# ENVIRONMENTAL IMPACT ASSESSMENT (EIA) STUDY OF PAYRA 1320 MW THERMAL POWER PLANT PROJECT

ENVIRONMENTAL IMPACT ASSESSMENT (EIA) STUDY REPORT FOR

**PAYRA 1320 MW THERMAL POWER PLANT PROJECT**

SEPTEMBER 2015

PREPARED FOR:

**BANGLADESH-CHINA POWER COMPANY (PVT.) LIMITED**

( **A JOINT VENTURE COMPANY OF CMC AND NWPGCL** )

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# LETTER OF TRANSMITTAL

We are pleased to submit herewith the Final Report for Environmental Impact Assessment Study (EIA) study for the "Payra 1320 MW Thermal Power Plant Project". This study was entrusted to the Environmental Quality and Management System, Bangladesh, during the period from November 2014 to December 2014.

The report contains the advices and suggestions from Bangladesh-China Power Company (Pvt.) Limited. We would like to express our sincere gratitude to Government of the People's Republic of the Bangladesh, Ministry of Power, Energy and Mineral Resources, Power Division and Bangladesh-China Power Company (Pvt.) Limited for providing the opportunity to conduct the Study. We are grateful for the cooperation, guidance and assistance of the Project Director and the Steering Committee. We also appreciate the team involved in this Project.

Therefore, this Final Report for Environmental Impact (EIA) Study for "Payra 1320 MW Thermal Power Plant Project" incorporates the feedback from Bangladesh-China Power Company (Pvt.) Limited (BCPCL).

We hope that this report will contribute to improve the economic conditions in Bangladesh.

Yours Faithfully,

Kazi Farhed Iqubal
Executive Director
Environmental Quality and Management System (EQMS)
Email: farhed.iqubal@eqmsbd.com

Project: "Payra 1320 MW Thermal Power Plant Project"

# DISCLAIMER

This Final Environmental Impact Assessment (EIA) Study report is subject to the limitations and scope of work for **"Consultancy Services for Environmental Impact Assessment (EIA) of Payra 1320 MW Thermal Power Plant Project"**, contained in the contract between the **Bangladesh- China Power Company (Pvt.) Limited (A Joint Venture Company of CMC and NWPGCL)** and **Environmental Quality & Management System (EQMS)**, Bangladesh.

# PROJECT SYNOPSIS

| | | |
|---|---|---|
| Project Title | : | Payra 1320 MW Thermal Power Plant Project (Consulting Services for Environmental Impact Assessment (EIA) Study of Payra 1320 MW Thermal Power Plant Project) |
| Project Reference | : | Contract Agreement No: Contract Agreement (No: 52/PD/Pyra 1320 MW/ NWPGCL/ 2014<br>Dated: 16/11/2014 |
| Location | : | Mouza: Modhupara, Char Nisanbaria and Nisanbaria; Union: Dhankhali;<br>Upazila: Kalapara; District: Patuakhali; Bangladesh |
| Country | : | Bangladesh |
| Client | : | Bangladesh-China Power Company (Pvt.) Limited<br>[A joint Venture Company of CMC and NWPGCL]<br><br>Corporate Office:<br>Biddyut Bhaban (Level - 14), 1- Abdul Gani Road, Dhaka - 1000, Bangladesh<br><br>Contact Person:<br>Mr. Mizanur Rahman<br>Project Director<br>Land Acquisition, Land Development and Protection for Payra 1320 MW Thermal Power Plant Project<br>North-West Power Generation Company Limited<br>Email: mizanur@nwpgcl.org.bd |
| Consultant | : | Environmental Quality & Management System (EQMS)<br><br>Representative Office:<br>Suit# C1, House# 76, Road# 05, Block# F,<br>Banani, Dhaka-1213, Bangladesh<br><br>Contact Person:<br>Kazi Farhed Iqubal<br>Executive Director<br>Environmental Quality and Management System (EQMS)<br>Phone: +88029873282<br>Email :farhed.iqubal@eqmsbd.com<br>Web: www.eqmsbd.com |
| Project Start Date | : | 16th November 2014 |
| Project Duration | : | 1 Month |

# ABBREVIATIONS

| | |
|---|---|
| ADB | Asian Development Bank |
| AEZ | Agro-Ecological Zone |
| AHP | Ash Handling Plant |
| AR | As received |
| BBS | Bangladesh Bureau of Statistics |
| BCPCL | Bangladesh-China Power Company (Pvt.) Limited |
| BIWTA | Bangladesh Inland Water Transport Authority |
| BMD | Bangladesh Meteorological Department |
| BOD | Biological Oxygen Demand |
| BPDB | Bangladesh Power Development Board |
| BRRI | Bangladesh Rice Research Institute |
| BSAP | Biodiversity Strategy and Action Plan |
| BWDB | Bangladesh Water Development Board |
| CAAB | Civil Aviation Authority of Bangladesh |
| CAS | Catch Assessment Survey |
| CEGIS | Center for Environmental and Geographic Information Services |
| CF | Capacity Factor |
| CHP | Coal Handling Process |
| CITES | Convention on International Trade of Endangered Species |
| COD | Chemical Oxygen Demand |
| CW | Cooling Water |
| CWPH | Cooling Water Pump House |
| DAE | Department of Agricultural Extension |
| DC | Deputy Commissioner |
| DEM | Digital Elevation Model |
| DGPS | Differential Global Positioning System |
| DM | Demineralization |
| DO | Dissolve Oxygen |
| DoE | Department of Environment |
| DoF | Department of Fisheries |
| DPHE | Department of Public Health Engineering |
| DSP | Demand Supply Management |
| DSS | Dust Suppression System |
| DTW | Deep Tube Well |
| ECA | Environment Conservation Act /Ecological Critical Area |
| ECC | Environmental Clearance Certificate |

| | |
|---|---|
| ECR | Environment Conservation Rules |
| EGCB | Electricity Generation Company of Bangladesh |
| EIA | Environmental Impact Assessment |
| EMP | Environmental Management Plan |
| EOT | Electrical Overhead Travelling |
| EPC | Engineering Procurement and Construction |
| EPZ | Export Processing Zone |
| ESBN | Estuarine Set Bag Nets |
| ESP | Electrostatic Precipitator |
| FAO | Food and Agricultural Organization |
| FD | Force Draft/Forest Department |
| FGD | Focus Group Discussion |
| FGD | Flue Gas Desulfurization |
| FRSS | Fishery Resources Survey System |
| GAR | Gross As Received |
| GCP | Ground Control Point |
| GCV | Gross Calorific Value |
| GDP | Gross Domestic Product |
| GIIP | Good International Industry Practice |
| GSB | Geological Survey of Bangladesh |
| HAVC | Heating Ventilation and Air Conditioning |
| HAZMAT | Hazardous Material |
| HCSD | High Concentration Slurry Disposal System |
| HFO | Heavy Fuel |
| HHV | High Heating Value |
| HP | High Pressure |
| HYV | High Yielding Variety |
| ID | Induced Draft |
| IEE | Initial Environmental Examination |
| IESCs | Important Environmental and Social Components |
| IMO | International Maritime Organization |
| IPP | Independent Power Producer |
| KII | Key Informants Interview |
| KV | Kilo Volt |
| KWh | Kilo Watt hour |
| LGED | Local Government Engineering Department |
| LP | Low Pressure |
| MEAs | Multilateral Environmental Agreements |

| | |
|---|---|
| MoA | Ministry of Agriculture |
| MoC | Ministry of Communication |
| MoCAT | Ministry of Civil Aviation and Tourism |
| MoEF | Ministry of Environment and Forestry |
| MoFL | Ministry of Fisheries and Livestock |
| MoPEMR | Ministry of Power, Energy and Mineral Resources |
| MoWR | Ministry of Water Resources |
| MoU | Memorandum of Understanding |
| MPA | Mongla Port Authority |
| MW | Mega Watt |
| NCA | Net Cultivable Area |
| NCS | National Conservation Strategy |
| NEMAP | National Environmental Management Action Plan |
| NEP | National Environmental Policy |
| NGO | Non-Government Organization |
| NOC | No Objection Certificate |
| NOx | Oxides of Nitrogen |
| NWPGCL | North-West Power Generation Company Limited |
| OD | Operation Directorates |
| OP | Operational Policy |
| PAP | Project Affected Person |
| PCM | Public Consultation Meeting |
| PL | Post Larva |
| PP | Port Authority |
| PPA | Payra Port Authority |
| PPE | Personal Protective Equipment |
| PPM | Parts Per Million |
| PPP | Public Private Partnership |
| PRA | Participatory Rural Appraisal |
| PSMP | Power System Master Plan |
| PWD | Public Works Department |
| RO | Reverse Osmosis |
| RRA | Rapid Rural Appraisal |
| RS | Remote Sensing |
| SCC | Site Clearance Certificate |
| SMEC | SMEC International Private Limited |
| Sox | Oxides of Sulfur |
| SPM | Suspended Particulate Matter |

| | |
|---|---|
| SRDI | Soil Resource Development Institute |
| STW | Shallow Tube-Well |
| SWRO | Sea Water Reverse Osmosis |
| TDS | Total Dissolved Solid |
| ToR | Terms of Reference |
| TPH | Ton Per Hour |
| UFO | Upazila Fisheries Office |
| UNCED | United Nations Conference on Environment and Development |
| UNDP | United Nations Development Program |
| UNO | Upazila Nirbahi Officer |
| WARPO | Water Resources Planning Organization |
| WZPDCL | West Zone Distribution Company Ltd |

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# EXECUTIVE SUMMARY

## INTRODUCTION

### Background

Planned and appropriate use of power is one of the pre-conditions for economic development of Bangladesh. There is a huge demand for electricity in our day-to-day life as well as in various sectors of the economy. The total power produced in the country is not enough to ensure adequate access to electricity. As of now, only 62 percent of the total population has access to electricity. Per capita electricity generation is only 321 kwh (BPDB, 2014), which is very low compared to that of other developing countries. In order to improve this situation, the Government has given the highest priority to power sector development and is committed to make electricity available to all by 2021.

To meet up this, the Government of Bangladesh has formulated a Power System Master Plan (2010). Taking consideration of high dependency on natural gas (77% 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 is 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 Bangladesh, natural gas reserve is depleting and recent gas demands are increasing in other sectors. So Government of Bangladesh has decided to install new coal based power plants for future power generation expansion. With the objective of fuel diversification for sustainable power generation and reliable electricity supply, Bangladesh-China Power Company (Pvt.) Limited (A joint venture company of CMC and NWPGCL) has planned to install a new coal based thermal Power Plant in Patuakhali district covering areas of Dhankhali Union under Kalapara Upazila..

### Scope of EIA Study

The scope includes literature review, field studies, impact assessment and preparation of the EIA Report covering the disciplines of Land Use, Water Use, Demography & Socio-economics, Geology, Soils, Water Quality, Meteorology, Air Quality, Terrestrial and Aquatic Ecology, Noise and Occupational Health and Safety. The EIA study comprises of the following stages. Detail Scope of this study are:

1. Environmental Policy and Legal Requirement analysis
    - For emission control
    - For handling and disposal of generated ash
    - For health and safety
    - Identification of obligatory requirements of donor agencies
2. Determination of baseline conditions.
    - Physical
    - Biological and
    - Socio-economic condition
3. Assessing the impacts on the environment and socio-economic due to the construction and operation of the power plant

4. Identification of suitable control measures for emissions
    - Control measures for SOx, NOx, $CO_2$
    - Exhaust stack requirements
5. Preparation of Environmental Management Plan (EMP)
6. Preparation of the EIA report on the basis of DoE approved TOR for obtaining Environmental Clearance from the DoE

**Methodology for the EIA Report**

This EIA report has been developed based on the review and collection of primary and secondary sources of information. Primary sources have included observations, stakeholder consultation outcomes and the results of sampling programs. Secondary sources included published material, statistics, maps and results from other investigative methods.

Information and data collected from primary and secondary sources has been summarized to develop a robust, reliable and detailed baseline case. This baseline is used as a standard to which the proposed Project can be compared in order to determine appropriate potential impacts and suitable mitigation and management measures.

## POLICY, LEGAL AND ADMINISTRATIVE FRAMEWORK

To address the environmental and social risks of any proposed project and its associated components; any protect and conserve the environment from any adverse impacts, the GoB has specified regulations, policy and guidelines. Potential Lenders' also have their own set of requirements (such as the ADB's Safeguard Policy and IFC's Performance Standards) to which any project funded by them must operate.

The activities of proposed coal based thermal power plant project of Bangladesh Government fall under the 'red' category according to the Bangladesh Environment Conservation Rules (ECR) 1997 and therefore, need to conduct IEE and EIA studies to obtain site and environmental clearance from the DoE.

## THE PROJECT

The site is located at Latitude: $22^0$ 59' 58" N and Longitude: $90^0$ 17' 58" E adjacent to the Kazol River or upstream of Rabnabad Channel at Dhankhali Union, Kalapara Upazila, Patuakhali District of Bangladesh.

The site is spread across the Mouza: Modhupara, Char Nisanbaria and Nisanbaria.

The site can be approached by a direct road from the nearby Dhaka – Kuakata Road (highway no. R880). The site is nearby the widely used Londa Kheya Ghat at Kalapara Upazila. Transport of heavy equipment can be made by adjacent river route. The site is approximately 13 km away from the nearest Upazila.

There are no major industrial establishments near the site.

The only economic activities are agriculture, fisheries & plantation. The site is away from any notified eco sensitive area like Natural Park, wild life sanctuary, buildings of archaeological importance etc. The important transport connections to the site are as under:

| | | |
|---|---|---|
| Nearest port | : | Chittagong Port (Existing Port) (about 200 nautical mile from Plant's Jetty) and Proposed Payra Port (about 3 nautical mile from the Plant's Jetty) |
| Nearest airports | : | Barisal Airport (about 110 km by road) |

**Total Affected Household with Tree = 120**

No community facilities like mosque, hospital, clinic and graveyards etc have been found in the project area. About 6.25 km of katcha road network has been found within the project area. There exists about 74 numbers of pond/ditch while about 12.65 km of natural khal network found within the project area.

The land has an elevation varies between -0.248 mPWD to 3.797 mPWD. The maximum land is used for cultivation and basically silt-loam and clay.

**Table 1: Basic plant information of the proposed coal based thermal power plant**

| Component | Design Condition |
|---|---|
| Plant type | Ultra supercritical PC |
| Carbon capture | Nil |
| Net power output | 1320 MW |
| Primary fuel (type) | Bituminous/ sub bituminous coal having GCV of 4700-5500 Kcal/kg and low Sulfur content (0.47%) |
| Coal flow* | 15197 T/Day (at 100% plant load factor) |
| Annual coal requirement** | 4.12 MT/year |
| Ash production | 4.68% |
| Temperature of flue gas at stack | 125°C |
| Flue gas volume | $2.11X10^6$ |
| Flue Gas Desulfurization (FGD) | To maintain concentration of Sulfur in ambient air below the MoEF standard (80µg/$Nm^3$) limestone-gypsum web desulfurization process will be used for desulfurization |
| Maximum emission of Sox | 827 g/s |
| Maximum emission of NOx | 630.8 g/s |
| Particulate matter | ≤40mg/$Nm^3$ |
| Stack height | 275m |
| Water intake (make up water) | 4424.3 $m^3$/h |
| Water discharge after treatment | 2015.5 $m^3$/h |
| Total Fresh Water consumption | 2408.8 $m^3$/h |

## ANALYSIS OF ALTERNATIVES

Due to land scarcity in the country, seeking an alternative site for establishing the power plant area is quite difficult. Also, land acquisition is a lengthy and complex procedure under the existing Land Acquisition Law of Bangladesh (LA Ordinance 1982). Not only that, the project conceptual development over alternative sites is quite difficult because delay in overall land acquisition process might create social conflicts and risks for the project.

To avoid or minimize the impacts resulting from the activities of the project, BCPCL authority is expected to adopt appropriate technological design, improvements or adjustments, policy including good site operational practices and applicable EMP and SMP, etc. The overall strategy shall follow the following sequence:

- Impact avoidance or minimization
- Adequate Compensation where impacts are unavoidable
- Enhancement Measures – Employment benefit enhancement measures proposed by the consultants.

## DESCRIPTION OF THE ENVIRONMENT

The description of the existing environment provides the baseline case against which any potential impacts of the Project can then be assessed. A 10 km radius from the Project site has been the main focus for assessment of the existing environment. The description of the existing environment section of this EIA is presented in two main parts. First, the environmental aspects of the Project area are presented covering physical environments (i.e. soils, air quality, water quality aspects, etc.) and biological environments (i.e. flora, fauna and ecological aspects) are presented. Secondly, the social and economic aspects of the Project area (i.e. demographics, employment, cultural aspects, etc.) are presented.

Noteworthy aspects of the natural environments of the Project area include typically moderate rainfall, flash flooding and a less diversity of local fauna and a relatively abundant amount of plants.

The social and economic environment, the Project area is categorized by its relatively high population density and presence of several small settlements. There is a prevalence of low average incomes and the social infrastructure of the area is moderately developed. Low literacy rates and high rates of unemployment around the Project area are common. Agricultural pursuits such as vegetation account for the dominant land uses.

## ENVIRONMENTAL AND SOCIAL IMPACTS

Environmental and social impacts have been estimated according to the project description and scheduling of the pre-feasibility report. The potential impacts for important components are described one after another.

### Impacts on landscape

Impacts of landscape during pre-construction & construction stage might be lessen the scenic beauty and topography of the project area for a certain period of time. Most of the impacts related to landscape are described in section 7.3.2 and 7.4.1. Site establishment and construction activities may be an issue of visual intrusion only.

### Impacts on air quality

During construction activities, minor increase of Suspended Particulate Matter (SPM) in the local air within the close proximity of the construction yard within the project area may be noticed due to sourcing of fugitive particulate matter from different construction activities and vehicle movements on earthen roads. Adoption of air quality management plan during construction phase would keep the SPM within the limit of ECR 1997.

During power plant operation, the emission from SOx, NOx, and fly ash might not be significant as the plant will be designed adopting environmental protective measures to limit within the standard of emission. All the gaseous pollutants will be discharged after treatment and through the stack of 275 m height. For reducing SOx emission low Sulfur content coal (less than 0.7%) will be used. Impact on air quality during operation of has been discussed in section 7.5.5.

**Noise**

The proposed plant may produce noise but very limited noise outside the project boundary. The project's purpose planted greenbelt and boundary wall will act as noise barrier. All the potential sources of noise during pre-construction, construction and operation stages have been identified and discussed in 7.3.6, 7.4.5 and 7.5.6 respectively.

**Solid waste**

Solid waste disposal during pre-construction, construction and operation stage are described elaborately in section 7.3.11, 7.4.10 and 7.5.8. During construction phase, different kind of construction solid waste may be generated from construction activities and shall be managed properly to prevent any impact on surrounding environmental quality. During operation, coal dust, bottom ash and domestic waste may also be the major types of solid waste, which may be generated from the plant and as such proper EMP has been suggested. More than 99.9% efficient ash collection and management plan has been adopted to limit the ash emission within the limit of ECR 1997.

**Impact on fisheries**

Only some minor immediate and short term impacts on fish habitat may be observed in case of dredging activities for sand filling for site development. Water intake, discharge of treated water and coal transportation activities may cause limited impact on fisheries of the study area. The detail of the impact on fisheries during construction stage is discussed in section 7.4.2.2. Moreover, Section 7.5.1.2 describes details of the impacts of plant operation on fisheries habitat, production, and diversity.

**Impact on ecosystem**

Impact of ecosystem during pre-construction and construction stage is described elaborately in section 7.3.4 and 7.4.3.The existing mangrove strip along the Rabnabad Channel within the project site shall be conserved limiting the vegetation clearance activities. Special care shall be taken to minimize all kind of base stripping activities. Site establishment may require clearing of bushes.

The operation of the plant possesses less impact on ecosystem as it will emit low SOx and NOx. Impacts during operation phase are discussed in section 7.5.2.

**Impact on socio-economy**

BCPCL will be acquired 1,000 acre of land for the project purpose. Land acquisition may cause Property loss (agricultural land and house) and loss of income generating activities of the Project Affected Persons (PAPs). The acquisition requires resettlement of households. On the other hand, the power plant may trigger positive impacts like regional development, creation of employment opportunity, and thereafter improvement of livelihood. The proposed thermal power plant will bring social and economic development of the region through infrastructural improvement, rural electrification and industrial development. These developments might reduce the poverty of the region through generation of employment opportunity and income generating activities. Impact on socio-economy during construction and operation stage is described in section 7.4.11 and 7.5.15.

## EVALUATION OF IMPACTS

Potential impacts have been identified of the proposed power plant in detail. Their modes of impacts are identified in multiple aspects for taking appropriate controlling measurement. Chapter Eight (8) represents a detail evaluation of the impacts on the basis of nature, extend, temporal, spatial, reversibility and likelihoods in matrix form. After taking the inbuilt pollution abetment measures, those impacts have been ultimately categorized into different classes like minor, moderate, significant etc. agricultural land is significantly impact during preconstruction for land development. In the mean time, communication network will be improving significantly and flourishing livelihood opportunities during the construction period. Releasing of $CO_2$ is the major resultant pollutants after using high efficient modern thermal power plant. However, socio-economic improvement will be the significant insights for the southern region in future.

## MITIGATION OF IMPACTS

Mitigation of negative impacts and enhancing the positive impacts are the prime intent of this environmental study that represent in a separate chapter (e.g. Chapter 9). Potential impacts of the proposed power plant have been identified at every steps of development, the mode of impacts have been detailed ins and outs to understand its significance towards socio-economic, ambient environment, landscape and water resources. Aftermath, this study suggests necessary mitigation measures to the project with the objective of limiting negative impacts as minimum as possible in compliance with ECA 1995 and enhancing ecological and societal benefit. Therefore, all of the identified impacts have been further evaluated without and with mitigation measures. The resultant impacts will reduce considerably after taking the suggested measures. Effective and timely compensation both for properties and livelihoods loss would attenuate the socio-economic impacts of the project affected people. In addition, introducing awareness and capacity building activities, technical training, incentives, safety net program, disaster management program and infrastructure development would flourish the positive benefits into the society.

## ENVIRONMENTAL MANAGEMENT PLAN

As per the scope of EIA study, a detail Environmental Management Plan (EMP) has been developed that shall be duly implemented in project preconstruction, during construction and operation phase in order to minimize the negative impacts. The management plan has been categorized into inbuilt abatement measures and external management measures that have been described elaborately in Chapter 10.

The inbuilt environmental management plan

- Air quality management plan
- Noise management plan
- Waste management plan
- Coal stock yard management plan
- Coal transportation management Plan
- Waste water management plan
- Hazard and Risk management plan

- Health and safety management plan

Additional environmental management plan

- Water resources management plan
- Land and agriculture management plan
- Fisheries management plan
- Dolphin conservation plan
- Ecosystem management plan
- Afforestation plan
- Socio-economy management plans
- Awareness and skill development training

## RISK ASSESSMENT

Hazard and risk assessment is important for any energy related industries. Chapter 11 describes hazard and risk assessment. The proposed project may possess mechanical risk from turbine and generator; electrical risk from power transformer, switchyard, 400 KV & 230 KV switchyard control room, 400 KV & 230 KV transmission line; risk of fire and explosion from boiler, live steam line, and fuel stockpile; risk of toxic/carcinogenic chemical exposure from chemical storage and accidental discharge of sulfuric acid from SOx absorber.

In addition, some hazards may be produced from malfunctioning of machinery and equipment like filter, ESP, air pollution control devices, air circulating system of boiler, lightning arrestor, safe working place, etc. To mitigate these risks, necessary the specific measures have been identified in this report. As the project activities include working on height, near rotary machinery and parts, high pressure parts and pipeline, high voltage yards and handling of hazardous materials, the project may possess occupational health risk. The risk includes: risk of stick by falling/moving parts, rotary parts; fire; explosion; falls from high height; electrocution; intoxication; spreading of contagious diseases Hazards and risk related to shipping and barging activities for coal transportation have also been assessed. Hazard and risk management plan has been prepared to limit the risks of any accidental hazards.

## ENVIRONMENTAL MONITORING PLAN

Successful implementation of the EMP depends on regular monitoring with the selective indicators at specified locations. The automatic inbuilt mentoring devices regularly update every potential source of hazards and the project personnel will submit the performance report particularly the level of emissions compliance to ECR 1997. Therefore, an individual environmental monitoring team has been proposed under the department of environmental health and safety. Environmental quality and safety department for monitoring the EMP implementation in pre construction, during construction and operation phase of the project. A number potential location has been identified outside of the power plant for measuring the ambient pollution level which has been expressed in chapter 12.

The environmental monitoring officer should monitor the EMP implementation and submit a quarterly report to the concerned department. The monitoring cost has been incorporated during estimation of EMP cost. Additionally, another yearly monitoring report with quarterly monitoring data should be submitted to the DoE.

## STAKEHOLDER CONSULTATION

A range of stakeholder engagement and consultation methods have been used to identify concerns, issues and suggestions for the Project. This included any suggested management and mitigation measures. This involved Government consultation, face-to face interviews, small group meetings, focus group discussions and a household level survey.

Outcomes from this consultation showed that the community was generally supportive of the proposed Project and that the community believed that Project would bring some benefits to them and the local area. Such perceived benefits included the potential for local employment relating to the Project and the potential that infrastructure investment in the local area may occur as a result of the Project.

Key concerns that government stakeholders and local people were found to have about the Project included safety aspects of the Project, the potential for pollution to occur and that there might be some damage caused to local roads or other infrastructure during construction. This EIA has addressed each stakeholder concern with the development of specific mitigation and management measures.

## CONCLUSION

Due to the scarcity of electricity, Government of Bangladesh has intended to construct power plant with the requirement of PSMP 2010. From the social and economic point of view, the project is very much important. So there is no doubt about the establishment of the power plant. But the question arise how the plant will be established in environmental friendly manner at the proposed site. The environmental studies reveal the possible environmental issues and mitigation measures to reduce the environmental impacts of the project.

The EIA study team members observed that the site of the proposed power plant contain human settlement and the lands are used for agricultural activities at present. Major environmental and social impact of the project would be water pollution, air pollution and noise pollution in construction and post-construction/ operation phase due to wastewater, gaseous emission and noise from power plant, loss of agricultural land and settlement. These problems would be overcome by taking proper mitigation measures as stated in EMP. There are also very significant positive impacts during construction like local people job opportunities and increase business opportunities.

Local people showed interest to the project considering the needs for national development. Monitoring plan, if properly implemented during the pre-construction. Construction and operation phases will ensure taking corrective measures.

## RECOMMENDATION

Finally, the following recommendations are made on the basis of IEE and EIA study that should be considered for achieving the goal of optimum minimum environmental impact and optimum benefits:

- Proper Resettlement and Rehabilitation plan is necessary for proper compensation to Project Affected People
- People (not owner) dependent on the land to be acquired should also be compensated and created scope for alternative livelihoods
- Findings and suggestion of EIA study in project planning, design and operation should be considered and implement with strong monitoring

- All activities (pre-construction, construction and post-construction stage) should be implemented according to EMP
- Environmental Management Plan and, Hazard and Safety Management Plan should be implement at every suggested steps of plant construction and operation
- Establishing Institutional arrangement with proper logistic and training for Environment, Health and Safety in Project Management Unit during pre-construction, construction and operation phases of the project
- Special care should be taken for Dolphin community protection as per EMP
- Relevant national laws and IMO conventions signed by the GOB should be enforced properly by the relevant authorities (MPA, DG Shipping, BIWTA, etc); accordingly, the Coal Transportation Agency should oblige the relevant laws and conventions
- Environmental Management Plan has been formulated considering anticipated impacts. However, further updating of impact management procedure must be made with respect to spatial and temporal regularly based on monitoring of impacts during construction and operation of the project
- The plant should be operated ensuring all pollution abatement measures e.g. ESP, FGD (in case of Sulphur contain more than 0.6%), Low NOx burner, effluent treatment plant, etc are in order and regular monitoring has to be done to evaluate their performance

## PROJECT JUSTIFICATION TO GET EIA APPROVAL

EQMS believes that the Payra 1320 MW Thermal Power Plant Project should get EIA approval, considering the following:

- This EIA has fulfilled the requirements of the ECA'95, ECR'97 and other associated rules of DoE;
- This Project is in the national interest of Bangladesh;
- Potential negative impacts arising from the Project can be effectively managed and mitigated;
- There are no potentially insurmountable impacts;
- Potential cumulative impacts from existing operations are not significant; and
- The Project will also have potential positive (beneficial) impacts.

Considering the above mention points, BCPCL should get EIA approval from the Department of Environment (DoE)

# CHAPTER 1

# 1. INTRODUCTION

## 1.1 Background

Planned and appropriate use of power is one of the pre-conditions for economic development of Bangladesh. There is a huge demand for electricity in our day-to-day life as well as in various sectors of the economy. The total power produced in the country is not enough to ensure adequate access to electricity. As of now, only 62 percent of the total population has access to electricity. Per capita electricity generation is only 321 kwh (BPDB, 2014), which is very low compared to that of other developing countries. In order to improve this situation, the Government has given the highest priority to power sector development and is committed to make electricity available to all by 2021. Several programmes have already been taken up to implement short, medium and long term plans for the balanced development of power sector to scale up electricity generation. FY 2013-14 (Till January 2014), a total of 23,204 million-kilowatt hour (MkWh) net energy (10,804 MkWh in public sector and 12,399 MkWh in private sector including (IPP, SIPP, Rental and REB) was generated. Of the total generation, the public sector power plants generated 46.56 percent while private sector generated 53.44 percent. The share of gas, hydro, coal and oil based energy generation was 74.71 percent, 1.77 percent, 2.48 percent and 17.61percent respectively. On the other hand, in FY 2012-13, 38,213 million-kilowatt hour (MkWh) and in FY 2011-12, 35,199 million-kilowatt hour (MkWh) net energy were generated i.e. net energy generation growth in FY 2012-13 was 8.13 percent more than the FY 2011-12.

To meet up this, the Government of Bangladesh has formulated a Power System Master Plan (2010). Taking consideration of high dependency on natural gas (77% 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 is 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 Bangladesh, natural gas reserve is depleting and recent gas demands are increasing in other sectors. So Government of Bangladesh has decided to install new coal based power plants for future power generation expansion. With the objective of fuel diversification for sustainable power generation and reliable electricity supply, North-West Power Generation Company Limited (an Enterprise of Bangladesh Power Development Board) has planned to install a new coal based thermal Power Plant in Patuakhali district covering areas of Dhankhali Union under Kalapara Upazila. The project location has been shown in the **Figure 1-1** and **Figure 1-2**. The proposed power plant shall be joint venture of North-West Power Generation Company Limited (NWPGCL) and CMC, China. The name of the company shall be “Bangladesh-China Power Company (pvt) Limited. The proposed power plant will to some extent meet up electricity demand for the country which will improve the system reliably and reduce load shedding.

Proper location /siting, its process and waste abatement and control are very important for an industry to be environmentally sound. In tackling environmental problems of the country, various environmental legislations have been made time to time in Bangladesh. Here, like in some other countries environmental issues are handled by various sectoral legislations. Policies, strategies adopted on environment conservation and on sectoral issues – all have given conservation, protection and preservation of the environment a paramount importance. Sustainable development is therefore the corner stone of the policies and procedures regarding Industrial or any other development activities in Bangladesh. As such the proposed project need to comply with all the relevant national legislation in general and in particular to the Environment Conservation Act, 1995 (ECA, '95) and Environment Conservation Rules, 1997 (ECR, '97). The environmental legislation encompasses laws relating to the protection of environmental health, the control of pollution, and conservation of wildlife and natural resources.

As stipulated in the Environmental Conservation Acts, 1995, no project shall be established without obtaining Environmental Clearance from the 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 Location Clearance Certificate and Environmental Clearance Certificate from the Department of Environment (DoE). As such, for obtaining these aforementioned clearance certificates from DoE, the project proponent, BCPCL entrusted the Environmental Impact Assessment study to Environmental Quality and Management System (EQMS).

This report presents the findings of the EIA study in the manner of DoE prescribed format and following the ToR approved by DoE, so that the project proponent can obtain the Environmental Clearance Certificate from DoE after submitting the EIA report to the DoE.


**Figure 1-1: Project Site at Kalapara Upazila in Patuakhali District**

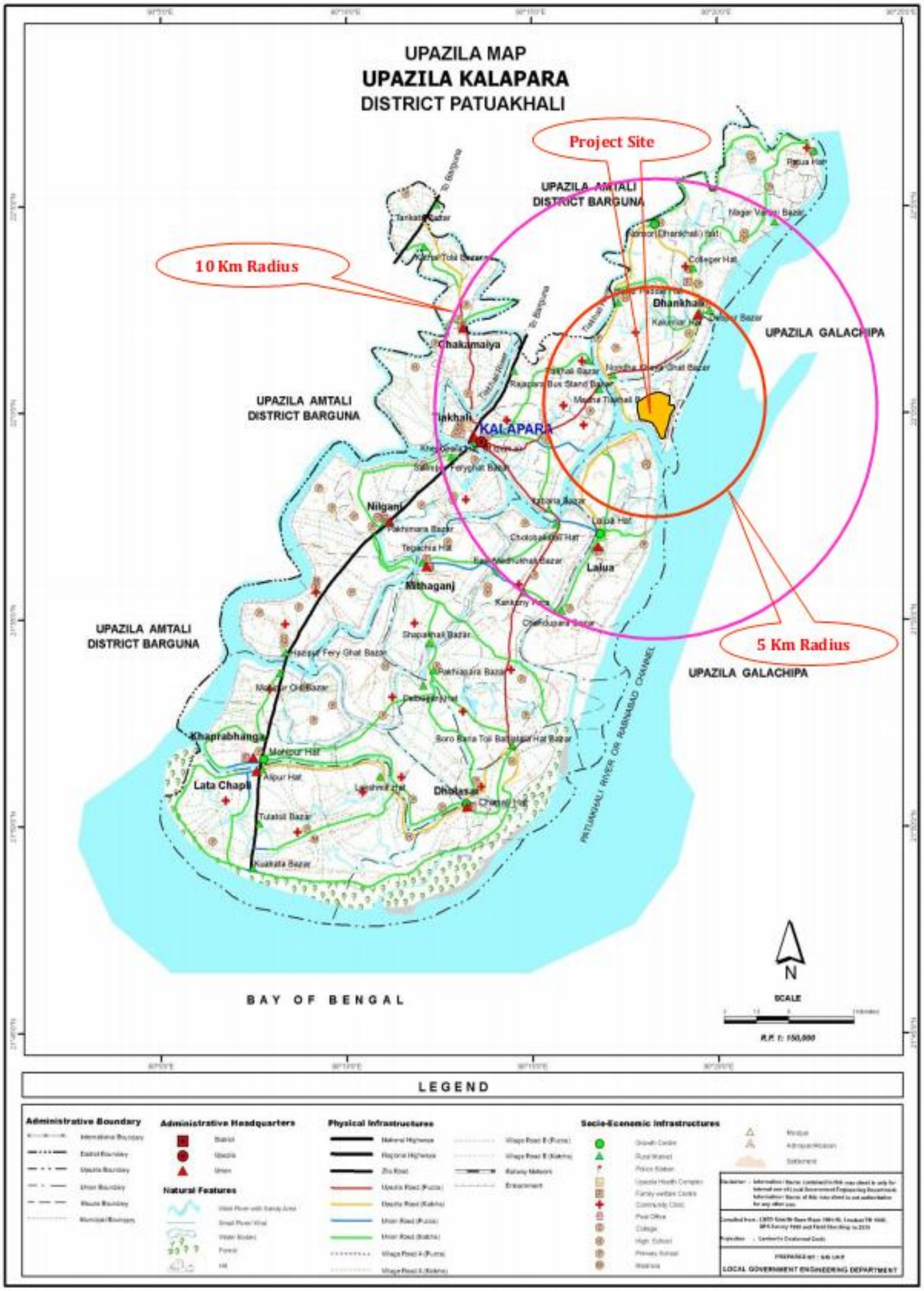



**Figure 1-2: Project Site beside the Rabnabad Channel in Dhakhali Union of Kalapara Upazila**

## 1.2 Purpose of the Study

The proposed coal based thermal power plant falls under the Red category project as per ECA, 1995 and the followed up rules ECR, 1997, and needs Site Clearance Certificate and Environmental Clearance Certificate from Department of Environment (DoE). Department of Environment (DoE) has approved a Terms of Reference (ToR) for conducting an Environmental Impact Assessment Study. This EIA study has been commenced with the objective of obtaining Environmental Clearance Certificates from DoE. The overall objective of the study is to conduct Environmental Impact Assessment (EIA) study of the proposed Payra 1320 MW thermal power plant with the purpose of obtaining Environmental Clearance Certificate from the DoE. The specific objectives of the study are;

- Present a general description of the project and the process
- Identification of national and international legal environmental requirements
- Present a description of environmental and socio-economic baseline condition of the study area
- Delineate the anticipated significant environmental and socio-economic issues found and believed to be involved
- Identify the environmental impacts of the project and quantify them to the extent possible
- Assessment of occupational risk and hazard
- Identification of mitigation and abatement measures
- Development of Environmental Management Plan (EMP)

## 1.3 Need of the project

At present, Bangladesh having total capacity of 10445MW generates maximum 7418 MW in 2014. In The demand of power is rising with the economic development of the country. It is observed from the daily load curve that the load management has not very effective and there is predominant peak during the evening hours. Bangladesh is gradually shifting to industrialization and this growth is certain, if security of supplies and load shedding can be avoided. MoPEMR has forecast power demand growth in line with the desired economic growth of the country under Power System Master Plan (PSMP, 2010). As per the forecast, with government policy scenario the power demand will reach 17000 MW in 2017 and 34,000MW by 2030. The PSMP also forecasts the demand as per different GDP growth rate. **Figure 1-3** shows power demand forecasts of PSMP, 2010 up to 2030.

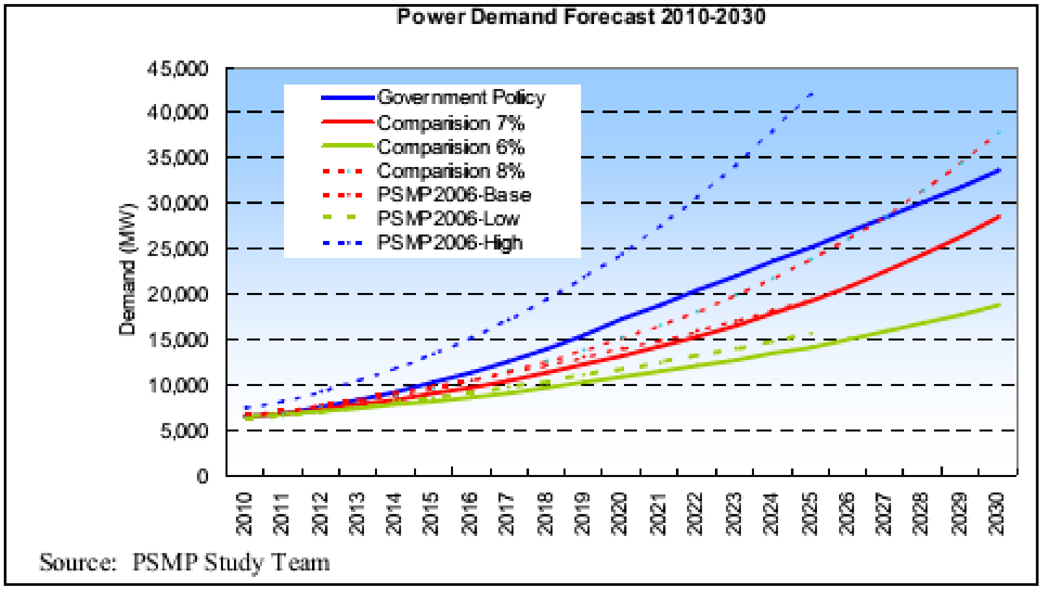



**Figure 1-3: Power demand forecast for different scenarios**

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 losses industrial production about $1billion 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 upto 2016 in line with the PSMP (2010). The summary of the plan is shown in the **Table 1-1**.

**Table 1-1: Summary of Power Generation Increase Plan**

| Year Type | 2012 (MW) | 2013 (MW) | 2014 (MW) | 2015 (MW) | 2016 (MW) | Total (MW) |
|---|---|---|---|---|---|---|
| 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 (79% of total power generation from gas based units), the PSMP recommends diversification of fuel for electricity generation and coal based power generation as least cost option to reduce the dependency on natural gas. In this line, Government has taken initiatives to install the proposed thermal power plant at Kalapara upazila in Patuakhali under Bangladesh-China Power Company (Pvt.) Limited (BCPCL).

## 1.4 Importance of the project

The proposed power plant will add 1300MW electricity to our national grid that will improve our present electricity generation significantly and as well as trigger our 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 EIA Study

The scope includes literature review, field studies, impact assessment and preparation of the EIA Report covering the disciplines of Land Use, Water Use, Demography & Socio-economics, Geology, Soils, Water Quality, Meteorology, Air Quality, Terrestrial and Aquatic Ecology, Noise and Occupational Health and Safety. The EIA study comprises of the following stages.

1. Environmental Policy and Legal Requirement analysis
    - For emission control
    - For handling and disposal of generated ash
    - For health and safety
    - Identification of obligatory requirements of donor agencies
2. Determination of baseline conditions.
    - Physical
    - Biological and
    - Socio-economic condition
3. Assessing the impacts on the environment and socio-economic due to the construction and operation of the power plant
4. Identification of suitable control measures for emissions
    - Control measures for Particulate Matter, SOx, NOx, $CO_2$
    - Exhaust stack requirements
5. Preparation of Environmental Management Plan (EMP)
6. Preparation of the EIA report on the basis of DoE approved TOR for obtaining Environmental Clearance from the DoE

## 1.6 Study Methodology and Data Collection Method

### 1.6.1 Introduction

The approach and methodology outlined in the proposal is based on limited information available about the projects by the client and our previous experience of understanding of gas based engine power plant projects and regulatory requirement in Bangladesh and the requirements to meet international EIA standards.

In terms of the study implementation for the project, EQMS will primarily review all the project documents.

The main focus of the EIA will be to anticipate environmental and social effects, both positive and negative that may result from the project or its alternatives as well as their potential magnitude, reversibilitu, period of occurance, nature, etc. predictions will consider all aspects and phases of the project and any indirect environmental and social effects, cumulative effects, and any environmental effects that may result from accidents or malfunctions.

The EIA of the project will follow a systematic process of:

- **Screening Study:** The proposed Project falls under Item Red Category as per Schedule –1 of The Environment Conservation Rules, 1997 for power plants, therefore, would require EC from the DoE based on IEE and EIA, carried out as per the approved terms of reference for the EIA study;
- **Consult environmental and social baseline conditions** against which the assessment will be undertaken;
- **Consult with stakeholder** and to integrate their views into the project design and mitigation;
- Systematically **predict and evaluate the positive and negative changes** in these baseline conditions;
- All impacts and benefits of the project should be documented and fully explained within the **EIA report**
- **Identify the mitigation measures** that BCPCL will take to avoid, reduce, remedy offset or compensate for adverse impacts, and to provide or enhance benefits from the project.
- Develop an **Environmental Management Plan (EMP)**; and
- The timeframe for the EIAs will be discussed and agreed with BCPCL subsequent to the initation of the work. In our experience, the development of a comprehensive EIA can take approximately Four to Six months to complete the draft report depending upon the availability of the project related information.

### 1.6.2 Reference framework for the ESIA study

As per discussion for the project, the reference framework will include:

- Bangladesh Environmental Conservation Rules' 1997

### 1.6.3 Approach for the ESIA study

The approach proposed for the EIA study will be presented in **Figure 1-4** (overleaf)

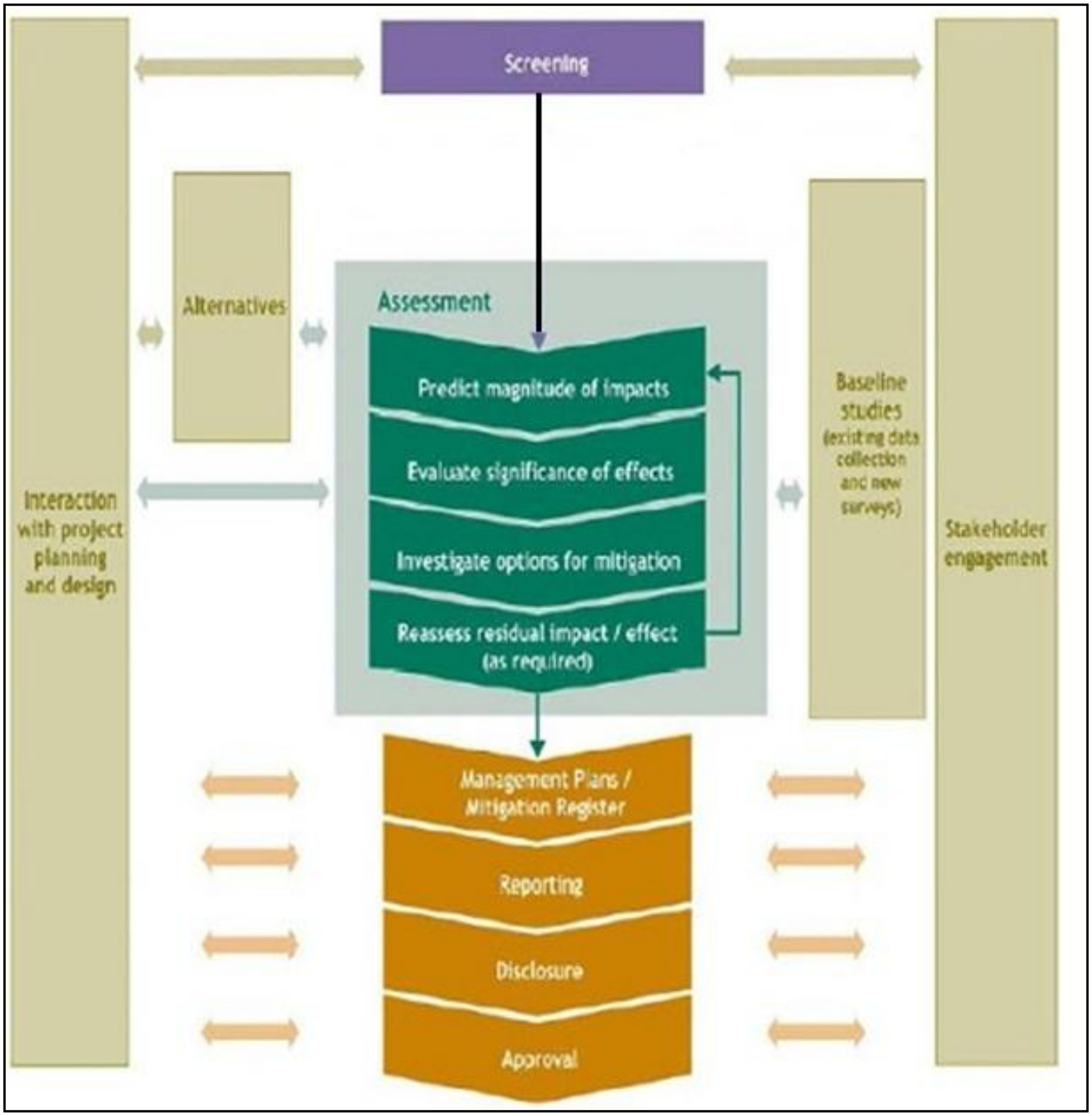



**Figure 1-4: EIA Approach**

The EIA will follow the steps:

STEP I: SCREENING STUDY

The proposed three Project falls under “RED” Category as per Schedule –1 of The Environment Conservation Rules, 1997.

STEP II - PREPARATION OF EMP AS PER THE REQUIREMENTS

STEP II (A): ENVIRONMENTAL BASELINE DATA COLLECTION

The environmental baseline data will be collected for the Project site and study area of 10 km radius from the Project site covering important features on the land e.g. sensitive habitats, settlements cultural sites, water bodies and other places of environmental and social significance. Environmental baseline data will be collected through primary baseline surveys also based on readily available secondary information.

STEP II (B): IMPACT ASSESSMENT

Following establishment of baseline environmental quality, assessment of potential impacts will be carried out for various environmental elements due to proposed Project activities. The likely impacts on the environment will be identified based on the actual and foreseeable events/Project activities. For the impact assessment, wherever necessary, professional judgment, experience and knowledge on similar projects will be used.

The extent and potential consequences of the impacts would be compared against applicable standards and guidelines. Mitigation measures will be suggested for each of the identified adverse impacts.

STEP II (C): ENVIRONMENTAL AND MANAGEMENT PLAN (EMP)

An Environmental Management Plan (EMP) would be prepared covering mitigation measures, environmental control technologies and best available practices with defined Environmental and Social Management System. The mitigation measures would be targeted at reducing impacts to as low as reasonably practical.

### 1.6.4 Methodology for the EIA report

In order to attain the earlier mentioned scope of work, the EIA study would be based on collection of primary and secondary baseline environmental information, impact assessment and delineation of EMP. The methodology proposed to complete the EIA study is divided into Tasks as presented in **Table 1-2** and elaborated in subsequent sections.

**Table 1-2: Tasks to be undertaken for the EIA Study**

| Task Number | Task |
|---|---|
| Task 1 | Kick-off Meeting and Mobilisation. |
| Task 2 | Project Description |
| Task 3 | Analysis of Alternatives |
| Task 4 | Environmental and Social Baseline Conditions |
| Task 5 | Impact Assessment including developing mitigation measures to minimise adverse impacts/risks |
| Task 6 | Development of EMP |

| Task Number | Task |
|---|---|
| Task 7 | Preparation of Draft EIA Reports |
| Task 8 | Preparation of Final EIA Reports |

### *Task 1: Kick-off Meeting and Mobilisation*

Immediately following the completion of the contract negotiations, the Team Leader, together with the Project Coordinator will complete all logistical arrangements. In accordance with EQMS quality requirements, the Project Coordinator will formalise team briefing notes outlining the scope of work and outputs required from each of the team member.

Shortly after this, a kick-off meeting will be held at a mutually convenient place with the officials of the client. The main purpose of this meeting will be to:

- clarify our understanding and major objectives of the Project;
- finalise local logistical arrangements and identify continuous points of contact (Client's as well as EQMS );
- present key elements of EQMS 's approach to fulfil all aspects of the Project.
- During the kick off meeting, relevant Project related information will be requested to client.

### *Task 2: Project Description*

A section on Project Description will be prepared. This will be developed to a level of detail needed to adequately understand potentially significant Project impacts. This will cover Project location, size, life, schedule, implementation arrangements and discharge information inventories and maps using appropriate scales. EQMS proposes that in the kick-off meeting the Project Team and Client will agree a date beyond which no design changes will be accommodated in the EIA, to avoid abortive work.

Achievement of Project milestones is dependent on receiving information on the design of the Project ancillary facilities quickly. EQMS will issue an information request list at study kickoff to facilitate this.

### *Task 3: Analysis of Alternatives*

An analysis of alternatives including benefits due to the proposed Project versus no project scenario will be considered, as is required under GoB and other international guidance. This will require close liaison with Client contract personnel to understand alternatives and decision making processes considered to date.

### *Task 4: Environmental and Social Baseline Conditions*

The environmental and social baseline data for the assignment will be refined as part of the scoping exercise to be undertaken under Task proposed to be collected for 1 km radius from the Project site during immediately available dry season. Environmental baselines study the following:

a) Meteorological data at the Project site;
b) Ambient air quality;
c) Ambient noise quality;
d) Water resources and quality - both surface and groundwater;
e) Soil quality;

f) Ecology - covering terrestrial and aquatic flora and fauna (detailed fish survey), habitats and ecologically sensitive spots within the Project siteand surrounding area;
g) Prevailing land use; and
h) Socio-economics and Aesthetics.

***Primary baseline data collection***

In the IEE stage all environmental parameter collected and depicted in IEE report. During the EIA stage with the assistance of Client, EQMS will identify an accredited environmental laboratory of repute which will be engaged for collection of baseline information on micrometeorology, ambient air quality, surface and ground water quality, soil quality, ambient noise quality as per aspects detailed in the following **Table 1-3**.

**Table 1-3: Primary Baseline Data for the EIA Study**

| Sl. | Environmental Attribute | No. of locations |
|---|---|---|
| 1. | Ambient Air Quality | 6 |
| | PM10 and PM2.5 | |
| | Oxides of Nitrogen (NOx) | |
| | Oxides of Sulphur (SOx) | |
| | Carbon monoxide (CO) | |
| 2. | Ambient Noise Level | 5 |
| 3. | Socio-economics | Project area |

***Secondary baseline data collection***

Readily available secondary information would be collected for following aspects:

a) Physical Environment

- Regional setting
  - ✓ Geography and geomorphology
  - ✓ Land use
  - ✓ Geology and soil
- Climate and meteorology
  - ✓ Climatic pattern
  - ✓ Ambient temperature
  - ✓ Relative humidity
  - ✓ Rainfall
  - ✓ Regional wind patterns (wind speed & direction)
- Hydrology and water use
  - ✓ Natural Hazards
  - ✓ Seismic activities
  - ✓ Seasonal storms & cyclones

b) Socio- economic Environment:

- Demographic profile
- Education & literacy
- Economic activities & livelihood pattern
- Socio-economic Infrastructure & Indicators
  - ✓ Health care facilities
  - ✓ Education facilities
  - ✓ Drinking water & sanitation
  - ✓ Agriculture

- ✓ Transportation facilities
- ✓ Sites of cultural/archaeological importance

Few of the identified sources for collecting secondary data include the following:

- Bangladesh Meteorological Department (BMD) at Dhaka;
- Department of Environment;
- Bangladesh Bureau of Statistics; and
- Published technical journals and books.

### *Task 5: Impact Assessment and Mitigation Measures*

The principal aim of this task will be to identify and assess potential impacts on various environmental components due to the proposed Project. Based on baseline data collected for the study area, information on type and quantity of emission of pollutants (to be provided by client) and surveys of the study area, EQMS ' EIA team will identify and predict potential impacts due to the proposed Project on the surrounding environment both during construction and operation stages of the Project.

The methodology for the impact assessment will follow the ADB's safeguards Policy statement (2009), World Bank Operational Guideline, IFC Health Safety Guidelines including the General EHS Guidelines and those for Development Project. It will involve the prediction, evaluation and mitigation of impacts, and will report on impacts including residual impacts (impacts remaining after all possible mitigation has been incorporated) and cumulative impacts.

The impacts will be identified and quantified for the intensity using modeling and/ or matrix techniques and evaluated as major, medium, minor or insignificant impacts on the environment and communities in the study area as per the prescribed Format of The Environment Conservation Rules, 1997.

The anticipated changes enhancing the baseline conditions, with respect to air, noise, water, ecology and land environments or potential deterioration of human health, ecology and cultural baseline conditions of the study area will be assessed and predicted using prediction tools as per the following description:

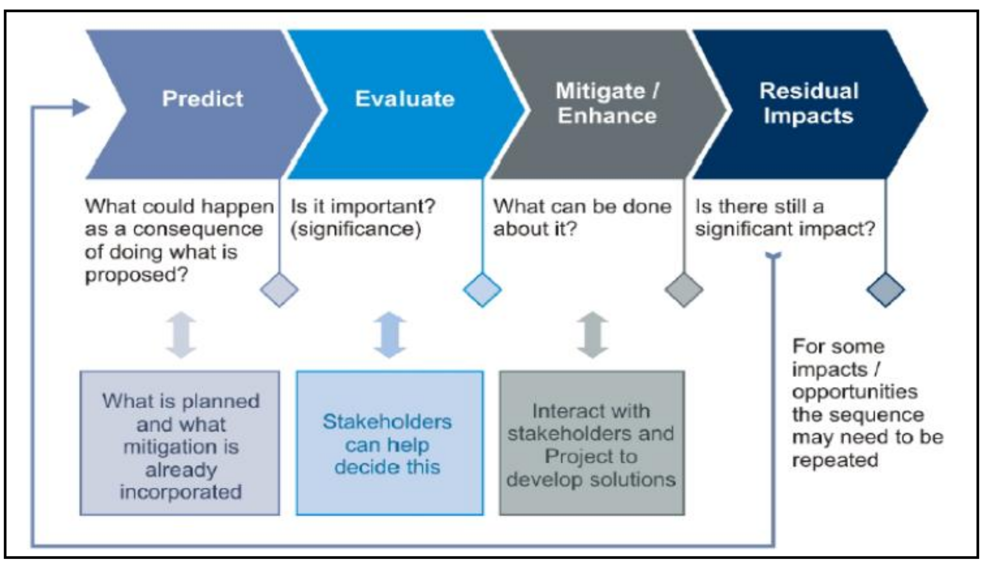



**Figure 1-5: Impact Assessment Process for the EIA Study**

#### *Task 6: Environmental and Social Management Plan (ESMP)*

Requirement and details of the controls measures will be suggested in the ESMP for implementation by Client during construction and operation phases of the Project. The EMP will comprise of the following aspects based on the impacts assessed for the Project:

- Introduction to the purpose of the EMP;
- Institutional mechanism - roles and responsibilities for EMP implementation;
- Summary of significant adverse impacts and potential hazards;
- Mitigation measures and control technologies, safeguards etc to minimise adverse impacts on air, water, soil and biological and socioeconomic environment, measures to minimise associated hazards and control emergency situation; and
- Project monitoring programme for effective implementation of the mitigation measures and ascertain efficacy of the environmental management and hazard control systems in place.

This sets out the mitigation and management measures required during Project implementation to avoid or reduce the environmental and/ or social impacts, including developing the Action Plan in accordance with international lenders' requirements. A monitoring plan will be included here, covering the type of monitoring to be done, responsible parties, schedule, standards to be used and resources. Plans that can be developed at a later stage (e.g. construction waste management plan, emergency response plan) will be identified and provided as initial documents which will be updated prior to start of construction activities by the contractor.

#### *Tasks 7 & 8: Reporting - Draft & Final EIA Report*

Draft EIA report will be prepared upon completion of the above tasks as per the prescribed format of The Environment ConservationRules, 1997 and. A glossary of technical terms and abbreviations will also be provided.

Based on one set of consolidated comments of Client, this Draft EIA will be finalized for submission to DoE.

## 1.7 EIA Team

The consultants team consist the following experts who have contributed to develop and prepare this report with their sound knowledge and specialization in their consequence fields and guidance to resolve the every critical technical issues. (**Table 1-4**)

**Table 1-4: EIA Team**

| Sl | Name of Staff | Area of Expertise | Position Assigned |
|---|---|---|---|
| 1 | Samar Kumar Banerjee, PhD | Environmental Engineering | Environmental Expert / Team Leader |
| 2 | Asif M. Zaman, PhD | Water Resources Engineering | Water Resources Engineer |
| 3 | Quazi Ali Tareq | Morphology | Morphologist |
| 4 | Kazi Farhed Iqubal | Ecology | Ecologist |

| Sl | Name of Staff | Area of Expertise | Position Assigned |
|---|---|---|---|
| 5 | Md. Ayub Ali | Socio-Economy | Socio-Economist |
| 6 | Mohammad Mamun Chowdhury | Fisheries | Fisheries Specialist (Biologist) |
| 7 | Md. Asaduzzaman | Environmental Law | Environmental Law Specialist |
| 8 | Md. Roknuzzaman | Soil and Agricultural | Soil and Agricultural Specialist |
| 9 | Md. Shafiqur Rahman | Environmental Engineering | Junior Environmental Engineer |
| 10 | Tauhidul Hasan & Abu Sayed Md. Faysal | Field Research | Field Researcher |

## 1.8 Report Format

The report fulfills the requirements of EIA study under ECR, 1997 and has been prepared in accordance with the ToR approved by the DoE. The report contains fifteen chapters and the chapter details are outlined below:

- Chapter 1 describes the introduction containing background, objectives of the EIA study, limitations, scope of the study and list of the members of EIA study team;
- Chapter 2 is on policy, legal and administrative framework describing the relevant policy and legal frameworks for the EIA process;
- Chapter 3 covers detailed project description of the proposed power plant;
- Chapter 4 describes the detail analysis for evaluation of alternative sites including the methodology followed
- Chapter 5 empasize on the details description of land use of the project area and study area of 10 km radius.
- Chapter 6 describes the environmental and social baseline conditions with detail on physical environment, water resources, land resources, agricultural resources, fisheries, ecosystem and socio-economic condition;
- Chapter 7 presents all the predicted impacts of the project during pre-construction, construction and operation phases and evaluates all the predicted impacts as per DoE suggested methodology;
- Chapter 8 evaluated all the identified impacts;
- Chapter 9 identifies mitigation measures and responsible institutes;
- Chapter 10 describes the Environmental Management Plan (EMP) with mitigation measures for minimizing the effect of the negative impacts and enhancement measures for increasing the benefits of the positive impacts and a monitoring plan;
- Chapter 11 outlines all possible hazards and risks associated with the proposed thermal power plant, and also suggest safety requirements;
- Chapter 12 describes the Environmental Monitoring Plan;
- Chapter 13 depicted the possible work plan for the project;
- Chapter 14 describes the benefit and cost assessment of the power plant project;

- Chapter 15 comprises public consultation and disclosures conducted at different sites of the study area;
- Chapter 16 is the concluding chapter of the EIA report with conclusion and recommendations;
- Chapter 17 lists all references cited in the report; and
- Annexes

# CHAPTER 2

# 2. LEGAL AND LEGISLATIVE FRAMEWORK, REGULATIONS AND POLICY CONSIDERATIONS

## 2.1 Overview

The Government of Bangladesh proposed to establish Payra 1320 MW thermal power plant in Patuakhali, which is expected to curtail the national generation Shortfall apart from expediting the industrialization process. To do so the respective authority required conducting Initial Environmental Examination (IEE) and Environmental Impact Assessment (EIA) as it is obligatory under the national law of Bangladesh. According to the Environment Conservation Act, 1995, no industrial unit or project will be established Or undertaken without obtaining an Environmental Clearance Certificate from the Department of Environment.

Along with the environmental assessment, relevant legal provisions, policies, strategies and institutional issues of planned projects/industries are very important for any project proponent or developer before they actually execute a program or plan. The proponent has to be well aware of these requirements and comply with the provisions as applicable and necessary. Before initiating any development project, it is hence required to obtain environmental clearance from the Department of Environment. The activities of the proposed coal based thermal power plant project of Bangladesh Government fall under the ‘red’ category according to the Bangladesh Environment Conservation Rules; 1997 and therefore need to conduct IEE and EIA studies to obtain site/location and environmental clearance from the Department of Environment.

In respect of legal obligations and policy guidelines under the EIA study of the coal based power plant in Patuakhali the following activities have been carried out:

- Identification of national legal obligations in relation to the interventions which will be required to review under the EIA study of the proposed thermal power plant;
- Exploration of the national legislative provisions and policy guidelines on environmental sectors;
- Identification of the international legal obligations and relevant provisions of multilateral environmental agreements related to the proposed project interventions;
- Exploration of national and international legal provisions on coal and power plant development sector; and
- Identification of the standard guidelines at regional and international level related to the thermal power plant setup.

National laws, by-laws and official resolutions relevant to coal based thermal power plant installation, operation and maintenance and associated activities have been identified under this study. Under the national legal framework the proposed intervention needs to comply with the environmental legislations of the country and needs to fulfill the requirements to obtain required permissions to implement these activities.

Department of Environment (DoE) approved a ToR for preparing an Environmental Impact Assessment study. This EIA report follows the approved ToR to comply with the national laws and regulations.

## 2.2 Applicable Policies and Legal Provision

All legal provisions relevant to environmental protection applicable to the planning, construction, operation and coal transportation were identified under the scope of the EIA. **Table 2-1** below summarizes all relevant legal provisions:

**Table 2-1: National Legal provisions applicable to the proposed power plant for ensuring environmental protection**

| Issue | Bangladeshi Legislation or Regulation |
|---|---|
| Governance of Power Generation and Management System | a. Bangladesh Energy Regulatory Commission Act, 2003<br>b. Power System Master Plan, 2010<br>**c.** National Energy Policy |
| Coal Sourcing | a. Bangladesh Coal Policy (Draft)<br>b. Master Plan on Coal Power Development, 2010<br>**c.** Import and Export Control Act, 1950 |
| Coal Transportation | a. Terrestrial Water and Maritime Zones Act 1974 & Rules 1977<br>b. The Ferries Act, 1885<br>c. Ports Act, 1908<br>d. Bangladesh Merchant Shipping Ordinance 1983<br>e. The Prevention of the Interference With Aid to Navigable<br>f. Waterways Ordinance, 1962<br>g. Payra Port Authority Act, 2013 |
| Prevention of pollution, and Protection of Environment | a. Payra Port Authority Act, 2013<br>b. Ports Act, 1908<br>c. The Forests Act, 1927<br>d. Environment Conservation Act, 1995 and the Amendments thereafter<br>e. Environment Conservation Rules, 1997<br>**f.** The Environment Court Act, 2000 |
| Health and Safety | a. Fatal Accidents Act, 1855<br>b. Dock Laborers Act, 1934<br>c. Dangerous Cargoes Act, 1953<br>d. Imports and Exports (Control) Act, 1950<br>e. Public Safety Ordinance, 1953<br>f. The Explosives Act, 1884<br>**g.** Fire prevention and Extinguish Act, 2003 |
| Procurement in Bangladesh | a. The Public Procurement Regulations, 2003 and Revisions thereafter |
| Transport, Handling and Storage of Dangerous Goods | a. Environment Conservation Act, 1995 (Amendments thereafter)<br>b. Ports Act, 1908<br>c. Petroleum Act, 1934<br>d. Dangerous Cargoes Act, 1953 |

## 2.3 National Environmental Legal Provisions in Connection with Setup, Operation & Maintenance

The Environment Conservation Act of 1995 is the key legislation in relation to environment protection in Bangladesh. This Act has been promulgated for environment conservation, standards, development, pollution control and abatement. It has repealed the Environment Pollution Control Ordinance of 1977. The Act has been subsequently amended in 2000, 2002, 2007 and latest amendments done up to year 2010. The main objectives of the Act are:

- Conservation and improvement of the environment and
- Control and mitigation of pollution of the environment

The main strategies of the Act can be summarized as:

- Declaration of ecologically critical areas and restriction on the operations and processes, which can or cannot be carried/initiated in the ecologically critical areas
- Regulations in respect of vehicles emitting smoke harmful for the environment
- Environmental clearance
- Regulation of the industries and other development activities’ discharge permits
- Promulgation of standards for quality of air, water, noise and soil for different areas for different purposes
- Promulgation of a standard limit for discharging and emitting waste and
- Formulation and declaration of environmental guidelines

According to the law before setting up any new project/interventions by the Government/ non government agencies/public, the proponents are required to obtain respective clearance from the Department of Environment. Under the Environment Conservation Rules 1997, the project promoter must obtain site clearance from the Director General of Department of Environment. An appeal procedure does exist for those promoters who fail to obtain clearance. The Department of Environment executes the Act under the leadership of the Director General.

Under the Environment Conservation Act, 1995 the first set of rules promulgated is the Environment Conservation Rules, 1997. The Rules have provided categorization of industries/ projects, hence identified types of environmental assessments needed against respective categories of industries/projects. The Environment Conservation Act (Amendment), 2000 provides responsibility for compensation in cases of damage to ecosystems: (1) The polluter pay principle is included herein, (2) increased provision of punitive measures both for fines and imprisonment and (3) fixing authority on cognizance of offences.

The Bangladesh Environment Conservation Act (Amendment), 2002 elaborates on: (1) restriction on polluting automobiles, (2) restriction on the sale and production of environmentally harmful items like those that polythene bags, (3) assistance from law enforcement agencies for environmental actions, (4) break up of punitive measures and (5) authority to try environmental cases.

The Environmental Rules are not explicit for various oil and gas exploration interventions. Rather, this is covered under the broader heading of “exploration, extraction and distribution of mineral resources” under the ‘Red’ category projects.

So far the Rule has been updated three times - February and August 2002 and April 2003.

### 2.3.1 Procedure to Obtain Environmental Clearance Certificate

According to the Section 12 of the Environment Conservation Act 1995 no industrial unit or project will be established or undertaken without obtaining, in the manner prescribed by the Environment Conservation Rules 1997, an Environmental Clearance Certificate from the Director General. Therefore, every development projects/industries which are specified under the Schedule – 1 of the Environment Conservation Rules 1997 require obtaining site and environmental clearance from the Department of Environment. According to the Rule 7 (1) of the Environment Conservation Rules 1997; for the purpose of issuance of Environmental Clearance Certificate (ECC), every industrial units or projects, in consideration of their site and impact on the environment and will be classified into the four categories and they are:

| | |
|---|---|
| Class A: | Green |
| Class B: | Orange-A |
| Class C: | Orange-B |
| Class D: | Red |

The project are included under these four categories as specified above have been described in Schedule – 1 of the Environment Conservation Rules 1997.The proposed coal based thermal power plant 1320 MW of the Government of Bangladesh falls under the Class-D i.e. the ‘Red Category’. For projects under this category, it is mandatory to carry out Environmental Impact Assessment (EIA) including Environmental Management Plan (EMP) and where necessary develop a Resettlement Plan for getting environmental clearance from the Department of Environment. The Rules provide the application procedure for obtaining site and environmental clearance and the application procedure of Red category. According to the Sub-Rule 7(6) (d) of Environment Conservation Rules 1997, the Bangladesh-China Power Company (Pvt.) Limited (BCPCL) is required to pursue the following steps to obtain the environmental clearance from Department of Environment to install coal based thermal power plant:

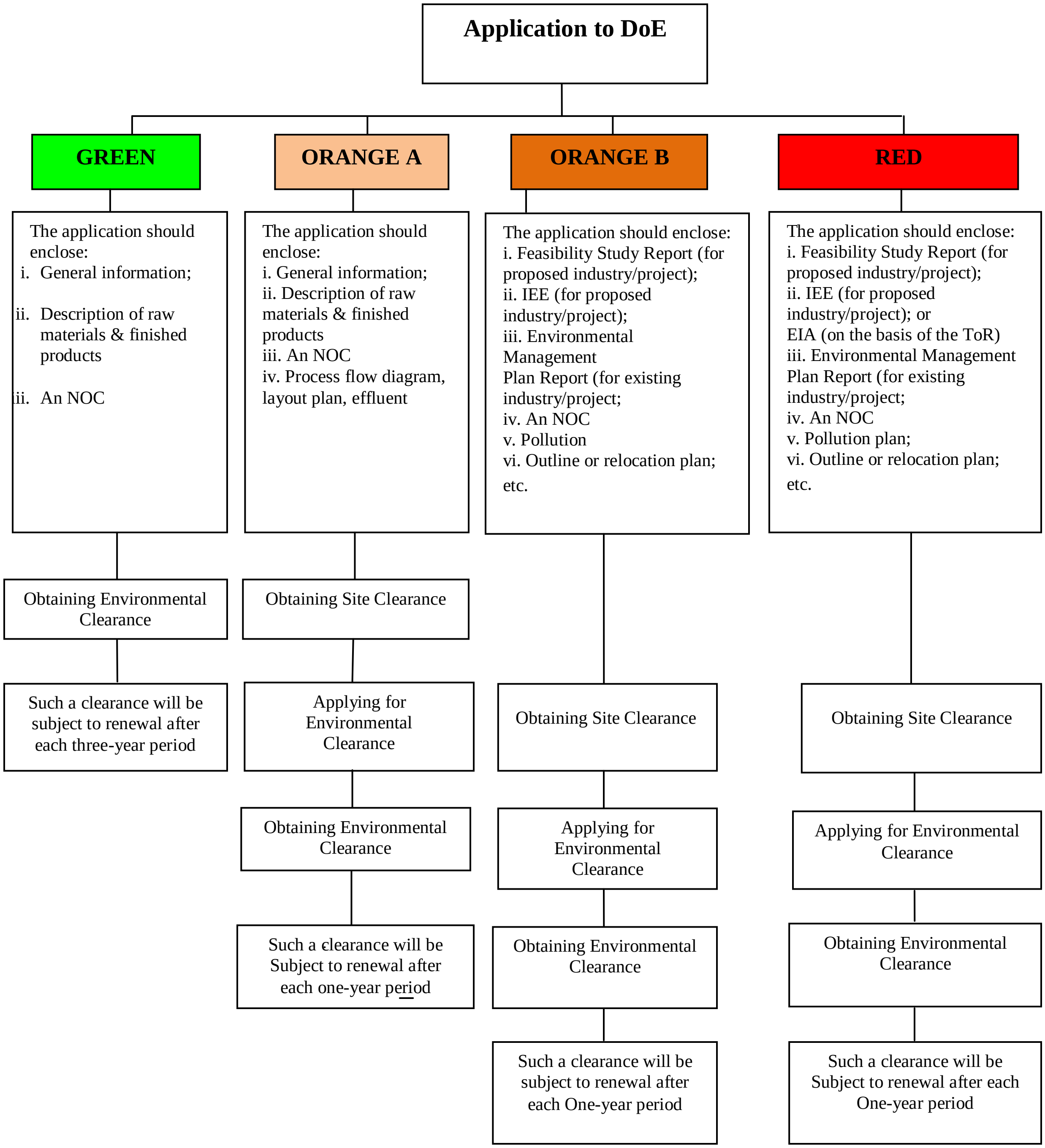



**Figure 2-1: Process for obtaining Clearance Certificate from Department of Environment**

### 2.3.2 Effluent discharge

The proposed project might emit different types of gaseous pollutants, noise, liquid and solid waste to the surrounding environment. 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 in **Annex A**.

### 2.3.3 Stack Height

The Schedule 11: Standards for Gaseous Emission from Industries or Projects, of the Environment Conservation Rules 1997 provides that the lowest height of stack for dispersion of sulfuric acid for 500 MW or above capacity coal based power plant is 275 meter. This standard has been established based on dispersion of $SO_2$ considering that the stack will emit the pollutants above the inversion layer of the air.

| Capacity of the Power Plant | Lowest height of stack |
|---|---|
| 500 Megawatt or above | 275 meter |
| 200 to 500 Megawatt | 200 meter |

Under the Manual of Aerodrome Standard, 2005 of Civil Aviation of Bangladesh, height of any structure within seven nautical miles is restricted up to 500 ft. The proposed site is located 48 nautical miles south-west from the Barisal Airport.

## 2.4 Compliance under the National Laws

### 2.4.1 The Forest Act, 1927 & Amendment Act 2000

The proposed location of the power plant in Patuakhali is situated 18 km and 35 km away from the Kuakata National Park and Char Kukri Mukri Wildlife Sanctuary respectively. The Forest Act, 1927 is the first and omnibus law of the land on forestry. It provides for reserving forests over which the Government has an acquired property right.

According to the Act the Government (Forest Department) can prohibit certain activities in the declared Reserved Forest area such as any intervention kindles, keeps or carries any fire; trespasses or pastures cattle, or permits cattle to trespass; causes any damage by negligence in felling any tree or cutting or dragging any timber; etc.

“26. Acts prohibited in such forests. –

Any person who, in a reserved forest-

a) Kindles, keeps or carries any fire except at such seasons as the Forest-Officer May notify in this behalf;
b) Trespasses or pastures cattle, or permits cattle to trespass;
c) Causes any damage by negligence in felling any tree or cutting or dragging any timber;
d) Quarries stone, burns lime or charcoal, or collects, subjects to any manufacturing process, or removes any forest produce other than timber; or who enters a reserved forest with firearms without prior permission from the Divisional Forest Officer concerned, shall be punishable with

> imprisonment for a term which may extend to six months and shall also be liable to fine which may extend to two thousand taka, in addition to such compensation for damage done to the forest as the convicting Court may direct to be paid."

The proposed intervention should not carry out any such activities that may cause damage or adversely impact on the natural resources including wildlife of the Kuakata national park and Char Kukri Mukri Wildlife Sanctuary.

### 2.4.2 The Penal Code, 1860

The Penal Code of 1860 has some valid provisions related to pollution management, environment protection and protection of health and safety. Chapter XIV of the Penal Code provides offences affective public health, safety, convenience, decency and morals: Section 277: Falling Water or Public Spring or Reservoir; Section 278: Making Atmosphere Noxious to Health; Section 284: Negligent Conduct with Respect to Poisonous Substance; Section 285: Negligent Conduct with Respect to Fire or Combustible Matter; and Section 286: Negligent Conduct with Respect to Explosive Substance.

According to the Section 277, whoever voluntarily corrupts or fouls the water of any public spring or reservoir, to render it less fit for the purpose for which it is ordinarily used will be punished under the law.

According to the Section 278 whoever voluntarily vitiates the atmosphere in any place so as to make it noxious to the health of persons in general dwelling or carrying on business in the neighborhood or passing along a public way will get punishment.

### 2.4.3 The Acquisition and Requisition of Immovable Property Ordinance (1982)

This Ordinance has replaced the Land Acquisition Act of 1894 and the East Bengal (Emergency Requisition of Property Act of 1948. The Ordinance governs acquisition and requisition by the government of immovable property for any public purpose or in the public interest. It may be noted that contrary to the previous Acts (i.e. Act XIII of 1948); this Ordinance deals only with immovable property.

The Ordinance has well-defined procedures regarding payment of compensation for an acquired piece of land. If, for example, the land is used for rice growing, then an amount equivalent to approximately 1.5 times the market value of a given variety of rice (e.g., paddy) that is currently being (or could be) produced annually is fixed as a yearly lease value. In case of outright purchase (carried out on a 99-year lease), the compensation-value of acquired land varies widely according to the locality, soil fertility, and access to transportation and related infrastructure factors. The current compensation and resettlement provisions are however inadequate both in terms of timing of payments and quantum. The procedures involved are cumbersome and time consuming and often causes hindrance to the smooth execution of the project. Legal provisions covering adequate compensation to the project affected persons, particularly disadvantaged groups such as women & squatters and such other vulnerable groups are yet to be framed.

### 2.4.4 The Protection and Conservation of Fish Act 1950

The Protection and Conservation of Fish 1950 was enacted to provide for the protection and conservation of fish. The law defines 'Fish' as all cartilaginous, bony fishes, prawn, shrimp, amphibians, tortoise, turtles, crustacean animals, mollusks, echinoderms and frogs at all stages in their life history. Under the Act the Protection and Conservation of Fish Rules was adopted in 1985. This is a set of rules in line with the overall objectives of the Act. The Rule 5 of the Rules provides that no person shall destroy or make any attempt to destroy any fish by explosives, gun, bow and arrow in inland waters or within coastal waters. During the Project intervention, it should be noted that if waste effluent is not treated then it may cause significant damage to the local fishery and thus violate the provision of the law.

Rule 6 states that no person shall destroy or make any attempt to destroy any fish by poisoning of water or the depletion of fisheries by pollution, by trade effluents or otherwise in inland waters.

Therefore the proposed intervention of BCPCL will need to be carried in such a manner that the activities do not cause damage or adversely impact the inland waters or within coastal waters fisheries.

### 2.4.5 Civil Aviation Ordinance 1960 & Civil Aviation Rules, 1984

The Civil Aviation Ordinance 1960 was made to make better provisions for the control of manufacture, possessions, use, operation, sale, import and export of aircraft, the control and regulation of air transport services, and the control and development of aerodromes in the country. It repealed the Aircraft Act, 1934 (XXII of 1934).

Present legal regulatory framework for civil aviation activities in Bangladesh is the Civil Aviation Rules, 1984 and the Air Navigation Orders issued by the Chairman under this rule. All civil aviation activities in Bangladesh are regulated by the Civil Aviation Rules, 1984 which was made and promulgated by the Government in exercise of the powers conferred by sections 4, 5, 7 and 8 of the Civil Aviation Ordinance, 1960 (XXXII of 1960), section 10 of the Aircraft (Removal of Danger to Safety) Ordinance, 1965 (XII of 1965), section 4 of the Telegraph Act, 1885 (XIII of 1885) and in suppression of the Aircraft Rules, 1937 and the Airport Obstruction Clearance Rules, 1981. This set of rules elaborately dealt with personnel (pilot, flight engineer, air traffic controller, aircraft maintenance engineer etc.) licensing, airworthiness requirements, operation of aircraft, rules of the air, air transport services; construction height of the surrounding infrastructure etc. Much of today's operational responsibilities and functions of CAAB are defined and formulated in these Rules.

The proposed location of the Payra Power Plant project is far away from the proposed Barisal airport's location.

### 2.4.6 Ports Act, 1908

The Ports Act 1908 was adopted to consolidate the enactments relating to Ports and port charges. The administering authority is the Ministry of Shipping. Subject to this Act, a Conservator Shall be appointed in to the port. Specific environmental management provisions of the Act are given under s.21 (1) which prohibits the discharge of ballast, rubbish and oil into any port or adjacent areas. Under s.31 of the Act, the movement of vessels of 200 tons or more cannot enter, leave or be moved within any port without having a pilot on board. In addition, no vessel of more than 100 tones is to enter, leave or be moved within any port without having a pilot, unless authority to do so has been given in writing. The lawful use of infrastructure such as piers and moorings, and ensuring navigable waters are not obstructed is detailed under s.10, whereas s.21 prohibits interference with buoys, beacons and moorings. Unless permission has been granted by the Conservator, any action that causes or may cause injury to the bank or shore is prohibited under s.30 (1).

### 2.4.7 Payra Port Authority Act, 2013

The Payra Port Authority (PPA) Act 2013, under the Ministry of Shipping, Government People's Republic of Bangladesh established the PPA. The Act provides the PPA with the authority, function and jurisdiction over docks (wharves, warehouses, railways, piers, bridges, and other works) and vessels (including any ship, barge, boat, or raft designed or used for the transport by water of passengers or goods) within the port limits. The PPA also has authority to reclaim or excavate any part of the bank or bed of the river, to construct, maintain and operate dredgers and appliances for clearing, deepening and improving the bed of the river, and to construct, maintain and operate all means and appliances for berthing, loading and discharging vessels.

Under s.18 of the Act, the PPA may permit any person to make, erect or fix below high water-mark within the Port any dock, pier, erection or mooring.

The PPA also has the authority to issue fines for the pollution of water or environment by throwing or allowing into the water, bank or land, any goods, ballast, ashes or any other material that leads to pollution.

### 2.4.8 Environment Conservation Act (1995, Amended in 2000 & 2002)

The Bangladesh Environment Conservation Act of 1995 (ECA '95) is currently the main legislation in relation to environment protection in Bangladesh. This Act is promulgated for environment conservation, environmental standards development and environment pollution control and abatement. It has repealed the Environment Pollution Control Ordinance of 1977.

The main objectives of ECA '95 are:

- Conservation and improvement of the environment; and
- Control and mitigation of pollution of the environment.

The main strategies of the Act can be summarized as:

- Declaration of ecologically critical areas and restriction on the operations and processes, which can or cannot be carried/initiated in the ecologically critical areas;
- Regulations in respect of vehicles emitting smoke harmful for the environment;
- Environmental clearance;
- Regulation of the industries and other development activities' discharge permits;
- Promulgation of standards for quality of air, water, noise and soil for different areas for different purposes;
- Promulgation of a standard limit for discharging and emitting waste; and
- Formulation and declaration of environmental guidelines

Before any new project can go ahead, as stipulated under the rules, the project promoter must obtain Environmental Clearance from the Director General. An appeal procedure does exist for those promoters who fail to obtain clearance. Failure to comply with any part of this act may result in punishment to a maximum of 3 years imprisonment or a maximum fine of Tk. 300,000 or both. The Department of Environment (DOE) executes the Act under the leadership of the Director General (DG).

***Environmental Conservation Act (Amendment 2000)***

This amendment of the Act focuses on: (1) ascertaining responsibility for compensation in cases of damage to ecosystems, (2) increased provision of punitive measures both for fines and imprisonment and (3) fixing authority on cognizance of offences.

***Environmental Conservation Act (Amendment 2002)***

This amendment of the Act elaborates on: (1) restriction on polluting automobiles, (2) restriction on the sale and production of environmentally harmful items like polythene bags, (3) Assistance from law enforcement agencies for environmental actions, (4) break up of punitive measures and (5) authority to try environmental cases.

***Environmental Conservation Act (Amendment 2010)***

This amendment of the act introduces new rules & restriction on: a) Ensure proper management of hazardous wastes to prevent environmental pollution and Health Risk, b) No remarked water body cannot be filled up/changed; in case of national interest; it can be done after getting clearance from the respective department; and c) Emitter of any activities/incident will be bound to control emission of environmental pollutants that exceeds the existing emission standards.

### 2.4.9 The Environment Conservation Rules, 1997

These are the first set of rules, promulgated under the Environment Conservation Act of 1995 (so far there have been three amendments to this set of rules - February and August 2002 and April 2003).

The Environment Conservation Rules of 1997 has provided categorization of industries and projects and identified types of environmental assessments needed against respective categories of industries or projects.

Among other things, these rules set (i) the National Environmental Quality Standards for ambient air, various types of water, industrial effluent, emission, noise, vehicular exhaust etc., (ii) the requirement for and procedures to obtain environmental clearance, and (iii) the requirement for IEE and EIA's according to categories of industrial and other development interventions.

### 2.4.10 The Environment Court Act, 2000

The Environment Court Act, 2000 provides for the establishment of environment courts and matters incidental thereto. This act also provides the jurisdictions of environment court, penalty for violating court's order, trial procedure in special magistrate's court, power of entry and search, procedure for investigation, procedure and power of environment court, 26 authority of environment court to inspect, appeal procedure and formation of environment appeal court.

### 2.4.11 The Fatal Accidents Act, 1855

An Act to provide compensation to families for loss occasioned by the death of a person caused by actionable wrong. It is mentioned in s.1, whenever the death of a person shall be caused by wrongful act, neglect or default, and the act, neglect or default is such as would (if death had not ensued) have entitled the party injured to maintain an action and recover damages in respect thereof, the party who would have been liable if death had not ensued shall be liable to an action or suit for damages, notwithstanding the death of the person injured, and although the death shall have been caused under such circumstances as amount in law to felony or other crime.

### 2.4.12 The Dock Laborers Act, 1934

An Act to give effect in Bangladesh to the Convention concerning the protection against accidents of workers employed in loading and unloading ships. It is stated in s.5 (1), the Government may make regulations providing for the safety of working places on shore and of any regular approaches over a dock, wharf, quay or similar premises which workers have to use for going to or from a working place at which the processes are carried on, and for the lighting and fencing of such places and approaches, prescribing the measures to be taken in order to prevent dangerous methods of working in the stacking, unshackling, stowing and unstaring of cargo, or handling in connection therewith, prescribing the precautions to be observed when the workers have to work where dangerous or noxious goods are, or have bee, stowed or have to deal with or work in proximity to such goods.

It is mentioned in s.9, any person who unless duly authorized, or in case of necessity, removes any fencing, gangway, gear, ladder, life-saving means or appliance, light, mark, stage or other thing required to be provided by or under the regulations made under this act; or having in case of necessity removed any such fencing, gangway, gear, ladder, lifesaving means or appliance, light, mark, stage or other thing, omits to restore it at the end of the period for which its removal was necessary; shall be punishable with fine which may extend to five hundred taka.

### 2.4.13 The Dangerous Cargoes Act, 1953

The Dangerous Cargoes Act, 1953 was enacted to provide provisions related to the safety of ports in respect of the transit, working and storage of dangerous cargoes. Relevant provisions include s.3 (which deals with explosives and fires on vessels), s.6 (safety of vessels imports) and s.9 (enforcement). The concerned authority is the Deputy Conservator of the Port, Board of Trade or the Ministry of Communication and the Chief of Naval Staff.

### 2.4.14 The Fire Services Ordinance 1959

The Fire Services Ordinance 1959 also states that the owner needs to obtain a license under the ordinance before using premises as a warehouse. In addition, under this Ordinance the Government by order no. HSLG/SVII/1R-1/60/295 dated 3rd June 1960 declared that any stock of coal exceeding four tones shall be considered to be a fire risk.

### 2.4.15 The Bangladesh Petroleum Act, 1974

The Bangladesh Petroleum Act is enabling legislation that allows the Government of Bangladesh to enter into all aspects of petroleum exploration, development, exploitation, production, processing, refining and marketing. In addition, the Government is authorized to enter into Petroleum Agreement(s) with any person(s) for the purpose of petroleum operations. The duties of such person(s) are:

- ✓ To ensure that petroleum operation is carried out in a proper and workman like manner and in accordance with good oil field practice.
- ✓ To carry out petroleum operation in any area in a manner that does not interfere with navigation, fishing and conservation of resources.
- ✓ To consider the factors connected with the ecology and environment.

Clause 6(2) of the Act sets out certain details related to environment and safety:

“In particular, and without prejudice to the generality of the foregoing provision, a person engaged in any petroleum operations shall, in carrying out such operations in any area:

- Control the flow and prevent the waste or escape in the area, of petroleum or water;
- Prevent the escape in that area of any mixture of water or drilling fluid with petroleum or any other matter;

- Prevent damage to petroleum-bearing strata in any area, whether adjacent to that area or not; and
- Keep separate any petroleum pool discovered in the area.”

Apart from the above the law provides the following obligations:

a) Prescribing places where petroleum may be imported and prohibiting its import elsewhere; regulating the import of petroleum;
b) Prescribing the periods within which licenses for the import of [class I] petroleum shall be applied for, and providing for the disposal, by confiscation or otherwise, of any [class I] petroleum in respect of which a license has not been applied for within the prescribed period or has been refused and which has not been exported;
c) Regulating the transport of petroleum;
d) Specifying the nature and condition of all receptacles and pipe-lines in which Petroleum may be transported;
e) Regulating the places at which and prescribing the conditions subject to which petroleum may be stored;
f) Specifying the nature, situation and condition of all receptacles in which petroleum may be stored;
g) Prescribing the form and conditions of licenses for the import of dangerous petroleum, and for the transport or storage of any petroleum, the manner in which applications for such licenses shall be made, the authorities which may grant such licenses and the fees which may be charged for such licenses; determining in any class of cases whether a license for the transport of petroleum shall be obtained by the consignor. Consignee or carrier;
h) Providing for the granting of combined licenses for the import, transport, storage and distribution] of petroleum, or for any two of such purposes;
    i. prescribing the proportion in which any specified poisonous substance may be added to petroleum, and prohibiting the import, transport or storage of petroleum in which the proportion of any specified poisonous substance exceeds the prescribed proportion;
    ii. Regulating the distribution of petroleum;
    iii. Prescribing the conditions for the appointment of, and the granting of the licenses to, agents, dealers and stockiest;
    iv. Prescribing the form and conditions of agreement between and agent, dealer or stockiest and an oil marketing company;
    v. providing for cancellation or restoration of licenses of an agent or a dealer and of agreement between an oil marketing company and an agent, dealer or stockiest; and
    vi. Generally, providing for any matter which in its opinion, in expedient for proper control over the import, transport, storage and distribution of petroleum.”

### 2.4.16 The Explosives Act, 1884

The Government may for any part of Bangladesh, make rules consistent with this Act to regulate or prohibit, except under and in accordance with the conditions of a license granted as provided by those rules, the manufacture, possession, use, sale, transport and importation of explosives or any specified class of explosives.

Any person manufacturing, possessing, using, selling, transporting or importing an explosive in contravention of a notification issued shall be punishable with imprisonment for a term which may extend to ten years and shall not be less than two years and also with a fine which may extend to fifty thousand Taka, in default of which with a further imprisonment for a term which may extend to one year, and in the case of importation by water or land, the owner and master of the vessel or carriage in which the explosive is imported shall, in the absence of reasonable excuse, each be punishable with imprisonment for a term which may extend to ten years and shall not be less than two years and also with a fine with a further imprisonment for a term which may extend to one year.

### 2.4.17 Wildlife Conservation (protection and safety) Act 2012

The government in 1973 framed a law for conservation of the forests. Since the independence, no effective measure had been taken for conservation of the wildlife. The existence of a number of animals is now under severe threat as no adequate measures were taken to protect wildlife in the pre-independence period. Bangladesh has expressed deep concern about the existing wildlife and a new wildlife law passed in parliament. The act has been formulated for the conservation and safety of wildlife to manage the protected areas. The act depicts 10 new types of protected areas. The bill with many other provisions proposed stern action for violation of the law. It proposed one-year imprisonment and Taka 50,000 fine for such a violation. The law also proposed at least two years and highest seven years imprisonment and minimum Taka one lakh and maximum Taka 10 lakh fine for killing a tiger or elephant.

## 2.5 Policy Guidance

Under the study a number of sectoral national policies have been reviewed to identify the guiding principles which are relevant to the coal based thermal power plant installation, operation and maintenance activities. The sectoral policies will include energy, environment, water, forest, transport, import; fisheries etc.

### 2.5.1 National Environment Policy

The National Environment Policy of 1992 sets out the basic framework for environmental action, together with a set of broad sectoral action guidelines. The Policy provides the broader framework of sustainable development in the country. It also stated all major undertakings, which will have a bearing on the environment; (including setting up of an industrial establishment) must undertake an IEE and EIA before they initiate the project.

The Policy delineates DoE, as the approving agency for all such IEE and EIA's to be undertaken in the country. The policy guidelines of fifteen sectors are stated in the Policy. Under the 'energy and fuel sector' (section 3.4), the use of environmentally sound and less harmful fuel has been encouraged in Section 3.4.1. Section 3.4.5 provides, 'Conservation of country's fossil fuel reserve and renewable sources of energy'. And section 3.4.6 provides that EIA should be conducted before implementation of projects for extraction of fuel and mineral resources.

Under the Environmental Action Plan Section of the Policy and sub-section 'Fuel and Energy' provides that:

- Section 4.2 "In the rural areas the use of gas, coal, kerosene and petrol as fuel will be expanded in the rural areas, so that fuel wood, agricultural residues and cow dung are conserved. This will help the use of agricultural residues, and cow dung etc. as manure"

- Section 4.7 “Appropriate measures will be taken to ensure that extraction, distribution and use of natural resources such as oil, gas, coal, peat etc. do not adversely affect air, water, land, the hydrological balance and the ecosystem”.
- Section 3: ‘Forest, wildlife and biodiversity’ directs the followings:
  - ✓ Conserve wildlife and biodiversity, strengthen related research and help dissemination and exchange of knowledge in these areas; and
  - ✓ Conserve and develop wetlands and protection of migratory birds.

### 2.5.2 Draft Coal Policy

The Draft Coal Policy (version 1) was published on 1st December 2005 by the Energy and Mineral Resources Division of Ministry of the Power, Energy and Mineral Resources. After that, it was revised several times. The latest one is the Bangladesh Draft Coal Policy, 2010.

The latest Draft Coal Policy (2010) outlines gas shortage, power generation, coal development, investment for coal sector, import coal, environment etc. in Bangladesh. Therefore, this policy will become useful data in relating the domestic coal supply. This policy states that coal will be used for power generation instead of gas as an alternative fuel to maintain national energy stability.

### 2.5.3 Power System Master Plan, 2010

The main objective of this study is to formulate a Master Plan for the attainment of stable power supply in the People's Republic of Bangladesh up to year 2030 in consideration of the diversification of fuel resources, including an optimum power development plan, power system plan, and identification of the potential power plant sites based on the fuel diversification study. Therefore, this study includes a comprehensive power development master plan where the study of the fundamental conditions of the development (demand forecast, procurement of primary energy resources, optimum power development plan, future optimum power supply structure including the positioning of gas-fired power plants, and so on) are added.

The power sector was heavily dependent on gas. Even two/three years back almost 90% of the electricity used to be generated from the natural gas of the country and rest by hydro electricity and coal. The power sector master plan 2010 has stressed on diversification of the fuel such as natural gas, coal, furnace oil, diesel etc as well as renewable energy sources.

In this Master Plan, the target composition of power supply as of 2030 is 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 as oil, nuclear power and renewable energy.

### 2.5.4 National Environment Management Action Plan 1995

The National Environment Management Action Plan (NEMAP) is a wide ranging and multifaceted plan, which builds on and extends the statements set out in the National Environment Policy (NEP). NEMAP was developed to address issues and management requirements for a period between 1995 to 2005 and set out the framework within which the recommendations of the National Conservation Strategy (NCS) are to be implemented.

NEMAP has the following broad objectives:

- Identification of key environmental issues affecting Bangladesh;

- Identification of actions necessary to halt or reduce the rate of environmental degradation;
- Improvement of the natural and built environment;
- Conservation of habitats and biodiversity;
- Promotion of sustainable development; and
- Improvement in the quality of life of the people

One of the key issues in NEMAP regarding the energy sector is “energy conservation awareness is generally low throughout the country”. NEMAP did not recognize mineral resources as an important sector and there is no separate discussion on this.

### 2.5.5 The National Forest Policy (1994)

The National Forestry Policy of 1994 is the revised version of the National Forest Policy of 1977 in the light of the National Forestry Master Plan. The major targets of the Policy are to conserve the existing forest areas; bring about 20% of the country’s land area under the afforestation program, and increase the reserve forestland by 10% by the year 2015 through coordinated efforts of GO-NGOs and active participation of the people.

The need of amendments of the existing forestry sector related laws and adoption of new laws for sect oral activities have been recognized as important conditions for achieving the policy goals and objectives. The Forest Policy also recognizes the importance of fulfilling the responsibilities and commitments under international multilateral environmental agreements.

### 2.5.6 The National Energy Policy (1995)

The National Energy Policy provides for utilization of energy for sustainable economic growth, supply to different zones of the country, development of the indigenous energy sources and environmentally sounds sustainable energy development programs. The Policy highlights the importance of protecting the environment by requiring an EIA for any new energy development project, introduction of economically viable and environment friendly technology.

One (Section 1.2) of the seven objectives addresses the environment and states, "(vi) *to ensure environmentally sound sustainable energy development programs causing minimum damage to the environment"*.

The seven specific policy recommendations are listed under Chapter 1.9. Of those, the following three are relevant to the present project:

- EIA should be made mandatory and should constitute an integral part of any new energy development project;
- Use of economically viable environment friendly technology is to be promoted; and
- Public awareness is to be promoted regarding environmental conservation

### 2.5.7 The National Water Policy (1999)

The National Water Policy of 1999 was adopted to ensure efficient and equitable management of water resources, proper harnessing and development of surface and ground water, availability of water to all concerned and institutional capacity building for water resource management. It has also addressed issues like river basin management, water rights and allocation, public and private investment, water supply and sanitation and water needs for agriculture, industry, fisheries, wildlife, navigation, recreation, environment, preservation of wetlands, etc.

The Policy states that excessive water salinity in the southwest region is a major deterrent to industrial growth. In addition, pollution of both surface and groundwater around various industrial centers of the country by untreated effluent discharge into water bodies is a critical water management issue. The Policy suggests that the following matters should be considered:

a) Zoning regulations will be established for location of new industries in consideration of fresh and safe water availability and effluent discharge possibilities;
b) Effluent disposal will be monitored by relevant Government agencies to prevent water pollution;
c) Standards of effluent disposal into common watercourses will be set by WARPO in consultation with DOE;
d) Industrial polluters will be required under law to pay for the cleanup of water- body polluted by them.

### 2.5.8 World Bank's Safeguards (Relevant Policies)

The Bank requires environmental assessment (EA) of projects proposed for Bank support to ensure that they are environmentally sound and sustainable, and thus to improve decision making. EA is a process whose breadth, depth, and type of analysis depend on the nature, scale, and potential environmental impact of the proposed project. EA evaluates a project's potential environmental risks and impacts in its area of influence; examines project alternatives; identifies ways of improving project selection, sitting, planning, design, and implementation by preventing, minimizing, mitigating, or compensating for adverse environmental impacts and enhancing positive impacts; and includes the process of mitigating and managing adverse environmental impacts throughout project implementation. EA takes into account the natural environment (air, water and land); human health and safety; social aspects (involuntary resettlement, indigenous peoples and physical cultural resources); and trans-boundary and global environmental aspects.

The Bank classifies the proposed project into three major categories, depending on the type, location, sensitivity, and scale of the project and the nature and magnitude of its potential environmental impacts.

Category A: The proposed project is likely to have significant adverse environmental impacts that are sensitive, diverse, or unprecedented. These impacts may affect an area broader than the sites or facilities subject to physical works.

Category B: The proposed project's potential adverse environmental impacts on human population or environmentally important areas-including wetlands, forests, grasslands, or other natural habitats- are less adverse than those of Category A projects. These impacts are site specific; few if any of them are irreversible; and in most cases mitigation measures can be designed more readily than Category A projects.

Category C: The proposed project is likely to have minimal or no adverse environmental impacts.

Analysis of the relevant policies is summarized in **Table 2-2**.

