North-West Power Generation Company Limited
(An Enterprise of Bangladesh Power Development Board)

Volume I: Main Report

"Environmental Impact Assessment (EIA) of the proposed Sirajganj 225MW Combined Cycle Power Plant Project (Dual Fuel-3rd Unit)"

November 2015

Dhaka

Submitted By

CEGIS Center for Environmental and Geographic Information Services
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Abbreviations and Acronyms

AE	Assistant Engineer
AEZ	Agro-ecological Zone
AIDS	Acquired Immuno Deficiency Syndrome
AM	Assistant Manager
AMSL	Average Mean Sea Level
APR	Automatic Power Regulation
AP	Affected Person
APS	Automatic Plant Startup/Shutdown
APSCL	Ashuganj Power Station Company Limited
ASA	Association for Social Advancement
AWD	Alternate Wetting Drying
BADC	Bangladesh Agricultural Development Corporation
BBS	Bangladesh Bureau of Statistics
BMD	Bangladesh Meteorological Department
BPC	Bangladesh Petroleum Corporation
BPDB	Bangladesh Power Development Board
BRAC	Bangladesh Rural Advancement Centre
BSCIC	Bangladesh Small and Cottage Industry Corporation
BWDB	Bangladesh Water Development Board
CCPP	Combined Cycle Power Plant
CDM	Clean Development Mechanism
CE	Chief Engineer
CETP	Central Effluent Treatment Plant
CEGIS	Center for Environmental and Geographic Information Services
CMB	Central Monitoring Basin
CMC	China National Machinery Import & Export Corporation
CO	Carbon Monoxide
COD	Chemical Oxygen Demand
CT	Cooling Tower
DAE	Department of Agricultural Extension
dB	Decibel
DCS	Distributed Control System
DCIS	Distributed Control and Information System
DFPS	Dual Fuel Power Station

DGPS	Differential Global Positioning System
DM	Deputy Manager/De-Mineralized
DO	Dissolved Oxygen
DoE	Department of Environment
DoF	Department of Forest
DORP	Development Organisation of the Rural Poor
DPHE	Department of Public Health Engineering
DTPA	Diethylenetriamine Pentaacetate
DTW	Deep Tube Well
EC	Electric Conductivity
ECA	Environment Conservation Act /Ecologically Critical Area
ECP	Environmental Code of Practice
ECR	Environment Conservation Rules
EGCB	Electricity Generation Company Bangladesh
EHS	Environmental Health and Safety
EHSU	Environmental Health and Safety Unit
EIA	Environmental Impact Assessment
EMP	Environmental Management Plan
EPC	Engineering, Procurement and Construction
EPFI	Equator Principles Financial Institution
EPZ	Export Processing Zone
ERG	Emergency Response Group
ERP	Emergency Response Plan
ESIA	Environmental and Social Impact Assessment
ETP	Effluent Treatment Plant
EZ	Economic Zone
FD	Forced Draft
FGD	Focus Group Discussion
FMD	Foot and Mouth Disease
F/TFW	Food/Taka for Work
FY	Fiscal Year
GCP	Ground Control Point
GDP	Gross Domestic Product
GIS	Gas Insulated System/ *Geographical Information System*
GoB	Government of Bangladesh
GPS	Global Positioning System

GRC	Grievance Redress Committees
GRM	Grievance Redress Mechanism
GT	Gas Turbine
GTG	Gas Turbine Generator
ha	Hectares
HAZOP	Hazard and Operability Assessment
HFO	Heavy Fuel Oil
HH	Household
HIES	Household Income and Expenditure Survey
HIV	Human Immunodeficiency Virus
HP	High Pressure
HRSG	Heat Recovering Steam Generator
HSD	High Speed Diesel
HSE	Health Safety Environment
HYV	High Yielding Variety
ID	Induced Draft
IEE	Initial Environmental Examination
IFC	International Finance Corporation
IMT	Incident Management Team
IP	Intermediate Pressure
IPM	Integrated Pest Management
IRT	Incident Response Team
ISO	International Organization for Standardization
IUCN	International Union for Conservation of Nature
JAM	Junior Assistant Manager
KII	Key Informant’s Interview
Km	Kilometer
KPI	Key Point Installation
KV	Kilo Volt
KWh	Kilo Watt hour
LEL	Lowest Explosion Limit
LGI	Local Government Institute
LGRC	Local Grievance Redress Committee
LOC	Level of Concern
LP	Low Pressure
MAOP	Maximum Allowable Operating Pressure

MDG	Millenium Development Goal
MLSS	Member Of Lower Subordinate Staff
MMCFD	Million Cubic Feet per Day
MMS	Manab Mukti Sangstha
MoEF	Ministry of Environment and Forest
MoPEMR	Ministry of Power, Energy and Mineral Resources
MoWR	Ministry of Water Resources
MP	Monophosphate
mPWD	Meter Public Works Datum
MSDS	Material and Safety Data Sheet
MVA	Mega-volt Ampere
MW	Mega Watt
NBSAP	National Biodiversity Strategy and Action Plan
NCA	Net Cultivable Area
NDP	National Development Programme
NE	North East
NEBOSH	National Examination Board in Occupational Safety and Health
NEP	National Energy Policy
NG	Natural Gas
NGO	Non-Government Organization
NOC	No Objection Certificate
NO_x	Oxides of Nitrogen
NW	North West
NWRD	National Water Resources Database
NWPGCL	North West Power Generation Company Limited
OE	Owner’s Engineer
OHSE	Occupational Health Safety and Environment
OHSAS	Occupational Health and Safety Management Systems
OM	Organic Matter
O&M	Operation and Maintenance
OP	Operational Policy
PA	Personal Assistant
PAC	Protective Action Criteria
PCM	Public Consultation Meeting
PGCB	Power Grid Company Bangladesh
PGCL	Pashchimanchal Gas Company Limited

PGRC	Project Grievance Redress Committee
PIU	Project Implementation Unit
PLF	Plant Load Factor
PM	Particulate Matter
PMU	Project Management Unit
PPE	Personal Protective Equipment
PPM	Parts Per Million
PPR	Peste Des Petits Ruminants
PSMP	Power System Master Plan
RCC	Roller-Compacted Concrete
RMS	Regulating Metering Station
RO	Reverse Osmosis
RRA	Rapid Rural Appraisal
RS	Remote Sensing
SAAO	Sub-Assistant Agriculture Officer
SAE	Sub-Assistant Engineer
SDE	Sub-Divisional Engineer
SE	South East/Superintendent Engineer
SGPP	Sirajganj Power Plant
SGCCPP	Sirajganj Combine Cycle Power Plant
SO_x	Oxides of Sulfur
SPM	Suspended Particulate Matter
SPS	Sirajganj Power Station
SRDI	Soil Resources Development Institute
ST	Steam Turbine
STD	Sexually Transmitted Disease
STG	Steam Turbo Generator
STI	Sexually Transmitted Infection
STW	Shallow Tube Well
SW	South West
TDS	Total Dissolved Solid
ToR	Terms of Reference
TSP	Triple Super Phosphate
TSS	Total Suspended Solid
UCR	Unit Control Room
UEL	Upper Explosive Limit

UFO	Upazila Fisheries Officer
UNICEF	United Nations Children's Fund
VGD	Vulnerable Group Development
VOC	Volatile Organic Compound
WARPO	Water Resources Planning Organization
WB	World Bank
WTP	Water Treatment Plant
XEN	Executive Engineer

Glossary

Aman:	Group of rice varieties grown in the monsoon season and harvested in the post-monsoon season. This is generally transplanted at the beginning of monsoon from July-August and harvested in November-Dec. Mostly rain-fed, supplemental irrigation needed in places during dry spell.
Aus:	Group of rice varieties sown in the pre-monsoon season and harvested in the monsoon season. These are broadcasted/transplanted during March-April and harvested during June-July. Generally rain-fed, irrigation needed for HYV T. Aus.
B:	When preceding a crop means broadcast (B. Aus)
Bazar:	Market
Beel:	A saucer-shaped natural depression, which generally retains water throughout the year and in some cases seasonally connected to the river system.
Boro:	A group of rice varieties sown and transplanted in winter and harvested at the end of the pre-monsoon season. These are mostly HYV and fully irrigated, planted in December-January and harvested before the onset of monsoon in April- May.
Char	Sandbar
Dinghy:	Small boat
Jhupri:	House which consist mud walls of 1.5 to 3.0 ft thickness, which carry the roof load. Earthen floor, thatch or CI sheets are used as roofing materials. There is no monolithic joint between the wall and the roof.
Kutcha:	A house made of locally available materials with earthen floor, commonly used in the rural areas.
Khal:	A drainage channel usually small, sometimes man-made. The channel through which the water flows. These may or may not be perennial.
Kharif:	Pre-monsoon and monsoon growing season. Cropping season linked to monsoon between March-October, often divided into kharif-1 (March-June) and kharif-2 (July-October).
Kosha	Flat-bottomed boat without an elaborate bow/stern
Jal:	Fishing net
Mauza:	Smallest revenue geographic unit having Jurisdiction List (JL) number.
Pucka:	Well constructedbuilding using modern masonry materials.
Rabi:	Dry agricultural crop growing season; mainly used for the cool winter season between November and February.
T. *Aman*:	When preceding a crop means transplanted (T. Aman).
Upazila:	Upazila is an administrative subdivision of a District.
Red Category	The projects that have the potential to degrade the environment highly if left uncontrolled

Unit Conversion

General Units

1 meter = 3.28 ft

1 kilometer = 0.621371192 mile

1 nautical mile = 1.852 kilometer

1 kilogram = 2.20 pound

1 metric ton = 1000 kg

1 barrel = 42 U.S. gallons = 159.0 liters

1 liter = 0.264172052 gallon (US)

1 square mile = 640 acres = 2.590 km^2

1 hectare = 10^{-2} km^2 = 2.471 acres

1 Pascal = 1 N/m^2= 0.01 millibar

1 liter = 0.001 cubic meter

1^0C = 274.15K=33.80F

1 mg/m^3 = 1 μg /L

1 mg/L ≈ 1 g/m^3 ≈ 1 ppm (w/w)

1 ≈ g/L ≈ 1 mg/ m^3 ≈ 1 ppb (w/w)

Energy Units

1 Cal = 4.19 J

1 Btu = 1055.87J

1 Btu = 251.9958 cal

1 joule = 0.239 cal

1 kWh = 3412 Btu.

1 MW=1000KW=10^6 W

1 kWh = 3.6 x 10^6 J

1 kWh = 859.85 kcal

1 horsepower = 746 W

1 GWyr = 8.76 x 10^9 kWh

Executive Summary

Background

Sustainable power supply is an important precondition for the socio-economic development of Bangladesh. At present, about 60% (including off-Grid & Renewable) population of Bangladesh has access to electricity (World Bank, 2014). The present electricity demand growth is 12% per annum, with installed generation capacity of around 11,088 MW. Considering fuel (gas & HSD) supply facilities in the area, the North West Power Generation Company Limited (NWPGCL), an enterprise of the Ministry of Power, Energy and Mineral Resources (MoPEMR) in line with the Government's Power Sector Master Plan of 2010, has planned to enhance the electricity generation by constructing a new Combined Cycle Power Plant (CCPP), 3rd unit at Sirajganj.

As per the definition of the*Environment Conservation Rules (ECR), 1997* of Bangladesh, the proposed Project falls under "**Red**"Category Project. Hence, for the fulfillment of the condition required under this Category, an Environmental Impact Assessment (EIA) study has been carried out with the aim of assessing the impacts of this Project, proposing mitigation measures and its implementation plan (EMP). NWPGCL has entrusted the CEGIS (Center for Environmental and Geographic Information Services)– a Public Trust under the Ministry of Water Resources of the Government of Bangladesh – to carry out the EIA of the 3rd unit of the Sirajganj Power Station. NWPGCL is also planning to seek financial assistance from the International Lender to implement the Project. Therefore, the EIA took into consideration the environmental rules and regulations of the country as well as the lender's operational policies and guidelines, including the IFC's Environmental, Health and Safety Guidelines.

Project Brief

The proposed Plant will be established adjacent to the 2nd unit of the Sirajganj Power Station (SPS) which is under construction. The site is located at about 15 km south-east of Sirajganj town, about 130 km north-west of Dhaka and 1.8 km south-west from the western end of Bangabandhu bridge. The proposed Plant will be built on 7.5 acres of land. The major components include a 150 MW gas turbo generator (GTG) with a bypass stack of 60 meter high, one horizontal type HRSG with a main stack of 60 meter high for outdoor installation and a heavy duty condensing type Steam Turbo--Generator (STG) for indoor installation in the configuration of 1:1:1, feed water pumps, condensate extraction pumps, cooling towers, 230 KV plant sub-station, transformers, gas Regulating Metering Station (RMS), Central Effluent Treatment Plant (CETP), Water Treatment Plant (WTP), administration building, workshop, warehouse, guard houses, internal roads, etc.

The proposed Project is a dual fuel based CCPP, will be operated predominantly by Natural Gas (NG) but has also the provision of High Speed Diesel (HSD) in case of emergency and non-availability of NG. Natural gas required for the Plant is 35 MMCFD and the Pashchimanchal Gas Company Limited (PGCL) will supply natural gas at a pressure of 500 psi through a 1.7 Km long and 16 inch diameter pipeline from its existing valve station to the PGCL RMS, which is to be constructed. From this RMS a 12 inch line will be extended up to the power Plant's RMS (to be constructed inside the Plant's boundary) at a pressure of 350 psi. Liquid fuel (HSD) requirement is estimated to be about 920 m^3/day at 80% PF. The oil will be supplied by Bangladesh Petroleum Corporation (BPC) from its Daulatpur and/or

Khulna depot by railway wagons to Bangabandhu Bridge (Setu) West Railway Station and stored in the HSD tanks in the Plant.

The hot flue gas that produced in the combustor will then be directed to the GTG, where it expands, loses pressure and temperature and causes the GTG to spin and generate about 150 MW of power. The hot exhaust gas of GTG will pass through the HRSG and main stack to the atmosphere. The HRSG in turn will generate High Pressure (HP), Intermediate Pressure (IP), and Low Pressure (LP) steam that will be directed to the STG, which would in turn generate 75 MW of power, thus totaling the Plant output to 225 MW. The generated power of GTG and STG will be stepped up to grid voltage level (11/230 KV) by station transformers (240 MVA for GT and 120 MVA for ST) and feed to the national grid, via underground cables (Sirajganj sub-station), through the Plant sub-station.

Total water demand for Units 1-3 is 1400 m^3/h, with third Unit requiring 400 m^3/h as per the Feasibility Report. There is a provision of fourth Unit to be constructed beside the third Unit. These units altogether will raise the water requirement to 2550 m^3/h. Water requirement for Plant construction and operation can be fulfilled from **ground water** and it was reported from the feasibility study that the maximum allowable withdrawal of ground water is 3,200 m^3/h without causing conspicuous problem in the groundwater table of the SPS area (EAL, 2014 and SDCPL, 2015). The major air pollutants that are produced from the power generating units due to burning of fossil fuel are SO_x, NO_x, CO_2, CO and SPM. Major sources of contaminated water from the proposed power plant are blow downs of HRSG, cooling tower, back wash and rejects of water treatment plant, oily water from turbine floor and transformer area etc.

Description of Baseline Environment

Environmental and social baseline has been prepared using both primary and secondary data collected for the proposed Project site and defined study area. The proposed Project falls under Zone-II, which has a moderate vulnerability for earthquake with a risk of possible earthquake reaching up to magnitude 6 on Richter scale.

The Jamuna River main drainage channel of the region with monthly maximum discharge of 103,129 cumec recorded in September, 1998 and the minimum discharge of 2,037 cumec recorded in March, 2013 flows beside the east side of the Project. . Because of the dynamic characteristics of Jamuna River, the area is highly vulnerable to riverine flood and river bank erosion. The area is relatively rich in **ground water** availability because of its high recharge potentials. Recharge of the aquifer primarily occurs during June to September through vertical percolation from relatively large amounts of rainfall and floodwaters. During dry season lateral recharge occurs from the river and vertical recharge occurs from stored water within bunds around the paddy field. The minimum ground water elevation varies from 5 to 13 m and the maximum elevation varies from 6 to 18 m. Groundwater is mainly abstracted on a wide scale throughout the study area for agricultural use and also for domestic and industrial purposes.

Surface water quality parameters checked under this study were found within Bangladesh standard. In case of ground water quality, DO level showed little inferior values in the samples of Rehabilitation Center and Banshata area than the standard. Values of Fluoride in the Banshata sample and Total Suspended Solid (TSS) of all three samples showed exceedance. Values of all other parameters were found within the Bangladesh standard. Values of all parameters of effluents of existing first Unit at various discharge points are within the Bangladesh standard.

The air quality parameters measured at four sensitive locations showed nothing exceedance from the Bangladesh standard.

Out of 23 different locations where noise level was measured, at four locations noise level has the exceedance of the day time standard whereas at 10 locations it has the exceedance of night time standard of noise level. Night time noise is influenced by the sound produced by the insects like cricket, etc. Noise level in the Eco Park, about 1.34 km away from the SPS, exceeds standard where power Plant has no/minimal impact.

The net cultivable area of the study area is about 14,500 ha. Agriculture practice around the Project site and also in the study area is predominantly based on ground water irrigation. The cropping intensity is about 244 %. The annual crop production of the area is about 180,000 MT of which 60,268 MT is rice and 119,592 MT is non-rice crops.

The Jamuna River is the lifeline of fisheries of the area. It is a major migratory route of major carps and other commercially valued fishes. It has major carp spawning ground at upstream and hatchlings are collected by setting 'Savar' at different points along the river. By recharging ground water aquifer it has been supporting pond aquaculture for maintaining water depth. The total fish habitats of the area is about 12,000 ha and producing annually about 1,650 MT of fish. The major capture fish species are: Rui, Katol, Mrigel, Kalibaush, Boal, Ayer, Baghayer, Chital, Pialee, Rayek, Banshpata, etc.

The proposed site is a raised and terrestrial land having vegetation coverage dominated by tall grasses, local herbs and number of shrubs. There is no economically valued plant species in the site. The vegetation supports avifaunal species like sparrow, mynahs, drungoes, etc.; mammals like mongoose and mouse; and reptiles like garden and house lizard. All wild dwellers are habituated with the present noise level produced by the first Unit. The Bangbandhu Eco Park which is 1.34 km away from and its extended semi-protected forest patches is very close to the Project site. No floral species of national and international conservation significance was found in the site. But seven species of fauna which are designated by Bangladesh Government Wildlife Act or CITES (Convention on International Trade in Endangered Species of Wild Fauna and Flora) database have been recorded occasionally found inside the Sirajganj Power Station.

The study area consists of 17 unions and 1 municipality either partially or fully having population of about 441,000 with the average household size of 4.5. The male (222,256) is marginally dominated over the female (218,513). The average population density is 1,273 which is little higher than the national density of 1,015 persons per sq. km. The inhabitants belong to two main religious groups; i.e. the Muslim and the Hindu. The distributions of employment of the area at reference period of census are as follows: about 40% are engaged in agricultural activities, about 25% in industrial and about 35% in service sectors. Electricity facility is very poor (about 44%) in the area. The overall housing condition is not satisfactory. About 96% of the households use ground water as drinking water.

Environmental Impacts

Major environmental impacts of the Project are registered under pre-construction, construction and operation phases. Potential major adverse impacts in pre-construction phase may include; susceptibility of unconventional relations between the migrant laborers and local vulnerable women leading to the risk of gender oriented/sexually transmitted diseases like HIV/ AIDS and STI and; aesthetic tiring due to negligence in management of kitchen waste.

