming that 20% of the total project cost is comprised of the non-eligible portion, 80% of the total investment cost is to be financed by the subsidiary loan of the ODA Yen Loan, and 8% of them by domestic loans from the government of Bangladesh to CPGCBL. The remaining 12% will be financed in equity from the government of Bangladesh.

f. Debt Amortization

The repayment of loans is assumed to be made in accordance with normal financing practices. The principal of the loan elapsing the grace period shall be repaid in equal installments semi-annually at the end of June and December of each year. The interest on loans shall be calculated on the outstanding balance of the loan and be paid at the end of June and December each year. The interest accruing prior to the commissioning of the Project shall be capitalized at the time of the transfer of the asset from the capital work in progress to the fixed asset.

Table 11.2.4 Estimated Annual Debt Amortization

	Repayment Period	Grace Period
ODA loan	34 years	10 years
Government loan	20 years	10 years

(Source: JICA Study Team)

g. Revenue

The source of revenue is the electricity tariff to be fixed between CPGCBL and BPDB, the single buyer, based on the actual cost of supplying the electricity plus the ROE allowed.

In September, 2012, the Bangladesh Energy Regulatory Commission revised the bulk tariff of power supplied by the Bangladesh Power Development Board (BPDB) and the revised tariff has been used by a different Power Distribution Authority/Company/Rural Electrification Board with effect from September 1st, 2012. The average bulk tariff has been set at 4.7 Tk/kWh as of September, 2012 as mentioned in Chapter 11 (Changes in Bulk Tariff). The tariff thus revised stays at far below the unit power generation cost of the Project, which is revealed to be 6.99 Tk/kWh including the Return on Equity (ROE) of 12%. Details on the required tariff level are mentioned below (Refer to (3) Financial Simulation.) The financial analysis assumes that the actual generation cost including the ROE obtained under the Study shall be deemed as the tariff to be established in the PPA to be concluded for the sale of power output of the Project upon completion.

h. Interest Rate and Interest during Construction (IDC)

The interest rates for the ODA loan and ODA subsidiary loan are assumed to be 0.01% p.a. The prevailing practices in Bangladesh in extending the subsidiary loan to power sector generation companies are at the interest rate of 1.5% - 3.0% p.a. In order to materialize the Project with the reasonable generation cost and the wholesale price of the power within the reasonably acceptable range, the Study Team recommends that GOB allows the accommodative rate of interest in the subsidiary loan at 0.01% p.a. which should be exactly same with the rate of interest at which GOB borrows the donor funds. For the government loan, the interest rate is assumed to be 3.0% p.a., which is according to the standard interest rate of the government loan to BPDB and its subsidiaries.

i. Physical Contingency

The physical contingency is a part of the project cost for the financial and economic evaluation of the Project. The physical contingency is assumed at 10% of the total EPC including the equipment and civil work whereas 5% is appropriated for consulting services.

j. Administrative Overhead

Administrative overhead is budgeted at 2% of the total eligible component of the Project, while the administrative overhead belongs to the non-eligible component.

11.3 Financial Simulation

Base Cases and Financial Targets

Lately, MPEMR adopted the fixing of the wholesale tariff based on the total cost of generation including the return on equity (ROE) at 12%[1] in line with the tariff guidelines established by Bangladesh Energy Regulatory Commission[2]. The analysis prepares the Base Cases with ROE at 12%. Through the consultation with Bangladesh counterpart and in view of the on-going practices in the financial world, JICA Study Team establishes the targets to be financially satisfied by the Project. The targets established for the financial indicators are;

(i) The generation cost of power including ROE should be not more than Tk 7.00/kWh.

The target is established based on the grounds such as; (i) that the discussion the Study Team held with Bangladesh counterpart suggested the range as tolerable; (ii) that the Power Sector Master Plan 2010 gives the indicative cost of generation to stay in the range of Tk 7-8/kWh; (iii) that the comparative analysis using the levelized cost indicates the level is deemed as the least cost among various updated generation processes based on the fossil energy.

(ii) The financial internal rate of return (FIRR) should be no less than the weighted average cost of capital (WACC).

The target is established based on the fact that the Project would not fail to earn, on the basis of present value, the financial return sufficient enough to recover the cost incurred to the investment.

(iii) The debt/equity ratio should be not less than 30:70.

The target has been established by MPEMR's Power Sector Financial Restructuring and Recovery Plan, assisted by IDA credit for Power Sector Development Technical Assistance Project, August 2006.

(iv) The debt service coverage ratio (DSCR) should not be less than 130%.

The ratio has also been established under the above Plan of MPEMR.

[1] Power Division, Ministry of Power, Energy and Mineral Resources, Notice dated February 20, 2013.

[2] The Bangladesh Energy Regulatory Commission Electric Generation Tariff Regulation 2007 prescribes that "In the case of licensees, which are wholly owned by the government, the cost of capital would equal the government's cost of capital. For the purposes of tariff rate development, the most recent treasury bill auction rate, pursuant to a central bank auction, for two-year Bangladesh treasury bills shall be utilized." (BERC, Bangladesh Energy Regulatory Commission Electric Generation Tariff Regulation 2007). 12% is the prevailing level of auction rate by the central bank whereas BPDB maintains a practice of allowing ROEs for the government owned generation companies at 5% across-the-board.

The Base Case thus established based on the above framework and assumptions produces the financial outcome of the Project as follows;

Table 11.2.5 Findings on Base Case

	Target	ROE=12%
WACC		1.60%
Generation Cost	Not more than Tk 7.0/kWh	Tk 6.99/kWh
FIRR	not less than WACC	2.52%
D/E Ratio	not less than 70:30	2024: 15.0%, 2031: 30.2%
DSCR	not less than 130%	Ave.: 128.5%
Net Present Value (NPV)	Positive	▲9,350 Tk million
Project Life Coverage Ratio (PLCR)	not less than DSCR +10%	121.1%
Loan Life Coverage Ratio (LLCR)	not less than DSCR + 10%	121.1%

(source) JICA Study Team

The Base Case satisfies the targets in the generation cost, FIRR and virtually meets the target in DSCR, though failing to clear other targets of Net Present Value (NPV) and Project Life Coverage Ratio (PLCR)/Loan Life Coverage Ratio (LLCR). The fact that NPV, which is the discounted value by using the discount factor of WACC, is falling in the negative territory implies that the Project is not able to generate sufficient return to cover its investment on the basis of the present value. The low earning power is also captured by PLCR/LLCR[3] being stagnant in the range of low 120% level indicating that the Project might have uncertainties concerning the repayment of the total loan again on the basis of the present value. Nevertheless, the average DSCR stands at 128.5% which is close to the commonly accepted standard of 130% though the ratio is failing to clear the threshold during the early years of operation; 2028-2035 and 2038-2039. D/E ratio which is structured to be 88:12 at the start-up of operation period but is found gradually building up towards the target supported by the ROE (=12%) built in.

Power Generation Cost

The following is the table showing the summarized generation cost and ROE;

[3] PLCR and LLCR results in an identical value as the Project assumes the loan life to be exactly coincide with the project life.

Table 0 Generation Cost including ROE

(Tk/kWh)

	Base Case (ROE=12%)
Generation Cost incl. ROE	Tk 6.99/kWh
Fixed Cost	
Depreciation	1.33
O&M	0.51
ROE	0.65
Sub-total	2.49
Variable Cost	
Fuel Cost	4.50
Other Variable Cost	0.00
Sub-total	4.50

(source) JICA Study Team

The average cost of generation for the Base Case turns out to be Tk 6.99/kWh being comprised of the fixed cost of Tk 2.49/kWh and the variable cost of Tk 4.50/kWh. The cost derived is found satisfying the target established.

Despite the clearance of the target for the generation cost, the cost of generation for the Project exceeds the prevailing wholesale tariff of power in Bangladesh which currently stands at Tk 4.70/kWh. Should the tariff remain below the generation cost of the Project, the high cost of generation under the Project may appear to have an adverse effect of expanding of the deficit at BPDB, but shall, without fail, contribute to save BPDB's deficit in two channels, namely, (i) to reduce the deficit at BPDB created by the purchase of electricity generated from liquid fuel based generation plants, and (ii) by the gradual revision of tariff through the materialization of the cost reflective tariff for the country.

Levelized Cost

The levelized cost is an economic assessment of the cost of generation system on a unit basis including all the costs over its life time; initial investment, operations and maintenance, cost of fuel, etc, on the basis of their present values. The analysis is of significant use in calculating the cost of generation from different sources of energy, types of generation plants and different time framework of generation projects, etc.

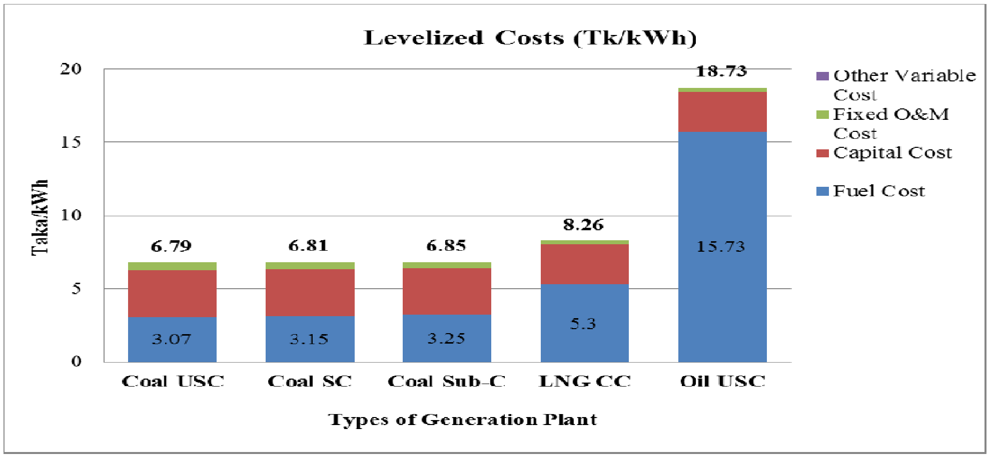
Using the methodology, the endeavor has been made to analyze the comparative costs of generation among the plants of; coal based USC plant adopted for this project, coal based SC plant, coal based Sub-C plant, LNG combined cycle plant and oil based USC plant. For the analysis, the Study has adopted a discount rate of 10% as such rate is commonly used for the similar analysis. The exchange rates applied are; US$ 1 = Taka 79.50 = JPY 94.80. The following table and figure show the result of the comparative analysis among the above selected generation plants;

Table 11.2.7 Levelized Generation Cost

(Tk/kWh)

	Coal based USC	Coal based SC	Coal based Sub-C	LNG combined cycle	Oil based USC
Fuel	3.07	3.15	3.25	5.30	15.73
Capital	3.23	3.18	3.14	2.72	2.71
O&M	0.49	0.48	0.46	0.24	0.29
Other variable	0.00	0.00	0.00	0.00	0.00
Total	6.79	6.81	6.85	8.26	18.73

(source) JICA Study Team



(source) JICA Study Team

Figure 11.2.1 Levelized Cost of Generation Plants

The assumptions used for the analysis are summarized as follows;

Table 11.2.8 Assumptions for Levelized Cost Analysis

	Coal based USC	Coal based SC	Coal based Sub-C	LNG combined cycle	Oil based USC
Rated capacity (MW)	1,200	1,200	1,200	1,200	1,200
Plant load factor (%)	80.0	80.0	80.0	80.0	80.0
Auxiliary consumption (%)	6.48	6.64	6.78	2.50	5.50
Net energy output (GWh)	7,865	7,851	7,839	8,199	7,947
Thermal efficiency (%)	41.29	40.32	39.15	51.00	41.29

	Coal based USC	Coal based SC	Coal based Sub-C	LNG combined cycle	Oil based USC
kJ/kWh	3,600	3,600	3,600	3,600	3,600

(source) JICA Study Team

The above table reveals that among the plants selected, coal based USC stands to be the least cost plant with the indicated total costs of Tk 6.79/kWh and are followed by the order of; coal SC (Tk 6.81/kWh), coal based Sub-C (Tk 6.85/kWh), LNG combined cycle (Tk 8.26/kWh) and oil based USC plants (Tk 18.73/kWh).

It is hereby proved that the coal based USC which is the technology adopted for the Project is the least cost in respect of the total life cost from the construction till the end of its life among the generally implemented generation technologies based on fossil fuels.

The above analysis implies another fact to be noted in Bangladesh which is the cost of power generation using natural gas. In Bangladesh, the tariff of natural gas is regulated by the government and the power sector as well as the fertilizer industry has been favored with the tariff established lower than the ones for other sectors. Electricity has been generated at less cost in utilization of the low price of natural gas. The analysis indicates that, should the gas be priced at the international level of price, the cost of generation based on the natural gas will be as high as at Tk 8.26/kWh which is much higher than the one by the imported coal. It endorses clearly the fact that there exists a cross subsidy practice in the power generation based on the natural gas.

11.4 Financial Evaluation

11.4.1 Methodology of Evaluation and Basic Parameters

The financial evaluation is based on an analysis of the financial viability of the Project. In other words, the financial evaluation aims to verify financial sustainability for the entity to operate and maintain the Project at a certain level of financial effectiveness for a certain period.

In general, financial viability is measured by the Financial Internal Rate of Return (FIRR), which measures and compares financial revenue (= financial benefit) on capital investment on project (= financial cost). The project can be judged as “financially viable” in the case where the calculated FIRR is higher than the weighted average capital cost (WACC) of the total capital investment of the project.

For the Project, FIRR can be separately calculated for the plant portion and the transmission portion because the transmission portion is to be executed by the independently run PGCB who is to be financially benefited through the collection the wheeling charge over the electricity transmitted for CPGCBL's sale to BPDB's purchase.

11.4.2 Financial Cost

(1) Project Cost

For the financial analysis of the Project, all the estimated costs are converted and expressed in the constant price as of 2012. The project cost, including power generation facilities, port facilities and the access road, is estimated based on the 2012 constant price.

(2) Fuel Price

Fuel coal are planned to be imported the coal from Indonesia, Australia or the Republic of South Africa as mentioned in feasibility study. A detailed analysis of the coal prices are referred to in feasibility study.

The fuel costs for the coal-fired power plant constructed by the Project shall be the total amount of FOB (Free on Board) of coal, F&I (Freight and Insurance). Coal prices are estimated based on the actual records for 2012 and in using the indexes derived on the reference export prices projected by the U.S. Energy Information Administration[4].

Table 11.4.1 Projections of Coal Prices (Indonesia and Australia)

	2010	2011	2012	2015	2020
Export Price Index (constant price; 2010=100)	100.00	103.40	106.80	117.00	128.80
Coal Price					
Indonesian Coal (4,200kcal/kg) US Cents/MM kcal	-	-	1,312	1,437	1,582
Australian Coal (5,867kcal/kg) US Cents/MM kcal	-	-	1,640	1,797	1,978
Freight and Insurance Cost					
Freight & Insurance for Indonesian Coal (USD/MT)	-	-	14.00	14.00	14.00
Freight & Insurance for Australian Coal (USD/MT)	-	-	22.00	22.00	22.00

(Source) JICA Study Team and The U.S. Energy Information Administration, "Annual Energy Outlook of 2012 with Projections to 2035"

(3) Operations and Maintenance Cost

The operations and maintenance (O&M) costs cover costs for operation and maintenance of all the facilities constructed by the Project, including the initial spare parts, fixed and

[4] USDOE, US Energy Information Administration, "Annual Energy Outlook 2012", June 2012.

valuable maintenance costs, and payrolls. Details of the O&M are discussed in feasibility study.

(4) Tax and duties

The custom duties, the value added taxes and the income taxes are counted as a part of the project costs for the financial analysis. However, the taxes and fiscal levies are deemed as the domestic unrequited transfer of revenue that plays no contributory function in the project and are omitted from the project cost for the economic analysis. The tax rates to be levied on the transactions related to the Project are shown in the table below.

Table 11.4.2 Tax and Duties to be Levied

Tax and Duties	Tax Rate
Corporate Income Tax (publicly traded company)	27.5%
Corporate Income Tax (non-publicly traded company)	37.5%
Value Added Tax (VAT)	5.0%
VAT for EPC Contractor & Consultants	10.5%
Custom Duties & VAT on Imports (C&F)	5.0%

(Source: JICA Study Team)

(5) Discount Rate

A discount rate for the financial analysis is required to be equal to the minimum return on capital investment in order to make an investment decision. Namely, the Project needs a higher Financial Internal Rate of Return (FIRR) than the financial costs derived by the Weighted Average of the Capital Cost (WACC). The WACC of the Project is calculated using the following formula:

WACC before tax = [rE x E/(D + E)] + [rD for ODA x (1-T) x D for ODA/(D + E)] + [rD for G loan x (1-T) x D for G loan/(D + E)]

rE: Cost of equity = 12% p.a.
rD for ODA subsidiary loan: Cost of ODA loan = 0.01% p.a.
rD for Government loan: Cost of domestic loan (government) = 3.0% p.a.
E/(D + E): Equity/(Equity + Debt) = 12%
D for ODA subsidiary loan/(D + E): ODA subsidiary loan/(Debt + Equity) = 80%
D for government loan/(D + E): government loan/ (Debt + Equity) =8%
Corporate Income Tax Rate in Bangladesh: 37.5%

The estimated WACC of the Project is calculated to be as follows:

WACC after income tax= 1.60%

11.4.3 Financial Benefit

Financial Benefit for the Plant Portion

The financial benefit of the plant portion is the electricity sales revenue and the salvage value of the plant at the end of the project life.

The tariff of the electricity to be sold by CPGCBL to BPDB shall be fixed in PPA before starting its commercial operations at the rate analyzed above; Tk 6.99/kWh. For the purpose of the financial evaluation of the Project, we do adopt the rate obtained, Tk 6.99/kWh including ROE, as the yardstick to measure the financial benefits of the Project.

Financial Benefit for the Transmission Portion

The financial benefits of the transmission portion is the wheeling charge of 0.2291 Tk/kWh and the salvage value of the transmission line at the end of the project life.

11.4.4 FIRRs

(1) Financial Internal Rate of Return (FIRR) for the Plant Portion

The FIRR of the plant portion is calculated by a financial model based on the assumptions mentioned above.

The provisional estimation of FIRR is 2.52%, which is higher than WACC for the Project and the Project is deemed financially viable.

(2) FIRR for the Transmission Portion

The estimated FIRR for the transmission portion based on the assumptions is 20.09%. The transmission portion can be expected to gain significant financial return, which is much higher than WACC.

Table 11.4.3 FIRR for the Power Plant

(million TK)

Fiscal Year	Financial Cost (A)			Financial Benefit (B)			Balance (B)-(A)
	Capital Cost	Operating Cost	Total	Sales Revenue	Salvage Value	Total	
2015	465	0	465	0	0	0	-465
2016	960	0	960	0	0	0	-960
2017	17,401	0	17,401	0	0	0	-17,401
2018	14,996	0	14,996	0	0	0	-14,996
2019	26,798	0	26,798	0	0	0	-26,798
2020	53,711	0	53,711	0	0	0	-53,711
2021	49,222	0	49,222	0	0	0	-49,222
2022	49,339	0	49,339	0	0	0	-49,339
2023	49,455	0	49,455	0	0	0	-49,455
2024	35,562	17,774	53,336	27,495	0	27,495	-25,841
2025	0	34,592	34,592	54,990	0	54,990	20,398
2026	0	35,792	35,792	54,990	0	54,990	19,199
2027	0	36,086	36,086	54,990	0	54,990	18,905
2028	0	35,474	35,474	54,990	0	54,990	19,516
2029	0	35,768	35,768	54,990	0	54,990	19,222
2030	0	39,690	39,690	54,990	0	54,990	15,301
2031	0	39,984	39,984	54,990	0	54,990	15,007
2032	0	36,650	36,650	54,990	0	54,990	18,340
2033	0	36,723	36,723	54,990	0	54,990	18,267
2034	0	37,922	37,922	54,990	0	54,990	17,068
2035	0	38,216	38,216	54,990	0	54,990	16,774
2036	0	37,605	37,605	54,990	0	54,990	17,385
2037	0	37,899	37,899	54,990	0	54,990	17,091
2038	0	44,632	44,632	54,990	0	54,990	10,358
2039	0	44,926	44,926	54,990	0	54,990	10,064
2040	0	38,781	38,781	54,990	0	54,990	16,209
2041	0	39,075	39,075	54,990	0	54,990	15,915
2042	0	40,274	40,274	54,990	0	54,990	14,716
2043	0	40,568	40,568	54,990	0	54,990	14,422
2044	0	39,957	39,957	54,990	0	54,990	15,034
2045	0	40,251	40,251	54,990	0	54,990	14,740
2046	0	44,172	44,172	54,990	0	54,990	10,818
2047	0	44,466	44,466	54,990	0	54,990	10,524
2048	0	40,453	40,453	54,990	0	54,990	14,537
2049	0	20,712	20,712	27,495	34,010	61,505	40,793
Total	297,909	978,444	1,276,353	1,374,761	34,010	1,408,770	132,417
FIRR	2.52%						

(Source: JICA Study Team)

Table 11.4.4 FIRR for the Transmission Lines

(million TK)

Fiscal Year	Financial Cost (A)			Financial Benefit (B)			Balance (B)-(A)
	Capital Cost	Operating Cost	Total	Sales Revenue	Salvage Value	Total	
2015	0	7	7	0	0	0	-7
2016	0	7	7	0	0	0	-7
2017	0	7	7	0	0	0	-7
2018	65	7	72	0	0	0	-72
2019	1,715	7	1,721	0	0	0	-1,721
2020	1,719	7	1,725	0	0	0	-1,725
2021	855	7	862	0	0	0	-862
2022	10	7	17	0	0	0	-17
2023	10	7	17	0	0	0	-17
2024	3	7	9	901	0	901	891
2025	0	7	7	1,801	0	1,801	1,795
2026	0	7	7	1,801	0	1,801	1,795
2027	0	7	7	1,801	0	1,801	1,795
2028	0	7	7	1,801	0	1,801	1,795
2029	0	7	7	1,801	0	1,801	1,795
2030	0	7	7	1,801	0	1,801	1,795
2031	0	7	7	1,801	0	1,801	1,795
2032	0	7	7	1,801	0	1,801	1,795
2033	0	7	7	1,801	0	1,801	1,795
2034	0	7	7	1,801	0	1,801	1,795
2035	0	7	7	1,801	0	1,801	1,795
2036	0	7	7	1,801	0	1,801	1,795
2037	0	7	7	1,801	0	1,801	1,795
2038	0	7	7	1,801	0	1,801	1,795
2039	0	7	7	1,801	0	1,801	1,795
2040	0	7	7	1,801	0	1,801	1,795
2041	0	7	7	1,801	0	1,801	1,795
2042	0	7	7	1,801	0	1,801	1,795
2043	0	7	7	1,801	0	1,801	1,795
2044	0	7	7	1,801	0	1,801	1,795
2045	0	7	7	1,801	0	1,801	1,795
2046	0	7	7	1,801	0	1,801	1,795
2047	0	7	7	1,801	0	1,801	1,795
2048	0	7	7	1,801	0	1,801	1,795
2049	0	7	7	901	1,896	2,797	2,790
Total	4,377	234	4,611	45,035	1,896	46,931	42,321
FIRR	20.09%						

(source) JICA Study Team

(3) Internal Rate of Return on Equity (IRR-E) for the Project

Internal Rate of Retune on Equity (IRR-E) indicates profitability of the Project on equity to be invested. IRR-E assumes that the inflows are the cash flows required minus any debt to be raised for the Project and the outflows are cash flows from the Project minus any interest and debt repayments. In the case that annual net profit after tax is considered as cash inflows, the amount of annual depreciation should be added up.

Based on the assumptions above, IRR-E for the total project is revealed to be 9.64%. Taking into consideration of the prevailing consensus on the ROE of IPP generation projects at around 15-20%, the gap between such ROE and the government bond rate of 12.48% (20 years T Bond) is understood to be the risk premium for the investor. In taking the risk premium as such, the hurdle rate of IRR-E for equity investment at CPGCBL is calculated to be 9.20% after Corporate Income Tax. The IRR-E calculated is found to be higher than the hurdle rate.

* Hurdle rate = ROE [12% x (100- tax rate of 37.5%)] + risk premium [the difference between the interest rate of Government Bond and ROE for IPP (15% - 12.48%) x (100 – tax rate of 37.5%)]

Table 11.4.5 Internal Rate of Return on Equity (IRR-E) for the Power Plant

(million TK)

Fiscal Year	Financial Cost (A)			Financial Benefit (B)				Balance (B)-(A)
	Equity Investment	Repayment of Loan	Total	Profit after Tax	Depreciation	Salvage Value	Total	
2015	261	0	261	0	0	0	0	-261
2016	128	0	128	0	0	0	0	-128
2017	4,105	0	4,105	0	0	0	0	-4,105
2018	1,992	0	1,992	0	0	0	0	-1,992
2019	3,591	0	3,591	0	0	0	0	-3,591
2020	7,230	0	7,230	0	0	0	0	-7,230
2021	6,698	0	6,698	0	0	0	0	-6,698
2022	6,768	0	6,768	0	0	0	0	-6,768
2023	6,838	0	6,838	0	0	0	0	-6,838
2024	4,862	0	4,862	2,157	5,897	0	8,053	3,191
2025	0	0	0	5,801	10,441	0	16,242	16,242
2026	0	11,586	11,586	5,117	10,441	0	15,559	3,973
2027	0	11,586	11,586	5,038	10,441	0	15,479	3,893
2028	0	11,586	11,586	5,521	10,441	0	15,962	4,376
2029	0	11,586	11,586	5,439	10,441	0	15,881	4,295
2030	0	11,586	11,586	3,094	10,441	0	13,535	1,949
2031	0	11,586	11,586	3,001	10,441	0	13,442	1,856
2032	0	11,586	11,586	5,162	10,441	0	15,603	4,017
2033	0	11,586	11,586	5,206	10,441	0	15,647	4,061
2034	0	11,586	11,586	4,558	10,441	0	14,999	3,413
2035	0	11,586	11,586	4,477	10,441	0	14,918	3,332
2036	0	9,344	9,344	4,928	10,441	0	15,369	6,026
2037	0	9,344	9,344	4,799	10,441	0	15,240	5,897
2038	0	9,344	9,344	647	10,441	0	11,088	1,745
2039	0	9,344	9,344	496	10,441	0	10,937	1,593
2040	0	9,344	9,344	4,345	10,441	0	14,786	5,442
2041	0	9,344	9,344	4,190	10,441	0	14,631	5,287
2042	0	9,344	9,344	3,490	10,441	0	13,931	4,588
2043	0	9,344	9,344	3,352	10,441	0	13,793	4,449
2044	0	9,344	9,344	3,774	10,441	0	14,215	4,872
2045	0	9,344	9,344	3,633	10,441	0	14,074	4,730
2046	0	9,344	9,344	1,226	10,441	0	11,667	2,323
2047	0	9,344	9,344	1,071	10,441	0	11,512	2,169
2048	0	9,344	9,344	3,588	10,441	0	14,029	4,685
2049	0	9,344	9,344	2,427	4,545	34,010	6,972	-2,372
Total	42,475	246,672	289,147	96,536	261,029	34,010	357,565	68,418
IRR-E	9.64%							

(source) JICA Study Team

11.4.5 Sensitivity Analysis

The sensitivity analysis is to assess the effects of the changes on the financial return of the Project. Per the sensitivity analysis, changes in selected variables can be assessed in terms of the extent that they result in changes in FIRR. In the Study, the following eight variables are selected for analysis;

Fuel mix

Foreign exchange rate

Interest rate of subsidiary loan

Share of donor loan in total fund raising
Government funding in equity
Plant cost
Plant load factor
Coal Price

Following table presents the result of the sensitivity tests conducted when the assumptions and/or the parameters of the Project change;

Table 11.4.6 Sensitivity Test on FIRR

Category	Variance	Generation Cost (Tk/kWh)	WACC (%)	FIRR (%)	DSCR (Ave.: %)
Base Case		6.99	1.60	2.52	128.5
Fuel Mix with Australian Coal	Indonesian 100%	6.70	1.60	2.51	128.7
Foreign Exchange Rate	Appreciation by 20%	5.71	1.60	2.55	130.2
	Depreciation by 20%	8.28	1.60	2.50	127.4
Interest Rate of Subsidiary Loan	1.0% p.a.	7.23	2.09	3.14	126.3
	2.0% p.a.	7.47	2.59	3.71	124.6
	3.0% p.a.	7.71	3.09	4.23	123.3
Share of Donor Loan in Total Fund Raising	85%	6.85	1.20	2.05	120.6
	75%	7.13	1.99	2.97	136.8
Government funding in equity	100%	7.37	2.41	3.74	159.4
	80%	7.18	2.00	3.19	143.1
Plant Cost	Increase by 20%	7.40	1.60	2.48	128.2
	Decrease by 20%	6.59	1.60	2.58	129.2
Plant Load Factor	90%	6.71	1.60	2.54	128.1
	70%	7.35	1.60	2.50	128.9
Coal Price	Increase by 20%	7.76	1.60	2.55	127.9
	Decrease by 20%	6.23	1.60	2.49	129.1

(source) JICA Study Team

It is to be noted that there exist two types of variables; controllable and uncontrollable. The controllable variables mean the ones whose changes can be managed by the Project sponsor and other parties concerned while the uncontrollable variables mean the ones that cannot be managed by the Project sponsor and the parties concerned individually or correctively as such belong to the outside environment such as the technological limitations, international market condition, or financial environment, etc. Out of the variables listed above, the categories of the fuel mix, the interest rate of the subsidiary loan, share of donor loan and government funding belong to the controllable and the remaining ones belong to the uncontrollable.

The above table indicates mixed results of the sensitivity tests for different categories of variables. Among the controllable, the increases in the interest rate of subsidiary loan and the government funding in equity bring the cases to stay out of the target range in terms of the generation cost. The uncontrollable categories of foreign exchange, plant cost, plant load factor and coal price, if they change for deterioration, will push the generation cost above the target level. For FIRR, all of the variant cases, controllable and uncontrollable are found satisfying the targets. For DSCR, limited number of cases are clearing the targets, though almost all of other cases are found to be staying close to the targets established with exception of a few cases of low values.

While there exists only one case in which all of the three targets are perfectly cleared simultaneously, i.e. the case where foreign exchange rate against US Dollar appreciates by 20%, no other cases satisfy all of the three targets simultaneously. Among those that are close to satisfy the three targets, the following cases are worth while taking close look; (i) Base Case, (ii) fuel mix to concentrate 100% in Indonesian, (iii) increase in the donor funding up to 85%, (iv) decrease in the plant cost, (v) increase in the PLF, and (vi) decrease in coal price. A half of the cases picked up are those of the uncontrollable variables and the Project may not able to obtain. The obtainable cases are found in (i), (ii) and (iii). It can be concluded that the Project can optimally adopt the Base Case for the financing structure. By adding the complementary measures of weighting the fuel mix to the Indonesian coal may help the Project to improve the generation cost and financial health of the Project.

A particular attention is invited into the changes in interest rate on the subsidiary loan from GOB to CPGCBL. The Base Case assumes the interest rate to be 0.01% p.a. and produces the output of the generation cost to be Tk 6.99/kWh. When the interest rate changes to 1.0% p.a., 2% p.a., and 3% p.a., the generation cost moves up to Tk 7.23/kWh, Tk 7.47/kWh and Tk 7.71/kWh with the result that the Project moves out of the acceptable range in respect of the targets established. The result indicates the indispensable nature of adopting the Base Case envisaging the interest rate on subsidiary loan at 0.01% p.a. Besides, it should be noted that GOB transfers all the cost and expenses to accrue on the donor loan to CPGCBL by virtue of the subsidiary loan agreement and bears no cost with exception of the risk inherent to the failure of CPGCBL in its debt servicing.

11.4.6 Conclusion and Recommendation

The analysis above reveals that the Base Case meets the target generation cost, financial conditions of FIRR and DSCR. The Study Team recommends CPGCBL to adopt the Base Case as the financing structure for the company

There remains some weakness in the Base Case in particular respect to the NPV and PLCR/LLCR. The NPV staying in the negative territory provides a caution that the Project may fail to produce sufficient value on the basis of present value for justifying the profitability. Such weakness of the Project stems from the basic structure of setting the revenue at the generation cost plus the ROE assigned with a limited amount of equity while all the other cost items are passed through to the generation cost which will be the tariff rate for the generated electricity. While the average DSCR is staying close to 130%, the company is understood to maintain sufficient strength for making the debt service in nominal terms. In fact, the company will be in a financially stable condition as it will neither be subject to the volatile fluctuation of the interest rate as the subsidiary loan provides virtually zero rate of interest nor the fluctuation in the sales revenue. The subdued conditions of low NPV, PLCR and LLCR of the case should be remedied by the strict execution of the tariff in reflection of the actual cost and ROE assigned together with the rigid observance of the contracted terms for collection of the invoice from the single buyer.

The Base Case is made of structure and practices that have not been seen before but to be adopted for the Project including;

(i) The concessionary terms and conditions should be adopted in the subsidiary loan agreement with the rate of interest at 0.01% p.a. and the repayment term in 34 years including the 10 years of grace; and

(ii) The longer terms for grace period should also be allowed for 10 years in the government lending in order to coordinate the repayment schedule with the longer term of construction.

The Study Team hereby recommends to GOB to adopt and accommodate above conditions in establishing the financial structure for the Project.

11.5 Economic Evaluation

11.5.1 Methodology of Evaluation and Basic Parameters

The economic analysis also appraises the benefit of an investment, but the concept of the economic benefit is different from the financial benefit. The economic analysis measures the effects on the national economy whereas the financial analysis assesses the financial profitability of the Project operating entity. The effect of the Project on the national economy is indicated by the Economic Internal Rate of Return (EIRR).

In order to calculate the EIRR, it is essential to identify the economic costs and the benefits. In particular, a comparison of the without-project and with-project situations is at the heart of the estimation of the net economic benefits of the Project. Then, those costs and benefits are quantified as much as possible, and are valued. In the case that EIRR is higher than the social discount rate which can be derived from the long-term treasury bond, the economic viability of the Project can be ensured.

11.5.2 Economic Costs

(1) Project Costs

The economic analysis is based on the Project costs which are used for the financial analysis but excluding the taxes and fiscal levies.

(2) Fuel Cost

The fuel costs for the financial analysis are also used for the economic analysis.

(3) Operation and Maintenance Costs

The O&M costs for the financial analysis excluding the taxes and fiscal levies are used for the economic analysis.

11.5.3 Economic Benefits

The economic benefits can be derived by the positive difference between the "with-project" situation and the "without-project" situation.

The Least Cost Alternative method is conventionally used for the economic analysis of power projects whereas the Willingness-to-Pay method is recently used to measure the economic benefits. Per the Least Cost Alternative method, "the avoidable cost" will be considered as the economic benefits of the Project. Avoidable costs can be estimated by the difference between the power generation cost, including capital and the O&M cost of the Project and the ones of alternative power generation, such as the existing power plants based on the liquid fuel energy, in order to increase the same volume of power production.

In the case of this Project, BPDB has been purchasing electricity from the power generation companies who operate the generation plants based on the liquid fuel energy, such as high speed diesel oil (HSD) and/or heavy fuel oil (HFO), etc. It is expected that the Project can replace the expensive electricity supplied by those costly generation. In cases where the Project can produce electricity at lower cost, the difference between the two costs can be assumed as the economic return of the Project as a result of cost saving. The details of generation based on the liquid energy are typically found at Quick Rental Power Producers as shown below;.

Table 11.5.1 Capacity and Tariff of QRPPs

Fuel	No. of QRPPs	Capacity	Current Average Tariff
HSD	5	350MW	18.92Tk/kWh
HFO	10	857MW	15.61Tk/kWh
Total	15	1,207MW	16.57Tk/kWh

(Source: JICA Study Team)

In addition to the saving the purchasing cost of power from such liquid fuel based generation companies, the salvage values of the plant and the transmission line at the end of the Project life are added for the economic benefit of the Project.

11.5.4 Economic Analysis

In utilization of the basic assumptions above, the EIRR will be computed using the economic analysis model with economic cash inflow and outflow.

The estimated EIRR is 20.12%. It is higher than the social discount rate for Bangladesh of 12.48%, which can be derived from the yield of the 20-year treasury bond issued by the Government of Bangladesh in April, 2013 and the Project is deemed as economically viable.

Table 11.5.2 Economic Internal Rate of Return (EIRR)

Fiscal Year	Economic Cost (A)			Economic Benefit (B)			Balance (B)-(A)
	Capital Cost	Operating Cost	Total	Saving cost of GRPPs	Salvage Value	Total	(million TK)
2015	441	0	441	0	0	0	-441
2016	870	0	870	0	0	0	-870
2017	16,324	0	16,324	0	0	0	-16,324
2018	13,820	0	13,820	0	0	0	-13,820
2019	26,474	0	26,474	0	0	0	-26,474
2020	51,828	0	51,828	0	0	0	-51,828
2021	46,762	0	46,762	0	0	0	-46,762
2022	45,967	0	45,967	0	0	0	-45,967
2023	45,967	0	45,967	0	0	0	-45,967
2024	33,161	16,933	50,094	65,145	0	65,145	15,051
2025	0	32,947	32,947	130,290	0	130,290	97,342
2026	0	34,073	34,073	130,290	0	130,290	96,216
2027	0	34,353	34,353	130,290	0	130,290	95,936
2028	0	33,787	33,787	130,290	0	130,290	96,502
2029	0	34,067	34,067	130,290	0	130,290	96,222
2030	0	37,737	37,737	130,290	0	130,290	92,552
2031	0	38,017	38,017	130,290	0	130,290	92,272
2032	0	34,907	34,907	130,290	0	130,290	95,383
2033	0	34,987	34,987	130,290	0	130,290	95,303
2034	0	36,113	36,113	130,290	0	130,290	94,177
2035	0	36,393	36,393	130,290	0	130,290	93,897
2036	0	35,827	35,827	130,290	0	130,290	94,463
2037	0	36,107	36,107	130,290	0	130,290	94,183
2038	0	42,405	42,405	130,290	0	130,290	87,885
2039	0	42,685	42,685	130,290	0	130,290	87,605
2040	0	36,947	36,947	130,290	0	130,290	93,343
2041	0	37,227	37,227	130,290	0	130,290	93,063
2042	0	38,353	38,353	130,290	0	130,290	91,937
2043	0	38,633	38,633	130,290	0	130,290	91,657
2044	0	38,067	38,067	130,290	0	130,290	92,223
2045	0	38,347	38,347	130,290	0	130,290	91,943
2046	0	42,017	42,017	130,290	0	130,290	88,273
2047	0	42,297	42,297	130,290	0	130,290	87,993
2048	0	38,551	38,551	130,290	0	130,290	91,738
2049	0	19,722	19,722	65,145	33,669	98,814	79,092
Total	281,614	931,497	1,213,111	3,257,238	33,669	3,290,907	2,077,796
FIRR				20.12%			

(Source: JICA Study Team)

11.5.5 Sensitivity Analysis

The objective of the sensitivity analysis is to assess the effects of the changes on EIRR. Per the sensitivity analysis, changes in selected variables can be assessed in terms of the extent that they result in changes in the EIRR. In the Study, the following six variables are selected for analysis:

- Plant Cost
- Plant load factor
- Coal price
- Cost of purchasing electricity from QRPPs
- Exchange rate
- Fuel mix

The Table 11.5.3 shows the results of sensitivity analysis on EIRR by the selected variables.

Table 11.5.3 Sensitivity Test on EIRR

Variables	Variance	EIRR
Base Case	-	20.12%
Plant Cost	+20%	17.71%
	-20%	23.29%
Plant Load Factor	90%	21.82%
	70%	18.27%
Coal Price	+20%	19.34%
	-20%	20.86%
Cost of purchasing power from liquid fuel plants	+20%	23.56%
	-20%	15.99%
Exchange Rate	+20% (appreciation of Tk)	24.05%
	-20% (depreciation of Tk)	16.93%
Fuel Mix (Indonesian 100%)	100%	20.41%

(source) JICA Study Team

In the benefit side, the increase in the cost of purchasing power from liquid fuel plants enhances EIRR to 23.56%. In the cost side, two variables can expand EIRR to more than 23%: the reduction of plant cost, and the appreciation of Taka against US Dollar. However, overall, the Project can generate sufficient level of EIRR staying above 16% and in excess of the social discount rate prevailing in Bangladesh at 12.48% regardless of the changes in any of the parameters. It can be judged that the economic viability of the Project can be endorsed.

Chapter 12

Public Consultation

Chapter 12

Public Consultation

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12.1 Meeting Minutes

Construction of 2x600MW Coal Fired Power Plant at Matarbari, Cox's Bazar
Minutes of 1st Stakeholder Meeting (Power Plant)

Venue	:	Yunus Khali Govt. Primary School, Kalarmarchhara, Moheshkhali :
Date	:	November 12, 2012
Time	:	10:00 AM to 2:00 PM
Participants	:	List of Participants is enclosed.

The meeting was presided over by Mr. Aloke Kimar Sarker, Managing Director of Coal Power Generation Company Bangladesh Ltd. (CPGCBL). Mr. Aloke Kumar Sarker welcomed all participants. He thanked Japan International cooperation Agency (JICA) for their cooperation to conduct the feasibility study for construction of 2x600MW Coal Fired Power Plant at Matarbari, Cox's Bazar. He also thanked the JICA Study team for carrying out the study. He requested all participants to give their valuable comments on implementation of the project.

Mr. Saito, Team Leader of JICA Study Team and Mr. Abdul Latif Khan of BPDB also spoke on the occasion followed by the power point presentation on the feasibility study for construction of 2x600MW Coal Fired Power Plant at Matarbari, Cox's Bazar presented by Mr. Rama Nath Roy of Engineers Associates Limited (EAL).

After presentation, the following discussions were held:

1. Mr. Badiul Alam, Unuskhali, Kalarmarchhora, Moheshkhali wanted to know the exact requirement of land for the power project in Matarbari and Dhalghata union. Secondly, salt and shrimp cultivation are done in Matarbari area, which meets the requirement of salt and shrimp throughout the country. He wanted to know whether the power plant will affect the salt and shrimp cultivation. In reply, Mr. A.Latif Khan, Superintendent Engineer of BPDB informed that about 1000 acres of land will be required for the plant. No adverse effect will take place on shrimp and salt cultivation in the surrounding area of the plant as the latest ultra super critical (USC) technology will be applied in the plant to make it environment friendly.
2. Mr. Hasan Bashir, Business man and local politician thanked JICA for their great initiative. He also thanked Japan government for their friendly attitude towards Bangladesh. People of Matarbari are very proud and happy about it. He requested the authority to ensure maximum protection for the nature and environment so that salt, shrimp and battle leaf cultivation are not affected. Moreover, he wanted to know whether this plant will affect the human being by any means. In reply, Mr, Mr. A.Latif Khan, Superintendent Engineer of BPDB informed that this power plant will be constructed using the most advanced technology. So, human being will not be affected.
3. Md.Gias Uddin, Business man and local politician raised that they will lose their livelihood if the 1000 acres of land of Matarbari is acquired for the project. So, he requested the project authority to provide employment to the local people in the project. In reply, Mr. A.Latif

Khan, Superintendent Engineer of BPDB assured that priority will be given to the local people for employment in the project. Moreover, JICA Study Team is working on it to develop a rehabilitation plan as well. So, there are no worries for the local people in this regard.

4. Mr. Nurun Nobi, UP member, Kalarmarchhora is very hopeful that the present shortage of power supply will be improved to some extent if this power plant is implemented. So, he is very much eager to know when this power plant will start functioning. In reply, Mr. A.Latif Khan, Superintendent Engineer of BPDB informed that feasibility study is being now carried out. This will be completed by June 2013. If the project is found viable, JICA will give a primary report to the Government of Japan. After that the Government of Bangladesh will execute a loan agreement with the Government of Bangladesh, which may take another one year at least. Then EPC contractors will be engaged to construct the plant. This may take few years to complete the construction and then the plant will be commissioned. So, it is a long process.

5. Mr. Muhibullah, School teacher, Matarbari reminded that few months ago in Japan due to an earthquake there was a huge damage to nuclear power plant, which causes pollution to the atmosphere. So, he wanted to know any consequences if this project in Matarbari faces the similar natural disaster in future.

   Secondly, he wanted to know the amount of vibration and sound caused by this power plant.

   Thirdly, he is very annoyed with the fly ash which may cause respiratory problems to the people in the surrounding area of the project.

   In reply, Mr. A.Latif Khan, Superintendent Engineer of BPDB informed that the proposed power plant is not nuclear power plant. It is a coal based power plant and well protected. So, it will not be affected by any natural disaster unless it is devastating.

   As this is a high tech power plant, there would not be much of sound outside power plant.

   In this power plant no fly ash will be produced as ultra super critical technology will be applied. Flue gas will contain only 0.02% ash and moreover the flue gas will be discharged to the atmosphere through a stack of about 275m high. So it will not affect the human being around the power plant

6. Mr Fazlul Karim, Businessman, Sariar Dail, Matarbari thinks that the power plant to be established in Matarbari is not only a pride to matarbari but Cox's Bazar also. The people of Matarbari are very happy but the communication system in Matarbari with other parts of Bangladesh is very bad. So, he hoped that the authority will construct road also apart from the power plant. In reply, Mr. A.Latif Khan, Superintendent Engineer of BPDB informed that there is a plan also to construct a road in Matarbari which will be extended to Chittagong-Cox's Bazar highway.

7. Md. Jomir Uddin, Businessman, Matarbari, a local resident of Matarbari is in favour of the construction of power plant in Matarbari. He also informed that people of Matarbari are very optimistic to see this project being implemented. However, he raised some points to take into consideration for wellbeing of the people of Matarbari.

The points are as follows:

a. Priority will be given to the local people for employment in the project.

b. All roads, school, college, madrashas, health centers, bazars and fisheries ghats etc. shall be developed. All roads of Matarbari island and roads along the east and west side of the island shall be made pucca.

c. The protective dams along the west coast of Matarbari Island shall be made very strong and permanent to save the island from cyclone, tidal waves and erosion.

d. The compensation for land shall be provided three times of registered rate.

e. Proper compensation shall be provided to the affected fishermen, salt farmers and others. They shall be rehabilitated with appropriate employment opportunities.

f. Road to Chittagong from Matarbari shall be improved.

g. The electricity shall be supplied to Matarbari area at reduced rate (tariff).

h. The plant must be environment friendly so that the environment is not affected.

In reply, Mr. Aloke Kumar Sarker, MD, CPGC and Mr. A Latif Khan, SE, BPDB assured them to take the above points into consideration. Both of them emphasized that the plant will be constructed using the latest technology, which has very negligible impacts on the environment. So, there is nothing to worry in this regard. They also mentioned that there are some points subject to government policy. These points will be raised to government level for consideration.

Finally, Mr. Aloke kumar Sarker, MD, CPGC thanked all participants for giving their valuable comments and assured the people to take all points raised by them into consideration for implementation of the power plant project in Matarbari.

Then he concluded the stakeholder meeting giving thanks to all participants.


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Photographs taken during Stakeholder Meeting

Preparatory Study on Chittagong area Coal Fired Thermal Power Plant Development Project

Minutes of 2nd Stakeholder Meeting (Power Plant)

Venue : Moheshkhali Upazila Parishad Auditorium, Cox'x Bazar

Date : 16/04/2013

Time : 11:30 AM

Participants : List of Participants is enclosed in **Annex-1**

Photographs : Some pictures taken during the meeting are given in **Annex-2.**

The meeting was presided over by Md. Anwarul Naser, Upazila Nirbahi Officer (UNO) of Moheshkhali Upazila. Mr Abul Quasem, Managing Director of Coal Power Generation Company Bangladesh Limited (CPGCBL) welcomed all participants. He thanked Japan International cooperation Agency (JICA) for their cooperation to conduct the feasibility study for construction of 2x600MW Coal Fired Power Plant at Matarbari, Cox's Bazar. He also thanked the JICA Study team for carrying out the study. He requested all participants to give their valuable comments on implementation of the project.

Then Mr. Saito, Team Leader of JICA Study Team spoke on the occasion followed by the power point presentation on the feasibility study for construction of 2x600MW Coal Fired Power Plant at Matarbari, Cox's Bazar presented by Mr. Rama Nath Roy of Engineers Associates Limited (EAL).

After presentation, the following discussions were held in the question & Answer session:

1. **Mr. Master Nur Baksh of Majidia Alim Madrasa, Matarbar**i raised that the first stake holder meeting was held back in November at Matarbari. In that meeting it was decided to hold the second stake holder meeting at Shariar Dail. But the second stakeholder meeting was being held at Moheshkhali Upazila Complex blaming that Shariar dail is not safe place. So, he became very upset and felt insulted. Apart from this, he raised that nothing has been specifically mentioned about the female workers in regard to the employment of local people. So, he requested to hold another stakeholder meeting at Matarbari site in the future to enable more local people to participate in the meeting. He mentioned that he would be in favour of establishing

power plant at Matarbari if the local people are in favour of the power plant at Matarbatri.

In reply, **Mr. Abul Quasem. Managing Director of CPGCBL** said that there are not enough people moving at night causing Matarbari site an unsafe place at night. However, he thinks that next stakeholder meeting would be held at Matarbari. In regard to the employment of female workers, he mentioned that there will be no discrimination with female workers. Workers of all genders will have equal opportunity.

2. One of the participants raised whether JICA has decided to finance this project or not. He asked how the compensation will be provided to the affected people. He also requested to hold another stakeholder meeting at Matarbari site.

   In reply, **Mr. Abul Quasem. Managing Director of CPGCBL** mentioned that JICA will take the decision for funding this project based on the discussions of these meetings and also from the results of social and environmental studies. JICA has not yet taken any decision. But, it is understood that JICA is interested to finance this project. Normal compensation will be provided to the affected people as per Government law. However, additional compensation may be provided to the affected people as per JICA's guidelines if the project is financed by JICA. He also assured to hold another stakeholder meeting at Matarbari if possible.

3. **Mrs. Shamim Ara Dulali, Upazilla Women Vice Chairman** also reiterated that no power plant shall be constructed unless the local people are fully motivated in terms of their compensation, equal rights for both genders and assurance of no negative impacts on environment. So, she requested to hold a meeting at a much larger scale at Matarbari and Dholghata and gather the opinions of the people living in these areas.

   In reply, **Mr. Abul Quasem. Managing Director of CPGCBL** told that it is not possible to take opinions from each and every people. The outcome of any stakeholder meeting is disseminated to concerned people to develop awareness among them. He also assured that people of both genders will enjoy equal opportunity in terms of employment and compensation etc.

4. **Md. Saleh Ahmed, Upazilla Freedom Fighter Commander,** Moheshkhali, Cox's Bazar was very overwhelmed with the decision of the Bangladesh Government for

the establishment of this power plant at Matarbari by the end of the year of 2021. He welcomed this project on behalf of local people and also welcome the organizations associated with this project. He would also like to add that the main vision after the independence was urbanization of villages. For this foreign aid is required for rapid urbanization. However, he mentioned that the local workers, both men and women will take part equally for this project. He also demanded that electricity must be provided to the people of Moheshkhali on priority basis if the power plant is established.

In reply, **Mr. Abul Quasem. Managing Director of CPGCBL** told that the local workers will be always privileged to work first. But, since this project is very big, workers from outside also have to be employed even after employing all the local workers. The main purpose of this power plant is to quench the necessity of electricity for the people; certainly the local people will get their necessary supply of electricity.

5. **Mr. Merul Aksar (Moni) of Dholghata** mentioned that the embankment is very necessary to protect the proposed power plant from cyclonic stroms and tidal surge. He understood that the existing embankment will be further developed to protect the power plant. Dhalghata union may be protected from the cyclonic storms and tidal surge if the embankment is further extended upto Dhalghata. So, He requested to develop the existing embankment along Dhalghata Union.

   In reply, **Mr. Abul Quasem. Managing Director of CPGCBL** assured to develop the existing embankment to protect the power plant and Dhalghata union as well.

6. **Mr. Aminul Haq, Teacher and Journalist** was very optimistic to see this power plant being implemented very soon for development of Dhalghata union. So, he requested to start construction work before the forthcoming rainy season.

   In reply, **Mr. Abul Quasem. Managing Director of CPGCBL** informed that the project is a large one. So, it is not possible to start construction of this project so early. If JICA finds that this project is feasible, a loan agreement will be signed between JICA and GOB by March, 2014. Then consultants will be employed for this project. EPC Contractor will be engaged subsequently. It will take 6 months for design of the plant. Then construction may be started by the year of 2016-2017 and the plant will be commissioned in 2022-2013.

7. **Md. Gias Uddin Shaheen, Kalarmar Chora Union, Leader of Krishok League and Businessman** mentioned that If a power plant is established at the boundary of Matarbari and Dholghata unions, surrounding areas e.g Kalarmar Chora union will also be affected as effluents and other chemicals will be discharged within a three mile radius from the power plant. It was learnt that smog due to flue gas will cover up the sky around a radius of 3 mile and the sun won't be visible for at least 4 hours starting from the morning sunrise. The people of Moheshkhali rely highly on the sun since they are farmers of shrimp, betel leaves and salt. As a result, they will lose their source of income. So, he requested to use such technology that will not affect the project site and the surroundings as well.

   In reply, **Mr. Abul Quasem. Managing Director of CPGCBL** told that there won't be any smog to block sunshine. Similar coal based power plant is now in operation at Boropukuria in Dinajpur, where no smog is produced. He invited the interested people to see the situation in Boropukuria for themselves.

8. **A political leader and teacher**, one of the participants asked why imported coal will be used for this proposed power plant in spite of the availability of domestic coal..

   In reply, **Mr. Abul Quasem. Managing Director of CPGCBL** informed that there is a huge reserve of coal at the northern region of Bangladesh. But, due to lack of coal policy, extraction of domestic coal is stopped. In addition, coal need to be transported to the project site. In order to generate 1200 MW electricity, 10,000 metric tone of coal will be required each day. It is quite difficult to transport this huge amount of coal from Dinajpur to the project site by poor roads and highways. So, it will be best to import coal from other countries.

9. **Md. Akhtaruzzaman, Member: Dholghata Union Parishad** informed that there are at least one thousand families in total at Matarbari and Dholghata union, whose land will be acquired for the project. Moreover they will also lose their means of livelihood. It was found in other project that the affected people don't get proper compensation for land and proper resettlement. So, he urged JICA to take necessary steps for proper compensation to the affected people and their proper resettlement with adequate means of livelihood.

   In reply, **Mr. Abul Quasem. Managing Director of CPGCBL** informed that only twenty one houses will be affected. He mentioned that the proposed site has been selected in the area where very few houses will be affected. The affected people will be properly resettled and as far as their income is concerned, they will be supervised in finding their means of livelihood before/ after their resettlement.

10. **Mr. Amir Gaffur Parvez, Secretary, Moheshkhali, Press club** mentioned that it is necessary to construct new power plants for development of Bangladesh. A land of 455hactare will be required for this proposed power plant. Most of the cases it was found that compensation for the land goes to the wrong hands. So, he wanted proper compensation to the actual owners of the lands. He also wanted proper resettlement of the people who will lose their houses. He wanted the equal opportunity for both male and female workers at the project site.

    In reply, **Mr. Abul Quasem. Managing Director of CPGCBL** informed that only the affected people will be compensated, and they will get it easily. The equality of male and female workers at the power plant site will be taken care.

At the end of question & answer session, **Mr. Mir Kashem Chowdhury, Chairman, Kalarmar Chora UP** spoke on the occasion. He gave greetings to all the people present at the meeting. There are many arguments and counter-arguments regarding the coal based power plant. The people of Moheshkhali are dependent on three very important things- fish, salt and water. If these three things are protected, there is no problem in establishing the power plant. He welcomed JICA study team members and requested them to keep in mind that there is no air pollution. Three unions over here will be affected the most. The local people and the environment will be highly affected. If the water temperature increases by a small margin of 2%, there will be negative impact on the fishes. So, he wanted assurance that the people of these 3 particular unions (Matarbari, Dhalghata & Kalar Marchora) won't be victims of any health related **hazards.**

Then Mr**. Ekramul Haq Chowdhuri Ruhul, Chairman Matarbari Union** spoke on the occasion. He raised few issues about the construction power plant at Matarbari. The lands which are required for the establishment of the power plant in Matarbari, the owners of these particular lands and the affected people due to this project, were not called on the stakeholder meeting. Only few of the people were called. If a power plant is established in Matarbari, then opinions of all the people living on this area have to be taken. If only the people are in favour of this project, only then a power plant can be established on this area. So, for the people of Matarbari and Dholghata, two stakeholders meeting have to be held on these two particular areas in a much larger scale and all of their opinions have to be taken, these steps are highly encouraged for JICA. If the above steps are followed accordingly, only then the establishment of this power plant is welcomed by him.

Then **Mr. Abu Bakar Siddique , Upazila Chairman of Moheshkhali Upazila** spoke on the occasion. He is also in favour of the project in Matarbari area if the plant is environment friendly.

Then **Mr. Ahmanullah Bacchu, Chairman, Dholghata Union** told that If a coal based power plant is established in Dholghata Union, then the people of this area will be deprived from the daily source of income. So, few alternative ways of income have to be introduced to these people. They have to be rehabilitated in a proper way. He requested JICA to pay a closer attention on the negative environmental impacts that are likely to occur in this area due to the establishment of this power plant. Each and every year, the people of Dholghata union suffer from floods. There is an embankment, but it is not enough to protect the people from the flood. So by taking this information into account, he requested JICA to build a state of the art embankment for the people of Dholghata Union and also for the proposedpower plant.

Finally, **Mr. Anwarul Naser, UNO Moheshkhali** gave greetings to all the people present in the meeting.. Matarbari and Dholghata need some development. These areas are always a hot spot for natural disasters. As a result, if a power plant is established here, the government has to take proper initiatives to protect this power plant as well. One of them would be to build an embankment and protect the people of this area first; this is nothing but a matter of common sense. He wanted these much needed developments.

And one or two speeches here today have been really great. He demanded to show the videos of other coal based power plants in the next meeting. To conclude, He would like to thank the people who are an integral part of their respected lands; managed their times and came here to be a part of this important meeting.

Then the meeting was concluded with thanks to all present in the meeting.


২য় স্টেক হোল্ডার


২য় স্টেক হোল্ডার মিটিং


হোল্ডার

12.2 List of Participants

(1) 1st Stakeholder meeting

Sl. No.	Name of Participant	Designation & Organization	Contract Phone No.
1	Tadashi NAKAMURA	JICA Study Team	
2	Tadashi Miyagi	JICA Study Team	
3	Shigeki WADA	JICA Study Team	
4	Junko Fujiwara	JICA Study Team	
5	Biplob Kumar Sarker	DGM, Cox's PBS	01769400127
6	Shafi Uddin Ahmed	AGM, Cox's PBS	01817385367
7	Md. Iddris	Assistant Teacher	01815152415
8	Zainal Abedin	Assistant Teacher	01839081196
9	Abdul Quddus	Unit Manager, BGS	01819633081
10	Anjoy Paul	Asst. Teacher, Unishkalli G.P. School	01836108329
11	Badiul Alam	Business	01838140576
12	Maniksha Hero	Doctor	01811672507
13	Engr. Md. A. Latifkha P.Eng	S.E, BPDB	01730705077
14	Hazi Mohammad Hossain	Business	01719324464
15	Mohammad Ledu		
16	Nurul Islam	Non Resident Bangladeshi	
17	Abdur Rahim	Businessman	01738430540
18	Jemsen Burua	Teacher	01735038206
19	Abdur Rahim	In Charge, BGS	01818521493
20	Hazi Monirul	Retired	01845670148
21	Sahnewaj	Sub Inspector of Police	01811811650
22	Iqbal Bahar Coung	Secretary Union Council (SUP)	01838142347
23	Badal Kanti Sheel	Service	01823910624
24	Amin Ullah		
25	Shamsul Alam	Business	01834011915
26	S.M Didarul Islam	Sub Assistant Agriculture	01824898929
27	Shahida Akhter	Member Union Council (MUP)	01713967391
28	S.M. Iqbal Bahar Choudhury		01813142433
29	Abdul Halim	Social Welfare Worker	01825251995
30	M. Rahman	Resource Expert, JICA, EAL	01917278455
31	Nasrin Akter (Poly)	JICA Study Team, EAL	01749450099
32	Sharmin Akter (Mita)	JICA Study Team, EAL	01710081362
33	Bipasha	JICA Study Team, EAL	01836740448
34	Md. Sahabuddin	Journalist & Councillor	01820538942
35	Rahul Bagum	Journalist	01713645923
36	Rejaul Karim	Asst. Teacher, Younus Khali G.P School	01813950200
37	Najim Uddin	Head Teacher, Younus Khali G.P School	01828423508
38	Mofaida Begum	Asst. Teacher	01723295355
39	Monowar Hossain	B.M	01716858318
40	A.M.M.K. Bashar	Director, CMD	01819221016
41	Shigeru SAITO	JICA Study Team	

42	Sachio KOSAKA	JICA Study Team	
43	Aloke Kumar Sarkar	C.E. Services & MD. CPGC, BPDB	
44	Aqrumul Amin	Business	
45	Sadrul Amin	Business	01837015401
46	Gias Uddin	Business	01834136960
47	Mohammad Hossain	Business	01811815176
48	Zamil Uddin	Business	01740806253
49	Mohammad Sayed	Agriculture	
50	Khalil		01839229593
51	Fazlur Rahman	Business	
52	Faizul Karim		01814330897
53	Hasan Bashir	Business	01727239280
54	Eman Ali	Retirement	01734976392
55	Noor Nobi	Member Union Council (MUP)	01713619965
56	Saidul Ali		
57	Jafor		
58	Abdul Mannan		
59	Rafique Uddin		
60	Md. Mujibul Haque	Agri Officer, SAO	
61	Belal Uddin	Business	01823911546
62	Amirul Bahai	UAO, Agri Officer	01715235590
63	Mosaddek Faruk	Business	01710388213
64	Mohammad Golam Ali	Asst. Teacher, Younus Khali G.P School	01814702525
65	Monjur Alam	Member Union Council (MUP)	01826309697
66	Bodiullah	Member Union Council (MUP)	01827228910

(2) 2nd Stakeholder meeting

Sl. No.	Name of Participant	Organization & Designation	Contact Phone No.
1	Md. Didarul Islam	Matarbari, Sariardail	01725540997
2	Md. Sibbir Ahmed	Matarbari, Sariardail	01740806250
3	Amina Begum	Matarbari, Sariardail	01845680214
4	Md. Alamgir	Health Asst. Kalarmarchara	01829254714
5	Gopal Krisna Das	U.S.S.O ®, Maheshkhali	01825709693
6	Mahmudul Karim	Imam, Matarbari	01740817215
7	Mohammad Zakaria	Imam, Matarbari	01733744574
8	Mohammad Helal	Imam, Matarbari	01732987322
9	Sahida Akter	Member, Kalarmarchara UP	01713967391
10	Dr. Mansur Ahmed	Ex. Member, Kalarmarchara	01710303036
11	Md. Gias Uddin Sahin	Unuskhali, Kalarmarchara UP	01834136960
12	Md. Saleh Ahmed	Maheshkhali	01823381104
13	Md. Kala Mia	Maheshkhali	01834507543
14	Md. Sadekullah Siddique	Maheshkhali	01816863776
15	Md. Aman Ullah	Head Master, Kalarmarchara High School	01815576603
16	Rabi Chandra Chakma	Office Assistant, SAFO	01855679681
17	Samar Chandra Day	Statistical Officer	01816059970
18	Abdur Rahim	BGS APC	01818521493
19	Abdul Hamid	Head Teacher, Matarbari Govt. Primary School	01718468339
20	Mr. Mahbub	Journalist, Dainik Himchari	01819330675
21	Md. Mokshod	Maheshkhali	01815540669
22	Md. Altas	Maheshkhali	01825253810
23	Mohammad Rashid	Secretary, Dhalghata UP	01553754037
24	Md. Sahbuddin	Maheshkhali	01826141932
25	Md. Ataullah	Member, Dholghata UP	01824827566
26	Md. Kauser	Matarbari	01726283390
27	Nur Mohammad	Matarbari	01812586855
28	Md. Ismail	Matarbari	01740806258
29	Mr. Hamed Hossain	Social Worker, Matarbari	01740817275
30	Mr. Nur Box	Senior Teacher, Matarbari Alim Madrasha	01740974088
31	Md. Ishaque	President, Fisheries Co-operative Society, Matarbari	01928870893
32	Md. Abdul Malek	Department of Women Affairs Office	01942912550
33	Md. Abul Bashar Parvez	Press Club	01815356294
34	Mr. Zamir Uddin	Matarbari	01740806253
35	Md. Abu Taher	Daily Amader Cox's bazaar	01815099700
36	Shamim Ara Dulaly	Women Vice Chairman	01813060583
37	Sirazul Alam	Member Dhalghata UP	01815941395
38	Shakirullah Khokon	Maheshkhali	01831511907
39	Nurul Absar Chowdhury	Secretary, Nobojagoron Club, Dhalghata	01828586244

Sl. No.	Name of Participant	Organization & Designation	Contact Phone No.
40	Jiarul Absar Zia	Secretary, Nobojagoron Club, Dhalghata	01825311644
41	Farij Ullah	Maheshkhali	01818715541
42	Nabir Hossain Ajad	Member, Dholghata UP	01824910207
43	Rahul Borman	The Daily Prothom-alo	01713645923
44	Mr. Anamul Haque Rahul	Chairman, Matarbari UP	01713620023
45	Aminul Haque	Moheshkhali, Press Club	01712112726
46	Sokuntaj Begum	Member, Matarbari UP	01821819940
47	Mahbub Rokon	Moheshkhali, Press Club	01832077961
48	Meer Kashim Choudhuri	Chairman, Kalarmarchara UP	01743524552
49	Ahasan Ullah Bacchu	Chairman, Dhalghata UP	01813622118
50	Norihiko FUKAZAWA	JICA Study Team	
51	Shigeru SAITO	JICA Study Team	
52	Tadashi NAKAMURA	JICA Study Team	
53	Shigeki WADA	JICA Study Team	
54	Tadashi MIYAGI	JICA Study Team	
55	Md. Mozammel Hossain	JICA Study Team	
56	Katsuya Kasai	JICA	
57	Kazuhiro YOSHIDA	JICA Study Team	01775486867
58	Osamu NAKAZAWA	JICA Study Team	01775486866
59	Abdur Rahman	Access Road IDEA	01911010714
60	Engr. Md. Asid Masud	Access Road Project, JICA Study Team	
61	Md. Aktaruzzaman	MUP of Dhalghata	01812750143
62	Yoichiro KUBOTA	JICA Study Team / TEPCO	01726360353
63	A.K.M Anisur Rahman	Executive Director, EAL	01711687327
64	Junko FUJIWARA	JICA Study Team	
65	Rama Nath Roy	JICA Study Team	01712619317
66	Md. Anwarul Haque	UNO, Moheshkhali	01731592321
67	Md. Abdul Quasem	MD, Coal Power Generation Co.	01716442098
68	Abu Bakar Siddique	Chairman, Moheshkhali UP	01817222851
69	Md. Habibur Rahman	Officer-in-Charge Moheshkhali PS	01713773669
70	Mostak Ahmed	Vice Chairman	01819628668
71	Shamim Ara Dulari	Vice Chairman	01813060583
72	Moksud Miah	Mayor, Moheshkhali Municipality	01815861832
73	M. Rahman	JICA Study Team	01917278455
74	Nasrin Akter (Poly)	JICA Study Team	01749450099
75	Md. Sumon	JICA Study Team	01726789008
76	Naznin Akter	JICA Study Team	01717757087
77	M. Ilyeas Rahman	BPEB	01711168468
78	Md. Tofazzal Hossain	JICA Study Team	01914464114
79	Waresur Rahman	JICA Study Team	01754175330
80	Md. Sahab Uddin	Journalist, Daily Samokal	01820538942
81	Engr. Biplob Kumar Sarker	DGM, Pally Bidyut Samity	01769400127
82	M. Ramjan Ali	Journalist, Purbodesh	01840226071
83	Md. Anwarul Azim	ULAO, Matarbari	01818246445

Sl. No.	Name of Participant	Organization & Designation	Contact Phone No.
	Chowdury		
84	Mr. Nurul Absar	Political Leader, Dhalghata	
85	Mr. Abu Taleb	Member, Dhalghata	
86	Shamima Akter	Head Teacher,	01824875985
87	Md. Shakir Ullah	Moheshkhali	01831511907
88	Md. Anisul Haque	Forest Range Officer	01716535337
89	Gowranga Ch. Biswas	UAE, LGED	01712092958
90	Md. Jahangir Iqbal	Range Officer	01714404441
91	Md. Solayman	Beat Officer	01714868720
92	Sarder Shariful Islam	AD, Department of Environment	01556340776
93	Jahangir Alam	MLSS, LGED, Moheshkhali	01818850644
94	Mafizur Rahman	Affected People	01815943357
95	Bodoruddin Md. Ali	Affected People	0184507943
96	Dalilur Rahman	Affected People	
97	Abdul Salam	Affected People	
98	Younus Ali	Affected People	
99	Md. Alam	Affected People	
100	Bodor Uddin	Affected People	
101	Saidul Haque	Affected People	
102	Zahed Hossain	Affected People	
103	Arof Ali	Affected People	
104	Mohiuddin (Son of Md. Ali)	Affected People	
105	Ayat Ullah	Affected People	
106	Abdul Razzak	Affected People	
107	Obaidul Haque	Shirar Dail	
108	Sura Khatun (Md. Nacher)	Affected People	
109	Chinu Ara Begum (Kamal Hossain)	Affected People	
110	Zubaida Khatun (W/O Hasan Ali)	Affected People	
111	Rahima Khatun (W/O Abdul Hakim)	Affected People	
112	Shamim Ara (D/O Md. Ismail)	Affected People	
113	Shahadat Ullah (Relatives of Ayatullah)	Affected People	
114	Mr. Sultan	Member, Bazar Committee	
115	Dr. Wadud	Secretary, Bazar Committee	
116	Nazim Uddin	Majee, Matarbari	
117	Hasan Ali	Affected People	
118	Abdus Sattar	Businessman, Santi Bazar	
119	Maolana Abu Naser	Imam	
120	Moulana Hamed Ullah	Imam, Matarbari	
121	Shaokat (S/O Nasir Uddin)	Affected People	
122	Mr. Supon	Worker, BGS NGO	01812809655
123	Md. Alam	Shairar dail	01822858007
124	Zamir Uddin	Shairar dail	
125	Riazul Islam	Shairar dail	

Sl. No.	Name of Participant	Organization & Designation	Contact Phone No.
126	Mr. Munnah	Officer, ASA NGO, Matarbari	01826142004
127	Mr. Saleh Ahmed	Head Teacher, Dhalghata High School	01813727367
128	Mr. Moksedul Karim	President, Managing Committee, Dhalghata High School	01812604844
129	Md. Shihab Uddin	Secretary, Matarbari UP	01819647948
130	Ansarul Karim	Member	01826503992
131	Sirajul Haque	Journalist, Moheshkhali	01727628295
132	Ahmed Ullah	Head Teacher, Matarbari Govt. Primary School	01818401797
133	Md. Shafiqul Islam	JICA Study Team	01711984984

6.3 Presentation Materials (Annexure-6)

Report on

Environmental Impact Assessment

of

Construction of Matarbari 600X2 MW Coal Fired Power Plant and Associated Facilities

Volume 2/2

Submitted By

Coal Power Generation Company of Bangladesh Limited

(An Enterprise of the People's Republic of Bangladesh)

Conducted By

Tokyo electric Power Services Co. Ltd (TEPSCO)
(Japan International Cooperation Agency Study Team)

June 2013

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Annexure 1

Environmental Regulation

Annex 1

Environmental Regulation

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1.1 Environmental Regulation

Details of the environmental standards applicable in Bangladesh are described in the Environmental Conservation Rules (ECR). Regulated areas cover all industries, and regulated items are air quality, water quality (surface water, drinking water), noise (boundary, source), emissions from motor vehicles or ships, odor, sewage discharge, waste from industrial units and industrial effluents or emissions. Items and standards, which are related to the construction and operation of coal-fired power plants, are listed below. Tables and annotations of environmental regulations are described as textual descriptions of ECR.

ECR is currently in the process of amendment. There is a possibility that the environmental regulations of the following items will be amended, but the current regulations are applicable until the amendment process is completed.

In addition to ECR, this project will also comply with IFC (International Finance Corporation) EHS (Environmental, Health and Safety) Guideline “General”, “Thermal power” and “Transmission and Distribution”.

(1) Air quality

Table 1.1-1 shows the air quality standards in Bangladesh. Air quality standards adhere to WHO guidelines, also mentioned in the table below.

Table 1.1-1 Standards for air quality in Bangladesh [1]

No.	Parameter	Concentration (mg/m^3)		Exposure Time
		ECR	IFC Guideline (General: 2007)*	
a)	Carbon Mono-oxide	10	-	8 hours
		40	-	1 hour
b)	Lead (Pb)	0.5	-	Year
c)	Nitrogen Oxide	0.1	0.04	Year
		-	0.2	1 hour
		-	0.2	1 hour
d)	Suspended Particulate Matter (SPM)	0.2	-	8 hours
e)	Particulate Matter 10μm (PM_{10})	0.05	0.02	Year
		0.15	0.05	24 hours
f)	Particulate Matter 2.5μm ($PM_{2.5}$)	0.015	0.01	Year
		0.065	0.025	24 hours
g)	Ozone	0.235	-	1 hour
		0.157	0.160	8 hours
h)	Sulfur Dioxide	0.08	-	Year
		0.365	0.125	24 hours

Notes: * Air quality standard of IFC Guideline is quated from WHO Guideline.

(Source: Bangladesh Gazette July 19, 2005, IFC Environmental Health and Safety Guidelines 2007

[1] Not exceed one time per year

Table 1.1-2 shows gas emission standards for industrial facilities in Bangladesh, and Table 1.1-3 shows gas emission standards for industrial boilers in Bangladesh.

Table 1.1-2 Gas emission standards for industrial facilities

No.	Parameter	Unit	Standard Limit
1	Particulates		
	a) Electric Power plants of 200 Megawatts and above	mg/Nm^3	150
	b) Electric Power plants less than 200 Megawatts	mg/Nm^3	350
2	Chlorine	mg/Nm^3	150
3	Hydrochloric Acid gas & mist	mg/Nm^3	350
4	Total Fluoride (F)	mg/Nm^3	25
5	Sulfuric Acid mist	mg/Nm^3	50
6	Lead particles	mg/Nm^3	10
7	Mercury particles	mg/Nm^3	0.2
8	Sulfur Dioxide		
	a) Sulfuric Acid manufacture (DCDA process)	kg/ton	4
	b) Sulfuric Acid manufacture (SCSA process) Minimum Stack height for Sulfuric Acid emissions	kg/ton	10
	Lowest height of stack for dispersion of sulfuric acid a) Coal Fired Electric Power plants		
	i) 500 Megawatts & above	m[2]	275
	ii) 200-500 Megawatts	m	220
	iii) Below 200 Megawatts	m	$14\,(Q)^{0.3}$ [3]
	b) Boilers		
	i) For Steam up to 15 tons/hour	m	11
	ii) For steam above 15 tons/hour	m	$14\,(Q)^{0.3}$
9	Nitrogen Oxides		
	a) Nitric Acid manufacture	kg/ton	3
	b) Gas Fired Electric Power plants		
	i) 500 Megawatts & above	ppm	50
	ii) 200-500 Megawatts	ppm	40
	iii) Less than 200 Megawatts	ppm	30
	c) Metal Treatment Furnace	ppm	200
10	Soot & Dust Particles		
	a) Air Ventilated Furnaces	mg/Nm^3	500
	b) Brick-fields	mg/Nm^3	1000
	c) Cooking Furnaces	mg/Nm^3	500
	d) Limestone Furnaces	mg/Nm^3	250

(Source: The Environmental Conservation Rules, 1997)

Table 1.1-3 Gas emission standard for industrial boiler

No.	Parameters	Standard for presence in a unit of mg/Nm^3
1	Soot and particulates (fuel based)	
	a) Coal	500
	b) Gas	100

[2] Lowest height of stack is defined
[3] $Q=SO_2$ emission in kg/hour

No.	Parameters	Standard for presence in a unit of mg/Nm^3
	c) Oil	30
2	Oxides of Nitrogen (fuel based)	
	a) Coal	60
	b) Gas	15
	c) Oil	30

(Source: The Environmental Conservation Rules, 1997)

A coal-fired power plant utilizes coal (main fuel) and oil (auxiliary fuel for startup). Since the planned output of the power plant is 600MW, the emission standard limit of particulates is 150mg/Nm^3. For Sulfur Dioxide, if a stack of 275m height is installed, there are no standard limits of emissions densities and amount limits. The emission standard limit of Oxides of Nitrogen shown in Table-3 is 600 mg/Nm^3 in the case of coal-firing and 300 mg/Nm^3 in the case of oil firing.

It is common to set emission standards to SO_2 based on global standards. Table 1.1-4 shows a comparison of the flue gas emission standards of Bangladesh to the World Bank (IFC). A new coal-fired power plant should consider these world standards.

Table 1.1-4 Comparison of flue gas emission standards between Bangladesh and IFC

Parameters	Bangladesh Standard	IFC Guidelines (Thermal Power: 2008)
SO_2	- [4]	850mg/m^3 [5]
NO_x	600 mg/m^3	510 mg/m^3
Particulate Matter (PM)	500mg/m^3	50mg/m^3
Dry Gas , Excess O_2 Content	-	6%

(Source: The Environmental Conservation Rules 1997, IFC Environmental Health and Safety Guidelines 2008)

(2) Water quality

Table 1.1-5 shows ambient water quality standards (inland surface water), Table 1.1-6 shows environmental water quality standards (drinking water), and Table 1.1-7 shows waste water standard parameters in Bangladesh. For drinking water standards and waste water standards, WHO standards are also stated in the tables below for comparison. World Bank (IFC) guidelines stipulate monitoring necessary heavy metals according to the characteristics of each thermal power plant.