**Table 2-2: Summary of the Relevant Polices**

| Title and Scope | Relevant Provisions to the Project Activities | Obligations of Bangladesh-China Power Company (Pvt.) Limited (BCPCL) | Requirement of BCPCL |
|---|---|---|---|
| **Agricultural Policy, 1999** | | | |
| Agricultural Policy, 1999 | Preserve and develop land productivity | Bangladesh-China Power Company (Pvt.) Limited Should: take appropriate measures to prevent loss of land fertility in and around Project site during the project implementation period. If not then compensate the loss. | Extension Department, Soil Resource Development Institute |
| Agricultural Policy, 1999 | Section 2.1 Objective; Preserve existing biodiversity of different crops | Bangladesh-China Power Company (Pvt.) Limited Should take appropriate measures to prevent loss of any indigenous crop variety of the project site Viz. preserve the indigenous crop verity. If not then compensate the loss. | MoA, Bangladesh Rice Research Institute (BRRI), BARC |
| Agricultural Policy, 1999 | Section 12.1 Land Use; Appropriate measures will be taken in the light of the Land Use Policy, to stop the trend of shifting agricultural land into to other due to its use for non-agricultural purposes. | Bangladesh-China Power Company (Pvt.) Limited must follow the appropriate land acquisition procedure as per the GOB | MoA, MoFL |
| **Environment Policy 1992** | | | |
| Environment Policy,1992 | Section 3.2.1 Industry; Adoption of corrective measures by polluting industries in phases | Bangladesh-China Power Company (Pvt.) Limited must comply with the Government regulation. | MoEF, MoFL, MoPEMR, DoE and other relevant government agencies |
| Environment Policy 1992 | Section 3.2.4 Industry; Encourage development of environmentally sound and appropriate technology and initiatives on research and extension in the fields of Industry. Balance such initiatives with the best use of labor and provision of proper Wages. | Bangladesh-China Power Company (Pvt.) Limited should use economically viable and environmental friendly technology Provide analysis of alternatives in the EIA report | MoEF, MoFL, DoE |
| Environment Policy 1992 | Section 3.3.1 Health; Prevent activities, which are harmful to public health in all spheres, including development | Bangladesh-China Power Company (Pvt.) Limited should take all appropriate measures to prevent risky activities that may affect the Public. | MoEF, LGED, DPHE, Local Administration |
| Environment | Section 3.3.5 Health; Ensure healthy | Bangladesh-China Power Company (Pvt.) Limited should take | DoE, DPHE |

| Title and Scope | Relevant Provisions to the Project Activities | Obligations of Bangladesh-China Power Company (Pvt.) Limited (BCPCL) | Requirement of BCPCL |
|---|---|---|---|
| Policy 1992 | workplace for workers | all appropriate measures to ensure healthy workplace for the workers | |
| Environment Policy 1992 | Section 3.4.1 Energy and Fuel<br>Reduce and discourage the use of those fuels which pollute the environment and increase the use of environmentally sound and less harmful fuels | Bangladesh-China Power Company (Pvt.) Limited must use the fuels in their machinery and vehicles that reduce pollution in the environment | MoEF, DoE, MoPEMR, Local Government Institutes |
| Environment Policy 1992 | Section 3.4.2 Energy and Fuel reduce the use of fuel wood, agricultural residues etc. to meet energy need and increase the use of alternative energy sources | Bangladesh-China Power Company (Pvt.) Limited should use materials other than fuel wood and agricultural residue | MoPEMR |
| Environment Policy 1992 | Section 3.4.5 Energy and Fuel<br>Conserve country's fossil fuel reserves and renewable sources of energy | Bangladesh-China Power Company (Pvt.) Limited should: Consider the provision for long term aspects | MoPEMR |
| Environment Policy 1992 | Section 3.4.6 Energy and Fuel; Conduct EIA before implementing the projects for extraction of fuel and mineral resources | Bangladesh-China Power Company (Pvt.) Limited should conduct EIA | MoEF |
| Environment Policy 1992 | Section 3.5.1 Water development; Ensure environmentally sound utilization of all water resources | Bangladesh-China Power Company (Pvt.) Limited should: Ensure conservation of freshwater resources | MoEF |
| Environment Policy 1992 | Section 3.5.5 Water development<br>keep the rivers, canals, ponds, lakes, haors, baors and all other water bodies and water resources free from pollution | Bangladesh-China Power Company (Pvt.) Limited should:<br>Make sure that the nearby water bodies and resources are not polluted due to project activities. | MoEF |
| Environment Policy 1992 | Section 3.6.2 Prevent land erosion, preserve and increase soil fertility, and expand activities for conservation and environmentally sound management of newly accreted land | Bangladesh-China Power Company (Pvt.) Limited should take appropriate measures to prevent land erosion in the project site. | MoEF, MoFL |
| Environment Policy 1992 | Section 3.7.2 Forest; Include tree plantation programme in all relevant development activities | Bangladesh-China Power Company (Pvt.) Limited should: Carry out afforestation in and around the project site | MoEF, FD |

| Title and Scope | Relevant Provisions to the Project Activities | Obligations of Bangladesh-China Power Company (Pvt.) Limited (BCPCL) | Requirement of BCPCL |
|---|---|---|---|
| Environment Policy 1992 | Section 3.7.3 Forest; Stop shrinkage and depletion of forest land and forest resources | Bangladesh-China Power Company (Pvt.) Limited should: Take appropriate measures minimize the deforestation around the site | MOEF, FD |
| Environment Policy 1992 | Section 3.7.5 Forest<br>Conserve wildlife and biodiversity | Bangladesh-China Power Company (Pvt.) Limited should: Take appropriate measures to prevent loss of the biodiversity and undertake compensatory measures in case of inevitable damage if any | MoEF, FD |
| Environment Policy 1992 | Section 3.7.6 Forest; Conserve and develop wetlands and protect migratory birds | Bangladesh-China Power Company (Pvt.) Limited must: avoid activities which cause huge damage to wetlands and destroy the any fish sanctuary or species habitat of conservation significance | MoEF, MoWR, FD |
| Environment Policy 1992 | Section 3.8.2 Fisheries; Prevent activities that diminish the wetlands natural habits of fish | Bangladesh-China Power Company (Pvt.) Limited should: Take appropriate measure, so that the nearby fish habitats are not threatened due to project activities, viz. do not discharge untreated waste water into the river | WET, EIA Report |
| Environment Policy 1992 | Section 3.11.2 Transport and Communication; Ensure that vehicles and people using roads, rails, air and inland waterways do not pollute the environment and take steps to protect health of the workers running these transports | Bangladesh-China Power Company (Pvt.) Limited should: Use the vehicles (which are going to be used during the operation of the project) which cause less pollution to the environment. Take necessary measures to protect health of the workers running transports | MoEF, MoC, Roads and Highway Department, Railway Authority, Inland Water Transport Authority |
| Environment Policy 1992 | Section 3.11.3 Transport and Communication; Control activities in inland ports and dockyards which cause pollution of water and the local environment | Bangladesh-China Power Company (Pvt.) Limited should: Need to consider this provision while importing and transporting the coals | MoEF, MoC, Roads and Highway Department, Port Authority, Inland Water transport Authority |
| Environment Policy 1992 | Section 3.12.1 Integrate environmental consideration into all housing and urban planning activities and research | Bangladesh-China Power Company (Pvt.) Limited should: While setting up the proposed location town, consider the integrated environmental aspects | MoEF |
| **Energy Policy 1996** | | | |
| Energy Policy 1996 | Section 1.2 Objective (iv); Ensure | Bangladesh-China Power Company (Pvt.) Limited should: Ensure that the project activities does not hamper the | MoPEMR, Power |

| Title and Scope | Relevant Provisions to the Project Activities | Obligations of Bangladesh-China Power Company (Pvt.) Limited (BCPCL) | Requirement of BCPCL |
|---|---|---|---|
| | sustainable operation of the energy utilities | sustainable of operations of energy utilities in the Proposed location | Development Board, Rural Electrification Board |
| Energy Policy 1996 | Section 1.2 Objective (v); Rational use of total energy sources | Bangladesh-China Power Company (Pvt.) Limited should: Ensure the coal are used rationally | MoPEMR<br>Hydrocarbon Unit |
| Energy Policy 1996 | Section 1.2 Objective (vi); Ensure environmentally sound sustainable energy development program causing minimum damage to the environment | Bangladesh-China Power Company (Pvt.) Limited must: Consider this provision while implementing the project viz. ensure minimum damages caused to the environment | MoPEMR |
| Energy Policy 1996 | Sectio1. 9 Environmental Conservation issues will be considered for all type of fuels and in each and every step of fuel cycle; namely, exploration, appraisal, extraction, conversion, transportation and consumption. | Bangladesh-China Power Company (Pvt.) Limited Should: Need to consider this Provision during their project cycle. | MoPEMR |
| Energy Policy 1996 | Section 7.3 Technology Assessment, Necessary arrangements are to be made to select appropriate technologies i.e. conversion, efficiency, transferability, adaptability, environmental effects, cost should be considered while selecting technologies | Bangladesh-China Power Company (Pvt.) Limited should: Consider these (Mentioned) factors while selecting the technologies. | MoPEMR |
| Energy Policy 1996 | Promote use of economically viable environment friendly technology are to be promoted | Bangladesh-China Power Company (Pvt.) Limited should: Use economically viable and environmental friendly technology | MoPEMR |
| Energy Policy 1996 | Discourage use of fuel wood | Bangladesh-China Power Company (Pvt.) Limited should: Use materials other than fuel wood | MoPEMR |
| Energy Policy 1996 | Section 1.9 (g) Encourage the use of lead free petrol | Bangladesh-China Power Company (Pvt.) Limited should: Use lead free petrol | MoPEMR |
| **Land Use Policy 1994** | | | |
| Land Use Policy | Section 2 (e) Objective Ensure the land | Bangladesh-China Power Company (Pvt.) Limited should: | MoFL and DoE |

| Title and Scope | Relevant Provisions to the Project Activities | Obligations of Bangladesh-China Power Company (Pvt.) Limited (BCPCL) | Requirement of BCPCL |
|---|---|---|---|
| 2010 | use in Harmony with the natural environment. | Follow the Government's land use plan | |
| Land Use Policy 2010 | Section 2 (i) Objective; Conserve the natural forest | Bangladesh-China Power Company (Pvt.) Limited must: Compensate for destroying the natural forest, viz. plantation on the other nearby areas, Reforestation and plantation on the annulled forest area. | MoFL, Forest Department |
| Land Use Policy 2010 | Section 2 (i) Objective; Prevent river bank erosion | Bangladesh-China Power Company (Pvt.) Limited should: Prevent activities that may cause river bank erosion | MoFL and MoWR |
| Land Use Policy 2010 | Section 2 (h) Objective; Prevent the land pollution | Bangladesh-China Power Company (Pvt.) Limited should: Take appropriate measures to prevent/ reduce the land pollution | MoFL and DoE |
| Land Use Policy 2010 | Section 3.4 Land Use; Maintaining a balanced ecosystem | Bangladesh-China Power Company (Pvt.) Limited should: Proper authorization to utilizing the area (project site) from the concerned authority, via, seek authorization from the Forest Department for utilizing the forest land | MoFL, MoWR, Forest Department and others |
| **The Forest Policy 1994** | | | |
| Forest Policy 1994 | Conserve the natural forest (protected, reserved and unclassified state forest) | Bangladesh-China Power Company (Pvt.) Limited should: Take appropriate measures to mitigate adverse impact (due to project activities) on the forest of the proposed location area | MoEF, FD |
| Forest Policy 1994 | Restoration of natural forest to preserve biodiversity and wildlife | Bangladesh-China Power Company (Pvt.) Limited should: Carry out afforestation and reforestation of forests cleared during the project activity | MoEF, FD |
| Forest Policy 1994 | Without proper authorization, forest land Cannot be used for non forest purpose. | Bangladesh-China Power Company (Pvt.) Limited should: Seek for permission from the Forest Department for using the forest area for non forest purpose | MoEF, FD |
| **The Tourism Policy 1992** | | | |
| Tourism Policy 1992 | Section 5 (3): Development, preservation and maintenance of tourism resources of the country | Bangladesh-China Power Company (Pvt.) Limited need: To look into the matter so that any tourism resource nearby the proposed plant are not affected due to the project activities | MoCAT |
| Tourism Policy 1992 | Section 7: Restoration and maintenance of archaeological and historical sites | Bangladesh-China Power Company (Pvt.) Limited must: Not destroy any archaeological and historical sites of the with the proposed location of the Power Plant | MoCAT |

| Title and Scope | Relevant Provisions to the Project Activities | Obligations of Bangladesh-China Power Company (Pvt.) Limited (BCPCL) | Requirement of BCPCL |
|---|---|---|---|
| Tourism Policy 1992 | Section 8: Conservation of wildlife | Bangladesh-China Power Company (Pvt.) Limited need to consider this provision | MoEF |
| **The Fisheries Policy 1998** | | | |
| Fisheries Policy 1998 | Section 9.10; Protect natural water bodies and marine biodiversity. | Bangladesh-China Power Company (Pvt.) Limited must: Consider this provision and take appropriate measure to reduce adverse impact on the water bodies | MoFL, Fisheries Department |
| Fisheries Policy 1998 | 9.10.2 Control activities which may have adverse effect on the fish resources | Bangladesh-China Power Company (Pvt.) Limited must: Control the activities which may have adverse impact on the fish resources | MoFL, Fisheries Department |
| Fisheries Policy 1998 | 9.10.6 Implement laws to prevent discharge of untreated waste into water bodies. | Bangladesh-China Power Company (Pvt.) Limited must comply with these laws | MoFL, Fisheries Department |
| **The Water Policy 1999** | | | |
| Water Policy 1999 | Section 4.8 Water and Industry; a) Zoning regulation will be established for location of new industries in consideration of fresh and safe water availability and effluent discharge possibilities. | Bangladesh-China Power Company (Pvt.) Limited must: Follow the zoning regulation of the Government | MoFL, MoWR |
| Water Policy 1999 | b) Effluent disposal will be monitored by relevant Government agencies to prevent water pollution | Bangladesh-China Power Company (Pvt.) Limited must: Allow the monitoring authority to monitor their effluent discharge | MoWR |
| Water Policy 1999 | c) Standards of effluent disposal into common water courses will set by WARPO in consultation with DoE | Bangladesh-China Power Company (Pvt.) Limited need to comply with the polluter pay principle under the national legislation | DoE/MoWR |
| Water Policy 1999 | d) Industrial polluters will be required under law to pay for the cleanup of water body Polluted by then. | Bangladesh-China Power Company (Pvt.) Limited need to comply with the polluter pay principle under the national legislation | DoE/MoWR |
| Water Policy 1999 | Section 4.12 Water and Environment; d) Protect against degradation and resuscitate natural water bodies such as lakes, ponds, heels, khals, tanks, etc. affected by man- | Bangladesh-China Power Company (Pvt.) Limited should: Consider this provision while implementing the project | MoWR |

| Title and Scope | Relevant Provisions to the Project Activities | Obligations of Bangladesh-China Power Company (Pvt.) Limited (BCPCL) | Requirement of BCPCL |
|---|---|---|---|
| | made Intervention or other causes. | | |
| Water Policy 1999 | i) Enforce the 'polluter pay' principle in the development of regulatory guidelines for all regulatory actions designed to protect public health and the environment | Bangladesh-China Power Company (Pvt.) Limited need to follow the regulatory Guidelines. | DoE |
| **The Industrial Policy 1999** | | | |
| Industrial Policy 1999 | Objective (p); To take appropriate measures for preventing | Bangladesh-China Power Company (Pvt.) Limited need to consider the provision during implementation of the project activities | DoE, MoPEMR |
| **The Housing Policy 1999** | | | |
| Housing Policy 1999 | Section 4.7; Initiate planning to produce more forest products used to build infrastructures and attention be given to environmental management | Bangladesh-China Power Company (Pvt.) Limited should: Carry out afforestation and Reforestation activities to restore degraded lands | MoHPW/MoHFW |
| Housing Policy 1999 | Section 4.9; While implementing any new housing project, need to consider the local building modes, upholding and conservation of the cultural heritage | Bangladesh-China Power Company (Pvt.) Limited should: Consider the provision while implementing the proposed township under the project activities | MoHFW/MoC |
| Housing Policy 1999 | Section 5.1.3 Land; Ensure that the minimum land acquired for any development project/programme | Bangladesh-China Power Company (Pvt.) Limited should: Adopt the principle during land acquisition | MoHPW<br>Bangladesh-China Power Company (Pvt.) Limited |
| **Biodiversity Strategy and Action Plan (BSAP)** | | | |
| BSAP | Strategy 2: Conserve ecosystems, species and genetic pool of the country to ensure that the present and future well-being of the country and its people are secure | Bangladesh-China Power Company (Pvt.) Limited should:<br>• Create an inventory of all the species of flora and fauna in the area.<br>• Conduct EIA and SIA reports. | MoEF/ DoE |
| BSAP | Strategy 3: Restore ecosystems and rehabilitate endangered species | Bangladesh-China Power Company (Pvt.) Limited should:<br>• Construct ETP to restrict amount of pollution<br>• Create buffer zones in and around the project site<br>• Carry on afforestation and reforestation activities on | MoEF/ DoE |

| Title and Scope | Relevant Provisions to the Project Activities | Obligations of Bangladesh-China Power Company (Pvt.) Limited (BCPCL) | Requirement of BCPCL |
|---|---|---|---|
| | | abandoned site | |
| BSAP | Strategy 10: Ensure wise use of wetland resources environment pollution and maintaining the ecological balance | Bangladesh-China Power Company (Pvt.) Limited should: Consider the provision while implementing the project. | MoWR/ MoEF |

The Constitution of the People's Republic of Bangladesh considered the issue of environmental protection and agreed through its 15th amendment. The high-level committee on Constitutional amendment included the following article in 'Part II: Fundamental Principles of State Policy 'and was passed accordingly: "18A. Protection and improvement of environment and biodiversity: The State shall endeavor to protect and improve the environment and to safeguard the natural resources, biodiversity, wetlands, forests and wild life for the present and future citizens."

## 2.6 International Maritime Conventions, Protocols and Agreements applicable for coal transportation

Bangladesh is signatory of the International Maritime Organization (IMO). Therefore, all activities relating to shipment of coal through the Port shall have to be done strictly in compliance with the standards set by the IMO, particularly the conventions, protocols and agreements.

The following Conventions/ Protocols of IMO have been agreed by the GoB-

| | | | | | |
|---|---|---|---|---|---|
| 1. | IMO Convention 1948 | 2. | IMO amendments 1991 | 3. | IMO amendments 1993 |
| 4. | SOLAS Convention 1974 | 5. | SOLAS Protocol 1988 | 6. | LOAD LINES Convention 1966 |
| 7. | LOAD LINES Protocol 1988 | 8. | TONNAGE Convention 1969 | 9. | COLREG Convention 1972 |
| 10. | STCW Convention 1978 | 11. | SAR Convention 1979 | 12. | STP Agreement 1971 |
| 13. | STP Protocol 1973 | 14. | IMSO Convention 1976 | 15. | INMARSAT OA 1976 |
| 16. | FACILITATION Convention 1965 | 17. | MARPOL 1973/1978 (Annex I/II) | 18. | MARPOL 1973/1978 (Annex III) |
| 19. | MARPOL 1973/1978 (Annex IV) | 20. | MARPOL 1973/1978 (Annex V) | 21. | MARPOL Protocol 1997 (Annex VI) |
| 22. | INTERVENTION Convention 1969 | 23. | SUA Convention 88 | 24. | SUA Protocol 1988 |
| 25. | OPRC Convention 1990 | | | | |

Some of the Conventions/Protocols acceded by GoB are highlighted below-

**Table 2-3: International maritime conventions, protocols and agreements of different issues**

| Issues | International Maritime Conventions, Protocols and Agreements | Remarks |
|---|---|---|
| International Maritime | IMO Convention, 1948 | The Convention establishing the IMO was adopted in1948 but the Organization started life as the Inter- Governmental Maritime Consultative Organization (IMCO) until it was changed to the IMO in 1982.<br>The Aims of the IMO include a range of objectives:<br>✓ To provide machinery for co-operation among Governments in the field of governmental regulation and practices relating to technical matters of all kinds affecting shipping engaged in international trade, and to encourage the general adoption of the highest practicable standards in matters concerning maritime safety and efficiency of navigation;<br>✓ To provide for the consideration by the organization of |

| Issues | International Maritime Conventions, Protocols and Agreements | Remarks |
|---|---|---|
| | | any matters concerning shipping that may be referred to it by any organ or specialized agency of the United Nations;<br>✓ To provide for the exchange of information among Governments on matters under consideration by the organization.<br>There have been a series of amendments to the Convention which are 1975 amendments, 1977 amendments, 1991 amendments. This Convention came Into force in Bangladesh on May 27, 1976. The amendment 1993 acceded on November 7, 2002. |
| Maritime safety | SOLAS Convention, 1974 | The SOLAS Convention in its successive forms is generally regarded as the most important of all international treaties concerning the safety of merchant Ships. The 1974 version includes the tacit acceptance procedure - which provides that an amendment shall enter into force on a specified date unless, before that date, objections to the amendment are received from an agreed number of Parties. The Convention came into force on May 25, 1980 and acceded by GoB on February 6, 1982. The 1988 Protocol of SOLAS 1974 was acceded by Bangladesh on November 4, 2002. |
| Measurement of ships | Load Lines Convention, 1966 | It has long been recognized that limitations on the draught to which a ship may be loaded make a significant contribution to her safety. These limits are given in the form of freeboards, which constitute, besides external weather tight and watertight integrity, the main objective of the Convention. The Convention acceded by GoB on August 10, 1978. The Protocol of the load Line Convention acceded by GoB on November 4,<br>2002. |
| Preventing collisions at sea | Convention on International Regulations for Preventing Collisions at Sea (COLREG), 1972 | The 1972 Convention was designed to update and replace the Collision Regulations of 1960 which were adopted at the same time as the 1960 SOLAS Convention.<br>One of the most important innovations in the 1972 COLREGs was the recognition given to traffic separation schemes - Rule 10 gives guidance in determining safe speed, the risk of collision and the conduct of vessels operating in or near traffic separation schemes. The Convention was acceded by Bangladesh on May 10, 1978. |
| International Maritime Satellite System | Convention on International Maritime Satellite Organization (INMARSAT), 1976 | IMO recognized the potential for satellite communications to assist in distress situations at sea soon after the launch of the world's first telecommunications satellite, Telstar, in 1962. In<br>February 1966, IMO's Maritime Safety Committee (MSC) decided to study the operational requirements for a satellite |

| Issues | International Maritime Conventions, Protocols and Agreements | Remarks |
|---|---|---|
| | | communications system devoted to maritime purposes.<br>In 1973, IMO decided to convene a conference with the object of establishing a new maritime communications System based on satellite technology. The Convention came into force by GoB on July 16, 1979. |
| Prevention of Pollution from Ships | International Convention for the Prevention of Pollution from Ships (MARPOL) | The MARPOL Convention is the main international convention covering prevention of pollution of the marine environment by ships from operational or accidental causes. It is a combination of two treaties adopted in 1973 and 1978 respectively and also includes the protocol of 1997 (Annex VI). It has been updated by amendments through the years. MARPOL 73/78 (Annex-I, II, III, IV, V and VI) was acceded by GoB on November 4, 2002. |
| | Convention on Facilitation of International Maritime Traffic (facilitation), London, 1965 | The Convention's main objectives are to prevent unnecessary delays in maritime traffic, to aid cooperation between Governments, and to secure the highest practicable degree of uniformity in formalities and other procedures. In particular, the Convention reduces the number of declarations which can be required by public authorities. The Convention came into force in Bangladesh on October 28, 2000. |
| Safety of maritime navigation | Convention for the Suppression of Unlawful Acts of Violence against the Safety of Maritime Navigation (SUA convention), 1988 | The main purpose of the convention is to ensure that appropriate action is taken against persons committing unlawful acts against ships. These include:<br>a. The seizure of ships by force;<br>b. Acts of violence against persons on board ships; and<br>c. The placing of devices on board a ship which are likely to destroy or damage it.<br>The convention obliges Contracting Governments either to extradite or prosecute alleged offenders. The Convention came into force in Bangladesh on September 7, 2005. |

In addition to the aforementioned conventions, Government of Bangladesh will sign the following conventions very soon;

1. STCW- 2010
2. Bunker Convention
3. Anti-fouling Convention
4. Hong Kong Convention for Ship Recycling
5. Ballast Water Management Convention

## 2.7 International Legal Obligations

Bangladesh is signatory to a number of Multilateral Environmental Agreements (MEAs) and also some bilateral instruments. Some of them are very important in the context of environmental protection. The legal obligations and provisions of MEAs related to the proposed project interventions will be reviewed; (**Convention on Biological Diversity; Convention on Wetlands of International**

**Importance Especially as Waterfowl Habitat; United Nations Convention on the Law of the Sea; Convention Concerning the Protection of the World Cultural and Natural Heritage)**

Bangladesh has already had accessed to, ratified or signed a number of important MEAs related to environment protection and conservation of natural resources which shall have to be complied with during implementation of the project. The pertinent ones of these are highlighted below:

### 2.7.1 Rio Declaration

The 1992 United Nations Conference on Environment and Development (UNCED) adopted the global action program for sustainable development called 'Rio Declaration' and 'Agenda 21'.

Principle 4 of the Rio Declaration, 1992, to which Bangladesh is a signatory along with a total of 178 countries, states, "In order to achieve sustainable development, environmental protection should constitute an integral part of the development process and cannot be considered in isolation from it".

### 2.7.2 Convention on Biological Diversity (1992)

The Convention on Biological Diversity, Rio de Janeiro, 1992 was adopted on 5 June 1992 and entered into force on 29 December, 1993. Bangladesh ratified the Convention on 20 March, 1994.

The Contracting Parties of the Convention have committed to:

- Introducing appropriate procedures requiring environmental impact assessments of its proposed projects that are likely to have significant adverse effects on biodiversity, with a view to avoiding or minimizing such effects, and where appropriate allow for public participation in such procedures; and
- Introducing appropriate arrangements to ensure that environmental consequences of its programs and policies, that are likely to have significant adverse impacts on biodiversity, are duly taken into account.

Obligation has been placed on State parties to provide for environmental impact assessments of projects that are likely to have significant adverse effects on biological diversity (art. 4).

### 2.7.3 Convention on Wetlands of International Importance Especially as Waterfowl Habitat, Ramsar (1971)

This convention is also known as the Ramsar Convention. It was adopted 2 February, 1971 and entered into force on 21 December, 1975. Bangladesh has ratified the Convention 20 April, 2002. This provides a framework for national action and international cooperation for the conservation and wise use of wetlands and their resources. There are 127 Parties with 1085 wetland sites designated as Wetlands of International Importance'.

This is an intergovernmental treaty, which provides the framework for international cooperation for the conservation of wetlands habitats. Obligations for Contracting Parties include the designation of wetlands to the "List of Wetlands of International Importance', the provision of wetland considerations within their national land use planning, and the creation of Natural Reserves.

### 2.7.4 United Nations Convention on the Law of the Sea, Montego Bay, (1982)

This Convention was adopted on 10 December 1982 at Montego Bay, Jamaica. Bangladesh has ratified this Convention.

Main objectives of the convention are:

- To set up a comprehensive new legal regime for the sea and oceans, as far as Environmental provisions are concerned, to establish material rules concerning environmental standards as well as enforcement provisions dealing with pollution of the marine environment; and
- To establish basic environmental protection principals and rules on global and regional cooperation, technical assistance, monitoring, and environmental assessment, and adoption and enforcement of international rules and standards and national legislation with respect to alt sources of marine pollution.

### 2.7.5 UNESCO World Heritage Convention

Convention concerning the Protection of the World Cultural and Natural Heritage, Paris, 1972: This convection has been ratified by 175 states. This defines and conserves the world's heritage by drawing up a list of natural and cultural sites whose outstanding values should be preserved for all humanity. Of the 730 total sites, there are currently 144 natural, 23 mixed and 563 cultural sites that have been inscribed on the World Heritage List (distributed in 125 State parties). These are the 'Jewels in the Crown' of conservation.

### 2.7.6 Development Agency's Health and Safety Guidelines

Under the study health and safety guidelines of few development agencies has been reviewed. This included ADB's Social Safeguard Policy and the World Bank's Environmental Process.

### 2.7.7 Social Safeguard Policy of ADB and World Bank

ADB has had environment assessment requirements for more than 20 years and own safeguard policy framework which is currently taken to consist of three operational policies, namely the Environment Policy (2002), the Policy on Indigenous Peoples (1998), and the Policy on Involuntary Resettlement (1995), together with their respective operations manual sections and guidelines. In 1989 the World Bank adopted Operational Directive (OD) 4.00, "Annex A: Environmental Assessment". EA became standard procedure for Bank financed investment project. In 1991 the directive was as OD 4.01, which has subsequently been changed to operational policy OP 4.01 in January 1999 and the operational policy statement has been updated in March, 2007. EA is designed to be a flexible process that part of project preparation allows environmental issues to be addressed in a timely and cost-effective way during project preparation and implementation.

ADB's safeguard policies are central to achieving sustained development impact and poverty reduction. The objective of these policies is to avoid, minimize or mitigate adverse environmental impacts, social costs to third parties or marginalization of vulnerable groups that may result from development projects. Safeguard policies prescribe; "do no harm" requirements that must be met for all ADB projects. Regarding the resettlement plan of a project ADB provides that 'A satisfactory resettlement plan must include all eleven essential elements'. The safeguard policies are at the front line of ADB's accountability mechanism and compliance review process, since these policies, if properly implemented, help ensure that third parties do not incur material damages, either directly or through environmental media, and thus have no basis for complaint.

All three safeguard policies involve a structured process of impact assessment, planning and mitigation to address the adverse effects of projects and programs throughout the project cycle. The safeguard policies require that: (i) impacts are identified and assessed early in the project cycle; (ii) adverse impacts are avoided, minimized, or mitigated; and (iii) affected people are consulted.

In July 2009, ADB's Board of Directors approved the new Safeguard Policy Statement (SPS) governing the environmental and social safeguards of ADB's operations. The SPS aims to avoid, minimize, or mitigate harmful environmental impacts, social costs, and to help borrowers/clients strengthen their safeguard systems. The SPS builds upon ADB's previous safeguard policies on the environment, involuntary resettlement, and Indigenous Peoples, and brings them into one consolidated policy framework with enhanced consistency and coherence, and that more comprehensively addresses environmental and social impacts and risks. The SPS also provides a platform for participation by affected people and other stakeholders in project design and implementation.

### 2.7.8 Compliance with World Bank Environmental Assessment (EA) Process

The primary responsibility for the Environmental Assessment process lies with the borrower. The Bank’s role is to advise borrower throughout the process, to confirm that practice and quality are consistent with Environmental Assessment requirements and to ensure that the process feeds effectively into project preparation and implementation.

The 2001 Environment Strategy for the World Bank emphasizes the importance of integrating–or mainstreaming–environment into country development programs, sector strategies, and investments and underpinning sustainable development. WB introduced environmental policies and procedures to integrate good environmental management into our operations, and we have also developed environmental assistance programs to help client countries integrate environmental issues into their development process, to address their pressing environmental challenges.

In addition to efforts identified in the 2001 Strategy, the Bank has adopted a set of operational policies and procedures that deal with the Bank's core development objectives and goals, the instruments for pursuing them, and specific requirements for Bank financed operations.

World Bank seeks to ensure that -supported infrastructure and other development projects take into account the conservation of biodiversity, as well as the numerous environmental services and products which natural habitats provide to human society. The policy strictly limits the circumstances under which any Bank-supported project can damage natural habitats (land and water areas where most of the native plant and animal species are still present).

Specifically, the policy prohibits Bank support for projects which would lead to the significant loss or degradation of any Critical Natural Habitats, whose definition includes those natural habitats which are either:

- Legally protected,
- Officially proposed for protection, or
- Unprotected but of known high conservation value.

In other (non-critical) natural habitats, Bank supported projects can cause significant loss or degradation only when

i. There are no feasible alternatives to achieve the project's substantial overall net benefits; and
ii. Acceptable mitigation measures, such as compensatory protected areas, are included within the project.

# CHAPTER 3

# 3. THE PROJECT

## 3.1 Project Data Sheet

### 3.1.1 Project Proponent

The Bangladesh-China Power Company (Pvt.) Limited (BCPCL) is the proponent of this proposed 1,320 MW coal based thermal power plant. The Electricity Directorate was established in order 1947 in order to plan and improve supply situation of the then East-Pakistan (Present Bangladesh). Considering the increasing demand of electricity and its importance in agriculture and industry, Water and Power Development Authority (WAPDA) was created to ensure the rapid development of power system in 1959. After independence of Bangladesh on 31st May, 1972 by the P.O. No. 59, WAPDA was bifurcated into two parts - Bangladesh Power Development Board (BPDB) and Bangladesh Water Development Board (BWDB). BPDB was overall responsible for power generation, transmission and distribution. But under Govt. Power Sector Reforms Policy several transmission, distribution and generation companies were established. As a consequence, BPDB has become the nodal institution in the power sector under the jurisdiction of Ministry of Power, Energy and Mineral Resources. In the recent past, a number of generation companies have been created under the reforms program.

Despite the creation of Ashuganj Power Station Company Ltd. (APSCL), Electricity Generation Company of Bangladesh (EGCB), North West Power Generation Company Ltd. (NWPGCL) and West Zone Power Distribution Company Ltd. (WZPDCL), Power Grid Company of Bangladesh (PGCB) as company under BPDB, the BPDB still maintains the major part in power generation and distribution. NWPGCL is an outcome of this program. NWPGCL is an enterprise of BPDB. This company was created in order to meet the prevailing demand of electricity and to solve the low-voltage problem in the North-West region of the country.

In compliance with the revised Power System Master Plan (PSMP), 2010, with the aim of providing quality and reliable electricity to people for desired economic and social development the proposed power plant has been planned to construct within the shortest possible time.

### 3.1.2 Project Location and Area

The site is located at Latitude: 22° 59' 58" (N) and Longitude: 90° 17' 58" (E) adjacent to the Kazol River or upstream of Rabnabad Channel at Dhankhali Union, Kalapara Upazila, Patuakhali District of Bangladesh. The site is spread across the Mouza: Modhupara, Char Nisanbaria and Nisanbaria. It's about 8km away from Kalapara Upazila and 39km away from Patuakhali.

The proposed site stretches about 2.5 km. from north to south and 2.3 km. from east to west. This open site is capable of meeting the land-use demand of the proposed 2× 660MW ultra-supercritical coal-fired power plants, as well as the need for further expansion. The project location with respect to Bangladesh is presented in **Figure 3-1** and the geographic location of the proposed site has been shown in **Figure 3-2**.

The only economic activities are agriculture, fisheries & plantation. The site is away from any notified eco sensitive area like Natural Park, wild life sanctuary, buildings of archaeological importance etc

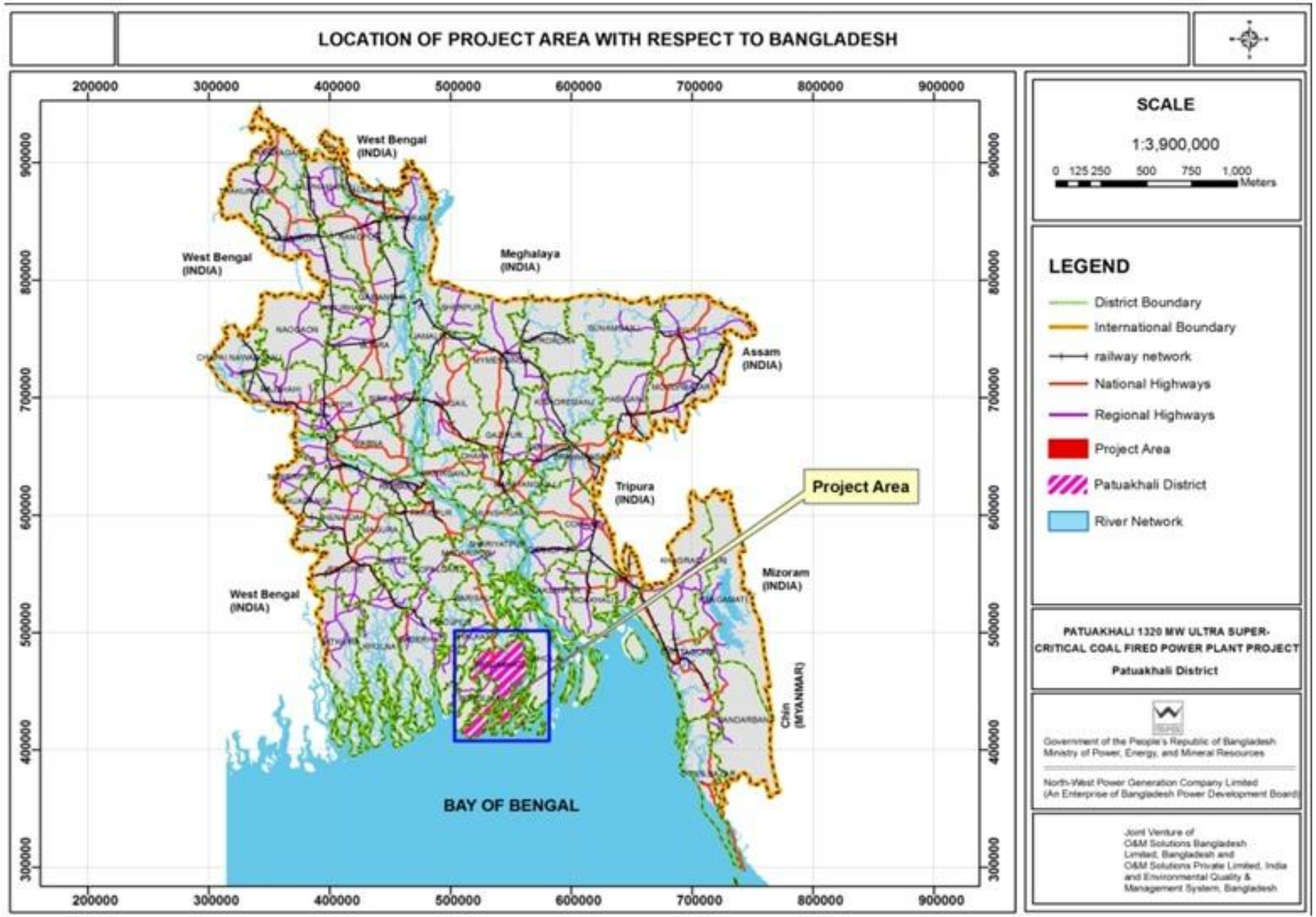



**Figure 3-1: Project Location in Bangladesh**


**Figure 3-2: Geographic location of the proposed site**

#### 3.1.2.1 Topography

The proposed site features is estuary delta, and adjacent to Ramnabad Channel and Andharmanik river, with altitude being 1.80m ～2.30m (Bangladesh Mean Sea Level, the same below). The proposed site is surrounded by water on three sides (east, south and west), each protected with an earth dam which is roughly 3 .5～ 5.0m higher than the rice fields. At the top of the earth dam there is a rural unpaved road with width being 3.0～ 4.0 meter. On both sides of the earth dam there grow many tall trees, with dwellings scattered on the outer side of the earth dam. Inside the earth dam there are well irrigated paddy fields and scattered villages. The dwellings are generally 1 -floor thatched houses or iron sheet houses.

#### 3.1.2.2 Transportation

***Highway***

Because of well-developed river system in Barisal division, most of the roads through j etty lightering connected when it cross the river. The traffic conditions in Barisal division are not good. Currently, there is not available highway reaching the proposed site. The regional highway R881 which from Dhaka to Kuakata is located 8.5 kilometers in the west of proposed site. R881 is bituminous pavement, whose width is 6 meters. The most convenient route of road transportation is connected from R881 then through Kalapara Upazila to Londa Kheya Ghat and further to the proposed site after lightering. The mileage of highway is about 16 kilometers. The traffic conditions around the site are poor.


**Figure 3-3: Highway network of proposed site**

***Railway***

There is no railway close the proposed site. It's not suitable for the proposed site to carry out railway transportation.

***Water Transportation and Jetty***

The neatest port to the proposed site is Chittagong, which located in the northeastern of the Bay of Bengal. Chittagong is built in 16th century. It is the biggest port in Bangladesh and have 28 berth whose draught is 6.4～ 8.5 meters. The distance between from the proposed site to Chittagong is 200 miles. The river system around the proposed site is well-developed. There is a Londa Kheya Ghat on the west side of the plant site (mainly the small jetty used by local residents for lightering).

### 3.1.3 Nature and Size of the Project

The nature of the project is ultra-supercritical coal fired power plant with ultra-supercritical variable-pressure operation coal-fired DC boiler, single reheat, tangential firing or opposite wall firing, balanced draft, outdoor arrangement, dry ash extraction, all-steel suspension structure and ultra-supercritical, reheat, four-cylinder and four-tailpipe or three-cylinder and four-tailpipe, single axle, condensing steam turbine; low sulfer content (0.47%)coal and installing flue gas desulfurizing unit, thus having the desulfurization efficiency reach 90%; advanced lownitrogen combustion technology to control the discharge concentration of NOx. The power eneration of the proposed project will be 2X660 MW.

### 3.1.4 Project Concept

Basically, the project consists of a coal fired thermal power plant with two units of 660MW each and induced draft cooling tower sations, recirculating cooling water system including proper intake piping and discharge channel and stack of 275 m each. The power will be designed in such a way so that the construction of another additional unit of 1320 MW can be made possible. A typical diagram of a coal based thermal power plant is shown in **Figure 3-4**.

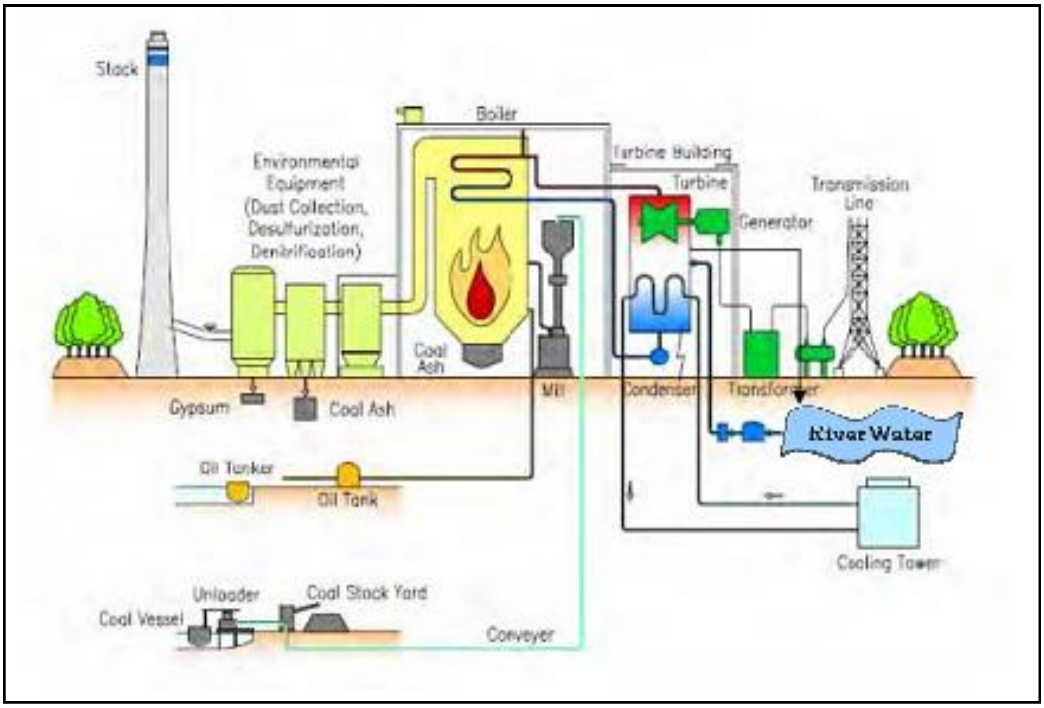



**Figure 3-4: Typical diagram of coal fired thermal power plant**

The main project facilities comprises of a power house and auxiliary facilities that include a switch yard, raw water reservoir, water pretreatment system, demineralization plant, desalinization plant (surface water reverse osmosis), circulating cooling water pump house, FGD, coal hanfdling system (onveyor belt and stockpiles), ash handling and disposal system, effluent treatment plant and residential townshipfor projet staff.

The proposed 2X660 MW (net power output) ultrasupercritical bituminous/ sub bituminous pulverized coal (PC) plant will be constructed at a green field site. This plant designed to meet Best Available Control Technology (BACT) emission limits. The step up voltage level has been considered as 400 kv as the capacity of the project has been considered as 1320 MW.

The primary fuel will be bituminous/sub bituminous coal with a Gross Calorific Value (GCV) of 4700 to 5500 kcal/kg. A summary of plant performance data for the ultrasupercritical pulverized coal (PC) plant is presented in **Table 3-1**.

**Table 3-1: Basic plant information of the proposed coal based thermal power plant**

| **Component** | **Design Condition** |
|---|---|
| Plant type | Ultra supercritical PC |
| Carbon capture | Nil |
| Net power output | 1320 MW |
| Primary fuel (type) | Bituminous/ sub bituminous coal having GCV of 4700-5500 Kcal/kg and low Sulfur content (0.47%) |
| Coal flow* | 15197 T/Day (at 100% plant load factor) |
| Annual coal requirement** | 4.12 MT/year |
| Ash production | 4.68% |
| Temperature of flue gas at stack | 125°C |
| Flue gas volume | $2.11X10^6$ |
| Flue Gas Desulfurization (FGD) | To maintain concentration of Sulfur in ambient air below the MoEF standard (80µg/$Nm^3$) limestone-gypsum web desulfurization process will be used for desulfurization |
| Maximum emission of Sox | 827 g/s |
| Maximum emission of NOx | 630.8 g/s |
| Particulate matter | ≤40mg/$Nm^3$ |
| Stack height | 275m |
| Water intake (make up water) | 4424.3 $m^3$/h |
| Water discharge after treatment | 2015.5 $m^3$/h |
| Total Fresh Water consumption | 2408.8 $m^3$/h |

Source: Feasibility study

* The daily coal consumption of boiler is based on 24-hour operation per day of the boiler

** The yearly coal consumption of boiler is based on 6500-hour operation per year of the boiler

The detail design including general layout plan and main plant cross section has been attached in Annex C.

### 3.1.5 Project Componenets

#### 3.1.5.1 Boiler

The power plant consists of two 660 MW units. Both units will have steam-based, pulverized coal-fired boiler units of ultasupercritical type, steam turbines and generators.

Boiler type: ultra-supercritical variable-pressure operation coal-fired DC boiler, single reheat, tangential firing or opposite wall firing, balanced draft, outdoor arrangement, dry ash extraction and all-steel suspension structure. A space is reserved for a denitration device at the end part of the boiler

Parameters at BMCR load:

| | |
|---|---|
| Main steam flow (t/h) | 1962 |
| Superhater outlet pressure (MPa) | 27.56 |
| Superhater outlet temperature (°C) | 605 |
| Reheater flow (t/h) | 1657.3 |
| Reheater inlet pressure (MPa) | 5.90 |
| Reheater outlet pressure (MPa) | 5.75 |
| Reheater input temperature (°C) | 368.3 |
| Reheater outlet temperature (°C) | 602 |
| Outlet gas temperature (°C) | 127 |
| Boiler efficiency (low hat value) (%) | ≥93.9％ |

The main plant consists of three interconnected structures: (i) boiler structures, (ii) turbine building, and (iii) an integrated control and electrical building.

#### 3.1.5.2 Steam Turbine

Ultra-supercritical, reheat, four-cylinder and four-tailpipe or three-cylinder and four-tailpipe, single axle, condensing.

| | |
|---|---|
| Rated power (MW) | 660 |
| Rated pressure before the main steam Valve (MPa) | 26.25 |
| Rated temperature before the main Steam valve (°C) | 600 |
| Rated temperature before the reheat Steam valve (°C) | 600 |
| Main steam flow at rated power (t/h) | 1868.3 |
| Reheat steam flow at rated power (t/h) | 1582.5 |
| Rated condensing flow (t/h) | 1156.7 |
| Max condensing flow | 1204.8 |
| Rated mean backpressure (kPa) | 8 (To be determined) |
| Feed temperature (°C) | 298.2 |
| Heating series of feedwater reheat system | 8-stage (three high pressure heaters and four low pressure heaters and one deaerator) |
| Heat rate at TMCR (KJ/kWh) | 7522 |

| | |
|---|---|
| Rated speed (r/min) | 3000 |

#### 3.1.5.3 Generator

Type: Water-hydrogen cooling, brushless excitation turbonator.

| | |
|---|---|
| Nameplate power | 660 MW |
| Rated capacity | 667 MVA |
| Rated voltage | 20kV |
| Power factor | 0.9 |
| Efficiency | 99% |
| Excitation mode | Brushless excitation or static excitation |
| Cooling mode | Stator coil water-cooling, stator core, rotor winding hydrogen cooling |

#### 3.1.5.4 Cooling Tower

A recirculating cooling system with Forced Draft Cooling Tower (FDCT) will be adopted for the proposed power plant. Detail of cooling tower is given below:

| Specification | Parameter | Parameter of CW pmp |
|---|---|---|
| Capacity: 4800 $m^3$/h<br>Quantity: 32 set | Diameter of fan:9140mm<br>Power:195KW<br>Operation quantity: 30 set | Q=10.3$m^3$/s<br>H=0.21MPa<br>N=2437kW<br>Operation: 4 set<br>Installation: 6 set |

CW pump (for each 660MW unit): 2 work 1 stanby.

Pump operation mode (for each 660MW unit): 1.5 works during winter season, 2 work during other seasons.

Cooling rate: 55 times (to condensed steam)

Size of condenser: 40000$m^2$

Forced draft cooling tower (FDCT): 4800 $m^3$/h, 30 work 2 standby in totall.

Size of circulating water pipe: DN3000

The capacity of CW pump is 110% of the CW flow. The back pressure of the steam turbine under the condition of recommendation is given as follow:

Check condition in summer (cumulative frequency of 10%): condenser inlet water temperature 32.2 centigrade, steam turbine back pressure 8.65KPa.

Normal condition (annual average temperature): condenser inlet water temperature 28.2 centigrade, steam turbine back pressure 7.38KPa.

#### 3.1.5.5 Stack

The DoE rules of maintaining stack height of minimum 275m for power plant over 500MW capacity under ECR, 1997 has been considered in design condition. A reinforced concrete outer cylinder with double cylinder with steel inner casing is advised to be shared by the two boilers of the project, the steel inner core of chimney of 7.2m in diameter and 275m in height. The flue gas emission point shall be 275 m above the plant grade level.

### 3.1.6 Project Activities

***Pre construction phase***

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

***Construction phase***

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

***Post construction***

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

### 3.1.7 Project Schedule

The project profile progress is preliminarily defined in combination with owner's requirements on project progress and by referring to Duration Quota of Power Construction Project:

#### 3.1.7.1 Initial preparation for construction of power plant

Feasibility research and review: Finish in June 2015

Backfill: Started at September 2015

EPC bidding: September 2015

Agreement and PPA closing date: December 2015

Financing closing date: September 2016

Qualified for water, electric, road, communication, gas and flat land: May 2017

Date for jetty with qualification of operation: end of 2017

#### 3.1.7.2 EPC schedule

Preliminary work for construction: 3 months

Foundational handling: 4 months

From main building start-up to #1 unit going into operation: 28months

Unit 1 going into operation to unit 2 going into operation: 2 months

This project is planned to be launched for construction in January 2016 and Unit 1 will be put into operation for power generation in December 2018 and Unit 2 in July 2019.

### 3.1.8 Resources and Utilities Demand

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

#### 3.1.8.1 Water for Construction

Total water consumption for construction is about 450t/h in this project, including 100t/h of the domestic water for construction and 350t/h water consumption for production use. The water is from nearby rivers through water intake pumps and a construction pool in $1000m^3$ is arranged in the construction site.

#### 3.1.8.2 Power supply for construction

On-peak power consumption in this project construction is about 5,600kW and the gross capacity of transformers to be provided is about 7,000kVA. Construction power supply is led from the transforming plant of Kalapara Upazila located on the west side of the factory, and two 10kV lines are erected to the construction site.

#### 3.1.8.3 Gas for construction

Oxygen: an oxygen generating station is arranged on site in a centralized supply way and used for providing oxygen to the boiler assembly yard, the turbine assembly yard, the processing and assembly yard, the main building and the electrical precipitation construction site through pipelines and oxygen tanks are used in other scattered and few construction sites.

Acetylene: the acetylene station is set up on site also in a centralized supply way for acetylene supply to the points requiring acetylene by pipelines.

Argon: it is provided in a decentralized way and is outsourcing bottled argon due to small amount required.

Compressed air: a traveling air compressor is used for offering compressed air by districts.

### 3.1.9 Sources of Primary Fuels (Quality and Country of Origin)

#### 3.1.9.1 Coal Sourcing

According to owner's planning, the coal for the proposed project will be imported from foreign countries through sea & river transportation, with Indonesia being the major source of coal supply. In the preliminary phase of this project, among the 37 type coal types supplied by Indonesia indo 6 was selected as the check coal.

Considering suggested coal specification, availability, cost of coal, cost of transportation and reliability to supply coal, judiciously it has been planned to import coal from Indonesia, under long term/short term agreement with coal producers and suppliers. In such case, good quality Bituminous/Sub-bituminous coal might be imported from Indonesia (GCV 4700 – 5500 kcal/kg AR basis).

Currently, the owner is negotiating with coal suppliers, and the coal supply agreement will be submitted subsequently.

**Coal supply in Indonesia**

Indonesia boasts abundant coal resources. According to the statistics of Indonesian Ministry of Energy and Mineral Resources taken in 2013, Indonesia boasts a total coal reserve of 58 billion tons, with proved reserves hitting 19.3 billion tons, including 5.4 billion tons of commercially workable reserves. Since the coal reserves have been proven in many regions, the Indonesian Government estimates that the gross coal reserve might exceed 90 billion tons. According to the statistics of US Department of Energy, Indonesia is the 4th largest country of coal reserves. The proven coal reserves are mainly distributed on Sumatra Island and Kalimantan Island, particularly in the middle and south of Sumatra Island (accounting for over 1/2 of the gross reserves nationwide).

99% of the coal mines in Indonesia are open-pit mines featuring favorable exploiting conditions. Of the gross reserves, anthracite coal accounts for 0.36%, bituminous coal 14.38%, sub-bituminous coal 26.63% and lignite coal 58.63%. The coal supplied by Indonesia is characterized by high moisture, low ash content, low sulfur content and high volatility. The sub-bituminous coal has a thermal value of 5700-7200 kcal/kg, with volatile constituent reaching 37%-42.15% and sulfur content reaching 0.1 %-0.85%. The lignite coal has a thermal value of 4345-5830 kcal/kg, with volatile constituent reaching 24.1%-48.8% and sulfur content reaching 0.1%-0.75%. According to regional distribution, of the gross coal reserves, South Sumatra contributes 39%, East Kalimantan contributes 30% and South Kalimantan contributes 13%. In addition, West Java, Sulawesi and West Irian also contribute a minor share.

According to regional distribution, of the gross coal reserves, South Sumatra contributes 39%, East Kalimantan contributes 30% and South Kalimantan contributes 13%. In addition, West Java, Sulawesi and West Irian also contribute a minor share.

Indonesia has two typical coalfields:

1. Ombilin coalfield. Covering a total area of 155 km2, this coalfield is located in the central mountainous area of Sumatra, with geological age falling into the tertiary period. The coal-bearing strata are represented by Eocene quartz-sand set, with thickness reaching 1000-1600m and containing three isolated 30m bituminous coal strata. The coal measure strata feature shallow occurrence, with coal-bed thickness being 2-10 meters. The coal has a moisture content of 7%, ash content of 1.5%, volatile constituent of 40% and thermal value of 6000-7000 kcal/kg, making it the high-rank coal produced in Indonesia.

2. Bukit Asam coalfield. This coalfield is located in the south of Sumatra, with geological age pertaining to the late tertiary period. The coal occurrence is a smooth syncline and a anticline with flattened middle. The 650m-thick coal seam features industrial coal-bearing properties, including a coal-bed with total thickness reaching 90 meters. These strata can be divided into three groups, all above 7000 kcal/kg. The coal-bearing strata mainly contain sub-bituminous coal and anthracite coal with high calorific value.

In recent years, the coal output and export of Indonesia went up year by year. According to the statistics of Indonesian Ministry of Energy and Mineral Resources, the coal output of Indonesia was 190 million tons, 216 million tons, 240 million tons, 256 million tons, 275 million tons and 353 million tons respectively from 2006 to 2011. In 2012, Indonesia produced 386 million tons of coal, 310 million tons of which were exported. The coal output of Indonesia has witnessed booming development in the past 20 years. Given the low domestic demand for coal (only about 20% of total output), 300 million tons of coal must be exported each year, well ensuring the supply of coal.

The coal mines of Indonesia are mainly distributed in coastal areas or inland drainage areas. Multiple ports have constructed the specialized wharfs for exporting coal. After the coal is transported by land from the coal mine to the storage yard or inland terminal depot, the coal will then be loaded onto the barge and transferred to the coal terminal or anchorage for loading onto the cargo ship, whose tonnage might reach 70,000 DWT.

Therefore, as a major coal supplier, Indonesia boasts stable thermal coal supply and robust logistics support.

### 3.1.9.2 Coal Quality

Considering the safety of surrounding ecosystem and public health & safety, the specification of the coal has been selected. The specification defined average sulfur content 0.47 %, maximum moisture content 13.57% and gross calorific value as 4700-5500Kcal/kg. Specification of the coal considered for this power plant is given in **Table 3-2**.

**Table 3-2: Coal quality analysis**

| Specification | Symbol | Unit | Check Coal (Indo 6) |
|---|---|---|---|
| **Calorific Value** | | | |
| Gross Calorific Value (AD) | GCV | Kcal/kg | 5550 |
| Gross Calorific Value (AR) | GCV | Kcal/kg | 4523 |
| **Element Analysis** | | | |
| Base carbon as received | Car | % | 46.59 |
| Base hydrogen as received | Har | % | 3.49 |
| Base oxygen as received | Oar | % | 14.43 |
| Base nitrogen as received | Nar | % | 0.84 |
| Base total sulfur as received | St, ar | % | 0.47 |
| Base ash content as received | A, ar | % | 4.68 |
| Total moisture as received | M,ar | % | 29.50 |
| **Total** | | **%** | **100** |
| **Technical analysis** | | | |
| Air-dried base moisture content | Mad | | 13.57 |
| Air-dried base volatile constituent | Vda | | 38.63 |
| **Base low heat value as received** | LHV, ar | MJ/kg | 17.408 |
| **Hardgrove grindability index** | HGI | | 48 |
| **Ash fusion temperature** | | | |
| Deformation temperature | DT | °C | 1210 |
| Softening temperature | ST | °C | 1310 |
| Flowing temperature | FT | °C | 1330 |
| **Ash component analysis** | | | |
| $SiO_2$ | - | % | 43 |
| $Al_2O_3$ | - | % | 23.1 |
| $Fe_2O_3$ | - | % | 9 |
| CaO | - | % | 9.5 |
| MgO | - | % | 3.58 |
| $Na_2O$ | - | % | 0.44 |
| $K_2O$ | - | % | 1.48 |
| $TiO_2$ | - | % | 0.96 |
| $Mn_3O_4$ | - | % | 0.12 |

| Specification | Symbol | Unit | Check Coal (Indo 6) |
|---|---|---|---|
| $SO_3$ | - | % | 7.95 |
| $P_2O_5$ | - | % | 0.86 |
| Other | - | % | 0.01 |
| BaO | - | % | - |

*Source: Feasibility report; Note: AD- Air Dried, AR- As Received*

#### 3.1.9.3 Presence of trace element and radioactivity in coal

In future, coal will keep its important position as aworld energy source because of its relatively abundant reserves in comparison to the decreasing reserves of both petroleum and natural gas. Practically all elements of the chemical periodic table are present in coal[1]. Trace element (TE) is defined as an element occurring in a very low amount (<100 ppm W). Presences of this small amount trace element in coal are again found to vary drastically with changes of mine and even within the same mine. The average quantities of trace element are expressed in **Table 3-3**.

**Table 3-3: Average quantity of trace element in the coal (Xu, M, *et, al*. 2003)**

| >50 ppm | 10-50 ppm | 1-10 ppm | <1 ppm |
|---|---|---|---|
| Barium (Ba) | Arsenic (As) | Beryllium (Be) | Mercury (Hg) |
| Fluorine (F) | Chromium (Cr) | Cadmium (Cd) | Silver (Ag) |
| Phosphorous (P) | Lead (Pb) | Iodine (I) | Selenium (Se) |
| Titanium (Ti) | Nickel (Ni) | Thorium (Th) | Tantalum (Ta) |
| Zinc (Zn) | Vanadium (V) | Uranium (U) | Potassium (K)-40 |

The radioactivity of all coals was found low compared to the earths crust and the natural radionuclides arising from the decay of uranium and thorium present in the coal were considered to be of minimal environmental concern. Coal contains radioactive elements (e.g. Thorium, Uranium and Potassium-40) as minor trace quantity. The radioactivity of ash products from power stations also showed similar to that of the earth's crust. **Table 3-4** has been presented the comparative emission of radioactivity from different sources. According to the USGS, the radioactive elements in coal and fly ash should not be sources of alarm as it is lower enriched in radioactive elements compared to soil or rocks.

**Table 3-4: Presence of radioactivity from different sources (ACARP, 2006)**

| Sources | Bq/kg |
|---|---|
| International Coal | 440 |
| Australian Coal | 370 |
| Coal Ash (laboratory prepared) | 1530 |
| Fly ash | 1680 |
| Bottom ash | 1410 |
| Earth's crust | 1430 |
| Common garden soil | 1480 |

Note: 1 Bq= 1 disintegration per second

[1] D.J.Swaine, F. Goodarzi, 1995. Environmental Aspects of Trace Elements in Coal, (M), Kluwer, Dordrecht

### 3.1.10 Transportation of Primary Fuel

According to the planning of Bangladesh, a coal storage base will be constructed on the opposite bank of plant site. Memorandum of Understanding (MoU) between BCPCL and Payra port authority is under process. However, considering the uncertainty of coal base, this section will only present a preliminary planning of coal transportation. The actual mode of coal transportation relies on the coal supply agreement and the coal transportation agreement.

#### 3.1.10.1 Characteristics of the proposed route

Since there is no adequate information about the hydrology and navigation channel of Rabnabad Channel, only preliminary estimates are provided herein for the route.

Map of waters outside Rabnabad Channel and harbor layout map are shown in **Figure 3-5** and **Figure 3-6**.

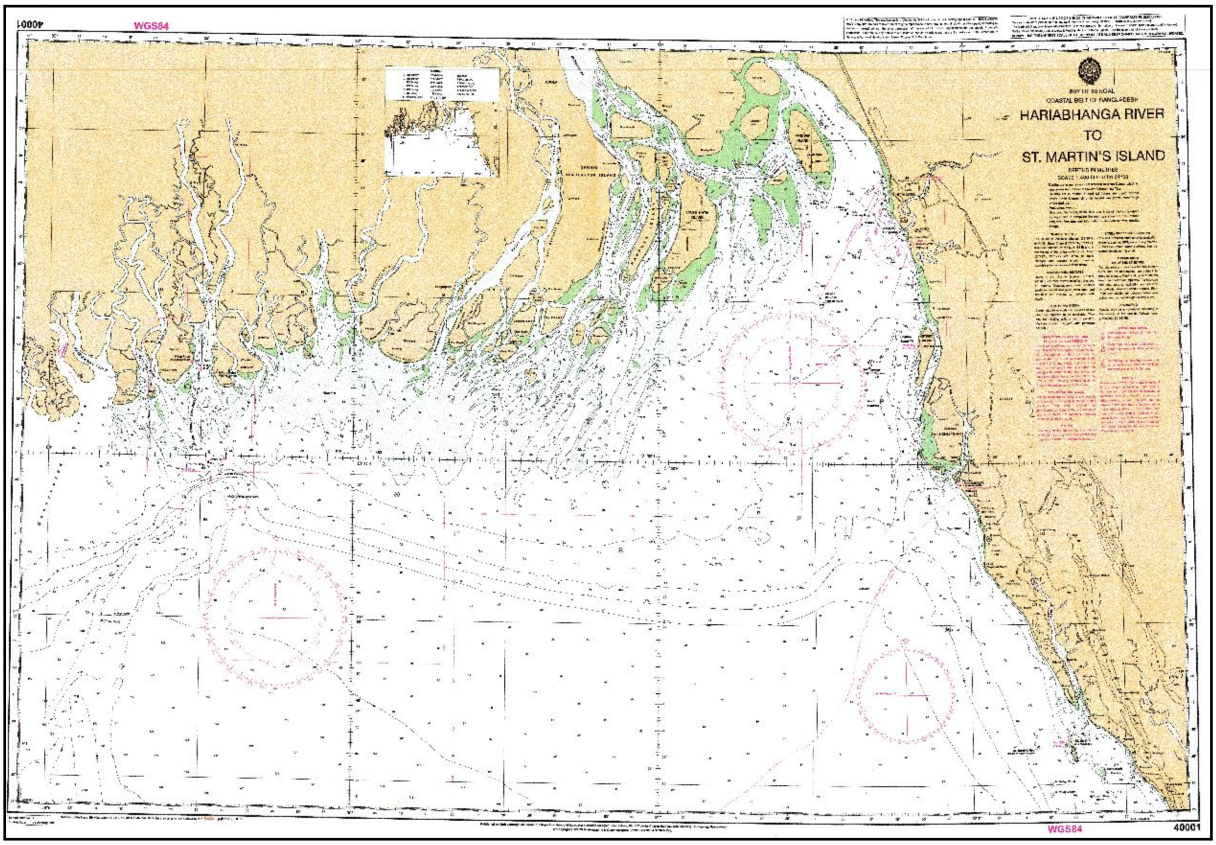



**Figure 3-5: Map of waters outside Rabnabad Channel**

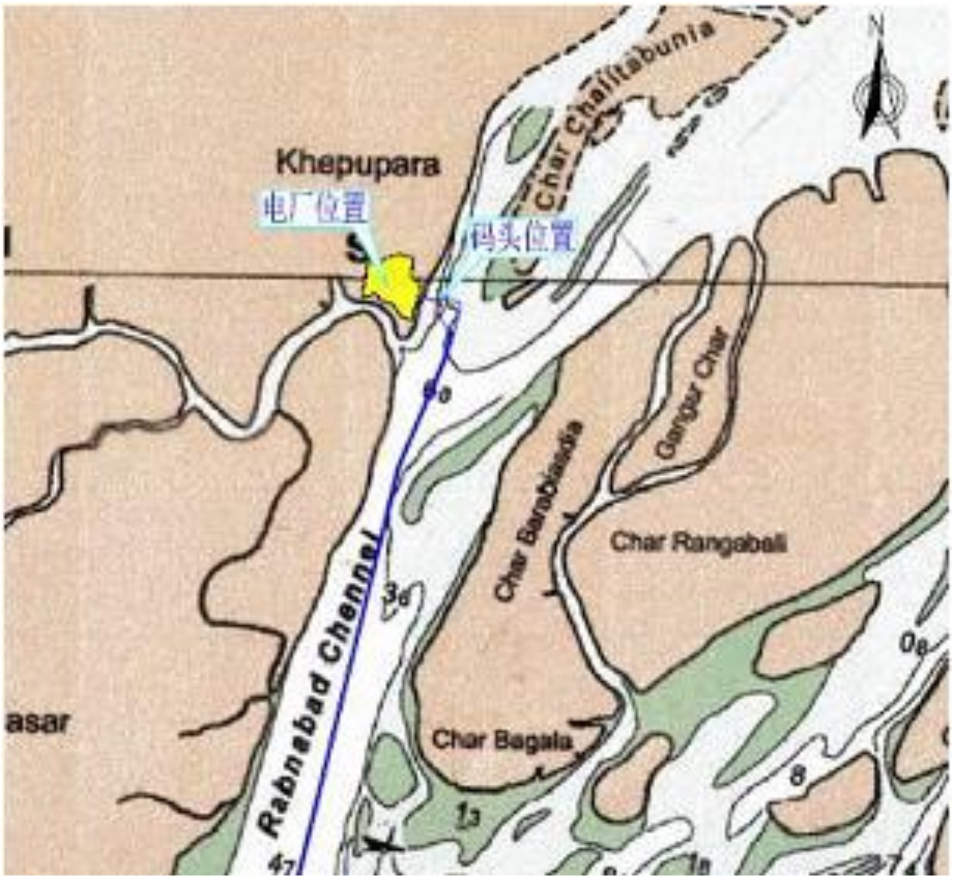



**Figure 3-6: Harbor layout map**

### 3.1.10.2 Transportation from coal mine to launching port

Means of coal transportation is assumed as:

Mother vessel loaded with coal at the Kalimantan Port of Indonesia > mother vessel transports the coal to the lightering anchorage on the waters where the plant site is located > the mother vessel transfers the coal to the barge > the barge transports the coal to the coal unloading wharf.

The coal haulage in Indonesia is dominated by water transportation. There are quite a number of rivers in Indonesia, and coal mines under exploitation are mostly located in inland drainage areas, coastal areas or adjacent areas which allow convenient shipping. The coal produced is generally transported from the coal mine to the storage yard or inland terminal depot through the dedicated route, before it's further transferred to the coal terminal or anchorage by the barge. After that, big vessels will then transport the coal to the port of departure.

Currently, Indonesia has 6 deepwater ports in Kalimantan, with yearly handling capacity reaching 268 million tons. These ports are capable of berthing 60,000-180,000-DWT cargo vessels. Sumatra also boasts outstanding coal transportation capacity. There are many offshore handling facilities specially designed for small-sized vessels.

It's recommended to transport coal from Indonesia to the lightering anchorage with a 70,000-80,000 DWT Panamax vessel (draught: 12 meters). The distance from the east side of Kalimantan to the deep-sea lightering anchorage is about 4900km. The speed of mother vessel is 13 knots/hour (23.4km/h).

The coal will be transferred from the mother vessel to the barge at the lightering anchorage. It's assumed that the mother vessel is equipped with coal handling facilities. If the mother vessel is not equipped with coal lightering facilities, the lightering barge must be leased. The 8000-DWT barge with draught reaching 4.5m shall be used. The net depth of the navigation channel must reach 6.5m. Certain parts of the river channel need dredging. The distance from the coal lightering anchorage to the power plant is about 60km. The transportation hours needed by the mother vessel and the barge are shown in **Table 3-5**. The arrangements of the mother vessels and the corresponding barges are shown in **Table 3-6** and **Table 3-7**.

**Table 3-5: Transportation hours of mother vessels and barges**

| Barge | Mother vessel 70000DWT | Barge 8000DWT |
|---|---|---|
| Distance from departure port to the lightering anchorage | 4900 Km | 60 km |
| Berthing, loading and leaving the port (hour) | 1x24 | 7 |
| Voyage (hour) | 9x24 | 5 |
| Dropping anchor, unloading and weighing anchor (hour) | 6x24 | 6 |
| Return trip (hour) | 9x24 | 5 |
| Bad weather (hour) | 1x24 | 1 |
| Total voyage (day) | 26 | 1 |

**Table 3-6: Arrangement of mother vessels**

| Imported coal | | Check coal (Indo 12) |
|---|---|---|
| Annual import volume | 10,000 tons | 430 |
| Sail schedule | Day | 26 |
| Yearly number of deliveries (365/26 times) | | 14 |
| Panamax | 1 year (vessel) | 2 |
| | Vessel type (10,000 tons) | 7 |
| | 1 year (vessel) | 2 |
| | Vessel type (10,000 tons) | 7.5 |
| Total yearly transport capacity/10,000 tons | | 406 |
| Remaining (transport capacity – demand)/10,000 tons | | -14 |

**Table 3-7: Arrangement of barges corresponding to each mother vessel**

| Mother vessel | | 70,000 DWT | 75,000 DWT |
|---|---|---|---|
| Coal lightering | 10,000 tons | 7 | 7.5 |
| Lightering schedule | Day | 1 | 1 |
| Number of deliveries per lightering schedule (6/1 times) | | 6 | 6 |
| Barge type | 1 year (barge) | 0 | 0 |
| | Barge type (10,000 tons) | 0.5 | 0.5 |
| | 1 year (barge) | 2 | 2 |
| | Barge type (10,000 tons) | 0.8 | 0.8 |
| Total yearly transport capacity/10,000 tons | | 9.6 | 9.6 |

| Mother vessel | 70,000 DWT | 75,000 DWT |
|---|---|---|
| Remaining (transport capacity – demand)/10,000 tons | 2.6 | 2.1 |

#### 3.1.10.3 Coal landing

According to the estimate of Section 3.1.10.2, it takes at least 27 days to transport coal from the loading wharf of Indonesia to Bangladesh the project is located. Assuming the suspension of shipment caused by typhoons would take 5 days and based on the availability of coal supply in Australia (needing additional 18-day sail schedule), it's recommended that the coal storage quantity at the coal yard shall allow 40 days coal consumption of the 2×660MW units.

The current-phase project will construct three 8000-DWT coal unloading berths, one 2000-DWT heavy cargo berth and the corresponding supporting facilities, with yearly design coal throughput reaching 3.74 million tons. The wharf will be located on the west side of Rabnabad Channel. The total length of berths will stretch 437 meters, and width of the wharf platform will reach 25 meters, and would be connected to the plant site via the 750m band conveyor.

Each coal unloading berth will be provided with two 16t gantry type grab ship unloaders, with track gauge reaching 10.5 meters. The coal arrived will be unloaded with the gantry type grab ship unloader, and the cabin will be cleared under the aid of a loader. The heavy cargo berth will be provided with a fixed crane (leased) to handle heavy cargos.

The coal unloading wharf will be installed with six gantry type grab ship unloaders, which will transfer the coal to the conveyor. Parameters of the belt conveyor: belt width B = 1400mm; belt speed V = 2.8m/s, capacity Q = 1750t/h.

#### 3.1.10.4 Ignition Fuel and Transportation

The boiler will be ignited with tiny oil (high speed diesel), which will be procured from the local petroleum authority and then transported to the plant with oil truck before it's unloaded into the oil tank via the unloading pump. The property of high speed diesel is shown **Table 3-8**.

**Table 3-8: Property of high speed diesel**

| Name | Unit | Data |
|---|---|---|
| Kinetic viscosity (°F) | cst | <9 |
| Flash point | °F | >95 |
| Pour point | °C | <6 |
| Ash (WT %) | % | <0.01 |
| Sulfur content (WT %) | % | ≤0.25 |

#### 3.1.10.5 Limestone Consumption and Transportation

The proposed project is located in Bangladesh, which boasts rich mineral resources such as natural gas, limestone, hard rock, coal, siliceous sand, argil, etc. Bangladesh has certain reserves of limestone, the exploitation of which requires a feasibility study in order to determine whether the limestone shall be purchased from local market or imported from neighboring countries. The limestone blocks to be used as the desulfurizer will be transported to the dry limestone shed via trucks, or transported to the wharf by cargo boat, then coal belt transported to the limestone yard. The desulfuration of 2×660MW units will require 144 tons/day of limestone, the storage quantity at dry limestone shed shall allow 30 days limestone consumption of the 2×660MW units. The investor must develop a plan to ensure the supply of limestone.

## 3.2 Prcess Description

### 3.2.1 Project Site

The proposed site is located in Dhankhali Union, Kalapara Upazila, Patuakhali District, Bangladesh. The site can be approached by having an access road from Kalapara in Dhaka-Kuakata road up to Londa boat terminal (kheya ghat). The existing road from Kalapara to Londa kheya ghat is bitumen paved and it is approximately 7 km. After crossing the Andermanik River at Londa Kheya ghat the Dhankhali site can be reached by an earth filled road. This distance is about 5 km. The proposed road will be 15 feet width excluding the slope. The proposed road is at the southern side of the project site and has been considered from Londa kheya ghat to the river (Rabnabad Channel). Following figures show the communication to the site by road from Amtali to Kuakata road through Kalapara Upazila town to the project site.

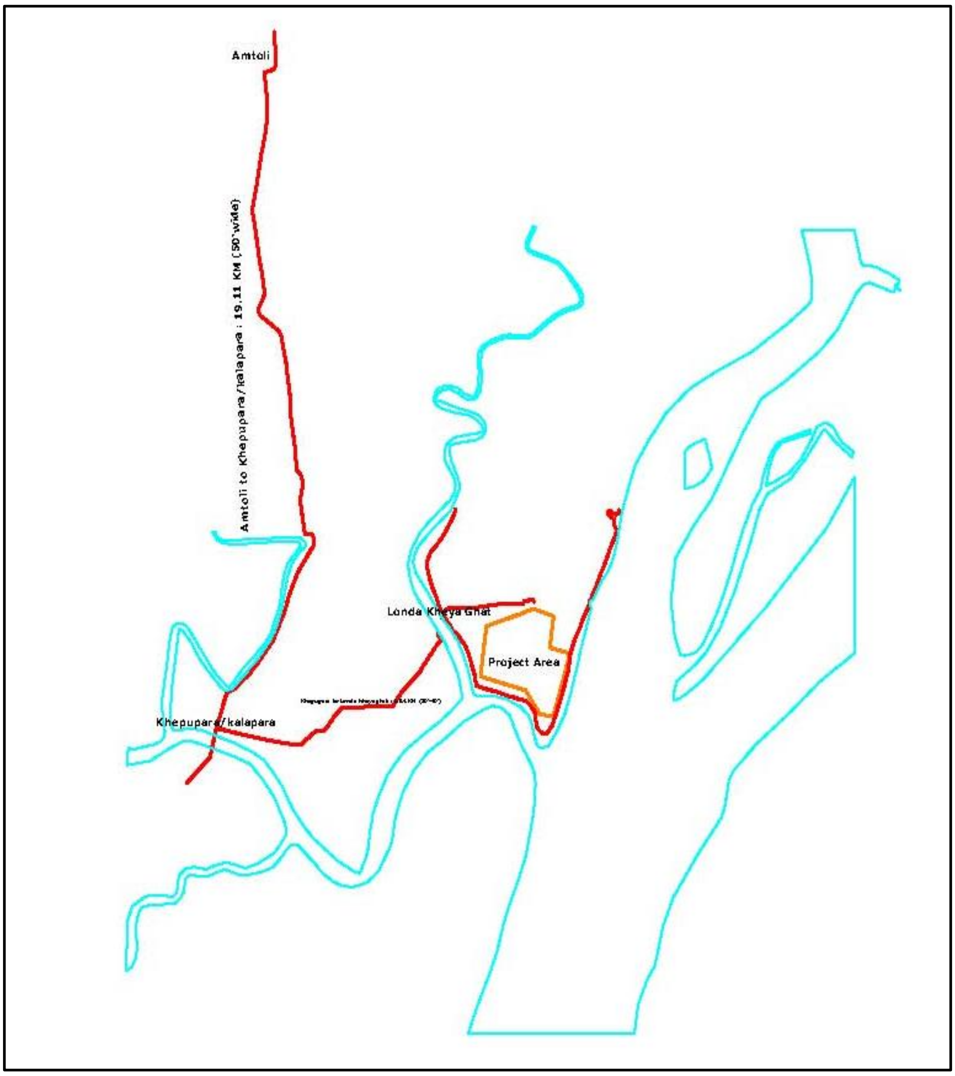



**Figure 3-7: Approach Road to the Site**

### 3.2.2 Project Layout

A general layout plan designed by the pre-feasibility study team is given in the **Annex-C**. The project is designed of 4x660MW ultra supercritical coal-fired power units in planning capacity, 2x660MW ultra supercritical coal-fired units in Phase I. The detail layout plan showing all structures, road network, drainage network, different pollution abatement measures, and water, waste water and effluent treatment facilities shall be developed by the EPC contractor before construction. The EPC contractor shall be appointed after receiving the Environmental Clearance Certificate from the DoE.

BCPCL shall submit the final layout planto DoE for their review and comments. Considerations of available land, landscape, ground features, elevation, and environmental and social concerns recommended by EIA study have been taken into account in developing the layout.

The plant is located to the west of Rabnabad Channel and the north of Andharmanik River in Dhanhali, Kalapara Upazila, Patuakhali. The overall planning of the plant site is designed as follows on the basis of the recommended plot plan:

**Plant position:** Row A of main building about 13º north by east. The plant is typically arranged in four lines with the switchgear yard, cooling tower area, main building and coal storage area from west to east in turn and the fixed end to the extended end from south to north.

**Freshwater source:** The power plant is planned to be supplied with the river water nearby as the freshwater required. The raw water lift pump is considered to be arranged in the circulation water pump house.

**Supply and discharge of cooling water:** The closed-circuit cooling system of cooling tower is used for the power plant cooling water.

**Outgoing lines:** According to the system planning, it will build double-circuit 400kV lines in Phase I with the transmission line corridor about 50m wide (double circuits on the same tower); the lines go west about 1.0 kilometers out from the plant and turn north access to the power grid of Bangladesh. It enjoys a wide line corridor.

**Coal supply:** The power plant requires 4.12 million tons coal (check coal) every year for Phase I (2x660MW), about 8.24 million tons coal (check coal) when the planned capacity (4x660MW) is reached. It uses the Indonesian coal by waterway transportation: the coal transported by 70,000-ton bulk vessel to the outer anchorage of Rabnabad Channel and then transferred by lighter to the power plant jetty for unloading; after coal unloading at the jetty, carried by band conveyor to the power plant. The coal jetty of the power plant is located in the water area on the southeast of the plant, which is planned to build one 2000-ton heavy cargo jetty and three 8000-ton coal jetty and reserve two 8000-ton coal jetty.

**Ash disposal yard:** The separated handling of ash and slag is planned to be used for the ash handling system, with the moisture-conditioned ash and slag carried by trunk to the ash storage yard for roller compaction and stockpile; the byproduct gypsum from FGD is also carried to the ash storage yard for stockpile. The dry ash yard is used in the low-lying area on the north side of the plant.

The plan is prepared in minimum area so as to reduce the quantity of filling by dredging. Gas Insulation Switchgear has been planned for switchyard orientation as a requirement for power evacuation. Permanent facilities like workshop, permanent stores, etc. are located close to the main plant. The ash slurry/ash water pump house is kept towards the chimney and Flue Gas Desulfurization (FGD) space is kept beyond the chimney. The intake/discharge ducts have been routed in the corridor between transformer yard and switchyard and location of CWPH is chosen, so as to minimize the length of CW ducts. Considering the soil condition induced Draft Cooling Towers are proposed and located considering the safe distance from the Main Plant and Switchyard. The water treatment plant and the DM water facilities are located close to the main plant. The coal is assumed to come from the nearest port and direct coal conveyor is assumed from the port to the plant.

Adequate space has been kept in the layout plan for lay-down and pre-assembling activities of open stores, contractor's offices and stores etc. Construction offices and storage sheds area located close to the main approach road to the plant. Administrative building is proposed to be located outside the plant boundary near the main approach road. The following major componentshave been included in the layout plan:

A: Industrial (plant area)

1. Main power plant (boiler, turbine, Generator, Workshop Store, etc)
2. Electrostatic Precipitator, Flue Gas Desulfurization (FGD) as required, and Chimney
3. Induced Draft Cooling Tower
4. Greenbelt and open space
5. Open air sub-station and network control room
6. Water treatment, sewerage treatment plant and sewerage channel
7. Coal terminal including jetty & coal conveyer belt
8. Ash handling control room, ash silo, ash disposal area
9. Coal shade (open & covered)
10. Embankment along the river side, internal road, khal, footpath, park, lake, school, hospital, mosque, lay-down area, area for safety length of structure to structure

B: Township

11. Residential buildings, school, mosque, play ground, community hall, rest house, dormitory, health center, club, etc.
12. Administrative building, auditorium and parking area including cafeteria & social building

### 3.2.3 Land Requirement

Adequate land is available within the identified boundary, for the proposed 1320 MW power plant and its infrastructure. Total land of about 982.77 acres will be planned for 1320 MW and its infrastructure (**Table 3-9**).

**Table 3-9: Detail land requirements for the proposed project and future extension**

| Sl. | Detail Description | Phase I($hm^2$) | Planning ($hm^2$) |
|---|---|---|---|
| 1. | ETP and WTP | 0.60 | 0.60 |
| 2. | Land area of construction production area | 17.00 | 17.00 |
| 3. | Material storage building | 0.15 | 0.15 |
| 4. | Overhaul workshop | 0.15 | 0.15 |
| 5. | 400kV switchgear yard （GIS） | 1.70 | 3.00 |
| 6. | S.T.G building | 0.56 | 1.12 |
| 7. | De-aeration room | 0.16 | 0.32 |
| 8. | Bunker bay | 0.25 | 0.50 |
| 9. | Boiler envelope | 0.60 | 1.20 |
| 10. | Central control building | 0.15 | 0.15 |
| 11. | Electrostatic Precipitator (ESP) | 0.30 | 0.60 |
| 12. | Slurring area | 0.04 | 0.04 |
| 13. | Absorber slurry circulation pump house | 0.06 | 0.12 |
| 14. | FGD building | 0.08 | 0.16 |
| 15. | Coal handing building | 0.08 | 0.08 |
| 16. | Canteen | 0.02 | 0.02 |

| Sl. | Detail Description | Phase I($hm^2$) | Planning ($hm^2$) |
|---|---|---|---|
| 17. | Startup boiler house | 0.06 | 0.06 |
| 18. | Coal settlement pond | 3.44 | 6.88 |
| 19. | IDCT | 0.60 | 1.20 |
| 20. | Supplementary water pump house | 0.03 | 0.05 |
| 21. | Ash pond | 98.80 | 195.00 |
| 22. | Oil storage area | 0.04 | 0.04 |
| 23. | Dry limestone shed | 0.14 | 0.14 |
| 24. | Hydrogen generation station area | 0.22 | 0.22 |
| 25. | C.W pump house | 0.08 | 0.16 |
| 26. | Water supply station area | 1.60 | 1.60 |
| 27. | Ash yard comprehensive building | 0.05 | 0.05 |
| 28. | office | 0.12 | 0.12 |
| 29. | Guest house | 0.12 | 0.12 |
| 30. | Fire fighting garage | 0.08 | 0.08 |
| 31. | Jetty area | 11.00 | 16.30 |
| 32. | Land area of construction living area | 4.50 | 4.50 |
| 33. | Owner residential area | 27.60 | 27.60 |
| 34. | Staff residential area | 40.40 | 40.40 |
| 35. | Internal Road | 8.70 | 8.70 |
| 36. | Embankment area | 45.14 | 45.14 |
| 37. | Green belt area | 23.60 | 23.60 |
| **Total in $hm^2$** | | **288.76** | **397.86** |
| **Total in acres** | | **713.28** | **982.77** |

*Source: Feasibility Study Report, BCPCL 2015*

### 3.2.4 Fuel Requirement

The main fuel to be used for generating electricity will be coal. Based on estimation of Feasibility Study, the hourly coal requirement for generation of 1320 MW power by operating two units of 660 MW each shall be 633.2 tons. It stands requirements of 15,197 tons daily and 4.11 million tons annually.

**Note:** Hourly coal consumption of the boiler refers to the hourly coal consumption under BMCR working condition

The daily coal consumption of boiler is based on 24-hour operation per day of the boiler.

The yearly coal consumption of boiler is based on 6500-hour operation per year of the boiler.

### 3.2.5 Requirement of Water

Water will be required for seam generation, condenser cooling, coal management, ash handling and disposal and domestic purposes.

#### 3.2.5.1 Source of water

The source of the water for the project is Andhamanik River. Andhamanik River has salinity and sediment load. The water will be used for cooling purpose, coal handling, ash handling, potable water, plant service and cycle makeup (DM water) etc.

#### 3.2.5.2 Circulating cooling water demand

The circulating cooling water demand is given in **Table 3-10**.

**Table 3-10: Circulating Cooling Water Quantity**

| Period | Unit Capacity (MW) | Condensed Steam Quantity (t/h) | Condenser Cooling Water Qty. ($m^3/h$) | Auxiliary Machine Cooling Water Qty. ($m^3/h$) | Circulating Water Qty. ($m^3/h$) |
|---|---|---|---|---|---|
| Phase I | 1x660 | 1157 | 63635 | 3600 | 67235 |
| | 2x660 | 2314 | 127270 | 7200 | 134470 |

According to international practice, a 110% capacity of CW pump shall be adopted. Hence, the exact intaking water flow shall be **147917** $m^3/h$ (**41.09** $m^3/s$) for Phase I.

#### 3.2.5.3 Make up water for circulating cooling water system

Make up water for cooling water system for the proposed 2x660 MW power plant is given in **Table 3-11**.

**Table 3-11: Make up water for circulating cooling water system**

| Sl. | Item | Water Demand ($m^3/h$) | Relaimed Water ($m^3/h$) | Consumed Water ($m^3/h$) | Remarks |
|---|---|---|---|---|---|
| 1. | Evaporated loss | 1973 | 0 | 1973 | |
| 2. | Drift loss | 15 | 0 | 15 | |
| 3. | Blow down | 1958 | 0 | 1958 | Drainage to river |
| 4. | Self consume | 58 | 58 | 0 | To sludge system |
| 5. | Sludge treatment system | 58 | 0 | 58 | 0.5 self consume 57.5 (treated water) drainage to river |
| 6. | Total | 4062 | 58 | 4004 | |

#### 3.2.5.4 Fresh water demand

Fresh water make-up of current engineering is given in **Table 3-12** as follows.

**Table 3-12: Fresh water quantity**

| No. | Item | Water Demand ($m^3/h$) | Reclaimed Water ($m^3/h$) | Consumed Water ($m^3/h$) | Remarks |
|---|---|---|---|---|---|
| 1. | Desulfurization equipment cooling water | 40 | 40 | 0 | Water used for desulfurizing process |
| 2. | Circulating pump room cooling make-up water | 1.2 | 0 | 1.2 | |
| 3. | Ash/slag damping water | 10 | 0 | 10 | |
| 4. | Main power building service water | 3 | 2.5 | 0.5 | Returned to industrial wastewater treatment station |
| 5. | Boiler feedwater treatment system make-up wate | 83.1 | 24.2 | 58.9 | Returned to industrial waste water treatment station and reusing water pool |

| No. | Item | Water Demand ($m^3/h$) | Reclaimed Water ($m^3/h$) | Consumed Water ($m^3/h$) | Remarks |
|---|---|---|---|---|---|
| 6. | Water for wharf area | 9 | 0 | 9 | |
| 7. | Water for dust precipitation and washing of wharf | 28.3 | 24 | 4.3 | Reclaimed to water reuse system |
| 8. | Ash yard sprinkle water | 20 | 0 | 20 | |
| | | (0) | (0) | (0) | (monsoon) |
| 9. | Water for desulfurizing process | 250 | 20 | 230 | As ash yard sprinkle water |
| | | (250) | (0) | (250) | (monsoon, 20 drainage to storm system) |
| 10. | Coal yard spraying water | 18.8 | 0 | 18.8 | |
| | | (12.6) | (0) | (12.6) | (monsoon) |
| 11. | Water for coal handling system | 36.5 | 23 | 13.5 | Reclaimed to water reuse system |
| 12. | Water for dust precipitation during coal handling | 8.5 | 5.4 | 3.1 | Reclaimed to water reuse system |
| 13. | Water for Slag disposal system | 12 | 6 | 6 | Reclaimed to water reuse system |
| 14. | Water for self use in water treatment plant | 40 | 40 | 0 | Returned to industrial waste water treatment station and reusing water pool |
| 15. | Domestic water | 5 | 4 | 1 | Reclaimed and be used for landscaping and road spray |
| | | (5) | (0) | (5) | (monsoon,4 drainage to storm system) |
| 16. | Water for landscaping and road spray | 4 | 0 | 4 | |
| | | (0) | (0) | (0) | (monsoon) |
| 17. | Unforseen water | 40 | 0 | 40 | |
| 18. | Total | 609.4 | 189.1 | 420.3 | |
| | | 579.2 | 165.1 | 414.1 | (monsoon) |

*Note: Data in bracket is water quantity for monsoon.*

### 3.2.6 Technology Selection and Process Description

#### 3.2.6.1 Technical conditions of Boiler

The major technical conditions of boiler for this project are summarized as follows:

1) It is the 660MW ultra-supercritical once-through boiler of variable-pressure operation, single reheat, tangential firing or opposite wall firing, balanced draft, outdoor arrangement, dry ash extraction, all-steel suspension structure.

2) The main steam and reheat steam pressures and temperatures should completely meet the parameters of steam turbine. The outlet steam parameter is temporarily determined as 27.56MPa (a) /605/602℃. The boiler maximum continuous rating (B-MCR) corresponds to the working condition of steam turbine VWO (valves wide open), which is determined in the public bidding.
3) The minimum once-through load of the boiler should not be bigger than 30%BMCR and the waterwall type should be recommended by the maker based on its own characteristics, with the technology mature and reliable and the technical supporter having operational performance.
4) The tiny-oil / low-oil ignition is adopted with the high-energy spark ignition device reserved. With no oil supporting, the minimum load for steady combustion should not be bigger than 30%BMCR (design coal and check coal) and the boiler should maintain long-term steady operation.
5) The pipes of superheater and reheater require high heat resistance, i.e. high creeping strength and endurance strength at high temperature, and should have fine high-temperature corrosion resistance on the fume side, fly ash erosion performance and high-temperature oxidation resistance on the steam side, which should be selected by the manufacturer based on the conditions and characteristics of the project.
6) The combustion technology of low NOx is used with the boiler load at the working condition of BRL as follows: the NOx emission per hour at the air pre-heater outlet should not exceed 350mg/Nm3 (converted to the oxygen content of 6%, dry state).
7) It reserves the interface for denitration device and, in the design of boiler steel frame, should take the layout space and load of denitration device into consideration.
8) The boiler should have reliable measures to prevent the waterfall, burner nozzle and radiation superheater from coking.
9) The boiler has base load as well as the ability of variable load operation at 35%～100%BRL load.
10) The boiler has strong load adaptability; the power unit with the RB (runback) function can bear the abrupt change of 50% rated load and remain steady operation and, at the abrupt change of 100% load, the power unit should ensure the boiler safe.
11) The boiler should run in the mode of constant-variable-constant pressure or constant-variable pressure and could meet the steam turbine determined in operation mode and startup curve.
12) When the high pressure heater is removed, the boiler should meet the feed steam parameter of the steam turbine at rated load.
13) The coal-pulverizing system uses the direct-firing pulverizing system of medium-speed cold primary air fan. At the load of 90% BMCR～BMCR, while using the design coal, the ensured thermal efficiency should be greater than 94% (low heat value). The acceptance test for boiler thermal efficiency should be measured and calculated as per ASME PTC4.1.
14) The boiler has no air heater but with the secondary air hot air recirculation system. The tail heating surface of the boiler should be designed with effective and reliable measures to prevent low-temperature erosion.
15) Life requirements of the boiler: The main pressure parts should have the designed life not less than 30 years; the heated elements of air pre-heater should have the service life greater than 50,000 hours; the nozzle of spray type desuperheater should have the service life greater than 80,000 hours.
16) The rotary tri-sectional air preheater is used with the dry process electrostatic coating for the ceramic elements of heat transfer at the cooling stage; the air leakage rate of air pre-heater in the

acceptance test should be less than 6% and 6.5% within one year and after one year respectively after the boiler put into service.

17) The flame check and cooling air instrument control system and the boiler pipe leakage detection device should be purchased separately and the soot blowing should be included in the scope of DCS monitoring. The selection and configuration of FSSS (Furnace Safety Supervision System) cast house instrument control equipments, instruments and actuators supplied by the boiler manufacturer should meet the integrated automation level of the whole plant and the interface requirements.
18) The design pressure of the furnace is temporarily determined as ±6.5kPa and the furnace transient design pressure is ±9.8kPa.

### 3.2.6.2 Technical conditions of steam turbine

The major technical conditions of steam turbine for this project are summarized as follows:

1) Steam turbine type: ultra-supercritical, single reheat, four-cylinder or three-cylinder four-exhaust, single axle, double back pressure, condensing, 8-stage bleed back
2) Rated steam parameter (turbine inlet): 26.25MPa(a)/600/600℃ (temporarily)
3) Mean back pressure of the steam turbine: 8.0kPa(a) (temporarily)
4) Final feed temperature: 298.2±5℃
5) Longitudinal arrangement of turbo-unit: from the steam turbine to the generator, the lubricating oil system on the right
6) Rated speed: 3000r/min; the turbo-unit should realize continuous and steady operation in the cycle of 48.5~51.0Hz.
7) Direction of rotation (from the steam turbine to the generator): clockwise or counterclockwise
8) Unit power: The steam turbine should ensure the power unit has the power of 660MW at the working condition of turbine rated load (TRL) with the mean back pressure of 11.8kPa(a) (temporarily); the steam turbine should ensure the power unit reaches the maximum continuous power value at the working condition of TMCR.
9) The net heat rate of turbo-unit at the working condition of turbine heat acceptance should not exceed 7522kJ/kW.h (temporarily) with the positive deviation of zero. The thermodynamic performance acceptance of turbine should be measured and calculated as per ASME PTC6.
10) While the steam turbine run at all working conditions of steady operation (rated speed), the relative vibration value of double-amplitude (in horizontal and vertical directions) measured at any journal should not be greater than 0.05mm; the vibration limit value of the bearing bracket should not be greater than 0.025mm; the allowable relative vibration value of double-amplitude measured at any journal should not be greater than 0.15mm when the rotor system allowable value passes through critical speed; and the vibration value of the bearing bracket should not be greater than 0.075mm.
11) The power unit should have certain variable load with the load change as follows: 50～100%TMCR, not less than 5%TMCR/min; 30～50%TMCR, not less than 3%TMCR/ min; below 30%TMCR, not less than 2%TMCR/min; at the load stage, 10%TMCR/min.
12) The max noise value measured at the supposed plane 1.0m to the turbine casing and 1.2m above the turbine operating floor should not be greater than 85dB(A); for the other auxiliary machines, the max noise value should not be greater than 85dB(A).

13) The turbine bypass systems of this project only consider the startup function. To simplify the startup bypass, the turbine works should specify the bypass capacity, parameters, control mode and matching with operation of the power unit according to the startup mode of the turbine.
14) The turbo-unit should ensure the rated power output when the high pressure heaters all shut down and all the other conditions are identical with the working condition of THA, except that some reheating systems could not work properly and the air inflow is different.
15) The steam turbine has base load as well as the ability of variable load operation at 35%～100%TMCR load.
16) The steam turbine should run in the mode of constant-variable-constant pressure or constant-variable pressure.
17) The steam turbine has strong load adaptability; the power unit with the RB (runback) function can bear the abrupt change of 50% rated load and remain steady operation and, at the abrupt change of 100% load, the power unit should ensure the turbine safe.
18) The steam turbine should allow no-load running and the allowable continuous running duration should meet the requirement for generator testing.
19) The digital electro-hydraulic control system (DEH), emergency trip system (ETS) and turbine supervisory instrument (TSI) are supplied by the turbine manufacturer. DEH and ETS software and hardware should be integrated with the power unit DCS to the greatest extent, or else, should reserve the bidirectional redundancy communication interface with the power unit. The selection and configuration of instrument control equipments supplied by the turbine manufacturer, such as the instruments and actuators, should meet the integrated automation level of the whole plant and the interface requirements.

#### 3.2.6.3 Technical conditions of generator

The turbonator capacity of three key turbonator plants in China could all match with the working conditions of the steam turbine. At rated power, the turbonators of three key turbonator groups could all run for long at cosφ=0.95 (leading).

The excitation systems recommended by the three turbonators in China are mainly self-excited static excitation system. It is also used by most 660MW power units in China and elsewhere, which is mature in technology, has high reliability and can realize high startup rapid reaction with short shafting and good mechanical stability. The excitation devices in complete are all imported. The generator of Shanghai Electric forms a complete set with that of Siemens, ABB or Mitsubishi; the one of DTC can form a complete set with that of ABB or GE and the one of Harbin Electric can do so with that of ABB and GE. In terms of parameters, the excitation systems of all could meet the output requirement of 660MW generator.

The major technical conditions of turbonator for this project are summarized as follows:

1) The generator and steam turbine should coordinate with each other in capacity selection. At rated power factor and rated hydrogen pressure, the rated capacity of generator should match with the rated output of steam turbine; the maximum continuous capacity of generator should match with the maximum continuous rating of steam turbine; the maximum output of generator could meet the working condition of VWO and the cooler inlet water temperature should agree with the cooling water temperature of the steam turbine at corresponding working conditions and meet the requirements stipulated in relevant codes and standards.

2) The generator should be totally enclosed and non-salient pole triphase synchro generator of high efficiency with one-piece frame.
3) Rating values: rated power 660MW; rated capacity ≥733MVA; maximum continuous rating ≥726MW (temporarily); rated voltage 20kV; rated power factor 0.9 (lagging); rated frequency 50Hz; rated speed 3000r／min; insulation class of stator winding F (Note: used at Class B insulation temperature); insulation class of rotor winding F (Note: used at Class B insulation temperature); insulation class of stator core F (Note: used at Class B insulation temperature); short-circuit ratio not less than 0.5; efficiency ≥98.8%.
4) At all working conditions and the power factors of 0.9 (lagging) and 0.95 (leading), the voltage variation range of rating ±5% and frequency variation range of rating ±2%, the generator should realize continuous rated capacity output. With the pilot frequency operation characteristics, the turbo-unit should realize continuous and steady operation in the cycle of 48.5～51.0Hz.
5) The generator could realize long term and continuous operation at the rated load and the power factor of 0.95(leading).
6) The motor excitation system is self-excited static excitation system or brushless excitation system.
7) The generator should have the variable load operation ability. For this reason, the generator should have the measures to ensure no distortion and damage for 10,000 start-stops.
8) Type of cooling: water-hydrogen cooling, i.e. internal water cooling for stator winding and hydrogen cooling for rotor winding and stator core.
9) The generator detecting elements and the instrument and control equipments of the hydrogen, oil and water systems are supplied by the power plant, the selection and configuration should agree with the automation level of the whole plant.

## 3.2.7 Description of Major Systems

### 3.2.7.1 Main steam, reheat steam and bypass systems

The main steam and high and low temperature steam systems adopt the unit system, the main steam pipe and reheat steam pipe leading out from the both sides of the outlet header of superheater and reheater respectively and the four branch pipes combined into two tubes and connected in front of the boiler to the steam turbine in parallel and then in two tubes to the main steam stop valve and reheat stop valve on left and right sides of the high pressure cylinder and the intermediate pressure cylinder. The cold reheat steam pipe leads out from the two air outlets of the high pressure cylinder and are combined into a main tube at the handpiece and then divides into two branch pipes in front of the boiler and connected respectively into the inlet header of the reheaters. In this way, it could reduce the deviation of steam temperature and pressure caused by heat deviation and piping layout difference on both sides of the boiler, contribute to safe operation of the boiler and save the pipe investment by selecting proper pipe specification.

The superheater has temporary blind at the outlet pipe for hydraulic test; the reheater has the isolating device at the inlet and outlet pipes for hydraulic test; and the side pipe system allows the isolation hydraulic test.

The power unit has the 2-stage serial turbine bypass system with the temporary design capacity of 60% and the final capacity to be determined on the basis of types, structure, performance and startup mode of the steam turbine and boiler. The capacity should meet the requirement for unit startup and provide station service when the unit is isolated plant.

#### 3.2.7.2 Steam extraction system

The power unit adopts 8-stage non-regulated extraction steam (including high pressure cylinder exhaust). The 1-stage, 2-stage and 3-stage steam extraction supply the three high pressure heaters respectively; the 4-stage steam extraction supply the deaerator, boiler feed pump turbine and auxiliary steam system; the 5-stage, 6-stage, 7-stage and 8-stage steam extraction supply the four low pressure heaters respectively.

To prevent turbine overspeeding, except for the extraction pipes of the last two stages, the rest all have positive-closing automatic check valve (pneumatic control).

The turbine steam extraction at all stages, except for that of the last two stages, all have dynamoelectric isolation valve with the function of quick closing as the main means for anti-water protection.

The steam extraction of the last two stages is designed with no valves since the heater is located at the condenser throat, with the four 7-stage extraction pipes and four 8-stage extraction pipes all arranged inside the condenser.

As required of ASME TDP-1, draining points should be arranged before and after the dynamoelectric isolation valve of the extraction pipes of all stages as well as the lowest point of the pipes to ensure no hydrops in the system when the power unit starts up or shuts down and the heater goes wrong.

The high pressure heater of each stage all adopts the 100% capacity heater; the deaerator is a 100% capacity heater with the low pressure heater at 5-, 6-, 7- and 8-stage all of 100% capacity.

#### 3.2.7.3 Water supply system

The system has two 50% capacity steam feed pump and one 25~30% electrically driven feed pump for startup and stand-by. Each steam feed pump is configured with a fore pump. The electrically driven feed pump adopts the adjustable speed pump and is equipped with a fore pump, which is driven by the identical motor with the main pump. The two steam feed pumps are used for regular service and the electrically driven feed pump is not only for the requirement of power unit startup, but also for backup. Three high pressure heaters adopt big by-pass (BP) system.

The water supply system also supplies high pressure desuperheating water.

#### 3.2.7.4 Condensation system

The condensation system adopts intermediate pressure condensate polishing system with no condensate booster pump: it is a simple system. The condensation water in the condenser hot well after boosting in the condensate pump, enters into the deaerator through the intermediate pressure condensate polishing unit, the gland steam cooler and the 4-stage low pressure heater. The system adopts 2*100% capacity condensate pumps, one for operation and one for backup.

The system is equipped with a full capacity gland steam cooler, four full capacity surface low pressure heater and one deaerator.

#### 3.2.7.5 Circulating cooling water system in plant

This project adopts the secondary cycle cooling water system for the condenser cooling water with condenser sponge ball cleaning device for the water inlet pipe to clean the condenser tube at regular intervals.

The secondary cycle cooling water system waters from the circulating water inlet pipe, which is divided into two paths based on the different water supply pressures required by the water treatment equipments, one directly to the vacuum pump heat exchanger without boosting with the backwater to the return pipe for circulating water; the other to the closed-circuit cooling water heat exchanger after boosting through the water filter and booster pump with the backwater to the return pipe for circulating water.

#### 3.2.7.6 Closed-circuit cooling water system

Except that the closed cooling water heat exchanger, water ring vacuum pump cooler use the secondary cooling water system for circulating water cooling, all the rest equipments use closed-circuit cooling water, which could not only reduce the pollution and erosion to the equipments and make the equipments have higher heat transfer efficiency, but also prevent channel blockage, improve the operation safety and reliability of the main and auxiliary equipments and greatly reduce the workload of equipment maintenance. The system has two closed-circuit cooling water pumps of 100% capacity (one for service and one for backup) and the water-water heat exchanger of 2*65% capacity.

#### 3.2.7.7 Vacuum-pumping system

At the startup beginning, this system is used to pump the air from the steam turbine, the space on the steam side of the steam condenser, auxiliary pipelines and equipments to meet the requirements for turbine startup; in regular service, it is used to exhaust the non-condensable gas accumulated in the air area of the steam condenser.

Three sets of water ring vacuum pump of 50% capacity are equipped for the vacuum-pumping system on the condenser steam side. The vacuum pump is connected to the steam condenser. In regular service, two vacuum pumps work and one vacuum pump back up; at the power unit startup, three vacuum pumps all works to shorten the startup time.

Furthermore, there are also many auxiliary systems supporting the power unit, e.g. gland seal drain and vent system, boiler drain system, service water system, compressed air system, turbine lube oi1 system and so on.

#### 3.2.7.8 Coal-pulverizing system

The design coal for this project is brown coal with Vdaf=49.03%, HGI=42 and Ke=0.95, which catches fire and burns out easily, clinkers easily and has weak wearability. Therefore, it uses the positive pressure direct-firing pulverizing system of medium-speed cold primary air fan. This system is simple in structure, compact in layout and quick to start and stop, enjoys variable load shaving performance, low electricity consumption in operation and good explosion protection. The boiler is equipped with six steel buckets of corrosion resistant plate lining. The coal storage of five buckets could meet 8~9 hours combustion of the design coal at the BMCR load (maximum continuous rating).

Each boiler has six medium-speed pulverizers, six electronic weighting belt coal feeders and two axial primary air fans. The seal air for the coal pulverizer comes from the cold primary air pipe with two centrifugal seal fans, one for service and one for backup. Among them, the gross output of five coal pulverizers, based on the design coal, could meet the requirement of maximum continuous rating with 10% allowance left. The coal feeder output is considered as 110% of the maximum design output of the coal pulverizer.

Two adjustable blade axial-flow cold primary air fans of 50% capacity are used for the system to pump cold air from the atmosphere.

### 3.2.7.9 Air-flue gas system

The air-flue gas system uses balanced draft, meeting the requirements for blowing rate and exhaust flue gas while burning the design coal from the startup to the maximum continuous rating (BMCR) and meeting the requirements for burning the check coal.

Each boiler is equipped with two adjustable blade axial-flow air feeders of 50% capacity.According to the coal analysis, outlet gas temperature and local meteorological condition, not set hot air recirculating pipe after calculating.

Each boiler is equipped with two tri-sectional rotary air pre-heaters of 50% capacity with the influence of denitration taken into account.

Flue gas system: This system is to extract the flue gas from the furnace and discharge into the atmosphere through the tail heating surface, air pre-heater, electrostatic precipitator, desulfuration absorption tower and chimney. This project has desulfuration bypass for the flue gas. When the desulfuration system breaks down, the flue gas is discharged directly through the chimney but not the absorption tower. Behind the precipitator is two adjustable static blade axial flow fan of 50% capacity. There is connection pipe at the precipitator inlet channel. According to environmental requirements, the electrostatic precipitator efficiency of this project should be ≥99%, with the double-chamber four-field electrostatic precipitator used, two for each boiler.

The flue gas denitration device is reserved with the desulfuration system constructed synchronously with the main works. It uses the limestone wet desulfurization system, one adjustable static blade axial-flow booster fan of 100% capacity for each boiler.

To meet the requirement of one boiler working and the other for chimney and desulfuration flue repair and maintenance, a reinforced concrete outer cylinder with double cylinder with steel inner casing is advised to be shared by the two boilers of the project, the steel inner core of chimney of φ7.2m in diameter and 275m in height.

### 3.2.7.10 Fuel oil system

This project uses light diesel oil for the ignition and combustion supporting, with the oil supplied by tank-car, arranged with 2*500$m^3$ oil tanks and corresponding unloading pump, oil feed pump, effluent oil pump and oil strainer as well. The scheme of main burner with the function of tiny-oil / low-oil ignition is adopted, with the high-energy spark ignition device for backup.

### 3.2.7.11 400kV system connection

In this phase, there are double-circuit outgoing lines, double-circuit main transformer incoming lines, single-circuit high voltage startup/standby transformer for the 400kV power distribution unit, five circuits outgoing or incoming lines in all. In the long term, it will increase six-circuit 400kV outgoing lines, double-circuit main transformer incoming lines and single-circuit high voltage startup standby transformer incoming line. Then, there will be fourteen circuits outgoing or incoming lines in all. Since there are so many incoming and outgoing lines for this project and it is related to the feeding out of four 660MW power units, as the important power supply in Bangladesh, this power plant adopts one and a half breaker connection for the 400kV system of this project. Each outgoing line will be with a set of shunt reactor, the final scheme shall following the approved power plant access system solutions.

#### 3.2.7.12 Auxialiary electrical system

Principle of Auxialiary electrical system: one high voltage house service operating transformer for #1 and #2 power unit respectively; one high voltage house service startup/standby transformer shared by the two power units in this phase.

The high voltage house service operating transformers for #1 and #2 units have the capacity of 63/35-35MVA and the high voltage house service startup/standby transformer has the capacity of 63/35-35MVA.

The auxiliary electrical system adopts two-stage voltages of 6.6kV and 0.415kV. The 6.6kV system will supply power to the low voltage house transformer and the electromotor load with the capacity greater than 200kW, while the 0.415kV system will supply power to such low voltage loads as the electromotor, lighting and maintenance with the capacity less than 200kW.

6.6kV high voltage house supply connection: The 6.6kV system is sectionalized single-bus configuration. Each unit has two sections of house service bus with the power supply from the low pressure side of the high voltage house service operating transformer to power the units load (including the power unit and desulfuration) and main building public load. In addition, this project also includes the 6.6kV dock section and 6.6kV plot section. The 6kV system is medium resistance grounding system.

0.415kV low voltage house supply connection: The power supply modes of power center (PC) and motor control center (MCC) are adopted for the plant. The mutual (alternate) standby mode is adopted for the low voltage house transformer, the power center (PC) and the motor control center (MCC) arranged in pair.

0.415kV AC emergency power connection: In order to ensure safe and reliable shutdown in case of forced outage of the plant, each unit is planned to be equipped with one quick start diesel power unit with the capacity of 1200kW as the AC emergency power. The diesel generator uses neutral-point solid ground.

#### 3.2.7.13 Flue gas desulfurization system

Limestone-gypsum wet method is adopted for flue gas desulfurization system, with flue gas bypass. Desulfurization system adopts centralized control in unit control room; control of flue gas system absorption system and oxidative systems is included into unit DCS respectively; desulfurization electric control building is provided with local control room with operator station. Control of desulfurization common systems of absorbent preparation system, gypsum handling system and wastewater treatment system is integrated into common DCS control.