Major impact during construction phase may include: aesthetic tiring due to negligence in management of kitchen waste and waste generated from construction activities and labor sheds. Noise generated from moving and idling vehicles, welding operations and movement of heavy machineries may cause hearing problem and create sudden panic to the adjacent people and; susceptibility of unconventional relations between the migrant laborers and local vulnerable women may lead to the risk of gender oriented/sexually transmitted diseases like HIV/ AIDS and STI

The major impacts during operation phase may include: degradation of water quality due to increased and cumulative discharge of effluent from all four units when in operation; accidental spillage of untreated effluent on the nearby land from the Plant and during filling the oil tank leakage of oil pipe, leading to degradation of the soil quality; possible changes in local infrastructure due to the operation of the power Plant; scarcity of ground water, due to their continued use for cooling purposes of the third unit and the other units of power plant, thus, leading to irrigation activity becoming more costly and crop production declined; cumulative effect of withdrawing ground water may affect the pond water availability period of the area under the influence of the cone of depression, which may lead to low productivity of pond aquaculture; deterioration of aquatic habitat quality and death of aquatic microorganisms/fishes due to accidental discharge of hazardous effluents; aesthetic tiring due to negligence in management of waste from kitchen waste and contamination of surface water, ground water and soil from hazardous substances such as hydrazine.

Operation of the second and third unit, the peak concentration of NO_2 would enhance by 169.3% for 1-hr average and 187.5% for annual average time. The resultant concentration during the operation of the three units will add 83.9% of the NO_2 with the present baseline concentration for the 1-hr average and 4.5% of the NO_2 for the annual average. The resultant concentration at the sensitive receptors is the compliance of the regulatory standards.

The highest GLC of CO will increase less than 1% with respect to the baseline situation both for 1-hr and 8-hr. The peak GLC of NO_2 will increase reasonably during operation of the three Plant but lower than the ambient air quality both ECR 2005 and IFC 2007. Those power plants will not significantly contribute $PM_{2.5}$ and PM_{10} at any of the receptors during operation of the power Plant. But PM_{10} may breach the IFC standard as the baseline concentration is relatively higher due to construction activities of unit-2 inside the power Plant complex. Only unit-3 will add 7.2E+5 ton of GHG to the atmosphere every year.

Modeling result shows the exceedance of noise level at two different locations i.e. labor colony near PGCL (NS10) and road in the Project site (NS14) during day and night only from the standard with the operation of 3rd Unit. Cumulative impact of noise considering first Unit (baseline noise) and third Unit shows the exceedance of noise level at six different locations during day time and 12 different locations during night time.

Considering 2nd and third Units in operation, the impact on noise level shows exceedance at three different locations inside the Plant such as main gate of NWPGCL (NS1), labor colony near PGCL (NS10) and road inside the project site (NS14). Cumulative impact of noise considering three units shows the exceedance at six different locations during day time and 13 different locations during night time. Excessive noise may cause disturbances to local inhabitants, hearing difficulties, fatigue and raising blood pressure, etc.

Potential Major Benefits

The power Plant will trigger regional development, creation of employment opportunities and thereafter improvement of livelihood. The proposed power Plant may also bring social and economic development of the region through infrastructural improvement, reducing energy shortfall, rural electrification and industrial (power loom) development. Communication network will also be improved significantly and will increase livelihood opportunities during the construction period. Finally, the proposed project would improve Environmental Performance by providing a means of effluent treatment of existing unit and proposed 2nd and 3rd units; thus significantly reducing the discharging of effluents in the canal around the site connected to the Jamuna River.

Mitigation Measures

The proposed third Unit CCPP has considered a number of environmentally friendly measures, such as combined cycle technology, close cooling system, central effluent treatment plant (CETP), etc. Moreover, changes bring into the layout of the Project through this study include: (i) A storm water drainage system around the proposed Plant and link it with the existing drainage network of the SPS; (ii) A temporary but arranged storage yard for scrap materials individually for all units in the southern side of the Sirajganj Power Station; and (iii) A green belt around the boundary of the SPS. The mitigation measures proposed during construction and operation phases are as follows:

The mitigation measures for potential major impacts are discussed in detail in Chapter 8 and 9. The minor and some moderate impacts will be managed and mitigated using environmental code of practices (presented in Appendix-8) and Contractors' good practice. The mitigation for some of the potential major impacts may include the following:

Construction phase

Aquatic habitat quality:

- Dredging operation should be carried out in the route having minimum aquatic habitats. Appropriate benthic survey must be carried out prior to any dredging activities.
- The shipping company must ensure that the ship carrying construction materials and other raw materials, obey the appropriate International Maritime Laws.

Dust and gases generated from excavation, construction equipments, and vehicles:

- Casing should be used when buried pipes crosses the road.
- Trench should be carefully cut so that the pipe is evenly bedded throughout its length with sufficient joint holes and trial holes made where necessary.
- Pipeline should be evenly bedded upon the bottom of the trench throughout its length and should be correctly positioned, before any back filing is performed.
- Compaction of back filling material should be performed by an approved method to prevent any subsequent settlement.
- Regular watering to the unpaved roads and open areas inside the project boundary may reduce the dust emission during construction phase.
- The vehicle speed should be limited to 15 kmph during the dry seasons and the truck must be covered when it hauling material.

Noise level:

- The machines/equipments/vehicles should be turned off when these are not in use.
- PPEs should be used during construction work.

Water pollution:

- Oils, lubricants and other hazardous materials should be bounded and stored separately so as to limit the spillage.
- Workers should be trained on safety precautions on using/handling such hazardous materials.
- The workers should be encouraged to use PPEs every time when handling oils, lubricants, chemicals and other hazardous materials.

Health and safety hazard:

- Proper health and safety training on hazard identification and handling hazardous equipments must be provided to the workers.
- The health and safety staff of contractor must ensure that the equipments and safety harness are working properly. On identification of faulty equipments, they must be promptly repaired or replaced.
- An on-site medical team should be set up and emergency first-aid kit should be at hand in case of any accidental injuries (burns, cuts, broken bones etc.).
- The workers should use appropriate PPEs.
- Workers hygiene and health status should be ensured. Monthly health check up should be conducted to monitor their health condition and appropriate treatment should be provided for any ailments.

Fire hazards from welding:

- All arc welding and cutting operations should be shielded by noncombustible or flameproof screens.
- In addition, the welders should use appropriate PPEs and welding trucks should be equipped with approved fire extinguishers and first aid.

Storage space and visual effect:

- Rubbles generated from the construction site should be stored in appropriate bins/skips, should be well-covered and later should be buried in an approved landfill site.
- All solid wastes, hazardous and non-hazardous, should be stored in designated sites prior to final disposal.

Operation phase

Maximum ground level concentration of air pollutants:

- Built-in Low-NOx burner in GT will reduce the NOx emission below 25 ppmv during operation stage of the power Plant.

Noise level inside the control room, turbine hall:

- A three (3) m high brick boundary walls should be constructed and thick plantation should be grown to attenuate noise in the sensitive receptors.
- Doors of the control room, windows and other doors should be fitted with proper sealing to attenuate noise.
- The machines/equipments/vehicles should be turned off when not in use.
- The turbines, pumps, fans etc. should be covered with soundproof dampeners to limit the spread of noise.

- Greenbelts should be developed around the power Plant area to limit the spread of noise to the nearby community.
- Workers should use appropriate PPEs (soundproof earpiece, earmuffs, etc.) while working close to the noise generating equipment.
- Local municipalities should have ordinances that regulate loud and objectionable noise; the authority should warn the local people about it.

Pollution of receiving water bodies:

- Construction of a leak-proof sump should be made to store sludge temporarily and to limit their spillage. They should then be transferred to sludge treatment plant for treatment.
- The sump should be monitored and maintained by on board chemist and technicians and make sure everything (e.g. pollutant content, spill control etc.) goes smoothly.
- Use of alternative oxygen scavenging chemical e.g. Helamin, Diethylhydroxylamine, etc in feed water for corrosion protection in HRSG boiler instead of hydrazine as this chemical is banned world wide.
- Introduction of Reverse Osmosis (RO) instead of using resin in demineralization plant.

Risks and emergencies:

- Pipes should be coated using 3 layer polyethylene's (3 LPE).
- Buried pipes and fittings should be protected against corrosion by means of external coating and wrapping.
- Holiday detector shall be used to detect any holiday and should be repaired.
- Cathodic protection test points should be installed and connected to temporary cathodic protection facilities in accordance with the specification as the final operation of lowering or tie-in is in progress.
- An inspection should be conducted after all installation activities and before back-filling.
- Cleaning regime should include a combination of on-line cleaning and semi-annual off-line washing.
- Welded joint sections of the pipeline should be separated and tied into a continuous system in such a manner that no stress would be exerted into the pipe as a consequence of the tie-in operation.

Ground water resources

- Recharge of groundwater using rainwater should be adopted by installing rooftop rainwater harvesting system, installing trench/groundwater recharge bed along the roadside within the Plant area.
- Considering, the consequences of the ground water withdrawal induced issue and the significant benefits to the communities; it is suggested to divert treated waste water to the crop fields around the Project site through irrigation canal for reducing pressure on ground water extraction.

Hazardous and non-hazardous waste

- A good practice of kitchen waste collection and disposal system should be adopted. The aim should be reduction of the waste generation. Degradable waste, glasses, recyclable and reusable waste, papers, plastic, etc should be collected by nature of the materials and managed separately. Some temporary bins with different colors indicating disposal of degradable and non degradable wastes might be installed at labor shed and work places to prevent scattered throwing of solid wastes.

- There should be a designated site for kitchen waste disposal.
- Scattered throwing and burning of waste should be prohibited.

Social awareness

Awareness programs on HIV/AIDS infection through well-designed campaign needs to be implemented. The contractor will put in place a referral healthcare facility to deal with medical aspects of HIV/AIDS treatment with specialized services.

Emergency Response Plan

As part of the EIA, an Emergency Response Plan (ERP) has been prepared and presented in Chapter 9. Each Contractor, after assessing potential emergencies that could be encountered during construction phase, would prepare site specific ERPs (guidance taken from the ERP proposed in this EIA) and would include them in their Construction Environmental Action Plan (CEAP). The CEAP would be submitted to the Owner's Engineer (OE) and Project Implementation Unit (PIU) for review and approval before contractor mobilization.

Environmental Management Plan

The Environmental Management Plan (EMP) includes several plans for implementing mitigation and enhancement measures, emergency response, occupational health and safety, and Environmental Code of Practices. Generally, the impacts, which are minor or moderate, are to be mitigated by adopting Environmental Code of Practices (ECP) and Contractor's good practices during project implementation. On the other hand, impacts and risks which are critical or major will be mitigated or prevented by adopting mitigation measures. The contractor would prepare and implement the mitigation measures, which will be supervised by the proponent, PIU or a Health and Safety Officer as required. The total estimated cost of implementing the EMP would be about USD 4.98 million.

Risk and Hazard Assessment

Potential hazard during construction stage might include leakage of flammable natural gas, leading to explosion and fire hazards. Finally, during operation phase, potential hazard might also include gas and other toxic compound leak, leading to fire hazards, explosion and human toxicity. Mitigation measures include: use of personal protective equipments (PPE); fall protection devices; proper training on health and safety and safety equipments; proper training on how to use machineries and tools for construction; regular check up of instruments and machineries; awareness on personal hygiene and road traffic rules and regulation; monthly health inspection of workers and staff etc. The contractor will also design an emergency response plan to better prepare in an event of emergency and how to recover after an emergency situation.

Environmental Monitoring Plan

Various monitoring programs have been proposed in the EIA, which include compliance monitoring, impact monitoring, and external or independent monitoring. The objective of this monitoring program is to ensure that the various tasks detailed in the environmental management plan, particularly the mitigation measures are implemented in an effective manner, and also to evaluate project's impacts on the key environmental and social parameters. The total estimated cost of monitoring would be around USD 2.1 million.

Indirect Project Benefits and Measures Proposed Beyond Compliance

The proposed Project would be designed as environmentally sound in comparison to the existing first Unit. Despite such design, the Project might have sensitivity to environment and thus measures to go beyond regulatory requirements would be introduced in the EIA and EMP. Aspects, such as corporate social responsibility (which included development of various socio-cultural facilities, toilets, hospitals and training of skilled/semi-skilled local youths for employment in SPS). For reducing the ground water pressure it is recommended to divert the treated waste water to use as irrigation water to the near crop field area.

Institutional Arrangements and Capacity Building

In order to implement the EMP as proposed in the EIA, an effective PIU with dedicated staff would be of crucial significance. For effective and meaningful implementation of the EMP, it is recommended that one Superintending Engineer and one Executive Engineer, with requisite training and practical experiences in implementing and/or monitoring environmental, health and safety issues pertaining to power sector are recruited. This team of two would be supported by two Assistant Managers (one experienced in environmental management and other in Occupational Health and Safety).

Capacity building training to strengthen the PIU and EHSU Circle of SPS staffs in the field of environmental management and occupational health and safety has also been proposed. Their aim would be to resolve most of the grievances at local level at the earliest convenience on receipt of compliant.

Stakeholder consultation and outcomes

People are, in general, in favor of this project as it would create employment opportunity for skilled, semi-skilled and unskilled people. Implementation of this project would also enhance the region’s standard of living because of the increased generation of electricity, contributing to further industrial set up (which further leading to more employment opportunities), etc. Noise was a particular problem that they addressed as well since it was disturbing people’s daily activities and causing hearing problems and increase of r blood pressure. But this is a short term problem when commissioning of the Plant will be done. Accordingly, the EIA has proposed mitigation measures to alleviate the above-mentioned issues and concerns, its implementation plan, monitoring plan and their required budgets.

Finally, the EIA, documenting the mitigation measures and consultation outcome, is available for public review along with the Executive Summary of the EIA (in both Bengali and English) at NWPGCL’s website for easy access.

1 Introduction

1.1 Background

1. As a rapidly developing country, which aims to achieve the medium income level as a nation by 2021, Bangladesh faces a sharp increase in the demand of power supply. Absence of sustainable power supply would act as a major hindrance in the expected socio-economic development goals. At present, about 60% (including off-grid renewable) population of Bangladesh has access to electricity and per capita electricity generation is only 348 KWh (including captive, FY 2014). The Government has therefore given top priority to the development of power sector and has formulated the Power System Master Plan (PSMP), 2010. To this end, the government has set the goal of providing electricity to all citizens by 2021. The present electricity demand growth is 12% per annum and current installed generation capacity is around 11,532 MW including 5,012 MW from private sector, and 500 MW from imported electricity (as of June, 2015). At present, most of the power plants are natural gas based. Bangladesh Power Development Board (BPDB) has planned to give thrust on combined cycle technology considering the scarce reserve of natural gas of the country.

2. The North West Power Generation Company Limited (NWPGCL), an enterprise of the BPDB adopts a plan of developing a Power Generation Hub at Saydabad of Sirajganj, on the right bank of the Jamuna River. Presently, a 225 MW Combined Cycle Power Plant (CCPP), upgraded from 150 MW Peaking Power Plant and later on termed as Unit-1, is being operated there and the construction of another 225 MW CCPP (Unit-2) is underway next to Unit-1. The NWPGCL now sets a plan of installing another 225 MW Dual Fuel based (HSD & Gas) CCPP (Unit-3) next to Unit-2. For this third unit, a land of 7.09 acre has been allocated in the same premise to the west of the Unit-2.

3. As per the Environmental Conservation Rules, 1997 (amended in 2005) of Bangladesh, this project falls under the ‘Red Category’ project that requires approval from the Department of Environment (DoE) before starting the construction. The approvalprocess requires carrying out Initial Environmental Examination (IEE) and Environmental Impact Assessment (EIA). However, NWPGCL has obtained an exemption of carrying out IEE from the DoE with a condition of conducting a comprehensive EIA in line with a Terms of References (ToR) approved by the DoE.

4. The Center for Environmental and Geographic Information Services (CEGIS), a Public Trust under the Ministry of Water Resources of the Government of Bangladesh and a pioneer scientific organization with vast experience in carrying out EIA studies of diversified fuel based power plants in Bangladesh, has been entrusted by NWPGCL for carrying out the EIA of the third unit of the power plant complex in Sirajganj.

1.2 Objective of the Study

5. The ToR defines the objectives of this consultancy service to carry out the EIA study for the proposed 225 MW Dual Fuel (NG & HSD) based Combined Cycle Power Plant at Saydabad, Sirajganj.

6. The specific objectives are:

   i. To identify environmental regulatory requirements for power plant designing, construction and operation;

ii. To assess the existing environmental and socio-economic baseline condition;

iii. To identify and assess all the potential environmental and socio-economic impact of the proposed plant during its construction and operation;

iv. To identify possible mitigation measures and propose an Environmental & Social Management Plan for ensuring environmental and social safeguard; and

v. To prepare an Environmental Monitoring Plan including Environmental Compliance Monitoring during pre-construction, construction, and operation.

1.3 Need and Importance of the Project

7. At present total installed electricity generation capacity is 11,532 MW, the current electricity demand is 10,283 MW and the supply is 8,763 MW (during fiscal year 2014-2015).[1] Around 60% of the population of the country has the access to electricity while electricity demand growth is 12% per annum. The Ministry of Power, Energy and Mineral Resources (MoPEMR) has forecasted that the increase in power demand in response to the desired economic growth of the country, will reach 13,000 MW in 2017 and 34,000MW by 2030. The PSMP also projected some scenarios of power demand with reference to different GDP growth rates. All these variable projections are depicted in the**Figure 1-1**.

8. To address the conflict between increasing power demand and prevailing shortage, BPDB has adopted a power generation enhancement plan till 2021 which is in line with the PSMP, 2010. The summary of the plan to increase power generation is depicted in **Table 1-1**. The plan includes different initiatives to generate additional electricity by diversifying fuel, rehabilitating age-old power plants, and importing electricity from the neighboring countries. The proposed Sirajganj 225 MW CCPP Project is one of such steps for contributing to meet the growing demand.

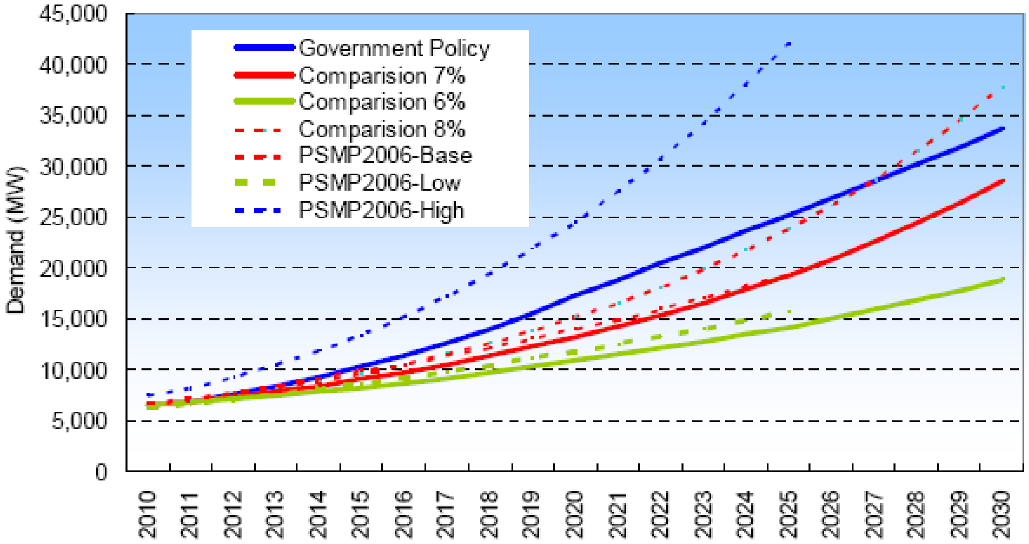


Figure 1-1: Power demand forecast for different scenarios (TEPCO 2010)[2]

[1] Power Sector Emergency Information, System Planning Department, BPDB, February 16, 2015.