[4] Lowest height of stack is defined
[5] As the high limit in non-degraded airsheds

Table 1.1-5 Ambient water quality standards (inland surface water)[6]

No.	Best Practice Based Classification	pH	BOD mg/1	Dissolved Oxygen (DO), mg/l	Total Coliform Bacteria quantity/ml
a)	Potable water source supply after	6.5-8.5	2 or less	6 or above	50 or less
b)	Water used for recreation	6.5-8.5	3 or less	5 or above	200 or less
c)	Potable water source supply after	6.5-8.5	3 or less	6 or above	5000 or less
d)	Water used for pisci-culture	6.5-8.5	6 or less	5 or above	5000 or less
e)	Industrial use water including chilling & other processes	6.5-8.5	10 or less	5 or above	
f)	Water used for irrigation	6.5-8.5	10 or less	5 or above	1000 or less

(Source: The Environmental Conservation Rules,1997)

Table 1.1-6 Environmental water quality standards (drinking water)

No.	Parameter	Unit	Standard Limit	WHO Guidelines
1	Aluminum	mg/l	0.2	0.2
2	Ammonia (NH_3)	mg/l	0.5	-
3	Arsenic	mg/l	0.05	0.01
4	Barium	mg/l	0.01	0.7
5	Benzene	mg/l	0.01	0.01
6	BOD_5 $20^{O}C$	mg/l	0.2	-
7	Boron	mg/l	1.0	0.5
8	Cadmium	mg/l	0.005	0.003
9	Calcium	mg/l	75	-
10	Chloride	mg/l	150-600	-
11	Chlorinated Alkanes			-
	Carbon Tetrachloride	mg/l	0.01	-
	1.1 Dichloroethylene	mg/l	0.001	-
	1.2 Dichloroethylene	mg/l	0.03	-
	Tetrachloroethylene	mg/l	0.03	-
	Trichloroethylene	mg/l	0.09	-
12	Chlorinated Phenols			-
	Pentachlorophenol	mg/l	0.03	-
	2.4.6 Trichlorophenol	mg/l	0.03	-
13	Chlorine (residual)	mg/l	0.2	-
14	Chloroform	mg/l	0.09	0.3
15	Chromium (hexavalent)	mg/l	0.05	-
16	Chromium (total)	mg/l	0.05	0.05
17	COD	mg/l	4	-
18	Coliform (fecal)	n/100 ml	0	-
19	Coliform (total)	n/100 ml	0	-
20	Color	Huyghens unit	15	-
21	Copper	mg/l	1	-
22	Cyanide	mg/l	0.1	-
23	Detergents	mg/l	0.2	-
24	DO	mg/l	6	-
25	Fluoride	mg/l	1	1.5
26	Hardness (as $CaCO_3$)	mg/l	200-500	-
27	Iron	mg/l	0.3-1.0	-

[6] Textual annotations are as follows.
(1) Maximum amount of ammonia presence in water is 1.2 mg/l (as nitrogen molecule) which is used for pisciculture.
(2) For water used in irrigation, Electrical Conductivity-2250 micro mho/cm (at 25oC). Sodium less than 26 mg/l, Boron less than 2 mg/l

No.	Parameter	Unit	Standard Limit	WHO Guidelines
28	Nitrogen (Total)	mg/l	1	-
29	Lead	mg/l	0.05	0.01
30	Magnesium	mg/l	30-35	-
31	Manganese	mg/l	0.1	0.4
32	Mercury	mg/l	0.001	0.006
33	Nickel	mg/l	0.1	0.07
34	Nitrate	mg/l	10	3
35	Nitrite	mg/l	Less than 1	-
36	Odor		Odorless	-
37	Oil & Grease	mg/l	0.01	-
38	pH		6.5-8.5	-
39	Phenolic compounds	mg/l	0.002	-
40	Phosphate	mg/l	6	-
41	Phosphorus	mg/l	0	-
42	Potassium	mg/l	12	-
43	Radioactive Materials (gross alpha	Bq/l	0.01	-
44	Radioactive Materials (gross beta	mg/l	0.1	-
45	Selenium	mg/l	0.01	-
46	Silver	mg/l	0.02	-
47	Sodium	mg/l	200	-
48	Suspended particulate matters	mg/l	10	-
49	Sulfide	mg/l	0	-
50	Sulfate	mg/l	400	-
51	Total dissolived solids	mg/l	1000	1000
52	Temperature	Ⅲ	20-30	-
53	Tin	mg/l	2	-
54	Turbidity	JTU	10	-
55	Zinc	mg/l	5	-

(Source: The Environmental Conservation Rules 1997, Guidelines for Drinking-water Quality WHO 2008)

Table 1.1-7 Wastewater Discharge Standards [7]

No.	Parameter	Unit	Inland Surface Water	Public Sewer at Secondary Treatment plant	Irrigated Land	IFC Guideline (Thermal power: 2008)
1	Ammoniacal Nitrogen (N molecule)	mg/l	50	75	75	-
2	Ammonia (free ammonia)	mg/l	5	5	15	-
3	Arsenic (As)	mg/l	0.2	0.05	0.2	0.5

[7] Textual annotations are as follows.
(1) These standards shall be applicable to industrial units or projects other than those given under Quality Standards for Classified Industries (Schedule 12).
(2) These quality standards must be ensured at the moment of going into trial production for industrial units and at the moment of going into trial production for industrial units and at the moment of going into operation for other projects.
(3) The value must not exceed the quality standard during spot checks at any time; if required, the quality standards may be stricter to meet the environment terms in certain areas.
(4) Inland Surface Water shall mean drains, ponds, tanks, water bodies or water holes, canals, rivers, springs and estuaries.
(5) Public sewer shall mean sewers connected with fully combined processing plant including primary and secondary treatment.
(6) Irrigated land shall mean appropriately irrigated plantation areas of specified crops based on quantity and quality of waste water.
(7) Inland Surface Quality Standards (Schedule 13) shall be applicable for any discharge taking place in public sewers or land not defined in Notes 5

No.	Parameter	Unit	Inland Surface Water	Public Sewer at Secondary Treatment plant	Irrigated Land	IFC Guideline (Thermal power: 2008)
4	BOD_5 20°C	mg/l	50	250	100	-
5	Boron	mg/l	2	2	2	-
6	Cadmium (Cd)	mg/l	0.05	0.5	0.5	0.1
7	Chloride	mg/l	600	600	600	-
8	Chromium (total Cr)	mg/l	0.5	1.0	1.0	0.5
9	COD	mg/l	200	400	400	-
10	Cr^{6+} (hexavalent Cr)	mg/l	0.1	1.0	1.0	-
11	Copper (Cu)	mg/l	0.5	3.0	3.0	0.5
12	Dissolved Oxygen (DO)	mg/l	4.5-8	4.5-8	4.5-8	-
13	Electrical Conductivity	micro mho/cm	1200	1200	1200	-
14	Total Dissolved Solids	mg/l	2,100	2,100	2,100	-
15	Fluoride (F)	mg/l	7	15	10	-
16	Sulfide (S)	mg/l	1	2	2	-
17	Iron (Fe)	mg/l	2	2	2	1
18	Total Kjeldahl Nitrogen (N)	mg/l	100	100	100	-
19	Lead (Pb)	mg/l	0.1	1.0	0.1	0.5
20	Mangaense (Mn)	mg/l	5	5	5	-
21	Mercury (Hg)	mg/l	0.01	0.01	0.01	0.005
22	Nickel (Ni)	mg/l	1.0	2.0	1.0	-
23	Nitrate (N molecule)	mg/l	10.00	Undetermined	10	-
24	Oil & grease	mg/l	10	20	10	10
25	Phenol compounds(C_6H_5OH)	mg/l	1.0	5	1	-
26	Dissolved Phosphorus (P)	mg/l	8	8	10	-
27	Radioactive Materials.	As determined by Bangladesh Atomic Energy Commission				-
28	pH		6-9	6-9	6-9	6-9
29	Selenium	mg/l	0.05	0.05	0.05	-
30	Zn (Zn)	mg/l	5.0	10.0	10.0	1
31	Total Dissolved solid	mg/l	2,100	2,100	2,100	-
32	Temperature	Centigrade	40	40	40-Summer	-
			45	45	45-Winter	-
33	Total Suspended Solid (TSS)	mg/1	150	500	200	50
34	Cyanide (CN)	mg/1	0.1	2.0	0.2	-

(Source: The Environmental Conservation Rules 1997. IFC Environmental Health and Safety Guidelines 2008)

(3) Noise and Odor

In regards to noise, the standard limit is set for every category of zone class. Table 1.1-8 shows the noise standards in Bangladesh.

Table 1.1-8 Standards for Noise [8]

<table>
<tr><th rowspan="3">No</th><th rowspan="3">Zone Class</th><th colspan="4">Limits in dBA</th></tr>
<tr><th colspan="2">ECR</th><th colspan="2">IFC Guideline (General: 2007)</th></tr>
<tr><th>Day</th><th>Night</th><th>Day</th><th>Night</th></tr>
<tr><td>a)</td><td>Silent Zone</td><td>45</td><td>35</td><td rowspan="2">55</td><td rowspan="2">45</td></tr>
<tr><td>b)</td><td>Residential Zone</td><td>50</td><td>40</td></tr>
<tr><td>c)</td><td>Mixed Zone (this area is used combining residential, commercial and industrial purposes)</td><td>60</td><td>50</td><td rowspan="3">70</td><td rowspan="3">70</td></tr>
<tr><td>d)</td><td>Commercial Zone</td><td>70</td><td>60</td></tr>
<tr><td>e)</td><td>Industrial Zone</td><td>70</td><td>70</td></tr>
</table>

(Source: The Environmental Conservation Rules, 1997 IFC Environmental Health and Safety Guidelines 2008)

Ammonia is used in SCR, which is possible to be introduced for the purpose of nitrogen oxide reduction. Including ammonia, Table 1.1-9 shows the odor emission standards in Bangladesh.

Table 1.1-9 Standards for Odor [9]

Parameter	Unit	Standard Limit
Acetaldehyde	ppm	0.5 – 5
Ammonia	ppm	1 – 5
Hydrogen Sulfide	ppm	0.02 – 0.2
Methyl Disulfide	ppm	0.009 – 0.1
Methyl Sulfide	ppm	0.01 – 0.2
Styrene	ppm	0.4 – 2.0
Trim ethylamine	ppm	0.005-0.07

(Source: The Environmental Conservation Rules 1997)

[8] Textual annotations are as follows.
(1) Day time is considered from 6 a.m. to 9 p.m. and night time is from 9 p.m. to 6 a.m.
(2) From 9 at night to 6 in the morning is considered night time.
(3) Areas within 100 meters of hospitals, education institutions, educational institutions or government designated / to be designated / specific institution / establishments are considered Silent Zones. Use of motor vehicle horns or other signals and loudspeaker are forbidden in Silent Zones.

[9] Textual annotations are as follows.
(1) Following regulatory limits shall be generally applicable to emission/exhaust outlet pipes of above 5 meter height: Q = 0.108 x He2Cm (Where Q = Gas Emission rate Nm3/hour)
He = Height of exhaust outlet pipe (m)
Cm = Above mentioned limit (ppm)
(2) In cases where a special parameter has been mentioned, the lower limit shall be applicable for warning purposes, and the higher limit shall be applicable for prosecution purposes or punitive measures.

(4) Electric and magnetic fields

IFC EHS Guideline (Electric Power Transmission and Disgtribution; 2007) recommends the following methods for managing EMF (Electric and magnetic fields) generated by transmission line.

- Evaluating potential exposure to the public against the reference levels developed by the International Commission on Non-Ionizing Radiation Protection (ICNIRP). Average and peak exposure levels should remain below the ICNIRP recommendation for General Public Exposure (Table 1.1-10).
- Considering siting new facilities so as to avoid or minimize exposure to the public. Installation of transmission lines or other high voltage equipment above or adjacent to residential properties or other locations intended for highly frequent human occupancy, (e.g. schools or offices), should be avoided;
- If EMF levels are confirmed or expected to be the recommended exposure limits (Table-10), application of engineering techniques should be considered to reduce the EMF produced by power lines, substations, or transformers. Examples of these techniques include:
    - o Shielding with specific metal alloys
    - o Burying transmission lines
    - o Increasing height of transmission towers
    - o Modifications to size, spacing, and configuration of conductors

Table 1.1-10 Recommended exposure limits for general public exposure to electric and magnetic fields
(IFC Guideline: “Transmission and Distribution”, 2007)

Frequency	Electric Field (V/m)	Magnetic Field (μT)
50 Hz	5,000	100
60 HZ	4,150	83

Source: International Commission on Non-Ionizing Radiation Protection (1998): “Guidelines for limiting exposure to time-varying electric, magnetic, and electromagnetic fields (up to 300 GHz).

1.2 Protected areas and environmentally controlled areas

Classification of protected areas and environmentally-controlled areas in Bangladesh are shown in Table 1.1-11. These areas are declared as National Parks, Wildlife Sanctuaries, Game Reserves, Botanical Gardens and Eco-parks under the Wildlife (Preservation) Order, Reserved Forests and Protected Forests under the Forest Act and Ecologically Critical Areas (ECA) notified under the Environmental Conservation Act.

Table 1.1-11 Classification of protected areas and environmentally controlled areas

Classification		Competent Authority	Governing law
A	National Parks	Department of Forest	Wildlife (Preservation) Order
B	Wildlife Sanctuaries		
C	Game Reserves		
D	Botanical Gardens, Eco-parks		
E	Reserved Forests, Protected Forests		Forest Act
F	Ecologically Critical Areas	Department of Environment	Environmental Conservation Act

(Source: Power System Master Plan 2010

There are fifteen national parks, thirteen wildlife sanctuaries, five botanical gardens and eco-parks in Bangladesh classified under the Wildlife (Preservation) Order, having a total area of 2,702.2 km^2. A list of the protected areas and environmentally-controlled areas declared under the Wildlife (Preservation) Order are shown in Table 1.1-12.

There are nine ECAs with a total area of 8,063.2 km^2 excluding the Gulshan–Banani-Baridhara Lake in Dhaka. Table-13 shows a list of ECA designated areas under the Bangladesh Environmental Conservation Act (BECA). BECA provides for ECA declarations by the Director General of the Department of Environment in cases where an ecosystem or biodiversity area is considered to be threatened to reach a critical state. Along with the ECA declaration, each ECA has notifications declared in which specific activities to be restricted in that ECA are specified.

Table 1.1-12 List of protected areas and environmentally controlled areas

Item	No	Name	Place	Size (km^2)
A	1	Bhawal National Park	Gazipur	50.2
	2	Modhupur National Park	Tangail/ Mymensingh	84.4
	3	Ramsagar National Park	Dinajpur	0.3
	4	Himchari National Park	Cox's Bazar	17.3
	5	Lawachara National Park	Moulavibazar	12.5
	6	Kaptai National Park	Chittagong Hill Tracts	54.6
	7	Nijhum Dweep National Park	Noakhali	163.5

Item	No	Name	Place	Size (km^2)
B	8	Medha Kachhapia National Park	Cox's Bazar	4.0
	9	Satchari National Park	Habigonj	2.4
	10	Khadim Nagar National Park	Sylhet	6.8
	11	Baraiyadhala National Park	Chittagong	29.3
	12	Kuakata National Park	Patuakhali	16.1
	13	Nababgonj National Park	Dinajpur	5.2
	14	Shingra National Park	Dinajpur	3.1
	15	Kadigarh National Park	Mymensingh	3.4
B	1	Rema-Kalenga Wildlife Sanctuary	Hobigonj	18.0
	2	Char Kukri-Mukri Wildlife Sanctuary	Bhola	0.4
	3	Sundarban (East) Wildlife Sanctuary	Bagerhat	312.3
	4	Sundarban (West) Wildlife Sanctuary	Satkhira	715.0
	5	Sundarban (South) Wildlife Sanctuary	Khulna	369.7
	6	Pablakhali Wildlife Sanctuary	Chittagong Hill Tracts	420.9
	7	Chunati Wildlife Sanctuary	Chittagong	77.6
	8	Fashiakhali Wildlife Sanctuary	Cox's Bazar	32.2
	9	Dudh Pukuria-Dhopachari Wildlife Sanctuary	Chittagong	47.2
	10	Hazarikhil Wildlife Sanctuary	Chittagong	29.1
	11	Sangu Wildlife Sanctuary	Bandarban	57.6
	12	Teknaf Wildlife Sanctuary	Cox's Bazar	116.2
	13	Tengragiri Wildlife Sanctuary	Barguna	40.5
D	1	National Botanical Garden	Dhaka	0.8
	2	Baldha Garden	Dhaka	-
	3	Madhabkunda Eco-Park	Moulavibazar	2.7
	4	Sitakunda Botanical Garden and Eco-park	Chittagong	8.1
	5	Dulahazara Safari Parks	Cox’s Bazar	6.0

(Source: http://www.bforest.gov.bd/conservation.php, accessed January 2011)

Table 1.1-13 List of Environmental Critical Areas

Item	No	Name	Place	Size (km^2)
F	1	The Sundarbans	Bagerhat, Khulna, Satkhira	7,620.3
	2	Cox’s Bazar (Teknaf, Sea beach)	Cox’s Bazar	104.7
	3	St. Martin Island	Cox’s Bazar	5.9
	4	Sonadia Island	Cox’s Bazar	49.2
	5	Hakaluki Haor	Moulavi Bazar	183.8
	6	Tanguar Haor	Sumamganj	97.3
	7	Marjat Baor	Jhinaidha	2
	8	Gulshan-Banani-Baridhara Lake	Dhaka	-
	9	Rivers (Buriganga, Turag, Sitalakhya and Balu) around Dhaka city	Dhaka	-

(Source: Biodiversity National Assessment and Programme of Action 2020, DOE Bangladesh, 2010)

Annexure 2

Data Sources

Annex 2

Data Sources

-: Table of Contents:-

2.1 List of Terrestrial Flora

Table 2.1-1(1) Terrestrial Flora (Power plant site; Rainy season)

Sl. No.	*Scientific name*	Local name	English name	Family	Survey sites (Rainy season)				Conservation Status		Remark
					Power plant area	Kutubdia Island	Mouth of Matarbari Channel	Sonadia Island	IUCN	Local status	
1	*Abelmoschus esculentus* (L.) Moench.	Bhendi	Okra	Malvaceae	√						
2	*Acacia auriculiformis* Benth.	Akashmoni	Darwin black wattle	Mimosaceae	√	√	√				
3	*Acacia mangium* Willd.	Mangium	Wattle	Mimosaceae	√						
4	*Acanthes ilicifolius* L.	Hargoza	Holy-leaved acanthus	Acanthaceae				√			
5	*Achyranthes aspera* L.	Apang	Red chaff tree	Amaranthaceae		√	√	√			
6	*Aegiceras corniculatum* (L.) Blanco.	Koilsha		Myrsinaceae			√				
7	*Aegle marmlos* (L.) Corr. Serr.	Bel	Wood aple	Rutaceae		√	√				
8	*Ageratum conyzoides* (L.) L.	Ochunti	Goat weed	Asteraceae	√	√					
9	*Albizia lebbek* (L.) Benth.	Sirish	Parrot tree	Mimosaceae		√	√				
10	*Albizia saman* (Jacq.) Merr.	Raintree	Monkey pod	Mimosaceae	√						
11	*Alocasia cucullata* (Lour.) G. Don	Bishkachu	Chinese taro	Araceae	√						
12	*Alstonia macrophylla* Wall. Ex G.Don	Baro Chhatim	Devil's tree	Apocynaceae			√				
13	*Alternanthera philoxeroides* (Mart.)Griseb.	Helencha	Alligator weed	Amaranthaceae	√						
14	*Alternanthera sessilis* (L.)R.Br.ex DC.	Chanchi	Sessile joyweed	Amaranthaceae		√					
15	*Amaranthus spinosus* L.	Katamaris	Spiny pigweed	Amaranthaceae		√					
16	*Amaranthus viridis* L.	Notey	Green pigweed	Amaranthaceae		√	√				

Sl. No.	*Scientific name*	Local name	English name	Family	Survey sites (Rainy season)				Conservation Status		Remark
					Power plant area	Kutubdia Island	Mouth of Matarbari Channel	Sonadia Island	IUCN	Local status	
17	*Ananus comosus* (L.) Merr.	Anaros	Pineapple	Bromeliaceae			√				
18	*Arecha catechu* L.	Supari	Arecha palm	Arecaceae	√						
19	*Artocarpus heterophyllus* Lam.	Kathal	Jack fruit	Moraceae		√	√				
20	*Averrhoa carambola* L.	Kamranga shim	Carambola apple	Fabaceae	√		√				
21	*Avicennia alba* Blume	Barabaen		Verbenaceae		√		√			
22	*Avicennia officinalis* L.	Baen		Verbenaceae		√		√			
23	*Bambusa tulda* Roxb.	Mitinga	Indian bamboo	Poaceae	√	√	√				
24	*Barringtonia acutangula* (L.) Gaertn.	Hijol	Indian oak	Lecythidaceae			√				
25	*Basella rubra* L.	Puishak	Indian Spinach	Basellaceae	√						
26	*Benincasa hispida* (Thumb.) Cogn.	Chalkumra	White gourd	Cucurbitaceae			√				
27	*Blumea lacera* (Burm. F.) Dc.	Barakukshima		Asteraceae		√					
28	*Bombax ceiba* L.	Simul	Red silk cotton tree	Bombacaceae			√				
29	*Borassus flabellifer* L.	Tal	Barb tree	Arecaceae	√		√				
30	*Bougainvillea glabra* Choisy	Baganbilas	Bougainvillea	Nyctaginaceae	√		√				
31	*Calamus guruba* Buch.-Ham.	Jalibet	Cane	Arecaceae	√					TH	
32	*Calotropis gigantea* (L.) Ait.f.	Akand	Shallow tree	Asclepiadaceae	√						
33	*Carica papaya* L.	Pepe	Papaya	Caricaceae	√	v	√				
34	*Cassia alata*	Dadmordon				√	√				
35	*Cassia fistula* L.	Sonalu	Burging fistula	Caesalpiniaceae	√						
36	*Centella asiatica* (L.) Urban	Thankuni	Indian pennywort	Apiaceae	√						
37	*Cestrum nocturnum* L.	Hasna hena	Night jasmin	Solanaceae	√						
38	*Cheliocostus speciosus* (J.Koenig)	Keumol, Tiatot	Canereed	Costaceae	√						

Sl. No.	*Scientific name*	Local name	English name	Family	Survey sites (Rainy season)				Conservation Status		Remark
					Power plant area	Kutubdia Island	Mouth of Matarbari Channel	Sonadia Island	IUCN	Local status	
	Specht										
39	*Chrysopogon aciculatus* (retz.) Trin.	Premkata	Love grass	Poaceae			√				
40	*Citrus maxima* (Burm. F.)Merr.	Jambura	Pummelo	Rutaceae		√	√	√			
41	*Citrus aurantifolia* (Christm.)Swingle.	Lebu	Lime	Rutaceae	√						
42	*Cocos nucifera* L.	Nairkel	Coconut palm	Arecaceae	√	√					
43	*Colocasia esculenta* (L.) Schott	Kachu	Cocoyam	Araceae	√		√				
44	*Commelina benghalensis* L.	Kansira	Day flower	Commelinaceae	√						
45	*Corchorus olitorius* L.	Toshapat	Jute	Tiliaceae	√						
46	*Crotolaria juncea* L.	Shonpat	Sunn hemp	Fabaceae	√						
47	*Cynodon dactylon*(L.) Pers.	Durba grass	Star grass, Couch grass	Poaceae	√						
48	*Cyperus rotandus* L.	Mutha	Nut grass	Cyperaceae	√						
49	*Dalbergia sissoo* Dc.	Shishoo	Rosewood	Fabaceae	√						
50	*Delonix regia* (hook.) Raf.	Krishnachura	Peacock flower	Caesalpiniaceae	√						
51	*Erioglossum rubignosum* Bl.	Rirha		Sapindaceae	√						
52	*Erymgium foetidum* L.	Bilati dhone	Wild coriender	Apiaceae	√						
53	*Erythrina variegta var. picta* Maheshw.	Mandar	Indian coral tree	Fabaceae	√	√	√				
54	*Eucalyptus globulus* Labill	Globu eucalyptus		Myrtaceae	√	√	√				
55	*Eupatorium antiquorum* L.	Tesramansa	Malayan spurge	Euphorbiaceae	√						
56	*Eyithrina suberosa* Roxb.	Madar		Fabaceae	√						
57	*Ficus hispida* L.f.	Dumur	opposite leave fig	Moraceae		√	√				

Sl. No.	*Scientific name*	Local name	English name	Family	Survey sites (Rainy season)				Conservation Status		Remark
					Power plant area	Kutubdia Island	Mouth of Matarbari Channel	Sonadia Island	IUCN	Local status	
58	*Glycosmis pentaphylla* (Retz.) A.DC.	Ashsaora	Motar tree	Rutaceae	√						
59	*Gmelina arborea* Roxb.	Gamari	White teak	Verbenaceae		√					
60	*Heliotropicum indicum* L.	Hatishur	Indian heliotrope	Boraginaceae	√						
61	*Hibiscus rosa sinensis* L.	Joba	China rose	Malvaceae	√	√	√				
62	*Ipomoea aquatica* Forssk.	Kolmi	Swamp cabbage	Convolvulaceae	√						
63	*Ipomoea fistulosa* Mart.ex Choisy	Dol kolmi		Convolvulaceae	√	√	√				
64	*Justicia gendarussa* Burm.f.	Jagatmadan	gendarussa	Acanthaceae	√						
65	*Lablab purporeus subsp. Bengalensis* (Jacq.) Verdc.	Bangla shim	Bean	Fabaceae	√						
66	*Lagernaria siceraria* (Molina) Standl.	Kadu	Club gourd	Cucurbitaceae	√						
67	*Lantana camara* L.	Lantana	Lantana	Verbenaceae	√						
68	*Leucaena leucocephala* (Lam.) de Wit	Ipil –Ipil	wild tamarind	Mimosaceae	√						
69	*Leucana leucocephala* (Lam.) de Wit	Epil-epil	Horse tamarind	Mimosaceae	√						
70	*Lindernia ciliata (*Colsmann) Pennell	Vuiokra	Fringed false pimpernel	Scrophulariaceae	√						
71	*Ludwigia hyssopifolia*(G.Don) Exell.	Zaikura	Seedbox	Onagraceae	√	√	√				
72	*Malvaviscus arboreus* Dill.ex Cav.	Lanka joba	Tree malvaviscus	Malvaceae	√						
73	*Mangifera indica L.*	Aam	Mango	Anacardiaceae	√	√	√				
74	*Melastoma malabathricum* L.	Datranga	Indian rhoddodendron	Melastomataceae	√						
75	*Melia azederach* L.	Ghoranim	Bead tree	Meliaceae		√	√				

Sl. No.	*Scientific name*	Local name	English name	Family	Survey sites (Rainy season)				Conservation Status		Remark
					Power plant area	Kutubdia Island	Mouth of Matarbari Channel	Sonadia Island	IUCN	Local status	
76	*Mikania micrantha* kunth	Asamlata	heartleaf	Asteraceae		√					
77	*Mimosa pudica* L.	Lajjabati	Sensitive plant	Mimosaceae	√						
78	*Momordica charantia* L. *var. Charantia*	Tita corolla	Bitter melon	Cucurbitaceae		√	√				
79	*Moringa olifera* Lam.	Sajna	Horse radish tree	Moringaceae	√	√	√				
80	*Musa itinerans* Cheesman	Atikola	Banana	Musaceae	√						
81	*Musa paradisiaca* L.	Kacha kola	banana	Musaceae	√	√	√				
82	*Phoenix sylvestris*(L.) Roxb.	Khajur	Date sugar palm	Arecaceae	√		√				
83	*Phyllanthus acidus* (L.) Skeels	Horboroi	Country gooseberry	Euphorbiaceae			√				
84	*Phyllanthus emblica* L.	Amloki	Indian gooseberry	Euphorbiaceae	√						
85	*Pithecellobium dulce* (Roxb.) Benth.	Khoibabla	Madras thron	Mimosaceae	√						
86	*Polyalthia longifolia* (Sonn.) Thwaites	Debdaru	Cemetry tree	Annonaceae	√						
87	*Pongamia pinnata* (L.) Pierre	Koronja	indian beach	Fabaceae		√	√				
88	*Psidium guajava* L.	Peyara	Guava	Myrtaceae	√	√					
89	*Psophocarpus tetragonolobus* (L.) DC.	Kamranga shim	Goa bean	Fabaceae	√						
90	*Ricinus communis* L.	Verenda	Castor	Euphorbiaceae	√						
91	*Scoparia dulcis* L.	Bondhoney	Sweet broom	Scrophulariaceae	√						
92	*Sesbania sesban* (L.) Merr	Dhaincha	Common sesban	Fabaceae	√						
93	*Sida acuta* Burm.f.	Kureta	Spinyhead sida	Malvaceae	√						
94	*Snedrella nodiflora* (L.) gaertn.	Relanodi	Nodeweed	Asteraceae	√						
95	*Solanum americanum* Mill.	Tit begun		Solanaceae			√				

Sl. No.	*Scientific name*	Local name	English name	Family	Survey sites (Rainy season)				Conservation Status		Remark
					Power plant area	Kutubdia Island	Mouth of Matarbari Channel	Sonadia Island	IUCN	Local status	
96	*Solanum melongena* L.	Begun	Brinjal	Solanaceae			√				
97	*Spilenthes acmella* (L.) L.	Marhatitika		Asteraceae		√					
98	*Spondius pinnata*(L.f.) kurz	Amra	Hog-plum	Anacardiaceae	√						
99	*Sterculia foetida* L.	Udal	Wild almond	Sterculiaceae	√						
100	*Streblus asper* lour.	Shaora	toothbrush tree	Moraceae	√						
101	*Swietenia mahagoni* (L.) Jacq.	Mahogany	Spanish mahogony	Meliaceae		√	√				
102	*Tamarindus indica* L.	Tetul	Tamarind tree	Tamaricaceae	√		√				
103	*Terminalia arjuna* (Roxb.ex Dc.) Wight& Arn.	Arjun	Arjun	Combretaceae	√						
104	*Trichosanthes cordata* Roxb.	Data chichinga	Snake guard	Cucurbitaceae	√					TH	
105	*Urena lobata* L.	Batapuran	Aramina fibre	Malvaceae	√						
106	*Vernonia elliptica* DC.	Patavernon	Curtain creeper	Asteraceae	√						
107	*Vigna unguiculata (L.) Walp.*	Borboti	Yard long bean	Fabaceae	√						
108	*Vitex negundo* L.	Nishinda	Chaste tree	Verbenaceae		√					
109	*Ziziphus mauritiana* Lam.	Kul	Plum	Rhamnaceae	√		√				

(Source: JICA Study Team)

Table 2.1-1(2) Terrestrial Flora (Power plant site; Dry season)

Sl. No.	*Scientific name*	Local name	English name	Family	Survey sites (Dry season)				Conservation Status		Remark
					Power plant area	Kutubdia Island	Mouth of Matarbari Channel	Sonadia Island	IUCN	Local	
1	*Acacia auriculiformis* Benth.	Akashmoni	Darwin black wattle	Mimosaceae	√	√	√		-		
2	*Acacia mangium* Willd.	Mangium	Wattle	Mimosaceae	√				-		
3	*Acanthes ilicifolius* L.	Hargoza	Holy-leaved acanthus	Acanthaceae				√	-		
4	*Achyranthes aspera* L.	Apang	Red chaff tree	Amaranthaceae		√	√	√	-		
5	*Aegiceras corniculatum* (L.) Blanco.	Koilsha		Myrsinaceae			√		-		
6	*Aegle marmlos* (L.) Corr. Serr.	Bel	Wood aple	Rutaceae		√	√		-		
7	*Ageratum conyzoides* (L.) L.	Ochunti	Goat weed	Asteraceae	√	√			-		
8	*Albizia lebbek* (L.) Benth.	Sirish	Parrot tree	Mimosaceae	√				-		
9	*Albizia saman* (Jacq.) Merr.	Raintree	Monkey pod	Mimosaceae	√				-		
10	*Allium cepa L.*	Piaj	Onion	Liliaceae		√			-		
11	*Allium sativum L.*	Rusun	Garlic	Liliaceae		√			-		
12	*Alocasia cucullata* (Lour.) G. Don	Bishkachu	Chinese taro	Araceae	√				-		
13	*Alstonia macrophylla* Wall. Ex G.Don	Baro Chhatim	Devil's tree	Apocynaceae			√		-		
14	*Alternanthera sessilis* (L.)R.Br.ex DC.	Chanchi	Sessile joyweed	Amaranthaceae		√			-		

Sl. No.	*Scientific name*	Local name	English name	Family	Survey sites (Dry season)				Conservation Status		Remark
					Power plant area	Kutubdia Island	Mouth of Matarbari Channel	Sonadia Island	IUCN	Local	
15	*Amaranthus tricolor* L.	Lalshak	Josep’s coat	Amaranthaceae		√			-		
16	*Amaranthus viridis* L.	Notey	Green pigweed	Amaranthaceae					-		
17	*Ananus comosus* (L.) Merr.	Anaros	Pineapple	Bromeliaceae			√		-		
18	*Arecha catechu* L.	Supari	Arecha palm	Arecaceae	√				-		
19	*Artocarpus heterophyllus* Lam.	Kathal	Jack fruit	Moraceae		√	√		-		
20	*Averrhoa carambola* L.	Kamranga shim	Carambola apple	Fabaceae	√		√		--		
21	*Avicennia alba* Blume	Barabaen		Verbenaceae		√		√	-		
22	*Avicennia officinalis* L.	Baen		Verbenaceae		√		√	-		
23	*Bambusa tulda* Roxb.	Mitinga	Indian bamboo	Poaceae	√	√	√		-		
24	*Barringtonia acutangula* (L.) Gaertn.	Hijol	Indian oak	Lecythidaceae			√		-	TH	
26	*Benincasa hispida* (Thumb.) Cogn.	Chalkumra	White gourd	Cucurbitaceae			√		-		
27	*Blumea lacera* (Burm. F.) Dc.	Barakukshima		Asteraceae		√			-		
28	*Bombax ceiba* L.	Simul	Red silk cotton tree	Bombacaceae			√		-		
29	*Borassus flabellifer* L.	Tal	Barb tree	Arecaceae	√		√		-		
30	*Bougainvillea glabra* Choisy	Baganbilas	Bougainvillea	Nyctaginaceae	√		√		-		
31	*Brassica juncea* (L.) Czern.	Raisarisha	Chinese mustard	Brassicaceae		√			-		
32	*Brassica oleracea* var *botrytis* L.	Phulkofi	Cauliflower	Brassicaceae		√			-		
33	*Brassica oleracea* var. *capitata* L.	Bandhakofi	Cabbage	Brassicaceae		√			-		
34	*Calamus guruba* Buch.-Ham.	Jalibet	Cane	Arecaceae	√				-	TH	

Sl. No.	*Scientific name*	Local name	English name	Family	Survey sites (Dry season)				Conservation Status		Remark
					Power plant area	Kutubdia Island	Mouth of Matarbari Channel	Sonadia Island	IUCN	Local	
35	*Calotropis gigantea* (L.) Ait.f.	Akand	Shallow tree	Asclepiadaceae	√				-		
36	*Carica papaya* L.	Pepe	Papaya	Caricaceae	√	V	√		-		
37	*Cassia alata*	Dadmordon				√	√		-		
38	*Cassia fistula* L.	Sonalu	Burging fistula	Caesalpiniaceae	√				-		
39	*Centella asiatica* (L.) Urban	Thankuni	Indian pennywort	Apiaceae	√				-		
40	*Cestrum nocturnum* L.	Hasna hena	Night jasmin	Solanaceae	√				-		
41	*Cheliocostus speciosus* (J.Koenig) Specht	Keumol, Tiatot	Canereed	Costaceae	√				-		
42	*Chrysopogon aciculatus* (retz.) Trin.	Premkata	Love grass	Poaceae			√		-		
43	*Citrus maxima* (Burm. F.)Merr.	Jambura	Pummelo	Rutaceae		√	√	√	-		
44	*Citrus aurantifolia* (Christm.)Swingle.	Lebu	Lime	Rutaceae	√				-		
45	*Cocos nucifera* L.	Nairkel	Coconut palm	Arecaceae	√	√			-		
46	*Colocasia esculenta* (L.) Schott	Kachu	Cocoyam	Araceae			√		-		
47	*Crotolaria juncea* L.	Shonpat	Sunn hemp	Fabaceae	√				-		
48	*Crotolaria pallida* Aiton	Jhunjhuni		Fabaceae		√			-		
49	*Cucurbita maxima* Duchesne	Kumra	Sweet gourd	Cucurbitaceae		√			-		
50	*Dalbergia sissoo* Dc.	Shishoo	Rosewood	Fabaceae	√				-		
51	*Delonix regia* (hook.) Raf.	Krishnachura	Peacock flower	Caesalpiniaceae	√				-		

Sl. No.	*Scientific name*	Local name	English name	Family	Survey sites (Dry season)				Conservation Status		Remark
					Power plant area	Kutubdia Island	Mouth of Matarbari Channel	Sonadia Island	IUCN	Local	
52	*Erioglossum rubignosum* Bl.	Rirha		Sapindaceae	√				-		
53	*Erymgium foetidum* L.	Bilati dhone	Wild coriender	Apiaceae	√				-		
54	*Erythrina variegta var. picta* Maheshw.	Mandar	Indian coral tree	Fabaceae	√	√	√		-		
55	*Eucalyptus globulus* Labill	Globu eucalyptus		Myrtaceae	√	√	√		-		
56	*Eupatorium antiquorum* L.	Tesramansa	Malayan spurge	Euphorbiaceae	√				-		
57	*Eyithrina suberosa* Roxb.	Madar		Fabaceae	√				-		
58	*Ficus hispida* L.f.	Dumur	opposite leave fig	Moraceae		√	√		-		
59	*Glycosmis pentaphylla* (Retz.) A.DC.	Ashsaora	Motar tree	Rutaceae	√				-		
60	*Gmelina arborea* Roxb.	Gamari	White teak	Verbenaceae		√			-		
61	*Heliotropicum indicum* L.	Hatishur	Indian heliotrope	Boraginaceae	√				-		
62	*Hibiscus rosa sinensis* L.	Joba	China rose	Malvaceae	√	√	√		-		
63	*Ipomoea aquatica* Forssk.	Kolmi	Swamp cabbage	Convolvulaceae	√				-		
64	*Ipomoea fistulosa* Mart.ex Choisy	Dol kolmi		Convolvulaceae	√	√	√		-		
65	*Jatropha curcas L.*	Bon verenda	Poison nut	Euphorbiaceae		√			-		
66	*Justicia gendarussa* Burm.f.	Jagatmadan	gendarussa	Acanthaceae	√				-		
67	*Lablab purporeus subsp. Bengalensis* (Jacq.) Verdc.	Bangla shim	Bean	Fabaceae	√				-		

Sl. No.	*Scientific name*	Local name	English name	Family	Survey sites (Dry season)				Conservation Status		Remark
					Power plant area	Kutubdia Island	Mouth of Matarbari Channel	Sonadia Island	IUCN	Local	
68	*Lagernaria siceraria* (Molina) Standl.	Kadu	Club gourd	Cucurbitaceae	√				-		
69	*Lantana camara* L.	Lantana	Lantana	Verbenaceae	√				-		
70	*Lepisanthes rubiginosa (Roxb.)Leenh.*	Rubihorina	Rusty Sapindus	Sapindaceae	√				-	TH	
71	*Leucaena leucocephala* (Lam.) de Wit	Ipil –Ipil	wild tamarind	Mimosaceae	√				-		
72	*Leucana leucocephala* (Lam.) de Wit	Epil-epil	Horse tamarind	Mimosaceae	√				-		
73	*Ludwigia hyssopifolia*(G.Don) Exell.	Zaikura	Seedbox	Onagraceae	√	√	√		-		
74	*Malvaviscus arboreus* Dill.ex Cav.	Lanka joba	Tree malvaviscus	Malvaceae	√				-		
75	*Mangifera indica L.*	Aam	Mango	Anacardiaceae	√	√	√		-		
76	*Melastoma malabathricum* L.	Datranga	Indian rhoddodendron	Melastomatacea e	√				-		
77	*Melia azederach* L.	Ghoranim	Bead tree	Meliaceae		√	√		-		
78	*Mikania micrantha* kunth	Asamlata	heartleaf	Asteraceae		√			-		
79	*Mimosa pudica* L.	Lajjabati	Sensitive plant	Mimosaceae	√				-		
80	*Momordica charantia* L. *var. charantia*	Tita corolla	Bitter melon	Cucurbitaceae		√	√		-		
81	*Moringa olifera* Lam.	Sajna	Horse radish tree	Moringaceae	√	√	√		-		

Sl. No.	*Scientific name*	Local name	English name	Family	Survey sites (Dry season)				Conservation Status		Remark
					Power plant area	Kutubdia Island	Mouth of Matarbari Channel	Sonadia Island	IUCN	Local	
82	*Musa itinerans* Cheesman	Atikola	Banana	Musaceae	√				-		
83	*Musa paradisiaca* L.	Kacha kola	banana	Musaceae	√	√	√		-		
84	*Phoenix sylvestris*(L.) Roxb.	Khajur	Date sugar palm	Arecaceae	√		√		-		
85	*Phyllanthus acidus* (L.) Skeels	Horboroi	Country gooseberry	Euphorbiaceae			√		-		
86	*Phyllanthus emblica* L.	Amloki	Indian gooseberry	Euphorbiaceae	√				-		
87	*Pithecellobium dulce* (Roxb.) Benth.	Khoibabla	Madras thron	Mimosaceae	√				-		
88	*Polyalthia longifolia* (Sonn.) Thwaites	Debdaru	Cemetry tree	Annonaceae	√				-		
89	*Pongamia pinnata* (L.) Pierre	Koronja	indian beach	Fabaceae		√	√		-		
90	*Porteresia coarctata* (Roxb.) Roberty	Dhani ghas		Poaceae	√				-		
91	*Psidium guajava* L.	Peyara	Guava	Myrtaceae	√	√			-		
92	*Psophocarpus tetragonolobus* (L.) DC.	Kamranga shim	Goa bean	Fabaceae	√				-		
93	*Raphanus sativus L.*	Mula	Radish	Brassicaceae		√			-		
94	*Ricinus communis* L.	Verenda	Castor	Euphorbiaceae	√				-		
95	*Scoparia dulcis* L.	Bondhoney	Sweet broom	Scrophulariaceae	√				-		
96	*Sesbania sesban* (L.) Merr	Dhaincha	Common sesban	Fabaceae	√				-		

Sl. No.	*Scientific name*	Local name	English name	Family	Survey sites (Dry season)				Conservation Status		Remark
					Power plant area	Kutubdia Island	Mouth of Matarbari Channel	Sonadia Island	IUCN	Local	
97	*Solanum americanum* Mill.	Tit begun		Solanaceae			√		-		
98	*Solanum lycopersicum* L.	Tomato	Tomato	Solanaceae		√			-		
99	*Solanum melongena* L.	Begun	Brinjal	Solanaceae		√	√		-		
100	*Spondius pinnata*(L.f.) kurz	Amra	Hog-plum	Anacardiaceae	√				-		
101	*Sterculia foetida* L.	Udal	Wild almond	Sterculiaceae	√				-		
102	*Streblus asper* lour.	Shaora	toothbrush tree	Moraceae	√				-		
103	*Swietenia mahagoni* (L.) Jacq.	Mahogany	Spanish mahogany	Meliaceae		√	√		-		
104	*Tamarindus indica* L.	Tetul	Tamarind tree	Tamaricaceae	√		√		-		
105	*Tephrosia purporea* (L.) Pers.	Bon-nil	Wild Indigo	Fabaceae	√				-		
106	*Terminalia arjuna* (Roxb.ex Dc.) Wight& Arn.	Arjun	Arjun	Combretaceae	√				-		
107	*Trichosanthes cordata* Roxb.	Data chichinga	Snake guard	Cucurbitaceae	√				-	TH	
108	*Urena lobata* L.	Batapuran	Aramina fibre	Malvaceae	√				-		
109	*Vernonia elliptica* DC.	Patavernon	Curtain creeper	Asteraceae	√				-		
110	*Vigna unguiculata (L.) Walp.*	Borboti	Yard long bean	Fabaceae	√				-		
111	*Vitex negundo* L.	Nishinda	Chaste tree	Verbenaceae		√			-		
112	*Zea mays L.*	Bhutta	Maize	Poaceae		√			-		
113	*Ziziphus mauritiana* Lam.	Kul	Plum	Rhamnaceae	√		√		-		
114	*Zoysia matrella (L.) Merr.*	Baissa ghas	Manilla Grass	Poaceae	√				-		

(Source: JICA Study Team)

2.2 List of Terrestrial Fauna

Table 2.2-1(1) Terrestrial Fauna (Insect) (Power plant site; Rainy season)

Sl. No.	*Species Name*	English Name (Local Name)	Habitat	Survey Sites (Rainy Season)				Conservation Status		Remarks
				Power Plant Area	Kutubdia Islands	Mouth of Matarbari Channel	Sonadia Islands	IUCN	Local Status	
1	*Agriocnemis femina* (Brauer)	Narrow-winged Damselfly (Foring)	Bush bean (Near the pond)		√			-		Predator and Bioindicator
2	*Agriocnemis pygmaea* (Rambur)	Damselfly (Foring)	Common bean (Near the pond)	√	√	√		-		Predator and Bioindicator
3	*Ceriagrion cerinorubellum* (Brauer)	Damselfly (Foring)	Woods of vegetation	√	√	√		-		Predator and Bioindicator
4	*Tholymis* sp.	Evening Skimmer (Foring)	Woods of vegetation				√	-		Predator and Bioindicator
5	*Gryllus* spp.	Cricket (Urchunga)	Rice field	√	√	√	√	-		Agricultural pest
6	*Oxya chinensis* (Thunberg)	Small Rice Grasshopper (Ghas Foring)	Rice field	√	√	√	√	-		Agricultural pest
7	*Periplaneta Americana* Linn.	American Cockroach (Telapoka)	Restaurant	√	√	√	√	-		Household pest
8	*Agromyza spp.*	Miner flies	Bush bean	√	√	√	√	-		Leaf miner pest of vegetables
9	*Bactrocera cucurbitae*	Melon fly	Bottle gourd	√		√		-		Pest of vegetables

Sl. No.	*Species Name*	English Name (Local Name)	Habitat	Survey Sites (Rainy Season)				Conservation Status		Remarks
				Power Plant Area	Kutubdia Islands	Mouth of Matarbari Channel	Sonadia Islands	IUCN	Local Status	
	(Coquillett)									
10	*Eristalinus quinquelineatus* (Fabricius)	Hoverfly	Cucumber field		√			-		Pollinator in most cases
11	*Episyrphus spp.*	Hover fly	Cucumber field		√			-		Predator and pollinator in most cases
12	*Musca domestica* Linn.	House fly	Restaurant	√	√	√		-		Pathogen carrier and pollinaotr in few cases
13	*Chrysomya megacephala* (Fabricius)	Oriental latrine fly	Dry fish	√	√	√		-		Pest of dry fish and pollinaotr in few cases
14	*Eurema hecabe contubernalis* Moore	Common Grass Yellow (Holud)	Common been	√	√	√		-		Pollinator in adult aged
15	*Delias descombesi descombesi* (Boisduval)	Red spot jezebel (Kanka)	Secondary forest	√		√		-		Pollinator in adult aged
16	*Junonia atlites* (Linn.)	Chandnori	Agricultural field	√	√	√		-		Pollinator in adult aged
17	*Melanitis phedima bela* Moore	Dark Evening Brown	Agricultural field	√	√	√		-		Pollinator in adult aged
18	*Parnara guttatus mangala* Moore	Straight Swift (Nillbijuri)	Snake gourd		√			-		Pollinator
19	*Oriens goloides* Moore	Smaller Darlet	Agricultural field		√			-		Pollinator
20	*Aulacophora*	Red pumpkin	Pumpkin field	√	√	√		-		Agricultural

Sl. No.	*Species Name*	English Name (Local Name)	Habitat	Survey Sites (Rainy Season)				Conservation Status		Remarks
				Power Plant Area	Kutubdia Islands	Mouth of Matarbari Channel	Sonadia Islands	IUCN	Local Status	
	foveicollis Lucas	beetle								pest
21	*Aulacophora frontalis* Baly	Pumpkin beetle	Pumpkin field	√	√	√		-		Agricultural pest
22	*Nephotettix cincticeps* Matsumura	Spotted jassid	Ficefield	√		√		-		Pest of rice
23	*Leptocorisa acuta* Thunb.	Rice bug	Rice field	√		√		-		Pest of rice
24	*Rhopalosiphum sp.*	Aphis	Common bean	√				-		Agricultural pest
25	*Amegilla* spp.		Brinjal	√		√		-		Pollinator
26	*Lasioglossum* sp.	Solitary Bee	Cucumber field	√	√	√		-		Pollinator And bioindicator
27	*Trigona* sp.	Sweat bee	Cucumber field	√				-		Pollinator
28	*Apis mellifera* Linn.	Western Honey bee (Momachhi)	Cucumber field	√		√	√	-		Pollinator and Bioindicator
29	*Micraspis crocea* (Mulsant)	Lady beetle	Rice	√	√	√		-		Rice pest

(Source: JICA Study Team)

Table 2.2-1(2) Terrestrial Fauna (Amphibians and Reptiles) (Power plant site; Rainy season)

Sl. No.	*Species Name*	English Name	Local Name	Survey Sites (Rainy Season)				Conservation Status		Remarks
				Power Plant Area	Kutubdia Islands	Mouth of Matarbari Channel	Sonadia Islands	IUCN	Local Status	
(Amphibians)										
1	*Duttaphrynus (Bufo) melanostictus*	Southeast Asian toad	Kono bang	√	√	√	√	LC		Very common throughout the county
2	*Euphlyctis cyanophlyctis*	Green Forq	Kotkoti bang	√	√	√		LC		Very common
3	*Fejervarya limnocharis*	Cricket frog		√	√	√		LC		Common
4	*Fejervarya sp*	Cricket frog			√	√				
5	*Hoplobatrachus tigerinus*	Bull frog	Kola bang, Sona bang,Bhawa beng	√	√	√	√	LC		Wide spread
6	*Sylvirana leptoglossa*	Cope's Assam Frog	Koper Ashami Bang		√	√		LC		
7	*Rana temporalis*	Bronzed Frog	Gaso Bang		√			LC		
(Reptiles)										
1	*Calotes versicolor*	garden lizard	Roktochusha	√	√	√			TH	
2	*Mabuya mabuya*	skink	Achil	√	√	√			TH	
3	*Gekko gecko*	Tokay Gecko	Tokkhak/ Tokhha	√	√	√	√		TH	
4	*Hemidactylus brooki*	house lizard	Tiktiki	√	√	√	√	NO		
5	*Hemidactylus frenatus* Schlegel in Duméril & Bibron, 1836	house lizard	Tiktiki	√	√	√	√			
6	*Melanochelys trijuga* (Schweigger, 1812)	Indian Black Turtle	Kalo Kossop	√	√	√	√			
7	*Geoclemys hamiltonii* (Gray, 1830)	Spotted Pond Turtle	Kalo Kasim	√	√	√		EN	TH	
8	*Pangshura tentoria*	Median Roofed	Majhari Kaitta	√	√	√			TH	

Sl. No.	*Species Name*	English Name	Local Name	Survey Sites (Rainy Season)				Conservation Status		Remarks
				Power Plant Area	Kutubdia Islands	Mouth of Matarbari Channel	Sonadia Islands	IUCN	Local Status	
	(Gray, 1834)	Turtle								
9	*Ahaetulla prasina* (Boie, 1827)	Common Vine snake	Laodoga Shap/sutanoli Shap		√					
10	*Xenocrophis piscator*	Checkered keel back	Dhora sap	√	√	√	√			
11	*Naja kaouthia* Lesson, 1831	Monocled Cobra	Jati Sap	√	√	√	√			
12	*Naja naja*	Bicled Cobra	Gokhra Shap	√	√	√	√		TH	
13	*Cerberus rynchops* (Schneider, 1799)	Dog faced water snake	Andha sap	√			√			
14	*Enhydris sieboldii* (Schlegel, 1837)	Siebold's Smooth Water Snake	Sibolder Joloj Shap	√	√	√	√			

(Source: JICA Study Team)

Table 2.2-1(3) Terrestrial Fauna (Birds) (Power plant site; Rainy season)

Sl. No.	Species Name	English Name	Local Name	Survey Sites (Early winter)				Conservation Status		Remarks
				Power Plant Area	Kutubdia Islands	Mouth of Matarbari Channel	Sonadia Islands	IUCN	Local status	
1	*Passer domesticus*	House Sparrow	Pati Chorui	√	√	√		-		
2	*Dicrurus macrocercus*	Black Drongo	Kala Fingey	√	√	√	√	-		
3	*Sturnus contra*	Pied Myna	Pakra Shalik/Gubra Shalik/Gu Shalik	√	√	√	√	-		
4	*Sturnus malabaricus*	Chestnut-tailed Starling	Khoiralej Kathshalik/Deshi Pawei	√	√	√	√	-		
5	*Acridotheres cinereus*	Pale-bellied Myna	Dholatola Shalik	√	√	√	√	-		
6	*Acridotheres tristis*	Common Myna	Bhat Shalik	√	√	√	√	-		
7	*Acridotheres fuscus*	Jungle Myna	Jhuti Sahlik	√	√	√	√	-		
8	*Gracula religiosa*	Common Hill Myna			√		√	-		
9	*Copsychus saularis*	Oriental Magpie-Robin	Doel/Udoi Doel	√	√	√	√	-		
10	*Orthotomus sutorius*	Common Tailorbird	Pati Tuntuni	√	√	√	√	-		
11	*Columba livia*	Common Pigeon	Gola Paira/Jalali Kabutor	√	√	√	√	-		
12	*Treron bicintus*	Orenge-breasted Green Pigeon	Komlabook Horial/Horikol	√	√	√	√	-		
13	*Streptopelia decaocto*	Eurasian Collared Dove	Eurashio Konthighughu/Raj Ghughu	√	√	√	√	-		
14	*Streptopelia chinensis*	Spotted Dove	Tila Ghughu		√		√	-		

Sl. No.	Species Name	English Name	Local Name	Survey Sites (Early winter)				Conservation Status		Remarks
				Power Plant Area	Kutubdia Islands	Mouth of Matarbari Channel	Sonadia Islands	IUCN	Local status	
15	*Treron phoenicopterus*	Yellow-footed Green Pigeon	Holdepa Horial/Botkol	√	√	√	√	-		
16	*Pycnonotus cafer*	Red-vented Bulbul	Bangla Bulbul/Bulbuli	√	√	√	√	-		
17	*Pycnonotus jocosus*	Red-whiskered Bulbul	Shipahi Bulbul/Bulbuli	√		√	√	-		
18	*Corvus splendens*	House Crow	Pati Kak	√	√	√	√	-		
19	*Corvus macrorhynchos*	Jungle Crow	Dar Kak/Danr Kak	√	√	√	√	-		
20	*Oriolus xanthornus*	Black-hooded Oriole	Kalamatha Benebou/Holdey Pakhi	√	√	√	√	-		
21	*Artamus fuscus*	Ashy Woodswallow	Metey Bonababil/Latora	√	√	√	√	-		
22	*Dendrocitta vagabunda*	Rufous Treepie	Khoira Harichacha/ Hari Chacha	√	√	√	√	-		
23	*Dicaeum cruentatum*	Scarlet-backet Flowerpecker	Lalpith Fuljhuri	√	√	√	√	-		
24	*Dicaeum erythrorhynchos*	Pale-billed Flowerpecker	Metethot Fuljhuri	√	√	√	√	-		
25	*Dicaeum trigonostigma*	Orenge-bellied Flowerpecker	Komlapet Fuljhuri	√	√	√	√	-		
26	*Chalcoparia singalensis*	Ruby-cheeked Sunbird	Chunimukhi Moutushi	√	√	√	√	-		
27	*Leptocoma zeylonica*	Purple-rumped Sunbird	Begunikomor Moutushi	√	√	√	√	-		
28	*Cinnyris asiaticus*	Purple Sunbird	Beguni Moutushi	√	√	√	√	-		
29	*Aethopyga siparaja*	Crimson Sunbird	Shidure Moutushi	√	√	√	√	-		

Sl. No.	Species Name	English Name	Local Name	Survey Sites (Early winter)				Conservation Status		Remarks
				Power Plant Area	Kutubdia Islands	Mouth of Matarbari Channel	Sonadia Islands	IUCN	Local status	
30	*Arachnothera magna*	Streaked Spiderhunter		√	√	√	√	-		
31	*Ploceus philippinus*	Baya Weaver	Deshi Babui/Baoi	√	√	√	√	-		
32	*Lonchura malabarica*	Indian Silverbill	Deshi Chandithot				√	-		
33	*Lonchura malacca*	Blkack-headed Munia	Kalamatha Munia	√	√	√	√	-		
34	*Lonchura punctulata*	Scaly-breasred Munia	Tila Munia	√	√	√	√	-		
35	*Lonchura straiata*	White-rumped Munia	Dholakomor Munia	√	√	√	√	-		
36	*Anthus rufulus*	Paddyfield Pipit	Dhani Tulika	√	√	√	√	-		
37	*Pellorneum ruficeps*	Puff-throated Babler	Golafola Satarey	√	√	√	√	-		
38	*Zosterops palpebrosus*	Oriental White-eye	Udoi Dholachokh/Shet Ankhi	√	√	√	√	-		
39	*Prinia inornata*	Plain Prinia	Nirol Prina	√	√	√	√	-		
40	*Ficedula albicilla*	Taiga Flycatcher	Taiga Chutki/Lalbook Chotok	√	√	√	√	-		
41	*Aegithina tiphia*	Common Iora	Fatik Jal	√		√	√	-		
42	*Hypothymis azurea*	Black-naped Monarch	Kalaghar Rajon	√	√	√	√	-		
43	*Disrurus paradiseus*	Greater Racket-tailed Drongo	Boro Recket-Fingey/B himraj	√	√	√		-		
44	*Disrurus aeneus*	Bronzed Drongo	Fingey	√	√	√	√	-		

Sl. No.	Species Name	English Name	Local Name	Survey Sites (Early winter)				Conservation Status		Remarks
				Power Plant Area	Kutubdia Islands	Mouth of Matarbari Channel	Sonadia Islands	IUCN	Local status	
45	*Rhipidura albicollis*	White-throated Fantail	Dholagola Chatighurani/Lej Nachuni	√	√	√	√	-		
46	*Alcedo atthis*	Common Kingfisher	Pati Machranga	√	√	√	√	-		
47	*Alcedo meninting*	Blue-eared Kingfisher	Neelkan Machranga	√	√	√	√	-		
48	*Halcyon smyrnensis*	White-throated kingfisher	Dholagoloa Machranga	√	√	√	√	-		
49	*Ceryle rudis*	Pied Kingfisher	Pakra Machranga	√	√	√		-		
50	*Upupa epops*	Eurasian Hoopoe	Pati Hoodhood	√	√	√		-		
51	*Dinopium bengalensis*	Lesser goldenback	Bangla kaththokra				√	-		
52	*Merops leschenaulti*	Chestnut-headed Bee-eater	Khoiramatha Shuichora	√	√	√	√	-		
53	*Merops philippinus*	Blue-tailed Bee-eater	Neel-lej Shuichora	√	√	√	√	-		
54	*Psittacula alexandri*	Red-breasrted Parakeet	Modna Tia	√	√	√	√	-		
55	*Psittacula krameri*	Rose-ringed Parakeet	Shobuj Tia	√	√	√	√	-		
56	*Cypsiurus balasiensis*	Asian Palm Swift	Asio Talbatashi/Nakka ti	√	√	√	√	-		
57	*Ketupa zeylonensis*	Broun Fish Owl	Khoira mechupacha/Bho otoom Pecha	√	√	√	√	-		
58	*Athene brama*	Spotted Owlet	Khuruley Pencha/Konthi Kutipecha		√		√	-		

Sl. No.	Species Name	English Name	Local Name	Survey Sites (Early winter)				Conservation Status		Remarks
				Power Plant Area	Kutubdia Islands	Mouth of Matarbari Channel	Sonadia Islands	IUCN	Local status	
59	*Caprimulgus macrurus*	Large-tailed Nightjar	Lenja Ratchora	√		√		-		
60	*Ichthyophaga ichthyaetus*	Grey-headed Fish Eagle	Metemetha Kura Eagle					-		
61	*Spilornis Cheela*	Crested Serpent Eagle	Tila Nag-eegol/Shapkheko Baj		√		√	-		
62	*Phalacrocorax niger*	Little Cormorant	Choto Pankouri	√	√	√	√	-		
63	*Phalacrocorax fuscicollis*	Indian Cormorant	Deshi Pankouri		√		√	-		
64	*Egretta garzetta*	Little Egret	Choto Boga	√	√	√	√	-		
65	*Egretta intermedia*	Yellow-billed Egret	Majhla Boga/Korche Bok		√			-		
66	*Casmerudias albus*	Great Egret	Boro Boga	√		√		-		
67	*Bubulcus ibis*	Cattle Egret	Go Boga	√	√	√	√	-		
68	*Ardeola bucchus*	Chinese Pond Heron	China Kanibok	√	√	√	√	-		
69	*Ardeola grayii*	Indian Pond Heron	Deshi Kanibok	√	√	√	√	-		
70	*Sterna aurantia*	River Tern	Nodia Panchil	√		√	√	-		
71	*Glareola lactea*	Small Pratincole	Choto Babubatan			√	√	-		
72	*Ardea cinerea*	Grey Heron	Dhupni Bok	√	√	√	√	-		
73	*Sterna albifrons*	Little Tern	Choto Panchil	√	√	√	√	-		
74	*Nycticorax nycticorax*	Black-crowned Night Heron	Kalamatha Nishibok	√	√	√	√	-		
75	**Migratory/Winter visitors**							-		

Sl. No.	Species Name	English Name	Local Name	Survey Sites (Early winter)				Conservation Status		Remarks
				Power Plant Area	Kutubdia Islands	Mouth of Matarbari Channel	Sonadia Islands	IUCN	Local status	
76	*Pandion haliaetus*	Osprey	Machmural/Mech ubaj	√	√	√	√			
77	*Tadorna ferruginea*	Ruddy Shelduck	Khoira Chokachoki		√			-		
78	*Anas clypeata*	Northern Shoveler	Utturey Khuntehash/Panta mukhi				√	-		
79	*Jynx torquilla*	Eurasian Wryneck	Eureshio Gharbetha			√		-		
80	*Halcyon pileata*	Black-capped Kingfisher	Kalatupi Machranga		√			-		
81	*Todiramphus chloris*	Collared Kingfisher	Dholaghar Machranga	√	√	√		-		
82	*Porzana pusilla*	bailon's Crake	Bailoner Gurguri					--		
83	*Gallinago gallinago*	Common Snipe	Pati Chega				√	-		
84	*Gallinago stenura*	Pin-tailed Snipe	Lenja Chega		√		√	-		
85	*Limosa lapponica*	Bar-tailed Godwit	Dagilej Jourali			√	√	-		
86	*Limosa limosa*	Black-tailed Godwit	Kalalej jourali				√	-		
87	*Numenius arquata*	Eurasian Curlew	Eureshio Gulinda	√	√	√	√	-		
88	*Numenius phaeopus*	Whimbrel	Choto Gulinda			√		-		
89	*Tringa glareola*	Wood Sandpiper	Bon Batan/Balu Batan	√	√	√	√	-		
90	*Actitis hypoleucos*	Common Sandpiper	Pati Batan/ Chapakhi	√	√	√	√	-		
91	*Tringa stagnatilis*	Marsh Sandpiper	Bali Batan				√	-		
92	*Tringa guttifer*	Nordmann's Greenshank	Nordman Shabujpa				√	EN	TH	
93	*Tringa nebularia*	Common Greenshank	Pati Shabujpa			√	√	-		
94	*Tringa totanus*	Common Redshank	Pati Lalpa			√	√	-		

Sl. No.	Species Name	English Name	Local Name	Survey Sites (Early winter)				Conservation Status		Remarks
				Power Plant Area	Kutubdia Islands	Mouth of Matarbari Channel	Sonadia Islands	IUCN	Local status	
95	*Xenus cinereus*	Terek Sandpiper	Terek Batan				√	-		
96	*Arenaria interpres*	Ruddy Turnstone	Lal Nuribatan		√		√	-		
97	*Limnodromus semipalmatus*	Asian Dowitcher	Eshio Daucher				√	-		
98	*Calidris alba*	Sanderlin	Sanderlin		√		√	-		
99	*Calidris ferruginea*	Curlew Sandpiper	Gulinda Batan				√	-		
100	*Calidris minuta*	Little Stint	Choto Chaha				√	-		
101	*Calidris ruficollis*	Red-necked Stint	Lalghar Chaha				√	-		
102	*Calidris temminckii*	Timminck's Stint	Timinker Chaha		√	√	√	-		
103	*Calidris tenuirostris*	Graet Knot	Boro Noth				√	-		
104	*Himantopus himantopus*	Black-winged Stilt	Kalapakh Thengi/Lal pa Dhenga				√	-		
105	*Pluvialis fulva*	Pacific Golden Plover	Proshanto Shonajiria	√	√		√	-		
106	*Charadrius alexandrinus*	Kentish Plover	Kentish Jiria	√	√	√	√	-		
107	*Charadrius dubius*	Little Ring Plover	Choto Nothjiria	√		√		-		
108	*Charadrius leschenaultii*	Greater Sand Plover	Boro Dhuljiria	√	√	√	√	-		
109	*Charadrius mongolus*	Little Sand Plover	Choto Dhuljiria	√	√	√	√	-		
110	*Eurynorhynchus pygmeus*	Spoon-billed Sandpiper	Chamuchthuto Batan				√	CR	TH	
111	*Larus brunnicephalus*	Brown-headed Gull	Khoiramatha Gangchil	√	√	√	√	-		
112	*Larus ichthyaetus*	Great Black-headed Gull	Palasi Gangchil/Bara Jal	√	√	√	√	-		

Sl. No.	Species Name	English Name	Local Name	Survey Sites (Early winter)				Conservation Status		Remarks
				Power Plant Area	Kutubdia Islands	Mouth of Matarbari Channel	Sonadia Islands	IUCN	Local status	
			Kabutor							
113	*Larus heuglini*	Heuglin's Gull	Heugliner Gangchil				√	-		
114	*Larus ridibundus*	Common Black-headed Gull	Kalamatha Gangchil				√	-		
115	*Sterna sumatrana*	Black-naped Tern	Kalaghar Panchil	√	√	√	√	-		
116	*Threskiornis melanocephalus*	Black-headed Ibis	Kalamatha Kastechora		√		√	-		

(Source: JICA Study Team)

Table 2.2-1(4) Terrestrial Fauna (Mammals) (Power plant site; Rainy season)

Sl. No.	Species Name	English Name	Local Name	Survey Sites (Rainy Season)				Conservation Status		Remarks
				Power Plant Area	Kutubdia Islands	Mouth of Matarbari Channel	Sonadia Islands	IUCN	Local status	
1	*Canis aureus* Linnaeus, 1758	Jackal	Shial	√	√	√	√	-		
2	*Felis chaus* Schreber 1777	Wild cat	Bon biral	√	√	√	√	-		
3	*Lutra lutra* (Linnaeus, 1758)	Common otter	Ud biral	√	√	√	√	-		
4	*Viverra zibetha* Linnaeus 1758	Large Indian Civet	Baghdas		√		√	-		
5	*Suncus murinus* Linnaeus, 1766	House shrew	Chika	√	√	√	√	-		
6	*Bandicota indica* (Bechstein, 1800)	Indian Mole rat	Indur	√	√	√	√	-		
7	*Rattus rattus* (Linnaeus, 1758)	House rat	Indur	√	√	√		-		
8	*Callosciurus pygerythrus* (I. Geoffroy Saint Hilaire, 1832)	Hoary-bellied Himalayan Squirrel	Kathbirali		√			-		
9	*Pteropus giganteus* (Brunnich 1782)	Indian Flying Fox	Baro badur	√	√	√		-		
10	*Rousettus leschenaulti* (Desmarest, 1820)	Leschenault's Rousette	Kola Badur		√			-		
11	*Pipistrellus coromandra* (Gray, 1838)	Indian Pipistrelle	Chamchika		√	√		-		

(Source: JICA Study Team)

Table 2.2-2(1) Terrestrial Fauna (Insects) (Power plant site; Dry season)

Sl. No.	*Species Name*	English Name (Local Name)	Habitat	Survey Sites!(Dry Season)				Conservation Status			Remarks
				Power Plant Area	Dholghat and Kutubdia Islands	Mouth of Matarbari Channel	Sonadia Islands	IUCN	CITES	Local Law	
Order: Odonata Family: Coenagriidae											
1	*Agriocnemis pygmaea* (Rambur)	Damsel fly (Foring)	Cultivated field	√	√	√	√	NO			Predator and Bioindicator
2	*Ceriagrion cerinorubellum* (Brauer)	Damsel fly (Foring)	Cultivated field	√	√	√	√				Predator and Bioindicator
Family: Libellulidae											
3	*Tholymis* sp.	Evening Skimmer (Foring)	Roadside vegetation	√	√	√	√				Predator and Bioindicator
Order: Arthropoda Family: Gryllidae											
4	*Gryllus* spp.	Cricket (Urchunga)	Paddy field	√	√	√	√	NO			Agricultural pest
Family: Acrididae											
5	*Oxya chinensis* (Thunberg)	Small Rice Grasshopper (Ghas Foring)	Paddy field	√	√	√	√	NO			Agricultural pest
Order: Dictyoptera Family: Blattaria											
6	*Periplaneta Americana* Linn.	American Cockroach (Telapoka)	Restaurant	√	√	√	√	NO			Household pest
Order: Diptera Family: Agromyzidae											

Sl. No.	*Species Name*	English Name (Local Name)	Habitat	Survey Sites ! (Dry Season)				Conservation Status			Remarks
				Power Plant Area	Dholghat and Kutubdia Islands	Mouth of Matarbari Channel	Sonadia Islands	IUCN	CITES	Local Law	
7	*Agromyza spp.*	Miner flies	Bush bean	√	√	√	√	NO			Leaf miner pest of vegetables
8	*Liriomyza*	Leaf miners	Tomato	√	√	√					↘
Family: Calliphordidae											
9	*Lucilia*	Bluebottles	Crude fiesh		√						↘
Family Phoridae											
10	*Megaselia sp.*		Crude fiesh		√						↘
Family: Tephridae											
11	*Bactrocera cucurbitae* (Coquillett)	Melon fly	Bottle gourd	√		√		NO			Pest of vegetables
Family: Syrphidae											
12	*Eristalinus quinquelineatus* (Fabricius)	Hover fly	Paddy field		√						Pollinator in most cases
13	*Episyrphus spp.*	Hover fly	Paddy field	√	√	√	√	NO			Predator and pollinator in most cases
Family: Muscidae											
14	*Musca domestica* Linn.	House fly	Restaurant	√	√	√	√	NO			Pathogen carrier and pollinaotr in few cases
Family: Calliphoridae											
15	*Chrysomya megacephala* (Fabricius)	Oriental latrine fly	Dry fish	√	√	√	√	NO			Pest of dry fish and pollinaotr in few cases
Order: Lepidoptera											

Sl. No.	*Species Name*	English Name (Local Name)	Habitat	Survey Sites (Dry Season)				Conservation Status			Remarks
				Power Plant Area	Dholghat and Kutubdia Islands	Mouth of Matarbari Channel	Sonadia Islands	IUCN	CITES	Local Law	
Family: Pieridae											
16	*Eurema hecabe contubernalis* Moore	Common Grass Yellow (Holud)	Common been	√	√	√		NO			Pollinator in adult aged
Family: Nymphalidae											
17	*Junonia atlites* (Linn.)	Chandnori	Roadside Flower	√	√	√		NO			Pollinator in adult aged
Family: Satyridae											
18	*Melanitis phedima bela* Moore	Dark Evening Brown	Roadside Flower	√	√	√	√	NO			Pollinator in adult aged
Family: Hesperidae											
19	*Parnara guttatus mangala* Moore	Straight Swift (Nillbijuri)	Snake gourd		√	√		NO			Pollinator
20	*Oriens goloides* Moore	Smaller Darlet	Agricultural field		√	√		NO			Pollinator
Order: Coleoptera Family: Chrysomelidae											
21	*Aulacophora foveicollis* Lucas	Red pumpkin beetle	Agricultural field	√		√	√	NO			Agricultural pest
22	*Aulacophora frontalis* Baly	Pumpkin beetle	Agricultural field	√		√	√	NO			Agricultural pest
Order: Homoptera Family: Deltocephalidae											
23	*Nephotettix cincticeps* Matsumura	Spotted jassid	Paddy field	√		√		NO			Pest of rice
Order: Hemiptera Family: Coreidae											
24	*Leptocorisa acuta*	Rice bug	Paddy field	√		√		NO			↘

Sl. No.	*Species Name*	English Name (Local Name)	Habitat	Survey Sites!(Dry Season)				Conservation Status			Remarks
				Power Plant Area	Dholghat and Kutubdia Islands	Mouth of Matarbari Channel	Sonadia Islands	IUCN	CITES	Local Law	
	Thunb.										Pest of rice
Order: Hymenoptera Family: Aphidae											
25	*Rhopalosiphum sp.*	Aphis	Common bean	√	√	√	√	NO			Agricultural pest
Family: Halictidae											
26	*Lasioglossum* sp.	Solitary Bee	Cucumber field	√	√	√	√	NO			
Family:Anthophoridae											
27	*Amegilla spp.*		Tomato								↘
Family:Apidae											
28	*Apis mellifera* Linn.	Western Honey bee(Momachhi)	Cucumber field	√		√	√	NO			Pollinator and Bioindicator
Order: Coleoptera Family: Coccinellidae											
29	*Micraspis crocea* (Mulsant)	Lady beetle	Paddy field	√	√	√	√	NO			Rice pest
Order: Dictyoptera Family: Blattellidae											
30	*Blattella gemanica*	German Cockroach	Vegetable field		√		√	NO			↘ Rice pest
Order: Hemiptera Family: Coreidae											
31	*Leptocorisa acuta*	Rice bug	Paddy field	√		√		NO			↘ Rice pest
Order: Uiztbopqufsb Family: Thripidae											

Sl. No.	*Species Name*	English Name (Local Name)	Habitat	Survey Sites！(Dry Season)				Conservation Status			Remarks
				Power Plant Area	Dholghat and Kutubdia Islands	Mouth of Matarbari Channel	Sonadia Islands	IUCN	CITES	Local Law	
32	*Scirtothrips dorsalis Hood.*		Peper		√			NO			↘ Rice pest

Notes: 1. The survey in dry season was conducted twice. The first survey was carried out from December, 2012 to January, 2013. The second one was carried out in March, 2013.
2. ↘ =species newly identified only during 2nd dry season survey carried out March. Other species were identified both of 1st and 2nd dry season survey

(Source: JICA Study Team)

Table 2.2-2(2) Terrestrial Fauna (Amphibians and Reptiles) (Power plant site; Dry season)

Sl. No.	*Species Name*	English Name	Local Name	Survey Sites				Conservation Status		Remarks
				Dry Season						
				Power Plant Area	Dholghat and Kutubdia Islands	Mouth of Matarbari Channel	Sonadia Islands	IUCN	Local	
(Amphibians)										
1	*Duttaphrynus (Bufo) melanostictus*	Southeast Asian toad	Kono bang	√	√	√	√	-		Very common throughout the county
2	*Euphlyctis cyanophlyctis*	Skipper Frog	Kotkoti bang	√	√	√		-		Very common
3	*Fejervarya limnocharis*	Cricket frog		√	√	√		-		Common
4	*Fejervarya nepalensis*	Nepal Cricket Frog		√	√	√		-		
5	*Hoplobatrachus tigerinus*	Bull frog	Kola bang, Sona bang,B hawa beng	√	√	√		-		Wide spread
(Reptiles)										
1	*Calotes versicolor* (Daudin, 1802)	Garden lizard	Roktoc husha		√		√	-	TH	
2	*Mabuya mabuya*	Skink	Achil	√	√	√		-	TH	
3	*Hemidactylus brooki* Gray, 1845	House lizard	Tiktiki	√	√	√	√	-		
4	*Hemidactylus frenatus* Schlegel in Duméril & Bibron, 1836	house lizard	Tiktiki	√	√	√	√	-		

Sl. No.	*Species Name*	English Name	Local Name	Survey Sites				Conservation Status		Remarks
				Dry Season						
				Power Plant Area	Dholghat and Kutubdia Islands	Mouth of Matarbari Channel	Sonadia Islands	IUCN	Local	
5	*Xenocrophis piscator*	Checkered keel back	Dhora sap	√	√	√	√	-		
6	*Cerberus rynchops* (Schneider, 1799)	Dog faced water snake	Andha sap	√			√	-		
7	*Lepidochelys olivacea* Eschscholtz, 1758	Olive Ridley Turtle	Samudrik Kachim	√	√	√	√	VU-	TH	↘ It is protected by the Bangladesh Wildlife Preservation Act
8	*Eritmochelys imbricata* (Linnaeus, 1766)	Hawksbill Sea Turtle	Bajthuti Samudrik Kachim	√	√		√	CR	TH	↘ Do
9	*Chelonia mydas* (Linnaeus, 1758)	Green Turtle	Sabuj Samudrik Kachim	√			√	EN	TH	↘ Do
10	*Caretta caretta* (Linnaeus 1756)	Loggerhead Turtle	Mugur matha Kachhap	√	√		√	EN	TH	↘ Do

Notes: 1. The survey in dry season was conducted twice. The first survey was carried out from December, 2012 to January, 2013. The second one was carried out in March, 2013.
2. ↘ =species newly identified only during 2nd dry season survey carried out March. Other species were identified both of 1st and 2nd dry season survey

(Source: JICA Study Team)

Table 2.2-3(3) Terrestrial Fauna (Birds) (Power plant site; Dry season)

Sl. No.	Species Name	English Name	Local Name	Survey Sites！(Dry season)				Conservation Status		Remarks
				Power Plant Area	Dholghat and Kutubdia Islands	Mouth of Matarbari Channel	Sonadia Islands	IUCN	Local status	
1	*Passer domesticus*	House Sparrow	Pati Chorui	√	√	√	√			
2	*Orthotomus sutorius*	Common Tailorbird	Pati Tuntuni	√	√	√	√			
3	*Sturnus contra*	Pied Myna	Pakra Shalik/Gubra Shalik/Gu Shalik	√	√	√	√			
4	*Sturnus malabaricus*	Chestnut-tailed Starling	Khoiralej Kathshalik/Deshi Pawei	√	√	√	√			
5	*Acridotheres tristis*	Common Myna	Bhat Shalik	√	√	√	√			
6	*Acridotheres fuscus*	Jungle Myna	Jhuti Sahlik	√	√	√	√			
7	*Copsychus saularis*	Oriental Magpie-Robin	Doel/Udoi Doel	√	√	√	√			
8	*Orthotomus sutorius*	Common Tailorbird	Pati Tuntuni	√	√	√	√			
9	*Columba livia*	Common Pigeon	Gola Paira/Jalali Kabutor	√	√	√				
10	*Treron bicintus*	Orenge-breasted Green Pigeon	Komlabook Horial/Horikol	√						
11	*Streptopelia decaocto*	Eurasian Collared Dove	Eurashio Konthighughu/ Raj Ghughu	√	√	√	√			
12	*Streptopelia chinensis*	Spotted Dove	Tila Ghughu	√	√	√	√			
13	*Treron phoenicopterus*	Yellow-footed Green Pigeon	Holdepa Horial/Botkol	√						
14	*Pycnonotus cafer*	Red-vented	Bangla	√	√	√	√			

Sl. No.	Species Name	English Name	Local Name	Survey Sites (Dry season)				Conservation Status		Remarks
				Power Plant Area	Dholghat and Kutubdia Islands	Mouth of Matarbari Channel	Sonadia Islands	IUCN	Local status	
		Bulbul	Bulbul/Bulbuli							
15	*Pycnonotus jocosus*	Red-whiskered Bulbul	Shipahi Bulbul/Bulbuli	√			√			
16	*Corvus splendens*	House Crow	Pati Kak	√	√	√	√			
17	*Corvus macrorhynchos*	Jungle Crow	Dar Kak/Danr Kak	√	√	√	√			
18	*Oriolus xanthornus*	Black-hooded Oriole	Kalamatha Benebou/Holdey Pakhi	√	√	√	√			
19	*Artamus fuscus*	Ashy Woodswallow	Metey Bonababil/Latora	√	√	√	√			
20	*Dendrocitta vagabunda*	Rufous Treepie	Khoira Harichacha/ Hari Chacha	√	√	√	√			
21	*Dicaeum cruentatum*	Scarlet-backet Flowerpecker	Lalpith Fuljhuri	√	√					
22	*Dicaeum erythrorhynchos*	Pale-billed Flowerpecker	Metethot Fuljhuri	√						
23	*Leptocoma zeylonica*	Purple-rumped Sunbird	Begunikomor Moutushi	√	√	√	√			
24	*Cinnyris asiaticus*	Purple Sunbird	Beguni Moutushi	√	√	√	√			
25	*Aethopyga siparaja*	Crimson Sunbird	Shidure Moutushi	√						
26	*Arachnothera siparaja*	Little Spiderhunter	Choto Makormar	√	√		√			
27	*Ploceus philippinus*	Baya Weaver	Deshi Babui/Baoi	√	√	√	√			
28	*Lonchura malacca*	Black-headed	Kalamatha	√		√				