Desulfurization local control room and electronic equipment room are set inside the electric control building in desulfurization site, in which operator station/engineer station and electronic cabinet are placed. Operator may perform start/stop of entire desulfurization system and auxiliary equipment, running monitoring and accident handling through operator station LCD and mouse in local desulfurization control room. Monitoring of desulfurization system may also be done at the DCS operator station of centralized control room at the same time.

### 3.2.8 Material Balance

A detail of the Materials balance will be provided during details design of the Power plant.

### 3.2.9 Pollution Mitigation Measures (Unit Devices)

#### 3.2.9.1 Prevention and control of flue gas pollution

The following measures for preventing and controlling pollution are to be taken in connection with 2x660MW units ofthis project:

1) Burning low-sulfur coal, where the sulfur content St, ar ofcoal as received basis 0.47% in the case of check coal; installing flue gas desulfurizing unit, thus having the desulfurization efficiency reach 90%, ensuring the $SO_2$ discharge concentration at the outlet of the stack is $\leq$133mg/m$^3$, and meeting the requirement of 200-850mg/m$^3$ discharge limit ofthe World Bank.
2) Using four-electric field electrostatic precipitator as well as using the wet desulfurizing system to further remove dust, thus having the total dust removal efficiency higher than 99.5%, ensuring the discharge concentration of particulate is $\leq$40mg/m$^3$, and meeting the requirement of 50mg/m$^3$ discharge limit of the World Bank.
3) Using advanced low-nitrogen combustion technology to control the discharge concentration of NOx $\leq$350 mg/m$^3$, thus meeting the requirement of 510 mg/m$^3$ discharge limit ofthe World Bank.
4) The stack of this project is temporarily defined as 275m high, with the final height subject to the environmental impact statement and its approval opinions, thus using the diffusion, dilution and self-purification ability of the atmosphere to reduce the ambient concentration ofpollutants.
5) Installing continuous flue gas monitoring devices.
6) The $SO_2$ discharge concentration at the outlet of the stack is $\leq$133mg/m$^3$, the discharge concentration of particulate is $\leq$40mg/m$^3$ and the discharge concentration of NOx is $\leq$350mg/m$^3$, meeting the requirement of the discharge limit of the World Bank.

#### 3.2.9.2 Re-circulating cooling water discharge

A re-circulating cooling water system with forced draft cooling tower will be adopted in this project. According to the water quality, the re-circulating concentration ratio shall be 2.0. Blow down ofthe circulating water shall discharge into the river.

#### 3.2.9.3 Domestic sewage and industrial waste water treatment

The waste water and sewage of the power plant mainly includes: domestic sewage, desulfurization waste water, oily sewage, coal-bearing sewage, water discharged from ultrafiltration and backwash, reverse osmosis concentrated water, boiler acid washing waste water, sewage and mud from raw water pretreatment system. According to the characteristics of generating places and water quality and quantity, the following measures are to be taken:

1) Domestic sewage from the plant is gathered and conveyed to the new domestic sewage treatment station via the sewage pipe and is recycled after being treated and reaching the standard.
2) Water discharged from ultrafiltration and backwash is conveyed to the water purification station or waste water centralized treatment station for treatment, and reverse osmosis concentrated water directly flows into the reused water system for recycling.
3) Oily wastewater is gathered and conveyed in a centralized manner to the oily wastewater treatment facilities for treatment after oil-water separation.

4) Coal-bearing sewage is sent to the coal-bearing water treatment system for treatment after pre-precipitation in the coal slurry settling pond, with clean water flowing into the reused water system for recycling.
5) Boiler acid washing waste water and sewage and mud from raw water pretreatment system is sent to the centralized waste water treatment station for treatment, with clean water flowing into the reused water system for recycling.
6) According to such characteristics of wet limestone-gypsum desulfurization waste water as low pH value, high particulate content, high salt content and presence of metallic ion, the following treatment steps are taken to carry out continuous treatment on a single-flow basis: Ca $(OH)_2$ dosing and neutralizing system; $Ca(OH)_2$, organic sulfur and polyferric sulfate dosing system; flocculant dosing and precipitating system. Desulfurization waste water which reaches the standard after treatment is to be used for ash site spraying.

#### 3.2.9.4 Treatment of ash, cinder and desulfurized gypsum

Main solid waste of the power plant includes boiler cinder, dry ash from electro-precipitator and desulfurized gypsum. The total of annual output of cinder and desulfurized gypsum of 2*660MW units of this project is 32.776 $X10^4$t (design coal). Boiler cinder is mechanically conveyed to the cinder warehouse for temporary storage and then transported by special truck to the ash pond area; dry ash from electro-precipitator is treated by a pneumatic conveying system, and rough and fine ash is respectively sent to the rough and fine ash storage warehouse for temporary storage and then transported by special tank after wetted using water to the ash pond area; desulfurized gypsum is sent by belt conveyer to the gypsum warehouse for temporary storage after concentration and dehydration and then transported by special truck to the ash pond area for stockpiling.

In connection with fly ash and buck infiltration pollution likely present in the dry ash yard, the following measures are taken:

1) A windbreak forest is set at the outer side of the downstream dam site of the ash yard so as to reduce the influence ofwind.
2) A water sprinkler system is arranged to sprinkle water as required, thus guaranteeing the water content at the ash surface and increasing the cohesive force among ash particles.
3) Wetness adjusting ash transported to the ash yard is timely spread and compacted so as to guarantee that the ash surface is smooth and flat and to enhance the anti-wind capability.
4) Specific data of fly ash pollution is measured on a regular basis so as to facilitate effective control.
5) Initial ash embankment is watertight homogeneous earth dam; crest elevation is 6.00 m and width is 5.00 m; surface pavement material is clay-bound macadam. Inner and outer slope is 1:3.0; surface piling bag is loaded with clay and middle part is heaped up in layer with hydraulic dredger fill followed by loaded roller compaction under hierarchical control; bagged clay and the dredger fill in middle part are both packed in 400 g/m2 synthetic filament woven geotextile and each layer is 1.0 m thick. The terrain stratum of the yard from the top to down are plastic clay, loose flour sand, silty clay, flour fine sand and fine sand. Initial embankment base is directly put on soft foundation and bottom is in mattress structure composed of geotextile, medium coarse sand and plastic drain board. The widely distributed clay on the yard surface is mainly clay particle containing about 5% of fine sand, at the thickness of 1~12 m and 3.55 m on average; it is basically watertight. A layer of 600 g/m2 anti-seepage composite geomembrane is put only on the inward slope of embankment. As

there is an impermeable layer of breath-stopping soil behind the embankment, seepage tracking is extended and thus it may be confirmed that no external water can seep into the ash yard and water of the ash yard can't seep out either.

6) After the ash yard is fully piled with ash, two layers ofearth are covered (blocked layer and covering layer) and trees are planted for greening.

#### 3.2.9.5 Prevention and control of dust

1) Wind-dust-controlling net is used to prevent dust in the coal yard.
2) A guide chute and an airlock feeder are arranged at the coal dropping point of each belt conveyor of the coal conveying system so as to prevent coal dust from rising, and coal feeding equipment should be as air tight as possible.
3) Each transfer point, coal crusher room, bunker bay, head of belt conveyor and raw coal hopper are respectively provided with a spraying dust suppression device and a ventilation dust collector.
4) The stacker-reclaimer is provided with a spraying dust suppression device; the coal yard is provided with sprinkler facilities covering the surface of the whole coal dump; the dry ash yard is provided with a water sprinkler system.
5) A water cleaning system is respectively arranged on the ground ofcoal conveying system, each floor and wall ofthe coal warehouse, the basement floor ofboiler house, and the ground ofash warehouse and cinder warehouse and below the precipitator.

#### 3.2.9.6 Noise control

According to the measured data of power plants of the same kind, main noise source strength ofthis project is as shown in **Table 3-13**.

**Table 3-13: Main Noise Sources of the Power Plant**

| Noise Source Name | Location | Sound Level (dB(A)) | Spectral Characteristics |
|---|---|---|---|
| Suction blower | Outside boiler house | 85 (3m in front of air inlet) | High, low and medium frequency |
| Ventilating blower | Outside boiler house | 90 (3m in front of suction outlet) | High, low and medium frequency |
| Coal mill | Bunker bay | 95 | Low and medium frequency |
| Turbine | Turbine house | 90 (with casing) | Low and medium frequency |
| Generator and exciter | Turbine house | 90 | Low and medium frequency |
| Feed water pump | Turbine house | 101 | Low and medium frequency |
| Slurry circulating pump | Desulfurization area | 90 | Low and medium frequency |
| Coal crusher | Coal crusher room | 90 | Low and medium frequency |
| Circulating water pump | Water pump house | 85 | Low and medium frequency |
| Boiler steam venting | Boiler house | 120-150 occasional | High frequency |
| Emergency door steam venting | Boiler house | 100-110 occasional | High frequency |

Measures for preventing and controlling noise:

1) Use equipment of low noise or with noise control measures, and propose noise limit requirements when ordering equipment (installing anti-noise casing or noise silencer if necessary) so as to guarantee that the noise of main equipment is no higher than the level set out in the table above.
2) Steam/water pipes and flue gas/coal powder pipes are reasonably designed and arranged, and supporting and hanging frames are reasonably chosen, so as to avoid vibration and noise.
3) Such equipment of relatively loud noise as blower and pump are arranged in closed buildings so as to insulate sound by buildings.
4) Noise at the border of the plant is reduced by means of reasonable planning, arrangement and based on such conditions as distance, terrain and surface features.
5) Use silencers to control air power noise from boiler steam venting and emergency door steam venting, so as to ensure noise is <100dB(A).
6) Require construction and installation units to take such control measures as deadening against blowpipe noise.

### 3.2.10 Flue Gas Desulfurization

#### 3.2.10.1 Flue gas desulfurization process selection

Based on the geographic characteristic of power plant site, current engineering will adopt limestone-gypsum web desulfurization process, which has the following features:

**Table 3-14: Characteristics of Flue Gas Desulfurization method**

| Sl. | Name | Limestone-gypsum wet method |
|---|---|---|
| 1. | Process configuration | Flue gas+fliter (electric bag, bag filter, electrostatic precipitator) + limestone gypsum wet desulphurization. |
| 2. | Technical index | • Desulfuration : 95% efficiency, Outlet concentration with less than 200mg/$Nm^3$ ;<br>• Dust : Primary dedusting guarantee inlet flue gas wet desulphurization dust concentration, the desulfurization absorption tower has a certain dust removal effect ; |
| 3. | Adaptability of boiler high dust concentration | Super efficient dust collector, electricbag fliter, bag filiter or low temperature electric dust collector etc is needed to ensure the absorber inlet dust concentration. |
| 4. | Anticorrosion requirements | For wet desulfurization operation environment, system has high anti-corrosion design requirements, with the condition of without reheating flue gas, export flue and chimney should be designed for anticorrosion. |
| 5. | Waste water | Wastewater contains a large number of chloride ions, heavy metals and other substances should be treated separately. |
| 6. | Equipments stability | Mature system technology,stable operation, good reliability, reliable and safe desulfurizer source |
| 7. | Adaptability of flue gas sulfur content, smoke temperature and volume fluctuate | When the concentration of $SO_2$ or requirements changes, the desulfurization efficiency can be adjusted by the slurry flow to ensure the smoke emissions requirements, and with the good adaptability of coal. |

| Sl. | Name | Limestone-gypsum wet method |
|---|---|---|
| 8. | System condition | Stable system, mature technology, main system contains absorbent preparation system, absorption system, gypsum dewatering system, the desulfurization wastewater treatment system, etc, covering large area |
| 9. | Energy consumption | Dust collector, heat exchanger, and the accessory systems with large operation resistance has high energy consumption. |
| 10. | Water consumption | Low exhaust smoke temperature, large total system water consumption. |
| 11. | Chimney effect | Low exhaust smoke temperature, and easy to have white smoke chimney phenomenon. |
| 12. | Comprehensive properties | Each indicator can reach discharge requirements, but corrosion will affect the removal efficiency with the long-term operation environment. |
| 13. | Application achievements | For large and medium grade coal-fired units like 1000MW and 600MW units, with most application achievements. |

#### 3.2.10.2 General layout of desulfurizing unit

General layout complies with the requirements of relevant national laws and regulations in effect, meets the fire control and health protection requirements of desulfurizing unit, and fulfills the requirements of the production flow. Relevant devices are arranged closely, thus pipeline runs smoothly and is short and convenient.

In this project, each flue gas desulfurizing unit is provided with one absorber. Two absorbers are respectively arranged at both sides of boiler stack, and such equipment of the absorber system as slurry circulating pump, oxidation fan, sump and gypsum discharging pump are arranged near the column. Each boiler is provided with one slurry circulating pump and one oxidation fan room and with such equipment as slurry circulating pump and oxidation fan.

Gypsum dehydration workshop and desulfurizing waste water treatment station are arranged between the slurry pump and oxidation fan room behind the flue, thus shortening the transportation distance of materials, saving the land and also facilitating inspection and gypsum transportation.

In order to sufficiently use the site, the accident slurry tank is arranged on the vacant land near the desulfurizing facility.

#### 3.2.10.3 Source and consumption of absorbent

This project is located in Bangladesh where mineral resources are mainly natural gas, limestone, hard rock, coal, siliceous sand and white clay. The country has certain quantity of limestone resource reserve. Development of the resource requires survey and study to decide if limestone should be purchased from local market or imported from neighboring country. Limestone block used as desulfurizer in the power plant will be transported to plant storage via motor vehicle or ship. Limestone store shed is provided in the power plant, which is capable of storing limestone for 30 days of consumption when design fuel is used. Investor shall make decision about limestone supply plan.

Computation of limestone block is given in the **Table 3-15** below.

**Table 3-15: Computation of Limestone Block**

| Unit | Hourly Consumption (t/h) | Daily Consumption (t/d) | Yearly Consumption ($10^4$t/a) |
|---|---|---|---|
| 1x600MW | 4.3 | 103.2 | 2.795 |
| 2x600MW | 8.6 | 206.4 | 5.59 |

Note: 1) Daily number of unit utilization hour is 24 hours and yearly utilization hour is 6500hours.
2) CaCO3 content in limestone (pureness) is set as 90%.
3) Desulfurization efficiency is set as 90%.

#### 3.2.10.4 Disposal of flue gas desulfurization residual

Output of residual gypsum from desulfurization process is presented in **Table 3-16**.

**Table 3-16: Gypsum quantity from desulfurization process**

| Unit | Hourly Consumption (t/h) | Daily Consumption (t/d) | Yearly Consumption ($10^4$t/a) |
|---|---|---|---|
| 1x600MW | 7.8 | 187.2 | 5.07 |
| 2x600MW | 15.6 | 374.4 | 10.14 |

Gypsum from flue gas desulfurization is also a type of gypsum whose essential ingredients are the same as natural gypsum, i.e. calcium sulphate dihydrate ($CaSO_4 \cdot 2H_2O$); its physicochemical property follows the same laws as natural gypsum. At the same time, it has the property of regenerated gypsum. After dehydration and washing treatment, gypsum plaster from power plant contains about 10% of damp and loose fine particles of even size in gravity water form. The gypsum regularly generated from flue gas desulfurization is greyish-white; under service fluctuation, the gypsum contains more impurity substance like fly ash and color turns grey. From comparison of chemical composition, flue gas desulfurization gypsum is better than natural gypsum in quality and delicacy and thus desulfurization gypsum should be rationally collected for recovery utilization, such as cement retarder and building materials, to protect environment and save land resource and avoid waste of resource; it has certain economic benefit. If comprehensive utilization is not available, desulfurization gypsum will be dumped to ash disposal area with special vehicle and piled in separated section after roller compaction for the convenience of utilization in the future.

#### 3.2.10.5 Waste water treatment

Water in the slurry of the desulfurizing unit will gather heavy metal elements (mercury, lead, nickel and zinc), non-metallic pollutants (arsenic and fluorine) and chlorine ion during continuous circulation. Waste water is slightly acidic and thus corrodes equipment of the desulfurization system and also affects the quality of gypsum. Therefore, the desulfurizing unit needs to discharge a certain amount of waste water to the desulfurization waste water treatment system to separate heavy metal and other precipitable substances by such means as neutralization, flocculation, precipitation and filtration. Waste water is comprehensively utilized or discharged after being treated and reaching the primary discharge standard set out in the national standard of Bangladesh for comprehensive discharge of waste water.

The wastewater produced by the desulfurizer flows from the wastewater cyclone to neutralization tank (adding lime), then via the settling tank (adding organic sulfur solution) and flocculation tank (adding flocculating agent). After mixing evenly, the wastewater of outlet pipe added with coagulant flows into the clarifier;Through chemical processing and flocculation in clarifier, the wastewater is obviously divided into two layers, of which the upper for clean water overflows to recycle water tank and the lower for sludge is sent to the plate and frame filter press when reaching a certain height by the sludge pump; After filter pressing of sludge, the filter pressing water flows to waste water pool and mud cake is discharged via the bucket through the mud car to slag or ash field for piling; the filter pressing water in the wastewater pool is pumped to the neutralization tank for further processing; Clear water flows into the recycle water tank (timely adding the hydrochloric acid), and the desulfurization wastewater after being treated and meeting the requirements can be sent by recycle water pump for the ash field spraying, coal field spraying, wet ash, etc.

### 3.2.11 Flue Gas Denitration

Based on the boiler performance of China top 3 power groups, the supercritical boiler of 2x660MW unit of this project guarantees that the emission concentration of NOX will not exceed 350mg/m3, thus complying with the environmental protection requirement of no higher than 510mg/m3. In order to reach the increasing environmental protection standard, a space is reserved for a denitration device at the end part of the boiler in respect of 1# and 2# units of this project. In the case of design of the boiler body, conditions for building a denitration device (SCR) have been taken into consideration.

### 3.2.12 Coal Conveying System

The 2x660MW power units has the yearly coal consumption for check coal of 4.11 MT, all the fire coal conveyed by water to the coal unloading wharf and then into the plant through conveyor belt after coal unloading by the gantry type grab ship unloader.

#### 3.2.12.1 Coal storage system

There are two available manners for coal storage system in this project, one is strip coal yard and the other is enclosure round coal yard. From the environmental point of view it’s recommended to adopt round coal yard manner. The detail of round coal yard has been provided in **Table 3-17**.

**Table 3-17: Detail of Coal Yard**

| Characteristics | Round Coal Yard |
|---|---|
| The main equipment | 3 circular stacker reclaimers |
| Number | 3 round coal yard |
| Heap size and coal reserves | Each coal yard: 120 meters in diameter; 3 round coal yards storage capacity of $54x10^4$t. |
| Yard area | 34500m$^2$ |
| Coal yard equipment return rate | 95% |
| Environmental protection | Full closed coal yard, good environmental protection performance |
| Expansion conditions | Need to set up sepato be expanded rate, hard |
| Coal transfer station | High and large |

*Source: Feasibility study repor, BCPCL 2015*

The project has 3 round coal yards, 120 meters in diameter, each round coal yard have one set of circular stacker reclaimer, which can be stored in the coal yard, and coal yard can be taken to the main plant in raw coal bunker. Stacker stacker, reclaimer capacity is 1750t/h; 3 round coal yards storage capacity of 54 x104t, for 2x660MW units with 40 days.

The coal yards are equipped with three TY220 coal transporters and three ZL50 wheel loaders for auxiliary operation at the yards.

Retaining wall is arranged around the coal yard dust suppression sprinkler system.

The following description of system is considered as the round coal yard.

#### 3.2.12.2 Coal handling system

Of the coal handling system, except that the conveyors into and out of the round coal yards are arranged in one way, all the rest adopt double way arrangement, one for operation and the other for standby. In bunker bay, C-9A/B belt conveyor parameters: band width B=1600mm, band speed V=2.5m/s, output Q=1750t/h. The rest belt conveyor parameters: band width B=1 400mm, band speed V=2.8m/s, output Q=1750t/h. The coal loading margin is designed of two times coal consumption of the 2x660MW power units, meeting the output requirement of the coal conveying system.

The coal supplied by water is unloaded by gantry type grab ship unloader at the coal unloading wharf. In the T-2 transfer tower the coal can conveyed by C-7A/B conveyor to the coal crusher house and to the bunker bay after screening and crushing; or, conveyed by C-3A/B conveyor to the round coal yards for storage. To avoid secondary retrieval, the coal loading directly from the wharf conveyor to the bunker bay ofthe main house is preferred.

Coal handling system use the electric three devices and electric four devices, by switch, can achieve cross operation.

The electric two sides plow discharger is used for coal unloading at the coal bunker layer.

The three shift operation of coal handling system, each class operation is about 4 hours.

#### 3.2.12.3 Control of coal handling system

The coal handling system uses program control and industrial television monitoring, in which, the system protection elements are equipped to realize the interlocking operation, such as pull switch, speed detector, belt sway switch, coal flow signal and belt tearing detector.

Coal falling pipe is arranged on the vibrator, and plug interlock coal detection device start.

In raw coal bunker is provided with an ultrasonic material level meter and high and low material probe, the coal signal sent to control system, in order to improve the reliability ofautomatic coal blending.

#### 3.2.12.4 Coal dust control

The Coal storage area is equipped with the sprinkling facility covering the entire piling area, which could offer partitioning sprinkling and decrease coal dust raise.

The buffering swing gate is installed in the coal crusher room, at the coal dropping pipe with greater fall at the transfer points and at the funnel of the plow discharger. The dust control device is equipped at the feed channel at the band conveyor tails. The spraying and dust suppressing device is equipped at the reclaiming head of the bucket wheel stacker reclaimer.

The water soaking is considered for the coal conveying system, hydraulic cleaning is used for the transfer points, coal crusher room and coal conveyor gallery.

The washing sewage of the coal conveying system is collected to the settling pond at the coal yard by the dredge pumps at the discharge points and then the clarified backwater could be reused after treatment.

## 3.2.13 Ash and Slag Handling System

### 3.2.13.1 Ash and slag quantity

The ash and slag quantity is calculated in the **Table 3-18** below according to the coal consumption and coal data.

**Table 3-18: Ash and slag quantity of the proposed power plant**

| Power unit | Item | Hourly quantity (t/h) | Daily quantity (t/h) | Annual quantity ($10^4$t/a) |
|---|---|---|---|---|
| **1x660MW** | Ash quantity | 13.4 | 321.6 | 8.71 |
| | Slag quantity | 2.4 | 57.6 | 1.56 |
| | Mill rejects quantity | 1.6 | 38.4 | 1.04 |
| | Total | 17.4 | 417.6 | 11.31 |
| **2x660MW** | Ash quantity | 26.8 | 643.2 | 17.42 |
| | Slag quantity | 4.8 | 115.2 | 3.12 |
| | Mill rejects quantity | 3.2 | 76.8 | 2.08 |
| | Total | 34.8 | 835.2 | 22.62 |

*Source: Feasibility study report, BCPCL 2015*

Note: 1) The ratio of slag and ash is 15%:85%.

2) The utilization hours of the power unit in a day is 24h and the utilization hours in a year is 6500h.

3) The mill rejectsmill rejects quantity is calculated at 0.5% of the coal consumption.

### 3.2.13.2 Main design principle

1) For comprehensive utilization of the ash and slag and compliance with the national policies in environmental protection, the ash and slag handling system is designed in the principle of ash and slag separate removal, discharging in coarse-fine grading and discharging in dry-wet treatment.
2) In the ash handling system, the fly ash delivery system is designed in the unit of 1*660MW power unit, conveying it into the ash silo for storage by positive pressure dense phase pneumatic conveying system. The fly ash storage system is designed in the unit of 2*660MW power units.
3) The slag handling system is designed in the unit of 1x660MW power unit.
4) The mill reject smill rejects system is planned to adopt the conveying scheme of battery fork lift truck with manual assistance.
5) The systems are air supplied by the compressed air distribution center, including the air for conveying and instruments of the ash handling pneumatic conveying system, the air for instruments and others of the main house, the air for instruments of desulfuration and denitration and the air for miscellaneous use.
6) The motor transportation with social hauling capacity is planned for the ash and slag transportation outside the plant.

### 3.2.13.3 Ash handling system

In the ash handling system, the fly ash delivery system is designed in the unit of 1*660MW power unit, conveyed into the ash silo for storage by positive pressure dense phase pneumatic conveying system and outside the plant, transported by motor to the ash storage yard for storage or to the comprehensive utilization site. The design output of the the positive pressure dense-phase pneumatic conveying system is planned as not less than 150% ash discharge of the design coal combustion at BMCR. The coal types adopted for this project has low ash content and small ash and slag quantity: the fly ash transportation could adopt the positive pressure pneumatic conveying system, suction pressure pneumatic conveying or mechanical conveying system. The positive pressure pneumatic conveying system is simple in practice and matures in technique, requiring a few equipments, covering small area and needing low running cost, described in the following **Table 3-19**.

**Table 3-19: Fly ash conveying system**

| Sl. | Name | Positive pressure pneumatic conveying system |
|---|---|---|
| 1. | Conveying system | Simple |
| 2. | Technical experience | Mature |
| 3. | Output adaptability | Good adaptability |
| 4. | Conveying distance | Less than 1500m |
| 5. | Main equipments | Air compressor, pump, pipes, valves, bag filter |
| 6. | Operation environment | Good |
| 7. | Land occupation | Small flexible layout |
| 8. | Flow rate | 2～15m/s |
| 9. | Ash-gas ratio | 20～30kg/kg |
| 10. | Influence of pipeline leakage | Dry ash leakage， dusty |
| 11. | Insulation requirement | None |
| 12. | Maintenance cost | Low |
| 13. | Operation cost | Low |

*Source: Feasibility study report, BCPCL 2015*

The positive pressure pneumatic conveying system is preferred for the fly ash delivery system ofthis project, which is briefly described below:

An ash transporting and storage pump is installed under each economizer hopper and electric precipitator ash hopper of each boiler. The storage pump has the necessary instruments such as pneumatic feed valve, air inlet component, air inlet control mechanism, charge level indicator and pressure transmitter. The manual slide plate gate is equipped between the ash hopper outlet and the inlet valve of the storage pump for storage pump repair. In order to improve the ash flow in the ash hopper, a set of electric precipitator ash hopper fluidizing blower is equipped, which includes fluidizing blower, electric heater, fluidizing plate, etc. The fluidizing blower is arranged in the compressor room.

A coarse ash delivery pipe is equipped for economizer and No. 1 and No. 2 electric fields of the electric precipitator of each boiler to deliver the fly ash to the coarse ash silo for storage; a fine ash delivery pipe is shared by the fly ash of the storage pump under the ash buckets of No. 3 and No. 4 electric fields to deliver the ash to the fine ash silo. And meanwhile, the pneumatic pipe changeover valve is equipped at the ash delivery pipe at the top of the ash silo, through which, the coarse ash in the coarse ash delivery pipe could be changed over to any coarse ash silo or the fine ash in the fine ash delivery pipe could be changed over between the coarse and fine ash silos.

The fly ash storage system is planned temporarily to include three reinforced concrete structure ash silos with the storage capacity of $1000m^3$, two for coarse ash and one for fine ash, each of which has the effective storage capacity of $800m^3$ with the inside diameter of Φ10m and height of 29m. The two coarse ash silos could contain the ash discharge ofthe design coal combustion for 43.0 (47.8) hours ofthe two boilers at the working condition of BMCR.

A pressure vacuum relief valve and a pulse bag filter are equipped at the top of each ash silo, the air delivering the ash discharged directly into the atmosphere after filtration in the pulse bag filter. Each ash silo has one continuous level indicator, one low level indicator and one high level indicator.

The ash silo is equipped with the areation system, which includes the devices and accessories such as ash silo fluidizing blower, electric air heater, fluidizing groove at the bottom of the ash silo. The hot air supplied by the fulidizing blower and electric heater enters the fluidizing groove and fluidize the ash in the silo to improve the ash flow for easy discharge.

Two discharge outlets, one set of dry ash unloading device with the output of 100t/h and one set of wet type unloading device with the output of 100t/h are equipped at the bottom of each ash silo. The dry ash unloading device is used for the dry ash tank car to load and transport outward the dry ash for comprehensive utilization; the wet type unloading device makes the dry ash into ash wetting then to be transported outward by wetted dust dumper for comprehensive utilization or to the ash yard for storage.

### 3.2.13.4 Slag handling system

The slag handling system is designed in the unit of 1x660MW power unit. Dry slag removal system will be adopted for the proposed power plant.

It adopts the slag removal mode of slag pit + air-cooled type slag conveyor + bucket elevator + slag storage. The high temperature slag (800°C ~900°C) falls into air-cooled type slag conveyor after passing through the dry type slag pit and shutting door and then is transported outward by the air-cooled type slag conveyor. The cooling air entering through the dry type slag extractor inlet flows in reverse of the hot slag delivery direction and conduct full heat exchange inside the air-cooled type slag conveyor; and meanwhile, the combustible materials in hot slag could have secondary combustion and cooling. The hot slag after cooling with the temperature controlled at 50~100°C enters into the subsequent delivery system. The cooling air absorbs the heat of three parts: most heat of the slag, the radiant heat of the boiler throat and the heat from secondary combustion of the combustible of imperfect combustion, with the temperature up to 340°C and brings the slag discharge heat back into the furnace to decrease the thermal loss ofboilers.

An $80m^3$ slag pit is equipped at the bottom of each boiler with hydro-extrusion shutting door (preliminary crushing the coking slag block in the boiler), under which there is a wind cooling steel band slag extractor with the output of 5t/h~20t/h. The boiler furnace slag after continuous cooling is delivered into the slag crusher for crushing and then lifted by the bucket elevator with the output of 30t/h to the top of slag storage and fall in for storage.

Each boiler has a steel slag storage with the storage capacity of $100m^3$, which could contain the slag discharge of the design (check) coal combustion for 27.2 (30) hours of the boilers at the working condition of B-MCR. At the top of the slag storage, there is the bag-type dust remover to filter the air for incoming slag exchange in the slag storage and discharge into the atmosphere. At the bottom of the slag storage, there is a dry slag unloading system. The dry slag in the slag storage is loaded by dry slag bulk loader and transported outwards for comprehensive utilization or to the ash storage yard for deposit.

#### 3.2.13.5 Mill rejects system

The mill rejects can be transported in many ways such as manpower transportation, pneumatic conveying, hydraulic transport and mechanical conveying. In recent years, the new power plants have greater unit capacity and have the operation and management levels improved substantially and so, they have higher requirements in environmental protection, sanitary condition, automation level, number of personnel and labor intensity. However, for most power plants, there are many problems in the treatment system for mill rejects and it's difficult to deal with the mill rejects. According to current mill rejects operation in large power plants, the plan of manual work + battery fork lift truck assistance is the practice in general use, with the process flow as follows:

The mill rejects discharged from the coal pulverizers for each boiler is continuously delivered into the mill rejects bucket beside the coal pulverizer for storage. When a mill rejects bucket is filled, the mill rejects is discharged into the tipcart. The mill rejects in the tipcart is poured into the dumper and transported outward to the specified area at ash storage yard for storage.

### 3.2.14 Waste water treatment system

#### 3.2.14.1 Industrial waste water centralized treatment system

***Overview***

Outside the boiler make-up water treatment plant, there are four wastewater storage pools of 1500m3 for storage of the non-recurrent wastewater from the main building and the drainage from the boiler make-up water treatment system. In regular service, one of them is also used for collecting the ultrafiltration backwash drainage, which has higher suspended solids content and could be transmitted to clean water station or wastewater centralized treatment facility for treatment; one is also used for collecting the concentrated drainage from one-stage reverse osmosis, which almost contains no suspended solids but is high in salinity, about four times of the feedwater salt content, and could directly be transmitted to the water reuse system for reusing. Behind the boiler in the main building, there is a 500m$^3$ unit drainage pit for collecting and transporting the drainage from the main building, e.g. condensate polishing regeneration drainage, boiler acid cleaning drainage and wash water. The wastewater treatment is completed by the wastewater centralized treatment facility.

Main process of industrial wastewater treatment system is: wastewater storage pools→ mixed tank→ clarifier→concentration basin→monitoring pond→ reuse pond→recycle water system.

The sludge water from concentration basin and clean water station is sent to clarifier for concentrating, while that of concentration basin is transmitted to the wastewater centralized treatment system for dewatering treatment, the dehydrated mud is transported to a certain place by truck.

***Capacity of industrial wastewater treatment system***

Capacity of industrial waste water treatment system is the sum of usual waste water discharge of 4×660MW units and the biggest unusual waste water discharge treated in a certain time. The whole capacity of waste water storage pits is proposed to be 6000m$^3$ according to total discharge of both usual waste water and the biggest unusual waste water. Capacity of industrial waste water treatment system is proposed to be 50m$^3$ /h.

#### 3.2.14.2 Coal wastewater treatment system

The Coal wastewater treatment system is used to treat the drainage of the coal system, especially the wastewater from coal yard, coal trestle and coal unloading wharf. According to the coal contained wastewater quality and water quantity, it is planned to equip 3x30t/h coal water processors, two for operation and one for standby or all the three for operation. In the long term planning capacity, a set of coal water treatment equipment will be increased with the same capacity. The Coal wastewater disposal facility is planned to be arranged near the sludge settling basin, the effluent water from which is delivered to the coal water processor for treatment. The clear water after treatment is delivered to the reusing water pool for reusing. The coal waste water treatment is planned to adopt the treatment system with electric flocculation unit.

#### 3.2.14.3 Desulfuration wastewater treatment system

Considering that the drainage and wash water from the treatment equipments of the desulfuration wastewater treatment system should be returned to the desulfuration wastewater treatment system for treatment, the capacity of the desulfuration wastewater treatment system is designed as 1x20t/h.

The Desulfuration wastewater disposal facility is planned to be arranged in the comprehensive desulfuration building with the desulfuration wastewater delivered to the desulfuration waste water treatment station for coagulating sedimentation and dehydration treatment. The clear water after treatment is used for ash yard sprinkling. The sludge from the water extractor is carried by truck to the specified site for piling.

### 3.2.15 Utilisation Fly Ash and Gypsum of the project

At present, premixed fly ash concrete has been very popular in developed countries, but the total consumption volume is relatively low in such countries as Bangladesh and India. With rapid economic development of Bangladesh, the application of cement has rapidly increased recently. In such basic construction projects as roads, fly ash is an excellent supplementary material. Such technologies as mixing fly ash with sand and blending fly ash with cement will use a large amount of fly ash.

Flying ash generated in this project will be used for:

- producing fly ash bricks
- producing aerated wall blocks and sheets
- fly ash haydite
- backfilling and land reclamation
- premixed fly ash concrete
- paving roads
- producing cement with fly ash
- export of fly ash to India, Middle East countries, etc.

According to the special report of market investigation of comprehensive utilization, the scheme of comprehensive utilization cinder and desulfurized gypsum of this project is described as follows:

1) Dry ash below second and following electric fields of precipitator has its indicators good such as fineness, spherical particle content and activity and thus is excellent ash and can serve as concrete mixing material (high-value material).
2) Rough ash and boiler bottom cinder of slightly worse quality below the first electric field can serve as a cement mixing material.
3) Desulfurized gypsum can serve as a cement retarding agent.
4) Boiler bottom cinder has low ignition loss and $SO_3$ content and high vitreum content and thus can serve as aggregate for roads and building materials, with wide market.
5) With regard to dry ash below precipitator, in addition to such characteristics as low water content, ignition loss, MgO and $SO_3$ content and high $SiO_2$+$Al_2O_3$ content, its water requirement for normal consistency is low and its compressive strength is high, thus having

promising application prospect in building and building materials, for example, it can be used for producing silicate products (aerated concrete, fly ash steam-curing bricks, autoclaved fly ash masonry, etc.); replace clay as the raw material of cement; be used for producing sintered products (fly ash sintered bricks, haydite, etc.); be also used for producing heat insulation materials by sorting products; or be used for filling roads, port areas and cities.

6) Desulfurized gypsum can be utilized for many other purposes, such as cement, building material industry, building industry and agriculture. In respect of building products, desulfurized gypsum can be used for producing such products as gypsum plasterboard, gypsum rendering, fibrous plaster and slag gypsum board.

This project adopts ash-cinder separation, dry cinder removal, dry ash discharge and rough and fine ash discharge technology, and has cinder warehouse, rough and fine dry ash warehouse, carrier vehicles and loading and unloading machine, thus being able to provide high-quality dry ash and dry cinder and creating favorable conditions for the comprehensive utilization of cinder.

## 3.3 Bank Protection and Land Filling

The project area is surrounded by Rabnabad/ Kazol River at eastern side, Taikhali & Andharmanik River at western & southern side. All of these three rivers are discharged in Bay of Bengal. Average width of Rabnabad/ Kajal River is more than 1000 m near the project area and jetty will be built on Rabnabad/ Kajal River bank. Also, it can be recommended that during high flood, southern side Khal might be affected by Rabnabad/ Kajal River. Therefore, bank protection will required at the eastern and southern sides of the project area. At the western and northern side of the project area earth embankment will be sufficient enough to prevent erosion.

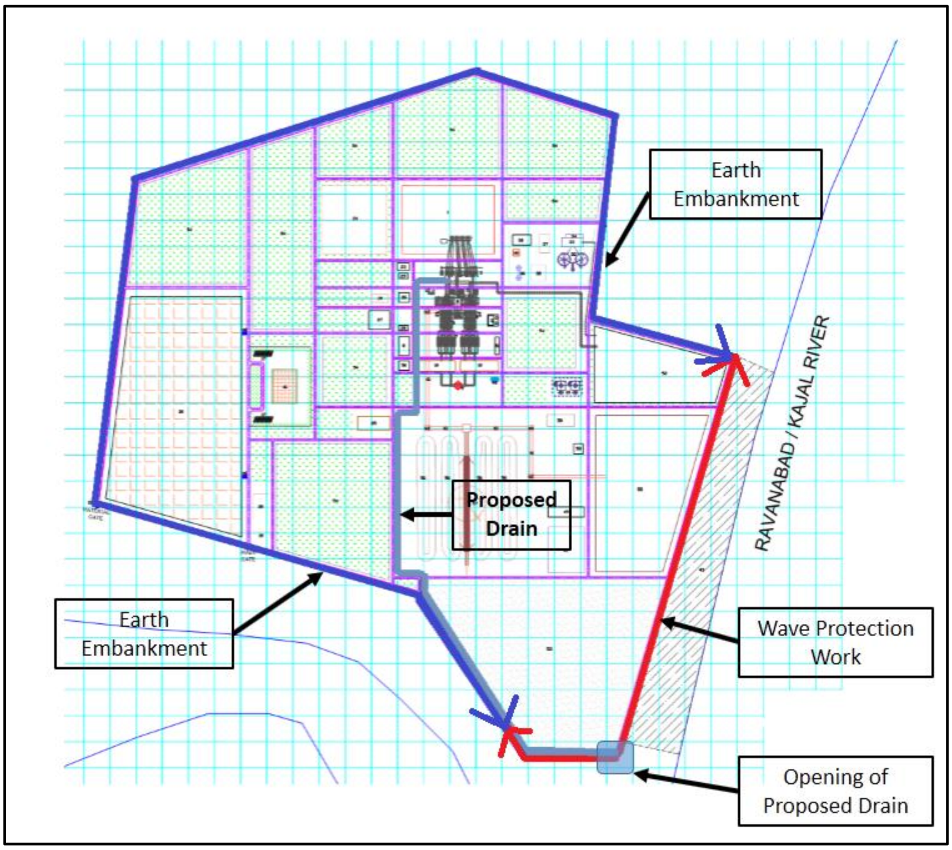



**Figure 3-8: Protection Work of River/Canal Banks for Project Area**

Land filling will be required in whole project area except at ash pond and jetty. Elevation of land filing will be around 6.65 m PWD. It can be recommended that FM value for land filling should be within 0.8 to 1.5. Land filling materials should be collected by dredging of Rabnabad/Kajal River but dredging should avoid near the bank of project area to protect bank erosion. In addition, during land filling soil need to compact by layer. Therefore it can be proposed that embankment crest should be design with 100 years flood event. From surveyed data analysis it has been found that highest flood level near the project area is 5.605 mPWD. According to Hochstein maximum wave height could be around 1.79 m. Therefore, crest level of the embankment will be 7.5 mPWD.

## 3.4 Project Cost

Based on the Principle above, the plant static investment is ¥14,380,750,000 RMB ($2,316,000,000 Dollar), static unit investment is ¥10894.51 RMB/kW ($1754.55 Dollar/kW). The plant dynamic investment is ¥15,800,390,000 RMB ($2,544,630,000 Dollar), dynamic unit investment is ¥11,969.99 RMB/kW ($1,927.75 Dollar/kW).

**Table 3-20: General Budget for proposed power plant**

| Sl. | Description | Civil Cost | Equipment Cost | Installation Cost | Other Fee | In Total | Proportion of the Total Investment |
|---|---|---|---|---|---|---|---|
| 1. | Main and Auxiliary Producing System | 172090 | 250695 | 123833 | | 546618 | 37.89% |
| 2. | Thermal System | 69161 | 170195 | 74895 | | 314251 | 21.79% |
| 3. | Fuel Supply System | 57278 | 9802 | 1454 | | 68534 | 4.75% |
| 4. | Ash Handling System | 2309 | 2358 | 549 | | 5217 | 0.36% |
| 5. | Water Treatment System | 1666 | 2878 | 1506 | | 6050 | 0.42% |
| 6. | Water Supply System | 11199 | 7036 | 3084 | | 21320 | 1.48% |
| 7. | Electric System | 5889 | 25606 | 19752 | | 51247 | 3.55% |
| 8. | I&C system | | 6552 | 10792 | | 17343 | 1.20% |
| 9. | Desulphurization System | 7112 | 22928 | 10628 | | 40668 | 2.82% |
| 10. | Denitrification System | | | | | | |
| 11. | Other Auxiliary System | 17476 | 3339 | 1174 | | 21989 | 1.52% |
| 12. | Single Project Relative to Site | 248346 | 22581 | 4768 | 9252 | 284947 | 19.75% |
| 13. | Transportation, Channel Dredgin | 60232 | 21249 | 3252 | 9252 | 93986 | 6.52% |
| 14. | Ash Field | 15164 | 276 | | | 15440 | 1.07% |
| 15. | Water Purification and Seawater Desalination | 2596 | 775 | 550 | | 3921 | 0.27% |
| 16. | Water Supply Engineering | 2236 | 280 | 966 | | 3483 | 0.24% |
| 17. | Foundation Handling | 94003 | | | | 94003 | 6.52% |
| 18. | Site Preparation and Living Quarters | 70710 | | | | 70710 | 4.90% |
| 19. | Temporary Project | 3405 | | | | 3405 | 0.24% |
| 20. | The Base Year Difference | | | -1301 | | -1301 | -0.09% |
| 21. | Other Fees | | | | 200185 | 200185 | 13.88% |
| 22. | Other Fee of project construction | | | | 48699 | 48699 | 3.38% |
| 23. | Project Construction Management Fee | | | | 54329 | 54329 | 3.77% |
| 24. | Project Construction Technical Service Fee | | | | 13137 | 13137 | 0.91% |
| 25. | Tax | | | | 10609 | 10609 | 0.74% |
| 26. | Start and Commission Fee | | | | 63900 | 63900 | 4.43% |
| 27. | Production Preparing Fee | | | | 9511 | 9511 | 0.66% |
| | Subtotal | 420436 | 273275 | 127300 | 209437 | 1030449 | 71.44% |
| 28. | Profit (3%) | | | | 30913 | 30913 | 2.14% |

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| 29. | Tax Refund of Equipments(about 10% of Equipment Cost in the situation of Using Chinese Equipment) | | | | -27328 | -27328 | -1.89% |
| 30. | Reserve Funds | | | | 104759 | 104759 | 7.26% |
| 31. | The Basic Reserve Funds | | | | 53057 | 53057 | 3.68% |
| 32. | Exchange Rate Reserve Funds | | | | 31021 | 31021 | 2.15% |
| 33. | Price Reserve Funds (2%) | | | | 20681 | 20681 | 1.43% |
| | Subtotal | 420436 | 273275 | 127300 | 317782 | 1138794 | 78.95% |
| 34. | Cost of Financing | | | | 303678 | 303678 | 21.05% |
| | **Project Static Investment** | **420436** | **273275** | **127300** | **621460** | **1442472** | 100.00% |
| 35. | Static Unit Investment(RMB/kW) | 3185.12 | 2070.27 | 964.40 | 4708.03 | 10927.82 | |
| 36. | Proportion of Whole static Investment for Each Cost(%) | 29.15% | 18.94% | 8.83% | 43.08% | 100.00% | |
| 37. | Dynamic Fee | | | | 142398 | 142398 | |
| 38. | Load Interest during Construction | | | | 142398 | 142398 | |
| 39. | **Project Dynamic Investment** | **420436** | **273275** | **127300** | **763858** | **1584870** | |
| 40. | Dynamic Unit Investment(RMB/kW) | 3185.12 | 2070.27 | 964.40 | 5786.80 | 12006.59 | |
| 41. | Proportion of Whole Dynamic Investment for Each Cost (%) | 26.53% | 17.24% | 8.03% | 48.20% | 100.00% | |
| 42. | **Dollar/Yuan Exchange Rate** | | | | | **6.40** | |
| 43. | Project Static Investment(10,000$) | | | | | 225471 | |
| 44. | Static Unit Investment($/kW) | | | | | 1708.11 | |
| 45. | Project Dynamic Investment(10,000$) | | | | | 247729 | |
| 46. | Dynamic Unit Investment($/kW) | | | | | 1876.73 | |

## 3.5 Economic Index

The main economical indexes are shown as follow based on recommended design envision.

| | | |
|---|---|---|
| 1. | Dynamic investment of the project： | $2,477,290,000 |
| | Static investment of the project： | $2,254,710,000 |
| 2. | Unit kilowatt investment (Dynamic ): | $1876.73/kW |
| | Unit kilowatt investment (Static ): | $1708.11/kW |
| 3. | Annual power generation | 8177GWh |
| 4. | Utilization hours | 6500h |
| 5. | Average Tariff (Exclude VAT) | $88.34/MW.h |
| 6. | Coal Price, CFR (Cost and Freight) | $110/t |
| 7. | Total land area of the site | 148.35 $hm^2$ |
| | 1) Plant area: | 41.10 $hm^2$ |
| | 2) Road area outside plant: | Combine in 1) |
| | 3) Ash yard: | 98.80 $hm^2$ |
| | 4) Construction rental area: | 21.50 $hm^2$ |
| 8. | Demolition quantity | Not in scope |
| 9. | Total amount of earthwork | Not in scope |
| 10. | Main material consumption | |
| | Steel | 32,770 t |
| | Steal bar | 68,210 t |
| | Wood | 1,880 $m^3$ |
| | Cement | 247,220 t |
| 11. | Whole power plant thermal efficiency | 44.49% |
| 12. | Standard coal consumption for power generation | 276.4 g/kW.h |
| 13. | Annual water consumption per million kW : | 0.532 $m^3$/s.GW |
| 14. | Auxiliary power rates including desulphurization: | 5.8 % |
| 15. | Pollutant emission amount based on design coal source | |
| | $SO_2$ | 133 mg/$m^3$ |
| | NOx | 350 mg/$m^3$ |
| | SPM | 40 mg/$m^3$ |
| | Ash and slag | 255,700 t/a |
| | gypsum | 68,900 t/a |
| 16. | Internal investment IRR considering income tax | 14 % |
| 17. | Internal capital IRR： | 25.72% |

| | | |
|---|---|---|
| 18. | ROI (return on investment) | 11.15% |
| 19. | ROE (Rate of Return on Common Stockholders' Equity) | % |
| 20. | Unit Generation Cost per MWh | $60.50/MW.h |
| 21. | Whole power plant staffs | 240 persons |
| 22. | Staffs for each MW power generation | 0.187persons/MW |

# CHAPTER 4

# 4. ANALYSIS OF SUITIBILITY OF DIFFERENT ALTERNATIVES

## 4.1 Introduction

This chapter discusses the alternative considerations that have been studied before finally proposing the present project.The alternatives can be considered for the following major issues

a) Requirement of the proposed project to meet the power demand
b) Selection of the proposed site
c) Selection of the project configurations and technology

The above issues are discussed below.

## 4.2 The No Build Scenario

From a purely physical environmental point of view, the ‘do-nothing’ is preferable to any project implementation, since it would avoid creation of any of the adverse impacts associated with the project. However, the potential socio-economic benefits to the nation would be foregone and industrial growth would be hampered by going for this option.

It is concluded that the ‘No build’ alternative is unacceptable, and the potential socio-economic benefits of implementation of such project far outweighs the adverse impacts which are minor and temporary can be controlled and minimized to an acceptable level.

## 4.3 Consideration of Alternatives

Due to land scarcity in the country, seeking an alternative site for establishing the power plant area is quite difficult. Also, land acquisition is a lengthy and complex procedure under the existing Land Acquisition Law of Bangladesh (LA Ordinance 1982). Not only that, the project conceptual development over alternative sites is quite difficult because delay in overall land acquisition process might create social conflicts and risks for the project.

To avoid or minimize the impacts resulting from the activities of the project, BCPCL authority is expected to adopt appropriate technological design, improvements or adjustments, policy including good site operational practices and applicable EMP and SMP, etc. The overall strategy shall follow the following sequence:

- Impact avoidance or minimization
- Adequate Compensation where impacts are unavoidable
- Enhancement Measures – Employment benefit enhancement measures proposed by the consultants.

# CHPATER 5

# 5. DETAILS DESCRIPTION OF THE LAND COVER/ LAND USE

## 5.1 Land Use

Land use/cover inventories are an essential component in land resource evaluation and environmental studies due to the changing nature of land use patterns. The land use study for the proposed power plant and its 10 km buffer was undertaken with the following objectives:

- To study the land use/cover in the 5 km and 10 km radius areas of the proposed Patuakhali coal based power plant site and provide inputs for environmental planning of the proposed plant by analyzing the existing land use/land cover scenario; and
- To establish the existing base line scenario using a GIS database for incorporation of thematic information on the different physical features including drainage and water bodies, settlements, transport networks and administrative boundaries etc.

#### 5.1.1.1 Land Use Interpretation of the Study Area

The evaluation of the existing environmental status of the study area was divided into 2 zones of 0-5 km and 0-10 km. This revealed that the land use/land cover consists mainly of agricultural land, water bodies and settlement area on land use categories. **Table 5-1** shows the existing land use composition around 2km, 5 km and 10 km of the study area. **Figure 5-1** gives the Land use/Land cover map for 10 km study area shows the land use pattern within 5 km and 10 km of the study area.

**Table 5-1: Existing Land Use Composition around 2km, 5 km and 10 km of the Study Area**

| Land use Category | Area in Acres | | | Percentage (%) | | |
|---|---|---|---|---|---|---|
| | 2 km | 5 km | 10 km | 2 km | 5 km | 10 km |
| Agriculture | 1991.00 | 10293.88 | 46775.05 | 64.33 | 52.28 | 59.82 |
| Water body | 684.27 | 7598.33 | 24969.04 | 22.11 | 38.59 | 31.93 |
| Settlement Area | 419.94 | 1796.06 | 6303.13 | 13.57 | 9.12 | 8.06 |
| Forest Area | - | - | 142.18 | - | - | 0.18 |
| **Total** | **3095.21** | **19688.27** | **78189.40** | **100.00** | **100.00** | **100.00** |

*Source: Physical feature Survey by Consultants, 2014*


**Figure 5-1: Land use/Land Cover Map for 10 km Study Area**

#### 5.1.1.2 Land Use Interpretation of the Project Site

It is clearly evident from the **Table 5-2** that agricultural land use with about 84 percent of the share of total land uses dominates the study area. Agriculture land use includes all types of cultivated land/barren land.

**Table 5-2: Existing Land Use of the Project Area**

| Landuse Category | Area in Acres | Area in Hectares | Percentage (%) |
|---|---|---|---|
| Agriculture | 832.70 | 336.90 | 84.73 |
| Water body | 74.49 | 30.14 | 7.57 |
| Settlement Area | 72.51 | 29.34 | 7.37 |
| Road Network | 3.07 | 1.24 | 0.31 |
| **Total** | **982.77** | **397.62** | **100.00** |

***Source****: Land Use Survey by the Consultant, 2014*

In the entire Project area the major land use goes to Agriculture that constitute 832.70 acres which is 84.73% of the total Project area. The second major land use is water body that occupy 7.57% (74.49 acres) of the project area. There exists scattered rural settlement which covers an area of 72.51 acres of land. Besides, there is about 3.07 acres of land under transport and communication network within the project area. Details about land use have been provided in **Table 5-2** and generalized land use pattern of Project area has been presented in **Figure 5-2**.

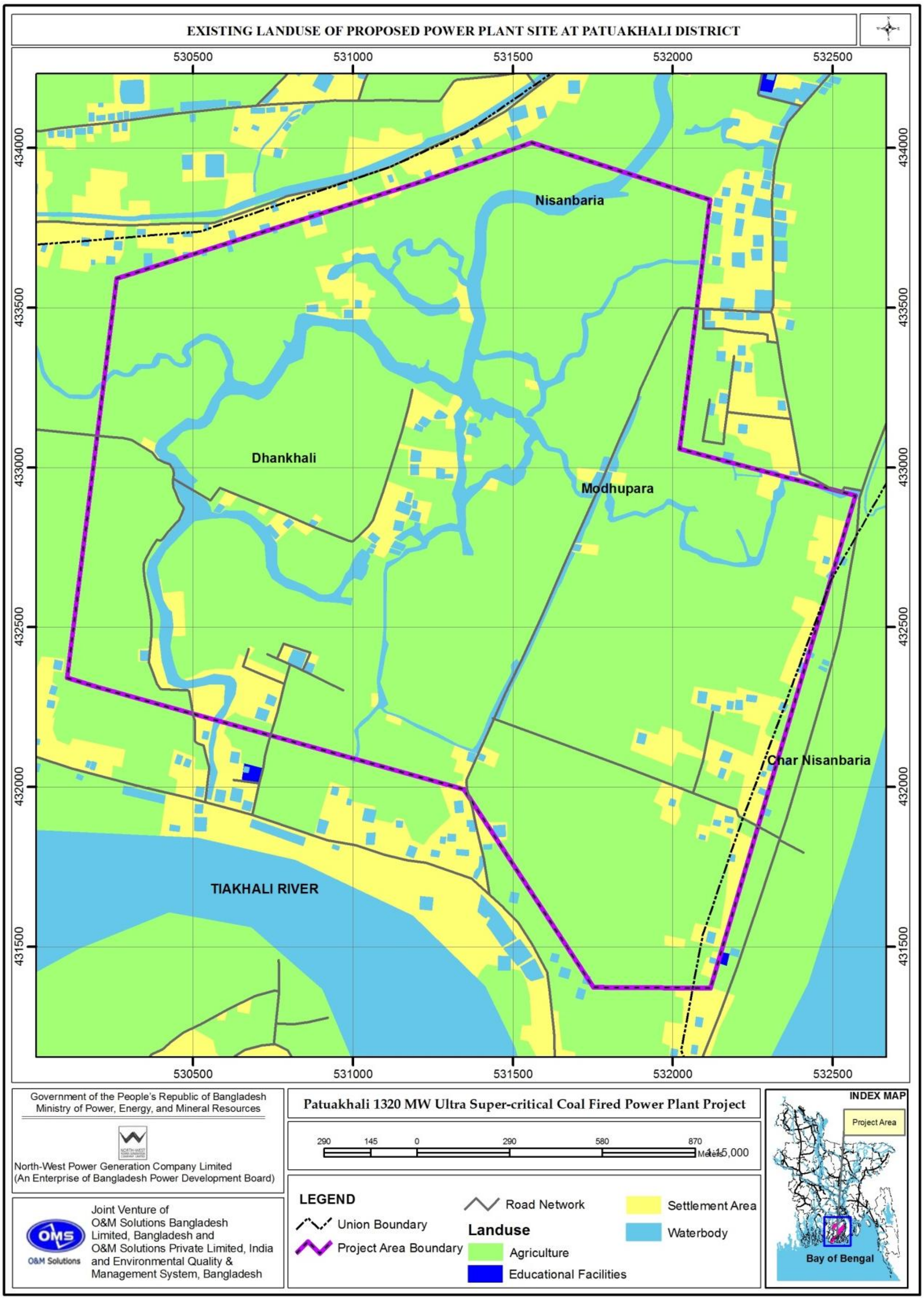



**Figure 5-2: Existing Generalized Land-use Pattern of the Project Site**

### 5.1.2 Topography Interpretation of the Study Area

The spot levels are denser, where the undulation of terrain is frequent. The general topography of the project site is almost flat land. The contours have been drawn from the spot level data with an interval of 0.3 mPWD and the grid interval was 50 meter. As per specified interval of spot level survey, heights (value) of 1188 spots have been collected from the field level survey (**Table 5-3**). The lowest spot height is -0.248 mPWD and the highest spot height are found 1.967 mPWD in the Project site. Average land height of the project area is 3.2218mPWD. The representative height is between 1.00 mPWD to 1.999 mPWD, which comprises about 56.23% of the spots surveyed (**Table 5-4**). **Figure 5-3** shows the digital elevation model of 10 km study area. **Figure 5-4** shows the contours and **Figure 5-5** shows the elevation of land surface in the Project Site.

**Table 5-3: Unit Wise Spot Height in the Project Site**

| Spot unit | Value (mPWD) |
|---|---|
| Total Spot Number | 1188 |
| Mean | 1.967 |
| Maximum Height | 3.797 |
| Minimum Height | -0.248 |
| Variance | 0.185 |
| Standard Deviation | 0.430 |

*Source: Topographic Survey by EQMS, 2014*

**Table 5-4: Percent Distribution of Spot According the Height Interval**

| Spot interval | Spot number (Frequency) | Percentage |
|---|---|---|
| Below 0.0 | 03 | 0.253 |
| 0.0 - .999 | 30 | 2.53 |
| 1.00 - 1.999 | 668 | 56.23 |
| 2.00 - 2.999 | 457 | 38.47 |
| More than 3.00 | 30 | 2.53 |
| | 1118 | 100.000 |

*Source: Topographic Survey by EQMS, 2014*

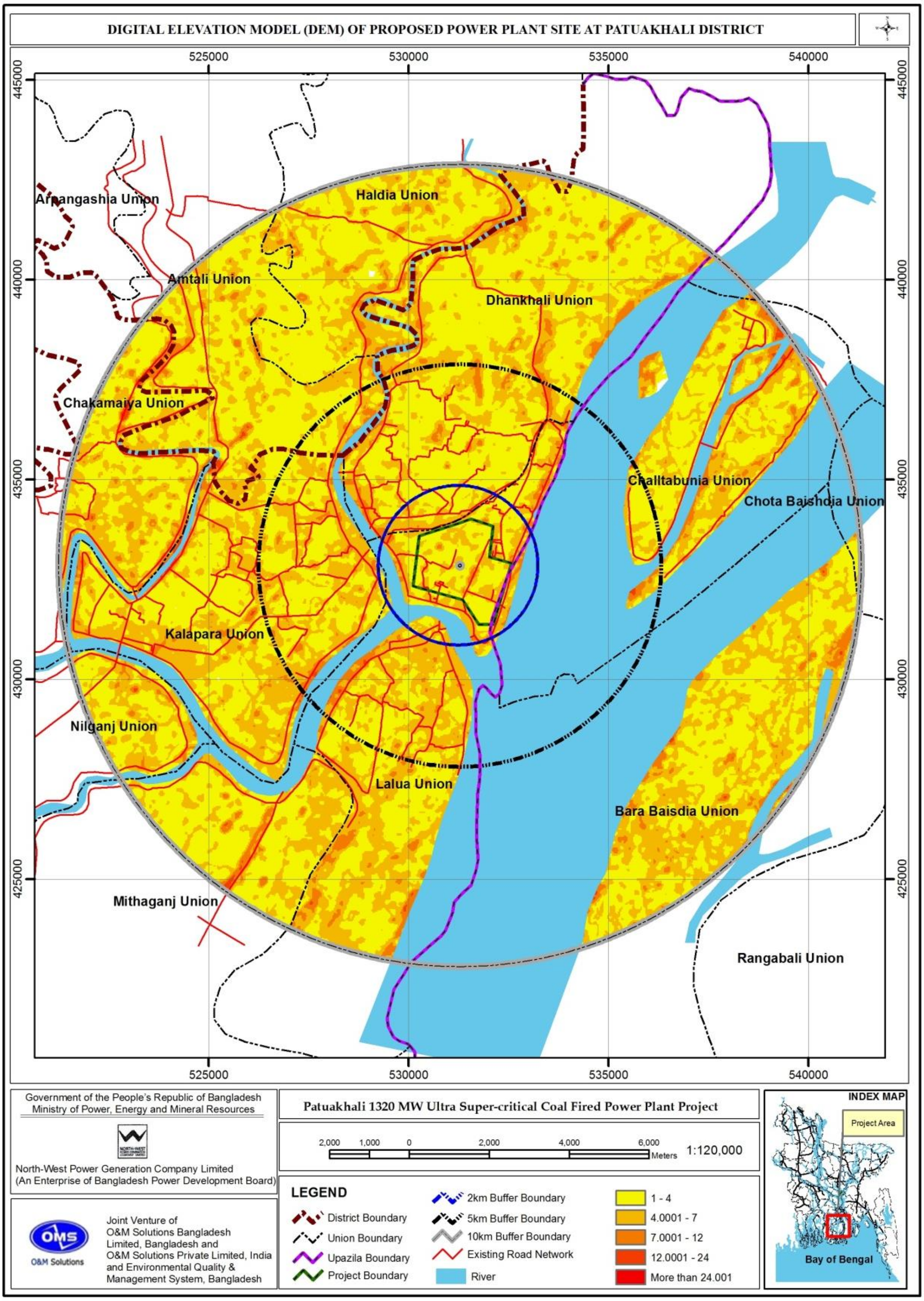



**Figure 5-3: Digital Elevation Model (DEM) for 10 Km Study Area**

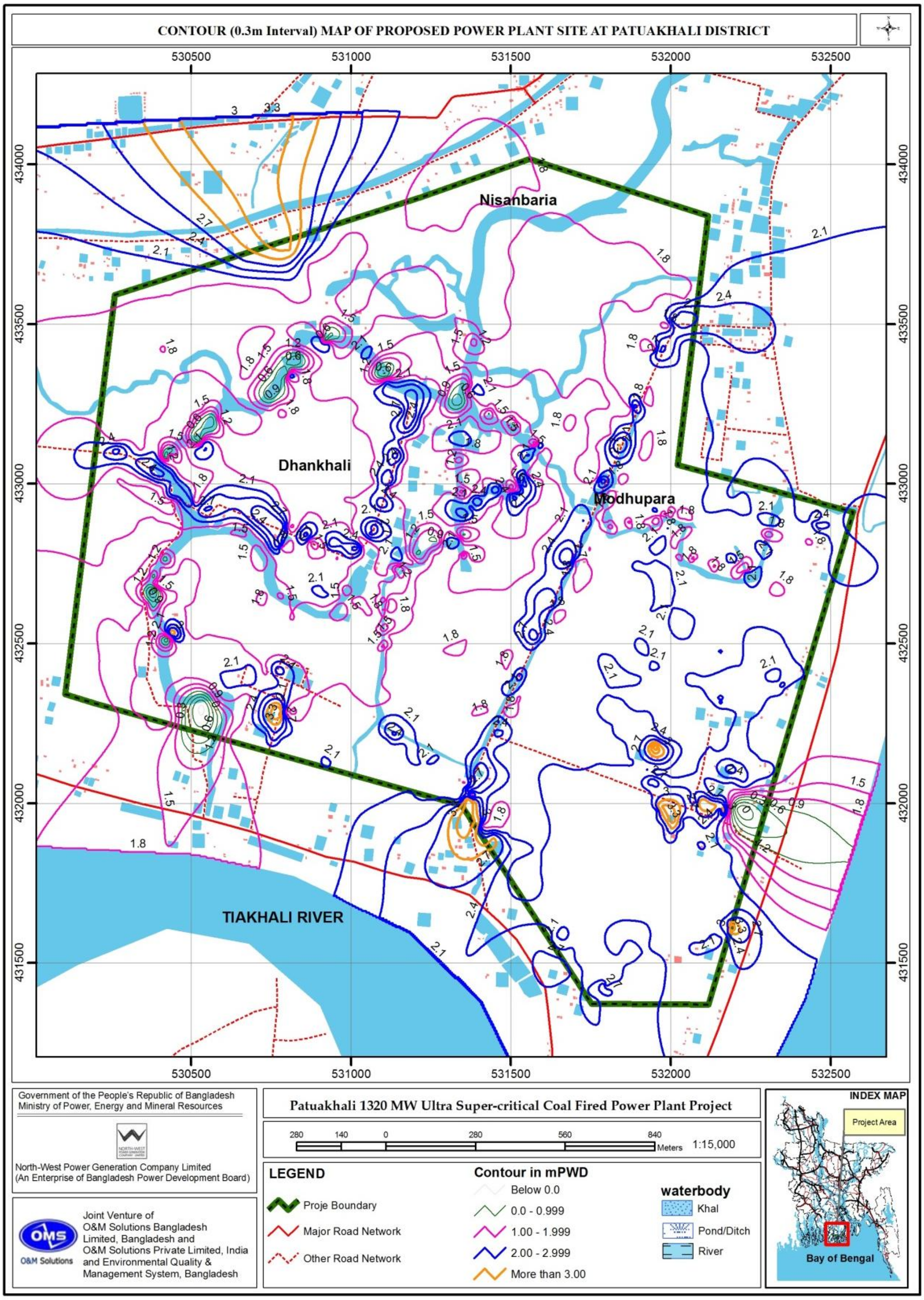



**Figure 5-4: Contours (0.3m) of Proposed Power Plant Site at Patuakhali**

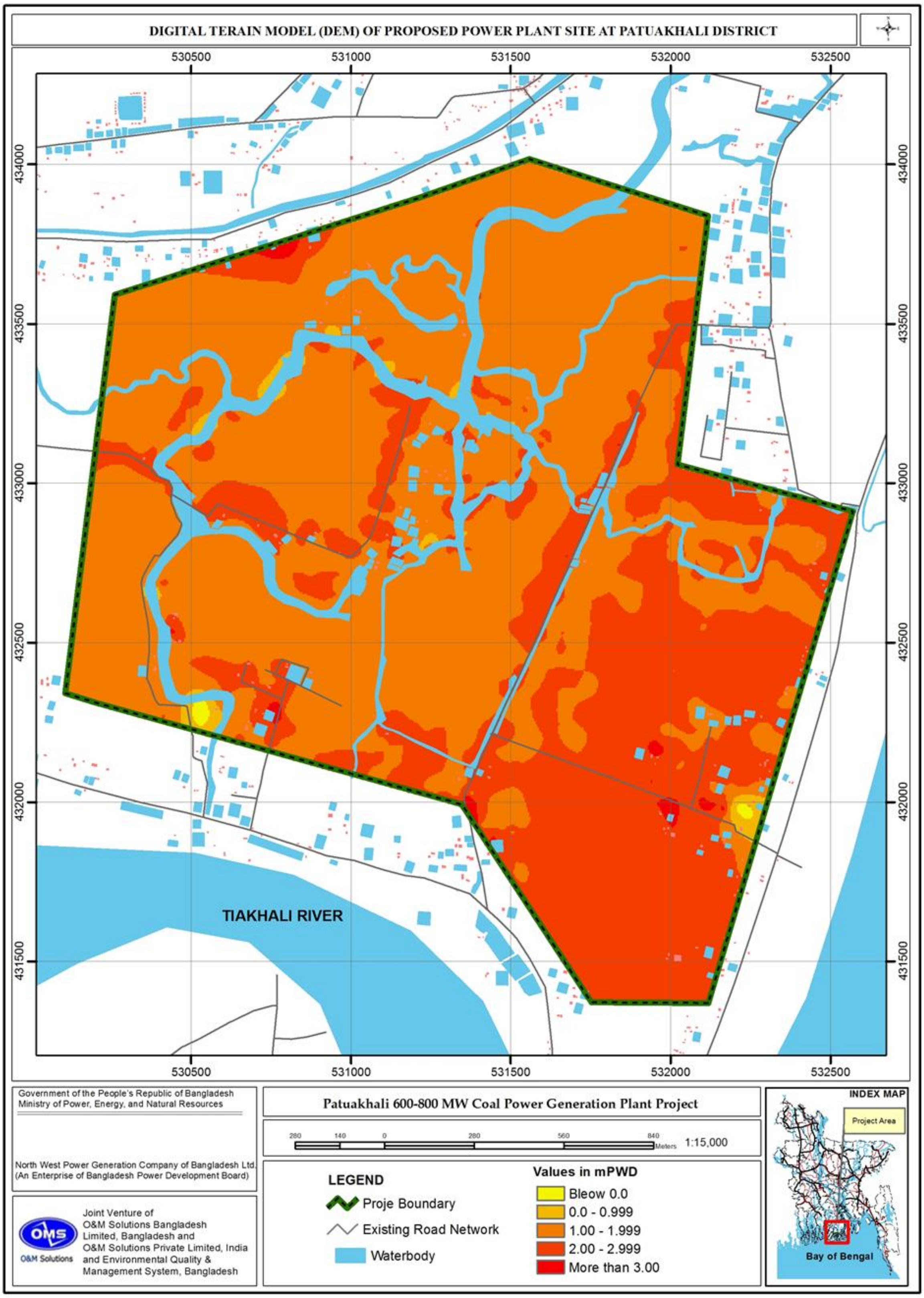



**Figure 5-5: Digital Elevation Model of Proposed Power Plant Site at Patuakhali**

### 5.1.3 Physical Feature of the Project Site

The findings of physical feature survey consist of all structures according to their uses as residential, commercial, education, religious, and community facilities, roads, water bodies etc (**Figure 5-6**).

It has been found from physical feature survey that, all the existing structures within the project area are Katcha (including jhupri and tinshed structure). Total 120 structures with trees will be imapacted by the proposed power plant. Most of the existing structures have been used as residential purposes in the project area.

No community facilities like mosque, hospital, clinic and graveyards etc have been found in the project area. About 6.25 km of katcha road network has been found within the project area. There exists about 74 numbers of pond/ditch while about 12.65 km of natural khal network found within the project area. Existing Physical features of the Project Area have been presented in the **Figure 5-6**.

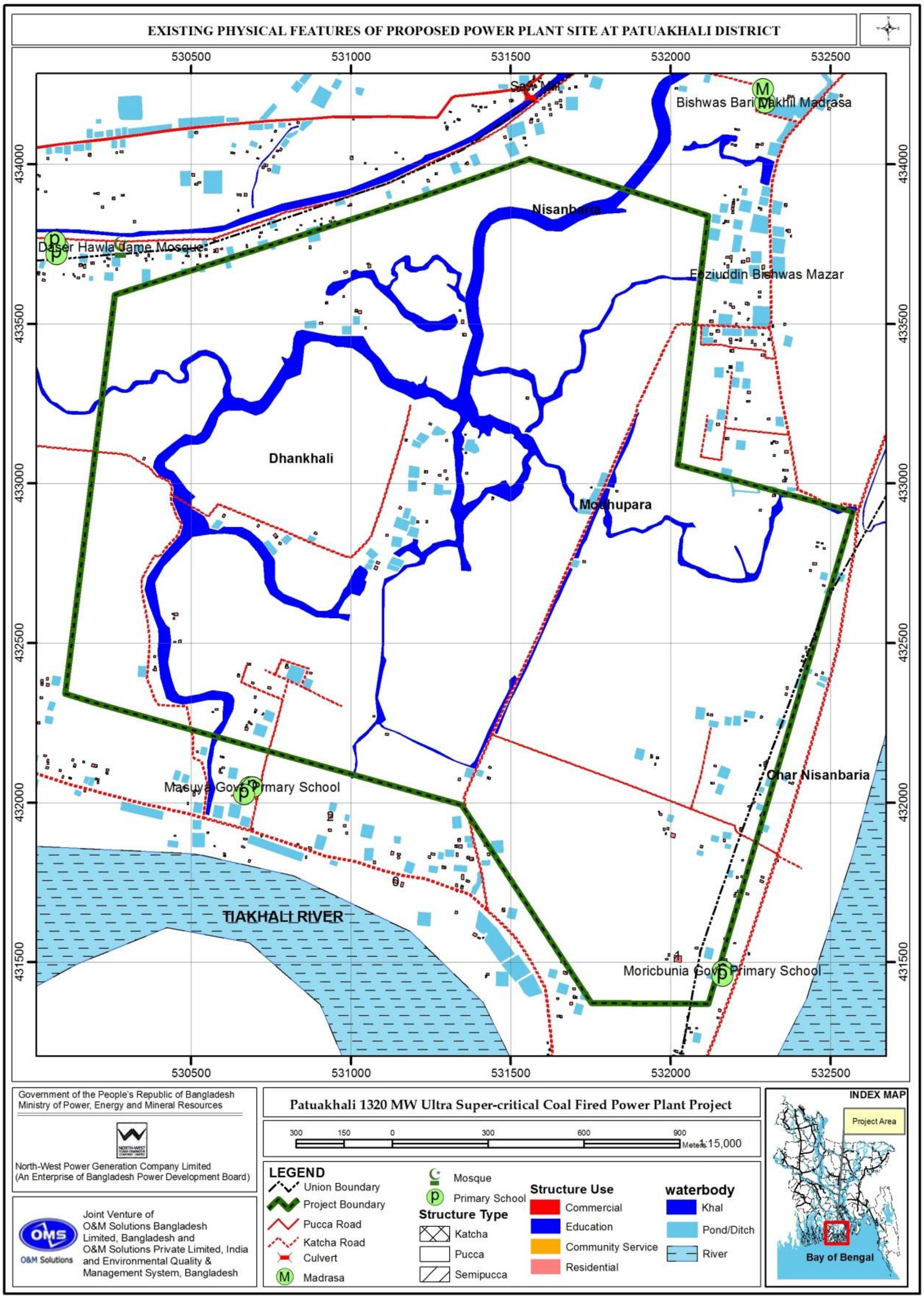



**Figure 5-6: Existing Physical Features of the Project Site**

# CHAPTER 6

# 6. DESCRIPTION OF ENVIRONMENT

## 6.1 Study Area

This section discusses the existing conditions within the Project study area, covering both the natural and social environments. The analysis was completed through the use of a combination of secondary data sources in addition to extensive on-ground reconnaissance and baseline studies.

To establish an understanding of the environmental and socio-economic baseline of the Project area, baseline monitoring was carried out two times April 2014 and two months from November 2014 to December 2014.

The project area is located on agricultural land with some settlement. Rabnabad Channal and Andharmanic River flows south and west side of the project area. The 10 km study area map is shown in **Figure 6-1**.The project site is located at Dhankhali union in Kalapara Upazila of Patuakhali district. Google image is showing the project footprint area in **Figure 6-2.**

The physical setting around the proposed project site is described as follows:

- **North –** Settlements and canal
- **East -** Settlement
- **South –** Rabnabad Channel
- **West –** Andharmanic River

Land use in the immediate vicinity of the project area is mainly rural. The settlements near the project area are relatively low populated area.

### 6.1.1 Objective and Methodology

The primary objective of the environmental and social baseline condition study is to provide an environmental and social baseline against which potential impacts from the construction and operational phases of the Project can be compared.

The methodology adopted for collecting the baseline data was as follows:

- Study area of 10 km radial zone from the centre of the proposed Project location was selected for the baseline studies.
- The environmental and social field monitoring and survey was carried out during the period of November 2014 to December 2014.
- Primary data collection was through environmental monitoring and field survey for water, air, soil, noise and ecology.
- Social baseline of the study area was captured through social surveys involving field consultations, interviews, meeting with stakeholders, discussions with government departments and secondary data review etc.
- Secondary data was collected from government reports, academic institutes, websites, published literature, interactions with government department and stakeholders etc.

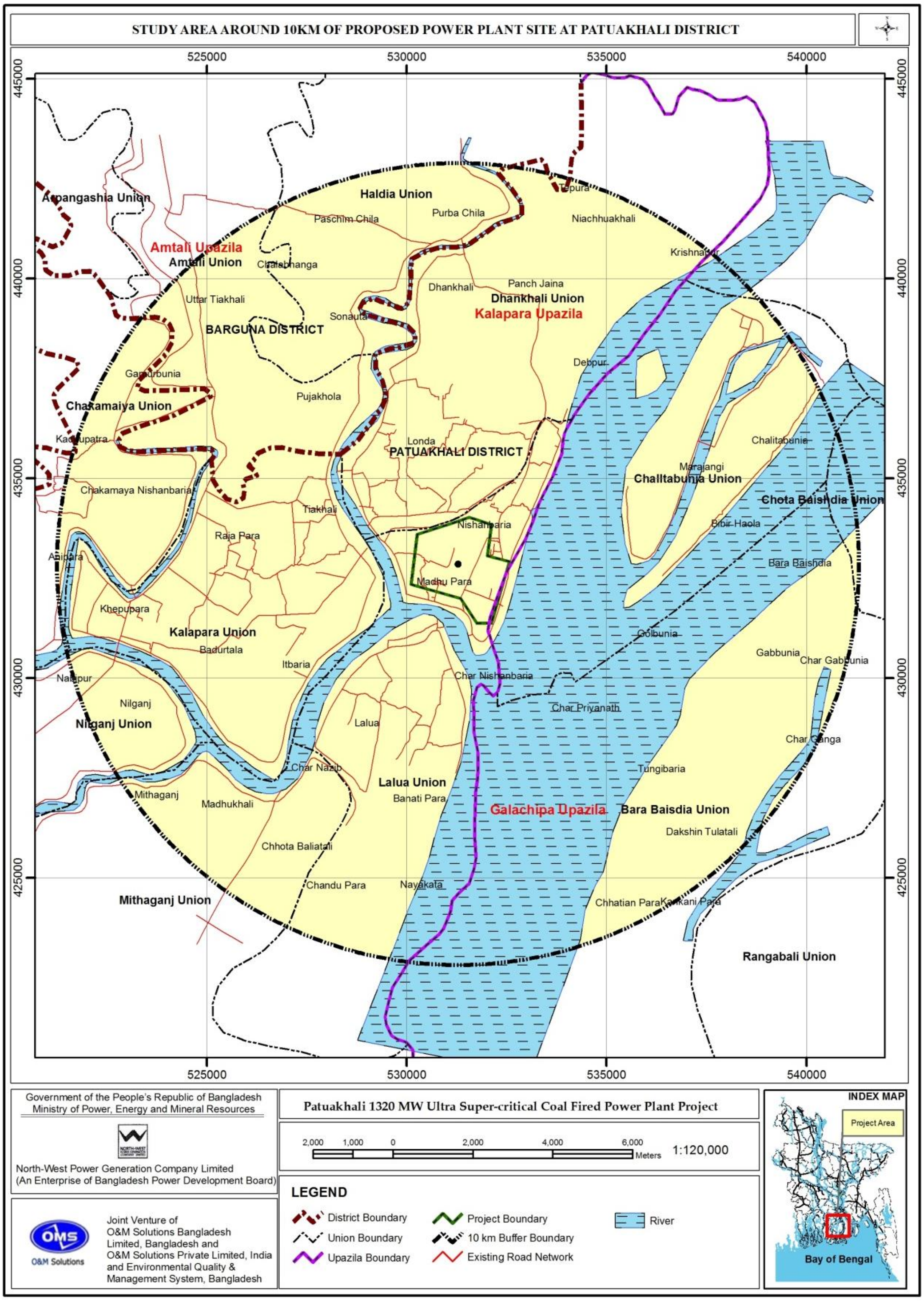



**Figure 6-1: 10 km Study Area Map**

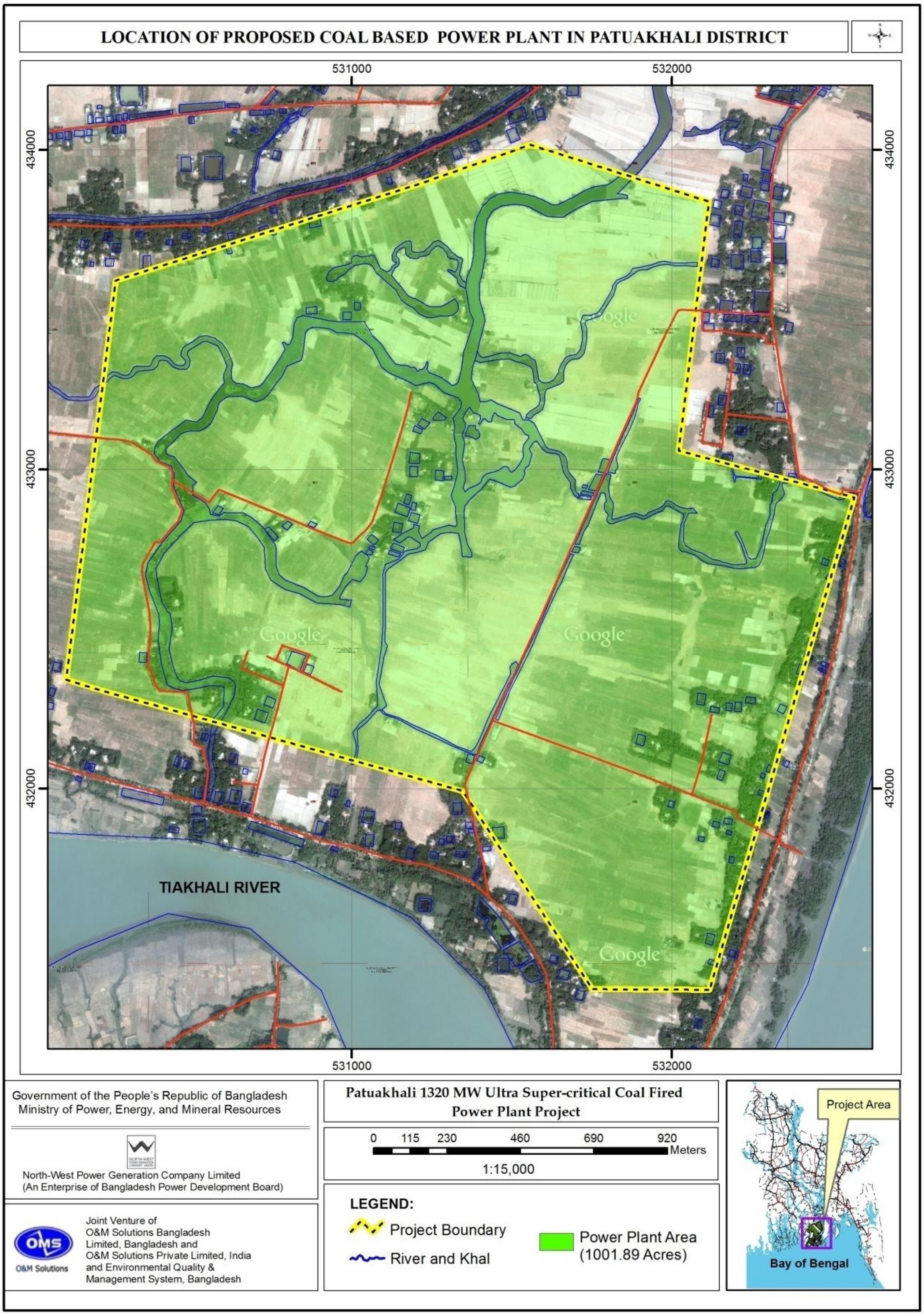



**Figure 6-2: Google Image Showing the Proposed Project Footprint Area**

## 6.2 Coal Availibility, including distance to “Mine Mouth”, the non sterilization coal reserves and the feasibility of dictance between stations and coal

The details of coal specification, availability and transportation has been depicted in **Section 3.1.9** and **3.1.10**

## 6.3 Water Availability

Analysis of water availability of the Rabnabad Channel was required to examine the fact that river has enough water to fulfill the requirement of the power plant for its cooling and other operational purpose. It was estimated that about 84 $m^3/s$ water would be required for the plant operation.

The availability of water though was not estimated in the present study due to absence of discharge data. However, data from a secondary source has been used to access the availability of the water in the river. The upstream flow through Rabnabad Channel mainly comes from the Tentulia River. About 10 – 20% flow of the Lower Meghna River pass through the Tentulia River. The river discharge of three majo r rivers of the country, such as the Ganges, Jamuna and Upper Meghna River, dominates the river inflow in the Meghna Estuary. According to IWM study (2014), it shows that, maximum flow in the Rabnabad Channel varies from 40,000 – 44,000 $m^3/s$ from dry to monsoon period. Hence, the water availability for the proposed power plant would not be a problem at all.

## 6.4 Sorbenet Availibilty

These data will be provided during details design stage of the power plant.

## 6.5 Physiography, Geology & Hydrogeology

### 6.5.1 Physiography

The physiography is the form of the earth’s surface. In Bangladesh this may be classified into three distinct physiographic regions (a) floodplains, (b) terraces, and (c) hills. Each physiographic region has unique distinguishing characteristics. The three main physiographic regions can be further subdivided into 24 sub-regions and 54 units.

The Project area occurs primarily within the Floodplain physiographic region and within the Ganges Tidal Floodplain physiographic sub-region as shown in **Figure 6-3**. The Ganges Tidal Floodplain landscape is characterized by low ridges and basins crossed by numerous tidal rivers and creeks. Differences in elevation across this physiographic region are generally less than one meter.

### 6.5.2 Geology

Bangladesh occupies a major part of the Bengal delta, one of the largest deltas in the world. The geological evolution of Bangladesh is related to the uplift of the Himalayan Mountains and outbuilding of deltaic landmass by major river systems in this delta. Thus the geology of Bangladesh is largely characterized by the rapid subsidence and filling of the Bengal Basin in which a huge thickness of deltaic sediments were deposited as a mega-delta out built in the past which then progressed towards the south of the country over time. The delta building still continues with material adding to the present Bay of Bengal.

Only the eastern part of Bangladesh has been uplifted into hilly landform incorporating itself into the frontal belt of the Indo-Burman range lying to the east. These landforms and processes have resulted from the Indian plate colliding with the Asian plate as explained by plate tectonics (Banglapedia, 2012).

Bangladesh is divided into two major tectonic units, the Stable Precambrian Platform in the northwest, and the Geosynclinal Basin in the southeast. The Project area occurs within the Geosynclinal Basin which is characterized by the vast thickness (maximum of about 20 km near the basin centre) of clastic sedimentary rocks, mostly sandstone and shale of Tertiary age (Banglapedia, 2012). The thickness of sediments in the basin is a result of tectonic mobility or instability of the areas causing rapid subsidence and sedimentation in a relatively short span of geologic time. The Geosynclinal Basin underlying Bangladesh is subdivided into two parts, that is, fold belt in the east and a foredeep to the west.

The fold belt is characterized by folding of the sedimentary layers into a series of anticlines (upward folds) and synclines (downward folds). The anticlines form the hills and the synclines form valleys as seen in the topography of the eastern Chittagong-Comilla-Sylhet regions. The intensity of the folding is greater towards the east of the country, causing higher topographic elevation in the eastern Chittagong hill tracts. As the intensity of folds decreases towards the west, the fold belts unit merges with the foredeep unit, which is characterised by only mild or no folding. Sedimentary layers are mostly horizontal to sub-horizontal and are free from major tectonic deformation in the foredeep area. This area covers the central part of the Basin, including the Project area, and is expressed as river to delta plain topography of the land (Banglapedia, 2012).

The geology of the Project area then primarily consists of deep sediments overlaying sedimentary rock. The geology of Bangladesh, showing the Project area is described in **Figure 6-4**. The sediments in the region contain mica and small pockets of gas, rendering them prone to failure when disturbed (either through cyclic loading associated with cyclone waves or through strain during earthquakes). The effect of cyclone waves has been estimated to be confined to the top 1.5 meters of sediments, although this will vary locally. The sediments are mainly non-calcareous clays, but on the riverbanks and in a transitional zone in the east adjoining the lower Meghna, they are silty and slightly calcareous (Banglapedia, 2012).

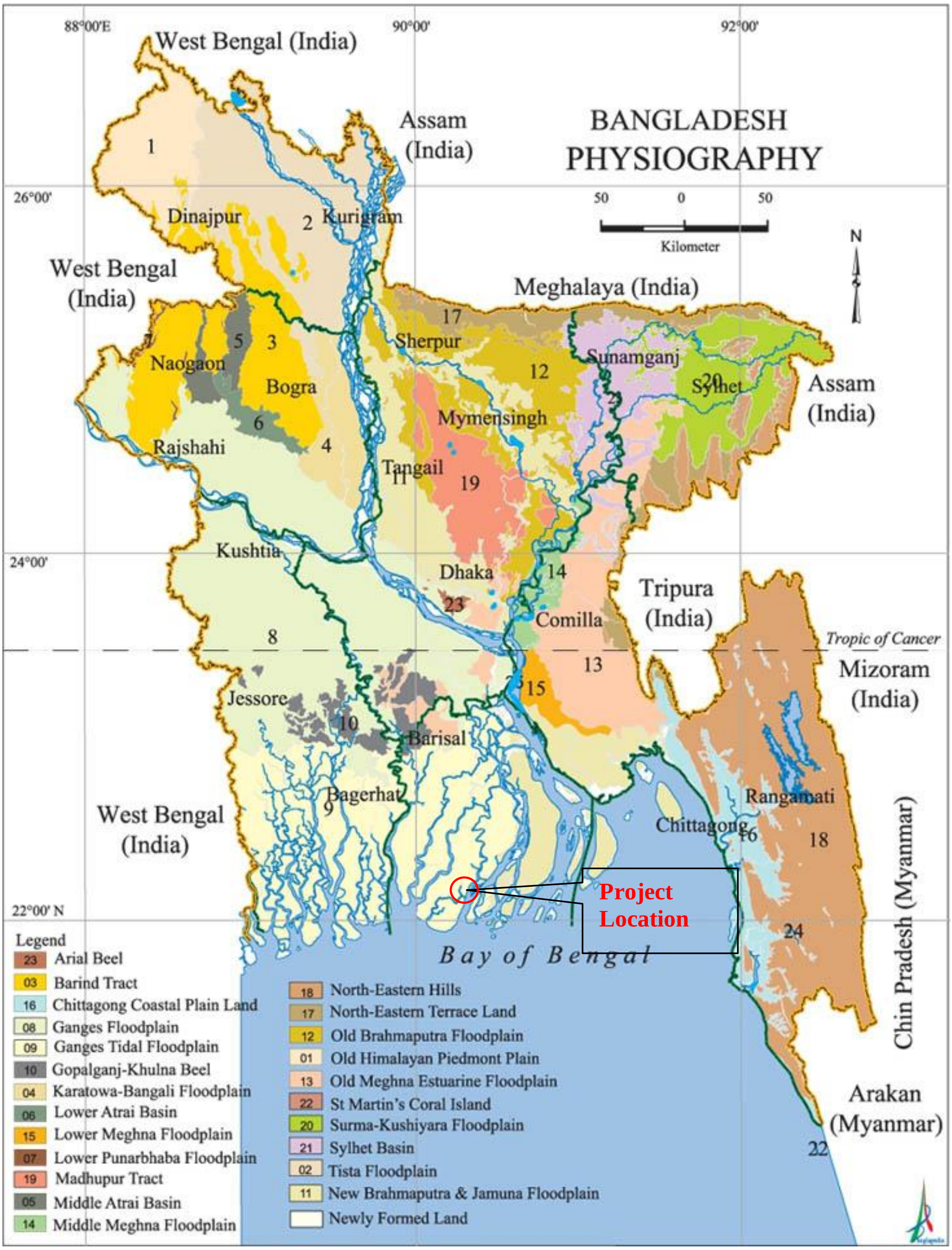



**Figure 6-3: Physiographic Sub-region of Bangladesh**

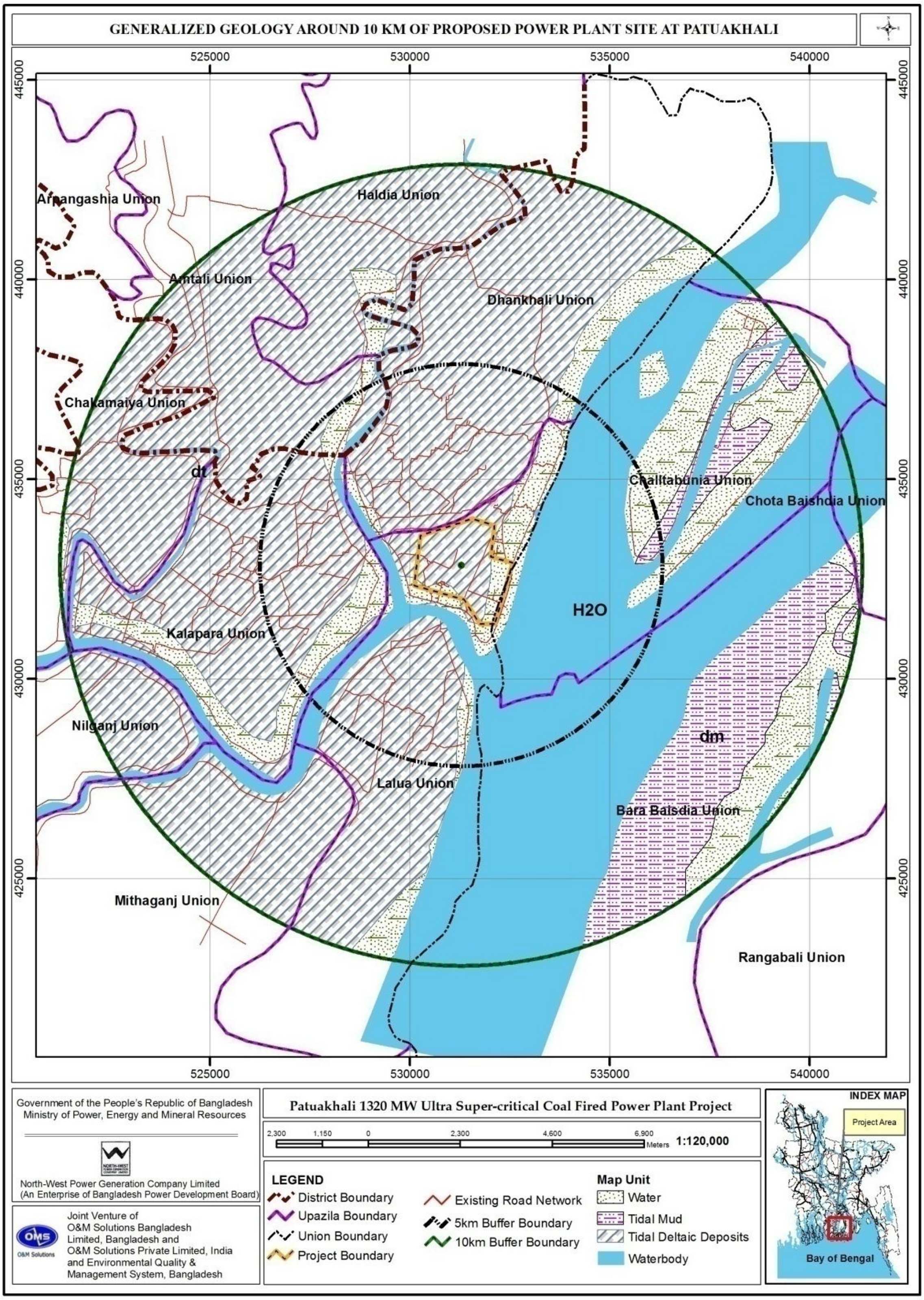



**Figure 6-4: 10 km Generalized Geology Map of the Study Area**

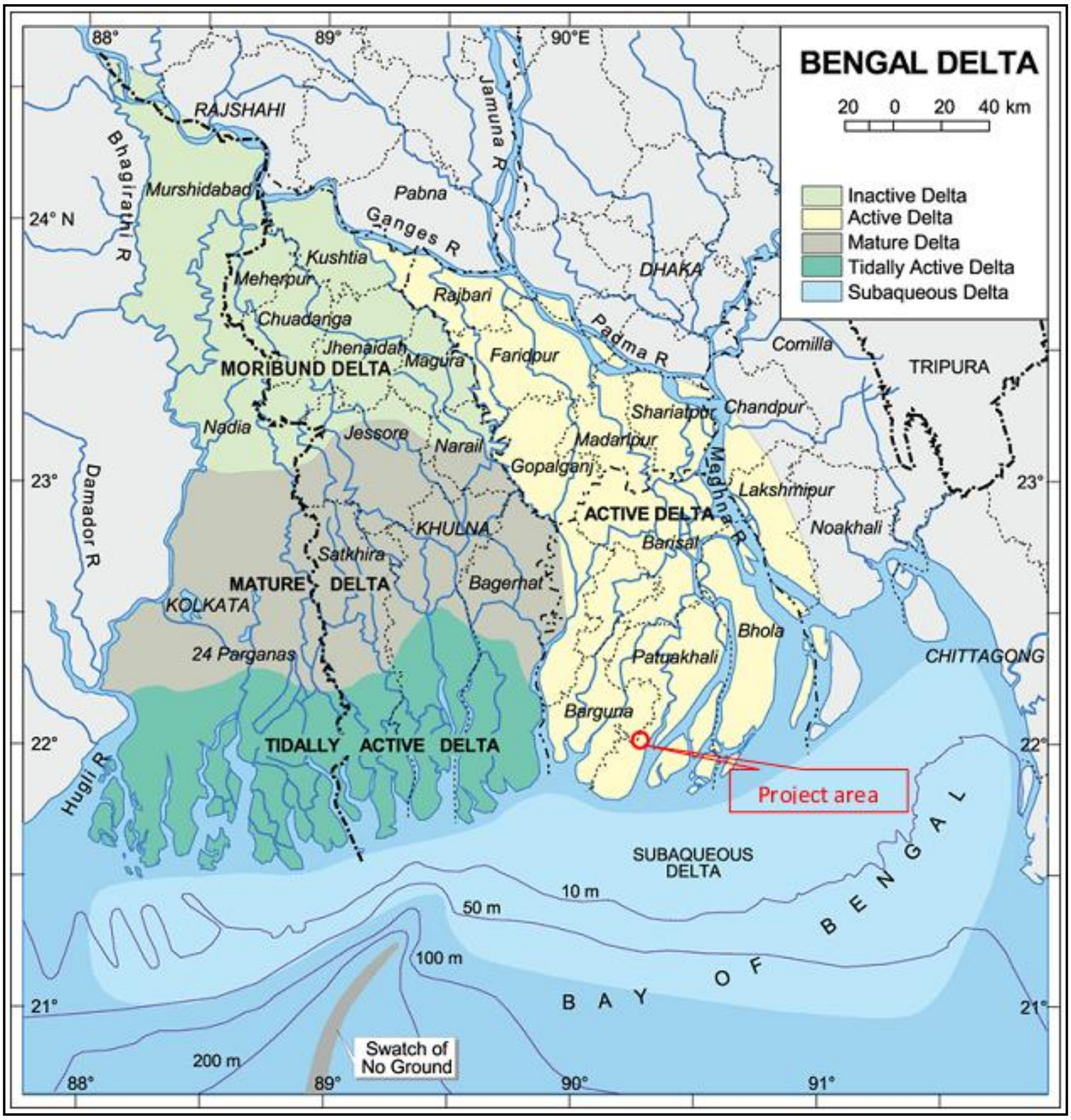



**Figure 6-5: Patukhali: Part of an Active Delta**

## 6.6 Meteorology

### 6.6.1.1 Climate

Several climatic zones occur within Bangladesh, with the study area falling within the North-eastern region as illustrated in **Figure 6-6**. This region includes most of East and South Sylhet, as well as a narrow strip of land south of the Meghalaya Plateau. The climate of Bangladesh is heavily influenced by the Asiatic monsoon pattern that creates three distinct seasons within the study area:

1. Pre-monsoon hot season (from March to May);
2. Rainy monsoon season (from June to October); and
3. Cool dry winter season (from November to February).

Mean daily maximum temperature rarely exceeds 32°C, and mean daily minimum temperature is approximately 10°C. Average humidity is relatively high, often exceeding 80%, and most rainfall occurs in summer. Fog is very common in winter, and study area is located in the cloudiest part of the country (Rashid, 1977). High temperatures and thunderstorms characterize the pre-monsoon, hot season. April is the hottest month in the country, with mean temperatures ranging from 27°C in the east and south, to 31°C in the west-central part of the country. After April, increasing cloud cover reduces the temperature. Wind direction is variable during this pre-monsoon season, especially in the early stages of the season. Rainfall during this period, mostly caused by thunderstorms, can account for 10 to 25% of the annual total (Rashid, 1977).

The summer monsoon season is typified by Southerly or South-westerly winds, very high humidity and heavy rainfall, as well as long periods of consecutive days of rainfall. These conditions are caused by tropical depression weather systems entering the country from the Bay of Bengal. About 80% of the annual precipitation occurs during the five-month monsoon season from May to September (Rashid, 1977).

Low temperatures, cool air blowing from the west or northwest, clear skies and low levels of rainfall characterize the dry season. The average temperature in January varies from 17°C in the northwest and north-eastern parts of the country to 20°C to 21°C in the coastal areas. Minimum temperatures in the extreme northwest in late December and early January reach between 3°C to 4°C.

Long-term average climatic data collected at the nearby Khepupara weather station (2003 to 2012) reflect the monsoonal effects on climate in this region (Bangladesh Meteorological Department, Dhaka 2014):

- M maximum temperature 33.9 ($^0$C)
- Mean daily minimum temperature 13.5 ($^0$C)
- Mean annual relative humidity 83%
- Mean annual rainfall 2632 (mm)

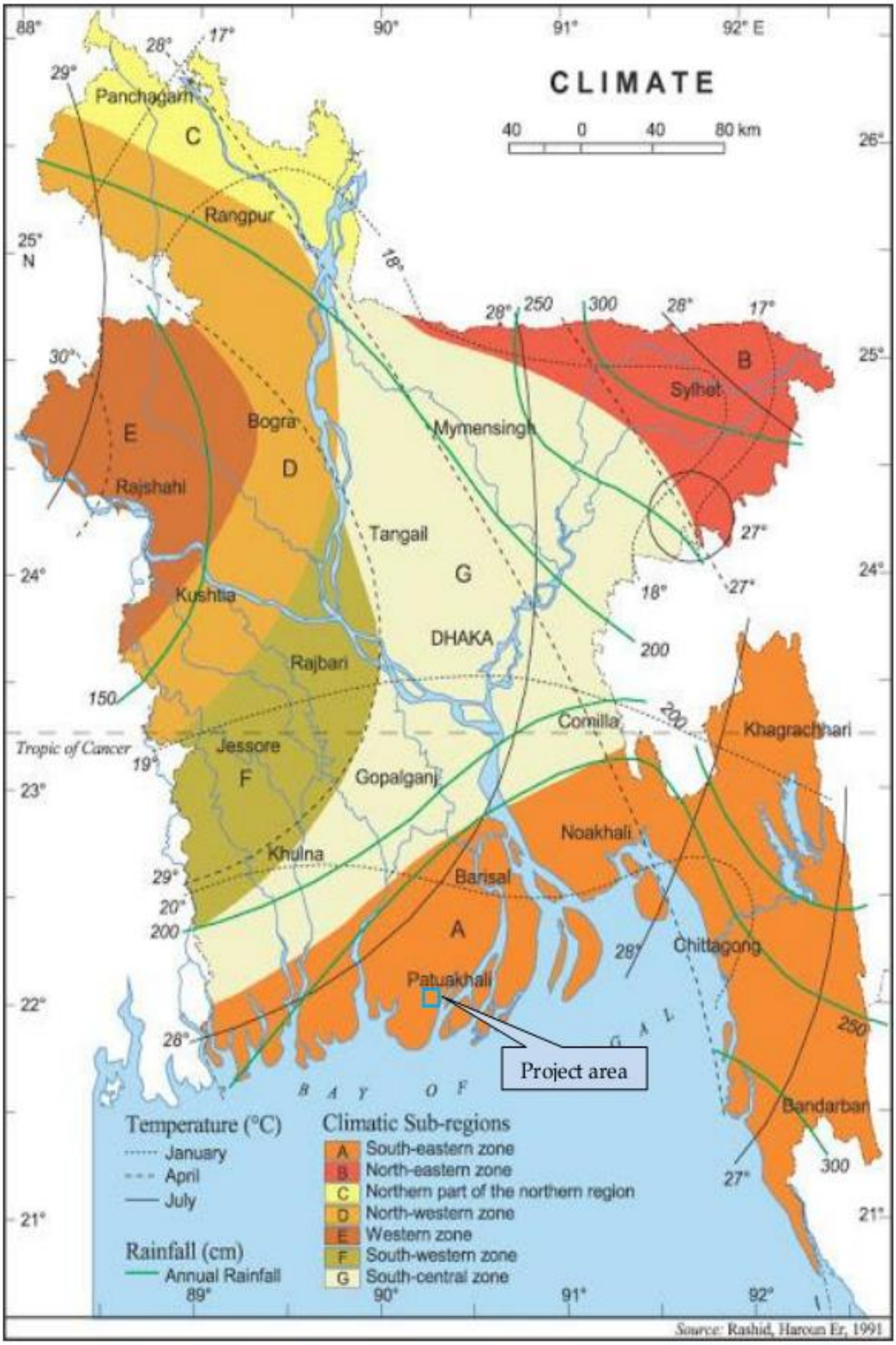



**Figure 6-6: Climatic Sub Regions of Bangladesh**

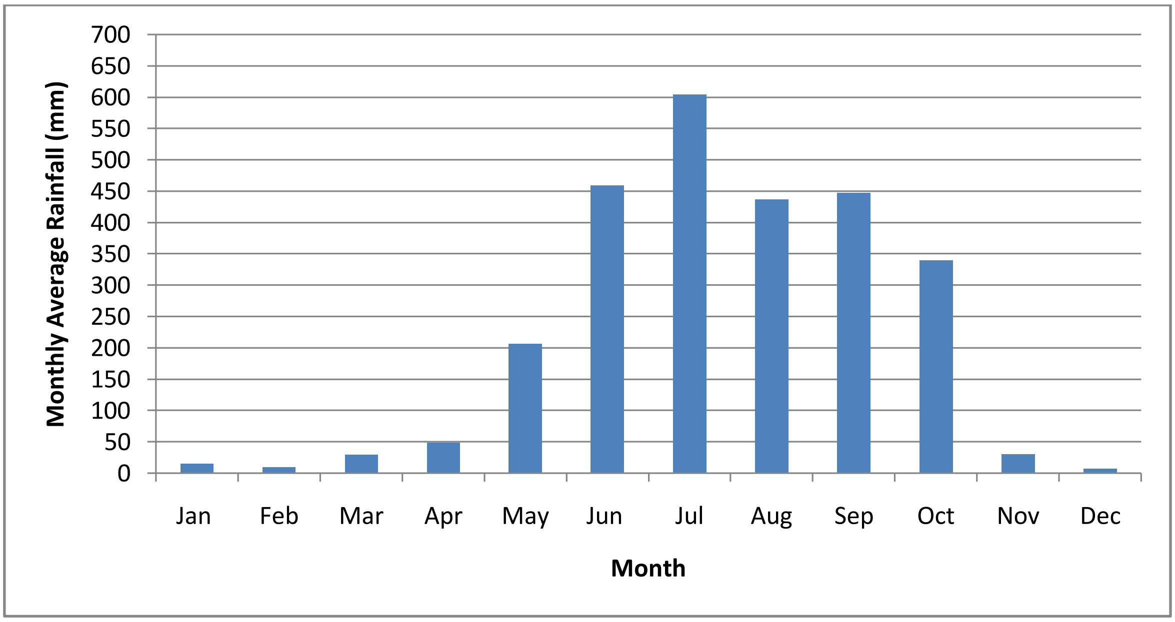
### 6.6.1.2 Rainfall and Humidity

The monthly and yearly rainfall recorded at the Sreemangal weather station is shown in **Table 6-1** and **Figure 6-7**. The records show that average monthly rainfall is highest from April through to October. The highest annual rainfall (3,348mm) recorded within the last 10 years was in the year of 2005, while the lowest annual rainfall (1,895mm) was recorded in 2012.