[2] TEPCO (2010); Power System Master Plan, Power Division, Ministry of Power, Energy and Mineral Resources, Government of the Peoples Republic of Bangladesh, http://www.powerdivision.gov.bd/user/brec/112/58

Table 1-1: Power Generation Enhancement Plan

Year / Type	2015	2016	2017	2018	2019	2020	2021	Total
Public (MW)	1,218	770	2,202	846	2,070	1,000	2,400	10,506
Private (MW)	1,130	748	799	1,270	568	1,287	1,912	7,670
Import (MW)	--		--	--	--	--	--	--
Total	2,348	1,518	3,001	2,116	2,634	2,247	4,312	18,176

Source: Power Sector Emergency Information, System Planning Department, BPDB, February 16, 2015

1.4 Scope of the EIA Study

9. The scope of the study is to carry out the EIA of the 225 MW Dual Fuel based CCPP (3rd Unit) of Sirajganj, which would fulfil the applicable environmental requirements, including the laws, by laws and rules of Bangladesh and would also comply the World Bank (WB) Group's operational policies and guidelines including health and safety issues.

- Description of the proposed project
- Description of the baseline condition of the environment of the study area *i.e.*
- Physical Environment
- Biological Environment
- Socio-Cultural Environment
- Legislative and regulatory considerations
- Determination of the potential impacts of the proposed project
- Analysis of the alternatives of the proposed project
- Cumulative impact assessment
- Development of the EMP which would also include emergency response requirement for accidental events and occupational safety followed by Monitoring Plan
- Consultation, disclosure and grievance redress.

1.5 Limitations of the Study

10. According to standard practice and instruction of DoE, all the seasonal aspects including a complete hydrological cycle should be considered during the conduction of EIA study. However, due to time constraints, a complete hydrological cycle covering all the seasonal aspects could not be covered in this study. Secondary data was used in this study to overcome this issue.

11. As it was a very time-bound project, the opportunity of collecting water and air samples during dry season was very limited, which should ideally be done to understand the worst case scenario. However, secondary data was used in this regard to comprehend the year-wise scenario.

1.6 EIA Study Team

12. A multidisciplinary EIA team was formed as defined in the ToR and proposed in the Technical Proposal. The study team and their responsibilities as per direction of the ToR, is presented in **Table 1-2** below:

Table 1-2: Team composition for the EIA Study

Sl. No	Name	Position
1.	Mr. Mohammed Mukteruzzaman	Team Leader/Environmental Impact Assessment Expert
2.	Mr. Jalal Ahmed Choudhury	Power System Engineer/ Deputy Team Leader
3.	Mr. Md Shibly Sadik	Environmental Management Planning Specialist
4.	Mr. Pronab Kumar Halder	Environmental Quality Specialist (Air, Noise & Water)
5.	Ms. Sabria Afrin	Water Resources Specialist
6.	Mr. Md. Amanat Ullah	Ecology and Biodiversity Specialist
7.	Mr. Muhammad Shifuddin Mahmud	Socio-economic Specialist
8.	Mr. Hasan Tawfique Imam	RS/GIS Specialist
9.	Mr. Ashoke Kumar Das	Fisheries Specialist
10.	Mr. Mohammed Zahid Hasan Dhali	Agriculture and Livestock Specialist

13. In addition to this core team, CEGIS also availed the expertise from more professionals to ensure smooth and timely completion of the assignment.

Table 1-3: Additional Team members

Sl. No	Name	Position Assigned
1.	Md. Azizul Haque	Water Resources and Power Management Adviser
2.	Md. Ebrahim Akanda	Agriculture and Livestock Advisor
3.	Ms. Sadeka Tasmin	Junior Environmental Specialist (Project Leader)
4.	Mr. Faisal Ahmed	Community Health and Safety Specialist
5.	Mr. Arup Kumar Biswas	Environmental Geologist
6.	Mr. Redwan Hossain Jeshan	Junior Health and Safety Specialist
7.	Mohammad Imran Hasan	Junior Morphologist
8.	Md. Monowar-ul Haq	Groundwater Specialist

1.7 Reporting Structure

14. The report has been prepared in accordance with the ToR, and it contains 14 chapters. These are:

Chapter 1 describes the introduction containing background, purposes, and limitations of EIA study, need and importance of the project and concludes by introducing the study team.

Chapter 2 is on legislative and regulatory aspect describing the relevant policies and legal frameworks for the EIA process of the power plant Project.

Chapter 3 covers project data sheet of the proposed power plant comprising of project proponent, project location and area, nature and size of the project, project components, project activities and schedule, resources required and their quality, and utilities demand, required manpower and tentative organogram, tentative costing and funding etc.

Chapter 4 covers process description depicting project layout, technology selection and process description, waste management system, green initiatives etc. of the proposed power plant

Chapter 5 presents an analysis of various alternatives options for project component such as fuel type, technology selection, water treatment system etc.

Chapter 6 describes the environmental and social baseline condition with detail physical environment, water resources, land use and land cover, land resources, agricultural resources, livestock and poultry, fisheries, ecological resources, transportation system, key point installations, socio-economic condition, community health and safety, etc.

Chapter 7 presents the potential impacts of project during pre-construction, construction and post-construction/operation phases.

Chapter 8 recommends mitigation measures for various identified impacts, enhancements, and compensation to restore including pollution control systems, waste treatment, engineering measures etc.

Chapter 9 describes the EMP with mitigation measures for minimizing the effect of the negative impacts and enhancement measures for increasing the benefits of the positive impacts during pre-construction, construction, and operation stages. The tentative budget for EMP is described in this chapter.

Chapter 10 outlines all possible hazards and risks associated with the decommissioning and proposed combined cycle dual fuel power plant, and management of the hazard and risks.

Chapter 11 describes the environmental monitoring plan, implementation of monitoring plan, performance indicators, and reporting and feedback mechanism.

Chapter 12 describes the indirect project benefits and measure beyond compliance from the proposed project.

Chapter 13 presents the results of public consultation and information disclosure including consultation with expert and representatives of institutions and selected focus group discussions.

15. Literature used in preparation of the report is listed under references at the end of the report.

2 Policy, Legal and Administrative Framework

2.1 Introduction

16. This chapter presents a review of the national Acts, Policies, strategies and regulatory frameworks, which are relevant to the environmental and social aspects of the Project (i.e., The Sirajganj 225 MW Combined Cycle Power Plant). We also aim to briefly discuss the World Bank and International Finance Corporation's environmental, health and social safety guidelines and the performance standards on environmental and social sustainability framework to complement, as applicable, the Bangladesh national policies and guidelines.

2.2 The Context

17. The Bangladesh Government is committed to accelerate inclusive economic growth and reduce poverty. The Government has articulated its development target in "The Vision 2021" document and these have been further elaborated in the Perspective Plan 2010-2021. The Perspective Plan, according to the Government, "is a lighthouse to point to the broad directions of the development perspective envisioned. It draws on development planners' viewpoints and the Government's development vision representing the hopes and aspirations of the people of Bangladesh" (GoB: 2010:1). Review of the plan/policy documents of the Bangladesh Government, attest to the fact that the Government wants to transform socio-economic environment of Bangladesh and continue to enhance the country's status from a "low mid- income" economy to "high middle income economy". Bangladesh Government is conscious of the fact that with the limited resources, it will not be able to address all the challenges it faces. Therefore, the logical choice is prioritization. The emphasis of the Government is not only to raise per capita income, but also to give its citizens the opportunity to pursue livelihood activities and a lifestyle of their choice, with higher standard of living, access to quality education, energy availability to ensure per capita energy consumption of about 600 kWh (*ibid.* 2010:2).

18. The key Policies, Acts, Plans and Strategies of the Government recognize that economic growth, environmental protection and sustainability and poverty reduction are inextricably linked and reinforce each others. According to available reports Bangladesh though succeeded in reducing poverty from 40% to 25%, however studies have also shown that due to environmental degradation the country is paying a very high premium. For example, a recent Government report notes loss of nearly 4% of GDP and 22% higher incidence of diseases are due to environmental degradation of which water quality is a predominant factor (GoB 2015. Planning Commission. Environment, Forestry and Biodiversity Conservation. Background Paper for the 7th Five Year Plan. (http://www.plancomm.gov.bd/7th-five-year-plan/).

19. In a densely populated country like Bangladesh where there is an intense pressure on its natural resources, the manifestation of above noted conflicting processes are not a total surprise, and also did not escape the Government's policy attention. Therefore, to redress some of the problems that came to the surface and also to prevent repetition of the same in future, the Government over the years enacted and/or adopted various Acts, Legislations, Policies, Plans, Strategies and Guidelines to ensure environmental sustainability of all development interventions.

20. In this effort, the latest being the Circular (*ref. MoEF/Environment-3/Clerance-2/2010/44. Dated 22 February 2015*), a Statutory Regulatory Order has been issued by the Ministry of Environment and Forest, Government of Bangladesh making EIA mandatory at each and every stages of the Project cycle. The Bangladesh Government taking cognizance of the Bangladesh Environment Conservation Act 1995 (including its 2010 amendments) and the Environmental Conservation Rules 1997, through the above noted Circular has made EIA obligatory for all projects before they are finalized and submitted for Government's approval. To this effect this Circular has outlined the nature and scope of environmental assessment and/or screening that all projects must undertake EIA process starting from the stage of project concept development all the way to post-project monitoring and maintenance. The said Circular also unequivocally stated that in all projects, provision for adequate resources must be ensured in consultation with the Ministry of Finance to accomplish these tasks, and the provision of resource allocation has to be authenticated by the Ministry of Finance, when the projects are submitted for Government's approval.

21. Keeping in view the core objective of this report i.e., Environmental and Social Impact Assessment of the Sirajganj 225 MW Combined Cycle Power Plant, we present a brief overview of Bangladesh Perspective Plan 2010-2021, followed by review and analysis of environmental acts, legislations, rules and regulations and thereafter with other sectoral policies and legislations of Bangladesh, which have direct relevance for designing and implementing power sector projects. Next in the light of this analysis the mandate of the key institutions are discussed. The chapter then discusses the World Bank and IFC's environmental, health and social safety guidelines and the performance standards on environmental and social sustainability framework to complement, as applicable, the Bangladesh national policies and guidelines. Finally the Chapter ends with a short summary.

2.3 The Perspective Plan 2010 - 2021

22. The Perspective Plan 2010-2021 elucidates the country's aspiration, and this is clearly reflected in the preamble, which notes that the Plan "is a lighthouse to point to the broad directions of the development perspective envisioned" (GoB 2010:1) The Plan envisages Bangladesh as a nation with "food and energy security, with low level of unemployment and poverty" and emphasizes on human development through greater access to education and health for them to take advance of science and technologies among others the information and communication technologies for establishment of a Digital Bangladesh.

23. The chapter 9 of the Perspective Plan elaborated Government vision with respect to "power sector" under the title 'Ensuring Adequate Supply of Electricity and Fuel'. In the Plan electricity has been considered as "an essential ingredient for development in both economic and social arena" (GoB 2010:89) and to ensure dependable electricity supply to its citizens at a reasonable price outlined its power generation strategy based on diversified sources of fuel such as gas, coal, liquid fuels as well as through renewable sources, for example, solar, wind and micro hydro (ibid. 90). This vision was further elaborated in the Power System Master Plan (February 2011). The "Master Plan aims to acquire a 25% share of domestic coal and a 20% share of domestic natural gas, and a 5% share of national hydropower and renewable energy, thus ensuring the self-sufficiency of the primary energy resource to be over 50% by Year 2030" (GoB 2011: 2-4).

2.4 National Energy Policy 1996 and 2004

24. The first National Energy Policy (NEP) of the county was formulated in 1996 "to ensure proper exploration, production, distribution and rational use of energy sources to meet the growing energy demand of different zones, consuming sectors and consumers groups on a sustainable basis" (GoB 2004:2). However, in recognition of the importance of energy in socio-economic development, the Government decided to update the NEP as an integral part of the overall development of the energy sector, and this was accomplished in May 2004. The NEP 2004 covers issues pertaining to "survey, exploration, exploitation and distribution of indigenous natural gas; establishment of petroleum refining facility and distribution systems; and establishment of power generation plants and networks for transmission and distribution of electricity" (GoB 2004:1).

25. The NEP 2004 recognized that "policy formulation is a continuing process for decision making at different levels by different institutions and individuals" and hence for operationalizing the NEP there is a need to ensure that these "decisions are taken in a synchronized manner at macro level, sectoral level as well as sub-sector (utility) level" to achieve the stated objectives (GoB 2004:17). The NEP also stated that implementation of the NEP "will necessitate introduction of new Acts and modifications of the relevant Acts and Ordinances in this regard and *Environmental issues to be considered under National Energy Policy are to be mandated under National Environment Policy and Environment Act*" (ibid. 22, emphasis added).

26. The NEP 2004 devoted a section on Environment Policy, which deserves closer attention with reference to this project and hence we give an extensive quote as under. As regards to environment, the NEP 2004 (ibid. 27-28) outlined 10 policy measures and they include the following;

a. Carrying out EIA (including a consideration of social impact) should be made mandatory and should constitute an integral part of any new energy development project;

b. Use of economically viable environment friendly technology is to be promoted;

c. Use of fuel wood is to be discouraged and replacement fuels are to be made available at an affordable price;

d. Popular awareness to be promoted regarding environmental conservation;

e. In case of coal based power plants, disposal of ash and reduction of environmental emission are to be considered in technology selection;

f. Use of lead free petrol is mandatory;

g. Use of low sulfur content diesel will be encouraged;

h. Production of liquid fuels like petrol, kerosene, diesel oil from natural gas (NG) will be encouraged;

i. Other technical options such as use of Catalytic Converter and Diesel Particulate Filter will be encouraged to reduce vehicular emissions;

j. For improving the environment condition in the country, producing energy from wastes will be encouraged.

2.5 Key Policies, Acts and Strategies

2.5.1 The National Environment Policy - 1992

27. The National Environment Policy 1992 sets out the basic framework for environmental action together with a set of broad sector guidelines. The Environment Policy provides the broader framework of sustainable development in the country. The core objective of the policy is to ensure the protection and improvement of the environment. It outlined actions that need to be pursued while planning development interventions by any sectors to facilitate long term sustainable use of all natural resources.

28. It embraces 15 broad sectors including energy to deal with overall environmental issues. Under the energy sector in section 3.4 of the policy it articulated the following objectives:[3]

- Reduce and discourage use of fuels that adversely impact the environment, and promote environment-friendly fuel use;
- Reduce use of wood and agricultural residues as fuel and encourage alternative sources;
- Adopt adequate precaution measures to safeguard environment while using nuclear energy;
- Promote innovation of fuel saving technologies and ensure dissemination of such technologies and knowledge for public uses;
- Ensure proper preservation of country's all energy resources; and
- Conduct comprehensive environmental impact assessment study before undertaking any intervention for exploitation of energy and other minerals in support of energy production.

29. The policy also gave the direction of amending the existing laws, formulating the new laws and implementing the same. To this effect, the policy assigned the Ministry of Environment and Forests to coordinate the implementation of the policy and to constitute a high level National Environmental Committee with the head of the Government as the Chairperson to give the direction, and ensure supervision and overseeing the implementation of the policy.

2.5.2 The Environment Conservation Act - 1995 (and the amendments)

30. The Bangladesh Environment Conservation Act, 1995 (ECA 1995) is currently the main Act governing environmental protection in Bangladesh. The ECA 1995 replaced the earlier environment pollution control ordinance of 1992 and provides the legal basis for Environmental Conservation Rules, 1997 (ECR 1997). The main objectives of ECA 1995 are: conservation of the natural environment and improvement of environmental standards, and control and mitigation of environmental pollution. The main strategies of the Act can be summarized as:

- Declaration of Ecologically Critical Areas (ECA), and restriction on the operation and process, which can be continued or cannot be initiated in the ecologically critical areas.
- Regulation in respect of vehicles emitting smoke harmful for the environment.

[3] Unofficial translation from Bengali text.

- Environmental clearance.
- Remedial measures for injury to ecosystem
- Regulation of the projects and other development activities - discharge permit.
- Promulgation of standards for quality of air, water, noise and soil for different areas for different purposes.
- Promulgation of standard limit for discharging and emitting waste.
- Formulation and declaration of environmental guidelines.

31. The Act is implemented by the Department of Environment (DoE), under the Ministry of Environment and Forest. Under the Act, for any new development project, the project proponent must take Environmental Clearance from the DoE. The procedures to take such clearance are in place. Failure to comply with any part of ECA 1995 may result in punishment by a maximum of 10 years imprisonment or a maximum fine of Tk. 100,000 or both.

32. The recent Circular (February 2015) issued by the MoEF, as noted in para 5 above has not only re-emphasized the importance of EIA but clearly outlined the nature of environmental assessment and/or screening that all projects must undertake covering all stages of project cycle starting from project concept development to post-project monitoring and maintenance. The said Circular also stated that all projects must keep provision for adequate resources to accomplish these tasks and secure approval of resource allocation from the Ministry of Finance before submission the projects for Government's approval.

33. Bangladesh Environmental Conservation Act (Amendment 2000) focuses on: (1) ascertaining responsibility for compensation in cases of damage to eco-systems, (2) increased provision of punitive measures both for fines and imprisonment and (3) fixing authority on cognizance of offences. This Act was amended in 2002 (Bangladesh Environmental Conservation Act - Amendment 2002) and added the following under the purview of the Act: (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. In 2010 the Act was further amended and the Bangladesh Environmental Conservation Act (Amendment 2010) elaborates on (1) demarcation of wetlands and water bodies, (2) Hazardous waste import, transportation, storage etc., (3) Cutting of hills, mountains (4) Ecologically Critical Areas.

2.5.3 The Environment Conservation Rules - 1997

34. The Environmental Conservation Rules 1997 (ECR 1997) was enacted in exercise of the powers conferred by section 20 of the Bangladesh Environment Conservation Act 1995 (ECA 1995), to ensure its proper implementation and enforcement. The salient features of the ECR 1997 are;

- Categorization of the projects as green, orange (A and B) and red depending on the potential pollutions threats to environment,
- Procedure to take environmental clearance and the appeal process,
- Determination of ambient environmental standards with respect to water, air and noise, as well as permitted discharge/emission levels of water and air pollutants and noise pollution.

35. The ECR 1997 classifies projects by potential environmental impact and assigns different assessment and management requirements as follows:

- **Green projects** are those with positive environmental impacts or negligible negative impacts such as plantation and nursery. Clearance for these is obtained on the basis of project description, initial screening and No Objection Certificate (NOC) by the local authority.
- **Orange projects** fall into two categories i.e., Orange A and Orange B. Orange A projects are those with minor and mostly temporary environmental impacts for which there are standard mitigation measures, such as the installation of tube wells, pond sand filter, tank/reservoir, sanitary latrines etc. Application for DoE's environmental clearance requires general information, a feasibility report, a process flow diagram and schematic diagrams of facilities, environmental screening form, NOC from local authority. Orange B projects are those with moderately significant environmental impacts for which mitigation measures are easily identified, such as construction/re-construction of earthen roads, culverts, community centers, office buildings for general services, re-excavation of canals, repairing embankments, and school fields, etc. Such interventions require environmental clearance certificate from DoE, based on an Initial Environmental Examination report and an Environmental Management Plan, among others.
- **Red projects** are those which may cause 'significant adverse' environmental impacts such as the construction of bridges, industries, flood shelters, embankments, water control structures, etc. Projects under this category require IEE report to obtain the Site Clearance Certificate, and subsequently a full EIA report for environmental clearance certificate, along with the information required for other Categories. A number of sectoral EIA guidelines have been prepared to assist the EIA process.

36. Environmental standards also promulgated under the Environment Conservation Rules 1997 are prescribed for varying water sources, ambient air, noise, odors, industrial effluents and emission discharges, vehicular emissions, etc. with the aim of limiting the volume and concentrations of pollution discharged into the environment. A number of surrogate pollution parameters like Biochemical Oxygen Demand, or Chemical Oxygen Demand; Total Suspended Solids, etc. are specified in terms of concentration and/or total allowable quality discharged in case of waste water and solid wastes. Additionally specific parameters are specified such as phenol, cyanide, copper, zinc, chromium, and various types of particulate, sulfur dioxide, nitrogen oxides, volatile organic compounds and other substances

National Environment Quality Standards

37. Under the Environment Conservation Rules of 1997 the Government has promulgated environmental standards and they are in operation. The standards have been defined for varying water sources and its quality, ambient air, noise, odors, industrial effluents and emission discharges, vehicular emissions, etc. Under the Rule, the Government imposes restrictions on the volume and concentrations of wastewater, solid waste and gaseous emissions discharged into the environment. In addition, a number of surrogate pollution parameters like biochemical oxygen demand, or chemical oxygen demand; total suspended solids, etc. are specified in terms of concentration and/or total allowable quality discharged in case of wastewater and solid wastes. Additionally, specific parameters depending on the manufacturing process are specified such as phenol, cyanide, copper, zinc, chromium, etc. Air emission quality standards refer mostly to concentration of

mass emission of various types of particulate, sulfur dioxide, oxides of nitrogen and in some cases volatile organic compounds and other substances.