Sl. No.	Species Name	English Name	Local Name	Survey Sites!(Dry season)				Conservation Status		Remarks
				Power Plant Area	Dholghat and Kutubdia Islands	Mouth of Matarbari Channel	Sonadia Islands	IUCN	Local status	
		Munia	Munia							
29	*Lonchura punctulata*	Scaly-breasred Munia	Tila Munia	√	√	√	√			
30	*Lonchura straiata*	White-rumped Munia	Dholakomor Munia	√						
31	*Anthus rufulus*	Paddyfield Pipit	Dhani Tulika	√	√		√			
32	*Pellorneum ruficeps*	Puff-throated Babler	Golafola Satarey	√	√	√				
33	*Turdoides earlei*	Straited Babler	Dagi Satari	√						
34	*Zosterops palpebrosus*	Oriental White-eye	Udoi Dholachokh/Shet Ankhi	√	√					
35	*Prinia inornata*	Plain Prinia	Nirol Prina	√	√	√	√			
36	*Ficedula albicilla*	Taiga Flycatcher	Taiga Chutki/Lalboo k Chotok	√	√	√	√			
37	*Aegithina tiphia*	Common Iora	Fatik Jal	√	√					
38	*Hypothymis azurea*	Black-naped Monarch	Kalaghar Rajon	√	√	√	√			
39	*Dicrurus macrocercus*	Black Drongo	Kala Fingey	√	√	√	√			
40	*Disrurus paradiseus*	Greater Racket-tailed Drongo	Boro Recket-Fingey/ Bhimraj	√						
41	*Disrurus aeneus*	Bronzed Drongo	Fingey	√		√	√			
42	*Rhipidura albicollis*	White-throated Fantail	Dholagola Chatighurani/Lej Nachuni	√	√	√	√			
43	*Alcedo atthis*	Common Kingfisher	Pati Machranga	√	√	√	√			

Sl. No.	Species Name	English Name	Local Name	Survey Sites!(Dry season)				Conservation Status		Remarks
				Power Plant Area	Dholghat and Kutubdia Islands	Mouth of Matarbari Channel	Sonadia Islands	IUCN	Local status	
44	*Alcedo meninting*	Blue-eared Kingfisher	Neelkan Machranga				√			
45	*Halcyon smyrnensis*	White-throated kingfisher	Dholagoloa Machranga	√	√	√	√			
46	*Ceryle rudis*	Pied Kingfisher	Pakra Machranga	√	√	√	√			
47	*Upupa epops*	Eurasian Hoopoe	Pati Hoodhood	√		√	√			
48	*Dendrocopos canicapillus*	Grey-capped Pigmy Woodpecker	Metetoopi Batkurali				√			
49	*Dendrocopos macei*	Fulvous-breasted Woodpecker	Batabi Katkurali	√						
50	*Dinopium bengalensis*	Lesser goldenback	Bangla kaththokra	√						
51	*Merops leschenaulti*	Chestnut-headed Bee-eater	Khoiramatha Shuichora	√	√	√	√			
52	*Merops philippinus*	Blue-tailed Bee-eater	Neel-lej Shuichora	√	√	√	√			
53	*Merops orientalis*	Green Bee-eater	Shabuj Shuichora	√		√	√			
54	*Psittacula alexandri*	Red-breasrted Parakeet	Modna Tia	√	√	√				
55	*Psittacula krameri*	Rose-ringed Parakeet	Shobuj Tia	√	√	√	√			
56	*Cypsiurus balasiensis*	Asian Palm Swift	Asio Talbatashi/Nakkati	√	√	√	√			
57	*Apus affinis*	Little Swift	Ghor Batashi	√	√	√	√			
58	*Ketupa zeylonensis*	Brown Fish	Khoira	√		√				

Sl. No.	Species Name	English Name	Local Name	Survey Sites!(Dry season)				Conservation Status		Remarks
				Power Plant Area	Dholghat and Kutubdia Islands	Mouth of Matarbari Channel	Sonadia Islands	IUCN	Local status	
		Owl	mechupacha/Bhootoom Pecha							
59	*Otus bakkamoena*	Collard Scops Owl	Konti Nimpesha	√		√				
60	*Tyto alba*	Barn Owl	Lokkhi Pecha	√	√					
61	*Athene brama*	Spotted Owlet	Khuruley Pencha/Konthi Kutipecha	√	√	√				
62	*Caprimulgus macrurus*	Large-tailed Nightjar	Lenja Ratchora	√						
63	*Ichthyophaga ichthyaetus*	Grey-headed Fish Eagle	Metemetha Kura Eagle	√			√			
64	*Spilornis Cheela*	Crested Serpent Eagle	Tila Nag-eegol/Shapkheko Baj			√	√			
65	*Haliaeetus leucoryphus*	Pallas's Fish Eagle	Kura/Kural				√	VU	**TH**	
66	*Phalacrocorax niger*	Little Cormorant	Choto Pankouri	√	√	√	√			
67	*Phalacrocorax fuscicollis*	Indian Cormorant	Deshi Pankouri				√			
68	*Egretta garzetta*	Little Egret	Choto Boga	√	√	√	√			
69	*Egretta intermedia*	Yellow-billed Egret	Majhla Boga/Korche Bok	√	√	√	√			
70	*Casmerudias albus*	Great Egret	Boro Boga	√		√				
71	*Bubulcus ibis*	Cattle Egret	Go Boga	√	√	√	√			
72	*Ardea cinerea*	Grey Heron	Dhupni Bok	√	√	√	√			
73	*Ardeola grayii*	Indian Pond Heron	Deshi Kanibok	√	√	√	√			

Sl. No.	Species Name	English Name	Local Name	Survey Sites (Dry season)				Conservation Status		Remarks
				Power Plant Area	Dholghat and Kutubdia Islands	Mouth of Matarbari Channel	Sonadia Islands	IUCN	Local status	
74	*Sterna aurantia*	River Tern	Nodia Panchil			√	√			
75	*Sterna acuticauda*	Black-bellied Tern	Gangchil				√	EN	TH	
76	*Amaurornis phoenicurus*	White-breasted Waterhen	Dholabook Dahuk	√	√	√	√			
77	*Porzana fuska*	Ruddy-breasted Crake	Lalbook Gurguri	√			√			
78	*Gallirallus striatus*	Slaty-breasted Rail	Metebook Jhilli				√			
79	*Vanellus duvaucelii*	River Lapwing	Hot-titi	√						
80	*Sterna albifrons*	Little Tern	Choto Panchil	√	√	√	√			
81	*Nycticorax nycticorax*	Black-crowned Night Heron	Kalamatha Nishibok				√			
82	*Hirundo rustica*	Barn Swallow	Metho Ababil	√	√	√	√			
83	*Pandion haliaetus*	Osprey	Machmural/Mechubaj	√			√			
84	*Phyllocopus affinis*	Tickell's Leaf Warbler	Tikeler Patafutki				√			
85	*Phylloscopus collybita*	Common Chiffchaff	Pati Chifchaf	√						
86	*Phylloscopus fuscatus*	Dusky Warbler	Kalchey Futki	√	√		√			
87	*Phylloscopus trochiloides*	Greenish Warbler	Saoboje Futki				√			
88	*Anas clypeata*	Northern Shoveler	Utturey Khuntehash/Pantamukhi	√	√	√	√			
89	*Tadorna ferruginea*	Ruddy Shelduck	Khoira Chokachoki		√					
90	*Arser indicus*	Bar-headed Goose	Rajhans				√			

Sl. No.	Species Name	English Name	Local Name	Survey Sites!(Dry season)				Conservation Status		Remarks
				Power Plant Area	Dholghat and Kutubdia Islands	Mouth of Matarbari Channel	Sonadia Islands	IUCN	Local status	
91	*Jynx torquilla*	Eurasian Wryneck	Eureshio Gharbetha	√		√				
92	*Halcyon pileata*	Black-capped Kingfisher	Kalatupi Machranga	√	√	√	√			
93	*Todiramphus chloris*	Collared Kingfisher	Dholaghar Machranga	√	√	√	√			
94	*Porzana pusilla*	Bailon's Crake	Bailoner Gurguri				√			
95	*Rallus aquaticus*	Water Rail	Panti Jhilli				√			
96	*Gallinago gallinago*	Common Snipe	Pati Chega		√	√	√			
97	*Gallinago stenura*	Pin-tailed Snipe	Lenja Chega	√			√			
98	*Limosa lapponica*	Bar-tailed Godwit	Dagilej Jourali				√			
99	*Limosa limosa*	Black-tailed Godwit	Kalalej jourali				√			
100	*Numenius arquata*	Eurasian Curlew	Eureshio Gulinda	√	√	√	√			
101	*Numenius phaeopus*	Whimbrel	Choto Gulinda	√	√		√			
102	*Tringa glareola*	Wood Sandpiper	Bon Batan/Balu Batan	√	√	√	√			
103	*Xenus cinereus*	Terek Sandpiper	Terek Batan		√	√	√			
104	*Eurynorhynchus pygmeus*	Spoon-billed Sandpiper	Chamuchthuto Batan	√[2]			√[3]	CR	**TH**	↘ !
105	*Limicola falcinellus*	Broad-billed Sandpiper	Motathuto Batan				√		**TH**	
106	*Philomachus pugnax*	Ruff	Geoala Batan	√						
107	*Recurvirostra avosetta*	Pied Avocet	Pakra Ultothuti				√		**TH**	
108	*Actitis hypoleucos*	Common	Pati Batan/	√	√	√	√			

Sl. No.	Species Name	English Name	Local Name	Survey Sites!(Dry season)				Conservation Status		Remarks
				Power Plant Area	Dholghat and Kutubdia Islands	Mouth of Matarbari Channel	Sonadia Islands	IUCN	Local status	
		Sandpiper	Chapakhi							
109	*Tringa stagnatilis*	Marsh Sandpiper	Bali Batan			√	√		**TH**	
110	*Calidris ferruginea*	Curlew Sandpiper	Gulinda Batan	√		√	√			
111	*Tringa guttifer*	Nordmann's Greenshank	Nordman Shabujpa				√	EN	**TH**	
112	*Tringa nebularia*	Common Greenshank	Pati Shabujpa		√		√	C	**Do**	
113	*Tringa tetanus*	Common Redshank	Pati Lalpa	√	√	√	√	C	**Do**	
114	*Arenaria interpres*	Ruddy Turnstone	Lal Nuribatan				√	UC	**TH**	
115	*Limnodromus semipalmatu*	Asian Dowitcher	Eshio Daucher	√						
116	*Calidris alba*	Sanderling	Sanderling			√	√			
117	*Calidris minuta*	Little Stint	Choto Chaha	√	√		√			
118	*Calidris ruficollis*	Red-necked Stint	Lalghar Chaha				√			
119	*Calidris temminckii*	Timminck's Stint	Timinker Chaha	√			√			
120	*Calidris tenuirostris*	Graet Knot	Boro Noth				√			
121	*Himantopus himantopus*	Black-winged Stilt	Kalapakh Thengi/Lal pa Dhenga				√			
122	*Pluvialis fulva*	Pacific Golden Plover	Proshanto Shonajiria	√	√	√	√			
123	*Charadrius alexandrines*	Kentish Plover	Kentish Jiria		√		√			
124	*Charadrius dubius*	Little Ring Plover	Choto Nothjiria	√			√			

Sl. No.	Species Name	English Name	Local Name	Survey Sites!(Dry season)				Conservation Status		Remarks
				Power Plant Area	Dholghat and Kutubdia Islands	Mouth of Matarbari Channel	Sonadia Islands	IUCN	Local status	
125	*Charadrius hiaticula*	Common Ring Plover	Pati Nothjiria				√			
126	*Charadrius leschenaultia*	Greater Sand Plover	Boro Dhuljiria	√		√	√			
127	*Charadrius mongolus*	Lesser Sand Plover	Choto Dhuljiria	√	√	√	√			
128	*Larus brunnicephalus*	Brown-headed Gull	Khoiramatha Gangchil	√	√	√	√			
129	*Larus ichthyaetus*	Great Black-headed Gull	Palasi Gangchil/Bara Jal Kabutor		√		√			
130	*Larus heuglini*	Heuglin's Gull	Heugliner Gangchil		√		√			
131	*Larus ridibundus*	Common Black-headed Gull	Kalamatha Gangchil	√	√	√	√			
132	*Sterna sumatrana*	Black-naped Tern	Kalaghar Panchil	√	√	√	√			
133	*Threskiornis melanocephalus*	Black-headed Ibis	Kalamatha Kastechora				√			
134	*Motacilla alba*	White Wagtail	Dhola Khonjon	√	√	√	√			
135	*Motacilla cinerea*	Grey Wagtail	Metey Khonjon	√				UC	**TH**	
136	*Motacilla citreola*	Citrine Wagtail	Sitrin Khonjon	√			√			
137	*Motacilla flava*	Western Yellow Wagtail	Poschima Holdey Khonjon		√	√	√			
138	*Lanius schach*	Long-tail Shrike	Lombaleji Koshai	√	√	√				
139	*Lanius cristatus*	Brown Shrike	Koshai	√	√		√			

Sl. No.	Species Name	English Name	Local Name	Survey Sites!(Dry season)				Conservation Status		Remarks
				Power Plant Area	Dholghat and Kutubdia Islands	Mouth of Matarbari Channel	Sonadia Islands	IUCN	Local status	
140	*Streptopelia*	Red Collared Dove	Lal Kontighugu	√						↘
141	*Ninox scutulata*	Brown Hawk Owl				√				↘
142	*Megalaima lineata*	Lineated Barbet	Bosonto Bawri	√	√	√				↘
143	*Megalaima haemacepala*	Copersmith Barbet	Coparer Bosonto Bawri	√						↘
144	*Parus major*	Great Tit	Baro Tit	√	√	√				↘
145	*Falco chiquera*	Red-naked Falkon	Lal gola Baj	√						↘
146	*Oriolus chinensis*	Black-naped Oriol		√						↘
147	*Ciconia episcopus*	Wooly-naked Stork					√			↘

Notes: 1. The survey in dry season was conducted twice. The first survey was carried out from December, 2012 to January, 2013. The second one was carried out in March, 2013.

2. *=species newly identified during 2^{nd} dry season survey carried out March. Other species were identified both of 1^{st} and 2^{nd} dry seaso survey except Spoon-billed Sandpiper identified only 2^{nd} dry season survey.

=√^{1}-only identifiedat 2^{nd} dry season , √^{2}-identified at both 1^{st} and 2^{nd} dry season

(Source: JICA Study Team)

Table 2.2-3(4) Terrestrial Fauna (Mammals) (Power plant site; Dry season)

Sl. No.	Species Name	English Name	Local Name	Survey Sites！(Dry Season)				Conservation Status			Remarks
				Power Plant Area	Dholghat and Kutubdia Islands	Mouth of Matarbari Channel	Sonadia Islands	IUCN	CITES	Local Law	
Order: Carnivora Family: Cadidae											
1	*Canis aureus* Linnaeus, 1758	Jackal	Shial	√	√	√	√	LC			
Family:Felidae											
2	*Felis chaus* Schreber 1777	Wild cat	Bon biral	√	√	√	√	LC			
Family: Mustelidae											
3	*Lutra lutra* (Linnaeus, 1758)	Common otter	Ud biral	√	√	√	√	NO			
Family: Viverridae											
4	*Viverra zibetha* Linnaeus 1758	Large Indian Civet	Baghdas		√		√	NO			
Order: Eulipotyphla Family: Soricidae											
5	*Suncus murinus* Linnaeus, 1766	House shrew	Chika	√	√	√	√	LC			
Order: Rodentia Family: Muridae											
6	*Bandicota indica* (Bechstein, 1800)	Indian Mole rat	Indur	√	√	√	√	LC			
7	*Rattus rattus* (Linnaeus, 1758)	House rat	Indur	√	√	√		LC			
Family: Sciuridae											

8	*Callosciurus pygerythrus* (I. Geoffroy Saint Hilaire, 1832)	Hoary-bellied Himalayan Squirrel	Kathbirali		√			LC			
Order: Chiroptera Family: Pteropidae											
9	*Pteropus giganteus* (Brunnich 1782)	Indian Flying Fox	Baro badur	√	√	√		LC			
10	*Rousettus leschenaulti* (Desmarest, 1820)	Leschenault's Rousette	Kola Badur					LC			
11	*Pipistrellus coromandra* (Gray, 1838)	Indian Pipistrelle	Chamchika			√		LC			
Order: Cetacea Family: Delphinidae											
12	*Tursiops aduncus* (Ehrenberg, 1833)	Indo-Pacific Bottlenose Dolphin	Dolphin		√		√	DD			

Notes: 1. The survey in dry season was conducted twice. The first survey was carried out from December, 2012 to January, 2013. The second one was carried out in March, 2013.

2. All of 12 species above were identified both of 1st and 2nd dry season survey

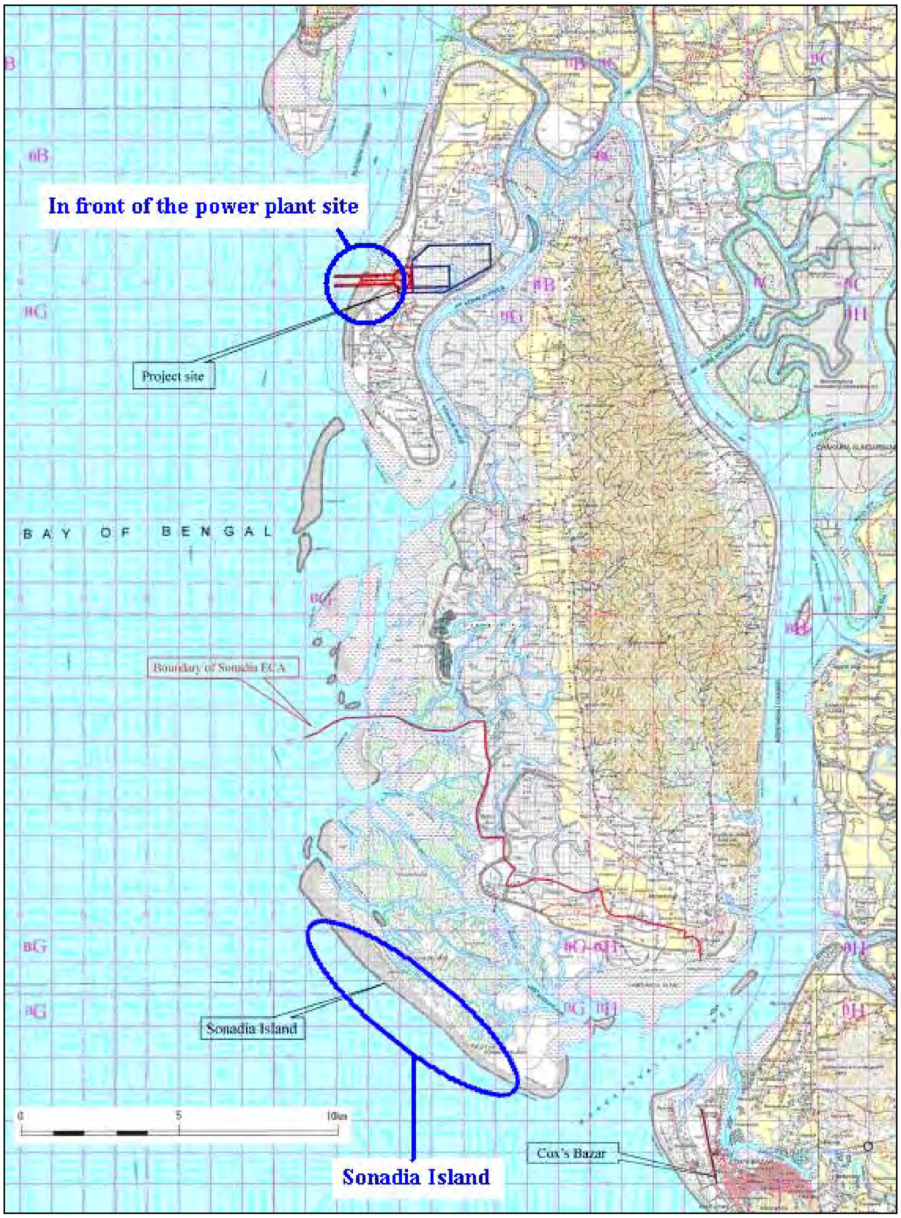
(Source: JICA Study Team)

2.3 Threatened species

(1) Spoon-billed Sandpiper (*Eurynorhynchus pygmeus*)

a. Method

The observation of Spoon-billed Sandpiper was carried out around 2 times per each week during stopover seasons (from December, 2012 to March, 2013). The observation area is shown the below figure.



(Source: JICA Study Team)

Figure 2.3-1 Observation are of Spoon-billed Sandpiper

b. Results of survey

Table 2.3-1 Observation Results of Spoon-billed Sandpiper

(Unit: Individuals)

Date/Time		Area	
		In front of the power plant site	Sonadia Island
Dec.7	06:00 - 07:00	0	0
	13:00 - 14:00	0	0
	18:00 - 19:00	0	0
Dec.8	06:00 - 07:00	0	0
	13:00 - 14:00	0	0
	18:00 - 19:00	0	0
Dec.14	06:00 - 07:00	0	0
	13:00 - 14:00	0	0
	18:00 - 19:00	0	0
Dec.15	06:00 - 07:00	0	0
	13:00 - 14:00	0	0
	18:00 - 19:00	0	0
Dec.21	06:00 - 07:00	0	**2**
	13:00 - 14:00	0	0
	18:00 - 19:00	0	0
Dec.22	06:00 - 07:00	0	0
	13:00 - 14:00	0	0
	18:00 - 19:00	0	0
Dec.28	06:00 - 07:00	0	0
	13:00 - 14:00	0	0
	18:00 - 19:00	0	0
Dec.29	06:00 - 07:00	0	0
	13:00 - 14:00	0	0
	18:00 - 19:00	0	0
Jan.4	06:00 - 07:00	0	**1**
	13:00 - 14:00	0	0
	18:00 - 19:00	0	0
Jan.5	06:00 - 07:00	0	**1**
	13:00 - 14:00	0	0
	18:00 - 19:00	0	0

Date/Time		Area	
		In front of the power plant site	Sonadia Island
Jan.11	06:00 - 07:00	0	0
	13:00 - 14:00	0	0
	18:00 - 19:00	0	0
Jan.12	06:00 - 07:00	0	0
	13:00 - 14:00	0	0
	18:00 - 19:00	0	0
Jan.18	06:00 - 07:00	0	0
	13:00 - 14:00	0	0
	18:00 - 19:00	0	0
Jan.19	06:00 - 07:00	0	0
	13:00 - 14:00	0	**2**
	18:00 - 19:00	0	0
Jan.25	06:00 - 07:00	0	0
	13:00 - 14:00	0	0
	18:00 - 19:00	0	0
Jan.26	06:00 - 07:00	0	0
	13:00 - 14:00	0	0
	18:00 - 19:00	0	0
Feb.1	06:00 - 07:00	0	**3**
	13:00 - 14:00	0	0
	18:00 - 19:00	0	0
Feb.2	06:00 - 07:00	0	0
	13:00 - 14:00	0	0
	18:00 - 19:00	0	0
Feb.15	06:00 - 07:00	0	0
	13:00 - 14:00	0	0
	18:00 - 19:00	0	0
Feb.16	06:00 - 07:00	0	0
	13:00 - 14:00	0	0
	18:00 - 19:00	0	0
Feb.22	06:00 - 07:00	0	**3**
	13:00 - 14:00	0	0
	18:00 - 19:00	0	0

Date/Time		Area	
		In front of the power plant site	Sonadia Island
Feb.23	06:00 - 07:00	0	0
	13:00 - 14:00	0	**1**
	18:00 - 19:00	0	0
Mar.1	06:00 - 07:00	0	0
	13:00 - 14:00	0	**6**
	18:00 - 19:00	0	0
Mar.2	06:00 - 07:00	0	0
	13:00 - 14:00	0	0
	18:00 - 19:00	0	0
Mar.9	06:00 - 07:00	0	0
	13:00 - 14:00	0	0
	18:00 - 19:00	**1**	0
Mar.10	06:00 - 07:00	0	0
	13:00 - 14:00	**2**	0
	18:00 - 19:00	0	0
Mar.15	06:00 - 07:00	0	0
	13:00 - 14:00	0	**5**
	18:00 - 19:00	0	0
Mar.16	06:00 - 07:00	0	0
	13:00 - 14:00	0	**2**
	18:00 - 19:00	0	0
Mar.22	06:00 - 07:00	0	0
	13:00 - 14:00	0	0
	18:00 - 19:00	0	0
Mar.23	06:00 - 07:00	0	0
	13:00 - 14:00	0	0
	18:00 - 19:00	0	0

(Source: JICA Study Team)

c. Analysis and recommendations based on weekly observations of the Spoon-billed Sandpiper

Based on the results of this survey, conducted from December 7th to March 30th 2013, migration behavior indicates that the study area cannot be classified as a wintering ground. That is, during winter while the Spoon-billed Sandpiper comes ashore to the sandy beach in front of the project site, the number of birds observed in the area is extremely small compared to the nearby coastal offshores of Sonadia Island. This is supported by findings by other researchers.

The survey results show landing frequency has been variable at almost all sites from December to March, indicating mass population has been available in the month of March. These results are consistent with the findings of different papers published in BLI[1]. Sonadia Island in Bangladesh, where 10% of the known population of the Critically Endangered Spoon-billed Sandpiper (Eurynorhynchus pygmeus) spends the winter, has been recognized as Bangladesh's 20th Important Bird Area (IBA) by Bird Life International.

In March-April 2010, a minimum of 49 individual birds were recorded during targeted surveys along the coast of Bangladesh, with most of the sightings on Sonadia Island (Bird, et al. 2010[2]). In addition, over the course of weekly surveys conducted from December 7 to March 30, 2013, birds were only observed flying on 3 days in the project site and on 11 days in the southern front of Sonadia. In one day, at most 2 individual birds were observed flying in one day in the project site, which is about 15%, whereas 13 birds were identified in the southern front of Sonadia in one day.

Mr. Sayam U. Chowdhury, the principal investigator of the Bangladesh Spoon-billed Sandpiper Conservation Project, a group of young conservationists who monitor the wader population and work with local communities to raise awareness and reduce threats, noted in the conclusion of a report that "A series of recent surveys confirms that Bangladesh is still an extremely important wintering ground for the Spoon-billed Sandpiper, and we identified Sonadia Island as the main wintering site in Bangladesh."

BirdLife Partners and others involved in the "Saving the Spoon-billed Sandpiper" project have been working at Sonadia since 2009 , when hunting of waders on the mudflats was identified as a major threat to the fast-diminishing Spoon-billed Sandpiper population there.

Mr. Inamul Haque, an assistant conservator of forest (coastal) for Bangladesh's Cox's Bazar region who has been involved in the restoration of mangrove cover on Sonadia said "We have

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[1] Bird Life International; http://www.birdlife.org/community/2013/04/spoon-billed-sandpiper-wintering-site-becomes-bangladeshs-20th-iba/

[2] Information on surveys record is available through "Bangladesh Spoon-billed Sandpiper diary Part I" and "Bangladesh Spoon-billed Sandpiper diary Part II" by http://birdguides.com/webzine/article.asp?a=2029, and, http://birdguides.com/webzine/article.asp?a=2066

been supporting the Bangladesh Spoon-billed Sandpiper Conservation Project by avoiding mangrove planting in areas that are important for shorebirds". He further explained "We have also been protecting the key sites from illegal hunting. I am delighted that Sonadia is receiving the international recognition it deserves by being declared an Important Bird Area."

Research indicates that the frequency of the Spoon-billed Sandpiper using Matabari Peninsula as a wintering ground is relatively very low in comparison to the nearby offshore island of Sonadia. Numerous survey results point out that Matabari Peninsula beach is not a main migratory habitat for migratory birds, especially the Spoon-billed Sandpiper in Bangladesh. This view is supported by many experts and reports.

(2) Sea Tutles

a. Method

The observation of sea turtles was carried out around 2 times per each week during landing seasons (from December, 2012 to March, 2013). The observation area is same as the one of Spoon-billed Sandpiper.

b. Results of survey

Table 2.3-2 Observation Results of the Sea Turtle

(Unit: Individuals)

Date/Time		Sites		Species Name and No. of individual
		In front of the power plant site	Sonadia Island	
Dec.7	20:00 – 22:00	1(b)	2(a)	a. *Lepidochelys olivacea* (Eschscholtz, 1758); 2 b. *Chelonia mydas* (Linnaeus, 1758); 1
	05:00 - 8:00	0	0	
Dec.8	20:00 – 22:00	0	0	Do not find any turtles, new footprints, or new nests.
	05:00 - 8:00	0	0	
Dec.14	20:00 – 22:00	0	1	*Lepidochelys olivacea* (Eschscholtz, 1758); 4
	05:00 - 8:00	2	1	
Dec.15	20:00 – 22:00	0	0	Do not find any turtles, new footprints, or new nests.
	05:00 - 8:00	0	0	
Dec.21	20:00 – 22:00	1	1	*Lepidochelys olivacea* (Eschscholtz, 1758); 4
	05:00 - 8:00	0	2	
Dec.22	20:00 – 22:00	0	1(a)	a. *Chelonia mydas* (Linnaeus, 1758); 1 b. *Cetta caretta* (Linnaeus 1756); 1
	05:00 - 8:00	1(b)	0	
Dec.28	20:00 – 22:00	0	0	Do not find any turtles, new footprints, or new nests.
	05:00 - 8:00	0	0	
Dec.29	20:00 – 22:00	0	0	Do not find any turtles, new footprints, or new nests.
	05:00 - 8:00	0	0	
Jan.4	20:00 – 22:00	0	0	*Lepidochelys olivacea* (Eschscholtz, 1758);2
	05:00 - 8:00	0	2	
Jan.5	20:00 – 22:00	0	0	a. *Lepidochelys olivacea* (Eschscholtz, 1758); 3 b. *Eritmochelys imbricata* (Linnaeus, 1766); 1
	05:00 - 8:00	1(a)	2(a),1(b)	
Jan.11	20:00 – 22:00	1	0	*Lepidochelys olivacea* (Eschscholtz, 1758); 6
	05:00 - 8:00	0	5	
Jan.12	20:00 – 22:00	0	1	*Lepidochelys olivacea* (Eschscholtz, 1758); 3
	05:00 - 8:00	0	2	
Jan.18	20:00 – 22:00	0	1(b)	a. *Chelonia mydas* (Linnaeus, 1758); 2 b. *Lepidochelys olivacea* (Eschscholtz, 1758); 3
	05:00 - 8:00	1(a)	1(a), 2(b)	
Jan.19	20:00 – 22:00	1(a)	0	a. *Lepidochelys olivacea* (Eschscholtz, 1758); 3 b. *Eritmochelys imbricata* (Linnaeus, 1766); 1 c. *Caretta caretta* (Linnaeus 1756); 1
	05:00 - 8:00	0	2(a),1(b),1(c)	
Jan.25	20:00 – 22:00	0	0	a. *Lepidochelys olivacea* (Eschscholtz, 1758); 5 b. *Caretta caretta* (Linnaeus 1756); 2
	05:00 - 8:00	2(a), 1(b)	3(a), 1(b)	
Jan.26	20:00 – 22:00	1	0	*Eritmochelys imbricata* (Linnaeus, 1766); 1
	05:00 - 8:00	0	0	

Date/Time		Sites		Species Name and No. of individual
		In front of the power plant site	Sonadia Island	
Feb.1	20:00 – 22:00	0	1	*Lepidochelys olivacea* (Eschscholtz, 1758); 8
	05:00 - 8:00	2	5	
Feb.2	20:00 – 22:00	0	1(a)	a. *Lepidochelys olivacea* (Eschscholtz, 1758); 1 b. *Chelonia mydas* (Linnaeus, 1758); 1
	05:00 - 8:00	0	1(b)	
Feb.15	20:00 – 22:00	4	6	*Lepidochelys olivacea* (Eschscholtz, 1758); 10
	05:00 - 8:00	0	0	
Feb.16	20:00 – 22:00	2	3	*Lepidochelys olivacea* (Eschscholtz, 1758); 5
	05:00 - 8:00	0	0	
Feb.22	20:00 – 22:00	0	2	*Lepidochelys olivacea* (Eschscholtz, 1758); 3
	05:00 - 8:00	0	1	
Feb.23	20:00 – 22:00	3	5	*Lepidochelys olivacea* (Eschscholtz, 1758); 10
	05:00 - 8:00	0	2	
Mar.1	20:00 – 22:00	1	0	*Lepidochelys olivacea* (Eschscholtz, 1758); 1
	05:00 - 8:00	0	0	
Mar.2	20:00 – 22:00	0	5	*Lepidochelys olivacea* (Eschscholtz, 1758); -6
	05:00 - 8:00	0	1	
Mar.9	20:00 - 22:00	1(a)	3 (a-2,b-1)	a. *Chelonia mydas* (Linnaeus, 1758); -3 b. *Cetta caretta* (Linnaeus 1756); 1
	05:00 - 8:00	0	0	
Mar.10	20:00 - 22:00	0	0	Do not find any turtles, new footprints, or new nests.
	05:00 - 8:00	0	0	
Mar.15	20:00 - 22:00	2	9	*Lepidochelys olivacea* (Eschscholtz, 1758); -12
	05:00 - 8:00	0	1	
Mar.16	20:00 - 22:00	0	4	*Lepidochelys olivacea* (Eschscholtz, 1758); -8
	05:00 - 8:00	1	1	
Mar.22	20:00 - 22:00	1	2	*Lepidochelys olivacea* (Eschscholtz, 1758); -3
	05:00 - 8:00	0	0	
Mar.23	20:00 - 22:00	0	3	*Lepidochelys olivacea* (Eschscholtz, 1758); -3
	05:00 - 8:00	0	0	
Mar.29	20:00 - 22:00	0	1(b)	a. *Chelonia mydas* (Linnaeus, 1758); -1 b *Lepidochelys olivacea* (Eschscholtz, 1758); -1
	05:00 - 8:00	1(a)	0	
Mar.30	20:00 - 22:00	2(a)	0	a *Lepidochelys olivacea* (Eschscholtz, 1758); -3 b *Eritmochelys imbricata* (Linnaeus, 1766); 1
	05:00 - 8:00	0	2 (a-1,b-1)	

(Source: JICA Study Team)

Total Number of landing turtles from Dec.7th 2012 to Mar. 30th 2013

Table 2.3-3 Total Number of landing turtles

(Unit: Individuals)

Species	Site		Total
	Matabari Peninsula	Sonadia Island	
Lepidochelys olivacea Olive ridley turtle	26	83	109
Caretta caretta Loggerhead turtle	2	3	5
Chelonia mydas Green turtle	4	3	7
Eretmochelys imbricate Hawksbill turtle	0	3	3
Total	32↖ 26↓↗	92↖ 74↓↗	124

(Source: JICA Study Team)

2. Analysis and recommendations

The survey results confirm that tidal behavior somehow controls the spawning habits of two species, the Hawksbill (Eretmochelys imbricata) and Olive ridley (Lepidochelys olivacea). Specifically, during neap tide the number of these turtles that come ashore to spawn on the sandy beach is extremely small compared with during the spring tide. This is supported by findings based on observations at other sites.

Landing frequency has been decreasing at almost all sites from March to April. These results are consistent with findings outlined in different papers published in MTN (Marine Turtles Network) by Marine Life Alliance based on surveys of Saint Martin's Island and Sonadia Island, which are located on the same coast.

In 2011, a study conducted from 2009-2010, showed confirmed landings of 192 turtles per year on Sonadia Island. Nineteen turtle landings were confirmed in the course of 24 hours during the same investigation (Islam et al 2011) conducted by the MarineLife Alliance survey. However, only 32 turtle landings were confirmed over 32 days of observation in Matabari Peninsula. Nesting frequency is also very poor in comparison to nesting frequency in the nearby offshore island of Sonadia.

A CNRS study (Center for Natural Resource Studies) found that the nesting population has been declining day by day on the Bangladesh coast, owing to severe exploitation of eggs, disturbances to the ecosystem, the killing of nesting turtles by fishing nets and dogs, and the effects of structural development for salt extraction and agricultural activities, and climate change. CNRS initiated sea turtle conservation activities on St. Martin's Island and on the Teknaf Peninsula in October 1998 to sustain the sea turtle population in the territorial waters of Bangladesh. Besides releasing over 35,000 hatchlings through in situ (protecting sea turtle eggs and hatchlings in natural nests) and ex situ hatching (collecting eggs and incubating them in a hatchery until they hatch and subsequently releasing the hatchlings to the sea), CNRS has launched a massive awareness campaign on the southeast coastline[3].

Unedited interviews with two wildlife conservation experts are provided:

1. Name: Prial Modsuddi

   Designation: Project Coordinator

   Name of the Project: Sea Turtle Conservation Project (STCP)

   Name of Employer: IUCN

   Funded By: Winrock International, Shell, Caern.

   Period of service: From December 1998 to June 2010

   Duty Station: Cox’s Bazar (Inani beach, Shah parir dip, Saint Martin)

Comments: Community migration, Lukkha nets, trawling nets, dog feeding, feeding the indigenous population, and disturbances caused by lighting are the main threats to turtle breeding. Now the forest department’s Jaw plantation is decimating the turtles’ nesting area, and Jaw root is destroying batches of turtle eggs.

2. Name: MD. Hasibur Rahman

   E-mail: hasibdh@yahoo.com

   Designation: Wild Life Conservation Officer

   Name of the Project: Coastal and Wetland Biodiversity Management Project (CWBMP)

   Name of Employer: Department of Environment, Government of the People’s Republic of Bangladesh.

   Funded By: UNDP-GEF.

   Period of service: From December 2005 to June 2011

   Duty Station: Cox’s Bazar (Patcher dip, Inani beach, Shah parir dip, Sant Martin, Snadia Island)

Comments: Lukkha nets, trawling nets, set bag nets, dog feeding, feeding the indigenous population, and disturbances caused by lighting are the main treats for turtle breeding. Now the forest department’s Jaw plantation is decreasing and destroying the turtle’s nesting area, and Jaw root is destroying clutches of turtle eggs. Another major factor is rising

[3] http://www.warpo.gov.bd/rep/coast_news/coast_news6.PDF

temperatures caused by climate change. This contributes to a higher proportion of female hatchlings, which threatens turtle reproductivity.

Finally, the establishment and operation of a turtle hatchery during the turtles' egg laying season (October to May) in the offshore island (Hasher dip) of section D is strongly suggested as a management measure given the "The Coal Fired Thermal Power Plant Construction Project (TPP)" in Moheshkhali, located on Matarbari island in Cox's bazaar in Bangladesh.

2.4(1) Analysis Report

（Rainy season）

Government of The People's Republic of Bangladesh.
Department of Environment
Chittagong Divisional office.
Zakir Hossain Road, Khulshi, Chittagong
www.doe-bd.org

Analysis Sheet Ambient Air & Sound Monitoring Sample of Matherbari Project Side, Matherbari, Moheskhali, Coxbazar.
Applicant: Engineers Associates Ltd, 1/3 Asad Gate Road, Block-A, Mohammadpur Housing Estate, Dhaka-1207.

Sl No.	Date	Lab Code	Sampling Location	SPM $\mu g/m^3$	SOx $\mu g/m^3$	NOx $\mu g/m^3$	Sound Level	Remarks
01	19/10/2012	1832	Shantibazar Area Matherbari, Moheskhali, Coxbazar.	54	3.2	6.2	57.0 dBa	-
02	20/10/2012	1833	Puranbazar Matherbari Matherbari, Moheskhali, Coxbazar.	56	3.4	6.5	57.3 dBa	-
03	20/10/2012	1834	Sairar Dail Matherbari, Moheskhali, Coxbazar.	42	3.0	6.0	49.5 dBa	-
Standard Limit.		-	-	Below 200	Below 80	Below 100	Below 60 dBa	-

Note:- 1. SPM – Suspended Particulate Matter. 2. NO_X – Oxides of Nitrogen. 3. SO_x – Oxides of Sulphur
4. dBa- Desible.

21.10.12
Md. Abdus Salam
Lab. Assistant.

21.10.12
Md. Nazrul Islam
Sample Collector.

21/10/12
Jamir Uddin
Sr. Chemist.

Government of The People's Republic of Bangladesh.
Department of Environment
Chittagong Divisional office.
Zakir Hossain Road, Khulshi, Chittagong
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Analysis sheet **Deep Tubewll water** Sample of Matherbari Project Side, Matherbari, Moheskhali, Coxbazar.

Applicant: Engineers Associates Ltd, 1/3 Asad Gate Road, Block-A, Mohammadpur Housing Estate, Dhaka-1207.

Sample Location	Lab code	Date	Temperature °C	P^H	Chloride mg/l	NH_3 mg/l	Iron mg/l	Hardness mg/l	Arsenic mg/l	DO mg/l	BOD_5 mg/l	COD mg/l	SS mg/l	Coliform n/100 ml	Salinity ‰	Remarks
Matherbari Project Side, MoheskhaliCoxbazar.	1831	07/10/12	29.7	7.48	167	0.04	0.92	164	0.01	3.5	0.4	0	02	0	0.3	-
Standard as per ECR1997 in Bangladesh.			Below 40°C	6.5-8.5	150-600	Below 0.5	Below 1.0	200-500	Below 0.05	06	Below 02	Below 04	Below 10	0	-	-

21.10.12
MD. Abdus Salam
Lab Assistant

21.10.12
Md. Nazrul Islam
Sample Collector.

22/10/12
Jamir Uddin
Sr. Chemist.

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Department of Environment
Chittagong Divisional office.
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Analysis sheet **Marine water** Sample of Matherbari Project Side, Matherebari, Moheskhali, Coxbazar.
Applicant: Engineers Associates Ltd, 1/3 Asad Gate Road, Block-A, Mohammadpur Housing Estate, Dhaka-1207.

Sample Location	Lab code	Date	Temperature ^0C	P^H	DO mg/l	BOD_5 mg/l	COD mg/l	Oil & Grease mg/l	SS mg/l	Salinity ‰	Remarks
SP-1 Top of the Sea.	1815	07/10/12	30	8.19	5.4	1.0	180	5.5	782	15.8	-
SP-1 Middle of the Sea.	1816	07/10/12	28.8	8.26	5.3	0.7	182	3.0	641	17.5	-
SP-1 Bottom of the Sea.	1817	07/10/12	29	8.11	5.0	0.6	160	0	834	18.5	-
SP-2 Top of the Sea.	1818	06/10/12	30	7.9	5.5	1.0	184	5.4	780	16.5	-
SP-2 Middle of the Sea.	1819	06/10/12	29	8.1	5.3	0.8	182	3.1	640	18.0	-
SP-2 Bottom of the Sea.	1820	06/10/12	28.5	8.0	5.1	0.7	182	0	835	18.5	-
SP-3 Top of the Sea.	1821	06/10/12	30.5	8.13	5.6	0.8	178	4.5	776	16.3	-
SP-3 Middle of the Sea.	1822	06/10/12	29.5	8.1	5.4	0.7	180	3.0	688	16.5	-
SP-3 Bottom of the Sea.	1823	06/10/12	28.5	8.12	5.1	0.6	180	0	795	17.2	-

21.10.12
Md. Abdus
Lab. Assistant.

21.10.12
Md. Nazrul Islam
Sample Collector.

/2012
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Analysis sheet **Marine water** Sample of Matherbari Project Side, Matherbari, Moheskhali, Coxbazar.
Applicant: Engineers Associates Ltd, 1/3 Asad Gate Road, Block-A, Mohammadpur Housing Estate, Dhaka-1207.

Sample Location	Lab code	Date	Tempe rature ^0C	P^H	DO mg/l	BOD_5 mg/l	COD mg/l	Oil & Grease mg/l	SS mg/l	Salinity ‰	Remarks
SP-4Top of the Sea.	1824	07/10/12	29	8.15	5.4	1.1	191	4.4	770	19.6	-
SP-4 Middle of the Sea.	1825	07/10/12	28.5	8.0	5.2	0.8	193	3.0	752	20.1	-
SP-4 Bottom of the Sea.	1826	07/10/12	30	8.2	4.9	0.7	193	0	883	20.2	-
SP-5 Top of the Sea.	1827	07/10/12	30.5	8.18	5.4	1.1	196	5.5	782	20.8	-
SP-5 Middle of the Sea.	1828	07/10/12	30.5	8.15	4.9	0.8	197	3.0	761	21.2	-
SP-5 Bottom of the Sea.	1829	07/10/12	29	7.95	4.6	0.8	195	0	910	21.6	-
Koheli River Be side of Project Top of the Sea.	1830	07/10/12	30.6	7.82	5.5	0.8	97	4.2	613	9.8	-

21.10.12
Md. Abdus Salam
Lab. Assistant.

21.10.12
Md. Nazrul Islam
Sample Collector.

22/10/12
Jamir Uddin
Sr. Chemist.

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BCSIR LABORATORIES, DHAKA

বাংলাদেশ বিজ্ঞান ও শিল্প গবেষণা পরিষদ

BANGLADESH COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH

Certificate No: T-1676

ANALYSIS REPORT

Ref. No.	: i) 1001 of BCSIR Lab. Dhaka dt. 14/10/2012
	: ii) D-656 of Analytical Service Cell, BCSIR. 14/10/2012
Lab ID	: A-9230 to A-9244
Name and address of Customer	: Engr. Syed Bahar Uddin Director & Local Team Laeder, JICA Study Team ENGINEERS ASSOCIATES LTD. 1/3, Asad Gate Road, Block-A, Mohammadpur Housing Estate Dhaka-1207.
Work order details	: **Submission of Samples of Marine Water and Sea Bottom Sediment for Performing Laboratory Tests for the Project "Feasibility Study of Coal Fired Power Plant Development Project at Matarbari, Cox's Bazar"**, Memo No.: EAL/JICA Study (CP)/2012/276, October 12, 2012
Type of sample*	: Water
Quantity of sample	: 1.5 Liter (15 bottles)
Packing and marking	: Plastic bottle
Date of receipt	: 15/10/2012
Period of analysis	: 15/10/2012 to 23/10/2012
Visual observation/Remarks	: Colourless

Lab ID	Particulars of supplied sample	Parameters	Concentration	Test Method (APHA)
A-9230	Marine water SP-1 Top Temperature 30^0C	Total Chromium	0.011 mg/L	3113.B
		Copper (Cu)	Less than 0.1 mg/L	3111.B
		Iron (Fe)	2.24 mg/L	3111.B
		Zinc (Zn)	Less than 0.1 mg/L	3111.B
		Lead (Pb)	Less than 0.01 mg/L	3113.B
		Cadmium (Cd)	Less than 0.001 mg/L	3113.B
		Murcury (Hg)	0.003 mg/L	3112.B
		Arsenic (As)	Less than 0.005 mg/L	3114.C

*The results relate only to the items tested.

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Lab ID	Particulars of supplied sample	Parameters	Concentration	Test Method (APHA)
A-9231	Marine water SP-1 Middle Temperature 28.8^{0}C	Total Chromium	0.014 mg/L	3113.B
		Copper (Cu)	Less than 0.1mg/L	3111.B
		Iron (Fe)	4.59 mg/L	3111.B
		Zinc (Zn)	Less than 0.1 mg/L	3111.B
		Lead (Pb)	Less than 0.01 mg/L	3113.B
		Cadmium (Cd)	Less than 0.001 mg/L	3113.B
		Murcury (Hg)	0.002 mg/L	3112.B
		Arsenic (As)	0.008 mg/L	3114.C
A-9232	Marine water SP-1 Bottom Temperature 29^{0}C	Total Chromium	0.057 mg/L	3113.B
		Copper (Cu)	Less than 0.1 mg/L	3111.B
		Iron (Fe)	60.5 mg/L	3111.B
		Zinc (Zn)	0.13 mg/L	3111.B
		Lead (Pb)	0.018 mg/L	3113.B
		Cadmium (Cd)	0.002 mg/L	3113.B
		Murcury (Hg)	0.006 mg/L	3112.B
		Arsenic (As)	0.01 mg/L	3114.C
A-9233	Marine water SP-2 Top Temperature 30^{0}C	Total Chromium	0.019 mg/L	3113.B
		Copper (Cu)	Less than 0.1 mg/L	3111.B
		Iron (Fe)	13.3 mg/L	3111.B
		Zinc (Zn)	Less than 0.1 mg/L	3111.B
		Lead (Pb)	Less than 0.01 mg/L	3113.B
		Cadmium (Cd)	Less than 0.001 mg/L	3113.B
		Murcury (Hg)	0.002 mg/L	3112.B
		Arsenic (As)	0.007 mg/L	3114.C

*The results relate only to the items tested.

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Lab ID	Particulars of supplied sample	Parameters	Concentration	Test Method (APHA)
A-9234	Marine water SP-2 Middle Temperature 29^0C	Total Chromium	0.023 mg/L	3113.B
		Copper (Cu)	Less than 0.1 mg/L	3111.B
		Iron (Fe)	21.6 mg/L	3111.B
		Zinc (Zn)	Less than 0.1 mg/L	3111.B
		Lead (Pb)	Less than 0.01 mg/L	3113.B
		Cadmium (Cd)	Less than 0.001 mg/L	3113.B
		Murcury (Hg)	0.003 mg/L	3112.B
		Arsenic (As)	Less than 0.005 mg/L	3114.C
A-9235	Marine water SP-2 Bottom Temperature 28.5^0C	Total Chromium	0.050 mg/L	3113.B
		Copper (Cu)	Less than 0.1 mg/L	3111.B
		Iron (Fe)	51.9 mg/L	3111.B
		Zinc (Zn)	0.11 mg/L	3111.B
		Lead (Pb)	0.019 mg/L	3113.B
		Cadmium (Cd)	Less than 0.001 mg/L	3113.B
		Murcury (Hg)	0.005 mg/L	3112.B
		Arsenic (As)	0.009 mg/L	3114.C
A-9236	Marine water SP-3 Top Temperature 30.5^0C	Total Chromium	0.009 mg/L	3113.B
		Copper (Cu)	Less than 0.1 mg/L	3111.B
		Iron (Fe)	2.50 mg/L	3111.B
		Zinc (Zn)	Less than 0.1 mg/L	3111.B
		Lead (Pb)	Less than 0.01 mg/L	3113.B
		Cadmium (Cd)	Less than 0.001 mg/L	3113.B
		Murcury (Hg)	0.004 mg/L	3112.B
		Arsenic (As)	Less than 0.005 mg/L	3114.C

*The results relate only to the items tested.

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BANGLADESH COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH

Certificate No: T-1676

Lab ID	Particulars of supplied sample	Parameters	Concentration	Test Method (APHA)
A-9237	Marine water SP-3 Middle Temperature 29.5^{0}C	Total Chromium	0.01 mg/L	3113.B
		Copper (Cu)	Less than 0.1 mg/L	3111.B
		Iron (Fe)	4.10 mg/L	3111.B
		Zinc (Zn)	Less than 0.1 mg/L	3111.B
		Lead (Pb)	Less than 0.01 mg/L	3113.B
		Cadmium (Cd)	Less than 0.001 mg/L	3113.B
		Murcury (Hg)	0.005 mg/L	3112.B
		Arsenic (As)	0.008 mg/L	3114.C
A-9238	Marine water SP-3 Bottom Temperature 28.5^{0}C	Total Chromium	0.016 mg/L	3113.B
		Copper (Cu)	Less than 0.1 mg/L	3111.B
		Iron (Fe)	8.72 mg/L	3111.B
		Zinc (Zn)	Less than 0.1 mg/L	3111.B
		Lead (Pb)	Less than 0.01 mg/L	3113.B
		Cadmium (Cd)	Less than 0.001 mg/L	3113.B
		Murcury (Hg)	0.005 mg/L	3112.B
		Arsenic (As)	Less than 0.005 mg/L	3114.C
A-9239	Marine water SP-4 Top Temperature 29^{0}C	Total Chromium	0.012 mg/L	3113.B
		Copper (Cu)	Less than 0.1 mg/L	3111.B
		Iron (Fe)	5.00 mg/L	3111.B
		Zinc (Zn)	Less than 0.1 mg/L	3111.B
		Lead (Pb)	Less than 0.01 mg/L	3113.B
		Cadmium (Cd)	0.002 mg/L	3113.B
		Murcury (Hg)	0.003 mg/L	3112.B
		Arsenic (As)	0.019 mg/L	3114.C

*The results relate only to the items tested.

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Lab ID	Particulars of supplied sample	Parameters	Concentration	Test Method (APHA)
A-9240	Marine water SP-4 Middle Temperature 28.5^{0}C	Total Chromium	0.015 mg/L	3113.B
		Copper (Cu)	Less than 0.1 mg/L	3111.B
		Iron (Fe)	10.2 mg/L	3111.B
		Zinc (Zn)	Less than 0.1 mg/L	3111.B
		Lead (Pb)	Less than 0.01 mg/L	3113.B
		Cadmium (Cd)	0.002 mg/L	3113.B
		Murcury (Hg)	0.004 mg/L	3112.B
		Arsenic (As)	Less than 0.005 mg/L	3114.C
A-9241	Marine water SP-4 Bottom Temperature 30^{0}C	Total Chromium	0.027 mg/L	3113.B
		Copper (Cu)	0.23 mg/L	3111.B
		Iron (Fe)	25.7 mg/L	3111.B
		Zinc (Zn)	1.21 mg/L	3111.B
		Lead (Pb)	0.13 mg/L	3113.B
		Cadmium (Cd)	0.001 mg/L	3113.B
		Murcury (Hg)	0.008 mg/L	3112.B
		Arsenic (As)	0.037 mg/L	3114.C
A-9242	Marine water SP-5 Top Temperature 30.5^{0}C	Total Chromium	0.013 mg/L	3113.B
		Copper (Cu)	Less than 0.1 mg/L	3111.B
		Iron (Fe)	5.17 mg/L	3111.B
		Zinc (Zn)	Less than 0.1 mg/L	3111.B
		Lead (Pb)	Less than 0.01 mg/L	3113.B
		Cadmium (Cd)	0.001 mg/L	3113.B
		Murcury (Hg)	0.005 mg/L	3112.B
		Arsenic (As)	0.014 mg/L	3114.C

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BANGLADESH COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH

Certificate No: T-1676

Lab ID	Particulars of supplied sample	Parameters	Concentration	Test Method (APHA)
A-9243	Marine water SP-5 Middle Temperature 30.5^{0}C	Total Chromium	0.017 mg/L	3113.B
		Copper (Cu)	Less than 0.1 mg/L	3111.B
		Iron (Fe)	10.6 mg/L	3111.B
		Zinc (Zn)	Less than 0.1 mg/L	3111.B
		Lead (Pb)	Less than 0.01 mg/L	3113.B
		Cadmium (Cd)	Less than 0.001 mg/L	3113.B
		Murcury (Hg)	0.003 mg/L	3112.B
		Arsenic (As)	0.014 mg/L	3114.C
A-9244	Marine water SP-5 Bottom Temperature 29^{0}C	Total Chromium	0.017 mg/L	3113.B
		Copper (Cu)	Less than 0.1 mg/L	3111.B
		Iron (Fe)	11.6 mg/L	3111.B
		Zinc (Zn)	Less than 0.1 mg/L	3111.B
		Lead (Pb)	Less than 0.01 mg/L	3113.B
		Cadmium (Cd)	0.002 mg/L	3113.B
		Murcury (Hg)	0.004 mg/L	3112.B
		Arsenic (As)	Less than 0.005 mg/L	3114.C

23-10-2012

Sig and Name of the Validator

Md. Aminul Ahsan
Principal Scientific Officer
Analytical Research Division
BCSIR Laboratories, Dhaka

*The results relate only to the items tested.

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Certificate No: T-1676

Lab ID	Particulars of supplied sample	Parameters	Concentration	Test Method (APHA)
A-9243	Marine water SP-5 Middle Temperature 30.5^{0}C	Total Chromium	0.017 mg/L	3113.B
		Copper (Cu)	Less than 0.1 mg/L	3111.B
		Iron (Fe)	10.6 mg/L	3111.B
		Zinc (Zn)	Less than 0.1 mg/L	3111.B
		Lead (Pb)	Less than 0.01 mg/L	3113.B
		Cadmium (Cd)	Less than 0.001 mg/L	3113.B
		Murcury (Hg)	0.003 mg/L	3112.B
		Arsenic (As)	0.014 mg/L	3114.C
A-9244	Marine water SP-5 Bottom Temperature 29^{0}C	Total Chromium	0.017 mg/L	3113.B
		Copper (Cu)	Less than 0.1 mg/L	3111.B
		Iron (Fe)	11.6 mg/L	3111.B
		Zinc (Zn)	Less than 0.1 mg/L	3111.B
		Lead (Pb)	Less than 0.01 mg/L	3113.B
		Cadmium (Cd)	0.002 mg/L	3113.B
		Murcury (Hg)	0.004 mg/L	3112.B
		Arsenic (As)	Less than 0.005 mg/L	3114.C

23-10-2012

Sig and Name of the Validator

Md. Aminul Ahsan
Principal Scientific Officer
Analytical Research Division
BCSIR Laboratories, Dhaka

*The results relate only to the items tested.

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বিসিএসআইআর গবেষণাগার, ঢাকা
BCSIR LABORATORIES, DHAKA
বাংলাদেশ বিজ্ঞান ও শিল্প গবেষণা পরিষদ
BANGLADESH COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH

ANALYSIS REPORT

Ref. No. : i) 1001 of BCSIR Lab. Dhaka dt. 14/10/2012
: ii) D-656 of Analytical Service Cell, BCSIR. 14/10/2012

Lab ID : A-9245

Name and address of Customer : Engr. Syed Bahar Uddin
Director & Local Team Laeder, JICA Study Team
ENGINEERS ASSOCIATES LTD.
1/3, Asad Gate Road, Block-A, Mohammadpur Housing
Estate Dhaka-1207.

Work order details : **Submission of Samples of Marine Water and Sea Bottom Sediment for Performing Laboratory Tests for the Project "Feasibility Study of Coal Fired Power Plant Development Project at Matarbari, Cox's Bazar",** Memo No.: EAL/JICA Study (CP)/2012/276, October 12, 2012

Type of sample* : Sea Bottom Sediment

Quantity of sample : 700 gm

Packing and marking : Plastic Pot

Date of receipt : 15/10/2012

Period of analysis : 15/10/2012 to 23/10/2012

Visual observation/Remarks : Blackish

Lab ID	Particulars of supplied sample	Parameters	Concentration
A-9245	Sea Bottom Sediment	Murcury (Hg)	0.142 mg/kg
		Cadmium (Cd)	0.032 mg/kg
		Lead (Pb)	11.6 mg/kg
		Arsenic (As)	4.45 mg/kg
		Copper (Cu)	23.8 mg/kg
		Zinc (Zn)	63.7 mg/kg
		Iron (Fe)	27400 mg/kg

23-10-2012 — for 23.10.12 — 23.10.12

Sig, and Name of the Validator	Counter Signature (Research Coordinator)	Counter Signature (Director)
Md. Aminul Ahsan Principal Scientific Officer Analytical Research Division BCSIR Laboratories, Dhaka	Md. Rakibul Hasan Scientific Officer Analytical Service Cell BCSIR, Dhanmondi Dhaka-1205	MD. ABU ANIS JAHANGIR Director BCSIR Laboratories Dhaka-1205

*The results relate only to the items tested.

Dr. Qudrat-I-Khuda Road, Dhanmondi, Dhaka-1205, Tel.: 88-02-8621741; Fax: 880-2-8613022,
PABX: 8611057-61, 8625038-9, 8626034-5, 8626032, Ext. /325; E-mail: directordl@yahoo.com, bcsir@bangla.net

2.4(2) Analysis Report

（Dry season）

গণপ্রজাতন্ত্রী বাংলাদেশ সরকার
পরিবেশ অধিদপ্তর
চট্টগ্রাম বিভাগীয় কার্যালয়
জাকির হোসেন রোড, খুলশী, চট্টগ্রাম -৪২০২।
www.doe-bd.org

০৩ /১০/১৪১৯ বঙ্গাব্দ
স্মারক নং : পঅ/চবি/ফিঃ আদায়/১৩০২৫(৩৬)/১২/ ২৬৩৭ তারিখ :--------------------
১ --/০২/২০১৩ খ্রিষ্টাব্দ

বিষয় : নমুনা বিশ্লেষণ ফলাফল প্রেরণ।

সূত্র : Engineers Associates Ltd এর ২৮/০১/২০১৩ খ্রিঃ তারিখের আবেদন ।

উপর্যুক্ত বিষয় ও সূত্রের প্রেক্ষিতে নমুনা সংগ্রহ করে অত্রবিভাগীয় গবেষণাগারে বিশ্লেষণ পূর্বক ফলাফল এতদসংগে প্রেরণ করা হলো।

সংযুক্তি : বর্ণনামতে ০৪ (চার) পাতা।

22/2/2013

(মোঃ জাফর আলম)
পরিচালক
ফোন-৬৫৯৩৭৯

ইঞ্জিনিয়ার সৈয়দ বাহার উদ্দিন
ডিরেক্টর এন্ড লোকাল টিম লিডার, জাইকা স্ট্যাডি টিম
ইঞ্জিনিয়ার্স এসোসিয়েটস্ লিমিটেড
১/৩, আসাদ গেইট রোড, ব্লক-এ
মোহাম্মদপুর হাউজিং এস্টেট
ঢাকা-১২০৭

বিতরণ :

১। অফিস কপি।

1) Ahmed On Payment-Result Forward 2.doc

Government of The People's Republic of Bangladesh.
Department of Environment
Chittagong Divisional office.
Zakir Hossain Road, Khulshi, Chittagong
www.doe-bd.org

Analysis Sheet Ambient Air & Sound Monitoring Sample of Matherbari Project Side, Matherbari, Moheskhali, Coxbazar.
Applicant: Engineers Associates Ltd, 1/3 Asad Gate Road, Block-A, Mohammadpur Housing Estate, Dhaka-1207.

Sl No.	Date	Time	Lab Code	Sampling Location	SPM $\mu g/m^3$	SOx $\mu g/m^3$	NOx $\mu g/m^3$	Sound Level	Remarks
01	29/01/2013	07.00am	141	Shantibazar Area Matherbari, Moheskhali, Coxbazar.	59	4.0	7.4	56.0 dBa	-
02	29/01/2013	15.30pm	142	Puranbazar Matherbari Matherbari, Moheskhali, Coxbazar.	62	4.1	7.6	57.0 dBa	-
03	30/01/2013	08.00am	143	Sairar Dail Matherbari, Moheskhali, Coxbazar.	45	3.0	5.0	45.3 dBa	-
Standard Limit.			-	-	Below 200	Below 80	Below 100	Below 60 dBa	-

Note:- 1. SPM – Suspended Particulate Matter. 2. NO_X – Oxides of Nitrogen. 3.SO_x – Oxides of Sulphur
4. dBa- Desible.

11.02.13
Md. Abdus Salam
Lab Assistant.

11.02.13
Md. Nazrul Islam
Sample Collector

22.02.16
Jamir Uddin
Sr. Chemist

D:\Ahmed On Payment AIR-Sound By Treasury Lab.

Government of The People's Republic of Bangladesh.
Department of Environment
Chittagong Divisional office.
Zakir Hossain Road, Khulshi, Chittagong
www.doe-bd.org

Analysis sheet **Marine water** Sample of Matherbari Project Side, Matherebari, Moheskhali, Coxbazar.
Applicant: Engineers Associates Ltd, 1/3 Asad Gate Road, Block-A, Mohammadpur Housing Estate, Dhaka-1207.

Sample Location	Lab code	Date	Depth	Time	Temperature ^0C	P^H	DO mg/l	BOD_5 mg/l	COD mg/l	Oil & Grease mg/l	SS mg/l	Arsenic mg/l	Salinity ‰	Notes
SP-1 Top of the Sea. Transparency- 23 cm	125	29/01/13	10 Miters	12.56 pm	19	8.03	6.0	0.2	207	4.4	52	0.0	37.3	-
SP-1 Middle of the Sea. Transparency- 23 cm	126	29/01/13	10 Miters	12.56 pm	19	8.01	5.8	0.4	209	3.0	73	0.0	35.8	-
SP-1 Bottom of the Sea. Transparency- 23 cm	127	29/01/13	10 Miters	12.56 pm	19	7.91	5.4	0.6	226	0	281	0.0	35.3	-
SP-2 Top of the Sea. Transparency- 19 cm	128	29/01/13	10 Miters	02.32 pm	18	7.86	6.1	0.2	205	4.3	49	0.0	35.2	-
SP-2 Middle of the Sea. Transparency- 19 cm	129	29/01/13	10 Miters	02.32 pm	18	7.91	5.9	0.4	211	3.1	84	0.0	36.2	-
SP-2 Bottom of the Sea. Transparency- 19 cm	130	29/01/13	10 Miters	02.32 pm	18	8.02	5.4	0.5	231	0	293	0.0	35.7	-
SP-3 Top of the Sea. Transparency- 18 cm	131	29/01/13	9 Miters	01.50 pm	18	8.00	6.2	0.2	205	4.2	51	0.0	35.0	-
SP-3 Middle of the Sea. Transparency- 18 cm	132	29/01/13	9 Miters	01.50 pm	18	7.82	6.0	0.3	208	3.0	81	0.0	35.8	-
SP-3 Bottom of the Sea. Transparency- 18 cm	133	29/01/13	9 Miters	01.50 pm	18	7.85	5.8	0.5	230	0	308	0.0	34.9	-

** Cm- Centimeters

11.02.13
Md. Abdus Salam
Lab. Assistant.

11.02.13
Md. Nazrul Islam
Sample Collector

22.02.16
Jamir Uddin
Sr. Chemist.

D: Ahmed On Payment Water Data sheet doc-2.doc

Government of The People's Republic of Bangladesh.
Department of Environment
Chittagong Divisional office.
Zakir Hossain Road, Khulshi, Chittagong
www.doe-bd.org

Analysis sheet **Marine water** Sample of Matherbari Project Side, Matherbari, Moheskhali, Coxbazar.
Applicant: Engineers Associates Ltd, 1/3 Asad Gate Road, Block-A, Mohammadpur Housing Estate, Dhaka-1207.

Sample Location	Lab code	Date	Depth	Time	Temperature ^0C	P^H	DO mg/l	BOD_5 mg/l	COD mg/l	Oil & Grease mg/l	SS mg/l	Arsenic mg/l	Salinity ‰	Notes
SP-4 Top of the Sea. Transparency- 45 cm	134	29/01/13	15.6 Miters	12.04 pm	18	7.95	6.4	0.2	205	4.2	48	0.0	34.4	-
SP-4 Middle of the Sea. Transparency- 45 cm	135	29/01/13	15.6 Miters	12.04 pm	18	8.02	6.1	0.3	211	3.1	79	0.0	35.4	-
SP-4 Bottom of the Sea. Transparency- 45 cm	136	29/01/13	15.6 Miters	12.04 pm	18	7.84	5.8	0.5	223	0	312	0.0	34.3	-
SP-5 Top of the Sea. Transparency- 23 cm	137	29/01/13	15.6 Miters	10.32 am	18	7.85	6.2	0.3	203	4.0	46	0.0	34.4	-
SP-5 Middle of the Sea. Transparency- 23 cm	138	29/01/13	15.6 Miters	10.32 am	18	7.86	6.0	0.4	212	3.0	81	0.0	34.7	-
SP-5 Bottom of the Sea. Transparency- 23 cm	139	29/01/13	15.6 Miters	10.32 am	18	8.01	5.7	0.6	235	0	329	0.0	34.8	-
Koheli River Be side of Project Top of the Sea.	140	30/01/13	02 Miters	11.10 am	18	8.0	5.8	0.4	241	-	-	-	35.8	-

** Cm- Centimeters

11.02.13
Md. Abdus Salam
Lab. Assistant

11.02.13
Md. Nazrul Islam
Sample Collector

33.02.36
Jamir Uddin
Sr. Chemist

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Government of The People's Republic of Bangladesh.
Department of Environment
Chittagong Divisional office.
Zakir Hossain Road, Khulshi, Chittagong
www.doe-bd.org

Analysis sheet **Deep Tubewll water** Sample of Matherbari Project Side, Matherbari, Moheskhali, Coxbazar.

Applicant: Engineers Associates Ltd, 1/3 Asad Gate Road, Block-A, Mohammadpur Housing Estate, Dhaka-1207.

Sample Location	Lab code	Depth	Time	Date	Temperature ^0C	P^H	Arsenic mg/l	DO mg/l	BOD_5 mg/l	COD mg/l	Salinity ‰	Remarks
Matherbari Project Side, Moheskhali Coxbazar.	144	220 Miters	12.30 pm	30/01/13	20.1	7.2	0.01	4.7	0.2	0	0.7	-
Standard as per ECR1997 in Bangladesh.					Below 40^0C	6.5-8.5	Below 0.05	06	Below 02	Below 04	-	-

11.02.13
Md. Abdus Salam
Lab. Assistant.

11.02.13
Md. Nazrul Islam
Sample Collector.

22.02.20
Jamir Uddin
Sr. Chemist.

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জীবনের জন্য বিজ্ঞান

বিসিএসআইআর গবেষণাগার, ঢাকা

BCSIR LABORATORIES, DHAKA

বাংলাদেশ বিজ্ঞান ও শিল্প গবেষণা পরিষদ

BANGLADESH COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH

Forwarding of Analysis Report

Ref No: i) 85 of BCSIR Lab. Dhaka dt. 27/01/2013

ii) D-897 of Analytical Service Cell, BCSIR. 27/01/2013

Attachment: Please find the analysis report as an attachment (page-1 of 6).

07-02-2013

Sig, and Name of the Validator

Md. Aminul Ahsan
Principal Scientific Officer
Analytical Research Division
BCSIR Laboratories, Dhaka

7.02.13

Counter Signature
(Research Coordinator)

Dr. Parvin Noor
Research Co-ordinator
BCSIR, Dhaka.

7.2.13

Counter Signature
(Director)

MD. ABU ANIS JAHANGIR
Director
BCSIR Laboratories
Dhaka-1205

জীবনের জন্য বিজ্ঞান

ISO/IEC17025:2005Certified

Certificate No:T-1676

বিসিএসআইআর গবেষণাগার, ঢাকা

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BANGLADESH COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH

ANALYSIS REPORT

Ref. No.	: i) 85 of BCSIR Lab. Dhaka dt. 27/01/2013
	: ii) D-897 of Analytical Service Cell, BCSIR. 27/01/2013
Lab ID	: A-9483 to A-9498
Name and address of Customer	: Engr. Syed Bahar Uddin Director & Local Team Laeder, JICA Study Team ENGINEERS ASSOCIATES LTD. 1/3, Asad Gate Road, Block-A, Mohammadpur Housing Estate Dhaka-1207.
Work order details	: **Submission of Samples of Marine Water and Sea Bottom Sediment for Performing Laboratory Tests for the Project "Feasibility Study of Coal Fired Power Plant Development Project at Matarbari, Cox's Bazar"**, Memo No.: EAL/JICA Study (CP)/2013/024, January 23, 2013
Type of sample*	: Water
Quantity of sample	: 1.5 Liter (15 bottles)
Packing and marking	: Plastic bottle
Date of receipt	: 28/01/2013
Period of analysis	: 28/01/2013 to 06/02/2013
Visual observation/Remarks	: Colourless

Lab ID	Particulars of supplied sample	Parameters	Concentration	Test Method (APHA)
A-9483	Marine Water SP-1 Top	Total Chromium	0.035 mg/L	3113.B
		Copper (Cu)	Less than 0.1 mg/L	3111.B
		Iron (Fe)	4.17 mg/L	3111.B
		Zinc (Zn)	Less than 0.05 mg/L	3111.B
		Lead (Pb)	Less than 0.01 mg/L	3113.B
		Cadmium (Cd)	Less than 0.001 mg/L	3113.B
		Mercury (Hg)	0.016 mg/L	3112.B
		Arsenic (As)	Less than 0.005 mg/L	3114.C

*The results relate only to the items tested.

Dr. Qudrat-I-Khuda Road, Dhanmondi, Dhaka-1205, Tel.: 88-02-8621741, 9664959, Fax: 880-2-8613022; PABX: 8611057-61, 8625038-9, 8626034-5, 8626032, Ext/325; E-mail: directordl@yahoo.com, bcsir@bangla.net

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বিসিএসআইআর গবেষণাগার, ঢাকা
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বাংলাদেশ বিজ্ঞান ও শিল্প গবেষণা পরিষদ
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Lab ID	Particulars of supplied sample	Parameters	Concentration	Test Method (APHA)
A-9484	Marine Water SP-1 Middle	Total Chromium	0.050 mg/L	3113.B
		Copper (Cu)	0.11 mg/L	3111.B
		Iron (Fe)	10.8 mg/L	3111.B
		Zinc (Zn)	0.10 mg/L	3111.B
		Lead (Pb)	0.01 mg/L	3113.B
		Cadmium (Cd)	Less than 0.001 mg/L	3113.B
		Mercury (Hg)	0.022 mg/L	3112.B
		Arsenic (As)	Less than 0.005 mg/L	3114.C
A-9485	Marine Water SP-1 Bottom	Total Chromium	0.050 mg/L	3113.B
		Copper (Cu)	0.31 mg/L	3111.B
		Iron (Fe)	27.2 mg/L	3111.B
		Zinc (Zn)	0.18 mg/L	3111.B
		Lead (Pb)	0.02 mg/L	3113.B
		Cadmium (Cd)	Less than 0.001 mg/L	3113.B
		Mercury (Hg)	0.018 mg/L	3112.B
		Arsenic (As)	0.007 mg/L	3114.C
A-9486	Marine Water SP-2 Top	Total Chromium	0.105 mg/L	3113.B
		Copper (Cu)	Less than 0.1 mg/L	3111.B
		Iron (Fe)	25.4 mg/L	3111.B
		Zinc (Zn)	Less than 0.05 mg/L	3111.B
		Lead (Pb)	Less than 0.01 mg/L	3113.B
		Cadmium (Cd)	Less than 0.001 mg/L	3113.B
		Mercury (Hg)	0.018 mg/L	3112.B
		Arsenic (As)	0.007 mg/L	3114.C

*The results relate only to the items tested.

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Certificate No:T-1676

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BANGLADESH COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH

Lab ID	Particulars of supplied sample	Parameters	Concentration	Test Method (APHA)
A-9487	Marine Water SP-2 Middle	Total Chromium	0.061 mg/L	3113.B
		Copper (Cu)	0.58 mg/L	3111.B
		Iron (Fe)	28.6 mg/L	3111.B
		Zinc (Zn)	0.16 mg/L	3111.B
		Lead (Pb)	0.03 mg/L	3113.B
		Cadmium (Cd)	Less than 0.001 mg/L	3113.B
		Mercury (Hg)	0.029 mg/L	3112.B
		Arsenic (As)	0.01 mg/L	3114.C
A-9488	Marine Water SP-2 Bottom	Total Chromium	0.052 mg/L	3113.B
		Copper (Cu)	0.54 mg/L	3111.B
		Iron (Fe)	18.1 mg/L	3111.B
		Zinc (Zn)	0.12 mg/L	3111.B
		Lead (Pb)	0.06 mg/L	3113.B
		Cadmium (Cd)	Less than 0.001 mg/L	3113.B
		Mercury (Hg)	0.014 mg/L	3112.B
		Arsenic (As)	0.005 mg/L	3114.C
A-9489	Marine Water SP-3 Top	Total Chromium	0.035 mg/L	3113.B
		Copper (Cu)	Less than 0.1 mg/L	3111.B
		Iron (Fe)	18.3 mg/L	3111.B
		Zinc (Zn)	Less than 0.05 mg/L	3111.B
		Lead (Pb)	Less than 0.01 mg/L	3113.B
		Cadmium (Cd)	Less than 0.001 mg/L	3113.B
		Mercury (Hg)	0.018 mg/L	3112.B
		Arsenic (As)	0.006 mg/L	3114.C

*The results relate only to the items tested.

Dr. Qudrat-I-Khuda Road, Dhanmondi, Dhaka-1205, Tel.: 88-02-8621741, 9664959, Fax: 880-2-8613022;
PABX: 8611057-61, 8625038-9, 8626034-5, 8626032, Ext/325; E-mail: directordl@yahoo.com, bcsir@bangla.net

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বিসিএসআইআর গবেষণাগার, ঢাকা

BCSIR LABORATORIES, DHAKA

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BANGLADESH COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH

Certificate No:T-1676

Lab ID	Particulars of supplied sample	Parameters	Concentration	Test Method (APHA)
A-9490	Marine Water SP-3 Middle	Total Chromium	0.048 mg/L	3113.B
		Copper (Cu)	0.30 mg/L	3111.B
		Iron (Fe)	25.8 mg/L	3111.B
		Zinc (Zn)	0.11 mg/L	3111.B
		Lead (Pb)	0.02 mg/L	3113.B
		Cadmium (Cd)	Less than 0.001 mg/L	3113.B
		Mercury (Hg)	0.021 mg/L	3112.B
		Arsenic (As)	Less than 0.005 mg/L	3114.C
A-9491	Marine Water SP-3 Bottom	Total Chromium	0.037mg/L	3113.B
		Copper (Cu)	0.31 mg/L	3111.B
		Iron (Fe)	26.1 mg/L	3111.B
		Zinc (Zn)	0.14 mg/L	3111.B
		Lead (Pb)	0.017 mg/L	3113.B
		Cadmium (Cd)	Less than 0.001 mg/L	3113.B
		Mercury (Hg)	0.009 mg/L	3112.B
		Arsenic (As)	0.008 mg/L	3114.C
A-9492	Marine Water SP-4 Top	Total Chromium	0.021 mg/L	3113.B
		Copper (Cu)	Less than 0.1 mg/L	3111.B
		Iron (Fe)	3.25 mg/L	3111.B
		Zinc (Zn)	Less than 0.05 mg/L	3111.B
		Lead (Pb)	Less than 0.01 mg/L	3113.B
		Cadmium (Cd)	Less than 0.001 mg/L	3113.B
		Mercury (Hg)	0.008 mg/L	3112.B
		Arsenic (As)	Less than 0.005 mg/L	3114.C

*The results relate only to the items tested.

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PABX: 8611057-61, 8625038-9, 8626034-5, 8626032, Ext/325; E-mail: directordl@yahoo.com, bcsir@bangla.net

জীবনের জন্য বিজ্ঞান

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বিসিএসআইআর গবেষণাগার, ঢাকা

Certificate No:T-1676

BCSIR LABORATORIES, DHAKA

বাংলাদেশ বিজ্ঞান ও শিল্প গবেষণা পরিষদ

BANGLADESH COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH

Lab ID	Particulars of supplied sample	Parameters	Concentration	Test Method (APHA)
A-9493	Marine Water SP-4 Middle	Total Chromium	0.027 mg/L	3113.B
		Copper (Cu)	0.17 mg/L	3111.B
		Iron (Fe)	3.88 mg/L	3111.B
		Zinc (Zn)	0.08 mg/L	3111.B
		Lead (Pb)	Less than 0.01 mg/L	3113.B
		Cadmium (Cd)	Less than 0.001 mg/L	3113.B
		Mercury (Hg)	0.007 mg/L	3112.B
		Arsenic (As)	Less than 0.005 mg/L	3114.C
A-9494	Marine Water SP-4 Bottom	Total Chromium	0.057 mg/L	3113.B
		Copper (Cu)	0.38 mg/L	3111.B
		Iron (Fe)	45.2 mg/L	3111.B
		Zinc (Zn)	0.18 mg/L	3111.B
		Lead (Pb)	0.02 mg/L	3113.B
		Cadmium (Cd)	Less than 0.001 mg/L	3113.B
		Mercury (Hg)	0.011 mg/L	3112.B
		Arsenic (As)	0.012 mg/L	3114.C
A-9495	Marine Water SP-5 Top	Total Chromium	0.019 mg/L	3113.B
		Copper (Cu)	Less than 0.1 mg/L	3111.B
		Iron (Fe)	2.97 mg/L	3111.B
		Zinc (Zn)	Less than 0.05 mg/L	3111.B
		Lead (Pb)	Less than 0.01 mg/L	3113.B
		Cadmium (Cd)	Less than 0.001 mg/L	3113.B
		Mercury (Hg)	Less than 0.005 mg/L	3112.B
		Arsenic (As)	Less than 0.005 mg/L	3114.C

*The results relate only to the items tested.