**Table 6-1: Total Monthly and Annual Rainfall (mm), Sreemangal Weather Station**

| Year | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec | Annual |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **2003** | 0 | 8 | 109 | 79 | 165 | 703 | 404 | 290 | 239 | 392 | 0 | 46 | 2435 |
| **2004** | 0 | 1 | 16 | 64 | 103 | 479 | 325 | 591 | 672 | 221 | 0 | 0 | 2472 |
| **2005** | 95 | 0 | 93 | 6 | 166 | 473 | 1000 | 489 | 475 | 534 | 1 | 16 | 3348 |
| **2006** | 0 | 0 | 0 | 65 | 452 | 389 | 611 | 398 | 699 | 23 | 11 | 0 | 2648 |
| **2007** | 10 | 37 | 0 | 80 | 227 | 240 | 926 | 334 | 557 | 693 | 127 | 0 | 3231 |
| **2008** | 40 | 35 | 1 | 28 | 111 | 438 | 931 | 459 | 514 | 467 | 0 | 0 | 3024 |
| **2009** | 0 | 0 | 2 | 45 | 210 | 221 | 758 | 439 | 323 | 239 | 52 | 0 | 2289 |
| **2010** | 0 | 17 | 0 | 5 | 371 | 681 | 340 | 279 | 237 | 604 | 29 | 5 | 2568 |
| **2011** | 0 | 0 | 17 | 34 | 180 | 680 | 356 | 655 | 406 | 80 | 6 | 0 | 2414 |
| **2012** | 7 | 2 | 48 | 80 | 79 | 287 | 392 | 439 | 348 | 142 | 71 | 0 | 1895 |
| **Average** | **15** | **10** | **29** | **49** | **206** | **459** | **604** | **437** | **447** | **340** | **30** | **7** | **2632** |

*Source: Bangladesh Meteorological Department, Dhaka.*




*Source: Bangladesh Meteorological Department, Dhaka.*

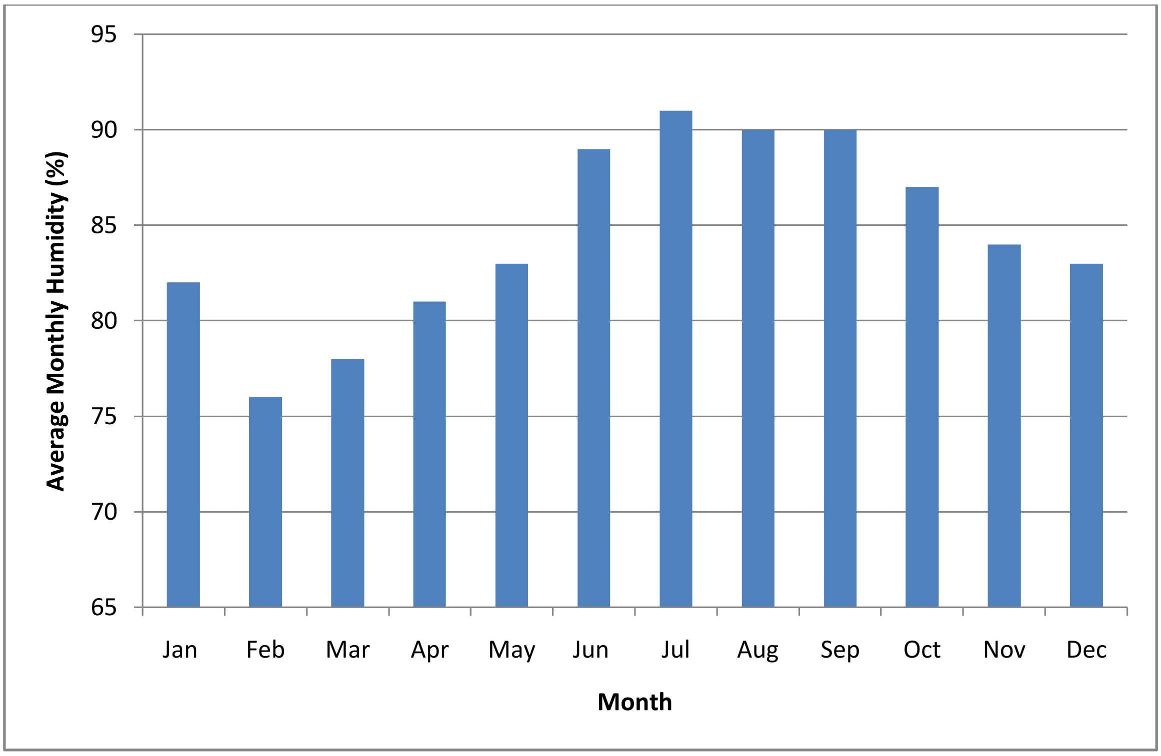
**Figure 6-7: Average Monthly Rainfall (2003-2012), Khepupara Weather Station**

Relative humidity remains fairly constant from June to December, though on average it is higher in January to May as shown in **Table 6-2** and **Figure 6-8**. This observed change in humidity correspond with the pre-monsoon and dry seasons within the study area.

**Table 6-2: Average Monthly Relative Humidity (%), Khepupara Weather Station**

| Year | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **2003** | 84 | 83 | 80 | 82 | 84 | 92 | 90 | 89 | 90 | 88 | 85 | 87 |
| **2004** | 83 | 75 | 84 | 88 | 84 | 88 | 89 | 90 | 90 | 87 | 83 | 80 |
| **2005** | 78 | 74 | 80 | 80 | 82 | 87 | 89 | 90 | 89 | 89 | 84 | 81 |
| **2006** | 79 | 78 | 72 | 77 | 83 | 88 | 90 | 89 | 89 | 86 | 84 | 82 |
| **2007** | 79 | 79 | 71 | 82 | 82 | 89 | 93 | 90 | 92 | 86 | 83 | 77 |
| **2008** | 78 | 73 | 79 | 78 | 79 | 89 | 91 | 88 | 89 | 86 | 83 | 86 |
| **2009** | 82 | 75 | 76 | 80 | 81 | 85 | 91 | 90 | 88 | 86 | 82 | 82 |
| **2010** | 87 | 80 | 83 | 83 | 85 | 92 | 94 | 94 | 93 | 91 | 91 | 88 |
| **2011** | 86 | 75 | 73 | 80 | 84 | 90 | 89 | 91 | 91 | 86 | 83 | 84 |
| **2012** | 81 | 72 | 77 | 80 | 85 | 85 | 90 | 89 | 90 | 86 | 83 | 85 |
| **Average** | **82** | **76** | **78** | **81** | **83** | **89** | **91** | **90** | **90** | **87** | **84** | **83** |

*Source: Bangladesh Meteorological Department, Dhaka.*




*Source: Bangladesh Meteorological Department, Dhaka.*

**Figure 6-8: Average Monthly Humidity (2003-2012), Khepupara Weather Station**

#### 6.6.1.3 Temperature

The monthly average minimum and maximum temperatures recorded at the Khepupara weather station are presented below in **Table 6-3** and **Table 6-4** respectively. The lowest average temperature recorded in the past 10 years was in January 2011 & 2012 (12.1°C). The highest average temperature reached 35°C in May 2012. Throughout the year the highest temperatures are generally in March through October, and the lowest temperatures are from December to January (**Figure 6-9**).

**Table 6-3: Average Monthly Miximum Temperature ($^0$C), Khepupara Weather Station**

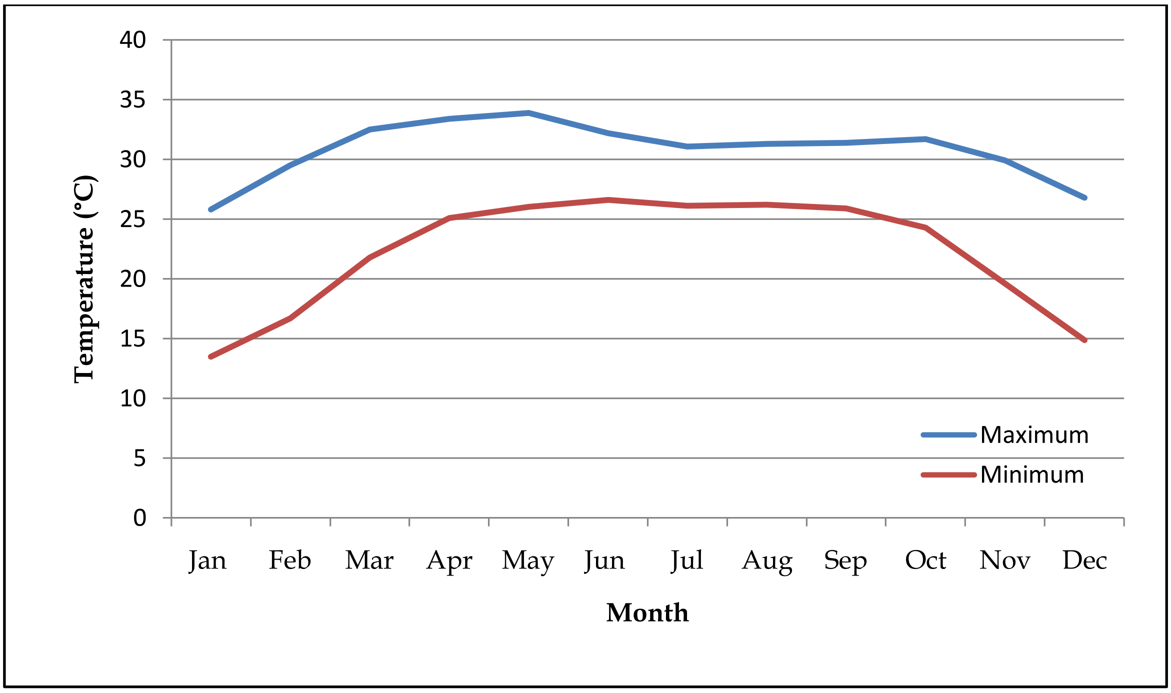
| Year | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **2003** | 24.8 | 29.1 | 30.7 | 32.2 | 33.1 | 30.9 | 31.2 | 31 | 31.5 | 31.9 | 29.9 | 26.6 |
| **2004** | 25.3 | 28.8 | 31.6 | 31.8 | 34.3 | 32.1 | 31.1 | 30.7 | 30.8 | 30.9 | 29.7 | 28 |
| **2005** | 25.9 | 30.1 | 31.7 | 34 | 34 | 32.8 | 30.5 | 31 | 31.2 | 31 | 29.2 | 26.9 |
| **2006** | 27 | 31.2 | 33.3 | 33.7 | 33.1 | 31.9 | 30.7 | 31 | 31.3 | 32 | 29.8 | 27.8 |
| **2007** | 26.1 | 28.4 | 32.4 | 32.8 | 33.7 | 32.4 | 30.7 | 31.2 | 30.8 | 31.2 | 29.5 | 26.7 |
| **2008** | 26.2 | 27.1 | 31.5 | 33.5 | 34.1 | 31.1 | 30.5 | 31.1 | 31.3 | 31.3 | 29.6 | 26.7 |
| **2009** | 27 | 30 | 33.3 | 33.9 | 33.8 | 32.8 | 30.8 | 31 | 31.6 | 31.3 | 30.1 | 26.9 |
| **2010** | 25.3 | 30.1 | 33.1 | 33.7 | 33.9 | 32.1 | 31.4 | 31.9 | 32.1 | 32.2 | 30.7 | 26.8 |
| **2011** | 25.3 | 29.8 | 33.3 | 34.4 | 34.2 | 32.4 | 32.2 | 31.4 | 31.4 | 33.1 | 30.6 | 26.3 |
| **2012** | 25.5 | 30.3 | 33.6 | 34.2 | 35 | 33.6 | 32.1 | 32.2 | 32.1 | 32 | 29.4 | 25.6 |
| **Average** | **25.8** | **29.5** | **32.5** | **33.4** | **33.9** | **32.2** | **31.1** | **31.3** | **31.4** | **31.7** | **29.9** | **26.8** |

*Source: Bangladesh Meteorological Department, Dhaka.*

**Table 6-4: Average Monthly Minimum Temperature (ºC), Khepupara Weather Station**

| Year | Jan | Feb | Mar | Apr | May | Jun | Jul | Aug | Sep | Oct | Nov | Dec |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **2003** | 12.3 | 17.2 | 20.3 | 25.3 | 26.3 | 25.9 | 26.6 | 26.6 | 26 | 25 | 19.1 | 15.5 |
| **2004** | 14.3 | 16.3 | 22.5 | 24.8 | 26.6 | 25.9 | 25.9 | 25.9 | 25.5 | 23.3 | 16.8 | 14.5 |
| **2005** | 12.5 | 18 | 22.7 | 25.3 | 25.8 | 27.4 | 26.1 | 26.2 | 25.8 | 24.7 | 19.1 | 15.3 |
| **2006** | 13.6 | 19 | 21.6 | 25.3 | 25.6 | 26.9 | 26.2 | 26.1 | 25.7 | 25 | 20.3 | 15.1 |
| **2007** | 12.4 | 17.3 | 19.9 | 24.8 | 26.1 | 26.8 | 26.1 | 26 | 26 | 23.5 | 20.9 | 14.9 |
| **2008** | 13.9 | 15.1 | 22.6 | 24.8 | 25.8 | 25.9 | 25.9 | 26.3 | 26 | 24.2 | 19.6 | 16.2 |
| **2009** | 14.6 | 16.5 | 22 | 25.8 | 26.2 | 26.8 | 26.1 | 26.4 | 25.8 | 23.7 | 20.3 | 14.1 |
| **2010** | 12.1 | 16.8 | 23.6 | 26.9 | 26.6 | 27 | 26.7 | 26.6 | 26.4 | 25.3 | 21.3 | 14.5 |
| **2011** | 12.1 | 15.8 | 20.4 | 23.3 | 25.3 | 26.2 | 26.2 | 25.8 | 25.6 | 24.5 | 18.8 | 15 |
| **2012** | 17 | 15.1 | 21.9 | 24.2 | 26 | 27.4 | 25.6 | 26.2 | 26 | 23.5 | 19.5 | 13.4 |
| **Average** | **13.5** | **16.7** | **21.8** | **25.1** | **26.0** | **26.6** | **26.1** | **26.2** | **25.9** | **24.3** | **19.6** | **14.9** |

*Source: Bangladesh Meteorological Department, Dhaka.*

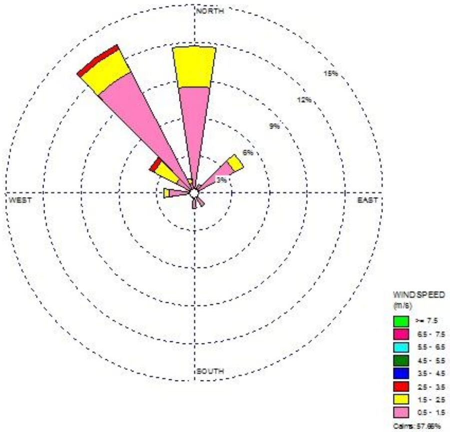



*Sources: Bangladesh Meteorological Department (BMD)*

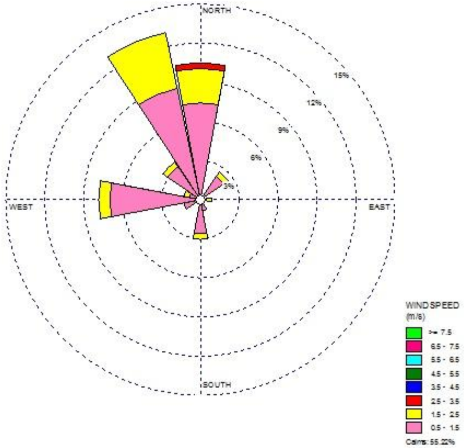
**Figure 6-9: Average Maximum and Minimum Temperatures (2003-2012), Khepupara Weather Station**

### 6.6.1.4 Wind Speed and Wind Direction

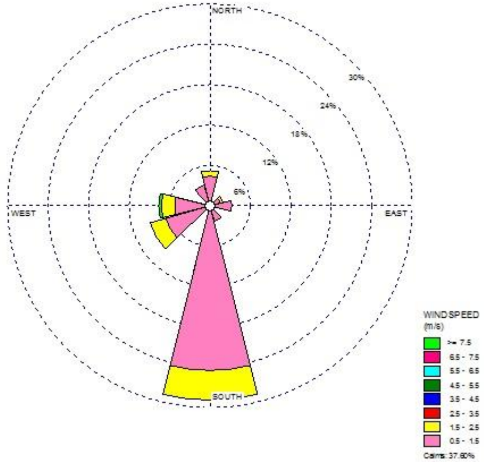
The wind direction in Khepupara station is generally towards to North to South direction. Maximum wind speed recorded in Khepupara is 12 knots in the North to South direction and average wind speed is 1.13 knots. Monthly wind roses based on the meteorological data collected from BMD for Khepupara observatory are presented in **Figure 6-10**. Seasonal and Annual wind roses are shown in **Figure 6-11**.



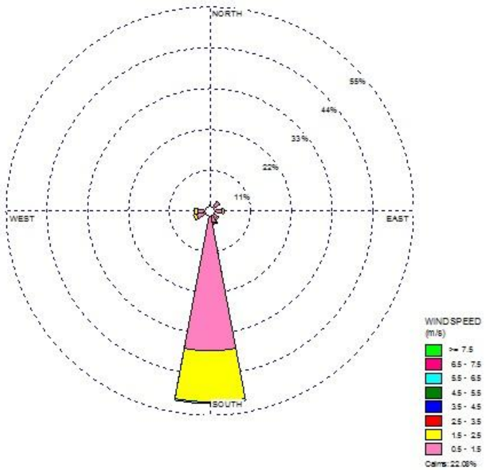

**January**



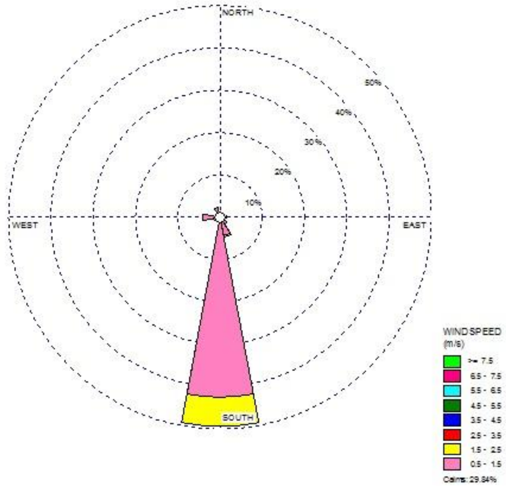

**February**



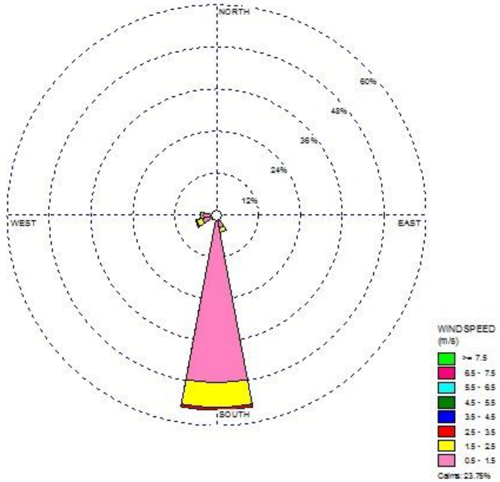

**March**




**April**

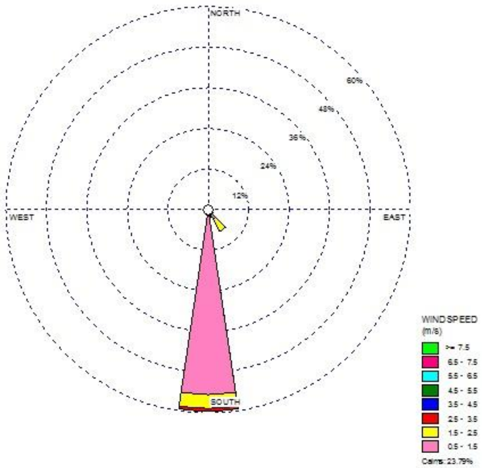



**May**

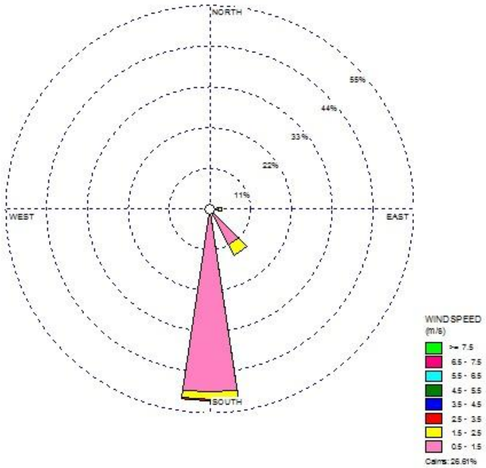



**June**

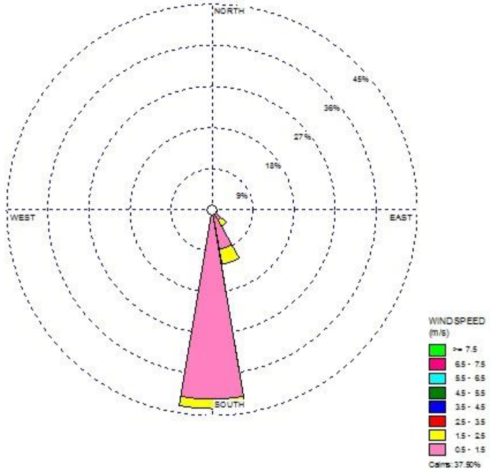
**Figure 6-10: Monthly Wind Rose Diagram, 2012**



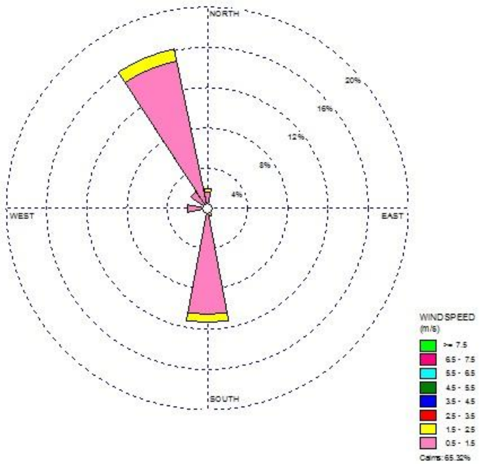
**July**



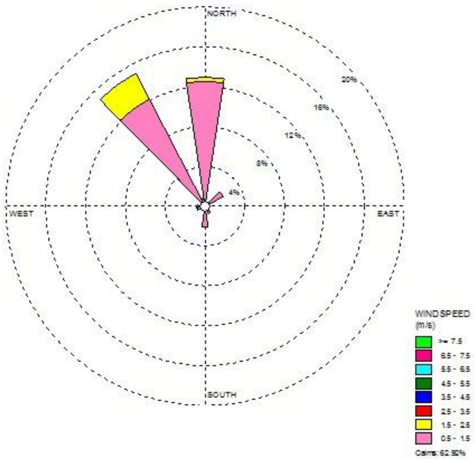
**August**



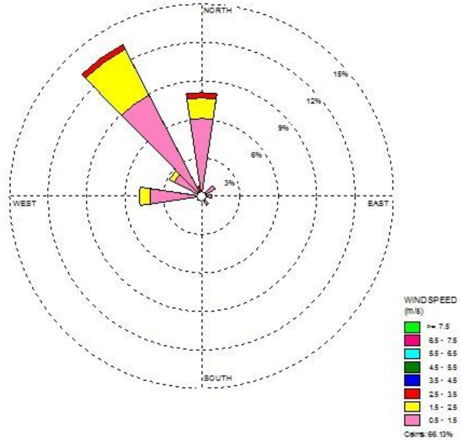
**September**



**October**

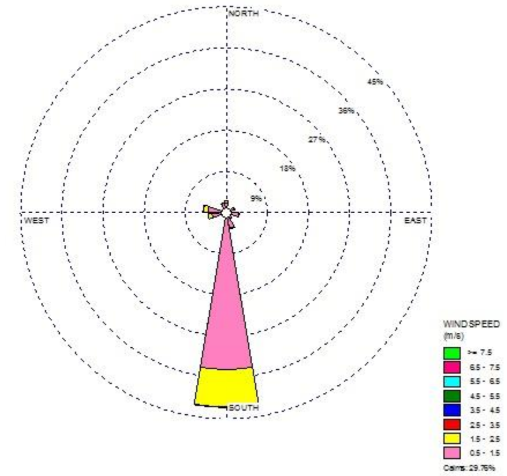


**November**

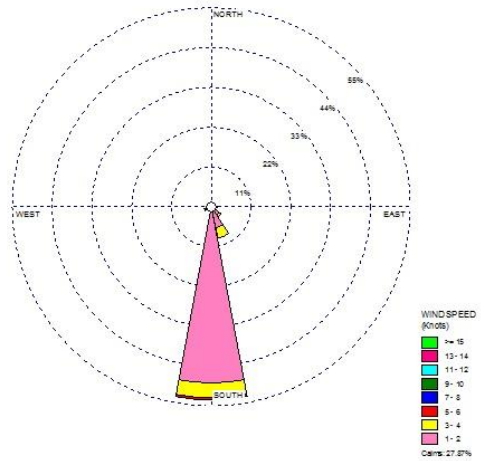


**December**

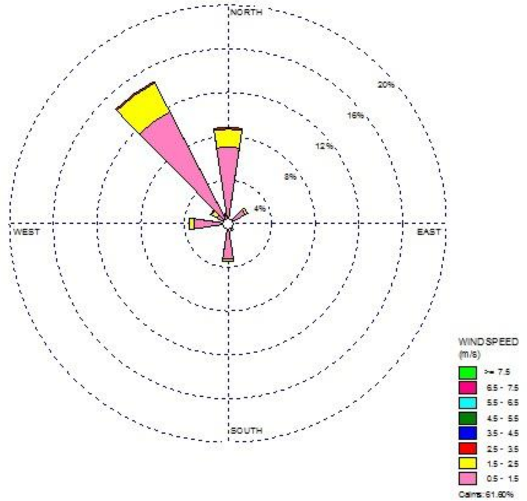
**Figure 6-10: Monthly Wind Rose Diagram, 2012 (Continued)**



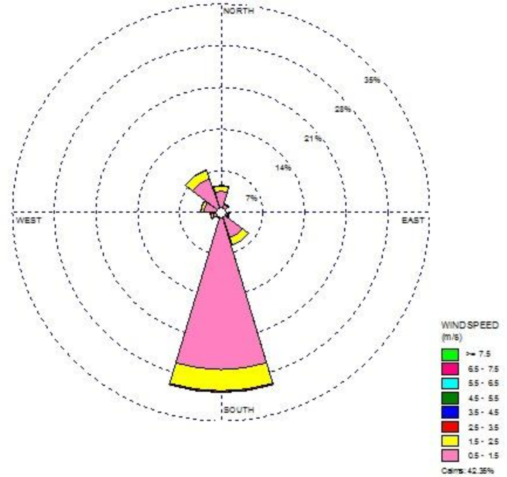

**Pre Monsoon (March to May)**




**Monsoon (June to September)**




**Winter (October to February)**




**Annual (January to December)**

**Figure 6-11: Seasonal and Annual Wind Rose Diagram, 2012**

### 6.6.2 Natural Hazards

#### 6.6.2.1 Seismicity/Earthquake Activity

Bangladesh is situated in one of the most tectonically active regions in the world. Here three major tectonic plates (the Indian Plate, the Tibet Sub-Plate, and the Burmese Sub-Plate) collide and thrust over each other. Earthquakes occur frequently in the wider region.

Bangladesh can be divided into three Seismic Zones, as described by the ranges of the seismic coefficient. Zone I is the most severe area for earthquake intensity and frequency and Zone III is the least severe. The Project area falls within Zone III and is therefore generally less seismically active than some other areas of Bangladesh. **Figure 6-12** shows the major fault lines and relative magnitude of historical earthquakes over Bangladesh. This figure shows that the Project is located in an area that in not at high earthquake risk. A seismic risk map is provided in **Figure 6-13**.

#### 6.6.2.2 Cyclone and Storm Surges

Bangladesh often becomes the landing ground of cyclones which are formed in the Bay of Bengal. In Bangladesh, cyclones occur in April-May and also in September-December. The most destructive element of a cyclone is its accompanying surge. The timing of the cyclones relative to the daily and lunar tide cycle, as well as the monsoon flood season and wind speed and direction all affect the height of the surge. On an average, five severe cyclonic storms hit Bangladesh every year and the accompanying surge can reach as far as 200km inland.

When cyclones track into Bangladesh, most of the damage occurs in the coastal regions of Khulna, Patuakhali, Barisal, Noakhali and Chittagong and the offshore islands of Bhola, Hatiya, Sandwip, Manpura, and Kutubdia (Banglapedia, 2009). During the years 1797 to1991, Bangladesh has been hit by 59 severe cyclones, 32 of which were accompanied by storm surges (Khalil, 1992).

The shallow bathymetry of the Bay of Bengal, the funneling shape of the coastline, the low lying flat terrain, the dense population, the poor housing conditions and lack of an effective early warning system all contribute to making the Project area particularly vulnerable to the effects of cyclones and storm surges (Islam and Peterson, 2009; MCSP, 1993).

Key cyclonic storm tracks and cyclone affected area in Bangladesh have been shown in **Figure 6-14 and Figure 6-15**.

From 1960 to 2008, Patuakhali District has been hit by the following severe cyclones:

1. 25 May 2009 (cyclone Aila with wind speeds of 100km/hr)
2. 18 April 2009 (cyclone Bijli with maximum wind speeds up to 90 km/hr)
3. 15 November 2007 (cyclone Sidr was the strongest named cyclone in the Bay of Bengal. It has maximum wind speeds up to 260 km/hr)
4. 19-22 November, 1998 (cyclonic storm with maximum wind speeds of 90 km/hr, storm surge of 1.22 to 2.44m)
5. 31 May to 2 June, 1991 (maximum wind speeds of up to 110 km/hr and surgeheight of 1.9m);
6. 8-9 November, 1986 (cyclonic storm hit with wind speeds up to 110 km/hr);
7. 5-9 November, 1983 (severe cyclonic storm (hurricane) with a wind speeds up to136 km/hr recorded and a storm surge of 1.52m height);

8. 9-12 May, 1977 (cyclonic storm with wind speeds up to 113 km/hr);
9. 6-9 December, 1973 (severe cyclonic storm accompanied by storm surge);
10. 12-13 November, 1970 (The maximum recorded wind speed of the 1970 cyclone was about 222 km/hr and the maximum storm surge height was about 10.6m – the cyclone occurred during high-tide);
11. 14-15 December 1965 (storm-surge rising 4.7-6.1m; maximum speeds recorded were 210 km/hr);
12. 30-31 October, 1960 (maximum wind speeds of 210 km/hr, surge height 4.5-6.1m); and
13. 9-10 October, 1960 (maximum wind speeds of 201 km/hr, maximum storm wave 3.05m). (Islam and Peterson, 2009; Damen and Westen; Khan, 1995).

The 1970 cyclone was particularly serious for the Project area due to the large surge which caused water to overtop embankments and resulting in widespread flooding. The 1985 cyclone was a mild event in national terms however it caused several deaths and widespread damage in the Project area. The 1991 cyclone, despite being far more intense than the 1985 event, caused fewer deaths, as the cyclone tracked to the south of the Project area.

#### 6.6.2.3 Floods

Every year near about one-fifth of Bangladesh undergoes flood during the monsoon season. A flood season in Bangladesh may start as early as May and can continue until November.

Floods of Bangladesh can be divided into three categories: (i) monsoon flood - seasonal, increases slowly and decreases slowly, inundate vast areas and causes huge loss to the life and property; (ii) flash flood-from sudden torrential flows, following a brief intense rainstorm or the bursting of a natural or manmade dam or levee; and (iii) tidal flood - short duration, height is generally 3-6m, prevents inland flood drainage. The project area is medium high land and normally inundated 30-90 cm. **Figure 6-16** shows the flood affected areas of Bangladesh.

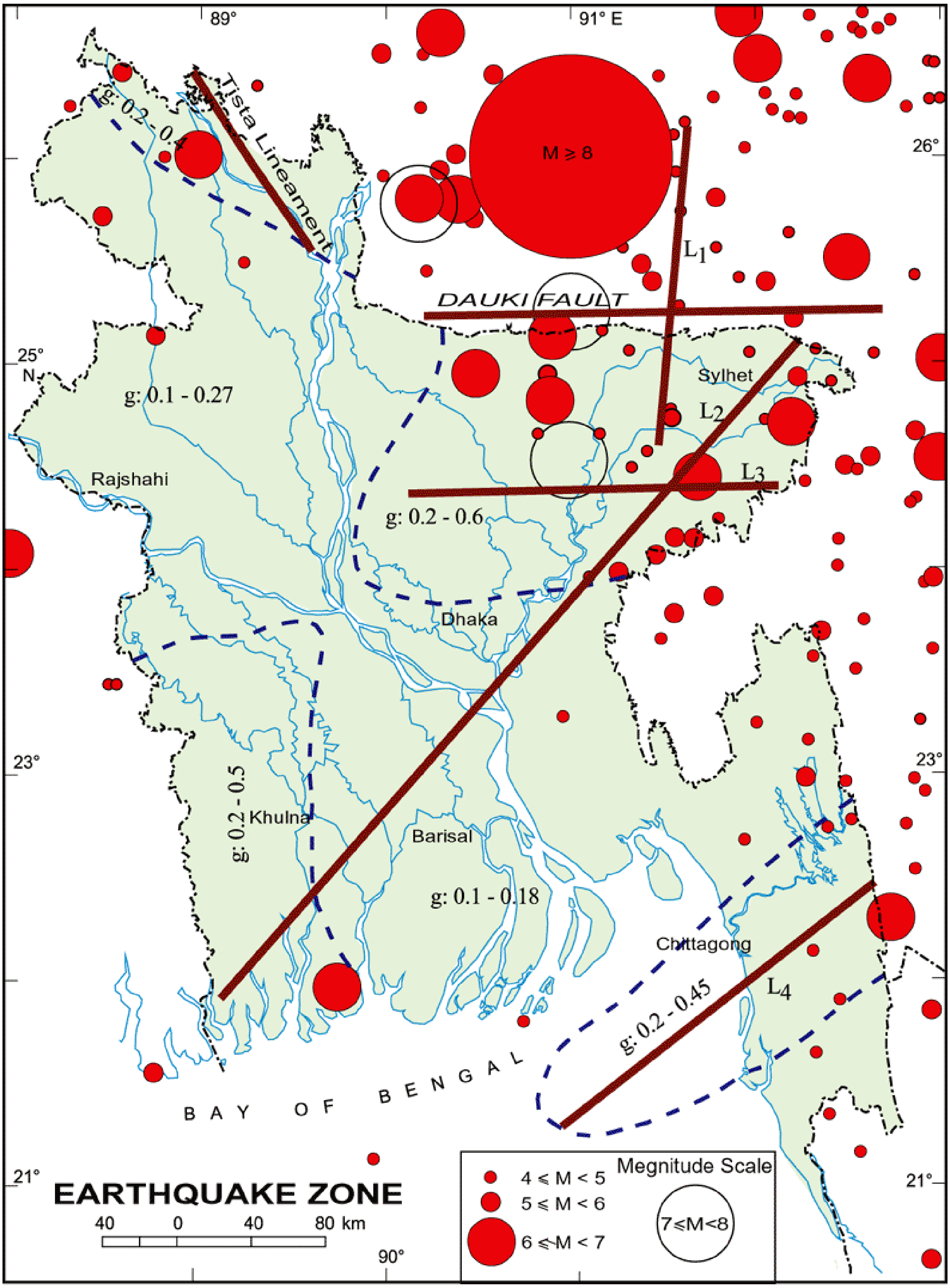



**Figure 6-12: Seismic activity and fault line map**

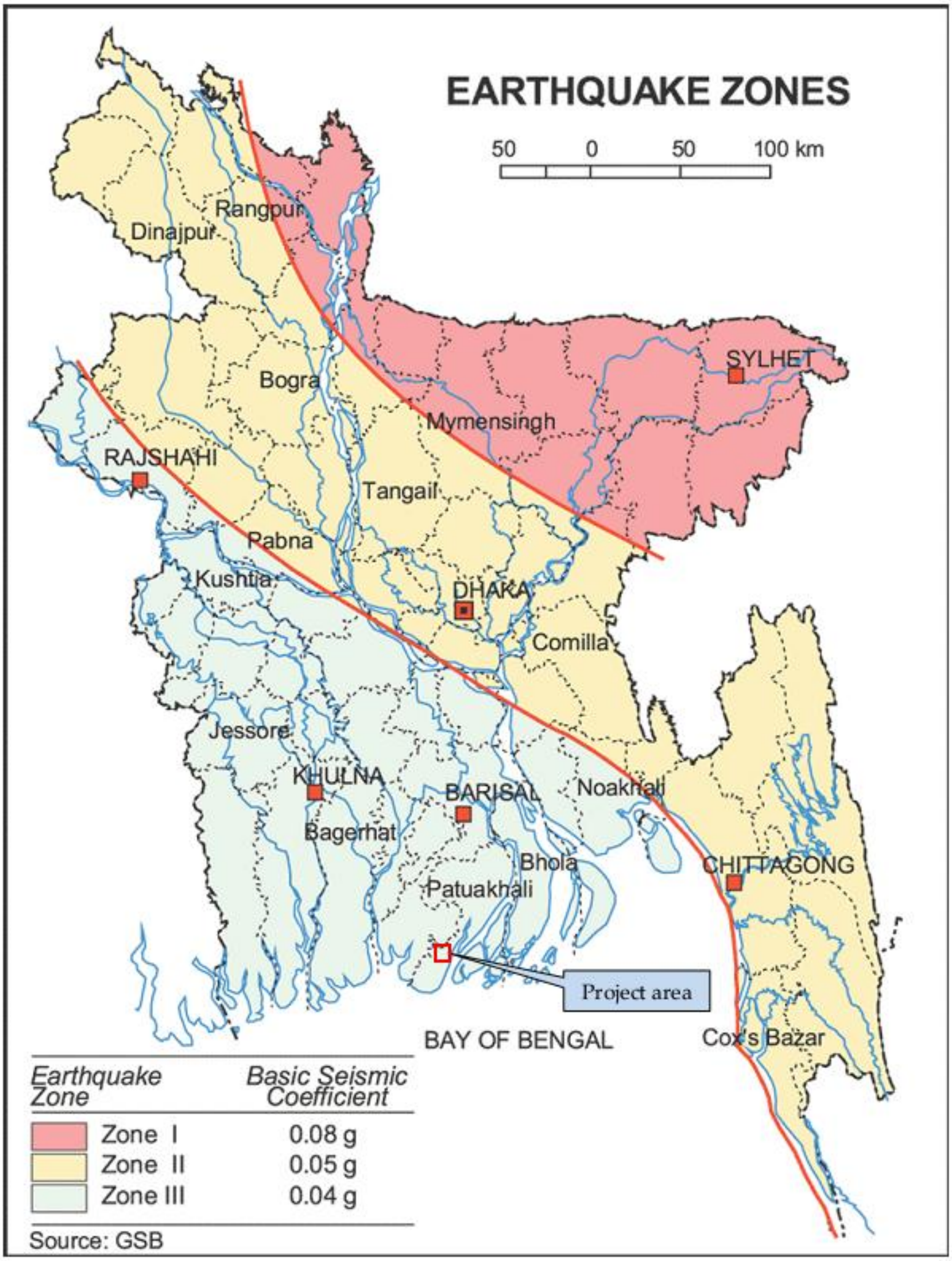



**Figure 6-13: Earthquake Zone Map of Bangladesh**

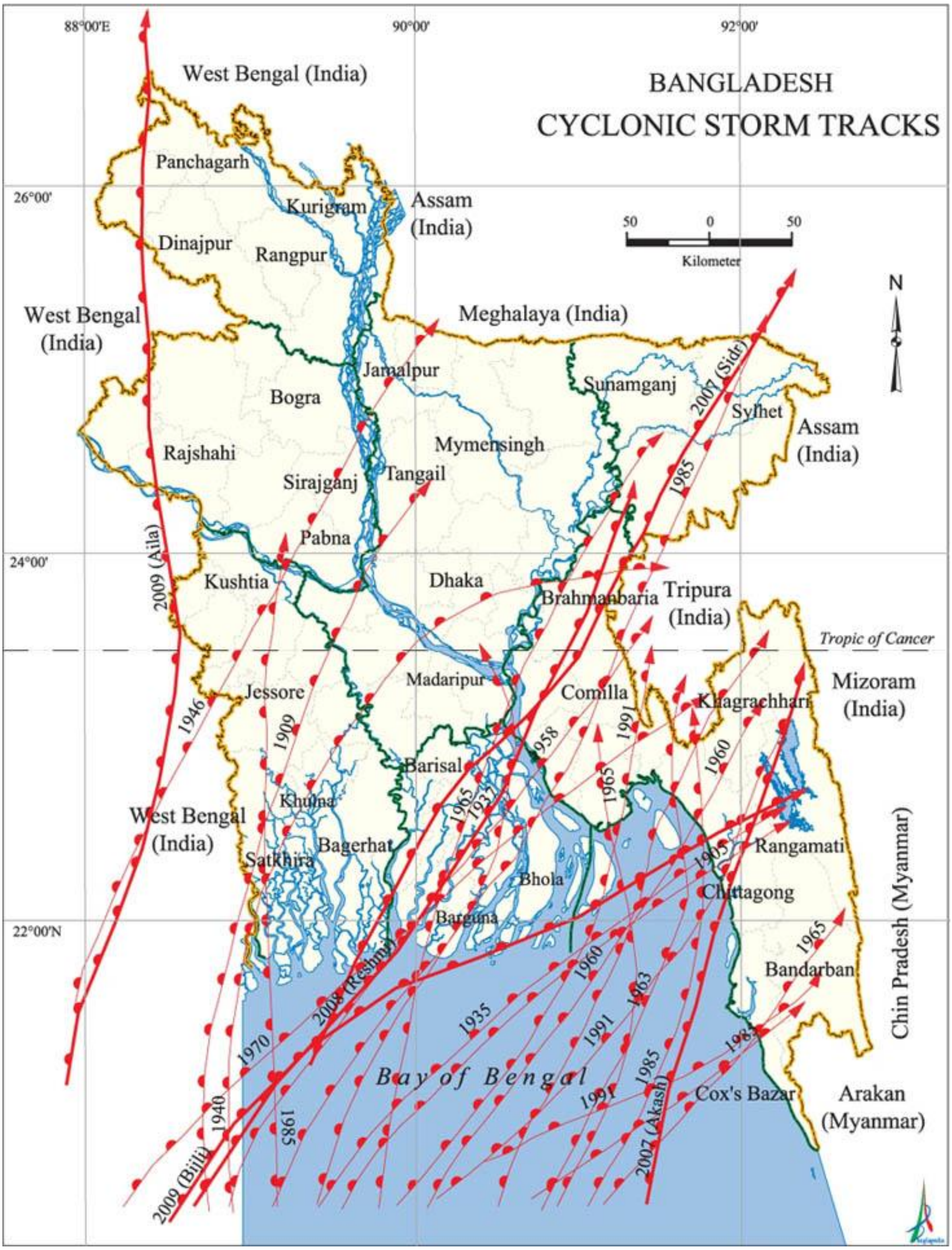



**Figure 6-14: Cyclonic Storm Tracks in Bangladesh**

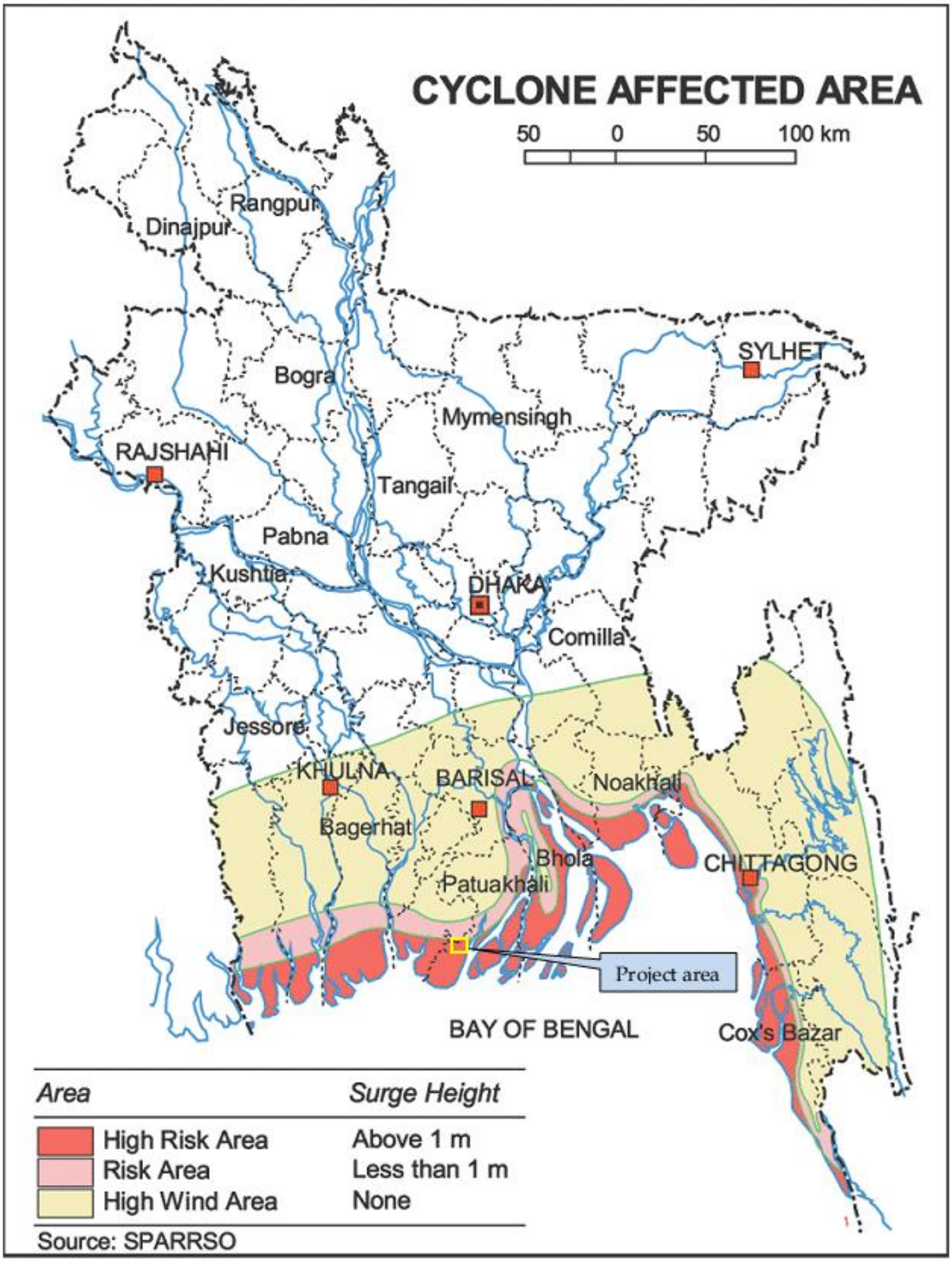



**Figure 6-15: Cyclone Prone Areas of Bangladesh**

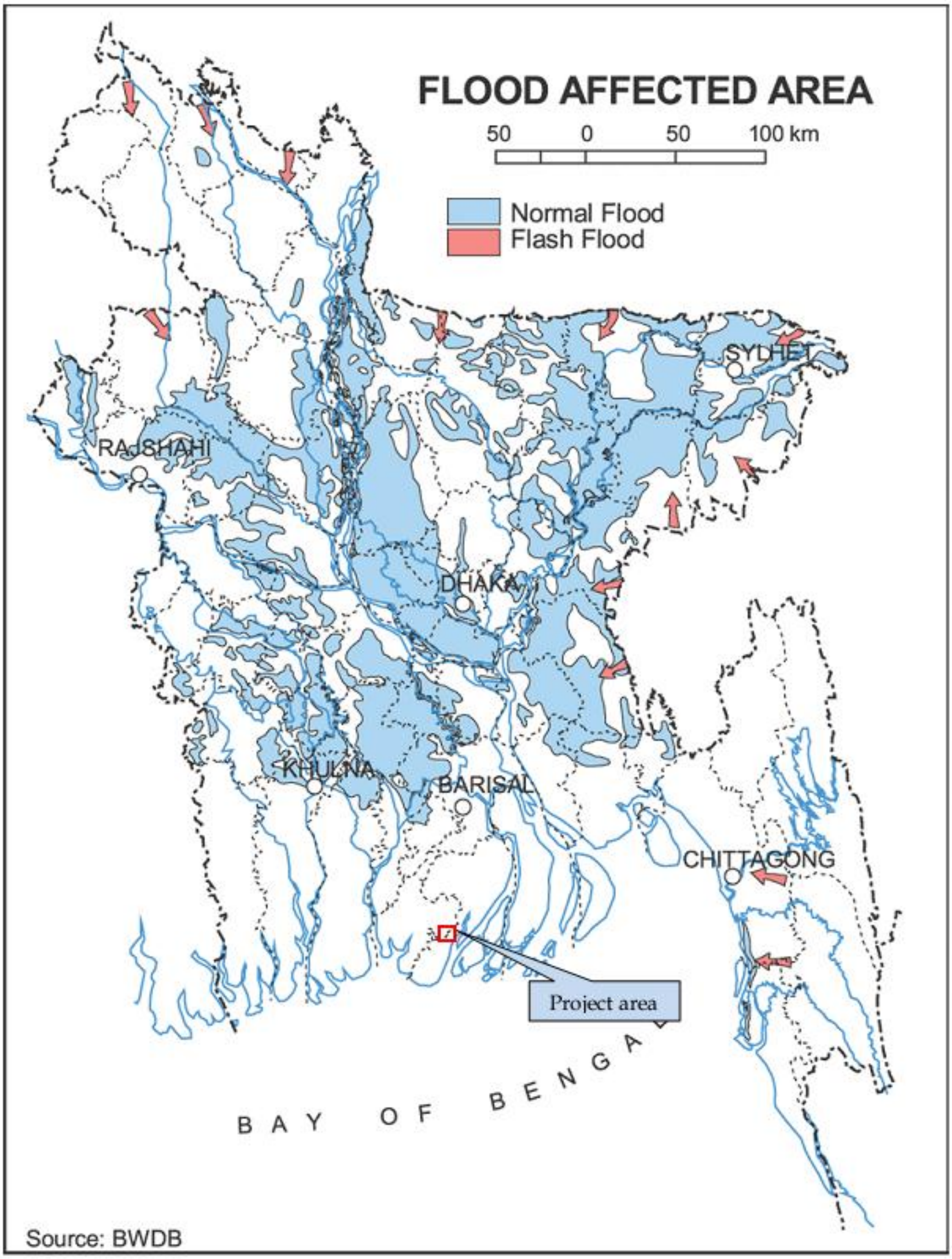



**Figure 6-16: Flood Prone Areas of Bangladesh**

## 6.7 Ambient Air Quality

### 6.7.1 Air Pollution

The objective of the ambient air quality monitoring program was to establish the baseline ambient air quality in the study area. The profile of the study area is mainly rural, which has mix of scattered settlements and agriculture areas. Generally air pollution sources in the Project area consists of road dust, black smoke from diesel engine vehicles, construction dust, windblown dust from agricultural lands, domestic heating and cooking, and brick kilns.

The air quality monitoring locations were selected based on the locations of settlements and receptors within the study area. Logistical factors such as consent of villagers, mainly the house owners, power connection, accessibility, security, etc. were also taken into account in finalizing the monitoring stations.

#### 6.7.1.1 Methodology of Air Quality Monitoring

The existing ambient air quality of the study area was monitored at six (6) locations during the monitoring period (April and November 2014). The monitoring parameters included Particulate Matter (SPM, $PM_{10}$ and $PM_{2.5}$), Sulphur Dioxide ($SO_2$), Oxides of Nitrogen (NOx), and Carbon Monoxide (CO). All the parameters were monitored on 24-hourly basis during the duration of the study.

**Selection of Sampling Locations**

The baseline status of the ambient air quality has been established through a scientifically designed ambient air quality monitoring network. The ambient air quality monitoring locations (**Figure 6-17**) were based on the following aspects covered in field survey plan developed prior to the field work:

- Meteorological conditions of the area based on information of BMD observatory at Dhaka;
- Topography of the study area; and
- Location of sensitive receptors such as major settlements;

The particulate and gaseous samples collected during the monitoring have been analysed as per the procedures specified in **Table 6-5**. The geographical locations and setting of the ambient air quality monitoring locations has been presented in **Table 6-6**.

**Table 6-5: Methodology for Analysis of Ambient Air Quality**

| Sl. | Parameter | Analysis procedure |
|---|---|---|
| 1. | SPM | Gravimetric method |
| 2. | PM10 | Gravimetric method |
| 3. | PM2.5 | Gravimetric method |
| 4. | $SO_2$ | Colorimetric method at 560nm using spectrophotometer (West-Gaeke method) |
| 5. | NOx | Colorimetric method at 540 nm using spectrophotometer (Jacob and Hochheiser method) |
| 6. | CO | Digital CO meter |

**Table 6-6: Ambient Air Quality Sampling Locations**

| Sl. | Sampling Station | Station Code | Geographic Location | Location Setting |
|---|---|---|---|---|
| 1. | Project site (Nishanbari) | AQ1 | 21°59'36.71"N 90°18'3.29"E | Village and Rural Setting |
| 2. | Londa Kheya Ghat | AQ2 | 22° 0'40.67"N 90°16'43.35"E | Village and Rural Setting |
| 3. | Dhankhali Union Complex | AQ3 | 22° 2'17.32"N 90°19'23.42"E | Village and Rural Setting |
| 4. | Tiakhali village | AQ4 | 21°59'16.74"N 90°16'32.70"E | Village and Rural Setting |
| 5. | Lalua village | AQ5 | 21°58'26.19"N 90°18'0.26"E | Village and Rural Setting |
| 6. | Nishanbari village | AQ6 | 22° 0'27.59"N 90°18'36.73"E | Village and Rural Setting |

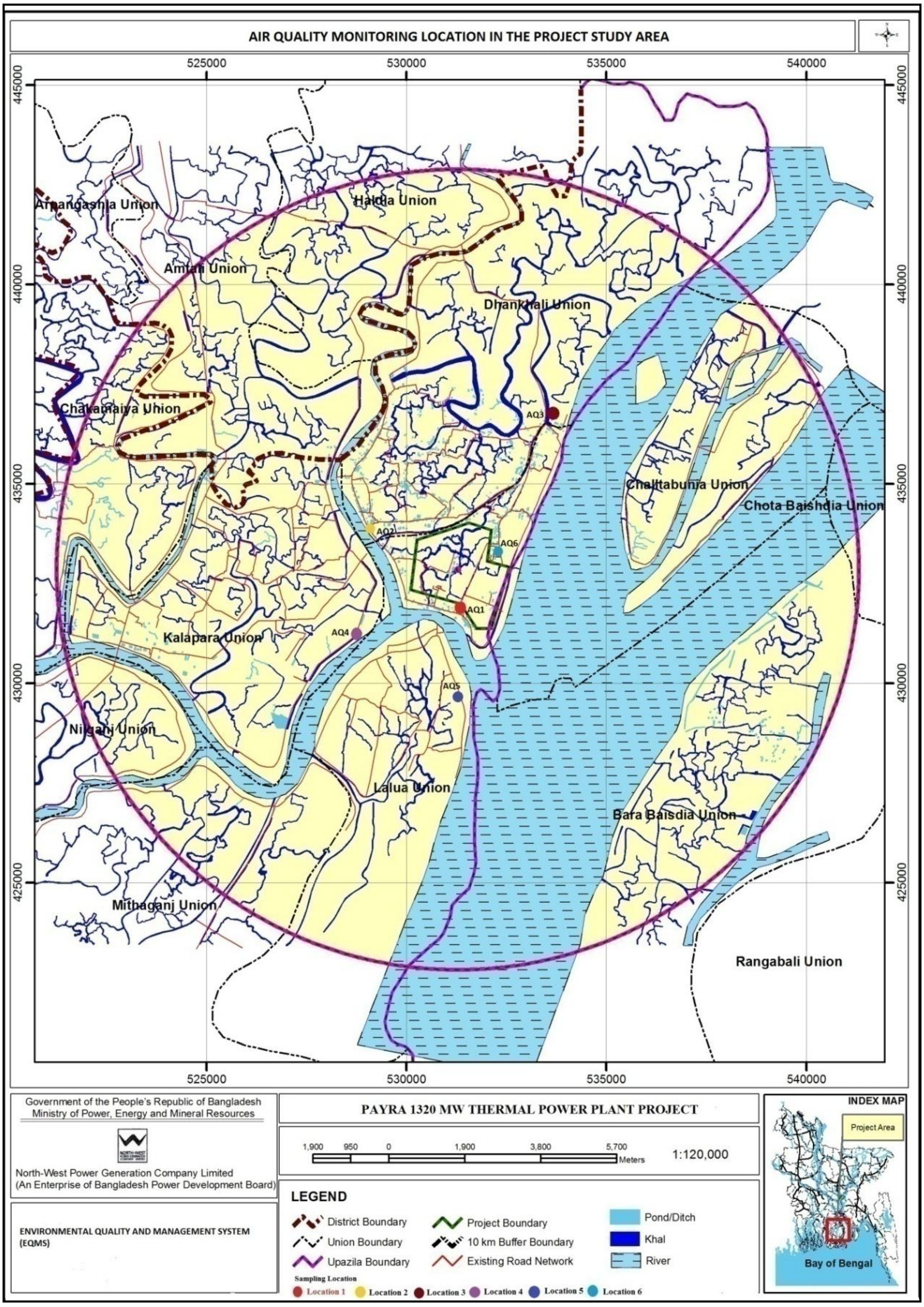



**Figure 6-17: Air Quality Monitoring Location**

### 6.7.1.2 Ambient Air Quality in the Study Area

The monitored ambient air quality is summarized in **Table 6-7**.

**Table 6-7: Ambient Air Quality in the Study Area**

| Sl. | Sampling location | Ambient air pollution concentration in µg/m³ | | | | | |
|---|---|---|---|---|---|---|---|
| | | $PM_{2.5}$ | $PM_{10}$ | SPM | $SO_2$ | NOx | CO* mg/m³ |
| 1. | AQ1 | 9.13 | 53.63 | 86.32 | 2.52 | 7.50 | <2 |
| 2. | AQ2 | 15.63 | 89.53 | 112.11 | 3.76 | 13.16 | <2 |
| 3. | AQ3 | 12.46 | 65.72 | 98.74 | 3.01 | 11.32 | <2 |
| 4. | AQ4 | 11.31 | 75.45 | 78.54 | 2.65 | 8.43 | <2 |
| 5. | AQ5 | 10.56 | 68.56 | 82.67 | 3.06 | 9.65 | <2 |
| 6. | AQ6 | 9.21 | 57.32 | 75.72 | 2.87 | 7.85 | <2 |
| **Duration (hours)** | | **24** | **24** | **8** | **24** | **24** | **8** |
| **Weather Condition** | | Sunny | | | | | |
| **Bangladesh Standard* (*according to Environmental Conservation Rules' 1997 and subsequent amendment in 2005*)** | | **65** | **150** | **200** | **365** | **100** | **10** |
| **Method of analysis** | | Gravimetric | Gravimetric | Gravimetric | West- Geake | Jacob and Hochheiser | Indicator tube |

*Date of analysis: 25th-28th April 2014 & 4th – 8th December 2014*

*Note:*

** CO concentrations and standards are 8-hourly only.*

*** The Bangladesh National Ambient Air Quality Standards have been taken from the Environmental Conservation Rules, 1997 which was amended on 19thJuly 2005 vide S.R.O. No. 220-Law/2005.*

### 6.7.1.3 Analysis and Discussion of Result

**SPM**

The 24-hourly SPM concentration in ambient air in the study area was recorded in the range of 75.72 – 112.11 µg/m³. During the monitoring period, the maximum SPM concentration was reported from Londa Kheya Ghat as 112.11µg/m³. SPM concentrations at this location are primarily due to traffic movement. SPM level of all locations were reported below the National Ambient Air Quality Standards of Bangladesh.

**$PM_{10}$**

The 24-hourly $PM_{10}$ concentration in ambient air in the study area was recorded in the range of 53.63 – 89.53 µg/m³. During the monitoring period, the maximum $PM_{10}$ concentration was reported from Londa Kheya Ghat as 89.53µg/m³. PM10 level at all monitoring locations were reported below the NAAQS.

**$PM_{2.5}$**

The 24-hourly $PM_{2.5}$ concentration in ambient air in the study area was recorded in the range of 9.13 – 15.63 µg/$m^3$. During the monitoring period, the maximum $PM_{2.5}$ concentration was reported from Pachim Mukterpur as 15.63µg/$m^3$. All the monitoring locations result was within the 24-hourly National Ambient Air Quality Standard (NAAQS) for $PM_{2.5}$ in Bangladesh.

**$SO_2$**

The 24-hourly $SO_2$ concentration was recorded in the range of 2.52 – 3.76 µg/$m^3$. Concentration of $SO_2$ is reported low at AQ1 due to their rural setting. During the monitoring period, the maximum $SO_2$ concentration is reported at Londa Kheya Ghat as 3.76 µg/$m^3$. $SO_2$ concentrations at all the monitoring locations were reported well below 365 µg/$m^3$, which is National Ambient Air Quality Standard (NAAQS) for $SO_2$ in Bangladesh.

**NOx**

The 24-hourly NOx concentration was recorded in the range of 7.50 – 13.16 µg/$m^3$. Concentrations of NOx were reported low at AQ1 and AQ3 due to their rural setting, whereas at AQ2, the levels are slightly higher due to the traffic movement. During the monitoring period, the maximum NOx concentration is reported at Londa Kheya Ghat as 13.16µg/$m^3$. There are no stipulated standards for 24-hourly NOx concentration in Bangladesh. The annual Bangladesh standard values for NOx are 100 µg/$m^3$ and present concentrations at all the locations are well below these values.

**CO**

CO concentrations are reported low at all the monitoring locations while comparing with the Bangladesh Standards (10 mg/$m^3$).

## 6.8 Ambient Noise Quality

Noise levels were recorded at eight (8) locations in the study area during the monitoring period. Noise levels were recorded in the form of sound pressure levels with the help of a digital sound level meter. The details of noise monitoring locations are given in **Table 6-8** and depicted in **Figure 6-18**. The purpose of ambient noise level measurement was to determine sound intensity at the monitoring locations. These locations are chosen in such a way that a representative data could be recorded all over the block. The sound level is recorded in form of A-weighted equivalent continuous sound pressure level (Leq) values with the use of A-weighting filters in the noise measuring instrument.

**Table 6-8: Details of Ambient Noise Monitoring Locations**

| Sl. | Code | Location | Geographic location | Location setting |
|---|---|---|---|---|
| 1. | NL1 | Char Nishanbari Primary School | 21°59'33.66"N 90°18'35.96"E | Silent |
| 2. | NL2 | Char Nishanbari Mosque | 21°59'38.18"N 90°18'33.69"E | Silent |
| 3. | NL3 | Rafique Mia's House, Nishanbari Village | 21°59'29.40"N 90°18'8.05"E | Residential |
| 4. | NL4 | Londa Kheya Ghat | 22° 0'42.08"N 90°16'44.23"E | Commercial |
| 5. | NL5 | Monir Hossain's House, Nishanbari village | 22° 0'30.58"N 90°18'33.61"E | Residential |
| 6. | NL6 | Salam Uddin's House, Tiakhali village | 21°59'36.98"N 90°16'37.53"E | Residential |
| 7. | NL7 | Akber Mia's House, Lalua | 21°59'14.37"N 90°17'44.09"E | Residential |
| 8. | NL8 | Sabder Ali's House, Madhupara | 22° 0'20.47"N 90°17'3.90"E | Residential |


**Figure 6-18 : Locations of Noise Level Monitoring of Proposed Power Plant**

**Table 6-9: Noise Level Parameter in and around the Proposed Site**

| Location | Average Noise level (dB(A)) | | | | Applicable Standard * (dB(A)) | |
|---|---|---|---|---|---|---|
| | $Leq_{day}$ | $Leq_{night}$ | $L_{max}$ | $L_{min}$ | Day | Night |
| **NL1** | 51.4 | 39.6 | 60.4 | 36.8 | 50 | 40 |
| **NL2** | 49.2 | 38.6 | 59.3 | 38.7 | 50 | 40 |
| **NL3** | 50.5 | 40.2 | 58.4 | 39.3 | 55 | 45 |
| **NL4** | 57.6 | 48.3 | 67.6 | 45.9 | 70 | 60 |
| **NL5** | 50.5 | 42.8 | 58.6 | 38.4 | 55 | 45 |
| **NL6** | 48.5 | 40.3 | 57.4 | 36.5 | 55 | 45 |
| **NL7** | 50.3 | 41.2 | 60.3 | 37.4 | 55 | 45 |
| **NL8** | 49.3 | 40.8 | 58.5 | 37.3 | 55 | 45 |

*Source: Field Survey by EQMS (April, 2014)*

**Environmental Conservation Rules, 1997 (Schedule 4) (subsequent amendment in 2006)*

Due to an absence of heavy industries, large urban development or other significant noise sources, the background noise level at the project area is low.

The project area falls into residential area zone according to Bangladesh Environmental Quality Standard ECR'97 categorization. **Table 6-9** average day time noise in NL1 location is higher than the national standard this may due to the school activity in the day time period whereas other locations average day time noise is well within the standard limit of ECR'97. Average night time noise level of all locations is well within the standard limit of ECR'97 (*subsequent amendment in 2006*).

## 6.9 Surface and Ground water Quality

Water sampling and analysis was undertaken to understand the overall baseline water quality characteristics of the surface and groundwater in the study area. Samples were taken from representative selected water bodies and groundwater sources representing different parts of the study area. The surface water sampling was based on the identification of major surface water bodies such as the Rabnabad Channal and Andharmanik River adjacent to the site. Groundwater sampling locations were selected to obtain a representative water sample from various zones within the study area. The samples were collected from existing tube wells (hand-pumps being used by the villagers). A total of 4 samples, Two (2) surface water and three (2) ground water samples were collected. Detail of the sampling location is provided in **Table 6-10** and depicted in **Figure 6-19**.

**Table 6-10: Details of Surface and Ground Water Sampling Locations**

| Sl. | Sampling location | Sampling Code | Geographic location | Type of Source |
|---|---|---|---|---|
| 1. | Londa Kheya Ghat (Andharmanik river adjacent to the project area) | SW1 | 22° 0'39.33"N 90°16'42.21"E | Andharmanik River |

| Sl. | Sampling location | Sampling Code | Geographic location | Type of Source |
|---|---|---|---|---|
| 2. | Rabnabad Channel (adjacent to the project area) | SW2 | 21°59'19.24"N 90°18'40.55"E | Rabnabad Channel |
| 3. | Project site | GW1 | 22° 0'7.74"N 90°18'41.78"E | Tubewell |
| 4. | Londa Kheya Ghat | GW2 | 22° 0'40.18"N 90°16'42.61"E | Tubewell |

The samples were analyzed for parameters covering Bacteriological and physico-chemical characteristics which include certain heavy metals and trace elements.

Water samples were collected as grab water sample in a pre-washed 5-litre plastic jerry can and 250 ml sterilized clean PET bottle for complete physio-chemical and bacteriological tests respectively.

The samples were analyzed as per standard procedure/method given in Standard Method for Examination of Water and Wastewater Edition 20, published by APHA. Details of the analysis method and protocol are presented in **Table 6-11**.

**Table 6-11: Method for Water Analysis**

| Sl. | Parameter | Test method (APHA) |
|---|---|---|
| 1. | Temperature ($^{\circ}$C) | Digital thermometer |
| 2. | TDS (mg/l) | Digital TDS meter |
| 3. | EC (µmhos/$\boldsymbol{cm}$) | Digital EC meter |
| 4. | DO (mg/l) | Digital DO meter |
| 5. | pH | Digital pH meter |
| 6. | Salinity (ppt) | Digital Salinity meter |
| 7. | Alkalinity ($HCO_3^-$) (mg/l) | 2320.B |
| 8. | Total Hardness (as $CaCO_3$) (mg/l) | 2340.C |
| 9. | Chloride ($Cl^-$) (mg/l) | 4110.B |
| 10. | Arsenic (As) (mg/l) | 3114.C |
| 11. | Calcium (Ca) (mg/l) | 3113.B |
| 12. | Chromium (Cr) (mg/l) | 3113.B |
| 13. | Cadmium (Cd) (mg/l) | 3113.B |
| 14. | Fluride (F) (mg/l) | 4110.B |
| 15. | Iron (Fe) (mg/l) | 3113.B |
| 16. | Lead (Pb) (mg/l) | 3113.B |
| 17. | Mercury (Hg) (mg/l) | 3112.B |
| 18. | Potassium (K) (mg/l) | 3500-K.B |

| Sl. | Parameter | Test method (APHA) |
|---|---|---|
| 19. | Sodium (Na) (mg/l) | 3500-Na.B |
| 20. | Boron (B) (mg/l) | 4500-B.B |
| 21. | Total Coliform | 9222.B |

The quality of surface water was compared with the standards for Inland Surface Water, Environment Conservation Rules (ECR), 1997-Schedule 3 whereas the groundwater was compared with the Drinking Water Standard E.C.R .-Schedule-3, 1997. The standards have been presented along with the monitoring results of surface and groundwater for comparison.

### 6.9.1 Surface Water Quality

The surface water Quality was compared with the Bangladesh ECR standard for best practice based classification criteria. **Table 6-12** shows the analysis results. Some of the water analysis parameters are discussed below in detail:

***pH***

All results for pH in surface water fell within the permissible limits of 6.5 to 8.5.

***Dissolved Oxygen (DO)***

The DO of all the samples is 6.9 and 7.1 mg/l and thus meets the surface water classification for different usages.

***Biological Oxygen Demand (BOD)***

The BOD level is 2.0 and 1.9 mg/l for samples and thus is well below the permissible limits.

**Table 6-12: Surface Water Quality Analysis**

| Characteristics | Unit | Sampling Location | | Bangladesh Standard* | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | SW1 | SW2 | Source of drinking water for supply only after disinfecting | Water usable for recreational activity | Source of drinking water for supply after conventional treatment | Water usable by fisheries | Water usable by various process and cooling industries | Water usable for irrigation |
| **Alkalinity ($HCO_3$)** | mg/L | 152.5 | 143.1 | - | - | - | - | - | - |
| **Arsenic (As)** | mg/L | <0.005 | <0.005 | - | - | - | - | - | - |
| **$BOD_5$** | mg/L | 2.0 | <0.05 | 2 or less | 3 or less | 6 of less | 6 of less | 10 or less | 10 or less |
| **Boron (B)** | mg/L | <0.05 | 1.9 | - | - | - | - | - | - |
| **Cadmium (Cd)** | mg/L | <0.005 | <0.005 | - | - | - | - | - | - |
| **Calcium (Ca)** | mg/L | 8.02 | 8.48 | - | - | - | - | - | - |
| **Chloride (Cl)** | mg/L | 9.2 | 10.6 | - | - | - | - | - | - |
| **Chromium (Cr)** | mg/L | <0.01 | <0.01 | - | - | - | - | - | - |
| **COD** | mg/L | 4.8 | 4.1 | - | - | - | - | - | - |
| **EC** | µmhos/ *cm* | 86 | 92 | - | - | - | - | - | - |
| **DO** | mg/l | 6.9 | 7.1 | 6 or above | 5 of more | 6 or more | 5 or more | 5 or more | 5 or more |
| **Fluoride (F)** | mg/L | <0.10 | <0.10 | - | - | - | - | - | - |
| **Iron** | mg/L | 0.53 | 0.46 | - | - | - | - | - | - |
| **Lead (Pb)** | mg/L | <0.01 | <0.01 | - | - | - | - | - | - |
| **Manganese** | mg/L | 0.04 | 0.03 | - | - | - | - | - | - |
| **Mercury (Hg)** | mg/L | <0.001 | <0.001 | - | - | - | - | - | - |
| **Nitrate** | mg/L | 0.78 | 0.85 | - | - | - | - | - | - |

| Characteristics | Unit | Sampling Location | | Bangladesh Standard* | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| | | SW1 | SW2 | Source of drinking water for supply only after disinfecting | Water usable for recreational activity | Source of drinking water for supply after conventional treatment | Water usable by fisheries | Water usable by various process and cooling industries | Water usable for irrigation |
| **Nitrite** | mg/L | <0.05 | <0.05 | - | - | - | - | - | - |
| **Oil and Grease** | mg/L | <2 | <2 | - | - | - | - | - | - |
| **Phosphate** | mg/L | 0.30 | 0.27 | - | - | - | - | - | - |
| **Potassium (K)** | mg/L | 3.59 | 4.21 | - | - | - | - | - | - |
| **pH** | - | 6.9 | 7.1 | 6.5-8.5 | 6.5-8.5 | 6.5-8.5 | 6.5-8.5 | 6.5-8.5 | 6.5-8.5 |
| **Salinity** | ppt | 2.3 | 1.5 | - | - | - | - | - | - |
| **Sodium (Na)** | mg/L | 16.32 | 18.64 | - | - | - | - | - | - |
| **Temperature** | ºC | 28.5 | 28.3 | - | - | - | - | - | - |
| **TDS** | mg/l | 75 | 70 | - | - | - | - | - | - |
| **Total Hardness (as $CaCO_3$)** | mg/L | 37.4 | 36.7 | - | - | - | - | - | - |
| **Turbidity** | NTU | 17 | 15 | - | - | - | - | - | - |

*(Source: Laboratory Analysis, Department of Soil, water and Environment, University of Dhaka and EQMS laboratory, Sampling Date: 16/4/14and Analysis date: 23/4/14)*

** Bangladesh Environment Conservation Rules, 1997- Schedule 3 (Standards for inland surface water*

Comparison of the data with the surface water quality standards of government of Bangladesh reveal the fact that water of the water bodies are fit for Source of drinking water for supply after conventional treatment, Water usable by fisheries, Industrial process and cooling industries and Water usable for irrigation.

### 6.9.2 Ground Water Quality

The results of two groundwater samples collected from the tubewells in project site and Londa Gheya Ghat are shown in **Table 6-13**.

In 1993, Department of Public Health Engineering (DPHE) first detected arsenic in hand tube wells (HTWs) and arsenic contamination has become one of the most pressing environmental issues in Bangladesh. The World Health Organization has defined the tolerance limit of arsenic for drinking water as 0.01mg/L, while the Bangladesh standard for arsenic in drinking water is 0.05mg/L. The arsenic content of the project site is 0.02 mg/l which is within the Bangladesh Standards (0.05mg/l).

Shallow tubewells (200-400 feet) of the project area contain arsenic contamination. Peoples in this area use surface water for their domestic purposes and use deep tubewells (900-1000 feet) water for drinking.

In April 2014, Groundwater samples were collected by EQMS from shallow tube wells in the project area. The result of the groundwater field samples and the GoB standards for potable water (ECR, 1997) are shown in **Table 6-13**. The concentration levels of pH, Alkanity, Mn, As, Fe, Ammonia Nitrate, total hardness, Chloride, Fecal Coliform and Total Coliform for tube well were found within the acceptable limit set by the DOE, GoB for drinking water. According to the overall water quality data, practically moderate quality and quantity of ground water is available in and around the project site.

**Table 6-13: Ground Water Quality Analysis Result**

| Sl. | Parameters | Sampling code | | Bangladesh Standard |
|---|---|---|---|---|
| | | GW1 | GW2 | |
| 1. | Alkalinity ($HCO_3^-$) (mg/l) | 156.2 | 190.6 | - |
| 2. | Arsenic (As) (mg/l) | <0.05 | <0.05 | 0.05 mg/l |
| 3. | Boron (B) (mg/l) | <0.05 | <0.05 | 1.0 mg/l |
| 4. | Cadmium (Cd) (mg/l) | <0.001 | <0.001 | 0.005 mg/l |
| 5. | Calcium (Ca) (mg/l) | 56.42 | 49.25 | 75.0 mg/l |
| 6. | Chloride ($Cl^-$) (mg/l) | 163.68 | 145.37 | 150-600 mg/l |
| 7. | Chromium (Cr) (mg/l) | <0.01 | <0.01 | 0.05 mg/l |
| 8. | Conductivity (µmhos/$cm$) | 280 | 260 | - |
| 9. | Depth (ft) | 1000 ft | 950 ft | - |
| 10. | Fluride (F) (mg/l) | 0.42 | 0.36 | 1 mg/l |
| 11. | Fecal Coliform (mg/l) | 0 | 0 | - |

| Sl. | Parameters | Sampling code | | Bangladesh Standard |
|---|---|---|---|---|
| | | GW1 | GW2 | |
| 12. | Iron (Fe) (mg/l) | 0.65 | 0.58 | 0.3-1.0 mg/l |
| 13. | Lead (Pb) (mg/l) | <0.05 | <0.05 | 0.05 mg/l |
| 14. | Mercury (Hg) (mg/l) | <0.001 | <0.001 | 0.001 mg/l |
| 15. | pH | 6.8 | 7.0 | 6.5-8.5 |
| 16. | Potassium (K) (mg/l) | 4.68 | 5.73 | 12.0 mg/l |
| 17. | Phosphorus (P) (mg/l) | <0.10 | <0.10 | 0 |
| 18. | Salinity (ppt) | 0.7 | 0.5 | - |
| 19. | Sodium (Na) (mg/l) | 35.32 | 43.64 | 200 mg/l |
| 20. | Temperature (°C) | 26.9°C | 27.6 °C | 20-30 °C |
| 21. | Total Coliform (mg/l) | 0 | 0 | - |
| 22. | Total Dissolved Solids (mg/l) | 380 | 340 | 1000 mg/l |
| 23. | Total Hardness (as $CaCO_3$) (mg/l) | 378.4 | 420.8 | 200 – 500 mg/l |

*(Source: Laboratory Analysis, Department of Soil, water and Environment, University of Dhaka and EQMS laboratory, Sampling Date: 16/4/14 and analysis date 21/4/14)*

The key parameters in groundwater are discussed below, compared with the Bangladesh ECR Standards for drinking water.

***pH***

The pH of the samples varies in the range of 6.8 to 7.0 which is well within the standard range of 6.5 to 8.5.

***Total Hardness***

Total Hardness varied in the range of 378.4 to 420.8 mg/l and is well within the standard limit of 200-500 mg/l.

***Chloride***

The chloride content in the samples is 163.68 to 145.37 mg/l and is well within the permissible standards of 150-600 mg/l.

***Iron and Arsenic***

The iron content of the groundwater samples is 0.65 to 0.58 mg/l which is well within the standard range of 0.3 to 1 mg/l.

The level of arsenic in the ground water of the study area is within the standard limit of 0.05 mg/l for the entire sample.

# 6.10 Aquatic Monitoring

## 6.10.1 Hydrology and Morphological Study

### 6.10.1.1 Introduction

With the objective of fuel diversification for sustainable power generation and reliable electricity supply, Bangladesh-China Power Company (Pvt.) Limited (A joint venture company of CMC and NWPGCL) has planned to install a new coal based thermal Power Plant in Patuakhali District. The proposed power plant will produce 1320 MW of electricity.

The Patuakhali coal fired power plant is proposed to be constructed at the right bank of the Rabnabad Channel (looking south), immediately upstream of the Andharmanik River and Rabnabad Channel in Dhankhali Union, Kalapara Upazila (**Figure 6-19**).

Before proceeding with the detail engineering design of such a big power plant, a hydro-meteorological, hydrological, hydro-geological and morphological study need to be carried out to demonstrate the feasibility of these project sites. With the idea of such pre-feasibility study, the present section describes the preliminary hydro-morphological study of the proposed power plant site. The report outlines the objectives, scope of works, expected outputs, methodology, works been carried out and the findings of the hydro-morphological study.

### 6.10.1.2 Objectives and Expected Outputs

**Objectives**

The detailed objectives according to the main technical requirement can be summarized as follows:

- To conduct a preliminary hydrological study of the rivers in the vicinity of the proposed power plant site to investigate the hydrodynamic characteristics of the river such as highest water level, flood level, seasonal water level hydrographs, and historical monthly maximum and minimum water level, monthly available flow rate of water in-taking reach, etc.
- To conduct a preliminary morphological study of the rivers in the vicinity of the proposed power plant site to assess the river bank line stability, erosion-deposition pattern, existing river bed, and river navigability, etc.

**Expected Outputs**

The expected results of the study listed in the proposal are as follows:

***Hydrological – Hydrodynamic Study***

- The highest water level against average, 1 in 5, 10, 20, 50 and 100 year return period
- Seasonal available water for the power plant
- Typical yearly water level hydrograph of wet, average and dry season
- Monthly maximum and minimum water level

***Morphological Study***

- River bed evolution, bank erosion and bank stability of the site area
- Overall erosion-deposition pattern of the river in the vicinity of the site area
- River historic changes, river regime changes, etc.

***Navigability***

- River navigability in and around the project site

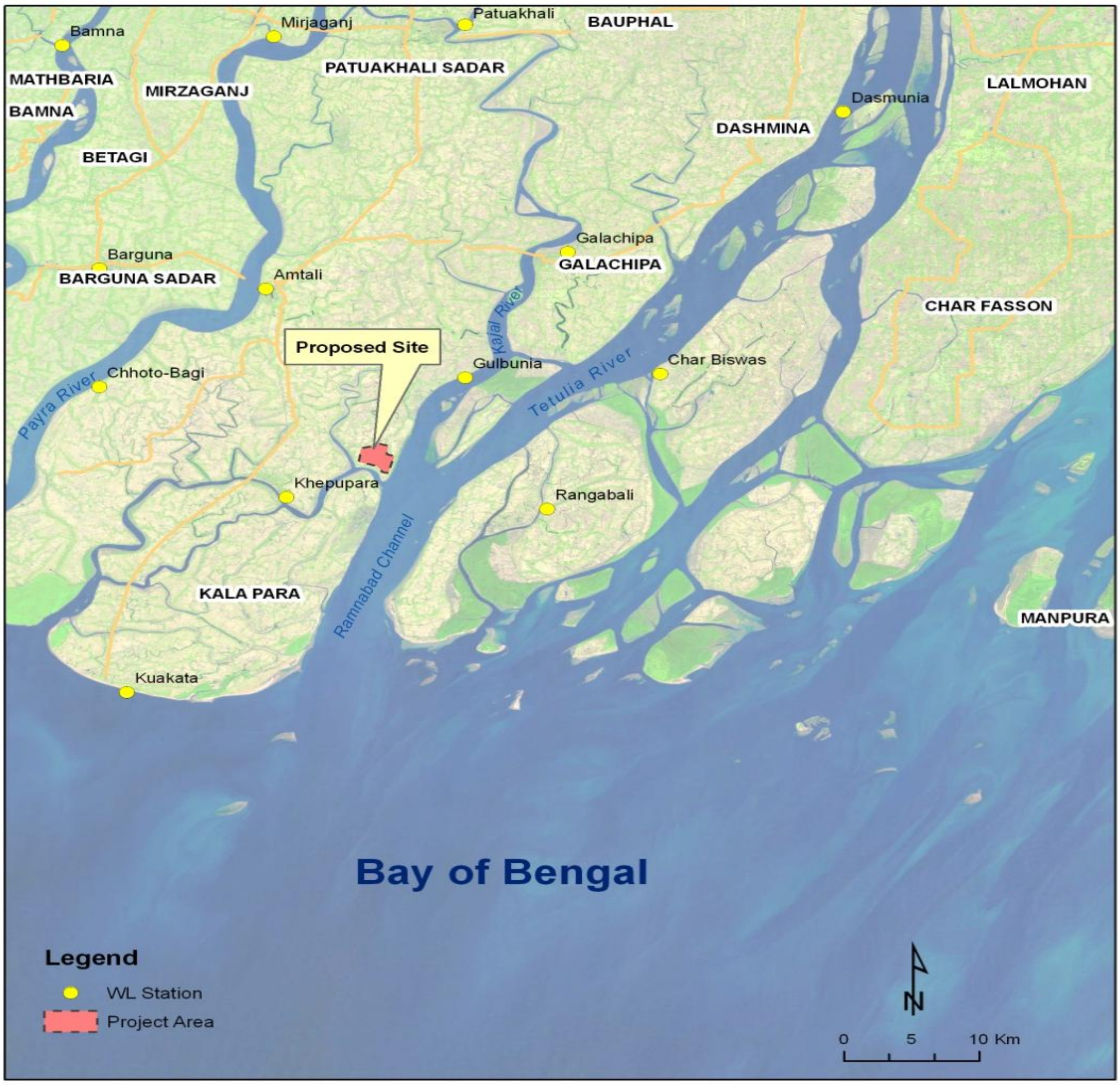



**Figure 6-19: Proposed Power Plant Site**

### 6.10.1.3 Approach and Methodology

The study had maintained the following processes as part of its approach and methodology:

- Data collection
- Hydrology and river hydraulics
- River morphology

**Data Collection**

An accurate description of the river flow is the important basis for all further assessments. Such accurate description relies on adequate data of good quality for water levels, discharge, bathymetry etc.

Representation of the flow dynamics and movement of sediment in any river area requires several categories of hydrodynamic, morphological and topographic data. The hydrodynamic data in this case includes water level and discharge. Topographic data includes river cross sections, river lengths, interconnectivity, etc. while morphological data and information includes historical satellite images, data of river bathymetry, sediment size and transport rate.

Relevant hydrometric, bathymetric, satellite images which are available in government and agencies have been collected and analyzed. Apart from these, historic satellite images of the study have been also collected from freely available online sources and analyzed to investigate the river bank line shifting over the years.

The main sources of existing hydrometric, bathymetry and satellite imageries are as follows:

- Bangladesh Water Development Board (BWDB)
- Bangladesh Inland Water Transport Authority (BIWTA)
- United States Geological Survey (USGS)

**Hydrology and River Hydraulics Study**

The hydrological and hydrometric stations such as rainfall and water level stations maintained by Bangladesh Water Development Board (BWDB) have been collected. The data of hydrometric stations maintained by Bangladesh Inland Water Transport Authority (BIWTA) has also been collected. This hydrological and hydrometric data have been used for the basic hydrological analysis required for this study.

The analysis includes the extreme value analysis of water level to find out the highest water level for 100 years return period (equivalent to 1% frequency), flood level and maximum flow of water for average, 1 in 5, 10, 20 and 100 years return period (equivalent to 43, 20, 10, 5 and 1% frequency, respectively). No discharge data is available for the adjacent river of the project area and therefore, could not be collected. However, the availability of water for the proposed power plant has been examined using the secondary source data.

**Morphological Study**

The present morphological study that has been carried out under this preliminary study addressed the stability of the river bank, overall erosion-depositional pattern in the rivers in and around the proposed site, movement of river bed and the river navigability.

Observation of the channel alignment using the series of past satellite images of the surrounding rivers is the most effective way to understand the bank line shifting of the river, hence the river bank stability, over a historical period. Such investigation tells the shifting characteristics of the channel over the years.

Surveyed river cross section data has been processed and analyzed to understand the river bathymetry, river bed profile, erosion-deposition pattern, and river navigability. Few cross sections have been surveyed under this study at the plant site to reveal the present river bathymetry formation.

**Data Collection and Analysis**

**Primary and Secondary Data Collection**

The primary data that were collected under this study are the river cross sections of the Rabnabad Channel and Andharmanik River at the vicinity of the power plant site and the land elevation of the project area. Both river cross sections and land elevation data were measured in meter Public Works Datum (mPWD). Using the land elevation data, a DEM of the project or site area has been prepared.

All hydrometric data such as water level of nearby hydrometric stations were collected from secondary sources, particularly from Bangladesh Water Development Board (BWDB). Apart from surveyed cross-sections, no other cross-section data of the adjacent river were available. River bathymetry data was collected from National Geophysical Data Centre of National Oceanic and Atmospheric Administration (NOAA) (https://earthexplorer.usgs.gov/). Besides that, historical Landsat Thematic Mapper 5 and 8 (TM5 and TM8) of the physical setup of the project area and its surroundings were collected from United States Geological Survey (USGS)'s Earth Explorer website (https://earthexplorer.usgs.gov/).

A brief discussion on the collected primary and secondary data is presented as below.

***River Cross-Sections***

Four cross-sections of right bank of the Rabnabad Channel (looking towards south) and two cross-sections of the Andharmanik River in the vicinity of the project area were surveyed under this study. The surveyed section locations are shown in **Figure 6-20** and cross-sections are shown in **Figure 6-21** and **Figure 6-22**.

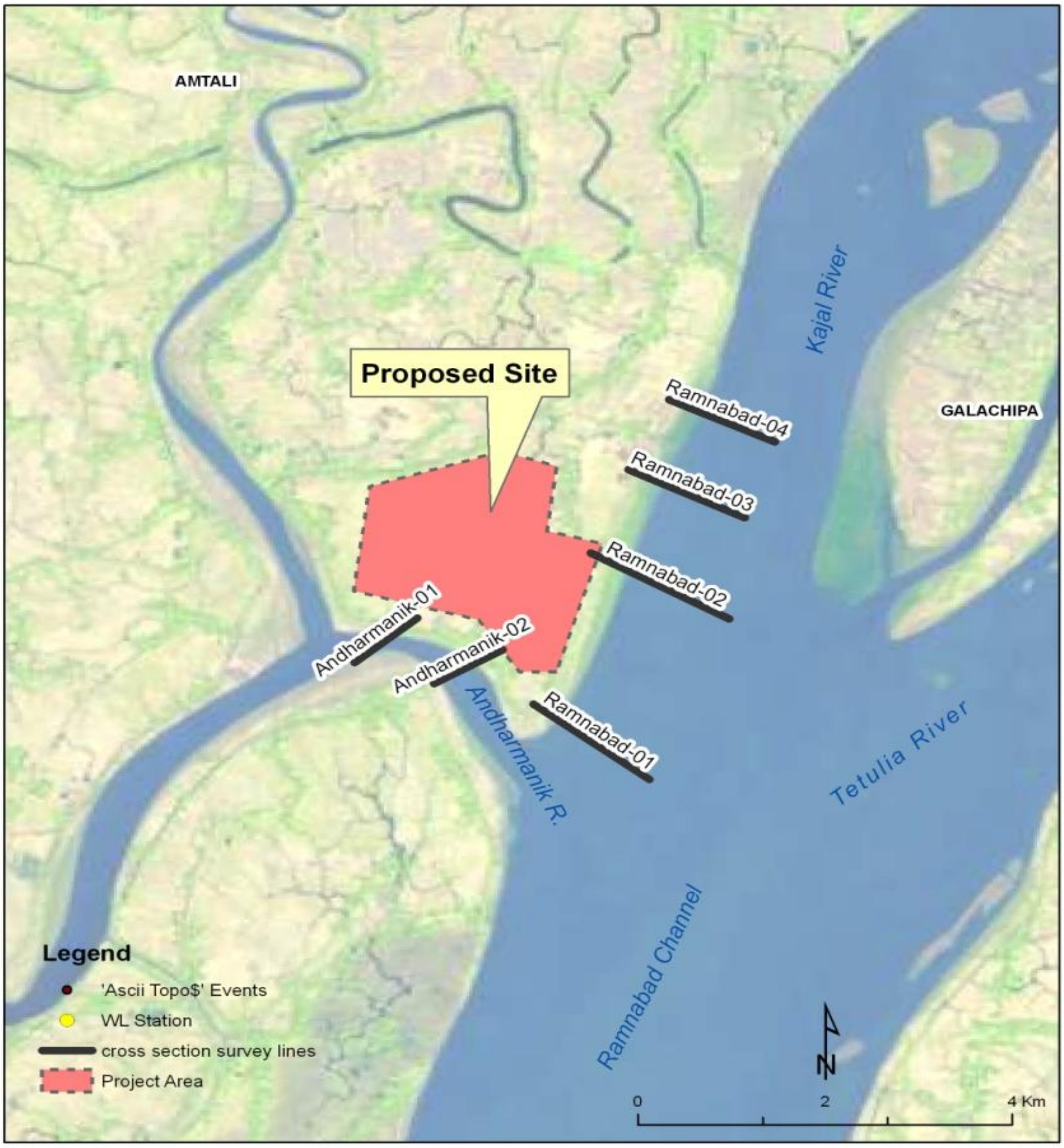



**Figure 6-20: Surveyed Cross-Section Position**

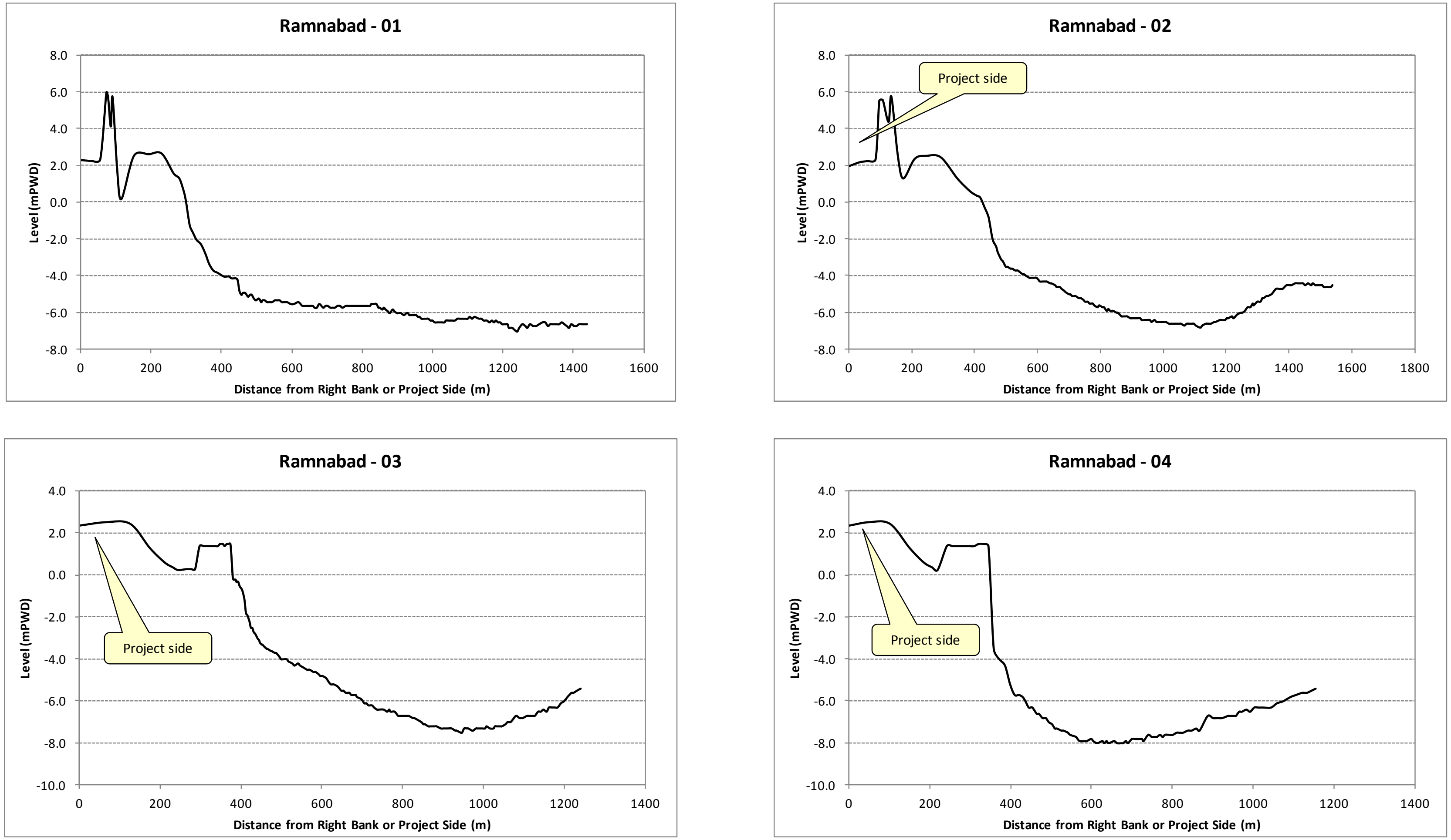



**Figure 6-21: Surveyed Cross-Sections of the Rabnabad Channel**

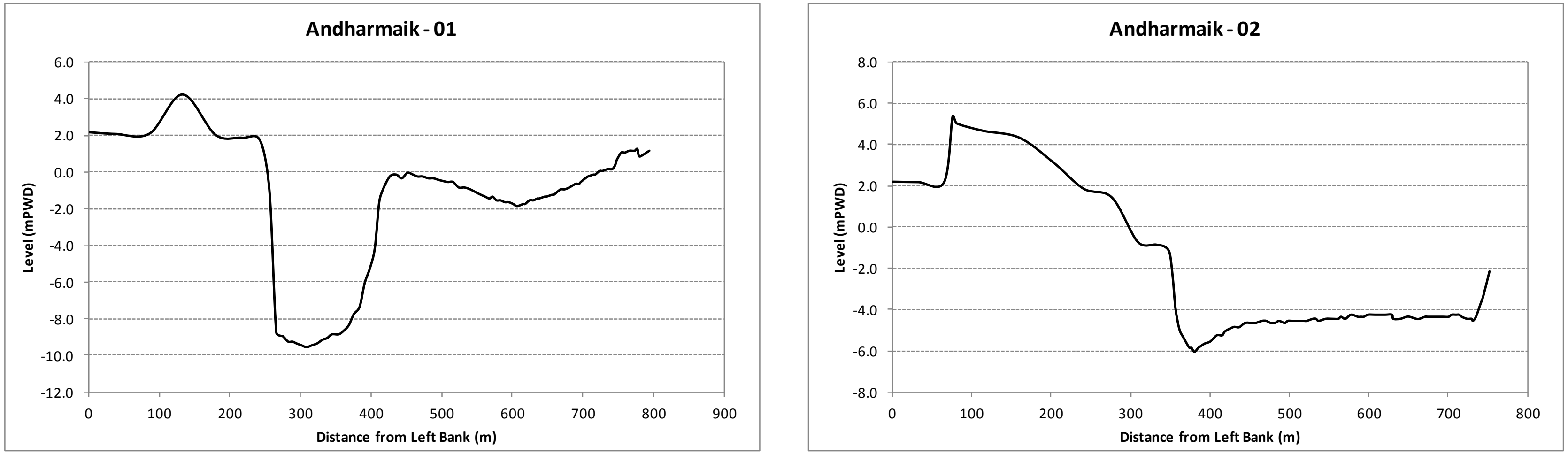



**Figure 6-22: Surveyed Cross Section of Andermanik River**

### Hydrometric and Hydrological Data

Water level data was collected from seven nearby hydrometric stations. No discharge data was available for these stations, hence could not be collected. A discussion on the collected data, availability status is discussed as following.

#### *Water level*

Water level data for four stations such as Khepupara, Kaitpara, Tongibari and Bhola was collected from BWDB. Status of the collected hydrometric data is shown in the following table while locations of these stations are shown in **Table 6-14.**

**Table 6-14: Hydrometric Data Collection Status**

| Station | River | Data type | Data measurement type |
|---|---|---|---|
| Khepupara | Nilganj | WL | High-Low tide |
| Kaitpara | Lohalia | WL | High-Low tide |
| Tongibari | Tentulia | WL | High-Low tide |
| Bhola | Tentulia | WL | High-Low tide |

#### *River bathymetry*

River bathymetry data was collected from National Geophysical Data Centre of National Oceanic and Atmospheric Administration (NOAA) (https://earthexplorer.usgs.gov/).

#### *Land Elevation (DEM)*

The DEM of this area as part of National DEM was readily available, but that was very coarse (300m resolution) and old; last updating was done back in mid-1980. Therefore, an updated DEM preparation was necessary for the project site. As such a land elevation survey was carried out under the present study. Using those surveyed data, a DEM of 50m resolution has been prepared for the project area. **Figure 6-23** shows the newly surveyed DEM of the power plant site. At the eastern part of the area, average land elevation is around 2 – 3 m PWD while it is around 1 – 2 m PWD at the western and northern side.

#### *Satellite Images*

Besides that, historical Landsat Thematic Mapper 5 and 8 (TM5 and TM8) of the physical setup of the project area and its surroundings were collected from United States Geological Survey (USGS)'s Earth Explorer website ((https://earthexplorer.usgs.gov/). Downloaded satellite image from the mentioned site is for year 1977, 1991, 2000, 2005 and 2014.

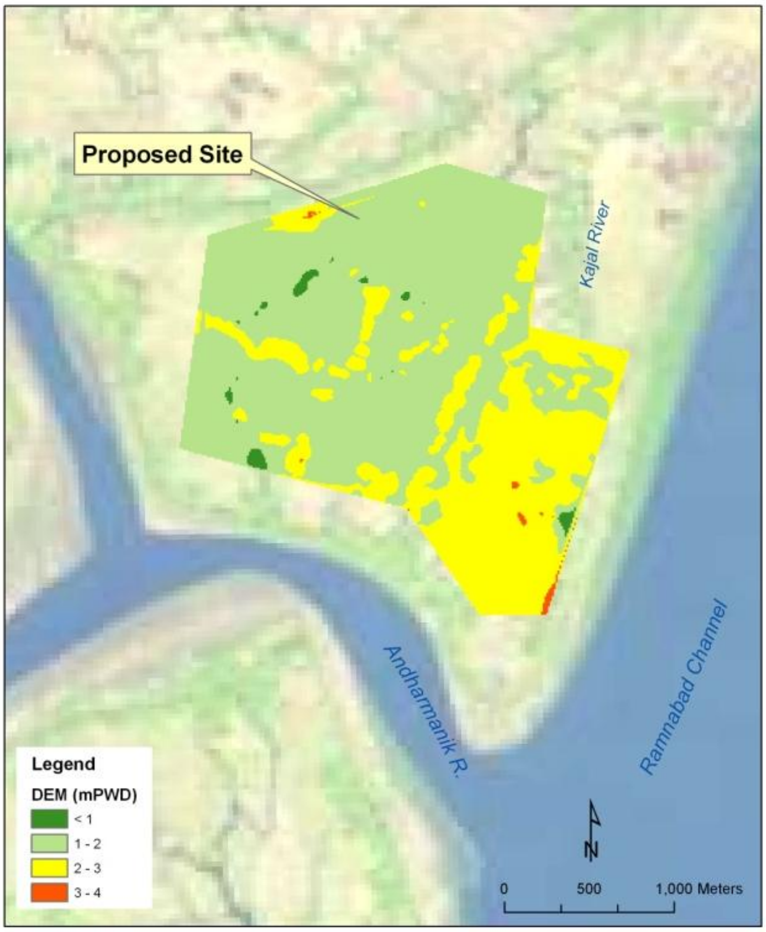



**Figure 6-23: DEM of the Project Site**

### 6.10.1.4 Hydrology and River Hydraulics Study

After collecting data from various sources, data consistency and reliability have been checked first. If there requires any correction in certain period of data for a particular station, standard method was followed for that. Sometimes it was also required to establish a correlation factor between two neighboring stations to fill the missing data. In such case, longer period of data of both stations were compared and a correlation factor was established.

A complete list of data analysis is summarized as following:

- High water level frequency analysis
- Low water level frequency analysis
- Cross section data processing
- Water availability analysis
- Flooding analysis
- Satellite image processing and bank line delineation

**Design Water Level**

Khepupara on the Nilganj River is the only nearby hydrometric stations of the proposed power plant site . The latitudinal distance between the project area and Khepupara is only 2.5 km, therefore, the difference in river stage between these two points is negligible. Considering this, a statistical analysis that includes high water level and low water level frequency analysis were carried out for Khepupara water level data. Design water level found for Khepupara stations is then considered to be the design water level for the project area also.

The statistical distributions namely Pearson III was found most appropriate for Khepupara water level data. Therefore, the results of Pearson III distribution were used to find out design water level for high and low water level against average condition, 5, 10, 20, 50 and 100 year return period. The frequency curves are shown in **Figure 6-24** and **Figure 6-25** while a summary of the statistical analyses is shown in **Table 6-15**.