38. The Bangladesh standards in general are less stringent compared to that of the developed countries. This is to promote and encourage industrialization in the country. However, under the ECR 1997 the defined standards are mandatory and there is no provision for partial compliance either. Furthermore, the Environmental Quality Standards are legally binding. There is a separate schedule on industry specific standards, other than the general industrial emission and effluent standards. This schedule covers a wide range of industries – fertilizer, tannery, integrated textile, food, cement, etc. Schedule II for quality standard is appended as **Appendix 1**.

2.5.4 The Environment Court Act - 2000

39. The Environment Court Act - 2000 has been enacted in order to establish environmental courts in each administrative division of Bangladesh. Under this Act, the court has concurrent jurisdiction i.e. to try both civil and criminal cases. The basis for instituting a case is a violation of the "environmental law", meaning the Bangladesh Environment Conservation Act - 1995 and Rules made there under. In particular, the environment court is empowered to:

- Impose penalties for violating court orders;
- Confiscate any article, equipment and transport used for the commission of the offence;
- Pass any order or decree for compensation;
- Issue directions to the offender or any person (a) not to repeat or continue the offence; (b) to take preventive or remedial measures with relation to any injury, specifying the time limit and reporting to the DoE regarding the implementation of the directions.

40. Under this Act the Director General of the DoE has the power to impose penalties to polluters who, for example, are dumping untreated wastewater into the environment or not operating their legally mandated effluent treatments plants.

41. The Environment Court Act - 2000 allowed the Government to form court only at divisional headquarters. According to this law, a person might be jailed for maximum three years or fined Taka 300,000 for polluting environment. But the new legislation increased the jail term up to five years and the fine up to Taka 500,000. Both the special magistrate's court and the environment court will enjoy authority to realize fines from the offenders. Besides, the courts may order to meet expenses for conducting cases and give the money in compensation to the affected individuals or organizations.

42. The Parliament also passed bills in 2010 for increasing the number of environment courts and their authority to take stern actions against polluters, making provision for establishing a trust to tackle adverse impacts of climate change. A new bill was also placed in the parliament seeking to enact a law to punish illegal sand extraction and to lease sand quarries in an environmentally friendly way. The new legislation, which was passed repealing the existing Environment Court Act - 2000, aims to expedite trial of environment related offences and offers setting up environment court at every district headquarters with expanded jurisdiction to take stern actions against all sorts of polluters.

2.5.5 Bangladesh Water Act 2013

43. The Bangladesh Water Act 2013 was passed by the Government on 6 November 2013 to ensure "integrated development, management, abstraction, distribution, use, protection and conservation of water resources". By virtue of this Act all rights over surface water, ground water, sea water rain water and water in the atmosphere is vested on the State. Notwithstanding the above, "rights over the surface water on any private land shall remain with the owners of such land", and such right to use the water shall be subject to the provision of the Act. Furthermore, under the provisions of this Act, "right to potable water, and to water for hygiene and sanitation shall be treated as the highest priority right".

44. The Act makes a provision for constituting a National Water Resources Council headed by the Prime Minister.[4] The Council is the highest decision making body and is empowered to make policies, give instructions to develop National Water Resources Plan for integrated development and safe abstraction of water and its proper use to ensure protection and conservation of water resources. The Council is also mandated to approve the National Water Resources Plan (NWRP) and ensure it's implementation, as well as give advice to the Government to enter into agreement through signing memorandum of understanding and/or signing conventions and treaty with any Government and international or regional organization to undertake joint survey, exchange data/information with respect to common water resources and it abstraction and development and undertaking joint measures to prevent pollution of common water resources.

45. The Act also makes a provision for approving national water resources plan prepared in accordance with the water resources planning Act, 1992 containing among others the following matters namely:

- Analysis of economic, natural, social, political, environmentaland ecological and institutional elements, characteristics and impact of water resources;
- Integrated use of surface and ground water emphasizing the highest possible use of rain water;
- Water has to be protected from the pollution from wastes and contamination from hazardous materials;
- Determination of water quality standard;
- Fixation of priority of water use.

46. The Act also makes further provision:

- Declaration of water stress area and management thereof;
- Preferential use of water in the water stress area and exemption thereof;
- Fixing the lowest safe yield level of aquifer and restrictions on abstracting groundwater;

[4]The other members of the Council are various Ministers, Secretaries of relevant Ministries, Heads of various water related autonomous (parastatal) bodies, Presidents of the Institute of Engineers and Institute of Diploma Engineers, one representative of the NGO and three independent water resources experts. The NGO representative and three water resources experts are to be nominated by the Prime Minister.

- That without the pre-approval of the Ministry of water Resources, no projects will be allowed on water extraction , use, development and maintenance , especially those infrastructure development projects that impede the natural flow of water; and
- Protection of flood control embankment, whichstates,“to ensure the sustainability of the flood control embankment, no person shall, without the permission of the appropriate authority, be allowed to construct any house, establishment or any other structure on, or on the slope of such embankment.”

47. Finally, if anybody deliberately violates or ignore the responsibility or protection under this Act, in that case, under the provisions of sub-section (2), she/he will get maximum of 5 years imprisonment or maximum Tk. 10,000 as financial punishment or both the punishments.

2.5.6 Noise Pollution (Control) Amendment, 2004:

48. As the noise level has increased sharply in recent years due to the use of microphones, loudspeaker, vehicles, horns, generator etc. and since mental and health impacts can be noticed among the exposed population, the noise pollution (control) amendment, 2004 was formulated. This act gives the authority to all the Paurasabhas, City Corporations, Capital development authority (RAJUK), Khulna Development Authority (KDA), Chittagong Development Authority (CDA), and Rajshahi Development Authority (RDA) to mark off the areas under their jurisdiction as silent, residential, mixed, commercial or industrial. They should also put sign to remark those areas. In case of union council, they should at least place signs or signboard at 100 meter distance of schools or hospitals. The act also describes the approved standard limit of sound in the added schedule 1 and 2. In the schedule 1, silent area means area up-to a radius of 100 meters around hospitals or educational institutions or special institutions/ establishment identified/to be identified by the government. In the silent area it is prohibited to use any kind of horns of vehicles, audio signals and loudspeakers. In case of using amplifier, microphones or loudspeaker in residential area, mixed area, commercial area or industrial area, permission should be taken from appropriate authority which is mentioned in schedule-3 of the act. According to this act, daytime is counted from 6am to 9pm whereas nighttime is counted from 9pm to 6am. The details of the standards for sound in different types of areas are listed down in **Appendix-1**.

49. According to noise pollution (control) amendment, 2004 use of pneumatic horn/hydraulic horn/multi-tuned horn in any kind of vehicle would be banned. The standard limit of the sound should be maintained if the selected spot is not designated for picnic. However, in designated picnic spot (selected by District Commissioner), loudspeakers can be used only form 8am to 7pm. However, it is banned to use loudspeaker during the journey, which is a very common practice in Bangladesh. It is also banned to use brick demolishing machine in residential area. Moreover, use of any kind of noise generating machine such as mixture machine is restricted to be used in residential area from 7pm to 7 am.

50. During election period it is permissible to use loudspeaker till 2 days before election from the period of announcing the schedule. However, this permission is not applicable for silent area. Only in residential and commercial areas, loudspeaker can be used from 8am to 8 pm.

51. This act also requires the people exposed to high noise in industries to wear personal protective equipments to reduce the impacts of noise pollution.

52. If someone uses sound amplifier, microphones or loudspeaker than s/he should take necessary measures so that the level of sound does not cross the standard limit in the neighbouring area.

53. However, using loudspeaker for religious activities, warning people during natural disasters, celebrating national programs declared by government such as Independence Day, victory day, Bengali New Year etc., disseminating emergency information or notice or promotional activities of/by government or authorized organization, circulating news of death or loss etc are exempted from the restrictions of this act. Moreover use of siren/loudspeaker in ambulance, in vehicles of fire brigade, police or defense force is also exempted from this act.

54. Violation of the statute would cause someone a minimum penalization of BDT 5,000 and/or 2 months of jail and maximum penalization of BDT 10,000 and/or 6 months of jail.

2.5.7 National 3R Strategy for Waste Management

55. "National 3R strategies" is developed to reduce the environmental, social and economic problems associated with the current disposal system of waste. 3Rs, which means Reduce, Reuse and Recycle, is the principle of reducing, reusing and recycling resources and products.The Strategy has been formulated in line with the National Goal of eliminating of waste disposal on open dumps, rivers and flood plain by 2015 and promoting recycling of waste through mandatory segregation of waste at source as well as creating a market for recycled products and providing incentives for recycling of waste

56. The inadequacy of national policy and support, absence of relevant strategies, lack of institutional capacity, lack of public cooperation, barriers in financing and cost recovery are recognized and discussed in the strategy report. The objectives of the National 3R Strategies are addressing the key issues and challenges of waste management which are acting as barriers in promotion of 3Rs, defining the roles of various actors to promote 3R and guiding the creation of enabling condition for successful implementation of 3R strategies. The priority sectors for 3R are identified as municipal solid waste, industrial waste, biomedical waste, institutional and commercial waste and agricultural waste.

57. The first core principle of the National 3R Strategies distinguishes waste as a resource. Realizing the importance of the source separation of waste, it is regarded as the second core principle of the strategies. Third and fourth principles state that technologies should be environment friendly, appropriate and affordable. Cleaner production is another core principle which is the continual effort to prevent pollution, reduce the use of energy, water and material resources and to minimize waste in the production process. Product life extension, industrial symbiosis and by-product exchange, polluters pay principle and take back provisions, green purchasing, establishing environmental management system, public-private partnership to secure improvements in the services, collaboration with scientific research bodies to promote 3R, correspondence between service received and payment made in the case of waste collection and disposal, supporting the informal sectors to achieve the objectives of 3R, gender sensitive approach and clear commitment to gender equity are also included as core principles of the strategies. Additionally another core principle of the strategies suggests undertaking separate laws for specific products, setting recycling target, including 'design for environment considerations' concepts for reducing environmental impacts at all phases of product life cycle.

2.6 Strategies and Plans

2.6.1 National Conservation Strategy - 1992

58. Bangladesh National Conservation Strategy was drafted in late 1991 and submitted to the Government in early 1992. This was approved in principle; however the Cabinet is yet to give its final approval of the document. For sustainable development in the energy sector,

the strategy document offered various recommendations but none was there concerning the present specific project execution program or related matter. Major relevant recommendations are:

- To use minimum possible area of land in exploration sites;
- Rehabilitate site when abandoned;
- To take precautionary measures against Environmental Pollution from liquid effluents, condensate recovery and dehydration Plants; and
- Technology assessment for selection of appropriate technologies.

2.6.2 National Biodiversity Strategy and Action Plan for Bangladesh - 2004

59. The National Biodiversity Strategy and Action Plan of Bangladesh (NBSAP) “provides a framework for conservation, sustainable use and sharing the benefits of biodiversity of the country” (GoB 2004: v). The core focus of NBSAP has been ensuring cross-sectoral linkages and provides a framework for securing the necessary environmental settings to reduce poverty and ensure sustainable development. Sixteen strategies have been developed to shape and direct the actions towards achieving the goals and objectives of the NBSAP. The NBSAP emphasizes on integration of biodiversity conservation into the national development planning and processes.

60. From this perspective, the proposed project needs to recognize the value and importance of biodiversity and adopt measure to ensure that the integrity of the ecosystems is not adversely impacted by project activities in any stages of project implementation and operations. This is also reflected in the National Energy Policy of 1995, which committed “to ensure environmentally sound sustainable energy development programs causing minimum damage to environment".

2.7 Other Sectoral Policies

61. In Bangladesh there are a large number of sectoral policies. In this section we limit our discussion only to those sectoral policies that are considered relevant for the proposed Sirajganj power project.

2.7.1 National Industrial Policy - 2010

62. The National Industrial Policy – 2010 outlined with the vision to accelerate “economic development that will, by 2021, witness the creation of a strong industrial sector in which the percentage of GDP with industrial ancestry will grow from the present 28% to 40%, and where the proportion of the labor force employed will rise from the present 16% to 25%” (GoB 2010:5-6).

63. The policy, presents an integrated strategy for rapid industrialization taking into consideration the Government’s determination to achieve the Millennium Development Goals (MDGs) by 2015, and halve the number of the unemployed and hunger- and poverty-stricken people by 2017. To realize this vision the policy emphasized on taking environment-friendly and technologically-modern initiatives to facilitate growth of all important industrial sectors such as energy and fuel, agriculture and forestry, acquiring and processing of minerals, tourism and hospitality, construction, information and communications technology by mobilizing capital and manpower.

64. The policy aims to ensure a high rate of investment by the public and private sectors, a strong productive sector, direct foreign investments, development of labor intensive

industries, introduction of new appropriate technologies, women's participation, development of small and cottage industries, entrepreneurship development, high growth of export, infrastructure development, and environmentally sound industrial development.

2.7.2 National Water Policy - 1999

65. The National Water Policy of 1999 was adopted by the Government "to manage the water resources of the country in a comprehensive, integrated and equitable manner to ensure continued progress towards fulfilling the national goals of economic development, poverty alleviation, food security, public health and safety, decent standard of living for the people and protection of the natural environment" (GoB 1999:2). Hon. Prime Minister in the Foreword of the policy noted that "the declaration of the *National Water Policy* is a bold step towards good governance in Bangladesh by bringing order and discipline in the exploration, management and use of water resources in Bangladesh and unequivocally declares the intention of the Government that all necessary means and measures will be taken to manage the water resources of the country in a comprehensive, integrated and equitable manner".

66. The policy is framed "to provide directions" to all agencies and institutions working in the water sector and/or are related to water in one form or another, 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.

67. It provides the framework for the management of water resources of the country in a comprehensive, integrated and equitable manner. The policy recognizes that water is essential for human survival, socio-economic development of the country, and preservation of its natural environment. It is vital that the continued development and management of the nation's water resources should include the protection, restoration, and preservation of the environment and its bio-diversity. The policy emphasized on development of knowledge and capability to design future water resources management plans addressing economic efficiency, gender equity, social justice and environmental needs through broad public participation.

68. With reference to "water and industry" the policy noted concern about the excessive salinity of water, especially in the southwest region of the country, and identified this as a major deterrent to industrial development. The discharge of untreated effluents from various industrial centers has been identified as an important source of pollution affecting the ground and surface water resources system, and defined as a core water management issue. With respect to industry, the policy outlined four actions namely (a) zoning regulations for establishment of new industries in consideration of fresh and safe water availability and effluent discharge possibilities; (b) monitoring of effluent disposal by relevant Government agencies to prevent water pollution; (c) to set standards of effluent disposal into common watercourses by WARPO in consultation with DoE and (d) polluting industries under the lay will be required to pay for the cleanup of water- body polluted by them (GoB 199:12)

2.7.3 National Agricultural Policy - 1999

69. The overall objective of the National Agriculture Policy is "to make the nation self-sufficient in food through increasing production of all crops including cereals and ensure a dependable food security system for all" (GoB 1999:2). One of the specific objectives of the

policy is "to ensure environmental protection as well as 'environment-friendly sustainable agriculture' through increased use of organic manure and strengthening of the Integrated Pest Management (IPM) programme" (ibid 2). The policy also suggests creating awareness so that the chemical fertilizers and pesticides used for increased crop production do not turn out to be responsible for environmental pollution. Water logging and salinity are identified as one of the serious problem in some parts of the country including the coastal areas for agricultural activities and environmental damage. The policy recommends for crop rotation and salt tolerant crop varieties. Uninterrupted power supply for irrigation would be a key element in ensuring food self-sufficiency.

2.8 Agencies and Institutions Mandated to Address and Ensure Environmental Sustainability

70. In Bangladesh, the MoEF is the apex body with the mandate for matters relating to national environmental policy and regulatory issues and to guide and monitor all activities pertaining to the state of the environment in the country. Realizing the ever-increasing importance of environmental issues, the MoEF was established in 1989 and made a permanent member of the Executive Committee of the National Economic Council, which is the highest decision-making body and mandated for approving all projects and public expenditures. Under the MoEF, there are several agencies which undertake specific tasks within the framework of the MoEF's mandate. They are:

- Department of Environment (DoE);
- Department of Forest (DoF);
- Forest Industries Development Corporation;
- Bangladesh Forest Research Institute and Institute of Forestry;
- Forestry Division of the Bangladesh Agricultural Research Council; and
- National Herbarium.

71. Of the above agencies, in view of the present project objectives, descriptions of the DoE and DoF are presented below:

2.8.1 Department of Environment

72. The Department of Environment (DoE), established in 1989 under the jurisdiction of the MoEF, is the executing agency for planning and implementing environmental issues including, but not limited to, the following activities.

- Reviewing environmental impact assessments and issuing environmental clearance where appropriate;
- Implementing environmental monitoring programs and enforcement measures;
- Developing and maintaining environmental data bases; and
- Coordinating international events with the MoEF (e.g., representing Bangladesh in the meetings of various multi-lateral environmental agreements, international seminars, workshops, etc).

73. The DoE is headed by a Director General who is supported by a team of Directors, Deputy Directors, Assistant Directors, Engineers, and other technical staff (e.g., chemists and laboratory technicians). The DoE has regional offices in Sylhet; Rajshahi; Khulna and Barisal, monitoring stations and several laboratories.

2.8.2 Forest Department

74. The Forest Department, under the MoEF, is responsible for protection and management of the Reserve Forests; National Parks; Sanctuaries in the country. The department manpower extends down to Union levels in areas where reserve forest exists. Officers of the Forest Department are responsible for protection of wildlife in these forest areas.

75. In addition to the MoEF there are several other ministries and departments which are also relevant to the project activities, and they are:

2.8.3 Ministry of Water Resources

76. The Ministry of Water Resources (MoWR) is responsible for the water management program of the country. This includes preparation and implementation of water master plans, flood control measures, surface and ground water hydrology, data-collection, modeling, monitoring and planning irrigation and drainage projects. Bangladesh Water Development Board is the executing agency of the MoWR.

2.8.4 Ministry of Power, Energy and Mineral Resources

77. The Ministry of Power, Energy and Mineral Resources (MoPEMR) is the apex body with responsibility for exploration, production and marketing of all forms of primary energy sources. These primary energy sources encompass natural gas, petroleum, coal and peat. This Ministry also deals with all issues related to the generation, transmission, distribution and sales of electricity.

2.8.5 Bangladesh Power Development Board

78. The Bangladesh Power Development Board (BPDB) is an autonomous body under the jurisdiction of the MoPEMR, is responsible for generation, transmission and distribution of electricity in the country. The BPDB is the proponent of the current project.

2.9 Policies and Guidelines of Development Partners

79. The development partners of Bangladesh such as the World Bank (WB) and the International Finance Corporation (IFC) have several policies and guidelines to ensure environmental protection and social sustainability of development interventions. Keeping in view the nature and objectives of the proposed Sirajganj combined cycle power project, and the Bangladesh Government's various Acts, Rules, Policies and guidelines, we endeavor to briefly discuss the WB and IFC's Environmental, Health, and Safety Guidelines, IFC's Performance Standards on Environmental and Social Sustainability and the WB and IFC's global environment and social guidelines for project finance (i.e., "Equator Principles").