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জীবনের জন্য বিজ্ঞান

ISO/IEC17025:2005Certified

Certificate No:T-1676

বিসিএসআইআর গবেষণাগার, ঢাকা
BCSIR LABORATORIES, DHAKA
বাংলাদেশ বিজ্ঞান ও শিল্প গবেষণা পরিষদ
BANGLADESH COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH

Lab ID	Particulars of supplied sample	Parameters	Concentration	Test Method (APHA)
A-9496	Marine Water SP-5 Middle	Total Chromium	0.039 mg/L	3113.B
		Copper (Cu)	0.28 mg/L	3111.B
		Iron (Fe)	32.1 mg/L	3111.B
		Zinc (Zn)	0.21 mg/L	3111.B
		Lead (Pb)	0.018 mg/L	3113.B
		Cadmium (Cd)	Less than 0.001 mg/L	3113.B
		Mercury (Hg)	0.007 mg/L	3112.B
		Arsenic (As)	0.009 mg/L	3114.C
A-9497	Marine Water SP-5 Bottom	Total Chromium	0.055 mg/L	3113.B
		Copper (Cu)	0.12 mg/L	3111.B
		Iron (Fe)	25.0 mg/L	3111.B
		Zinc (Zn)	0.12 mg/L	3111.B
		Lead (Pb)	0.01 mg/L	3113.B
		Cadmium (Cd)	Less than 0.001 mg/L	3113.B
		Mercury (Hg)	0.007 mg/L	3112.B
		Arsenic (As)	0.007 mg/L	3114.C

07-02-2013

Sig and Name of the Validator

Md. Aminul Ahsan
Principal Scientific Officer
Analytical Research Division
BCSIR Laboratories, Dhaka

*The results relate only to the items tested.

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জীবনের জন্য বিজ্ঞান

বিসিএসআইআর গবেষণাগার, ঢাকা
BCSIR LABORATORIES, DHAKA
বাংলাদেশ বিজ্ঞান ও শিল্প গবেষণা পরিষদ
BANGLADESH COUNCIL OF SCIENTIFIC AND INDUSTRIAL RESEARCH

ANALYSIS REPORT

Ref. No.	: i) 85 of BCSIR Lab. Dhaka dt. 27/01/2013
	: ii) D-897 of Analytical Service Cell, BCSIR. 27/01/2013
Lab ID	: A-9483 to A-9498
Name and address of Customer	: Engr. Syed Bahar Uddin Director & Local Team Laeder, JICA Study Team ENGINEERS ASSOCIATES LTD. 1/3, Asad Gate Road, Block-A, Mohammadpur Housing Estate Dhaka-1207.
Work order details	: **Submission of Samples of Marine Water and Sea Bottom Sediment for Performing Laboratory Tests for the Project "Feasibility Study of Coal Fired Power Plant Development Project at Matarbari, Cox's Bazar"**, Memo No.: EAL/JICA Study (CP)/2013/024, January 23, 2013
Type of sample*	: Water
Quantity of sample	: 1.5 Liter (15 bottles)
Packing and marking	: Plastic bottle
Date of receipt	: 28/01/2013
Period of analysis	: 28/01/2013 to 06/02/2013
Visual observation/Remarks	: Colourless

Lab ID	Particulars of supplied sample	Parameters	Concentration	Test Method (APHA)
A-9498	Sea Bottom Sediment 1 (One) Sampling Point	Mercury (Hg)	0.456 mg/kg	3112.B
		Cadmium (Cd)	Less than 0.05 mg/kg	3113.B
		Lead (Pb)	3.39 mg/kg	3113.B
		Arsenic (As)	2.91 mg/kg	3114.C
		Copper (Cu)	3.75 mg/kg	3111.B
		Zinc (Zn)	20.2 mg/kg	3111.B
		Iron (Fe)	11,183 mg/kg	3111.B

07-02-2013 7.02.13 7.2.13

Sig, and Name of the Validator	Counter Signature (Research Coordinator)	Counter Signature (Director)
Md. Aminul Ahsan Principal Scientific Officer		MD. ABU ANIS JAHANGIR Director BCSIR Laboratories Dhaka-1205

Page 1 of 1

*The results relate only to the items tested.

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Annexure 3

Simulation

Annex 3

Simulation

-: Table of Contents:-

3.1 Air Quality

3.1.1 Calculation Methodology

Meteorological data of 1 hour setting as 1 case, 8760 cases is calculated using dispersion model. Averaging the results of 8760 cases simulation, the value of a sampling point, which has the highest average ground concentration, is set as annual average value. Also, meteorological data of one day (24hour) setting as 1 case, 365 cases is calculated using dispersion model, and the value of a day when the ground concentration is highest in a year is set as average 24hour value. There are however some missing data, resulting in 362 days of valid data in a year.

3.1.2 Meteorological Data

Meteorological data from Kutubdia meteorological observatory located 10km north of the project site is used when conducting dispersion model of exhaust gas. Meteorological parameters used in the simulation are temperature, wind direction, wind speed and solar radiation.

(1) Verification regarding Abnormality of Meteorological Data

F-test on wind direction and wind speed was conducted in order to confirm if the meteorological data used in simulation is normal. F-test is any statistical test in which the test statistics has an F-distribution under the null hypothesis. Wind direction and wind speed data of the year 2000 up to 2011 are acquired from Kutubdia meteorological observatory, though the data of the year 2001 and 2002 are missing. Wind direction data in 2011 and wind speed data in 2010 are rejected by F-test; therefore, dispersion model is conducted using the meteorological data of 2009.

Table 3.1.2-1 Result of F-test

(Appearance Frequency by wind direction :%)

Wind Direction	2000	2003	2004	2005	2006	2007	2008	2010	2011	Average	Standard Deviation
N	11.13	6.08	5.98	5.12	2.28	2.15	1.82	4.78	2.28	4.62	2.99
NNE	1.10	0.69	0.48	0.76	3.11	7.79	4.85	4.91	2.39	2.90	2.52
NE	0.96	0.62	1.75	7.55	8.44	6.48	4.57	5.02	4.81	4.47	2.83
ENE	0.34	0.41	0.14	0.80	2.46	2.56	1.75	0.73	0.73	1.10	0.92
E	1.27	0.52	1.24	1.90	2.21	1.35	2.27	3.70	5.26	2.19	1.46
ESE	0.55	0.59	0.34	0.97	1.94	2.46	3.09	2.91	2.35	1.69	1.08
SE	1.20	3.14	3.71	7.17	10.69	11.57	12.13	2.11	8.58	6.70	4.27
SSE	7.80	9.09	2.68	8.72	14.15	15.66	10.14	7.09	4.12	8.83	4.19
S	28.71	19.25	26.81	18.80	14.01	7.83	10.07	22.73	14.80	18.11	7.15
SSW	4.02	4.25	7.46	10.25	7.64	5.09	5.09	5.40	1.76	5.66	2.47

Wind Direction	2000	2003	2004	2005	2006	2007	2008	2010	2011	Average	Standard Deviation
SW	1.27	1.80	1.27	2.87	2.70	3.67	3.20	4.05	7.09	3.10	1.79
WSW	2.16	1.45	0.76	0.83	0.80	1.73	1.82	0.66	0.76	1.22	0.57
W	2.58	2.04	4.02	3.01	1.28	1.21	2.71	3.08	4.64	2.73	1.14
WNW	1.55	1.52	2.37	3.84	2.91	1.45	2.27	0.35	0.24	1.83	1.16
NW	1.79	2.90	4.50	7.10	7.13	6.58	6.87	5.50	4.95	5.26	1.92
NNW	4.22	4.84	2.44	2.25	6.40	7.55	4.30	6.44	3.63	4.67	1.83
Calm	29.36	40.81	34.03	18.07	11.86	14.86	23.06	20.55	31.62	24.91	9.63

Wind Direction	Statistic Value		Verification (O: Accept X: Reject)			Critical Value of the Distribution (5%)	
	2009	F_0	5%	2.5%	1%	Upper Limit	Lower Limit
N	4.05	0.03	O	O	O	12.33	-3.08
NNE	3.11	0.01	O	O	O	9.39	-3.59
NE	2.52	0.38	O	O	O	11.77	-2.84
ENE	0.86	0.05	O	O	O	3.47	-1.27
E	1.63	0.12	O	O	O	5.95	-1.57
ESE	1.04	0.29	O	O	O	4.48	-1.10
SE	6.43	0.00	O	O	O	17.71	-4.31
SSE	9.75	0.04	O	O	O	19.64	-1.99
S	16.94	0.02	O	O	O	36.56	-0.33
SSW	5.12	0.04	O	O	O	12.03	-0.71
SW	3.70	0.09	O	O	O	7.73	-1.53
WSW	1.24	0.00	O	O	O	2.70	-0.26
W	4.56	2.07	O	O	O	5.67	-0.21
WNW	1.14	0.29	O	O	O	4.82	-1.15
NW	4.91	0.03	O	O	O	10.21	0.30
NNW	4.11	0.08	O	O	O	9.38	-0.04
Calm	28.87	0.14	O	O	O	49.73	0.09

(Appearance Frequency by wind speed :%)

Wind Speed (m/sec)	2000	2003	2004	2005	2006	2007	2008	2010	2011	Average	Standard Deviation
0.5-0.99	7.86	3.42	1.68	12.84	9.65	9.80	5.43	30.73	22.55	11.55	9.43
1.0-1.99	32.66	32.38	37.16	32.19	45.38	45.24	50.14	38.93	36.70	38.97	6.55
2.0-2.99	13.50	13.89	17.50	21.01	20.13	19.50	14.57	4.81	7.33	14.69	5.64
3.0-3.99	7.69	5.53	5.81	9.76	8.13	7.14	3.78	2.49	1.25	5.73	2.79
4.0-5.99	4.43	2.42	3.03	4.26	3.49	2.60	1.82	1.59	0.52	2.68	1.27
6.0-	4.50	1.55	0.79	1.87	1.35	0.87	1.20	0.90	0.03	1.45	1.26
Calm	29.36	40.81	34.03	18.07	11.86	14.86	23.06	20.55	31.62	24.91	9.63

Wind Speed (m/sec)	Statistic Value		Verification (O: Accept X: Reject)			Critical Value of the Distribution (5%)	
	2009	F_0	5%	2.5%	1%	Upper Limit	Lower Limit
0.5-0.99	15.49	0.14	O	O	O	35.87	-12.77
1.0-1.99	49.38	2.02	O	O	O	55.85	22.09
2.0-2.99	3.32	3.25	O	O	O	29.24	0.15
3.0-3.99	0.93	2.36	O	O	O	12.93	-1.46

Wind Speed (m/sec)	Statistic Value		Verification (O: Accept X: Reject)			Critical Value of the Distribution (5%)	
	2009	F_0	5%	2.5%	1%	Upper Limit	Lower Limit
4.0-5.99	0.90	1.57	O	O	O	5.97	-0.60
6.0-	1.11	0.06	O	O	O	4.69	-1.79
Calm	28.87	0.14	O	O	O	49.73	0.09

(Source: JICA Study Team)

(2) Supplementation of Data

a). Estimation of Solar Radiation

Pasquill- Gifford stability categories is the most common method to estimate the dispersion width of exhaust gas generated from emission source (Table 3.1.2-2). Atmospheric stability is categorized based on solar radiation and wind speed of the time, according to Pasquill-Gifford stability categories.

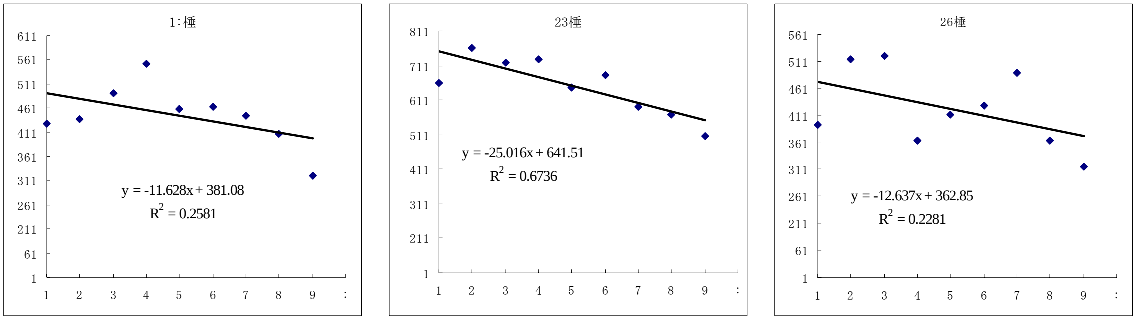
Table 3.1.2-2 Pasquill- Gifford stability categories

Wind Speed at the ground level U↖ m/sec ↗	Day Time				Night Time ↖ Q = 0 ↗
	Solar Radiation Q (W/m^2)				
	600 < Q	300 - 590	150 - 290	10 - 140	
U < 2.0	A	A - B	B	D	F
2.0 - 2.9	A - B	B	C	D	E
3.0 - 3.9	B	B - C	C	D	D
4.0 - 5.9	C	C - D	D	D	D
6.0 < U	C	D	D	D	D

(Source:)

Kutubdia Meteorological Observatory measures cloud amount data, but not solar radiation data. Solar radiation data and cloud amount data of Dhaka, Bangladesh are acquired from Weather Underground Company, which collects meteorological data from meteorological organizations in the world and publicizes them on website.

Since solar radiation data is correlated to the cloud amount data, solar radiation data of Kutubdia was calculated from the cloud amount data measured at Kutubdia Meteorological Observatory in reference to solar radiation and cloud amount data of 9, 12 and 15 o’clock at Dhaka with regression line as shown in Figure 2.



(Source: JICA Study Team)

Figure 3.1.2-1 Correlation between solar radiation and cloud amount by time

Atmospheric stability at the ground level was categorized based on the solar radiation data and wind speed data at the ground level. Atmospheric stability at the outlet of the 275m height of stack used in this project is however different from the stability at ground level. Therefore, atmospheric stability was converted as shown in Table-3 in case of the 275m height of stack for conducting dispersion model.

Table 3.1.2-3 Conversion of Atmospheric Stability

Atmospheric stability of ground	A	A-B	B	B-c	C	C-D	D_{day}	D_{night}	E	F	G
Atmospheric stability of upper air	B	B-C	C	D				D	D	E	F

b). Wind Speed Profile

The wind power law is used to adjust the observed wind speed, $U_{ref,}$ from a reference measurement height, Z_{ref}, to the stack or release height, $h_{s.}$ The stack height wind speed, U_s, is used in the Gaussian plume equation, and in the plume rise formulas. The power law equation is of the form;

$$u_s = u_{ref}\left(\frac{h_s}{z_{ref}}\right)^p$$

where, p is the wind profile exponent. Values of p may be provided by the user as a function of stability category and wind speed class. Default values are as follows:

Table 3.1.2-4 Exponent by Atmospheric Stability Category (p)

Stability Category	Exponent (p)
A	0.07
B	0.07

Stability Category	Exponent (p)
C	0.10
D	0.15
E	0.35
F	0.55

In case of 275m height of stack like this project, when wind speed is 0.1m/sec at ground level, the wind speed at stack outlet level becomes more than 0.5m/sec. Therefore, wind speed data of 0.5m/sec is assigned for the category of "calm" when the wind speed at ground level is 0.1m/sec.

c). Supplementation of Time
In Bangladesh, meteorological observation is only conducted every 3 hours, 8 times in a day. In order to acquire the meteorological data of every hour, the hourly data of wind speed and wind direction are calculated by interpolation between two measured data.

3.1.3 Meteorological Condition

Whether or not simulating exhaust gas dispersion models under special metrological conditions, such as inversion layers and downdrafts, was necessary was considered, in addition to the dispersion model under normal metrological condition.

(1) Inversion Layers
In case that an inversion layer of the temperature occurred temporarily above the stack of the power plant, exhaust gas would stay under the inversion layer, possibly causing the concentration of pollutants becoming high. Since there is no valid metrological data of the upper layer, the dispersion model was simulated with the worst case estimated.

(2) Consideration according to the occurrence of downwash and down draft
Based on the Briggs model, when gas emissions speed is lower than 1.5 times of the wind speed of stack height, downwash may occur. In this project, the gas emission speed is 15.4m/s, so that downwash will occur when wind speed at the stack outlet level is more than 23m/s.

In order for the wind speed at the stack outlet level to become more than 23m/s, wind speed at ground level needs to be greater than 10m/s. The frequency of wind speed being greater than 10m/s at ground level around the power plant was only observed 14 times in the previous 12 years, according to the meteorological data measured at the observatories closest to the project; therefore, downwash was not considered to have occurred, and a dispersion model under downwash conditions was not simulated.

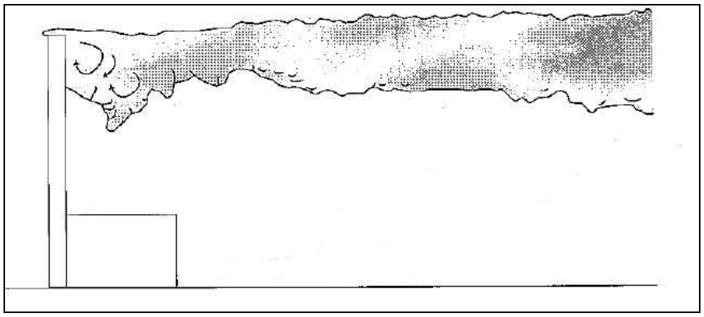


Figure 3.1.3-1 Outlook of the downwash

Based on the Huber model, when stack height is lower than 2.5 times of building height, downdraft may occur. In this project, stack height is 275 m. The building height in the vicinity of the stack for downdraft to occur would have to be more than 110 m. Since the height of all the proposed buildings will be less than 65m, downdraft will not occur.

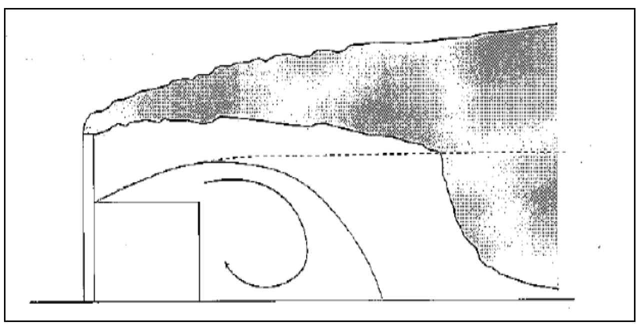


Figure 3.1.3-2 Outlook of the down draft

3.1.4 Dispersion Model of Exhaust Gas

Using the following Gaussian diffusion model, prediction of yearly averages, a 24-hour and 1-hour value was calculated according to the time scale in conformity with the environmental standards of Bangladesh and the IFC/EHS guidelines (General, 2008).

(1) Normal Meteorological Condition

$$C = \frac{Q_p}{2\pi \ \sigma_y \sigma_z u} \cdot \exp\left(-2\frac{y^2}{2\sigma_y{}^2}\right) \exp\left\{-\frac{(z-He)^2}{2\sigma_z{}^2}\right\} + \exp\left\{-\frac{(z+He)^2}{2\sigma_z{}^2}\right\}$$

Where:

C: Above-ground concentration at a leeward distance R (m)
Q_p: Emission volume
σ_y: Parameter in the horizontal direction (m)
σ_z: Parameter in the vertical direction (m)
u: Wind speed (m/s)
R: Horizontal distance between smoke source and calculated point (m)
z: Above-ground height
He: Effective stack height (m)

$He = H + \Delta H$
H: Stack height (m)
ΔH: Elevation height (m)

(2) Occurrence of Inversion Layer

The occurrence of an inversion layer as a temporary metrological phenomenon, the dispersion model on a 1-hour value was simulated, using the Gaussian Model shown below.

$$C(x) = \frac{Q_p}{2\pi \cdot \sigma_y \cdot \sigma_z \cdot u} \cdot \sum_{n=-3}^{3} \left[\exp\left\{ -\frac{(He + 2n \cdot L)^2}{2\sigma_z^2} \right\} + \exp\left\{ -\frac{(-He + 2n \cdot L)^2}{2\sigma_z^2} \right\} \right]$$

Where;
↿ ‡ ↨ Emission amount (g/s)
σ⇧ ↨ Parameter of horizontal direction (⇛)
σ⇨ ↨ Parameter of vertical direction (⇛)
⇣ ↨ Wind speed (⇛ /s)
↶ e↨ Effective stack height (⇛)
↺ ↨ Height of mixing layer (m) (set as L=He, which is the worst case)
⇜ ↨ Reflection times (set as ±3)

(3) Conditions for Simulation

Emission specifications

Table 3.1.4-1 shows the exhaust volume, temperature, speed, and emissions of the NOx, soot and dust.

All the sulfur oxide, nitrogen oxide and dust emitted from the stack are assumed to become SO_2, NO_2 and PM_{10}, respectively.

Table 3.1.4-1 Emission specifications

Item	Unit	2Ø 600 MW
Emission volume (wet)	Nm^3/h	$1,819.5\times10^3$
Exhaust temperature	ºC	75
Exhaust speed	m/s	15.4
Actual stack height	m	275
SOx	kg/h	1,554
NOx	kg/h	872

Item	Unit	2Ø 600 MW
PM	kg/h	95

Notes:

1. The values indicate the values under the maximum continuous load.
2. Sulfur content in coal is set to 1.0%.
3. The values take into consideration the following: SOx removal efficiency of FGD is 70%, and PM removal efficiency of EP is 99.8%.

(Source: JICA Study Team)

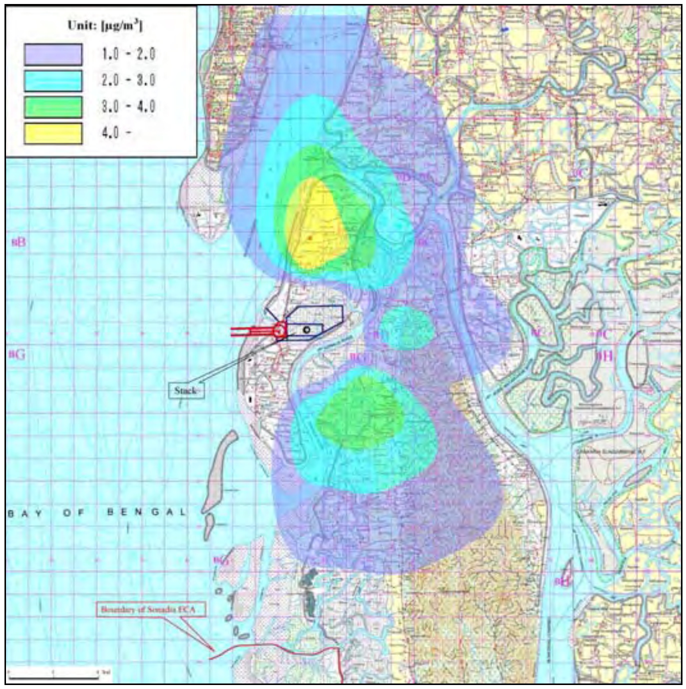
3.1.5 Result of Simulation

(1) Case 1: Stack height is 275m

Table 3.1.5-1 Dispersion concentration of air pollutants (Case 1)

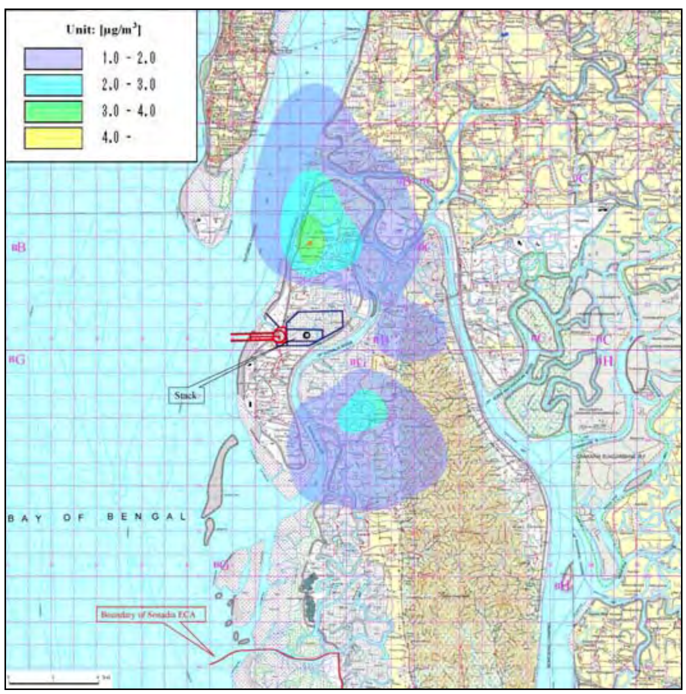
Time scale	Item	Background concentration (μg/m^3) (1)	The highest concentration (μg/m^3) (2)	The appearance distance from stack (km)	Prediction concentration in ambient air quality (μg/m^3) (1)+(2)	Air quality standards (μg/m^3)	IFC guideline value (General 2007) (μg/m^3)	EU Standards ↖ Japanese Standards ↗ (μg/m^3)
Annual Average	SO_2	↖ 3.0↛ 4.1↗	6.2	4.1	9.2↛ 10.3	80	-	20
	NO_2	↖ 5.0↛ 7.6↗	3.5	4.1	8.5↛ 11.1	100	40	40
	SPM/PM_{10}	↖ 42↛ 62↗	0.4	4.1	42.4↛ 62.4	50	70	70
24 hour Maximum	SO_2	3.0↛ 4.1	37.6	3.8	40.6↛ 41.7	365	125	125 ↖ 100↗
	NO_2	5.0↛ 7.6	21.1	3.8	25.1↛ 28.7	-	-	- (75 7 110)
	SPM/PM_{10}	42↛ 62	2.3	3.8	44.3↛ 64.3	150	150	150 ↖ 100↗
1 hour⇕ normal condition (Maximum B,1m/s)	SO_2	3.0↛ 4.1	87.2	3.7	90.3↛ 91.3	-	500(10min)	350 ↖ 260↗
	NO_2	5.0↛ 7.6	48.9	3.7	53.9↛ 56.5	-	200	200
	SPM/PM_{10}	42↛ 62	5.3	3.7	47.3↛ 67.3	SPM:200 ↖ 8hr↗	-	- ↖ 200↗
1 hour⇕ Occurrence of Invasion layer (Maximum B,1m/s)	SO_2	3.0↛ 4.1	175.0	3.7	178.0↛ 179.1	-	500(10min)	350 ↖ 260↗
	NO_2	5.0↛ 7.6	97.9	3.7	102.9↛ 105.2	-	200	200
	SPM/PM_{10}	42↛ 62	10.7	3.7	52.7↛ 72.7	SPM:200 ↖ 8hr↗	-	- ↖ 200↗

Note: This survey result indicates only short-term result in rainy and dry season and is not suitable to be directly compared with the standard value of the annual average value.



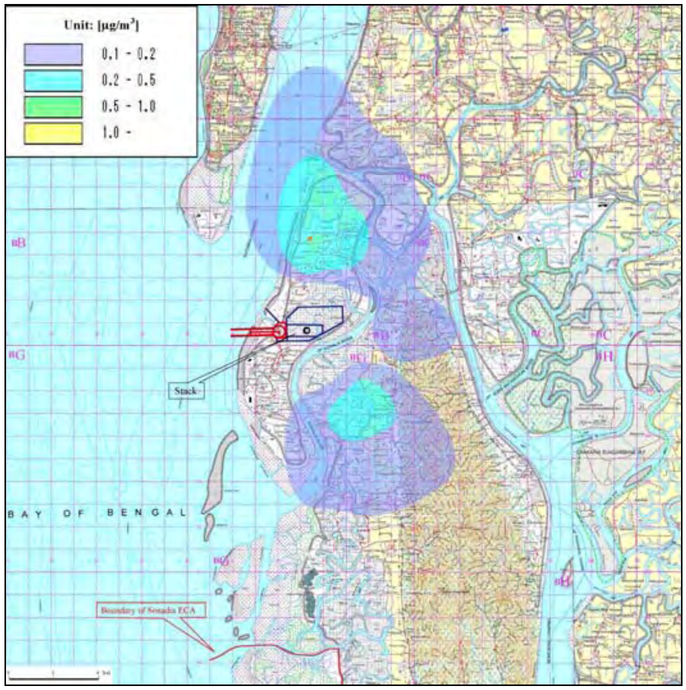
(Source: JICA Study Team)

Figure 3.1.5-1(1) Dispersion concentration of air pollutants (Annual Average) (SO_2)



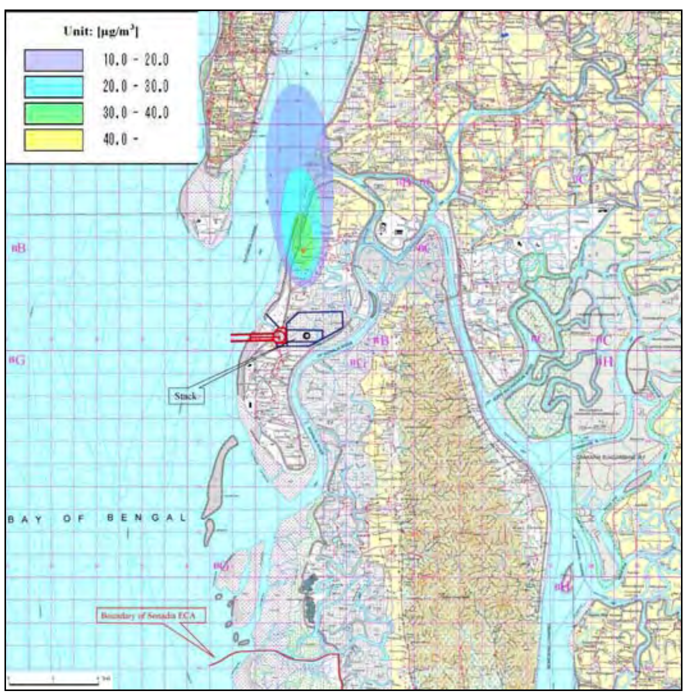
(Source: JICA Study Team)

Figure 3.1.5-1(2) Dispersion concentration of air pollutants (Annual Average) (NO_2)



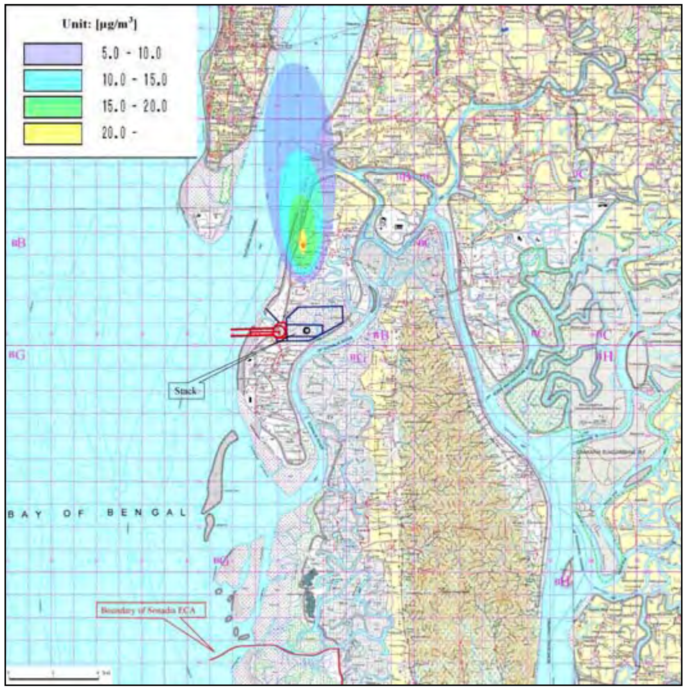
(Source: JICA Study Team)

Figure 3.1.5-1(3) Dispersion concentration of air pollutants (Annual Average) (PM_{10})



(Source: JICA Study Team)

Figure 3.1.5-2(1) Dispersion concentration of air pollutant (24 hour Maximum) (SO_2)

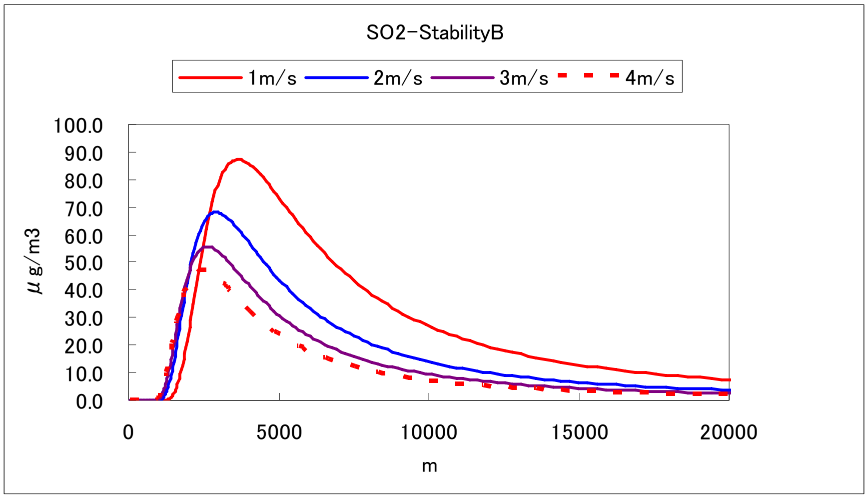


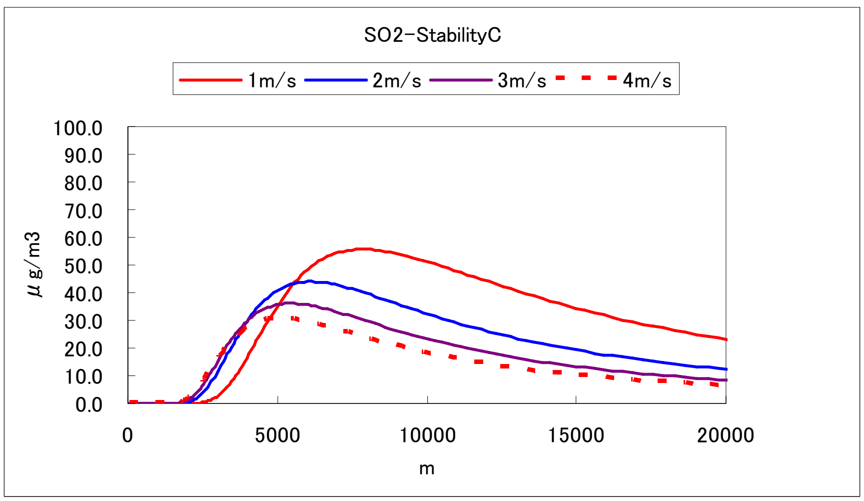
(Source: JICA Study Team)

Figure 3.1.5-2 (2) Dispersion concentration of air pollutants (24 hour Maximum) (NO_2)

(Source: JICA Study Team)

Figure 3.1.5-2(3) Dispersion concentration of air pollutants (24 hour Maximum) (PM_{10})





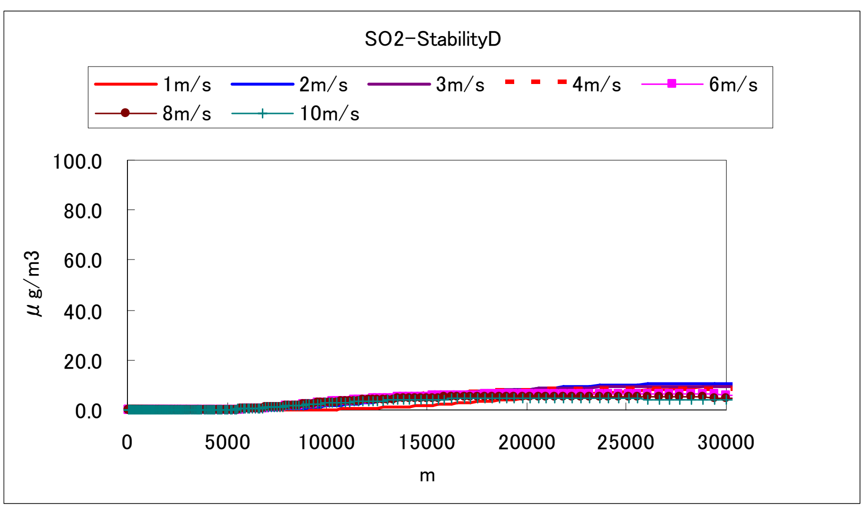


Figure 3.1.5-3(1) Dispersion concentration of air pollutants (1 hour Maximum) (SO_2)

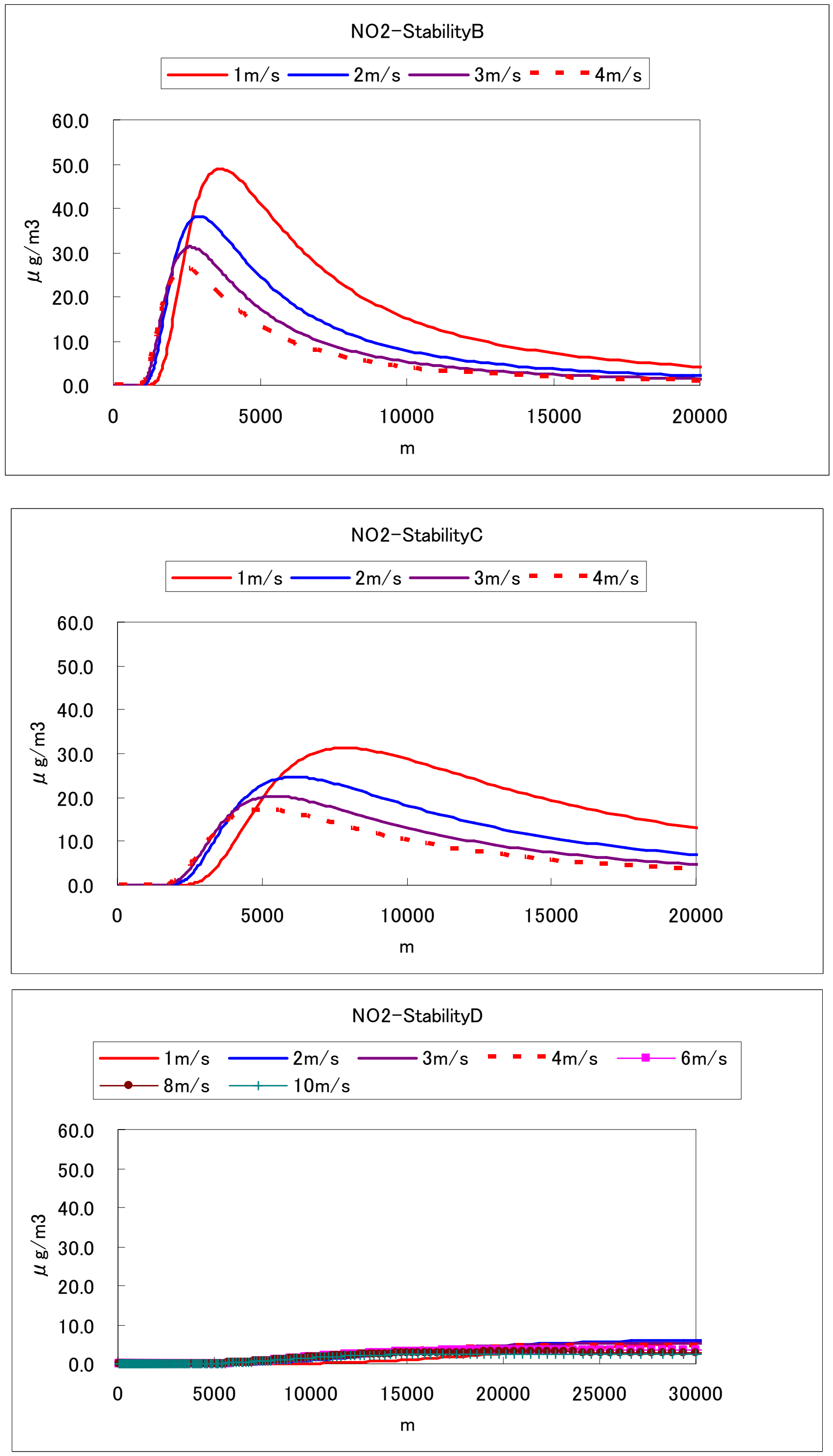
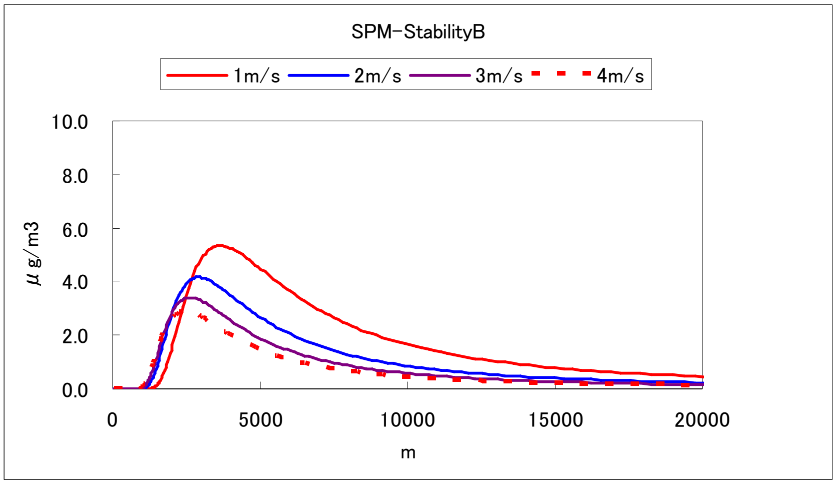
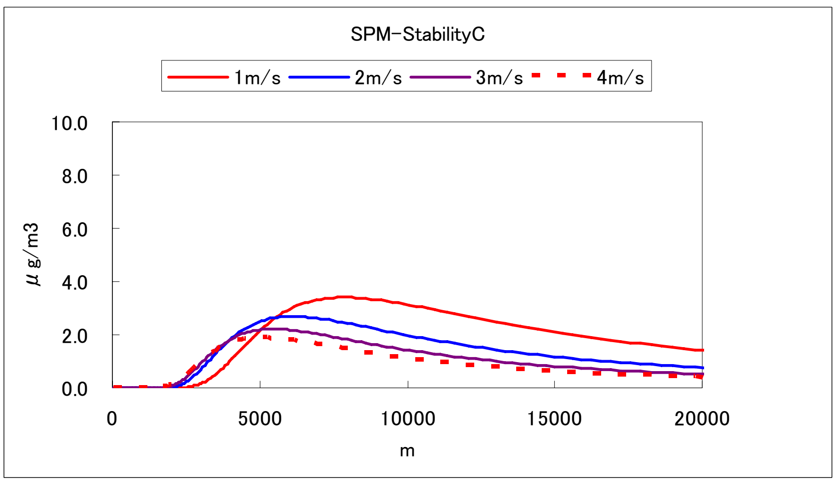


Figure 3.1.5-3(2) Dispersion concentration of air pollutants (1 hour Maximum) (NO_2)





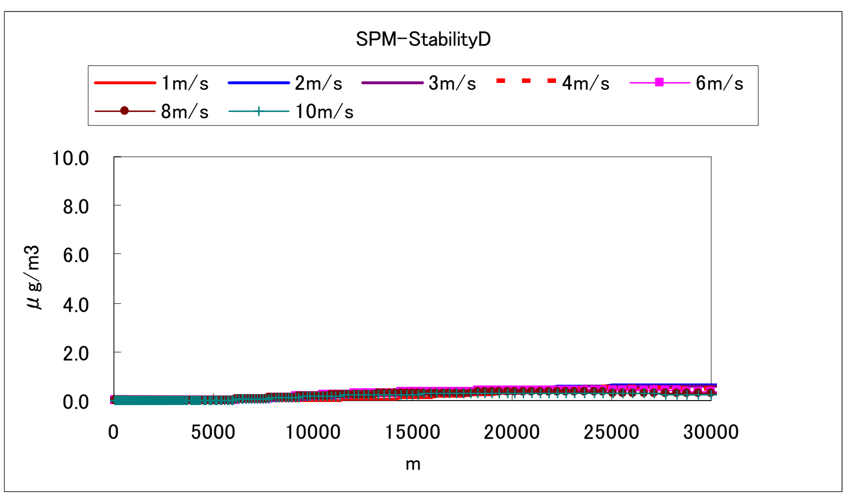


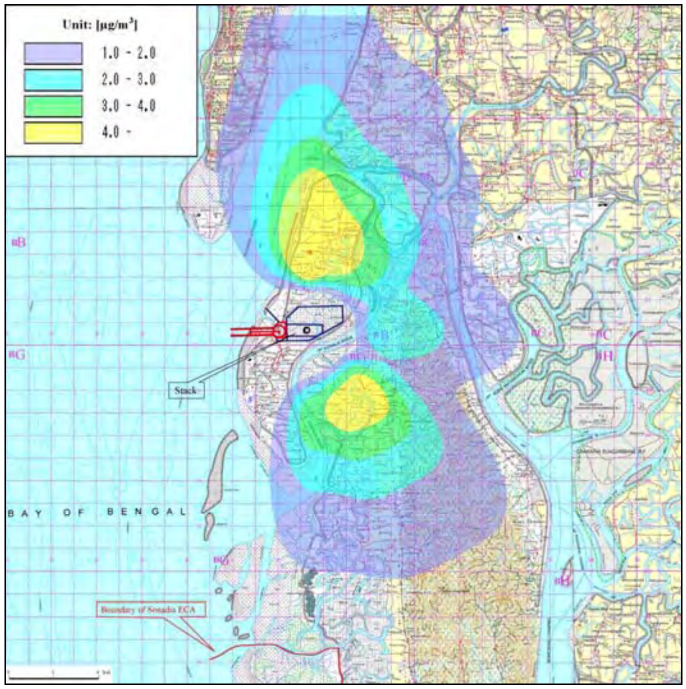
Figure 3.1.5-3(3) Dispersion concentration of air pollutants (1 hour Maximum) (PM_{10})

(2) Case 2: Stack height is 200m

Department of Environment, Bangladesh regulates the lowest stack height of coal-fired power plant as 275 meters for the control of sulfur oxide (SO_2) emitted out from the stack, according to the Environmental Conservation Rules 1997. The coal-fired power plant with Ultra Super Critical technology which this project will adopt is designed environmentally friendly and reducing the concentration level of the pollutants emitted from the power plant; therefore, SO_2 concentration will meet Bangladesh standard and the international standards even with the lower stack height (200 meters).

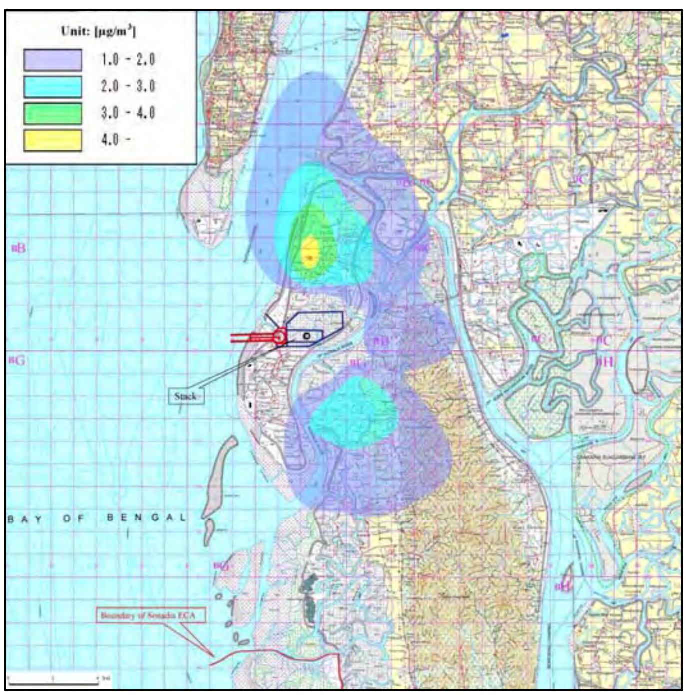
Table 3.1.5-2 Dispersion concentration of air pollutants (Case 2)

Time scale	Item	Background concentration (μg/m^3) (1)	The highest concentration (μg/m^3) (2)	The appearance distance from stack (km)	Prediction concentration in ambient air quality (μg/m^3) (1)+(2)	Air quality standards (μg/m^3)	IFC guideline value (General 2007) (μg/m^3)	EU Standards ↖ Japanese Standards↗ (μg/m^3)
Annual Average	SO_2	↖ 3.0↛ 4.1↗	7.8	3.5	10.8↛ 11.9	80	-	20
	NO_2	↖ 5.0↛ 7.6↗	4.4	3.5	9.4↛ 12.0	100	40	40
	SPM/PM_{10}	↖ 42↛ 62↗	0.5	3.5	42.5↛ 62.5	50	70	70
24 hour Maximum	SO_2	3.0↛ 4.1	47.2	3.5	50.2↛ 51.3	365	125	125 ↖ 100↗
	NO_2	5.0↛ 7.6	26.5	3.5	31.5↛ 34.1	-	-	- (75^{7} 110)
	SPM/PM_{10}	42↛ 62	2.9	3.5	44.9↛ 64.9	150	150	150 ↖ 100↗
1 hour⇕ normal condition (Maximum B,1m/s)	SO_2	3.0↛ 4.1	111.5	3.3	114.5↛ 115.6	-	500(10min)	350 ↖ 260↗
	NO_2	5.0↛ 7.6	62.6	3.3	67.6↛ 70.2	-	200	200
	SPM/PM_{10}	42↛ 62	6.8	3.3	48.8↛ 68.8	SPM:200 ↖ 8hr↗	-	- ↖ 200↗
1 hour⇕ Occurrence of Invasion layer (Maximum B,1m/s)	SO_2	3.0↛ 4.1	223.0	3.3	225.0↛ 227.1	-	500(10min)	350 ↖ 260↗
	NO_2	5.0↛ 7.6	125.0	3.3	130.0↛ 132.6	-	200	200
	SPM/PM_{10}	42↛ 62	13.6	3.3	55.6↛ 75.6	SPM:200 ↖ 8hr↗	-	- ↖ 200↗



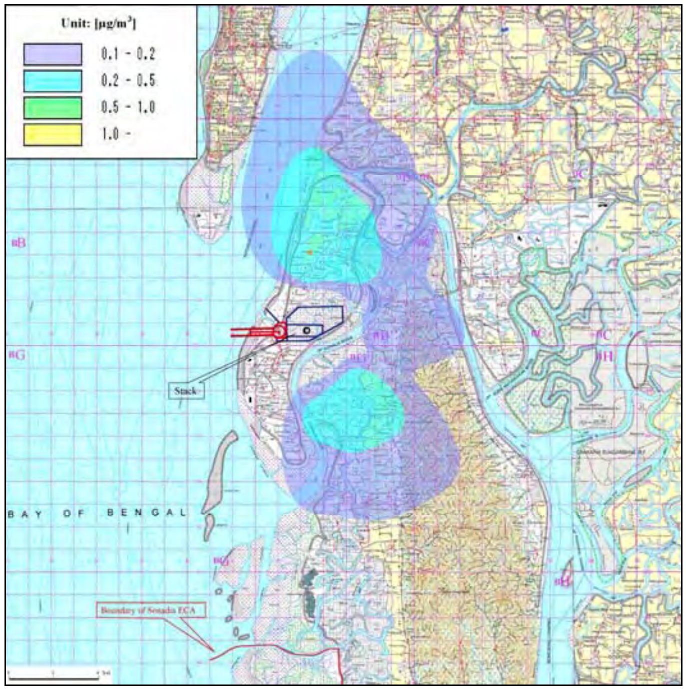
(Source: JICA Study Team)

Figure 3.1.5-4(1) Dispersion concentration of air pollutants (Annual Average) (SO_2)



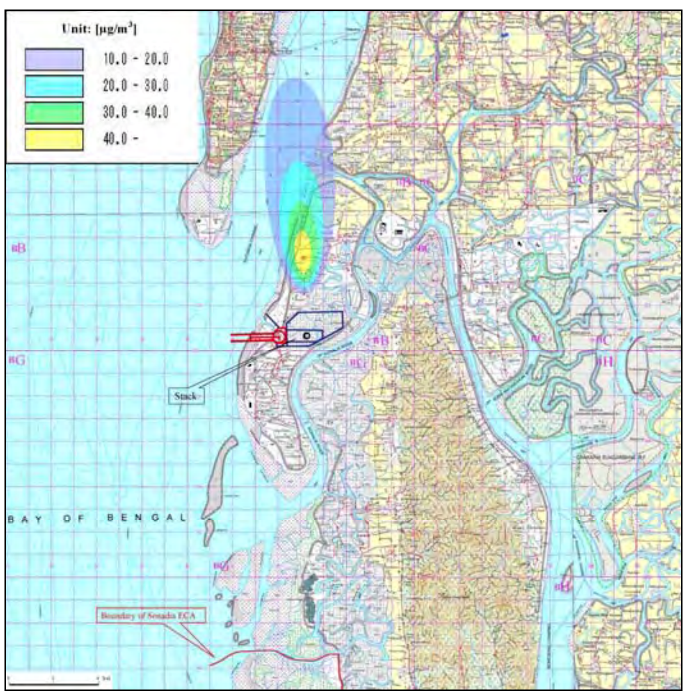
(Source: JICA Study Team)

Figure 3.1.5-4(2) Dispersion concentration of air pollutants (Annual Average) (NO_2)



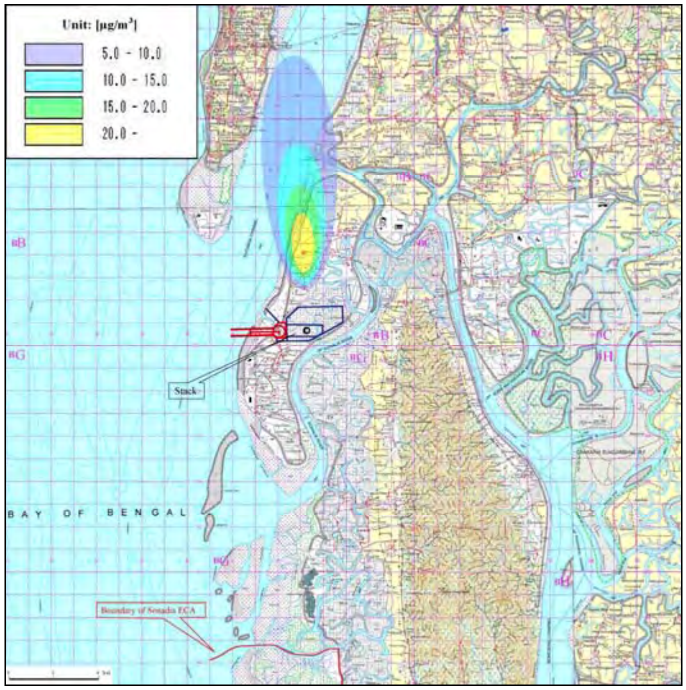
(Source: JICA Study Team)

Figure 3.1.5-4(3) Dispersion concentration of air pollutants (Annual Average) (PM_{10})



(Source: JICA Study Team)

Figure 3.1.5-5(1) Dispersion concentration of air pollutant (24 hour Maximum) (SO_2)

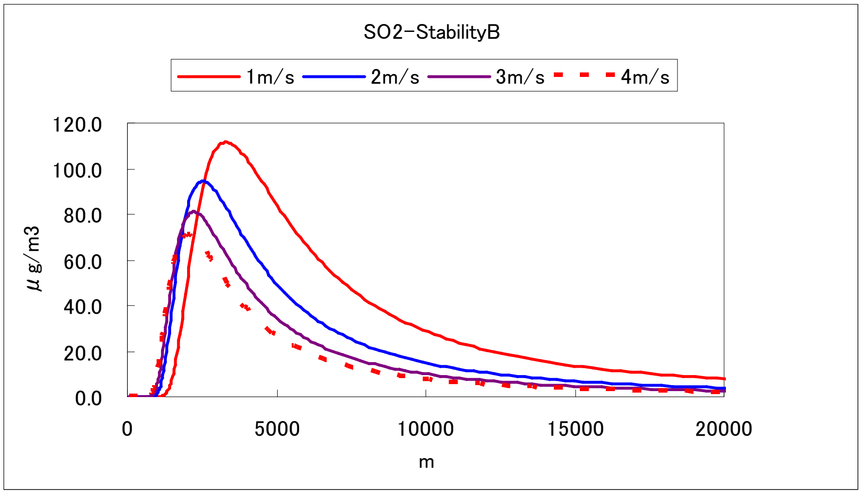


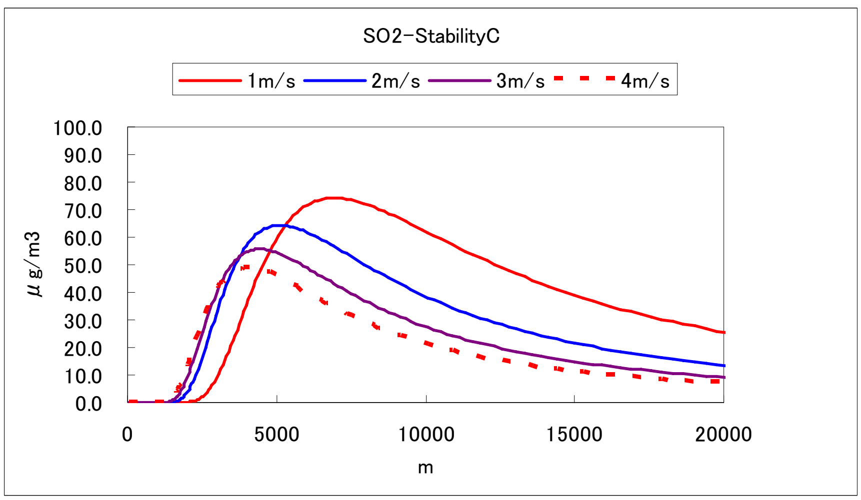
(Source: JICA Study Team)

Figure 3.1.5-5(2) Dispersion concentration of air pollutants (24 hour Maximum) (NO_2)

(Source: JICA Study Team)

Figure 3.1.5-5(3) Dispersion concentration of air pollutants (24 hour Maximum) (PM_{10})





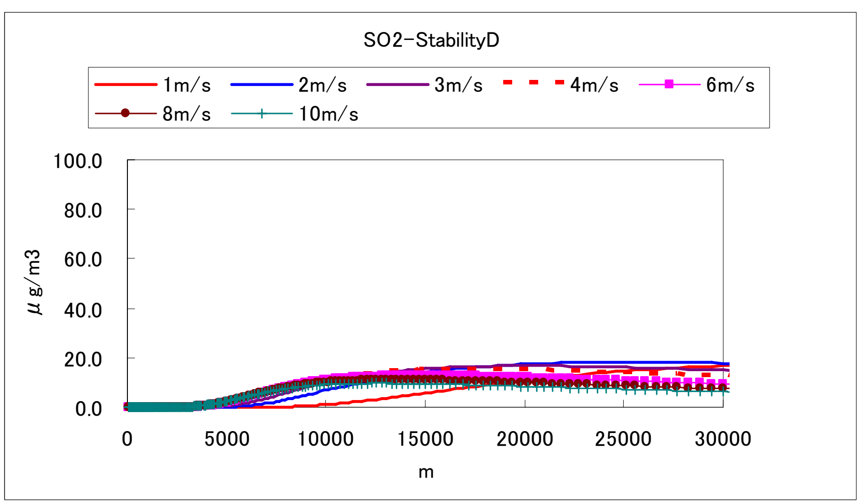


Figure 3.1.5-6(1) Dispersion concentration of air pollutants (1 hour Maximum) (SO_2)

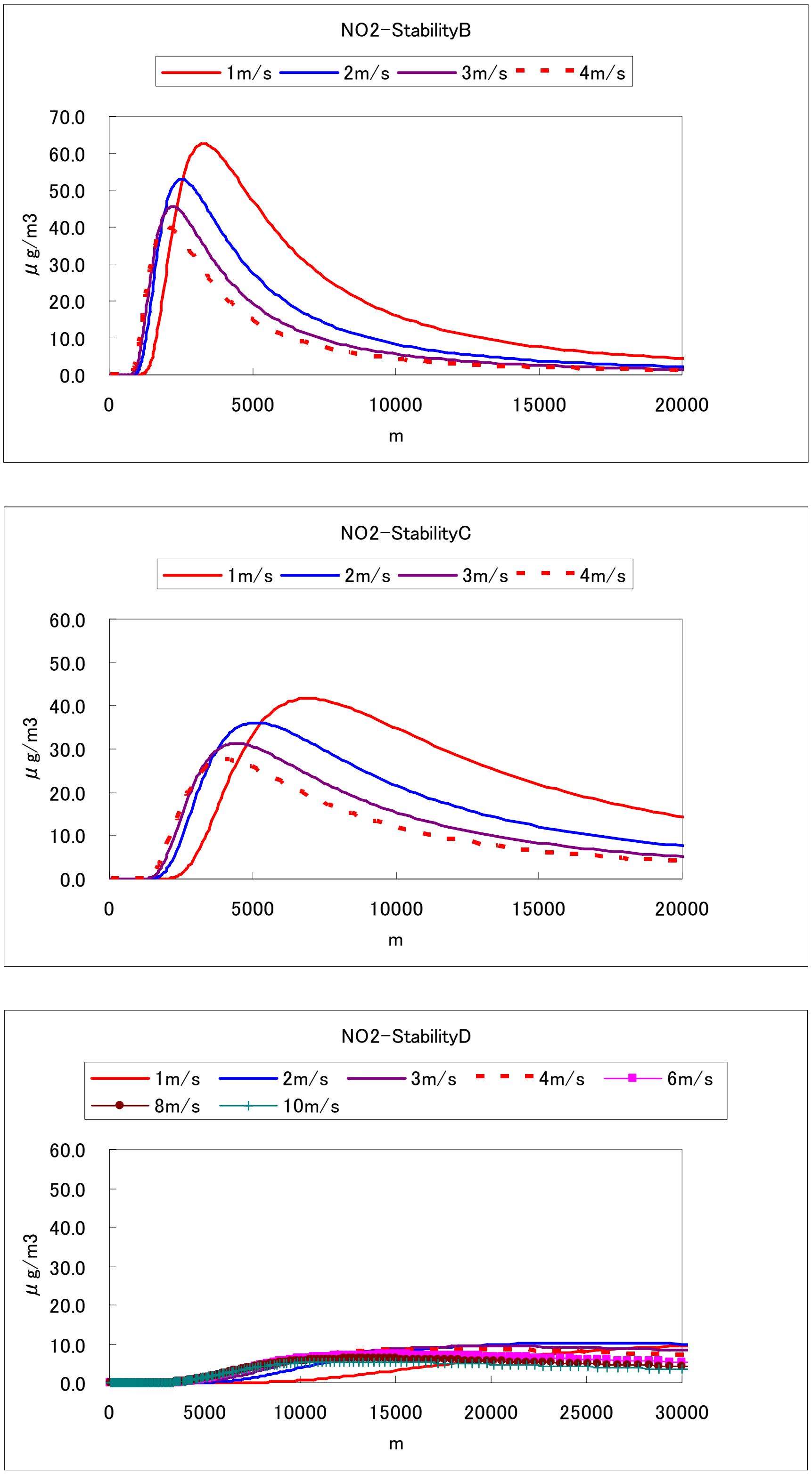
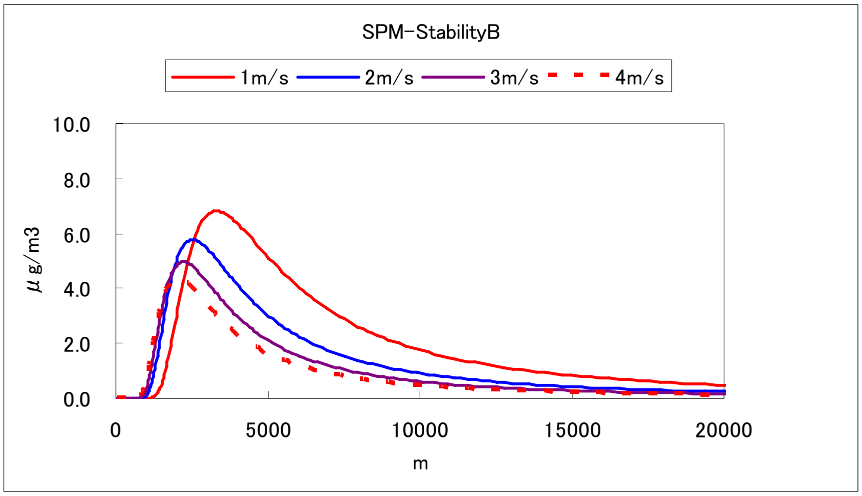
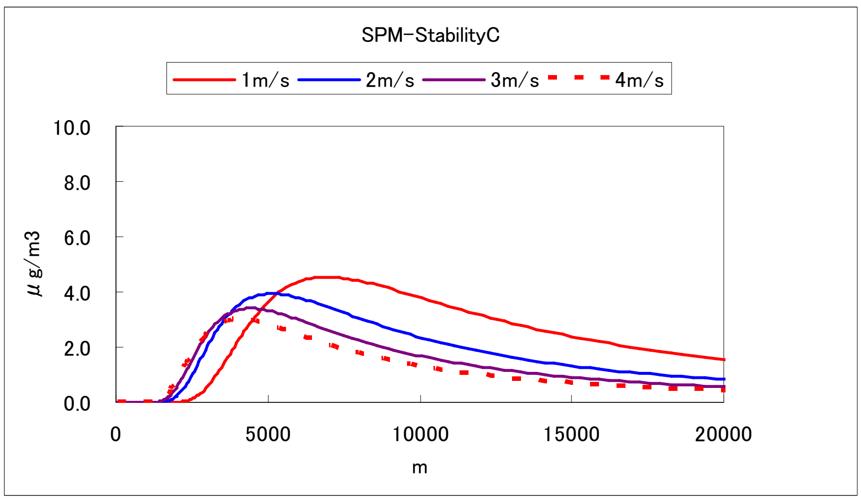


Figure 3.1.5-6(2) Dispersion concentration of air pollutants (1 hour Maximum) (NO_2)





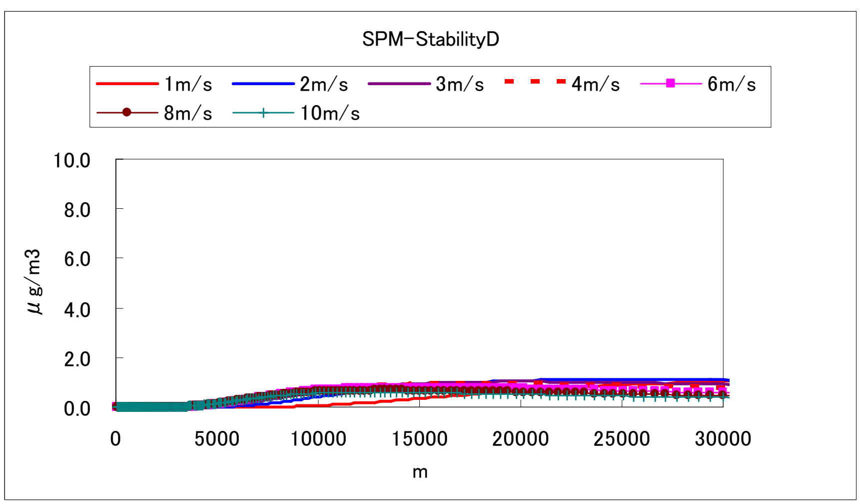


Figure 3.1.5-6(3) Dispersion concentration of air pollutants (1 hour Maximum) (PM_{10})

3.2 Thermal effluent

Water used in the power plant will have intake at low speed (0.2m/s) from low-temperature seawater in the deep layer at the water inlet located in the port using the curtain wall method. Thermal effluent will be discharged from the water discharge outlet located 1km north of the port in order to prevent recirculation. The temperature of thermal effluent will be discharged within ΔT 7°C compared to the water temperature of the intake water and will be less than 40°C. Therefore the temperature of the thermal effluent is within the discharge water regulation (40°C).

A diffusion estimation model of thermal effluents from the power plant is calculated based on the following formula.

Diffusion estimation model

$$\frac{\partial u}{\partial t}+\frac{\partial u^2}{\partial x}+\frac{\partial uv}{\partial y}+\frac{\partial uw}{\partial z}=-\frac{1}{\rho}\frac{\partial p}{\partial x}+\mu\nabla^2 u+\gamma\frac{\partial^2 u}{\partial z^2}$$

$$\frac{\partial v}{\partial t}+\frac{\partial uv}{\partial x}+\frac{\partial v^2}{\partial y}+\frac{\partial vw}{\partial z}=-\frac{1}{\rho}\frac{\partial p}{\partial y}+\mu\nabla^2 v+\gamma\frac{\partial^2 v}{\partial z^2}$$

$$\frac{\partial w}{\partial t}+\frac{\partial uw}{\partial x}+\frac{\partial vw}{\partial y}+\frac{\partial w^2}{\partial z}=g-\frac{1}{\rho}\frac{\partial p}{\partial z}+\mu\nabla^2 w+\gamma\frac{\partial^2 w}{\partial z^2}$$

(Continuity equation)

$$\frac{\partial u}{\partial x}+\frac{\partial v}{\partial y}+\frac{\partial w}{\partial z}=0$$

In which:

u,v,w: Current velocity in x, y, z

t : Time

P: Pressure

ρ_w : Water density

O and ν: Coefficient of the horizontal and vertical eddy viscosity

Calculation conditions

The simulation condition of the discharge rate of thermal effluent from the power plant is described in the table below. Based on the field survey, NNE current as the predominant current (permanent current) was selected. The parameters used for simulation are the seabed topography data taken from sea charts and air temperature, wind speed and water temperature data taken from the results of the field survey (Table 3.2-1).

Table 3.2-1 Discharge specifications

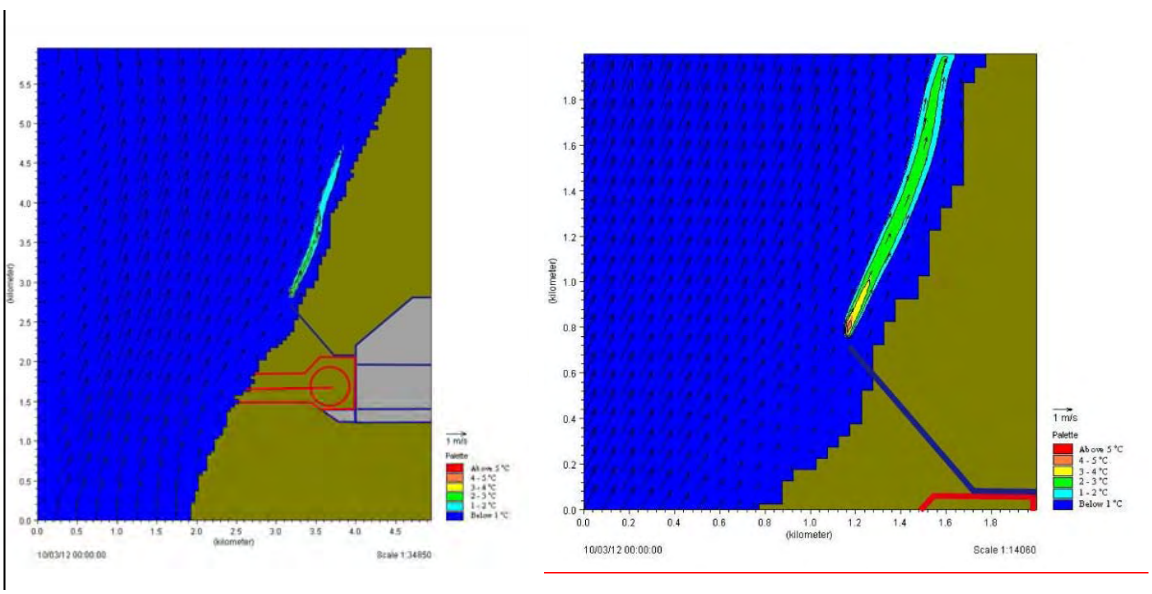
Item	Unit	2Ø 600MW
Discharge volume	m^3/ s	50
Discharge speeds	m/s	0.5
Discharge water temperature	ºC	38
Surrounding water temperature	ºC	30
Air temperature	ºC	28.8
Wind speed	m/ s	1.0

(Source: JICA Study Team)

Results of simulation

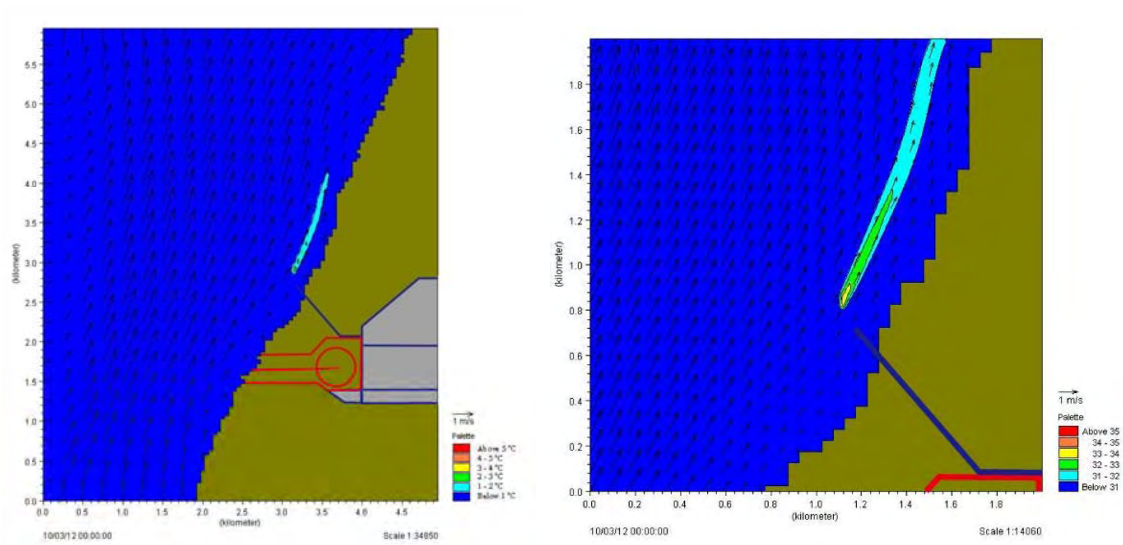
Thermal effluent would be expected to spread out along the coastal line, if the discharge point of thermal effluent is put at the coastal line. Fishing activity, especially shrimp fry fishing for shrimp cultivation is conducted at the coastal line, so that it should be avoided that the water temperature around the coastal area would become warmer.

Therefore, simulation of thermal effluent diffusion was conducted under two conditions; the discharge point is 140 meters away from the costal line, and 280 meters away from the costal line, in order to identify how far the discharge point should be to avoid the impact of thermal effluent to the coastal area. (Figure 4.2-9).



(Source: JICA Study Team)

Figure 4.2-9(1) Dispersion of thermal effluent (NNE Current: speed: 0.5m/s)
(Location of the discharge point: 140m offshore)



(Source: JICA Study Team)

Figure 4.2-9(2) Dispersion of thermal effluent (NNE Current: speed 0.5m/s)

(Location of the discharge point: 280m offshore)

In the case that the discharge point is 140m offshore:

The sea area that the water temperature increases more than 4°C is up to 70m away from the discharge point; more than 3°C increase is up to 240m away, more than 2°C increase is up to 1,300m away, and more than 1°C increase is up to 1,800m away from the discharge point.

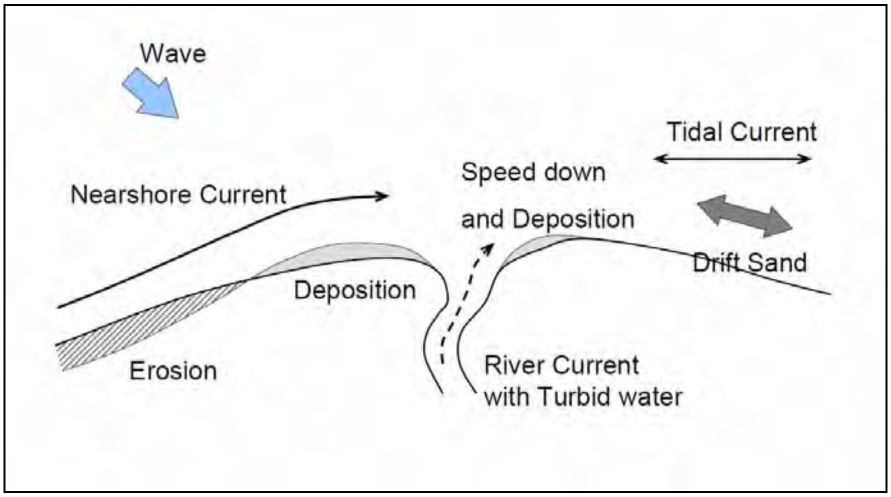
In the case that the discharge point is 280m offshore:

The sea area that the water temperature increases more than 4°C is none; more than 3°C increase is up to 90m away, more than 2°C increase is up to 530m away, and more than 1°C increase is up to 1,400m away from the discharge point.

3.3 Hydrology

3.2.1 Outline of simulation

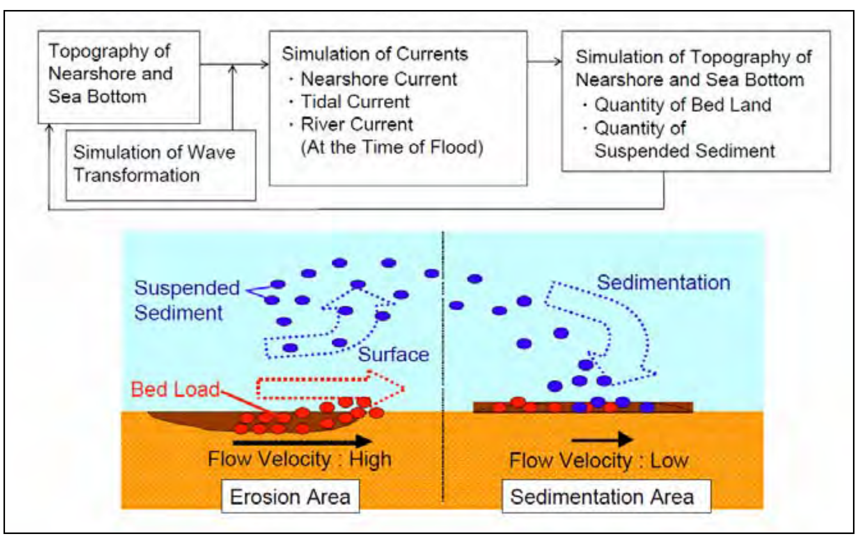
As shown in Figure 3.2.1-1 and 3.2.12-, it is considered that sediment transport of the seashore is caused by near shore currents, tidal currents and the inflow discharge of rivers. Suspended sediment accrues in areas where the velocity distribution is low, and where the velocity distribution is high, tides erode the sediment.



*Deposition :the natural process of leaving a layer of soil
**Erosion :the result of being eroded,

(Source: JICA Study Team)

Figure 3.2.1-1 Mechanism of Sediment Transport



(Source: JICA Study Team)

Figure 3.2.1-2 Simulation Model of Sediment Transport

Simulation condition

- Analyzed area ↨ 70km × 40km
- Water depth ↨ based on the Hydrographic Chart
- Input conditions

  Wave Height : 6.1 m (maximum wave of a neighborhood point)

  Tidal Current : flood 1.45 m/s, ebb 1.20 m/s

  River flow rate : Maiskhali Channel 3,200m^3/s, Kohalia River 320 m^3/s

  (based on data of a nearby hydrological observatory)

3.2.2 Results

Figure 3.2.2-1 shows the results of the simulation of current velocity.