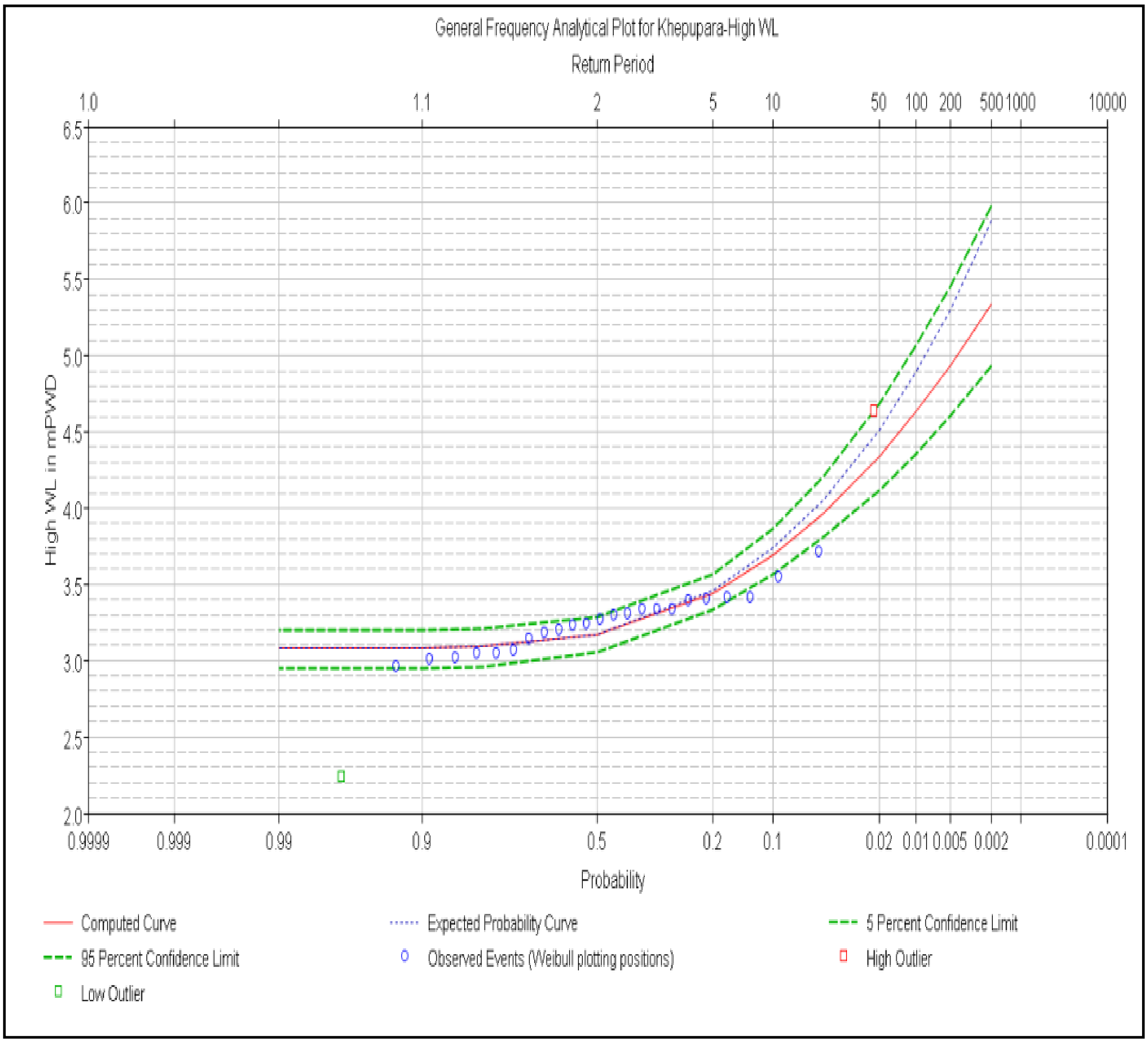



**Figure 6-24: Pearson III High Wter Level Frequency Analysis for Khepupara**

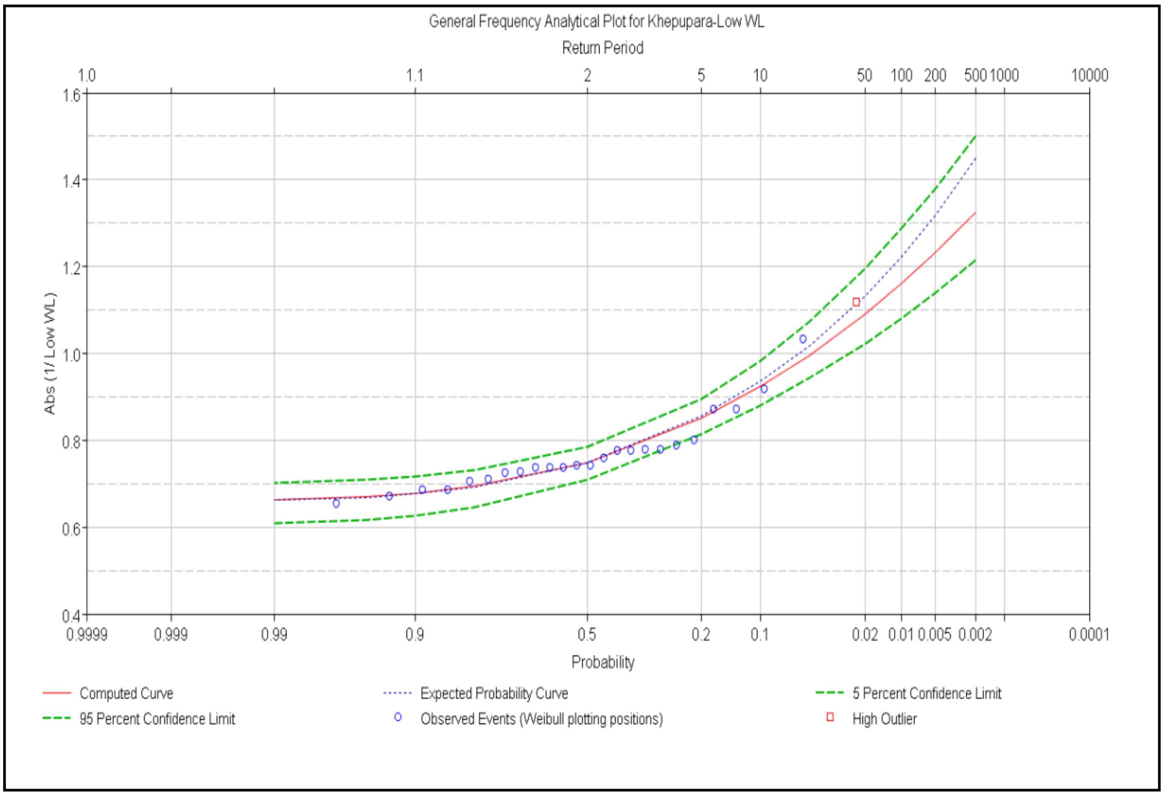



**Figure 6-25: Pearson III Low Water Level Frequency Analysis for Khepupara**

The average high water level is 3.21 m PWD while 20, 50 and 100 year return period high water level is 4.05, 4.51 and 4.89 m PWD, respectively. The 75 year return period value almost matches with the maximum tidal surge height of Sidr that hit over the southern coastal area of Bangladesh on May 25, 2009. During that cyclone surge, maximum water level reached up to 4.64 m PWD at Khepupara. Therefore, a cyclone surge protection embankment should be built along the river bank to protect the proposed power plant and the height of the embankment should be about 5.89 m PWD considering 1.0 meter freeboard and 100 year high water level.

Average low water level is -1.04 m PWD. For 20, 50 and 100 year return period, it is about -1.28, -1.46, and -1.58 m PWD, respectively. Therefore, the river bed should be at least at -5.98, -6.16, and -6.28 m PWD for 20, 50, and 100 year return period's low water level, respectively.

**Table 6-15: Flood and Low Water Level Against Different Return Period at the Project Site**

| Return Period | Flood level (high water level) (mPWD) | Low water level (mPWD) |
|---|---|---|
| Average | 3.21 | -1.04 |
| 5 | 3.46 | -1.08 |
| 10 | 3.74 | -1.14 |
| 20 | 4.05 | -1.28 |
| 50 | 4.51 | -1.46 |
| 100 | 4.89 | -1.58 |

**Water Availability**

Analysis of water availability of the Rabnabad Channel was required to examine the fact that river has enough water to fulfill the requirement of the power plant for its cooling and other operational purpose. It was estimated that about 84 $m^3/s$ water would be required for the plant operation.

The availability of water though was not estimated in the present study due to absence of discharge data. However, data from a secondary source has been used to access the availability of the water in the river. The upstream flow through Rabnabad Channel mainly comes from the Tentulia River. About 10 – 20% flow of the Lower Meghna River pass through the Tentulia River. The river discharge of three majo r rivers of the country, such as the Ganges, Jamuna and Upper Meghna River, dominates the river inflow in the Meghna Estuary. According to IWM study (2014), it shows that, maximum flow in the Rabnabad Channel varies from 40,000 – 44,000 $m^3/s$ from dry to monsoon period. Hence, the water availability for the proposed power plant would not be a problem at all.

**Table 6-16** shows the Length of Natural Drainage Channel around 2km, 5km & 10km of the Study Area. **Figure 6-26** shows the 10 km drainage map of the study area.

**Table 6-16: Length of Natural Drainage Channel Around 2km, 5 km and 10 km of the Project Area**

| Type of Natural Drainage Channel | 2 km | | 5 km | | 10 km | |
|---|---|---|---|---|---|---|
| | Length in Meter | % | Length in Meter | % | Length in Meter | % |
| Khal Network | 24364.52 | 78.10 | 131367.60 | 83.70 | 513893.91 | 84.75 |
| River Network | 6831.48 | 21.90 | 25577.64 | 16.30 | 92436.53 | 15.25 |
| **Total** | **31196.00** | **100.00** | **156945.24** | **100.00** | **606330.44** | **100.00** |

*Source: Physical feature Survey by Consultants, 2014*

The availability of water though was not estimated in the present study due to absence of discharge data. However, data from a secondary source has been used to access the availability of the water in the river. The upstream flow through Rabnabad Channel mainly comes from the Tentulia River. About 10 – 20% flow of the Lower Meghna River pass through the Tentulia River. The river discharge of three major rivers of the country, such as the Ganges, Jamuna and Upper Meghna River, dominates the river inflow in the Meghna Estuary. According to IWM study (2014), it shows that, maximum flow in the Rabnabad Channel varies from 40,000 – 44,000 $m^3/s$ from dry to monsoon period. Hence, the water availability for the proposed power plant would not be a problem at all.

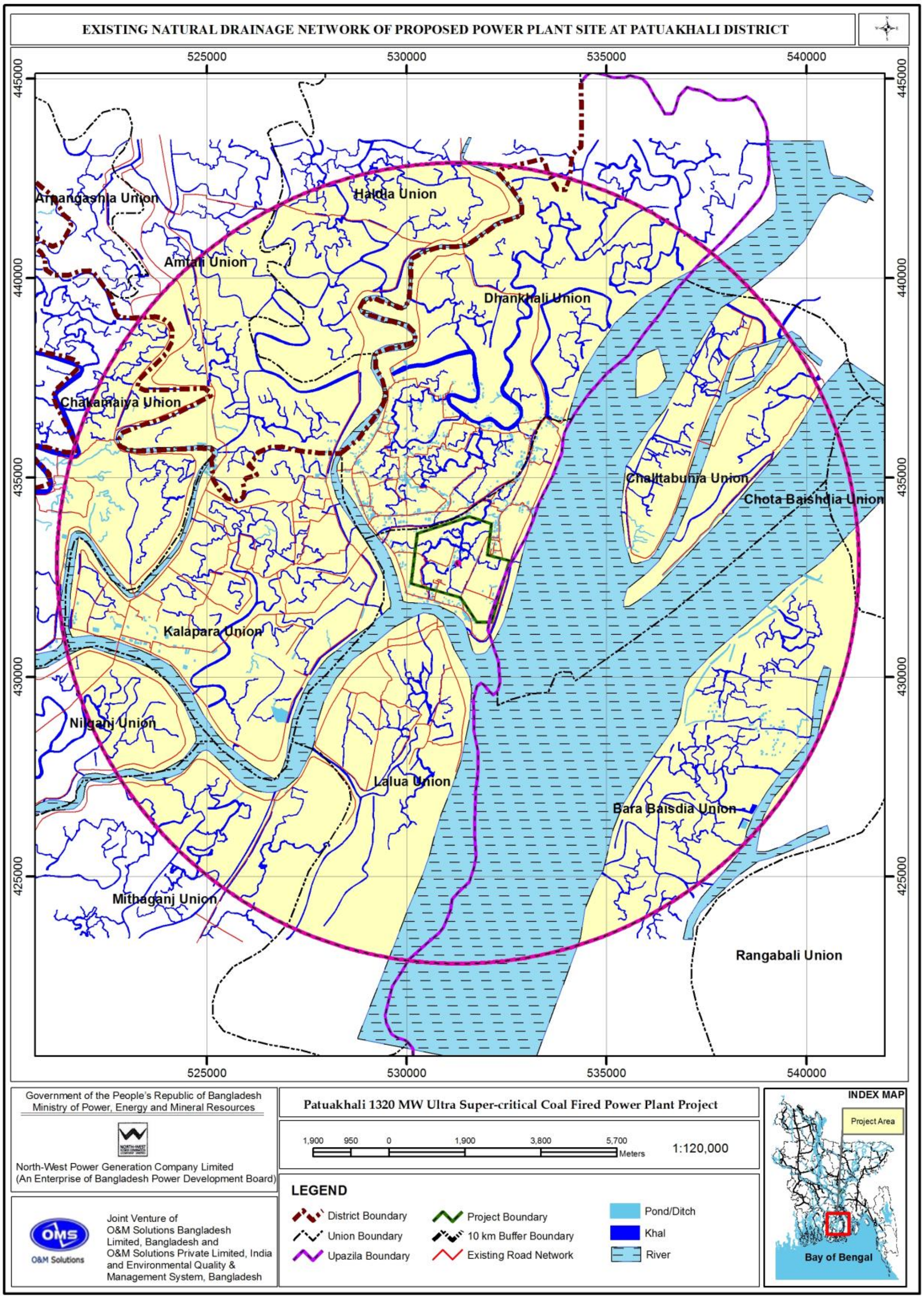



**Figure 6-26: Drainage Map of 10 km Study Area**

### Seasonal Water Level

The seasonal variability in daily high and low tidal water level at Khepupara stations is shown in the following **Figure 6-27.**

On average, high tide water level reaches up to 3.0 – 3.2 m PWD during monsoon while low water level goes down up to -1.23 m PWD during dry season at Khepupara. The same high and low water level scenario can be expected for the project area since the latitudinal difference between Khepupara and the project site is only 2.5 km and the difference in water level between these two points is considered to be negligible. On average, the fluctuation between high and low water level at the project site is 2.14 m during dry (Feb – May), 2.1 m during monsoon (Jun – Sep) and 1.87 m during post-monsoon (Oct – Nov) season.

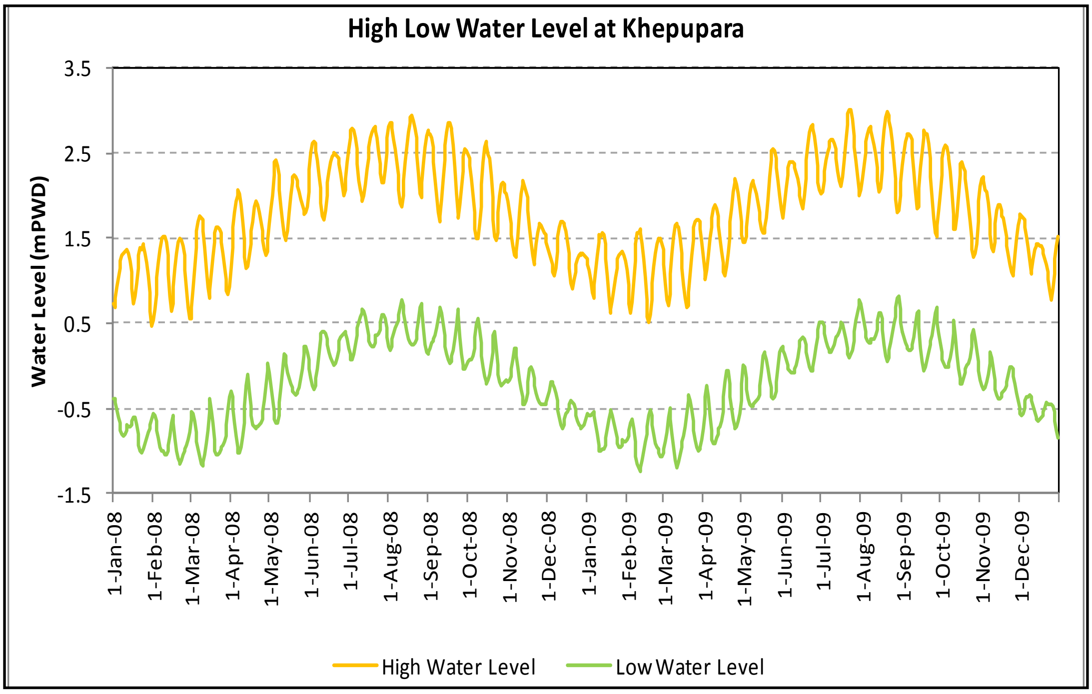



**Figure 6-27: Monthly Average Water Level at the Project Site**

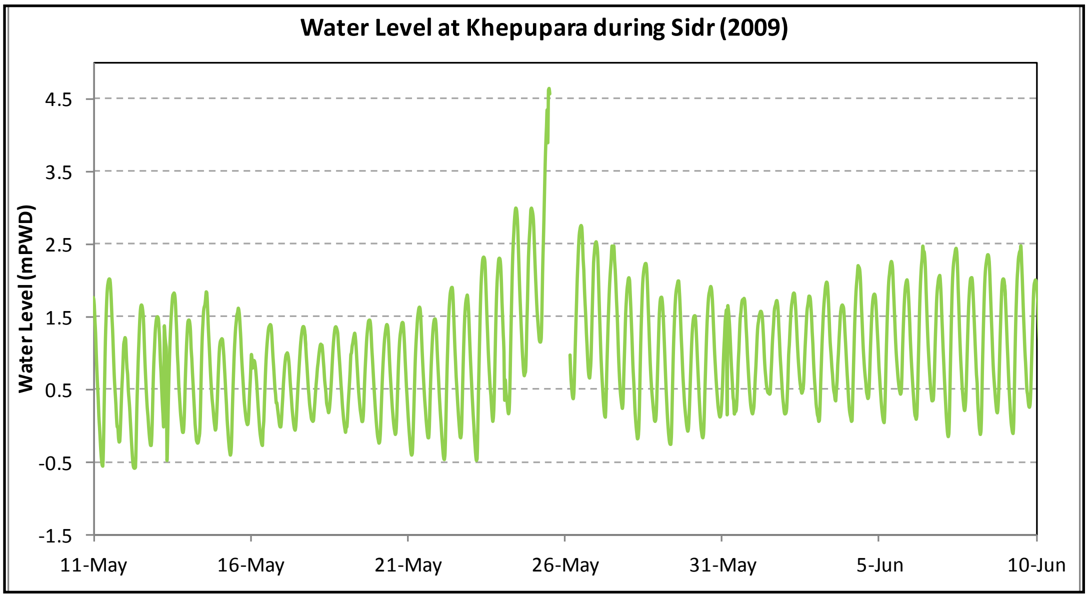


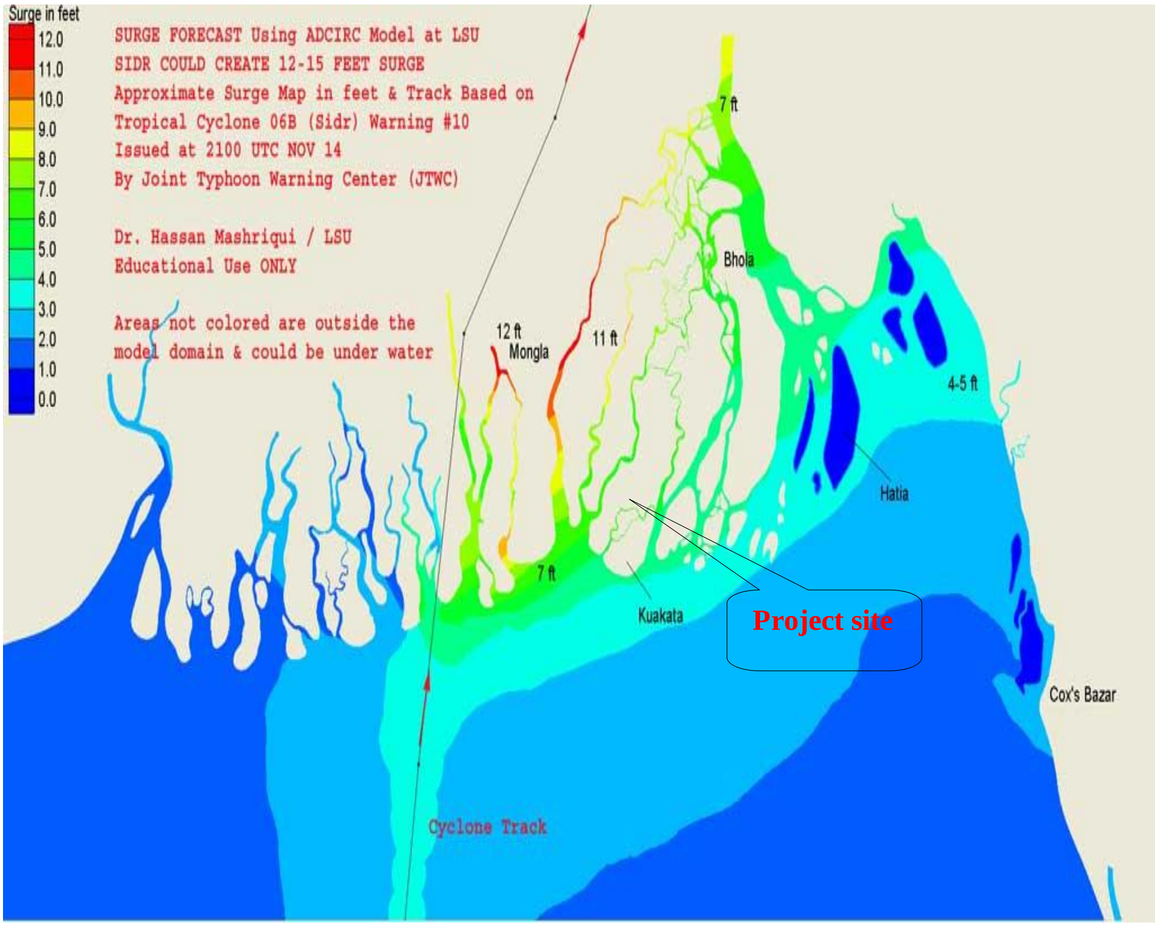
**Figure 6-28: Khepupara Water Level During Cyclone Sidr (May 25, 2009)**

**Flooding**

**Figure 6-29** shows the tidal surge during cyclone Sidr on May 25, 2009. According to this image, it occurred about 4 to 5 meter tidal surge during the cyclone Sidr. This 4 – 5 meter surge is well supported by the Khepupara water level data. Maximum water level during Sidr, 2009 was 4.64 m PWD at Khepupara point.

Since the coastal area of the country is protected by the polders, the surge induced flooding depends on the polder condition and its design height. It is seen in most of the cases that poor maintenance of polder or inadequate design crest level triggers the polder collapse, hence the flooding.

The local people of the project area though informed that they did not face flooding during Sidr due to the protection embankment or polder on the bank of Rabnabad and Andharmanik River. The embankment height is around 5.72 to 5.9 m PWD in the project area according to the cross-section survey (**Figure 5-16**). The high water level frequency analysis also found that the embankment height should be around 5.89 m PWD against 100 year tidal surge. Considering the scenario described above, the existing flood protection embankment should be maintained and routinely monitored to avoid cyclone surge related flooding.




Source: http://research.noaa.gov/Home/SiteNav.aspx

**Figure 6-29: Tidal Surge during Cyclone Sidr, May 25, 2009**

### Morphological Analysis

#### *Long Term Morphological Changes and Erosion Deposition Pattern*

Analyzing the historical satellite images of the project area and surroundings and inspecting the physical setup of the river system, it was found that river setup immediately upstream of the Rabnabad Channel and Andharmanik River, where the proposed power plant site is located, has not been drastically changed over the last 37 years (1977 – 2014).

**Figure 6-30** shows the historical satellite image of the physical setup in and around the proposed power plant site. Apparently it looks like that there is no significant erosion occurred at the confluence of the Andharmanik River and Rabnabad Channel over the last 37 years. However, a careful bank line delineation using these satellite images provides more clear information about this.

The left panel of **Figure 6-31** shows the changes in overall physical setup of large area including formation of charland between Kajal and Tentulia River, formation of even bigger charland at the eastern side of the Rabnabad Chanel. The right panel shows more zoomed area focusing the proposed power plant site and its nearby surroundings. Both images of the figure show the Rabnabad right bank (looking south) immediately before the confluence with the Andharmanik has not been changed lot over the period 1977 - 2014. Whatever changes happened at that bank is rather a deposition (accreditation of land) than a degradation or erosion.

The figure also clearly shows that major changes occur in the eastern part of the Rabnabad and Tentulia River as well the charland between the Tentulia and Kajal during the mentioned period. The right bank (looking south) of the Rabnabad Channel, after the confluence of the Andharmanik and Rabnabad that is the proposed location for the Payra Sea Port, has been eroded significantly during the period 1977 – 2014.

Landsat-TM 1977

Landsat-TM 1991

Landsat-TM 2000

Landsat-TM 2014

**Figure 6-30: Historical Satellite Images in and around the Proposed Site**

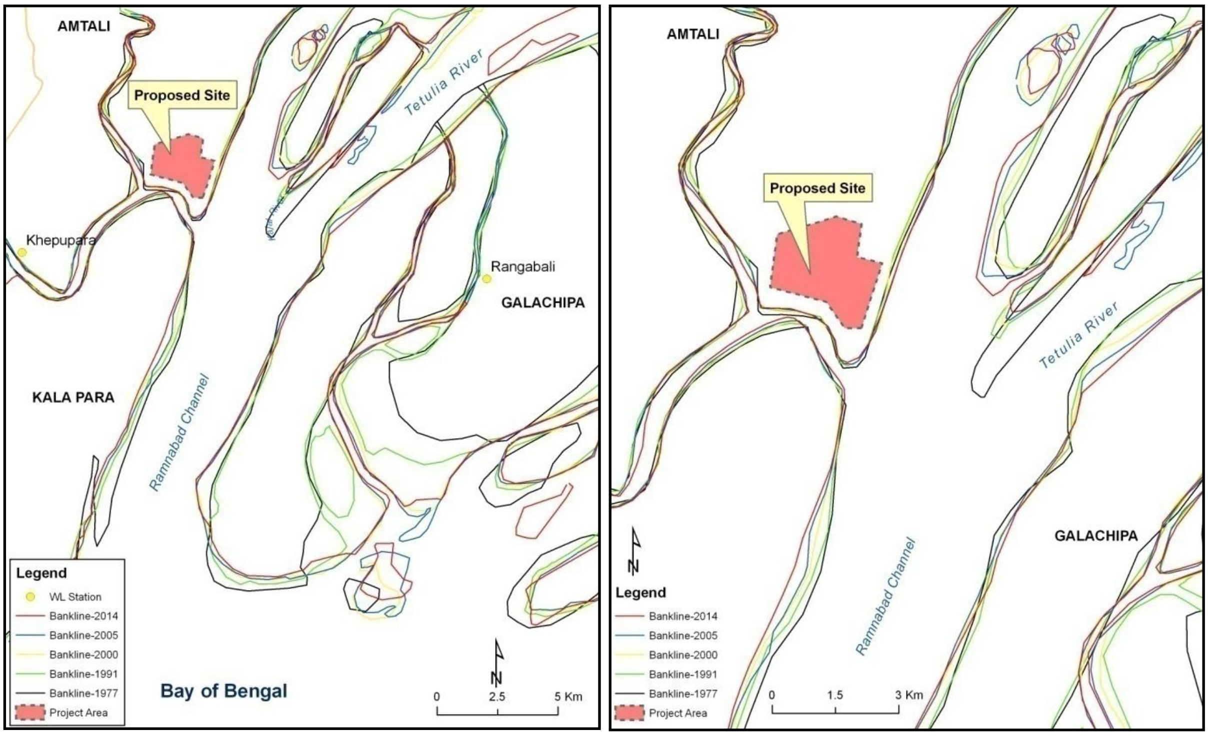



**Figure 6-31: Bank Line Movement and Erosion-Deposition Pattern in and around the Proposed Site from 1977 - 2014**

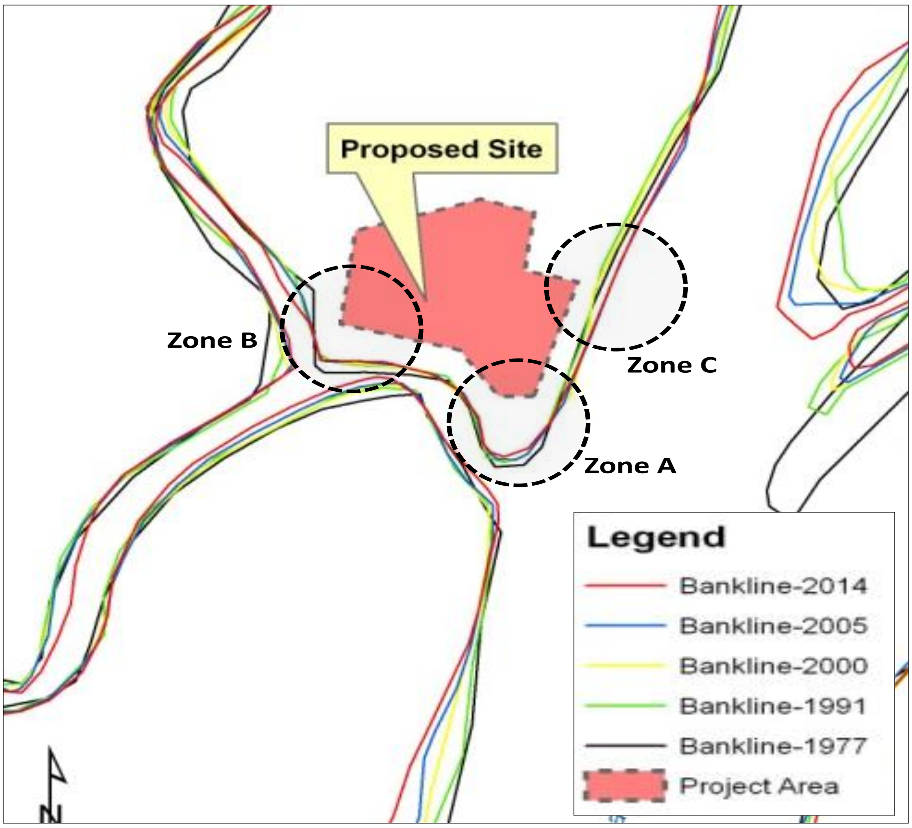



**Figure 6-32: Erosion-Deposition Pattern in and around of the Proposed Site during 1977 – 2014**

At the same time, the Andharmanik River, just before the confluence point with the Rabnabad Channel, has gone through a reasonable erosion-deposition pattern over the years. Despite these prominent changes in and around the area of proposed power plant site, the Rabnabad bank line at the proposed site looks like a more stable bank in compare to other banks. Though, a further closer inspection of the historical changes in river bank at that location (**Figure 6-32**) shows a minor tendency of having erosion immediately at confluence toe (Zone A in **Figure 6-32**). **Figure 6-32** also shows that bank line in the Zone B has gone through moderate erosion over the years, making it vulnerable against the river bank erosion. On the other hand, Zone C, marked over the **Figure 6-32**, is relatively less vulnerable to erosion. It shows rather a depositional pattern at the bank marked as Zone C.

From the discussion above, it could be summarized that, compare to other parts of the Rabnabad, Tentulia and Andharmanik River, the bank immediate around the project site is less vulnerable to erosion problem. Though the area has gone under a small to moderate erosion-deposition scenario over the last 37 years, it is generally understood that bank protection works of the proposed power plant would restraint those erosion tendency of the river bank. A further study comprising detail two- and three-dimensional model could investigate the matter more profoundly. However, based on the present preliminary study conducted here, it is recommended that the river bank at the project site should be protected.

#### 6.10.1.5 Present River Bathymetry and River Bathymetry

Present bathymetry of the river system in and around the project area up to deep sea is shown in **Figure 6-33**. This bathymetry data was collected from GEODAS data set and depth is shown against mean sea level.

A closer look of the river bed is shown in **Figure 6-34**. This near bank bed level is prepared based on cross-section survey data, carried out under this study. The figure clearly shows that in near bank bed where the power plant's jetty will be constructed has river bed about -2 to -5 m PWD. If the lowest water level (-1.04 m PWD for average condition, -1.28 m PWD for 20 year, -1.46 m PWD for 50 year, and -1.58 m PWD for 100 year return period is projected on this bed level, it is found that the near bank river does not have enough draft for the coal carrying vessel at the project site. Total depth of around 4.7 m (3.7 m draft + 1.0 m clearance from bottom of the vessel to river bed) is required for safe navigation of the proposed vessel type for this proposed power plant. Considering this 4.7 m draft required for vessel, bed level should be at around -5.74, -5.98, -6.16, and -6.28 m PWD for average, 20, 50 and 100 year return period's low water level at the project site. In such case, dredging of about 1.28 – 4.28 meter would be required for the jetty location to navigate the vessel up to the jetty point.

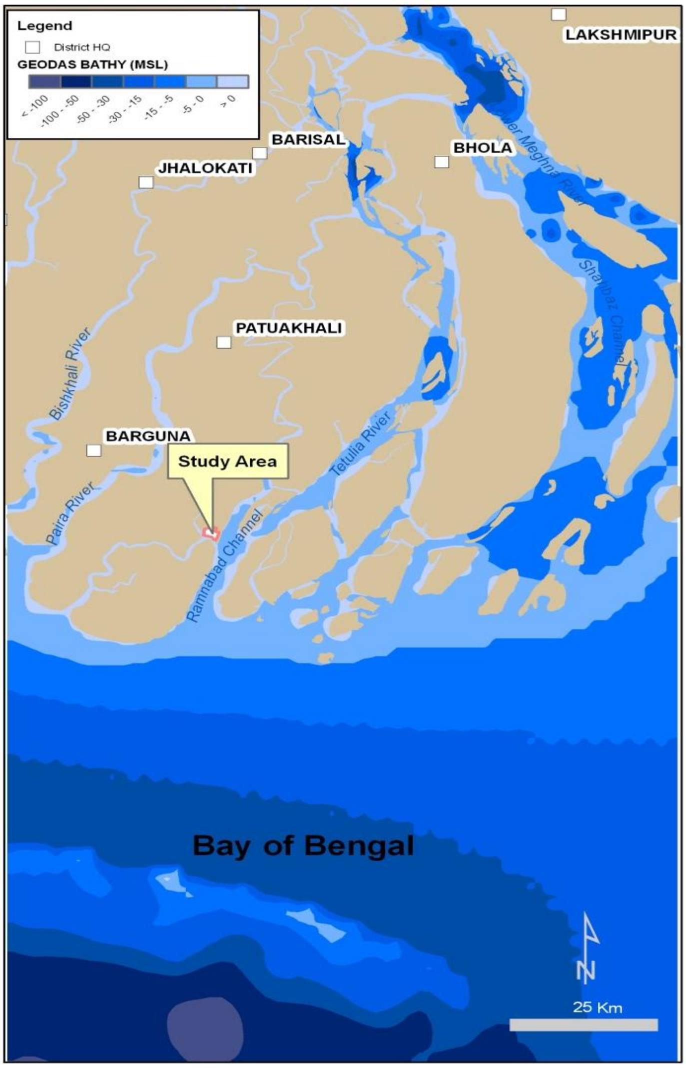



**Figure 6-33: GEODAS Bathymetry**

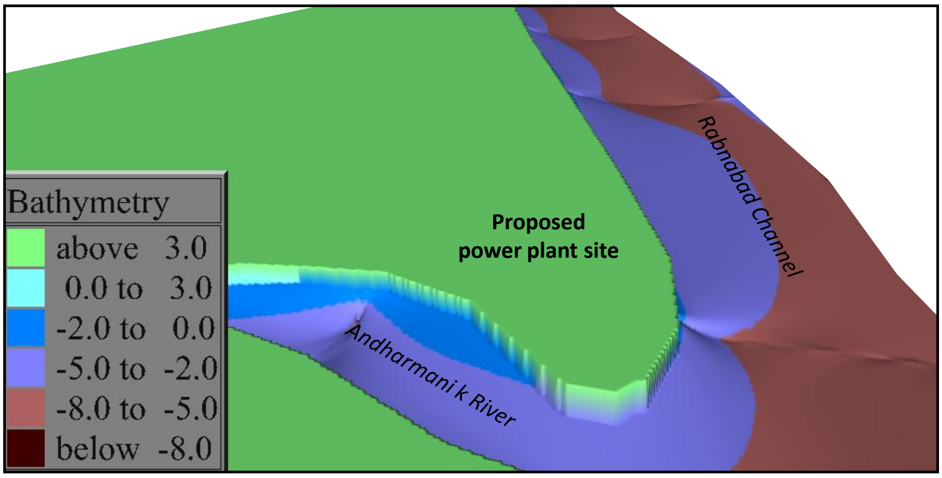



**Figure 6-34: Near Bank River Bed at the Project Site Based on Survey Data**

## 6.11 Soil Quality

In Bangladesh 21 different general soil types have been categorized based on the diagnostic horizons and diagnostic properties of the soil (FAO-UNDP, 1988). According to this classification to two types of soil class; calcareous alluvium, which are found within the Project area and non-calcareous grey flood plain soils which are found nearby the Project area. **Figure 6-35** shows these soil types in relation to the greater soil type distribution within Bangladesh.

***Calcareous alluvium (Saline) soils***

In general calcareous alluvium soils develop in active flood plains and river islands. In case of the Young Meghna estuarine areas such as the Project area, these soils are saline, while in Ganges flood plain areas, they are non saline. The soils of the Project area are subject to continuous river erosion and accretion cycles. Almost all the soils of the Project area are deep silts, however some clay occurs up to 20m depth of the top horizons that reduce the permeability of the soils.

***Non-calcareous grey flood plain***

The non-calcareous grey flood plain soils occur nearby the Project site, particularly on the opposite bank of Char Kajal to the Project area. The prudent diagnostic property of this type of soils is non saline grey soil. This soil type consists of prismatic and/or blocky structured, predominantly grey sandy loams to silty clay loams to clays in basins, which are slightly acid to neutral.

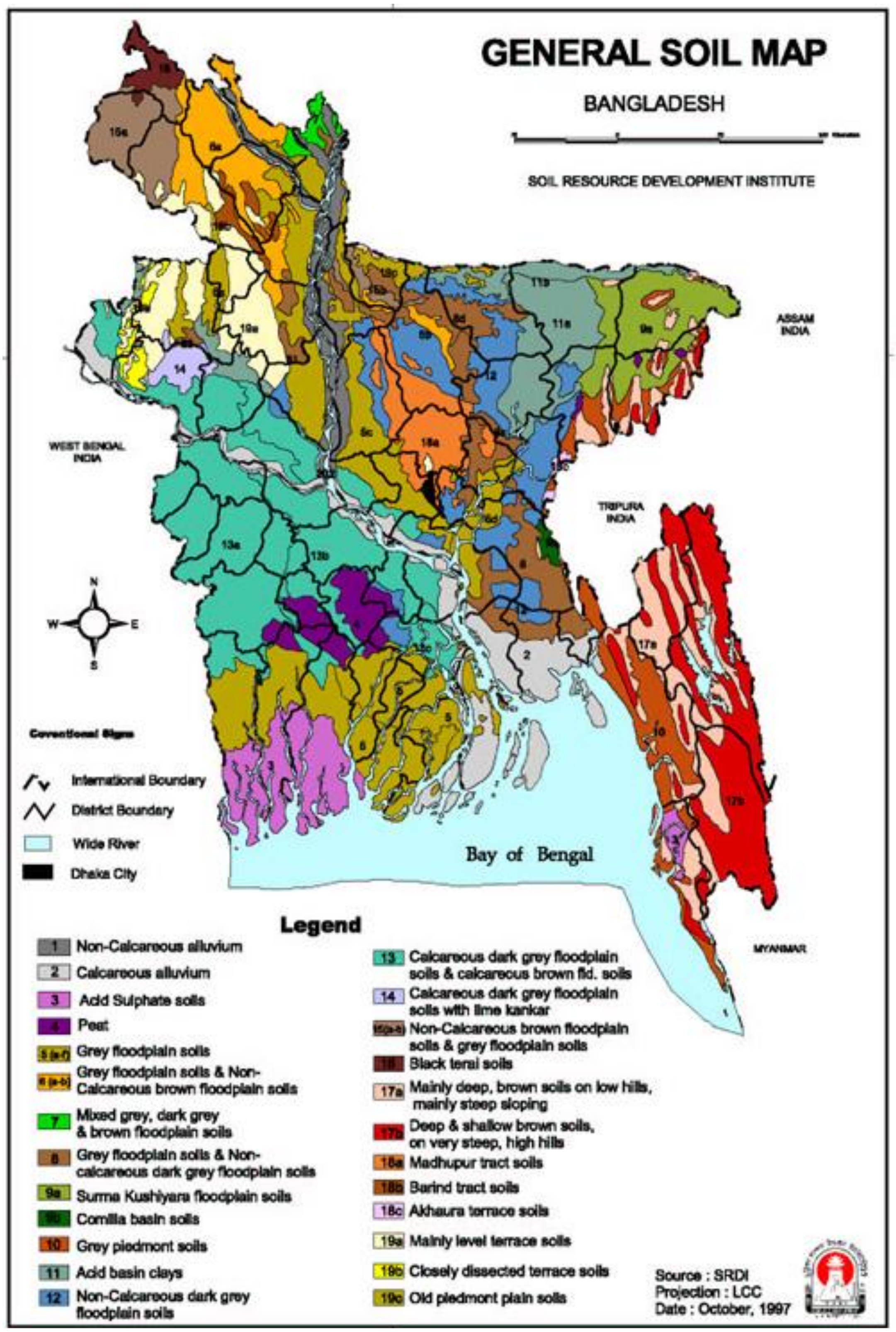



**Figure 6-35: General Soil Map of Bangladesh**

### 6.11.1 Soils of the Project Area

#### 6.11.1.1 Sampling Methodology and Locations

The soil sampling strategy was designed to assess the existing soil quality over the study area. Samples were collected from a total two (2) locations within the study area. The detail of the sampling locations is presented in **Table 6-17** and **Figure 6-36**. A composite sampling technique was used for soil sampling from each location.

**Table 6-17: Location of Soil Samples**

| Sl. | Sampling Station | Station Code | Geographic Location | Location Setting |
|---|---|---|---|---|
| 1. | Project site | SQ1 | 21°59'53.47"N 90°18'5.51"E | Agricultural land |
| 2. | Modhupara village | SQ2 | 22° 0'29.61"N 90°17'4.76"E | Agricultural land |

Soil samples were collected using tools from a depth of 45 cm from the top soil surface. At each location, soil samples were collected from three spots and homogenized. The homogenized samples were collecting following quartering technique and then packed in polythene plastic jars and sealed. The sealed samples were sent to the laboratory for analysis.

The soil samples were analyzed for physical and chemical characteristics including minerals, heavy metals and trace elements.


**Figure 6-36: Sampling Location Map for Ground water, Surface water and Soil Collection in the Project Area**

### 6.11.1.2 Analysis Results and discussions

The analysis results of physico-chemical parameters of samples are presented in **Table 6-18**.

**Table 6-18: Soil Quality Results in the Proposed Patuakhali Power Plant Site**

| Parameters | Soil Quality | | Methods of Analysis |
|---|---|---|---|
| Sample Code | SQ1 | SQ2 | |
| Particle size distribution | Sand-25%<br>Silt-40%<br>Clay-35% | Sand-26%<br>Silt- 42%<br>Clay-32% | USDA Textural Triangle |
| Texture | Clay loam | Clay loam | USDA Textural Triangle |
| EC (dS/m) | 1.3 | 1.2 | IS 14767 |
| Bulk Density (g/cm$^3$) | 1.30 | 1.31 | - |
| Cation Exchange Cpacity (meq/100g) | 0.04 | 0.05 | barium chloride-triethanolamine method |
| pH | 6.7 | 6.8 | pH meter |
| Organic Content (%) | 1.4 | 1.5 | ASTM D 2974 |
| Calcium (mg/kg) | 6.48 | 6.75 | Atomic Absorption Spectrometry |
| Magnesium (mg/kg) | 5.45 | 5.26 | Atomic Absorption Spectrometry |
| Potassium (mg/kg) | 0.38 | 0.35 | Near Infrared Reflectance Spectroscopy (1000-2500 nm) |
| Sodium (meq/100g) | 3.42 | 3.24 | PFP7 Flame Photometer |
| Ammonium-Nitrogen (mg/kg) | 30.54 | 29.32 | EN ISO 11732 |
| Phosphorus (mg/kg) | 4.21 | 4.18 | Kjeldahl method |
| Sulphur (mg/kg) | 34.23 | 36.36 | UV Spectrophotometer (450nm) |
| Copper (mg/kg) | 3.45 | 3.37 | Atomic Absorption Spectrometry |
| Iron (mg/kg) | 56.7 | 53.6 | Atomic Absorption Spectrometry |
| Manganese (mg/kg) | 24.5 | 30.3 | Atomic Absorption Spectrometry |
| Zinc (mg/kg) | 1.53 | 1.45 | Atomic Absorption Spectrometry |
| Lead (mg/kg) | 16.32 | 17.42 | Atomic Absorption Spectrometry |
| Cadmium (mg/kg) | BDL | BDL | Atomic Absorption Spectrometry |
| Arsenic (mg/kg) | 0.16 | 0.14 | Atomic Absorption Spectrometry |
| Mercury (mg/kg) | BDL | BDL | SW-846 method |

*(Source: Laboratory Analysis, Department of Soil, water and Environment, University of Dhaka, SamplingDate: 16/4/14)*

**Physical Characteristics of Soil**

The particle size distribution of the soil samples shows major percentage of silt, followed by sand and clay in most of the samples. The texture shows soil samples of the study area are of silty clay loam type.

***pH level of soil:*** The pH of the soil samples from the site was found to be neutral as per the standard soil classification.

***Organic content in soil:*** The organic content of soil greatly influences the plant, animal and microorganism populations in that soil. The soil of the SQ1 and SQ2 was found to have an organic content of 1.4% and 1.5 % respectively. This indicates a moderately high agricultural value of the soils.

***Soil minerals and nutrients:*** Nitrogen, Phosphorus and Potassium (NPK) are the main nutrients, which defines the soil fertility. Phosphorous was observed to be 4.21 and 4.18 mg/kg for SQ1 and SQ2 respectively. The Potassium content was 0.38 and 0.35 mg/kg for the respective samples.

***Metals in soil:*** Iron, Manganese, Zinc, Lead, Cadmium, Arsenic and Mercury were analyzed in the soil samples. All metals were detected in the soil samples. Comparatively lead was observed to be slightly higher (17.42 mg/kg) at SQ2 as compared to the soil sample of SQ1.

In the Environmental Conservation Rules (ECR), 1997 has no soil quality standard. So, the soil quality in the study area are compared with the heavy metal content standard of USEPA office of solid waste and emergency response, hazardous waste land treatment (**Table 6-19**).

**Table 6-19: Heavy Metal and other Component of the Natural Soil**

| Element | Symbol | Common Range (ppm or mg/kg) | Average Concentration (ppm or mg/kg) |
|---|---|---|---|
| **Arsenic** | As | 1-50 | 5 |
| **Boron** | B | 2-100 | 10 |
| **Cadmium** | Cd | 0.01-0.7 | 0.06 |
| **Copper** | Cu | 2-100 | 30 |
| **Lead** | Pb | 2-200 | 10 |
| **Magnesium** | Mg | 600-6,000 | 5,000 |
| **Manganese** | Mn | 20-3,000 | 600 |
| **Mercury** | Hg | 0.01-0.3 | 0.03 |
| **Zinc** | Zn | 100-300 | 50 |

*Source: USEPA office of solid waste and emergency response, hazardous waste land treatment, SW-874 (April 1983, page 273)*

Both baseline soil qualities were observed to be well below the threshold limit compared with the USEPA standard of heavy metal content in soil.

## 6.12 Ecology

### 6.12.1 Overview

The countries of South and Southeast Asia are considered by the IUCN as regions of high species diversity. A large number of native plants, including 3,000-4,000 species of woody flora, have been recorded from Bangladesh. The country lies at the meeting point (ecotonal region) of several floristic provinces, including the Manipur-Khasia, Bengal and North Burman provinces within the Indo-Malayan realm (IUCN, 2002).

The entire floodplain of Bangladesh was once well forested, but most of the native forests have disappeared in recent decades due to mounting pressure from human populations. The floodplain land has long been subject to cultivation, the most dominant land use within the study area. Thus only scattered patches of native trees, wetlands and associated fauna habitat remain in isolated locations within the terrestrial environment (IUCN, 2002). In many parts of the country, the abundance of plantations and groves of trees around villages creates an aspect of discontinuous forest (Wahab, 2008).

The river systems within the study area are used as local transport routes and are also important for fishing and fish farming. The freshwater watercourses also provide an important nursery ground for native fish. In addition, a number of fish ponds and freshwater wetlands occur within the study area. These areas provide diverse habitats for many freshwater aquatic flora and fauna.

### 6.12.2 Bio-ecological Zones

Twenty-five bio-ecological zones have been delineated within Bangladesh by the IUCN. Six parameters were used to determine the areas including: physiography, soil, rainfall and temperature, floral distribution, faunal distribution and flood depth (IUCN 2002). The Project area occurs in both the Ganges Floodplain and Offshore Islands bio-regions, which are separated by the Tentulia River. The Project location is contained within one bio-ecological zone, Ganges Floodplain bio-ecological zone (4b) mapped by IUCN and is shown in **Figure 6-37**.

***Ganges Floodplain Bio-ecological Zone***

The Ganges Floodplain Is basically consisted of the active Floodplain of the Ganges River and the adjoining meandering Floodplains, and is mostly situated in the administrative districts Jessore, kushtia, Fardpur and Barisal. The adjoining meander Floodplains mainly comprises a smooth landscape of ridges, basis and old channels. Noteworthy aspect here is that the Genetic alluvium is readily distinguishable from the old Brahmaputra, Jamuna and Meghna sediment but its high lime content. Besides, the relief is locally irregular alongside the present and former river courses, especially in the west, comprising a rapidly alternating series of linear low ridges and depressions. The Ganges channel is constant shifting within its active Floodplain, eroding and depositing large areas of new char lands in each Flooding season, but it is less braided than that of the Brahmaputra-Jamuna. Interestingly enough, both plants and animals move and adapt with the pattern of Flooding (Brammer, 1996)

This Floodplain is characterized by mixed vegetation. Presence of a lot of stagnant water bodies and channels, rivers and tributaries in this zone support a habitat of rich biodiversity to some extent. In the beels and other water bodies, free floating aquatic vegetation is prominent. Homestead forests, on the other hand, include both cultivated wild plants species, the dominant floral types are: the Panimorch (*Polygonum Orientale*), Jhanji (*Hydrilla vercillata*), Helecha (*Alternant era philoxroides*),Topapana (*Pistia statutes*), (*Sclenoplectus articulates*), Shade shapla (*Nymplaea nouchali*), Keshordam (*Ludwigia adscendense*), Kolmi (*Ipomoea aquatic*), Dhol kolmi (*I fitulosa*), Hijal (*Barrringtonia acutangula*), (*Iponoea aquatic*), Tamarind (*Tamaridus indica*), Panibaj (*Salix tetrsperma*), Etc. Moreover, Grasses are most abundant in the Ganges floodplain and begin to grow as soon as the Flood water begins to recede. The notable grass species are *Cyperus rotund us*, *C diformis, Eleocharis*. *Hemarthria sp.* etc. (GoB-IUCN, 1992).

Nearly all the major groups of the oriental birds are represented in this zone by one or more species. In addition, a large number of migratory birds are found here during the winter. Besides, different species of freshwater tortoises and turtles are also found in the river and ponds most of which are a popular delicacy among the non-Muslim locals. The amphibian species found in this zone include a new species toads and free frogs Among the mammalian fauna foxes, Rats, mice, species, bats, etc. are seen everywhere (GoB-IUCN,1992).

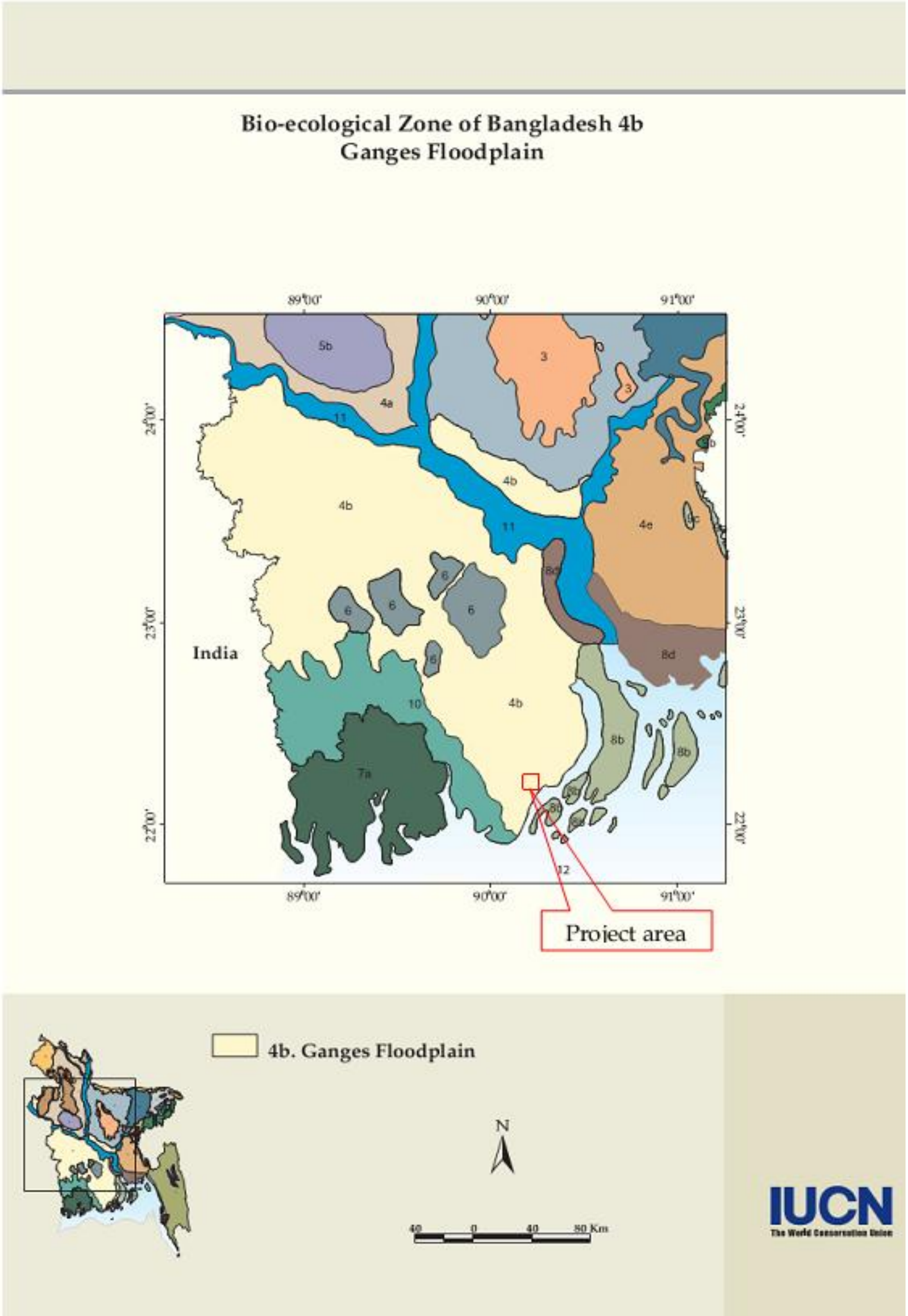



**Figure 6-37: Bio-Ecological Zones of the Study Area**

The bio-ecological zone has been separated into two broad ecosystem types that occur within the vicinity of the Project site. These are:

Terrestrial: which represents the flora and fauna that occurs in those areas that remain relatively unaffected by inundation associated with the monsoon; and

Aquatic: which includes the following sub-ecosystems:

i. Freshwater: which represents the freshwater rivers, channels and semi-permanently inundated freshwater bodies and their associated flora and fauna within the Project area; and

ii. Estuarine: which represents the estuarine, mangrove and associated biodiversity within the Project area.

### 6.12.3 Methodology

This section deals with the methodology for biodiversity assessment of Flora (tree, shrubs, and herbs) and Fauna (birds, reptiles, amphibians, mammals) as well as the surrounding ecosystems. Most of the field work within the Project study area addressed these groups although each group was dealt with different approaches and requirements. A four person multidisciplinary team was organized to deal with these various aspects. 10 km radial zone around the Project site has been taken into consideration to establish the representative baseline in the study area.

#### 6.12.3.1 Flora

Based on satellite imagery and reconnaissance field visit, an attempt made to assess the various vegetation types with ecosystems prevail within the study area. Once established, the main ecosystems areas visited and plant species assessment made. In the most important ecosystems, standardized transects established in order to assess species composition and vegetation structure. To facilitate the identification of the maximum number of species, several visits made.

#### 6.12.3.2 Fauna

***Birds***

The basic method that will be chosen is based on setting up a single line at each site called atransect. Birds can be identified either visually, by their calls or digitally recorded. This method involves identifying all the birds we see or hear while standing at a series of points along transects (a straight line through the site). Bird counts are conducted at the start of first light which is before sunrise. This is the time when birds vocalize most, and is known as the 'Dawn Chorus'. It is also a time of maximum bird movement as birds move through the bush to begin feeding. Focus Group Discussion (FGD) with local people (including villagers, photographers, academicians, help us to get information of the local species available in the project area.

***Amphibians and Reptiles***

Amphibians and Reptiles were assessed on an opportunistic basis by the team. For this inventory, we used a combination of diurnal and nocturnal time-recorded visual encounter surveys ("general surveys"), road driving with capturing digital image from the spot. Interviews were held with known "hunters" in the area to assess the presence of game species. Focus Group Discussion (FGD) with local people also consider during this inventory the project area.

***Mammals***

For mammal's inventory, it is generally huge challenging, time consuming as well as costly. During our inventory of this project study area with the stipulated short time, we have followed "Observational methods" including imaging by digital camera, identification of dung, tracks and others signs, night walks. Sometimes indigenous knowledge (especially from hunters) is shared to prepare preliminary list of species and/or help with identification of signs. Focus Group Discussion (FGD) with local people also consider during this inventory of the project study area.

### 6.12.4 Terrestrial Ecosystem

Terrestrial ecosystems comprise a community of organisms and their environment that occurs on the land masses of continents and islands (Sci-tech dictionary, 2009). As a result of past and continued land use within the Project area, there are four main terrestrial ecological communities within the Project area. They are:

- Agricultural Land;
- Village Forest and Homestead Plantation;
- Embankment and Roadside Vegetation; and
- Mangrove and Charland.

***Agricultural land***

Agricultural land extends over more than 85 percent of the terrestrial Project area. The agricultural area is used for Aman rice monoculture in the monsoon season, while in winter irrigation water is too saline to use for rice (Boro) production. High value crops such as vegetables, watermelon and chili are only found in plots at higher elevations, above the inundation level of tide water in the dry season. In general, land remains fallow in the winter season and is used for grazing. Given the dominance of crops in these areas, cultivated land is relatively low in species diversity with few if any native flora species occurring. Some of the most common weed species (other than planted crops) within the Project area are provided in **Table 6-20** below. Detail checklist of plant has been provided in **Annex D.**

**Table 6-20: Common flora species recorded within Project area agricultural lands**

| Scientific Name | Family | Local Name |
|---|---|---|
| *Ageratum conyzoides* | Compositae | Fulkuri |
| *Alternanthera sessilis* | Amaranthaceae | Sachishak |
| *Clerodendrum inerme* | Verbenaceae | Bhant |
| *Cotula hemispherica* | Compositae | Kancha ghash |
| *Croton bonplandianum* | Euphorbiaceae | Banjhal |
| *Cynodon dactylon* | Gramineae | Durba |
| *Cyperus cephalotes* | Cyperaceae | Niratraba |
| *Dentella repens* | Rubiaceae | Hachuti |
| *Eupatorium odoratum* | Compositae | Assamlata |
| *Euphorbia hirta* | Euphorbiaceae | - |
| *Heliotropium indicum* | Boraginaceae | Hatisur |
| *Nicotiana plumbaginifolia* | Solanaceae | Bantamak |
| *Rorippa indica* | Cruciferae | Bansarisha |
| *Rumex dentata* | Polygonaceae | Bonpalang |
| *Vernonia petula* | Compositae | Shilmuta |

| Scientific Name | Family | Local Name |
|---|---|---|
| *Xanthium indicum* | Compositae | Hagra |

Note: Excludes crop species.

Cultivation and plantation areas support a diverse range of common fauna species however the quality of such habitat is influenced by a variety of agricultural practices, including cultivation processes and the use of agro-chemicals. Within the Project area, cultivated land, with their associated vegetation types, represents the majority of habitat available for terrestrial fauna species.

Agricultural cropland is considered to be the least diverse of the terrestrial vegetation communities. However, such areas still provide important hunting and feeding grounds for birds and other wildlife. Species such as the Lesser bandicoot rat (*Bendicota bengalensis*) and Greater bandicoot rat (*Bandicota indica*) prefer agricultural areas. Thus, predatory birds such as the Brahminy kite (*Haliastur indius*) are commonly found foraging in the agricultural areas around the Project location.

The agricultural floodplains, predominantly used for rice production, retain waters for a substantial part of the year. These areas provide suitable habitat for fish breeding and growth. This is discussed further in the freshwater aquatic ecosystem section below.

***Settlement Vegetation***

Village forests or homestead plantations are known to support some 149 tree species which consist mainly of fruit trees and multi-purpose species (IUCN, 2002). The vegetation in these areas supplies food, fodder, medicine, fuel and timber for local villagers. Village and homestead vegetation is the single most important plant community in terms of diversity.

Settlement vegetation occupies about 10 percent of the Project area. This vegetation generally included two types of plants: those cultivated for their economic value and those that are self-propagating. Settlement vegetation is not as diverse as natural forest since only economic species are cultivated. Despite this, there is significant variation in the composition of settlement vegetation. The most dominant species in the Project area is Rain tree (*Samanea saman*), which occupies more half of the canopy cover in many areas. Other common species are Narikel (*Cocos nucifera*), Khejur (*Phonix sylvestris*), Amm (*Mangifera indica*), Supari (*Areca catechu*), Gab (*Diospyros perigrina*), Tal (*Borassus flabelifer*), Raj Sirish (*Albizia richardiana*) and Bot (*Ficus benghalensis*).

Other species such as Bamboo (*Bambusa sp.*) is also common in the homestead areas. On the ground numerous species of shrubs and herbs compose the under storey. Climbers and creepers are also very common on the ground and into the canopy.

Besides supplying food, fodder, medicine, fuel and other household requirements settlement vegetation are the major sources of timber and renewable biomass energy. Common species in the project area are provided in following **Table 6-21** and detail list has been depicted in **Annex D.**

**Table 6-21: Common species recorded within settlement vegetation areas**

| Scientific Name | Family | Local Name |
|---|---|---|
| *Acacia nilotica* | Mimosaceae | Babla |
| *Albizia procera* | Leguminosae | Silkaroi |
| *Albizia richrdiana* | Legminosae | Gogon Sirish |
| *Albizia saman* | Leguminosae | Raintree |
| *Areca catechu* | Palmae | Supari |

| Scientific Name | Family | Local Name |
|---|---|---|
| *Artocarpus lacucha* | Moraceae | Dephal |
| *Barringtonia acutangula* | Barringtoniaceae | Hijal |
| *Cleorodendrum siphonanthus* | Verbenaceae | Banchat |
| *Cocos nucifera* | Palmae | Narikel |
| *Casuarina equisetifolia* | Casurianaceae | Jahu |
| *Diospyros perigrina* | Ebenaceae | gab, deshigab |
| *Diospyros discolor* | Ebanaceae | Bilatigab |
| *Erythrina variegata* | Leguminosae | Mandar |
| *Mangifera indica* | Anacardiaceae | Am |
| *Mikania scandens* | Compositae | Assamlata |
| *Mikania scandens* | Compositae | Assamlata |
| *Musa paradisiaca var. sapientum* | Musaceae | Kala |
| *Pandanus sp.* | Pandanaceae | Keya |
| *Physalis minima* | Solanaceae | Bantepari |

Settlement, embankment and roadside vegetation plays a very important role in providing shelter for many wildlife species and, due to lack of natural forest in the project area, its importance as wildlife habitat is even greater. These areas also provide habitat corridors for fauna to move throughout the landscape.

The village areas and homestead vegetation within the Project area provide habitat for a number of reptile species, particularly shelter and foraging resources for insects and small vertebrates and reptiles. Reptiles that may inhabit these areas include the Common garden lizard (*Calotes versicolor*), Common skink (*Mabuya carinata*) and the Binocellate cobra (*Naja naja*). There is a general downward trend in reptile abundance in these areas due to over collection. Of note in these areas are Ring lizards (*Varanus salvator*) and the Rat snake (*Coluber mucosus*), which are becoming uncommon nationally.

The village areas are considered to provide an abundance of habitat resources, including nesting, roosting and foraging resources, for a range of birds. The House sparrow (*Passer domestics*), Crow (*Corvus sp*.), and the Magpie robin (*Copsychus saularis*) are common species that are associated with the village areas and were recorded during the surveys at a high frequency.

The village plantations also provide habitat for small mammals. Species that may utilize this habitat include the Jackal (*Canis aureis*), Small Indian civit (*Viverricula indica*), Large Indian civit (*Viverra zibetha*), Small Indian mongoose (*Herpestes auropunctatus*) and a number of bat species, which prefer denser homestead vegetation. There is anecdotal evidence from villagers of occasional sightings of Rhesus Macaques (*Macaca mulatta*), civits, mongoose and foxes within the Project area.

***Embankment and roadside vegetation***

In addition to settlement vegetation, almost all the slopes (embankments and roadsides) in the Project area are vegetated with plantations or naturally occurring vegetation. The slope vegetation can be divided into two categories depending on the types of substratum.

Project site is surrounded by embankment and except for some small portions the entire embankment contains various tree species on both the slopes. The common species found on the embankment are *Samanes saman*, *Acacia moniliformis*, *Albizia sp.*, and *Terminalia sp*. Embankment vegetation provides roosting habitat for local bird species and other faunas common to the village groves. Further, these areas provides optimal roosting habitat for migratory birds and are likely to act as wildlife corridors within the Project area, connecting village and homestead vegetation areas for local fauna species.

***Mangrove and Char land Vegetation***

There is no major large mangrove patch in the project study area. Only present a small mangrove patch alng the Barnabad channel bank near the project site which is not rich planted. Plants common to the mangrove areas include:

- Hargoza (*Acanthus ilicifolia*) forming a luxuriant growth on the intertidal zone;
- Keora (*Sonneratia apetala*) single dominating tree;
- Tiger fern (*Acrstichum aureum*) close to creek banks: and
- Gol pata (*Nypa fruticans*) on the edge of creek banks.

Mangroves are very important habitat for the breeding of brackish water fishes. Moreover, they provide roosting and breeding habitat for coastal birds. Another important feature of the mangrove ecosystems is their stabilizing ability, which provides additional safety to the embankment areas preventing erosion. They are important for stabilizing the coast and a number of char islands have been planted with mangroves to reclaim and stabilize transient locations for later settlement. Detail mangrove lis are provided in **Annex D**.

### 6.12.5 Aquatic Ecosystems

Two aquatic ecosystems occur within the Project areas. These are freshwater and estuarine. Freshwater ecosystems mainly occur during and following the monsoon period, while estuarine ecosystems extend up the river systems past the Project site. Overviews of the occurrence of each of these ecosystems within the Project area are provided in the section below.

***Freshwater Ecosystems***

The river systems around the Project area are used as local transport routes, and are important for fishing and fish farming as well as providing an important nursery ground for native fish. In addition, a number of fishponds and freshwater wetlands occur within the Project area, particularly following the monsoon season. These areas provide diverse habitats for many aquatic flora and fauna.

The agricultural floodplains, predominantly used for rice production, retain waters for a substantial part of the year. These areas provide suitable habitat for fish breeding and growth. Fish perform lateral migration between rivers and floodplains via canals during the monsoon period. Many freshwater fish species migrate from river to floodplains for feeding and retreat to rivers when water levels are drawn down, and thus the renewal system of fisheries continues. The rivers and canals support a very rich fish diversity including many commercially important species. This includes important migratory habitat for Hilsha fish.

The river and its associated creeks have semi-diurnal tidal flow with lush halophytic vegetation on the bank. Some common river/creek bank species are *Acanthus ilicifolia*, *Acrstichum aureum, Hibiscus tiliaceus, Pongamia glabra*, *Sonneratia apetala* and *Streblus asper*. Canals, which are closed by the embankment, contain fresh water from rainfall and are lush with floating and submerged vegetation. These canals are mostly used for irrigating nearby fields in the winter. Ponds inside the settlements with fresh water often contain culture fisheries and have some kind of floating plants. These ponds are the source of fresh water for small wildlife, living in the homestead grooves and provide feeding grounds for some of these species.

Seasonal water bodies are supported on most of the land and the actual extent of these vary from year to year depending on flooding intensity. These water bodies are biologically diverse and very important as feeding areas for fish and other aquatic animals. Moreover, they provide connections to surrounding perennial water bodied allowing wildlife to migrate in search of food and breed and provide a substratum for some species to lay eggs.

Macrophytes are abundant within and around the project site, mainly in the wetlands, floodplains and ponds during and following the monsoon. Macrophytes are often seen as weeds and are therefore unwanted, however some are eaten as vegetables (*Alternanthera, Enhydra, Ipomoea, Nymphaeaand Trapa sp.*) and have commercial value, such as fodder (*Hydrilla, Pistia, Coix, Hygroryza, Leersia, Panicum, Paspelidium, Lemna, Wolffiaand Spirodella*), medicinal plants (*Nymphoides, Cyperus*) and for basket and mat making materials (*grasses*). In addition, some are used as fertilizers. By the end of the monsoon season most of the aquatic plants complete their life cycle, die, decay or dry up. They contribute significantly by adding organic matter and nutrients to the soil.

Wetlands within the impact area are mostly permanent and include fresh water river and fresh water fishponds. However, there are small areas of seasonal fresh water marshes and borrow pits within the Project area also. Few freshwater ecosystems will occur within the Project area in the dry season.

***Aquatic Invertebrates***

The coastal waters of the Bay of Bengal support a wide variety of invertebrates, including shrimps, crabs, mollusks, echinoderms and coelenterates. About 36 marine shrimp species are known to be present in the marine ecosystems of Bangladesh (Paul, 1995).

Shrimps, both Galda (*Macrobrachium rosenbergii*) and Bagda (*Penaeus monodon*), are known in Bangladesh for their export value. Bangladesh earns a substantial part of foreign currency by exporting shrimp. Although Galda is now cultured almost all over Bangladesh,

Bagda culture is limited to coastal areas, including the Project area, as these areas contain high water salinity, which is required for this species growth and propagation. The Char Chalitabunia area contains 8 species of shrimp with some major species of commercial importance.

Crabs are common to all estuarine areas of Bangladesh with a total of 16 crab species occurring; of which 11 species (two freshwater) occur in Char Chalttabunia and Dhankhali. Mud crabs are harvested on a small scale for commercial purposes in some areas of the Char Chalttabunia.

These freshwater invertebrates play several important roles in freshwater ecosystem. They are instrumental in cleaning excess living and non-living organic material from freshwater systems, a service that contributes to the overall quality of the freshwater resource. Detritivores that feed on decaying organic matter speed up the decomposition process, maintaining the nutrient load in the freshwater resource. Freshwater mussels filter the water on a microscopic level, removing algae, bacteria, and other micro-organisms. Water quality degradation adversely impacts the health of aquatic communities including fish and invertebrates. As a result, benthic freshwater invertebrate communities are valuable indicators of water quality.

***Fish***

Fish habitats within the Project area can be segregated into brackish and fresh water habitats. Brackish water habitats are dynamic in nature and influenced by daily tidal fluctuation. The number of brackish fish species is highly variable based on tidal flows, with the Rabnabad Channel and Tentulia River becoming almost dry during low tide. Fresh water habitats are mainly restricted by embankments and are an important nursery ground for native fish species.

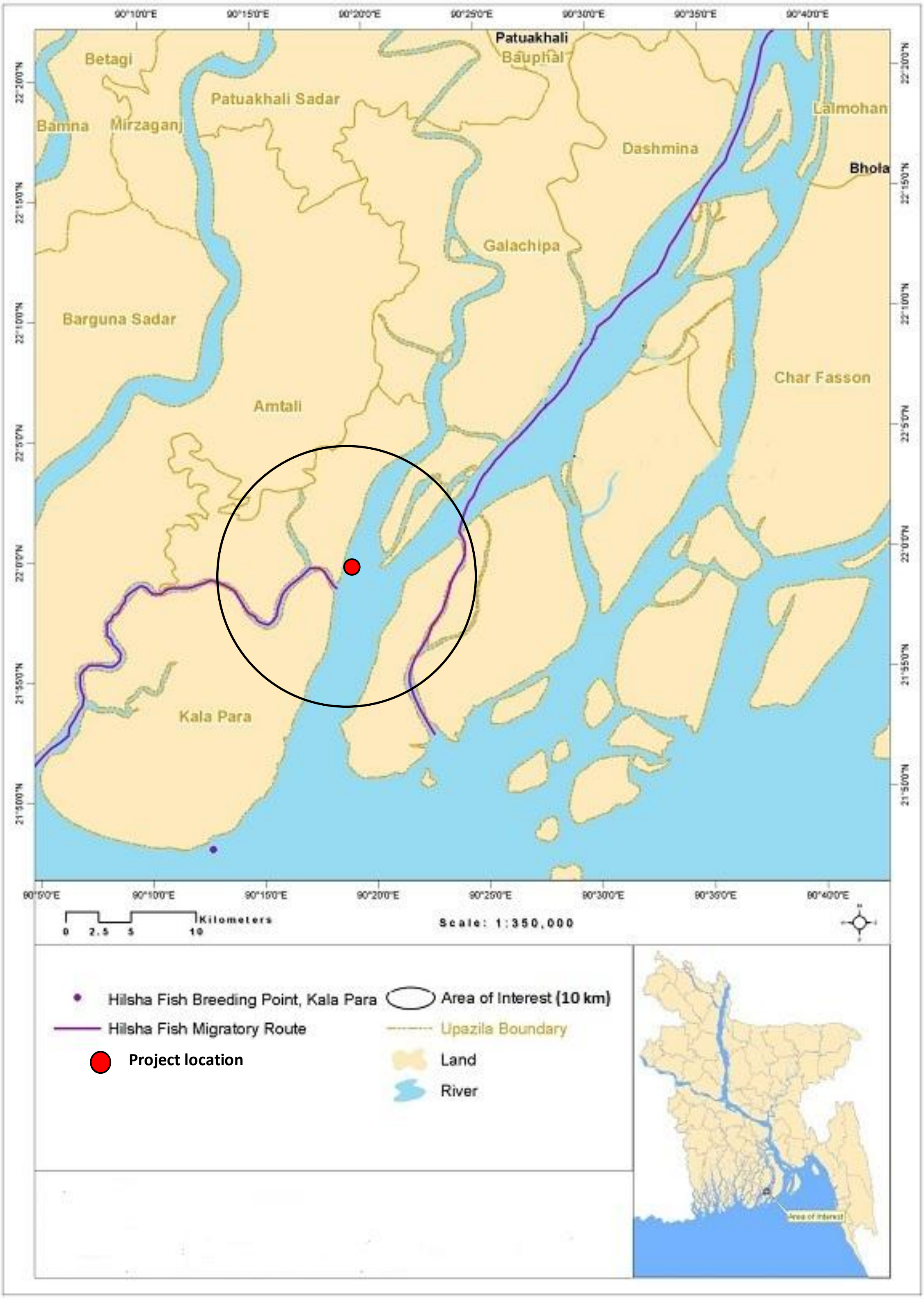
Marine and brackish fish common to the Project area belong to the eels, clupeids, siluroides, lophiformes, sygnaths, perces, mugiloid, sharks, and ray families. In general, Gulla, Hilsa, Tapsi (locally called Ricksaw fish), Rui, Chewa occurs within the area during high tides. On the other hand, during low tide Loitta, Bata, Poa, Gulla, Chewa, Chingri and Pangas are the dominant species within the Project area.

In the mudflats Icha, Poa, Gulla, Pangas and other small fishes occur. Big shrimp, Hilsa, Pangas, Poa, sharks and rays occur within the deeper water areas. In the dry season, Chingi and Chewa account for the majority of fish catches in the Project area (about 90%), while Hilsha (about 98%) dominate the wet season catch.

The river is important for migration of both fresh and brackish water fishes. Many of the brackish water species migrate through the Tentulia River for breeding and feeding purposes. Golda, the giant fresh water prawn, also migrates to the Project area from upstream fresh water streams for breeding.

The key migratory fish species within the Tentulia River is the Hilsha – the national flagship fish of the country. Hilsha (*Tenualosa ilisha*) is anadromous (migratory through sea-estuary-river-estuary-sea) in nature. During the commencement of the south-west monsoon and consequent flooding of all the rivers, Hilsha shad starts its spawning migration upstream. After spawning occurs, the newly hatched larvae and juveniles make their way downstream to the sea during a period of several months, feeding and growing on the way. At this stage of their life cycle they are locally known as "Jatka" (approximately 4-23cm), which occurs widely throughout the Project area from February to May. Jatka is usually a plankton feeder preferring zooplankton, and the rate of food intake is comparatively very high at this stage of the Hilsha lifecycle changing food habitat to become a largely phytoplankton feeder as it matures. After growing for 1-2 years in sea, Hilsha shad matures and reaches a size of 32-55 cm prior to their spawning migration towards inland rivers, and the cycle continues.

Hilsha migration routes and sanctuary areas where Hisha are known to breed are shown in **Figure 6-38**. Detail Fish species list are provide in **Annex E**.




*Source: SMEC, 2010*

**Figure 6-38: Hilsha migration and sanctuary areas**

***Amphibians***

Frogs and toads were found to be numerous within the Project area during the field survey. They are the major biological pest controller in the agricultural areas of Bangladesh.

A total of ten amphibian species within five families were recorded around the Project area. The Common Toad (*Duttaphrynus melanostictus*) was the only toad found within the site. The most numerous tree frog recorded was the Asian Brown Tree Frog (*Polypedates leucomystax*). It usually found homestead forests, roadsides, around human habitation.

Other species included the Ornate Microhylid (*Microhyla ornata*), Cricket Frog (*Fejervarya limnocharis*), Skipper Frog (*Euphlyctis cyanophylctis*) are available in newly accreted charland. Detail Amphabians list are provide in **Annex E.**

***Turtles***

Chalttabunia contains a number of turtle species including the Indian Roofed Turtle (*Pangshura tectum*), Spotted flap shell turtle (*Lissemys punctata*), Narrow-headed Soft shell Turtle (*Chitra indica*), Peacock-marked Soft shell Turtle (*Aspederitis hurum*).

Many of the settlement ponds also contain turtles, as do the canals, rivulets and other areas with wetland vegetation. Basking turtles at the water surface of ponds is a common site in Dhankhali.

***Birds***

Coastal wetlands of Bangladesh are very dynamic in terms of accretion and erosion which contributes to the formation of extensive wetlands. These wetlands are fertile and nutrient rich. Life forms of planktons are in good abundance, which attracts a large numbers of waterfowl each and every year. Cheklist of bird in the project area are provided in **Annex E**.

***Mammals***

A number of dolphin species are known to occur within the Project area and its surrounds.

At least four species of dolphins occurs within marine waters close to the Project area. These are the Irrawaddy dolphin (*Orcaella brevirostris*), Finless porpoise (*Neophocaena phocaenoides*) Ganges River dolphin (*Platinista gangetica*) and the Spinner dolphin (*Stenella longirostris*). Of the recorded species, the Irrawaddy dolphin is very common within the area, followed by the Ganges dolphin, particularly throughout the larger rivers of the area.

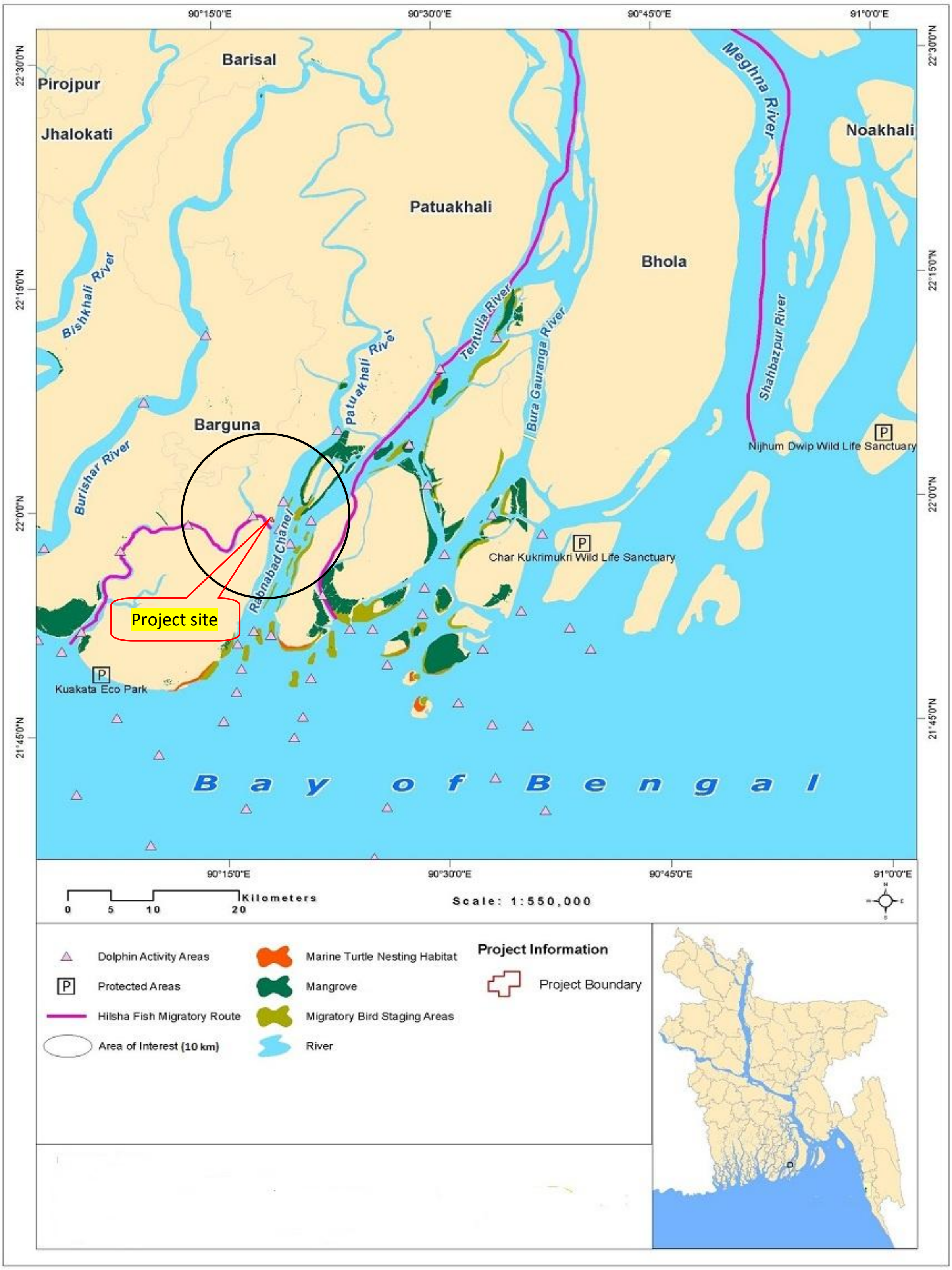
The abundance of dolphins around the Project areas is seasonally dependant, peaking in winter. Dolphin populations become concentrated at the confluence of the larger rivers during winter. Areas of greatest dolphin activity (mainly Ganges River dolphin) have been mapped for the Project area. The spatial distribution of dolphins within the area is shown in **Figure 6-39**.

The Ganges river dolphin calving period is concentrated between December to January and March to May. This species is mainly limited to the freshwater ecosystems and observed in the Project area.

Other mammals common to the village and agricultural areas are often found utilizing the river and canal areas as foraging habitat. Cheklist of mammals in the project area are provided in **Annex E**.

### 6.12.6 Protected Areas

No areas of protected status occur within the Project area. The most notable protected area in the region is the Sundarban Reserve Forest, which is located a minimum of 65km from the Project area. Other protected areas include the Kaukata ecopark and Char Kukrimukri Wildlife Santury; however these are located greater than 20 km from the Project site. Several of these protected areas can be seen in **Figure 6-39**.




*Source: SMEC, 2010*

**Figure 6-39: Protected areas**

## 6.13 Decmographic Profile and Occupational Pattern

### 6.13.1 Demographic profile of the project study area

In accordance to the Census of Bangladesh (2011), the total population of the project study area was 96,522. In Dhankhali union specifically (where the project site is located), the population is 26073; the population density is 648 persons per sq km. In comparison, the density of population of complete Kalapara, Amtali, & Galachipa upazila is approximately 484, 376 and 285 persons per sq km. Kalara Upazila consists of 2 Municipality (Paurashava), 18 wards, 34 Mahallahs (Streets), 11 Unions, 57 Mauzas and 239 villages. **Table 6-22** and **6-23** provides a snapshot of the key demographic indicators of the key unions within the project study area for 5 km study area as well as district wise database for 10 km study area.

**Table 6-22: Demographic Profile of 5 km Radius of Project Area**

| Upazila | Union | Total Population | Total Household | Average Household Size | Sex Ratio | Literacy (%) |
|---|---|---|---|---|---|---|
| Kalapara | Kalapara Paurashava | 17332 | 4347 | 3.9 | 105 | 75.1 |
| | Dhankhali** | 26073 | 5859 | 4.5 | 100 | 45.2 |
| | Lalua | 21562 | 5313 | 4 | 102 | 40.3 |
| Amtali | Amtali | 24,155 | 5,565 | 4.3 | 96 | 50.6 |
| Galachipa/ Rangabali | Chalitabunia | 7400 | 1646 | 4.5 | 105 | 35.5 |
| **Project Study Area** | | **96522** | **22730** | **4.2** | **101.6** | **49.3** |
| **Kalapara Upazila** | | **237831** | **57525** | **4.1** | **103** | **52** |
| **Patuakhali District** | | **1535854** | **346462** | **4.4** | **96** | **54.1** |

*Source: Population and Housing Census, 2011, Bangladesh Bureau of Statistics (BBS)*

*** Project area is located in this union*

**Table 6-23: Demographic Profile of 10 km Radius of Project Area**

| District | Upazila | Total Population | Total Household | Average Household Size | Sex Ratio | Literacy (%) |
|---|---|---|---|---|---|---|
| Patuakhali | Kalapara | 237831 | 57525 | 4.1 | 103 | 52 |
| | Galachipa/ Rangabali | 361518 | 80054 | 4.5 | 99 | 45.4 |
| Barguna | Amtali | 270,802 | 63,212 | 4.3 | 95 | 52.8 |
| **Patuakhali District** | | **1535854** | **346462** | **4.4** | **96** | **54.1** |
| **Barguna District** | | **892,781** | **215,842** | **4.1** | **96** | **57.6** |

*Source: Population and Housing Census, 2011, Bangladesh Bureau of Statistics (BBS)*

### 6.13.2 Gender Ratio

The average household sizes in the project study area, Kalapara, Amtali & Galachipa Upazila are 4.2, 4.1, 4.3, & 4.5. The Gender ratio in the project study area is 101.6 as against 103, 95 & 99 for Kalapara, Amtali & Galachipa Upazila respectively and 96 for Patuakhali district. The lowest gender ratio recorded within the study area is in Amtali union at 96 whereas the highest is in Kalapara Paurashava & Chalitabunia at 105.

#### 6.13.2.1 Occupational Pattern

In accordance to the Census of Bangladesh (2011), agriculture is the dominant source of employment and household income both in rural and urban area of Patuakhali. The situation is similar at Kalapara, Amtali & Galachipa Upazila and the project study area with a majority of the population involved in agricultural practices including direct farming, sharecropping, agricultural labourers etc. According to census 2011 in project study area and Kalapara, Amtali & Galachipa Upazila, agriculture (including livestock and agricultural labour) is the primary source for income. With respect to employment profile specifically for the project study area, the following **Table 6-24 and Table 6-25** provides a snapshot on the key occupation practices.

**Table 6-24: Employment Status by Field of Activity in the 5 km Radius of Project Area**

| Upazila | Union | Total Population | | Field of Activity | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Agriculture | | | | Industry | | | | Service | | | |
| | | Male | Female | Male | | Female | | Male | | Female | | Male | | Female | |
| | | | | Pop. | % | Pop. | % | Pop. | % | Pop. | % | Pop. | % | Pop. | % |
| **Kalapara** | **Kalapara Paurashava** | 514 | 94 | 113 | 22.0 | 18 | 19.1 | 35 | 6.8 | 11 | 11.7 | 366 | 71.2 | 65 | 69.1 |
| | **Dhankhali**** | 2581 | 150 | 2245 | 87.0 | 83 | 55.3 | 14 | 0.5 | 5 | 3.3 | 322 | 12.5 | 62 | 41.3 |
| | **Lalua** | 2336 | 224 | 1761 | 75.4 | 40 | 17.9 | 29 | 1.2 | 6 | 2.7 | 546 | 23.4 | 78 | 34.8 |
| **Amtali** | **Amtali** | 1735 | 109 | 1538 | 88.6 | 61 | 56.0 | 30 | 1.7 | 11 | 10.1 | 167 | 9.6 | 37 | 33.9 |
| **Galachipa/ Rangabali** | **Chalitabunia** | 898 | 22 | 849 | 94.5 | 17 | 77.3 | 16 | 1.8 | 0 | 0 | 33 | 3.7 | 5 | 22.7 |
| **Project Study Area** | | **8064** | **599** | **6506** | **73.5** | **219** | **45.1** | **124** | **2.4** | **33** | **5.6** | **1434** | **24.1** | **247** | **40.4** |
| **Kalapara Upazila** | | **16707** | **1081** | **13295** | **79.6** | **423** | **39.1** | **839** | **5.0** | **105** | **9.7** | **2573** | **15.4** | **553** | **51.2** |
| **Patuakhali District** | | **106113** | **8565** | **82478** | **77.7** | **3876** | **45.3** | **5818** | **5.5** | **688** | **8.0** | **17817** | **16.8** | **4001** | **46.7** |

*Source: Source: Population and Housing Census, 2011, Bangladesh Bureau of Statistics (BBS)*

*** Project area is located in this union*

**Table 6-25: Employment Status by field of Activity in 10 km Radius of Project Area**

| District | Upazila | Total Population | | Field of Activity | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Agriculture | | | | Industry | | | | Service | | | |
| | | Male | Female | Male | | Female | | Male | | Female | | Male | | Female | |
| | | | | Pop. | % | Pop. | % | Pop. | % | Pop. | % | Pop. | % | Pop. | % |
| Patuakhali | Kalapara | 16707 | 1081 | 13295 | 79.6 | 423 | 39.1 | 839 | 5.0 | 105 | 9.7 | 2573 | 15.4 | 553 | 51.2 |
| | Galachipa/Rangabali | 2088 | 204 | 1769 | 84.7 | 97 | 47.5 | 30 | 1.4 | 5 | 2.5 | 289 | 13.8 | 102 | 50 |
| Barguna | Amtali | 16563 | 1180 | 14155 | 85.5 | 667 | 56.5 | 459 | 2.8 | 89 | 7.5 | 1949 | 11.8 | 424 | 35.9 |
| **Patuakhali District** | | **106113** | **8565** | **82478** | **77.7** | **3876** | **45.3** | **5818** | **5.5** | **688** | **8.0** | **1781** | **16.8** | **4001** | **46.7** |
| **Barguna District** | | **41515** | **2874** | **33494** | **80.7** | **1370** | **47.7** | **1844** | **4.4** | **214** | **7.4** | **6177** | **14.9** | **1290** | **44.9** |

## 6.14 Land Use and Cropping Pattern

Details land use of the project has been depicted in **Chapter 4**.

Patuakhalis economy is primarily agrarian economy with significant revenue to its GDP coming from agriculture and agro based industries. Maximum land is single crop land.

A snapshot of agricultural produce of some of the key crops in Dhankhali union of Kalapara upazila.

| Sl. | Crop name | Production year (Metric Ton/Hector) |
|---|---|---|
| 1. | Aman Rice | 4.5 |
| 2. | Sweet Potato | 10-12 |
| 3. | Green Chilli | 1.5 |
| 4. | Nut | 2.5 |
| 5. | Water Melon | 30-35 |
| 6. | Mug dal | 0.8-1.2 |
| 7. | Khesari dal | 0.9 |
| 8. | Felon dal | 0.8-1.2 |

*Source: Agricultural Department, Kalapara upazil, Date: 16/4/14*

It can be observed from the above table that Water melon, Spices crops contribute to the majority of the total crop output. Potato especially is cultivated both for self-consumption as well as export to other places in Bangladesh.

## 6.15 Socio-Economic Scenerio

The socio-economic baseline environment of the project area was captured to have a picture of the current situation to allow comparison with that of any potential impact associated with the proposed project. The study included an assessment of the baseline condition of the local stakeholders including the local community, governmental organizations, and community development agencies such as NGO/Self Help Groups etc amongst other as well as taking into account their perceptions on the impacts and benefits from this upcoming project.

### 6.15.1 Approach and Methodology

The approach and methodology adopted for the socio-economic baseline assessment relied on readily available secondary information and primary information collected through consultations with a range of stakeholders for the project as well as sample socio-economic survey of households within the project area of influence . The key activities that were carried out for primary and secondary data collection are summarized as follows:

1. **Desk-Based Review** of available project documentation and profile of the project site;
2. **Reconnaissance to the Project Site** to visually observe the social setting in and around 5 km of the area;
3. **Secondary Information** is used from the Bureau of Statistic data for 5 km and 10 km study area.
4. **Consultations with the Various Stakeholders** ranging from governmental institutions, local administration (municipality & village administration) , local community, land losers, project proponent and NGOs amongst others

5. **Socio-Economic Survey** of the key settlements within 2 km radius of the project area. The survey was conducted for 70 households and data was collected based on a pre-developed questionnaire to ascertain general socio-economic indicators of the area;

### 6.15.2 Demarcation of the Project Area for Socio-economic Study

From the social perspective, considering that the 5 km radius might entail a very large socio-economic landscape, which may not be entirely relevant from the point of studying the social impact for this project, the administrative boundaries of the unions, villages and settlements that lie in the immediate vicinity of the project site and within a radial distance of 10 km have been taken as the limit of the project area. This 2 km radius covers the following unions of Dhakhali, Lalua and Kalapara Paurashava.

The **Figure 6-40** indicates the socio-economic and cultural infrastructure locations in the project study area and the unions/settlements from where the socio-economic data has been collected.

### 6.15.3 Site Visit and Reconnaissance

The site visit was conducted by a team comprising of two social specialists from EQMS. The entire site visit was conducted from 15$^{th}$ April, 2014 to 22$^{th}$ April, 2014. The socio economic survey as well as the stakeholder consultations was concluded during this period.

### 6.15.4 Stakeholder Consultations

The team consulted with a diverse range of stakeholders associated with the project. These included governmental agencies and departments, local administration, NGO, as well as the community, land owners and sharecroppers. Furthermore, in order to assess the community and household level impacts, a socio-economic survey for a sample household size of 750 within 2 km radius of the project site was undertaken. This survey helped establish the baseline conditions of the community living in the vicinity of the project footprint and their opinions, expectation and apprehensions about the proposed project. The analyses of this data and the inferences drawn have been provided in the following sections.

### 6.15.5 Documentation Collection and Review

During the field assessment and stakeholder meetings, documents of relevance to this study were collected and data from the same was utilized in developing this social baseline. The following is a list of documents that were collected and reviewed during this site assessment.

- Bangladesh population Census for 2011 for Patuakhali District
- Agricultural Census Data 2013, Kalapara Upazila
- Fisheries Census data
- Land Regulation Policy, Bangladesh
- Land Acquisition and Compensation data for the project site

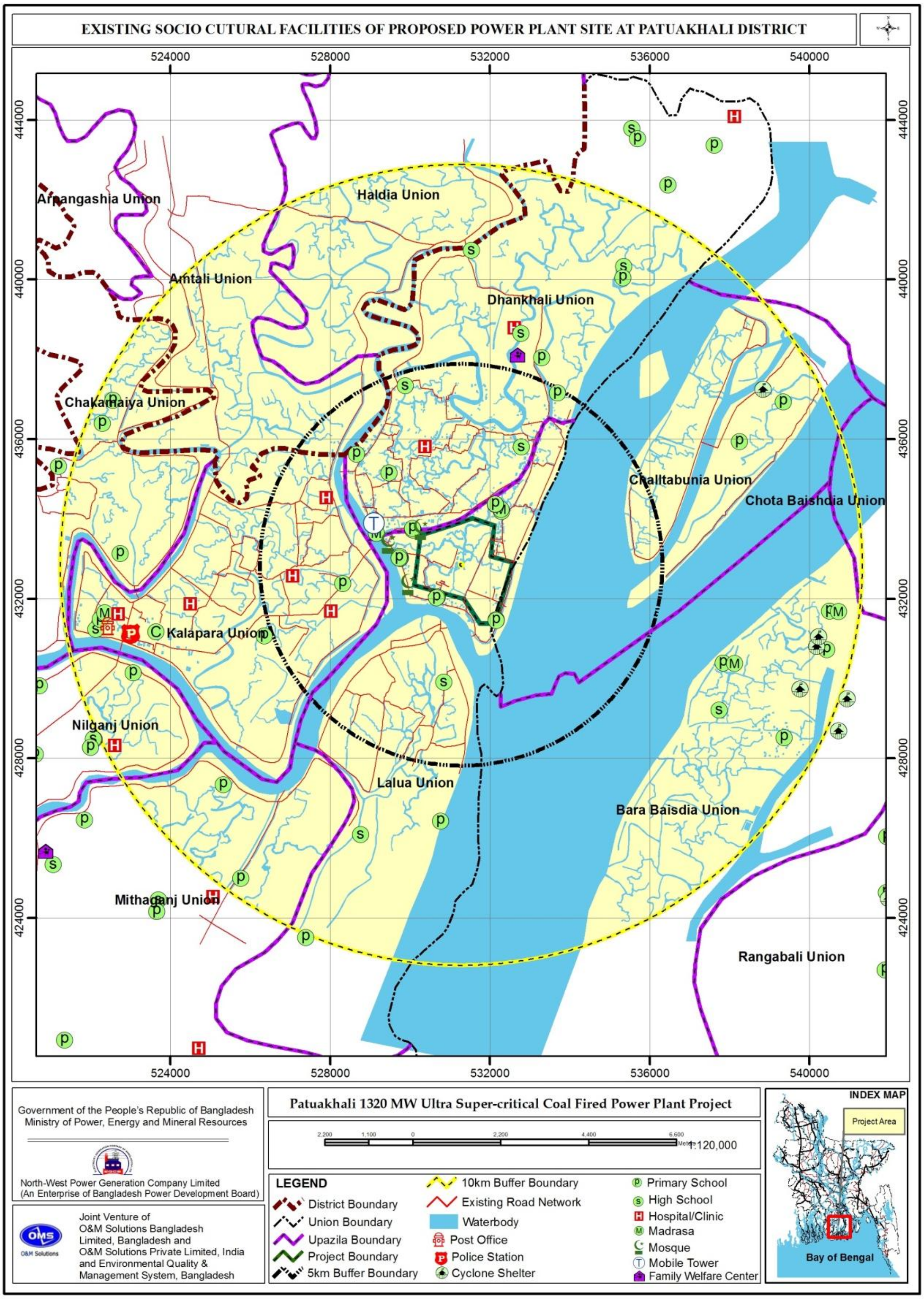



**Figure 6-40: Project Study Area Map for Socio Economic Baseline**

### 6.15.6 Administrative profile of Patuakhali

Patuakhali is a district in South-Western Bangladesh. It is a part of the Barisal Division. This is the main entrance for the beach of Kuakata. There are eight upazilas in this district. Total area of Patuakhali district is 3,221.31 $km^2$. The proposed site is located at Dhamkhali union of Kalapara upazila under Patuakhali district. The project area located approximately 8 km far from upazila headquarters and areally 40 km from Patuakhali district headquaters.

### 6.15.7 Social Classification

As per the 2011 census, the population of the project study area primarily consists of Muslims constituting almost 94.4% of the total population. The remaining 5.6% is primarily constituted by Hindus with Christians, Buddhists and others comprising an insignificant percentage. In the project area, the population primarily consists of Muslims with majority of the same from the Sunnisect. However, based on ground consultations with the local community, it was reported that there is a large faction of Hindu settlements around the site. The Hindus are primarily from the “Kayasth” (Writers and Banker Caste) community with title groups including Dey, Ghosh, Dutta and Basu amongst others whereas the Muslims as mentioned above are primarily Sunni Muslims. The following **Table 6-26** and **Table 6-27** indicates the various religious profile of the project study area.

**Table 6-26: Religion Profile of 5 km Radius of Project Area**

| Upazila | Union | Total Population | Muslim | | Hindu | | Christian | | Buddhist | | Others | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Pop. | % | Pop. | % | Pop. | % | Pop. | % | Pop. | % |
| Kalapara | Kalapara Paurashava | 17332 | 14264 | 82.3 | 2992 | 17.3 | 25 | 0.14 | 50 | 0.3 | 1 | 0.006 |
| | Dhankhali** | 26073 | 24348 | 93.4 | 1724 | 6.6 | 0 | 0 | 0 | 0 | 1 | 0.004 |
| | Lalua | 21562 | 21481 | 99.6 | 67 | 0.3 | 1 | 0.005 | 13 | 0.06 | 0 | 0 |
| Amtali | Amtali | 24,155 | 23,653 | 97.9 | 502 | 2.1 | 0 | 0 | 0 | 0 | 0 | 0 |
| Galachipa/ Rangabali | Chalitabunia | 7400 | 7354 | 99.4 | 46 | 0.6 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Project Study Area** | | **96522** | **91100** | **94.4** | **5331** | **5.5** | **26** | **0.03** | **63** | **0.1** | **2** | **0.002** |
| **Kalapara Upazila** | | **237831** | **225345** | **94.8** | **11125** | **4.7** | **145** | **0.06** | **1196** | **0.5** | **20** | **0.008** |
| **Patuakhali District** | | **1535854** | **1428601** | **93.02** | **105496** | **6.9** | **345** | **0.02** | **1355** | **0.09** | **57** | **0.004** |

*Source: Population and Housing Census, 2011, Bangladesh Bureau of Statistics (BBS)*

*** Project area is located in this union*

**Table 6-27: Religion Profile within 10 km Radius of Project Area**

| District | Upazila | Total Population | Muslim | | Hindu | | Christian | | Buddhist | | Others | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | Pop. | % | Pop. | % | Pop. | % | Pop. | % | Pop. | % |
| Patuakhali | Kalapara | 237831 | 225345 | 94.8 | 11125 | 4.7 | 145 | 0.06 | 1196 | 0.5 | 20 | 0.008 |
| | Galachipa/ Rangabali | 361518 | 338323 | 93.6 | 23069 | 6.4 | 17 | 0.005 | 106 | 0.03 | 3 | 0.0008 |
| Barguna | Amtali | 270,802 | 253,742 | 93.7 | 16020 | 5.9 | 11 | 0.004 | 985 | 0.4 | 44 | 0.02 |
| **Patuakhali District** | | **1535854** | **1428601** | **93.02** | **105496** | **6.9** | **345** | **0.02** | **1355** | **0.09** | **57** | **0.004** |
| **Barguna District** | | **892,781** | **822,652** | **92.1** | **68,678** | **7.7** | **283** | **0.03** | **1097** | **0.1** | **71** | **0.008** |

*Source: Population and Housing Census, 2011, Bangladesh Bureau of Statistics (BBS)*

#### 6.15.7.1 Education & Literacy

According to the Census of Bangladesh (2011), the literacy rate in the project study area is only 49.3%. In comparison, literacy rates in Kalapara, Amtali & Galachipa Upazila are also moderate with only 52%, 52.8% & 45.4% of the population classified as literate respectively. The literacy rate was found to be lower in the rural areas as compared to the urban settlements where it was observed to be comparatively greater. The low literacy can be attributed to low availability of educational infrastructure in the district, lack of accessibility, as well as use of traditional and archaic means of education practices.

#### 6.15.7.2 Vulnerability Classification

Vulnerability in the project study area has been defined in the context of socioeconomic status of both individual groups as well as household groups. These include women; old, physically handicapped and destitute people at the individual level and houses headed by women, the physically handicapped, and those below the poverty line. Amongst various categories of vulnerable identified for the project, physically challenged, women and old aged are at the highest risk.

### 6.15.8 Livelihoods and Economic Profile

#### 6.15.8.1 Employment Profile

In accordance to the Census of Bangladesh (2011), agriculture is the dominant source of employment and household income both in rural and urban area of Patuakhali. The situation is similar at Kalapara, Amtali & Galachipa Upazila and the project study area with a majority of the population involved in agricultural practices including direct farming, sharecropping, agricultural labourers etc. According to census 2011 in project study area and Kalapara, Amtali & Galachipa Upazila, agriculture (including livestock and agricultural labour) is the primary source for income. With respect to employment profile specifically for the project study area, the following **Table 6-28 and Table 6-29** provides a snapshot on the key occupation practices.