2.10 Environmental, Health, and Safety Guidelines

80. The Environment, Health and Safety (EHS) guidelines is a technical reference document produced by the World Bank and International Finance Corporation (April 2007), which provide general and industry-specific examples of good international industry practice. This "guidelines contain the performance levels and measures that are generally considered to be achievable in new facilities by existing technology at reasonable costs" (WB and IFC 2007:1). The guidelines also call for establishment of site-specific targets, with an appropriate timetable for achieving them. It covers a wide range of issues under broad headings of environment, occupational health and safety; community health and safety and

construction and decommissioning. The proponents of the EHS guidelines are however, conscious of the fact that the variable identified and the threshold values suggested all of them may not be applicable and/or justified in all circumstances. Therefore, it is suggested that "the applicability of the EHS Guidelines should be tailored to the hazards and risks established for each project on the basis of the results of an environmental assessment in which site-specific variables, such as host country context, assimilative capacity of the environment, and other project factors, are taken into account"….The guidelines also stated that "when host country regulations differ from the levels and measures presented in the EHS Guidelines, projects are expected to achieve whichever is more stringent. If less stringent levels or measures than those provided in these EHS Guidelines are appropriate, in view of specific project circumstances, a full and detailed justification for any proposed alternatives is needed as part of the site-specific environmental assessment. This justification should demonstrate that the choice for any alternate performance levels is protective of human health and the environment" (ibid. 1).

81. The variables and the thresholds that are suggested in the EHS guidelines under the four themes 'environment, occupational health and safety; community health and safety and construction and decommissioning' have distinct merits and on several counts will complement and enhance the efficacy of the Bangladesh national environmental quality standards as discussed above. However, there are some areas, for example, communication and training, biological and radiological hazards with respect to occupational and health safely; for which there are no clearly articulated Bangladesh Laws and/or policies, therefore the BPDB may take a cohesive management approach to address the issues noted above.

82. **The Performance Standards on Environmental and Social Sustainability framework of IFC (January 1, 2012)** outlines "IFC's commitments, roles, and responsibilities related to environmental and social sustainability and its commitment to transparency and good governance including its disclosure obligations with respect to its investment and advisory services. The "performance standards" that are defined in the document are to assist implementation of project in a sustainable manner through stakeholders' engagement to avoid risk and mitigate the unavoidable, as appropriate. Eight performance standards have been outlined in this document, they are:

i. Assessment and Management of Environmental and Social Risks and Impacts
ii. Labor and Working Conditions
iii. Resource Efficiency and Pollution Prevention
iv. Community Health, Safety, and Security
v. Land Acquisition and Involuntary Resettlement
vi. Biodiversity Conservation and Sustainable Management of Living Natural Resources
vii. Indigenous Peoples
viii. Cultural Heritage

83. The above noted standards are consistent with various rules, policies and strategies of the Bangladesh Government. They would certainly compliment and may even add value to the national policies and regulations at the level of enforcement and compliance, and thus deserves attention.

84. **The "Equator Principles" - the Environment and Social Guidelines for Project**The Equator Principles, is "a risk management framework, adopted by financial institutions, for determining, assessing and managing environmental and social risk

in projects and is primarily intended to provide a minimum standard for due diligence to support responsible risk decision-making".[5] The Equator Principles are a voluntary set of standards which are developed to support implementation of environmental and social policies and the Principles are outlined under 10 headings as noted under:

Principle 1: Review and Categorisation;

Principle 2: Environmental and Social Assessment;

Principle 3: Applicable Environmental and Social Standards;

Principle 4: Environmental and Social Management System and Equator Principles Action Plan;

Principle 5: Stakeholder Engagement;

Principle 6: Grievance Mechanism;

Principle 7: Independent Review;

Principle 8: Covenants;

Principle 9: Independent Monitoring and Reporting and

Principle 10: Reporting and Transparency.

85. Though not immediately recognizable from the list of principles, the proponents of the Equator Principles take cognizance of climate change, biodiversity, and human rights, and stressed that negative impacts on project-affected ecosystems, communities, and the climate should be avoided where possible. If these impacts are unavoidable they should be minimized, mitigated, and/or offset (for details of the principles see **Appendix-2**).

86. **Compliance with the Policies, Rules and Guidelines of Bangladesh Government and the Development Partners –** A summing upenvironmental protection is enshrined in The Article 18A of the Bangladesh Constitution, which guarantees that "the State shall endeavor to protect and improve the environment and to preserve and safeguard the natural resources, bio-diversity, wetlands, forests and wildlife for the present and future citizens". Therefore it is a constitutional obligation to design and ensure measures with adequate provision for environmental protection. The concern about environmental issues also has been reflected in different policy initiatives taken by the Government of Bangladesh at various point in time. The major policy initiatives, strategies and plans emphasized on due attention to environment and natural resources management in pursuance of sustainable development strategy.

87. Until recently in most of the policies the emphasis is on environmental awareness and adoption of integrated management strategy. The various environment acts and policies adopted by the Government aims to address environmental degradation and pollution, and providing guidelines to the sectors which are responsible for this degradation and pollution. Under the Environmental Conservation Act 1995, EIA has been accepted as a mandatory tool to identify and predict impacts and undertake proper mitigation measures on a project scale.

88. The recent Circular issued by the MoEF, Government of Bangladesh in February 2015 (as noted in para 5 above) has not only re-emphasized the importance of EIA but has made EIA mandatory at each and every stages of the project cycle. The Bangladesh Government in cognizance of the ECA 1995 (including its 2010 amendments) and the ECR 1997, unequivocally stated that in project design and its budget provision for adequate resources must be ensured with approval of the Ministry of Finance in order to accomplish

[5] http://www.equator-principles.com/index.php/about-ep

EIA and effective implementation and monitoring of environmental management plan that are proposed.

89. Within the framework of EIA it is also mandatory to ensure that people likely to be affected takes part in making development decision. Furthermore, the EIA results of any proposed projects and/or industries are to be presented to people for public scrutiny. The DoE under the MoEF is mandated to oversee such public hearing and disclosure of EIA. This process is established to increase accountability. Setting of Environmental Quality Standard and the Environment Court are steps in the right direction and gives the DoE means to ensure better compliance of rules and legislations.

90. In conformity of the existing Acts, Rules, Circular and Guidelines of the MoEF and DoE, in the National Energy Policy (1992, 1996 and 2004) environmental and social impact assessment has been made mandatory and constitutes an integral part of any new energy development project under the NEP. The WB and IFC Environment, Health and Safety guidelines and Performance Standards on Environmental and Social Sustainability framework also promoteenvironmental and social assessment, and establishment and maintenance of an appropriate environmental and social management system. The same policy documents also ask for performance standards to manage environmental and social risks and impacts so that development opportunities are enhanced.

91. The Sirajganj Project under review, which is a Combined Cycle Power Plant fall under the ‘red’ category according to the Bangladesh Environment Conservation Rules 1997 (Amendment, 2005). For project under this category, it is mandatory to carry out EIA including Environmental Management Plan and where necessary develop a resettlement plan for getting environmental clearance from the DoE.

92. The National Energy Policy 2004 also clearly stated that any intervention must pay due attention to all environmental issues and deal with them in accordance to the national environment policy and environment act. To this effect the National Energy Policy recommended for “carrying out environmental impact assessment (including a consideration of social impact) should be made mandatory and should constitute an integral part of any new energy development project” (GoB 2004:27).

93. Environmental sustainability is a prime consideration of the Bangladesh Government. To this effect, the GOB has formulated and enacted a number of legislations, policies and guidelines. In the light of these legislations and policies and the mandate of various department and agencies, an overarching coordinating framework has also been clearly defined to ensure environmental protection and/or to maintain environmental integrity. The EIA Guidelines for Industries issued by the DoE (December 1997) will thus form the basis of undertaking the ESIA. The ESIA process as per DoE guidelines is presented in the **Figure 2-1**.

94. The project proponent should adhere to all statutory requirements and therefore must evaluate all its activities/programs in the light of the national legislative and policy frameworks, and the outcomes/conclusions of ESIA. Where needed due process has to be initiated to re-define/re-prioritize project’s schedule of programs and the contents therein to respond to ESIA recommendations. It is worth to reiterate that economic development strategies must be compatible with environmental goals and the project approval and/or implementation should not be driven by economic and financial pressure which often tends to dominate other concerns such as environment, social equity and human wellbeing.

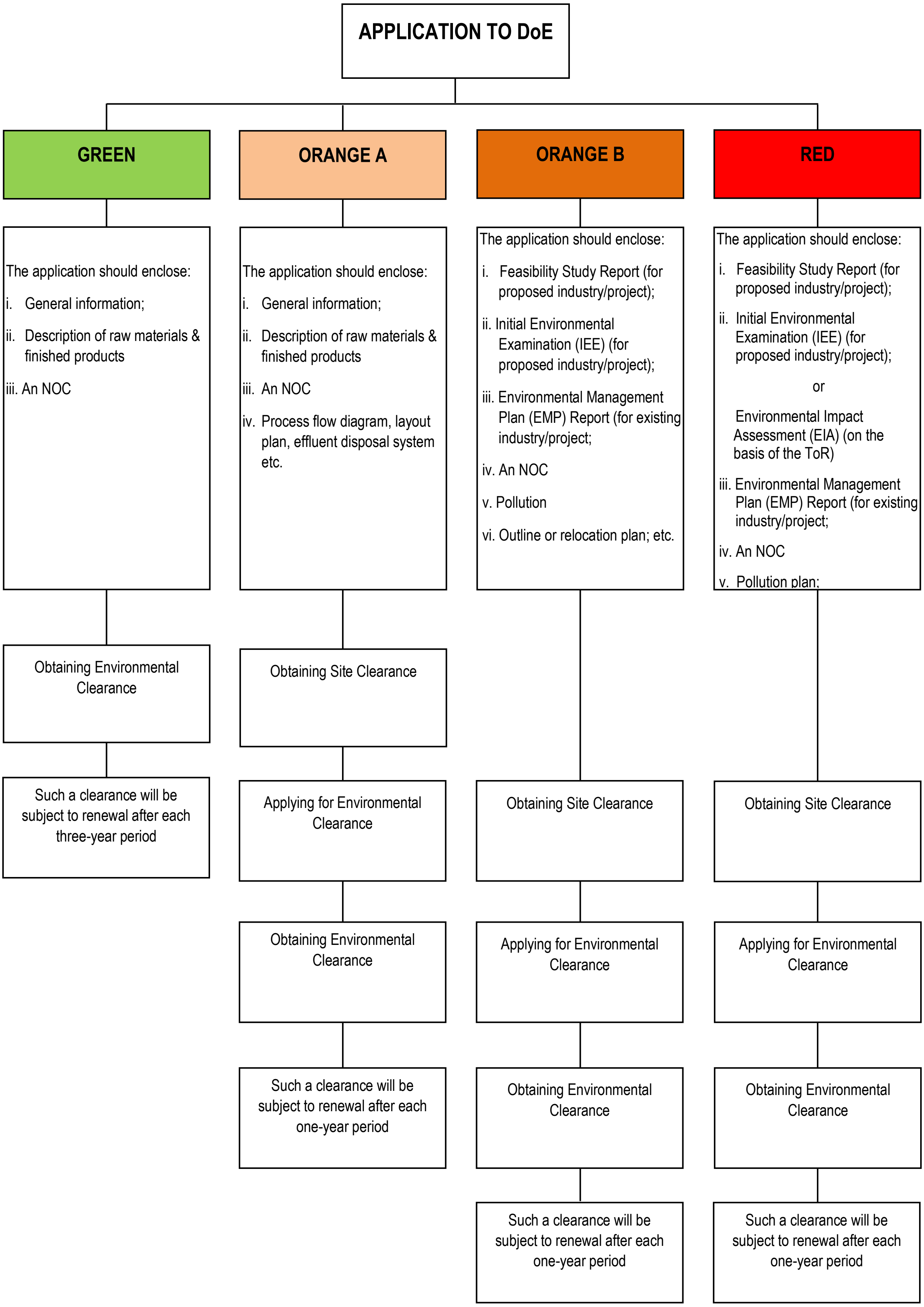


Figure 2-1: Process of obtaining site and environmental clearance certificate from DoE

3 Project Data Sheet

3.1 Project Proponent

95. The North West Power Generation Company Ltd. (NWPGCL), an enterprise of the Bangladesh Power Development Board (BPDB), which is an autonomous body under the Ministry of Power, Energy and Mineral Resources (MoPEMR) is the proponent of the Project “Sirajganj 225 MW Combined Cycle Power Plant (Dual Fuel 3rd Unit)”.

96. In the recent past, a number of power generation companies have been created under the Power Sector Reform Policy of the Government entity. The companies include: Electricity Generation Company Bangladesh (EGCB), Ashuganj Power Station Company Limited (APSCL) etc. The NWPGCL is another outcome of this program. It was created in order to meet the prevailing as well as the increasing demand of electricity and to solve the low-voltage problem in the North-West region of the country.

3.2 Project Location

97. The proposed Project “Sirajganj 225 MW Combined Cycle Power Plant (Dual Fuel 3rd Unit)” will be established adjacent to the under construction 2nd unit of the existing Power Plant Complex. This power plant complex of the NWPGCL is located at Barashimul Mouza of Saydabad Union in Sirajganj Sadar Upazila, Sirajganj District (**Map 3-1**). The site is located at about 15 km south-east of Sirajganj town, about 130 km north-west of Dhaka and 1.8Km south-west from the right end of Bangabandhu Bridge. Geographically the site can be denoted as NW (24^{0}23’12.9”N:89^{0}44’42.05”E), SW(24^{0}23’0.1”N:89^{0}44’41.6”E), SE(24^{0}22’59.8”N: 89^{0}45’1.8”E) and NE(24^{0}23’14.63”N: 89^{0}45’1.39”E).

98. A number of strategically important structure i.e. Key Point Installation (KPI) have been found around the present power plant complex such as 1st and 2nd unit inside the power plant complex, Bangabandhu bridge, Sirajganj Hard Point etc. Banghabandhu Eco-park, Jamuna Eco-Resort, Cantonment, rail stations, rehabilitation villages are also recorded in the study area (**Map 3-2**). Moreover, two proposed industrial areas named BSCIC industrial area and Sirajganj EPZ are also pointed out in the same Map.

3.3 Nature and Size of the Project

99. The nature of the proposed project is an electricity generation Project with relatively less fuel consuming technology “ Combined Cycle Power Plant” (CCPP), with one 150 MW Gas Turbine (GT) with built in fuel NOx control technology like dry-low NOx burners, premix mode, etc, one Heat Recovery Steam Generator (HRSG) of proper capacity for outside installation and a 75 MW heavy duty Steam Turbine (ST) for indoor installation with cooling tower technology for condenser cooling. This Project considers duel fuel technology, predominantly using natural gas as fuel with the provision of High Speed Diesel (HSD) in case of emergencies. The net power generation capacity of the proposed combined cycle Project will be 220.008 MW in gas and 220MW in HSD while the net power generation in simple cycle with gas will be 147 MW and with HSD 150 MW.

3.4 Project Components

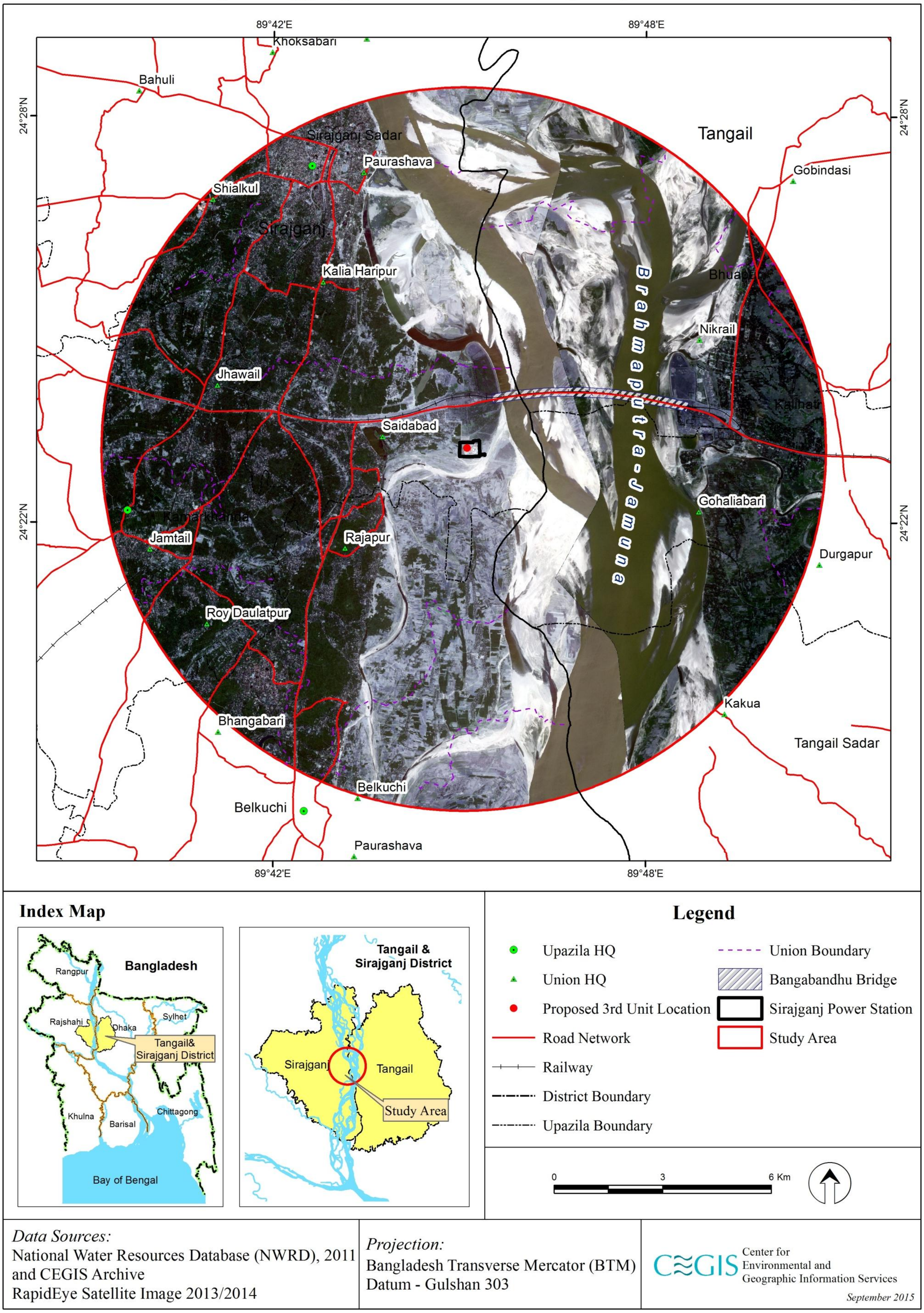
100. The major project components of the 225MW CCPP are an industrial type Gas turbine for indoor installation with a bypass stack of 60 meter high with diverting damper for simple cycle operation, one horizontal type HRSG with a main stack of 60 meter high for

outdoor installation and a heavy duty condensing type Steam turbine for indoor installation in the configuration of 1:1:1, feed water pumps, condensate extraction pumps, cooling towers, 230 KV plant sub-station, transformers, Gas Reducing Metering Station (RMS), Central Effluent Treatment Plant (CETP), Water Treatment Plant (WTP), administration building, workshop, warehouse, guard houses, internal roads, etc.