Dredged channel effects tidal current changes in the channel, but there are no considerable changes to the surrounding area. Deposition occurs slightly in a part of channel. But this phenomenon also does not greatly affect to the surrounding area.

Figure 3.2.2-2 shows the results of the simulation of coastal topographyゐ

Deposition occurs close to the channel, but there is not considerable siltation in the channel. Deposition and erosion do not occur in the surrounding area.

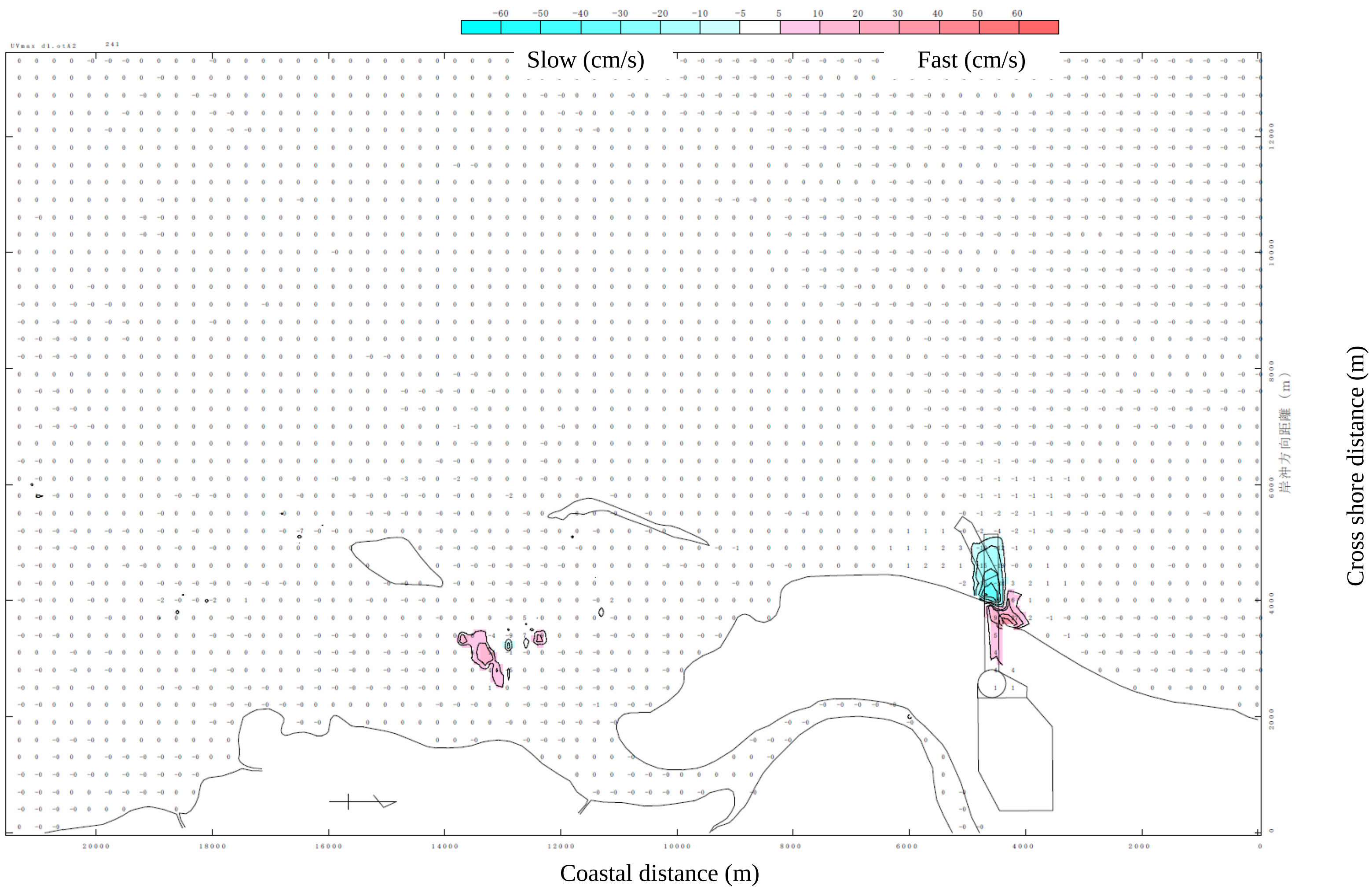


Figure 3.2.2-1 Transition of velocity distribution

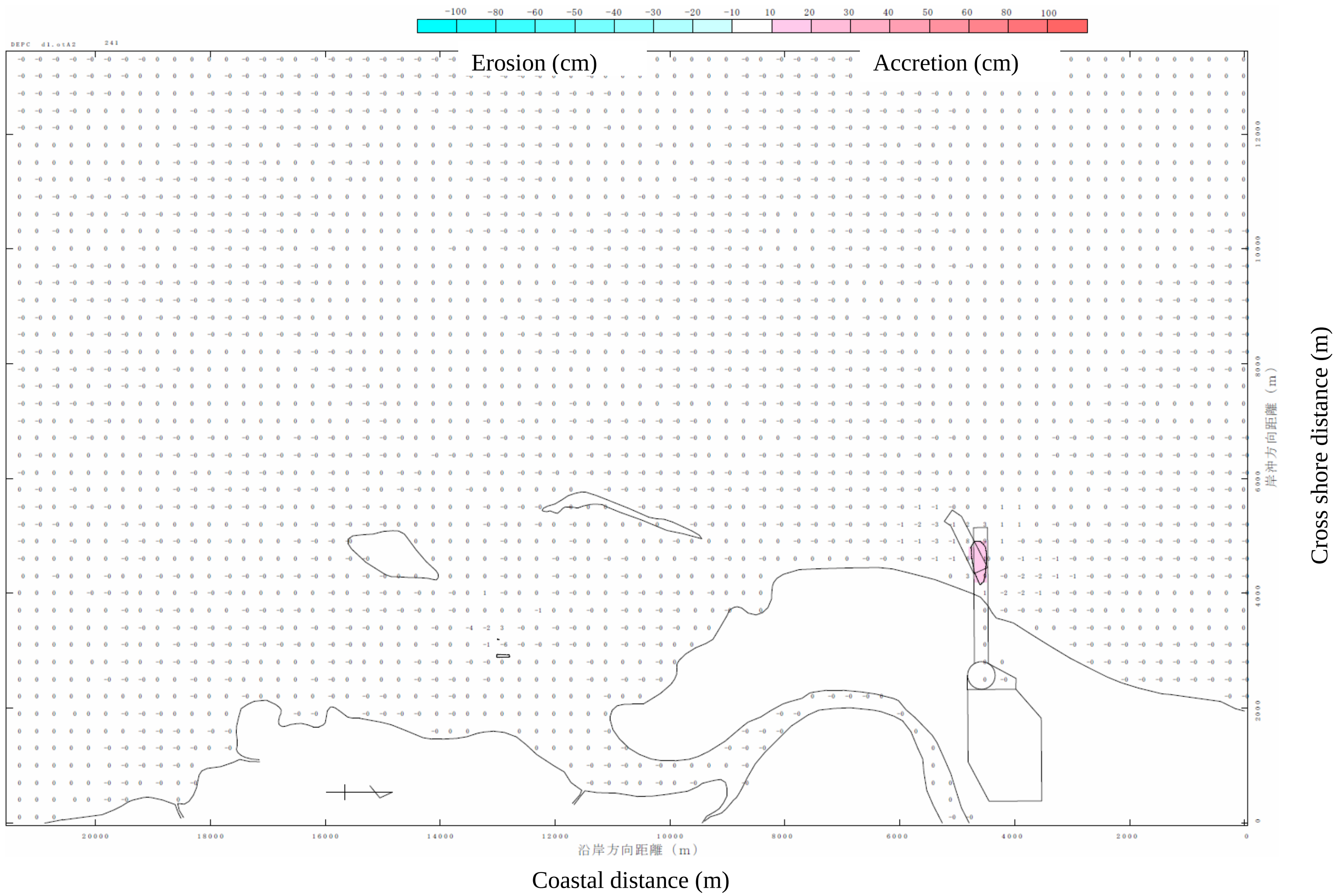


Figure 3.2.2-2 Transition of coastal topography

Annexure 4

Risk Management

Annex 4

Risk Analysis

-: Table of Contents:-

4.1 Risk Management

4.1.1 Identification of Risks

The implementation of a large scale infrastructure project involves many complex and diverse risks. The identification and allocation of those risks is critical in structuring the financing facility for such a project. The project finance which is the technology widely used by internationally established financial institutions for infrastructure projects thoroughly analyzes the risks associated and constructs appropriate measures for mitigation. Unlike the project financed under a commercial basis, the project formulated under the government sector relies upon the credibility of the government in arranging financing for implementation. For the project financed by ODA assistance, in particular, the project is implemented by the Executing Agency (Project Company) with support of the government who bears the eventual and ultimate risk for debt servicing while the provider of assistance remains keen on the debt servicing with the view to the achievement and continuation of successful operations and sustainability of the project. The concern of the provider of ODA assistance centers is the smooth implementation of the project, the efficient operation and materialization of the output, and the effect and impact is achieved as has been designed. The technology used for project finance in identifying and allocating the risks and establishing the safeguarding measures, however, remains valid and reflective in enabling the government and the Executing Agency to tightly control the project. In general, a large infrastructure project is conceived to be associated with the following materially significant risks;

- ✓ Political risk,
- ✓ Capability of the executing agency for implementation,
- ✓ Natural calamities, etc.,
- ✓ Occurrence of fatal accident,
- ✓ Project completion,
- ✓ Social and environmental risk,
- ✓ Economic and financial viability,
- ✓ Availability and stable supply of fuel,
- ✓ Related infrastructure such as the transmission lines, and
- ✓ Others

4.1.2 Analyses of Risks

The risks listed above are reviewed and the mitigation measures to be taken are described in the following table for each of the risks mentioned;

Table 4.1-1 Identification of Risks by Causes (prior to COD)

Risk Category	Sub-category	Profile of Risk	Risk Born by			Contract for Risk Covering	Mitigating Measures	Possible Impact from Non-Mitigated Risks
			GOVT/ BPDB	CPG CBL	SHARED			
Political risk	War or civil commotions, etc.	Suspension or destruction during the implementation phase.	X (GOB)					㉦Suspension, postponement of the project and/or destruction of the plant under construction.
	Seizure by government	Seizure of the Project resulting in disruption or deterioration of the efficiency	X (GOB)			㉦Implementation Agreement (IPP)		㉦same as above
	Foreign exchange control	Change in the exchange control	X (GOB)			㉦Implementation Agreement (IPP)		㉦same as above
	Law, policy or taxation change	Changes in Power Sector Policy, Coal Policy, taxation, etc.	X (GOB)			㉦Implementation Agreement (IPP)		㉦same as above
	Socio-economic instability	Riot, strikes, social unrest, etc.	X (GOB)			㉦Implementation Agreement (IPP)		㉦same as above
	Concession or operational right	Revocation of license or changes in the business rights	X (GOB)			㉦Implementation Agreement (IPP)		㉦same as above
Capability of sponsor risk	Managerial incapability	Unsophisticated management causing delay, over-run cost		X			㉦Recruitment of capable staff and employment of capable consultants	

Risk Category	Sub-category	Profile of Risk	Risk Born by			Contract for Risk Covering	Mitigating Measures	Possible Impact from Non-Mitigated Risks
			GOVT/ BPDB	CPG CBL	SHARED			
	Financial incapability	Failure to attain healthy financial conditions for, timely provision of paid-up capital and funding support for covering the cost over-run.		X			㋪Recruitment of capable staff	
Natural calamities, etc.	Cyclone				X	㋪Insurance	㋪Design standard (raising the ground level by 10m) and insurance	
	Tidal wave				X	㋪Insurance	㋪Design standard (raising the ground level by 10m) and insurance	
	Earthquake				X	㋪Insurance	㋪Design standard (aseismatic structure) and insurance	
	Tsunami				X	㋪Insurance	㋪Design standard (raising the ground level by 10m) and insurance	
	Others	Lightening, Storm, Tornado, Radioactive contamination, Fire, Epidemics, etc.			X	㋪Insurance	㋪Design standard (various), insurance and other appropriate measures.	
Occurrence of fatal accident	Occurrence of accident	Disruption and delay in construction due to accident investigation and introduction of countermeasures				㋪Insurance	㋪Continuous training for safety management and insurance coverage	

Risk Category	Sub-category	Profile of Risk	Risk Born by			Contract for Risk Covering	Mitigating Measures	Possible Impact from Non-Mitigated Risks
			GOVT/ BPDB	CPG CBL	SHAR ED			
Plant Completion (incl. access road, port and coal unloading facilities, etc.)	Insufficient capability of the consultants			X		ⒺConsulting Contract	ⒺTechnical assessment and screening through prequalification	
	Insufficient capability of the EPC contractor			X		ⒺConstruction Contract	ⒺTechnical assessment and screening through prequalification	
	Poor Performance or defaults of sub-contractors			X		ⒺConstruction contracts	ⒺPerformance management by prime contractors and supervision by consultant	
	Delay in Govt approvals in planning, development and operation		X (MPEMR)			ⒺShareholder's Agreement	ⒺEffective and timely management by CPGCBL for total project	
	Delay in progress and completion	Failure to complete the project as has been planned and designed. Along with the Project, related infrastructure required for the Project needs to be completed.		X		ⒺConstruction Contract	ⒺConstruction management by sponsor, consultant and EPC contractor	
	Increase in the cost of plant and material	Insufficiency of funds due to cost increase.		X		ⒺConstruction Contract	ⒺContingency	

Risk Category	Sub-category	Profile of Risk	Risk Born by			Contract for Risk Covering	Mitigating Measures	Possible Impact from Non-Mitigated Risks
			GOVT/ BPDB	CPG CBL	SHARED			
	Failure in procurement of the fuel for plant testing	Discontinuation or disruption of plant testing operation due to the shortage of fuel.		X		㋪Fuel Supply Contract (Coal, Gas & Oil) ㋪Government Guarantee for Supply of Gas (IPP)	㋪Mobilization of trading firms for procurement↖ to be funded by GOB or by JICA↗	
Social and environmental risk	Non-acceptance of the Project by the local government	Failure or delay in starting construction of the plant	X (MPEMR)			㋪Implementation Agreement (IPP)	㋪Consultation	
	Failure or delay in acquisition of the land	Failure or delay in starting construction of the plant	X (MPEMR)			㋪Land Lease Agreement	㋪Consultation	
	Failure in resettlement	Failure or delay in starting construction of the plant	X (MPEMR)			㋪Land Lease Agreement	㋪Consultation	
	Resistance by local inhabitants	Failure or delay in starting construction of the plant	X (MPEMR)				㋪Consultation	
	Failure or delay to obtain dredging permit	Failure or delay in starting construction of the plant	X (MPEMR)			㋪Implementation Agreement (IPP)		
	Congestion in surface transport	Delay in construction schedule	X (MPEMR)				㋪Construction of access road	
	Identification of the rare species (animals or plants)	Disruption or suspension of project implementation	X (MPEMR)				㋪Environmental Impact Assessment	

Risk Category	Sub-category	Profile of Risk	Risk Born by			Contract for Risk Covering	Mitigating Measures	Possible Impact from Non-Mitigated Risks
			GOVT/ BPDB	CPG CBL	SHAR ED			
	Contamination/ pollution to the site environment			X			㋪Compliance with environmental protection guidelines	
	Deficiency financing risk	Temporary deficiency in cash flow (delay in budget execution, etc.)		X		㋪Borrowing Facilities from Banks ㋪Shareholder's Support (Agreement)	㋪Financial assistance by GOB or BPDB	
	Budgeting and financing	Purchasing of fuel for plant testing and working capital required prior to COD		X		㋪Borrowing Facilities from Banks ㋪Shareholder's Support (Agreement)	㋪Preparation of budget and fund raising for budget implementation	
	Fluctuation of exchange rate	Unexpected cost increase in construction cost, etc. and insufficiency of funds due to exchange loss.		X		㋪Borrowing Facilities from Banks ㋪Shareholder's Support (Agreement)	㋪Contingency	
	Increase in inflation	Unexpected cost increase in construction cost, etc. and insufficiency of funds due to cost increase.		X			㋪Contingency	
	Insurance risk	Availability of specific coverage and/or fluctuation of insurance premium		X		㋪Insurance contract	㋪Consultation with insurance broker or company	
	Non-compliant bids	Delay in project implementation		X		㋪Invitation for Bidding, Conditions for Pre-qualification and Specifications	㋪Quality enhancement of cost estimation	

Risk Category	Sub-category	Profile of Risk	Risk Born by			Contract for Risk Covering	Mitigating Measures	Possible Impact from Non-Mitigated Risks
			GOVT/ BPDB	CPG CBL	SHARED			
Transmission lines	Failure in acquisition of the right of way	Delay in construction of the transmission lines	X (MPEMR)			㋪Implementation Agreement (IPP)	㋪Consultation	
	Delay in completion of the inter- linked transmission lines	Non-readiness for trial run	X (MPEMR, PGCB)			㋪Implementation Agreement (IPP)	㋪Formulation of the Project without relying on the other transmission lines	

(source) JICA Study Team

Similarly, the risks listed for the phase after the commissioning date are reviewed and the measures to be taken for mitigation are described in the following table for each of the risks mentioned;

Table 4.1-2 Identification of Risks by Causes (post COD)

Risk Category	Sub-category	Profile of Risk	Risk Born By			Contract for Risk Covering	Mitigating Measures	Possible Impact from Non-Mitigated Risks
			GOVT/ BPDB	CPG CBL	SHA RED			
Political risk	War or civil commotions, etc.	Suspension or destruction during the implementation phase.	X (GOB)			㋪Implementation Agreement (IPP) ㋪Power Purchase Agreement		㋪Suspension, postponement of the project and/or destruction of the plant under operation
	Seizure by government	Seizure of the Project resulting in disruption or deterioration of the efficiency	X (GOB)			㋪Implementation Agreement (IPP) ㋪Power Purchase Agreement		㋪same as above
	Foreign exchange control	Change in the exchange control	X (GOB)			㋪Implementation Agreement (IPP) ㋪Power Purchase Agreement		㋪same as above
	Law, policy or taxation change	Changes in Power Sector Policy, Coal Policy, taxation, etc.	X (GOB)			㋪Implementation Agreement (IPP) ㋪Power Purchase Agreement		㋪same as above
	Socio-economic instability	Riot, strikes, social unrest, etc.	X (GOB)			㋪Implementation Agreement (IPP) ㋪Power Purchase Agreement ㋪Insurance		㋪same as above
	Concession or operational right	Revocation of license or changes in the business rights	X (GOB)			㋪Implementation Agreement (IPP) ㋪Power Purchase Agreement		㋪same as above

Risk Category	Sub-category	Profile of Risk	Risk Born By			Contract for Risk Covering	Mitigating Measures	Possible Impact from Non-Mitigated Risks
			GOVT/ BPDB	CPG CBL	SHA RED			
Capability of sponsor risk	Managerial incapability	Unsophisticated management causing operational inefficiency		X			Recruitment of capable staff and Incentive system	
	Financial incapability	Failure to attain healthy financial conditions for, timely provision of working capital.		X				
	Operational and maintenance incapability	Increase in accidents, maintenance cost, and inefficiency in operation		X			Training system for operational staffs and incentive system	
	Incapability of the outsourced company	Failure to achieve the targeted level of performance under contract		X		ⓔOutsourcing Contract	Enhancement of training system and employment of foreign engineers	
Natural calamities, etc.	Cyclone	Continuous non-accessibility period for berthing by the coal carriers			X	ⓔInsurance	Design standard (coal storage for 60 days) and insurance	
	Tidal wave				X	ⓔInsurance	Design standard (raising the ground level by 10m) and insurance	
	Earthquake				X	ⓔInsurance	Design standard (a seismically strong structure) and insurance	
	Tsunami				X	ⓔInsurance	Design standard (raising the ground level by 10m) and insurance	

Risk Category	Sub-category	Profile of Risk	Risk Born By			Contract for Risk Covering	Mitigating Measures	Possible Impact from Non-Mitigated Risks
			GOVT/ BPDB	CPG CBL	SHA RED			
	Others	Lightening, Storm, Tornado, Radioactive contamination, Fire, Epidemics, etc.			X	㋪Insurance	Design standard (various), insurance and other appropriate measures.	
Occurrence of fatal accident	Occurrence of a major scale of accident	Long term disruption in plant operation		X		㋪Insurance	Preventing maintenance and insurance	
Plant Completion (incl. access road, port and coal unloading facilities, etc.)	Failure to achieve the designed capacity performance	Less revenue due to reduction of output		X		㋪Construction Contract	Extension of warranty period	
	Unexpected deterioration in operational performance	Increased consumption of fuel due to inefficiency or less revenue due to reduction of output		X		㋪Construction Contract	Periodical maintenance	
Social and environmental risk	Negative impact on fishery	Suspension in plant operation or reduction in operating ratio			X	㋪Insurance	Reconsideration on warm water discharge	
	Traffic congestion on surface transport				X		Construction of access road	
	Contamination/pollution to the site environment			X			㋪Compliance with environmental protection guidelines	
	Malfunctioning and/or deterioration of environmental devices	Suspension in plant operation or reduction in operating ratio		X		㋪Manufacturer's Warranty ㋪Insurance	Periodical maintenance and insurance	
Economic and financial viability risk	Sales and collection risk	Sales price in short of cost recovery and/or slow collection		X		㋪Power Purchase Agreement		

Risk Category	Sub-category	Profile of Risk	Risk Born By			Contract for Risk Covering	Mitigating Measures	Possible Impact from Non-Mitigated Risks
			GOVT/ BPDB	CPG CBL	SHA RED			
	Delay and/or insufficiency in tariff adjustment				X	㋪PPA	Good operational performance, close monitoring and adjustment of tariff	
	Deficiency financing risk	Unexpected shortfall of funds for expenditure and/or debt servicing		X		㋪Borrowing Facilities from Banks ㋪Escrow Account ㋪Shareholder’s Support (Agreement)	Parental funding support by BPDB	
	Budgeting and financing	Failure in financial management for O&M, in particular, the fund shortage for periodical maintenance		X		㋪Borrowing Facilities from Banks ㋪Shareholder’s Support (Agreement)	Incorporation of sufficient budget for periodical maintenance↗	
	Fluctuation of foreign exchange	Unexpected cost increase in fuel cost and O&M and insufficiency of funds due to exchange loss.		X		㋪Power Purchase Agreement ㋪Borrowing Facilities from Banks ㋪Shareholder’s Support (Agreement)		
	Insurance risk	Availability of specific coverage and/or fluctuation of insurance premium		X		㋪Insurance contract	㋪Consultation with insurance broker or company	

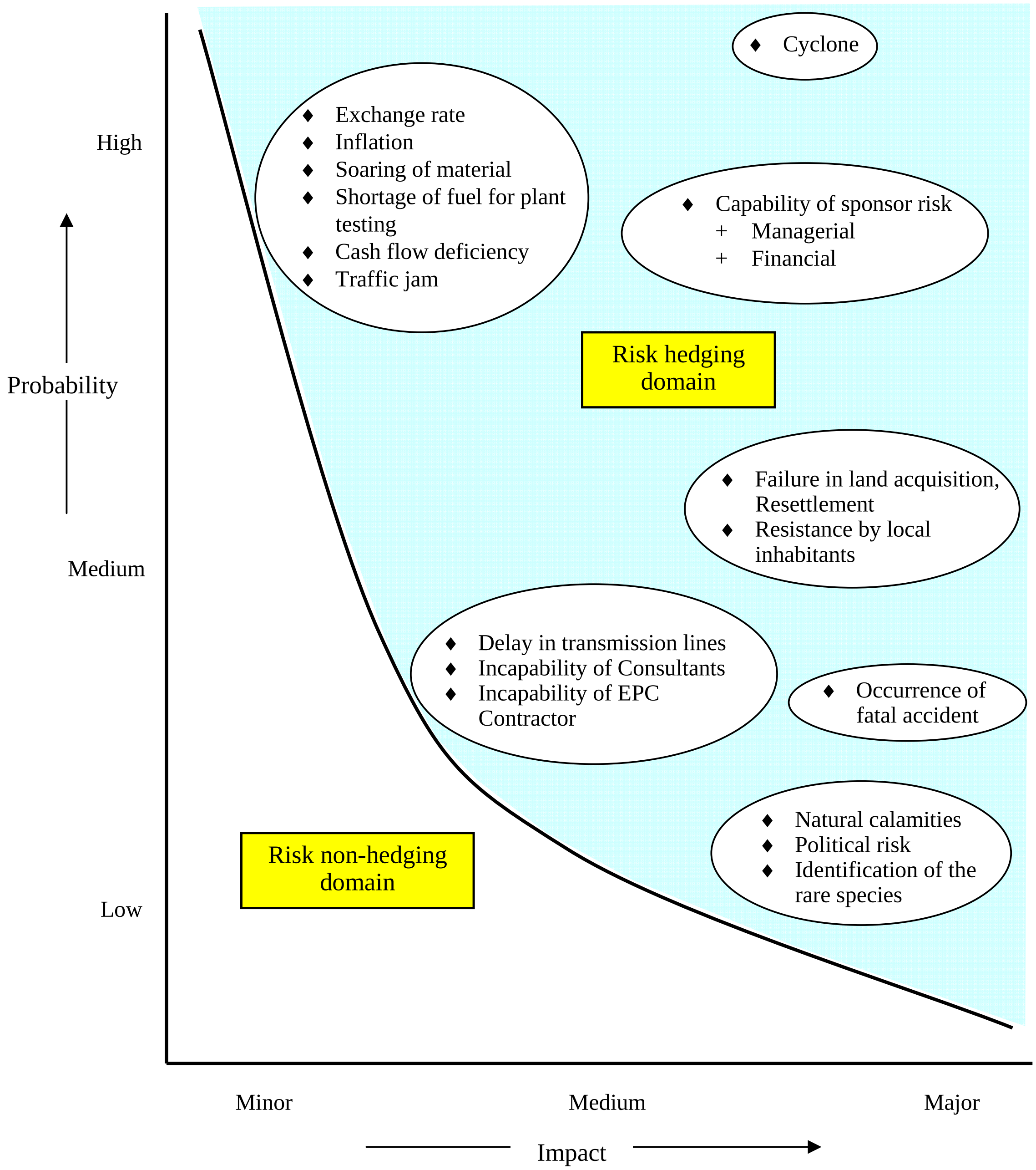
Risk Category	Sub-category	Profile of Risk	Risk Born By			Contract for Risk Covering	Mitigating Measures	Possible Impact from Non-Mitigated Risks
			GOVT/ BPDB	CPG CBL	SHA RED			
	Aggravation of inflation	Unexpected cost increase in fuel cost and O&M and insufficiency of funds due to cost increase.		X		㋪Power Purchase Agreement ㋪Borrowing Facilities from Banks ㋪Shareholder's Support (Agreement)		
Availability and stable supply risk of fuel	Non-availability of Fuel and other materials	Occurrence of shortfall in fuel coal and/or other materials		X		㋪Coal Supply Contract	㋪Diversification of supply sources ㋪Sufficient stocks maintained	
	Non-availability of coal-carrying vessel	Occurrence of shortfall in fuel coal		X		㋪Charter-hire contract	㋪Medium term charter contract of spot hire contract diversified ㋪Sufficient stocks maintained	
	Long term contract risk	Discontinuation or disruption of stable operation due to the shortage of fuel while Binding obligation for purchase for the contract term and/or take-or-pay obligation		X		㋪Coal Supply Contract	Diversification of contract terms	
	Volatile market price	Instability in the import cost of fuel resulting in the loss of economic/financial viability		X		㋪Power Purchase Agreement		

Risk Category	Sub-category	Profile of Risk	Risk Born By			Contract for Risk Covering	Mitigating Measures	Possible Impact from Non-Mitigated Risks
			GOVT/ BPDB	CPG CBL	SHA RED			
	Unbalanced qualities of fuel coal	Inharmonious quality for mixing		X		ⓒCoal Supply Contract	Construction of a reserve mills for coal of low calorific value	
	Non-availability of start-up fuel	Inability to start-up the plant		X		ⓒFuel Supply Contract ⓒGovernment Guarantee for Fuel (Gas or Oil) Supply (IPP)	Sufficient storage of fuel	
Transmission lines	Troubles at transmission lines	Inability to transmit the power causing the suspension of plant operation	X (PGCB)			ⓒPower Purchase Agreement ⓒImplementation Agreement (IPP)		
Others	Sluggish increase in power demand	No dispatch instruction to the plant	X (MPEMR)			ⓒPower Purchase Agreement ⓒImplementation Agreement (IPP)		
	Development of low cost gas field and/or procurement of LNG (provision of lower price gas)	Dispatch instruction to the coal fired plant becomes subordinate to other fuel and the coal fired plant to be operated as the middle-load system	X (MPEMR)			ⓒPower Purchase Agreement ⓒImplementation Agreement (IPP)		

(source) JICA Study Team

It should be noted that in the two tables given above, it shows that the risk categories as well as the sub-categories appear similar in many of the risk items but the profiles are described distinctively different as the risks surrounding the Project may appear in a different manner between the two phases of the Project.

The risks are then analyzed in terms of their probability of occurrence and the impacts associated. In order to distinguish the risks that should be safeguarded or mitigated from the ones that should be left unattended, an attempt is herein made to draw a curve and plot each of the risks in a figure above or below the mitigation curve. The mitigation curve distinguishes the sphere for mitigation from the one for non-mitigation. For the risks plotted above the mitigation curve, appropriate measures for mitigation should be deliberated and introduced as their products of the probability multiplied by the impact becomes substantial. Meanwhile, the risks below the mitigation curve will be left without mitigation as the products of the probability multiplied by the impact will be less substantial. The following figure is one that describes the analysis for the phase prior to the commissioning date;



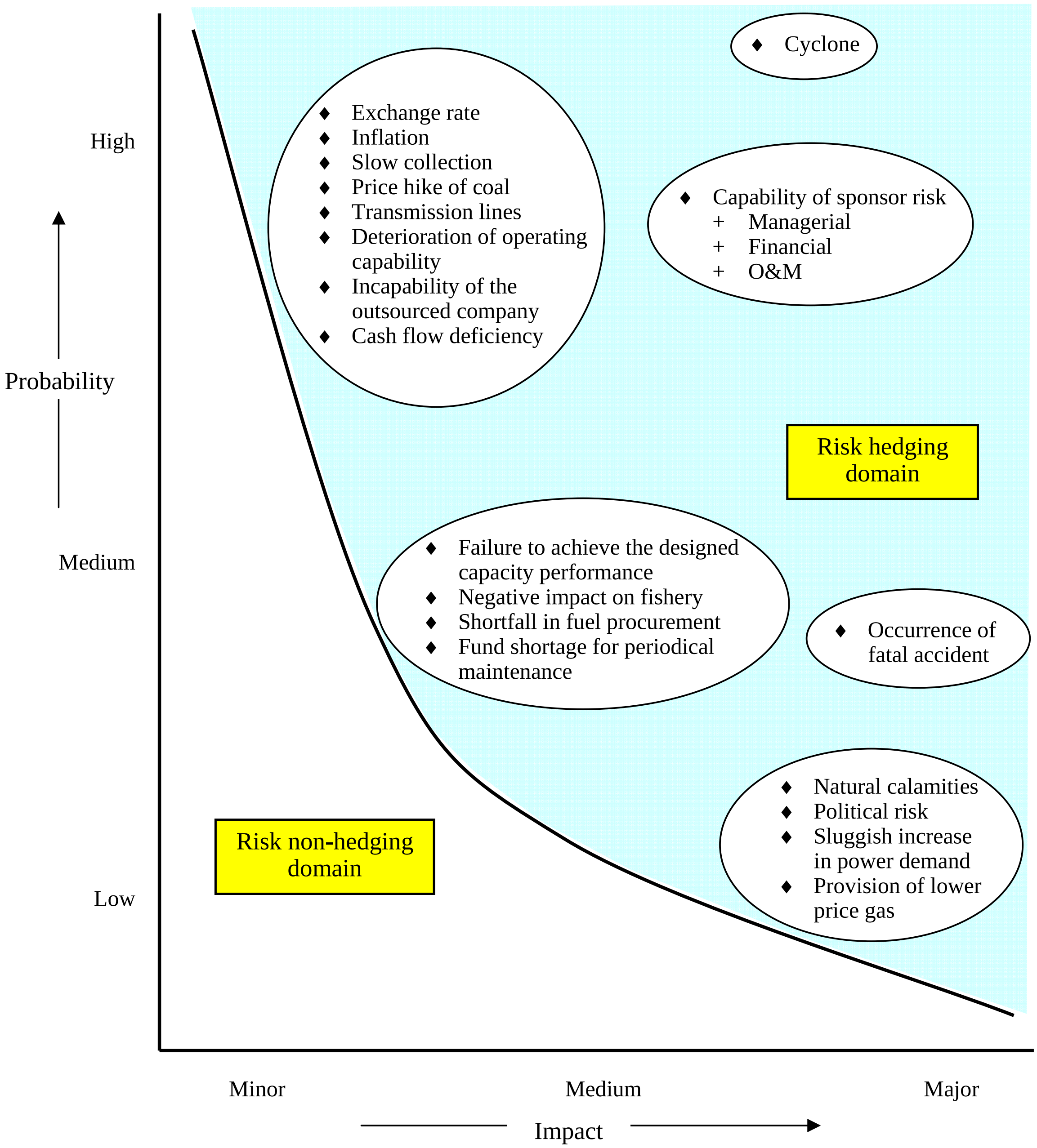
Probability
High: 1 time per 3 years or less
Medium: 1 time per 5 to 10 years
Low: 1 time per 20 years or longer

Impact
Minor: several months of delay in construction or about 10% increase in construction cost
Medium: approximately 2 years of delay in construction or about 50% increase in construction cost
Major: cancellation of the Project or more than 100% increase of construction cost

(Source) JICA Study Team

Figure 4.1-1 Identification of Risks by Causes (prior to COD)

Similarly, the following figure depicts the risks analyzed for the period after the commissioning date;



Probability
High: 1 time per 3 years or less
Medium: 1 time per 5 to 10 years
Low: 1 time per 20 years or longer

Impact
Minor: about 10% of annual turnover
Medium: about 50% of annual turnover
Major: exceeding 100% of annual turnover

(Source) JICA Study Team

Figure 4.1-2 Identification of Risks by Causes (post COD)

4.1.3 Contractual Safeguards and Prevailing Practices in Bangladesh

In Bangladesh, actual cases of project finance and contractual agreements thereof are observed in the formations of IPPs. A typical case of the security package of IPP financing is comprised of the following contracts[1];

a) Implementation Agreement,
b) Power Purchase Agreement,
c) Gas Supply Agreement,
d) Oil Supply Agreement,
e) O&M Agreement,
f) Construction Contract,
g) Shareholders' Agreement, if any,
h) Financing Documents,
i) Escrow Agent,
j) Insurance Policies,
k) Guarantee,
l) Land Lease Agreement,
m) Consents to and acknowledgements of assignments and direct agreements in favor of Lenders in respect of the documents assigned as security to the Lenders under the Financing Documents.

For the public sector project, similar agreements are brought in and practiced among the parties concerned with the exception of; implementation agreement, shareholders' agreement, escrow agent, a part of the guarantee package, and assigning of documents. Following table lists up important contracts normally signed for power development projects to be implemented by the public sector and by the private sector together with some of their relevant specifics;

[1] Power Cell, MPEMR, "Sirajganj Power Project", (website) as of June 12, 2012

Table 4.1-3 List of Important Contracts to be Involved for Power Development Projects

Name of Contract	Parties to the Contract	Content	Time Limit for Signing		Particulars (Reason of Difference between Public & IPP Projects)
			Public Sector Projects	IPP Projects	
Implementation Agreement	Government – IPP	The government commits its involvement and commitment to IPP for development and generation of electricity for delivery to national grid.	Not customarily practiced	Project Effective Date (PED) *1	To enable Lenders assess the financial viability and security package so that the Lenders can make commitment for extending long term loan based on the financial structure and the security package
Land Lease Agreement	Land Owner – Executing Agency (E/A)	Lease of land by land owner (BPDB) to E/A for the location of the Facility	Sufficiently prior to Construction Start	PED	
Power Purchase Agreement	E/A – BPDB	Off-take agreement between the single buyer, BPDB, and the generation company, E/A for the sale of the electricity generated	Sufficiently prior to Commercial Operations Date (COD)	PED	
Gas Supply Agreement	E/A - Gas Supplier	Agreement between the Gas Supplier and E/A for the Supply of Gas for generation of power	Plant Testing Date	PED	
Coal Supply Agreement	E/A - Coal Supplier	Agreement between the Coal Supplier and E/A for the Supply of Gas for generation of power	Sufficiently prior to Plant Testing	PED	
Oil Supply Agreement	E/A - Oil Supplier	Agreement between the Oil Supplier and	Sufficiently prior	PED	

		E/A for the Supply of Gas for generation of power	to Plant Testing		
Consulting Service Contract	E/A - Consultant	Agreement between the consultant and E/A for the advisory and assistances for E/A's work in designing, engineering, procurement, construction, completion, start-up, testing and commissioning of the Facility	Upon Execution of Loan Agreement		IPP is not mandated to employ the consultant.
Construction Contract	E/A - Contractor	Agreement between the construction contractor and E/A for the design, engineering, procurement, construction, completion, start-up, testing and commissioning of the Facility	Upon Execution of Loan Agreement	Construction Start Date	IPP retains option for signing of the construction contract so long as it meets the key milestone dates established up till the eventual COD
O&M Service Agreement	E/A – O&M Service Provider	Agreement between E/A and O&M contractor for assisting E/A in the operation and maintenance activities	COD	Upon execution but not later than 120 days prior to COD	
Shareholder's Agreement	Shareholder – E/A	Agreement between the shareholder and E/A for assisting E/A with provision of equity capital, subordinated capital, if and when required	Not customarily practiced	PED	To enable Lenders assess the financial viability and security package so that the Lenders can make commitment for extending non-recourse long term loan based on
Share Purchase Agreement	BPDB - IPP	Agreement between BPDB and IPP committing BPDB and/or IPP to make equity investment		PED	

					the financial structure and the security package
Budget Financing Agreement	Government – E/A	Agreement between the government and E/A for provision of equity and loan from the national budget	Not customarily practiced		
Loan Agreement (for Donor Lending)	Government - Donor	Agreement between the donor and the government for provision of financial assistance for long term	Upon appraisal of the Donor and approval of ECNEC		
Subsidiary Loan Agreement	Government – E/A	Agreement between the government and E/A for on-lending the donor loan received by the government	Upon appraisal of the Donor and approval of ECNEC		
Loan Agreement (for IPP)	E/A – Lender Institutions	Agreement between the lender institutions and E/A for provision of long term loans		Financial Closing Date (FCD) *2	Lenders sign and commit extension of non-recourse long term loan based on the financial structure and the security package.
Escrow Agreement (for IPP)	E/A – Lender Institutions	Agreement between E/A and the lender institutions to establish an account under control of escrow agent for pooling funds for debt servicing		FCD	
Government Guarantee	Government - IPP	Guarantee to be issued by the government for the payment obligations of; BPDB under PPA; the Gas Supplier under Gas Supply Agreement; BPDB under the Land	Not customarily practiced	FCD	

		Lease Agreement; BPDB under Share Purchase Agreement; PGCB for wheeling responsibility under Implementation Agreement			
Assignment of Securities	E/A – Lender Institutions	Agreement between E/A and the lender institutions for assigning to the lenders the security packages of; Implementation Agreement, PPA, Gas Supply Agreement; Oil Supply Agreement; O&M Agreement; Construction Contract; Consulting Contract; Shareholder's Agreement; Budget Financing Agreement; Escrow Agreement; Insurance Policies; Guarantee; Land Lease Agreement; and Consents to the assignment in favor of the lenders in respect of documents assigned as security to the lenders.	Not customarily practiced	FCD	Lenders sign and commit extension of non-recourse long term loan based on the financial structure and the security package.
Letters of Credit	E/A's Bank - Supplier		Prior to Shipment of Supplies	Prior to Shipment of	

				Supplies	
Insurance Policies	Insurance Company – E/A		Construction Start Date for Construction Insurance and COD for Operations Insurance	Construction Start Date for Construction Insurance and COD for Operations Insurance	

(note) *1: Project Effective Date is defined as the date on which the last of the Project Agreements, i.e. the Implementation Agreement, the Land Lease Agreement, the Fuel Supply Agreement, the Power Purchase Agreement and the Share Purchase Agreement, is executed and delivered by each of the parties thereto.

*2 Financial Closing Date is defined as the date on which the Financial Closing occurs. Financial Closing is achieved through the execution of the Financial Documents, i.e. the Loan Agreement, Notes, Indentures, the Security Agreement, Guarantees, and other documents relating to the construction and permanent financing of the Facility between the company and the Lenders.

(Source: JICA Study Team)

By and large in the power sector development projects, the types of contracts involved can be classified into two; one is the project documents and the other is financing documents. The former includes the Implementation Agreement, the Land Lease Agreement, the Fuel Supply Agreement, the Power Purchase Agreement and the Share Purchase Agreement and are to be signed among the Government, the Sponsor, the Sponsor's Parent Companies, the Fuel Suppliers, the Off-taker, etc. The latter includes the Loan Agreement, Notes, Indentures, the Security Agreement, Guarantees, and other documents relating to the construction and permanent financing of the Facility and are to be signed by the Sponsor and the Lenders. It is customary that for the IPP projects the signing of the projects agreement precedes the signing of the financing documents with the time interval of approximately nine months. The time interval is introduced so that the potential lenders can conduct due diligence of their own based on the financial structure established by the project agreements and assess the financial viability of the project for extending the non-recourse long term loan. For the public sector project on the other hand, There is no such distinctive time gap between the type of documents and rather it tends to that the agreements are signed at the last minutes before their implementation.

The contents, terms, and conditions contracted in those agreements, however, are not significantly different between the public sector project and the private sector one. But what is recognized is that there is a marked difference in the ways those agreements are enforced. In the private sector, those agreements contracted are rigidly observed and complied with during execution whereas the ones in the public sector are less rigidly observed and complied with. Signing agreements and commitment to the agreements must be followed by strict enforcement and due compliance by the parties concerned.

The important agreements have been drafted and are attached into the Appendix.

4.1.4 Power Purchase Agreement (PPA)

BPDB is to purchase all the generated electricity from BPDB's subsidiaries and the IPPs. The Power Purchase Agreement (PPA) is made between BPDB and BPDB's subsidiaries and IPPs to determine the purchase price. The IPP Cell of BPDB is responsible for PPA matters not only with private IPP but also with BPDB's subsidiaries. Payment for electricity is paid based on the PPA from BPDB to BPDB's subsidiaries and IPPs. Therefore, PPA is of considerable significance for the BPDB's subsidiaries and IPPs' management system.

A key position of a typical PPA between BPDB and BPDB's subsidiaries and IPP's is shown below;

(1) Payment conditions

- Payment consists of two portions, Capacity payment and Energy payment
- BPDB's subsidiary-IPP sends the bill for the previous month to BPDB by the 7th of every month, and BPDB pays the charge within 30 or 45 days after receiving the bill.

(2) Capacity payment

- Capacity payment is determined by dependable capacity.
- Dependable capacity is determined based on the dependable capacity test, which is carried out within one month after annual periodical maintenance. However, when the results of the dependable test are different from the actual value, the company has the right to claim a re-test.
- Dependable Capacity Test measures 12 Net Energy Output continuously every 30 minutes in a power transmission end (delivery point). Dependable capacity is taken as the average value.
- Capacity payment consists of 2 parts, namely escalable part and non-escalable part. For the escalable part, the predetermined escalation rate (consumer price index) is to be taken into account.

(3) Energy payment

- Energy payment is proportional to the generated electric energy (Net Energy Output).
- When the gas price fluctuates, the unit price of energy payment also changes according to the amount of such changes.

(4) The penalty for outage in operation

- As stopped operations, forced outages, maintenance outages, and scheduled outages are specified.
- In the sum total of the three outages specified above, the annual total of 876 hours (36.5 days) is allowed. In addition, every 3 years an annual total of 1376 hours (57.3 days) or 1440 hours (60 days) is permitted.
- When the number of outage hours exceeds the permitted period, BPDB's subsidiary-IPP needs to pay a penalty according to the number of hours which exceeded the allowable hours. The unit price of a penalty is the same as those of the capacity payment.

(5) Risks related to PPA

- Procurement of coal would be the possible major risk for CPGCBL. Different from the PPAs for the existing BPDB Subsidiaries, whose power plants are fueled by domestic gas procured by BPDB, CPGCBL might not be able to receive an even capacity charge in case the company fails to generate enough power for the agreed dependable capacity level due to a shortage of imported coal. Although the current draft PPA with private IPPs whose power plant will be also fueled by imported coal does not mention the payment conditions of the capacity charge in case of a fuel shortage, it might add the conditions because the power generation companies will be solely responsible for the procurement of imported coal.

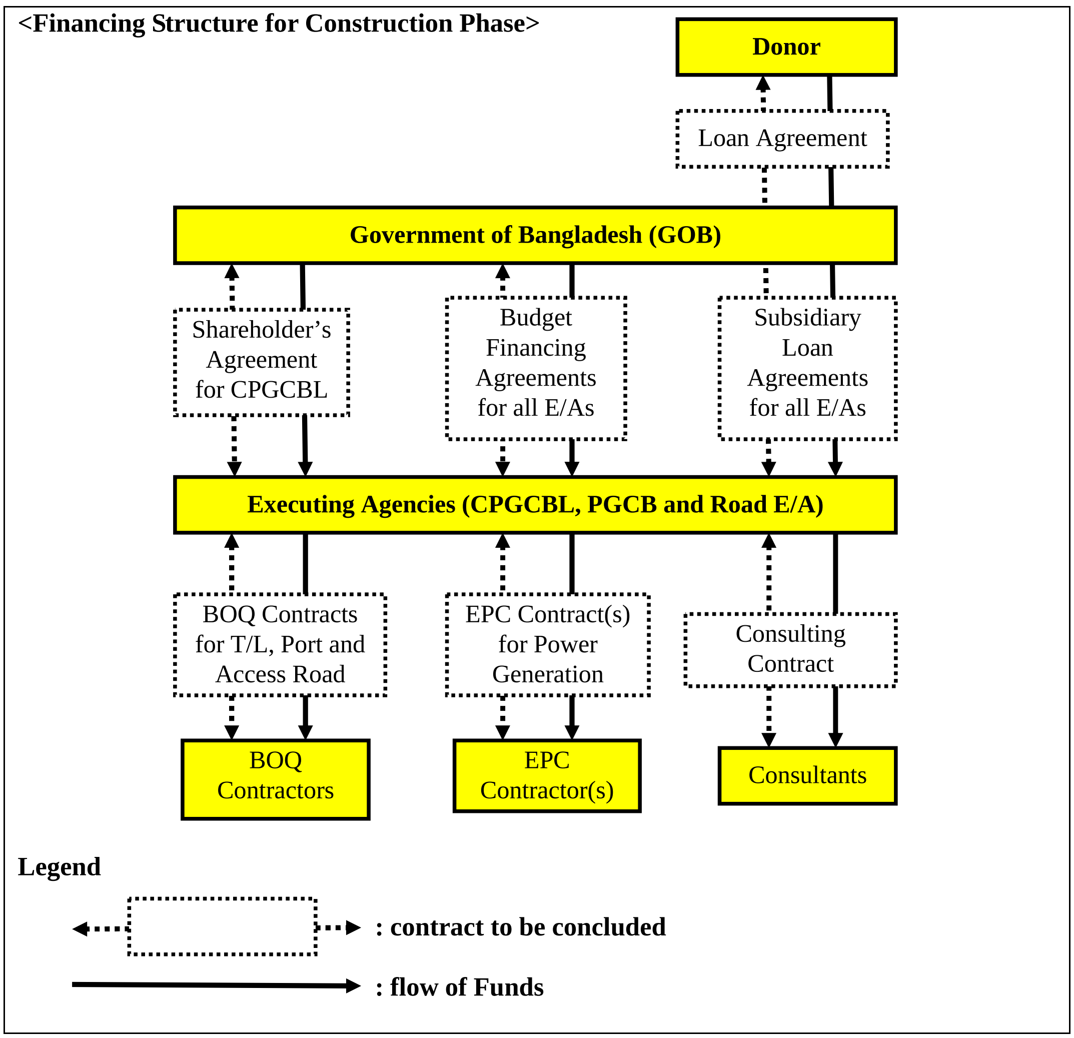
- Besides the above, there seem to be no significant financial risks related to PPA for CPGCBL because, like other BPDB subsidiaries, the company may be able to expect financial assistance from BPDB finally.

(6) Measures for protection from fluctuation risks

- In the PPA, BPDB's subsidiaries and IPPs are exempted from risks related to currency exchange fluctuation, inflation, and fuel expense fluctuation.

4.1.5 Measures for Minimization of Risks

The financing structure places the major parties to be involved in the Project and the contractual relationship to be established. The following two figures illustrates the contractual agreements and the flow of funds among the parties concerned with the project during the phases of construction and commercial operation separately, the first being the financial structure during the construction phase where the funds raised by the executing agency through the equity and loans provided by the government and the donor are dispended for the construction of the project as the payments under the EPC contract as well as the consulting contract ;



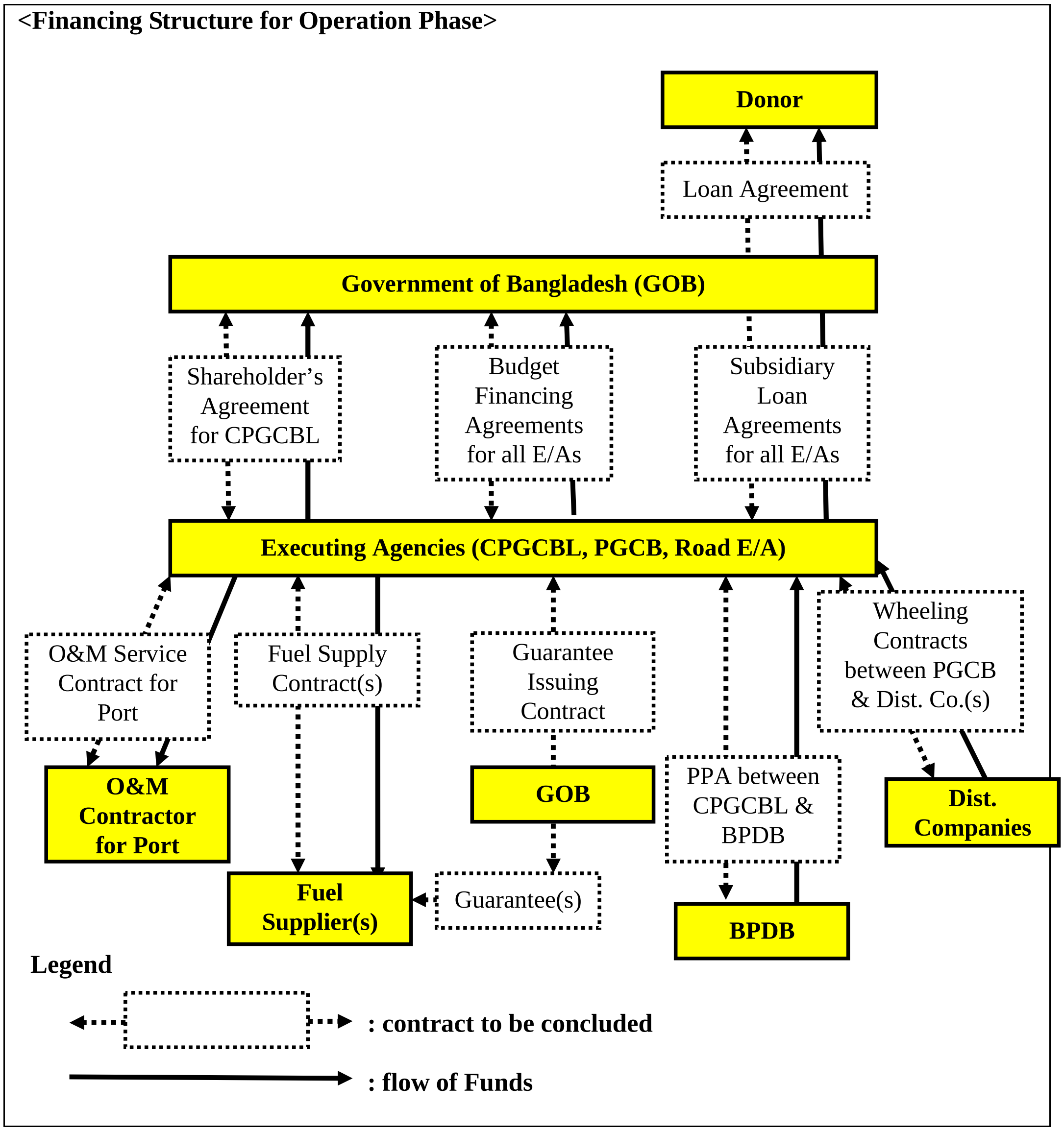
(source) JICA Study Team

Figure 4.1-3 Financing Structure during Construction Phase of ODA Funded Project

The financing method as well as the terms and conditions of the ODA funded projects have been described in 12.4.3 (2) above. In essence, the standard terms of conditions by which the government provides lending its own finance and relending foreign loans to BPDB including its subsidiaries are; (i) the foreign loans received is relent 100%, (ii) for the government provides the rest of the funds required of which 60% in equity and 40% in loans, (iii) repayment term: 20 years including a 5-year grace period. By relending the foreign loans, the government is transferring the responsibility of repaying the foreign loans to the Executing Agency together with the foreign exchange risk, although the ultimate responsibility for repayment and debt servicing is assumed by the government.

With respect to the budget financing agreement between the government and CPGCBL, the prevailing practice is that no specific agreement is signed between the government and the power entities for provision of budget funds. It deems to be imperative that the government and the generating company should have a clear document stipulating the terms and conditions of the funds provided as well as the obligation and responsibility to be obeyed for such funding. The budget financing agreement can be replaced by separate agreements can be signed for equity investment and for government lending between the both parties.

What follows next is the financial structure during the commercial operation phase in which the executing agency produces and sells the electricity to BPDB as the single buyer from whom the executing agency collects payment for the sale and then to pay for the import of fuel and other expenses while making land lease payments; principal and interest on loans borrowed.



(source) JICA Study Team

Figure 4.1-4 Financing Structure during Commercial Operation of ODA Funded Project

In respect of the major risks stipulated earlier and the financing structure constructed, there remains some vulnerability to be addressed for reinforcement and mitigation. The vulnerability is admitted within the realm of the following risk categories and it is hereby recommended that strong and effective measures be taken to safeguard and minimize the risks;

(1) Capability of the Executing Agency for implementation

The Executing Agency of the Project is designated to be the CPGCBL who has been established of very late in September, 2011 under the Company Act 1994. All of the company's capital comes from the government. BPDB has been authorized by the government to hold shares in the company. The company appointed two top positions of Managing Director and Company Secretary from the incumbent staff of BPDB on a deputation basis. Aside from those positions, no one else has been appointed nor hired for the company. On the other hand, BPDB has been working through a unit established for the development of three coal based mega power projects[2] in different locations of the country which includes the Project. The company remains a nominal vehicle with no full time personnel. Any of the preparatory work has to rely on BPDB's unit for the mega projects. The preparation of the Project includes a feasibility study for which the project owner has to actively engage, acquire and accumulate the complete knowledge and full ownership of the Project. It is of vital importance that the company is reinforced with an appropriate organizational set-up including the structuring of the board, human resource policies and mobilization entailing the employment of skilled staff and financial resources to make itself a full-fledged institution for carrying out the Project's preparation, execution and implementation. At an early stage of project implementation and commercial operation, the company may take advantage of the assistance to be provided by international consultants and/or experts. In addition, there must be a firm commitment by BPDB to provide CPGCBL with sufficient financing support including a capital injection.

(2) Availability and stable supply of fuel/raw materials

The supply of fuel is of vital importance to the stable and continuous operation of the power generation plant. A certain volume of coal meeting a prescribed quality standard has to be fed into the Project continuously. There should be no break of time in the feeding of coal to the generation plant. It is desired that the coal fuel becomes available to the Project on a long term contract basis. Project finance normally requires the conclusion of a long term supply contract of fuel to minimize the risk of operational disruption due to the deficiency of fuel. The Project is confronted with the same risk of the non-availability or instable supply of fuel. Should it happen that the supply of fuel coal shall be arranged with the mixture of multiple contracts in the shorter and/or

[2] The three projects are; 1,320 MW Coal Based Thermal Power Plant each at Khulna, Chittagong and 5,320 MW Coal Based Thermal Power Plant at Maheshkhali. (CEGIS, "Consulting Services on Coal Sourcing, Transportation and Handling of 2X660 MW Coal Based Thermal Power Plants Each at Chittagong and Khulna, and 8,320 MW LNG and Coal Based at Maheshkhali", June 2012)

medium term, it is imperative to make sure that the mixture of those contracts enables the Project to utilize fuel continuously without a break with the exception being the period of time when the plant is shut down while clearing the quality standard designed for the plant. The Project may find it difficult to enter into a long term contract with the suppliers minus a government guarantee to follow through with a buying obligation. The government is urged to provide support by issuing the guarantee for such purchase contracts if required.

(3) Project completion

The completion of the Project requires not only the physical completion of the plant but also the achievement of the designed capacity and efficiency of operation. In addition, the large infrastructure project also requires the completion of related infrastructures such as the port, access road and transmission lines, etc. A delay in the construction of any part of the plant and related infrastructure results in the inability or inefficient operation of the Project. The causes for the failure or delay in completion can vary. The Executing Agency, CPGCBL, together with its parent, BPDB and the government (collectively "Sponsor") have to ensure that the whole of the Project including the related infrastructure is completed within the planned schedule and budget. The measures introduced by the project finance to safeguard the project completion include; (i) selection and employment of the EPC contractor with a good track record and adequate capability; (ii) monitoring of the implementation of EPC contract through monthly reporting and inspection, (iii) giving proper consideration and providing measures for social and environmental protection with appropriate assistance from the consultants and/or by NGOs; (iv) construction supervision through the consultant, (v) commitment and provision of the additional finances by the Sponsor for cost over-run, (vi) commitment to a financial agreement that establishes certain financial ratios to be achieved immediately prior to the completion.

(4) Stable operations

The Executing Agency has little experience in operating the coal-based power generation plant of advanced technology. The operation and maintenance of the Project requires assistance to be provided under the O&M service contract with experienced contractor(s). The project finance may even adopt the outsourcing of the management of the plant under the management contract or the introduction of a technical assistance agreement with the Sponsor or the third party. The sponsor may reasonably consider outsourcing of O&M to an experienced contractor under a service contract. Needless to say, a sufficient budget is secured for O&M irrespective of the adoption of the outsourcing or not.

(5) Sales and collection risk

The project finance relies solely upon the revenue from the sales proceeds of the Project for repayment of the loans provided. The disruption of cash flow due to unstable sales endangers the debt servicing by the borrower. The financers require the Project to secure the stable and long term contract for sale of the products. The conclusion of the PPA covering the entire project period is a must requirement for the commercial project financing. Even if the sales contract covers the long term, there remains the risk of a price fluctuation. The project can be protected from the risk of price fluctuation by making sure that PPA accommodates the payment in full reflection of both the inflation and fluctuation in the exchange rate. For additional protection, the risk of collection and price fluctuation can be minimized through the opening of an escrow account to which any excess portion of funds derived when the sales proceeds exceeding the operational expense and debt servicing is credited and pooled for future debt servicing purpose. Alternatively, the Sponsor commits paying the deficiency amount to the Executing Agency when the sales proceeds are short of covering the operational expenses and debt servicing. Such a case of deficiency payments can be resorted to when the government commits to paying a subsidy to bridge the gap in electricity prices.

Annexure 5

Land Acquisition and Resettlement Action Plan

Annex 5

Land Acquisition and Resettlement Action Plan

-: Table of Contents:-

People’s Republic of Bangladesh
Ministry of Power, Energy and Mineral Resources

Land Acquisition and Resettlement Action Plan (Draft)

Chittagong Area Coal Fired Power Plant Development Project

(for Power Plant, Port Facility and Transmission Line)

May 2013

Japan International Cooperation Agency (JICA)
Tokyo Electric Power Services Co., LTD
Tokyo Electric Power Co., LTD

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Abbreviations

AG	Additional Grant
BFD	Forest Department
CPGCBL	Coal Power Generation Company of Bangladesh Limited
CUL	Compensation under the Law
DAM	Department of Agricultural Marketing
DC	Deputy Commissioner
DOE	Department of Environment
DOF	Department of Fisheries
EP	Eligible Person
GOB	Government of Bangladesh
GRC	Grievance Redress Committee
HH	Household
IOL	Inventory of Losses
JICA	Japan International Cooperation Agency
LA	Land Acquisition
LAO	Land Acquisition Officer
LGED	Local Government Engineering Department
MOPEMR	Ministry of Power, Energy and Mineral Resources
NGO	Non-Governmental Organization
PAPs	Project Affected Persons
PGCB	Power Grid Company of Bangladesh Limited
PWD	Public Works Department
RB	Resettlement Benefit
RHD	Roads and Highways Department, Ministry of Communications
RP	Resettlement Plan
RPF	Resettlement Policy Framework
RV	Resettlement Value

Definitions

Resettlement Plan (RP) or **Resettlement Action Plan (RAP)**: A resettlement plan (or resettlement action plan) is the planning document that describes what will be done to address the direct social and economic impacts associated with the involuntary taking of land.

Project Affected Person (PAP): Any person (household) that loses their home, land, or business interests because of land acquisition.

Compensation: A payment in kind, cash or other assets given in exchange for the taking of land, or loss of other assets, including fixed assets thereon, in part or whole.

Cut-off Date: This is the date on and beyond which any persons who encroach on the area are not entitled to compensation or any other form of resettlement assistance. It is often established on the commencement date or last date of the census of PAPs.

Eligibility: The criteria for qualification to receive benefits under a resettlement program.

Resettlement Entitlements: Resettlement entitlements with respect to a particular eligibility category are the sum total of compensation and other forms of assistance provided to displaced persons in the respective eligibility category.

Replacement Cost: In determining the replacement cost, depreciation of the asset and the value of salvage materials are not taken into account, nor is the value of benefits to be derived from the project deducted from the valuation of an affected asset.
For agricultural land, it is the pre-project or pre-displacement, whichever is higher, market value of land of equal productive potential or use located in the vicinity of the affected land, plus the cost of preparing the land to levels similar to those of the affected land, plus the cost of any registration and transfer taxes.
For land in urban areas, it is the pre-displacement market value of land of equal size and use, with similar or improved public infrastructure facilities and services and located in the vicinity of the affected land, plus the cost of any registration and transfer taxes.
For houses and other structures, it is the market cost of the materials to build a replacement structure with an area and quality similar to or better than those of the affected structure, or to repair a partially affected structure, plus the cost of transporting building materials to the construction site, plus the cost of any labor and contractors' fees, plus the cost of any registration and transfer taxes.

Grievance Procedures: The processes established under law, local regulations, or administrative decision to enable property owners and other displaced persons to redress issues related to acquisition, compensation, or other aspects of resettlement.

Population Census: A complete and accurate count of the population that will be affected by land acquisition and related impacts. When properly conducted, the population census provides the basic information necessary for determining eligibility for compensation.

Asset Inventory: A complete count and description of all property that will be acquired.

Household Survey: A complete and accurate survey of the project-affected population. The survey focuses on income-earning activities and other socioeconomic indicators.

Socioeconomic Survey: The population census, asset inventory, and household survey together constitute the socioeconomic survey of the affected population.

Note: Definitions are taken from the JICA Guidelines for Environmental and Social Consideration, or subsequently from the World Bank OP4.12 and glossary of *the Involuntary Resettlement Sourcebook, Planning and Implementation in Development Projects* (2004).

Chapter 1 Rationale

1.1 Objectives

Out of the project components of Chittagong Area Coal Fired Power Plant Development Project, this Land Acquisition and Resettlement Action Plan (LARAP) is being prepared for a large-scale land acquisition and resettlement under the construction of power plant and port facility in Matarbari island of Maheshkhali Upazila in Cox's Bazar District, and extension of transmission line from Maheshkhali Upazila to Anowara Upazila of Chittagong District.

The LARAP is based on the principle of *the JICA Guidelines for Environmental and Social Considerations* that development projects must serve the needs of the society and ensure that PAPs are not made worse off by the proposed intervention. It aims to clarifying resettlement principles, organizational arrangements, and design criteria to be applied to the Project. It also addresses and fills the gap between the existing legislations of Bangladesh and the JICA Guidelines. In response to the above principle, involuntary resettlement should be an important consideration in project identification. Three important elements of involuntary resettlement are: 1) compensation for loss of assets, loss of income sources and livelihood means; 2) assistance for relocation including provision of relocation sites with appropriate facilities and services, and; 3) assistance for rehabilitation to achieve at least the same level of well-being.

The LARAP will be translated into Bengalese and disclosed for the reference of PAPs as well as other interested groups.

1.2 Project Description

The proposed Chittagong Area Coal Fired Power Plant Development Project is an initiative to cope with a rapid increase in power demand in Bangladesh and supply power in a stable manner through the construction of a coal-fired power plant (2 x 600MW) in Chittagong Division in the southeast of Bangladesh.

1.2.1 Project Components

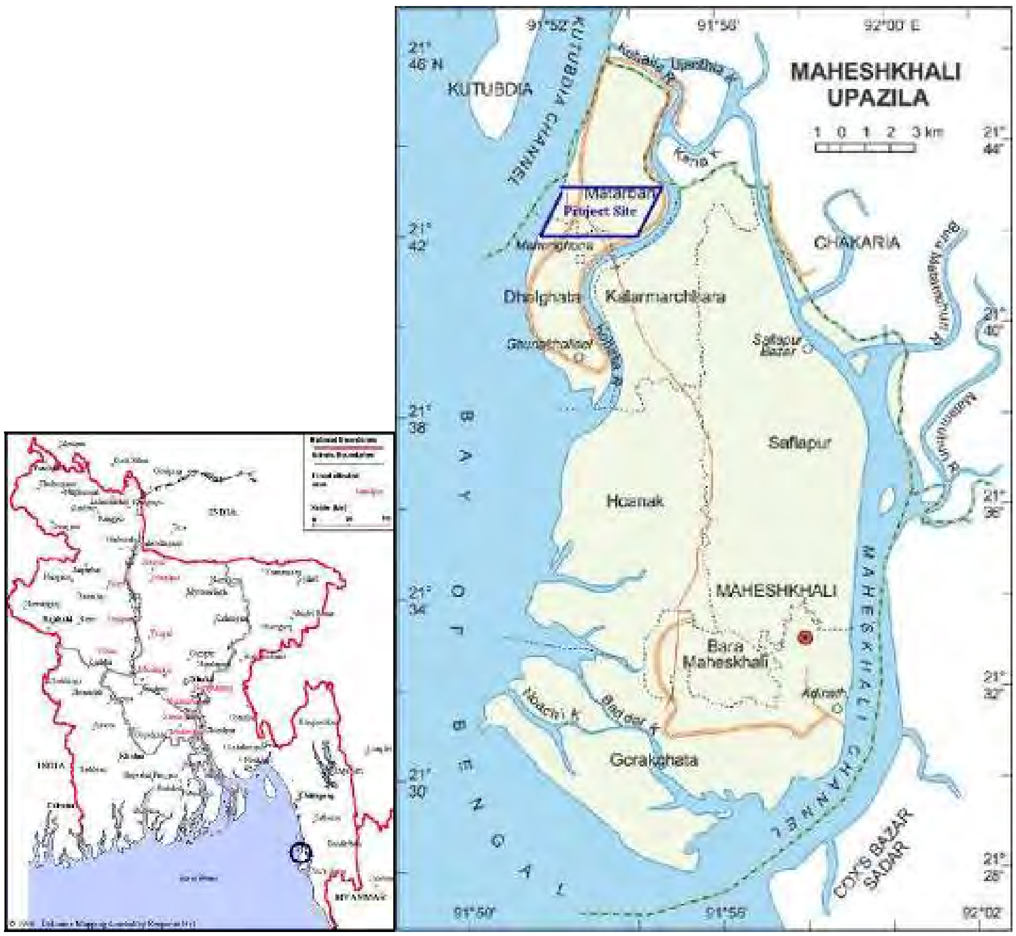
To achieve the above objectives, the project components will be as follows:

- construction of a coal-fired power plant (2 x 600MW) with ultra super critical technology (Cox's Bazar District)
- construction of an excavated port including a fuel berth and a fuel transportation facility to the power plant (Cox's Bazar District)
- construction of an access road (Cox's Bazar District)
- extension of a 400kV transmission line between Matarbari and Anowara (Cox's Bazar District and Chittagong District)

1.2.2 Location of the proposed site

(1) Power plant and Port facility

The proposed coal-fired power plant (CPCG Matarbari Coal-Fired Power Plant, 2 x 600MW) is located in Matarbari Union and Dhalghata Union in Maheshkhali Upazila in Cox's Bazar District, Chittagong Division (Figure 1-1).



Source: http://www.in2bangla.com/upazilaMap.php?id=293 (accessed in March 2013)
Note: The location is 21 42'15" N, 91 53'16" E

Figure 1-1 Location of the Power Plant

(2) Transmission line

The power plant will be connected to the substation facility in Anowara power plant, which will be constructed in the south of Chittagong, with a 400kV transmission line of approximately 60km. The transmission line will take a route along the local road (R-170) as shown in Figure 1-2. As land for construction of the transmission towers are subject to compensation, the final route will be determined so as to avoid any residential areas, taking into account the firmness of the land foundation.

(Source: JICA Study Team)

Figure 1-2 Route of the proposed transmission line

Table 1-1 Area covered by the proposed transmission line

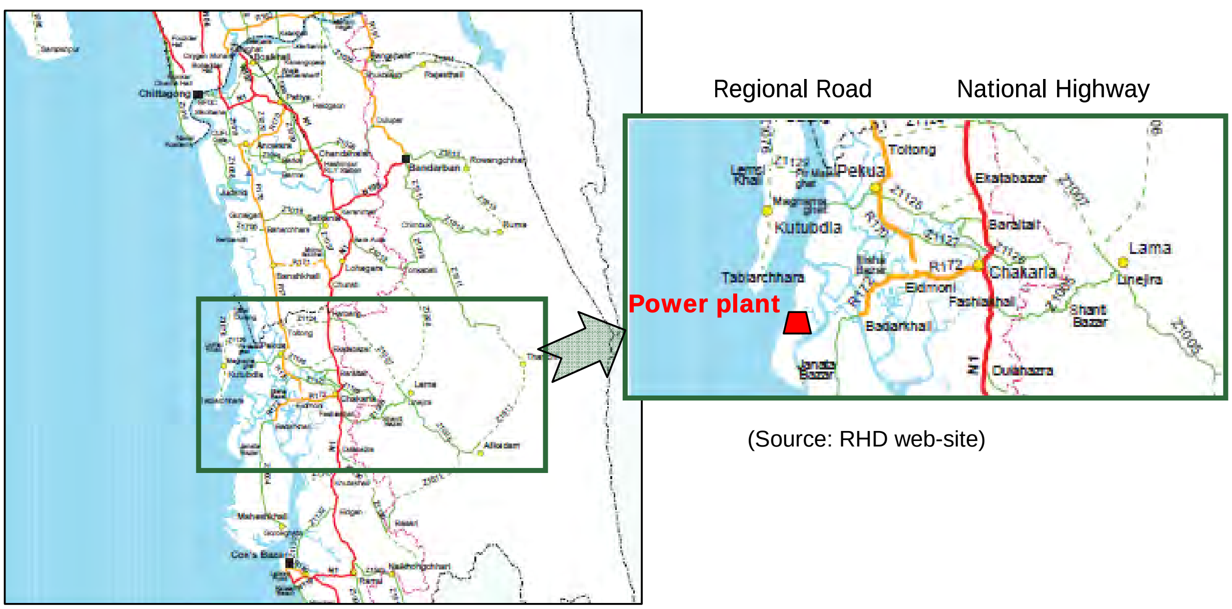
District	Upazila	Union
Chittagong	Anowara	Barasat
		Burumchhara
	Banshkhali	Khankhanabad
		Baharchhara

District	Upazila	Union
		Kalikapur
		Boilchori
		Banshkhali
		Sheakerkhil
		Fulchari
Cox's Bazar	Pekua	Bara Bakia
		Pekua
		Ujantia
	Maheshkhali	Matarbari

(Source: JICA Study Team)

(3) Access Road

The location and route of access road is shown in Figure 1-3. The route of access road is in the area from the national highway running between Chittagong and Cox's Bazar to the power plant site. Basically, existing road facilities will be utilized wherever possible. It is envisioned that the route segments to join the national highway in the north and the route from Maheshkhali Island to the power plant site will involve new road and bridge construction.



(Source: RHD web-site)

Figure 1-3 The location of access roads

1.3 Brief Description of Social Impacts

1.3.1 Brief Description

Among the above project components, the CPGCBL will acquire 455 ha of land for the construction of a coal-fired power plant, PGCB will acquire 157 locations for tower erection, and RHD will acquire 3.1 ha of land for bridge and road construction as shown in the following table:

Table 1-2 Anticipated Land Acquisition

Project Component	Implementing Agency	Acquired Land	
		Location	Area (Ha)
(1) Power Plant and Port Facility	CPGCBL	Matarbari Union and Dhalghata Union of Maheshkhali Upazila (Cox's Bazar District)	455
(2) Transmission Line	PGCB	157 locations for tower erection from Anowara Upazila (Chittagong District) to Maheshkhali Upazila (Cox's Bazar District)	0.13
(3) Access Road	RHD	Matarbari Union, Dhalghata Union and Kalarmarchara Union of Maheshkhali Upazila (Cox's Bazar District)	3.1
Total			458.23

(Source: JICA Study Team)

1.3.2 Anticipated Impact caused by Power Plant and Port Facility Construction

At the site where the power plant and port facility are to be constructed, there are 343 households (2,031 members in total) who will be directly affected by the project implementation. These households own, rent or use private land within the site. There are certain households who rent or occupy government land for salt and shrimp cultivation. In addition, there are squatters living on government land without legal tenure, most of whom live along with the dyke road. About 70% of these 343 households' heads that will be directly or indirectly affected are working in salt or shrimp farms as laborers, mazi, businessmen or cultivators. They conduct salt, shrimp and fish cultivation by employing laborers. They run salt and shrimp business. Some of them are involved in agriculture, boat business, tea selling and construction as carpenters.

Apart from such land owners and users, there are also permanent and temporary laborers employed by them. Including laborers from outside, there are 165 permanent and 892 temporary employees involved in shrimp cultivation, salt farming, fishing activities and others. There are also twelve sharecroppers.

Table 1-3 Anticipated Impact (Power Plant and Port Facility)

No of household	No of household members	Anticipated impact
343	2,031	- Lose land ownership to private land: 237 HHs - Lose shelters on their private land and will be physically displaced: 4 HHs - Lose tenant rights to private land: 77 HHs - Lose tenant rights to government land: 10 HHs - Lose occupancy of land to government land: 156 HHs - Lose occupancy of government land for living place: 16 HHs - Permanent loss of means of livelihood / sources of income: 34 HHs+ - Loss of standing crops at home gardens, shrimp and fish: 499 HHs - Loss of timber and fruit bearing trees: 274 HHs (Note) Numbers of HHs are all cumulative.
-	165	Permanent employees involved in shrimp cultivation, salt farming, fishing activities and others
-	892	Temporary employees involved in shrimp cultivation, salt farming, fishing activities and others
-	12	Sharecroppers of agriculture

(Source: JICA Study Team)

Total amount required for land acquisition, resettlement, and assistance for transition that includes the restoration of livelihood and income sources are 3.86 billion taka.

1.3.3 Anticipated Impact caused by the Extension of Transmission Line

There will be 1,256 m^2 of land required for the installation of tower bases as shown in the following table. Each tower will require 8 m^2 for its base. There will be 157 towers for both angle towers and suspension towers from Anowara Upazila to Maheshkhali Upazila.

Table 1-4 Breakdown of Land Acquisition (Transmission Line)

Tower Area (Per Tower)	Tower Base Area (Per Tower)	Acquired Land		
		Per Tower	No. of Towers	Total Area
11.1m x 11.1m	$2m^2$ x 4	8 m^2	157	1,256 m^2

(Source: JICA Study Team)

The anticipated impact on the land owners will not last permanently or be critical, as the land area for tower bases are relatively small, and land owners' livelihood activities will be hindered only during the construction period. The table below shows the anticipated impact on the owners of the angle tower locations from P1 to P10. There are no people living or using the P10 location (government land).

Table 1-5 Anticipated Impact on the Owners of Angle Tower Locations

Category	Impact	No. of HH	No. of HH Members
Owners of private land (P1 to P8)	- Temporarily affected during construction period	8	83
Users of Government land with official agreement (P9)	- Temporarily affected during construction period	1	9
Total		9	92

(Note) There are no people living or using the P10 location (government land).

(Source: JICA Study Team)

Total amount required for land acquisition of tower locations and compensation for the affected people is 3 million taka.

1.4 Specific Measures Taken to Minimize Adverse Impacts

1.4.1 Examination of Alternatives

For the construction of power plant and port facility, there had been two alternative locations for the CPGCBL to consider. One was the located 2 km south from the present one on Matarbari Island, and another on Maheshkhali Island.

Large settlements with thousands of people on private lands were found on the first location (administrative location was Dhalghata Union), which required large-scale land acquisition and resettlement. In order to minimize such issues, the present site was discovered, which is located right on the north next to it. Although resettlement was indeed minimized (around 20 households), construction at the present site will cause losses of private land, livelihood and income sources such as salt and shrimp farming were still anticipated.

Another alternative site on Maheshkhali Island (administrative location was Hoanak Union) was also considered. However, while no resettlement was anticipated, this was projected to lead to similar losses, i.e., losses of private land, livelihood and income sources such as salt and shrimp farming, and agriculture. The degree and scale of such adverse impacts remained same as the present one.

After thorough analyses from numerous aspects, not only from social aspect but from environmental, financial, technical aspects, the present location was finally prioritized and accepted.

As per transmission line route between the expected Anowara substation site and the planned coal-fired power plant site in Matarbari, there were two candidates: one along the National Highway No. 1 (“N1”) and the other along Regional Road No. 170 (“R170”). As a result of route selection, the route in the western side of the “R170” running parallel to the “R170” was selected for this project. This route can avoid crossing with the planned transmission line between Maheskhali power station and Anowara substation in the future and secure space for the transmission line route. There is no reserve forest and existing extra high voltage transmission line to be crossed over in this area and the “R170” allows for relatively easy construction and maintenance work. The terrain surrounding the route is mostly flat area and covered with bushes, farmlands and salt fields. A route in parallel with the “N1” was found unsuitable because there are reserve forests and an existing 132 kV transmission line along the “N1” and the total route length increases up to approximately 80 km.

1.4.2 Application of International Standards to Land Acquisition and Resettlement

As stipulated in *the Acquisition and Requisition of Immovable Property Ordinance 1982*, the CPGCBL will submit an application of land acquisition to the Government of Bangladesh (GOB), with sufficient data and information about the project design and cost, through the Deputy Commissioner (DC) of Cox’s Bazar. As this project will be financed by the Government of Japan, the CPGCBL will allocate its budget to fill the gap between the Ordinance 1982 and *JICA Guidelines for Environmental and Social Considerations* in order to compensate not only titleholders but also non-titleholders for their loss of land ownership, relocation, and loss of their livelihood means in an internationally accepted manner.