**Table 6-28: Employment Status by Field of Activity in the 5 km Radius of Project Area**

| Upazila | Union | Total Population | | Field of Activity | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Agriculture | | | | Industry | | | | Service | | | |
| | | Male | Female | Male | | Female | | Male | | Female | | Male | | Female | |
| | | | | Pop. | % | Pop. | % | Pop. | % | Pop. | % | Pop. | % | Pop. | % |
| **Kalapara** | **Kalapara Paurashava** | 514 | 94 | 113 | 22.0 | 18 | 19.1 | 35 | 6.8 | 11 | 11.7 | 366 | 71.2 | 65 | 69.1 |
| | **Dhankhali**** | 2581 | 150 | 2245 | 87.0 | 83 | 55.3 | 14 | 0.5 | 5 | 3.3 | 322 | 12.5 | 62 | 41.3 |
| | **Lalua** | 2336 | 224 | 1761 | 75.4 | 40 | 17.9 | 29 | 1.2 | 6 | 2.7 | 546 | 23.4 | 78 | 34.8 |
| **Amtali** | **Amtali** | 1735 | 109 | 1538 | 88.6 | 61 | 56.0 | 30 | 1.7 | 11 | 10.1 | 167 | 9.6 | 37 | 33.9 |
| **Galachipa/ Rangabali** | **Chalitabunia** | 898 | 22 | 849 | 94.5 | 17 | 77.3 | 16 | 1.8 | 0 | 0 | 33 | 3.7 | 5 | 22.7 |
| **Project Study Area** | | **8064** | **599** | **6506** | **73.5** | **219** | **45.1** | **124** | **2.4** | **33** | **5.6** | **1434** | **24.1** | **247** | **40.4** |
| **Kalapara Upazila** | | **16707** | **1081** | **13295** | **79.6** | **423** | **39.1** | **839** | **5.0** | **105** | **9.7** | **2573** | **15.4** | **553** | **51.2** |
| **Patuakhali District** | | **106113** | **8565** | **82478** | **77.7** | **3876** | **45.3** | **5818** | **5.5** | **688** | **8.0** | **17817** | **16.8** | **4001** | **46.7** |

*Source: Source: Population and Housing Census, 2011, Bangladesh Bureau of Statistics (BBS)*

*** Project area is located in this union*

**Table 6-29: Employment Status by field of Activity in 10 km Radius of Project Area**

| District | Upazila | Total Population | | Field of Activity | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | Agriculture | | | | Industry | | | | Service | | | |
| | | Male | Female | Male | | Female | | Male | | Female | | Male | | Female | |
| | | | | Pop. | % | Pop. | % | Pop. | % | Pop. | % | Pop. | % | Pop. | % |
| Patuakhali | Kalapara | 16707 | 1081 | 13295 | 79.6 | 423 | 39.1 | 839 | 5.0 | 105 | 9.7 | 2573 | 15.4 | 553 | 51.2 |
| | Galachipa/Rangabali | 2088 | 204 | 1769 | 84.7 | 97 | 47.5 | 30 | 1.4 | 5 | 2.5 | 289 | 13.8 | 102 | 50 |
| Barguna | Amtali | 16563 | 1180 | 14155 | 85.5 | 667 | 56.5 | 459 | 2.8 | 89 | 7.5 | 1949 | 11.8 | 424 | 35.9 |
| **Patuakhali District** | | **106113** | **8565** | **82478** | **77.7** | **3876** | **45.3** | **5818** | **5.5** | **688** | **8.0** | **1781** | **16.8** | **4001** | **46.7** |
| **Barguna District** | | **41515** | **2874** | **33494** | **80.7** | **1370** | **47.7** | **1844** | **4.4** | **214** | **7.4** | **6177** | **14.9** | **1290** | **44.9** |

## 6.15.9 Local Economy

### 6.15.9.1 Agriculture

Patuakhalis economy is primarily agrarian economy with significant revenue to its GDP coming from agriculture and agro based industries. The following **Table 6-30** provides a snapshot of agricultural produce of some of the key crops in Dhankhali union of Kalapara upazila.

**Table 6-30: Production of Key Crops in Dhankhali Union of Kalapara Upazila as per 2012-13 statistics**

| Sl. | Crop name | Production year (Metric Ton/Hector) |
|---|---|---|
| 9. | Aman Rice | 4.5 |
| 10. | Sweet Potato | 10-12 |
| 11. | Green Chilli | 1.5 |
| 12. | Nut | 2.5 |
| 13. | Water Melon | 30-35 |
| 14. | Mug dal | 0.8-1.2 |
| 15. | Khesari dal | 0.9 |
| 16. | Felon dal | 0.8-1.2 |

*Source: Agricultural Department, Kalapara upazil, Date: 16/4/14*

It can be observed from the above table that Water melon, Spices crops contribute to the majority of the total crop output. Potato especially is cultivated both for self-consumption as well as export to other places in Bangladesh.

### 6.15.9.2 Fisheries & Aquaculture

Fishing is a common livelihood practice around the project study area. The Rabnabad Channel, Tetulia River and Andharmanik River are close to the project study area and large percentages of people are depends on these rivers. In the project study area, most of the fishing that is actively carried out in Rabnabad Channel, Tiakhali River and Andharmanik River, small pond and water-bodies is primarily for household consumption and sell in the market.

### 6.15.9.3 Livestock & Poultry

Rearing of livestock and poultry is also a major occupation in Kalapara upazila. It is mostly a sub-practice carried out in conjunction with farming activities and one of the key sectors that includes participation from women and children. The types of livestock reared include Cow, cattle, buffalo, goats, sheep, fowl, and ducks amongst others. The livestock is reared primarily for milk and meat for self-consumption as well as retail and export.

## 6.15.10 Access to Infrastructure

### 6.15.10.1 Infrastructure

There are significant numbers of primary school and high school as well as Madrasa in the study area. **Table 6-31** shows the total socio-cultural facilities within 10 km study area.

**Table 6-31: Existing Socio-Cultural Facilities around 10km of the Study Area**

| Sl. | Facilities | Number |
|---|---|---|
| 1. | Primary School | 26 |
| 2. | High School | 9 |
| 3. | Community Clinic | 7 |
| 4. | Cyclone Shelter | 4 |
| 5. | Madrasa | 6 |
| 6. | College | 1 |
| 7. | Family Welfare Center | 1 |
| 8. | Hospital | 1 |
| 9. | Police Station | 1 |
| 10. | Post Office | 1 |
| **Total** | | **57** |

### 6.15.10.2 Electricity

Electricity is a key issue within the project study area and also an overall concern in Patuakhali with about 31.8%% of the district electrified. In Patuakhali household electricity is not available both in urban and rural clusters. During the consultation it has been reported that the project area village face scarcity of electricity. The following **Table 6-32 and Table 6-33** indicate the availability of electricity connection and source of drinking water facility of the project study area.

**Table 6-32: Sources of Drinking Water and Electricity Facility of 5 km Radius of the Project Area**

| Upazila | Union | Total Households | Source of Drinking Water (%) | | | Electricity Connection (%) |
|---|---|---|---|---|---|---|
| | | | Tap | Tube-well | Other | |
| Kalapara | Kalapara Paurashava | 4347 | 18 | 79.9 | 2.1 | 87.1 |
| | Dhankhali** | 5859 | 0 | 99.1 | 0.9 | 20.7 |
| Amtali | Amtali | 5,565 | 1.7 | 96.3 | 2 | 18.9 |
| Galachipa/Rangabali | Chalitabunia | 1646 | 0.1 | 99.5 | 0.5 | 19.3 |
| **Project Study Area** | | **17417** | **5.0** | **93.7** | **1.4** | **36.5** |
| **Kalapara Upazila** | | **57525** | **1.4** | **97.6** | **1** | **31.6** |
| **Patuakhali District** | | **346462** | **0.8** | **96.8** | **2.3** | **31.8** |

*Source: Population and Housing Census, 2011, Bangladesh Bureau of Statistics (BBS)*

*** Project area located in this union*

**Table 6-33: Sources of Drinking Water and Electricity Facility within 10 km Radius of the Project Area**

| District | Upazila | Total Households | Source of Drinking Water (%) | | | Electricity Connection (%) |
|---|---|---|---|---|---|---|
| | | | Tap | Tube-well | Other | |
| Patuakhali | Kalapara | 57525 | 1.4 | 97.6 | 1 | 31.6 |
| | Galachipa/Rangabali | 80054 | 0.8 | 97.2 | 1.9 | 22.9 |
| Barguna | Amtali | 63,212 | 1.2 | 96.9 | 1.9 | 21.6 |
| **Patuakhali District** | | **346462** | **0.8** | **96.8** | **2.3** | **31.8** |
| **Barguna District** | | **215,842** | **1.8** | **86.6** | **11.6** | **28.8** |

*Source: Population and Housing Census, 2011, Bangladesh Bureau of Statistics (BBS)*

### 6.15.10.3 Water & Sanitation

The primary source of drinking water throughout the district and Kalapara, Amtali & Galachipa Upazila is deep tube well. As per the 2011 census, in Kalapara, Amtali & Galachipa Upazila, respectively 97.6%, 96.9% & 97.2% of the populations were dependant on tube well for meeting their water requirements. As per the census, it was estimated that almost 93.7% of the population in study area have access to safe drinking water while the remaining are exposed to other water sources. With respect to the sanitation facilities in the project study area, only about 21.6% of the total dwellings have sanitary (water sealed) and 43.2% (non water sealed) latrines. Almost 30.1 percent have non sanitary latrines or Kuchcha toilets and remaining 5.2% is dependent on open defecation. The key factors impeding better sanitation practices are primarily poverty, lack of drainage systems and traditional practices used for generations. The following **Table 6-34** & **Table 6-35** show the toilet facility in the project area.

**Table 6-34: Toilet Facility within 5 km Radius of the Project Area**

| Upazila | Union | Total HHs | Type of Toilet Facility (%) | | | |
|---|---|---|---|---|---|---|
| | | | Sanitary (water-sealed) | Sanitary (non water-sealed) | Non-sanitary | None |
| Kalapara | Kalapara Paurashava | 4347 | 56.7 | 33 | 9.8 | 0.5 |
| | Dhankhali** | 5859 | 5.9 | 38.3 | 48.7 | 7.1 |
| Amtali | Amtali | 5,565 | 10 | 44.4 | 41 | 4.6 |
| Galachipa/ Rangabali | Chalitabunia | 1646 | 13.8 | 57.1 | 20.7 | 8.4 |
| **Project Study Area** | | **17417** | **21.6** | **43.2** | **30.1** | **5.2** |
| **Kalapara Upazila** | | **57525** | **29.6** | **41.3** | **24.9** | **4.2** |
| **Patuakhali District** | | **346462** | **23.9** | **47.5** | **25.3** | **3.4** |

*Source: Population and Housing Census, 2011, Bangladesh Bureau of Statistics (BBS)*

*** Project area located in this union*

**Table 6-35: Toilet Facility within 10 km Radius of the Project Area**

| District | Upazila | Total HHs | Type of Toilet Facility (%) | | | |
|---|---|---|---|---|---|---|
| | | | Sanitary (water-sealed) | Sanitary (non water-sealed) | Non-sanitary | None |
| Patuakhali | Kalapara | 57525 | 29.6 | 41.3 | 24.9 | 4.2 |
| | Galachipa/ Rangabali | 80054 | 16.7 | 45.6 | 29.9 | 7.7 |
| Barguna | Amtali | 63,212 | 22.3 | 44.6 | 28.7 | 4.4 |
| **Patuakhali District** | | **346462** | **23.9** | **47.5** | **25.3** | **3.4** |
| **Barguna District** | | **215,842** | **26.1** | **47.7** | **23.7** | **2.5** |

*Source: Population and Housing Census, 2011, Bangladesh Bureau of Statistics (BBS)*

### 6.15.11 Cultural Heritage

The project area as such, does not encompass any key cultural heritage or resource of national or regional value.

### 6.15.12 Analysis of the Socio-economic Survey

The baseline assessment also comprised a socio-economic survey which was conducted within 2 km of the project area and data collected from randomly selected 70 household in order to gain first hand information about the key household level socio-economic indicators. The data was collected primarily from the following unions located within the project study area.

- Kalapara Paurashava
- Dhankhali Union
- Lalua Union

The household distribution from each union is presented in the following **Table 6-36**. It also indicates the total respondents from these unions to whom the survey was subjected.

**Table 6-36: Sample Distribution Statistics**

| Sl. | Union | Total HH | Total Male Respondents | Total Female Respondents |
|---|---|---|---|---|
| 1. | Kalapara Paurashava | 20 | 12 | 8 |
| 2. | Dhankhali Union | 30 | 21 | 9 |
| 3. | Lalua Union | 20 | 9 | 11 |
| **Total Household** | | **75** | **42** | **28** |

*Source: During field visit (Date: 15/4/14-20/4/14)*

The socio-economic data was collected on the following main indicators:

- Demographic Trends
- Access to Public Amenities and Infrastructure

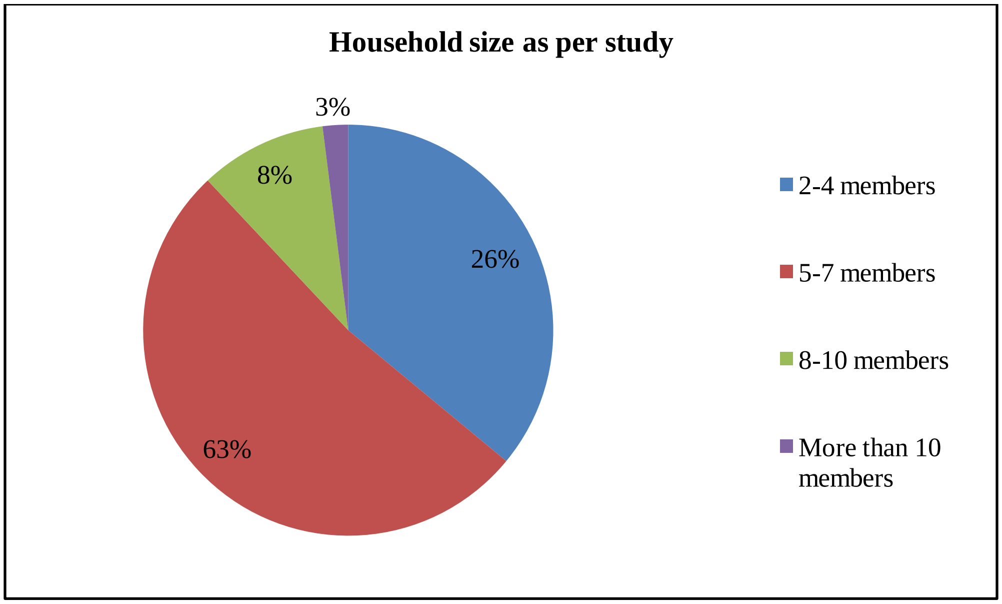
- Access to Utilities and Resources
- Asset ownership
- HH Expenditure & Loan and Debt
- Participation of Women
- Overall awareness and opinion about the project

The following sections provide results from the analysis of the data collected as per the above indicators.

#### 6.15.12.1 Demographic Trends

***Household Size & Religion***

According to the survey data, the majority of the households in the project area have more than 5 members. A significant percentage (63%) has 5-7 members followed by (26%) households having 2-4 members. Only about 8% of the total sample constituted of households having below 8-10 members. **Figure 6-41** show the household size of the study area.




*Source: Socio-economic Survey by EQMS (April, 2014)*

**Figure 6-41: Average Household Size in the study area**

The majority of the families in the 2 km study area follow Islam and only 7 households of the 70 surveyed in the area were observed to be followers of Hinduism. Sunni is observed to be the dominant caste in Islam with all households reportedly belonging to this caste. In Hinduism, most of the households belonged to the Kayasth and Shudra castes.

***Population***

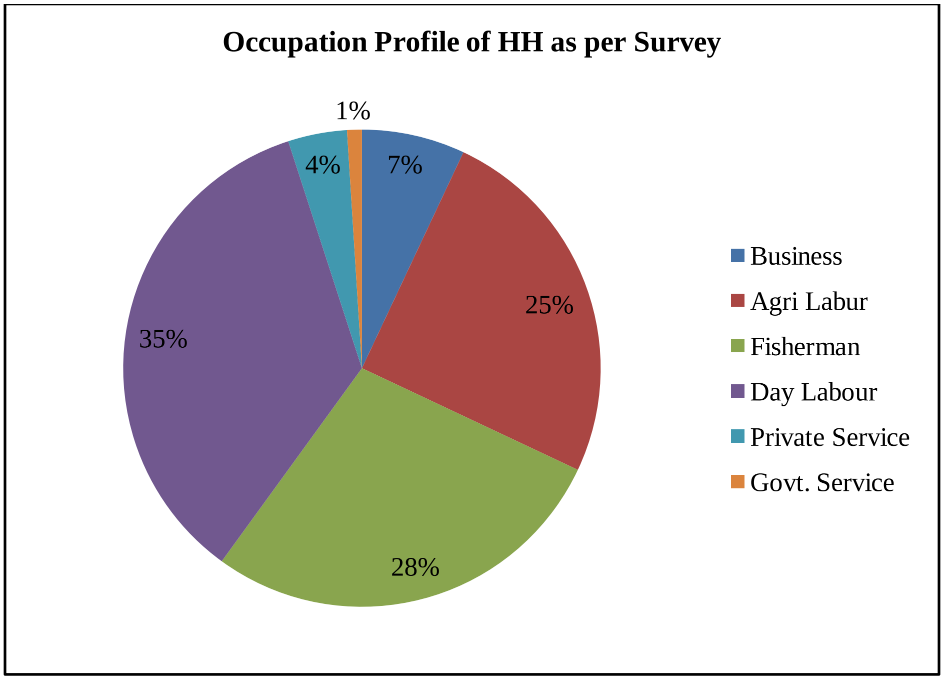
There are 357 people living in 70 households in the area giving an average of 5 persons per household.

***Population age and sex distribution***

According to the survey data, the majority of the households in the project area have average population age 31 years. There are 47% women and 53% men.

***Occupation Profile***

As per the survey data it can be observed that almost 35% of the respondents are involved in day labour followed by fisherman (28%) and agricultural labour 25% in project area. Doing business, private service and government service that almost total 12%. It can also be observed that majority of the women respondents are housewives or involved in household activities. **Figure 6-42** show the occupational profile of the study area.

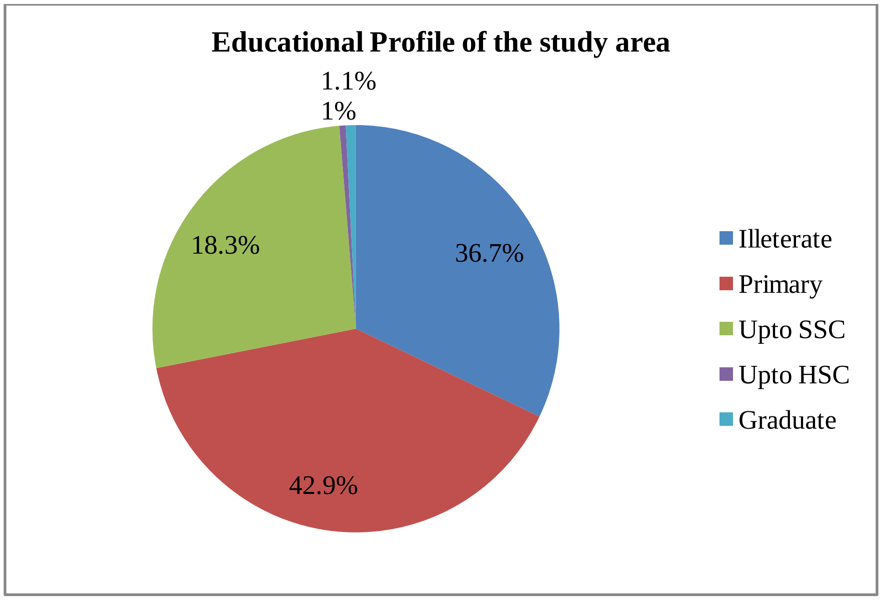



*Source: Socio-economic Survey by EQMS (April, 2014)*

**Figure 6-42: Occupation Profile of the Project Area**

***Education & Literacy***

In terms of education and literacy amongst the sample, majority of the respondents were found to be primary level almost 42.9% and a significant proportion has illiterate almost 36.7%. Also secondary 18.3% of the total sample where also observed to have an intermediate and graduate degree almost 2.1%. **Figure 6-43** show the educational profile of the study area.




*Source: Socio-economic Survey by EQMS (April, 2014)*

**Figure 6-43: Education and Literacy of the Study Area**

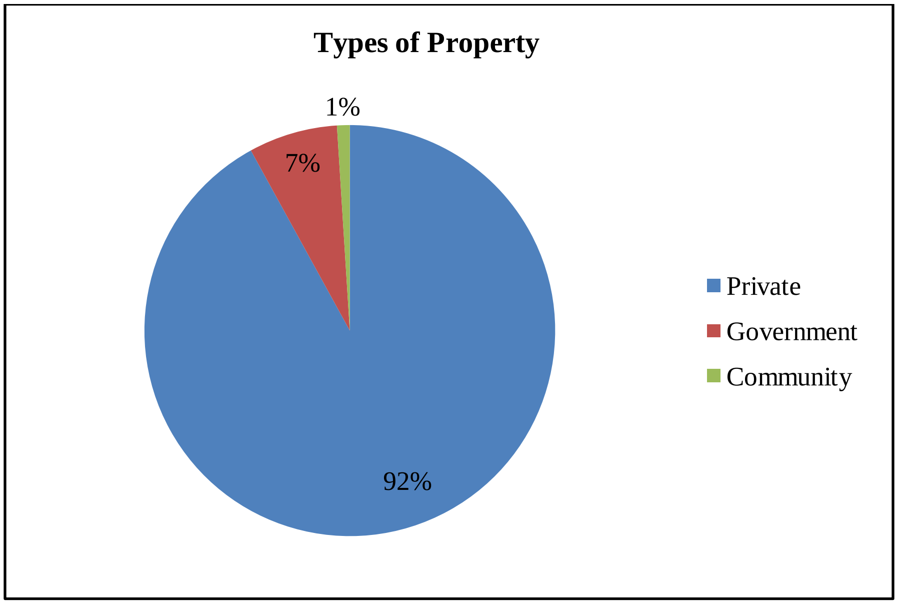
#### 6.15.12.2 Access to Public Amenities and Infrastructure

Public amenities and infrastructure included schools, hospitals, postal services, banks, water ways and bus stops. It was observed that almost 96% of the households had access to school within 2 kms. With respect to nearby hospitals, 10% where within 1 km distance, 72% within 5 km and 18% at greater than 5 km distance.

#### 6.15.12.3 Access to Utilities & Resources

***Property of household***

In the Surveyed area, category of land ownership namely Private, Government, Trust, Community property are available and recognized. In the present survey, data or household land ownership by category and by type of land were collected to sketch the land ownership scenario for the Villages. The whole land ownership scenario in Surveyed area has been sketched by drawing two different scenarios with Scenario-I land owner, scenario-II is household renter. Conservative estimation considering private Property 92%,Government Property 7% and community property 1%. Almost these property households have been conveying Ownership about 97% property owner and 3% giving house hold Rent. **Figure 6-44** show the property type of the study area.

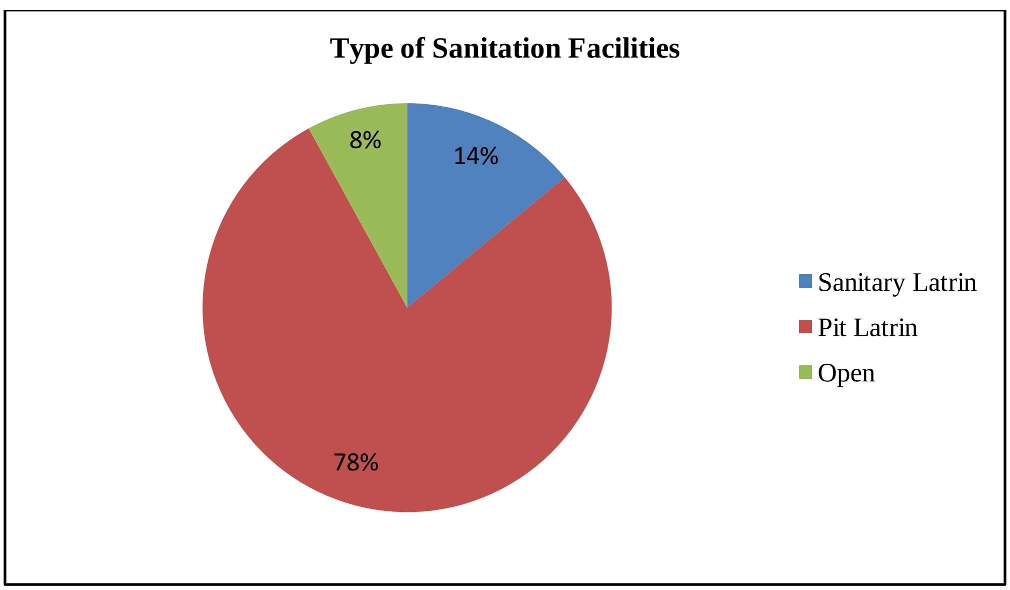



*Source: Socio-economic Survey by EQMS (April, 2014)*

**Figure 6-44: Type of Property of the Study Area**

***Sanitation Facilities***

It can be observed from the below figure that some of the households or approximately 8% in the project study area comprise of open Latrine and sanitation facilities. In most of the cases these facilities are connected to household ponds for drainage. Moreover, proper sanitation facilities almost 75% mostly observed in the middle and upper middle class sections of the society and more common in practice in municipalities and ward than in villages. **Figure 6-45** show the sanitation facilities of the study area.




*Source: Socio-economic Survey by EQMS (April, 2014)*

**Figure 6-45: Type of Sanitation Facilities Profile in the Study area**

***Source of Fuel for Cooking***

Households in the study area use fuel for cooking purposes from different sources including Firewood, crop residue, Kerosene, Cylinder gas, Biogas etc. Almost 21% Source of Fuel has bought from market and 79% collected from nearby sources.

### 6.15.12.4 Asset Ownership

***Land Ownership***

The survey has revealed that about 4% households living in rural Area do not have own any land (irrespective of types), about 83% own homestead and 69% own agricultural irrigated land and 12% non irrigated land.

***House Type***

Majority of the houses in the sample area surveyed are Kuccha and made of locally resourced materials such as mud, straws, Asbestos and burnt bricks. In the study area there are 95% are Kuccha, 5% are Semi pacca.

***Household Income***

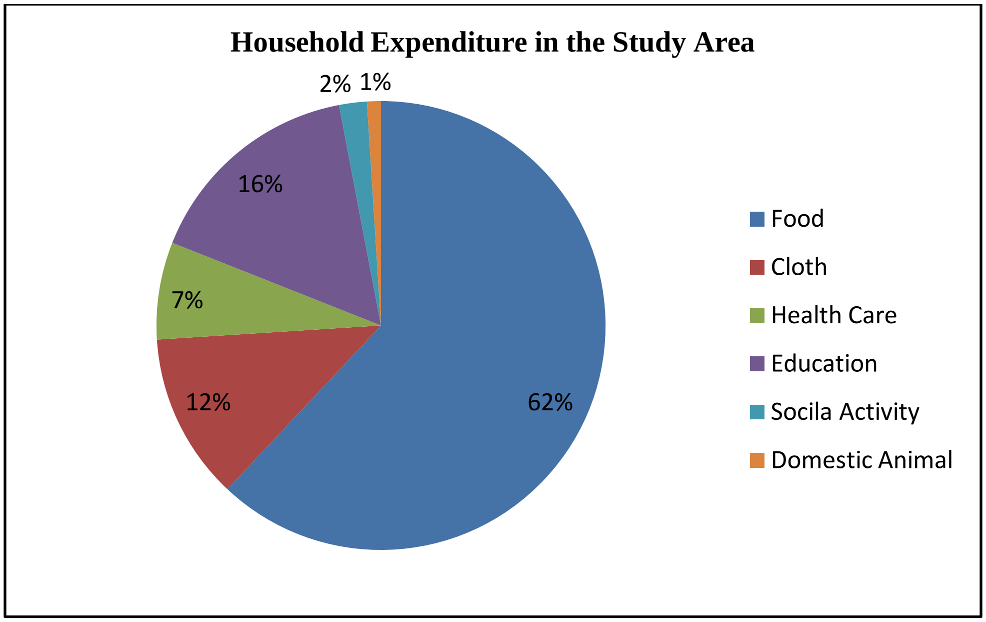
The main sources of income of the surveyed area are agriculture and livestock, agriculture labour, non-agriculture labour, industry, business, hawker, transport, construction, religious, service, rent remittance, and others. The income-earner in the HH on average 72% earns below 5000Tk per month. Almost 18% earns 6000-10000 Tk per months. 7% earns 11000-15000 Tk per month. Only 3% households earns 15000Tk above which have been helping their solvency.

***Domestic Animals***

The percentage of households possessing domestic animals is observed to be quite low in the study area with more than 35% not owning any form of domestic animals. However within the remaining 65% most of the HH owned or reared cows, goats, hens and ducks.

### 6.15.12.5 Household Expenditure

Based on the survey, the average household expenditure observed for key social needs and requirements have been indicated in the following figure. It can be observed from the **Figure 6-46** that the majority of the expenditure is attributed to food and consumable resources with almost half of the monthly income being allocated for the same. Other significant expenditures include clothing, education and healthcare.




*Source: Socio-economic Survey by EQMS (April, 2014)*

**Figure 6-46: Monthly Household Expenditure**

#### 6.15.12.6 Overall Awareness about the Project

Almost 92% of the respondents have a positive perception about the project. The people surveyed reported that the positive expectations are primarily with respect to overall development in the area, improved road facilities, regular electricity supply and employment opportunity for the local people.

## 6.16 Distance to Urban and Rural Communities from the Project Area

The project area is located on agricultural land with some settlement. Rabnabad Channal and Andharmanic River flows south and west side of the project area. The 10 km study area map is shown in **Figure 6-1**.The project site is located at Dhankhali union in Kalapara Upazila of Patuakhali district. Google image is showing the project footprint area in **Figure 6-2.**

The physical setting around the proposed project site is described as follows:

- **North –** Settlements and canal
- **East -** Settlement
- **South –** Rabnabad Channel
- **West –** Andharmanic River

Land use in the immediate vicinity of the project area is mainly rural. The settlements near the project area are relatively low populated area. The distance of surrounding important features from the site is stated in the following **Table 6-37**.

**Table 6-37: Important Features of the Project Influence Area in accordance with Distance**

| Sl. | Places/Areas | Direction | Distance (Km) | Features/ Remarks |
|---|---|---|---|---|
| **1.** | Madhupara village | West | Adjacent | Settlement, EHS |
| **2.** | Bazar | North-west | 2.0 | Settlement, SBE |
| **3.** | Upazila headquarter | South-West | 7.0 | Settlement, SBE, EHS |
| **4.** | Dhaka- Kuakata national highway | West | 7.75 | Road |
| **5.** | Londa Kheya Ghat | North west | 2.10 | SBE |
| **6.** | Khepupara Weather Station | North west | 7.70 | - |
| **7.** | Mosque | West | Adjacent | EHS |
| **8.** | Graveyard | South | Adjacent | EHS |
| 9. | Primary School | West/South | Adjacent | EHS |

***Note:*** *All directions are in reference to the CEE site.*
*HH- Households, SBE- Small Business Enterprise, EHS- Environmental Hotspots (Mosque, Madrasa, School and College).*

## 6.17 Transmission capacity/options for linking to grid

Power generated from the plant units will be evacuated through a 400 KV outdoor switchyard which will be connected by 400 KV double circuit transmission lines to the nearby proposed 400 kV grid substation. The study proposes a 400 kV grid substation in Patuakhali and transmission line connected to the national grid both to be implemented by Bangladesh Power Grid Company of Bangladesh (PGCB).

Startup power will be drawn from 33 kV gridline by laying 33kV transmission line from nearby grid and installing sub-station during construction.

The 400 KV switchyard shall be designed for one and half breaker scheme. All necessary protections for bus, line feeders, and transformer will be provided in the 400 KV switchyard.

## 6.18 Distance of Existing Infrastucture

| | |
|---|---|
| Distance From Nearest Town/City | 13 km from Kalapara Upazila Town |
| Distance From Water Source | River: On The Bank of Kazol River |
| Distance of Nearest Reserve / Wild Life From Site | About 65 km from Sundarban |
| Details of Major Industries, Thermal Power Plants, Mines etc. | Presently no thermal power plants or industries exist nearby.<br>There are no airports or defence installations in the vicinity of the site.<br>The only economic activity (other than agriculture, fisheries & plantation) |
| Approach Road, | A) Approach Road From Dhaka Kuakata Highway: 13 km |

| | |
|---|---|
| Railway, Airport | B) Railway Station: Very far and not able to easily communicate<br>C) Airport (Barisal ): 110km<br>D) Port : 200 Nautical Mile from Chittagong Port |
| Transportation of Fuel | Coal unloading at anchorage 80 km from the project site in deep sea of 20 m draught. Unloading will be done directly from cape-size ship to barges and transportation by barges to the captive jetty and thereof by conveyors from the jetty to the site. |

## 6.19 Current and surrounding land Use and Associated Communities

Details land use of the project area and 10km radius of the project area has been depicted in **Chapter 5**.

# CHAPTER 7

# 7. ENVIRONMENTAL IMPACTS

## 7.1 Identification of Impact

This section identifies and predicts the probable impacts on different environmental parameters due to Pre construction, construction and operation of the proposed plant. After studying the existing baseline environmental scenario, monitoring environmental parameters, reviewing the process, experts comment and perception of the local people, impact identified during IE study and related statutory norms, the major impacts can be identified during construction and operation phase. The impacts have been evaluated in respect to their nature of impact (i.e. direct or indirect), spatial nature (i.e. local or widespread), temporal nature (i.e. long term or short term), and likelihood of occurrence. Finally, the consequences of these impacts have been categorized into a qualitative scale defined by word scenarios for each category. The following sections describe all the potential impacts (stage wise) on physical environment, physical resources (water resources, land resources, agricultural resources, fisheries resources, ecosystem resources) and socio-economic environment of the surrounding.

## 7.2 Sustainibility of Quality of Coal and Continuity of Supply

The project sponsor, BCPCL will be responsible for the coal sourceing and coal quality. All the coal sources, its availinity and sutainablitity of coal quality have been depicted in **Section 3.1.9.**

## 7.3 Pre-Construction and Development Stage Impact

### 7.3.1 Impact on the sites from where material would be collected

During the pre-construction and development stage only site preparation and land filling work will be done. Land filling will be done by river dredging material which may impact on aquatic body. Higher noise may be generated during this stage. Surrounding natural/artificial drainage of the proposed area might be impacted due to land filling material. This work will run for short time and impact will insignificant.

### 7.3.2 Impact on Landform

Total 982.77 acres land will be acquired for the proposed power plant. Land development will be changed the existing land form of the project site but might not the surrounding area. Land use of the surrounding area will not be affected for pre-construction and construction activities of the project but in future, the surrounding area might be changed due to local and regional infrastructure development.

### 7.3.3 Impact on Natural Resources

Total land will be required for the proposed power plant is 982.77 acres of which 832.70 acres are agricultural land. For this reason approximately 15000 metric ton rice as well as water melon, nut, pulse production might be reduced.

There is a limited impact on fisheries during the pre-construction phase. Few cultured pond and natural canal are present in the project boundary. There will be no other significant direct impacts on fish resources during pre-construction phase.

During pre-construction and development stage work including land filling by dredging, sand lifting, site clearance etc. which may have impacts on open water fish habitats, fish diversity and hence to some extent on capture fisheries production. The project adopts waste management plan, so impact on fish habitat due to waste discharge would be minimum.

The only direct impact of land acquisition would be loss of culture fish production from the acquired small pond area which is very insignificant. There may not be any loss of capture fish from the Rabnabad Channel and Andharmanik River during construction period. Only during dredging operation, local fisher may notice less catch from the dredging operation area and its close proximity.

### 7.3.4 Impact on Eco-systems

In the project site only scattered bushes growing in the agricultural land and homestead plantation within the site establishment area need to be cleared for site development. These bush habitats are important for a number of common birds, aquatic birds e.g. Heron and Egrets. However, these impacts will be limited within the project boundary.

The project area occupy some native homestead plantation, weeds, reeds and other vegetation are need to be cleared. These trees, shrubs and herbs are the feeding ground and nesting habitat of different terrestrial common birds. The faunal community may migrate to nearby agricultural and homestead area.

Dredging activities in the Rabnabad Channel/ Andharmanik River may have minor impact on dolphin movement but it will be limited because the Rabnabad channel is approximately 5 km wide. EIA suggests Environmental Management Plan to avoid/limit the disturbance on the swimming, surfacing and migration of Dolphin during dredging and navigational activities that shall be followed by the implementing agency. Thence, the impact on dolphin community may be insignificant.

### 7.3.5 Impact on Ambient Air

Land filling, site establishment, earth works etc. may generate fugitive dust particles. It is necessary to adopt management plan for controlling the fugitive particulate matter during pre-construction and development activities. However, these ground sourced generation will be limited to the project boundary and the impact might be for short period, only during the pre-construction activities. Moreover, the consequence will be significant as the settlement is located adjacent to the project boundary.

### 7.3.6 Impact on Ambient Noise

During pre-construction stage some noise generating meachinary will be used. The noise impact will be minimum and short term during this pre-construction stage.

### 7.3.7 Impact on Water bodies

During pre-construction phase the environmental quality of water resources may not be impacted significantly, as there will be no activities on water resources except some navigation for site visit.

### 7.3.8 Impact on Soil

Soil will be compacted during the site preparation. Project area will also result in soil compaction and possible damage to the soil structure. The extent of soil compaction will be limited by designating routes for movement of heavy vehicles. As soil compaction is primarily restricted to the Project site and its extent is expected to be limited.

### 7.3.9 Impact on Workers Health, Sanitation and Safety

Ergonomic injuries and illnesses, such as repetitive motion, over-exertion, and manual handling, are among the most common causes of injuries on construction sites. Liquid spills and uncontrolled use of electrical cords and ropes on the ground are also among the most frequent causes of lost time accidents at pre-construction sites.

Pre-construction stage may pose a risk of exposure to dust and wastes in a combination of liquid, solid, or gaseous forms. Access to construction areas, including the pipeline corridor and the access road, will be restricted to reduce risks to public health and safety. These risks could create long-terms impacts to the health and safety of the construction workforce and therefore the impact severity is assessed to be medium. Measures will be implemented to ensure that these risks are considered prior to the commencement of site development and that all risks are communicated to the workforce.

### 7.3.10 Impact on Key Point Installations & Others

As there is no major key point installations in and around the project boundary so impact on key point installation and others will be insignificant.

### 7.3.11 Solid Waste Disposal

Pre- donstruction activities may generate different categories of solid wastes and might have impact on local environment only if not managed properly. Wastes may be generated from earth works, site establishment activities. The wastes might be metals, concrete, excavated spoils, spilled oil from machinery and vehicles, etc. The site development activities shall be carried out following environmental rules and regulation so that no significant environmental impact would be resulted from the pre-construction activities.

### 7.3.12 Impact due to Transportation of Raw Materials

During pre-construction phase, the Important Environmental Components (IECs) under this sector will not be severely impacted. During pre- construction of the project, vehicles movement in the project and surrounding area will be increased due to transportation of raw materials. Therefore, traffic load on the road as well as on the waterway may be increased during pre-construction period; thereby road and waterway accidents might be increased.

## 7.4 Impact on Construction Stage

### 7.4.1 Impact on Landform

Constructions activities may change the visual landscape of the project area. Site clearance activities, gathering of equipment and construction materials, machinery and camp establishment on green field site may reduce the scenic beauty. Nevertheless, the impact is for a short duration, and reversible as the project plan includes landscape planning, green belt development etc.

### 7.4.2 Impact on Natural Resources

#### 7.4.2.1 Impact on Agricultural Resources

The process of land acquisition has already been completed. People of the area should be informed before initiation of the construction work so that affected people get enough time to harvest their crops so that construction activities shall not cause any damage to the standing crops. The construction activities shall be limited within the project area. Hence, the construction activities may not cause any damage of standing crops of the project surrounding area. EPC contractor shall follow the standard practice and EMP to manage construction waste that may prevent damage to surrounding agricultural area from waste disposal.

#### 7.4.2.2 Impact on Fisheries

During construction work including physical construction of plant setup which may have impacts on open water fish habitats, fish diversity and hence to some extent on capture fisheries production. The project adopts waste management plan, so impact on fish habitat due to waste discharge would be minimum. Open water fisheries habitats like rivers (Rabnabad Channel, Andharmanik River), canal may be affected due to dredging, traffic movements, and oil and chemical spilling. Dredging activities may also alter the habitat of the bottom feeder fish for short period. Nevertheless, EMP has been suggested to limit the pollution causing activities that shall be duly considered during construction.

Only if the suggested EMP is not followed properly, turbidity of the water column of nearby river may be observed due to discharge of solid load and construction works may change fish habitat as well as production. Feeding and spawning ground of fish are sensitive to high settling on solid load on river bed.

The Rabnabad Channel, Andharmanik and Tetulia rivers are the main channels for open water fish migration. All the migratory fishes move inward and seaward for their biological needs (e.g. spawning, feeding).

Navigational activities for transporting construction materials through existing navigation route and dredging activities may result minor disturbance to fish migration. Only during the dredging operation, fish migration may be disturbed within the dredging operation area. This impact may be very limited due to adoption of Environmental Management Plan during construction activities.

The EPC contractor shall be obliged by the ECR 1997. All kind of wastes and waste water to be generated from the construction activities shall be managed as per requirement of ECR 1997. Hence, it can be anticipated that the proposed construction activities may not have any impact on fish habitat in the Rabnabad Channel and Andharmanik River.

Only the dredging activities may cause migration of some bottom feeder fish species from the dredging operation zone. On the other hand, increased turbidity in water column may attract some fish species for food sourcing. In general, there may be a minor change in fish composition only during dredging operation but it would not affect the local fish diversity.

#### 7.4.2.3 Impact on Livestock

The proposed power plant land provides food, fodder and grazing land for livestock. Acquisition of this land will reduce grazing area for livestock. However, there are also other grazing areas for livestock within 10 km radius of the project that shall be unaffected.

### 7.4.3 Impact on Ecosystems

Suspended particulate matter to be produced from construction activities may be deposited in the surrounding areas and may change habitat quality of aquatic and terrestrial ecosystem if no corrective measures are taken. During construction no waste and wastes water shall be discharged directly to the river without treatment, satisfying standard defined in ECR 1997. Hence, impact of waste disposal and waste water discharge would be minimum and limited within the close proximity of the project area.

## 7.4.4 Impact on Ambient Air

### 7.4.4.1 Generating particulate dust materials

Construction materials processing, construction activities, vehicle movement, etc. may generate fugitive dust particles. The proposed project involves construction activities like civil construction, mechanical construction, handling and stocking of construction materials, etc. It is necessary to adopt management plan for controlling the fugitive particulate matter during construction activities. However, these ground sourced generation will be limited to the project boundary and the impact might be for short period, only during the construction activities. Moreover, the consequence will be significant as the settlement is located adjacent to the project boundary.

### 7.4.4.2 Emission of greenhouse gases

Carbon dioxide and nitrogen oxides may be emitted from combustion of the petroleum products in project related vehicles, machinery, generators, and vessels/barges etc during the construction period. Their impact on air quality will not be significant as the pollutant emission activities (point and area sources) will be limited within the project boundary and the activities will be short term (only for construction period). However, this impact may further be minimized by adopting Environmental Management Plan.

## 7.4.5 Impact on Ambient Noise

During pre-construction and construction work foundation work and super-structural work will be progressed. Certain foundation work may involve pile driving rigs etc. These activities may generate noise pollution. The super-structural work will involve steel and concrete work, masonry work etc. and will involve use of equipment like hoists, cranes, mixers, welding sets etc. There may be noise pollution from this work. The mechanical erection work involves extensive use of mechanical equipment for storage, retrieval and erection, site fabrication etc. leading to considerable noise pollution.

Construction of a large project requires major transportation of materials and people. This involves large-scale movement of vehicles in a virgin area. The vehicle movement, especially heavy vehicles carrying construction materials and equipment can cause significant noise pollution. Noise pollution is significant impact that the local people will be affected by the noise which might be produced from point sources (construction activities) as the nearest settlement is located adjacent to the project boundary.

## 7.4.6 Impact on Water Bodies

The construction activities and installation of power plants may cause changes in the surface water and ground water quality and potential. Some of the predicted changes are pointed out as follows:

Little drawdown of local groundwater table may be noticed in dry season due to withdrawing of groundwater for construction activities. In the project area, lowest ground water table occurs during April-May. Therefore, it is necessary to initiate proper management plan for limiting the use of groundwater during dry season. However, the problem of this phenomenon will be short term and consequences of this problem might be significant as there are several hand pump and deep tube well adjacent to the project. Therefore, it is very unlikely that withdrawing of ground water for construction activities might affect the surrounding hand pump tube wells.

#### 7.4.6.1 Impact on Surface Water Quality

Oil spillage from the workshop, rain water runoff, water vessel may contaminate surface water near the construction site.

#### 7.4.6.2 Effluent from workers colony

During construction, large number of labors will work and huge domestic garbage and sanitary waste water will be generated from various facilities such as workers shed units, which shall have to be properly managed.

#### 7.4.6.3 Impacts of dredging activities (if required)

Dredging operation may increase turbidity of water at dredging locations. If the dredgers cannot be managed properly, water quality of river may be contaminated by spillage of oil, grease and effluent from dumping site. Dumping of dredged material and seepage from dumped dredged material may also increase the turbidity of river water at project site. Nevertheless, the dredging may improve navigability of the Rabnabad Channel/Andharmanik River. The implementing agency shall be responsible for taking necessary measures suggested in Chapter 8 for mitigation of impact. Thereby, it is expected that impact during dredging may be minimum.

### 7.4.7 Impact on Soil

#### 7.4.7.1 Soil Compaction

Soil will be compacted during the establishment of laydown areas, construction camps, the access road and installation of equipment to ensure soil stability. Movement of heavy vehicles and heavy construction machinery in the Project area will also result in soil compaction and possible damage to the soil structure. The extent of soil compaction will be limited by designating routes for movement of heavy vehicles. As soil compaction is primarily restricted to the Project site and its extent is expected to be limited.

#### 7.4.7.2 Soil Contamination-Spills and Leaks

Soil contamination during the construction phase may result from leaks and spills of oil, lubricants, or fuel from heavy equipment, improper handling of sanitary effluent or chemical/fuel storage. Such spills could have a long-term impact on soil quality, but are expected to be localised in nature. Spill control measures such as the storage and handling of chemicals and fuel in concreted areas will be implemented to minimize impacts in the event of a spill. Liquid effluents arising from construction activities will be treated to the standards specified in Schedule 9 and 10 of ECR, 1997 of the GOB prior to discharge.

#### 7.4.7.3 Soil Contamination from waste Handling

Contamination of the soil may occur from improper handling of waste. The majority of the generated wastes will be non-hazardous. General construction waste will comprise of surplus or off-specification materials such as concrete, wooden pallets, steel cuttings/filings, packaging paper or plastic, wood, plastic pipes, metals etc. Domestic-type wastes consisting of food waste, plastic, glass, aluminium cans and waste paper will also be generated by the construction workforce.

A small proportion of the waste generated during construction will be hazardous and may include:

- Spent batteries or spent acid/alkali from the maintenance of machinery on site;
- Used paint, engine oils, hydraulic fluids and waste fuel;

- Spent mineral oils and cleaning fluids from mechanical machinery; and
- Spent solvents from equipment cleaning activities.

If improperly managed, hazardous waste could create impacts not only to land but also to local air quality, water quality, and human health.

### 7.4.8 Impact on Workers Health, Sanitation and Safety

The sources of impact to the health and safety of the Project’s construction workforce are listed below:

- Accidents and injuries associated with the operation of heavy machinery and other construction activities; and
- Health impacts associated with environmental conditions and changes in environmental quality, arising from emissions to air, water, land and noise emissions from construction activities as well as from storage and handling of waste, particularly hazardous waste.

#### 7.4.8.1 Accidents and Injuries from General Construction Activities

Over-exertion, ergonomic injuries and illnesses, such as repetitive motion, over-exertion, and manual handling, are among the most common causes of injuries on construction sites. Loose construction materials, liquid spills, and uncontrolled use of electrical cords and ropes on the ground, are also among the most frequent causes of lost time accidents at construction sites. Falls from elevation associated with working with ladders, scaffolding, and partially built structures are also among the most common causes of fatal or permanent disabling injury at construction sites.

Construction activities may pose significant hazards related to the potential for dropping materials or tools, as well as ejection of solid particles from abrasive or other types of power tools which can result in injury to the head, eyes, and extremities.

Vehicle traffic, use of lifting equipment and the movement of machinery and materials on a construction site may pose temporary hazards, such as physical contact, spills, dust, emissions, and noise. Heavy equipment operators have limited fields of view close to their equipment and may not see pedestrians close to the vehicle. Center-articulated vehicles create a significant impact or crush hazard zone on the outboard side of a turn while moving.

Construction sites may pose a risk of exposure to dust, chemicals, hazardous or flammable materials, and wastes in a combination of liquid, solid, or gaseous forms. Access to construction areas, including the pipeline corridor and the access road, will be restricted to reduce risks to public health and safety. These risks could create long-terms impacts to the health and safety of the construction workforce and therefore the impact severity is assessed to be medium. Measures will be implemented to ensure that these risks are considered prior to the commencement of construction, and that all risks are communicated to the workforce.

#### 7.4.8.2 Health Impact associated with Environmental Conditions

Changes in the environmental quality of air, surface water, groundwater and soil quality may occur as a result of construction activities. High noise levels are also expected from the operation of heavy machinery. An increase in dust and noise during the construction period has the potential to lead to health impacts associated with eye irritation and general disturbance to daily activities.

### 7.4.9 Impact on Key Point Installations & others

As there is no major key point installation in and around the project boundary so impact on key point installation and others will be insignificant.

### 7.4.10 Solid Waste Disposal

Construction activities may generate different categories of solid wastes and might have impact on local environment only if not managed properly. Wastes may be generated from earth works, site establishment, civil construction, stockpile of materials, and domestic household activities. The wastes might be metals, concrete, spoiled construction material, excavated spoils, spilled oil from machinery and vehicles, etc. The construction activities shall be carried out following environmental rules and regulation so that no significant environmental impact would be resulted from the construction activities. The EIA also suggests different management plan as EMP for controlling generation and scattered disposal of wastes. If EMP is properly implemented, there might be only some minor local and short term impact of waste disposal on physical environmental resources i.e. water, land resources and agriculture.

### 7.4.11 Socil Impact due to Industrial Setup and harnessing of Coal and other resources locally

#### 7.4.11.1 Land ownership and land price

Deputy Commissioner, Patuakhali will be acquired 1,000 acres land and handed over to BCPCL for project. The acquisition plan includes acquisition of 120 households. Thereby, land ownership pattern especially in the project area will be changed. Land acquisition will have impact on the land price of the surrounding area. These impacts can be two fold – price of the land very close to the project area may decrease owing to the establishment of power plant on the other hand, in the surrounding of the study area, it may increase due to resettlement of the displaced households(about 120), and induced infrastructural development, establishment of shops, markets, etc.

#### 7.4.11.2 Population displacement

The land acquisition will cause eviction of around 120 households. BCPCL has the provision to resettle the affected household within the 982.77 acres land.

#### 7.4.11.3 Employment and manpower in pre-construction phase

At present most of the households and the core part of the manpower, the youth, are engaged in shrimp agriculture and fishing activities. People depending on these activities may migrate to other area or may change their livelihood. The immediate impact of this land acquisition would be unemployment of the agricultural labor dependent on the acquired lands. Compensation may help them to find new employment.

#### 7.4.11.4 Employment and manpower during construction phase

The proposed project involves huge construction activities that offer employment opportunity to locals. If the labor recruitment policy of the project favors, this manpower may get jobs in non-technical posts. During hiring employees, priority should be given to the affected people and the locals.

#### 7.4.11.5 Communication

During construction most of the construction materials and heavy equipment shall be transported through river. The existing approach road to be upgraded which will lead to easy communication for local people.

#### 7.4.11.6 Income and expenditure

There will be twofold impacts: affected people may lose their income opportunity; on the other hand, locals to be employed by the project will get income opportunity. If proper compensation is paid and local people get access to project employment, then income level of the locals will increase.

#### 7.4.11.7 Harnessing of Coal and other resources locally

There is no available coal mine locally to supply coal to this power plant. There will be urbanization due to power plant establishment; market price of the locally available product will be increased.

### 7.4.12 Impacts on Transportations of Raw Materials

During pre-construction phase, the Important Environmental Components (IECs) under this sector will not be severely impacted. During construction of the project, vehicles movement in the project and surrounding area will be increased due to transportation of raw materials and construction materials. Therefore, traffic load on the road as well as on the waterway may be increased during construction period; thereby road and waterway accidents might be increased.

## 7.5 Operation Stage Impact

### 7.5.1 Impact on Natural Resources

#### 7.5.1.1 Impact on Livestock

Operation of the power plant will not have any impact on livestock resources of the locality.

#### 7.5.1.2 Impact on Fisheries

***Fish Habitat***

The power plant adopts an integrated water and wastewater management system including reuse, recycling and treatment of wastewater. No waste and wastewater shall be discharged to the river without satisfying MoEF's standard (ECR 1997). Hence, the discharge of treated wastewater (within the limit of ECR 1997) may not result any change in water quality to have impact on fish habitat.

In a worst case, treated water may only change water quality of water column up to a certain distance from the discharge point but this change may not be significant to have any impact on fishery habitat. Risk of accidental discharge of any processed water, including wash waters, boiler blow down that may cause deterioration of fishery habitat, may be very low for adopting centrally controlled computer based monitoring and controlled system and hazard and risk management plan.

As the plant emits flue gas through the stack of 275m satisfying MoEF standard by adopting ESP, wet and dry deposition of fly ash, $SO_2$and $NO_2$ over the fish habitat (river, canals, intertidal areas, pond, ghers, etc) would be very limited. Low sulfur content coal, FGD (if required) and Low NOx burners would also help to mitigate environmental impacts.

The total estimated make up river water requirement for the cooling water system and other consumptive for 1320 MW plant is 4,004 $m^3$/hr(96,096 $m^3$/day) whereas 2016 $m^3$/h will be discharged to the River from the plant. According to IWM study (2014), it shows that, maximum flow in the Rabnabad Channel varies from 40,000 – 44,000 $m^3$/s from dry to monsoon period which is very insignificant to result any change in river flow condition as well as fish habitat

Construction of water intake structure may locally obstruct fish activities but will not have any impact on fish habitat.

***Fish migration***

The operation of the power plant and its related activities may not have any impact on fish migration. In addition, the water intake structure may not create any obstruction to fish migration. Nevertheless, the intake current may attract some fish. The fishes those are not strong enough to swim against the current but will be saved by the fish screen.

***Fish diversity***

Power plant operation may not have any direct impact on fish diversity. The minor impacts on fish migration and habitat discussed in the aforementioned sections may not lead to bring any permanent change to fish diversity and composition.

The water intake structure has been designed provided with appropriate fish screens including travelling screens, fixed bar racks, etc to prevent impingement and entrainment of fish by water intake. Despite, some fish and aquatic species, which cannot swim faster against the intake current, may get impingement and entrainment by the water intake. Fish eggs and larva may get entrainment by the intake water. Fine mess screen might also be adopted to save fish eggs and larva from getting entrainment by the intake water.

***Fish Production***

Impact on fisheries will be minimum that may not change the river fish production.

## 7.5.2 Impact on Eco-systems

### 7.5.2.1 Ecosystem habitat

The proposed power plant does not possess any significant negative impact on ecosystem habitat during operation phase while the emission of SOx, NOx and SPM expecte to be within the MoEF's standard.

The project adopts automated monitoring and centrally controlled computer based controlling system to ensure effective plant operation and to prevent any accidental event that may cause environmental damage.

As the plant shall not discharge any thermal plume, and untreated waste water to the river, the aquatic ecosystem of the Rabnabad Channel and Andharmanik River may not be affected from the plant operation.

### 7.5.2.2 Terrestrial flora

Fly ash to be generated from the coal burning shall be arrested by the 99.9% efficient ESP before dispersion through the stack. Major portion of the remaining ash (0.01%) in the flue gas may be deposited on the buffer area (e.g. green belt to be developed) within the project area. Hence, it is very unlikely that the remaining ash would be deposited on the leaves of the vegetation of the surrounding area to cause any loss in productivity.

#### 7.5.2.3 Terrestrial fauna

Project traffic load, human movement and other project activities may sometime disturb free movement of different wildlife like Mongoose, Ring lizards, Rats, Small Indian civet, etc living in road side vegetation. Lighting in the project area may disturb activities of nocturnal animals. On the other hand, green belt (to be developed) for the project shall provide important habitat to different wildlife, local common birds, and other aquatic birds.

#### 7.5.2.4 Aquatic flora

No thermal plume, no untreated waste water shall be discharged to the river so that aquatic environment of the surrounding area may not be affected due to plant operation. Nevertheless, discharge of untreated wastewater may change water quality of the water column within the close proximity but may hardly affect planktonic habitat of the Rabnabad Channel.

Deposition of the remaining ash after arresting by the ESP on surrounding water bodies may hardly affect health of aquatic flora. For preventing accidental release of any pollutant there shall be central controlling and automated monitoring system.

### 7.5.3 Impact on Endangered Species

During the plant operation there is no provision of waste water discharge in the Rabnabad Channel. During coal transporation, there is a possibility of impact on dolphin. Coal transportation shall be carried out using existing navigational route. If the vessel do not comply the maritime rules and regulation and IMO conventions for transporting and Environmental and Social Impacts handling coal, ECR 1997, in the Rabnabad Channel, it may have impact on the aquatic ecosystem. If the responsible authorities enforce the rules properly, no malpractice like discharge of ballast water, bilge water, oily water discharge, waste and waste water shall take place within the territory of Bangladesh. Best practice of operation shall be followed by the coal transportation agency due to enforcement of the environmental rules and regulation. Hence, during ship to ship transfer, risk of coal spillage would be minimum.

### 7.5.4 Impact Due to Collection of Resources from Local Sources within the Country

The fuel of the power plant is coal which will be imported. So no impact has been predicted locally for collection of resources.

### 7.5.5 Impact on Ambient Air

Existing status of the background air quality of the area has been discussed in details in **Section 6.7**. The air quality of the area is generally good. The ambient levels of $SO_2$ remained very low. NOx level was also low and well within limit for the standard limit.

The power plant will emit some air pollutants, mostly suspended particulates, sulphur dioxide, carbon dioxide and nitrogen oxides which will be maintained in conformity of allowable environment limits through the use of suitable technology. The gaseous wastes are disposed through a number of high stacks and those disperse in the atmosphere. The following section discusses the impact of dispersion of gaseous pollutants.

#### 7.5.5.1 Particulate Dust Materials

The proposed project will be based on imported coal that will involve handling and storage of large volume of coal while the daily coal requirement is about 15,197 Ton per day. Handling and storage facilities of coal shall be equipped with dust suppression system. The conveyor belt shall be covered and the transfer point shall be equipped with dust suppression system. Hence, dust generation from coal handling and storage activities shall be minimum and within the limit of ECR 1997. Nevertheless, sometime, within the close proximity of the handling and storage facilities, SPM of the local air might rise but automatic dust sensor and suppression system shall control the generated dust within limit of ECR 1997. On the other hand, there is no dense settlement within the 1 km radius from the stockyard; hence, dust generation from the power plant may not be a health risk issue for the local community.

The coal combustion process will produce maximum 15% ash from the total coal inflow. Ash residue left from coal combustion process will be managed with efficient ash collecting, conveying and storage system. The total process may include Bottom ash collector, Fly ash collector (filtered by Electrostatic Precipitator with the efficiency of 99.9%), Pneumatic ash conveying system, Ash storage silo and Ash pond. All the setup will be installed to limit the outlet ash emission to 200 $\mu g/Nm^3$ in compliance with the Particulate Matter emission standard of Bangladesh (defined in ECR, 1997 amendment 2005).

Despite efficient ash management system, some fugitive ash might be produced and dispersed to the surrounding area but the impact will not be significant as the amount will be too low. On the other hand, accidental release of ash from ash separation and handling system might have impact on surrounding air quality. The accidental release of ash through stack due to failure of ash separation system may be dispersed to the locality and deposited on water bodies, agricultural land, and settlements around the proposed power plant. However, this impact will be short term and reversible. The plant adopts centrally controlled automatic monitoring and controlling system to prevent any accidental event.

#### 7.5.5.2 Emission of Sulfur Dioxide and Nitrogen Oxides

Major emissions from the coal thermal based power plants will be $SO_2$ and NOx. Emission depends on coal quantity and quality. The proposed power plant will be relatively cleaner technology in comparison to the conventional coal based thermal power plant. During pulverized coal combustion, the nitrogen in NOx originates either in the fuel (fuel NOx) or in the air (thermal NOx). Fuel NOx is more important than thermal NOx during coal combustion, making up 60-95% of the total NOx formed in typical coal flames (Pohl and Sarofim 1977; Boardman and Smoot 1993). Nitrogen content is around 0.84% of the selected sources of coal. However, about 1.68% of nitrogen is assumed to be the ultimate composition (e.g. fuel and thermal) to release NOx from the single unit power plant. Therefore, approximately 631 g/s NOx might be emitted from combustion of 7,598.5 ton per day from a single unit for required electricity production (**Table 7-1**). For the proposed power plant, coal to be used will have low Sulfur content (avg. 0.47%, as mentioned in the feasibility Study). However, approximately 819 g/s Sulfur Dioxide will be released from a single unit (660 MW) without using any flue gas desulphurization plant (FGD). Flue gas desulfurization scrubbers have been applied to combustion units firing coal and oil that range in size from 5 MW to 1500 MW. Efficiency of high desulfurization system is normally over 95%. However, the limestone-gypsum wet method is capable of achieving efficiency in the order of 90%. The estimation of emission rate of $SO_2$ and NOx from coal for each 660 unit is given below:

| | |
|---|---|
| Coal Consumption for each unit | 7598.5 ton/day |
| Sulfur content in coal | 0.47% |
| Molecular weight of $SO_2$ | 64 |
| Equivalent weight of $SO_2$ after Combustion | 0.47% X (Molecular weight of $SO_2$/Molecular Weight of S) |
| Hence, emission rate of $SO_2$ | 0.47% X 7598.5 ton/day X (64/32)<br>= 71.42 ton/day<br>≈ 827g/s |
| Hence, using FGD plant, the rate of $SO_2$ | ≈ 82.7 g/s (e.g. considering 90% efficiency of reducing $SO_2$ from the flue gas) |
| Nitrogen content in coal | 1.68% (supplied fuel and air) |
| Molecular weight of NOx (Considering $NO_2$) | 46.01 |
| Equivalent weight after Combustion | 1.68% X (Molecular weight of $NO_2$/Molecular Weight of N) |
| Efficiency of Low NOx (LNI) Integrated System | 87% (Release only 13% of NOx) |
| Hence, emission rate of $NO_2$ | 1.68% X 7598.5 ton/day X (46.01/14.01) X 13%<br>= 54.5 ton/day<br>≈ 631 g/s |

These standards shall be attached with the tender documents, the machinery and equipment will be chosen based on environmental along with other technical criteria. The coal quality prescribed in Chapter 3 (section 3.1.9.2) should be maintained not only the environmental quality control but also well mechanical performances of the plant. Coal quality always varies with origin, marketing process etc. If inferior quality of coal would use, FGD (Flue gas Desulfurization), Low NOx Integrated system (two stage combustion or low NOx burner) have to be installed suiting to the environmental standard rules and regulation of the country as well as Equator Principle. FGD will relax to intake lower grade of coal (e.g. higher Sulfur content) for running the power plant under worst circumstances. Therefore, there is a provision of installing FGD for functioning in case of having higher Sulfur and Nitrogen content coal and limit the SOx and NOx emission of MoEF’s standard (ECR 1997) and World Bank Standard.

**Table 7-1: Emission of $SO_2$ and NOx from Proposed Coal based Ultra Supercritical Thermal Power Plant**

| Element | Elementary content in Coal, % by wt | Coal flow, Tons/day | Emission rate from stack | Bangladesh Standard | World Bank Standard* | Remarks |
|---|---|---|---|---|---|---|
| Sulfur Dioxide | 0.47 (as Sulfur) | 7598.5 for each unit of 660 MW | 827 g/s for each unit | No specific regulation is defined in ECR, 1997 for emission from Coal based power plant. However, Ambient air quality standard, (365 μg/m$^3$) might be applied. | 200-850 mg/Nm$^3$ for non-degraded airshed and 200 for degraded airshed. The proposed power plant location fall under the non-degraded airshed. | Flue Gas Desulfurization must provide in case of higher sulphur contain (e.g.more than 0.6% Sulfur content in Coal), 275 m stack height and specified designed condition of the stack is ensured. |
| Nitrogen Oxides | 1.68(including fuel and thermal) | | 631 g/s from each unit | Ambient air quality standard, (100 μg/m$^3$ for annual) might be applied. | 510 mg/Nm$^3$ or up to 1,100 if volatile matter of fuel<10% for non-degraded airshed | The furnace may be provided with low NOx burner |

*Source: Estimated from pre-feasibility study report data*

** World bank Environmental, Health and Safety guideline for Thermal Power Plant*

#### 7.5.5.3 Ground level concentration of $SO_2$ and NOx

Maximum ground level concentration of $SO_2$ and NOx (contribution of each unit of 660 MW to ambient air) were calculated using SCREEN 3.5.0 model. The model is fully approved by the United States Environmental Protection Agency (USEPA) for calculation of maximum short-term concentrations of non-reactive pollutants emitted from a single source. Short-term concentration represents here peak one-hour ground level concentration (which would be the contribution of each unit to ambient air). The SCREEN 3.5.0 model set up has been prepared including buoyancy-induced dispersion (BID), subroutines to estimate shoreline fumigation due to presence of river and sea, rural dispersion, and simple terrain. SCREEN 3.5.0 is an optimized version of the USEPA reference Industrial Source Complex model (ISC). Maximum concentrations are calculated based on a screening set of 54 meteorological conditions for distances downwind of the source. The parameters considered for air pollution assessment is presented in **Table 7-2.**

SCREEN 3 assumes that pollutants are conserved (i.e.no chemical reactions take place). The combined concentrations of NO and $NO_2$ are therefore expressed as total NOx. Emission of NOx from combustion plants generally include 10%-25% $NO_2$ and 75%-90% NO (Mott Ewbank Preece, 1997).

**Table 7-2: Source Parameters for SCREEN 3.5.0**

| Parameter | Value (Single unit ) | Value (Double unit ) |
|---|---|---|
| Source Type | Point | Point |
| Dispersion Coefficient | For Rural | For Rural |
| Receptor Height Above Ground | 0 m | 0 m |
| Emission Rate ($SO_2$) | 827 g/s | 1653 g/s |
| Emission Rate ($SO_2$) using FGD | 82.7 g/s | 165.3 g/s |
| Emission Rate (NOx) | 631 g/s | 1260 g/s |
| Stack Height | 275 m | 275 m |
| Stack Inside Diameter | 7.2 m | 7.2 m |
| Velocity | 25 m/s | 25 m/s |
| Stack Gas Exit Temperature | 125°C (398k) | 125°C (398k) |
| Ambient Air Temperature | 27°C (300 k) | 27°C (300 k) |
| Terrain | Simple and Flat | Simple and Flat |

***Dispersion of $SO_2$***

The model predicts in total double units maximum ground level concentration for 1-hour concentration, 24 hour and annual average concentration of $SO_2$ would be maximum 654 µg/m$^3$ and 261.6 µg/m$^3$ and 52.3 µg/m$^3$ respectively at 1.36 km downwind from the chimney. The highest ground level concentration is not beyond the airshed. Most of the coal based power plant considers around 3 km airshed. The level of Sox for 24 hr and annual are represented in **Figure 7-1** where the dispersion of SOx concentration is given in µg/m$^3$unit.

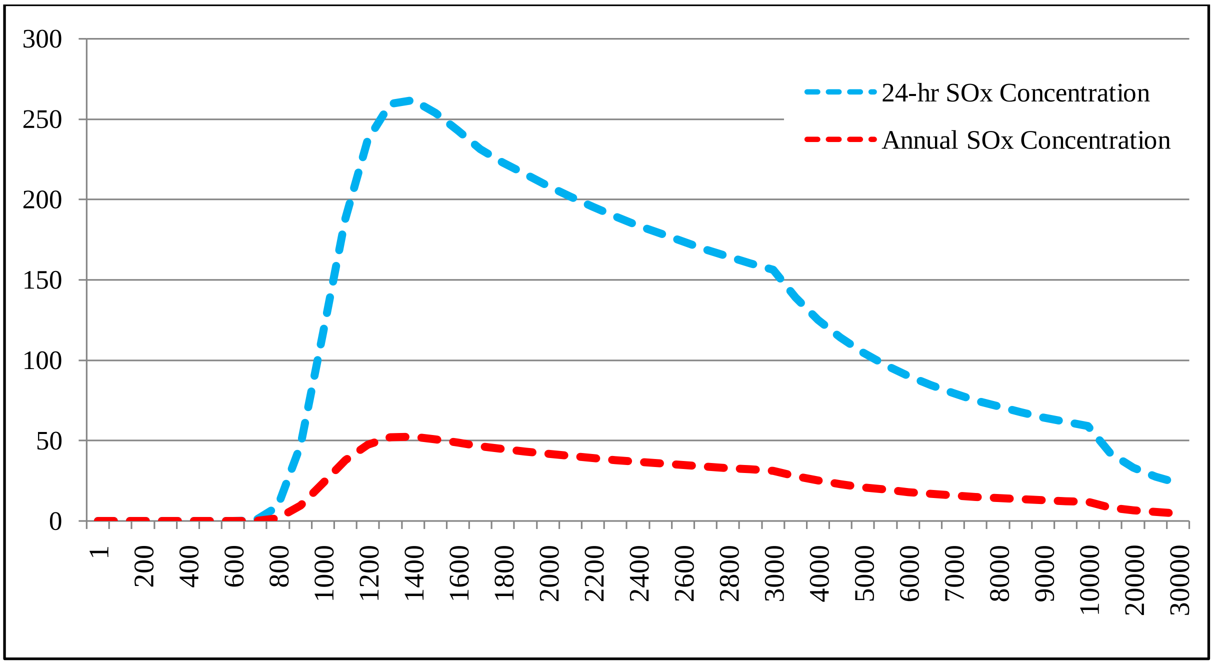



**Figure 7-1: Model results on dispersion of $SO_2$ at downwind direction**

Pasquill-Gifford Stability Index the wind stability of the study area falls into extremely unstable (Class A) to moderately unstable (Class B) conditions. The method estimates that the emitted $SO_2$ will be dispersing easily and will lowering down below the ambient air quality standard for $SO_2$ (80 μg/m$^3$ for annual as per ECR, 1997). The predicted GLC of SOx would be in detail of the **Table 7-3** and **Annex J.**

**Table 7-3: Ground Level Concentration (GCL) of $SO_2$ at different distance for double unit**

| Distance (m) | Max. 1hr Conc. (μg/m$^3$) | 24hr average Conc. (μg/m$^3$) | Annual average Conc. (μg/m$^3$) | With FGD (μg/m$^3$) |
|---|---|---|---|---|
| | | (±0.7) | (±0.02) | Reduction of 90% |
| 1 | 0 | 0 | 0 | 0 |
| 100 | 0 | 0 | 0 | 0 |
| 200 | 0 | 0 | 0 | 0 |
| 300 | 0 | 0 | 0 | 0 |
| 400 | 0 | 0 | 0 | 0 |
| 500 | 4.35E-08 | 1.74E-08 | 3.48E-09 | 3.48E-10 |
| 600 | 2.88E-03 | 0.001152 | 0.0002304 | 2.3E-05 |
| 700 | 0.9846 | 0.39384 | 0.078768 | 0.007877 |
| 800 | 22.06 | 8.824 | 1.7648 | 0.17648 |
| 900 | 118.1 | 47.24 | 9.448 | 0.9448 |
| 1000 | 292 | 116.8 | 23.36 | 2.336 |
| 1100 | 470.1 | 188.04 | 37.608 | 3.7608 |
| 1200 | 592.5 | 237 | 47.4 | 4.74 |
| 1300 | 647.9 | 259.16 | 51.832 | 5.1832 |
| 1400 | 654 | 261.6 | 52.32 | 5.232 |
| 1500 | 634.4 | 253.76 | 50.752 | 5.0752 |
| 1600 | 606.4 | 242.56 | 48.512 | 4.8512 |

| Distance (m) | Max. 1hr Conc. (µg/m$^3$) | 24hr average Conc. (µg/m$^3$) | Annual average Conc. (µg/m$^3$) | With FGD (µg/m$^3$) |
|---|---|---|---|---|
| 1700 | 578.1 | 231.24 | 46.248 | 4.6248 |
| 1800 | 557.3 | 222.92 | 44.584 | 4.4584 |
| 1900 | 538.4 | 215.36 | 43.072 | 4.3072 |
| 2000 | 520.7 | 208.28 | 41.656 | 4.1656 |
| 2100 | 504 | 201.6 | 40.32 | 4.032 |
| 2200 | 488.3 | 195.32 | 39.064 | 3.9064 |
| 2300 | 473.5 | 189.4 | 37.88 | 3.788 |
| 2400 | 459.6 | 183.84 | 36.768 | 3.6768 |
| 2500 | 446.4 | 178.56 | 35.712 | 3.5712 |
| 2600 | 434 | 173.6 | 34.72 | 3.472 |
| 2700 | 422.3 | 168.92 | 33.784 | 3.3784 |
| 2800 | 411.1 | 164.44 | 32.888 | 3.2888 |
| 2900 | 400.6 | 160.24 | 32.048 | 3.2048 |
| 3000 | 390.6 | 156.24 | 31.248 | 3.1248 |
| 3500 | 347.3 | 138.92 | 27.784 | 2.7784 |
| 4000 | 312.8 | 125.12 | 25.024 | 2.5024 |
| 4500 | 284.8 | 113.92 | 22.784 | 2.2784 |
| 5000 | 261.7 | 104.68 | 20.936 | 2.0936 |
| 5500 | 242.2 | 96.88 | 19.376 | 1.9376 |
| 6000 | 225.5 | 90.2 | 18.04 | 1.804 |
| 6500 | 211.1 | 84.44 | 16.888 | 1.6888 |
| 7000 | 198.6 | 79.44 | 15.888 | 1.5888 |
| 7500 | 187.6 | 75.04 | 15.008 | 1.5008 |
| 8000 | 177.8 | 71.12 | 14.224 | 1.4224 |
| 8500 | 169 | 67.6 | 13.52 | 1.352 |
| 9000 | 161.2 | 64.48 | 12.896 | 1.2896 |
| 9500 | 154.1 | 61.64 | 12.328 | 1.2328 |
| 10000 | 147.6 | 59.04 | 11.808 | 1.1808 |
| 15000 | 105.2 | 42.08 | 8.416 | 0.8416 |
| 20000 | 82.72 | 33.088 | 6.6176 | 0.66176 |
| 25000 | 68.71 | 27.484 | 5.4968 | 0.54968 |
| 30000 | 59.08 | 23.632 | 4.7264 | 0.47264 |

The power plant project has been located on the flat terrain with no surrounding high rise buildings and about 18 km distance from the shoreline of Bay of Bangal. Therefore, the effects of building down wash, complex terrain and shoreline fumigation have been avoided.

Only during November to February, prevailing wind flows towards North, North-west and rest of the year it flows mostly towards South.

The concentration of $SO_2$ in the ambient air in the project area is found 2.52 to 3.76 µg/m$^3$ (Field monitoring data, see Table 6-7). This study has taken average 3µg/m$^3$ for 24 hr as background concentration to predict the resultant highest concentration around the project site. **Table 7-4** represents highest GLC of SOx and standard limit.

**Table 7-4: Highest resultant GLC of SOx for 24-hr and Annual**

| Prevailling period | Background Conc. ($\mu g/m^3$) | Predicted Conc. ($\mu g/m^3$) | Resultant Conc. ($\mu g/m^3$) | MoEF Standard, ECR, 1997 ($\mu g/m^3$) | MoEF Standard, 2005 ($\mu g/m^3$) | WB Standard (IFC, 2007) ($\mu g/m^3$) |
|---|---|---|---|---|---|---|
| 24-hr | 3.0 | 261.6 | 264.6 | | 365 | 125 |
| 24-hr (using FGD) | 3.0 | 26.1 | 29.1 | | 365 | 125 |
| Annual | 3.0 | 52.3 | 55.3 | 80 | 80 | |
| Annual (Using FGD) | 3.0 | 5.23 | 8.23 | 80 | 80 | |

The closest protected area is Kuakata Eco Park which is located approximately 23 km South-west direction from the proposed power plant location. As per the estimated results, stack emissions will not affect in this Eco Park. The resultant GLC of SOx will maintain the standard of MoEF. But the resultant GLC of SOx for 24hr would be higher than IFC, 2007 standard. Use of FGD would reduce the level of GLC of SOx significantly.

***Dispersion of NOx***

The model predicts the GLC of NOx for each unit (e.g. 660MW which is converted for double unit and estimated for 24-hr average and annual average). GLC of $NO_2$ would be maximum 199.4$\mu g/m^3$ and 39.8$\mu g/m^3$ respectively at 1.36 km downwind from the chimney which is belongs to the airshed area of the power plant. Figure shows the $NO_2$ dispersion where distances ar given in meter and concentrations given in $\mu g/m^3$.

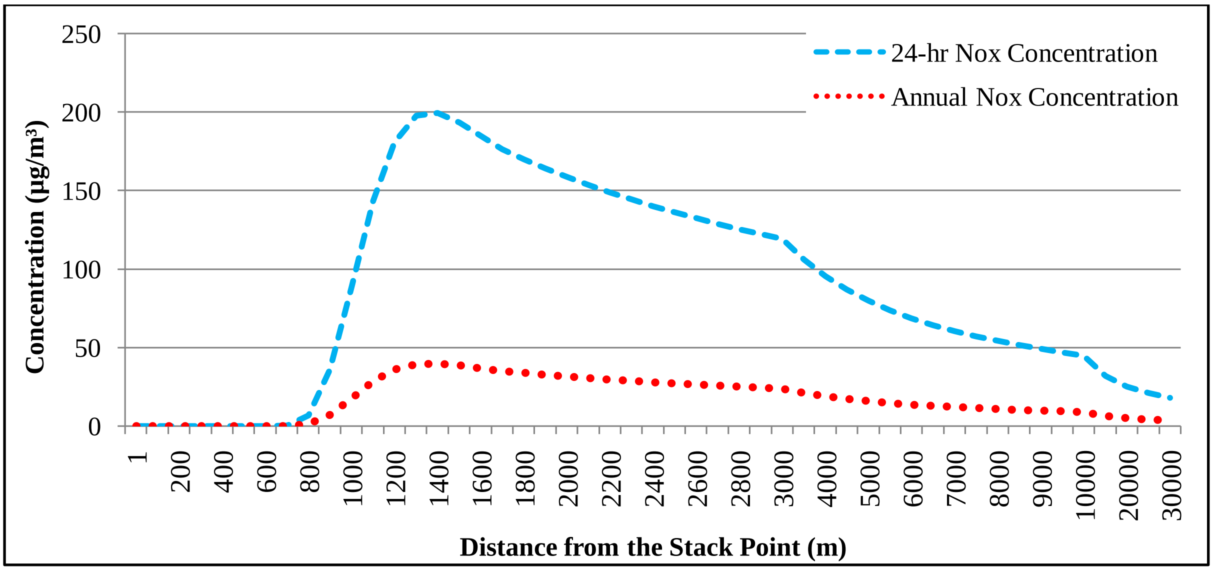



**Figure 7-2: Model result on dispersion of NOx**

Considering wind stability class-A (unstable), the model estimates, the emitted $NO_2$ will be dispersing easily and will always be lower than the ambient air quality standard for $NO_2$ (80 $\mu g/m^3$ for residential as per ECR, 1997 and annual average 100 $\mu g/m^3$ as per ECR amendment 2005). Only during November to February, prevailing wind flows towards North, North-west and rest of the year it flows mostly towards South. The closest protected area is Kuakata Eco Park which is located approximately 23 km South-west direction from the proposed power plant location. As per the estimated results, stack emissions will not affect in this Eco Park. Detail data of the same is given in **Table 7-5** and **Annex J.**

**Table 7-5: 1hr, 24hr and annual concentration of NOx at different distances**

| Distance (m) | Max. 1hr Conc. (μg/m$^3$) | 24hr average Conc. (μg/m$^3$) | Annual average Conc. (μg/m$^3$) |
|---|---|---|---|
| 1 | 0 | 0 | 0 |
| 100 | 0 | 0 | 0 |
| 200 | 0 | 0 | 0 |
| 300 | 0 | 0 | 0 |
| 400 | 0 | 0 | 0 |
| 500 | 3.31E-08 | 1.33E-08 | 2.65E-09 |
| 600 | 2.20E-03 | 0.000879 | 0.000176 |
| 700 | 0.7505 | 0.3002 | 0.06004 |
| 800 | 16.82 | 6.728 | 1.3456 |
| 900 | 90.02 | 36.008 | 7.2016 |
| 1000 | 222.5 | 89 | 17.8 |
| 1100 | 358.3 | 143.32 | 28.664 |
| 1200 | 451.6 | 180.64 | 36.128 |
| 1300 | 493.9 | 197.56 | 39.512 |
| 1400 | 498.5 | 199.4 | 39.88 |
| 1500 | 483.6 | 193.44 | 38.688 |
| 1600 | 462.2 | 184.88 | 36.976 |
| 1700 | 440.6 | 176.24 | 35.248 |
| 1800 | 424.8 | 169.92 | 33.984 |
| 1900 | 410.4 | 164.16 | 32.832 |
| 2000 | 396.9 | 158.76 | 31.752 |
| 2100 | 384.2 | 153.68 | 30.736 |
| 2200 | 372.2 | 148.88 | 29.776 |
| 2300 | 360.9 | 144.36 | 28.872 |
| 2400 | 350.3 | 140.12 | 28.024 |
| 2500 | 340.3 | 136.12 | 27.224 |
| 2600 | 330.8 | 132.32 | 26.464 |
| 2700 | 321.9 | 128.76 | 25.752 |
| 2800 | 313.4 | 125.36 | 25.072 |
| 2900 | 305.3 | 122.12 | 24.424 |
| 3000 | 297.7 | 119.08 | 23.816 |
| 3500 | 264.7 | 105.88 | 21.176 |
| 4000 | 238.5 | 95.4 | 19.08 |
| 4500 | 217.1 | 86.84 | 17.368 |
| 5000 | 199.5 | 79.8 | 15.96 |
| 5500 | 184.6 | 73.84 | 14.768 |
| 6000 | 171.9 | 68.76 | 13.752 |

| Distance (m) | Max. 1hr Conc. (µg/m$^3$) | 24hr average Conc. (µg/m$^3$) | Annual average Conc. (µg/m$^3$) |
|---|---|---|---|
| 6500 | 160.9 | 64.36 | 12.872 |
| 7000 | 151.4 | 60.56 | 12.112 |
| 7500 | 143 | 57.2 | 11.44 |
| 8000 | 135.5 | 54.2 | 10.84 |
| 8500 | 128.8 | 51.52 | 10.304 |
| 9000 | 122.9 | 49.16 | 9.832 |
| 9500 | 117.4 | 46.96 | 9.392 |
| 10000 | 112.5 | 45 | 9 |
| 15000 | 80.16 | 32.064 | 6.4128 |
| 20000 | 63.05 | 25.22 | 5.044 |
| 25000 | 52.37 | 20.948 | 4.1896 |
| 30000 | 45.03 | 18.012 | 3.6024 |

The concentration of NOx in the ambient air in the project study area is found 7.5 to 13.1µg/m$^3$ (Field monitoring data, see Table 6-7). Therefore, 10µg/m$^3$ has been considered as background concentration of the study area. **Table 7-5** gives maximum ground level concentration contributes of NOx from combined two units for 1hr, 24hr anerage and annual average would be predicted. However, the resultant concentrations of NOx in ground level are presented in **Table 7-6**. This concentration of emitted $NO_2$ is very lower than the national standard but slightly higher than World Bank standard. However, regular monitoring of emission rate is recommended for protecting the surrounding envirornment from impact of emitted gas.

**Table 7-6: Highest Resultant GLC of NOx for 24-hr and Annual**

| Prevailling period | Background Conc. (µg/m$^3$) | Predicted Conc. (µg/m$^3$) | Resultant Conc. (µg/m$^3$) | MoEF Standard, ECR, 1997 (µg/m$^3$) | MoEF Standard, 2005 (µg/m$^3$) | WB Standard (IFC, 2011) (µg/m$^3$) |
|---|---|---|---|---|---|---|
| 24-hr | 10.0 | 199.4 | 209.4 | | | |
| Annual | 10.0 | 39.8 | 49.8 | 80 | 100 | 40 |

The long- term concentration will also be very limited. The project is located in tropical cyclone prone area. Unstable atmospheric environment and heavy precipitation during cyclonic event will reduce the pollutant concentration significantly (chang et al., 2010).

### 7.5.6 Impact on Ambient Noise

In environmental noise assessment for the proposed project, considerations have been given to two aspects, those relating to the noise source and the other relating to potential receivers. An attempt was, therefore, first made to describe the physical characteristics of sound, i.e. characterization of its loudness as a function of frequency in the audible frequency range weighing them according to their, response to the human ear. The value, thus obtained could be compared to the damage risk criteria for hearing as enforced by the occupational safety and Health Administration (OSHA) of USA. As already observed and reported in Section 5.2.11, the noise levels in the area are presently within the recommended limits of the Bangladesh Standards.

In Power projects, of the type planned here, very high noise levels could be expected especially near P.A Fan, F.D Fan and Coal Handing Plants. However, the sound pressure level (SPL) generated by noise sources decreases with increasing distance from the source mainly due to wave divergence (geometric attenuation).

The phenomenon of decrease in SPL with increasing distances was studied with the help of computer simulation of **"Multisource Noise Attenuation Model"** which is based on community/In-Plant Noise Model developed by “Flour”. The corresponding algorithms considering geometric attenuation are presented below:

$L_p = L_w + 10 \log [(Q/4).F(R)]$

Where, $L_p$= SPL at any receptor in dB (A)
$L_w$ = SPL of a source in dB (A)
10 log [(Q/4). F (R)] = Distance /geometric attenuation
Q= antilog (DI/10)
DI= Source directivity factor (0 for spherical radiation)
(R) = A function of R [F (R) = $1/R^2$ for point sources)
R= Distance between source and receptor in m.

Input data used for the Computer simulation/modelling are presented in **Table 7-7**. In the multisource attenuation modelling, 21 major noise sources have been considered. They are:

Source No. 1 to 6 : Feed pumps (SPL L 97 dB (A)
Source No. 7 to 12: Turbo Generators (SPL: 91 dB (A)
Source No. 13 to 15: Compressors (SPL: 97 dB (A)
Source No. 16 to 21: D.G. Sets (SPL: 106 dB (A)

Frequency of the source noises was assumed to be 1000 Hz for all the sources. All the sources have been assumed to be point sources with spherical radiation of sound waves.

Isopleths of noise depicting the noise sources and attenuation pattern are presented in **Table 7-8**.

It would be observed from **Table 7-8** that the SPL reduces to 54 dB (A) within 750 metres of the considered origin (the center of the turbo-generator row). It reveals that the SPL reduces to 70 dB (A), the night time limit for Industrial Areas as stipulated in the Ambient Noise standards within a short distance. It reduces below 54 dB (A) within a distance of 750 metres. This would imply that impacts of plant noise is likely to be felt in the residential and other quiet areas within 0.75 km in the neighbourhood of the project. However, there will be no tangible impacts on the population residing beyond 750 m.

It would also be noted that this attenuation exercise was conducted without accounting for ground effects and absorption due to soreens, which will lower the receptor noise levels.

Impacts on persons working very close to the sources are likely. Therefore, the latter should be provided with adequate protection against noise in the form of ear plugs, helmets etc.

**Table 7-7: Input data used for computer simulation of Multisource Noise Attenuation model**

| Sl. | x (m) | y (m) | SPL dB (A) | Frq (hz) |
|---|---|---|---|---|
| 1 | 47.04 | 338.10 | 97.00 | 1000 |
| 2 | 47.04 | 241.08 | 97.00 | 1000 |
| 3 | 47.04 | 141.12 | 97.00 | 1000 |
| 4 | 47.04 | 44.10 | 97.00 | 1000 |

| Sl. | x (m) | y (m) | SPL dB (A) | Frq (hz) |
|---|---|---|---|---|
| 5 | 47.04 | -61.74 | 97.00 | 1000 |
| 6 | 47.04 | -155.82 | 97.00 | 1000 |
| 7 | 0.00 | 332.22 | 91.00 | 1000 |
| 8 | 0.00 | 241.08 | 91.00 | 1000 |
| 9 | 0.00 | 135.24 | 91.00 | 1000 |
| 10 | 0.00 | 41.16 | 91.00 | 1000 |
| 11 | 0.00 | -64.68 | 91.00 | 1000 |
| 12 | 0.00 | -155.82 | 91.00 | 1000 |
| 13 | -55.86 | 311.64 | 97.00 | 1000 |
| 14 | -55.86 | 117.60 | 97.00 | 1000 |
| 15 | -55.86 | 79.38 | 97.00 | 1000 |
| 16 | 70.56 | 376.32 | 106.00 | 1000 |
| 17 | 70.56 | 282.24 | 106.00 | 1000 |
| 18 | 70.56 | 182.28 | 106.00 | 1000 |
| 19 | 70.56 | 85.26 | 106.00 | 1000 |
| 20 | 70.56 | -11.76 | 106.00 | 1000 |
| 21 | 70.56 | -117.60 | 106.00 | 1000 |

**Table 7-8: Results of Computer Simulation of Noise Attenuation Model**

| Sound Pressure Levels (SPL) in dB (A) at Various Receptor Point | | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **Dir** | **Radial distance of the point from the origin (m)** | | | | | | | | | | | | | | |
| | **50** | **100** | **150** | **200** | **250** | **300** | **350** | **400** | **450** | **500** | **550** | **600** | **650** | **700** | **750** |
| N | 70 | 68 | 68 | 67 | 69 | 67 | 67 | 65 | 63 | 60 | 58 | 57 | 56 | 55 | 54 |
| NNE | 68 | 66 | 71 | 64 | 63 | 62 | 61 | 60 | 58 | 57 | 56 | 55 | 54 | 53 | 53 |
| NE | 70 | 65 | 63 | 61 | 60 | 59 | 58 | 57 | 56 | 55 | 54 | 54 | 53 | 52 | 52 |
| ENE | 67 | 64 | 61 | 60 | 59 | 57 | 56 | 56 | 55 | 54 | 53 | 53 | 52 | 51 | 51 |
| E | 65 | 63 | 61 | 59 | 58 | 57 | 56 | 55 | 54 | 53 | 53 | 52 | 51 | 51 | 50 |
| ESE | 65 | 63 | 61 | 59 | 58 | 57 | 56 | 55 | 54 | 53 | 52 | 52 | 51 | 51 | 50 |
| SE | 66 | 66 | 62 | 60 | 58 | 57 | 56 | 55 | 54 | 53 | 52 | 52 | 51 | 50 | 50 |
| SSE | 67 | 66 | 67 | 62 | 59 | 58 | 56 | 55 | 54 | 53 | 52 | 52 | 51 | 51 | 50 |
| S | 68 | 66 | 71 | 63 | 60 | 58 | 57 | 56 | 55 | 54 | 53 | 52 | 51 | 51 | 50 |
| SSW | 68 | 69 | 72 | 65 | 61 | 59 | 57 | 56 | 55 | 54 | 53 | 52 | 52 | 51 | 50 |
| SW | 69 | 69 | 69 | 64 | 61 | 59 | 58 | 56 | 55 | 54 | 53 | 53 | 52 | 51 | 51 |
| WSW | 73 | 71 | 66 | 63 | 61 | 59 | 58 | 56 | 55 | 55 | 54 | 53 | 52 | 52 | 51 |
| W | 73 | 71 | 65 | 63 | 61 | 59 | 58 | 57 | 56 | 55 | 54 | 53 | 53 | 52 | 51 |
| WNW | 70 | 70 | 66 | 64 | 62 | 60 | 59 | 58 | 57 | 56 | 55 | 54 | 53 | 53 | 52 |
| NW | 69 | 77 | 70 | 66 | 64 | 63 | 61 | 60 | 59 | 57 | 56 | 55 | 55 | 54 | 53 |
| NNW | 69 | 72 | 71 | 84 | 69 | 69 | 66 | 65 | 62 | 60 | 58 | 57 | 56 | 55 | 54 |

Note: All 21 sources are assumed as point sources with spherical radiation of sound waves.
Origin has been assumed at the centre of the turbo-generator row.

### 7.5.7 Impact on Water Bodies (Surface and Ground Water)

#### 7.5.7.1 Wash off from coal stock piles

Wash-off from the stockpiles shall be drained out to the central effluent treatment pump. Water spraying (in the form of mist) for controlling coal combustion and coal dust suppression shall be made in a way so that no surplus water is produced. Leachate from the coal stock yard shall also be drained to the central effluent treatment plant. Little amount of leachate might be leaching to the ground.

#### 7.5.7.2 Disruption of tidal inundation

The proposed power plant shall not obstruct the natural flow of Rabnabad Channel. Site establishment in this isolated land may not cause any obstruction to tidal inundation of the surrounding areas.

#### 7.5.7.3 Drainage congestion and water logging

The project area of 1,000 acre land will be developed for project purpose. The site development may not cause any drainage congestion and water logging in the nearby villages.

#### 7.5.7.4 Erosion and Accretion

There will be no significant impacts on erosion and accretion process of the Rabnabad Channel due to operation of this project. However, construction of Jetty and movement of large vessel for coal transportation may cause shoreline erosion due to generated wave from vessel. If the vessels maintain speed restriction (7 knots to 8 knots), the generated wave may be insignificant to have impact on shoreline erosion.

#### 7.5.7.5 Impacts due to maintenance dredging (if required)

Maintenance dredging for maintaining navigability of the River for coal transportation may be required. The dredging works shall be executed by the relevant authorities (MPA, BIWTA or BWDB). The relevant authorities shall keep close communication with DoE for necessary clearances. Dredging activities may have impacts on river water quality. During dredging operation, water column may be contaminated due to spillage of oil, grease, machine oil, etc. Unplanned dredging may also cause erosion in some places.

### 7.5.8 Solid Waste Disposal

Waste may be generated from coal handling and storage facilities, ash collection and disposal system and domestic activities. Per day 1150 tons of ash might be generated from the plant of which 80% shall be dry fly ash and the rest 20% shall be bottom ash. The project targets 100% utilization of this generated ash with adoption of efficient ash management system. Very little portion of this ash might escape from the system as waste. A solid wastes management plan has been envisaged that involves ash collection, management and utilization system. No waste shall go unmanaged and be disposed without satisfying MOEF’s standard. Leakage or accidental release of hazardous chemicals stored for water treatment plant may affect the soil and water quality.

### 7.5.9 Impact on Soil and Agriculture

#### 7.5.9.1 Crop production

Deposition of fly ash to be emitted from the stack on agricultural land may not have any negative impact on crops. Rather it may increase crop production. Application of fly ash and pond ash in agricultural land increases crop production. Provision should be kept for utilization of generated ash and pond ash in crop field.

#### 7.5.9.2 Crop Damage

Operation of the power plant might not cause crop damage of the surrounding agricultural land. With the experience of Barapukuria Coal Fired Thermal Power Plant, it is examined as anticipated that deposition of fly ash emitted from stack will not cause crop damage. Lighting in and around the project area might attract pest. Pest infestation due to this light pollution may cause crop damage.

### 7.5.10 Impact on Ground Water

During the rainy season Ground water may be impacted from the ash dumping location by waste water leahing. As the ash dumping location will be concreate bounded so the impact on ground will minimum.

### 7.5.11 Impact Due to Ash Disposal

#### 7.5.11.1 Agricultural land type

The operation of the project will not have any impact on agricultural land type of the locality, as it will not alter the hydrological process and flood regime of the area. Only the project areas of 1,000 acres that is to be acquired for project development will no longer be used for agricultural and shrimp farming practice. This land will be raised by 5 - 6m above the mean sea level.

#### 7.5.11.2 Land use

It might be anticipated that the existing agricultural dominant rural land use of the locality will be changed in future due to induced infrastructural and industrial development after completion of the project. Industrial development, township development, new road and communication may take place due to generation and supply of reliable electricity from the proposed power plant. However, a regional development plan should be prepared by the concerned Government Authority to guide the induced development in a planned way and to conserve agricultural land from encroachment.

#### 7.5.11.3 Soil nutrient status

The power plant will emit fly ash through the stack of 275 m height within the limit of ECR, 1997 defined standard. However, this ash might be deposited on the surrounding agricultural land. Deposition of fly ash increases water retention capacity and nutrient status of soil. On the other hand, deposition of ash on agricultural land during accidental release or malfunction of ash collection system might cause toxicity to standing crop.

#### 7.5.11.4 Heavy metal

Coal and coal waste products, including fly ash, bottom ash, and boiler slag, contain many heavy metals, including arsenic, lead, mercury, nickel, vanadium, beryllium, barium, cadmium, chromium, selenium and, radium, which are dangerous if released into environment. Major portion of these heavy metals may remain with ash. The efficient ash management system adopted for the proposed power plant shall control release of ash as well as heavy metal into environment. Mercury emission from coal burning is converted into methyl mercury, a toxic compound that harms people who consume freshwater fish. Failure of waste management and ash management system may cause release of these hazardous wastes to environment that might also contaminate food chain.

### 7.5.12 Impact on Occupational Health

Plant operation will involve working on high height, near rotary machinery and parts, high voltage yards, storage, handling and use of hazardous materials like heavy fuel, coal, chemicals, etc. These essential components of the project may cause different types of hazards for example, fire, explosion, falls, electrocution, intoxication/ toxic exposure etc. And the consequences of these hazards may be health injury, electrocution, organ disease outburst, loss of health, loss of life etc. Employees carrying contagious disease may aggravate health problems. In addition with keeping all safety & precaution measure, the authority must take some hazard and risk management plan, such as fire safety plan, explosion safety plan, electrocution safety plan, medical emergency plan, hazardous material management plan etc., to avoid these adverse impacts on occupation health. The poor health status of the employee may affect the working efficiency. The details of the occupational health and safety have been discussed in Chapter 10 of this report.

### 7.5.13 Impact on Public Health and Safety

The different structures of the power plant project may cause environmental hazard, which may eventually affect the health profile of this area. Some of the hazards may rise from ash and $SO_2$ dispersion if mitigation measures are not properly implemented. Besides, there are some occupational hazards and health risks for the project workers. The details of the health risk have been discussed in Chapter 10.

Another major health risk involves cooling tower. With world experience, different studies suggest that bacterial contamination of cooling tower may cause outbreak of pneumonia in the surrounding community. Aerosol dispersed from the cooling tower favor growth of bacteria causing pneumonia. So, the cooling system shall have to be maintained as per manufacturer's guideline.

### 7.5.14 Impact on Traffic Movement and Navigation

The operation of the project might trigger local and regional infrastructural development. Power security along with the proposed Payra port will attract industrial development. Thence, the following indirect impacts may be observed after commissioning of the plant.

#### 7.5.14.1 Traffic load on roads

Due to induced development, traffic load on Dhaka-Kuakata road will increase. Accordingly, traffic system may be developed by the relevant agencies.

#### 7.5.14.2 River traffic

River traffic will increase due to coal transportation and induced industrial development. It is anticipated that the port activities will also increase accordingly.

#### 7.5.14.3 Traffic accident

The increased traffic load in both road and river may increase risk of traffic accident.

### 7.5.15 Social Impact

#### 7.5.15.1 Employment

Acquisition of 1,000 acre land might cause loss of employment opportunity of affected people. However, proper compensation plan might help the affected people to opt for other jobs. On the other hand, operation of the proposed power plant will offer employment opportunity and local people should be given priority in employment and hiring for project activities.

#### 7.5.15.2 Communication infrastructure

The proposed power plant will trigger local and regional development. The communication infrastructure will be developed in line with the induced industrialization. Locals will also be benefited from the access road of the project.

#### 7.5.15.3 Water sanitation

As the project has been envisaged with plan of using surface water from the nearby Rabnabad Cahnnel, there will be no impact of plant operation on groundwater level. It might be anticipated that the health and sanitation system of the locality will be improved due to induced development.

#### 7.5.15.4 Poverty

Land acquisition will cause capital loss of affected people that might lead them to poverty. However, proper compensation plan has to be adopted to prevent them from poverty. On the other hand, the induced infrastructural development, rural electrification, industrial development might contribute in poverty reduction of the locality.

#### 7.5.15.5 Literacy

Operation of the proposed project shall not affect the literacy of the locality. Rather, employment opportunity may encourage local people to educate their child. The induced development may ease the education system to the locality. Hence, the literacy rate might be improving.

#### 7.5.15.6 Land ownership and land price

As the time passes, the price of land in the adjacent area of the project site would be increased. In general, due to induced development, land value of the region may increase.

#### 7.5.15.7 Safety net

It might be anticipated that GO and NGO will extend their safety net program up to the project area due to induced development and other economic activities.

### 7.5.16 Impact on Tourism

The closed Kuakata Eco Park is located more than 25 km south west from the proposed power plant. Here it is mentionable that the project area placed clearly outside the Ecological Critical Area. Thus, operation of the project (e.g. vehicle movement, equipment gathering etc) would not directly affect the tourism.

### 7.5.17 Impact due to transportation of primary fuels

#### 7.5.17.1 Impact on ambient air quality

Coal will be imported through ships; it will have sufficient moisture that will scale down propensity of dust generation. All the coal carrying vessels, floating crane (FC), floating transfer vessel (FTV) shall be equipped with dust suppression system. Hence, dust generation from the ship's holds during shipping and barging activities within the territory of Bangladesh may be minimum. Furthermore, the proposed project plans efficient dust suppression systems, coal stockyard management and air quality management system to limit generation and dispersion of dust particle.

#### 7.5.17.2 Impact on noise

Noise may be generated from operation of these vessels. Similarly, coal unloading system and handling system may also generate noise. Coal transportation agency shall limit generation within the MoEF's standard of noise adopting noise management plan.

#### 7.5.17.3 Wastes from ships

Generally, different types of wastes are produces from ships. The waste includes residue of the bulk (coal in this case), ballast water, bilge water, oil, lubricant, garbage, domestic waste, food and kitchen waste, slurry of sea water, sewage, etc. Discharge of any waste directly to the environment especially within the territory (Exclusive Economic zone) of any country is strongly prohibited by different IMO

Conventions on Protecting Marine Environment. Discharge of waste from ships may be minimum if the mentioned regulations are properly enforced and followed by the relevant authorities (PA, BIWTA and DG Shipping) and coal transportation agency. BCPCL shall mention enforcement of these conventions in the Coal Supply and Transportation Agreement so that the coal transportation agent feels obligatory to follow these conventions with the aim of preventing pollution from ships. The responsible authorities (PA, BIWTA and DG Shipping) shall monitor and spot-check the shipping and barging activities.

#### 7.5.17.4 Water pollution

Water column may be polluted due to oil spillage, coal spillage and other malpractice like waste discharge, discharge of ballast and bilge water, etc which are prohibited by IMO conventions and ECR 1997. Hence, if the responsible authorities properly enforce these regulations, water pollution due to shipping and barging activities will be minimum.

#### 7.5.17.5 Wave erosion

All the coal carrying vessels shall be plying along the Rabanabad Channel limiting the speed in between 7 knots to 8 knots. Thence, wave to be generated from the vessels are to be insignificant to have impact on shore erosion.

# CHAPTER 8

## 8. EVALUATION OF IMPACTS

Taking into consideration of inbuilt facilities of pollution abatement measures adopted in the plant design as per the pre feasibility reports, the impacts were identified and assessed in the previous chapter. In this chapter, the identified impacts have been evaluated based on nature, extend, spatial and temporal nature, likelihood, and reversibility. Evaluations were made following expert judgment in Delphi approach. Several round table discussion meeting with the team members were made to finalize the evaluation. A matrix method has been adopted for this evaluation. Evaluation has been made to indicate the magnitude of each impact. Each impact was evaluated based on a word scale defined by word scenario instead of numeric scale. The scaling was finalized by structured expert judgment followed by Delphi approach. The word scale and the scenarios are given below:

| **Scale** | | **Word Scenario or Description** |
|---|---|---|
| **Code** | **Meaning** | |
| | **Impact** | |
| D | Direct Impact | Directly related with project activities |
| Id | Indirect Impact | Resultant of any other impacts |
| S | Short Term | Impact occurs only for a particular time |
| L | Long term | No particular time, it may extends project life time |
| Lo | Localized | Impact is limited within the study area |
| W | Widespread | Impact spreads outside the study area also |
| R | Reversible | If the loss can be recoverable through implementing EMP or by naturally |
| Ir | Irreversible | If the loss cannot be recoverable |
| | **Likelihood** | |
| Fr | Frequent | Consequence occurs before, during and after the project implementation |
| Lk | Likely | Conditions may allow the consequence to occur during the project lifetime |
| O | Occasional | Exceptional consequences to occur within the project lifetime |
| Sl | Seldom | Conditions do not seem to occur any consequence except some extreme cases |
| R | Rare | Reasonable to expect that the consequence will not occur though it has rare possibility to occur |
| | **Consequence** | **Defined based on combination of the nature mentioned above** |
| In | Insignificant | No significant negative impact |
| Mr | Minor | Localized short term degradation of Environmental quality |
| M | Moderate | Localized long term/ short term, widespread and reversible loss of environmental quality |
| Sg | Significant | Widespread, long term and reversible loss of environmental quality or Local, Long term, irreversible loss of environment |
| Ct | Catastrophic | Widespread, long term and irreversible loss of environmental quality |

This evaluation will help the decision makers to take decision of issuing environmental clearance certificate and to take further policy initiatives. **Table 8-1** presents the impact evaluation.