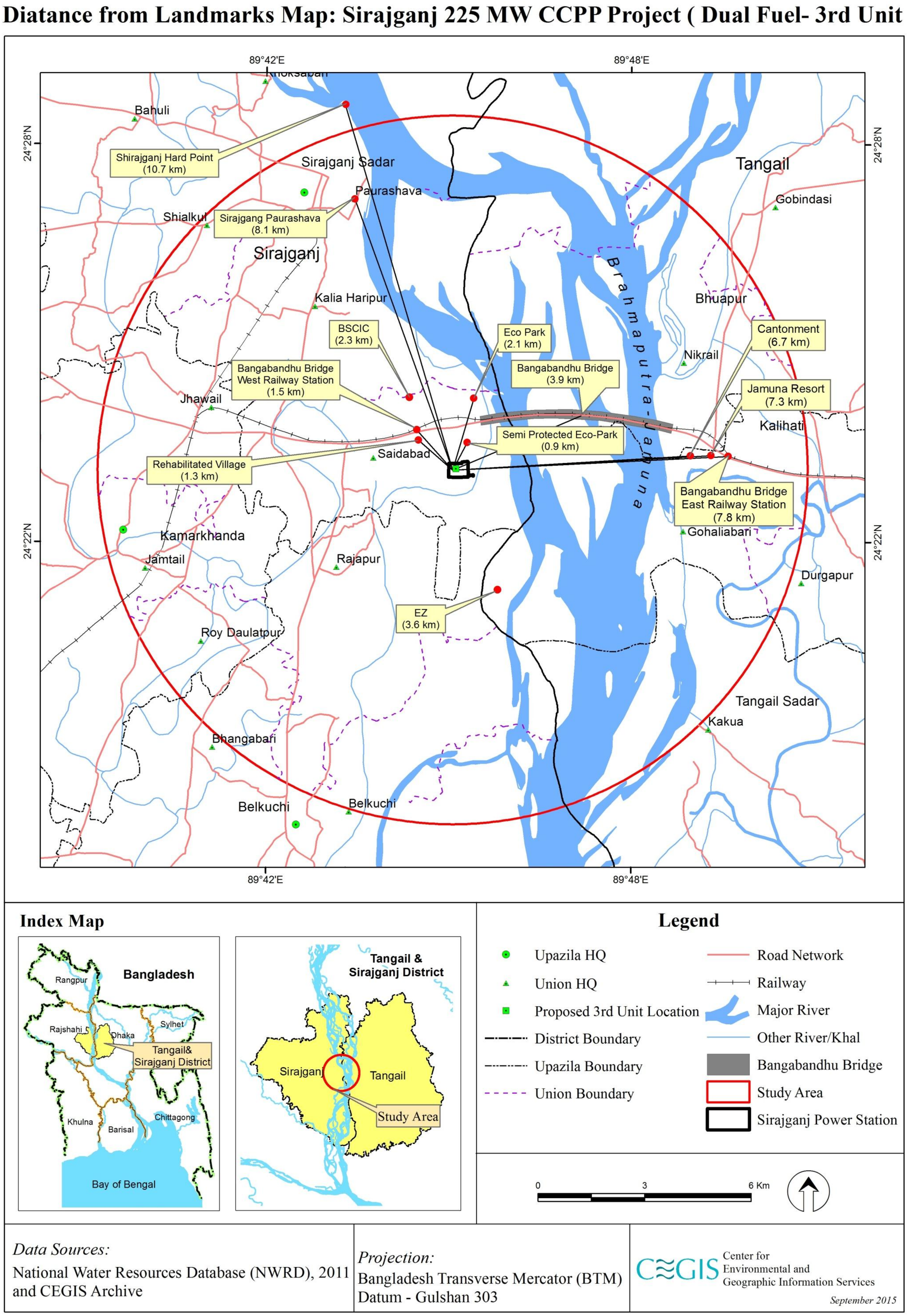
3.5 Project Activities and Schedule

101. The major activities of the project are executing engineering design, erecting gas turbine and auxiliaries, bypass stack and auxiliaries, steam turbine and auxiliaries, HRSG and auxiliaries etc. Civil work such as soil investigation, piling, SC foundation and building, CC foundation and building etc would be conducted simultaneously with the other mentioned steps. The detailed project activities and schedule is presented in **Figure 3-1**.

Location Map: Sirajganj 225 MW CCPP Project (Dual Fuel- 3rd Unit)



Map 3-1: Location map of the proposed project



Map 3-2: Distance of the project site from different landmarks of the study area

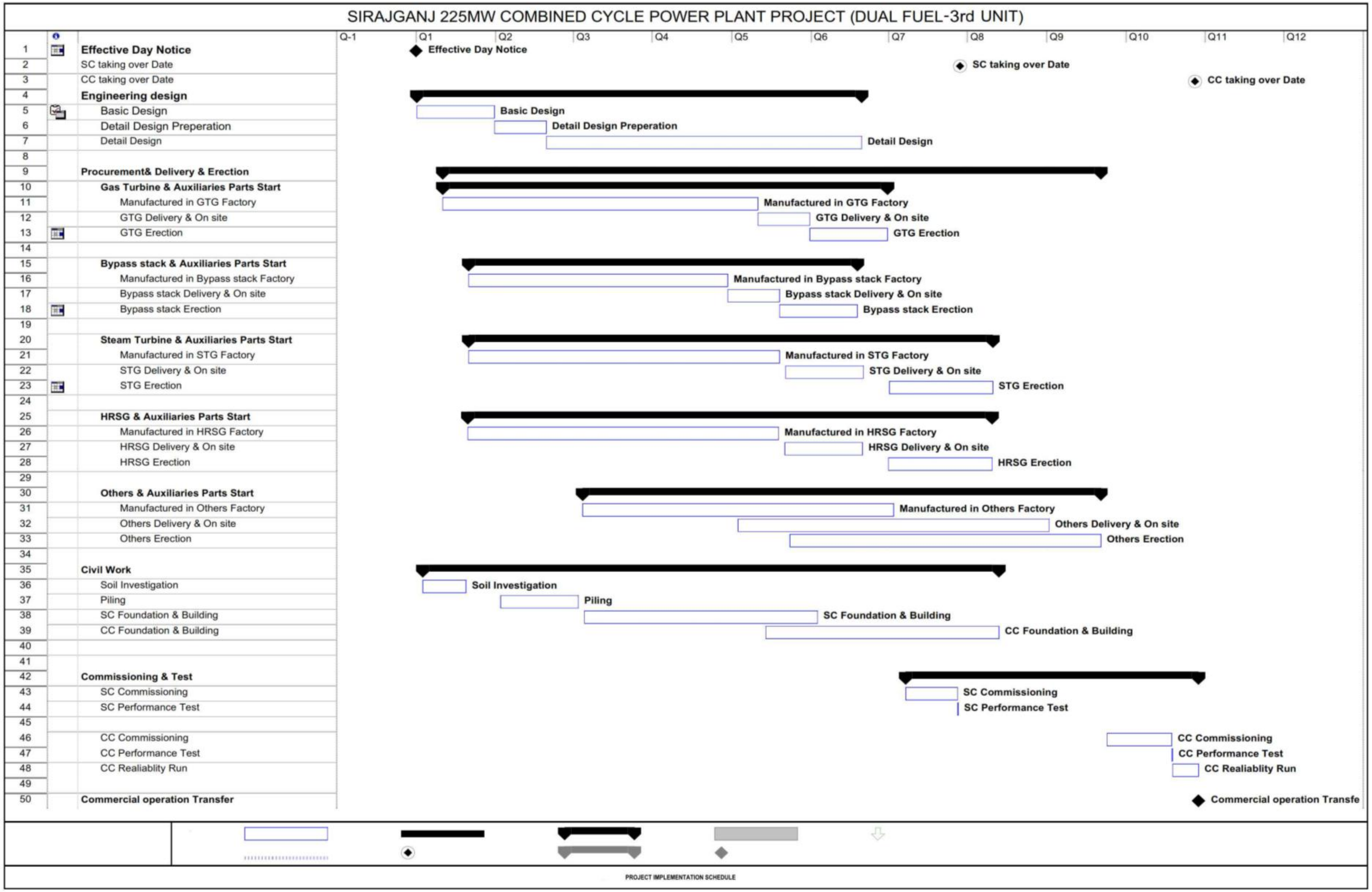


Figure 3-1: Project Activities and Schedule of Sirajganj 225 MW CCPP (Dual Fuel-3rd Unit)

3.6 Resources and Utilities Demand

3.6.1 Water Demand and source

102. According to the feasibility report of 3rd unit of SGPP water requirement of the proposed 3rd unit is 400 m^3/h and of the existing 1st unit is 600 m^3/h and the ongoing 2nd unit is 400 m^3/h. There is a provision of constructing one more unit (4th unit) in the same premise of 55 acres of land which may require another 1150 m^3/h of water. This gives a total water requirement of 1400 m^3/h for 1st, 2nd and 3rd units and that for all the four units is 2550 m^3/h.

103. This required water for plant operation and construction can be fetched either from nearby "The Jamuna" river as surface water or from under ground aquifer as ground water. During monsoon (2-3 months) the Jamuna River flows by the side of the project area. Rest of the year the river flows at about 1.5 Km away from the project. There is a small river channel close to the proposed site. The water availability in this channel is very low specially during dry period. To use surface water in the plant, Jamuna water is to be transported through this channel by installing pumps of required capacity at the Jamuna river and with the help of necessary pipe lines. Additional protective measures would be required to save the pump from riverbank erosion which would require additional financial involvement. On the other hand ground water availability in the project area as per the comments cited in the feasibility report is good enough to meet the water demand of all the four units. The feasibility report under the title "Water availability study" states that "Both EAL (2014) and SDCPL (2015) studies clearly mentioned that the maximum allowable withdrawal / of groundwater for NWPGCL Power Generation Complex is 3,200 m^3/h without causing conspicuous problem in the groundwater table of the plant complex area (EAL, 2014 and SDCPL, 2015). If the findings of those two prior studies are completely relied upon, it can be said that total water requirement of about 2,550 m^3/h for all the four units of Sirajganj Power Generation Complex could be met by groundwater abstraction." Considering the non-availability and difficulty of meeting surface water requirement over the year, use of ground water for the project has been considered as a more viable option. To minimize the associated environmental consequence and ground water withdrawal for the Plant use, a closed cooling water system using cooling tower technology has been planned for the proposed 3rd unit of Sirajganj Power Plant.

3.6.2 Utility Demand and sources

104. Resources and utilities required for the development of the project includes land (site), construction materials, electricity, fuel, water and other facilities. The site for unit 3 is a part of the total project site and is located in the western adjacent side of unit 2 which is currently under construction. The entire project site is a raised land and was developed during the site development work of other two units. For the construction of Unit-3, no further site development is required except cleaning bushes, leveling of pot holes and minor dressing. No soil filling is required for the above activities. Electricity demand during construction and commissioning phases will be met from the existing sub-station and distribution facilities of Unit 1 and 2.

3.7 Source and Transportation of Construction Material

105. All construction materials like concrete, iron rods, sand, scaffolding material etc are available locally and can be transported to site by railway, roads and riverways.

3.8 Transportation of Equipment, Machinery, etc.

106. Heavy machineries, control equipments and other protective equipments are to be imported and transported through sea and finally to the site through river and road.

3.9 Requirement, Source and Composition of Fuel for Plant operation

107. Natural gas required for the plant is 35MMCFD and will be be supplied by Pashchimanchal Gas Company Limited (PGCL). The gas analysis report is enclosed in **Appendix 3.**

108. At 80% PLF about 920 m3/day of HSD has been estimated. Bangladesh Petroleum Corporation (BPC) will supply HSD from its Daulatpur/ Khulna Depot by rail up to Bangabandu Bridge West Railway Station. The HSD analysis report is enclosed in **Appendix 4.**

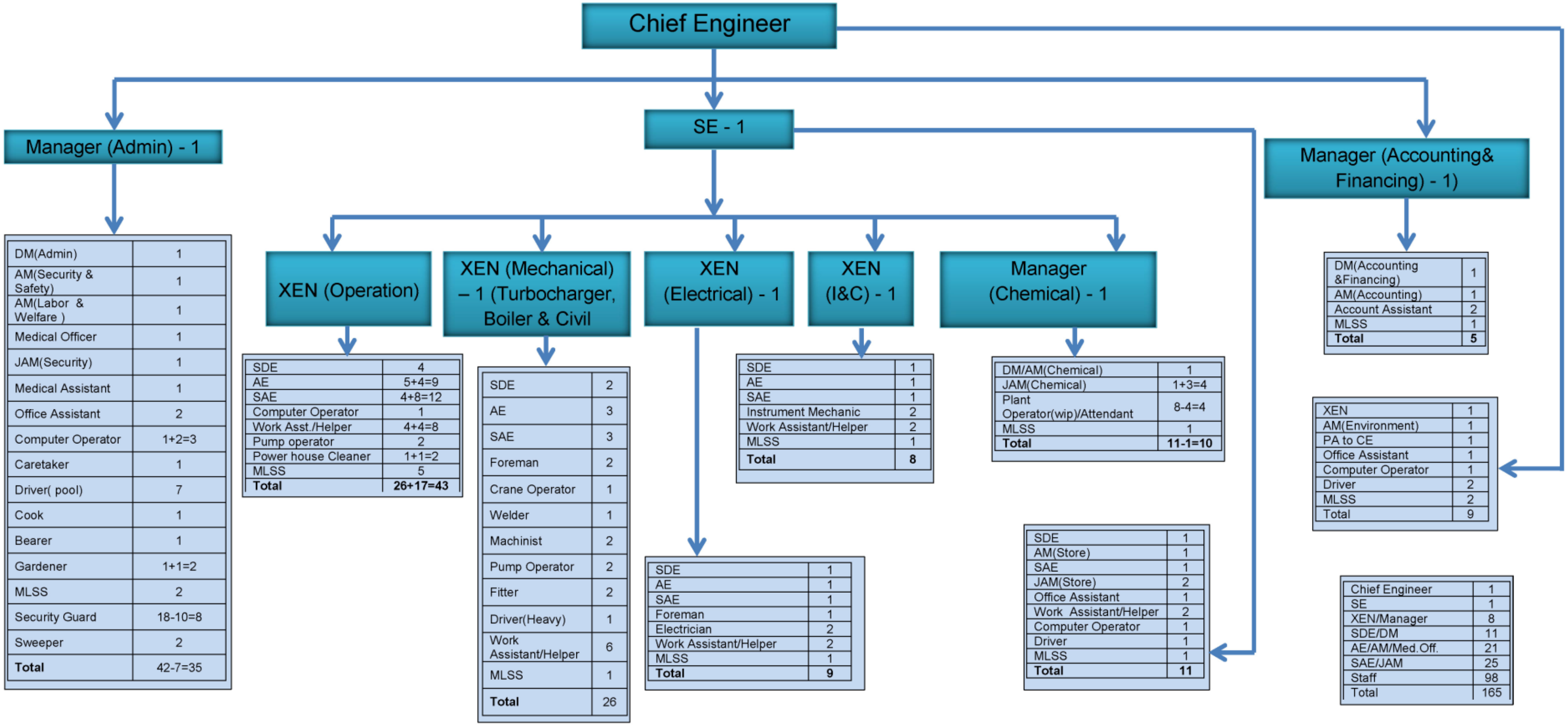
3.10 Transportation of Fuel for plant operation

109. Natural gas as fuel will be supplied through a 20 inch dia. Pipe by Pashchimanchal Gas Company Limited (PGCL) from its valve station on 30 inch line up to the proposed RMS inside the power plant boundary. From the RMS gas will be supplied through a 14 inch dia. Pipe to the gas booster and then to the combuster through 18 inch dia pipe. Bangladesh Petroleum Corporation (BPC) has arranged to supply the stand by fuel HSD for unit 1 from its Daulatpur/ Khulna Depot by rail up to BangoBandu setu west rail way station .Two railway lines have been dedicated for unloading the fuel. Thirty numbers of unloading points have been installed for unloading thirty fuel wagons at a time with five transfer pumps of each capacity 200 m3/hr. A burid pipe line of about 2.5 Km long and 10 inch dia is connected from the pumping station to unit 1 fuel tank. Every unit will have a oil tank of capacity 5,000 m^3 and a day tank. Using a transfer station at the receiving end the existing facility can be used for Unit 3 and others.

3.11 Manpower and Tentative Organogram

110. The proposed organogram from the feasibility report suggests a team of total 155 members for the operation and maintenance of the proposed power plant will be required which include one (1) Chief Engineer, one (1) Superintendent Engineer (SE), eight (8) Executive Engineer (XEN)/manager, eleven (11) Sub-Divisional Engineer (SDE)/Deputy Manager (DM), twenty (21) Assistant Engineer (AE)/Assistant Manager (AM)/Medical Officer, twenty five (25) Sub-Assistant Engineer (SAE)/Junior Assistant Manager (JAM) and eighty eight (88) staff. The detailed proposed organogram is presented in**Figure 3-2**. However, the analysis of this organogram shows the need of some reshuffling in the position/s and inclusion of an environment and safety division and a medical unit. The proposed reshuffling and inclusion is described later in Chapter 9.

Proposed Organogram for O&M of 225 MW Combined Cycle Power Plant at Sirajganj



DM(Admin)	1
AM(Security & Safety)	1
AM(Labor & Welfare)	1
Medical Officer	1
JAM(Security)	1
Medical Assistant	1
Office Assistant	2
Computer Operator	1+2=3
Caretaker	1
Driver(pool)	7
Cook	1
Bearer	1
Gardener	1+1=2
MLSS	2
Security Guard	18-10=8
Sweeper	2
Total	42-7=35

SDE	4
AE	5+4=9
SAE	4+8=12
Computer Operator	1
Work Asst./Helper	4+4=8
Pump operator	2
Power house Cleaner	1+1=2
MLSS	5
Total	**26+17=43**

SDE	2
AE	3
SAE	3
Foreman	2
Crane Operator	1
Welder	1
Machinist	2
Pump Operator	2
Fitter	2
Driver(Heavy)	1
Work Assistant/Helper	6
MLSS	1
Total	26

SDE	1
AE	1
SAE	1
Foreman	1
Electrician	2
Work Assistant/Helper	2
MLSS	1
Total	**9**

SDE	1
AE	1
SAE	1
Instrument Mechanic	2
Work Assistant/Helper	2
MLSS	1
Total	**8**

DM/AM(Chemical)	1
JAM(Chemical)	1+3=4
Plant Operator(wip)/Attendant	8-4=4
MLSS	1
Total	**11-1=10**

SDE	1
AM(Store)	1
SAE	1
JAM(Store)	2
Office Assistant	1
Work Assistant/Helper	2
Computer Operator	1
Driver	1
MLSS	1
Total	**11**

DM(Accounting &Financing)	1
AM(Accounting)	1
Account Assistant	2
MLSS	1
Total	**5**

XEN	1
AM(Environment)	1
PA to CE	1
Office Assistant	1
Computer Operator	1
Driver	2
MLSS	2
Total	9

Chief Engineer	1
SE	1
XEN/Manager	8
SDE/DM	11
AE/AM/Med.Off.	21
SAE/JAM	25
Staff	98
Total	165

Note: 10 (ten) Security Guards shall be contract out. Ansars for security purpose shall also be outsourced. Remaining manpower will be recruited on contract basis as per service rules.

*Mali, Sweeper & Cleaner additional if required will be hired.

Figure 3-2: Tentative Organogram of O&M of 225 MW CCPP at Sirajganj Dual Fuel 3rd Unit

4 Process Description and Technology

4.1 Process of Site Development

111. The proposed site is located on the west to the Unit 2, which is under construction. The Project site is a raised land and was developed during the site development work of other units. For the construction of 3rd Unit, the site will need only clearing bushes, leveling the pot holes and minor dressing. No soil will be required for filling.

4.2 Project Layout

112. Project layout drawing provided by the feasibility consultant is enclosed in **Appendix-5.**

4.3 Technology and Process Description of Individual Plant Components

4.3.1 Power generation

113. A combined cycle power plant mainly consists of a Combustor, GTG(s), a HRSG and a STG. Natural gas from the RMS and then from gas booster mixes with compressed ambient air in the combustor and then ignites. The hot flue gas thus produced from the combustor is then directed to the GTG, where it expands, loses pressure and temperature and causes the GTG to spin and generate about two third of plant's power at the generator terminal (Gross 150MW).