The DC Office will follow all the official procedures to acquire land and provide compensation as stipulated in the Ordinance 1982. It will take over eight months to complete all the procedures from the CPGCBL’s application to the payment of compensation through the DC Office to the project affected persons (PAPs).

1.4.3 Entitlements of Affected People without Legal Claims to Land

Lack of ownership does not imply ineligibility for compensation, if the JICA Guidelines and other internationally accepted practices are to be followed. CPGCBL will endeavor to provide suitable alternatives to resettle the squatters or to provide cash compensation on a replacement cost basis.

PAPs that lose only a part of their physical assets will not be left with a portion that is inadequate to sustain their current standards of living. The minimum size of the remaining land and structures will be agreed to during the resettlement planning process. People temporarily affected will also be considered PAPs and resettlement plans shall address the issue of temporary acquisitions.

1.4.4 Measures for Avoidance and Further Influx of Illegal Occupation

All PAPs residing, working, doing business and/or cultivating land within the project impacted areas upon the cut-off date, will be entitled to compensation for their lost assets (land and/or non-land assets), at replacement cost, if known, and the restoration of incomes and businesses. Compensation will be provided with rehabilitation measures sufficient to assist the PAPs to improve or at least maintain their pre-project living standards, income-earning capacity and production levels.

In the Project, the cut-off date for titleholders will be the date of notification under Section 3 of the Ordinance of 1982. For non-titled holders, CPGCBL declared a cut-off date on the last day of the population census (December 28, 2012) and on the occasion of organizing 2nd public consultation meeting (February 13, 2013). CPGCBL intended to fix the number of households and their members who occupy the government land without permission so as to limit encroachment for the purpose of qualifying for entitlement. CPGCBL will also take appropriate measures to ensure that all land cleared for the project remains clear of squatters.

1.4.5 Methods of Valuing Affected Assets

All compensation for land and non-land assets owned by any households/shop owners who met the cut-off-date will be based on the principle of replacement costs. Replacement costs are the amounts calculated before displacement which are needed to replace any affected assets without depreciation and without deductions for taxes and/or costs of transaction.

The land acquisition officer (LAO) will support the sub-registrar’s office for determining the price of land. Land price averages from the sub-registrar’s office for the previous one year from the date of the notice given under Section 3 of the Ordinance of 1982 will be considered for the land valuation. The transacted price, recorded price, existing prices and expected prices should be averaged to ascertain the replacement value (RV).

1.4.6 Livelihood Restoration and Rehabilitation

The livelihood restoration and improvement program are based on consultation with PAPs and their socio-economic profile, living environment, level of education, etc., Such programs often incorporate vocational training, microfinance, and provision of job opportunities at the construction sites and new facilities.

Chapter 2 Legislations in Bangladesh and Gaps from JICA's Policy

2.1 Key legislations

The Acquisition and Requisition of Immovable Property Ordinance of 1982 and its subsequent amendments in 1993 and 1994 provide the key legal instrument for the acquisition of private land for development activities in Bangladesh.

Salient provisions of the Ordinance which show tangible gaps with *the JICA Guidelines for Environmental and Social Considerations* are as follows:

Avoiding/ minimizing land acquisition: The Ordinance only implicitly discourages unnecessary acquisition as land acquired for one purpose cannot be used for a different purpose. There are, however, no mechanisms to monitor if this condition is actually adhered to.

Eligibility for compensation: The Ordinance stipulates compensation only for the persons who appear in the land administration records as the owners (i.e., titleholders). It does not recognize the rights of those without legal title to the land, who live in or make a living from it.

Compensation paid for: The Ordinance provides for compensation of land and other objects built and grown on it (structures, trees and orchards, crops and any other developments on the land like ponds, built amenities, etc.). There are no provisions to assess and restore lost income streams or income sources caused by the land acquisition to the PAPs.

Compensation standards: Landowners receive compensation under the law (CUL) as per the market value of the property at the publication date of the notice[1] with a premium of 50% on the assessed price. Any damage to standing crops or trees on the property, expenses incidental to compelled changes to the residence or place of business, and reduction of profits of the property in the acquisition period are also entitled to a sum of 50% on top of such market value[2]. The 1994 amendment made provisions for payment of crop compensation to tenant cultivators (*"bargadar"*).

Although the Ordinance stipulates 'market prices' of the acquired land as just compensation, the legal assessment method almost always results in prices far below the actual market prices. Certain pricing standards, which are regarded as unrealistic, are used to assess other losses like structures and various built amenities, trees, and crops, etc.

Relocation of homestead losers: There is no legal obligation to relocate, or assist with the relocation of, those whose homesteads have been acquired.

1 The average value of the properties of similar description and with similar advantages in the vicinity during the last twelve months prior to the publication date of the notice. (Section 8 (1) of *the Acquisition and Requisition of Immovable Property Ordinance 1982*.)

2 The market value thus determined does not always reflect the actual market value.

Ensuring payment/ receipt of compensation: Even with the given legal provision, the compensation process is time-consuming. There is, moreover, no certainty as to when an affected landowner will obtain the stipulated compensation or whether he will obtain it at all.

Land is legally acquired and handed over to the project proponent as soon as the acquisition authority identifies the owners ('awardees') by examining the records, and sends a legal notice advising them to claim compensation ('awards'). And it also turns out that it is an obligation of the PAPs to prove that the acquired land legally belongs to them.

Socio-economic rehabilitation: The provisions are so restricted that the Ordinance shows no concern about the long-term socio-economic changes the PAPs might undergo in the post-acquisition period. Except for the compensation at the legal 'market price', there are no other provisions in the acquisition or other-laws that require the government to mitigate the resultant adverse impacts caused by the acquisition. Socio-economic rehabilitation of the involuntarily displaced persons is absent in the legal regime of Bangladesh.

2.2 JICA's policy on land acquisition and resettlement

The key principle of JICA policies on involuntary resettlement is summarized below.

(1) Involuntary resettlement and loss of means of livelihood are to be avoided when feasible by exploring all viable alternatives.

(2) When, population displacement is unavoidable, effective measures to minimize the impact and to compensate for losses should be taken.

(3) People who must be resettled involuntarily and people whose means of livelihood will be hindered or lost must be sufficiently compensated and supported, so that they can improve or at least restore their standard of living, income opportunities and production levels to pre-project levels.

(4) Compensation must be based on the full replacement cost as much as possible.

(5) Compensation and other kinds of assistance must be provided prior to displacement.

(6) For projects that entail large-scale involuntary resettlement, resettlement action plans must be prepared and made available to the public. It is desirable that the resettlement action plan include elements laid out in the World Bank Safeguard Policy, OP 4.12, Annex A.

(7) In preparing a resettlement action plan, consultations must be held with the affected people and their communities based on sufficient information made available to them in advance. When consultations are held, explanations must be given in a form, manner, and language that are understandable to the affected people.

(8) Appropriate participation of affected people must be promoted in planning, implementation, and monitoring of resettlement action plans.

(9) Appropriate and accessible grievance mechanisms must be established for the affected people and their communities.

Above principles are complemented by World Bank OP 4.12, since it is stated in JICA Guideline that "JICA confirms that projects do not deviate significantly from the World Bank's Safeguard Policies". Additional key principle based on World Bank OP 4.12 is as follows.

(10) Affected people are to be identified and recorded as early as possible in order to establish their eligibility through an initial baseline survey (including population census that serves as an eligibility cut-off date, asset inventory, and socioeconomic survey), preferably at the project identification stage, to prevent a subsequent influx of encroachers of others who wish to take advance of such benefits.

(11) Eligibility of Benefits include, the PAPs who have formal legal rights to land (including customary and traditional land rights recognized under law), the PAPs who don't have formal legal rights to land at the time of census but have a claim to such land or assets and the PAPs who have no recognizable legal right to the land they are occupying.

(12) Preference should be given to land-based resettlement strategies for displaced persons whose livelihoods are land-based.

(13) Provide support for the transition period (between displacement and livelihood restoration.

(14) Particular attention must be paid to the needs of the vulnerable groups among those displaced, especially those below the poverty line, landless, elderly, women and children, ethnic minorities etc.

(15) For projects that entail land acquisition or involuntary resettlement of fewer than 200 people, abbreviated resettlement plan is to be prepared.

In addition to the above core principles on the JICA policy, it also laid emphasis on a detailed resettlement policy inclusive of all the above points; project specific resettlement plan; institutional framework for implementation; monitoring and evaluation mechanism; time schedule for implementation; and, detailed Financial Plan etc.

In terms of categories of PAPs and types of lost assets, the gaps in the existing legal framework of Bangladesh and requirements of the JICA Guidelines are identified as presented in the table below.

Table 2-1 Gap Analysis between Bangladeshi Laws and JICA Guidelines

No	Category of PAPs / Types of Lost Assets	Bangladesh Laws	JICA Guidelines
1	For all types of land and other assets for legal land	Acquired by DC as per legal requirements/ procedures	Preference should be given to land-based resettlement strategies for displaced persons whose livelihoods are land-based
2	Land tenants	Compensation for standing crops if harvesting of crops is not possible	People who must be resettled involuntarily and people whose means of livelihood will be hindered or lost must be sufficiently compensated and supported.
3	Land Users	Squatters, encroachers and unauthorized users/ occupiers are not recognized	Ditto
4	Owners of temporary structures	Only cash compensation under law (CUL)	Compensation must be based on the full replacement cost as much as possible.
5	Owners of permanent structure buildings	Ditto	Ditto
6	Perennial crops	Market prices of the standing crops with value of plants	Compensation must be based on the full replacement cost as much as possible.
7	Timing for payment of entitled compensation to the PAPs	No concern on the part of the project proponent. Land is handed over to the project proponent as soon as the compensation funds are placed with the DC.	On the completion of payment of compensation to the PAPs, the land is to be vacated and handed over to the project proponent.
8	The issue of relocation and income generation activities	No concern about relocation and income generation activities.	People who must be resettled involuntarily and whose livelihood will be hindered or lost must be sufficiently compensated and supported, so that they can improve or at least restore their standards of living, income opportunities and production levels to pre-project levels.
9	Vulnerability of PAPs	No distinction between the PAPs	Particular attention must be paid to the needs of the vulnerable groups among those displaced, especially those below the poverty line, the landless, elderly, women and children, ethnic minorities, etc.
10	Role of DC, project proponent and PAPs	DC to acquire land, the project proponent to use the land, and PAPs to seek compensation from the DC.	DC and project proponent to assist the PAPs in getting the compensation, assist to collect the legal and required documents, and provide support for the transition period between displacement and livelihood restoration.

(Source: JICA Study Team)

2.3 Procedures of land acquisition

Under the Ordinance of 1982 and its subsequent amendments 1989,1993, and 1994, the DC at District level is entrusted to acquire land for agencies requiring land for any public or private infrastructure projects. The procedures of land acquisition will follow the following steps:

Step 1: After identifying and selecting the exact ground locations of the required land, the project proponent will carry out detailed engineering surveys and design the construction work and lay them out on mauza maps. The project proponent will prepare the land acquisition proposals to obtain administrative approval by the line ministry.

Step 2: The project proponent, after obtaining the approval of the administrative ministry, will make a request to the DC, with sufficient information including the amount of land to be acquisitioned from each plot, and the ownership status such as private and public lands, for the acquisition of the land as per the proposal.

Step 3: Within 90 days, the DC will appraise the application through a) site observation, b) consultation with local politicians and residents, c) develop project profiles, and d) cost estimates. The DC will then develop and submit a proposal on land acquisition to the Ministry of Land for an appraisal by the central government within 90 days.

- The DC will publish a notice as stipulated in Section 3 of the Ordinance of 1982 stating that there is a proposal for the property to be acquired. The persons to be displaced may submit an objection to the land acquisition to the DC within 15 days after the notice is served. All the legal titleholders will be advised to show their ID cards and other documents that verify their rights. For those with no registrations, the DC Office will call for circumstantial evidence from community leaders, local elite people, and religious leaders, etc., to add these people to the list.
- The DC will consult with the Public Works Department (PWD), Forest Department (BFD), Department of Agricultural Marketing (DAM) and Department of Fisheries (DOF) to assess the value of structures, trees, crops and aqua products for their existing rates.
- Under Section 6, a second public notice will be served stating the GOB’s decision on the land acquisition and taking possession thereof. The DC Office will confirm the PAPs, exact land area and size for acquisition, number of relocated houses, agriculture land, forestry and fishing areas that will be lost. The persons to be displaced will be requested to submit their statements of property, amounts and particulars of the claims to compensation after 15 days of the second notice being served. The DC Office will respond to any grievances made by the PAPs in order to agree to the assistance package.
- The project proponent shall deposit the estimated amount of the award of compensation with the DC within 60 days from the receipt of the estimate given by the DC.
- Upon serving the last notice (Section 7), the DC shall pay the amount to the owners of the acquired property within another 60 days from the date of deposit by the project proponent. The DC will take possession of the property after completion of the compensation payment to the PAPs and immediately declare this in the official gazette, and hand the property over to the project proponent.

Chapter 3 Social Impact Survey

3.1 Socioeconomic Survey and Focus Group Discussions at Power Plant and Port Facility Site

3.1.1 Survey Outline

(1) Socioeconomic Survey

a) Objective

The survey aim was to collect the typical characteristics of the affected households, basic data of their livelihoods and living standards, and to gain a comprehensive idea of the socioeconomic conditions at the project site.

b) Main use of the results

- Analyze the socioeconomic conditions of the project site to draw the needs of the affected people for the livelihood restoration/ improvement program and the area development
- Estimate the cost required for land acquisition, resettlement, compensation and the implementation of the livelihood restoration program

c) Selection of interviewees

The interviewees were the directly affected people who own/ lease/ use their private land (or lease government land) and who work within the site. Squatters were also surveyed as well as the indirectly affected people living around the project site.

There were 343 household heads interviewed under the survey, and their major characteristics are as described below. Out of 343 household heads, 274 were from Matarbari Union, and the majority of these households lived in Shirar Dail village. The remaining 69 households were from Dhalghata Union, which is in southern part of the project site, and most of these households lived in Mohiraghona village.

Table 3-1 Interviewed Households

Union	Village	No. of Households	No. of Household Members
Matarbari		274	1,666
	Matarbari	3	
	Maiz Para	1	
	Shirer Dail*[1]	270	
Dhalghata		69	365
	Mohiraghona*[2]	59	

	Sutaria Para	1	
	Nasir Mohammaddhil	9	
TOTAL		343	2,031

Note 1) Shirer Dail includes “Shirer Dail” (149 HHs), “East Shirer Dail” (19 HHs), “Middle Shirer Dail”(21 HHs), “West Shirer Dail” (4 HHs), “Dakshin Shirer Dail” (74 HHs) and “Uttar Shirer Dail” (3 HHs).
2) Mohiraghona includes “Mohiraghona” (7HHs) and “Uttar Mohiraghona” (52 HHs).

(Source: JICA Study Team)

d) Survey Method

The three pillars of the socioeconomic survey, i.e., population census, asset inventory, and household survey, were compiled into one set of questionnaires and targeted all the potential PAPs regardless of their entitlement of land ownership or whether they were affected/ displaced PAPs.

Table 3-2 Structure of Socioeconomic Survey

Survey	Achievements
Population Census	A complete and accurate count of the population was made in the population census to confirm who and how many of the people would be affected by land acquisition and related impacts. The population census provided the basic information necessary for determining eligibility for compensation. A cut-off date was fixed as December 28, 2012, including the accurate/ exact number of PAPs, names, photos for identification, and assets. It was also declared on February 13, 2013 in the presence of such PAP.
Asset Inventory	In the asset inventory survey, a complete count and description of all property was undertaken for the property to be acquired. An asset inventory of losses (IOL) involved a mapping of all households affected by land acquisition, agricultural, homestead and business, trees, crops, fish, structures of residential and business and other kinds of losses, i.e., wages and income. A list of the losses was remunerated into a database. The IOL for each PAP recorded the following: - amount and type of land to be acquired (residential, commercial, agricultural) - type of trees and/ or crops to be acquired - residential houses to be acquired - commercial structures to be acquired - loss of livelihood (type and income loss) - other types of losses - types of community infrastructure or common property resources to be acquired The IOL also recorded the legal status of the land, residential houses, shops and other structures to be acquired. In conjunction with the population census and IOL of the PAPs, household data was collected on the following items: - size, sex and age composition of each affected household - types of occupation/ livelihood for each economically active household member - assessment of income levels for each economically active household member - number of school age children attending school - ethnic, language, and religious identity of each affected household PAPs attitudes (intentions/ opinions) towards the project, land acquisition and resettlement were

Survey	Achievements
	also recorded.
Household Survey	The household survey focused on income-earning activities and other socioeconomic indicators to observe the social and economic conditions of PAPs, such as income, expenditure, employment, education, skills, livelihood, utilities, health services facilities, social services, and other socio-economic and cultural aspects that prevailed in the targeted areas. The household survey also included an inventory of formal and informal community level organizations that represented the PAPs, which can be engaged in information dissemination and consultation related to the implementation of the resettlement plan.

e) Interviewers

CPGCBL/ BPDB officials and researchers representing the Engineers Associates Ltd., who were commissioned by the JICA Study Team, conducted the survey.

f) Survey period

December 17 - 28, 2012.

g) Limitations of the survey:

The severe time constraints during the survey period and geographical remoteness of the site made it unable for the surveyors to return to the interviewed households to reconfirm their answers before they left the site. Incoherency of answers done by a person therefore is admitted in the data, which made it unable to implement a complete set of scientific analysis. The number of people for each occupation were as of December 2012. Land tenure, they insisted, could not be double-checked as they were reluctant to disclose their official registration including land registration certificate. Likewise, their household income and expenditure, land lease and lease amount stated by them were not certified.

(2) Focus Group Discussions

a) Objective

The focus group discussions aimed to collect specific information from particular groups, such as women and children who were regarded as vulnerable, and laborers who were mostly found at the project site in order to evaluate their specific characteristics.

b) Main use of the results

- Analyze the specific conditions of particular clusters of populations, who were placed in such groups with or without their wishes
- Draw specific needs of the vulnerable groups
- Obtain local needs for the livelihood restoration/ improvement program and the area development

c) Selection of interviewees

Each population cluster had three groups in which 86 people were randomly sampled at the project site.

Table 3-3 Interviewed Population in Focus Group Discussion

Cluster	No. of Groups	No. of People in Total	Age Range (as of Dec. 2012)
Children	3	21	6 to 11
Women	3	25	20 to 45
Salt laborers	3	19	13 to 50
Shrimp laborers	3	21	18 to 70
Total		86	

(Source: JICA Study Team)

d) Survey Method

Focus Group Discussions

e) Interviewers

CPGCBL/ BPDB officials and researchers representing the Engineers Associates Ltd., who were commissioned by the JICA Study Team, conducted the FGDs.

f) Survey period

December 18 - 25, 2012.

g) Limitation of the survey:

Not applicable.

3.1.2 Findings

The followings are the major findings from socioeconomic survey and FGDs.

(1) Profile of Interviewees and their family members

a) Surveyed Population

Out of 2,031 people comprising 343 interviewed households, 1,663 were from Matarbari union, of whom males shared 54.6%, and adults did 50.3%. In Dhalghata Union, on the other hand, males comprised of 57.3% and adults shared 56.0%.

Table 3-4 Total Surveyed Population

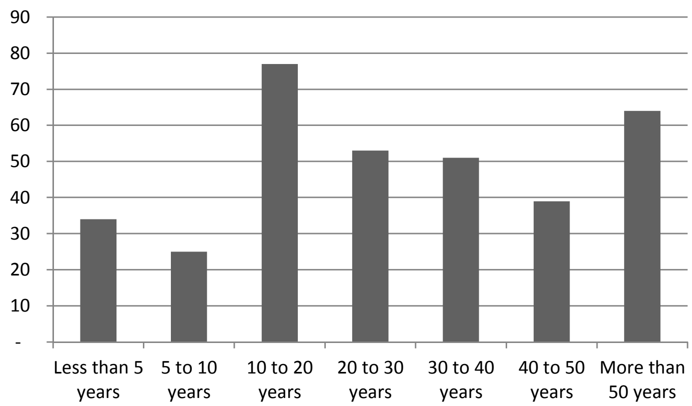
	Total Surveyed Population			Matarbari Union			Dhalghata Union		
	Male	Female	Total	Male	Female	Total	Male	Female	Total

Adult	599	444	1,043	474	363	837	125	81	206
Child	520	468	988	434	392	826	86	76	162
Total	1,119	912	2,031	908	755	1,663	211	157	368

(Source: JICA Study Team)

b) Length of Residing at the Site

The length of time of households residing at the site varied. Those residing for over 50 years were 64 households, and the maximum length of time reached 300 years. This means that there are households residing at the site over generations.

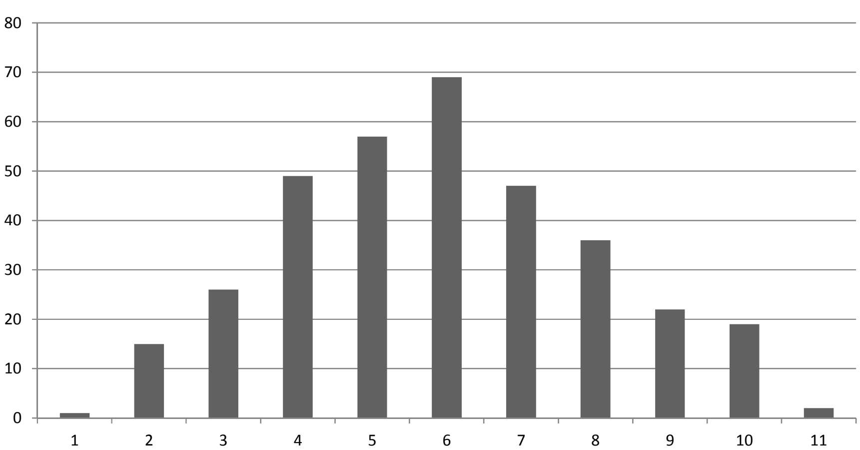


Note: The median is amount of time is 25 years, and the mode is 15 years.
(Source: JICA Study Team)

Figure 3-1 Length of Time Residing at the Site

c) Size of Household

Average household size was 5.92 people, which is close to the median (6.0) and the mode (6.0). The minimum number of household member was 1, and the maximum number was 11.



(Source: JICA Study Team)

Figure 3-2 Household Size

(2) Education Level and Literacy

Taking a look at the education level of the household heads, 33.5% were illiterate, and 38.8% could only write their own names (signature). This implies that 72.3% of household heads live without reading or writing as part of their day-to-day activities. The household heads under these two clusters had a slightly larger number of household members than the other categories that had graduated from Universety.

Table 3-5 Education Level of Heads and Household Size

Education Degree/ Level	No. of HH Heads	%	Average of HH Size
Illiterate	115	33.5%	6.17
Write name	133	38.8%	6.14
Class I-V	25	7.3%	5.20
Class VI-X	40	11.7%	5.35
SSC	9	2.6%	5.33
HSC	9	2.6%	4.44
BA	5	1.5%	5.80
BA (Hons)	1	0.3%	7.00
MA	2	0.6%	6.00
Other 1	3	0.9%	7.33
Other 2	1	0.3%	3.00
TOTAL	343	100.0%	5.92

(Source: JICA Study Team)

Among the literate population, who comprised of 40.9% of the total surveyed population, males were 52.3%, and adults 34.1%. In Matarbari, 69.4% of the literate population were children under 18 years old, and more female than male children were literate. In Dhalghata, on the contrary, more males than females were literate (for both adults and children), and the literate population children shared half (50.9%). Although literacy rates of Matarbari and Dhalghata were similar in total (40.3% and 43.2% respectively), 56.4e% of children in Matarbari were literate, whereas 50.0% were in Dhalghata.

Table 3-6 Literate Population

	Total Surveyed Population			Matarbari Union			Dhalghata Union		
	Male	Female	Total	Male	Female	Total	Male	Female	Total
Adult	170	113	283	118	87	205	52	26	78
Child	264	283	547	222	244	466	42	39	81
Total	434	396	830	340	331	671	94	65	159

(Source: JICA Study Team)

According to the FGD, females, salt laborers and shrimp laborers did not have sufficient opportunities for education. The number of government primary schools around the site was reported to be not sufficient, although there were Islamic schools. Due to households being poor, many people dropped out of school when they were children, even before they completed primary education.

There was no major difference found in education levels between male and female children.

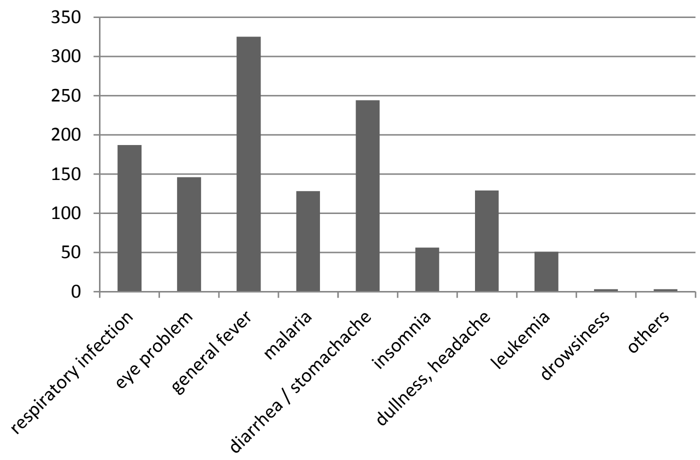
Table 3-7 Educational Levels and Literacy (FGD)

	Educational Qualifications			Literacy Levels		
Clusters	Primary	Secondary ≤	Unknown	Read & Write	Signature Only	Illiterate & N/A
Children	15	1	5	19	0	2
Women	4	3	18	9	12	4
Salt laborers	3	4	12	6	11	2
Shrimp laborers	9	3	9	13	7	1
Total	31	11	44	47	30	9

(Source: JICA Study Team)

(3) Health Conditions of Affected People

From the total households, 325 households (94.8%) answered that they suffered from general fevers. They also suffered from diarrhea/ stomachaches (244 households, 71.1%) and respiratory infections such as colds (187 households, 54.5%).



Note: Household heads were asked to select as many illnesses as they experienced.

(Source: JICA Study Team)

Figure 3-3 Types of Illness

(4) Occupations of Household Heads

Among the interviewed household heads, over 30% (108 household heads) were salt cultivators. These household heads are the owners and/or lessees of salt fields who invest money in salt cultivation. Sixty out of the 62 salt laborers (18%) were from Matarbari Union, being laborers who prepared the salt beds. These laborers always work under the guidance of salt cultivators, receiving wages. There was a lower number of shrimp cultivators, businessmen, mazi and laborers as the survey was conducted in December 2012 when salt cultivation was taking place. However, the majority of most types of laborers were from Matarbari, not Dhalghata.

Table 3-8 Occupations of the Household Heads

Occupations		Matarbari	Dhalghata	Total	
Cultivators				113	32.9%
	Salt Cultivators	66	42	108	
	Shrimp cultivators	5	0	5	
Businessman				36	10.5%
	Salt Businessmen	12	2	14	
	Fish Businessman	11	0	11	
	Businessmen (other)	10	1	11	
Mazi				35	10.2%
	Mazi (Salt)	18	10	28	
	Mazi (Shrimp)	5	2	7	
Laborers				94	27.4%
	Salt Laborers	63	2	65	

Occupations		Matarbari	Dhalghata	Total	
	Shrimp Laborers	15	0	15	
	Day Laborers	12	2	14	
Fishing				28	8.2%
	Fishermen	18	1	19	
	Boatmen	5	3	8	
	Crab Catchers	1	0	1	
Agriculture				1	0.3%
	Orchardists/ gardeners	1	0	1	
Others				36	10.5%
	Teachers	4	1	5	
	Grocery Shop Owners	4	0	4	
	Masons	4	0	4	
	Service Industry Workers	2	2	4	
	Housewives	4	0	4	
	Master Tailors	3	0	3	
	Quack Doctors	2	1	3	
	Carpenters	2	0	2	
	Beggars	2	0	2	
	Security Guards	1	0	1	
	Singers	1	0	1	
	Students	1	0	1	
	Home Makers	1	0	1	
TOTAL		274	69	343	100.0%

Note: Cultivators are the owners or lessees of the salt, shrimp or fish fields who invest their own money for cultivation. Businessmen in salt, shrimp and fish are those who purchase the products from the fields and local markets, and sell them at different markets and other places. Laborers are those who sell their labor and prepare the fields. They work under the guidance of cultivators and receives wages from them. “Mazi” refers to middleman in Bengalese who recruit day laborers to introduce to businessmen, land owners and employers who need laborers.

(Source: JICA Study Team)

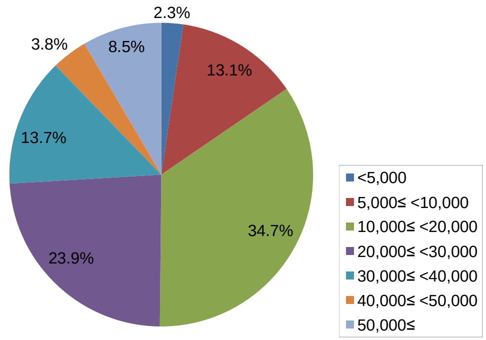
According to the FGD, salt laborers and shrimp laborers mentioned that they had fewer job opportunities because of their low education and literacy levels. They responded in the group interviews that discontinuation of education and school drop-out rates continued to increase due to the involvement of their children into these income generation activities. Women, on the contrary, gave up looking for jobs because of their low literacy levels and social barriers.

Fishing occurs throughout the year at the site, and the fish selected are of bigger size, good quality, or large quantity although smaller sized fish are sold at the fish markets in Cox’s Bazar and Chittagong from vehicles and engine boats. Fish of lower quality and smaller sizes are retailed by local businessmen at local markets.

(5) Household Incomes and Expenditure

a) Household Incomes

For monthly income, 119 households (34.7%) had 10,000 to 20,000 taka, and 82 (23.9%) had 20,000 to 30,000 taka. The average household monthly income was approximately 26,500 taka, but the median was 19,000 taka. There were 29 households receiving more than 50,000 taka per month, among whom the largest income was 842,000 taka.

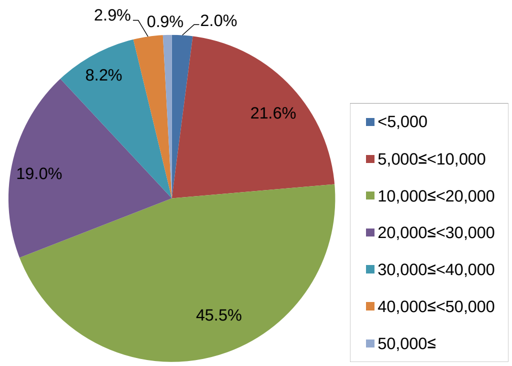


(Source: JICA Study Team)

Figure 3-4 Household Monthly Income

b) Household Expenditure

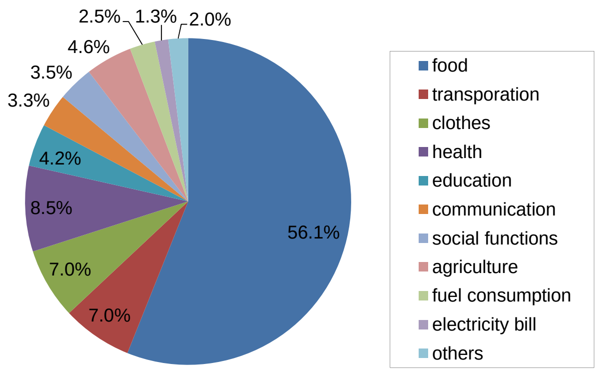
For household expenditure, 156 households (45.5%) spent 10,000 to 20,000 taka per month, 74 (21.6%) spent between 5,000 to 10,000 taka, and 65 (19.0%) spent from 20,000 to 30,000 taka. The average household monthly expenditure was approximately 18,000 taka, but the median was as much as 15,000 taka. There were three households which spent more than 50,000 taka per month, among whom the largest expenditure was 104,200 taka.



(Source: JICA Study Team)

Figure 3-5 Household Monthly Expenditure

A glance at the breakdown of average expenditure shows that approximately 10,000 taka (56.1%) was spent for food consumption, 1,522 taka (8.5%) on health, around 1,261 taka for clothes and 1,249taka (7.0%) for transportation.



(Source: JICA Study Team)

Figure 3-6 Average Expenditure Patterns

c) Per Capita Monthly Income and Expenditure

According to the Household Income & Expenditure Survey 2010 issued by the Bangladesh Bureau of Statistics (BBS)[3], the population below the upper poverty line was 31.5% nationwide and 26.2% in Chittagong Division that includes Chittagong District and Cox's Bazar District. The population below the lower poverty line, on the other hand, was 17.5% nationwide and 13.1% in the Chittagong Division.

Table 3-9 Incidence of Poverty (Head Count Ratio) by CBN Method in 2010

	Nationwide			Chittagong		
	Average	Urban	Rural	Average	Urban	Rural
Upper poverty line	31.5	21.3	35.2	26.2	11.8	31.0
Lower poverty line	17.5	7.7	21.1	13.1	4.0	16.2

(Source: Bangladesh Bureau of Statistics (2011) Household Income & Expenditure Survey 2010)

In both cases, the incidence of poverty occurred more in rural areas, and 35.2% of the population were below the upper poverty line nationwide and 31.0% in Chittagong Division respectively.

[3] BBS has conducted the HIES since the 1970s, and it has collected 12,240 households from the entire nation as samples for the HIES 2010. They have received technical and financial support from the World Bank for conducting the survey. They estimate the upper and lower poverty line taking into consideration the cost of basic needs (CBN) that include both food and non-food items.

Those who received 1,270.93 taka nationwide was 31.5% and 1,307.27 taka (26.2%) in Chittagong Division, and the population below the lower poverty line was estimated to receive as much as 1,102.84 taka nationwide, 17.5% of the population, and 1,051.67 taka in Chittagong Division (13.1%).

Table 3-10 Incidence of Poverty (by per capita monthly income) in 2010

	Nationwide			Chittagong		
	Average	Urban	Rural	Average	Urban	Rural
Upper poverty line	1,270.93	1,545.96	1,211.57	1,307.27	1,328.03	1,304.64
Lower poverty line	1,102.84	1,240.18	1,083.72	1,051.67	1,259.46	1,034.62

(Source: Bangladesh Bureau of Statistics (2011) Household Income & Expenditure Survey 2010)

Table 3-11 Incidence of Poverty (by per capita monthly expenditure) in 2010

	Nationwide			Chittagong		
	Average	Urban	Rural	Average	Urban	Rural
Upper poverty line	1,245.76	1,457.65	1,200.02	1,381.76	1,540.60	1,361.68
Lower poverty line	1,064.92	1,133.41	1,056.03	1,174.50	1,231.87	1,169.79

(Source: Bangladesh Bureau of Statistics (2011) Household Income & Expenditure Survey 2010)

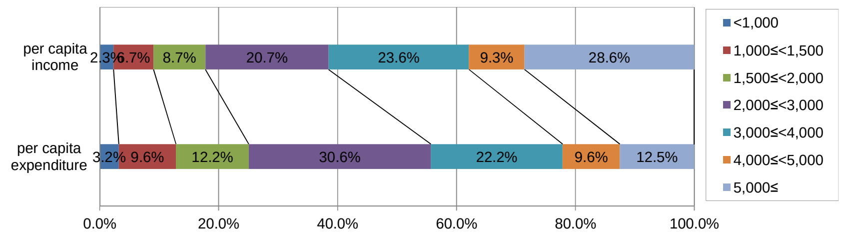
Taking the geographical location of the project site and the inflation rates of FY 2010 and FY 2011 into consideration[4], the surveyed population whose per capita income and expenditure were below 1,500 taka were assumed as the poor in this report. Therefore, 31 surveyed households (9.0%) were categorized as poor households on monthly income basis, and 44 households (12.8%) on monthly expenditure basis.

Table 3-12 Household Head's Per Capita Monthly Income and Expenditure

	<1,000	1,000≤< 1,500	1,500≤< 2,000	2,000≤< 3,000	3,000≤< 4,000	4,000≤< 5,000	5,000≤	Total
Per capita income	8	23	30	71	81	32	98	343
Per capita expenditure	11	33	42	105	76	33	43	343

(Source: JICA Study Team)

[4] The inflation rate of FY 2010 in rural areas was 11.73% and for FY 2011 it was 8.69% on the year 2005 basis.

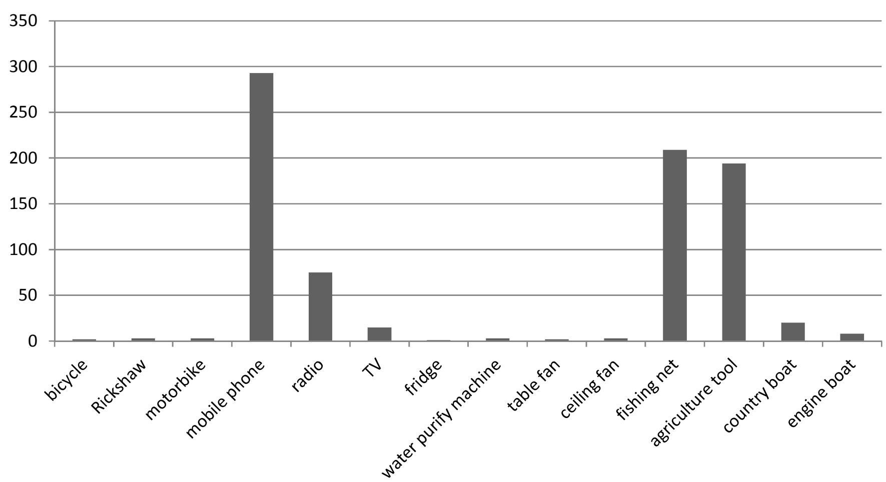


(Source: JICA Study Team)

Figure 3-7 Ratio of Household Head's Per Capita Monthly Income and Expenditure

(6) Assets

Out of 343 households, 295 (86.0%) had at least one mobile phone. There was one household head who said he had six phones at home, and the average number of mobile phones among 295 households was 1.23 phones. In addition, 212 households had fishing nets (1.91 on average) and 195 households had more than one kind of agriculture tool (average was 3.92 tools). Only 76 household had radios, and 15 had TV sets.



Note: Household heads were asked to choose as many assets as they had.

(Source: JICA Study Team)

Figure 3-8 Household Assets

In regards to animals and poultry, 149 interviewed households (37.3%) kept chickens at home, followed by ducks (95 households) and goats (81 households).

Table 3-13 Animals and Poultry owned by Households

Livestock	Household Ownership		Total Number	Average No. Per Household
	No. of Households	%		
Cows	74	18.5%	118	1.6
Pigs	1	0.3%	5	5.0
Ducks	95	23.8%	604	6.4
Chickens	149	37.3%	1,707	11.5
Goats	81	20.3%	389	4.8

Note: Household heads were asked to choose as many livestock as they owned.
(Source: JICA Study Team)

(7) Basic Infrastructure for Living

a) Energy Source

There were 332 household heads that responded that they did not have electricity yet. In fact, no single electric wire has been extended to Dhalghata Union as of March 2013, so that all interviewed households in Dhalghata Union had no choice but to depend on energy sources other than electricity.

Some 341 households (99.4%) used firewood for cooking, and 301 (87.8%) exclusively depended on kerosene lamps for lighting. There were 22 households who owned solar panels on their roofs.

Table 3-14 Energy Source by Purpose

Energy Source	Cooking	Lighting	Irrigation	Other
Electricity	0	7	1	1
Gas	0	0	0	0
Kerosene	1	301	19	0
Firewood	341	0	0	0
Solar	0	0	0	22
Diesel	0	0	3	0
None	1	2	320	320
Electricity + Kerosene	0	1	0	0
Kerosene + Solar	0	32	0	0
Total	343	343	343	343

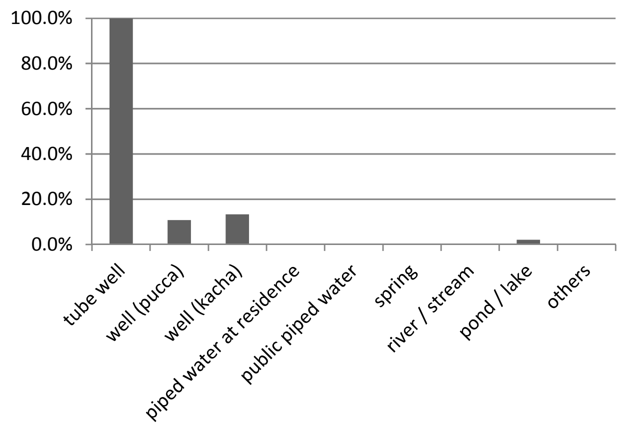
Note: Household heads were asked to choose as many sources as they had.
(Source: JICA Study Team)

Deteriorating living environments were commonly observed in the FGD as well. Sixty six out of 86 interviewees did not have electricity at home, whereas the remaining 20 had solar panels installed with the assistance of Rahimafrooz (Bangladesh) Ltd. Since there was no REB or

BPDB distribution network available at the project site, solar systems were introduced for lighting. Rahimafrooz works all over Bangladesh installing solar systems without charging the initial cost. However, households are supposed to make monthly repayments of the installment costs ranging from 200 to 800 taka depending on the actual costs until the full costs are recovered.

b) Water and Sanitation

All affected households depended on tube wells for water. Along with tube well water, some of them also used *pucca* wells and *kacha* wells of which water quality was not secured. Seven households used pond water and one used public piped water.



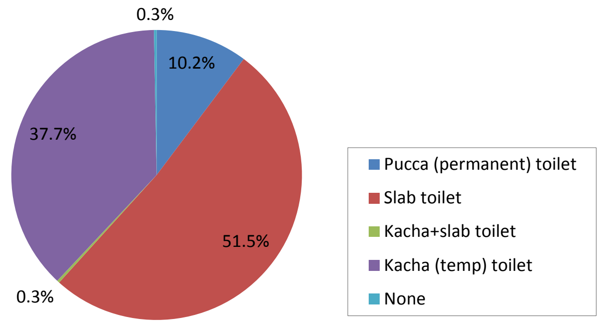
Note: Household heads were asked to choose as many facilities as they used.
(Source: JICA Study Team)

Figure 3-9 Water Sources

No household heads said they had the habit of boiling water before drinking[5]. And 13 household heads said that they had experienced arsenic contamination.

Out of 343 households, 35 (10.2%) used *pucca* toilets. In addition, 176 (51.5%) used slab toilets, and the remaining 129 used temporary facilities and one household did not use toilet facilities at all.

[5] According to the FGD, local residents used alum (*phitkari*) for purifying water instead of boiling water.



(Source: JICA Study Team)

Figure 3-10 Type of Toilet

c) Medical Facilities

Asked where they consult with doctors, quack doctors and other sources of medical and health treatment, over 80% of household heads responded that they had medical consultations at the local markets. Nearly 50% of households also went to town for medical consultations.

Table 3-15 Availability of Medical Facilities

Availability of Medical Facilities	Village		Market		Town	
	Number	%	Number	%	Number	%
Yes	13	3.8%	275	80.2%	169	49.3%
No	330	96.2%	68	19.8%	174	50.7%
TOTAL	343	100.0%	343	100.0%	343	100.0%

Note: Household heads were asked to choose as many facilities as they used.

(Source: JICA Study Team)

According to the FGD, local people usually saw quack doctors for normal cases such as general fevers, and they went to Chakaria Upazila to consult private doctors for more complicated symptoms. They faced difficulty in traveling to Chakaria due to the deteriorated road access and transportation. Although men had more mobility in terms of access to private clinics and doctors, women and children had less such mobility.

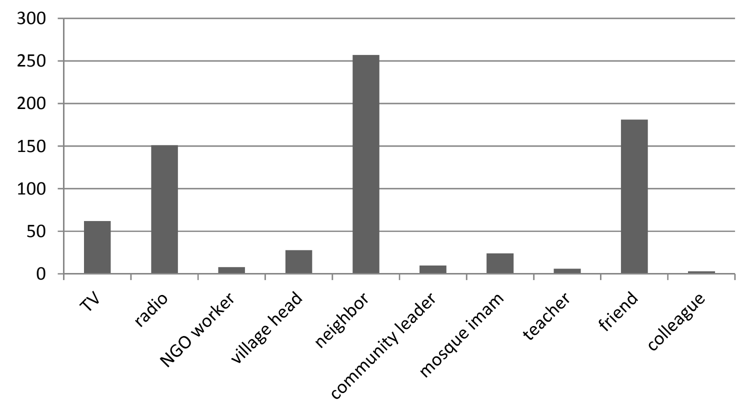
d) Tidal Waves

There were 304 household heads (88.6%) that said they had experienced tidal waves. Of these households, 303 said they experienced such tidal waves once or twice a year. And 263 people mentioned the floods of 1991 and 1997 as the biggest ones which they remembered.

(8) Others

a) Source of Information

There were 257 households that responded that they collected information through neighbors, and another 181 collected information from their friends. Not many of the households collected information from TV or radio as they did not have these items at home (see **Assets** above), but they often listened to radio or watched TV at tea stands or in the local markets.

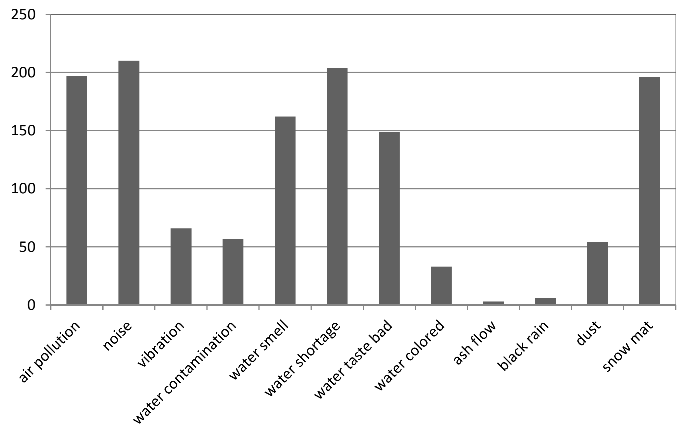


Note: Household heads were asked to choose as many sources as they used.
(Source: JICA Study Team)

Figure 3-11 Source of Information

b) Type of Pollution

As types of pollution, 210 household heads (61.2%) recognized noise, water shortages (204 households, 59.5%), air pollution (197 households, 57.4%) and snow mats (196 households, 57.1%). Complaints regarding water related issues were raised most among households. Not only water shortages, but also bad smells, bad tastes of water, colored water and contaminated water were mentioned.



Note: Household heads were asked to choose as many sources as they had liked.
(Source: JICA Study Team)

Figure 3-12 Examples of Pollution Experienced in the Past

(9) Available Job Opportunities

Responding to whether there were any job opportunities available around the project site, 19 household heads said fishing cultivation, 16 domestic animal husbandries, six said poultry and two stated tailoring work. As stated in the FGD, people living or working at the site had fewer job opportunities because of their low education and low literacy levels.

(10) Skill Development Needs

In response to the needs for skill development, household heads answered that they would like a wider variety of training skills. The skills demanded by the household heads were in fishing cultivation, followed by domestic animal husbandry, poultry, tailor, and technical work.

Table 3-16 Skill Development Requests

Rank	Skill Development Requests	No. of HH Heads who Show their Interests
1	Fishing cultivation	100
2	Domestic animal husbandry	79
3	Poultry	64
4	Tailor	53
5	Technical work	50
6	Social development	38
7	Vehicle licenses	20
8	Salt cultivation	15
9	Computer	14
10	Education (coaching)	5
11	Training for going abroad	3

Rank	Skill Development Requests	No. of HH Heads who Show their Interests
12	Shrimp cultivation	2
13	Agriculture farming	1
14	Music	1
15	Hatchery	1

Note: Household heads were asked to select as many needs as they liked.
(Source: JICA Study Team)

In the FGD, women were interested in receiving training for tailoring, making puppets and *Nakashi Katha* (hand-stitched bed covers) although they were not given any job opportunities.

3.2 Socioeconomic Survey and Focus Group Discussions at Transmission Line Site

3.2.1 Survey Outline

(1) Socioeconomic Survey

a) Objective

The survey aim was to collect the typical characteristics of the households who owned the potential locations of angle towers from Anowara Upazila to Maheshkhali Upazila, basic data of their livelihoods and living standards, and to gain a comprehensive idea of the socioeconomic conditions there.

b) Main use of the results

- Analyze the socioeconomic conditions of the angle tower locations
- Estimate the cost required for involuntary land acquisition for the base area of each tower and compensation.

c) Selection of interviewees

The interviewees were the land owners of angle tower locations:

Table 3-17 Profile of Interviewed Households

Angle Tower No.	House-hold No.	Location				Main Occupation
		Village	Union	Mauza	Upazila	
Chittagong District						
P1	No.1	Boalia	Borashat	Boalia	Anowara	Agriculture
P2	No.2	Barumchara	Barumchara	West Barumchoda	Anowara	Agriculture
P3	No.3	Barumchara	Barumchara	Barumchara	Banshkhali	Agriculture
P4	No.4	Raichatta	khankhana bad	Raichatta	Banshkhali	Agriculture

Angle Tower No.	House -hold No.	Location				Main Occupation
		Village	Union	Mauza	Upazila	
P5	No.5	Chechuria	6 No. Ka, Katharia	Purbo Katharia	Banshkhali	Businessman
Cox's Bazar District						
P6	No.6	Barabakia	Barabakia	Fasiakhali Rahatali para	Pekua	Agriculture
P7	No.7	Barabakia	Barabakia	Fasiakhali	Pekua	Service provider
P8	No.8	Uzantia	Uzantia	Sutachuda	Pekua	Shrimp cultivator
P9	No.9	Matarbari	Matarbari	Maiz Para	Maheshkhali	Businessman
P10	-	Matarbari	Matarbari	Maiz Para	Maheshkhali	-

Note: Land area of P9 and P10 belong to government, and there was nobody renting the land on P10.

(Source: JICA Study Team)

d) Survey Method

A questionnaire-based survey was conducted at household. The survey focused on income-earning activities and other socioeconomic indicators to observe the social and economic conditions of land owners / lessees, such as income, expenditure, employment, education, skills, livelihood, utilities, health services facilities, social services, and other socio-economic and cultural aspects that prevailed in the locations of angle towers.

e) Interviewers

Researchers representing the Engineers Associates Ltd., who were commissioned by the JICA Study Team, conducted the survey on behalf of PGCB.

f) Survey period

December 2012.

g) Limitation of the survey:

Locations of suspension towers were not surveyed as the locations were not identified yet at this stage. Findings at the angle tower locations through household interviews and focus group discussions therefore do not represent the local context throughout the transmission line route.

(2) Focus Group Discussions

a) Objective

The focus group discussions aimed to collect specific information from particular groups, such as women and children who were regarded as vulnerable, and agricultural farmers, who were mostly found at the transmission line route, in order to evaluate their specific characteristics.

b) Main use of the results

- Analyze the specific conditions of particular clusters of populations, who were placed in such groups with or without their wishes
- Draw specific needs of the vulnerable groups

c) Selection of interviewees

Eighteen people were randomly sampled (five children, five women and eight farmers) at either of angle tower locations.

Table 3-18 Interviewed Population in Focus Group Discussion

Cluster	Location	Number of People	Age Range (as of Dec. 2012)
Children	P8	5	7 to 10
Female	P7	5	29 to 40
Farmers	P3	8	28 to 65
Total		18	

Source: JICA Study Team

d) Survey Method

Focus Group Discussions

e) Interviewers

Researchers representing the Engineers Associates Ltd., who were commissioned by the JICA Study Team, conducted the FGDs on behalf of PGCB.

f) Survey period

December 2012.

g) Limitation of the survey:

Not applicable.

3.2.2 Findings

(1) Profile of Interviewees

a) Length of Time Residing at the Site

The length of time of households residing at the site varied from 20 to 100 years from one generation to the next.

b) Size of Household

The number of household members varied from five to eighteen, and the average size was 10.2.

c) Education Level and Literacy

Three out of nine respondents were illiterate or could write their own signature only. Others varied from Class VI-X to MA. Out of total members of nine families, 92 people, 61 were literate. 67.4% of adults and 65.3% of children were literate. Compared between male and female, 72.9% of male population were literate, whereas literate female remained 59.1% of total female population. Gender gap in literacy was caused by the low literacy of female adult (55.0%).

This tendency was also found among female respondents in the FGDs. Among three different groups (female at P7, children at P8 and male farmers at P3), no women of five members were literate, whereas all five children and eight farmers were literate.

d) Health Conditions of Affected People

Of nine respondents, all of them said they suffered from general fever, seven suffered from respiratory infection such as cold, six suffered from diarrhea and stomachache, and five from eye problem.

In the FGDs, four women had suffered from malaria. Respiratory problems, general fevers were commonly seen. Among children, respiratory problems and general fevers were commonly admitted. Three of them suffered from diarrhea and stomachache. Farmers' group members also showed similar tendency: six of them suffered from general fevers, diarrhea/stomachache, and respiratory diseases.

(2) Occupations of Household Heads

Among the interviewed household heads, five were involved in agriculture. Two were businessmen (P5 and P9). One was involved in service industry (P7), and the other (P8) was a shrimp cultivator. Their secondary livelihood means varied from Imam, UP member, travel agent, and construction worker.

According to the ad-hoc interviews at P3, P4, P5, P7 and P8 locations, most of the population in the villages depended on agriculture as farmers and agricultural laborers. People working abroad, business and services industry were also found. At P8, however, shrimp and salt cultivation were found as their secondary occupations.

The husbands' occupations of female group of FGD at P7 were: two salt laborers, two daily laborers, and one agriculture laborer. The fathers' occupations of children group at P8 were: two involved in fishing industry, two daily laborers, and one rickshaw puller.

(3) Household Incomes and Expenditure

a) Household Incomes

For monthly income, five households involved in agriculture of socioeconomic survey had 20,000 to 60,000 taka per month. Two involved in business had 40,000 taka and 43,000 taka. One involved in service industry only had 12,000 taka. The biggest income was found at a household whose occupation was shrimp cultivator: 80,000 taka per month.

Female group of FGD (P7) said that their husbands' income varied from 4,500 to 6,000 taka per month who were all laborers. Among fathers of children group (P8), laborers and rickshaw puller received 5,000 to 7,000 taka, while two involved in fishing industry earned either 10,000 or 20,000 taka per month.

b) Household Expenditure

Household expenditure ranged from 11,750 to 57,250 taka. The average household expenditure was approximately 32,000 taka. Of all items, respondents spent most for food (average: 17,000 taka, max: 30,000 taka and min: 6,000 taka), followed by expenditure for agriculture activities (average: 5,000 taka, max: 13,000), health (average: 2,700 taka, max: 8,500 taka, min: 300 taka) and education (average: 2,000 taka, max: 5,000 taka, min: 350 taka).

c) Per Capita Income and Expenditure

Taking the geographical location of the project site and the inflation rates of FY 2010 and FY 2011 into consideration, the surveyed population whose per capita income and expenditure were below 1,500 taka were assumed as the poor in this report. The owners and a lessee, and their family members of the angle tower locations from P1 to P9 are not assumed as poor both on income and expenditure basis. Their per capita income ranged from 3,000 to 8,000 taka, and their per capita expenditure ranged from 1,958 to 4,250 taka.

(4) Assets

Out of nine interviewed households, all of them had at least one mobile phone and agriculture tools. Six of them had fishing nets and five of them had either table fan or ceiling fan. In regards to animals and poultry, six kept chickens at home, followed by cow (five households), ducks and goats (four).

(5) Basic Infrastructure for Living

a) Housing condition

Among participants of FGDs, houses of women were made of clay and thesis. Children's houses were made of clay: two had tin as their roof material, and three had thesis. Among farmers, two lived in bamboo-made houses, three lived in permanent houses, two lived in clay-walled house, and the last one lived in a house made of thesis and tin.

b) Energy Source

Five of nine land owners and a lessee of the angle towers had electricity at home. All of them use firewoods for cooking. They use electricity or kerosene for lighting. They use diesel for irrigation purpose.

Among female group members at P7 location, three had no electricity yet and two had lighting only by solar panels. Children group at P8, three had no electricity yet, and two had lighting only by solar panels. One of farmers of P3 location had solar panels at home, but others had no lights at home.

c) Water and Sanitation

All land owners and a lessee used tube wells for water. They had no habit of boiling water before drinking. No respondent said their water was contaminated with arsenic. Six of them had pucca latrine, and three had ring-slab latrines.

Among members of FGDs, all women, children and farmers in the groups took water from tube wells for cooking and drinking purposes. All women and children had ring-slab latrine (hygienic latrine).

d) Medical Facilities

People under the socioeconomic survey went to either markets or towns for medical treatment. Women and children of FGDs went to Upazila Health Complex for medical treatment. All farmers saw quack doctors for general diseases. They went to private doctors in Bottoli and Chittagong for more complex diseases.

e) Tidal Waves

All nine interviewed household heads said they had experienced tidal waves once to three times a year. They mentioned the floods of 1991 and 1997 as the biggest ones which they remembered.

(6) Others

a) Source of Information

As source of information, all respondents said they collected from their neighbors. Seven of them collected information from TV as they watched TV at tea stands or in the local markets, followed by mosque imam (five people), community leader (four people) and friends (three).

Among FGD participants, women collect information through NGO workers and neighbors, but not from TV or radio. Children collected information through TV, neighbors and their teachers.

b) Type of Pollution

No major pollutions were recognized among nine respondents in the socioeconomic survey, except snow mat.

c) Available Job Opportunities

Responding to whether there were any job opportunities available around the project site, the land owners from P1 to P7 stated that there was no job opportunity available. The land owner of P8 said that there would be job opportunities in shrimp farming.

d) Skill Development Needs

In response to the needs for skill development, household heads answered that they would like to learn tailoring, salt farming technique, shrimp farming technique, training for working abroad, computer skill, and agriculture farming technique.

3.3 Local Consultation

CPGCBL has so far conducted two public consultation meetings (PCM) with the support of the JICA Study Team and EAL. The following is a summary of the meetings.

3.3.1 First Public Consultation Meeting

(1) Objectives

- Disclose information about the project
- Collect opinions and comments from individuals and organizations regarding the project
- Appropriately reflect such opinions, etc., into the LARAP

(2) Consultation Results

The first PCM was held at the scoping stage of the Feasibility Study of the Coal-fired Power Plant Development Project. CPGCBL hosted the meeting assisted by the JICA Study Team. Notification letters were distributed to all key stakeholders prior to the meeting. Outcomes of the meeting were shown below.

Table 3-19 Outcomes of First PCM

Date & Time	From 10am to 2pm, November 14, 2012
Venue	Puran Bazar Government Primary School, Matarbari, Maheshkhali Upazila, Cox's Bazar District
Host and Chair	Mr. Aloke Kimar Sarker, Managing Director of CPGCBL
Participants	Local affected residents, community leaders, local elite people, local government officers, local NGOs, etc., a total of 115

Agenda	- Registration - Recitation of Quran - Welcome Speech by MD, CPGC - Background of the project by CPGC - Presentation on Project Description by CPGC - Question & Answer Session - Closing Speech by CPGC - Lunch

(Source: JICA Study Team)

At the meeting, a power-point presentation with a full explanation of the project was given to the participants in their local language, to allow the audience to fully understand the project and to contribute valuable comments. Major comments raised by the participants and the responses made by CPGCBL are shown in the table below, as per the meeting minutes and list of participants attached in the Annex.

Table 3-20 Major Comments from Participants and Responses by the Project Owner

<table>
<tr><th>Comments</th><th>Response</th><th>Reflection to LARAP (or EIA)</th></tr>
<tr><td>Mr. Nazrul Islam, teacher, local school, wanted to know the exact location of the proposed power plant. He suggested selecting a site towards the Bay of Bengal.</td><td>The project owner replied that the site for the power plant had been primarily selected between Matarbari and Dhalghata Union. The site will be finalized after the social and environmental survey.</td><td rowspan="5">[Water pollution] (EIA)
- Cover installation on conveyor for coal transportation to coal yard.
- Unloading of coal will be minimized (e.g., reduce the frequency of activity, etc.) during times of high speed winds.
- Watering coal yard to keep the surface wet and prevent wind blowing coal and dust.
- Installation of a dust control fence
- Re-greening especially along boundary of project, surrounding coal yard with domestic plants
- Water quality of tube wells and others will be checked periodically for the safety of local residents.

[Employment]
- Employ local residents as much as possible.
- Developing an appropriate “land acquisition and resettlement action plan”, including “livelihood restoration program”
- Enrollment in vocational</td></tr>
<tr><td>Mr. Saiful islam, job holder, LGED, Matarbari, commented that the main profession of local people of Matarbari is sea fishing. If hot water from the power plant is discharged into the sea, it will harm the fish. Therefore, the fishing profession will be affected.</td><td>The project owner replied that hot water will be cooled down to almost normal temperatures and then it will be released submerged into the sea without any harm to fish or other aquatic animals.</td></tr>
<tr><td>Mr. Nurul Islam, Ex-Chairman Matarbari Union Council, wanted to know whether priority will be given to the affected people who will lose their livelihoods due to the power plant in Matarbari.</td><td>The project owner assured the audience that local people will be given high priority for employment in the project and related industries as well.</td></tr>
<tr><td>Mr. Kamrul Hassan Hanif, student, Matarbari, pointed out that agricultural land is normally affected by fly ash or dust produced from the coal-based power plants. As a result, agriculture is also affected. He also pointed out that people may suffer from respiratory problems.</td><td>The project owner replied that this power plant will be constructed using Ultra Super Critical (USC) technology and only negligible dust will be produced. As a result, agricultural land, agriculture and public health will not be affected.</td></tr>
<tr><td>Mr. G.M. Somi Uddin, Chairman of Matarbari Union Awami league, requested to hold the next meeting in the project area to motivate more people of the area to participate in the meeting. He also demanded the following points:
a. Local residents should be given high priority for employment in the project.
b. Local competent people should be</td><td>The project owner gave assurances that the next stakeholder meeting will be held at the project site.
He also confirmed that local people will be given priority for employment in the project based on their skills.
The affected salt farmers and fishermen will be compensated and rehabilitated.
Regarding social facilities, he was told</td></tr>
</table>

Comments	Response	Reflection to LARAP (or EIA)
employed in the project. c. Roads, schools, colleges, fishery jetties, and health centers shall be developed. Roads along the east side and west side of Matarbari island should be made of *pucca*. d. The protective structure along the west coast of Matarbari island should be made very strong and permanent to protect the people of Matarbari from cyclones, tidal waves and erosion. e. Compensation for acquisition of land should be paid at least three times the present rate. f. No households should be damaged. g. All affected fishermen and salt farmers should be compensated and rehabilitated. h. The road from Matarbari to Chittagong should be improved. i. Electricity should be supplied to the people of Matarbari at a subsidized rate. j. The plant should be constructed in such a way that it does not cause any damage to the environment and location.	that the plant authority will establish a school, college and hospitals, etc., for the staff of the plant. Local people will also be able to use the above facilities. Apart from this, other infrastructure shall be developed in the Matarbari area to attract tourists as well. The compensation of the land shall be paid as per prevailing rules of the Government of Bangladesh.	training courses based on assessment of skills **[Air pollution] (EIA)** - To reduce PM emissions, Electrostatic Precipitator (EP; around 99.8% efficiency) will be installed. - Duct will be provided with CEMS (Continuous Emission Monitoring System) with the supported infrastructure as required under the gas emission standards and IFC guideline **[Protective structure]** -Coordination will be continuously made with local authorities to improve the local infrastructure. **[Compensation]** - Compensation under the Law (CUL) for all the private land as stipulated by the Ordinance 1982: average of last 12 months' sales values of same kind of land X 1.5 (50% premium) - Cash grant that covers the difference between CUL and the replacement value (RV) - Provision of stamp duty, land registration fee, capital gains tax and value added tax incurred for replacement land **[Electrification]** Electrification of surrounding area will be examined.

(Source: JICA Study Team)

3.3.2 Second Public Consultation Meeting

(1) Objectives

- To update information on study progress (location of Power plant and anticipated social impact)
- To discuss possible actions and measures for the local residents
- To discuss implementation mechanisms

(2) Consultation Results

The meeting was presided over by Mr. ATM Zahirul Islam, Managing Director, CPGCBL, assisted by the JICA Study Team. Notification letters were distributed to selected representatives of the affected people prior to the meeting. Chairmen of Matarbari Union and Dhalghata Union, UNO of Maheshkhali Upazila, DOE of Cox's Bazar District, and a local NGO were consulted prior to the PCM. Results of the meeting are shown below.

Table 3-21 Outcomes of Second PCM

Date & Time	From 11:30 a.m. to 2:00 p.m., February 13, 2013
Venue:	Chakaria Upazila Parishad Auditorium
Host and Chair	Mr. Aloke Kimar Sarker, Managing Director of CPGCBL
Participants	Local affected residents, Union Chairmen, local elites, local government officers, local NGOs, etc., a total of approximately 50
Agenda	- Registration - Recitation of Quran - Welcome Speech by MD, CPGCBL - Opening Remarks by Team Leader of JICA Study Team - Presentation on Project Description by EAL - Question & Answer Session - Closing Speech by CPGCBL - Lunch

(Source: JICA Study Team)

Table 3-22 Major Comments from Participants and Responses by the Project Owner

Comments	Response	Reflection to LARAP (or EIA)
Md. Aminul Haque Choudhury, teacher, Dhalghata Ideal High School, worried that there were rumors about the negative impacts on ecological balance, air quality, water quality, biodiversity, fish cultivation, livelihood, etc., in the project area if the power plant was constructed. He said that the affected people must be relocated as well. He wanted to know the extent of impacts if the power plant was constructed.	CPGCBL responded that the JICA Study Team was conducting a social and environmental survey in the project area to assess the impacts of the power plant. He also mentioned that the power plant would be environmentally friendly and the quality of the environment would be ensured by the department of environment. He mentioned the access road to be constructed for the power plant which would ease travel in the area. He clearly stated that local people would have employment opportunities in the power plant depending on their skills.	**[Water pollution] (EIA)** - Cover installation on conveyor for coal transportation to coal yard. - Unloading of coal will be minimized (e.g., reduce the frequency of activity, etc.) during times of high speed winds. - Watering coal yard to keep the surface wet and prevent wind blowing coal and dust. - Installation of a dust control fence - Re-greening especially along boundary of project, surrounding coal yard with domestic plants - Water quality of tube wells and others will be checked periodically for the safety of local residents. **[Employment]** - Employ local residents as much as possible. - Developing an appropriate “land acquisition and resettlement action plan”, including “livelihood restoration program” - Enrollment in vocational training courses based on assessment of skills **[Air pollution] (EIA)** - To reduce PM emissions, Electrostatic Precipitator (EP; around 99.8% efficiency) will be installed. - Duct will be provided with CEMS (Continuous Emission Monitoring System) with the supported infrastructure as required under the gas emission standards and IFC guideline **[Protective structure]** -Coordination will be
Mr. Faridul Alam, an NGO worker, pointed out that Matarbari was famous for shrimp cultivation. If the land was to be acquired, shrimp cultivation would be affected. Also, private land owners would lose their land. On the other hand, there was lot of government land unused in Chokoria Upazila and he suggested acquiring the government land in Chokoria Upazila to construct the power plant instead of Matarbari.	CPGCBL responded that there were several selection criteria to select the location of the power plant. Availability of land was one of the selection criteria. But the availability of fuel was also another criterion. In the proposed power plant the primary fuel would be imported coal which would require transportation and unloading facilities. In Matarbari, coal might be imported from foreign counties by large vessels and an unloading jetty facility would be created there. But Chokoria was far away from the Bay of Bengal, so the JICA Study Team selected the Matarbari site for the power plant.	
Mr. Faizul Karim, salt businessman, Sairer Dail, Matarbari, wanted to know whether any embankment would be constructed in Matarbari and Dhalghata if the power plant was to be constructed. The people who were passing the government land with their livelihood from cultivating those lands would be affected if the power plant would be constructed. He asked whether these affected people would get compensation or not. He also wanted to know whether those who would lose their houses in the project area would be resettled or not.	CPGCBL responded that the affected people would be compensated as per Bangladesh Laws (Ordinance 1982) through the district administration. There was no provision for compensating illegal residents or occupants of government land. But as per JICA guidelines, illegal residents or occupiers should also be compensated. The JICA Study Team was working on this issue and the illegal residents/occupants would also be compensated in accordance with JICA’s guidelines and Bangladesh government laws through the district administration. Regarding the embankment, he was unable to comment, but gave assurances that an access road would be constructed along with the power plant.	
Mr. Nazrul Islam, a resident of Sairer Dail, Matarbari, wanted to know whether residents would receive free electricity. He also wanted to know whether they would get employment opportunities at the power plant.	CPGCBL responded that the surrounding area of the power plant would certainly get electricity extended there, and the electricity would be as per standard rates fixed by the government. Regarding employment opportunities, assurances were given that priority would be placed on hiring local people	

Comments	Response	Reflection to LARAP (or EIA)
	in the power plant depending on their skills.	continuously made with local authorities to improve the local infrastructure. **[Compensation]** - Compensation under the Law (CUL) for all the private land as stipulated by the Ordinance 1982: average of last 12 months' sales values of same kind of land X 1.5 (50% premium) - Cash grant that covers the difference between CUL and the replacement value (RV) - Provision of stamp duty, land registration fee, capital gains tax and value added tax incurred for replacement land **[Electrification]** Electrification of surrounding area will be examined. **[Education]** School facilities at power plant will be shared with the local residents. **[Health]** Health facilities at power plant will be shared with the local residents.
Mr. Shariful Islam, Assistant Director, DoE, Cox's Bazar, said that coal-based power plants had negative impacts on the environment. But, the negative impacts could be mitigated by using the latest technology. He, however, raised the point that some birds were observed flying in the power plant area. He was worried about the negative impacts on the birds by the high stack/ chimney of the power plant. He then requested the JICA Study Team to design the height of the stack/chimney properly to avoid any negative impacts on the birds. He also suggested adopting adequate mitigation measures to keep SOx and NOx of ambient air quality within standard limits. Warm water of the power plant should be discharged into the sea in such a way that aquatic plants/animals were not affected. He assured the local people not to worry about the implementation of this power plant as the DoE is the enforcing agency of the GOB to ensure a pollution free environment.		
Mr. Aminul Haque learnt that forestation for 20 years was needed if a coal-based power plant was to be constructed. In order to meet the present power crisis in Bangladesh, he said that nobody could wait 20 years to construct a coal-based power plant.	CPGCBL responded that the latest coal-based power plant would be environment friendly. Forestation and other necessary mitigation measures might be undertaken during the construction/ operation period.	
Mr. Ahsanullah Bacchu, Chairman, Dhalghata Union Council, welcomed the initiative to construct a coal-based power plant in Matarbari. He expected that an embankment, roads, schools/ colleges, and hospitals would be developed at Matarbari island. He learned that an access road would be constructed up to the power plant site, and requested the concerned authority to extend this access road up to Dhalghata via Mutila for about 5-6 km. He also requested the construction of hospitals and schools/ colleges around the power plant area for area development. He urged that project affected people be properly compensated.	CPGCBL responded that another JICA Study Team was conducting a feasibility study of the access road for the power plant. A similar public consultation meeting would be held for the access road also. He requested Mr. Bacchu to raise this issue in that PCM to include an additional 5-6 km road up to Dhalghata via Mutila. Regarding the construction of schools/colleges and hospitals outside the power plant, he said that sincere cooperation would be extended with other development agencies to construct the above facilities. However, schools/colleges, hospitals. etc., would be constructed in the power plant area for the power plant employees. He gave assurance that the above facilities would be accessible to the public residing around the power plant.	

Comments	Response	Reflection to LARAP (or EIA)
Mr. Enamul Haque Choudhury Ruhul, Chairman, Matarbari Union Council, told the meeting that there were both positive and negative perceptions for construction of a coal-based power plant in Matarbari. The local residents were very concerned about the negative impacts of the power plant. They must be motivated before the construction of this power plant so that they would not raise any objections against the construction of this plant.	CPGCBL responded that the project would be implemented after motivating the local people and satisfying all criteria set by the Government of Bangladesh and JICA as well.	
Md. Anwarul Naser, UNO, Maheshkhali Upazila, told the meeting that electricity was a very essential commodity for modern civilization. In order to meet the power crisis, he said that it would be essential to construct a big power plant. Some rental and quick rental power plants had been installed in Bangladesh to overcome the immediate power crisis, but the cost of energy of these power plants was very high. On the other hand, the cost of energy of this coal-based power plant would be very low. He therefore urged everybody to come forward with GOB to implement this big power plant. He gave assurances that the project affected people would be properly compensated and resettled as per the government and international rules.		

(Source: JICA Study Team)

Chapter 4 Detailed Description of Impacts and Category of PAPs

4.1 Power Plant

4.1.1 Pre-construction Phase and Construction Phase

(1) Land Acquisition

Findings: It is anticipated that 16 households currently living on the site without permission and four households who purchased the land will have to vacate their domiciles due to the land acquisition for the construction of the power plant. Apart from resettlement, land owners of the project site area will lose their land. Employers/ employees of salt farms and shrimp farms will lose their means of livelihood. Those people who run business, employers or employees at salt farms and shrimp farms in the site will lose their livelihood means. Note that the site selection was reconsidered to the present site from the previous one (2 km south), where large settlements were found on private land, in order to avoid a large-scale resettlement.

343 households and 2,031 people will be affected by the construction of the power plant and the port facility. They had complex land use patterns: some of them had lands of their own, rented additional private land and government land; some others had no land but rented private land and had domicile without permission. The following table shows the anticipated impact to the 343 households. The number of household for each category is cumulative as most of households have several kinds of statuses to the land they use.

Table 4-1 Anticipated Social Impact to 343 Households (Power Plant)

Category		Impact	No. of HH (cumulative)	No. of HH Members (cumulative)
Owners of private land				
	Own & live	Lose land ownership Lose shelters and be physically displaced	4	25
	Own but do not live	Lose land ownership	237	1,429
Users of private land (lease)		Lose tenant rights	77	460
Users of government land with official agreement		Lose tenant rights	10	70
Users of government land without official agreement		Lose occupancy of land	140	844
Squatters living on government land		Lose occupancy of land for living place Lose shelters and be physically displaced	16	86

Note: HH means household.

(Source: JICA Study Team)

Mitigation Measures: Not only a compensation plan but also a livelihood restoration program for affected people shall be established.

(2) Disturbance to Poor People

Findings: There are poor households among those to be resettled and/or will lose their livelihood. The household monthly income of 343 households (2,031 people) directly and indirectly affected by this project is from zero taka to 842,000 taka, and the income of nearly 60% of the households is within the range of 10,000 taka to 30,000 taka. For individual monthly incomes, 44% of the all family members fall into the range of 2,000 taka to 4,000 taka.

According to the national household revenue and expenditure survey conducted in 2010, the poverty line of agricultural area of Bangladesh is 1,211.57 taka per person/ month, and Chittagong District is 1,304.64 taka per person/ month. Setting the poverty line at 1,500 taka per person/ month for the proposed power plant site at the end of 2012, less than 10% of the local population falls below the poverty line on income basis. This rate is far better than the poverty rate of rural areas for the whole of Bangladesh (35.2%), and of the Chittagong District (31.0%).

Mitigation Measures: Their living conditions will not deteriorate compared to their current conditions, and they will have job opportunities at the construction site.

The employment of local people should be promoted to increase employment opportunities for various subcontract work resulting from the power plant construction activity. However, approximately 70% of heads of household are illiterate or can only write their signatures, so these people can only be engaged in very simple tasks due to their lack of skills. Livelihood restoration measures shall be established, including job training for those who want it.

(3) Deterioration of Local Economy such as Losses of Employment and Livelihood Means/ Land Use and Utilization of Local Resources

Findings: It is expected that employers and employees of salt farms, shrimp farms, and fishermen will lose their means of livelihood. Fishing activities around the site will also be affected due to a rise of water temperature and restriction of fishing. The implementation of this project will change the traditional land use patterns and utilization of local resources, which may have a large impact on the existing local economy.

About 70% of the heads of 343 households that will be directly or indirectly affected are working in salt or shrimp farms as laborers, mazi, businessmen or cultivators. Including laborers from outside, there are 165 permanent and 892 temporary employees involved in shrimp cultivation, salt farming, fishing activities and others. There are also twelve sharecroppers. Twenty two businessmen stated they received cash income from the salt business and three stated they received income from agriculture. There was also one boatman, six carpenters, and one tea seller.

Approximately 70% of heads of household are illiterate or can only write their signatures, so they can only be engaged in very simple tasks due to their lack of skills.

The sandy beach is 7km long at the west coast of Matarbari Island, according to the Maheshkhali Upazila Officer. The width of the navigation channel to be altered is 400m and the length of discharge outlet is 100m, resulting in less than 10% of the sandy beach becoming disappeared. Then fishing ground for push net will be loss.

Fishermen around the project site fish offshore (3-50km from the coast), and as all dredged material will be land filled into land sites, not disposed into the ocean, therefore, there is no expected impact on fishery by the power plant construction.

The catches of shrimp fly in the coastal area may be affected by the change of the sand beach due to the construction of the navigation channel and water outlet.

Mitigation Measures: Although the number of salt and shrimp farms will decrease due to the construction of the power plant, employment opportunities will increase for various subcontract work of the construction. Local people will be given priority in employment. Livelihood restoration measures shall be established, including job training for those who want it. Decreased income from shrimp-fly fishing of the fishermen may be easily supplemented by increased job opportunities and job switching. Job training shall be provided for those who want it in order to assist in livelihood restoration.

(4) Disturbance to Water Usage, Water Rights, etc.

Findings: All water to be used for the construction work will be transported by vessels and stored in a tank. Ground water and river water will not be used.

The local economy may be affected by turbid water discharged from the construction site. Outflows of street dust and oil during rainy periods may also have certain effects. The turbid water discharged from the construction site and any oil spills may affect the water quality of the marine area, rivers and ground water, and adequate mitigation measures shall be taken.

Mitigation Measures: Water quality of well water, which is the main supply of drinking water, shall be monitored in order to monitor any adverse effects on ground water.

(5) Disturbance to Existing Social Infrastructure and Services

Findings: As material and equipment transportation will be mainly conducted by vessels, increased marine traffic may disturb existing marine traffic including fishing boats. Additionally, vehicles transporting commuting workers may cause increased traffic and traffic jams around the project area.

Mitigation Measures: In regard to vessels, water routes shall be determined after consultation with the related authorities. And in regard to vehicles, bus use will be promoted to reduce increasing the number of vehicles on the roads. The bus schedules shall be managed in consultation with related organizations.

(6) Social Institutions such as Social Infrastructure and Local Decision-making Institutions

Findings: Laws of Bangladesh stipulate the need to conduct public consultations in land acquisition processes. The Deputy Commissioner’s Office of Cox’s Bazar District will officially take responsibility for initiatives to conduct local consultations concerning compensation.

Mitigation Measures: A number of consultations with local residents have been conducted in preparing the draft LARAP. In consideration of changing emotions of local residents over the course of negotiations with office staff, personnel responsible for responding to complaints or suggestions from local residents will work at the power plant office in the resettlement process.

(7) Misdistribution of Benefits and Compensation -

Findings: There is a possibility of unequal compensation among local residents.

Mitigation Measures: Equality of compensation shall be assured in the resettlement process.

(8) Local Conflicts of Interest

Findings: Local conflicts may occur between local residents who may feel that they receive unfair compensation and other local residents or conflict with staff of the Deputy Commissioner’s Office. Conflict may occur between local residents and external workers because of any changes to local customs if external workers cannot understand local customs.

Mitigation Measures: A number of consultations with local residents have been conducted in preparing the draft LARAP. In the resettlement process, personnel responsible for responding to complaints or suggestions from local residents will work at the power plant office.

Local people should be employed at the power plant to the maximum extent possible, and any workers from other countries should be taught to respect local customs in order to facilitate good relationships with local people. The lodgings of the project workers should be equipped with sufficient living facilities to keep workers at the project site as much as possible.