**Table 8-1: Impact Matrix**

| Potential Impacts | Nature | Temporal nature | Spatial nature | Reversibility | Likelihood | Consequence |
|---|---|---|---|---|---|---|
| | D/Id | S/L | Lo/W | R/Ir | Fr/Lk/O/Sl/Rr | In/Mr/M/Sg/Ct |
| **Pre-construction phase (A)** | | | | | | |
| **Land acquisition** | | | | | | |
| **Ecosystem** | | | | | | |
| Alteration of feeding grounds of aquatic birds | D | L | Lo | Ir | Fr | Sg |
| **Land and Agriculture** | | | | | | |
| Crop production loss due to survey activities and construction of shed | D | S | L | R | Lk | Mr |
| Acquisition of 1,000 acre of homestead and agricultural land | D | L | Lo | Ir | Fr | Sg |
| **Socio-economic Condition** | | | | | | |
| Population displacement | D | L | Lo | R | Fr | M |
| Migration of displaced people | D | L | Lo | R | Fr | M |
| Increase in population density | D | L | Lo | R | Fr | M |
| Increase in landlessness | D | L | Lo | R | Fr | M |
| Changes in land price | D | L | Lo | R | Fr | M |
| Loss of employment | D | L | Lo | R | Fr | M |
| **Land development** | | | | | | |
| **Physical Environment** | | | | | | |
| Diminution of landscape and scenic beauty | D | L | Lo | Ir | Fr | M |
| Generation of fugitive particulate matter | D | S | Lo | R | Lk | Sg |
| **Water Resources** | | | | | | |
| Impact on surface water quality | D | S | W | R | Lk | Sg |

| Potential Impacts | Nature | Temporal nature | Spatial nature | Reversibility | Likelihood | Consequence |
|---|---|---|---|---|---|---|
| | D/Id | S/L | Lo/W | R/Ir | Fr/Lk/O/Sl/Rr | In/Mr/M/Sg/Ct |
| Waste water from workers colony | D | S | L | R | Lk | M |
| **Transportation System** | | | | | | |
| Increase in traffic load | D | L | W | R | Fr | M |
| **Agriculture** | | | | | | |
| Loss of vegetation | D | L | Lo | Ir | O | Sg |
| Decrease of grazing land for the livestock | D | L | Lo | Ir | O | Sg |
| **Fisheries Resources** | | | | | | |
| Loss of aquatic life | D | L | Lo | Ir | O | Sg |
| **Ecosystem Resources** | | | | | | |
| Health of the ecosystems | D | L | Lo | R | Lk | M |
| Loss of ecosystem habitat due to site establishment activities | D | S | Lo | R | Fr | M |
| **Construction (B)** | | | | | | |
| **Physical Environment** | | | | | | |
| Diminution of landscape and scenic beauty | D | S | Lo | R | Fr | Mr |
| Generation of fugitive dust particle | D | S | Lo | R | Fr | Mr |
| Emission of Greenhouse gases | D | L | Lo | R | Fr | Mr |
| Noise generation | D | S | Lo | Ir | Fr | Mr |
| Generation of construction material waste | D | S | Lo | R | Fr | Mr |
| **Water Resources** | | | | | | |
| Impact on ground water table | N/A | S | Lo | R | Lk | M |
| Impact on surface water quality | D | S | Lo | R | Lk | M |
| Impact on ground water quality | D | S | Lo | Ir | Sl | M |

| Potential Impacts | Nature | Temporal nature | Spatial nature | Reversibility | Likelihood | Consequence |
|---|---|---|---|---|---|---|
| | D/Id | S/L | Lo/W | R/Ir | Fr/Lk/O/Sl/Rr | In/Mr/M/Sg/Ct |
| Oil Spillage from maintenance Workshops | D | S | Lo | R | Sl | Mr |
| Effluent from workers Colony | D | S | Lo | R | O | Mr |
| **Transportation System** | | | | | | |
| Increase in Accident due to increasing vehicles movement | D | S | L | R | O | Mr |
| **Land and Agriculture** | | | | | | |
| Impact on Soil fertility due to disposal of waste and waste water | D | S | Lo | R | Sl | Mr |
| Decrease of livestock fodder due to loss of grazing land in the project area | D | L | Lo | Ir | Fr | M |
| **Fisheries Resources** | | | | | | |
| Impact on fish habitats due to land development activities, traffic movements, oil and chemical spilling | D | S | Lo | R | Lk | M |
| Loss of aquaculture area due to land acquisition for power plant | D | S | Lo | Ir | Lk | Mr |
| Impact on fish migration due to land development activities and intensive traffic movement | D | S | Lo | R | Lk | M |
| Impact on Fish diversity | Id | S | Lo | R | O | Mr |
| Shifting of fish species to avoid the obnoxious environment and disturbance in the migration channel | D | S | Lo | R | O | Mr |
| Reduction of open water fish production due to deposition of ash (within the limit of ECR 1997) | Id | S | Lo | R | O | Mr |
| **Ecosystem Resources** | | | | | | |
| Impact on habitat quality and ecosystem health due to deposition of SPM generated from construction | D | S | Lo | R | O | Mr |

| Potential Impacts | Nature | Temporal nature | Spatial nature | Reversibility | Likelihood | Consequence |
|---|---|---|---|---|---|---|
| | D/Id | S/L | Lo/W | R/Ir | Fr/Lk/O/Sl/Rr | In/Mr/M/Sg/Ct |
| activities | | | | | | |
| Impact on habitat quality due to disposal of construction waste | D | S | Lo | R | O | Mr |
| Impact on benthic habitat due to soil extraction in Rabnabad Channel/Andharmanik River | D | S | Lo | R | Fr | M |
| Disturbance to Dolphin movement in Rabnabad Channel | D | S | Lo | R | Lk | Mr |
| Disturbance to nocturnal animals due to lighting in construction site | D | S | Lo | R | O | Mr |
| **Socio-economic Environment** | | | | | | |
| Possibility of employment opportunities | D | S | Lo | - | Fr | M (positive) |
| Development of communication | D | L | Lo | - | Fr | Sg (positive) |
| Pressure and disturbance to the existing water-sanitation facilities | D | S | Lo | R | Lk | Mr |
| Poverty reduction | Id | L | Lo | R | Fr | M (positive) |
| Occupational health hazard | D | S | Lo | R | Lk | Mr |
| **Post-construction/Operation (C)** | | | | | | |
| **Physical Environment** | | | | | | |
| Rise of local air temperature due to heat emission through stack | D | L | Lo | R | Sl | Mr |
| Impact due to generation of fugitive particulate matter (within the limit of ECR 1997) | D | L | Lo | R | Sl | Mr |
| Impact due to Emission of $SO_2$, NOx (within the limit of ECR 1997) | D | L | Lo | R | SI | Mr |
| Emission of CO, $CO_2$ | D | L | W | Ir | Fr | Sg |
| Noise generation | D | S | Lo | Ir | SI | M |

| **Potential Impacts** | **Nature** | **Temporal nature** | **Spatial nature** | **Reversibility** | **Likelihood** | **Consequence** |
|---|---|---|---|---|---|---|
| | D/Id | S/L | Lo/W | R/Ir | Fr/Lk/O/Sl/Rr | In/Mr/M/Sg/Ct |
| Waste generation and discharge to natural environment | D | S | Lo | R | SI | Mr |
| **Water Resources** | | | | | | |
| Impact on Ground Water table | No Impact | | | | | |
| Impact on Surface and Ground Water Quality | D | S | Lo | R | O | M |
| Impact on surface water due to water withdrawal | D | L | Lo | R | Lk | In |
| Wash off from coals | D | L | Lo | R | Sl | M |
| Oil Spillage from maintenance Workshops | D | S | Lo | R | O | Mr |
| Effluent from workers Colony | D | S | Lo | R | O | Mr |
| Discharge of treated effluent from central effluent treatment plant | D | S | Lo | R | Lk | Mr |
| Disruption of Tidal inundation | D | S | Lo | R | O | Mr |
| Drainage congestion and water logging | Id | L | Lo | R | Lk | M |
| Erosion and Accretion | D | S | Lo | R | Lk | M |
| **Transportation System** | | | | | | |
| Increase in Accident due to increasing vehicles movement | D | S | Lo | R | O | Mr |
| Increase in Traffic load on roads | D | S | Lo | R | O | Mr |
| Increase in River traffic | D | L | Lo | R | Lk | M |
| **Land and Agricultural Resources** | | | | | | |
| Change of local and regional land use | D | L | Lo | Ir | Fr | Ct |
| Increase of crop production due to areal deposition of ash on crop field | D | L | Lo | N/A | Lk | M (positive) |
| Runoff and areal deposition from uncovered coal piles may contaminant the soil with heavy metals like arsenic, | D | S | Lo | Ir | Rr | M |

| Potential Impacts | Nature | Temporal nature | Spatial nature | Reversibility | Likelihood | Consequence |
|---|---|---|---|---|---|---|
| | D/Id | S/L | Lo/W | R/Ir | Fr/Lk/O/Sl/Rr | In/Mr/M/Sg/Ct |
| mercury, chromium, and cadmium present in the coal. | | | | | | |
| Crop damage may increase by pest infestation due to lighting of the plant area | Id | S | Lo | R | O | Mr |
| Crop damage due to acid rain | Id | S | Lo | Ir | Rr | Mr |
| **Fisheries** | | | | | | |
| Impact on fish habitat due to water abstraction from river and traffic movements | D | L | Lo | R | Sl | Mr |
| Impact on fish migration due to coal transportation, and other water way traffic movement | D | L | Lo | R | Lk | M |
| Impact on fish diversity | Id | L | Lo | R | Sl | Mr |
| Shifting of fish species to avoid the obnoxious environment and disturbance in the migration channel | Id | L | Lo | R | Rr | In |
| Reduction of overall fish production | Id | L | Lo | R | Sl | M |
| **Ecosystem Resources** | | | | | | |
| Impact on ecosystem habitat quality and ecosystem health due to deposition fly ash (within the limit of ECR 1997) | D | S | Lo | R | Sl | Mr |
| Disturbance to animal due to noise generation from water vessel during coal transportation | D | L | Lo | R | Sl | Mr |
| Disturbance to Dolphin movement in Rabnabad Channel | D | L | Lo | Ir | O | M |
| Disturbance to nocturnal animals due to lighting in project area | D | L | Lo | R | Sl | Mr |
| **Socio-economic Environment** | | | | | | |
| Employment opportunities | D | S/L | Lo | - | Lk | M(positive) |
| High land price | Id | L | Lo | R | Lk | M |

| Potential Impacts | Nature | Temporal nature | Spatial nature | Reversibility | Likelihood | Consequence |
|---|---|---|---|---|---|---|
| | D/Id | S/L | Lo/W | R/Ir | Fr/Lk/O/Sl/Rr | In/Mr/M/Sg/Ct |
| Rural Electrification | Id | L | W | - | Lk | S(positive) |
| Regional development | Id | L | W | - | Lk | S(positive) |
| Outbreak of Pneumonia | Id | S | W | Ir | Rr | Mr |
| Poverty reduction | Id | L | Lo | - | Lk | M(positive) |
| Improvement of sanitation condition | Id | L | Lo | - | Lk | M(positive) |
| **Coal Transportation, Transshipment and Handling** | | | | | | |
| Increase of PM in local air quality | D | L | Lo | R | Lk | M |
| Noise generation | D | L | Lo | Ir | Fr | M |
| Increased wave erosion. | D | L | Lo | Ir | Sl | Mr |
| Deterioration of river water quality | D | L | Lo | R | Lk | M |
| Increase river traffic | D | L | Lo | R | Fr | M |
| Impact on Fish resources | D | L | Lo | R | Lk | M |

Source: *https://civilprojects.wordpress.com/category/eia-by-delphi-technique/....*

# CHAPTER 9

## 9. MITIGATION OF IMPACTS

The impacts identified through this study were later evaluated considering their nature, spatial and temporal extent, reversibility, and consequences. These analyses identify the scope of adopting mitigation measures or reconciliation the project design with the objective of preventing environmental pollution in compliance with ECA 1995. Thereafter, all of the identified impacts were further evaluated with and without mitigation measure adoption. **Table 9-1** describes mitigation measure required for limiting the negative impacts of the project activities and contingency measures required for reducing risk of accidental hazard and enhancement measures for enhancing positive impacts with the aim of sustainable implementation and operation of the project ensuring environmental and community safety. The consequence analysis with and without consideration of mitigation measures adoption will give an idea of effectiveness of the measure. It will help the decision makers to have clear idea to reconcile project plan and design preventing negative impacts and conserving project benefits.

**Table 9-1: Mitigation Measures of Impact**

| Impact | Consequence with no mitigation measures adopted | Mitigation/Enhancement/Contingency measure | Responsible Institution (s) | Consequence with mitigation measures adopted |
|---|---|---|---|---|
| **Pre-construction phase (Land acquisition and site development)** | | | | |
| **Mitigation measures for preventing impacts on Land and Agriculture** | | | | |
| Loss of agricultural and homestead land due to land acquisition. This loss of land and production include :<br>i. Loss of opportunities for agricultural laborers;<br>ii. Decrease in economic participation and loss of opportunities for women especially in post-harvesting stage | Sg | • Efforts have to be made to use khas land as well as fallow land to the extent possible to minimize future further requirement of lands<br>• Project Affected Persons (PAPs) losing homesteads and land should be compensated as per the Law of the Land<br>• PAPs loosing occupation may be involved in project's job opportunity if possible.<br>• Compensation should be given for acquisition of agricultural land as per law of the Land | BCPCL and DC office, Patuakhali | M |
| **Measures for compensating socioeconomic impacts** | | | | |
| Population displacement | M | The authority should be careful and take necessary measures that every displaced people can be resettled as per law of the land. | BCPCL and DC office, Patuakhali | Mr |
| Migration of displaced people | M | The displaced people may be resettled in suitable areas as per the law of the land. | BCPCL and DC office, Patuakhali | Mr |
| **Measures for controlling air and water quality** | | | | |
| Dust particle releases during land development | Sg | • Fencing of project area by drum sheet<br>• Adoption of Dust Suppression Mechanism (water spraying system) to control generation of SPM | BCPCL | M |
| Deterioration of water quality due to wash out of sediments and waste water from the worker colonies | Sg | • Proper run off management should be adopted to limit sediment runoff fromthe land developing area.<br>• No waste should be disposed to canals/river | BCPCL | M |

| Impact | Consequence with no mitigation measures adopted | Mitigation/Enhancement/Contingency measure | Responsible Institution (s) | Consequence with mitigation measures adopted |
|---|---|---|---|---|
| | | | | |
| **Construction Phase** | | | | |
| **Measures controlling waste generation and mitigating impacts** | | | | |
| Change of landscape and scenic beauty | M | • Limiting site clearance and base stripping activities within the project boundary<br>• Dispersed gathering and stocking of construction materials and machinery should be within a limited area in the project boundary<br>• The project area should be fenced prior to initiation of construction activities<br>• Stock piles of construction materials should be covered in order to protect them from wind and weathering action<br>• The existing right of way should be used in material transportation and existing right of ways should not be blocked<br>• Provision of sanitary toilet, one toilet for 10 persons<br>• Location of spoil stock pileshould be located in safe area and protected from wind and rain action.<br>• No spoil should be stored on River bank/slope<br>• Construction wastes must be reused or recycled as and where possible<br>• Burning of waste material should be restricted<br>• Quality housekeeping should be maintained by regular inspection and checking<br>• Keep provision of onsite waste collection and disposal<br>• Keep provision of different colored waste bin for dumping biodegradable, reusable and recyclable wastes. | BCPCL/EPC Contractor | In |
| Generation of construction material waste | M | | | Mr |

| Impact | Consequence with no mitigation measures adopted | Mitigation/Enhancement/Contingency measure | Responsible Institution (s) | Consequence with mitigation measures adopted |
|---|---|---|---|---|
| | | • Keep provision of awareness building meeting and training for employees | | |
| **Mitigation measures for controlling Air pollution** | | | | |
| Generation of fugitive dust particle | Mr | • Limiting activities may produce fugitive dust particle within project area<br>• Vegetation clearance and base stripping should be minimized<br>• Vehicle speed restriction should be enforced to control dust generation<br>• Earthen roads and undeveloped roads should be avoided to minimize dust generation<br>• Construction materials should be covered to protect from wind action<br>• Keep provision of water spraying system to suppress fugitive dust<br>• Dust particle generated from access roads must be controlled by spraying water during dry season<br>• Stock piles of construction materials should be covered in order to protect from wind action<br>• An appropriate free board should be maintained in trucks hauling construction materials | BCPCL/ EPC Contractor | In |
| Emission of Greenhouse gases | M | • Burning of any kind of solid waste should be banned<br>• Regular maintenance of water vessels, vehicles, generator and machinery in accordance with manufacturer's specifications.<br>• Approved pollution control devices to be fitted in equipment and machinery.<br>• Transport vehicles should not be overloaded.<br>• Avoid queuing of vehicles in areas adjacent to site, | BCPCL/EPC Contractor | In |

| Impact | Consequence with no mitigation measures adopted | Mitigation/Enhancement/Contingency measure | Responsible Institution (s) | Consequence with mitigation measures adopted |
|---|---|---|---|---|
| | | particularly near sensitive receptors including housing.<br>• Switch off / throttle down all site vehicles, water vessels, generator and machinery when not in use | | |
| **Mitigation measures for controlling Noise generation** | | | | |
| Noise generation | M | • Switch off / throttle down all site machinery, vehicles, water vessels, and generator when not in use<br>• No construction activities at night<br>• Use noise damper on project boundary<br>• Introduce vehicle speed limit and its monitoring | BCPCL/EPC Contractor | Mr |
| **Mitigation measures for controlling impacts on Water Resources** | | | | |
| **Ground water table**<br>• Dry season water table may lower down due to excess withdrawal during construction period table | Mr | • Keep provisions of rain water harvesting system to limit ground water use | BCPCL/EPC Contractor | In |
| **Surface Water Quality**<br>• Deterioration of surface water quality by kitchen wastes from worker shade or colony and construction wastes.<br>• Oil Spillage from maintenance Workshops<br>• Effluent from workers Colony | M | • Surface water must be saved from any harmful effluent emission and waste dumping from project site using Garbage Disposal Management plan. Municipality of Kalapara should take care of this issue.<br>• Provide closed system facilities and wastewater treatment plant to minimize emission of effluents from workers colony.<br>• Good housekeeping at workshop and construction site<br>• Appropriate equipments with safety measures should be used for storage and handling of oil | | Mr |

| Impact | Consequence with no mitigation measures adopted | Mitigation/Enhancement/Contingency measure | Responsible Institution (s) | Consequence with mitigation measures adopted |
|---|---|---|---|---|
| | | • Provide training and awareness building program to the workers during construction. The training and awareness programs are: a) arrange weekly consultation session among the workers through plant site managers. The duration of consultation is one hour according to ISO14031 standard, b) arrange monthly environmental meeting among the mid level officers through top management when those issues will be discussed under guidance of ECR 1997 | | |
| **Ground water quality**<br>• Deterioration of ground water quality by leakage of oil and chemical from tank or storage.<br>• Oil Spillage from maintenance Workshops<br>• Effluent from workers Colony | M | • Harmful effluents and wastes leakage from oil and chemical tank or storage are to be controlled.<br>• High tech treatment plant will be installed in the plant site. So effluent discharged to the Rabnabad Channel/Andharmanik River would be minor as the proposed treatment plant will be operated satisfying all relevant standards of MoEF.<br>• Provide training and awareness building program to the labors and professionals. | | Mr |
| **Mitigation measures for controlling impacts on Land and Agriculture** | | | | |
| Impact on soil fertility due to disposal of waste and waste water | Mr | • Construction materials should be collected, stored, and disposed in an appropriate manner<br>• Recycled waste should be disposed in a suitable landfill<br>• Fencing of project area by drum sheet<br>• Limiting the construction activities and stocking within the project boundary | BCPCL/EPC Contractor | In |
| Damage to surrounding crops | Mr | | | In |
| Deterioration of soil and ground water quality by leakage of oil, fuels | M | • Harmful effluents and waste leakage from oil and chemical tank or storage should be controlled strictly | | Mr |

| **Impact** | **Consequence with no mitigation measures adopted** | **Mitigation/Enhancement/Contingency measure** | **Responsible Institution (s)** | **Consequence with mitigation measures adopted** |
|---|---|---|---|---|
| and hazardous chemicals from tank or storage | | • Wastes or used oil should be stored in a designated area for disposal through authorized vendors<br>• Measures should be undertaken for fire suppression and the neutralization and collection of any spilled materials<br>• Treatment plant should be installed<br>• Provide training and awareness building program to the labors and professionals. | | |
| **Mitigation measures for controlling impacts on Fisheries** | | | | |
| Impact on fish habitats due to land development activities, traffic movements, oil and chemical spilling | M | • Avoid fish breeding season during construction works (if possible)<br>• Most excavation, backfilling, and site grading will be undertaken during the dry season. Sediment should be trapped on-site using sediment fences and traps and basins, and by preventing the off-site movement of coarse material.<br>• Alternate sourcing of sand other than river bed dredging.<br>• Enforcing the speed restriction and regular maintenance to control noise, dust generation.<br>• Oil spillage from vehicle/water vessel should be controlled | BCPCL/EPC Contractor | Mr |
| Impact on Fish migration due to land development activities and intensive traffic movement | M | • Avoid construction works (if possible) during fish breeding season. Generally, April to July for common fish and Sept-October and March to May for Hilsa spawning migration, should be avoided for construction work | BCPCL/EPC Contractor | In |
| Impact on Fish diversity due to change in fish habitats, spawning, | Mr | • Enforce banning of fishing activity within the sanctuary zone | BCPCL/EPC Contractor/ | In |

| Impact | Consequence with no mitigation measures adopted | Mitigation/Enhancement/Contingency measure | Responsible Institution (s) | Consequence with mitigation measures adopted |
|---|---|---|---|---|
| etc | | | DoF | |
| Shifting of fish species to avoid the obnoxious environment and disturbance in the migration channel | Mr | • EMP for effluent discharge,waste water discharge, construction material disposal and traffic movement should be followed | BCPCL/EPC Contractor, DoF, DoE | In |
| Reduction of open water fish production due to disposal of waste within ECR 1997 limit | Mr | | | In |
| **Mitigation measures for conserving Ecosystem** | | | | |
| Impact on habitat quality and ecosystem health due to deposition of SPM generated from construction activities | Mr | • Implement On-site Waste and Air quality Management Plan | BCPCL/EPC Contractor | In |
| Impact on habitat quality due to disposal of construction waste | Mr | | | In |
| Impact on benthic habitat due to soil extraction from the Rabnabad Channel/and Anharmanik River | M | • Limiting dredging activities within defined area if possible | BCPCL/EPC Contractor | Mr |
| Loss of ecosystem habitat due to site establishment activities | Mr | • Limiting vegetation clearance and base stripping within project boundary<br>• Protect existing Mangrove strip along the Rabnabad Channel<br>• Mangrove plantation program along Andharmanik River river | BCPCL/EPC Contractor, DoE | In |
| Disturbance to Dolphin movement in Rabnabad Channel | M | • Avoid soil extraction activities during surfacing and swimming time of Dolphini.e. at dawn and evening<br>• Dolphin conservation program may be implemented | BCPCL/EPC Contractor, DoE | Mr |
| Disturbance to nocturnal animal due | Mr | • Restrict night lights atplaces where necessary | BCPCL/EPC | In |

| Impact | Consequence with no mitigation measures adopted | Mitigation/Enhancement/Contingency measure | Responsible Institution (s) | Consequence with mitigation measures adopted |
|---|---|---|---|---|
| to lighting in construction site | | • Keep provision of outdoorlights with shade directed downwards<br>• Cut-off time to switch off unnecessary lights at night | Contractor | |
| **Measures for enhancing Socioeconomic condition** | | | | |
| Possibility of employment opportunities | M (positive) | • The labor recruitment policy should be formulated in such a way that the local laborers can easily get chance of employment in the power plant project<br>• Gov/NGOs should provide support skill development program and income generation activities to local people | BCPCL, Contractor, NGOs | ++Sg (positive) |
| Impact on communication: the communication may be developed | +Sg (positive) | • For the increased movement of people and heavy vehicles the road networks should be developed | BCPCL in association with LGED and RHD | ++Sg (positive) |
| **Measures for controlling negative impacts on socioeconomic** | | | | |
| Imposing the pressure and disturbance to the existing water sanitation facilities | Mr | • Manage separate water and sanitation facilities for the construction workers in the project area so that they cannot make any disturbance to the existing facilities of the local people<br>• Provision of appropriate water supply and sanitation facilities at construction site as well as labor sheds<br>• Provision of rain waterharvesting system at construction site as well as labor sheds | BCPCL/ EPC Contractor/ DPHE | In |
| Shifting or losing of occupation due to land occupation | M | • To mitigate the sudden loss of habitat and occupation, the displaced people should be compensated and rehabilitated for their income restoration and poverty reduction<br>• PAPs should be preferred in project related | BCPCL/EPC Contractor, DC Patuakhali | Mr |

| Impact | Consequence with no mitigation measures adopted | Mitigation/Enhancement/Contingency measure | Responsible Institution (s) | Consequence with mitigation measures adopted |
|---|---|---|---|---|
| | | employment | | |
| Occupational health hazard | Mr | • Arrangements of gloves, helmets, sunglasses and other tools, dresses & uniforms for each worker so that the workers can keep themselves safe from any kinds of accident | BCPCL/EPC Contractor/ Civil Surgeon office, Patuakhali | In |
| **Operation Phase** | | | | |
| **Air Pollution Control** | | | | |
| Rise of local air temperature due to heat emission through stack | Mr | • The plant equipment must be performance tested during commissioning phase to ensure that standard has been maintained<br>• Regular inspection and maintenance of boiler, pressure parts, FD and ID fans and ash separation<br>• and handling system, and other ancillaries<br>• Safety and emergency plan for accidental hazard<br>• Remote monitoring and control of total production process<br>• Regular maintenance and overwhelming as per design specification | BCPCL | In |
| Rise of local air temperature during accidental fire or explosion event | M | | | Mr |
| Generation of fugitive particulate matter | Mr | | | In |
| Emission of $SO_2$, NOx within ECR 1997 limit | Mr | | | In |
| Emission of CO, $CO_2$ | Sg | | | M |
| **Noise control** | | | | |
| Noise generation | M | • Plant must be designed so as to ensure Bangladesh's standard of emission<br>• 275m stack height and high velocity of plume (minimum 20m/s) should be maintained<br>• Discharge of emissions through stack must be directed vertically upward without any impedance or hindrance | BCPCL | In |

| Impact | Consequence with no mitigation measures adopted | Mitigation/Enhancement/Contingency measure | Responsible Institution (s) | Consequence with mitigation measures adopted |
|---|---|---|---|---|
| | | • Provision of buffer zone and green belt | | |
| | | • Maintain coal quality of low Sulfur content as stipulated in project description<br>• Maintain DoE standard of Noise level<br>• Provision of buffer zone<br>• Provision of green belt through tree plantation<br>• Construct high and thick boundary wall that could act as noise damper<br>• Noise insulation should be implemented surrounding the turbine and generator casing<br>• Noise dumper/insulator must be installed around the casing of conveyor belt<br>• Introduce and enforce vehicle speed limit<br>• Switch off / throttle down all vehicle and engine of vessel when not in use | | |
| **Controlling waste generation and its impacts** | | | | |
| Waste generation and discharge to natural environment | Mr | • On site waste collection and disposal system should be provided by municipality of Kalapara Upazila administration.<br>• Dust control mechanism must be utilized for Ash handling and coal handling system<br>• Provision of different waste bin with color code for different waste (recyclable, reusable, biodegradable, hazardous, etc) in road side, parking places, office, eco-parks, and other official and public places in the plant site.<br>• Provision of waste management department with given responsibility of waste collection, hauling, disposal and | BCPCL | In |

| Impact | Consequence with no mitigation measures adopted | Mitigation/Enhancement/Contingency measure | Responsible Institution (s) | Consequence with mitigation measures adopted |
|---|---|---|---|---|
| | | overall management and the department should be vested under Environmental quality and Safety Management wings<br>• Provision of regular awareness building meeting of programs | | |
| **Controlling impacts on water resources** | | | | |
| Impact on Rabnabad Channel flow due water withdrawal | Mr | • Provision of Rain Water harvesting System<br>• Water reuse and recycling<br>• Water conservation program | BCPCL | In |
| **Surface Water Quality**<br>• Surface water may be contaminated by coal residues due to wash off from storage.<br>• Change of river water quality due to effluent discharge within ECR 1997 standard.<br>• Ash from coal can contaminate water bodies.<br>• Deteriorate surface water quality by domestic waste effluent from residential area of power plant<br>• Oil spillage from maintenance workshops | M | • Direct emission of harmful effluents and waste from power plant should be restricted.<br>• Provide closed system facilities to minimize emission of effluents from power plant area<br>• Effluent treatment plant should be constructed in the project site<br>• Green building concept should be initiated in preparation of residential plan to minimize the emissions of effluent<br>• Proper ash management and reuse plan should be initiated for sustainable resource management | BCPCL | In |
| **Ground water quality**<br>• Deterioration of ground water quality by leakage of oil and chemical from tank or storage. | M | • Ground water must be free from any harmful effluents and wastes leakage from oil and chemical tank or storage through seepage<br>• Provide training and awareness building program to the | BCPCL | In |

| Impact | Consequence with no mitigation measures adopted | Mitigation/Enhancement/Contingency measure | Responsible Institution (s) | Consequence with mitigation measures adopted |
|---|---|---|---|---|
| | | labors and professionals | | |
| **Erosion and Accretion**<br>• River bank erosion may occur for wave action due to frequent movement of feeder vessels in Rabnabad Cahnnel | M | • Bank protection measures (River training work, mangrove plantation, controlling vessel speed, etc) should be taken under consideration | BWDB/ BCPCL | Mr |
| **Controlling impacts on Land and Agriculture** | | | | |
| Rate of solid waste specially coal burned ash and other domestic and industrial waste production may increase.<br>Soil fertility might be reduced due to deposition of ash or disposal of solid waste | M | • Advanced technique should be initiated for ash management and reuse<br>• Temporary waste dumping facilities on site and permanent waste dumping facilities off site<br>• Fly ash (dry form) generated from the plant should be commercially utilized to maximum extent possible<br>• Unutilized fly ash should be transferred from the silo in wet form and stored in the ash pond until suitable users are identified.<br>• Bottom ash should be collected in wet form and should be stored in the ash dyke until suitable users are identified | BCPCL/ DAE | In |
| Crop damage may increase by pest infestation due to lighting of the plant area | Mr | • Pest infestation can be minimized by Integrated Pest Management (IPM) through “Light Trap” | DAE | In |
| Rise of Crop Production due to deposition of ash or utilization of ash | M (positive) | • Proper training to the farmer on using fly ash in agricultural field<br>• Awareness building | DAE | Sg (positive) |
| Crop Damage due to dry and wet deposition of Sox and NOx (to be | Mr | • Flue gas desulfurization scrubbing systems, which use lime to remove the sulfur dioxide, and steam injection | BCPCL/ DAE | In |

| **Impact** | **Consequence with no mitigation measures adopted** | **Mitigation/Enhancement/Contingency measure** | **Responsible Institution (s)** | **Consequence with mitigation measures adopted** |
|---|---|---|---|---|
| emitted within the limit of ECR 1997) | | method to reduce the NOx emission, can reduce or eliminate the likelihood of acid rain.<br>• Adoption of Air quality Management Plan | | |
| **Controlling impacts on Fisheries** | | | | |
| Disturbance to Fish habitat due to water abstraction from river and traffic movements | Mr | • The water supply pipeline intake point from the feeder canal should be provided with sufficient screening to filter out larger aquatic organisms (e.g., fish, frogs, and toads) and foreign matter, preventing this material from being drawn into the pumps<br>• Drum screens need to be adopted in order to limit the entrainment of fish in the cooling water system and intake velocities should be as low as possible.<br>• The water velocity in the intake channel should be less than 0.5 m/s in normal conditions.<br>• Temporary water reservoir can be built for water storage rather than direct abstraction from river.<br>• Monitoring should continue to ensure the deterrents are working effectively. | BCPCL | In |
| Disturbance to fish habitat due to oil and chemical spilling, accidental discharge and effluents from different units of the plant. | M | • On-site wastewater should be treated to achieve maximum reuse and recycling.<br>• Left over waste water should be used to irrigate onsite vegetation throughout the year except in monsoon. | BCPCL | In |
| Disturbance on Fish migration due to coal transportation, coal handling, Ash disposal and other water way traffic | M | • Enforcement of ECR 1997, IMO Conventions, MARPOL, etc<br>• Spot check of shipping and barging activities by relevant | BCPCL/ Coal Transportation | |

| Impact | Consequence with no mitigation measures adopted | Mitigation/Enhancement/Contingency measure | Responsible Institution (s) | Consequence with mitigation measures adopted |
|---|---|---|---|---|
| movement | | agencies.<br>• Ash should be handled in dry form, using a closed circuit pneumatic mechanism, and directly loaded into enclosed trucks through ash silos.<br>• Fly ash should be collected in dry form. Fly ash generated from the plant should be commercially utilized to the maximum extent possible in industries such as cement and ash brick manufacture, road construction, pavement laying, and fly ash aggregates production. | agency/PA, BIWTA/DG Shipping/DoF | Mr |
| Impact on Fish diversity due to minor changes on fish habitats, spawning ground, etc | Mr | • Rehabilitation of fish and shrimp habitats by conserving and protecting existing fish nursing ground by extending the existing mangrove forest area other than power plant area.<br>• Enforcement of fishing ban in the mangrove forest areas during breeding/nursing period | BCPCL, DoF, DoE | In |
| Shifting of fish species to avoid the obnoxious environment and disturbance in the migration channel | In | • EMP measures for effluent discharge, and traffic movement should be followed | BCPCL, DoF, DoE | In |
| Reduction of overall fish production | M | • All the above mentioned EMP measure for fisheries | BCPCL, DoF, DoE and Other mentioned above | In |
| **Measures for controlling impacts on Ecosystem** | | | | |
| Impact on ecosystem habitat quality and ecosystem health due to deposition fly ash during accidental release | Mr | • Implement Air quality Management Plan | BCPCL | In |

| Impact | Consequence with no mitigation measures adopted | Mitigation/Enhancement/Contingency measure | Responsible Institution (s) | Consequence with mitigation measures adopted |
|---|---|---|---|---|
| Disturbance to wildlife due to noise generation from water vessel during coal transportation | M | • Introduce speed limitation for vessel | BCPCL/Coal Transportation agency/PA, BIWTA/DG Shipping/ | Mr |
| Disturbance to Dolphin colony in Rabnabad Channel | M | • No trapping and killing of Dolphin<br>• Plan measures for accidental oil spillage, refueling<br>• Anchorage of water vessel only in designated sites<br>• Adoption of Dolphin Conservation Program | | Mr |
| Disturbance to nocturnal animal due to lighting in project area | M | • Restrict night lights at places where necessary<br>• Outdoor lights with shade directed downwards<br>• Cut-off time to switch off unnecessary lights at night | | In |
| **Measures for enhancing better socio-economic condition** | | | | |
| Employment opportunities | M (positive) | • The local labors should be recruited permanently and temporarily in both technical and non-technical posts. Some posts should be reserved for the local workers. This recruitment may help to reduce the poverty status of the whole study area.<br>• At least 10% of the jobs (non-hazardous) in the power plant should be reserved for women. | BCPCL | Sg |
| Induced infrastructural development, rural and regional development | Sg (positive) | • Concerned government department like Patuakhali District Parishad, Kalapara Upazila Parishad, LGED, RHD, MPA etc should guide the induced development. The existing development plans, Master plans might be improved in harmony with the project. | Mentioned Govt. Department | Ct (positive) |
| Rural Electrification | M (positive) | • Development of electric transmission and distribution line, priority of local and displaced people in providing electricity, priority in providing electricity for irrigation | BCPCL, REB, GoB | Sg (Positive) |

| **Impact** | **Consequence with no mitigation measures adopted** | **Mitigation/Enhancement/Contingency measure** | **Responsible Institution (s)** | **Consequence with mitigation measures adopted** |
|---|---|---|---|---|
| | | water pump for local people | | |
| Poverty reduction | M (positive) | • Integrated planning<br>• Priority of local people in employment opportunity<br>• Extension of social safety nets for affected people and people under exposure of plant possessed risk<br>• Monitoring NGO's activities | DC office, Patuakhali, UNO office Kalapara, GOB | Sg (Positive) |
| **Measures for controlling impacts on socio-economy** | | | | |
| Outbreak of Pneumonia from contaminated Cooling tower | Mr | • Limiting cooling tower drift using eliminator as per world standard<br>• Use biocides to prevent bacterial contamination<br>• Maintenance of cooling tower as per Manufacturer guideline<br>• Strong monitoring of bacterial contamination in cooling tower<br>• Community Health monitoring within 10 km radius of cooling tower<br>• Establish communication with nearby hospital to keep record of pneumonia affected patient to monitor outbreak of Pneumonia | BCPCL | In |
| High land price | M | • Both the land acquisition and economic development of the area for the project implementation may cause the higher price of land. If the displaced people are not provided with compensation properly the poor displaced | DC of Patuakhali | Mr |

| **Impact** | **Consequence with no mitigation measures adopted** | **Mitigation/Enhancement/Contingency measure** | **Responsible Institution (s)** | **Consequence with mitigation measures adopted** |
|---|---|---|---|---|
| | | people will not be able to purchase land in compliance with the market price of land. Their land compensation should be equivalent to the market price. They also deserve additional resettlement support for their income restoration. | | |
| **Coal Transportation, Transshipment and Handling** | | | | |
| Increase of SPM in local air quality | M | • Adoption of Dust suppression system<br>• The vessel to be engaged should comply with international and national standards<br>• Adopt enclose system for coal unloading and transportation (through conveyor belt)<br>• Maintain ECR 1997, IMO Conventions, MARPOL, etc | BCPGCL/ Coal Transportation agent/ PA/DG Shipping/ BIWTA | Mr |
| Noise generation | M | • Switch off / throttle down all equipment and Machinery when not in use<br>• Introduce speed limit for vessel<br>• Anchorage should be allowed at selected location<br>• Limit dropping of coal and escapee during unloading to feeder vessel/lighter vessel | | Mr |
| Deterioration of river water quality | M | • Ensure no dumping of ballast water, no oil spillage, no discharge of waste water, no waste dumping<br>• Practice of dust suppression should be to moisten the coal, not to wet the coal | | Mr |
| Wave erosion | Mr | • Introduce speed limit of coal transportation vessel<br>• Keep vessel speed in between 7 knots to 8 knots<br>• Plant mangrove forest along the bank of rivers vulnerable to wave erosion<br>• Regular monitoring of erosion | BCPCL/ Coal Transportation agent/ PA/DG Shipping/ BIWTA | In |

| Impact | Consequence with no mitigation measures adopted | Mitigation/Enhancement/Contingency measure | Responsible Institution (s) | Consequence with mitigation measures adopted |
|---|---|---|---|---|
| | | | /BWDB | |
| Increase river traffic accident | M | • Proper training for vessel crews, traffic inspectors, in charges, and other concerned professionals<br>• All vessel should be provided with GPS, radar and other electronic navigation systems to prevent grounding or collisions, such as depth sounder, radar and radio equipment for communication<br>• All vessel should comply with rules and regulation of IMO, Port authority, BIWTA and national laws of safety, and environmental conservations<br>• Ensure that port/coal terminal inspector, environment and safety manager are available. | BCPCL/ Coal Transportation agent/PA/ DG Shipping/ BIWTA /Coast Guard | M |
| Impact on Fish resources | M | • Awareness building for fisher and facilitate the fisher to use nets/boats provided with signals and marking<br>• Reduce speed if net is seen<br>• Ensure no dumping of ballast water, no oil spillage, no discharge of waste water, no waste dumping | JV Company/ Coal Transportation agent/PA/ DG Shipping/ BIWTA | Mr |

# CHAPTER 10

# 10. ENVIRONMENTAL MANAGEMENT PLAN

## 10.1 Introduction

Environmental Management Plan (EMP) outlines the way as how to implement the mitigation measures identified and discussed in the previous chapter. The main objective of the EMP is to guide the implementing agency- Bangladesh-China Power Company (Pvt.) Limited (BCPCL) to achieve sustainability of the project ensuring environmental conservation as per national and international standard.

The EMP includes mitigation, enhancement, compensation and contingency measures for each of the three phases of the project – pre-construction, construction and post-construction/operation. The management plan covers air quality management plan, noise management plan, waste management plan, site establishment plan, water resources management plan, ash management plan, fisheries management plan, ecosystem management plan, agricultural management plan and socio-economic management plan. Scope of those management plans will adopt pollutants abatement measures in different phase of the power plant. Important instrument like ESP, ETP, Water treatment plant and process like green belt development, flood protection measures will be guided by relevant management plan. Each plan describes implementation procedure, task to be completed, and responsible person or body. Some of the pollution abetment measures take account of inbuilt construction and some of them are external. Inbuilt measures include ESP, ETP, WTP, DSS, Ash disposal, Occupational health and safety and regular training and motivations to the employees. External measures include green belt development, air quality monitoring stations, water quality monitoring stations, acoustic monitoring and regular training and monitoring to the respective management plan.

The implementation and monitoring of EMP shall have to be ensured. Therefore, a team of Environmental Specialist and Environmental Auditor has to be engaged with responsibility of strong monitoring during implementation of EMP and their environmental and social consequences.

## 10.2 EMP during Pre-construction Phase

### 10.2.1 Land Development

It is proposed that site development for power plant and townships will be developed sequentially one after another. Land filling will be required in whole project area except at ash pond and jetty. Elevation of land filing will be around 6.65 m PWD. Land filling materials will be collected by dredging of Rabnabad/ Kajal River. During the land development soil and surface water quality may be impacted. The following management plan shoul be condired during the land development stage.

- All topsoil will be retained and reused where possible;
- Scheduling activities (as far as possible) to avoid extreme weather events, such as heavy rainfall and high winds;
- Minimizing the amountof soil handled;
- Stabilising exposed areas;
- Covering or spraying water on stockpiles of excavated material.

- Provision of channels, earth bunds or sand bag barriers on site to direct storm water to silt removal facilities;
- Collection of surface runoff or extracted ground water contaminated by silt and suspended solids by the on-site drainage system and removal of silt in silt removal facilities prior to discharge into storm drains;
- Protection of stockpiles by plastic sheeting to ensure that they are suitably secured against the wind at the end of each working day if rain is forecasted;
- Provision of surface protection and drainage works. Earthworks to form the final surfaces will be followed up with surface protection and drainage works to prevent erosion caused by rainstorms;
- Appropriate surface drainage will be designed and provided where necessary;
- Temporary trafficked areas and the access road will be protected by coarse stone ballast or equivalent. These measures will be designed to prevent soil erosion caused by rainstorms. Temporary or permanent roadside drains shall be provided for the access road;
- Drainage systems, erosion control and silt removal facilities will be regularly inspected and maintained to ensure proper and efficient operation at all times and particularly following rainstorms. Deposited silt and grit will be removed regularly;
- Any temporarily diverted drainage will be reinstated to its original condition when theconstruction work has finished or when the temporary diversion is no longer required;
- Measures will be taken to reduce the ingress of site drainage into excavations. If trenches have to be excavated during the wet season, they will be excavated and backfilled in short sections wherever practicable. Water pumped out from trenches or foundation excavations will be discharged into storm drains via silt removal facilities;
- Open stockpiles of construction materials (for example, aggregates, sand and fill material) of more than 50 $m^3$will have measures in place to prevent the washing away of construction materials, soil, silt or debris into any drainage system;
- Manholes (if any) will be adequately covered and temporarily sealed soas to prevent silt, construction materials or debris being washed into the drainage system;
- The necessary precautions for seasonal wet periods and for when a rainstorm is imminent or forecasted will be clearly identified;
- Temporary and permanent drainage pipes and culverts will be provided to facilitate runoff discharge. These will be designed for the controlled release of storm flows.

#### 10.2.1.1 Dredging activities and dredge spoil management plan

In dredging works proper dredging and spoil management should be followed in the following procedure to mitigate the temporary and localized turbidity and sedimentation in Rabnabad Channel/Kajol River.

- Installation of bamboo placating to contain suspended sediments within dredge perimeter
- Installation of bamboo fencing to protect entry of water hyacinth along the periphery of the protected area
- Equipments should be kept in good order with skilled operators. Disposal must be made in confinement chamber

- Cutter head speed will always be kept to the minimum level that yields an acceptable production rate
- Dredging activities should be planned avoiding surfacing and swimming time of Juvenile Dolphins (i.e. dawn and evening)

The dredge spoil management plan has to be participatory with the presence of stakeholders before starting the dredging activities and through spoil along side of Rabnabad Channel/Kajol River.

#### 10.2.1.2 Dredging spoil management plan

Spoil management from dredging activates is important in construction phase if the project site were developed through the dredging of adjacent river. The following activities should take care during capital dredging at the outer bar region.

- Dredged spoil should be disposed off in such a manner so that it does not any additional environmental issues and refill the dredged channel.
- Probable spoil disposal locations should be selected considering distance from dredging sites, environmental issues and social surveys and after discussions with local people.
- Proper management of dredged spoil should be planned and implemented during site development by the implementing agency. The implementing agency should obtain necessary approval from DoE (if required).
- Detail separate study should be carried out for dredging and spoil management

### 10.2.2 Location and Sources of Soil and Other Material for Development

For land development the materials and its sources has been following:

- Bricks – have to check ECC of the brick klin owner
- Dredging –
    - Have to check for dredging permission from DC office and DoE.
    - Have to follow Section 10.2.1

### 10.2.3 Transportation of Soil and other Material

- Drainage systems, erosion control and silt removal facilities will be regularly inspected and maintained to ensure proper and efficient operation at all times and particularly following rainstorms. Deposited silt and grit will be removed regularly;
- Measures will be taken to reduce the ingress of site drainage into excavations, If trenches have to be excavated during the wet season, they will be excavated and backfilled in short sections wherever practicable. Water pumped out from trenches or foundation excavations will be discharged into storm drains via silt removal facilities;
- Open stockpiles of construction materials (for example, aggregates, sand and fill material) of more than 50 m3 will have measures in place to prevent the washing away of construction materials, soil, silt or debris into any drainage system;
- Vehicle servicing areas, vehicle wash bays and lubrication bays will, as far as practical, be located within roofed and cemented areas. The drainage in these covered areas will be connected to sewers via an oil water interceptor;

- Any oil leakage or spillage will be contained and cleaned immediately. Waste oil will be collected and stored for recycling or disposal;
- Any surplus wastewater from the concrete batching plant will be treated to comply with discharge standards before it is discharged to the Jamuna River;
- Barge transport operators who are compliant to the GOB regulations and are permitted to operate barges for transportation purpose by appropriate authorities in Bangladesh will be engaged for providing the transport services.; and
- Barges used for Project material transport will be periodically independently inspected and audited by the Project EHS Management Team. Each barge will be inspected at least once in every 6 months or earlier. If any continued none compliance with respect to the GOB regulations is observed over two (2) audit inspections, the Project will terminate the services of the barge transporter.

### 10.2.4 Method and Equipment for Collection of Soil and Other Material

As per the **Section 10.2.3**

### 10.2.5 Closing of Sites of Sources of Soil and Other Material

Ramnabad chalan, Kajor River and Andermanik River for materials transportation and possible drediging source. The management plan for dreding is depicted in **Section 10.2.1.**

### 10.2.6 Socio-economic management plan

#### 10.2.6.1 Compensation Plan

The process of compensation is based on act and rules of Bangladesh Government. This process is generally depends on the types of land and properties to be loss for the project which has already been initiated by DC office Patuakhali. The DC office is being estimated compensation cost following Immovable Property Ordinance, 1982 (Ordinance II of 1982). BCPCL will be handed over this amount of money to DC office Patuakhali. The project affected people are being listed out. The estimation considered land price (as per registration), home, trees, standing crops, and 50% of present market price of land. DC office, Patuakhali will be paid this compensation directly to the affected person as per the Government Rules. However, it is recommended to monitor the compensation process to ensure transparency in the payment process. Compensation should also be paid to the people dependent on the acquired land like agricultural labor in that area, etc. Therefore, the authority must take all efforts to complete the compensation payment before construction starts.

#### 10.2.6.2 Resettlement Action Plan

The authority should carefully take necessary measures that every displaced people can be resettled. Every displaced people must be contented with this resettlement plan.

#### 10.2.6.3 Youth Empowerment Plan

A proper management plan should be taken in this pre-construction phase to utilize evicted local youth labor. This youth labor force was engaged in shrimp farming. Before the construction of this project, the authority should train them to initiate alternative employment opportunities, such as, technical and vocational training, cattle rearing, poultry farming training etc or some specific income generating training so that this youth can be engaged in the construction and operation phase of this project. In this away, their livelihoods will improve which subsequently progress regional socio-economy status in future.

## 10.3 EMP during Construction Phase

### 10.3.1 Site Preparation

#### 10.3.1.1 Site development by backfilling

It is proposed that site development for power plant and townships will be developed sequentially one after another. This development will be either using dredging spoils or only extracted soil from other places. So far, any part of site development, it is required to encompass the site development demarcated and well-compacted earthen ring dyke initially. So that, no loose earthen materials can move to the river by runoff water. Before dumping of dredging materials, base stripping of top soil has to be made proper bonding and stripped materials has to be kept in safe place for reuse it after completion of site development. Backfilling has to be made layer by layer ensuring proper compaction and water spraying so that no dust can emit in air causing air pollution.

#### 10.3.1.2 Construction site management plan

The construction yard and the site should be managed in such a way that would cause minimum degradation or damage to the surrounding environment. The contractor must take responsibility for the construction site to confirm contractual aspects and applicable environmental standards. Adequate numbers of bins, sanitary toilet, water supply system, run-on and run-off drains, fire safety and fighting system, etc should be provided in the site. However, good housekeeping is necessary for preventing environmental damage. All the construction materials and stockpiles should be maintained within the project area provided with rain and wind protection. An Environment Manager should be employed with responsibility of monitoring the activities which causes any environmental effects and ensuring enforcement of EMP during construction activities.

#### 10.3.1.3 Construction waste management plan

Construction waste should be managed properly. The rate of waste generation should be reduced adopting efficient technique and limiting waste generating activities. The measures for controlling construction waste may include limiting site clearance activities, planned stocking and gathering of construction materials and equipments, fencing around the construction yard, maintaining existing right of way to carry construction materials, adopting proper sanitation system for employees, banning of waste burning, and quality housekeeping. A waste dumping place should be provided with efficient waste collection and disposal techniques. No waste should be dumped to the surrounding rivers. Appropriate measures provided with run-on and run-off system might be constructed from controlling run off from construction yard and liquid waste. Initiatives must be taken to reuse and recycle of waste materials. Hazardous material including fuel and other combustible materials shall have to be stored with highest care and safety. Spillage, accidental release must be controlled adopting Hazardous material handling guideline.

### 10.3.2 Infrastructure Services

The Contractor shall follow the following management plan during construction stage

- Locate the construction camps at areas which are acceptable from environmental, cultural or social point of view.
- Consider the location of construction camps away from communities in order to avoid social conflict in using the natural resources such as water or to avoid the possible adverse impacts of the construction camps on the surrounding communities.
- Submit to the PIU for approval a detailed layout plan for the development of the construction camp showing the relative locations of all temporary buildings and facilities that are to be constructed together with the location of site roads, fuel storage areas (for use in power supply generators), solid waste management and dumping locations, and drainage facilities, prior to the development of the construction camps.
- Local authorities responsible for health, religious and security shall be duly informed on the set up of camp facilities so as to maintain effective surveillance over public health, social and security matter
- Adequate housing for all workers
- Safe and reliable water supply. Water supply from deep tube wells of 300 m depth that meets the national standards
- Hygienic sanitary facilities and sewerage system. Provide separate latrines and bathing places for males and females with total isolation by wall or by location. The minimum number of toilet facilities required is one toilet for every ten persons.
- Treatment facilities for sewerage of toilet and domestic wastes
- Storm water drainage facilities. Both sides of roads are to be provided with shallow drains to drain off storm water to a silt retention pond which shall be sized to provide a minimum of 20 minutes retention of storm water flow from the whole site. Channel all discharge from the silt retention pond to natural drainage via a grassed swale at least 20 meters in length with suitable longitudinal gradient.
- Paved internal roads. Ensure with grass/vegetation coverage to be made of the use of top soil that there is no dust generation from the loose/exposed sandy surface. Pave the internal roads of at least haring-bond bricks to suppress dusts and to work against possible muddy surface during monsoon.
- Provide child crèches for women working construction site. The crèche should have facilities for dormitory, kitchen, indoor and outdoor play area. Schools should be attached to these crèches so that children are not deprived of education whose mothers are construction workers
- Provide in-house community/common entertainment facilities. Dependence of local entertainment outlets by the construction camps to be discouraged/prohibited to the extent possible. Ensure proper collection and disposal of solid wastes within the construction camps
- Insist waste separation by source; organic wastes in one pot and inorganic wastes in another pot at household level.
- Store inorganic wastes in a safe place within the household and clear organic wastes on daily basis to waste collector. Establish waste collection, transportation and disposal systems with the manpower and equipments/vehicles needed.
- Dispose organic wastes in a designated safe place on daily basis. At the end of the day cover the organic wastes with a thin layer of sand so that flies, mosquitoes, dogs, cats, rats, are not

attracted. One may dig a large hole to put organic wastes in it; take care to protect groundwater from contamination by leachate formed due to decomposition of wastes. Cover the bed of the pit with impervious layer of materials (clayey or thin concrete) to protect groundwater from contamination.

- Locate the garbage pit/waste disposal site min 500 m away from the residence so that peoples are not disturbed with the odor likely to be produced from anaerobic decomposition of wastes at the waste dumping places. Encompass the waste dumping place by fencing and tree plantation to prevent children to enter and play with.
- Do not establish site specific landfill sites. All solid waste will be collected and removed from the work camps and disposed in approval waste disposal sites.
- Provide adequate health care facilities within construction sites.
- Provide first aid facility round the clock. Maintain stock of medicines in the facility and appoint fulltime designated first aider or nurse.
- Provide ambulance facility for the laborers during emergency to be transported to nearest hospitals.
- Initial health screening of the laborers coming from outside areas
- Train all construction workers in basic sanitation and health care issues and safety matters, and on the specific hazards of their work
- Provide HIV awareness programming, including STI (sexually transmitted infections) and HIV information, education and communication for all workers on regular basis
- Complement educational interventions with easy access to condoms at campsites as well as voluntary counseling and testing
- Provide adequate drainage facilities throughout the camps to ensure that disease vectors such as stagnant water bodies and puddles do not form. Regular mosquito repellant sprays during monsoon.
- Carryout short training sessions on best hygiene practices to be mandatorily participated by all workers. Place display boards at strategic locations within the camps containing messages on best hygienic practices

### 10.3.3 Construction Equipment

During construction stage heavy mechinary will be used which causes noise and air pollution.the following mitigation measure should be taken during the construction stage.

- Minimise movement of construction vehicles and enforce a speed limit around the construction site;
- Regularly maintain all diesel-powered equipment and reduce idling time to avoid emissions of NOx, $PM_{10}$and $SO_2$;
- Where available use low sulphur diesel (LSD) in HGVs and diesel powered equipment in collaboration with best management practices;
- Implement best practice procedures to control vehicle / equipment air emissions (such as turning off equipment when not in use); and
- Vehicle / equipment exhausts observed to be emitting significant black smoke from their exhausts should be serviced/ replaced.

- Normal working hours of the contractor will be between 06:00 and 21:00 hours. If work needs to be undertaken outside these hours, it should be limited to activities that do not lead to exceedance of the noise criteria at nearby NSRs;
- Only well-maintained equipment should be operated on-site;
- Regular maintenance of equipment including lubricating moving parts, tightening loose parts and replacing worn out components should be conducted;
- Machines and construction plant items (e.g. trucks) that may be in intermittent use should be shut down or throttled down between work periods;
- Low noise equipment should be used as far as practicable;
- The number of equipment operating simultaneously should be reduced as far as practicable;
- Equipment known to emit noise strongly in one direction should be orientated so that the noise is directed away from nearby NSRs as far as practicable;
- Noise enclosures should be erected around stationary equipment;
- Noise barriers should be installed such that the nearest receptors are shielded from the line of sight
- Noisy machinery (such as breakers and rollers) should be located as far away from NSRs as practicable;
- Material stockpiles and other structures should be utilised, where practicable, to screen noise from on-site construction activities.

### 10.3.4 Safety Measures

Following health and safety measure should be taken during the construction stage

- The Contractor will prepare and implement a Health and Safety Plan prior to commencing work. This plan will include method statements for working methods, plant utilisation, construction sequence and safety arrangements;
- Measures will be implemented to reduce the likelihood and consequence of the following hazards:
  - ✓ falling from height;
  - ✓ falling into water;
  - ✓ entanglement with machinery;
  - ✓ tripping over permanent obstacles or temporary obstructions;
  - ✓ slipping on greasy or icy walkways;
  - ✓ falling objects;
  - ✓ asphyxiation;
  - ✓ explosion;
  - ✓ contact with dangerous substances;
  - ✓ electric shock;
  - ✓ mistakes in operation;
  - ✓ variable weather conditions;
  - ✓ lifting excessive weights; and
  - ✓ traffic operations.
- A Permit to Enter system will be established to ensure that only authorised persons gain entry to the site;

- Competent and adequately resources sub-contractors will be used where construction activities are to be sub-contracted;
- All persons working on site will be provided information about risks on Site and arrangement will be made for workers to discuss health and safety with the Contractor;
- The Contractor will prepare and implement a Health and Safety Plan prior to commencing work. This plan will include method statements for working methods, plant utilisation, construction sequence and safety arrangements;
- All workers will be properly informed, consulted and trained on healthand safety issues;
- Personal Protective Equipment (PPE) shall be worn at all times on the Site. This shall include appropriate safety shoes, safety eyewear, and hard hats. Non-slip or studded boots will be worn to minimize the risk of slips;
- Women in the region generally wear “sarees”, which is not appropriate while working in hazard prone construction areas. If women will be working in the hazard prone areas, then the contractor needs to ensure proper outfit and PPEs.
- Before starting work all the appropriate safety equipment and the first-aid kit will be assembled and checked as being in working order. Breathing apparatus will be tested at regular intervals in the manner specified by the manufacturer;
- All lifting equipment and cranes will be tested and inspected regularly. All hoistways will be guarded;
- All scaffolding will be erected and inspected in conformity with the Factories Act and the appropriate records maintained by the Contractor;
- Safety hoops or cages will be provided for ladders with a height in excess of two metres;
- When there is a risk of drowning lifebelts shall be provided and it shall be ensured that personnel wear adequate buoyancy equipment or harness and safety lines, and that rescue personnel are present when work is proceeding;
- All breathing apparatus, safety harnesses, life-lines, reviving apparatus and any otherequipment provided for use in, or in connection with, entry into ConfinedSpaces, and for use in emergencies, will be properly maintained and thoroughly examined at least once a month, and after every occasion on which it has been used;
- Where sound levels cannot be reduced at the source, suitable hearing protection will be provided when noise levels indicate a Leq of more than 85 dB (A). When hearing protection is used, arrangements will be made to ensure the wearers can be warned of other hazards; and
- The Contractor shall provide appropriate safety barriers with hazard warning signs attached around all exposed openings and excavations when the work isin progress.

### 10.3.5 Air Quality Management Plan

Construction activities generate large volume of particulate matter and some time significant volume of green house gases. However, with these project activities, a large amount of particulate matter might be generated. Hence, an efficient air quality management plan has to be adopted. The mitigation plan includes limiting PM generating activities, adopting dust suppression system, limiting vegetation clearance activities, avoiding earthen road for traffic movement, covering of stockpiles, traffic management, etc.

### 10.3.6 Acoustic Management Plan

Noise to be generated from different mechanical equipment machineries and vehicle used in construction activities shall have to be managed to ensure ECR, 1997 defined standard. Adopting the necessary mitigation measures might reduce the generation of noise.

### 10.3.7 Water resources management plan

To control drawdown of ground water level, surface concreting may be minimized as minimum as possible for allowing natural recharge. Dependency of ground water might be reduced adopting rainwater harvesting system and anticipating consumptive water use.

Construction waste water management would control discharge of waste into river. Proper training might be provided involving the monitoring professionals during construction work.

### 10.3.8 Agricultural resources management plan

Crop production may reduce for misplacement of spoil and intrusion of saline water if proper measures are not being taken during construction period. Care should be initiated so that the standing crops are not been damaged by the placement of spoils. During construction of structures, precautionary measures should be taken so that intrusion of saline water will not inundate the standing crops/agriculture lands. For this, alternative bund should be made to overcome the risk of breach of the concerned temporary bundh.

### 10.3.9 Socio-economic Management Plan

#### 10.3.9.1 Priority for Affected and Local People in Project Employment

The affected people and locals shall have to be given priority in hiring and employing of construction worker, labor, and professionals. Besides, local businessmen should be given priority in hiring supplying agent for food, construction materials, vehicles and other daily supplies.

#### 10.3.9.2 Occupational Health and Safety Plan

Use of Personal Protective Equipment shall be made mandatory for each project personnel, worker and even for the visitor. The safety plan described in Chapter 10 shall have to be adopted. Necessary training shall be given to project employees. Awareness program shall be arranged regularly. Safety talk, safety meeting, safety motto, safety billboard etc. are good techniques of raising awareness among the workers, visitors and locals.

#### 10.3.9.3 Labor Recruitment Plan

The labor recruitment policy should be formulated in such a way that the local laborers can get preference in both temporary and regular employment of the power plant project. As these labors have no previous experience on such type of technical jobs, it is suggested that, the authority can recruit them in non-technical posts of this project or the authority can facilitate technical training them.

#### 10.3.9.4 Employment Generation Plan

This is true that because of the implementation of this project a good number of local people will lose their only means of livelihood. To make up this loss, the implementing authority should develop an alternative employment generation plan. This plan will include active Public-Private Partnership

(PPP). The PPP should motivate the NGOs to provide support for skill and capacity development and for income generation activities.

#### 10.3.9.5 Community Liaison

During construction, a close liaison with community and local government institution should be maintained. The local community and local government institution should be made aware of all the construction activities and possible environmental and socio-economic disturbances. A community liaison officer or Health and Safety Manager should be given responsibility of maintaining close communication with community groups, local government institutions and concerned government departments.

## 10.4 EMP during Operation Phase

### 10.4.1 Air Pollution Management

#### 10.4.1.1 Transportation and Handling of Raw Materials

The vessel to be used for coal transportation shall have to satisfy all national laws and IMO conventions signed by GOB. Bangladesh is a signatory 25 IMO Conventions and Maritime Protocols to protect marine and terrestrial environment of the country. All of these conventions and protocols have been discussed in Chapter 2. Therefore, all activities relating to shipment of coal through the Port shall have to be done strictly in compliance with the standards set by the IMO, particularly the conventions, protocols and agreements. Shipping, barging and transferring should be regularly monitored by the relevant authorities (e.g. Chairman) Shipping, Port Authority and BIWTA to ensure enforcement of these conventions and protocols. Coast guard might be given responsibility for inspecting whether the vessels are adopting mitigation measures, complying national and international rules of safety and environmental conservation. Besides, an Environment Manager shall be given responsibility of monitoring transportation activities and of auditing environmental efficiency of the transportation system.

Proper dust suppression and self combustion mitigation system must be adopted. Practice to moisten the coal but not wet them should be followed. However, water treatment plant should be planned and constructed for management of runoff and wash off water from coal stockpile and unloading system. The unloading system and conveyor system should be enclosed typed that would reduce generation of fugitive dust particles from coal.

#### 10.4.1.2 Operation Stage

Operation and maintenance of boiler, ESP, stack has to be carried out regularly as per instruction given in the manufacturer's maintenance manual. At the same time, the quality of the coal has to be maintained as per design of the boiler and to comply with ECR, 1997. The coal shall have low sulfur content. The ash handling system must be regularly inspected and tested to evaluate its performance as per the standard. Regular inspection of boiler, FD and ID fans, separation and handling system and other ancillaries shall also be inspected and tested regularly weather this level remains lower than the allowable limit. Safety measures shall have to be ensured of all components and accessories for entire life period of the project. Emission level of $SO_2$, NOx and PM shall also have to be monitored regularly. The Environment Manager shall be responsible for regular monitoring of emission level, inspection and testing of mitigation measures, environmental efficiency of the plant and regular reporting of the inspection. The monitoring and inspection report shall have to be submitted to DoE for renewing Environmental Clearance Certificate.

### 10.4.2 Waste Water Management Plan

The waste water management plan provided with recycling, reuse and treatment of water designed for the project should be inspected regularly. Performance of the treatment plants shall have to be monitored and maintained as per manufacturer's maintenance manual.

Effluent quality shall have to be monitored at different stage of discharge and intake. Before discharging the treated effluent from the central monitoring sump the effluent standard shall have to be complied with ECR, 1997 defined standard for effluent.

### 10.4.3 Noise Management

All equipments and mechanical machineries shall have to be maintained in good working order. Noise level should be monitored at different selected location within power plant and nearest community. The greenbelt shall be planted with the aim of dampening the noise level. The boundary wall will also dampen the noise level further. Whether possible, mechanical parts of high noise potential shall be provided with acoustic hood. Noise from other line sources like project vehicle, vessel, etc shall be controlled adopting mitigation measures. An Environment Manager shall be given responsibility of monitoring efficiency of the management plan and regular monitoring of noise level.

### 10.4.4 Solid Waste Management Plan

Waste to be generated from different point sources like office, household, workshops, construction yards, etc shall be efficiently collected, disposed and managed. Waste shall be collected and managed separately as per type. Hazardous waste should be managed separately. Initiatives might be taken for recycling and re-use of waste. On site waste disposal system should be constructed and their performance should be monitored.

#### 10.4.4.1 Fly Ash Utilization

The daily ash generation of the plant is about 1440 tons at 100% MCR. The maximum ash generation with ash content of 12% is 0.42 MTPA at a plant load factor of 80%. Out of this about 20% would be bottom ash and about 80% would be fly ash.

The dry ash is taken to buffer hoppers for its onward transportation in dry form to storage silo near plant boundary for utilization. The residual ash can be used in Brick manufacturing, clinker industries, cement industries, feelings the low lands, compaction purposes etc. There will be also scope for ash export. At initial stage, the generated ash will be used in and for development of the project area.

Many Cement plants exist in the vicinity, hence, 100% fly ash utilization might be considered. Hundred percent bottom ash utilization might also been considered. However, ash dyke of 100 acres has been planned in case of non-utilization of ash.

Ash may be utilized for the following purposes:

- Concrete production, as a substitute material for Portland cement and sand
- Embankments and other structural fills(usually for road construction)
- Grout and Flowable fill production

- Waste stabilization and solidification
- Cement clinkers production - (as a substitute material for clay)
- Mine reclamation
- Stabilization of soft soils
- Road sub-base construction
- As aggregate substitute material (e.g. for brick production)
- Mineral filler in asphaltic concrete
- Agricultural uses: soil amendment, fertilizer, cattle feeders, soil stabilization in stock feed yards, and agricultural stakes
- Loose application on rivers to melt ice
- Loose application on roads and parking lots for ice control

Among these 13 uses of ash, few uses have high potential and have present market in case of Payra 1320 MW Thermal power plant. The following sections discuses potential sectors of ash utilization in case of Payra 1320 MW Thermal Power Plant.

***Production of Fly Ash Bricks***

For production of good quality fly ash bricks, the quality of fly ash should be as under:

- It should be either dry or moist {containing moisture not more than 5 %}
- Visual appearance should be light steel grey or smoky grey in color. The brownish or light yellowish grey color fly ash is of inferior quality.
- The fly ash should be very fine and can pass through 200 mesh sieve.
- The un-burnt carbon in fly ash with negligible fraction is tolerable for use.

Moreover those can also be used in the manufacture of mosaic tiles, plain tiles, pre-stressed roofing steps, thermal insulation bricks and road sub-grades. The fly ash can also be used as fertilizer to increase the production of crops particularly rice, wheat and cereals. Depending on the type of crops, an optimum amount of fly ash can be used for better production. Field trials have been made in this regard.

***Fly Ash- Sand-Lime - (Gypsum / Cement) Bricks / Blocks***

Fly Ash can be used in the range of 40-70%. The other ingredients are lime, gypsum (/cement), sand, stone dust/chips etc. Minimum compressive strength (28 days) of 70 kg/cm2 can easily be achieved and this can go up to 250 Kg/cm2 (in autoclaved type). Advantage of these bricks over burnt clay bricks:

- Lower requirement of mortar in construction
- Plastering over brick can be avoided
- Controlled dimensions, edges, smooth and fine finish & can be in different colors using pigments
- Cost effective, energy-efficient & environment friendly (as avoids the use of fertile clay)

***Clay-Fly Ash Bricks***

Fly Ash content can be 20 to 60% depending on the quality of clay. Process of manufacturing is same as for the burnt clay bricks. Advantages are as under:

- Fuel requirement is considerably reduced as fly ash contains some percentage of un-burnt carbon
- Better thermal insulation
- Cost effective and environment friendly

***Manufacture of Aerated Wall Blocks and Panels***

Fly ash is used in the building industry largely as a concrete additive. Fly ash can also be sintered into pellets for use as light weight aggregate.

Laboratory and pilot plant trials carried out at Central Building Research Institute (CBRI), Roorkee have established that sintered light weight aggregate can be successfully produced from -Indian fly ash and used for producing plain concrete as well as reinforced concrete beams and slabs. Laboratory investigations and factory trials have shown the technical feasibility of manufacture of cellular concrete from lime and fly ash.  It is more economical to produce this cellular concrete than the cement-sand cellular concrete, which is being produced in the country at present.

Fly ash can also be used as masonry mortar. The work done at CBRI suggests that mixtures shall be thicker than 1:6 (by volume) to enable them to be used as mortar. As a masonry mortar, fly ash is used in place of Surkhi and prepared in a way similar to Lime-Surkhi mortar. Lime fly ash mortars are cheaper and better in performance and strength than Lime-Sand mortars.

***Fly Ash Aggregate***

The fly ash can be converted to light weight aggregate which can substitute the presently used conventional aggregate, in concrete blocks, flooring and non-load bearing structures such as compound walls, canals, pavements, etc.  The main components of the process are fly ash, calcium oxide, fresh water quenched bottom ash (optional), sand, water and chemically bonding additives.

The calcium from lime reacts with silica and alumina in fly ash to produce calcium/aluminium materials in a reaction similar to that of Portland Cement.  These minerals bond the fly ash particles tightly so that hard, strong and practically unleachable pellets are formed.  These pellets are heated at low temperature to cure them.

***Land Reclamation***

Land reclamation by filling low lying areas after which the application of a top layer of soil and trees shall be planted, which shall be given as free of cost.

***Ready Mixed Fly Ash Concrete***

Though Ready Mix concrete is quite popular in developed countries but in -India it consumes less than 5 percent of total cement consumption. Only recently its application has started growing at a fast rate. On an average 20% Fly ash (of cementations material) in the country is being used which can easily go very high. In ready mix concrete various ingredients and quality parameters are strictly maintained/controlled which is not possible in the concrete produced at site and hence it can accommodate still higher quantity of fly ash.

***Utilization in Roads / Paving***

It has been reported from the laboratory tests conducted by the Cement Association that fly ash with other ingredients can be used for paving roads and airport runways.  Fly ash mixed with sand and hydrated lime is used as a base course of asphalt pavement. The breaking strength of such a pavement is calculated to be as high as 68 kg/sq.cm (1000 psi). As a result of a series of experiments, the mixtures of ingredients added in the following recommended proportions gave a good paving material with adequate strength and reasonable setting time.

| Ingredients | Composition by Weight (%) |
|---|---|
| Fly ash | 12 – 14 |
| Lime | 2.8 – 3.6 |
| Portland Cement | 0.7 – 0.9 |
| Sand | 80 – 84.5 |

The above mixture developed strength from 54 to 95 kg/sq.cm (800-1400 psi) in about 90 days at a temperature of 18 deg. C to 21 deg. C. Further, the experiments have shown that 30% of crushed stones (instead of sand) established strength of 102 – 136 kg/sq.cm (1500-2000 psi).

The total cost of manufacturing the paving mixture comes to about one and half that of ordinary road stone which has much less strength and to less than one third the cost of lime concrete which has good strength. Even the extra strength obtained by using 30% crushed stones as a substitute for sand the cost is not expected to exceed that of conventional materials.

***Cement Manufacturing Using Fly Ash***

Pozzolans are defined as silicious and aluminous materials which in themselves possess little or no cementitious value but, will in finally divided form and in the presence of moisture chemically react with calcium hydroxide at ordinary temperature to form compounds possessing cementitious properties.

Up to 35% of suitable fly ash can directly be substituted for cement as blending material. Addition of fly ash significantly improves the quality & durability characteristics of resulting concrete. Hence even without enhancing the production capacity of cement; availability of the cement (fly ash based PPC) can be significantly increased.

Fly ash is used in the production of Pozzolona cement by intergrinding Portland cement clinkers and fly ash or by blending intimately and uniformly Portland cement and fly ash. ASTM C 618 (AASHTO M 295) Class F and Class C specifications limit the Pozzolona (fly ash or similar material) component from 15 to 40%. Class F fly ash is often used at dosages of 15% to 25% by mass of cementitious material and Class C fly ash is used at dosages of 15% to 40% by mass of cementitious material.

Type of cement process

- Wet Process
- Dry Process - 74% of cement produced
- Preheater / Precalciner Process

Hydraulic cement made by finely pulverizing the clinker produced by calcining to incipient fusion a mixture of argillaceous and calcareous materials. Portland cement is the fine gray powder that is the active ingredient in concrete.

***Portland Pozzolana Cement (Fly Ash Based)***

The advantages of fly ash in the manufacture of Portland Pozzolona Cement (PPC) as compared to other Pozzolonic materials are two-fold. Better hydraulic properties of fly ash. Cement retains its natural and accepted grey color instead of becoming mud-red in case bricks / tiles are used as Pozzolonic materials.

As a first step towards the utilization of ash, BCPCL have planned to explore the possibilities for Fly ash bricks, Fly Ash aggregate and use in Cement manufacturing.

Such facility can be located near the Power Project or can be used in the nearby local brick and cement industry. The technology for fly ash wall block/wall panels developed by well-known European manufacturers shall be tried.

#### 10.4.4.2 Bottom Ash Utilization

1. Nowadays bottom ash can be extracted, cooled and conveyed using dry ash which has many benefits. When left dry the ash can be used to make concrete and other useful materials. There are also several environmental benefits.
2. Bottom ash may be used as raw alternative material, replacing earth or sand or aggregates, for example in road construction and in cement kilns (clinker production).
3. A noticeable other use is as growing medium in horticulture (usually after sieving).

#### 10.4.4.3 Ash Utilization Logistics

Fly ash generated from the project can be transported to the cement based industries in Bangladesh. There are a number of cement Industries of repute in the Bangladesh and it is envisaged that the demand for the fly ash getting generated from the power project will be fully utilized by these cement companies.

Transportation of fly ash disposal from the project will be by river.

#### 10.4.4.4 Dust Suppression System (DSS)

Dust suppression systems have to be installed at coal receiving terminal and plant site. The system functions (dust suppression) replenishing the evaporated moisture. An integrated system has to be installed to control dust at ship’s hold, ship unloader, loaders, stackers, reclaimers, conveyor system (including each transfer point), and stock yard. An automated system may be adopted to suppress the dust maintaining moisture level of coal surface not below 7%– 8%. Sprinklers have to be set up in a way that will spray maximum water inform of the mist so that no surplus water will be generated. However, water collecting and recycling system also needs to be installed in line with dust suppression system.

Furthermore, the conveyor system might be covered typed so that coal dust from wind action can be controlled. At transfer points, water sprinkler should be installed.

In case of ship’s holds, water sprinkler jets should be provided at the bottom of the boom of the unloaders so that the operator will be able to operate the sprinkler as and when required. In such case, no need to install automated sensor.

The major source of dust generation is stockyard. The entire stockyard should be covered with water sprinkler provided with automated moisture sensor. Sprinkler system provided with electrically operated valves and pumps are standard. Entire system i.e. sensor, valves, pumps should be connected with computerized monitoring and control system.

#### 10.4.4.5 Ash Management Plan

Ash is the prime coal combustion products that release as fly ash and bottom ash during the operation of power plant. In order to avoid airborne dust about 99% fly ash has been captured in the ESP and temporary storage at ash silo. Ash carries out to the ash pond mixing with water. Closed cycle water system should be implemented during ash transfer process. The following measures should be taken for proper management of ash.

- Engineering control measures should be considered to maintain the ash dust concentration as low as is reasonably practicable.
- The capacity of ash pond should be higher
- Additional ash disposal facilities should be plan as for contingencies
- Proper design is necessary for local and national marketing of the ash
- Regular monitoring the ash disposal facilities
- Avoid prolonged skin contact especially where the product is dampened
- Wear protective clothing; good working practices as well as high standards of housekeeping and personal hygiene should be maintained

### 10.4.5 Housekeeping

Good housekeeping is one of the prime steps of safety. Good housekeeping of mechanical parts, rotator parts, electrical equipments, plant site, green belt, ESP, stack, etc will ensure workplace safety and efficient functioning of the system. This good housekeeping has to be made in regular interval and as per need.

### 10.4.6 Safety and Occupational Health

- Develop and implement an HSE and Social Management System (HSE & SMS) to international standards for the entire Plant premises and AOI within two (2) years of commissioning the Project;
- The Plant HSE & SMS should be certified to International standards such as ISO 14001 and OHSAS 18001 through a reputed, independent third party agency; As part of HSE&SMS, develop HSE Policy, Social Policies, Vision and Mission Statements, HSE&SMS Manual, Aspect-Impact matrices, Regulatory Register, Standard Operating Procedures (SOPs), Level 2/3 documents, Auditing systems, Training systems, Senior Management Review systems, etc. the HSE&SMS will fuiiy comply with ADB SF5 and IFC Performance Standard 1 requirements;
- Implement facility level programs aligned to global corporate initiatives such as Sustainabiity Reporting, Resource conservation programs and Climate Change programs as part of HSE&SMS through the project life cycle.
- Comply with GOB/DOE/BPDB acts, regulations, codes and other statutory requirements that are currently in force including the amendments and new regulations that may come in future. In addition to the national regulations, comply with the emission and effluent

standards in the IFC's General EHS guidelines and those for Thermal Power Plant projects. In case of discrepancy or contradiction between national regulations and the IFC EHS guidelines, Project commits to comply with the more stringent standards.

- The management system will comply with the IFC Performance Standard 2 for labour and working conditions and the same will be implemented during the operation phase.
- No child and/or forced labour
- Working conditions and terms of employment will be fully compliant to the Bangladesh labour laws.

## 10.5 Greenbelt Development

A green belt shall be developed within the project boundary. This greenbelt will act as a buffer zone. The greenbelt will dampen the generated noise from the power plant. This zone will also be acting as safeguard from power plant for nearby community and Power Plant Township. Local tree species should be selected for green belt development. In addition, mangrove plant species should be planted along the river banks of Rabnabad Channel and Andharmanik River around the project boundary. However, a landscape planning is necessary for obtaining benefit from green belt. This green belt will increase scenic beauty around the plant area.

## 10.6 Rain Water Harvesting Plan

In Township, each building should be constructed with rain water harvesting system, which will help to harvest the water for different water activities as well as for domestic uses. In addition, water efficient technology should be opted. This process will reduce the pressure of river water.

## 10.7 Rehabilitation and Resettlement Plan

The key guiding principle of this RRP should be the associated GoB rules and regulations. The compensation plan should be made on these guidelines. The study team consulted with various stakeholders on the institutional arrangement for resettlement and compensation payment and considering their perceptions the RRP should include the following facts:

- In addition to the landowners, people those do not own land but directly dependent on acquired land for livelihoods should be included in the RAP;
- The value of land should be determined by the current market price instead of government price;
- The compensation should be given in one installment before starting the construction work and the payment should be given in cash;
- As the households will lose their occupation because a great portion of households engaged with jobs based on the locality, a labor recruitment strategy should be taken to rehabilitate the jobless workers;
- Infrastructural development of newly settled area;
- After the acquisition, the authority should take immediate initiatives for skill development of unemployed labor force etc.

## 10.8 Thermal Pollution Management

In the proposed power plant closed cycle cooling water system will be used so no thermal pollution is expected.

## 10.9 Coal Washery

Coal is a sedimentary rock made from buried vegetation, transformed through the action of pressure and temperature over tens or hundreds of millions of years. But not just the organic material becomes coal: the vegetation was usually accompanied by inorganic material, impurities in the form of mineral matter, also commonly known as ash, which forms as part of the coal. Other impurities get added during the stripping process while mining. The proportion of ash in coal is very variable, from less than 10% in high-quality coal to more than 40%. Ash has several negative effects. It raises transportation costs per energy unit because the ash (which has no useful heating value) gets transported as part of the coal; it cuts power plant efficiency by hampering heat transmission; and it complicates plant operation and maintenance because of corrosion, fly and bottom ash removal, etc. Higher ash contents also lead to a greater variety of pollutants, while the lower coal-burning efficiency increases $CO_2$ emissions. So removing ash through coal washing improves product quality, and hence prices, and it saves money in transportation and end-use at the consumption point.

The coal that has been utilized for this power plant will be washed coal. The raw coal will be washed in mine mouth. So no coal washery impact will be predicted at project site.

## 10.10 Coal Yard Management

Coal is a self combustible material. Proper aeration system and water spraying system must be installed to control self-heating of coal in stock pile. The dimension and height of the stockpile should be designed considering self heating, aeration, wind effect, etc. There should be a continuous monitoring of the inside temperature of coal stockpile.

Coal stocking, handling, and other activities generate considerable amount of coal dust. The surface moisture of the coal should be maintained in such a way that would limit propensity to spontaneously combust and produce dust. Generally, with surface moisture of at least 7%, coal shows low propensity to self combustion and producing dust. Water must be sprayed on the stockpile if surface moisture goes below 8%. There should be an automated monitoring and water spraying system. In addition, water must be applied on coal:

- As it moves on conveyor belt
- At transfer points
- At stockpile

Care should be taken to control aerosol formation after water spraying. The runoff and wash off from the stockpile and coal unloading system should be treated properly before discharging it to open environment. However, wash off and runoff from stock pile should be limited. The water spraying approach should be, to moisten the coal not to wet the coal.

The recommended practice is to fog spray or mist the stockpile surface as frequently as necessary to maintain the surface of the coal in moist condition, not in wet condition. This will minimize propensity of self combustion and dust generation and accordingly no runoff water will be produced.

Provision of regular monitoring has to be kept for inspection proper pathway with entry and exit should be provided in stockpile area and conveyor belt.

## 10.11 CDM Intent

Coal has been the fuel of choice for many industrializing countries over the past two centuries. Coal plants generate over 40% of the world's electricity, and a much larger share in major emerging economies like India (70%) and China (80%). Since 1970, new coal-fired power plants have been the dominant source of added CO2emissions in the power sector, the sector making the largest contribution to increases in global CO2 emissions. According to International Energy Agency forecasts, these trends are likely to continue. It might seem surprising then that, since the approval of CDM Methodology ACM0013 in 2007, new coal plants in developing countries "using a less GHG intensive technology" are eligible to claim tradable Certified Emissions Reductions (CERs) under the Clean Development Mechanism (CDM). Such plants represent long-lived investments that will deliver emissions-intensive electricity for 30 years or more, with potentially significant local environmental and health impacts from air pollution and associated coal mining. Given this context, it is vital that any CDM methodology for ascribing emission reductions and providing carbon finance to new coal plants be robust and correctly applied. Coal project developers should have to demonstrate conclusively that in the absence of CDM support, a less-efficient, higheremitting coal plant would have been built. Once operational, the plants must truly emit less CO2 per unit of electricity than a non-CDM-supported plant would have emitted. In this sense, using the CDM to improve a coal plant's efficiency is not unlike using it to improve the efficiency of a cement plant, commercial building, or other facility. Carbon finance, in the form of tradable CERs, can, in principle, provide sufficient incentive for a project developer to build and operate a facility that might cost more, but is lower-emitting, than what would have been built and operated absent the CDM. These CERs can be used in place of costlier emission reductions by a country or company subject to a binding emission cap. The cost of complying with the Kyoto Protocol, EU Emissions Trading System (EU ETS), or other relevant emission trading system would be reduced, resulting in economic benefits, and, arguably, increasing the likelihood of more ambitious emissions caps in the future. However, for all this to occur, the emissions reductions must be real and additional. The crediting methodology must ensure that the crediting baseline against which they are estimated is appropriate and realistic, and that indeed, higher-emitting facilities would otherwise have been built.

To qualify for the CDM, coal projects must show the CDM played a decisive role in moving from less-efficient subcritical coal technology to more-efficient and lower-emitting supercritical or ultra-supercritical technologies.

And BCPCL is a proposed ultra super critical technology using power plant.

## 10.12 Budget for EMP

The Project cost is inclusive of cost for implementing Environmental Management Plan and installation of pollution abatement and mitigation measures described in the feasibility study report. The costs for Environmental Management Plan and responsible institute have been estimated in **Table 10-1**.

**Table 10-1: Environmental Management Plan (EMP) Cost Estimate**

| EMP for the Impacts | Mitigation/Enhancement/Compensation/Contingency measure | Responsible Institutions | EMP Cost (BDT. million) |
|---|---|---|---|
| **Pre-construction phase (Land acquisition and site development)** | | | |
| EMP for preventing impacts on land and agriculture | • Efforts have been made to use khas land as well as fallow land to the extent possible to minimize future requirement of lands<br>• Project Affected Persons (PAPs) losing homesteads and land should be compensated as per the law of the land<br>• PAPs loosing occupation may be involved in project's job opportunity if possible<br>• Compensation should be given for acquisition of agricultural land as per the law of the land | BCPCL and DC office, Patuakhali | Included in Project cost |
| EMP for compensating land acquisition and resettlement | • The authority should be careful and take necessary measures that every displaced people can be resettled as per law of the land<br>• The displaced people may be resettled in suitable areas as per the land of the law | BCPCL and DC office, Patuakhali | Included in Project cost |
| EMP for Controlling the regional air and water quality | • Fencing of project area by drum sheet<br>• Regularly spraying over the land development site for control the generation of SPM<br>• Proper run off design needs to be implemented for reducing any water logging<br>• Location of backfilling stockpile should be located in safe areaand protected from wind and rain action<br>• No backfilling materials/spoil should be stored on River bank/slope<br>• No waste should be disposed to canals/river<br>• Create awareness program | BCPCL and DC office, Patuakhali | (In clued in Project cost and BDT.3 m external cost)<br><br>3 |
| EMP in case of river dredging for site development | • Stakeholder consultation is prerequisite for selection of dredging spoil disposal<br>• Dredging spoil should be dumped in such a manner that it would not create any additional environmental issues as well as refill the dredged channel<br>• Monitoring the site of spoil disposaland its associated issues regularly | BCPCL/DoE/EPC Contractor/Local administrations | 4 |
| **Sub-total (A)** | | | **7** |
| **Construction phase** | | | |
| EMP for controlling waste generation | • Limiting site clearance and base stripping activities within the project boundary<br>• Dispersed gathering and stocking of construction materials and machinery should be | BCPCL/DoE/EPC Contractor | (Included in project cost and |

| EMP for the Impacts | Mitigation/Enhancement/Compensation/Contingency measure | Responsible Institutions | EMP Cost (BDT. million) |
|---|---|---|---|
| and mitigating impacts | within minimum area in the project boundary<br>• The project area should be fenced prior to initiate the construction activities<br>• Stock piles of construction materials should be covered in order to protect them from wind and weathering action<br>• The existing right of way should be used in material transportation and existing right of ways should not be blocked<br>• Provision of sanitary toilet facilities, one toilet for 10 persons<br>• Construction wastes must be reused or recycled where possible<br>• Burning of waste material should be restricted<br>• Quality housekeeping should be maintained by regular inspection and checking<br>• Keep provision of onsite waste collection and disposal<br>• Keep provision of different colour waste bin for biodegradable, reusable and recyclable waste dumping<br>• Keep provision of awareness building meeting and training to the employees<br>• Awareness build up program | | Tk. 5 million external cost)<br>5.0 |
| EMP for controlling air pollution | • Limiting activities may produce fugitive dust particle within project area<br>• Vegetation clearance and base stripping should be done carefully<br>• Vehicle speed restriction should be enforced to control dust generation<br>• Avoid using of earthen road and undeveloped road to minimize dust generation<br>• Construction materials should be covered to protect from wind action<br>• Keep provision of water spraying system to suppress fugitive dust<br>• Dust particle generated from access roads must be controlled by water spraying during dry season<br>• Stock piles of construction materials should be covered in order to protect from wind action<br>• An appropriate freeboard should be maintained in trucks hauling construction materials<br>• Creating awareness program | BCPCL/DoE/EPC Contractor/Local administrations | (Included in project cost and Tk. 4 million)<br>4.0 |
| EMP for controlling greenhouse gases | • Burning of any kind of solid waste should be banned<br>• Regular maintenance of water vessels, vehicles, generator and machinery in | BCPCL/DoE/EPC Contractor/Local | 3.0 |

| EMP for the Impacts | Mitigation/Enhancement/Compensation/Contingency measure | Responsible Institutions | EMP Cost (BDT. million) |
|---|---|---|---|
| | accordance with manufacturer's specifications<br>• Approved pollution control devices to be fitted in equipment and machinery<br>• Switch off / throttle down all site vehicles, water vessels, generator and machinery when not in use<br>• Crating awareness and monitoring program | administrations | |
| EMP for controlling noise generation | • Regularly monitoring noise level both night and days<br>• Switch off / throttle down all site machinery, vehicles, water vessels, and generator when not in use<br>• Construction activities should be limited in night<br>• Use noise damper on project boundary<br>• Monitoring the speed limit of the vehicles and vessels<br>• Avoid queuing of vehicles in areas adjacent tosite, particularly near sensitive receptors including housing. | BCPCL/DoE/EPC Contractor/Local administrations | (Include in project cost and external Tk. 2 million)<br>2.0 |
| EMP for controlling impacts on ground water resource | • Keep provisions of rain water harvesting system to limit ground water use<br>• Use of surface water as much as possible | BCPCL/DoE/EPC Contractor | Include in project and external Tk. 3 million)<br>3.0 |
| EMP for controlling impacts on surface water resources | • Surface water must be saved from any harmful effluents and waste dumping from project site using waste disposal management plan<br>• Provide close system facilities and wastewater treatment plant to minimize domestic waste from workers colony<br>• Provide training and awareness building program to the workers during construction. The training and awareness programs are: a) arrange weekly consultation sessions among the workers through plant site managers. The duration of consultation is one hour according to<br>• ISO14031 standard, b) arrange monthly environmental meeting among the mid level officers through top management. The issue will be discussed under this meeting is ECR 1997 | BCPCL/DoE/EPC Contractor | 5.0 |
| EMP for controlling | • Harmful effluents and wastes leakage from oil and chemical tank or storage would be | BCPCL/DoE/EPC | 4.0 |

| EMP for the Impacts | Mitigation/Enhancement/Compensation/Contingency measure | Responsible Institutions | EMP Cost (BDT. million) |
|---|---|---|---|
| impacts on ground water quality | • controlled<br>• High tech treatment plan will be installed in the plant site for effluent discharged to the Rabnabad Channel/Kajol River/Andharmanik River. It must be operated satisfying all relevant standards of MoEF<br>• Regularly monitoring the ground water to identify the anthropogenic interferences<br>• Provide training and awareness building programs to the labors, professionals and local people | Contractor | |
| EMP for controlling impacts on land and agriculture | • Construction materials have to be collected, stored, and disposed in an appropriate manner<br>• Recycled waste should be disposed in a suitable landfill<br>• Limiting the construction activities and stocking within the project boundary<br>• Regular monitoring the waste disposal process carefully<br>• Harmful effluents and waste leakage from oil and chemical tank or storage should be<br>• controlled strictly<br>• Wastes or used oil should be stored in a designated area for disposal through authorized vendors<br>• Measures should be provided for fire suppression and the neutralization and collection of any spilled materials<br>• Treatment plant should be installed<br>• Provide training and awareness building programs to the labours and professionals and local people | BCPCL/DoE/EPC Contractor | (Include in project cost and Tk. 3 million external cost)<br>3.0 |
| EMP for controlling impacts on fisheries | • Avoidance of construction work during fish breeding season if possible. Generally, April to July for common fish and Sept-October and March to May for Hilsa spawning and migration<br>• Most excavation, backfilling, and site grading will be undertaken during the dry season.<br>• Sediment will be trapped on-site using sediment fences and traps and basins and by<br>• preventing the off-site movement of coarse material<br>• Alternate sourcing of sand other than river bed dredging<br>• Limiting the vessel speeds and regular maintenance to control noise | BCPCL/DoE/EPC Contractor | (Include in project cost and external Tk. 5 million)<br>5.0 |

| EMP for the Impacts | Mitigation/Enhancement/Compensation/Contingency measure | Responsible Institutions | EMP Cost (BDT. million) |
|---|---|---|---|
| | • Oil spillage from vehicle/ vessel should be controlled<br>• Carefully monitoring the water quality upstream and downstream of the project regularly and traffic movement should be followed the law<br>• Fish conservatory (sanctuary) should be established at a safe zone<br>• Enforce banning of fishing activity within the sanctuary zone<br>• The disturbance of habitats in the inter-tidal zones should be minimized<br>• Reduce to cut of trees, bushy plants and swampy plants around the water areas | | |
| EMP for conserving ecosystem | • Implement on-site waste management plant and air quality monitoring system<br>• Limiting soil extraction activities within defined area if possible<br>• Limiting vegetation clearance and base stripping within project boundary<br>• Protect existing mangrove strip along the Rabnabad Channel<br>• Avoid dredging activities during surfacing and swimming time of Dolphin i.e.at dawn and evening<br>• Dolphin conservation program may be implemented<br>• Restrict light at night where necessary<br>• Keep provision of outdoor lights with shade directed downwards<br>• Cut-off time to switch off unnecessary lights at night Regular monitoring the above activities and consultation with the stakeholders | BCPCL/DoE/Forest department/ EPC Contractor/ Local administration | (Included in project cost and Tk. 15 million external cost)<br><br>15.0 |
| EMP for enhancing socioeconomic condition | • The labour recruitment policy formulate in such a way that the local labourers can easily get chance of employment in the power plant project<br>• Gov. and NGOs should provide support skill development program and income generation activities to local people<br>• Youth and women empowerment training centre, introducing diverse income generating activities training<br>• Stronger the safety net program in this area<br>• Regular consultation meeting should be introduce between locals and project personnel to exchange the knowledge<br>• For the increasing movement of people and heavy vehicles the road networks should be developed<br>• Manage separate water and sanitation facilities for the construction workers in the | MoLE/ MoSW, BCPCL/ DoE/ MoE/NGOs/LGED/ RHD/ DPHE/EPC Contractor/ local government and administration | (Included in project cost and Tk. 15million external cost)<br><br>15.0 |

| EMP for the Impacts | Mitigation/Enhancement/Compensation/Contingency measure | Responsible Institutions | EMP Cost (BDT. million) |
|---|---|---|---|
| | project area so that they cannot make any disturbance to the existing facilities of the local people | | |
| EMP for safety and emergency situation | • Safe design should be implement to reduce the risk in each of the construction process<br>• Use of Personal Protective Equipment (PPE) like gloves, helmets, sunglasses and other tools, dresses & uniforms<br>• Regular checking, monitoring and carefully handing with safety procedure<br>• Precautions has to be ensured during handling the hazardous chemicals | BCPCL/DoE/EPC Contractor | Included in project cost |
| **Sub-total (B)** | | | **64.0** |
| **Operation Phase** | | | |
| EMP for air pollution control | • Ensuring the standard of Bangladesh (MoEF) where emission always should be lower due to nearly presence of any sensitive area<br>• The plant equipment must be performance tested during commissioning phase to ensure standard has been maintained<br>• Regular inspection and maintenance of boiler, pressure parts, FD and ID fans ESP, FGD and ash separation and handling system, and other ancillaries<br>• Maintain coal quality of low Sulfur content as stipulated in project description<br>• Properly use of flue gas desulfurisation scrubbing systems to remove sulfur dioxide through lime and steam injection method to reduce the NOxemission<br>• Safety and emergency materials for accidental hazard<br>• Remote monitoring and control of total production process<br>• Regular maintenance and overwhelming as per design specification<br>• Regular monitoring the air quality at identified locations<br>• Automatic monitoring process and presenting on the real time WebPages should be implemented | BCPCL/DoE | (Include in plant operation cost and Tk. 18 million external cost)<br><br>18.0 |
| EMP for controlling noise pollution | • 275 m stack height and high velocity should be maintained<br>• Discharge of emissions through stack must bedirected vertically upward without any<br>• impedance or hindrance<br>• Maintaining DoE standard of acoustic environment with spatial and temporal basis | BCPCL/DoE | (Include in plant operation cost and Tk. 7 million external cost) |

| EMP for the Impacts | Mitigation/Enhancement/Compensation/Contingency measure | Responsible Institutions | EMP Cost (BDT. million) |
|---|---|---|---|
| | • Use sound absorbing boundary wall that act as noise damper<br>• Noise insulation should be implemented surrounding the turbine and generator casing<br>• Noise dumper/insulator must be installed around the casing of conveyor belt<br>• Switch off / throttle down all vehicle and engine of vessel when not in use | | 7.0 |
| EMP for controlling the impact of waste generation | • Onsite, waste collection and disposal system would be provided by municipality of Kalapara Upazila administration<br>• Dust control mechanism must be utilized for coal and ash handling system<br>• Provision of different waste bin with colour code for different waste (recyclable, reusable,<br>• biodegradable, hazardous, etc) in road side, parking places, office, eco-parks, and other official and public places in the plant site<br>• Temporary waste dumping facilities on site and permanent waste dumping facilities off site after treatment should properly continue<br>• Green building concept will be initiated in the preparation of residential plan to minimize the effluent<br>• Provision of waste management department with given responsibility of waste collection, transportation, disposal and overall management and the department may be maintain<br>• Environmental Quality and Safety Management wings<br>• Regular monitoring the waste management instruments and process<br>• Provision of regular awareness building meetings programs | BCPCL/Local Administration/ DoE | (Include in plant operation cost and Tk. 13 million external cost)<br><br>13.0 |
| EMP for the produced ash from the power plant | • Advanced technique like ESP, ash silo and ash pond have to be maintained regularly for ash management<br>• Fly ash (dry form) generated from the plant should be separated after burning of coal<br>• through ESP and commercially utilized to maximum extent possible<br>• Unutilized fly ash should be transferred from the silo in wet form and stored in the ash pond until suitable users are identified<br>• Bottom ash should be collected in wet form and should be stored in the ash dyke until suitable users are identified<br>• Increase the facilities of ash marketing through infrastructure development, creating | BCPCL | (Include in plant operation cost and Tk. 15 million external cost)<br><br>15.0 |

| EMP for the Impacts | Mitigation/Enhancement/Compensation/Contingency measure | Responsible Institutions | EMP Cost (BDT. million) |
|---|---|---|---|
| | • awareness and formulating policies | | |
| EMP for controlling impacts on surface water resources | • Regular maintain of the rain water harvesting process<br>• Increase the efficiency of water reuse and recycling<br>• Water conservation plan should be implemented in broader scale<br>• Direct emission of any harmful effluents and wastes from power plant must be restricted<br>• Provide close system facilities to minimize emission of effluents from power plant area<br>• Effluent treatment plant needs to proper working with the provision of additional load bearing capacity during accidental cases<br>• Regular monitoring to the water quality at specified locations in certain time interval<br>• Regular consultation meeting should be introduce between locals and project personnel to<br>• improve the surface water quality | BCPCL/Local Administration/ DoE | (Included in plant operation cost and Tk. 15 million external cost)<br>15.0 |
| EMP for controlling impacts on ground water resources | • Ground water must be free from any harmful effluents and wastes leakage from oil and chemical tank or storage through seepage<br>• Regular monitoring the level and quality of ground water in side and adjacent to the power plant<br>• Provide training and awareness building programs to the labours and professionals during monitoring the sources of ground water contamination<br>• Implies incentives for conserving the local wet lands<br>• Sealed or paved the coal, ash and waste silo/storage/disposal site to blocked the communication between hazardous materials/leacheate and ground water | BCPCL/DoE/ DPHE | (Included in plant operation cost and Tk. 5 million external cost)<br>5.0 |
| EMP for controlling impacts of tidal intrusion | • Proper connectivity should be maintained through the tidal creeks<br>• Regular maintenance the tidal natural and artificial creeks/khals/channel for easy tidal water movement<br>• Proper guide lines would be followed for Operation & Maintenance facilities | BCPCL | 4.0 |
| EMP for erosion and accretion | • Bank protection measure like hard structure, tree plantation on the bank<br>• Maintain the green belt development areas regularly | BWDB/ BCPCL | 13.0 |

| EMP for the Impacts | Mitigation/Enhancement/Compensation/Contingency measure | Responsible Institutions | EMP Cost (BDT. million) |
|---|---|---|---|
| | • Scientifically justified for any kind of dredging in a particular place<br>• Monitoring the vessel speed, river flow and erosion and accretion prone areas | | |
| EMP in case of maintenance dredging for river navigation | • Scientifically justified for any kind of dredging work in the river<br>• Stakeholder consultation is necessary for site selection for dredging spoil disposal<br>• Regular monitoring is necessary during maintenance dredging<br>• Monitoring the site of spoil disposal and its associated social and ecological issues regularly | BCPCL/DoE/ EPC Contractor/ Local government and administrations | Included in plant operation and Tk. 25 million external cost)<br>25.0 |
| EMP for controlling impacts on land and agriculture | • Introduce the Integrated Pest Management (IPM) technique for pest control adjacent agricultural field like "Light Trap"<br>• Proper training to the farmer on using fly ash in agricultural field<br>• Awareness growing to use the by-product of the power plant efficiently<br>• Monitoring not only inside but also outside the land areas free from any kind of waste disposal or potentially to be polluted lands<br>• Use of bio-indicator for pollution measurement | DAE/Local Administration/ BCPCL | (Included in plant operation cost and Tk. 10 million external cost)<br>10.0 |
| EMP for controlling impacts on fisheries | • The water supply pipeline intake point from the feeder canal should be provided with sufficient screening to filter out larger aquatic organisms (e.g., fish, frogs, and toads) and foreign matter, preventing this material from being drawn into the pumps<br>• Drum screens need to adopt in order to limit the entrainment of fish in the cooling water system and intake velocities should be as low as possible<br>• The water velocity in the intake channel should be less than 0.5 m/s during normal conditions<br>• Temporary water reservoir can be built for water storage rather than direct abstraction from river<br>• Monitoring should continue to ensure that the deterrents are working effectively.<br>• On-site wastewater should be treated to achieve maximum reuse and recycling rather than ultimate disposal to the river<br>• Leftover wastewater should be used to irrigate on-site vegetation throughout the year except during the monsoon<br>• Regular consultation, training and stakeholder meeting should be arranged with the local bodies and project personnel | BCPCL/ DoE/ Coal Transportation agency/PPA, BIWTA/DG Shipping/DoF | (Included in plant operation cost and Tk. 10 million external cost)<br>10.0 |

| EMP for the Impacts | Mitigation/Enhancement/Compensation/Contingency measure | Responsible Institutions | EMP Cost (BDT. million) |
|---|---|---|---|
| | • Use of bio-indicator for pollution measurement like benthic community, plankton or sensitive organisms Enforcement of ECR 1997,IMO Conventions, MARPOL, etc<br>• Spot-check of shipping and barging activities by relevant agencies<br>• Enforcement of fishing ban during breeding/nursing period | | |
| EMP for controlling impacts on ecosystem | • Automatic air quality monitoring at certain ecological important point regularly<br>• Enforce the relevant law of restricting ballastwater and haul water dumping in the River<br>• Enforce existing law of controlling oil spillage<br>• Monitoring activities of the Foreign ships during coal transportation<br>• Establish check post for monitoring activities of Foreign ships during coal transportation<br>• Limiting coal spillage and escapee during unloading to feeder vessel/lighterage vessels<br>• Follow standard practice for shipping and barging operation<br>• Introduce speed limitation for vessel<br>• Awareness building activities should be carried out continuously<br>• Restrict trapping, killing of migratory birds and local aquatic birds<br>• No trapping and killing of Dolphin<br>• Plan measures for accidental oil spillage, refuelling<br>• Anchorage for water vessel only in designated sites<br>• Adoption of Dolphin Conservation Program<br>• Restrict night lights, only in places where necessary | BCPCL/ DoE/ Coal Transportation agency/PPA, BIWTA/DG Shipping | (Included in plant operation cost and Tk. 25 million external cost)<br>25.0 |
| EMP for enhancing better socio-economic condition | • The employee (labors or professionals) should be recruited permanently and temporarily depending on the skills emphasizing on local man power<br>• Gov. and NGOs should continue training for developing skilled population and support them with micro capital<br>• Some posts should be reserved for the local project affected population (both properties and livelihoods)<br>• At least, 10% of the job should be reserved for women.<br>• Youth and women empowerment training centre and introducing diverse income | MoLE/ MoSW, BCPCL/ LGRD/ MoE/MHFW/NGOs// LGED/ REB/DC office/ Local administration | (Included in plant operation cost and Tk. 50 million external cost)<br>50.0 |

| EMP for the Impacts | Mitigation/Enhancement/Compensation/Contingency measure | Responsible Institutions | EMP Cost (BDT. million) |
|---|---|---|---|
| | generating activities training<br>• Relevant government department like Patuakhali District Parishad, Kalapara Upazila Parishad, LGED, RHD, PPA etc should guide the induced development. The existing development plans, Master plans might be improved in harmony with the project<br>• Development of electric transmission and distribution line, priority of local and displaced people in providing electricity, priority in providing electricity for irrigation water pump for local people<br>• Integrated planning among the power generation, industrial development, and socio-economic improvement<br>• Extension of social safety nets for affected people and people under exposure of plant possessed risk<br>• Support Gov and NGO's activities<br>• Use biocides to prevent bacterial contamination to the adjacent society<br>• Community health monitoring facilities within 10 km radius from the power plant<br>• Establish communication with nearby hospital to keep record of pneumonia and other related diseases like bronchitis, skin lesion, eye cataracts and accidental hazardous | | |
| EMP for Safety and emergence hazardous | • Regular monitoring both automatic computerized and manual in every hazard points<br>• Use of personal protective equipment (PPE) in the work places<br>• Regular checking, monitoring and carefully operations with standard procedure<br>• Precautions has to be ensured during handling the hazardous chemicals<br>• Ensure the hospital facilities emergency after any kind of accidental event<br>• Auto signalling system should be installed as a safety plan<br>• Training to the professionals regularly<br>• Regular practicing or showdown by the rescue team for pseudo accident<br>• Compliance monitoring to the charged professionals and monitoring devices<br>• Regular consultation meeting should be introduce between locals and project personnel to exchange the knowledge<br>• Introducing health insurance for the employees | BCPCL/DoE/MHFW/ Local Administration | Included in plant operation cost |
| **Sub-total (C)** | | | **210.0** |

| EMP for the Impacts | Mitigation/Enhancement/Compensation/Contingency measure | Responsible Institutions | EMP Cost (BDT. million) |
|---|---|---|---|
| **Coal Transportation, Transshipment and Handling** | | | |
| EMP for Coal Transportation, Transshipment and Handling | • Adoption of dust suppression system<br>• The vessel to be engaged shall have to be complied with international and national standard<br>• Adopt enclose system for coal unloading and transportation (through conveyor belt)<br>• Maintain ECR 1997, IMO Conventions, MARPOL, etc<br>• Switch off / throttle down of all equipment and machinery when not in use<br>• Introduce speed limitation for vessels<br>• Limiting dropping of coal and escapee duringunloading to feeder vessel/lighter vessel<br>• Ensure no dumping of ballast water, no oil spillage, no discharge of waste water, no waste dumping<br>• Practice of dust suppression should be to moisten the coal not to wet the coal | BCPCL/ Coal Transportation agent/ PPA/DG Shipping/BIWTA | Included in coal import cost |
| | • Introduce speed limit of coal transportation vessel<br>• Keep vessel speed in between 7 knots to 8 knots per hour<br>• Plantation program along the bank of rivers vulnerable to wave erosion<br>• Regular monitoring of erosion | BCPCL/ Coal Transportation agent/ PPA/DG Shipping/BIWTA /BWDB | 8.0 |
| | • Proper training for vessel crews, traffic inspectors, in charges, and other concerned professionals<br>• All vessels should be provided with GPS, radar and other electronic navigation systems to prevent grounding or collisions, such as depth sounder, radar and radio equipment for communication<br>• All vessels should be complied with rules and regulation of IMO, Port authority, BIWTA and national laws of safety, and environmental conservations<br>• Ensure port/coal terminal inspector, environment and safety manager are enforced<br>• Training for awareness building and monitoring | BCPCL/ Coal Transportation agent/ PPA/DG Shipping/BIWTA /Coast Guard | (Included in coal import cost and Tk. 20 million for training cost)<br><br>20.0 |
| | • Awareness building for fisher and facilitate the fisher to use nets/boats provided with signals and marking | BCPCL/ Coal Transportation agent/ | (Included in coal import cost and |

| EMP for the Impacts | Mitigation/Enhancement/Compensation/Contingency measure | Responsible Institutions | EMP Cost (BDT. million) |
|---|---|---|---|
| | • Reduce speed if net is seen<br>• Ensure no dumping of ballast water, no oil spillage, no discharge of waste water, no waste dumping<br>• Ensure enforcement of ECR, 1997 and other rules, regulation and treaties<br>• Ensure no dumping of ballast water, no oil spillage, no discharge of waste water, no waste dumping<br>• Limiting dropping of coal and escapee during unloading to feeder vessel/lighter vessel<br>• Introduce speed limitation for vessels<br>• Anchorage for water vessel only in designated sites<br>• Adoption of Dolphin Conservation Program<br>• Monitoring activities of the Foreign ships during coal transportation<br>• Establish check post for monitoring activities of Foreign ships during coal transportation | PPA/DG Shipping/BIWTA /DoE/ Coast Guard | Tk. 15 million for monitoring and training cost)<br><br>15.0 |
| Safety and emergency plan | • Use of personal protective equipment (PPE)<br>• Regular checking, monitoring and carefully handing with safety procedure<br>• Spraying water like mist in order to reduce the risk of ignition<br>• Precautions has to be ensured during handling the coal | BCPCL/DoE | Included in coal import cost |
| **Sub-Total (D)** | | | **43.0** |
| **Grand Total (A+B+C+D)** | | | **324** |

Note: These mentioned costs (e.g.the external cost) are tentative at the time of this study and might be changed during detail design of the project. The EPC contractor shall be appointed after obtaining of Environmental Clearance Certificate from DoE

## 10.13 Contigency Plans

Strong contingency measures for any kinds of potential risk, especially for health risks will be taken by BCPCL. **Table 9-1** describes mitigation measure required for limiting the negative impacts of the project activities and contingency measures required for reducing risk of accidental hazard and enhancement measures for enhancing positive impacts with the aim of sustainable implementation and operation of the project ensuring environmental and community safety. Preparation of Environmental Management Plan (EMP) cost, which shall include mitigation measures, enhancement and contingency measures and cost. (**Table 10-1**)

a) A conceptptual contingency plan has been given in Section 12.2 for any upset condition of the plant during operation.
b) There is no plan for any kind of modification or expansion of the proposed plant.