114. The exhaust flue gas of GT at a temperature of more than 500^{o}C is directed to HRSG, where feed water is converted into steam at different pressures (High Pressure- HP, and Low Pressure- LP) and is then directed to the STG where it expands and causes the STG to spin and generate about one third of plant's power at the generator terminal (Gross75 MW). The generated power of GTG and STG will be stepped up to grid voltage level (15.75/230 KV, 10.5/230KV respectively.) by step up transformers (240MVA for GT and 120MVA for ST) and feed to the national grid (Sirajganj sub-station) through the plant sub-station. Underground cables will be used for all inter-connections from transformer to the national grid sub-station. The condenser and other components cooling of the Plant will be done by **ground water** using cooling tower technology. A Typical process flow diagram is shown below in **Figure 4-1**.

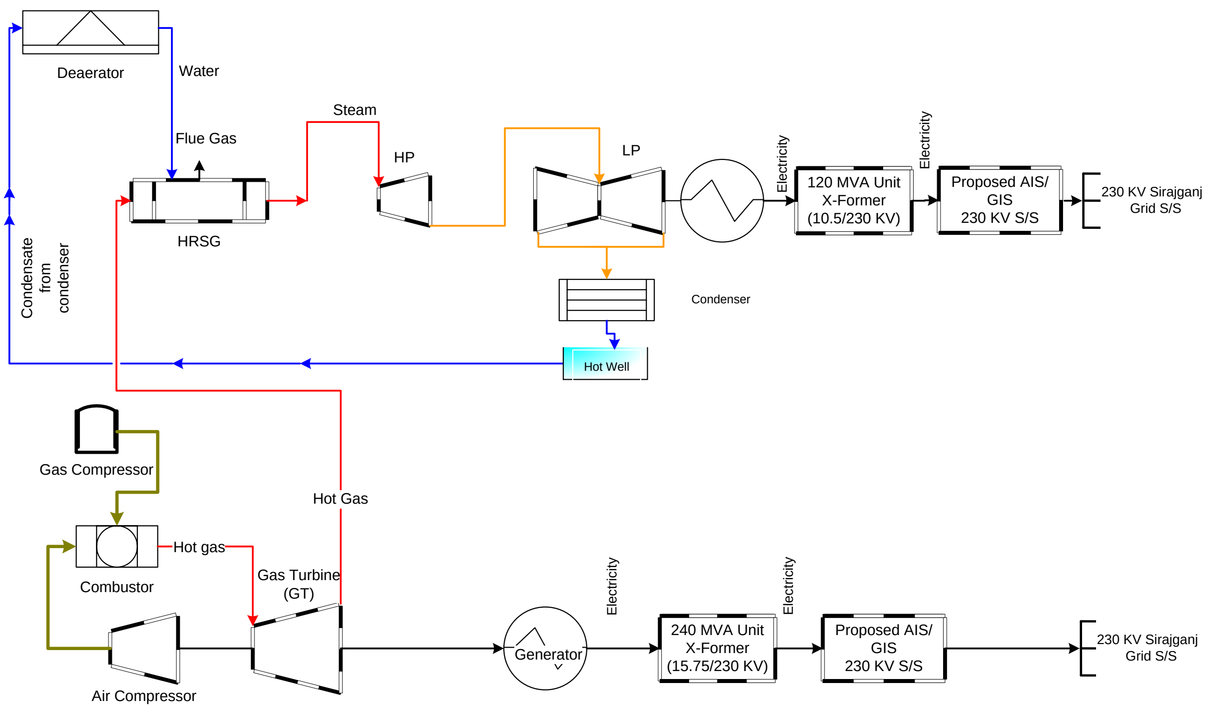


Figure 4-1: Process flow diagram of electricity generation

4.3.2 HRSG boiler and its auxiliaries

115. The steam generating unit of the proposed Project is not a conventional Boiler; rather it is a Heat Recovery Steam Generator (HRSG). A HRSG is an energy recovery heat exchanger that recovers heat from the GT exhaust hot gas stream. It produces steam that can be used in a process or used to drive a steam turbine. In this case, the hot exhaust flue gas of the GT flows horizontally over vertical tubes and generates steam at different pressures (Duel pressure HRSG) like HP and LP. A duel pressure HRSG consists of two sections: an LP (low pressure) section and an HP (high pressure) section. Each section has a steam drum, economizer, evaporator and a super heater.

116. The primary function of the **steam drum** is to separate water from steam which prevents carryover of the condensate into to the steam header.

117. An **economizer** is a mechanical device which is used as a heat exchanger to heat up feed water by recovering residual heat from the flue gases before being released in the open air through the chimney.

118. **Evaporator sections** are those sections where water boiling or steam generation occurs. Feed water in down comer tubes absorbers heat from GT exhaust stream and starts evaporating to steam. Through riser tube steam water mixture flows upward and escapes into the steam drum where steam is separated from water and is further heated in the super heater section. This is known as natural circulation loop.

119. **Super heater sections** are composed of extended or fine tube surface modules and have the highest metal temperatures in the HRSG. The major function of a super heater is to increase steam temperature above saturation. This high steam temperature minimizes the presence of fine water particle in steam and thereby protects turbine blades and improves steam cycle efficiency. The super heater absorbs heat energy from the exhaust gas and transfers this energy to the steam. Drainable super heaters are employed in the most HRSG

designs to ensure that any water accumulated in the lower headers can be drained during startup.

An HRSG feed water pump feeds water into the HRSG drum. The water may be freshly supplied or returning condensate from the ST condenser. Two types of feed pumps are generally used, such as positive displacement type and centrifugal type.

4.3.3 Turbine and its auxiliaries

120. A turbine is a rotary engine (mechanical device) that extracts kinetic energy of a moving fluid and converts it into mechanical energy or useful work. It has a series of higher temperatures withstanding blades (impulse and reaction) mounted on shaft called rotor. The fluid goes inside through one end, pushing the blades and causing them to spin and finally escapes to atmosphere through stack (in Gas Turbine) or to condenser for condensation (in steam turbine). In this proposed CCPP Project, there will be two turbines, such as one gas turbine and one steam turbine.

121. A **gas turbine** is a type of internal combustion engine. It has an upstream rotating compressor coupled to a downstream turbine, and a combustion chamber in between called combustor.

122. A **combustor** is a component of a gas turbine where combustion takes place. High pressure air from the air compressor is fed in to the combustion chamber that contains a ring of fuel injectors through which a steady supply of fuel is maintained. The fuel mixes with air and gets ignited. This combustion produces a high temperature and high pressure flue gas stream that enters and expands in the GT section and causes the Turbo Generator to spin and thus generates electrical power in GT.

123. A **steam turbine** is an internal combustion engine that extracts heat energy from high pressure – high temperature steam and converts it to mechanical energy or useful work. Steam from a Boiler/HRSG enters into the turbine in high pressure end and flows over the bladed rotor to the low pressure end. And in doing so steam loses its kinetic energy and enthalpy and causes the bladed rotor to spin. In other words, this loss of energy is converted into mechanical energy. At the low pressure end, the steam enters into the condenser where it is cooled and condensed by circulating cooling water. The condensate is then pumped to the feed water tank via Deaerator by a condensate extraction pump. The condensate (feed water) is then pumped from feed water tank to Boiler/HRSG drum through heaters by feed water pump and thus completes the steam-feed water –condensate cycle.

4.3.4 Cooling System

124. The proposed project is situated on the right bank (West side) of the Jamuna River. During dry season (winter), the river passes about 1.5-2 km away from the site and during wet season (full monsoon) the river comes closer to the project site. But this is for 2-3 months only. Considering this physical condition, it is concluded that the surface water of this river cannot be used for Plant cooling and other purposes without major intervention and financial investment. As there is no other potential source of surface water, the proponent has decided to withdraw **ground water** for the close cooling system using cooling tower.

125. A **cooling tower** is a heat exchanger, in which heat is withdrawn from the hot water by contacting between the hot water and the air and through the evaporation of a small portion of the hot water.

126. Hot water from the condenser is pumped to the top of the cooling tower and is then evenly dispersed using dispersion fans or spray nozzles over the top of the tower. The water

then evenly flows down the cooling tower's fill. This process causes the water to spread out over the thin sheets and constantly flow down the fill. Spreading of water over such a large area significantly accelerates evaporation and consequently dissipates heat. Big fans are utilized at the top of the cooling tower to suck air in (induced draft) through the sides of the fill system. This further accelerates the evaporation of the water as it flows down the fill. The hot water thus is cooled and is collected at the bottom of the cooling tower (cooling tower basin) is then pumped back to the condenser, and the process continues.

127. In case of other cooling, separate heat exchangers are used. A heat exchanger is a device that transfers heat from one medium to another. Heat exchangers are of different types. But shell and tube type heat exchanger are commonly used. In this type hot media (lube oil, hot water) runs through the tubes, and the cooling media (cooling water) flows over the tubes (inside the shell). Thus heat transfer takes place between the two fluids (hot media and cooling media).

4.3.5 Fuel storage and handling system

128. The proposed plant is a dual fuel (natural gas and HSD) based CCPP. The Pashchimanchal Gas Company Limited (PGCL) will supply natural gas at a pressure of about 500 psi through a 1.7 Km long and 20 inch diameter pipeline from its existing valve station on 30 inches line to the proposed RMS(To be constructed near the power plant). From this RMS gas will be supplied through 14 inch diameter line to the gas booster. Using gas booster gas will be supplied to the gas combuster through an 18 inch dia. pipe at a pressure of 350 psi.

129. Liquid fuel (HSD) will be supplied by Bangladesh Petroleum Corporation (BPC) from its Daulatpur and/or Khulna depot by railway wagons to Bangabandhu Setu West Railway Station. To supply HSD to unit 1, railway authority has dedicated two railway lines for the unloading of liquid fuel. Thirty (30) unloading points have been installed to connect 30 railway wagons (each capacity 120 m^3) for unloading fuel at a time. A total of 5 numbers of transfer pumps have been installed with each capacity of 200 m^3/hr. A buried pipeline of 10 inches diameter and 2.5 Km long is connected from the pumping station to the oil tanks of unit 1. The plant will have one oil tanks of capacity 5,000 m^3 and a day tank. The estimated HSD consumption at 80% PLF is 920m^3/day. Using a transfer station near the power plant complex, this existing infrastructures can be used to supply HSD to other plants. This could be a cost effective effort for the proponent. However, a technical inspection of the existing HSD transfer system, its capacity and performance is recommended.

4.3.6 Water System and effluent Treatment Plant

130. According to the feasibility report of the 3rd unit of SGPP water requirement of the proposed Unit 3 is 400 m^3/h. The required water for plant operation and construction can be fetched either from nearby "The Jamuna" river as surface water or from underground aquifer as ground water. After a detail study of ground water availability and the non-availability and difficulty of meeting surface water need over the year the feasibility report has proposed the use of **ground water**. Accordingly a water balance diagram has been developed showing the use of forced draft cooling tower technology with **ground water**.

131. An Effluent Treatment Plant/system has been proposed to maintain the standards of Industrial Waste as mentioned in the Environment Conservation Rules, 1997 and amendment, 2005. The chemical and oil contaminated water will be collected separately and treated in specialized plants within the CETP. A Central Monitoring Basin (CMB) of RCC construction shall be provided to collect all plant effluents. Through a set of waste effluent

disposal pumps and piping, the effluents shall be disposed of from CMB to the effluent treatment plant for further treatment.

132. The generated waste water from various sources can be reused as gardening water, washing water etc or discharged to the proposed dranage system for ultimate discharge to the river cannel after proper treatment and meeting the DoE's standard for effluent discharge.

133. Sludge may be generated from a number of sources like clarifier, water treatment plant, effluent treatment plant, cooling tower blowdown, etc. Sludge components may include oil and grease, suspended solid particles, sewage, demineralises, and other chemicals used to manage the quality of water in feed water and cooling systems.

134. All oil contaminated drains from process area (HRSG, turbines, steam turbine hall, storage tanks, etc.) will be collected in retention basins for treatment by oil sseperator.

135. Sludge from the septic tanks is expected to be removed once a year or as per the requirement of local laws and regulations by the Project Proponent.

136. A Reverse Osmosis (RO) plant has been proposed in this report as a replacement of commonly used resin based demineralization. Resin initially causes irritation and ultimately may cause cancer. The plant capacity can be finalized based on the detailed design.

4.3.7 Water Balance

137. The liquid waste geenrated from the plant during operation may include, but is not limited to (1) cooling tower blow down, (2) demineralization plant waste, (3) oily water and chemical area drains, (4) sanitary waste water, (5) HRSG blow down, etc. An estimate of the amount of liquid waste to be generated may include cooling tower purge, water treatment plant rejection, HRSG purge and oily water. All wastewaterand industrial wastewater effluents shall be collectedand treated in the CETP which will be constructed under this Project to comply with the effluent discharge limit criteria set forth in ECR 1997 as well as IFC Guidelines.

138. The proposed water balance for the Unit 3 is summarized in **Table 4-1**. The regular total requirement of water for this unit is 400 m^3/hr including the uses of office and staff colony. The amount of liquid waste water would be about 72 m^3/hr, evaporative loss from the condenser cooling system would be about 271 m^3/hr and other uses (make up water for generator CCCW, turbine washing, NOx control water & boiler along with waste waterreuse in the condenser cooling) would be about 57 m^3/hr.

Table 4-1: Water balance for Unit-3

Items	m^3/hr
Distribution	**400.00**
Cooling Water System	324.60
IBD Queched Water (HRSG Blowdown Flash Tank)	6.00
Service Water	2.00
DM Water Tank (With Blow Down 6 m^3/hr)	59.50
Make up water for generator CCCW	*3.00*
Make up water for turbine washing	*1.50*
NOx control water	*43.00*
Make up water for boiler	*6.00*
Potable Water (Office & Dormitory)	0.50

Items	m^3/hr
Unforeseen Demand (Sanitary water, etc.)	6.00
Clarifier & Sand Filter	1.40
Total Distribution (A)	**400.00**
Waste Generated	
Clarifier & Sand Filter loss as sludge	1.4000
Service Water & Potable Water	2.5000
DM Plant Blow down	6.0000
Cooling Tower Blowdown	61.6000
Total Discharged to the Garden/Agriculture field (B)	***71.500***
Losses, Uses and Evaporation	
Reuse of IBD Queched Water & HRSG Blowdown in Condenser Cooling	8.000
Other uses (Make up water for generator CCCW, turbine washing, NOx control water & boiler)	53.500
Condenser Cooling Water Evaporation	271.00
Total (C)	***332.50***
Total Waste, Losses and Uses (B+C)	**400.0000**
(Except Water from Oil-Water Separators)	

Source: CEGIS, 2015 (based on Feasibility Study Report)

139. The typical water balance for SGCCPP is presented in **Figure 4-2**.

4.3.8 Electrical System and Power evacuation

140. Electrical Power needed during the pre-construction, construction and commissioning phases can be drawn from the existing 11KV distribution line of BPDB. The proponent is to draw the necessary power line with other ancillary components from the existing distribution system to the Project site.

141. Generated power from the GT and ST will be evacuated through the existing Sirajganj 230kV national grid sub-station via properly rated step up transformers (240 MVA for GT and 120MVA for ST) and Plant's 230 KV sub-station.

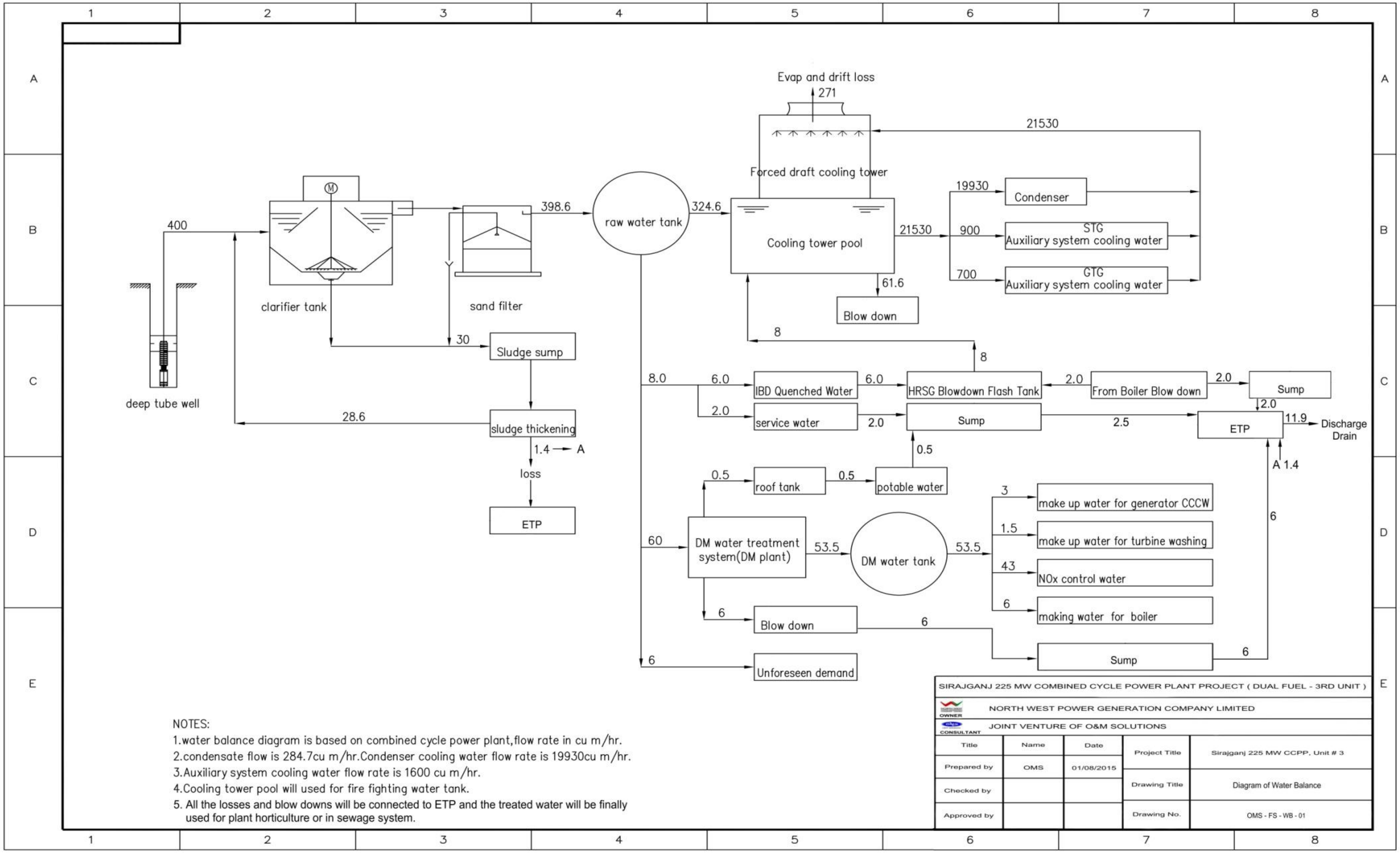


Figure 4-2: Water Balance Diagram for Sirajganj CCPP

4.3.9 Control and instrumentation System

142. State-of-the-art microprocessor based DCS control and protection system will be provided for the proposed CCPP. The system will be integrated with the control, instrumentation, alarm & protection of the plant, in addition to data acquisition, signal conditioning, closed loop control, open loop control, alarm processing and annunciation, event recording and real-time trend recording and communication with other devices/systems. For the purpose of communication between the components, a DCIS redundant communication system will be employed. The design of the control & monitoring system as well as its constructive feature will be guided by the following principles, namely:

- Standardization and interchangeability
- Modular concept of control system
- On line testing of critical parameters
- Fail safe operation

143. The control system shall consist of redundant controllers. The control system will be designed in distributed process control system based on the microprocessor technology. The plant control will be operated by auto/manual operations on the monitor located in Unit Control Room (UCR).

144. The Distributed Control and Information System (DCIS) will be provided for control & monitoring of the combined cycle power plant. The manufacturer’s standard packaged control system will be provided for GTG, ST, HRSG etc. for respective control and monitoring facilities. The standard packaged control system included instrumentation and alarm system and is integrated with the DCIS for centralized control, monitoring and supervision.