(9) Gender

Findings: There are women among those to be resettled and/or lose their livelihood means. They currently have low living standards, living without proper facilities, will have better access to social services throughout the year. However, wives of those men who lose their land or jobs may suffer from adverse effects on their household economy.

(10) Children's Rights

Findings: Children are often forced to work and cannot attend school, and this may occur in the construction stage of the power plant as well. There will be children among those to be resettled and/or lose their livelihood means. Children from those households losing their land or jobs may suffer from adverse impact on their household economy such as drop-out of school.

Mitigation Measures: Labor contracts between the construction industry and children shall be prohibited. Regular patrols to check for child workers shall be conducted.

(11) Infectious Diseases such as HIV/AIDS

Findings: A temporary influx of migrant labor during the construction period may increase the risk of sexual transmitted diseases, etc.

Mitigation Measures: Local people should be recruited for simple work as much as possible so to minimize the risk of infectious diseases being transmitted from external workers. Pre-employment and periodic medical check-ups should be conducted for external workers (technical workers, etc.).

(12) Work Environment (Including Work Safety)

Findings: A high risk rate of accidents is predicted for the construction work.

Mitigation Measures: Construction companies should establish work safety plans and submit them to CPGCBL to obtain approval. Work safety plans should stipulate mitigation measures on soft aspects (safety training, etc.) and hard aspects (provide workers with appropriate protective equipment, etc.).

(13) Accidents

Findings: Land traffic and marine traffic accidents during construction work may occur.

Mitigation Measures: As prevention measures for land traffic accidents, observation of traffic regulations, and training and education on safe driving will be implemented. The bus schedules shall be communicated to people in the surrounding villages. For vessel operation, marking buoys will be set around the construction area for marine safety. Vessel schedules shall be announced to fishermen, etc.

4.1.2 Operation Phase

(1) Disturbance to Poor People

Findings: Resettled people may experience a deterioration of their household economies and livelihood losses due to their relocation if appropriate measures are not taken. The road around the project site is especially in a bad condition (not possible to travel in the rainy season), preventing local access to social services.

Mitigation Measures: Poor people, who currently have low living standards, living without proper facilities, will have better access to social services throughout the year if roads are improved along with the construction of the power plant, especially improved access during the rainy season. An access road, a community road that will replace the existing road and a road around the power plant boundary shall be built. These roads will be built with sufficient height so that they can be used even in the rainy season.

Local people should be employed to work at the power plant and related facilities to the maximum extent possible according to their skills.

(2) Deterioration of Local Economy such as Losses of Employment and Livelihood Means/ Land Use and Utilization of Local Resources

Findings: There will be permanent losses or reduction of livelihood means in salt farming, shrimp farming and fishing activities. Employment opportunities will be offered at the power plant for local people.

The implementation of this project will change the traditional land use patterns and utilization of local resources, which may have a large impact on the existing local economy. Both fishermen around the project site who operate in the marine area (3-50km from the coast) outside of the adverse effects of thermal effluents and other wastewater discharge of the power plant, and fish catches, will not be affected.

Mitigation Measures: Local people should be employed to work at the power plant and related facilities to the maximum extent possible according to their skills. Livelihood restoration means shall be conducted including job training for those who want it. Services (e.g., laundry, catering services, etc.) and products offered by the local community should be used by the power plant as much as possible. Efforts for area development will be promoted, including the establishment of a local development plan in cooperation with the local government.

(3) Disturbance to Water Usage, Water Rights, etc.

Findings: In the operation phase, all water used for the project will be supplied not from ground water or river water, but from sea water desalinated by reverse osmosis. The local economy may be affected by discharged water from the power plant into the sea.

Mitigation Measures: Wastewater generated from the power plant will be appropriately treated before discharge. Waste will also be appropriately treated and disposed of, with necessary countermeasures to prevent any seepage of oil and chemicals.

(4) Disturbance to the Existing Social Infrastructure and Service

Findings: Traffic volume and traffic jams will increase in the surrounding roads during the operation phase.

Mitigation Measures: Mitigation measures to decrease traffic volume shall be conducted, such as the promotion of bus use. Additionally, an access road, community road and road around the power plant boundary shall be built. These roads will be built with sufficient height so that they can be used even in the rainy season, in order to enable public access to markets and social services.

In addition, a school and medical facility constructed within the power plant site shall be open to all local people for the improvement of their lives.

(5) Misdistribution of Benefits and Compensation

Findings: People who live in other areas have limited access or have been prevented from accessing the school and medical facility within the power plant site and the access road, which may cause grievances.

Mitigation Measures: The access road, school and medical facility constructed within the power plant site shall be open to all local people to the maximum extent possible in order to improve peoples' lives.

(6) Local Conflicts of Interest

Findings: Local conflicts of interest may occur between employers and employees of salt farms, shrimp farms and the fishing industry, and between local administration bodies and local political leaders. Conflicts among local residents may occur if such benefits were misdistributed.

Mitigation Measures: Local people should be employed at the power plant to the maximum extent possible, and workers from other countries should be taught to respect local customs in order to facilitate good relationships with the local people. The lodgings of project workers should be equipped with sufficient living facilities in order to keep workers at the project site as much as possible.

The access road, school and medical facility constructed within the power plant site shall be open to all local people to the maximum extent possible for the improvement of peoples' lives.

(7) Gender

Mitigation Measures: Residents will have better access to social services throughout the year if roads are improved along with the construction of the power plant, especially access during the rainy season.

(8) Children's Rights

Findings: There is a possibility that children may be forced to work and not attend school. Further, children's rights to go to school may further deteriorate if the access way to their school is physically blocked by the construction site.

Mitigation Measures: Labor contracts between the subcontractors and children shall be prohibited. Regular patrols to check for child workers shall be conducted. The access road, community road and road around the power plant boundary shall be built with sufficient height so that it can be used even in the rainy season, so that access to markets and social services shall be improved, including access by children.

(9) Work Environment (Including Work Safety)

Findings: Work accidents involving workers may occur at the power plant site.

Mitigation Measures: CPGCBL shall establish a work safety plan. The work safety plan shall stipulate mitigation measures on soft aspects (safety training, etc.) and on hard aspects (provide workers with appropriate protective equipment, etc.).

(10) Accidents

Findings: Marine traffic and land traffic accidents may occur during plant operation. Fires caused by spontaneous ignition of stored coal may also occur.

Mitigation Measures: Observation of traffic regulations, installation of traffic signs, and training and education on safe driving shall be conducted for land traffic vehicles. For ocean navigation, determining water routes after consultation with related authorities, and setting course buoys around navigation channel for marine safety will be undertaken as prevention measures for accidents. Fire prevention measures shall be conducted including regular watering of the coal storage site, installation of fire protection equipment in the power plant and organization of fire-fighting team and fire-fighting training.

4.2 Port Facility

4.2.1 Pre-construction Phase and Construction Phase

(1) Disturbance to Existing Social Infrastructure and Social Services

Findings: Pump dredgers will be used in dredging work in the marine area, and increased marine traffic may slightly disturb the existing marine traffic including fishing boats.

Mitigation measures: The construction area shall be determined after consultation with related authorities.

(2) Work Environment (Including Work Safety)

Findings: A high risk rate of accidents is predicted during the construction work.

Mitigation measures: Construction companies shall establish work safety plans and submit them to CPGCBL to obtain approval. Work safety plans shall stipulate mitigation measures on soft aspects (safety training, etc.) and on hard aspects (provide workers with appropriate protective equipment, etc.).

(3) Accidents

Findings: Marine traffic accidents may occur during the construction work.

Mitigation measures: The navigation route of vessels shall be determined after consultation with related authorities. Marking buoys will be set around the construction area for marine safety.

4.2.2 Operation phase

(1) Disturbance to the Existing Social Infrastructure and Services

Findings: Navigation of large coal transport vessels and tankers will cause increased marine traffic, and may disturb the existing marine traffic including fishing boats.

Mitigation measures: Navigation routes shall be determined after consultation with related authorities.

(2) Work Environment (Including Work Safety)

Findings: Accidents may be caused by the entry and departure of vessels and the loading-unloading of coal.

Mitigation measures: Work safety plans shall be established that stipulate mitigation measures on soft aspects (safety training, etc.) and on hard aspects (provide workers with appropriate protective equipment, etc.).

(3) Accidents

Findings: Marine traffic accidents may occur.

Mitigation measures: Navigation routes shall be determined after consultation with related authorities. Course buoys will also be set around navigation channel for marine safety.

4.3 Transmission Line

4.3.1 Pre-construction Phase and Construction Phase

(1) Land Acquisition and Compensation

The construction of one tower base requires $2m^2$ x 4 = $8m^2$ of land. The construction of 157 transmission towers, including angle towers and suspension towers, is planned requiring a total amount of $1,256m^2$ of land acquisition. Voluntary offers of land do not require compensation, but it is assumed here that all land necessary for tower construction will be acquired.

The table below shows the details of the assumed affected people. Land acquisition will be conducted on the basis of compensation at replacement cost. As the land to be acquired for each transmission tower is small, it is not expected that there will be any semi-permanent loss of livelihood means. However, there is a possibility of temporary impact on livelihood means during the construction period.

Table 4-2 Affected people and land owners at angle tower points

Category	Impact	No. of HH	No. of HH Members
Owners of private land	- Temporarily affected during construction period	8	83
Users of government land with official agreement	- Temporarily affected during construction period	1	9
Total		9	92

In the case of acquisition of farm land, entry into such land will be temporarily halted during the construction period and hence farming will be impossible. Also, all trees within clearance distance from cables will be removed. All standing crops and trees lost by the land owners will be compensated with a market price.

(2) Deterioration of Local Economy such as Losses of Employment and Livelihood Means/ Land Use and Utilization of Local Resources

Farm land located at the base of the towers will be lost, although the total area will be small. Land owners and users of tower locations will be tentatively affected during construction period resulting in a loss of means of livelihood. In addition, land located under the transmission line will decline in value. Tall trees will be cut down. However local people will be employed for construction work.

In the case of acquisition of farm land, entry into such land will be prohibited temporarily during the construction period and hence farming will be impossible. The construction work aims to employ as many local residents as possible, and to use the services and products of the local community as much as possible.

The transmission line construction areas can be reused for farming after the completion of each transmission tower construction, except for the $2m^2 \times 4 = 8m^2$ of land used for tower bases. Therefore, adverse effects on income will be very limited.

(3) Disturbance to Water Usage, Water Rights, etc.

There may be soil runoff from the exposed soil of the embankments and cut slopes, resulting in water pollution of the downstream area of the surrounding rivers and consequently alteration of water use. The transmission line route shall avoid using steep sloping land, and any slopes used shall be reinforced with concrete, plantation or other means to minimize soil runoff and turbid water generation.

(4) Social Institutions such as Social Infrastructure and Local Decision-making Institutions

The Deputy Commissioner’s Office of Cox’s Bazar District will be responsible for taking the initiative to conduct local consultations concerning compensation. In consideration of the possible changing emotions of local residents over the course of negotiations with office staff, Compensation should be carried out in consultation with the local people.

(5) Cultural Heritage

There is a possibility that some historical, cultural and/or archaeological property and heritage may be found in the course of the construction work. In this case, construction work will be interrupted and experts will be consulted.

(6) Infectious Diseases such as HIV/AIDS

A temporary influx of migrant labor during the construction period may increase the risk of transmitted diseases. Local people will be recruited for simple work as much as possible and there is low risk of infectious diseases transmitted from external workers. Pre-employment and periodic medical check-ups shall be carried out for external workers (technical workers, etc).

(7) Work Conditions (Including Work safety)

A high risk rate of accidents is predicted during the construction work. The construction company shall establish a work safety plan and submit it to PGCB to obtain approval. The work safety plan shall stipulate mitigation measures on soft aspects (safety training, etc) and on hard aspects (provide workers with appropriate protective equipment, etc).

(8) Accidents

There may be land traffic accidents during the construction work. Also, other accidents may occur, including soil runoffs and tower breakages caused by cyclones, etc. As prevention measures for land traffic accidents, observation of traffic regulations, installation of traffic signs and training and education on safe driving will be implemented.

In addition, the transmission line route shall avoid using steep sloping land, and any slopes used shall be reinforced with concrete, plantation or other means to minimize soil runoff and turbid water generation.

4.3.2 Operation Phase

(1) Deterioration of Local Economy such as Losses of Employment and Livelihood Means

Farm land located at the base of towers will be lost, although the total area will be small. The transmission line construction area can be reused for farming after the completion of the construction, except for the $2m^2 \times 4 = 8m^2$ of land for tower bases, and any adverse effects on income will be very limited.

(2) Disturbance to Water Usage, Water Rights, etc.

Soil runoff may occur from the exposed soil of the embankments and cut slopes, resulting in water pollution of the downstream area of the surrounding rivers and possible alteration of water use. The transmission line route shall avoid using steep sloping land, and any slopes used shall be reinforced with concrete, plantation or other means to minimize soil runoff and turbid water generation.

(3) Work Conditions (Including Work Safety)

There is a risk that accidents, such as electrification and workers falling, may occur during maintenance work. A work safety plan shall be established including mitigation measures on soft aspects (safety training, etc) and on hard aspects (provide workers with appropriate protective equipment, etc).

(4) Accidents

Accidents may occur from such factors as soil runoffs and tower breakages caused by cyclones, etc. The transmission line route shall avoid using steep sloping land, and any slopes used shall be reinforced with concrete, plantation or other means to minimize soil runoff and turbid water generation.

4.4 Entitlement for Different Types of Losses

Based on the findings and analyses in the field surveys, the entitlement matrix for the PAPs at the construction site of power plant and port facility, and transmission line route has been drafted as in the table below.

Table 4-3 Entitlement matrix for PAPs (power plant, port facility and transmission line sites)

No	Type of Loss	Entitled Persons (Beneficiaries)	Entitlement (Compensation and Assistance Package)	Responsible Organizations
1.	Loss of private land	Legal owners of land	✓ Cash compensation under thelaw (CUL) for all the private land stipulated by the Ordinance 1982 is the average of last 12 months' sales values of same kind of land X 1.5 (50% premium). CUL should be estimated based on the current market value of private land, not the average of last 12 months' sales values. ✓ Cash grant that covers the difference between CUL and the replacement value (RV) ✓ Provision of stamp duty, land registration fee incurred for replacement land (15%) ✓ value added tax ✓ One-time assistance for lost income (based on monthly income for three years at minimum wage rates)	DC LAO Property Valuation Advisory Team (PVAT) CPGCBL
		Tenants and leaseholders	✓ Provision of another land including 50% premium ✓ Provision of stamp duty, land registration fee (15%) ✓ One-time assistance for lost income (based on monthly income for three years at minimum wage rates)	
2.	Loss of government land including khas land	Tenants and lessee	✓ Provision of another khas land (assuming tenants and lessee will seek private land, 50% premium is added) ✓ Provision of stamp duty, land registration fee (15%) ✓ One-time assistance for lost income (based on monthly income for three years at minimum wage rates)	DC LAO PVAT CPGCBL
		Occupants without legal tenure	✓ Provision of another khas land (assuming tenants and lessee will seek private land, 50% premium is added) ✓ Provision of stamp duty, land registration fee (15%) ✓ One-time assistance for lost income (based on monthly income for three years at minimum wage rates)	

No	Type of Loss	Entitled Persons (Beneficiaries)	Entitlement (Compensation and Assistance Package)	Responsible Organizations
3.	Permanent loss of means of livelihoods/ source of income	✓ Lessor (land owners who rent their land will lose income from land lease contract)	✓ One-time assistance for opportunity loss (based on the lease amount) (assuming the inflation rate stays 10%)	DC DOF PVAT CPGCBL
		✓ Permanent laborers ✓ Temporary laborers ✓ Sharecroppers	✓ One-time assistance for lost income (based on monthly income for three years at minimum wage rates) ✓ Enrollment in vocational training courses based on assessment of skills (@300 taka / day for 120 days)	
		Businessmen, employers of salt farms, shrimp farms and fishing sites, self-employed people	✓ One-time assistance for opportunity loss (based on the lease amount) (assuming the inflation rate stays 10%) ✓ One-time assistance for lost income (based on monthly income for three years at minimum wage rates)	
4.	Loss of residential/ commercial structures	Legal title holders Owners of structures	✓ Cash compensation for affected portion of the structure and other fixed assets at replacement cost (50% premium) ✓ Option to be compensated for entire structure if remaining structure is no longer viable ✓ Provision of all taxes, registration costs and other fees incurred for replacement structure (15%) ✓ Reconstruction grant for reconstruction / repair of the remaining structure (@15 taka / sft) ✓ Shifting allowance based on actual costs of moving (@10 taka / sft)	DC PVAT PWD CPGCBL
		Legal tenants/ lease holders of the structure	✓ Cash compensation equivalent to replacement cost of structure (or part of structure) for the portions of the structure constructed by the tenant/ leaseholder (50% premium) ✓ Reconstruction grant for reconstruction / repair of the remaining structure (@15 taka / sft) ✓ Shifting allowance based on actual cost of moving (@10 taka / sft)	
		Socially recognized owners/ unauthorized occupants	✓ Cash compensation equivalent to replacement cost of structure (or part of structure) erected by the displaced person (50% premium) ✓ Reconstruction grant for reconstruction / repair of the remaining structure (@15 taka / sft) ✓ Shifting allowance based on actual cost of moving (@10 taka / sft)	
5.	Loss of standing crops at home gardens, shrimp, and fish	Land owners, *Bargadar*, Lessee and Unauthorized occupant of land	✓ One-time assistance for opportunity loss (based on the lease amount) (assuming the inflation rate stays 10%)	DC PVAT DOF DAM CPGCBL
6.	Loss of timber and fruit bearing trees	Legal owner of land	✓ Market value of trees	DC PVAT

No	Type of Loss	Entitled Persons (Beneficiaries)	Entitlement (Compensation and Assistance Package)	Responsible Organizations
		Non-titled user of land		BFD DAM CPGCBL
7.	Temporary loss of land during construction	Owners with legal title, tenants, leaseholders	✓ Rental assistance for the period for which the land is temporarily requisitioned ✓ Temporarily requisitioned land will be returned to owners rehabilitated to original or preferably better condition	DC LAO PVAT CPGCBL
8.	Temporary loss of access to land, structure, utilities, common property resource during construction	Owners with legal title, tenants, leaseholders	✓ Provision of temporary access and relocation where possible ✓ Restoration of access to the land, structure, utilities	DC PVAT CPGCBL
9.	Temporary loss of livelihood/ source of income during construction	Business owners, tenants, leaseholders, employees, vendors	✓ One-time assistance for lost income based on monthly income for three years from products, minimum wage rates or based on actual income, verified through incomes of comparable businesses in the area	DC DOF DAM CPGCBL

(Source: JICA Study Team)

A land and property valuation survey based on the prices recorded from formal and informal sources as below will determine the RV of land and structures:

- Government price
- Potential sales price
- Potential buyer price
- Enumerated price collected in the socioeconomic survey
- Price deemed appropriate as quoted by a retired government officer living in the vicinity
- Price deemed appropriate as quoted by local intellectuals
- Price deemed appropriate as quoted by religious leaders

For the valuation of affected property, a legal body called “Property Valuation Advisory Team” (PVAT) should be formed with a neutral position to obtain endorsement on the valuations from the GOB. The PVAT shall be comprised of representatives from the DC Office, CPGCBL, and the Ministry of Power, Energy and Mineral Resources (MOPEMR). The PVAT will recommend the replacement values of land and structures to the MOPEMR. CPGCBL will pay the difference between the RV and the compensation under law (CUL). In the case of any depreciation costs deducted from affected structures in the CUL by the DC, CPGCBL will pay the same as additional construction grants to re-settlers. It will also pay stamp duty and land registration fees when replacement land purchases are confirmed.

Chapter 5 Livelihood Restoration and Improvement Plan

5.1

The livelihood restoration and improvement plan will be implemented based on consultation with PAPs and their socio-economic profile, living environment, level of education, etc. which were identified in the socioeconomic survey. CPGCBL have agreed to incorporate the following measures into livelihood restoration program.

Table 5-1 Livelihood restoration measures

Current situation	Negative impact	Program
- Nearly 80 % of Household heads are illiterate or only write their names. - Only 43 % of the affected people are literate	- Hard to find job - Access to information is limited	- Power plant offers literacy classes to local children
- Skills remain undeveloped - Women stay home	- Hard to find good jobs - Salary stays low	- PS arranges skill training classes
- Job opportunity: limited	- High unemployed rates - Daily labor - Children drop out of school	- PS offers jobs at PS and associated facilities

(Source: JICA Study Team)

Chapter 6 Organizational Responsibilities and Implementation Procedures

6.1

The following figure shows the implementation schedule of LARAP. Major actions taken by CPGCBL are summarized down below:

6.1.1 Finalization of land acquisition and resettlement action plan

CPGCBL is the implementing agency of the project, and the Deputy Commissioner's Office of Cox's Bazar district is the immediate organization for affected people to consult for compensation as stipulated in the Ordinance 1982. CPGCBL will prepare and submit an application for land acquisition to MOPEMR and make a request to DC of Cox's Bazar. It will also prepare and submit the Resettlement Action Plan (RAP) to MOPEMR.

It will allocate the required budget for Additional Grant (AG) on top of DC's payment for land and Resettlement Benefits (RBs), which are to be approved by the GOB.

6.1.2 Data collection and EP identification

CPGCBL will, as shown in Figure 6-2 below, deploy adequate human resources for supervision, consultation, and monitoring of land acquisition, resettlement and rehabilitation activities during project implementation.

CPGCBL, in line with the DC, will design and conduct a socioeconomic survey and collect data. A supplemental survey can be conducted to obtain additional key information and update all the data, and the RAP should be revised if required. ID cards, EP files, and Entitlement Cards will be issued at this stage. It is desirable to formulate an inventory verification committee to ensure if this procedure is properly implemented among the affected people.

6.1.3 Local consultation and information management

CPGCBL will prepare an information brochure for information dissemination. Local consultations such as public consultation meetings and focus group discussion should be organized to ensure if project affected people keep informed of the project implementation process, benefits and losses, environmental and social impact, and etc. For effective information sharing, it is recommended to conduct such meetings not only for the affected people but local residents living in the surrounding area. Meetings can be conducted and brochure be distributed at local markets.

6.1.4 Finalization of budget

In order to ensure if proper valuation is conducted, CPGCBL will set up a property valuation advisory committee (PVAC) at this stage to assess the assets value.

6.1.5 Implementation of land acquisition and resettlement

The Deputy Commissioner will pay the cash Compensation under Law (CCL) for the affected lands, structures crops and trees to the EPs. CPGCBL will pay the AG on top of DC's payment for the lands and other RBs to the EPs. CPGCBL is responsible for assisting EPs purchase land and relocating, and encouraging them to take advantage of the livelihood rehabilitation/improvement program. CPGCBL will set up a grievance redress committee (GRC) for receiving grievance from stakeholders including the affected people (see next chapter for further detail on GRC). To implement the land acquisition and resettlement, a resettlement advisory committee is recommended to be formulated for CPGCBL to ensure proper implementation of resettlement.

6.1.6 Monitoring

Appropriate reporting including auditing and redress functions, monitoring and evaluation mechanisms will be identified and set in place as part of the resettlement management system. In addition to an internal monitoring conducted by CPGCBL, an external monitoring group should be hired that will evaluate the resettlement process and final outcome (see the last chapter for further details).

The following diagram (Figure 6-1) shows the implementation mechanism of land acquisition and resettlement, and the Figure 6-2 shows the tentative schedule for implementing LARAP.

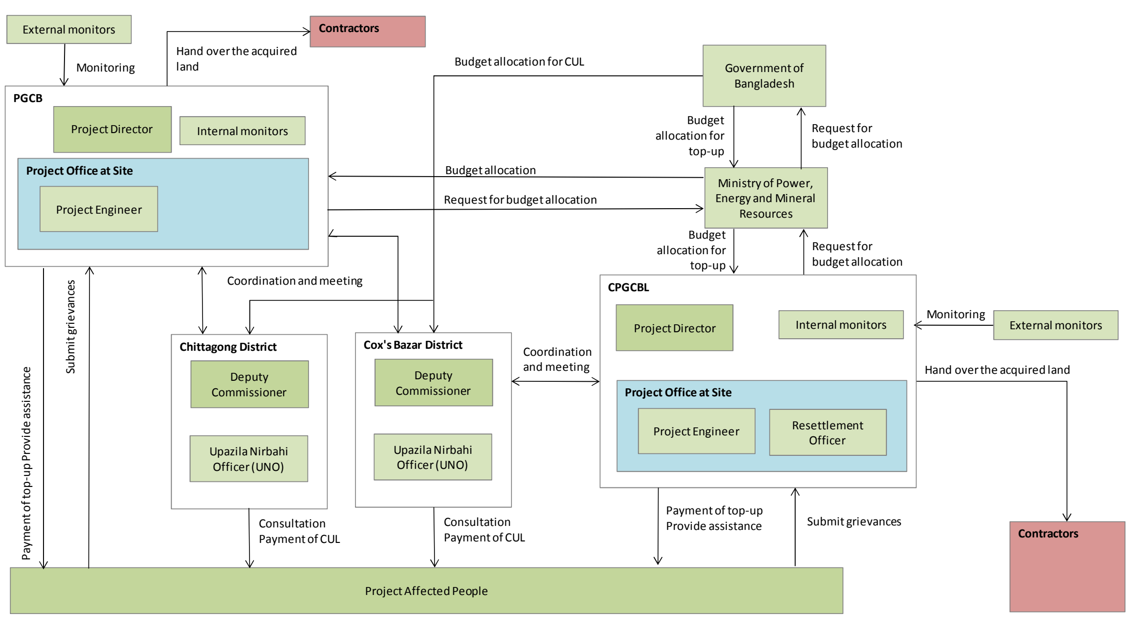
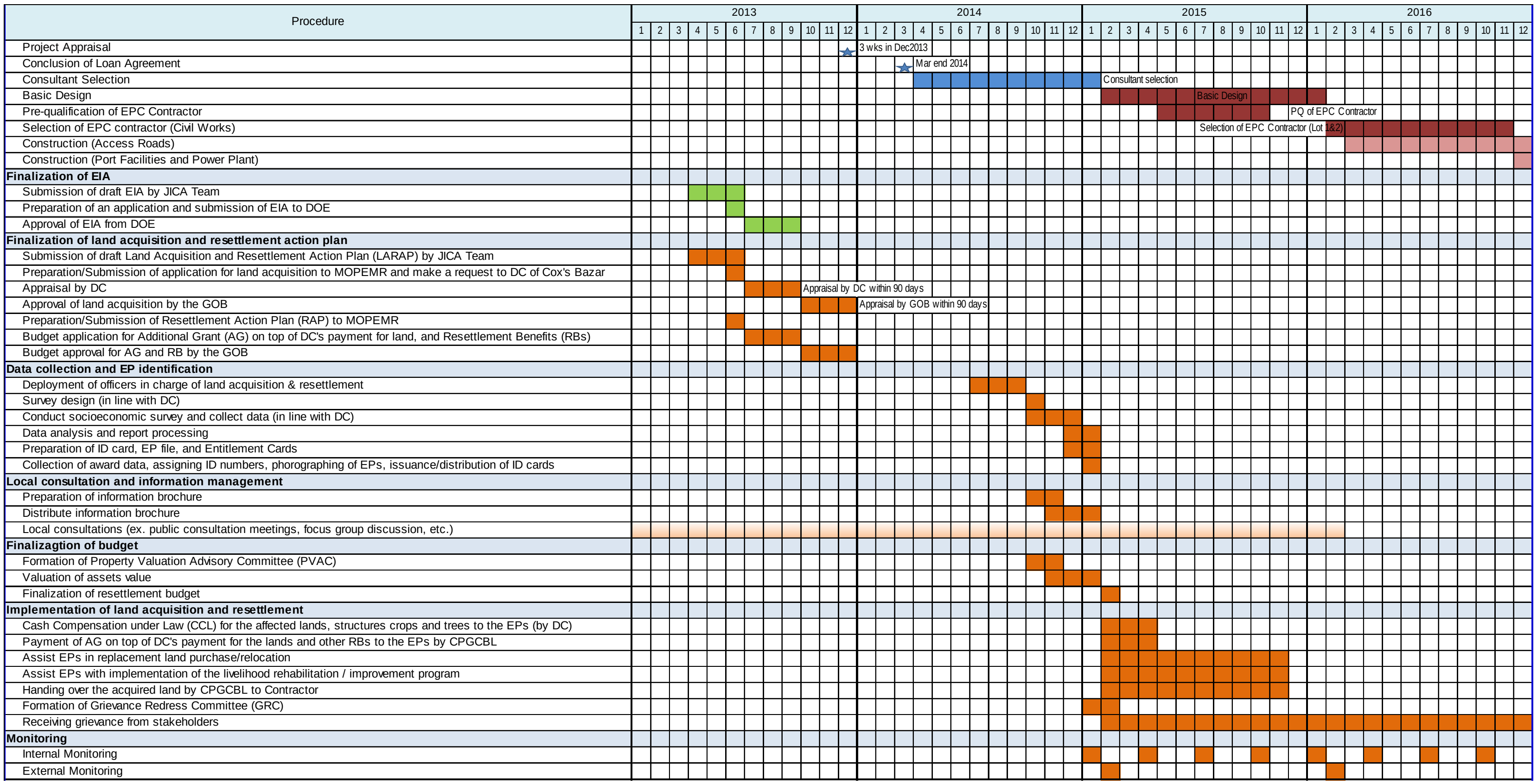


Figure 6-1 Implementation Mechanism of Land Acquisition and Resettlement



Note: EP implies eligible person.

(Source: JICA Study Team)

Figure 6-2 Tentative Schedule for Land Acquisition and Resettlement

Chapter 7 Grievance Redress Mechanisms

Other than the grievance redress mechanism stipulated by the Ordinance 1982, CPGCBL will make efforts at project level to resolve grievances through negotiations involving representatives of PAPs, village heads and Union Parishad Chairmen. The Project Director will allocate a resettlement officer at the project office, who deals with such negotiations up front. The resettlement officer will be the entry point and receive all the inquiries, concerns and complaints directly from PAPs. A notebook will also be installed at the project office entrance for anybody to write suggestions anonymously.

A grievance redress committee at project site will convene meetings monthly. Non-regular meetings will also be held ad-hoc basis as necessary at such places as it is considered appropriate (such as village, union, etc.) for dealing with urgent matters. The proceedings (or minutes of meetings) will be made with the object to promptly address the concerns and complaints using an accessible and transparent process to the PAPs, and to bring an amicable settlement between the parties. All reports will be recorded in Bengalese language and provided to all parties concerned.

The committee at project level will include the following people:

- Resettlement Officer
- Representative from local NGO/CBOs
- Representatives of Displaced Persons
- Representative from local government
- Local intellectuals or religious figures, who would represent the residents of the project area and be publicly known to be persons of integrity, good judgment and commands respect.

7.1 Entitlement for Different Types of Losses

In case dispute is not resolved at local level, the matter will be placed before a grievance resolution committee at the Upazila level. The Upazila Nirbahi Officer will chair the committee comprised of the project level GRC members, Project Engineers and legal advisors.

In case dispute still continues, the UNO will make a decision regarding entitlement and compensation, and the decision taken during negotiations and the meetings will be formally recorded for future reference and presentation in the court, if necessary.

If the matter cannot be resolved at the Upazila level, complaints will be referred to the Project Director, who will head a committee jointly with the Deputy Commissioner. Members of GRC at the Upazila level (including those at the project level) are summoned at any time for inquiry from PD and DC.

Steps for grievance are shown in the diagram below for easy reference. There will be no cost required when residents appeal to the authorities at each level. Each committee is responsible to solve the issues raised by the residents within 45 days.

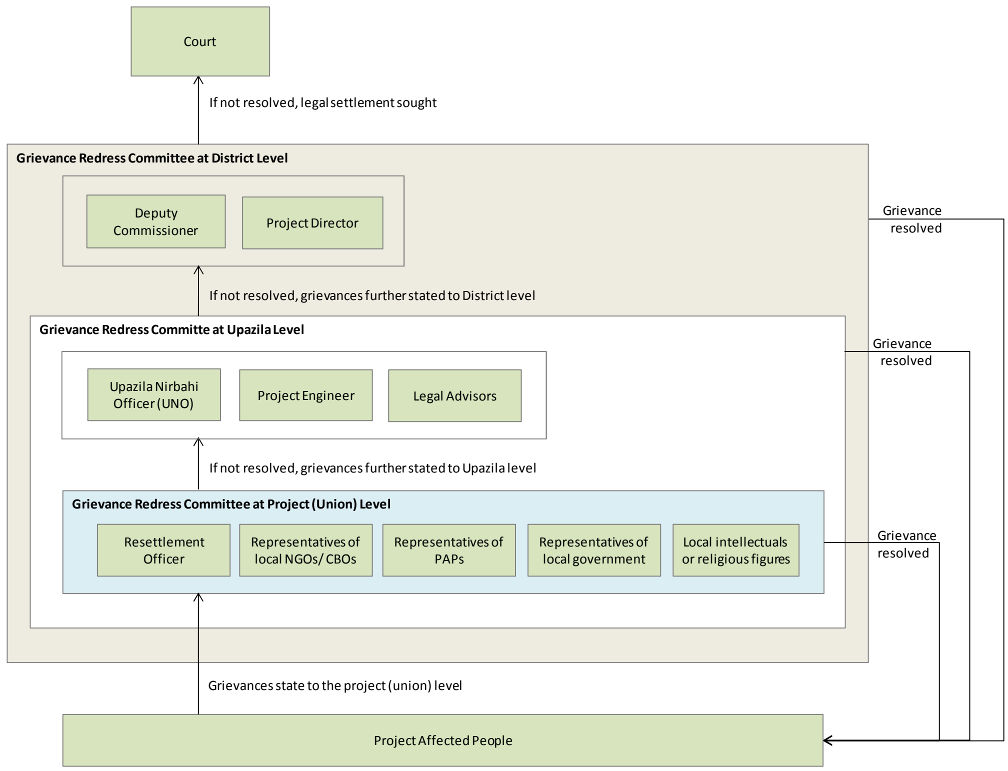


Figure 7-1 Flow of Grievance Redress

Chapter 8 Specific Measures provided to Vulnerable Groups and Income Rehabilitation Assistance

There are socially vulnerable people among those to be resettled and/or lose their livelihood means: poor households, women, children, elders.

Their living conditions however will not deteriorate compared to their current ones, and poor people who currently have deteriorated living standards without proper facilities will have better access to social services throughout the year if roads are improved along with the construction of the power plant, especially access during the rainy season. Deterioration of household economies and livelihood losses may occur, on the other hand, to the resettled people due to the relocation or losses of their livelihood means. Not all adult populations at the project site are literate, which often makes them stay unskilled. Wives of those men who lose their land or jobs and their children may suffer from adverse effects on their household economy. Number of male children who drop out of school may increase because of a huge demand of unskilled workers at the construction site if there is no age restriction of unskilled workers at the power plant site. Specific measures to the vulnerable groups taken in LARAP are as follows:

(1) Employment

When employing local residents at the construction site as well as power plant and associated facilities when the power plant operates,

- local residents will be more prioritized according to their skills
- no child will be allowed to work in order to prevent their drop-out from schooling and child labor. Periodic and regular patrol will be made to make sure there is no child.
- local women will be more prioritized if the requires skills meet local women’s.
- Enrollment in vocational training courses based on assessment of skills

(2) Education

School facilities at power plant will be shared with the local residents.

(3) Health

Health facilities at power plant will be shared with the local residents.

(4) Water and sanitation

Water quality of tube wells and others will be checked periodically for the safety of local residents.

(5) Electrification

Electrification of surrounding area will be examined.

Chapter 9 Estimated Land Acquisition and Resettlement Cost

9.1 Power plant and port facility site

Budget allocation will be fully committed by CPGCBL and made available to cover the costs of land acquisition (including compensation and income restoration measures) within the agreed implementation period. CPGCBL will finance the resettlement compensation as they will be impacting on the local people's livelihoods.

In addition to the compensation stipulated by the Ordinance 1982, CPGCBL will be required to finance those non-titleholders. All the compensation will be done according to the principle of the replacement cost, which will require CPGCBL to pay the gap between CUL and the replacement value (top up).

Based on the entitlement matrix for the PAPs shown in Table 4-3, the compensation package for the PAPs at the construction site of power plant has been drafted as in the tables below. Values appearing in the tables, such as land, income, standing crops etc., were the figures collected from the local residents through socioeconomic survey.

(1) Loss of private land

Table 9-1 Acquisition of private land from legal owners

Entitled Persons	No of HHs	Area (ha)	Land value (taka)	(a) cash compensation under law (taka)	(b) Replacement value of land exccept VAT and contingency (taka)	(c) One time assistance for lost income	(d) Total (a+b+c)
Legal owners of land	237	455.00	1,124,329,603	1,686,494,405	252,974,160.68	259,147,152	2,198,615,717

Note: Unit price (decimal) 10,000 taka (identified in land price survey)
Unit price (m2) 247 taka
Unit price (ha) 2,471,054 taka

Remarks: (a) CUL adds 50% premium to the current market price, not the average of last 12 months' sales values of same kind of land.
(b) Replacement value covers stamp duty and land registration fees incurred for replacement of land @0.15 VAT and contingency will be added for the total project cost.
(c) Lost income includes monthly household income for 3 years.
(d) Although 237 households identified in the household survey had 106.78 ha in total as of Dec 2012, land acquisition costs is estimated here assuming all 455 ha is privately owned.

(Source: JICA Study Team)

Table 9-2 Acquisition of private land from tenants and lessee

Entitled Persons	No of HHs	Area (ha)	Land value (taka)	Compensation package (taka)		
				(a) Amount for provision of another land	(b) One time assistance for lost income	(c) Total (a+b)
Tenants and lessee (private land)	77	155.86	385,150,000	664,383,750.00	83,300,400	747,684,150

Note: Unit price (decimal) 10,000 taka (identified in land price survey)
Unit price (m2) 247 taka
Unit price (ha) 2,471,054 taka

Remarks: (a) Amount for provision of another land includes 50% premium, stamp duty and land registration fees

@0.15
(b) Lost income includes monthly household income for 3 years.

(Source: JICA Study Team)

(2) Loss of government land

Table 9-3 Acquisition of government land from legal tenants and lessee

Entitled Persons	No of HHs	Area (ha)	Land value (taka)	Compensation package (taka)		
				(a) Amount for provision of another land	(b) One time assistance for lost income	(c) Total (a+b)
Tenants and lessee (gov land)	10	1.15	2,840,000	4,899,000.00	12,155,976	17,054,976

Note: Unit price (decimal) 10,000 taka (identified in land price survey)
Unit price (m2) 247 taka
Unit price (ha) 2,471,054 taka

Remarks: (a) Amount for provision of another land includes 50% premium, stamp duty and land registration fees @0.15
(b) Lost income includes monthly household income for 3 years.
It is assumed that tenants and lessee will seek private land.

(Source: JICA Study Team)

Table 9-4 Acquisition of government land from occupants without legal tenure

Entitled Persons	No of HHs	Area (ha)	Land value (taka)	Compensation package (taka)		
				(a) Amount for provision of another land	(b) One time assistance for lost income	(c) Total (a+b)
Occupants without legal tenure	156.00	19.41	47,973,161	82,753,703.00	129,902,400	212,656,103

Note1: Compensation amount is based on the land value stated by the interviewees for the sake of estimation.
Note2: Unit price (decimal) 10,000 taka (identified in land price survey)
Unit price (m2) 247 taka
Unit price (ha) 2,471,054 taka

Remarks: (a) Amount for provision of another land includes 50% premium, stamp duty and land registration fees @0.15
(b) Lost income includes monthly household income for 3 years.
Number of households include both occupants for cultivation (140 HHs) and occupants for domicile (16 HHs).

(Source: JICA Study Team)

(3) Permanent loss of means of livelihood / sources of income

Table 9-5 Assistance for transition in recovering loss of income source of land owners

Entitled Persons	Type of loss	Area (ha)	Annual value (taka)	Rate for opportunity loss	Compensation package (taka)
lessor (land owners who rent their land)	Income from land lease contract	155.86	8,748,665	10	87,486,650.00

Note: Compensation amount is based on the land value stated by the interviewees for the sake of estimation.
Remarks: It was not possible to identify the number of lessor who lend land to the tenants and lessee identified in the household survey.

(Source: JICA Study Team)

Table 9-6 Assistance for transition in recovering loss of income from livelihood activities

Entitled Persons	Type of Loss	Type of labor	No of employed persons	Total annual wage (taka)	Compensation package		
					(a) One time assistance for lost income	(b) Enrollment in vocational training courses	(c) Total (a+b)
Laborers	income from shrimp cultivation	Permanent	44	5,211,000	15,633,000	36,000	15,669,000
		Temporary	597	1,428,800	4,286,400	36,000	4,322,400
	income from salt farming	Permanent	117	6,943,000	20,829,000	36,000	20,865,000
		Temporary	256	2,844,550	8,533,650	36,000	8,569,650
	income from fishing activities	Permanent	4	0	0	36,000	36,000
		Temporary	22	2,400,000	7,200,000	36,000	7,236,000
	income from other activities	Permanent	0	0	0	36,000	36,000
		Temporary	17	30,800	92,400	36,000	128,400
Sharecroppers	income from crop	Sharecroppers	12	2,478,961	7,436,884	36,000	7,472,884

Note: Compensation amount is based on the actual wages stated by the interviewees for the sake of estimation.
Remarks: (a) Lost income includes monthly household income for 3 years.
(b) Vocational training is estimated @Tk.300/day for 120 days (6 months).

(Source: JICA Study Team)

Table 9-7 Assistance for transition in recovering loss of income from own business or self-employment

Entitled Persons	Type of Loss	No of people involved	Amount of capital (taka)	Rate for opportunity loss	Compensation for opportunity loss
Businessmen	Income from salt business	22	1,455,000	10	14,550,000
	Agriculture	3	0	10	-
Boat men	Boat	1	200,000	10	2,000,000
Teacher	Teaching	1	30,000	10	300,000
Carpenter	Construction	6	105,000	10	1,050,000
Tea staller	Shop	1	250,000	10	2,500,000
Others (unknown)	Unknown	Unknown	2,240,000	10	22,400,000

Note: Compensation amount is based on the actual wages stated by the interviewees for the sake of estimation.
Remarks: (a) Opportunity loss is fixed based on recent annual inflation rates in Bangladesh. It is assumed as 10% here.
(b) Lost income includes monthly household income for 3 years.

(Source: JICA Study Team)

(4) Loss of residential / commercial structure

Table 9-8 Assistance for transition in recovering loss of income from residential / commercial structure

Entitled Persons	No of HHs	House size	Compensation package (taka)				
			Replacement of structure value with 50 % premium (taka)	Stamp duty and registration fees (taka)	Reconstruction grant (taka)	shifting allowance (taka)	(c) Total (a+b)
Legal title holders / owners of sttructure	4	1,130 sft 105 m2	420,000	42,000	16,950	11,300	490,250
Legal tenants / lease holders of the structure	-	- -	-	-			
Socially recognized owners / unauthorized occupants	16	4,712 sft 438 m2	855,000	85,500	70,673	47,115	1,058,288

Note1: Compensation amount is based on the house size stated by the interviewees for the sake of estimation.
Note2: $1m^2$ is approximately equivalent to 10.7639 sft.
Remarks: (a) Amount for provision of another land includes 50% premium, stamp duty and land registration fees @0.15
(b) Reconstruction grant will be provided to the affected households at the rate of 15 taka per square feet.
(c') Shifting allowance will be provided at the rate of 10 taka per square feet.

(Source: JICA Study Team)

(5) Loss of standing crops at home gardens, shrimp and fish

Table 9-9 Assistance for transition in recovering loss of income from livelihood means

Entitled Persons	Source of income from activities	No of HHs	Production amount	Annual income from productive activities (taka)	Rate for opportunity loss	Compensation package (taka)
Land owners, bargadar, lesse and unauthorized occupants	income from shrimp cultivation	65	-	4,553,831	10	45,538,310
	income from salt bed	139	-	4,907,881	10	49,078,810
	income from fishing	23	-	50,010	10	500,100
	income from other activities	8	-	52,000	10	520,000
	income from pischiculture	109	-	3,398,303	10	33,983,030
	income from crop	155	6,669,715 kg	30,506,536	10	305,065,364

Note: Compensation amount is based on the actual wages stated by the interviewees for the sake of estimation.
Remarks: Opportunity loss is fixed based on recent annual inflation rates in Bangladesh. It is assumed as 10% here.

(Source: JICA Study Team)

(6) Loss of timber and fruit bearing trees

Table 9-10 Assistance for transition in recovering loss of trees

Entitled Persons	No of HHs	No of trees in total	Market value of tree (taka)	Compensation package (taka)
Owner of trees	274	28,589	2,000	57,178,000

Remarks: to be recalculated.

(Source: JICA Study Team)

(7) Temporary loss of land during construction

Not applicable.

(8) Temporary loss of access to land, structure, utilities, common property resource during construction

Not applicable.

(9) Temporary loss of livelihood/source of income during construction

Not applicable.

Total amount required for land acquisition, resettlement, and assistance for transition in restoring livelihood means and income sources are 3.86 billion taka.

Table 9-11 Compensation for PAPs at power plant site

	Compensation Item	Amount (taka)	Remarks

1	Permanent loss of private land caused by land acquisition	2,946,299,867	Table 9-1, Table 9-2
2	Permanent loss of government land caused by land acquisition	229,711,079	Table 9-3, Table 9-4
3	Permanent loss of means of livelihood	194,621,984	Table 9-5, Table 9-6, Table 9-7
4	Permanent loss of residential / commercial structure caused by resettlement	1,548,538	Table 9-8
5	Loss of standing crops at home gardens, shrimp and fish	434,685,614	Table 9-9
6	Loss of timber and fruit bearing trees	57,178,000	Table 9-10
7	Temporary loss of land during construction	0	-
8	Temporary loss of access to land, structure, utilities, common property resource during construction	0	-
9	Temporary loss of livelihood/source of income during construction	0	-
	Total	3,864,045,082	

(Source: JICA Study Team)

9.2 Transmission line route

It is PGCB who will allocate budget to cover the costs of temporary land acquisition and compensation for standing crops within the agreed implementation period. All the compensation will be done according to the principle of the replacement cost, and PGCB will pay the gap between CUL and the replacement value (top up).

Based on the entitlement matrix for the PAPs shown in Table 4-3, the compensation package for the PAPs has been drafted as in the tables below. Values appearing in the tables, such as land, income, standing crops etc., were the figures collected from the local residents through socioeconomic survey.

(1) Permanent loss of private land

There will be 157 towers for both angle towers and suspension towers from Anowara Upazila to Maheshkhali Upazila, which will require 1,256 m^2 of land for the installation of tower bases. When PGCB acquire land involuntarily from the land owners at the tower locations, PCGB will pay for the land. It is estimated as shown in the following table:

Table 9-12 Anticipated Land Acquisition and Assistance

Entitled Persons	No of HHs	Total area for towers (m^2)	Land value* (taka)	Cash compensation under law (taka)	Replacement value of land except VAT and contingency**	Total
land owners	157	1,256 (8 m^2 X 157)	932,279	1,398,419	0	1,398,419

Remarks: (a) Land value was estimated based on the current market prices of land varied from 247 m^2 to 1,236 m^2 from Maheshkhali Upazila to Anowara Upazila.

(b) Replacement value is estimated as zero as the landowners will not have to be shifted.

(Source: JICA Study Team)

(2) Permanent loss of government land

Not applicable.

(3) Permanent loss of means of livelihood / sources of income

Not applicable.

(4) Permanent loss of residential / commercial structure

(5) Permanent loss of standing crops at home gardens, shrimp and fish

Not applicable.

(6) Permanent loss of timber and fruit bearing trees

Not applicable.

(7) Temporary loss of land during construction

The anticipated impact on the land owners will not last permanently or be critical, as the land area for tower bases are relatively small, and land owners' livelihood activities will be hindered only during the construction period. Landowners with legal title, tenants and lease holders will receive rental assistance for the construction period for which the land is temporarily requisitioned. Temporarily requisitioned land will be returned to owners rehabilitated to original or preferably better condition.

(8) Temporary loss of access to land, structure, utilities, common property resource during construction

Landowners with legal title, tenants and leaseholders will be provided temporary access and relocation where possible. Restoration of access to the land, structure and utilities will be confirmed.

(9) Temporary loss of livelihood/source of income during construction

One-time assistance for lost income based on monthly income for three years from products, minimum wage rates or based on actual income, verified through incomes of comparable businesses in the area.

Table 9-13 Compensation for PAPs at power plant site

Entitled Persons	No of HHs	One-time assistance for lost income*	Total
land owners	157	1,720,800	1,720,800

Remarks: Lost income includes monthly household income for 3 years. It was based on the annual crop price as of Dec 2012 (30 taka / m^2).

(Source: JICA Study Team)

Total amount required for land acquisition, resettlement, and assistance for transition in restoring livelihood means and income sources are 3.86 billion taka.

Table 9-14 Compensation for PAPs at power plant site

	Compensation Item	Amount (taka)	Remarks
1	Permanent loss of private land caused by land acquisition	1,398,4190	Table 9-129-12
2	Permanent loss of government land caused by land acquisition	0	
3	Permanent loss of means of livelihood	0	
4	Permanent loss of residential / commercial structure caused by resettlement	0	
5	Loss of standing crops at home gardens, shrimp and fish	0	
6	Loss of timber and fruit bearing trees	0	
7	Temporary loss of land during construction	0	-
8	Temporary loss of access to land, structure, utilities, common property resource during construction	0	-
9	Temporary loss of livelihood/source of income during construction	1,720,800	Table 9-139-13
	Total	3,119,219	

(Source: JICA Study Team)

Chapter 10 Local Consultation, Participation, Monitoring and Evaluation Procedures

10.1 Further Consultation Process

CPGCBL is planning to conduct another consultation opportunity at the next stakeholder meeting planned in April 2013.

The PAPs and their communities will be further consulted about the project, the rights and options available to them, and the proposed mitigation measures for adverse effects, and to all extents possible they will be involved in the decision-making process concerning their resettlement. The PAPs will receive prior notification of the compensation, relocation and other assistance available to them.
CPGCBL will be responsible to hold and conduct a number of consultations with primary and secondary stakeholders and information dissemination on the following issues:

- The relevant details of the project
- The RP and various degrees of project impact
- Details of entitlements under the RP and what is required of PAPs in order to claim their entitlements
- Compensation process and compensation rates
- Relocation and resettlement site development operation in order to obtain agreement and support of affected people in participating in these operations
- Implementation schedule and timetable for the delivery of entitlements

Local participation should be spontaneously encouraged and information be made available during the preparation and implementations of the LARAP and at the minimum include community meetings and focus groups discussions. Information dissemination can be done not only for the project affected people but non-affected people out of the project site for sharing proper knowledge on the project with broader channels.
Where a host community is affected by the development of resettlement sites in that community, the host community shall be involved in any resettlement planning and decision-making. All attempts shall be made to minimize adverse impacts of resettlement upon host communities.

10.2 Monitoring and Evaluation Procedures

Appropriate reporting (including auditing and redress functions), monitoring and evaluation mechanisms, will be identified and set in place as part of the resettlement management system.

An external monitoring group will be hired by the Project and will evaluate the resettlement process and final outcome.

An Environmental Monitoring Plan will be prepared to provide guidelines for the construction activities of the power plant. The environmental components to be monitored are those that will be positively or negatively affected, or expected to be affected, by the construction activities. The purposes of creating an Environmental Monitoring Plan for the construction of the power plant are to:

- Confirm that mitigation measures shall reduce any negative impacts on the environment to allowable levels during the construction and operation phases.
- Set up an organization that is responsible for the implementation of monitoring the plan.
- Perform appropriate monitoring during the construction and operation phases.

Table 10-1 Contents of environmental management plan and monitoring plan

Item	Impact	Targeted Range	Contents of Environmental Management Plan	Contents of Monitoring Plan
Resettlement	- Land Acquisition and Resettlement	- Around the power plant site	-Preparation of LARAP (livelihood restoration plan)	- Monitoring the progress of land acquisition and resettlement - Monitoring the conditions of local residents' employment - Grievances from residents
Disturbance to Poor People	- Land Acquisition and Resettlement	- Around the power plant site	- Preparation of LARAP (livelihood restoration plan)	- Monitoring the livelihood conditions of the targeted households - Grievances from residents
Deterioration of Local Economy such as Losses of Employment and Means of Livelihood	- Loss or damage to the salt/shrimp cultivation ponds by land acquisition	- Around the power plant site	- Preparation of LARAP (livelihood restoration plan)	- Monitoring the livelihood conditions of the households engaged in salt cultivation/ shrimp aquaculture - Grievances from residents
Land Use and Utilization of Local Resources	- Change of land use	- Around the power plant site	- Employment of local residents - Procurement of materials from the local area	- Grievances from residents
Disturbance to Existing Social Infrastructure and Services	- Change of land use	- Around the power plant site	- Construction of roads that can be used by local residents - Permit usage of certain facilities in the power	- Grievance from residents

Item	Impact	Targeted Range	Contents of Environmental Management Plan	Contents of Monitoring Plan
			plant to local residents	
	- Increase of traffic during construction phase	- Around the power plant site	- Reschedule construction schedule	- Grievances from residents
Misdistribution of Benefits and Damages	- Loss or damages to the salt/shrimp cultivation ponds by land acquisition	- Around the power plant site	- Preparation of livelihood restoration plan to the targeted households, in case the households engaged in salt/shrimp cultivation are included in the relocated households	- Monitoring the livelihood conditions of the targeted households - Grievances from residents
Local Conflicts of Interest	- Loss or damages to the salt/shrimp cultivation ponds by land acquisition	- Around the power plant site	- Preparation of livelihood restoration plan to the targeted households, in case the households engaged in salt/shrimp cultivation are included in the relocated households	- Monitoring the livelihood conditions of the targeted households - Grievances from residents
Gender	- Change of land use	- Around the power plant site	- Construction of roads that can be used by local residents - Permit usage of certain facilities in the power plant to local residents	- Grievances from residents
Children's Rights	- Change of land use	- Around the power plant site	- Construction of roads that can be used by local residents - Permit usage of certain facilities in the power plant to local residents	- Grievances from residents

(Source: JICA Study Team)

The following tables shows the performance monitoring form for land acquisition, resettlement and assistance for transition of the project affected people, impact monitoring during implementation and post-project stage.

Table 10-2 Monitoring Form 1(for Performance Monitoring of Resettlement Action Plan)

Procedure		Indicator (specific step/action)	Unit	Year 1				Year 2				Comments
				1st qtr	2nd qtr	3rd qtr	4th qtr	1st qtr	2nd qtr	3rd qtr	4th qtr	
Staffing and Management												
Recruitment, training and deployment of staff / expert in charge	1.	Deployment of (an) officer(s) / expert(s) in charge of land acquisition	Man-months									
	2.	Deployment of resettlement officer(s) / expert(s)	Man-months									
	3.	Training and mobilization of officers-in-charge (if required)	No. of trained personnel									
Supervision and Management	1.	Supply of manpower and logistics	No. of persons									
	2.	Liaison with other agencies (ex. DC Office, Upazila Nirbahi Office, Union Parishads etc.)	No. of meetings									
	3.	Administrative management	Month									
Finalization of land acquisition and resettlement action plan												
Finalization of land acquisition	1.	Preparation of an application for land acquisition	%									
	2.	Submission of application to MOPEMR and make a request to the Deputy Commissioner of Cox's Bazar	Date of submission									
	3.	Approval of land acquisition by the GOB	Date of approval									
Adoption of the Resettlement Action Plan	1.	Review of the draft Resettlement Action Plan (RAP)	%									
	2.	Submission of application to MOPEMR and make a request to the Deputy Commissioner of Cox's Bazar District for implementation of RAP in line with land acquisition	Date of submission									

Procedure	Indicator (specific step/action)		Unit	Year 1				Year 2				Comments
				1st qtr	2nd qtr	3rd qtr	4th qtr	1st qtr	2nd qtr	3rd qtr	4th qtr	
	3.	Approval of RAP	Date of approval									
Identification of eligible persons												
Socioeconomic Survey (in liaison with DC office)	1.	Survey design	Time									
	2.	Field Survey and collection of data	%									
	3.	Computerization of field data	%									
	4.	Data analysis and report processing	%									
	5.	Preparation of ID card, EP file, and Entitlement Cards	%									
Identification of Eligible Persons (in liaison with DC office)	1.	Collection of award data	No. of EPs									
	2.	Assigning ID numbers	No. of EPs									
	3.	Photographing of EPs	No. of EPs									
	4.	Issuance of ID cards	No. of EPs									
	5.	Distribution of ID cards	No. of EPs									
Local consultation and information management												
Information Management (in liaison with DC office)	1.	Preparation of information brochure	%									
	2.	Distribute information brochure	No. distributed									
	3.	Personal contacts	No. contacted									
	4.	Local consultations (ex. public consultation meetings, focus group discussions (FGD) s, etc.)	No of consultations									
Budgeting												
Valuation of affected property (in liaison with DC office)	1.	Formation of Property Valuation Advisory Committee (PVAC)	%									
	2.	Planning for valuation	%									
	3.	Communication and collection of data	%									
	4.	Valuation	%									
	5.	Finalization of resettlement budget	%									

Procedure		Indicator (specific step/action)	Unit	Year 1 1st qtr	2nd qtr	3rd qtr	4th qtr	Year 2 1st qtr	2nd qtr	3rd qtr	4th qtr	Comments
Implementation of land acquisition and resettlement												
Payment of compensation for land acquisition (in liaison with DC office)	1	Motivate Eligible Persons (EP)	No. of EPs									
	2	Assist EPs to collect Cash Compensation under Law (CCL)	No. of EPs									
	3	Organize top-up payment to fill the gap between CUL and RV	No. of EPs									
Relocation of Project Affected Persons (in liaison with DC office)	1.	Motivate Eligible Persons (EP)	No. of EPs									
	2.	Payment of Transfer Grant	No. of EPs									
	3	Assist EPs in replacement land purchase/Relocation	No. of cases									
Resettlement of Project Affected Persons (in liaison with DC office)	1.	Assist EPs to collect Cash Compensation under Law (CCL)	No. of EPs									
	2.	Organize top-up payment to fill the gap between CUL and RV	No. of EPs									
	3.	Assist vulnerable EPs in resettlement	No. of EPs									
Assistance in transition (in liaison with DC office)	1.	Motivate EPs to join the livelihood rehabilitation / improvement program	No of EPs									
	2.	Literacy class	No of class									
			No of attendance									
	3.	Skill trainings	No o trainings offered									
			No of trained personnel									
	4.	Job opportunities at power station and associated facilities	No of posts offered to EPs									
			No of employed EPs									
Grievance Redress	1.	Formation of Grievance	No. of members									

Procedure	Indicator (specific step/action)		Unit	Year 1				Year 2				Comments
				1st qtr	2nd qtr	3rd qtr	4th qtr	1st qtr	2nd qtr	3rd qtr	4th qtr	
(in liaison with DC office)		Redress Committee (GRC)										
	2.	Publicizing/notifying of GRC	%									
	3.	Receiving grievance from stakeholders	No. of cases									
	4.	Resolving grievances	No. of cases (%)									
	5.	Other claim/criticism	No. of cases									
Report processing												
Performance Reporting	1.	Inception report	Date of submission									
	2.	Monthly progress report	Date of submission									
	3.	Draft final report	Date of submission									
	4.	Final report	Date of submission									

Table 10-3 Monitoring Form 2 (for Impact Monitoring during Project Implementation)

Indicator	Unit (Standard value)	Year 1				Year 2				Comments
		1st qtr	2nd qtr	3rd qtr	4th qtr	1st qtr	2nd qtr	3rd qtr	4th qtr	
Grievance redress mechanism										
Grievance submitted by the stakeholders	Number of cases									
Grievance resolved	No. of cases (%)									
Conflict with host community	No. of cases									
Other claim/criticism	No. of cases									
Land acquisition and compensation										
Households losing their own land	No of HHs (%)									
Households losing their domicile on their own land	No of HHs (%)									
Households losing their renting land (private land)	No of HHs (%)									
Households losing their renting land	No of HHs (%)									

Indicator	Unit (Standard value)	Year 1				Year 2				Comments
		1st qtr	2nd qtr	3rd qtr	4th qtr	1st qtr	2nd qtr	3rd qtr	4th qtr	
(government land)										
Households losing their occupancy on khas land	No of HHs (%)									
Households losing their illegal domicile on government land	No of HHs (%)									
Households losing income from own land	No of HHs (%)									
Households losing income from own livelihood activities	No of HHs (%)									
Households losing income from own business	No of HHs (%)									
Households losing income from standing crops	No of HHs (%)									
Compensation completed	No. of cases (%)									
Relocation and compensation										
Relocated households	No of HHs (%)									
Relocated households owning land	No of HHs (%)									
Relocated households owning domicile	No of HHs (%)									
Relocated households renting land	No of HHs (%)									
Relocated households renting domicile	No of HHs (%)									
Compensation completed	No. of cases (%)									
Household economy										
Project affected household that lacks the source of income	No of HHs (%)									
Project affected household with reduced monthly income	No of HHs (%)									
Livelihood restoration										
Literacy class	Number (%)									
Job training conducted	No. of courses									
PAPs (age over 16) that received job training	Number (%)									
Compensated/relocated structure for business (e.g. shop, garage, etc)	Number (%)									

Indicator	Unit (Standard value)	Year 1				Year 2				Comments
		1st qtr	2nd qtr	3rd qtr	4th qtr	1st qtr	2nd qtr	3rd qtr	4th qtr	
Allocation of substitute farmland	Area (%)									
Substitute farmland being utilized	Area (%)									
Employment of project affected people (age over 16) **by** the project	No. of PAPs (%)									
Employment of female PAPs (age over 16) by the project	No. of PAPs (%)									
Child labour	No. of children									
Provision of personal protective equipment (PPE)	PAPs provided with PPE (100%)									
Labour accident	No. of cases									
Area infrastructure development										
Water and sanitation facility	Number (%)									
Electricity distribution	Number of HHs (%)									
Clinics or health facilities	Number (%)									
Primary schools	Number (%)									

Table 10-4 Monitoring Form 3 (for Impact Monitoring at Post-project Stage)

Category	Source of information	Baseline data (at the commencement of Year 1)	Actual						Comments
			Month 24	Month 48	Month 72	Month 96	Month XX	End-line data	
Social									
Registers crimes/disputes (per 1,000 pop.)	Statistics obtained at local police								
Crimes/disputes involving women (per 1,000 pop.)	do								
Crimes/disputes involving vulnerable group (per 1,000 pop.)	do								
Primary school attendance (male)	Statistics								

	obtained at local education department								
Primary school attendance (female)	do								
Number of community-based organizations	Upazila Office								
Household Economy									
Average land holding per household (hectares)	Household survey								
Percentage households owning land	do								
Percentage households owning domicile	do								
Percentage households renting land	do								
Percentage households renting domicile	do								
Agricultural production: Rice	do								
Fish catch (ton per household/per annum)	do								
Shrimp catch (ton per household/per annum)	do								
Salt cultivation (ton per household/per annum)	do								
Employment: Number of male wage earners	do								
Employment: Number of female wage earners	do								
Average household income (Taka per annum)	do								
Average household expenditure (Taka per annum)	do								
Energy Consumption: Fuel wood (tons per annum)	do								
Energy Consumption: Kerosene (tons per annum)	do								
Energy Consumption: Electricity (kWh per annum)	do								
Health									
Water source	Household survey								
Incidence of diarrhea	do								
Incidence of upper respiratory infection	do								
HIV infection	do								
Other epidemics	do								
Others									
Traffic accidents in resettlement site	do								

Annexure 6

Presentation : Stakeholders Meeting

1st Stakeholder meeting

(Power plant)

12th November, 2012

মাতারবাড়ি ২x৬০০ মেঃওঃ কয়লাভিত্তিক তাপ বিদ্যুৎ কেন্দ্র ও আনুষঙ্গিক সুবিধাদি নির্মাণ প্রকল্প

কোল পাওয়ার জেনারেশন কোঃ বাংলাদেশ লিঃ

(সিপিজিসিবিএল)

1

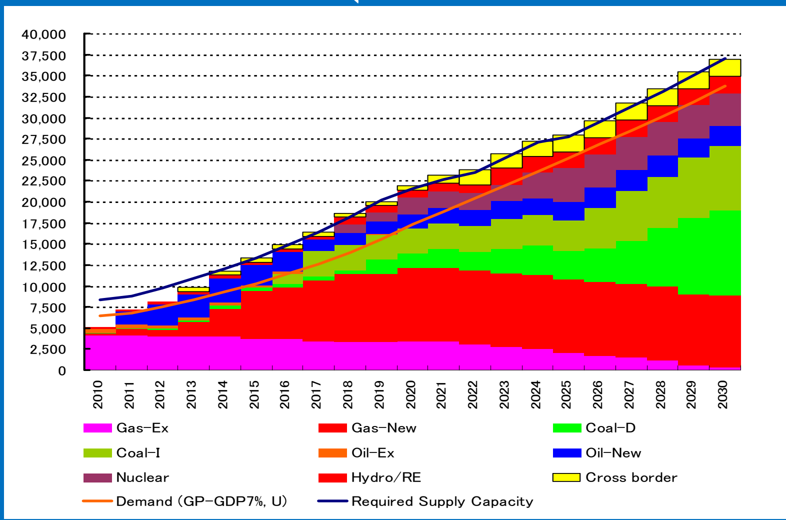
স্টেকহোল্ডার সভা, নভেম্বর ২০১২

উদ্দেশ্য

প্রকল্প সংশ্লিষ্ট স্থানীয় জনগণ ও অন্যান্য স্টেকহোল্ডারদের মনোভাব সম্পর্কে আলোচনা করা

2

প্রকল্পের পটভূমি ও প্রয়োজনীয়তা



➢ ক্রমবর্ধমান বিদ্যুতের চাহিদা পূরণের জন্য অনেক বড় বড় বিদ্যুৎ কেন্দ্র স্থাপন দরকার

3

প্রকল্পের পটভূমি ও প্রয়োজনীয়তা

➢ দেশীয় কয়লা উত্তোলন (আপাতত) স্থগিত ঘোষনা

➢ আমদানিকৃত কয়লা ভিত্তিক বিদ্যুৎ কেন্দ্র উন্নয়ন

4

সমী¶ার উদ্দেশ¨

প্রস্তাবিত প্রকল্পের বাস্তবায়নের জন¨ কারিগরি, পরিবেশ, ইকোনমিক ও আর্থিক দিক বিবেচনা পূর্বক সম্ভাব¨তা বিশ্লেষণ

চট্টগ্রাম অঞ্চলে কয়লাভিত্তিক বিদ¨ুৎ কেন্দ্র / সঞ্চালণ লাইন নির্মাণ

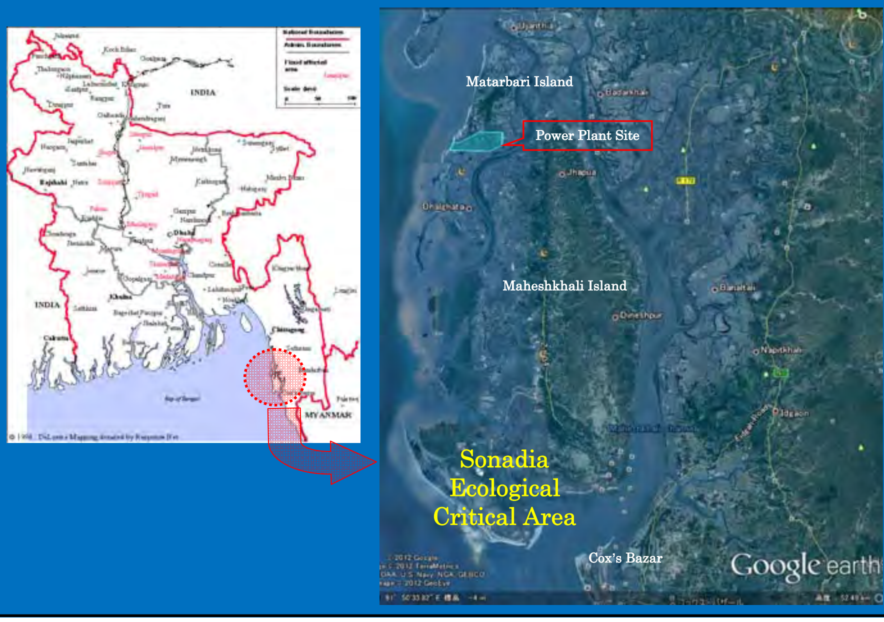
5

প্রকল্পের পরিধি

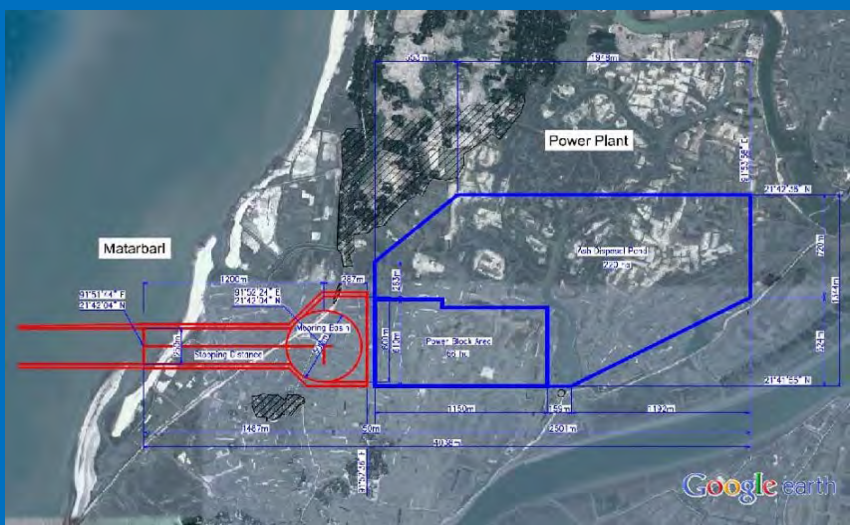
- ২X৬০০মেঃওঃ কয়লাভিত্তিক বিদ¨ুৎ কেন্দ্র
- কয়লা কেন্দ্র
- ছাই এর পুকুর
- কয়লা খালাশ বন্দর
- নৌচলাচল চ¨ানেল
- বন্দর সুবিধা (৮০,০০০টঃ ভেসেলের জন¨)
- ব্রেক ওয়াটার (যদি প্রয়োজন হয়)
- আনোয়ারা গ্রীড উপকেন্দ্র পর্যন্ত ৪০০কেভি সঞ্চালণ লাইন নির্মাণ

6

প্রকল্পের অবস্থান



প্রস্তাবিত নূতন বিদ্যুৎ কেন্দ্রের লে-আউট



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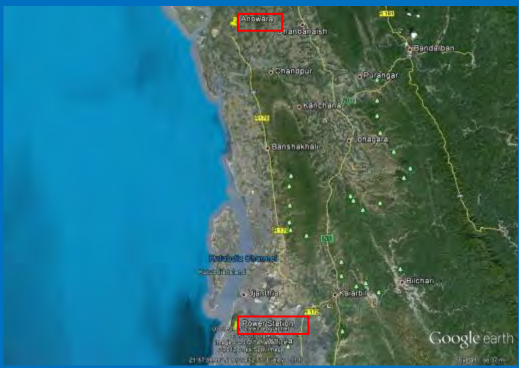
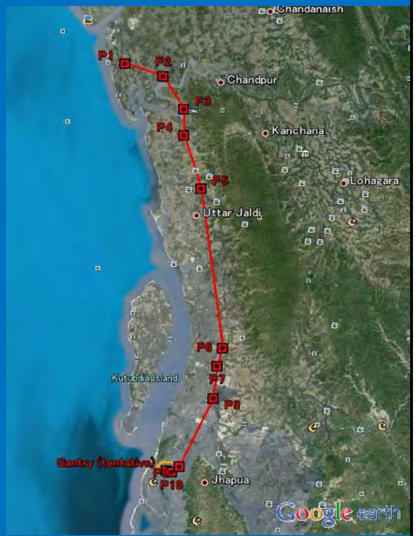
বিদ্যুৎ কেন্দ্র হতে আনোয়ারা পর্যন্ত প্রস্তাবিত সঞ্চালণ লাইন রুট





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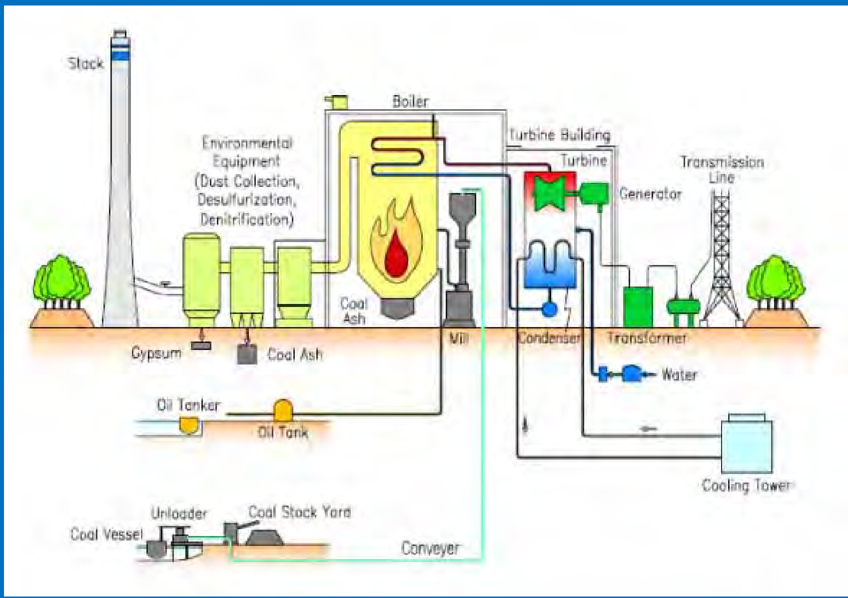
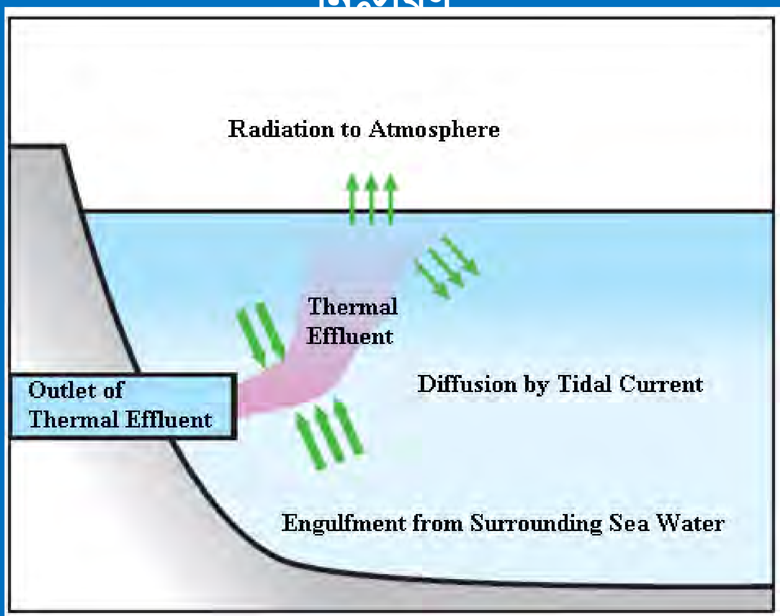
কয়লা ভিত্তিক তাপ বিদ্যুৎ কেন্দ্রের প্রধান প্রধান অংশ

10

কয়লা ভিত্তিক তাপ বিদ্যুৎ কেন্দ্রের খসড়া চিত্র

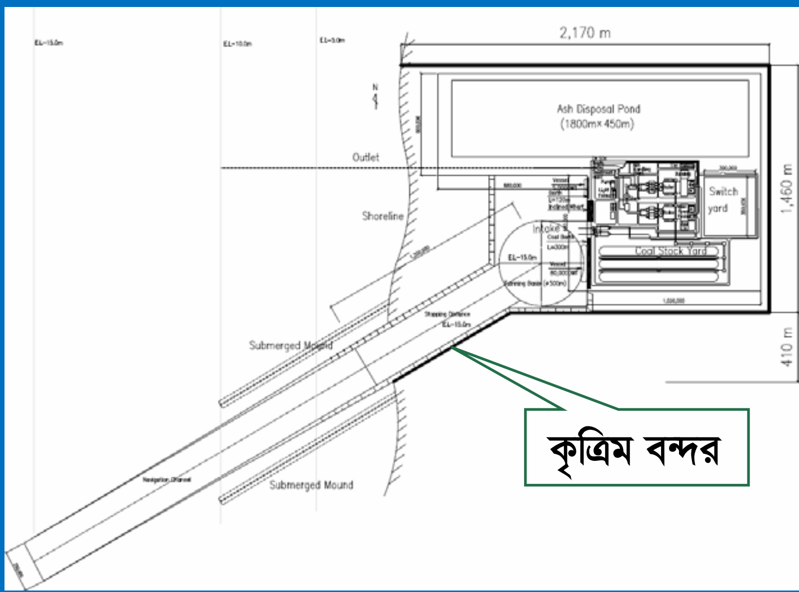


পানির অভ্যন্তরে ডিসচার্জ এর মাধ্যমে তাপ নিঃসরণ



12

কৃত্রিম বন্দর সুবিধার প্লান



13

প্রধান সম্ভাব¨ প্রভাব ও এর প্রতিকার সমূহ

14

আইটেম	প্রভাব	প্রতিকার
বায়ুদূষণ	• নির্মাণকালিন সময়ে নির্গত গ্যাস ও ধূলাবালি বৃদ্ধি। • বিদ্যুৎ কেন্দ্র চলন্ত অবস্থায় বায়ু দূষণ।	• নির্মাণকালিন সময়ে বায়ুদূষণ প্রতিরোধের ব্যবস্থা গ্রহন। • দূষণনিরোধক সুবিধা স্থাপনের মাধ্যমে নির্গত গ্যাসের মান নিয়ন্ত্রণ। • সিমুলেশণ মডেল ব্যবহার করে বায়ুমন্ডলে নির্গত গ্যাসের মাত্রা বের করে বায়ুগুনের মান নিশ্চিত করণ।
পানিদূষণ	• নির্মাণকালিন সময়ে ডিপোজিট বা কোটিং মেটারিয়েল নির্গমণ বা প্রবাহের ফলে পানিদূষন। • তাপীয় বর্জ্য নিঃসরণের ফলে পানির তাপমাত্রা বৃদ্ধি।	• নির্মাণকালিন সময়ে পানিদূষণ প্রতিরোধের ব্যবস্থা গ্রহন। • সিমুলেশণ মডেল ব্যবহার করে তাপীয় বর্জ্যের নিঃসরণ মাত্রা বের করে সিঃসরণের পরিসর নিশ্চিত করণ। • গৃহস্থালী ও অন্যান্য কাজে ব্যবহৃত পানির জন্য দূষিত পানি শোধনিকরণ সুবিধা স্থাপনের মাধ্যমে দূষিত পানির নির্গমন মান নিয়ন্ত্রণ।
কঠিণ বর্জ্য	• নির্মাণকালিন সময়ে বৃহৎ পরিমান ডিপোজিট ও দূষিত বস্তু তৈরী। • বিদ্যুৎ কেন্দ্র চলন্ত অবস্থায় প্রতিদিন প্রচুর পরিমান ফ্লাই ও বটম ছাই তৈরী।	• নির্মানকালিন ও চলন্ত অবস্থায় শিল্প ও গৃহস্থালী বর্জ্যের জন্য ডিস্‌পোজাল প্ল্যান প্রনয়ণ করা।