## 10.14 Water Resources Management Plan

Water resources should be conserved and prevented from any pollution and hydrological alteration. The internal canals, nearby rivers, tidal creeks should be kept away from any obstruction and waste dumping. No tidal creeks outside the project area should be obstructed by project activities. If any tidal creeks are flowing through the project area that drains water from outside the project area should be free flowing without any obstruction. Proper guidelines should be developed for Operation & Maintenance of drains, internal canals, and tidal creeks.

## 10.15 Ecological Management plan

### 10.15.1 Ecosystem Management Plan

Ecosystem Management Plan in an integral part of the EMP. Different management plans mentioned in this chapter has been developed with the aim of protecting ecosystem. Implementation of these management plans is essential for safeguarding the ecosystem. The principle should be set that the plant shall be operated ensuring all pollution abatement measures are in order. The following measures should be implemented during different stage of the power plant

- Limiting vegetation clearance and base stripping within project boundary
- Development of Green Belt:
    - ✓ Local species should be chosen for green belt development
    - ✓ In green belt plant composition should be made considering plant of different height and different canopy size to facilitate deposition of ash
    - ✓ Protect existing Mangrove strip along the Rabnabad Channel
    - ✓ Along the Rabnabad Channel and Andharmanik river bank adjacent to the project area, mangrove species e.g. Gewa, Keora, Sunduri, Bain, etc should be planted
    - ✓ Plantation should be made following the guideline of the Department of Forest
- Other management plan suggested in this chapter should be implemented for ensuring safeguard of ecosystem
- Plant operation:
    - ✓ Plant should be operated ensuring all pollution mitigation and abatement measures e.g. ash management system, ESP, FGD ( in case of coal having high Sulfur

content), monitoring system, waste water and effluent treatment plant, etc are in order
  - ✓ Implement On-site Waste and Air quality Management Plan
  - ✓ Regular inspection and maintenance of the equipment following the manuals of the suppliers
  - ✓ Restrict night lights at places where necessary
  - ✓ Outdoor lights with shade directed downwards
  - ✓ Cut-off time to switch off unnecessary lights at night
- Coal Transportation and Handling:
  - ✓ Enforce the relevant law of restricting Ballast water dumping in the River
  - ✓ Enforce existing law of controlling oil spillage
  - ✓ Monitoring activities of the Foreign ships during coal transportation
  - ✓ Establish check post for monitoring activities of Foreign ships during coal transportation
  - ✓ Limiting coal Spillage and escapee during unloading to feeder vessel/lighter vessel
  - ✓ Follow standard practice for shipping and barging operation
  - ✓ Enforce Forest Protection Acts
  - ✓ Awareness building
  - ✓ Restrict trapping, killing of migratory birds and local aquatic birds
  - ✓ No trapping and killing of Dolphin
  - ✓ Plan measures for accidental oil spillage, refueling
  - ✓ Anchorage for water vessel only in designated sites
  - ✓ Adoption of Dolphin Conservation Program
  - ✓ Restrict night lights at places where necessary
  - ✓ Outdoor lights with shade directed downwards
  - ✓ Cut-off time to switch off unnecessary lights at night

### 10.15.2 Dolphin Conservation Plan

All coal carrying vessels should be obliged by IMO Conventions signed by GOB and national Environmental Regulations to ensure minimum impact on dolphin community and habitats. Vessels should be plying following the existing navigational routes. Speed of the vessels should be maintained within 7-8 knots. Standard operation practice should be followed in shipping and barging activities. All shipping and barging activities shall ensure zero waste dumping, zero ballast water dumping, zero pollution causing activities as per the IMO Conventions and national Environmental Regulations. DG Shipping, BIWTA, Port Authority, Coast.

Guard should regularly inspect shipping and barging activities to enforce the relevant conventions and rules. In addition, following measures should be taken into account during shipping and barging activities and other project related activities:

- Avoid dredging activities during surfacing and swimming time of Dolphin i.e. at dawn and evening
- No trapping and killing of Dolphin
- Plan measures for accidental oil spillage, refueling
- Anchorage of water vessel only in designated sites

- Throttle down vessel speed if dolphin activities are seen in navigational route
- Keeping noise from shipping and barging activities within the limit of ECR 1997
- Ensure zero waste dumping, zero ballast water, bilge water, oily water, etc dumping

### 10.15.3 Fisheries Management Plan

Fish management plan has been developed with the aim of avoiding pollution causing activities and to protect fisheries of the Rabnabad Channel and Andharmanik River. The EMP includes the followings:

***Measures for navigational activities***

- Enforcement of ECR 1997, IMO Conventions, MARPOL, etc
- Ensure non dumping of ballast water, non spillage of oil, non discharge of waste water and non dumping of wastes
- Spot check of shipping and barging activities by relevant agencies.
- Awareness growing for fisher and facilitate the fisher to use nets/boats provided with signals and marking
- Reduce speed if net is seen across the navigational route
- Ensure implementation of other EMP for coal transportation

***Measures for plant operation***

- Should follow the EMP for effluent discharge
- On-site wastewater should be treated to achieve maximum reuse and recycling.

***Measures for Water Intake Structure***

- The water supply pipeline intake point from the River should be provided with sufficient screening to filter out larger aquatic organisms (e.g., fish, frogs, and toads) and foreign matter, preventing this material from being drawn into the pumps
- Drum screens need to be adopted in order to limit the entrainment of fish in the cooling water system and intake velocities should be as low as possible.
- The water velocity in the intake channel should be below 0.5 m/s during normal conditions.
- Temporary water reservoir can be built for water storage rather than direct abstraction from river.
- Monitoring should continue to ensure that the deterrents are working effectively.

## 10.16 Employment Generation Plan

Preference should be given to the local labors in requirement of permanent and temporary post (both technical and non-technical). This recruitment may help to reduce the poverty status of the whole study area.

## 10.17 Rural Electrification Plan

Locality of the power plant area may be benefited by allocating certain loads from the national grid if possible. Relevant authority may formulate necessary rural electrification plan in order to satisfy both affected and unaffected people of that region.

# CHAPTER 11

## 11. RISK ASSESSMENT

The hazard and risk assessment including occupational hazard and safety analysis have been carried out based on the hazard and risk assessment carried out. In the EIA, hazard assessment has been carried out to identify the potential hazard associated with or inherent in the design process and to identify possible measures to avoid the hazard along with the safety plan for minimizing the risk. Incorporating these measures and safety plan in design, planning and operational procedure of the proposed power plant the potential hazard points can be eliminated.

### 11.1 Consequence Analysis

The potential hazards, root causes and the consequences were identified through hazard assessment. The hazards points were identified for pre-construction, construction and post-construction stages. Moreover, specific safety measures were identified for each of the identified hazards. Given the scope of EIA study, the findings of the hazard assessment with suggested safety plans are presented in **Tables 11-1** and **Table 11-2**.

**Table 11-1: Hazard assessment for the proposed power plant construction and operation**

| Hazard Point | Use | Potential hazard | Root causes | Consequences | Suggested safety measures |
|---|---|---|---|---|---|
| **Pre-Construction** | | | | | |
| Machinery and equipment | Site clearance activities | Accident | Unconsciousness, mechanical failure, | Health injury, life loss | Regular inspection and maintenance. Use of PPEs |
| **Construction** | | | | | |
| High heights | Construction of building, steel structure and its foundation, painting works, drilling work, etc | Falling during works | Unconsciousness, equipment failure | Health injury, life loss | Fall protection, use of PPE, awareness |
| Motor vehicle | transportation | Noise, accident | Noise from engine running, tire friction, Hydraulic horn, Mechanical failure, unconsciousness, | Health injury, life loss | Traffic safety measures, regular checking, servicing and maintenance of vehicle, awareness |
| Cutting and welding | For construction purpose | Burning, electrocution | Electric failure, lack of training, exposure to workers and passerby | Eye injury, health injury | Proper training, PPE, awareness, warning signal for passerby and adoption of welding standard practice. |
| Handling of hazardous chemical | For construction and storage purpose | Accidental release, explosion | Accidental failure, mechanical failure of handling equipment, unconsciousness | Health injury, life loss, loss of environmental quality | Regular maintenance of equipment, careful handling, following safety procedure, labeling of chemical specification and potential hazards, keeping Material Safety |

| Hazard Point | Use | Potential hazard | Root causes | Consequences | Suggested safety measures |
|---|---|---|---|---|---|
| | | | | | Data sheet |
| **Operation** | | | | | |
| Turbine and its ancillary components | Converts pressure and temperature of the generated steam into mechanical energy | Mechanical and fire hazard | Mechanical failure | Health injury, loss of life, loss of Environmental quality & damage of equipment. | Safe design, regular inspection, continuous monitoring, computerized controlling system and monitoring. Installation of fire defense and fighting systems. |
| Circulating cooling water pump station | Pump water from river to cooling system | | | | |
| Generator | Converts mechanical energy into electrical energy | Mechanical, electrical, fire hazard and short circuit, noise | Mechanical and electrical failure, | Health injury, loss of life & damage of equipment. | As above |
| Cable gallery | Transmit electricity from generator to unit transformer | Fire in cables galleries, short circuit in control room and switch gears | Fire hazard, Mechanical/electrical failure in generator, malfunction of ventilation system | Health injury, loss of life & damage of Cables | As above, Proper ventilation system, insulation of cables with non-inflammable fire resistance sealing materials |
| Power transformer | High voltage (230KV) power transmission | Fire and explosion | Electric short circuit, lightning, External fire hazard, etc | Health injury, loss of life, loss of environmental quality & damage of equipment. | Maintaining of the specific standard for all electric fittings and cables, insulation of covering of electric cable with non-inflammable fire resistance sealing materials. Installation of fire fighting system including water deluge |

| Hazard Point | Use | Potential hazard | Root causes | Consequences | Suggested safety measures |
|---|---|---|---|---|---|
| | | | | | System. |
| Switchyard | Open air power transmission | Electric fire, electrocution of the workers and passerby due to exposure to generated magnetic field and electric field | External fire, electrical failure, lightning, etc | Health hazard, loss of life. Loss of environmental quality from induced fire hazards including damage of equipment and accessories. | As mentioned above for power transformer, Installation of light arrestor, keeping safe distance from right of way, fencing, warning signal, fire fighting system and portable fire extinguisher. |
| 230KV Switchyard control room | Controlling and monitoring the power transmitting system | Electric fire in cable gallery and switch | Electrical failure, external fire | As above | As mentioned above for power gallery and power transformer, |
| Boiler and pressure parts | Coal combustion and steam generation | Fire (near burner) steam, explosion | Failure of the water pumps, busting of furnace and pressurized pipes, contaminant present in fuel, accidental leakage, lack of heat sink for combustion process and non functional safety and by pass valve. | Incomplete combustion, equipment damage, health injury, life loss, environmental degradation, | Control system to monitor and regulate temperature, intake air, and furnace system. Monitoring fuel quality & safety system. Provision of fire fighting and safety |
| Compressed air system and pipeline | Operate, pressure bulb, switch and control system | Explosion | Mechanical failure of safety switch and bulbs | Equipment damage, health injury | Safety bulb, limited entry, use of PPE, Control system to monitor required pressure at different points. |

| Hazard Point | Use | Potential hazard | Root causes | Consequences | Suggested safety measures |
|---|---|---|---|---|---|
| Live steam line | Flows live high pressure steam from boiler to turbine | Explosion, High pressure steam build-up | Blocking of line, throttled valve, line rupture and pressure loss at the weaker points | Damage to equipment, health injury | Regular monitoring and testing of all pipe lines. Provision of fire fighting and safety |
| Fuel stockpile | Fuel supply to the boiler | Fire hazard and explosion, self combustions in coal stock pile | Quality deviation of coal, lack of maintenance of storage system and monitoring | Damage to equipment, Health injury, Loss of air quality | Availability of appropriate fire hydrant with auto water sprinkler and regular monitoring |
| Water pre-treatment, treatment and waste water treatment plant | Produce clarified, dematerialized water for steam generation and treat effluent water before discharge | Chemical hazard | Chemical spillage and misuse, accidental release | Health injury, Loss of life, degradation of air, water and soil quality | Chemical use safety, Limited entry, use of PPE, available spill kits in case of accident, safety shower, eye wash and first aid facilities |
| Chemical storage | Use for water treatment in different phases of dematerialized water, cooling water and potable water. | Toxic accidental release due to multifunction of equipment & callousness of operator. | Chemical spill and misuse | Damage to equipment, Health injury, Loss of life, degradation of air, water and soil quality | Limited entry in storage, PPE, available spill kits in case of accident, safety shower, eye wash and first aid facilities |
| Different oil system | Different bearing cooling, | Fire, mechanical failure of any equipment or parts, oil spillage | Failure of temperature monitoring system | Damage to equipment, Health injury, Loss of life, degradation of air, water and soil quality | Continuous monitoring, safety bulb, safety measures for fire hazards and oil spillage |

| **Hazard Point** | **Use** | **Potential hazard** | **Root causes** | **Consequences** | **Suggested safety measures** |
|---|---|---|---|---|---|
| SOx absorber | Use for maintaining rate of sulfur emission as per design standard | Toxic accidental release, Air pollution | Discharge of sulfuric acid due to technical failure in sulfur absorption system | Damage of air quality as well as surrounding ecosystem | Regular monitoring of absorption system and quality of coal |
| Blocked filters (Particulate filter system) | Filter out particles during combustion | Toxic gas release, Atmospheric pollution | Generation of excess coarse size particles due to incomplete combustion of coal | Hazard to human health and surrounding environment | Regular maintenance, alert temperature, oxygen and CO alarms |
| Non-functional ESP | Remove fine particulate fly ash | Toxic accidental release | Malfunction of device and equipment failure, lack of monitoring | Equipment damage and environmental degradation | Proper monitoring of combustion process and functioning of boiler. |
| Air circulating system | Use for generated air flow both into and out of boiler | Non-functional air circulating system | Failures of fans, incomplete combustion | Equipment damage and risk to human health and surrounding environment | Regular maintenance and monitoring control system, functioning of FD, ID Fans and vacuum systems. |
| Non-functional lightning arrestor | To arrest thunder and keep the equipment safe | Risk of lightning | Malfunction | Equipment damage and electric fire, short circuit | Regular testing and maintenance following the specification provided by the manufacturer |
| Lack of safe working condition | To maintain accident free working atmosphere | Risk of major, minor & fatal accident | Due to unsafe working condition and unawareness of workforce | Health injury, Electrocution, organ loss including death | Keeping all safety & precaution measures in order, maintaining first aid & well equipped primary health centre & training on awareness. |

**Table 11-2: Hazard assessment for coal transportation and handling**

| Hazard Point | Root Cause | Potential hazard | Consequences | Suggested safety measures | Remarks |
|---|---|---|---|---|---|
| Fuel spillage from FC/FTV during refueling | • Unskilled operation of refueling<br>• Mechanical failure<br>• Ignorance of operational procedure, principal<br>• Ignorance of Rules and Regulations | • Spillage of heavy oil/light oil during refueling of FC/FTV | • The spilled oil will be transported by prevailing wind and tide. During dry season northwesterly wind is dominant that will transport the spilled towards Bay of Bengal. The transportation time will depend on wind speed and tidal condition. Oil spillage may have impact on marine | • The fuel suppliers shall practice standard refuelling and operating procedure to be specified by the BCPCL/coal transportation agency in tender document<br>• The suppliers should be well trained and equipped<br>• The responsible agencies (DoE, PA, DG Shipping, BCPCL etc) shall inspect and spot check the operation periodically.<br>• Environmental Rules and Regulations of the Country and IMO conventions shall have to be obliged by the suppliers.<br>• DG Shipping, BIWTA and PA shall enforce and monitor the relevant rules and regulation to ensure best operation practice.<br>• PA should prepare an | If the suggested safety measures are followed properly during operation, the possibility of the hazard would be very low. |

| Hazard Point | Root Cause | Potential hazard | Consequences | Suggested safety measures | Remarks |
|---|---|---|---|---|---|
| | | | | Emergency Response Plan provided with emergency response equipments | |
| Ship Collision/wrecks | • Unskilled operation<br>• Poor loading<br>• Poor ship condition<br>• Extreme weather condition<br>• Mechanical failure<br>• Ignorance of navigational signals, warning and safety laws | • Discharge of oil/oily water<br>• Coal Pollution<br>• Injuries or fatalities of employees<br>• Navigational obstruction | • The spilled oil will be transported by prevailing wind and tide. During dry season northwesterly wind is dominant that will transport the spilled towards Bay of Bengal. The transportation time will depend on wind speed and tidal condition. Oil spillage may have impact on aquatic ecosystem.<br>• Wrecks might obstruct navigational activities if not rescued properly.<br>• Environmental and Ecosystem Damage<br>• Injuries and fatalities | • Tender documents for CoalTransportation shall include specifications of Ships and Barges<br>• All the coal carrying vessels shall be certified and monitored by DG Shipping and IMO<br>• Standard operating procedures (SOPs) for loading and handling of coal to be specified by the Coal Transportation Agency shall be followed<br>• Mother Vessel shall be guided by the facilities of PA<br>• The barges shall be navigated by Certified Master Pilots<br>• Periodical training shall be provided by the coal transportation agencies<br>• Cooperation between GoB departments to | Probability of ship collision may be rare if the suggested safety measures are properly followed. |

| Hazard Point | Root Cause | Potential hazard | Consequences | Suggested safety measures | Remarks |
|---|---|---|---|---|---|
| | | | | develop, implement an enforce robust legislation and systems to predict and disseminate information regarding impending adverse weather conditions<br>• Suspension of barge operations in adverse weather conditions.<br>• Coal barges shall be complied with COLREGS and other legislative instruments of DG Shipping<br>• DG Shipping, PA and<br>• BIWTA should enforce and monitor rules, regulation and IMO conventions (signed by GOB).<br>• Transportation Agency shall follow PA, BIWTA, DG Shipping's guideline and emergency response plan in case of collision | |
| Coal spillage from cargo | • Extreme weather condition<br>• Poor loading | Coal Pollution | • Contamination of water column with coal particles | • Coal transportation Agency shall prepare a best operation | PA and BIWTA regularly circular cyclone and |

| Hazard Point | Root Cause | Potential hazard | Consequences | Suggested safety measures | Remarks |
|---|---|---|---|---|---|
| | | | • Local changes of water quality:<br>– Increase in turbidity and DO<br>– Change of salinity and acidit | procedure for loading, unloadingand operation of the coal carrying vessels<br>• Transportation Agency shall follow PA, BIWTA, and DG Shipping's guideline and emergency response plan in case of collision<br>• DG Shipping, PA and BIWTA should enforce and monitor rules, regulation and IMO conventions (signed by GOB).<br>• Coal barges shall be complied with COLREGS and other legislative instruments of DG Shipping<br>• Operation shall be carried out following navigational information, signals and warning of PA and BIWTA.<br>• The barges shall be navigated by Certified Master Pilots<br>• Periodical training shall | storm forecast of BMD. If the warning is properly followed and coal loading activities are properly operated, the risk of coal spillage may be very rare. |

| Hazard Point | Root Cause | Potential hazard | Consequences | Suggested safety measures | Remarks |
|---|---|---|---|---|---|
| | | | | be provided by the coal transportation agencies | |
| Coal dust from Ship Holds | • Poor dust suppression system<br>• Poor moisture<br>• Wind action | • Exposure to coal dust<br>• Air pollution | • Dry and wet deposition of coal dust on surrounding area | • Coal surface moisture shall be maintained above 7% to control coal dust generation<br>• Mother vessel shall have dust suppression system<br>• FTV shall be equipped with dust suppression system to control dust generation from ship holds,loading/ unloading activities and to moisturize coal during loading of barge | In general, coal is loaded n the mother vessel with proper moisture to control coal dust generation. Vessels are also equipped with dust suppression system at ship holds. Hence, generation of coal dust from the ship hold may be minimum. |
| Fire at Ship Holds | • Poor fire prevention system<br>• Poor dust suppression system | • Fire<br>• Injuries and fatalities<br>• Damage to ships | • Fire at ship holds | • Use of heat monitoring instrument<br>• Use of moisture monitoring instruments<br>• Periodical training for barge and FC/FTV operators | If the inbuilt fire preventing equipment (water gun or spray system) is properly operated the coal fire at holds of barge and ships can be controlled.Hence, possibility of fire at ships hold may be rare. |
| Shoreline erosion | Wave generated from | Shoreline erosion | • Loss of land | • Control barge speed. | In general, wave |

| Hazard Point | Root Cause | Potential hazard | Consequences | Suggested safety measures | Remarks |
|---|---|---|---|---|---|
| | barging and shipping activities | | | • Use of barges with low wake.<br>• River bank protection at vulnerable areas | generated from barge moving with 7 knots are relatively shallower to have impact onshoreline. |
| Ship Pollution | • Ignorance of rules and regulation<br>• Malpractice<br>• Unskilled manpower | Discharge of ballast water, bilge water from Ships | • Deterioration of river water quality<br>• Ecosystem damage<br>• Impact on Fisheries | • DG Shipping, BIWTA and PA shall enforce and monitor the relevant rules and regulation, IMO conventions, MARPOL to ensure best operation practice. | Discharge of any kind of waste, waste water, ballast water, bilge water are strongly prohibited by ECR 1997, Port Act, IMO Conventions, MARPOL, etc. If the rules and conventions are properly enforced, the possibility of any pollution from ship would be rare. |
| Occupational Hazard | • Lack of consciousness<br>• Unskilled operation<br>• Bad weather<br>• Ignorance of safety | Injuries and fatalities | • Loss of health<br>• Loss of life<br>• Loss of working hour | • Enforcement of SOLAS conventions, IMO Conventions by DG Shipping, BIWTA and PA | GOB has adopted different IMO Conventions and SOLAS conventions that |

| Hazard Point | Root Cause | Potential hazard | Consequences | Suggested safety measures | Remarks |
|---|---|---|---|---|---|
| | procedures | | | | are enforced to ensure safety on Ships. |

## 11.2 Emergency Response Plan

Safety plan has been developed based on safety measures identified through hazard assessment process. During hazard assessment including occupational hazard, safety measures for each potential hazard were identified. Incorporating the identified hazard safety measures, this safety plan has been developed. The safety plan includes fire safety plan, explosion safety plan, electrocution safety plan, medical emergency plan and hazardous material management plan. Proposed Payra Port Authority and BIWTA shall prepare emergency response plan for ship collision, oil spillage and pollution from ships. The tender documents of BCPCL for engaging coal transportation shall include relevant rules and regulation (described in Chapter 2) that have to be obliged by the transportation agency. The detail plan including safety and emergency preparedness are presented in **Table 11-3**.

**Table 11-3: Safety and emergency Plan**

| Hazard | Safety Plan | Responsible person | Emergency Plan | Responsible Person |
|---|---|---|---|---|
| Fire | Fire prevention, instruction and training of staff, maintenance of escape route, fire protection systems and equipment, maintenance of fire safety register, provision of information to workers, reporting | Emergency Manager, Fire Officer | Fire alarm system, exit system, fire extinguishing equipment, smoke control equipment, fire and emergency evacuation plans, drills, assistance to the fire brigade | Fire Safety Director |
| Explosion | Explosion prevention, instruction and training stuff, maintenance of escape route, explosion protection systems and equipment, provision of information to building users, regular inspection and monitoring of pressure parts and units, reporting | Employer, owner, occupier | Explosion and emergency evacuation plans, exiting the building as quickly as possible and move to designated evacuation areas, roadways and walkways should be clear for emergency vehicles and crews | Emergency Personnel |
| Electrocution | Prevention measures, instruction and training of staff, maintenance of escape routes, proper training, awareness, control room, reporting | Supervisor, Coordinator | Prevention and precaution from electricity and avoid contact with overhead lines | Safety Officer |
| Medical | Provision of Health service center, Provision | Chief Medical | Rescue action, first aid, ambulance services, | Rescue Officer |

| Hazard | Safety Plan | Responsible person | Emergency Plan | Responsible Person |
|---|---|---|---|---|
| | of on duty trained medical officers specializing in burn injury, orthopedics, electrocution, chemical toxicity or poisoning and shock treatment. | Officer | transportation facilities | |
| Hazardous Material Management | Safe design, regular inspection, continuous monitoring, regular maintenance, reporting | Emergency Manager | Internal alarm, notification, use of personal protective equipment | Hazard responding agencies |

Note; Emergency personnel means safety officers, medical officers, fire fighter, rescue offices and other responsible persons

### 11.2.1 Safety training

In order to reduce the risks associated with accidents, internal and external threats, and natural disaster a safety training program is essential for workers in plant operation. There should be a regular training program on safety for the workers to increase their awareness and also to reduce the risks. Provision of yearly professional training for health and safety, would enhance the effectiveness of safety. Safety training should be planned for the local people living around the project area so that they can be aware about the risk possessed by the power plant and can take appropriate preparedness. The suggested training schedule has been shown in **Table 11-4**.

**Table 11-4: Present the training schedule that should be adopted for safety**

| Target Trainee | Training Schedule |
|---|---|
| Worker | Four training per year |
| Professional | Two training per year |
| Local People | Two training per year |
| Drivers | Four training per year |
| Safety Professional | Two training per year |

In addition, there could be a discussion and awareness session for increasing awareness on safety in each kind of meeting. The employee should regularly practice toolbox meeting and job safety analysis.

### 11.2.2 Documenting and reporting

Implementation status of the safety plans should be monitored and documented regularly. Monthly monitoring report should be prepared based on regular inspection and should be submitted to the Managing Director of the Power Plant. Any kind of incidents or even near misses should be documented and reported to the Managing Director.

### 11.2.3 Environmental safety management team

There should be provision of Environmental Safety Management Team with responsibility of implementation, inspection, documentation, and reporting of the safety plans. The team will also be responsible for implementing emergency plans under the Directorate of Environment, Health and Safety. The team should be a combination of multidisciplinary professionals. The team composition could be as:

- Environmental Quality and Safety Manager (Team Leader)
- Emergency Manager
- Fire Safety manager
- Safety Manager
- Chief Security Officer
- Security Officer
- Chief Medical Officer
- Medical Officer
- Rescue Officer

### 11.2.4 Hazardous and toxic material management plan

Hazardous materials (HAZMAT) management must be done in a manner that is conducive to the maintenance of the safety and health of all employees and in accordance with national legislation, regulations and procedures as per ECA 1995 and ECR 1997. World Bank Group. Environmental Health and Safety Guideline should be followed in management of hazardous and toxic materials. Proper management of the hazardous materials will minimize the risk of public, environment and financial cost. Therefore, proper planning will be needed to efficient documentation, storage, handing, transportation and disposal of the hazardous materials. The following philosophy should be taken into account for appropriate management of hazardous and toxic management plan:

- Categorization of the toxics or hazardous materials depending on the potential impacts
- Producing data inventory for each of the hazardous materials throughout the production cycle
- Listing of the hazardous or toxic materials with its persistence life
- For proper documentation, a comprehensive data sheet/inventory should be developed. Computer based Management Information System (MIS) is a best tools for inventory management
- The inventory should contain name and description, classification, threshold, quantity, characteristic, HAZMAT quantity to be used in a month
- Appropriate labels must be affixed to containers holding hazardous substances, including those substances that have been decanted from their original container
- Safety measurement has to be taken care for storage of the hazardous materials
- Appropriate personal protective equipment (PPE), engineering controls have to be taken during storage, handing and management of hazardous and toxic materials
- Appropriate equipment, safety measures and accidental cases have to be taken at every steps of hazardous materials management for the safety of human health and environment
- Try to minimize the hazardous waste generating materials in the production system

- Efficient hazardous waste removal plant has to be detailed out considering the toxicity and potentiality of the hazardous materials
- Leaching proof canal line and site has to be constructed for hazardous waste transportation
- All categories of hazardous waste have a specific waste container and disposed maintaining the regulations
- Regular monitoring needs to carry out at every level of storage, handling and management of hazardous and toxic materials
- Legislative or regulatory action has to be taken for zero hazardous wastes disposal
- Hazardous Material Management Guideline of World Bank Group 11 Section 1.5 of the EHS Guideline of World Bank Group

## 11.3 Risk Mitigation Measure

Hazard & risk Management Plans are developed to address a range of plausible hazard scenarios and emphasize the tasks required to respond to a physical event. The Hazard Management Plan for the proposed power plant has been developed listing various actions to be performed in a very short period in a predetermined sequence if it is to deal effectively and efficiently, major and minor accidents, and even near misses. The primary objective of the plan is to keep the workplace safe and to achieve zero incidents for health hazard, and to minimize the potentiality of material, machinery/equipment damage, impacts on the environment to minimum.

The plan should include:

- Fire safety plan
- Explosion safety plan
- Electrocution safety plan
- Medical emergency plan
- Hazardous material management plan

### 11.3.1 Hazard assessment process

Attempt has been made to identify and evaluate the potential points of the hazards with possible safety plan. The assessment also includes occupational hazard and safety analysis.

Steps followed in this assessment are mentioned below:

1. Identification of potential hazard points
2. Hazard cause identification
3. Consequences of exposure
4. Risk management
5. Safety plan

The hazard assessment was carried out based on the experience gained through visiting expert opinion and secondary literature. Effort was made to identify the potential hazards possessed by the proposed thermal power plant. Cause and consequence analysis was carried out to identify the root cause and potential consequence. Apart from the hazard assessment, remedial measures for safety were suggested.

### 11.3.2 Hazard categorization and potential hazard points

#### 11.3.2.1 Plant construction and operation

The potential hazards associated with the plant construction and operation screened preliminary assessment have been categorized for identifying the root cause and consequences. The potential hazard points are listed in **Table 11-5**.

**Table 11-5: Potential hazard points possessed in proposed coal based thermal**

| Hazard Category | Hazard Point |
|---|---|
| Mechanical | Turbine and its ancillary components |
| Electrical | Generator and its ancillary components |
| | Cable gallery |
| | Power transformer |
| | Switchyard |
| | 230KV switchyard control room |
| | 230KV transmission line |
| Fire and Explosion | Boiler and its pressure parts |
| | Live steam line |
| | Fuel stockpile (Heavy fuel and coal) |
| Toxic/Carcinogenic chemical exposure | Chemical storage |
| | Discharge of Sulfuric acid from SOx absorber |
| Failure mode hazard | Blocked filter |
| | Non-functional ESP |
| | Non-functional NOx absorber |
| | Non-functional dematerialized water and waste water treatment plant |
| | Non-functional air circulating system |
| | Non-functional lightning arrestor |
| | Safe working place |

#### 11.3.2.2 Coal transportation and handling

Hazard and risk assessment have been carried out for smooth operation of the coal transportation ensuring environmental safety. Through preliminary assessment process the following hazards have been identified in **Table 11-6**.

**Table 11-6: Potential hazards associated with coal transportation and handling**

| **Hazard Category** | **Hazard Points** |
|---|---|
| Fuel Spillage | Floating Crane (FC)/Floating Transfer Vessel (FTV) |
| | Purpose built Coal Carrying Barge |
| | Mother Vessel |

| Hazard Category | Hazard Points |
|---|---|
| Discharge/Spillage of fuel/oily water | Wrecks/collision |
| Coal pollution | Floating Transfer Vessel (during adverse climate) |
| | Project site stockyard (during adverse climate) |
| | Wrecks |
| Coal dust | Ship holds |
| | Floating Transfer Vessel |
| | Unloading/loading operation |
| | Project site stockyard |
| Fire | Ship holds |
| | Floating Transfer Vessel |
| | Project site stockyard |
| Wave erosion | Erosion vulnerable place of river bank |
| Injuries and fatalities | Mother vessel |
| | Barge |
| | Coal terminal |

#### 11.3.2.3 Occupational Hazard Assessment

Plant operation will involve working on high height, near rotary machinery and parts, high voltage yards, storage, handling and use of hazardous materials like heavy fuel, coal, chemicals, etc. Work place hazard assessment and safety are therefore important for the safety of the employees and the plant as well. Besides, the health status of the employees is also important which may affect the working efficiency. Hazard assessment and job safety analysis are very much essential for ensuring the safe working place for the employees. The **Table 11-7** presents the potential occupational hazards with safety measures.

**Table 11-7: Occupational Hazard and Safety Analysis**

| Hazard | Source | Consequences | Safety measures |
|---|---|---|---|
| Stuck by | Falling/moving pipe, tools/ debris dropped from elevated location, vehicles, any rotator machinery or parts, turbine and its ancillary | Health injury, loss of life | Fall protection, use of Personal Protection Equipments (PPE) |
| Fire | Cable gallery, power transformer, generator, turbine and its ancillary components, furnace, switchyard, switchyard control room fuel stockpile | Health injury and loss of life | Adoption of fire safety for each equipments and machinery subject to fire hazard<br>Use of PPE Consciousness during working period. |
| Explosion | Fall from elevated areas, high heights, | Health injury, loss of life | Fall protection, awareness, use of PPE |
| Electrocution | Cutting and welding, | Health injury | Use of PPE, Proper |

| | | | |
|---|---|---|---|
| | switchyard, cable gallery, | and loss of life | training, awareness, keeping safe distance from hazardous points, maintaining safety of high switchyard, cable gallery, control room |
| Intoxication/ Toxic exposure | Chemical storage, Sox absorber, Blocked filters (Particulate filter system), Non-functional ESP | Health injury, Loss of life | Safe storage of chemicals<br>Safe working condition<br>Use of PPE, Emergency Health Services |
| Health | Lack of safe working condition, employee having contagious disease | Health injury, Electrocution, organ Disease outburst, loss of health, loss of life | Keeping all safety & precaution measure in order, maintaining first aid & well equipped primary health centre & training on awareness<br>Monthly health inspection, provision of medical leave for labor, awareness |

# CHAPTER 12

## 12. ENVIRONMENTAL MONITORING PLAN

### 12.1 Monitoring Plan

The environmental monitoring programme has been devised with the following objectives:

- To evaluate the effectiveness of the proposed mitigation measures and the protection of the ambient environment as per prescribed/ applicable standards for the Project;
- To identify the need for improvements in the management plans;
- To verify compliance with statutory and community obligations; and
- To allow comparison against baseline conditions and assess the changes in environmental quality in the Project area.

Following **Table 12-1** shows the Environmental and Social monitoring plan during construction and operational phase

**Table 12-1: Environmental Monitoring Plan (Construction and Operation Phase)**

| Project Stage/ Affected Component | Environmental Issue | Parameters to be Monitored | Location | Measurements | Frequency | Responsibility | Cost |
|---|---|---|---|---|---|---|---|
| **Site Preparation and Construction Phase** | | | | | | | |
| General | Inspection of mitigation compliance | General compliance with mitigation measures presented in the EMP and as specified in EPC Contractor Manual | Project activity areas and construction workers camp | Visual inspection of all active work areas | Daily | EHS Team of EPC Contractor | EPC Contractor Cost |
| Ambient Air Quality | Dust generation | SPM, PM 2.5, PM10, CO,SOx, NOx | 6 sample from the Project boundary and surrounding village<br>Location: Project site<br>GPS Point:<br>21°59'36.71"N 90°18'3.29"E<br>Location: Londa Kheya Ghat<br>GPS Point:<br>22° 0'40.67"N 90°16'43.35"E<br>Location: Dhankhali Union Complex<br>GPS Point:<br>22° 2'17.32"N 90°19'23.42"E<br>Location: Nishanbari Village<br>GPS Point:<br>22° 0'27.59"N 90°18'36.73"E<br>Location: Tiakhali Village<br>GPS Point:<br>21°59'16.74"N 90°16'32.70"E | 24-hour | Quaterly | 3rd Party Environmental Consultant | EPC Contractor |

| Project Stage/ Affected Component | Environmental Issue | Parameters to be Monitored | Location | Measurements | Frequency | Responsibility | Cost |
|---|---|---|---|---|---|---|---|
| | | | Location: Lalua<br>GPS Point:<br>21°58'26.19"N 90°18'0.26"E | | | | |
| Noise | Increase in ambient noise levels | Noise levels in Leq, Leq day, Leq nigh and hourly Leq | Location: Char Nishanbari Primary School<br>GPS: 21°59'33.66"N 90°18'35.96"E<br>Location: Char Nishanbari Mosque<br>GPS: 21°59'38.18"N 90°18'33.69"E<br>Location: Rafique Mia's House, Nishanbari Village<br>GPS: 21°59'29.40"N 90°18'8.05"E<br>Location: Londa Kheya Ghat<br>GPS: 22° 0'42.08"N 90°16'44.23"E<br>Location: Monir Hossain's House, Nishanbari village<br>GPS: 22° 0'30.58"N 90°18'33.61"E<br>Location: Salam Uddin's House, Tiakhali village<br>GPS: 21°59'36.98"N 90°16'37.53"E<br>Location: Akber Mia's House, Lalua<br>GPS: 21°59'14.37"N 90°17'44.09"E<br>Location: Sabder Ali's House, Madhupara | 24-hour Once every fortnight | Monthly | 3rd Party Environmental Consultant | EPC Contractor |

| Project Stage/ Affected Component | Environmental Issue | Parameters to be Monitored | Location | Measurements | Frequency | Responsibility | Cost |
|---|---|---|---|---|---|---|---|
| | | | GPS: 22° 0'20.47"N 90°17'3.90"E | | | | |
| Soil | Quality of filling earth/ sand | pH, salinity, NH4+, total P, heavy metals, oil & grease | Barge/ trawler | Standard analytical methods | The first delivery from any source and then random sampling of deliveries from that source | 3rd Party Environmental Consultant | EPC Contractor |
| Water | Contamination of surface water | Turbidity, pH, DO, Total dissolved solids, oil & grease, total coliform, heavy metals | Rabnabad Channel/Kajol River (close to Project boundary) at 2 locations (upstream and downstream) Upstream: 22° 0'39.33"N 90°16'42.21"E Downstream: 21°59'19.24"N 90°18'40.55"E | Standard Analytical methods | Monthly | 3rd Party Environmental Consultant | EPC Contractor |
| | Ground water quality | Drinking water quality parameters as per Schedule 3 of ECR 1997 | Location: Project Site GPS: 22° 0'7.74"N 90°18'41.78"E Location: Londa Kheya Ghat GPS: 22° 0'40.18"N 90°16'42.61"E | Standard Analytical methods | Monthly | 3rd Party Environmental Consultant | EPC Contractor |
| Occupational Health and Safety | Accidents or incidents due to construction | Near-misses, incidents, occupational | Project activity areas and construction workers camp | As defined in construction phase Health & | As defined in H&S Plan | EHS Team of EPC Contractor | EPC Contractor |

| Project Stage/ Affected Component | Environmental Issue | Parameters to be Monitored | Location | Measurements | Frequency | Responsibility | Cost |
|---|---|---|---|---|---|---|---|
| | activities, workers' health | diseases, dangerous occurrences | | Safety Plan to be prepared by EPC contractor | | | |
| Community Health and Safety | Community disturbance and potential safety hazard due to road traffic | Accidents, incidents and complaints | Approach Road | Incidents, accidents and community complaints | Based on occurrence | EHS and/or Community Liaison Officer of EPC Contractor | EPC Contractor |
| Land acquisition and livelihood restoration | Loss of land, loss of earning | Details will be covered in RP | Project activity area | Will be covered in RP | Regularly during RP implementati on and follow up | BCPCL/ District Administration | Part of RP Implementati on Budget |
| **Operational Phase** | | | | | | | |
| General | Inspection of mitigation compliance | General compliance with mitigation measures presented in the EMP and as specified in EPC Contractor Manual | Project activity areas and construction workers camp | Visual inspection of all active work areas | Daily | EHS Team of BCPCL | Included in operation and maintenance (O&M) cost |
| Climate | Meteorological Monitoring | Temperature, Humidity, Rainfall | Inside the plant and nearest meteorology station | Standard methods and secondary information | Continuous | BCPCL | O&M cost |
| Air Pollution | Stack emissions concentrations | NOx, SOx, CO, SPM | Main stack and by-pass stack | CEM | Continuous and twice in | BCPCL and 3rd Party | Installation included in |

| Project Stage/ Affected Component | Environmental Issue | Parameters to be Monitored | Location | Measurements | Frequency | Responsibility | Cost |
|---|---|---|---|---|---|---|---|
| | | | | | a year by 3rd party | Environmental Consultant | EPC Cost Monitoring and maintenance in O&M cost |
| | Ambient air quality | NOx, CO, $PM_{10}$, $PM_{2.5}$, $SO_2$ | 6 sample from the Project boundary and surrounding village<br>Location: Project site<br>GPS Point:<br>21°59'36.71"N 90°18'3.29"E<br>Location: Londa Kheya Ghat<br>GPS Point:<br>22° 0'40.67"N 90°16'43.35"E<br>Location: Dhankhali Union Complex<br>GPS Point:<br>22° 2'17.32"N 90°19'23.42"E<br>Location: Nishanbari Village<br>GPS Point:<br>22° 0'27.59"N 90°18'36.73"E<br>Location: Tiakhali Village<br>GPS Point:<br>21°59'16.74"N 90°16'32.70"E<br>Location: Lalua<br>GPS Point:<br>21°58'26.19"N 90°18'0.26"E | Standard methods | Quaterly | 3rd Party Environmental Consultant | O&M cost |

| Project Stage/ Affected Component | Environmental Issue | Parameters to be Monitored | Location | Measurements | Frequency | Responsibility | Cost |
|---|---|---|---|---|---|---|---|
| Noise | Noise generation by Plant equipment | Sound Pressure Level | 1 m from the noise generating equipment | Noise monitor | Monthly | BCPCL EHS Team or 3rd Party Environmental Consultant<br>In case of monitoring done by BCPCL, verification by 3rd Party Environmental Consultant | O&M cost |
| | Ambient noise | Ambient noise levels | Location: Char Nishanbari Primary School<br>GPS: 21°59'33.66"N 90°18'35.96"E<br>Location: Char Nishanbari Mosque<br>GPS: 21°59'38.18"N 90°18'33.69"E<br>Location: Rafique Mia's House, Nishanbari Village<br>GPS: 21°59'29.40"N 90°18'8.05"E<br>Location: Londa Kheya Ghat<br>GPS: 22° 0'42.08"N 90°16'44.23"E<br>Location: Monir Hossain's House, Nishanbari village<br>GPS: 22° 0'30.58"N 90°18'33.61"E | Noise monitor with data logger | Monthly | 3rd Party Environmental Consultant | O&M cost |

| **Project Stage/ Affected Component** | **Environmental Issue** | **Parameters to be Monitored** | **Location** | **Measurements** | **Frequency** | **Responsibility** | **Cost** |
|---|---|---|---|---|---|---|---|
| | | | Location: Salam Uddin's House, Tiakhali village<br>GPS: 21°59'36.98"N 90°16'37.53"E<br>Location: Akber Mia's House, Lalua<br>GPS: 21°59'14.37"N 90°17'44.09"E<br>Location: Sabder Ali's House, Madhupara<br>GPS: 22° 0'20.47"N 90°17'3.90"E | | | | |
| Water | Ground water quality | Drinking water quality parameters as per Schedule 3 of ECR1997 | Borewell water to be used for domestic purposes and treated water quality to be used for drinking<br>Location: Project Site<br>GPS: 22° 0'7.74"N 90°18'41.78"E<br>Location: Londa Kheya Ghat<br>GPS: 22° 0'40.18"N 90°16'42.61"E | Standard analytical methods | Quaterly | 3rd Party Environmental Consultant | O&M cost |
| | | | Madhupara,<br>Char Nishabari,<br>Nishanbari | Standard analytical methods | Monthly | 3rd Party Environmental Consultant | O&M cost |
| | Wastewater | Temperature, chlorine, pH, BOD5, COD, oil & grease, heavy metals, total fecal coliform | Outlet of discharge channel | Standard analytical methods | Monthly | 3rd Party Environmental Consultant | O&M cost |

| Project Stage/ Affected Component | Environmental Issue | Parameters to be Monitored | Location | Measurements | Frequency | Responsibility | Cost |
|---|---|---|---|---|---|---|---|
| | Surface water quality | Temperature, conductivity, pH, DO, TDS | Upstream: 22° 0'39.33"N 90°16'42.21"E Downstream: 21°59'19.24"N 90°18'40.55"E | Standard Analytical methods | Monthly | BCPCL EHS Team or 3rd Party Environmental Consultant | O&M cost |
| | | | | | Quarterly | In case of monitoring done by BCPCL, verification by 3rd Party Environmental Consultant | |
| Solid & hazardous waste | Internal domestic/ kitchen waste, and medical centre waste | Solid waste | Waste disposable point | Waste a quality | Daily | BCPCL | O&M Cost |
| Aquatic Ecology | Fisheries | Visible fish kills | Water intake and outlet and downstream of Rabnabad Channel | Visual inspection | Fortnightly | BCPCL EHS Team | O&M Cost |
| | Aquatic ecology | Phytoplankton, zooplankton and benthos | Rabanbad Channel and Andharmanik River | Abundance and Species composition | Quarterly | 3rd Party Environmental Consultant | O&M cost |
| | Fish survey | Fish fauna | Rabanbad Channel and Andharmanik River | Abundance, species composition, fish catch | Quarterly during initial 2 years of operations. Any further monitoring based | 3rd Party Environmental Consultant | O&M cost |

| Project Stage/ Affected Component | Environmental Issue | Parameters to be Monitored | Location | Measurements | Frequency | Responsibility | Cost |
|---|---|---|---|---|---|---|---|
| | | | | | on the analysis of results | | |
| Terrestrial Ecology | Ecology | Visible Flore and fauna monitoring | Plant surrounding area of 5km rdius | Abundance, species composition | Half yearly initial 2 years of operations. Any further monitoring basedon the analysis of results | 3rd Party Environmental Consultant | O&M cost |
| Works health and safety Monitoring | Accidents or incidents due to operation and maintenance activities, workers' health | Near-misses, incidents, occupational diseases, dangerous occurrence etc. | Project activities areas | As to be defined in the H&S plan to be prepared BCPCL | As defined in H&S plan | BCPCL EHS Team | O&M Cost |
| Community Health Monitoring | Community disturbance and potential safety hazard due to road traffic | Accidents, incidents and complains | Access Road | Accidents, incidents and complains | Based on occurrence | BCPCL EHS Team | O&M Cost |
| | Public Concern | Complains | Neighboring communities | As to be defined in the H&S plan to be prepared BCPCL | Continuous | BCPCL EHS Team | O&M Cost |
| Disaster Management Plan (DMP) Monitoring | Earthquake | Structure Design | Project Area | As to be defined in the DMP to be prepared BCPCL | Continuous | BCPCL EHS Team | O&M Cost |

| Project Stage/ Affected Component | Environmental Issue | Parameters to be Monitored | Location | Measurements | Frequency | Responsibility | Cost |
|---|---|---|---|---|---|---|---|
| | Flooding | Structure Design | Project Area | As to be defined in the DMP to be prepared BCPCL | Continuous | BCPCL EHS Team | O&M Cost |
| | Cyclone | Project Structure Design | Project Area | As to be defined in the DMP to be prepared BCPCL | Continuous | BCPCL EHS Team | O&M Cost |
| CSR Activities | Community Development | Activities/ Programmes and No. of beneficiaries | Neighbouring communities around the Project activity areas | No. of beneficiaries and outcome of the activities | Periodic and need based | Admin/ HR Manager and Station Manager | CSR Budget |

## 12.2 Action during Abnorman Operating Condition

### 12.2.1 Construction Phase

Prior to the beginning of major land works, the EPC contractor in cooperation with Project Developer will develop the following plans:

***Emergency Response Plan***

A site specific emergency response plan will be prepared for soil clean-up, decontamination and any accidental spill management on Rabnabad Channel.

***Health and Safety Plan***

The EPC Contractor will prepare and implement a Health and Safety Plan prior to commencing work. This plan will include method statements for working methods, plant utilisation, construction sequence and safety arrangements. Measures will be implemented to reduce the likelihood and consequence of the following hazards:

- falling from height;
- falling into water;
- entanglement with machinery;
- tripping over permanent obstacles or temporary obstructions;
- slipping on greasy or icy walkways;
- falling objects;
- asphyxiation;
- explosion;
- contact with dangerous substances;
- electric shock;
- mistakes in operation;
- variable weather conditions;
- lifting excessive weights; and
- traffic operations.

### 12.2.2 Operation Phase

During the operation phase of the Project, the Project Developer will develop the following plan/ management systems for effective operation of the Project:

***HSE and Social Management System***

The Project Developer will develop and implement an HSE and Social Management System (HSE&SMS) to international standards for the entire Plant premises and its impact zones (project area of influence as defined under IFC PS) within two (2) years of commissioning the Project.

***Waste Management Plan***

For effective segregation, handling, storage and disposal of solid and hazardous wastes generated from the Project operations, a waste management plan will be developed by the Project Developer.

***Spill Response and Emergency Plan***

The Project Developer will prepare a spill response and emergency plan to address accidental spillages or release of hazardous wastes.

***Emergency Response and Disaster Management Plan***

Based on the outcome of the consequence analysis, an emergency response and disaster management plan will be developed by the Project Developer. This will charter proper protocol to be followed in the event of a disaster in order to limit the impact on the local community. The plan will disclose potential disasters and potential risks from the plant to the local community as well as the plan of action on emergency protocol in the event of these accidents. This will also include awareness programs for the Plant personnel, local community and local administration.

## 12.3 Budget for Monitoring

The EPC Contractor and the Project Developer will allocate separate budget for environmental and social management plan implementation, training, environmental monitoring, analysis and reporting, verification monitoring and capacity building. It should be noted that cost for many in-built mitigation measures, such as, acoustic enclosures for noise control, water and wastewater treatment, CEM etc, are already included in the EPC contract cost estimate and/or operating cost estimates. The ESMP budget estimates for construction and operation phase of the Project has been provided in **Table 12-2**. In addition to that separate budget will be allocated for CSR activities, which will be conducted by the Project Developer for community development.

**Table 12-2: Cost of Environmental Monitoring During Construction and Operation**

| Activities/item | Unit | Unit No | Rate (USD) | Amount (USD) |
|---|---|---|---|---|
| **A. Monitoring Cost during Construction stage/ yr** | | | | |
| CSC (Environmental Specialist/Engineer) | Month | 12 | 3000 | 36,000 |
| Transportation for Site Visits | LS | | | 2,000 |
| Air Quality Testing | No | 24 | 3000 | 72,000 |
| Surface Water Quality Testing | No | 24 | 1000 | 24,000 |
| Ground Water Quality Testing | No | 24 | 1000 | 24,000 |
| Noise Quality Testing | No | 24 | 500 | 12,000 |
| Contingency | LS | | | 10,000 |
| **Total** | | | | **1,80,000** |
| **B. Operational Monitoring Cost/ yr** | | | | |
| Meteorological Monitoring | No | LS | | 3000 |
| Stack emissions concentrations | No | 24 | 1500 | 36000 |
| Ambient air quality | No | 24 | 3000 | 72000 |
| Noise generation by Plant equipment | No | 12 | 500 | 6000 |
| Ambient noise | | 12 | 500 | 6000 |
| Ground water quality | | 12 | 1000 | 12000 |

| Activities/item | Unit | Unit No | Rate (USD) | Amount (USD) |
|---|---|---|---|---|
| Wastewater | | 12 | 2000 | 24000 |
| Surface water quality | | 12 | 1000 | 12000 |
| Cooling water | | 12 | 500 | 6000 |
| Aquatic ecology | | 4 | 3000 | 12000 |
| Fish survey | | 4 | 3000 | 12000 |
| Ecology | | 2 | 5000 | 10000 |
| Community Development | | 4 | 5000 | 20000 |
| Contingency | LS | | | 10000 |
| **Total** | | | | **2,41,000** |

## 12.4 Reporting

A robust reporting system will provide the Project with the necessary feedback mechanisms to ensure quality and timely implementation of the works. The reporting system will ensure regular flows of information from the Project site to the Project headquarters and, as necessary, to regulatory authorities and funding agencies. The reporting system will provide a mechanism for ensuring that the measures proposed in the Project's EMP are implemented.

Before the civil works start, the EHS Division of BCPCL will finalise the format for reporting on the status and progress of environmental monitoring. The format will be designed to meet all the compliance conditions associated with the environmental clearance from the Department of Environment and the Government of Bangladesh. The contractor will be required to submit the duly filled up reporting form on a monthly basis to the Project Developer (i.e, BCPCL). A further report, detailing the results of pollution monitoring for air, noise, soil, and water will be submitted quarterly as envisaged in the monitoring plan. A health and safety incident/accident report will be prepared and submitted in the event of an incident or accident. The Operations Manager and EHS Personnel will monitor the effectiveness of the EMP implementation. The Project Administration and Human Resources (HR) Manager will have additional responsibility of monitoring the implementation of social components of the EMP. He/ she will also responsible for implementation of corporate social responsibility (CSR) activities to be conducted by BCPCL. Both Operations Manager and HR Manager will further report to the Station Manager, who will be overall incharge of the Plant operations and management.

The quarterly reports of the management measures will form an integral part of the Quarterly Progress Reports that can be submitted to the lenders. Additional compliance reports to the Regional Office and Head Office of the DoE required as a part of environmental clearance process shall also be prepared and submitted based on the necessary monitoring and reporting formats.

## 12.5 Implementation of EMP and Environmental Monitoring Plan

Main purpose of this environmental assessment is to delineate correct measures to enhance the environmental sustainability of the proposed project through providing suggestion on design consideration, implementation, management and operation as suggested in the EMP. The effective implementation and operation of EMP depends on regular monitoring. BCPCL should establish a directorate headed by a Director, Environment and Safety. The organogram of the proposed monitoring directorate may be as **Figure 12-1**.

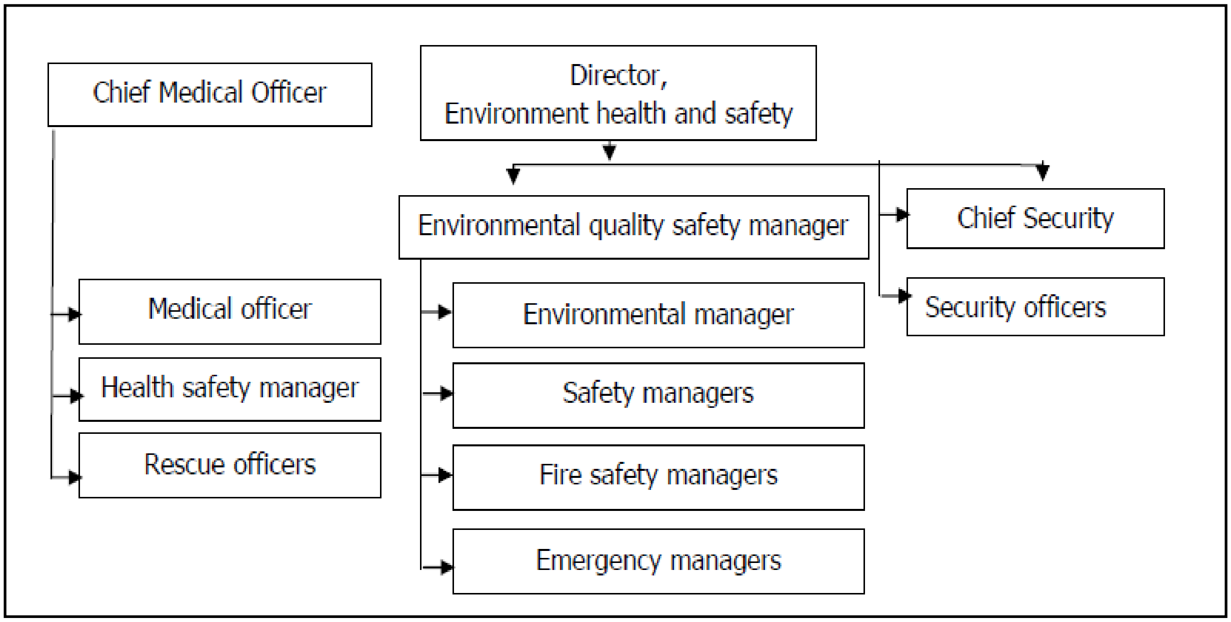



**Figure 12-1 : Organogram of proposed environment and safety directorate/ EHS Cell**

# CHAPTER 13

# 13. WORK PLAN

The project profile progress is preliminarily defined in combination with owner's requirements on project progress and by referring to Duration Quota of Power Construction Project:

## 13.1 Initial preparation for construction of power plant

Feasibility research and review: Finish in June 2015

Backfill: Started at September 2015

EPC bidding: September 2015

Agreement and PPA closing date: December 2015

Financing closing date: September 2016

Qualified for water, electric, road, communication, gas and flat land: May 2017

Date for jetty with qualification of operation: end of 2017

## 13.2 EPC schedule

Preliminary work for construction: 3 months

Foundational handling: 4 months

From main building start-up to #1 unit going into operation: 28months

Unit 1 going into operation to unit 2 going into operation: 2 months

This project is planned to be launched for construction in January 2016 and Unit 1 will be put into operation for power generation in December 2018 and Unit 2 in July 2019.

# CHAPTER 14

# 14. PROJECT BENEFIT WITH BENEFIT-COST ANALYSIS

## 14.1 Introduction

The feasibility is a process of checking technical feasibility, economical viability, social accountability and environmental sustainability of a project. The cost-benefit analysis (CBA) is usually carried out to examine the project feasibility and is widely used for financial and economic appraisal tool of a project. It is particularly useful when a choice has to be made out of several alternatives and when the project involves a stream of benefits and costs over time. Other issues like achieving national goal, reducing regional imbalance, national strategic planning, environmental externalities etc. are also significantly important for the project feasibility studies.

In the power sector, CBA is used as an essential tool for the policy formulation and decision making in multiple aspects like site selection, construction, operation, decommissioning, fuel quality and selling prices. The basic idea here is to evaluate whether the investment in construction, operational and maintenance costs of the power plant is justified in terms of a higher electricity production with lower external cost. Cost- Benefit is a standardized tool, but can take several forms, and is usually complemented with a number of processes. The process of cost- benefit assessment is estimated on the following process.

**Financial and Economic analysis**

- Benefit Cost Ratio (BCR) – Ratio of the present value (PV) of total incremental benefits over the PV of total incremental costs
- Net Present Value (NPV) – the difference between the PV of total incremental benefits and the present value of the total incremental costs
- Internal Rate of Return (IRR) – The discount rate at which the PV of benefits equals the PV of costs
- Sensitivity analysis – This is done considering specific boundaries that will depend on one or more input variables, such as the effect of changing coal cost and gross calorific value (GCV) on the production cost.

The financial and economic analysis has been carried out in feasibility report (FR). Environmental and social protection and improvement cost are also integrated in this feasibility to assess the ultimate CBA ensuring environmental and social protection for making it acceptable. However, the environmental and social cost and benefit assessment are attempted to estimate in tangible and intangible forms as bellows.

- Externalities – Potentially to affect the third parties
- Categorize for valuation of the potential affected resources
- Environment, social protection and enhancement cost estimation
- Opportunity cost - Include the value of forgone opportunities
- Benefits of the projects – both for tangible and intangible benefits

## 14.2 Investment Estimate and Financial Evaluation

### 14.2.1 Financial Evaluation

This project plans to adopt PPP (Public—Private—Partnership) pattern to run this project and this project will be operated for 25 years. We assume that the Facility annual utilization is 6500hours and the net energy output is 8177GWh per year. Based on the financial evaluation system of china and the data in **Table 14-1**, in the financial analysis the feed-in tariff (exclude VAT) has been shown US Dollar 88.34/MWh, and Project Investment IRR is 14%, Project IRR of capital is 25.72%.

**Table 14-1: Data of Financial Evaluation**

| Item | Description | Unit | Num | Remarks |
|---|---|---|---|---|
| Investment | | | | |
| | Dollar/Yuan Rate | Yuan/Dollar | 6.40 | |
| | Construction Periods | month | 42 | Construction Periods of the First Generating Unit is 36 month; Construction Periods of the Second Generating Unit is 42 month |
| | Total Investment | 10 000 dollars | 247729 | The total investment includes the system (including ash system and water supply system) within the walls, coal unloading port and trestle, Channel Dredgin, field backfill and flood control and Living Quarters. And the investment of field backfill and flood control and Living Quarters is ¥686,290,000 RMB ($105,000,000 Dollar). The total Investment is not includes (not limite to):<br>① Land Cost,<br>② the high tension line from the power plant to the nearest interconnection poin |
| | Unit Investment | US Dollar/kW | 1876.73 | |
| | Proportion of Own Capital | % | 20 | Thereinto:<br>Chinese contributes 50%,<br>Bangladesh contributes 50%. |
| | Proportion of Long-term Loans | % | 80 | Hereinto:<br>Chinese contributes 50%, 6.66% annual rate<br>Bangladesh contributes 50%, 6.66% annual rate |
| | Long-term Loans Repayment Methods | | Equal Principal | Both of the long-term loans are repaid in equal principal. |
| | Repayment Period of Long-term Loans | Years | 15 | Both of the repayment periods of long-term loans area 15 years. |
| | Rate of Floating Capital Loans | % | 5.35 | Refer to short term lending rate in China. |
| | Floating Capital Loans | % | 70 | |
| Tax | | | | |
| | Income Tax | % | 37.5 | Tax ratio of Private Company |

| Item | Description | Unit | Num | Remarks |
|---|---|---|---|---|
| | | | | Corporation. The Company shall, commencing on the Initial Operations Date and continuing until the fifteenth (15 th) anniversary of the Commercial Operations Date be exempt from taxation or withholding tax in Bangladesh. |
| | Added-Value Tax, AVT | % | 15 | The benefits of output tax of VAT deduct input tax of VAT will be considered as income |
| | Tax on Dividend Payable | % | 25 | Rate of Tax on Dividend Payable is 25% In China and 15% in Bangladesh. According to 《AGREEMENT BETWEEN THE GOVERNMENT OF THE PEOPLE'S REPUBLIC OF CHINA AND THE GOVERNMENT OF THE PEOPLE'S REPUBLIC OF BANGLADESH FOR THE AVOIDANCE OF DOUBLE TAXATION AND THE PREVENTION OF FISCAL EVASION WITH RESPECT TO TAXES ON INCOME》, Chinese company has to pay 25% of dividend payable as tax. |
| **Cost** | | | | |
| | Generating Standard Coal Consumption Rate | kg/kW.h | 290.22 | |
| | Power Consumption Rate | % | 5.8 | |
| | Coal Price | US Dollar/t | 110 | CFR (Cost and Freight), including Carriage paid to wharf, payment of any Taxes and/or import duties. |
| | Water Price | US Dollar/t | 0.3154 | Exclude VAT |
| | Number of staff | person | 240 | Estimated |
| | Annual Average Salary | 10 000 dollars | 8 | Estimated |
| | Insurance | % | 0.25 | Estimated |
| | Material Cost | Dollar/MWh | 1.62 | Estimated |
| | Other Charges | Dollar/MWh | 1.62 | Estimated |
| | Permanent Repairs Cost | % | 2.4~3 | 3.0% forin operation athe 1nd 2.4%st to $5^{th}$ for year after put the $6^{th}$ to $25^{th}$ year after put in operation |
| | Price of Desulfurizer ($CaCO_2$) | Dollar/t | 130 | Estimated, exclude VAT |
| | Accumulated Depreciation Rate | % | 100 | Estimated |
| | Depreciation Period | Year | 8 | Estimated |
| | Discharge fee | 10 000 dollars/year | 100 | Estimated |
| | Channel Dredging Fee | 10 000 dollars/year | 322.66 | Estimated |

| Item | Description | Unit | Num | Remarks |
|---|---|---|---|---|
| **Income** | | | | |
| | Annual Utilization Hours | Hours | 6500 | Estimated |
| | Operating Period | Year | 25 | |

Source: Feasibility Study Report, BCPCL 2015

### 14.2.2 Sensitivity Analyze

Considering to ensure the project investment internal rate of return(IRR) under the condition of 10%, when the project total investment, annual utilization hours and coal price each changes in the range of -10% ~ +10% (step5%), the estimated feed-in tariff(exclude VAT) result refers to **Table 14-2**.

**Table 14-2: Sensitivity Analyze on Tariff (Exclude VAT)**

| Uncertain Factors | Variation Rate | Tariff(Exclude VAT) | Variation Rate of Tariff | Sensitivity Coefficient |
|---|---|---|---|---|
| Basic scheme | 0.00 | 88.34 | 0.00 | 0.00 |
| Total Investment | -10.00 | 83.19 | -5.83 | 0.58 |
| | -5.00 | 85.76 | -2.91 | 0.58 |
| | 5.00 | 90.91 | 2.91 | 0.58 |
| | 10.00 | 93.49 | 5.83 | 0.58 |
| Annual Utilization Hours | -10.00 | 94.44 | 6.91 | -0.69 |
| | -5.00 | 91.23 | 3.27 | -0.65 |
| | 5.00 | 85.72 | -2.96 | -0.59 |
| | 10.00 | 83.34 | -5.65 | -0.57 |
| Coal Price | -10.00 | 85.33 | -3.41 | 0.34 |
| | -5.00 | 86.83 | -1.70 | 0.34 |
| | 5.00 | 89.84 | 1.70 | 0.34 |
| | 10.00 | 91.35 | 3.41 | 0.34 |

Source: Feasibility Study Report, BCPCL 2015

When feed-in Tariff (exclude VAT), Total Investment, Annual Utilization Hours and Coal Price changes in the range of -10% ~ +10% (step5%), and the estimated Project Investment IRR refers to **Table 14-3**.

**Table 14-3: Sensitivity Analyze on Project Investment IRR**

| Uncertain Factors | Variation Rate | IRR | Variation Rate of IRR | Sensitivity Coefficient |
|---|---|---|---|---|
| Basic scheme | 0.00 | 14.00 | 0.00 | 0.00 |
| Total Investment | -10.00 | 15.82 | 13.02 | -1.30 |
| | -5.00 | 14.88 | 6.26 | -1.25 |
| | 5.00 | 13.19 | -5.82 | -1.16 |
| | 10.00 | 12.42 | -11.26 | -1.13 |
| Annual Utilization Hours | -10.00 | 12.14 | -13.27 | 1.33 |
| | -5.00 | 13.09 | -6.53 | 1.31 |
| | 5.00 | 14.89 | 6.34 | 1.27 |
| | 10.00 | 15.75 | 12.51 | 1.25 |
| Coal Price | -10.00 | 14.97 | 6.94 | -0.69 |
| | -5.00 | 14.49 | 3.50 | -0.70 |
| **Tariff(Exclude VAT)** | -10.00 | 10.95 | -21.79 | 2.18 |
| | -5.00 | 12.52 | -10.60 | 2.12 |
| | 5.00 | 15.42 | 10.11 | 2.02 |

| Uncertain Factors | Variation Rate | IRR | Variation Rate of IRR | Sensitivity Coefficient |
|---|---|---|---|---|
| | 10.00 | 16.77 | 19.81 | 1.98 |

Source: Feasibility Study Report, BCPCL 2015

## 14.3 Environmental and social cost – benefit assessment

Environmental and social cost – benefit is related to the externalities of the project. Carrying out this Environmental Impact Assessment (EIA) is mandatory for any power plant project in order to impede the negative externalities and promote the benefit of the project. Therefore, attempts have been made to identify externalities. The importances of externalities are required for the following aspects

- Specification of power stations and related facilities
- Setting of regulations in terms of technology or emissions standards and regulations based on fiscal incentives (e.g. emissions charges or laws, emissions caps etc)
- Planning and development of power systems at the state and regional level, taking account of the environmental costs

## 14.4 Assessment of the externalities

The approach followed for assuming external costs is illustrated through the 'impact pathway' (**Table 14-4**). The impacts are assessed not just for generation stage but also for the full life cycle of the implementation process (e.g. Pre, during and post construction), including the extraction of the fuel, its transportation, transformation into electric energy, disposal of the waste, and the transport of the electricity. Emissions from a source are traced when they disperse in the environment, following which the impacts of the dispersed pollutants was estimated. The dispersion modeling takes account of the distance dispersion of the pollutants especially SOx, NOx and SPM from the power plant that causes noticeable health impacts, ecosystem impacts and aesthetic impacts. Finally, these impacts are valued both in tangible and intangible forms. All the primary, secondary and tertiary impacts are evaluated at the respective phases of the power plant projects.

**Table 14-4: Impacts pathways included in the analysis of the electricity generation**

| Impact Category | Pollutant/Burden | Effects |
|---|---|---|
| Human health mortality | $PM_{10}$, $PM_{2.5}$, SOx, NOx, $O_3$ | Reduction in life expectancy |
| Morbidity for the living beings | $PM_{10}$, $PM_{2.5}$, SOx, NOx, $O_3$, CO<br>Accidental risk | Fatal risk from transport of materials<br>Respiratory problem, heart failure, hypertension, asthma attacks<br>Risk of injuries from traffic and work place accidents |
| Detrimental to building materials | Acid rain deposition, combustion particles ,shoot, accidents | Ageing galvanized steel, limestone, paint, soiling of the building and accidental damage |
| Crops and fisheries production | Loss of land, SOx, NOx, Acid deposition | reducing production , Change in yield of wheat, tobacco, rye, sunflower seed<br>Increased expenditure on liming |
| Amenity losses | Noise, visibility, artificial structure | Disturbing the natural habitats, ecosystems, tourisms |

| Impact Category | Pollutant/Burden | Effects |
|---|---|---|
| Ecosystem damage | Land loss, water and air pollution, anthropogenic activities, accidents | Decreasing the natural resources, Pressure on other resources, reduces ecoprotection, increasing living cost |
| Global warming | Emission of $CO_2$ | Sea level rise, increasing the intensity and magnitude of natural hazards, shifting regime, salinity intrusion |
| Social unrest | Land acquisition, employment process, benefit sharing among the whole society, accidents, livelihood security | Migration, production failure, crime or terrorisms, political agitation etc |

## 14.5 Categorize for valuation of the potentially affected resources

The potential impacts can be categorized depending on different valuation process. The valuation process is important to determine the cost includes harnessing the potential benefits, are expressed bellow.

- Direct values: These are related to the production and consumption of goods and services (e.g. primary, secondary) that could be easily traded (so that the value becomes visible) Example: Land, crops, fish, fire wood, wage labor, dredging, electricity etc
- Indirect values: These are derived more from the ecological functions of the ecosystem, which support and protect other economic activities Example: watershed protection, cyclone and storm surge protection, health, carbon sequestration, dredging spoil management, tourism, social improvement etc.
- Option values: This describes the potential values that can be accrued from both direct and indirect use of the potential affected areas. Example: Medicinal values of the flora, ground water resources, benthos communities, soil microbes etc.
- Non-use values: The value derived from the conserving things from for existing satisfaction and future generations. People may place an implicit value on this without any direct or indirect use. Example: Heritage, archeological site, spiritual or sacred places etc.
- Intrinsic value: The value of living resources in its own right, unrelated to human utilization. Example: Irrawaddy dolphin etc.

Monetary valuation is generally difficult for ecosystems. A number of effects including neonatal mortality, morbidity, behavioral effects, neurological disorders, allergies, innovations, life loss and intra-generational views are the major limitations of the valuation process. Not any single valuation process could count the total values of the cumulative impacts and benefit from a power plant. Moreover, valuation of environmental externalities is very difficult considering its multidimensional aspects like determination of statistical life loss, willingness to pay for developing countries etc. Therefore, this report has the limitation in valuation of the intangible variables into monetary terms.

## 14.6 Measures to control pollution and enhance the benefits

The use of technology and measures are clearly very important as technologies differ in the emissions generated from the power plant and finally the location of the plant remains a key factor. Air and water pollutants disperse quite widely and over long period of time, resulting the risk of damages occurring outside the normally considered range. To avoid any kind of damages and keep the environment clean as present, a number of modern technologies have been strictly adopted and multiple measures have been taken care of. Ultra Supercritical boiler, FGD, de-NOx burner, ESP, high stack height, desalination plant, cooling tower, effluent management plan, ash management plan, ecosystem conservation and socio-economic development program, ambient air, water and acoustic monitoring and management, health and safety management plan, environmental institutional set up, integrated water and river management etc will be the major pollution abatement /benefit enhancement measures of this project. Those have been elaborated in the respective sections of the project description and environment management plan appended in earlier chapters.

## 14.7 Envrionmental Protection Investment

Greening of the plant area is based on performance of greening function, pollution prevention and control and environment beautifying. Greening should adapt to local conditions in the general layout of the plant area.

In this project, fixed flue gas discharge continuous monitoring devices are installed in the flue, thus meeting the environmental monitoring management requirements.

As the kind and quantity of pollutants discharged from this project is relatively few, and the flue gas continuous monitoring system is adopted for such pollutants as $SO_2$, NOx and flue dust, water used by the plant is measured, and water quality is examined and supervised, the regular monitoring of other pollutant sources of the power plant may be entrusted to qualified units.

The power plant has an environment supervision and management organization, formulates corresponding environmental management plans and appoints full-time environmental protection personnel, thus meeting the environmental supervision and management requirements.

**Table 14-5: Environmental protection investment**

| No. | Special project content | Investment (Ten thousand yuan) |
|---|---|---|
| 1. | Electrostatic precipitator (including power supply device, foundation, installation, etc.) | 14410 |
| 2. | Flue gas desulfurization system (containing desulfurization agent storage and preparation system, the desulfurization wastewater treatment system, flue gas continuous monitoring system) | 19900 |
| 3. | The chimney and flue | 27870 |
| 4. | Sewage treatment and recycling system, coal-bearing wastewater treatment and recycling system (including the slime settling basin), industrial wastewater treatment and recycling system | 1692 |
| 5. | ash and slag handling system and ash yard | 15423 |

| No. | Special project content | Investment (Ten thousand yuan) |
|---|---|---|
| 6. | vegetation measure | 690 |
| 7. | Environmental impact assessment, environmental supervision, environmental protection facilities completion inspecting and monitoring costs,etc. | 880 |
| **Total** | | **80865** |

Source: Feasibility Study Report, BCPCL 2015

## 14.8 Benefit of the Project

### 14.8.1 Socio-economic benefits

Socioeconomic externalities associated with the electricity generation include a wide range of social, cultural, and direct economic impacts. During one or more phases of electricity generation life cycle there can be impacts related to view sheds, infrastructural development, regional tourism, recreational activities, and cultural resources etc. In general, well-established methodologies exist to measure or estimate the magnitude of these impacts.

- Aesthetic resources: The Net impacts are considered since intangible benefits may be derived from perceived visual improvements (e.g. planned industrial area, green belt development etc.).
- Social development program:
  - Construction of roads
  - Improvement of water supply and sanitation
  - Regional electricity supply
  - Establishment and development of educational institutions
  - Initiation of educational scholarships
  - Improvement of health and Medicare facilities
  - Development of cultural and sports facilities
  - Skill or capacity build up training program
  - Livelihood development
  - Improvement of the quality of life style
- Infrastructure development: A high investment project like power plant projects generates a number of secondary benefits. It will be tempting to include as many of them as possible. Enough secondary benefits calculation will support to accept this project remarkably. In regional macro-economic investment, a certain development will result in such sectors as roads, railways and waterways, hotels, health complexes, institutions, industries communication and service sector improvement etc. A large project has linkages to the rest of the economy, buying materials and inputs, paying workers etc. Therefore, national product continues to increase through this multiplier effect.
- Employment opportunity: It is evident that the increasing supplies of electricity directly or indirectly promote the economic productivity. It will be not only for the power plant related services but also for other industries. Factories, farms, organizations, business house will

create opportunity which will reduce regional unemployment as well as disguised employment.

- Health improvement: Development of employment opportunities, quality of life and ambient environmental monitoring will ultimately improve the health facilities of the project area remarkably.
- Urbanization: Development of new townships, industrial zone, infrastructures, institutions etc will promote the project area towards urbanization and improve the facilities of existing urban areas.
- Institutional development: High investment for a particular development projects will influence multiple sectors to share the benefit. A number of institutions will be created related to the project activities over the year. Creation of service sectors will assist the population in achieving standard quality of life. However, this project will indirectly assist to achieve the important national goal especially Education for all and quality of health facilities.
- Improve communication facilities: Development of existing roads and dredging of Rabnabad Channel/Kajol River will facilitate the regional communication systems. Construction of new roads and maintaining navigation of Rabnabad Channel/Kajol River. Through dredging for coal import, will play a crucial role in the regional development.

### 14.8.2 Environmental Benefits

- Ecosystem improvement facilities: The afforestation program, fisheries management program, dolphin conservation program etc will mitigate the negative impact of the project and ensure enhancement of the ecosystem.
- Disaster management program: Structural development and creating awareness program will enrich the disaster management system in the south western region.
- Ambient environmental quality: Regular monitoring of air, water and acoustic environment at specific locations will ensure the quality of the surrounding ecosystem vis-à-vis any kind of anthropogenic interventions.
- Improve aquatic environment: Capital dredging of the coal import route may initially impact on the benthic community of Rabnabad Channel/Kajol River. However, this navigation Cost and Benefit Assessment improvement will create a long-term benefit for hydro-morphological as well as aquatic environment of the Rabnabad Channel /Kajol river regime.
- Green development: Afforestation, community forestry, buffer zone creation are aimed at developing a green belt around the projects. Moreover, bank protection works and regular monitoring will indirectly reduce the deforestation around the project areas.
- Market development: Development of any project invariably increases market facilities, communities, infrastructure etc. Therefore, enhanced facilities of value chain for the products, reduction of transportation costs and regional industries and business development will be significant.

# CHAPTER 15

# 15. PUBLIC CONSULTATION

## 15.1 Introduction

Participation is a process, through which stakeholders influence and share control over development initiatives, the decisions and the resources, which affects them. The effectiveness of environment and social management plan is directly related to the degree of continuing involvement of stakeholders in the project development process. Participation of stakeholders in the projects is also a primary requirement in developing an appropriate ESMP that addresses project's requirement and suited to the needs of the stakeholders. Stakeholder's involvement is also vastly increases the probability of successful implementation of management plan. In order to make consultation and disclosure process effective and fruitful, comprehensive planning is required to assure that local government, NGOs, host population and project staff interacts regularly and purposefully, throughout all stages of the project and contribute toward a common goal.

## 15.2 Approach and Methodology for Consultation

The approach undertaken for information disclosure and consultation involved the following key processes.

- Mapping and Identification of key stakeholders such as primary (direct project influence) and secondary (indirect project influence) stakeholders;
- Undertaking expert consultations, interviews and focus group discussions (FGD) with the respective stakeholders;
- Undertaking structured on field consultations, interviews and focus group discussions (FGD) with the respective stakeholders;
- Assessing the influence and impact of the project on these stakeholder groups;
- Summarizing of key findings and observations from the consultations; and
- Preparing a future stakeholder engagement strategy consultation plan for a more detailed assessments at a microscopic level taking into account the various project lifecycle phases and their implications on the stakeholder.

## 15.3 Stakeholder Assessment

A stakeholder is defined as "a person, group, or organization that has direct or indirect stake in a project/organization because it can affect or be affected by the Project or its Proponent's actions, objectives, and policies". Stakeholders vary in terms of degree of interest, influence and control they have over the Project or the proponent. In the present study, all the stakeholders have been primarily categorized into two categories that have been identified as:

- Primary Stakeholders: include people, groups, institutions that either have a direct influence on the project or are directly impacted (positively or adversely) by the project and its activities; and
- Secondary stakeholders: are those that have a bearing on the project and its activities by the virtue of their being closely linked or associated with the primary stakeholders and due to the influence they have on the primary stakeholder groups.

Apart from categorization, the stakeholders have also been classified in accordance with the level of influence they have over the project as well as their priority to the project proponent in terms of importance.

The influence and priority have both been primarily rates as:

- High Influence/Priority: This implies a high degree of influence of the stakeholder on the project in terms of participation and decision making or high priority for project proponent to engage that stakeholder.
- Medium Influence/Priority: This implies a moderate level of influence and participation of the stakeholder in the project as well as a priority level for project proponent to engage the stakeholder who are neither highly critical nor are insignificant in terms of influence.
- Low Influence/Priority: This implies a low degree of influence of the stakeholder on the project in terms of participation and decision making or low priority for project proponent to engage that stakeholder.

Based on the above attributes, the following **Table 15-1** delineates the stakeholders identified for the project and their analysis.

**Table 15-1: Stakeholder Mapping for the Project**

| Stakeholders | Category of stakeholder | Brief profile | Overall influence on the project | Basis of Influence Rating |
|---|---|---|---|---|
| **Project Management** | | | | |
| Bangladesh-China Power Company (Pvt.) Limited (BCPCL) | Primary | • BCPCL is the primary project proponent own a controlling stake of 100% in the project | Highest | • Are the primary project proponents<br>• Responsible for establishment and operation of this project<br>• Primary financial beneficiaries<br>• Responsible for all the project related risks and impact liabilities |
| **Community** | | | | |
| Land Losers (Project Site); | Primary | • Land Owners impacted with respect to loss of land and potential livelihood impact. | Medium | • Lack of information during land acquisition process<br>• Support to land losers in terms to temporary sustenance and employment opportunities<br>• Preference for Employment opportunities |
| Vulnerable Groups (poor, old aged, and destitute) | Primary | • The marginal groups within the project area primarily comprises of landless households as a result of acquisition, households below poverty threshold, women headed households, old aged & destitute | Low | • Employment opportunity during construction.<br>• Job prospect for their children<br>• Compensation paid to male member of family<br>• Little control over compensation amount<br>• Employment opportunities |
| Local Community | Primary | • Primarily includes adjacent community to the project site especially Nishanbari, Char Nishanbari and Madhupara<br>• It also includes specific community groups in close interaction with project site and related activities anywhere within the 5 km area of influence | Medium | • No major restrictions around the project site especially with respect to grazing land<br>• Project will bring development to the area<br>• Increase in employment opportunities and preference in job<br>• Improvement in electrical supply and infrastructure in the area<br>• Minimise impact |

| Stakeholders | Category of stakeholder | Brief profile | Overall influence on the project | Basis of Influence Rating |
|---|---|---|---|---|
| Fisherman | Secondary | • Fisherman in the area are primarily local farmers engaging in fishing in the adjoining River<br>• Project study area is a major fishing hotspot | Medium | Medium scale fishing for livelihood |
| **Regulatory/Administrative Authorities & Agencies** | | | | |
| Department of Environment, Bangladesh | Primary | • The Department of Environment is the primary government regulatory authority for Environmental protection in Bangladesh.<br>• The closest office is located in Barisal Division | High | • Government Regulatory agency to provide Environmental Clearance (EC) to the project based on evaluation and approval of Environmental Impact Assessment (EIA) study<br>• Responsible for monitoring project's Environmental compliance throughout the project lifecycle |
| Forest Department, Ministry of Environment and Forest, Bangladesh | Primary | • The forest department under the Ministry of Environment and Forest is responsible for management of forests and ecological assets of national or international importance within Bangladesh | Low | • No major influence on project related activities |
| District Commissioners Office , Patuakhali | Primary | • The District commissioners office is the primary agency responsible for land acquisition and distribution of compensation | Medium | • Government authority responsible for the additional land acquisition for the project<br>• Responsible for valuation and distribution of compensation to land losers<br>• Responsible for address of compensation related grievances of the land losers area which will also act as a secondary access road to the site to cater the increased traffic and goods |
| Local Government Engineering Department (LGED), Kalapara | Secondary | • Local Government Engineering Department (LGED) is one of the largest public sector | Low | • Is responsible for maintenance of the approach road to the project site over the lifecycle of the project |

| Stakeholders | Category of stakeholder | Brief profile | Overall influence on the project | Basis of Influence Rating |
|---|---|---|---|---|
| | | organizations in Bangladesh entrusted with planning and implementation of local level infrastructure development programs. | | |
| Dept. of Social Welfare (DSW) | Secondary | • Local governmental agency responsible for implementation of governmental social welfare schemes and activities in Patuakhali | Low | • No major influence on project related activities<br>• However participation level and influence may increase in case community welfare activities proposed by the project proponent are implemented in coordination with this agency |
| Dept. of Public Health Engineering | Secondary | • Primary department responsible for managing the overall water supply and sanitation facilities in the upazila | Low | • No major influence on the project relate activities<br>• Controlling out-break of any major disease and monitoring the disease pattern |
| Other Regulatory & Permitting Authorities | Primary | | High | • Agencies required for obtaining permits and licenses for establishment and operation of the project<br>• Primary involvement during pre-construction and operation phases |
| **Contractor & Sub-contractors** | | | | |
| Other Contractors (local and foreign) | Primary | • Other Contractors include OEM(Original Equipment Manufacturers), part suppliers, mechanical installers and maintenance service providers who would be engaged during the project lifecycle | Medium | • Construction phase will require almost 700 people (for both civil and mechanical work) including both local and migrant workers over a span of 2 years<br>• Engagement levels would be mostly during construction, and decommissioning phases |
| Migrant Workers and Labourers | Primary | • Labourers and workers arriving from outside of Patuakhali for participating in construction activities | Medium | • Responsible for undertaking mostly skill based work during construction phase<br>• Engagement level during both civil and mechanical phases of work |
| Local Workers and | Primary | • Labourers and workers | | • Responsible for undertaking mostly un-skill based |

| Stakeholders | Category of stakeholder | Brief profile | Overall influence on the project | Basis of Influence Rating |
|---|---|---|---|---|
| Labourers | | recruited from the area of influence mostly during the construction phase of the project | | work during construction phase and housekeeping related work during operation phase of the project<br>• Engagement level primary in civil construction part of the work |
| **Political Administration** | | | | |
| Upazilla (sub District Level) Political Administration | Secondary | • Elected representative of people at sub-district level for a fixed tenure | Medium | • Key linkage between the community and the project proponent |
| Union leaders & local representatives | Secondary | • Elected representative at union level i.e. village level for a fixed tenure | Medium | • Plays important role in providing public opinion and sentiment on the project<br>• Empowered to provide consent and authorization for establishment of project on behalf of the community |
| **Other Institutional Stakeholders Groups** | | | | |
| Local NGOs and Community & Social Welfare Groups (CSWG) | Secondary | Microfinance agencies, social welfare groups and charitable organizations working in the area | Low | • No major involvement in the project as per today<br>• Possible inclusion during future stages of the project with respect to project related community welfare activities |
| Media | Secondary | | Medium | • Public watchdog on the project related activities<br>• No major influence on the project as of today |

## 15.4 Information disclosure and consultation

Number of consultation exercises was conducted during this phase of EIA preparation. The stakeholders consulted include Project Affected People, sharecroppers, community in the vicinity of project area, local elected representatives and other external stakeholders such as relevant government officials and NGOs. The details of consultations held with issues raised or discussed and suggestions provided by the respective stakeholders are presented in **Table 15-2** of this chapter and the photographs of consultation session are given in **ANNEX F.**

A combination of mixed methods of information disclosure and consultation process was adopted at this stage of EIA preparation. The method selected for consultation was basically designed keeping in mind the profile of the stakeholders, type of information desired and level of engagement required. In each consultation session the consultant introduced themselves, introduced the project and the purpose of engagement with the respective stakeholder. The primary methods followed in the consultation process are:

- Individual level consultation/discussion;
- Focus group discussion; and
- Community meeting

**Table 15-2: Details of Consultations Held for the Project**

| Date | Stakeholder Details | Details of participants | Issues discussed/raised | Response/ Suggestions made |
|---|---|---|---|---|
| 27/11/14 | Deputy Commissioners Office, Patuakhali | 1. Amitav Sarkar, Deputy Commissioners, Patuakhali | • Overview on the Land Acquisition and procurement process for the project<br>• Any key issues emanating in the community from the project<br>• Compensation distribution process<br>• Expected benefit from the project | • The land acquisition for the project is under processing<br>• Compensation will be provided in monetary form and determined by the government based mouza prices on previous years estimates provided by the sub-register office<br>• Asset valuation will be carried out by Public Works Division and crops, trees etc. by Forest department.<br>• There is no government level rehabilitation policy<br>• No major opposition to the land acquisition process. People are forthcoming about the project<br>• Key benefit of the project is proper supply of electricity in this region as well as national level. Industrial development will be taken place in this region and raise huge employment opportunity. |
| 26/11/14 | Bangladesh Water Development Board (BWDB) | 1. Md. Shafi Uddin, Executive Engineer, BWDB, Kalapara, Patukhali<br>2. A.K.M. Abul Bashar, Sub-Divisional Engineer, BWDB, Kalapara | • Flood Scenario in Kalapara<br>• Protection/control measures being adopted<br>• Perception regarding the Proposed Power Plant<br>• Practicality of he suggested height up to which the land will be raised | • All the rivers around the project area are tidal river and tidal flood is occurred in every year. BWDB construct a embankment around the river bank close to the project site which also required for development.<br>• It is a good initiative of government which will develop this region as well as the |

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| | | | | country.<br>• The project site needs to rise above the height flood level.<br>• River training work must be required to protect the proposed power plant site<br>• Rabnabad channel/Andhamanik river has sufficient amount of sediment for site proposed site development<br>• BWDB has 18 dredger and own capacity to dredge the channel and River |
| 26/11/14<br>27/11/14 | Department of Forest, Patuakhali | 1. Mihir Kumar Do, Divisional Forest Officer, Coastal Forest Department, Patuakhali<br>2. Md. Balayet Hossain, Range Officer (in charge), Kalapara Range | • Any forest stretches or patches/ reserve forest within 10 km radius of the project site<br>• Major forest clusters within the Patuakhali<br>• Perception about the proposed project | • No designated reserve forest land is present within the 10 km area. The closest forests are located in Kuakata national park and char kukrimukri wildlife sanctuary<br>• Roadside plantation under the purview of the forest department.<br>• The project should comply with legal requirements or guidelines for any construction related activities.<br>• Authority should be taken proper management plan to mitigate the air pollution during the operation of plant |
| 27/11/14 | Bangladesh Inland Water Transport Authority Office, Launch Ghat, Patuakhali | 1. Md. Shajahul Haque, Assistant Director, BIWTA | • Coal transportation and handling<br>• Navigation facilities<br>• Coal terminal development | • After Payra port development it will be a major route for water way transportation and will be easy to transport coal to the site. BIWTA will be dredged the Rabnabad Channel regularly.<br>• BCPCL need to have permission from BIWTA head office for river dredging in |

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| | | | | order to collect sand for site development and jetty construction. In this respect they require to contact Dredging, Hydrology and Piloting Department of BIWTA. |
| 26/11/14 | Local Government Engineering Department (LGED), Kalapara | 1. Delwar Hossain, Sub Asst. Engineer, LGED | • Understanding on the road network in and around the project site<br>• Plan for widening and strengthening of LGED road connection plant access | • LGED has a plan to develop the embankment which is an access road for the proposed plant. Another plan is to widen and paved the road which is pass though the middle of the plant location and connect to the Nishanbari village. |
| 27/11/14 | Public Works Department, Patuakhali | 1. Engr. A.K.M Kamruzzaman, Executive Engineer, PWD, Patuakhali | • Roles and responsibilities of PWD<br>• Perception of the proposed project | • Major works of the PWD are the construction of the public infrastructure, repair and maintenance. Acquisition and requisition of land for construction. Valuation of property and fix the value.<br>• This proposed project is the largest development project in this southern region of Bangladesh and it's a good initiatives<br>• PWD will be involved in this project to fix the assets value in the project area after getting letter from the deputy commissioner office.<br>• It is large project so authority should take proper management plan during construction and operation periods. |
| 16/4/14<br>27/11/14 | Department of Fisheries, Patuakhali district and Dhankhali | 1. S.M. Azharul Islam, District Fisheries Officer, Patuakhali<br>2. Md. Kamrul Islam, Kalapara Upazila Fisheries officer | • Role and Responsibily of the local fisheries departments and how is the department structured<br>• Primary fishing Point/ports/sanctuary | • The primary fishing ports are located in the Kalapara upazila.<br>• Fisheries sanctuary is located in the kalapara upazila which is whole 40 km |

| Date | Stakeholder Details | Details of participants | Issues discussed/raised | Response/ Suggestions made |
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| | upazila | | Located in and around in Kalapara<br>• Fish production in Kalapara in quality & monetary value.<br>• Details on the key species of fishes observed in Rabnabad channel, Andharmanik and Tetulia River<br>• Understanding on the Fishermen community<br>• Any envisaged impacts on the aquatic population in the canal from the release of hot water in to the river | stretch of Andhermanik River in the Kalapara upazila of Patuakhali. Lata Chapali point, Kalapara, Patuakhali in the southeast (90°12.59'E and 21°47.56'N) is the Hilsa spawning ground<br>• The mainstay fish Hilsa is captured from the Rabnabad Channel, Andharmanik, Tetulia River and other river in this upazila and distribute in the local bazaar. Approximately 5000 household involved in fishing activities in Kalapara upazila<br>• Expressed concern for the Hilsha fish breeding, its catchment and availability during the period June to November which may be impacted from project activities<br>• Turbidity in the water during the river dredging for site development should not create any harm for Holsha fish, rather Hilsha prefer turbidity in the water<br>• Coal loading, unloading and transportation may pollute the river water<br>• Suggestion for temperature variation between hot water released from power plant to the river ideally is not more than 3degree centigrade of the surrounding water temperature.<br>• Plant authority should be taken international standard mitigation measures and waste management plan to prevent impact from project activities on local |

| Date | Stakeholder Details | Details of participants | Issues discussed/raised | Response/ Suggestions made |
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| | | | | riverine fish resources. It is important because, around 20,000 households are depending on fish trading for maintaining their livelihood. |
| 16/4/14 | Department of Health, Kalapara | 1. Dr. Mozzammel Haque, Medical Officer, kalapara Upazila Health Complex | • Primary diseases pattern and healthcare problems in Kalapara upazila<br>• Concerns with respect to impacts envisaged from the project<br>• Health programmes under implementation in the Kalapara | • Primary diseases and health concerns in Kalapara include gastrointestinal pain, peptic ulcer, Typhoid fever, Pneumonia and Water borne diseases.<br>• Concerns with respect to the migration of labour into the area leading to sexually transmitted diseases, communicable diseases. However, the chief medical officer was of opinion that it would not be a major issue if local Bangladeshis are migrant workers. |
| 16/4/14 | Upazila Nirbahi Officer (UNO) | 1. Md. Jahangir Hossain, Upazila Nirbahi Officer, Kalapara | • Expected benefit from the project<br>• Overall economy of the Kalapara upazila | • Project area people mainly live in a private land in the project area<br>• Peoples in the project area depend on agriculture and fisheries.<br>• The project will create employment, and contracting opportunities for the local population. Also, a significant need from the project is better electricity supply. |
| 26/11/14 | Muslim Aid-UK Bangladesh, Kalapara | 1. Ariful Islam, District Coordinator | • Background of Muslim Aid-UK Bangladesh as an agency and the area of work it is involved in<br>• Key social challenges and issues in Kalapara | • Muslim Aid-Uk Bangladesh has been working at the Kalapara upazila in different sector. Now they have five ongoing projects in 31 unions of 5 upazilas. Approximately 18858 families and 99529 students have been gotten facilities under the different project.<br>• Primary challenges faced by the local |

| Date | Stakeholder Details | Details of participants | Issues discussed/raised | Response/ Suggestions made |
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| | | | | community are natural disaster and road communication network<br>• Muslim Aid-Uk Bangladesh will be provide the helping hand to the project affected peoples and taken corporate social responsibility scheme to affected population |
| 17/4/14 | Department of Agriculture Extension | 1. Md. Mashiur Rahman, Upazila Agriculture Officer, Kalapara Upazila | • Understanding and Broad overview of the agricultural sector in Kalapara<br>• Information on the crops grown in the area and agricultural practices<br>• Information the agricultural schemes under implementation from the local government<br>• Sharecropping practices in the project area<br>• Any envisaged impacts on the agriculture | • Agriculture is the primary mainstay of the upazila with almost 68% households involved in this<br>• Main crops include rice, water melon and vegetables. Water melon production is the highest amongst crops. Other vegetables are also grown in significant quantity and used for export to other parts of Bangladesh.<br>• The agricultural practices in the region are a mix of both cultivating one's own land as well as sharecropping.<br>• Agricultural land will be lost due to this project but electricity is required for the national development. Plant authority need to be careful about natural and environmental hazards. Proper mitigation measures as well as waste management should be in place during the project. |
| 17/4/14 | Department of Social Welfare | 1. Shila Rani Das, Upazila Social Service Officer, Kalapara Upazila<br>2. Md. Masharaf Hossain, Trainner, Kalapara Social Welfare | • Social Welfare schemes and programs that are being implemented by the department in Kalapara Upazilla<br>• Primary areas of social concern in Kalapara Upazila<br>• How is the project beneficial in that area and will it any way have | • The department is implementing various government sponsored schemes<br>• Any NGO or welfare organization working in the area are required to obtain permit or clearance from the Social welfare department<br>• The department runs Women specific |

| Date | Stakeholder Details | Details of participants | Issues discussed/raised | Response/ Suggestions made |
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| | | | any negative impact as such on the locals<br>• Participation level of the international and domestic NGO's and welfare organizations | microcredit scheme and monthly pension scheme for other vulnerable groups such as old aged, divorced women<br>• Education, healthcare, social fads like child marriage are also some of the other issues in the area. .<br>• The project will bring uninterrupted electricity in the area; will create opportunities in the form of jobs and small business. |
| 17/4/14 | Union Parishad Chairman, Dhankhali | 1. Abdul Latif Gazi, Chairman, Dhankhali Union<br>2. Md. Salam Khan, 8 no. Union Parishad Member<br>3. Md. Nasir Talukder, 7 no. Union Parishad Member | • Understanding and awareness about the project<br>• Expectations from the project<br>• General questions on the social structure of Dhankhali, role of marginalized groups such as women, primary work profiles, availability of key utilities etc.<br>• Participation levels of the project proponent till now and level of community consultation undertaken | • Knowledge about the project is limited. The general opinion is that the project is being put up by the government group.<br>• The project will create employment, development of road, school, college and contracting opportunities for the local population. Also, a significant need from the project is better electricity supply.<br>• Participation level of women in the society is improving.<br>• People are also expecting for other industries to come up from the advent of this project, particularly fertilizer factory, cold storage units which will help in supporting Kalapara agrarian based economy.<br>• Proper compensation should be provided to the land loser and given priority to provide unskilled labour job in the development and operation phase |

| Date | Stakeholder Details | Details of participants | Issues discussed/raised | Response/ Suggestions made |
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| 27/11/14 | FGD with local community (Char Nishanbari) | Participant list has been provided in **Annex I** | • Common employment profile<br>• Common livelihoods and income levels<br>• Facilities within the village<br>• Any grievance in respect to proposed power plant<br>• Expectation from the proposed power plant | • Most of villager's area farmers and fisherman.<br>• The agricultural land of this area mainly used for cultivation of water melon, pulses and vegetation during the dry season.<br>• On an average people earn between Tk 2000-6000<br>• Remarkable percentage of people involve in fishing activities<br>• The village level infrastructure is poor with no medication facilities, electricity supply, kerosene lamps used for lighting<br>• A primary school and masjid are the public facilities available within the village<br>• Main grievance of the proposed power plant is people will be lost their land and not gotten proper compensation.<br>• Plant authority should be given priority to involve the local people during construction period of the plant. |
| 27/11/14 | FGD with project affected peoples (Madhupara) | Participant list has been provided in **Annex I** | • Knowledge about the project<br>• Household income and expenditures<br>• Any issues, expectations and apprehensions in regard to power plant<br>• Issues in general in the village<br>• Nature of impact and loss of the proposed power plant | • People are aware of the proposed development into coal based power plant<br>• Significant source of income is agriculture<br>• Another significant income is fishing which provides Tk 50-100 daily and dairy products too contribute to the family income.<br>• Primarily grows paddy in the project site land in wet season. Water melon, nut, pulses are grown in the dry season.<br>• Due to the proposed plant land owner lost land, crop and orchard ( consist of coconut, betel nut, timber tree) for the project site<br>• Major grievance is that project affected |

| Date | Stakeholder Details | Details of participants | Issues discussed/raised | Response/ Suggestions made |
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| | | | | peoples need to move from their own land. Approximately 15000 metric ton rice is being cultivated every year from the project site which will be lost.<br>• Project site people mostly depend on agricultural activities. Due to the proposed project they will lose their job.<br>• This proposed project may impact on local water body that may destroy fish species which may lead to jobless of the fisherman community<br>• Plant authority must be provided the unskilled job opportunity to the local people during the construction period especially given permanent job to the land loser.<br>• Authority should be resettled the PAPs who will be lost their household land |

The main findings and observations from the consultations have been summarized here:

- **Local Expectations from the project:** it was conferred during consultation that most of the people saw the project as a positive impact and development for the area specifically in terms of employment and contracting opportunities, better infrastructure and electricity supply. Also this project will support additional industrial ventures such as fertilizer factories, cold storage units, and rice mills etc. which are also key requirements from the regional prospective.
- **Impact on the Rabnabad Channel and Andharmanik River from Water Discharge:** The Rabnabad Channel and Andharmanik River are flowing adjacent to the project site is a major fishing hotspot in the area. The community in an around the Channel/River use the same for fishing activities primarily for livelihood. It was also confirmed by the fisheries department that the Channel is a major source fishing point. It was conveyed during consultation with the Department of Fisheries, Kalapara that the hot water discharged from the power plant is required to be regulated within 3°C of the channels/Rivers water temperature to prevent impact of fish life in the Channel/River as well as should careful during loading and unloading of coal.
- **Health Impacts from Migrant Workers & Labourers:** The concern reported by the Department of Health and Welfare was in regards to the incoming migrant working population that may lead to potential health implication on the local population and advent of new diseases including communicable diseases, sexually transmitted diseases and foreign pathogens and disease strains coming into the surrounding project area.
- **Impact of Vulnerable Groups:** issues identified for vulnerable groups from stakeholder consultation are.
    - ✓ The old aged persons may not take full advantages of employment opportunities arising from the project due to their inability to undertake labour intensive work;
- **Impact on Women:** issues identified as part of the stakeholder consultation on women are:
    - ✓ No major say in financial decision making at the household level especially with respect to utilization of compensation money.
    - ✓ Kalapara being highly traditional in social structure, women participation in employment opportunities generated by the project is expected to be low and the impact could be more significant in case of women headed households that have been impacted by the project.

# CHAPTER 16

# 16. CONCLUSION AND RECOMMENDATION

## 16.1 Conclusion

Due to the scarcity of electricity, Government of Bangladesh has intended to construct power plant with the requirement of PSMP 2010. From the social and economic point of view, the project is very much important. So there is no doubt about the establishment of the power plant. But the question arise how the plant will be established in environmental friendly manner at the proposed site. The environmental studies reveal the possible environmental issues and mitigation measures to reduce the environmental impacts of the project.

The EIA study team members observed that the site of the proposed power plant contain human settlement and the lands are used for agricultural activities at present. Major environmental and social impact of the project would be water pollution, air pollution and noise pollution in construction and post-construction/ operation phase due to wastewater, gaseous emission and noise from power plant, loss of agricultural land and settlement. These problems would be overcome by taking proper mitigation measures as stated in EMP. There are also very significant positive impacts during construction like local people job opportunities and increase business opportunities.

Local people showed interest to the project considering the needs for national development. Monitoring plan, if properly implemented during the pre-construction. Construction and operation phases will ensure taking corrective measures.

## 16.2 Recommendation

Finally, the following recommendations are made on the basis of IEE and EIA study that should be considered for achieving the goal of optimum minimum environmental impact and optimum benefits:

- Proper Resettlement and Rehabilitation plan is necessary for proper compensation to Project Affected People
- People (not owner) dependent on the land to be acquired should also be compensated and created scope for alternative livelihoods
- Findings and suggestion of EIA study in project planning, design and operation should be considered and implement with strong monitoring
- All activities (pre-construction, construction and post-construction stage) should be implemented according to EMP
- Environmental Management Plan and, Hazard and Safety Management Plan should be implement at every suggested steps of plant construction and operation
- Establishing Institutional arrangement with proper logistic and training for Environment, Health and Safety in Project Management Unit during pre-construction, construction and operation phases of the project
- Special care should be taken for Dolphin community protection as per EMP
- Relevant national laws and IMO conventions signed by the GOB should be enforced properly by the relevant authorities (MPA, DG Shipping, BIWTA, etc); accordingly, the Coal Transportation Agency should oblige the relevant laws and conventions

- Environmental Management Plan has been formulated considering anticipated impacts. However, further updating of impact management procedure must be made with respect to spatial and temporal regularly based on monitoring of impacts during construction and operation of the project
- The plant should be operated ensuring all pollution abatement measures e.g. ESP, FGD (in case of Sulphur contain more than 0.6%), Low NOx burner, effluent treatment plant, etc are in order and regular monitoring has to be done to evaluate their performance

# CHAPTER 17

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