আইটেম	প্রভাব	প্রতিকার
শব্দ / কম্পন	• নির্মাণকালিন সময়ে/ বিদ্যুৎ কেন্দ্র চলন্ত অবস্থায় শব্দ / কম্পন তৈরী।	• নির্মাণকালিন সময়ে/ বিদ্যুৎ কেন্দ্র চলন্ত অবস্থায় শব্দ / কম্পন প্রতিরোধের ব্যবস্থা গ্রহন। • সিমুলেশণ মডেল ব্যবহার করে শব্দের মাত্রা নির্ণয় করে শব্দের মান নিশ্চিত করণ।
সামুদ্রিক ও পার্থিব জীববৈচিত্র	• ভূমি ব্যবহার পরিবর্তন, পরিবেশ দূষণ ও নেভিগেশন চ্যানেল নির্মাণের কারনে বাহ্যিক অবস্থার পরিবতনের ফলে জীববৈচিত্রের উপর সম্ভাব্য প্রভাব।	• জীববৈচিত্র রক্ষার্থে গুরুত্বপূর্ন বাসস্থান (ম্যানগ্রোভ, করাল রীফ ও মাডফ্লাট) সমূহের উপর সম্ভাব্য প্রভাবের মাত্রা নির্দ্ধারণ এবং তাৎপর্যপূর্ণ প্রভাবের ক্ষেত্রে যথাযথ প্রতিরোধের ব্যবস্থা গ্রহন।
বিপন্ন প্রজাতি	• প্রকল্প এলাকা সংলগ্ন পরিবেশগতভাবে সংকটাপন্ন এলাকায় কিছু বিপন্ন প্রজাতি দেখা যায়। বিদ্যুৎ কেন্দ্র নির্মানের ফলে জীববৈচিত্রের উপর প্রভাব পড়ার কারনে এ সকল বিপন্ন প্রজাতির উপর প্রভাব পড়তে পারে।	• বিপন্ন প্রজাতি সমূহের উপর সম্ভাব্য প্রভাবের মাত্রা নির্দ্ধারণ এবং তাৎপর্যপূর্ণ প্রভাবের ক্ষেত্রে যথাযথ প্রতিরোধের ব্যবস্থা গ্রহন।
জোরপূর্বক বাসিন্দা পুনর্বাসন	• প্রকল্প এলাকায় বসবাসকারী লোকজনদের পূনর্বাসন করতে হবে। • কয়লাভিত্তিক বিদ্যুৎ কেন্দ্রের ছাঁই পুকুর ও কয়লা রাখার স্থানের জন্য বহু ভুমি দরকার। তাই ভূমি অধিগ্রহনের ফলে ক্ষতিগ্রস্থ লোকজনদের ক্ষতিপূরন ও সহযোগিতা প্রদান করতে হবে।	• যথাযথ ভূমি অধিগ্রহন ও পূনর্বাসন প্ল্যান প্রনয়ণ।

16

আইটেম	প্রভাব	প্রতিকার
অসহায় গ্রুপের উপর চাপ	• বাসস্থান পুনর্বাসন, কর্মসংস্থান ও জীবিকার কারনে অসহায় গ্রুপের উপর চাপ তৈরীর সম্ভাবনা।	• জীবিকা পুনরুদ্ধার প্ল্যান প্রনয়ণ করা।
অসম সুবিধা/ক্ষতির সৃষ্টি	• স্থায়ী বিদ্যুৎ সরবরাহ স্থানীয় অর্থনীতির উন্নয়ন ঘটাবে। কিন্তু প্রকল্প এলাকায় সরাসরি সুবিধা পাবে না। ফলে অসম সুবিধা/ক্ষতি তেরী হবে। তবে নির্মাণ শ্রমিক / পরিচালনা স্টাফদের কর্মসংস্থান তৈরী হবে এবং বিদ্যুৎ কেন্দ্রকে ঘিরে ব্যবসায়িক সুবিধা বৃদ্ধি পাবে।	• যথাযথ ভূমি অধিগ্রহন ও পূনর্বাসন প্ল্যান প্রনয়ণ। • ক্ষতিগ্রস্থ লোকদের জন্য কর্মসংস্থান প্ল্যান প্রনয়ণ।
পানির ব্যবহার ও অধিকার	• বিদ্যুৎ কেন্দ্রের কুলিং পানির চাহিদার জন্য পানির ব্যবহার ও অধিকারের উপর প্রভাব ফেলতে পারে। • পরিবেশ দূষণ ও বাহ্যিক অবস্থার পরিবর্তনের জন্য মৎস চাষে প্রভাব ফেলতে পারে।	• নির্মাণকালিন সময়ে পানিদূষণ প্রতিরোধের ব্যবস্থা গ্রহন। • সিমুলেশণ মডেল ব্যবহার করে তাপীয় বর্জ্যের নিঃসরণ মাত্রা বের করে নিঃসরণের পরিসর নিশ্চিত করণ। • গৃহস্থালী ও অন্যান্য কাজে ব্যবহৃত পানির জন্য দূষিত পানি শোধনিকরণ সুবিধা স্থাপনের মাধ্যমে দূষিত পানির নির্গমন মান নিয়ন্ত্রণ।

17

“ইআইএ” ÷¨াডির প্রধান বিষয়সমূহ

- পরিবেশ জরিপ

  বায়ুগুন, শব্দ, পানির গুন, ভূগর্ভস্থ পানি।
- সামাজিক জরিপ
- সিমুলেশন মডেল দ্বারা ভবিষদ্বাণী।
- পরিবেশগত প্রভাব নির্ণয়।
- পরিবেশ ব¨বস্থাপনা প্লান প্রনয়ণ - প্রতিকার ব¨বস্থা, উন্নয়ণ ব¨বস্থা, ¶তিপূরণ ব¨বস্থা এবং পর্যবে¶ন প্লান ।

18

প্রাকৃতিক ও সামাজিক পরিবেশের মাঠ পর্যায়ে জরিপের আইটেমসমূহ

19

মাঠ জরিপের আইটেম (১)
(প্রাকৃতিক পরিবেশ)

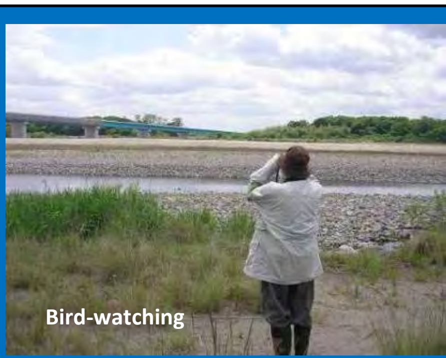
1| ভূমি
টপোগ্র¨াফি, সমুদ্রের তলদেশ টপোগ্র¨াফি
২। ভূকম্পণ মাত্রা
৩। সামুদ্রিক পরিবেশ
স্রোত, জোয়ারের লেভেল, ঢেউ, পানির গুন, তলদেশের পলি
৪। ভূপৃষ্ঠ ও ভূগর্ভস্থ পানির গুন
৫। বায়ুমন্ডল
আবহাওয়া, বায়ুগুন
৬। শব্দ ও কম্পণ
৭। প্রানী ও উদ্ভিদ
ক) সামুদ্রিকঃ
কোরাল, ম¨াক্রো বেন্থোস, ফাইটোপ্লাংকটন, জুপ্লাংকটন, মাছ ও জলজ জীব
খ) বন¨ প্রানী/উদ্ভিদঃ
প্রানী ও উদ্ভিদ, স্তন¨পায়ী, পাখি, সরিসৃপ ও উভচর, পোকামাকড়
গ) মূল¨বান ও বিরল প্রজাতি
স্পুনবিল্ড স¨ান্ড পাইপার, স্পটেড গ্রীনশ¨াঙ্ক, গ্রেট নট ও অন¨ান¨ অতিথি পাখি, সামুদ্রিক কচ্ছপ, ডলফিন

20

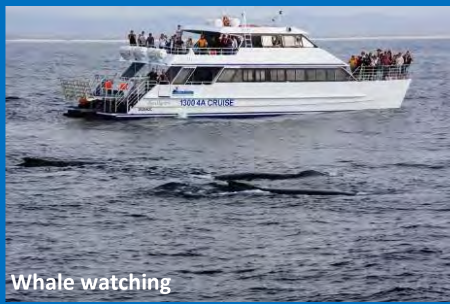

Grab sampler
Benthos sampling
Preservative treatment
Arrangement
21


Air sampler
Air Quality Measurement
Noise measurement
Noise measurement
22


Insect collecting


Bird-watching


Counting of nesting turtles



Whale watching

23

মাঠ জরিপের আইটেম (২)
(সামাজিক পরিবেশ)

1| স্থানীয় বসতি
ক) আর্থ-সামাজিক, আদমশুমারী, সম্পদ/ভূমি, জীবন ও জীবিকা জরিপ
খ) পূনর্বাসন খরচ
গ) জীবিকা পূনর্বাসন প×তির চাহিদা

২। ভূমি ব¨বহার ও ট্রাফিক
ভূমি ব¨বহার, সমুদ্র ট্রাফিক, ভূমি ট্রাফিক

৩। সামাজিক অবকাঠামো
পয়ঃব¨বস্থা, জনসংখ¨া ও ডেমোগ্রাফি, শি¶া, সরকারী অবকাঠামো, কর্মসংস্থান, আয় এবং ব¨য়

৪। অন¨ান¨
দর্শণীয় স্থান, সাংস্কৃতিক বৈশিষ্ট¨, সংখ¨ালঘু

24

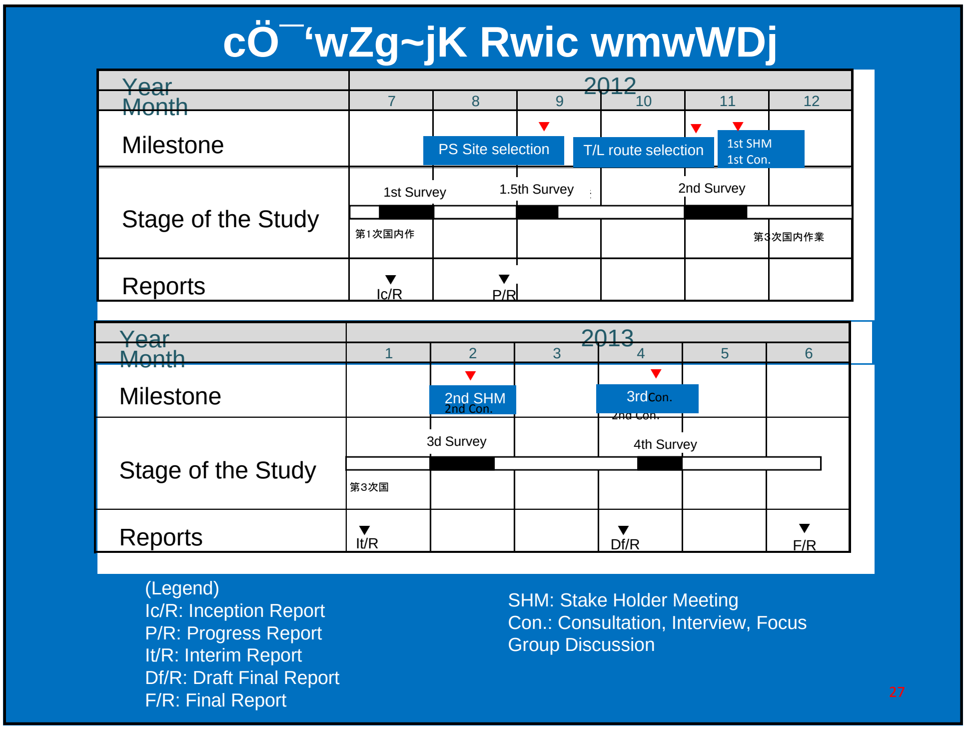
25

সিডিউল

পরবর্তী ে÷কহোল্ডার সভা

- তারিখ ঃ এপ্রিল ২০১৩
- স্থান ঃ
- বিষয় ঃ খসড়া "ইআইএ" উপস্থাপনা ও আলোচনা

26


cÖ¯'wZg~jK Rwic wmwWDj
Year
2012
Month
7
8
9
10
11
12
Milestone
PS Site selection
T/L route selection
1st SHM
1st Con.
Stage of the Study
1st Survey
1.5th Survey
2nd Survey
第1次国内作
第3次国内作業
Reports
Ic/R
P/R
Year
2013
Month
1
2
3
4
5
6
Milestone
2nd SHM
2nd Con.
3rd Con.
2nd Con.
Stage of the Study
3d Survey
4th Survey
第3次国
Reports
It/R
Df/R
F/R
(Legend)
Ic/R: Inception Report
P/R: Progress Report
It/R: Interim Report
Df/R: Draft Final Report
F/R: Final Report
SHM: Stake Holder Meeting
Con.: Consultation, Interview, Focus
Group Discussion
27


উপস্থিত সকলকে ধন¨বাদ
28

2nd Stakeholder meeting

(Power plant)

16th April, 2013

মাতারবাড়ি ২x৬০০ মেঃওঃ কয়লাভিত্তিক তাপ বিদ্যুৎ কেন্দ্র ও আনুষঙ্গিক সুবিধাদি নির্মাণ প্রকল্প

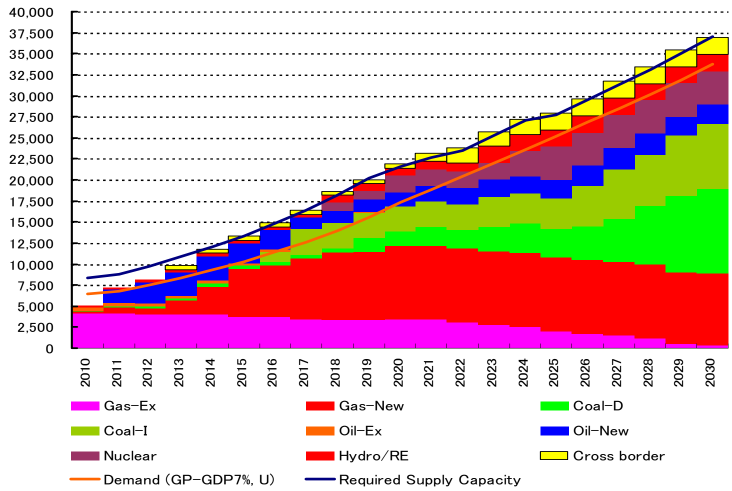
এপ্রিল, ২০১৩

কোল পাওয়ার জেনারেশন কোঃ বাংলাদেশ লিঃ

(সিপিজিসিবিএল)

1

প্রকল্পের পটভূমি ও প্রয়োজনীয়তা



- ক্রমবর্ধমান বিদ্যুতের চাহিদা পূরণের জন্য অনেক বড় বড় বিদ্যুৎ কেন্দ্র স্থাপন দরকার

2

প্রকল্পের পটভূমি ও প্রয়োজনীয়তা

- দেশীয় কয়লা উত্তোলন (আপাতত) স্থগিত ঘোষনা
- আমদানিকৃত কয়লা ভিত্তিক বিদ¨ুৎ কেন্দ্র নির্মাণে উৎসাহিত করা

3

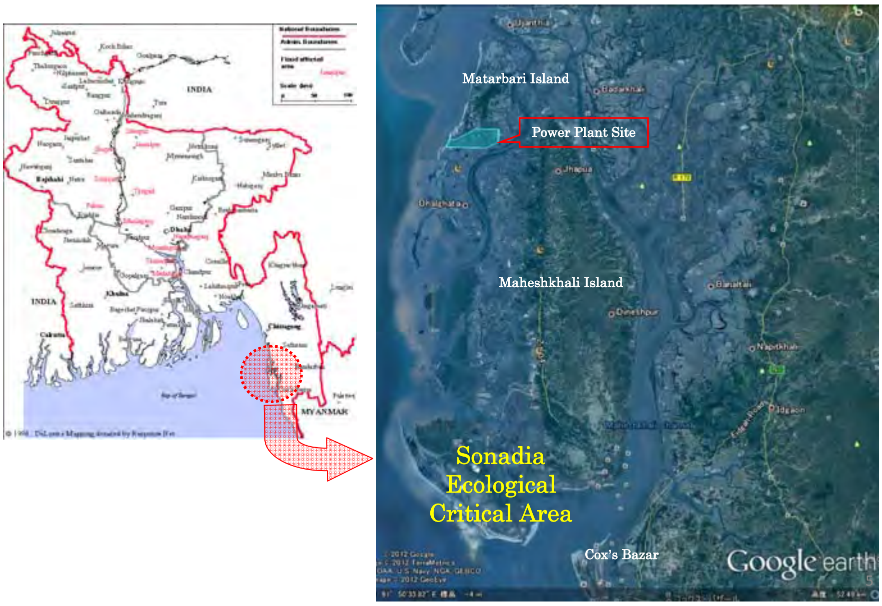
সমী¶ার উদ্দেশ¨

প্রস্তাবিত প্রকল্প বাস্তবায়নের জন¨ কারিগরি, পরিবেশ, ইকোনমিক ও আর্থিক দিক বিবেচনা পূর্বক সম্ভাব¨তা বিশ্লেষণ

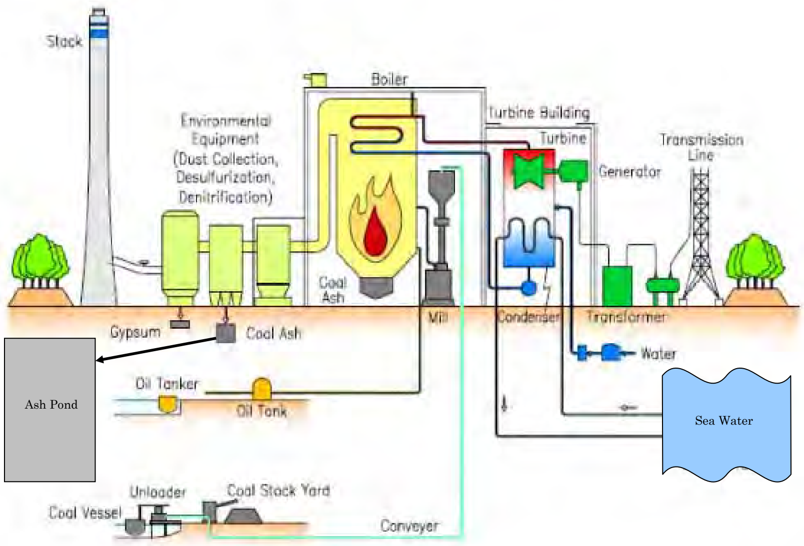
মাতারবাড়ি কয়লাভিত্তিক বিদ¨ুৎ কেন্দ্র / সঞ্চালণ লাইন নির্মাণ

4

প্রকল্পের অবস্থান

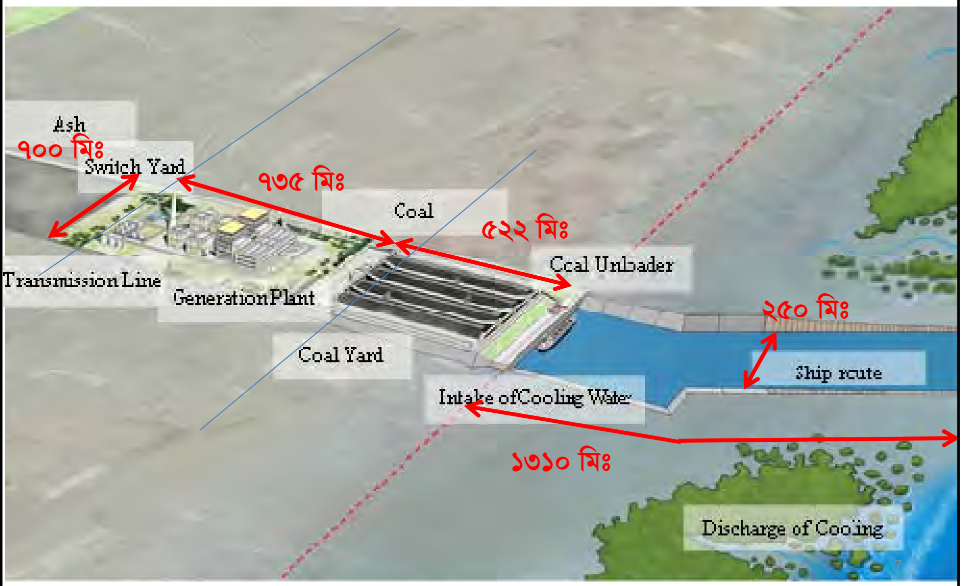


কয়লা ভিত্তিক তাপ বিদ্যুৎ কেন্দ্রের খসড়া চিত্র

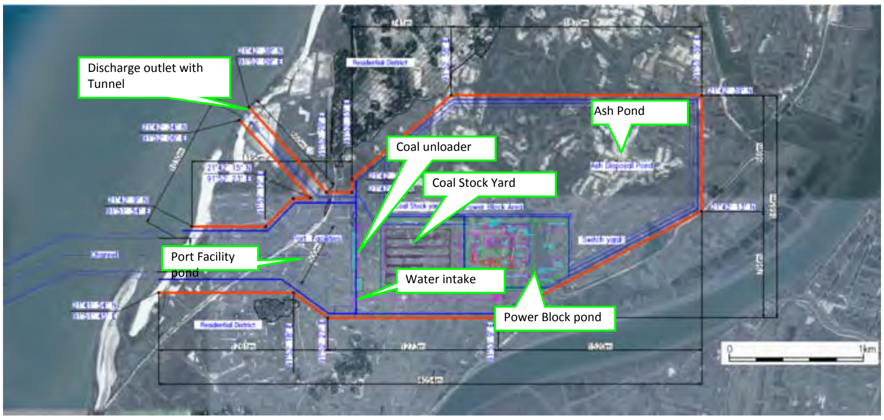


6

বিদ্যুৎ কেন্দ্রের প্রধান প্রধান অংশ



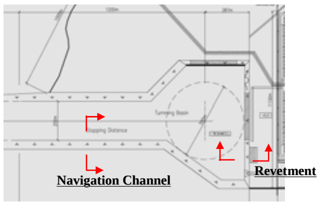
নূতন বিদ্যুৎ কেন্দ্রের লে-আউট

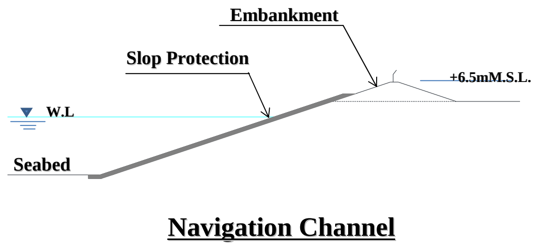


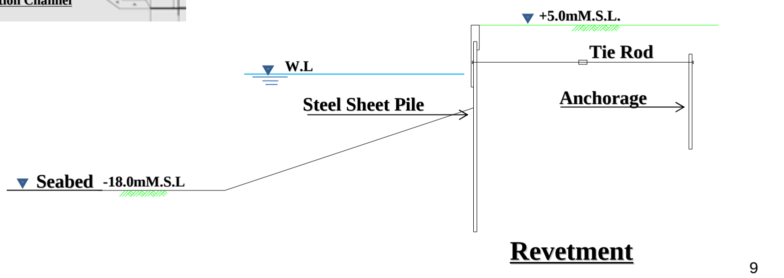
8

বন্দর সুবিধার ডিজাইন সম্পর্কে ধারনা

Filling up the ground and Constructing revetment against high water level

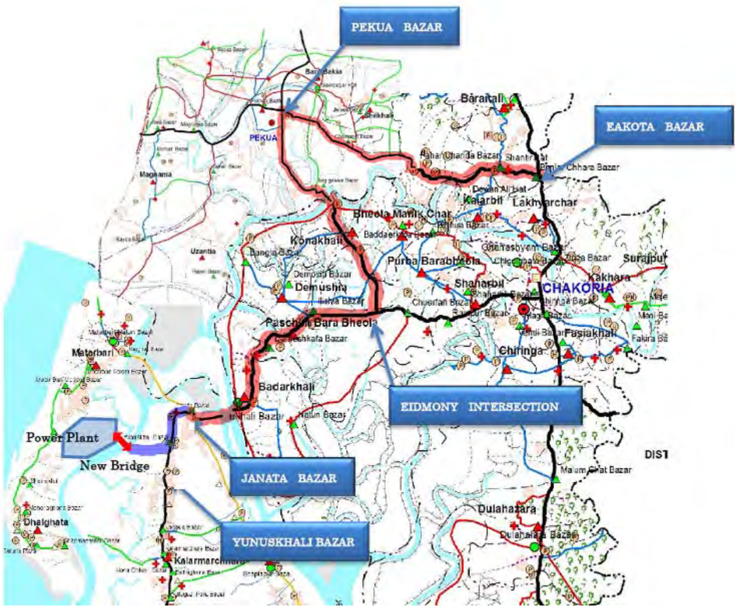




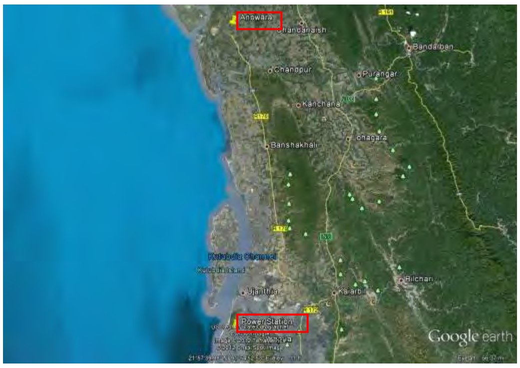


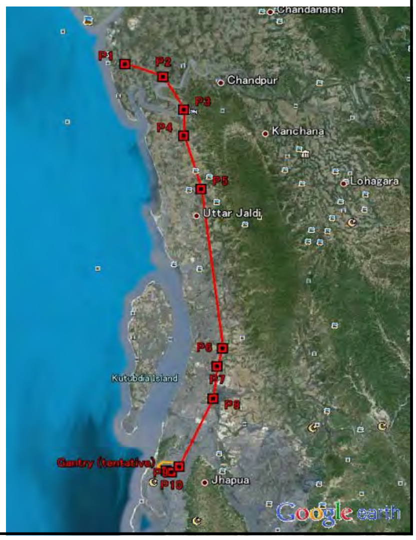
9

বিদ্যুৎ কেন্দ্রের সংযোগ সড়ক

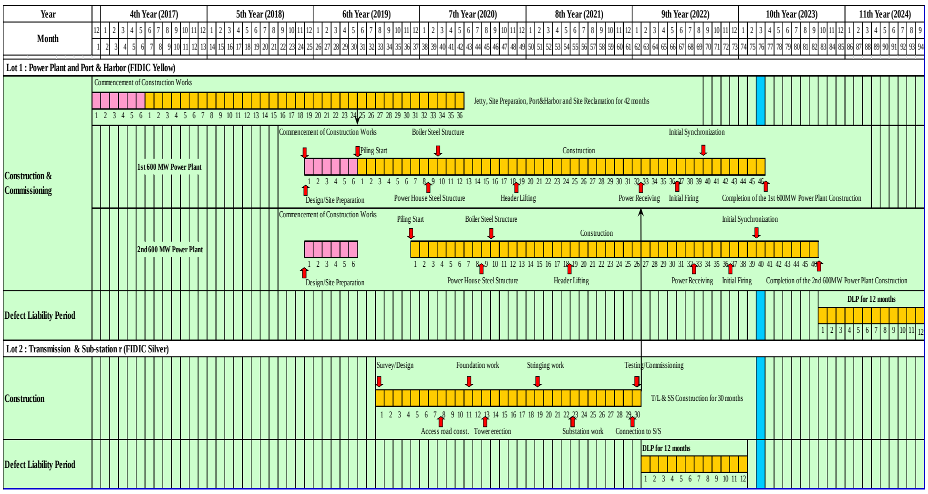


বিদ্যুৎ কেন্দ্র হতে আনোয়ারা পর্যন্ত ৪০০কেভি সঞ্চালন লাইনের রুট





পরীক্ষামূলক প্রকল্প বাস্তবায়ন সিডিউল

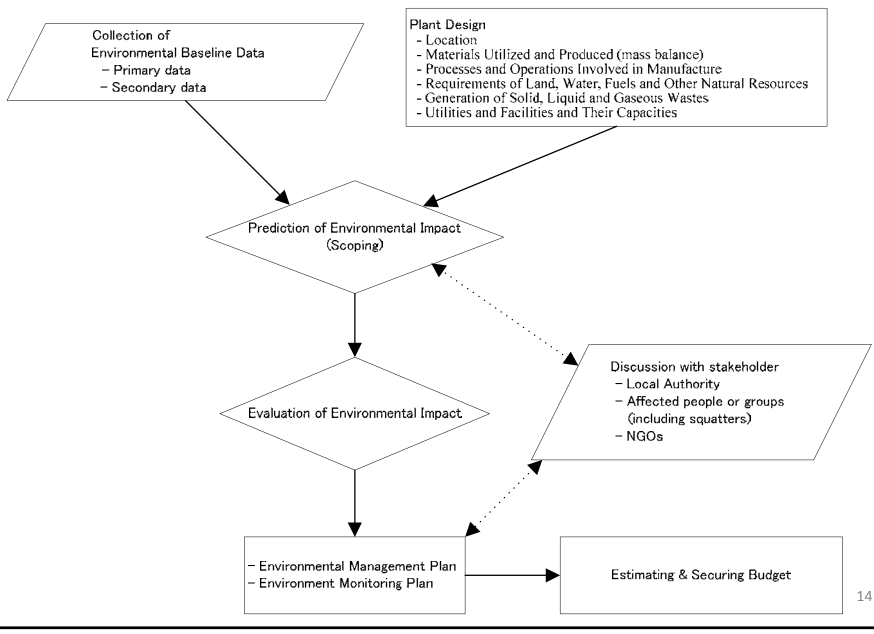


পরিবেশগত প্রভাব নিরূপন (ইআইএ) এর প্রয়োজনীয় নীতিমালা

- নির্ধারিত ইন্ডাষ্ট্রিজের জন্য পরিবেশ অধিদপ্তরের নীতিমালা (ডিওই-১৯৯৭); ও
- পরিবেশ ও সামাজিক বিষয় বিবেচনার জন্য জাইকার নীতিমালা (২০১০)

13

“ইআইএ” এর পদ্ধতি



14

পরিবেশগত ব¨বস্থাপনা পরিকল্পনা

- পরিবেশগত ব¨বস্থাপনা পরিকল্পনা নির্মাণ/পরিচালন কালে বাস্তবায়িত করা হবে যাতে দূষন মাত্রা ÷¨ান্ডার্ড মানের নীচে থাকে এবং কোন ¶তিকর প্রভাব না ফেলে।
- প্রতিকার ব¨বস্থা বাস্তবায়নের জন¨ দায়িত্বশীল সংগঠন গঠন করতে হবে ।
- পরিবেশ পর্যবে¶ণ নির্মাণ/পরিচালন কালে যথাযথভাবে সম্পাদন করা।
- সিপিজিসিবিএল ও ঠিকাদার প্রতিষ্ঠান প্রকল্পে গৃহীত কার্যক্রম ও প্রতিকার ব¨বস্থাসমূহের বিষয় ও সিডিউল সম্পর্কে প্রকল্প সংলগ্ন এলাকার বাসিন্দাদের ধারনা প্রদান করবে। প্রয়োজনে স্থানীয় জনগনের মতামত গ্রহন করে যথোপযুক্ত প্রতিকার ব¨বস্থা প্রনয়ণ করবে।

15

প্রধান প্রধান প্রতিকার ব¨বস্থাসমূহ (নির্মাণকালিন)

- বিদ¨ুৎ কেন্দ্র

আইটেম	প্রতিকার ব্যবস্থা
বায়ুর গুন	• বিশেষতঃ শুষ্ক মৌসুমে প্রকল্পের প্রবেশ সড়ক (এক্সেস সড়ক) ও প্রকল্প এলাকায় পানি ছিটানো। • মাটি বহনকালে ট্রাকের উপর ঢাকনা ব্যবহার করা। • সকল নির্মাণ যন্ত্রপাতি ও ভেহিকেল নির্দিষ্ট সময় পর মেরামত ও সংরক্ষণ করা।
পানির গুন, পানির ব্যবহার/ অধিকার এর প্রতিবন্ধকতা	• প্রকল্প এলাকার চারদিকে চ্যানেল, গর্ত ও অস্থায়ী পুকুর খনন করা। • শ্রমিকদের জন্য বর্জ্য পানি শোধন ব্যবস্থা, যেমন সেপটিক ট্যাংক স্থাপন করা। • তেল ও রাসায়নিক দ্রব্য সঠিক গুদাম ও যথাযথ পদ্ধতিতে সংরক্ষণ করা।
বর্জ্য	• আলাদাভাবে বর্জ্য সংগ্রহ এবং পুনঃশোধন ও ব্যবহার করতে উৎসাহিত করা। • পুনঃশোধন অযোগ্য বর্জ্য নিয়মানুসারে সঠিকভাবে পরিত্যাগ করা।

16

আইটেম	প্রতিকার ব্যবস্থা
শব্দ/কম্পন	• বিশেষতঃ পাইলিং কাজ দিনের বেলা সম্পাদন করা। • যতদূর সম্ভব কম শব্দ/কম্পন সৃষ্টিকারী ইক্যুইপম্যান্ট ব্যবহার করা। • নির্মাণ মালামাল ও ইক্যুইপম্যান্ট জাহাজে পরিবহন করা। • বিশেষতঃ আবাসিক এলাকায় ট্রাকের গতি সীমাবদ্ধ রাখা।
জীবজগৎ	<বিপন্ন প্রজাতি> • শ্রমিকদের দ্বারা প্রতিবন্ধকতা প্রদান, হয়রানি ও শিকার নিষিদ্ধ করা। • প্রয়োজনে নিকটবর্তী স্থানে প্রতিস্থাপন করা। <সামুদ্রিক কচ্ছপের ডিম পাড়া> • ডিম পাড়ার সময় অপ্রয়োজনীয় লাইট বন্ধ রাখা। • অল্পসংখ্যক লাইট / কম ওয়াটেজ সম্পন্ন লাইট ব্যবহার করা।

17

আইটেম	প্রতিকার ব্যবস্থা
ভূমি অধিগ্রহন / কর্মসংস্থান ও জীবিকার উপায় হারানো	• যথাযথ ভূমি অধিগ্রহন এবং পুনর্বাসন পরিকল্পনা প্রনয়ন করা। • সংশ্লিষ্ট আইন ও বিধি মেনে ভূমি অধিগ্রহন করা। • স্থানান্তরিত লোকজনের স্থানান্তর খরচ প্রদান করা। • যতদুর সম্ভব স্থানীয় লোকজনের বিশেষত যারা লবন চাষ, চিংড়ী চাষ এবং মাছ ধরার জায়গা হারাবেন, তাদের কর্মসংস্থানের ব্যবস্থা করা। • স্থানীয় লোকজনের প্রদত্ত সেবা (যেমন কাপড় ধোয়া বা খাবার সরবরাহ) এবং স্থানীয় লোকজন দ্বারা তৈরী দ্রব্যাদি ব্যবহার করা।
বিদ্যমান সামাজিক অবকাঠামো এবং সেবা / দুর্ঘটনা	• সংশ্লিষ্ট কতৃপক্ষের সঙ্গে আলোচনা করে নির্মাণ সামগ্রী বহনকারী জাহাজের সিডিউল প্রনয়ন করা। • নির্মাণ এলাকার চারদিকে চিহ্নিত বয়া স্থাপন। • স্থানীয় জেলেদের জাহাজের সিডিউল জানানো। • ট্রাফিক বিধি মেনে চলা, ট্রাফিক চিহ্ন স্থাপন করা, নিরাপদ গাড়ী চালানো শেখা। • ভেহিকেলের নিরাপদ পরিচালনার উপর প্রশিক্ষণ প্রদান। • বাস ব্যবহার করে ভেহিকেলের সংখ্যা কমানো। • সংশ্লিষ্ট কতৃপক্ষের সঙ্গে আলোচনা করে বাসের সিডিউল প্রনয়ন করা। • চারদিকের গ্রামে বাসের সিডিউল জানানো।

18

- বন্দর সুবিধা

অইটেম	প্রতিকার ব্যবস্থা
পানির গুন, পানির ব্যবহার/ অধিকার এর প্রতিবন্ধকতা	• সমুদ্র এলাকায় পাম্প ড্রেজার অথবা গ্রাব ড্রেজার দিয়ে ড্রেজিং করা এবং দূষন রোধকল্পে ফিল্ম বসানো। • পাশের জমি থেকে পতিত ঘোলা পানি, যেমন বৃষ্টির পানি, থিতানো পদ্ধতিতে পরিশোধন করে বন্দরের খননকৃত অংশে ছেড়ে দেওয়া।

19

যে সমস্ত গ্রাম ¶তিগ্রস্থ হবে

যে সমস্ত গ্রামের জমি অধিগ্রহন করা হবে ঃ

– সাইরের ডেল (মাতারবাড়ী ইউনিয়ন)

– উত্তর মহুরিগোনা (ধলঘাটা ইউনিয়ন)

– নাসির মোহাম্ § দ ডেল (ধলঘাটা ইউনিয়ন)

20

গ্রামবাসীরা কিভাবে ¶তিগ্রস্থ হবেন ?

- ভূমি হারানো

  ৪৫৫ হে±র জমি স্থায়ীভাবে অধিগ্রহন করা হবে।
- আয়ের উৎস (জীবিকার উপায়) হারানো

  প্রকল্প এলাকায় লবন চাষ, চিংড়ী চাষ, মাছধরা ও সংশ্লিষ্ট ব¨বসাজনিত জীবিকা স্থায়ীভাবে হারিয়ে যাবে।
- প্রকল্প এলাকার সম্পদ অথবা সম্পদে প্রবেশাধিকার হারাবে।
- যারা প্রকল্প এলাকায় থাকে তারা আশ্রয়স্থল হারাবে।

21

¶তিপূরণ

- সংশ্লিষ্ট জেলা প্রশাসকের দপ্তর ভূমি অধিগ্রহনের জন¨ প্রয়োজনীয় ব¨বস্থা গ্রহন করবেন।
- ভুমি অধিগ্রহন আইনের ধারা-৩ মোতাবেক জেলা প্রশাসকের দপ্তর মত-বিনিময়ের ব¨বস্থা করবেন।
- যদি জাইকা প্রকল্পে অর্থায়নের সি×ান্ত গ্রহন করে, তবে
  - আন্তর্জাতিকভাবে স্বীকৃত শর্তানুসারে অতিরিক্ত ¶তিপূরনের ব¨বস্থা গ্রহন করা হবে।
  - জীবিকা পুনরু×ারের কার্যক্রম অর্ন্তভুক্ত করা হবে।
  - প্রতিস্থাপন খরচের উপর ভিত্তি করে জমি এবং সম্পদের মূল¨ নির্ণয় করা হবে।

22

জীবিকা পুনরু ✕ ার কার্যক্রম

বর্তমান অবস্থা	কু-প্রভাব	কার্যক্রম
☐ প্রায় ৮০% বাড়ীর প্রধান অশিক্ষিত অথবা কেবল নাম লিখতে পারে। ☐ কেবলমাত্র ৪৩% ক্ষতিগ্রস্থ জণগন শিক্ষিত।	☐ চাকুরী পাওয়া কঠিন। ☐ সীমিত তথ্য জানার অধিকার ।	☐ বিদ্যুৎ কেন্দ্র কতৃপক্ষ স্থানীয় ছেলেমেয়েদের শ্রেনীশিক্ষার ব্যবস্থা করবে।
☐ অনুন্নত কর্মদক্ষতা। ☐ মহিলারা ঘরে অবস্থান করে।	☐ ভাল চাকুরী পাওযা কঠিন। ☐ বেতনও কম।	☐ বিদ্যুৎ কেন্দ্র কতৃপক্ষ দক্ষতা বাড়ানোর প্রশিক্ষণ প্রদান করবে।
☐ কর্মসংস্থানের সীমিত সুযোগ।	☐ কর্মহীনতার উচ্চ হার। ☐ দৈনিক শ্রম। ☐ ছেলেমেয়েরা স্কুল পরিত্যাগ করে।	☐ বিদ্যুৎ কেন্দ্র কতৃপক্ষ বিদ্যুৎ কেন্দ্র ও সংশ্লিষ্ট সুবিধা সমূহে চাকুরী প্রদান করবে।

23

এলাকা উন্নয়নের কার্যক্রম

বর্তমান অবস্থা	কু-প্রভাব	কার্যক্রম
☐ সকল ক্ষতিগ্রস্থ বাড়ী নলকূপের পানির উপর নির্ভরশীল। ☐ ৩৮% কাঁচা পায়খানা ব্যবহার করে অথবা কোন টয়লেট সুবিধা ব্যবহার করে না।	☐ নিরাপদ খাবার পানির অভাব। ☐ অস্বাস্থ্যকর পরিবেশ। ☐ সংক্রামক রোগের প্রাদুর্ভাব।	☐ পানি ও পয়ঃনিষ্কাশন ব্যবস্থা উন্নয়ণ সরকারের বিবেচনাধীন।
☐ ৯৫% ক্ষতিগ্রস্থ লোকজন বিদ্যুৎহীন। ☐ তারা রান্নার জন্য জ্বালানি কাঠ ও আলোর জন্য কেরোসিন ব্যবহার করে। ☐ কোন সড়ক বাতি নেই।	☐ কাজ করা এবং বাড়িতে পড়াশুনা করা কঠিন । ☐ অস্বাস্থ্যকর খাবার। ☐ রাত্রি অনিরাপদ।	☐ পল্লী বিদ্যুৎতায়ন ব্যবস্থা উন্নয়ণ সরকারের বিবেচনাধীন।

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এলাকা উন্নয়নের কার্যক্রম (ক্রমশঃ)

বর্তমান অবস্থা	কু-প্রভাব	কার্যক্রম
☐ গ্রাম পর্যায়ে সীমিত চিকিৎসা সুবিধা ☐ গ্রামবাসীরা স্থানীয় বাজার ও শহরে হাতুড়ে চিকিৎসকের শরনাপন্ন হন। ☐ জটিল ক্ষেত্রে তারা চকরিয়া উপজেলায় বেসরকারী চিকিৎসকের শরনাপন্ন হন।	☐ চিকিৎসার মান খারাপ। ☐ অস্বাস্থ্যকর অবস্থা। ☐ পুষ্টি জ্ঞানের অভাব।	☐ চিকিৎসা সুবিধার সংখ্যা বৃদ্ধি স্থানীয় সরকারের বিবেচনাধীন। ☐ বিদ্যুৎ কেন্দ্র কতৃপক্ষ স্থানীয় বাসিন্দাদের চিকিৎসা সেবা প্রদান করবে।
☐ বরফ তৈরীর সুবিধা অত্যন্ত নাজুক। ☐ মাছ চাষের দক্ষতা অত্যন্ত খারাপ।	☐ মাছ ও চিংড়ির মান খারাপ। ☐ দামও কম।	☐ বরফ তৈরীর কমিউনিটি সুবিধা

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প্রাতিষ্ঠানিক ব¨বস্থা

- সিপিজিসিবিএল বাস্তবায়নকারী সংস্থা।
- কক্সবাজার জেলা প্রশাসকের দপ্তর ¶তিগ্রস্থ জনগনকে ¶তিপূরণের পরামর্শ প্রদানের জন¨ নিকটবর্তী সংস্থা হিসাবে কাজ করবে।
- স্থানান্তর প্রক্রিয়া নির্মাণ কাজের পূর্বে বাস্তবায়ন করা হবে।

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অভিযোগ প্রতিকার প ×তি (নির্মাণকালিন সময়ে)

- প্রকল্প এলাকায় নিম্নলিখিত উদ্দেশে¨ একটি "অভিযোগ প্রতিকার কমিটি" গঠন করা হবে ঃ
  - ¶তিগ্রস্থ লোকজনদের সহজ প্রবেশাধিকার।
  - অতি দ্রুত তাঁদের উদ্বেগ ও অভিযোগের প্রতিকার করা।
- "অভিযোগ প্রতিকার কমিটি" নিম্নবর্নিত প্রতিনিধিদের সমন্বয়ে গঠিত ঃ

  সিপিজিসিবিএল, প্রকল্প ÷াফ, স্থানীয় এনজিও, ¶তিগ্রস্থ জনগনের প্রতিনিধি, ইউনিয়ন পরিষদের চেয়ারম¨ান সহ স্থানীয় গন¨মান¨ ব¨ক্তিবর্গ এবং আইন উপদেষ্টা।

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প্রধান প্রধান প্রতিকার ব¨বস্থাসমূহ (পরিচালনকালিন) - বিদ¨ুৎ কেন্দ্র

আইটেম	প্রতিকার ব্যবস্থা
বায়ুর গুন	• বস্তুকণার নির্গমন কমানোর জন্য ইলেক্ট্রোষ্ট্যাটিক প্রেসিপিটেটর (৯৯.৮% দক্ষ) স্থাপন করা হবে। • নক্স (নাইট্রোজেন অক্সাইড) নির্গমন কমানোর জন্য ফায়ারিং সিষ্টেমে কম দহনযুক্ত প্রযুক্তি ব্যবহার করা হবে। • সক্স (সালফার অক্সাইড) নির্গমন কমানোর জন্য সামুদ্রিক পানির এফজিডি (ফ্লু গ্যাস ডিসচার্জ) ইক্যুইপম্যান্ট (৭০% দক্ষ) স্থাপন করা হবে। • স্ট্যাক (চিমনি) এর উচ্চতা ২৭৫মিঃ করা হবে। • ছাই পুকুর ও কয়লা গুদামের উপরিভাগ পানি দিয়ে ভিজিয়ে রাখা হবে যাতে বায়ু প্রবাহে কয়লা /কয়লা-চূর্ণ উড়ে যেতে না পারে।

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বিদু¨ৎ কেন্দ্র হতে গ¨াস নির্গমনকালে দূষনকারীর ঘনত্ব

নির্গত দূষনকারীর ঘনত্ব বাংলাদেশের নির্গমন মানদন্ড এবং আইএফসি নীতিমালায় বর্নিত মানদন্ড এর নীচে রাখা হবে।

Item	Unit	Proposed Concentration	Emission Standards of Bangladesh	IFC Guidelines (Thermal power plants; 2008)
SOx	$\mu g/m^3$	820	-	850
NOx	$\mu g/m^3$	460	600	510
PM	$\mu g/m^3$	50	500	50

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পরিবেবেশগত ÷¨ান্ডার্ড

- বায়বীয় দূষণ থেকে জণসাধারনকে র¶া করার জন¨ পরিবেবেশগত ÷¨ান্ডার্ড মেনে চলা।
- বিশ্ব স্বাস্থ¨ সংস্থা, বিশ্ব ব¨াংক, ইউরোপীয় ইউনিয়ন, জাইকা এবং বাংলাদেশ সরকারের নিজস্ব বায়বীয় দূষনকারী পদার্থের (যেমন সক্স, নক্স, বস্তুকণা) জন¨ পরিবেবেশগত ÷¨ান্ডার্ড আছে।

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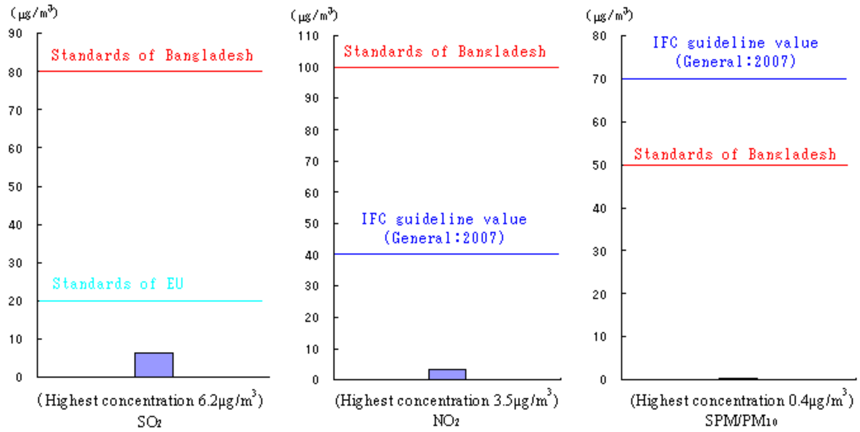
সিমুলেশন দ্বারা নির্নিত সম্ভাব¨ বায়ুদূষন

প্রতিকার ব¨বস্থা গ্রহনের ফলে সম্ভাব¨ বায়ুদূষনের মাত্রা বাংলাদেশের বায়ুদূষন ষ্ট¨ান্ডার্ড ও আন্তর্জাতিক ষ্ট¨ান্ডার্ড এর তুলনায় অনেক কম।



Predicted yearly averaged concentration and Air quality standards

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আইটেম	প্রতিকার ব্যবস্থা
পানির গুন	• বর্জ্য পানি পরিশোধন ব্যবস্থা (ওয়েষ্ট ওয়াটার ট্রিটম্যান্ট সিষ্টেম) যা নিরপেক্ষ, স্থিত ও তেল আলাদা করনের মাধ্যমে বাংলাদেশের ষ্ট্যান্ডার্ড এবং আইএফসি নীতিমালা মেনে বর্জ্য পানি পরিশোধন করা হবে।

- <তাপীয় বজ¨>
- তাপীয় বজ¨ ৪০° সেঃ তাপমাত্রা এর নীচে সমুদ্রে ছাড়া হবে।
- তাপীয় বর্জ¨ দ্রুত স্রোতের কারনে সমুদ্রের পানির সাথে মিশে যাওয়ায় পানির তাপমাত্রা ৩°সেঃ পর্যন্ত বাড়তে পারে।
- বর্জ¨ পানি ছাড়ার পয়েন্ট থেকে ২০০মিঃ পর্যন্ত পানির তাপমাত্রা ২°সেঃ পর্যন্ত বাড়তে পারে।

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আইটেম	প্রতিকার ব্যবস্থা
শব্দ/কম্পন	• ইক্যুইপম্যান্ট সংরক্ষণ করা। • কম শব্দ/কম্পন সৃষ্টিকারী ইক্যুইপম্যান্ট স্থাপন করা। • কম্পণ কমানোর জন্য যথোপযুক্ত ভিত্তির উপর ইক্যুইপম্যান্ট বসানো। • শব্দ কমানের জন্য ইক্যুইপম্যান্ট এর যথোপযুক্ত ঢাকনা ব্যবহার করা।

বিদ্যুৎ কেন্দ্র পরিচালনার সময় নিকটবর্তী আবাসিক এলাকায় বিদ্যুৎ কেন্দ্র থেকে উৎপাদিত শব্দের মাত্রা ৩০.২ - ৪১.২ ডিবি(এ) যা বাংলাদেশের আবাসিক এলাকার জন্য নির্ধারিত ষ্ট্যান্ডার্ড মাত্রার নীচে।

	Predicted Level (dB(A))	DOE Standard (dB(A))
Boundary (Industrial)	10.6 – 43.3	Day 70 Night 70
Residential	30.2 - 41.2	Day 55 Night 40

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আইটেম	প্রতিকার ব্যবস্থা
জীবজগৎ	<বিপন্ন প্রজাতি> • শ্রমিকদের দ্বারা প্রতিবন্ধকতা প্রদান, হয়রানি ও শিকার নিষিদ্ধ করা। <সামুদ্রিক কচ্ছপের ডিম পাড়া> • ডিম পাড়ার সময় অপ্রয়োজনীয় লাইট বন্ধ রাখা। • অল্পসংখ্যক লাইট / কম ওয়াটেজ সম্পন্ন লাইট ব্যবহার করা।
কর্মসংস্থান ও জীবিকার উপায় হারানো	• যতদূর সম্ভব স্থানীয় লোকজনদের কর্মসংস্থানের ব্যবস্থা করা। • স্থানীয় লোকজনদের প্রদত্ত সেবাসমূহ (যেমন কাপড় ধোয়া (লন্ড্রি) বা খাবার সরবরাহ প্রভৃতি) এবং স্থানীয় লোকজন দ্বারা তৈরী দ্রব্যাদি ব্যবহার করা।
বিদ্যমান সামাজিক অবকাঠামো এবং সেবা	• বাস ব্যবহার করে শ্রমিকদের রাস্তায় চলাচলের সংখ্যা কমানো । • সংযোগ সড়ক, স্থানীয় সড়ক ও বিদ্যুৎ কেন্দ্রের চারপাশে সড়ক নির্মাণ। • এ সড়কসমূহ বর্ষাকালেও ব্যবহার করা যেতে পারে। • বাস ব্যবহার করে যান চলাচলের সংখ্যা কমানো । • নূতন সেবাসমূহ যেমন, স্কুল, স্বাস্থ্যকেন্দ্র প্রভৃতি প্রয়োজনমাফিক স্থানীয় জণসাধারনের জন্য উন্মুক্ত করা।

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আইটেম	প্রতিকার ব্যবস্থা
দুর্ঘটনা	• ট্রাফিক বিধি মেনে চলা, ট্রাফিক চিহ্ন স্থাপন করা, নিরাপদ গাড়ী চালানো শেখা। • ভেহিকেলের নিরাপদ পরিচালনার উপর প্রশিক্ষণ প্রদান। • চারদিকের গ্রামে বাসের সিডিউল জানানো। • অগ্নি-নির্বাপন ব্যবস্থা বসানো।

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- বন্দর সুবিধা

আইটেম	প্রতিকার ব্যবস্থা
বায়ুর গুন	• কনভেয়ারের মাধ্যমে কয়লা গুদামে কয়লা পরিবহনের সময় আচ্ছাদন ব্যবহার করা হবে। • কয়লা গুদামের উপরিভাগ পানি দিয়ে ভিজিয়ে রাখা হবে যাতে বায়ু প্রবাহে কয়লা /কয়লা-চূর্ণ উড়ে যেতে না পারে। • মারপল ৭৩/৭৮ ট্রিটি মেনে জাহাজ ভাড়া করা।
পানির গুন, পানির ব্যবহার/ অধিকার এর প্রতিবন্ধকতা	• এমন সব ড্রেজিং পদ্ধতি বা ইক্যুইপম্যান্ট ব্যবহার করা যা পানিকে কম ঘোলাটে করবে। • তেল প্রতিবন্ধক (ওয়েল ফেন্স) স্থাপন করা। • দূষিত পদার্থ জমানো নিষিদ্ধ করা। • মারপল ৭৩/৭৮ ট্রিটি মেনে জাহাজ ভাড়া করা।
বিদ্যমান সামাজিক অবকাঠামো এবং সেবার উপর উপদ্রব/ দুর্ঘটনা	• সংশ্লিষ্ট কতৃপক্ষের সঙ্গে আলোচনা করে জলপথ নির্দ্ধারণ করা। • নির্মাণ এলাকার চারদিকে চিহ্নিত বয়া স্থাপন। • নৌ-চলাচল চ্যানেলে বয়া স্থাপন। • সংশ্লিষ্ট কতৃপক্ষের সঙ্গে আলোচনা করে জাহাজের সিডিউল প্রনয়ন করা। • স্থানীয় জেলেদের জাহাজের সিডিউল জানানো।

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পরিবেশ পর্যবেক্ষণ পরিকল্পনা (নির্মাণকালিন)

	প্রধান আইটেম	প্যারামিটার	স্থান	পর্যবেক্ষণের হার
বিদ্যুৎ কেন্দ্র	বায়ুর গুন	পিএম ১০	আবাসিক এলাকা	ত্রৈমাসিক
	পানির গুন	পিএইচ, বড, এসএস, তেল প্রভৃতি	ড্রেনের মুখ, ভূপৃষ্ঠস্থ পানি, ভূগর্ভস্থ পানি, সমুদ্রের পানি	ত্রৈমাসিক
	শব্দ	শব্দের মাত্রা	আবাসিক এলাকার সীমানা	ত্রৈমাসিক
	জীবজগৎ	বিপন্ন প্রজাতি	নির্মাণ এলাকা	পাখি - মাইগ্রেশন মৌসুমে সপ্তাহে একবার; অন্যান্য- শুষ্ক / বর্ষা মৌসুমে
		সামুদ্রিক কচ্ছপ	প্রকল্পের সামনের সৈকতে	ডিম পাড়ার মৌসুমে তিন দিন পর পর।
		প্ল্যাংটন, বেন্থস, মাছ ও নেকটন	নির্মাণ এলাকার সমুদ্র অঞ্চলে।	শুষ্ক / বর্ষা মৌসুমে
বন্দর সুবিধা	পানির গুন	এস এস	সমুদ্রের পানি	ত্রৈমাসিক

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পরিবেশ পর্যবেক্ষণ পরিকল্পনা (পরিচালনকালিন)

	প্রধান আইটেম	প্যারামিটার	স্থান	পর্যবেক্ষণের হার
বিদ্যুৎ কেন্দ্র	বায়ুর গুন	এসও২, এনও২, পিএম	গ্যাস ডাক্ট	অবিরাম
		এসও২, এনও২, পিএম	আবাসিক এলাকা	ত্রৈমাসিক
	পানির গুন	পিএইচ, ডিও, এসএস, তেল , সিওডি, হেভি মেটাল প্রভৃতি	ড্রেনের মুখ	ত্রৈমাসিক
		পানির তাপমাত্রা পিএইচ, ডিও, এসএস, তেল , সিওডি, হেভি মেটাল প্রভৃতি	সমুদ্র	ত্রৈমাসিক
	শব্দ	শব্দের মাত্রা	আবাসিক এলাকার সীমানা	ত্রৈমাসিক
	জীবজগৎ	বিপন্ন প্রজাতি	ছাই ফেলার পুকুর	পাখি - মাইগ্রেশন মৌসুমে সপ্তাহে একবার; অন্যান্য- শুষ্ক / বর্ষা মৌসুমে
		সামুদ্রিক কচ্ছপ	প্রকল্পের সামনের সৈকতে	ডিম পাড়ার মৌসুমে তিন দিন পর পর।
		প্ল্যাংটন, বেন্থস, মাছ ও নেকটন	প্রকল্প এলাকার সমুদ্র অঞ্চলে।	শুষ্ক / বর্ষা মৌসুমে
বন্দর সুবিধা	পানির গুন	এস এস	সমুদ্র	ড্রেজিং কার্যক্রম চলাকালে

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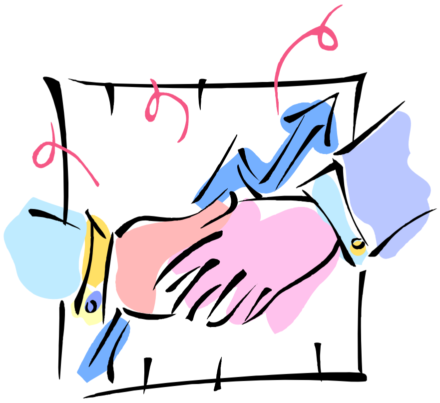

উপস্থিত সকলকে ধন¨বাদ

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Annexure 7

Analysis of Alternatives

Annex 7

Analysis of Alternatives

-: Table of Contents:-

7.1 Introduction

In the master plan of the coal-fired power plant project in Bangladesh, 16 locations have been examined as candidate construction sites, and 2 locations, southern Chittagong and Meghnaghat, were selected as the major proposed sites for their advantage in using imported coal. The follow-up investigation proved that Matarbari Island and Maheshkhali Island located in the south of Chittagong and in the north of Cox's Bazar, respectively, are the most promising construction sites for the coal-fired power plant.

7.2 Project Location

(1) The viewpoint of port and harbor engineering
On the basis of the results thus far, the JICA Study Team of port and harbor engineering has concluded that the Matarbari Site should have higher priority than the Maheshkhali Site. The comparative table is as shown below.

- The site conditions are based on field studies
- Maintenance dredging is based on the computer simulation of sediment transport results
- Operability is based on the calmness analysis results

The expansion of port and harbor is based on the land–use planning with the related surrounding circumstances.

Table 7.2-1 Site Selection Result (from the viewpoint of port and harbor engineering)

Items	Matarbari Site	Maheshkhali Site
Site Conditions	It is possible to plan a power plant at this site.	It is possible to plan a power plant at this site.
	○	○
Maintenance Dredging	Need maintenance dredging, but less than the Maheshkhali Site.	Need continuous maintenance dredging throughout the channel (7 km in length).
	△	×
Operability of Coal Vessels	Channel and mooring basin are calm because of the breakwater or the artificially excavated land, so there is no impact on cargo handling.	Ship handling demands extreme care through the restricted channel on account of several dipper dredgers working on the channel (7 km in length).
	○	△
Expansion of Port & Harbor	Can expand port and harbor, with little effect on coastal change.	To expand port and harbor increases risk of negatively impacting mangroves.
	○	×
Results	**Candidate site for a Power Plant**	Unsuitable
	○	×

(2) The viewpoint of natural environment
a) Field Survey by JICA Study Team
Table 7.2-2 shows the comparison of Matarbari and Maheshkhali site from the view point of natural condition based on the 1st field survey conducted by JICA Study Team. Both Matarbari and Maheshkhali site have poor vegetation and limited number of animal observed on land, thus there is nothing to choose between the two sites as a better project site. However, Maheshkhali site has huge mangrove forest and sandbar at sea side of the site; therefore, it is predicted that the mangrove forest and sandbar get impact during construction and operation phase of the power plant, if Maheshkhali site is selected as a project site.

Table 7.2-2 Comparison of Matarbari & Maheshkhali from Natural Condition

Items	Matarbari	Maheskhali
Vegetation	- Site: Poor - Forest: There are few trees place on the nearest residence area - Mangrove: No Mangrove	- Site: Poor - Forest: There are few trees place on the nearest residence area - Mangrove: <u>There are huge mangrove forests offshore.</u>
Animal	- Site: Sedentary birds observed -Surrounding area: Sedentary birds observed	- Site: Sedentary birds observed - Surrounding area: Sedentary birds are observed over the mangrove forests
Endanger species	- Site: Not observed - Surrounding area: Not observed	- Site: Not observed - Surrounding area: Not observed
Habitat condition surrounding the site	- Corral reef: Not observed - Seaweed bed: Not observed - Sandy beach: Observed Mudflat: Observed - Sandbar: Not observed	- Corral reef: Not observed - Seaweed bed: Not observed - Sandy beach: Not observed - Mudflat: Observed Sand bar: <u>There is a sandbar in estuarine region around 4km away from the site</u>

b) Simulation of Wave and Current

To evaluate effects of some main activities planning in each project site to the surrounding natural environment of alternative project site, the following types of simulation have been conducted. (See detailed description **Chapter 2**)

i. Simulation on wave-height and its effects to geological condition of offshore
ii. Simulation on tidal current and its effects to geological condition of offshore
iii. Simulation on dredging and its effects to geological condition of offshore

Table 7.2-3 shows main results of simulation on environmental issues (project sites) caused by dredging activity.

Table 7.2-3 Main results of simulation on environmental issues (Project sites)

Project sites / Items	Matarbari	Maheshkhali
Wave-height	a little (almost negligible) ✓ a little change of Mud-sediment around dredging site	Notable ✓ Mud-erosion around dredging site covered with mangrove
Tidal current	None	Notable ✓ Mud-sediment around dredging site covered with mangrove Mud-erosion around dredging site covered with mangrove
Dredging	a little ✓ Periodical dredging is needed but its times are lessる	Notable ✓ Periodical dredging covering with wide area is needed

c) Evaluation of Matarbari and Maheshkhali site

Both Matarbari and Maheshkhali site have been compared to each other on the degree of environmental impact by rating. Rating by using quantifiable method for Natural Environment are not established as an academic discipline yet, therefore, the Number (from 0 to -3) is being used to evaluate Natural Environment of alternative site meaning just qualitative tendency as

0: *None impact,*

-1*: a little impact but not serious,*
-2*: serious impact but not irreversible,*
-3*: irreversible impact.*

From the comparison of two project sites, the negative point of each alternative site is as below (Table 7.2-4).

Matarbari: -2
Maheshkhali: -10

Maheshkhali site gets higher negative point and has impact on the surrounding mangrove forest, which is ecologically sensitive area. <u>From the view point of environmental consideration, Maheshkhali site is not recommended.</u>

Table 7.2-4 Comparison of project alternative sites

Impact	**Matarbari**		**Maheshkhali**	
Impact to mudflats	(by wave, a little -1)	-1	(by wave, serious -2) (by current, serious -2)	-4
Impacts to migratory bird	None	0	None	0
Impacts to sea turtle	None	0	(by dredging near turtle habitat ,a little -1)	-1
Impacts to dolphin	None	0	None	0 [1]
Impact to juvenile fish	None	0	None	0
Impact to mangrove	None	0	(by wave, serious -2) (by current, serious -2)	-4 [2]
Impact to sea grass [3]	(by dredging, a little -1)	-1	(by dredging, a little-1,)	-1
Distance to Sonadia ECA	None	0	None	0
Evaluation		**-2**		**-10**

Note) 0[1] : there are some apprehensions causing impact to dolphin by dredging with 7Km forward to offshore, but no information or data

-4[2] : there are no direct impact cutting down mangrove vegetation , but deteriorating of habitat by losing mudflats near the its root would spur many harsh consequences to be fell down mangrove

sea grass[3] : evaluated as food for sea-turtle

(3) The viewpoint of social environment

a) Comparison of Matarbari and Maheshkhali Site

The overview of each site is summarized in the tables below. Matarbari site includes at least Sairer Dail village and Maheshkhali includes Kalaghagir Para village. As it is not easy at this moment to identify **all** villages where alternative sites are located, a complete comparison of two sites stays at union level (Table 7.2-5).

Table 7.2-5 Specifications of Located Unions

Project sites / Items		Matarbari	Maheshkhali
Located Union		Matarbari Union* (note) part of Dhalghata Union may be included as the site is located at the union border.	Hoanak Union
1	Area	6,682 acres (approximately 2,704 ha)	9,165 acres (approximately 3,721 ha)
2	Population	8,168 households (44,937 people) living in 21 villages of the Union.	9,373 households (51,587 people) living in 28 villages of the Union.
3	Population density	1,661 people per square km	1,386 people per square km
4	Land use	Cultivated land: 600 ha Rice production: 2,328 metric ton	Cultivated land: 1,150 ha Rice production: 4,450 metric

Items \ Project sites		Matarbari	Maheshkhali
5	Employment status	6,944 are employed out of 19,436 aged 7 and above not attending school	9,498 are employed out of 22,689 aged 7 and above not attending school
6	Field of activity	Agriculture: 75.6%, industry: 3.2%, service: 21.3%	Agriculture: 90.1%, industry: 1.7%, service: 8.1%
7	Source of drinking water	Tap: 0.2%, tube well: 95.0%, others: 4.8%	Tap: 0.2%, tube well: 91.3%, others: 8.5%
8	Literacy rate	27.7% (male: 26.1%, female: 29.4%)	29.9% (male: 28.8%, female:31.1%)
9	Type of house structure	Permanent: 4.4% Semi-permanent: 4.8% Mud / bamboo: 71.7% Temporary : 19.1%	Permanent: 1.4% Semi-permanent: 3.4% Mud / bamboo: 93.8% Temporary : 1.3%
10	Toilet facility	Sanitary (water-sealed) : 2.2% Sanitary (non water-sealed) : 36.6% Non-sanitary : 49.6% None : 11.6%	Sanitary (water-sealed) : 1.4%% Sanitary (non water-sealed) : 21.7% Non-sanitary : 69.6% None : 7.3%

(Source) Population Census 2011, data provided at the Agricultural Division of Maheshkhali Upazila Nirbahi Office.

Table 7.2-6 Type of Workers within 15 km radius of the Project Site

(unit: person)

Items \ Project sites		Matarbari	Maheshkhali
1	Salt farmers	800	-
2	fishermen	700	-
3	Shop business	300	-
4	Farmers	160	-
5	Transport workers	180	-
6	Hawkers	66	-
7	Others	50	-
Total		2,256	-

(Source) Discussion with local elites of Matarbari Union (August 6, 2012)
(Note) It is not easy at this moment to identify all villages where alternative sites are located, however, Matarbari site includes at least Sairer Dail village.

According to the secondary information[1], Maheshkhali Upazila has the highest concentration of salt farmers. Salt farmers are mostly poor and operate on a small scale. Their average size of farm is 0.62 ha. They work under adverse conditions. This hardworking job only interests the poor and the landless, and many of them lease in land from others. They are in close proximity to the open sea and often face all the hazards coming from the sea. The whole output is often washed away by heavy rain and storm surge because of lack of storage facility.

In the site survey of July 2012, there were salt farmers found at the both sites, along with fishermen and shrimp farmers. They are the dominant occupations at both sites. According to the interviews with local residents, their household income varies from 5,000 Taka per month to 100,000 Taka, and the economy level of local residents at two sites are judged similar.

[1] Program Development Office for Integrated Coastal Zone Management Plan, Water Resources Planning Organization, Ministry of Water Resources of the Government of Bangladesh. “Living in the Coast: People and Livelihoods” (2004).

b) Evaluation for Social Impact

Items for evaluation for Social Environment are based on the scoping items for social environment as quoted in the JICA Guidelines. Hierarchies among the said items have not been analyzed, and each rating does not reflect either as the degree of each impact remains unknown yet at this moment. Therefore, the number (-1, 0 or +1) simply reflects if the potential impacts are either negative, neglectable (or none), or positive:

-1*: Negative (adverse) impact anticipated*
0*: No impact or neglectable anticipated*
+1*: Positive impact anticipated*

c) Recommendation of the priority project site taking into account socio-economic conditions

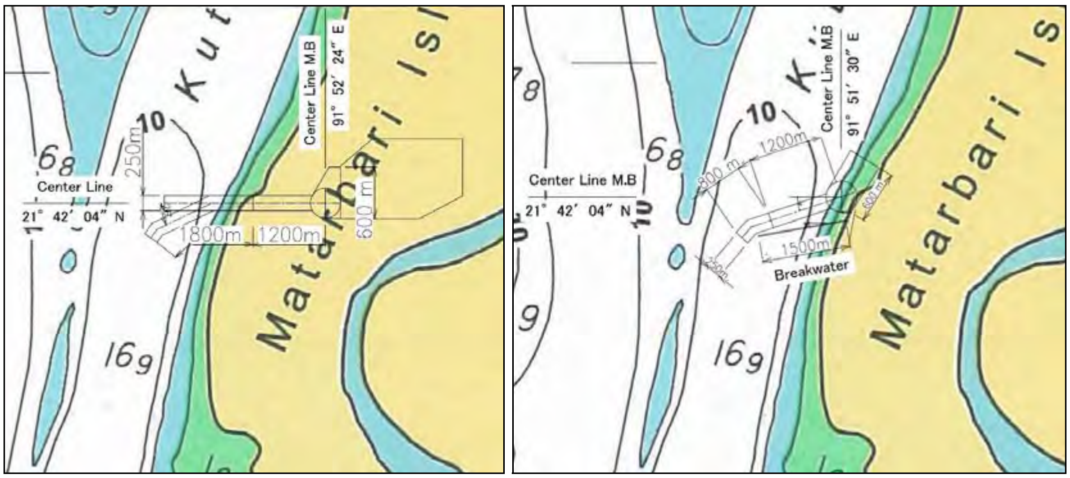
From the comparison of two project sites, the total rating of each alternative site is as below (Table 13-28).

- Matarbari: design / construction stage -15, operation stage +-0
- Maheshkhali: design / construction stage -11, operation stage +-0

Both sites have scores worse than -10 at design / construction stage, whereas it is expected to have positive impact at operation stage: +2 at both sites. Not only cash compensation stipulated by the relevant laws in Bangladesh, assistance packages should also be taken into consideration for both cases, especially for the loss of livelihood means and income sources. Therefore, there is no significant difference expected between the two sites from the social environmental point of view.

7.3 Technology Options

There are two design proposals regarding the port facility as shown in Figure 7.3-1. One is an excavated type, which is a port constructed inland with a dredged canal, and the other is a conventional type which is a port constructed on the coast with a breakwater.



(Excavated type) (Conventional type)

(Source: JICA Study Team)

Figure 7.3-1 Alternatives of the port facility

(1) Consideration of the port design technical components from technical and economic aspects

A comparison of the excavated type and the conventional type of port facilities was conducted from the technical and economic aspects (Table 7.3-1). The excavated type of port facilities needs dredging of a canal in addition to the construction of a breakwater, but the extent of dredging work will be less than the conventional type. The conventional type of port facilities, on the other hand, needs a larger extent of dredging work, but construction of a breakwater is not necessary.

Breakwater construction requires pavement materials for the foundation, which would be imported from India and other countries at certain transportation costs. Also, in the leveling work (landfill up to 8-12m above sea level) needed for the power plant to be protected against high tides and tidal waves, transportation of sand and soil is necessary for the conventional type (dredging soil from the canal will not be sufficient).

The excavation type does not involve the construction of a breakwater and therefore pavement material is not necessary. Also, a large amount of dredging sand from the canal may be used for leveling work.

Therefore, compared to the conventional type, construction costs will be lower for the excavation type.

Table 7.3-1 Technical comparison of the excavated type and the conventional type

Items	Excavated Type		Conventional Type
Preparation of the site	Dredging work of the port facility and the canal will generate a huge amount of dredging soil, but sandy soil in the dredging material can be		Pavement material for constructing a breakwater and a caisson type breakwater is needed, which is not available in Bangladesh.

Items	Excavated Type		Conventional Type
	used for leveling work of the power plant as a flood countermeasure. The cost for buying leveling materials is decreased.		Large amount of dredging soil will be generated, but will not be sufficient for the leveling work of the power plant.
Maintenance dredging	Maintenance dredging is necessary for maintaining the port facility.		Maintenance dredging is not necessary.
Expansion of the port	Expansion of the canal is expected, involving dredging of a sand beach at the side of the canal. The dredging sediment can be used for leveling work of the expanded port facility.		Dredging soil will be generated, but will not be sufficient for leveling work of the expanded port facility. Soil for leveling work needs to be purchased.

(Source: JICA Study Team)

(2) Consideration of the port design from environmental aspects

Social-environmental impacts will be similar for both types of design. A natural environmental impact is assessed as follows.

a) Simulation of ocean waves and tides

A simulation of ocean waves and tides was conducted, as in the case of the site selection, for the excavated type and the conventional type of port facilities, and a summary of the results is shown in Table 7.3-2.

Table 7.3-2 Summary of the simulation of ocean waves and tides

Items	Excavated Type	Conventional Type
Dredging	A little ✓ Periodical dredging is needed but fewer than the Conventional Type	None
Wave-height	A little (almost negligible) ✓ A small change of mud-sediment around dredging site	A little (but some areas serious) ✓ A small change of mud-sediment around breakwater
Tidal current	None	Notable ✓ Change of mud-sediment around breakwater and dredging site but limited to the site only

(Source: JICA Study Team)

b) Evaluation

The environmental impact of the project on the habitat and flora and fauna was assessed from the results described above, with the same scoring methods used in the case of the site selection. Table 7.3-3 describes the scores of the total assessment results. Although the conventional breakwater type has a higher score, the difference was not considered to be critical.

Excavated type: -2
Conventional type: -3

Table 7.3-3 Environmental impact of the excavated type/conventional type breakwater on the habitat and flora and fauna

Impact	Excavated Type	Conventional Type

Impact	Excavated Type		Conventional Type	
Impact on mudflats	(By waves, a little -1)	-1	(By waves, a little -1) (By current, significant -2)	-3
Impacts on migratory birds	None	0	None	0
Impacts on sea turtles	None	0	None	0
Impacts on dolphins	None	0	None	0
Impact on young fish	None	0	None	0
Impact on mangroves	None	0	None	0
Impact on sea grass	(By dredging, a little -1)	-1	None	0
Impact on Sonadia ECA (wave-height & tidal current)	None	0	None	0
Evaluation		**-2**		**-3**

(Source: JICA Study Team)

(3) Conclusion

Table 7.3-4 describes the total assessment results. The excavated type breakwater is considered to be more advantageous. The JICA Survey Team recommends the excavated type breakwater to the BPDB as a project item.

Table 7.3-4 Summary of a comparison of the two breakwater systems

Impact	Excavated Type		Conventional Type
Technical and economic aspects	Large amount of dredging soil will be generated, but sandy soil in the dredging material can be used for leveling work of the power plant. Cost for buying leveling material is decreased.		Pavement material is needed, which is not available in Bangladesh. A large amount of dredging soil will be generated, but will not be sufficient for leveling work of the power plant
Natural environment	The impact on the waves and tide is insignificant. Environmental impact due to maintenance dredging is predicted.		Impact of the breakwater on the waves and tide in the surrounding sea is predicted.

(Source: JICA Study Team)

7.4 No Project Scenario

The potential environmental impact in the case of non-implementation of the project is described in Table 7.4-1.

Table 7.4-1 Potential environmental impact in case of non-implementation

Items	Positive Effects	Negative Effects
Electricity power demand	- None	- To cope with power demand, a new thermal power plant will be built at another area using coal and not natural gas because of a shortage of gas
Pollution of environment	- No air pollution - No water pollution caused by cooling water - No waste - No noise problems - No continued dredging	- There are some apprehensions of air pollution because regulations on emission control of SO_X have not been enacted in Bangladesh
Natural environment	- No land clearing - No change of sea water current caused by a breakwater	- None
Social environment	- No resettlement - No acquisition of land	- No expected employment opportunities - No expected introduction of new business related to project
Other	- No greenhouse gas effect	- Increased amount of CO_2 gas will be emitted compared to this project as another project may not install equipment with state of the art technology efficiently reducing CO_2

(Source: JICA Study Team)

Annexure 8

List of References

Annex 8

List of Reference

-: Table of Contents:-

8.1 List of Reference

1. Environmental Conservation Act, 1995
2. Environmental Conservation Rules, 1997
3. EIA Guidelines for Industries, 1997
4. JICA Guideline for Environmental and Social Considerations
5. IFC EHS Guideline “General”
6. IFC EHS Guideline “Thermal Power Plant”

Annexure 9

Abstracts of Selected Reference

Annex 9

Abstracts of Selected Reference

-: Table of Contents:-

9.1 Abstracts of Selected Reference

9.1.1 Environmental Conservation Act, 1995

Environmental Conservation Act is an Act to provide for conservation of the environment, improvement of environmental standards and control and mitigation of environmental pollution.
Subject to the provisions of this Act, the Director General may take such measures as he considers necessary and expedient for the conservation of the environment, and improvement of environmental standards, and for the control and mitigation of environmental pollution, and he may issue necessary directions in writing to any person for the discharge of his duties under this Act.

9.1.2 JICA Guideline for Environmental and Social Consideration

While project proponents etc. bear the ultimate responsibility for the environmental and social considerations of projects, JICA supports and examines appropriate environmental and social considerations undertaken by project proponents etc. to avoid or minimize development projects' impacts on the environment and local communities, and to prevent the occurrence of unacceptable adverse impacts. JICA thus promotes sustainable development in developing countries.

In these guidelines, JICA has created clear requirements regarding environmental and social considerations, which project proponents etc. must meet. JICA provides project proponents etc. with support in order to facilitate the achievement of these requirements through the preparation and implementation of cooperation projects. JICA examines undertakings by project proponents etc. in accordance with the requirements, and makes adequate decisions regarding environmental and social considerations on the basis of examination results.

9.1.3 IFC General EHS Guideline

The Environmental, Health, and Safety (EHS) Guidelines are technical reference documents with general and industry-specific examples of Good International Practice. When one or more members of the World Bank Group are involved in a project, these EHS Guidelines are applied as required by their respective policies and standards. These General EHS Guidelines are designated to be used together with the relevant Industry Sector EHS Guidelines which provide guidance to users on EHS issues in specific industry sectors.

The EHS Guidelines contain the performance levels and measures that are generally considered to be achievable in new facilities by existing technology at reasonable costs. Application of the EHS Guidelines to existing facilities may involve the establishment of site-specific targets, with an appropriate timetable for achieving them. The applicability of the EHS Guidelines should be tailored to the hazards and risks established for each project on the basis of the results of an environmental assessment in which site-specific variables, such as host country context, assimilative capacity of the environment, and other project factors, are taken into account.