145. The DCIS will provide for the safe, efficient and reliable operation of the plant. It will be integrated with subsystem control of steam turbine, generator, gas turbine and HRSG and with their packaged auxiliaries systems control and supervision will be performed by this integrated plant control system. The DCIS will provide modulating and digital control monitoring, alarming, indication and data acquisition for overall CCPP and its auxiliaries.

146. The DCIS will provide automatic operation and supervision ranging from unit startup, load operation and unit shutdown.

147. The functions of plant control are as follows:

- Automatic Plant Startup/Shutdown Control (APS)
- Automatic Power Regulation Control (APR)
- Modulating Control
- Binary Control

148. Automatic Plant Startup/Shutdown control function (APS) is provided in order to control the startup and shutdown of the gas turbine, HRSG and steam turbine. APS produces the command signals for each control system such as Gas Turbine control system, HRSG control system, Steam Turbine control system and auxiliary control system after completion of manual preparation steps.

149. The Auto Power Regulator (APR) will adjust the generation of the gas turbine generator and steam turbine generator. APR will be designed to accept unit load demand signal (MW) from central load dispatch system, or unit load demand setting by operator. The APR will have provision of automatic control or for manual control of any element of the process equipment by the operator at unit control console. The operator interface will permit

the operator to adjust maximum and minimum unit load limits, load change rate, load set points.

150. The proposed control system will provide a safe operation of the plant that includes all interlocks and trips of Unit. The plant safety system will be configured in triplet channel with 2-out-of-3 redundant sensors. All drain valves will be motorized with auto or manual operation facility.

4.3.10 Life Cycle Overview

151. Project development for Sirajganj Unit-3 CCPP has proceeded to preparation phase. There are a number of important points for the plant life cycle (25 years) that must be carefully considered. These include (i) the current planning phase, (ii) installations including gas pipelines, cable lines, underground electrical lines, water pipelines, (iii) foundation of steam turbine, (iii) state-of-the-art control system of STG and interfacing with GTG and HRSG, (iv) foundation of GTG, unit transformer, and HRSG, (v) erection of GTG, transformer, and HRSG. In addition, energy consumption due to natural gas feedstock including drilling/extraction, processing, and pipeline transport are also considered in the life cycle analysis.

152. A total overview of the CCPP option including the total plant output and efficiency under ambient conditions averaged over the life time is shown in **Table 4-2**.

Table 4-2: Life cycle plant output and efficiency for CCPP

Items	**Unit**	**Impact**	**Outcome**
Heat input gas turbine	MJ/s		427.3
Natural gas consumption (LHV 950 BTU/scf) in the plant	MMSCFD		35.0
Net output gas turbine, ambient conditions	MW		146.7
Net output steam turbine, ambient conditions	MW		73.3
Auxiliary power (steam system, gas compressor)	MW		-5.0
Total net plant output, ambient conditions	**MW**		220.0
Impact of ageing and fouling	MW	-1.5%	-3.3
Average net capacity over life time	**MW**		216.7
Net efficiency ambient conditions	**%**		**50.0**

Source: CEGIS, 2015 (based on Feasibility Study Report)

System boundaries

153. An assessment is made to track the material and energy flows between the process blocks within the system and is presented in **Figure 4-3**. The solid lines in **Figure 4-3** represent actual material and energy flows, while the dotted lines indicate logical connections between process blocks. The steps associated with obtaining the natural gas feedstock are drilling/extraction, processing, and pipeline transport.

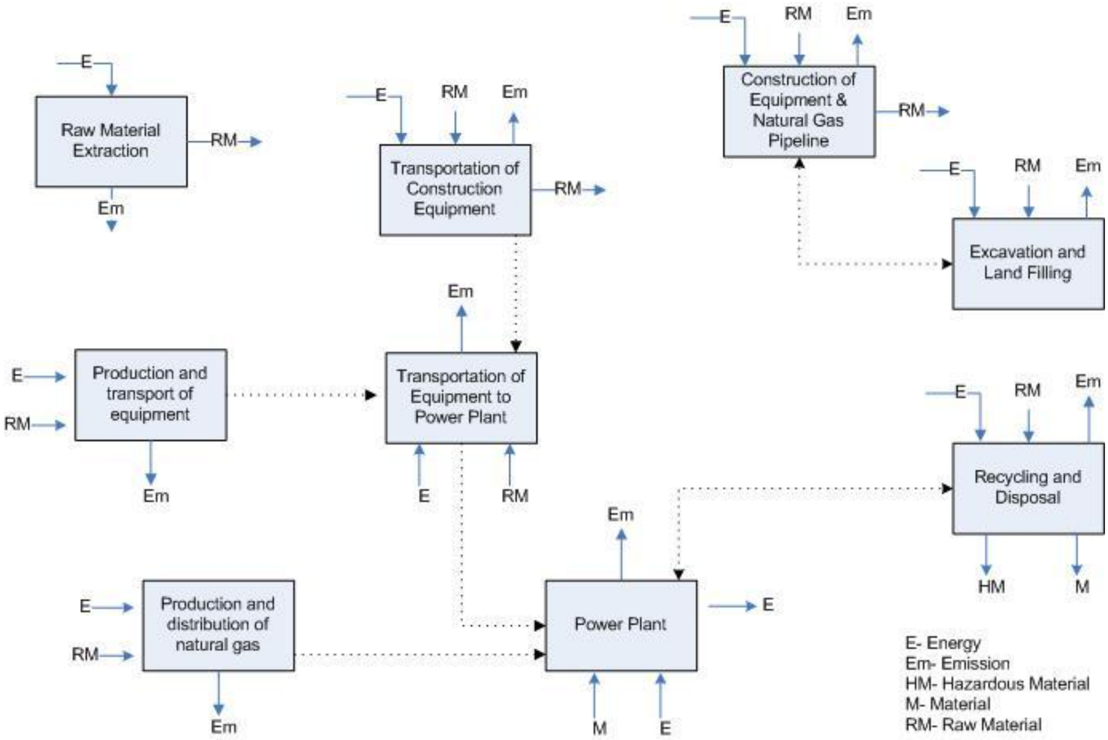


Figure 4-3: System boundaries for electricity production using natural gas combined-cycle process

4.3.11 Pollution Prevention Devices and Units

Air pollution

154. The major air pollutants that are produced from the power generating plants due to burning of fossil fuel are SO_x, NO_x, CO_2, CO and SPM. The proposed plant is a dual fuel (natural gas and HSD) based power plant. Natural gas of Bangladesh is known as sweet gas and contains negligible percentage of sulpher and HSD contains only 0.25% sulpher. Hence, formation of SO_2 is negligible and is ignored. Modern gas turbine manufacturers guarantee the formation of less than 25ppm of NO_x due to their improved firing system like dry low- NO_x burners, lean pre-mix firing etc. The modern digital DCS control system maintains combustion air about 1% (excess air) above the "stoichiometric" f/a ratio. Hence, formation of CO due to incomplete combustion is not expected. Normally, SPM contents in natural gas is negligible or near to negligible and that in HSD is about 0.01%. Hence additional preventative measures for SPM and SO_2 is not required.

155. Substantial reductions in emissions of CO_2 could be achieved by increasing combustion efficiency i.e. burning less fuel for same mega watt of electricity generation. The modern GTs are highly efficient compared to their earlier versions. Moreover, development of green belts in and around the power plant will also greatly reduce CO_2 from the environment. For continuous on-line effluent monitoring, different electronic analyzers like CO_2 analyzer, NO_x analyzer, etc. shall be installed in analyzer room.

156. The analyzers, taking samples of flue gas from chimney, shall display the result locally as well as will send electrical signal to the Distributed Control System (DCS) for displaying and warning in control room monitors.

Water pollution

157. The major sources of contaminated water from the proposed power plant are blow downs of HRSG, cooling tower, back wash and rejects of water treatment plant, oily water

from turbine floor and transformer area etc. All these polluted water along with others will be collected in a common basin known as ETP sump. This water will be then pumped to the Central Effluent Treatment Plant (CETP) where it will be treated as per DoE regulations before using in garden, re-using in the system or discharging to the local drainage system.

4.3.12 Waste Management System

158. Management of wastes, solid or liquid, generated during the construction and operation phases of the project is a very important issue. Waste generated during the construction phase of the project will include construction debris and wastes (e.g. scrap iron, steel, wood, piping, cartons etc.) and some other solid wastes (e.g. from labor sheds), human wastes from people working at the Project site and some liquid wastes from construction processes, labor sheds, etc. During operation phase, the solid wastes will mainly come from worker’s colony, human waste from employees and liquid waste from worker’s colony, office, oily water from plant and transformer areas.

159. During construction period all construction solid wastes shall be dumped in clearly marked, environmentally protected and properly fenced areas covered with Tarpaulin. It would be the responsibility of the contractor (EPC) to properly store these wastes at the Project site and then dispose off in an appropriate manner (e.g. in a Union Parishad landfill/waste dumping ground) outside the complex.

160. During construction and operation periods, all solid wastes/kitchen wastes from workers colony shall be handled separately and dumped in a separate enclosed area. An agreement has to be made with local municipality/Local Govt. Institutes (LGIs) to collect periodically all solid wastes/kitchen wastes from different dumping spots within the Project site and finally dispose off in a municipality/LGI approved areas. Human wastes e.g. those generated in the labor sheds/ employee’s colony should be appropriately disposed off, e.g. through construction of septic tank system.

161. The contaminated liquid wastes generated during construction phase will be collected in a pit inside the project site and neutralize and treat in the temporary water treatment laboratory before releasing in the open environment. Similarly, the contaminated liquid wastes including sludge in the operation phase will be collected and treated in the Central Effluent Treatment Plant (CETP) as the case may be, before reusing in gardens/plant or discharged into the existing drainage system. The appropriately designed wastewater disposal facilities of the proposed power plant will take care of all waste water and human wastes to be produced within the plant.

4.3.13 Green initiatives

162. Due to space restriction of the proposed Plant (Unit-3), DoE’s requirement for greenery (about 33% of the Project area should be covered with different types of plants/vegetations) may not be maintained. However, the endeavor of the proponent will be sustained for plantation in the open spaces of the project site so that vegetation coverage becomes closer as much as possible to the guideline of the DoE. On the contrary, the extended portion of the Bangabandhu Eco-park, semi-protected forest patches in nature, started from the northern boundary of the project site and ended in the protected/core portion of the Bangabandhu Eco-park will function as a environmental cleaner and protector from the adversity of the natural calamity. For ensuring the cleansing effect of the forest over the years, the proponent may work closely with the Eco Park authority so that pilferage and damage to it is stopped.

5 Analysis of Suitability of Different Alternatives

5.1 Suitability of Site

163. The proposed project site is already earmarked by the proponent and hence further selection of site through comparative analysis is redundant.

5.2 Suitability of Technology

164. One of the common classifications of electrical power generating units are i) Steam Turbine Plant ii) Gas Turbine Plant. Gas Turbine Plants are further classified as i) Simple Cycle Plant and ii) Combined Cycle Plant. Again a combined cycle power plant can be either gas based or liquid based.The proposed project is a gas based combined cycle power plant.

165. A comparative study of technology, fuel, and cooling system is placed below:

Table 5-1: Comparative Analysis of Alternative Technologies and Fuel

Steam Turbine Plant	Gas Turbine Simple Cycle.	Gas Turbine Combined Cycle
Less efficient due to loss of heat in condenser	Less efficient (around 35% - 40%)due to loss of heat throught exhaust fue gas.	Highly efficient (more than 50%) due to re-use of exhaust heat in HRSG to drive a steam turbine.Resulting a higher plant power out put with a very additional gas consumption (Ref. In Ghorashal unit 4. An increase of 123.8% power out put with an increase of 36.7% gas consumption. is
Fuel selection: Gas Turbine fuels are i) Gas OR ii) Liquid fuel		
Gasious Fuel	**Liquid Fuel**	**Selection of HSD as Stand by Fuel**
Natural gas available in Bangladesh, easy transportation from source to site, Negligible sulpher content hence more environment friendly	Needs to be imported, Transportation not so easy, high sulpher contant mitigation expansive,	The standby fuel, HSD contains only 0.25% sulpher againstHFO which contains more than 3% sulpher. So, HSD is more environmentfriendly than HFO. Apart from this, HFO needs continuous heating to keep it in diluted form for firing. HFO burners need additional air supply for atomization and additional light diesel oil for initial firing. So, use of HSD is less cumbersome than HFO.

Selection of cooling system:

166. Condenser and other cooling system of a thermal power plant is either of closed cycle using cooling tower or of open cycle system. The closed cycle cooling system requires lesser quantity of water and could be taken from underground. On the other hand the open cycle system a large quantity of water is required from river, lake, sea etc.

167. The proposed project adopts close cooling system using ground water. A comparative justification is placed below:

Table 5-2: Comparative Analysis of Alternative Cooling System

Surface water from Jamuna River (Open/Close cycle system)	Under Ground water (Close cooling system) using cooling tower
During wet season, the river passes by the project site, but during dry season, the river is about 1.5 to 2 km away from the project site. There is a small river channel close to the proposed site, but the water availability in this channel is very low especially during dry period. To use surface water in the plant, Jamuna water is to be transported through this channel by installing pumps of required capacity and necessary pipings at the Jamuna river end. Moreover, additional protective measures would be required to save the pump from river erosion. All these involving extra cost and separate study.	As per the feasibility report, water demand for Sirajganj 3rd unit is 400m^3/h and the ground water availability in the project area is good enough to meet the water demand of all the four units (2,550 m^3/h). The feasibility report under the title “Water availability study” states that the maximum allowable withdrawal of groundwater for NWPGCL power generation complex is 3,200 m^3/h without causing conspicuous problem in the groundwater table of the plant complex area. If the findings of EAL 2014 and SDCP 2015 are relied upon, it can be said that total water requirement of about 2,550 m^3/h for all the four units of Sirajganj power generation complex could be met by groundwater abstraction. Considering the complications and relevant expenditure involved for making Jamuna water available to the power plant over the year, use of ground water for the project has been considered as a more viable option. To minimize the associated environmental consequence and ground water withdrawal impact, a closedcooling water system using cooling tower technology has been planned for the proposed 3rd unit of Sirajganj power plant.

6 Description of Baseline Environment

6.1 Introduction

168. This chapter on environmental and social baseline has been prepared using both primary and secondary data collected for the proposed Project site and defined study area. The baseline condition has been defined in respect of physical environment (e.g., including meteorological, hydrological, geological components and processes), biological environment (e.g., including flora, fauna, and ecosystems), land use pattern, agriculture practices, cultural activities, economic status, and hazards of the study area.

6.1.1 Landscape and Topography

169. The proposed project, to be constructed in Sirajganj district, is located in the active Brahmaputra-Jamuna Flood Plain. The average elevation of the proposed location is about 12 m, sloping down generally from west to east direction. Since the land adjacent to the Jamuna River is slightly at a lower level, the floodwater does not cause any water logging. The topography does not inhibit drainage in the project site area. Due to the erosion control and bank protection infrastructure, carried out by BWDB, the project area is free from Active Flood.

6.2 Land cover and Land use

170. The total study area has been considered as 10 km radius from the stack point. Land use of the study area has been identified using satellite image and classified as agriculture land, sand bar/char land, forest, industrial area, road, settlement with homestead vegetation, power plant, urban built-up area and water bodies.

6.2.1 Description of Satellite Image

Basic information

171. RapidEye satellite image was used for the land use mapping. Images that have been used in land use classification were acquired on 15 March 2013 and 30 March 2014. Spatial resolution and color composition of the images are presented as follows in **Table 6-1**.

Table 6-1: Details of satellite images used for land use mapping

Area	Spatial Resolution	Spectral Resolution	Acquisition Dates
Sirajganj Power Plant Study Area	5 meter	5 Bands (B, G, R, RE and NIR)	15 March, 2013 and 30 March, 2014

172. The spectral bands of RapidEye Satellite images has a multi-spectral color composition for various wave lengths. The following **Table 6-2** shows the band names of the respective wavelengths.

Table 6-2: Spectral bands and wavelengths

Band ID	Band Name	Wave length (nm)
1	Blue (B)	440-510
2	Green (G)	520-590
3	Red (R)	630-685
4	Red Edge (RE)	690-730

Band ID	Band Name	Wave length (nm)
5	Near Infra-Red (NIR)	760-850

173. The above basic elements are required for analyzing the satellite images and obtaining the land uses for EIA.

6.2.2 Process of Analysis

174. Land use analysis was carried out using ERADAS IMAGINE and ArcGIS 10.1 software. A multi-step task has been followed in analyzing the images. A series of tasks were followed for analyzing After receiving the images from image provider, each of the images was processed using ERADAS IMAGINE software. Geo-referencing was done to make corrections of geometric distortions. CEGIS has a national archive of Ground Control Point (GCP) coordinates, which were collected by Differential Global Positioning System (DGPS) survey. These GCPs were used as reference coordinates for rectifying the images.

175. On screen digitization techniques were used to extract required land use and land cover data from the satellite images. Using this technique, major classes such as agriculture land, sand bar/char land, forestland, water bodies (baor, beel, rivers, canal, pond, ditch), rural settlement with homestead vegetation, urban built-up area, industrial area, road etc. were derived from the images.

Settlement with homestead vegetation

176. Settlement area contains homesteads, house structures and yards and sometimes attached small farmlands surrounded by different types of homestead vegetations.

Agricultural Land

177. Agricultural land is flat/plain lands comprising of many continuous plots, which may have crop or fallow. They were identified by their finer texture and specific shape (mostly rectangular form) from the satellite images.

178. The seasonal *Boro* rice area were prepared from latest available Landsat 5 and Landsat 8 satellite images and the monsoon seasonal *Aman* rice area were prepared from available Radarsat satellite images. Available published statistical data of seasonal *Boro* and *Aman* rice area were compared with the seasonal *Boro* and *Aman* rice area derived from the satellite images in order to be confident about the accuracy of the output.

Eco-Park

179. The Bangabandhu Park is identified as a public green area having abundance of trees and plants, grasses and various facilities, such as benches, wildlife cages, etc. those allow to enjoy the leisure and resting time.

Road

180. Road class includes all types of metal and non-metal roads of the study area those are visible in the satellite images. This class was identified from satellite images by its linear nature and connectivity with one another, sometimes exposed and in some places covered with trees. However, assistance from existing available road network was also used during identification, interpretation and digitization of the roads from satellite images.

Railway

181. Railway tracks are also linear feature and similar to roads in the satellite images. However, railways are found very straight, fixed width in all areas and are very smooth in the bendings. Existing GIS database of railway networks has also been used during classification.

Industrial Area

182. The classes of Industrial Area including BSCIC Industrial Area, Sirajganj CNG Station, Sirajganj Kowmi Jute mills and Power Plant were identified.

Brick field

183. This class was interpreted from images by using bright tone, regular shape pattern of piles of bricks, at least one vertical chimney and its shadow.

Sand Bar/Char Land

184. This class includes dry sands near or besides rivers. It was identified in the false colour composite of the images by bright white to light cyan colour, finer texture, without vegetation.

Urban built-up area

185. An urban area is characterized by higher population density and vast human features in comparison to the areas surrounding it. Urban areas may be cities, towns or conurbations, but the term is not commonly extended to ruralsettlements such as villages and hamlets. Urban areas are created and further developed by the process of urbanization.

River & Canal

186. River is considered as a land use section if the actual riverbed is linear and wide, naturally flowing water bodies and never without water during any period of the year. Branches of the rivers are considered as canal.

187. This class includes rivers, canals and other linear water bodies those are visible in the satellite images.

Baor

188. Baor are permanent natural collection of water. A baor is a U-shaped body of water that forms when a wide meander from the main stream of a river is cut off, creating a free-standing body of water. This landform is so named for its distinctive curved shape.

Pond and ditch

189. Ponds are artificial storage of water. Basically ponds have rectangular or square shape. Ditches are the water bodies like ponds that are situated beside the river side or road side. They do not have any regular shape like pond.

6.3 Geology

6.3.1 Geology

190. The geology of the study area consists of Quaternary deltaic sediments, which have been strongly influenced by tectonic movements on deep-seated faults.

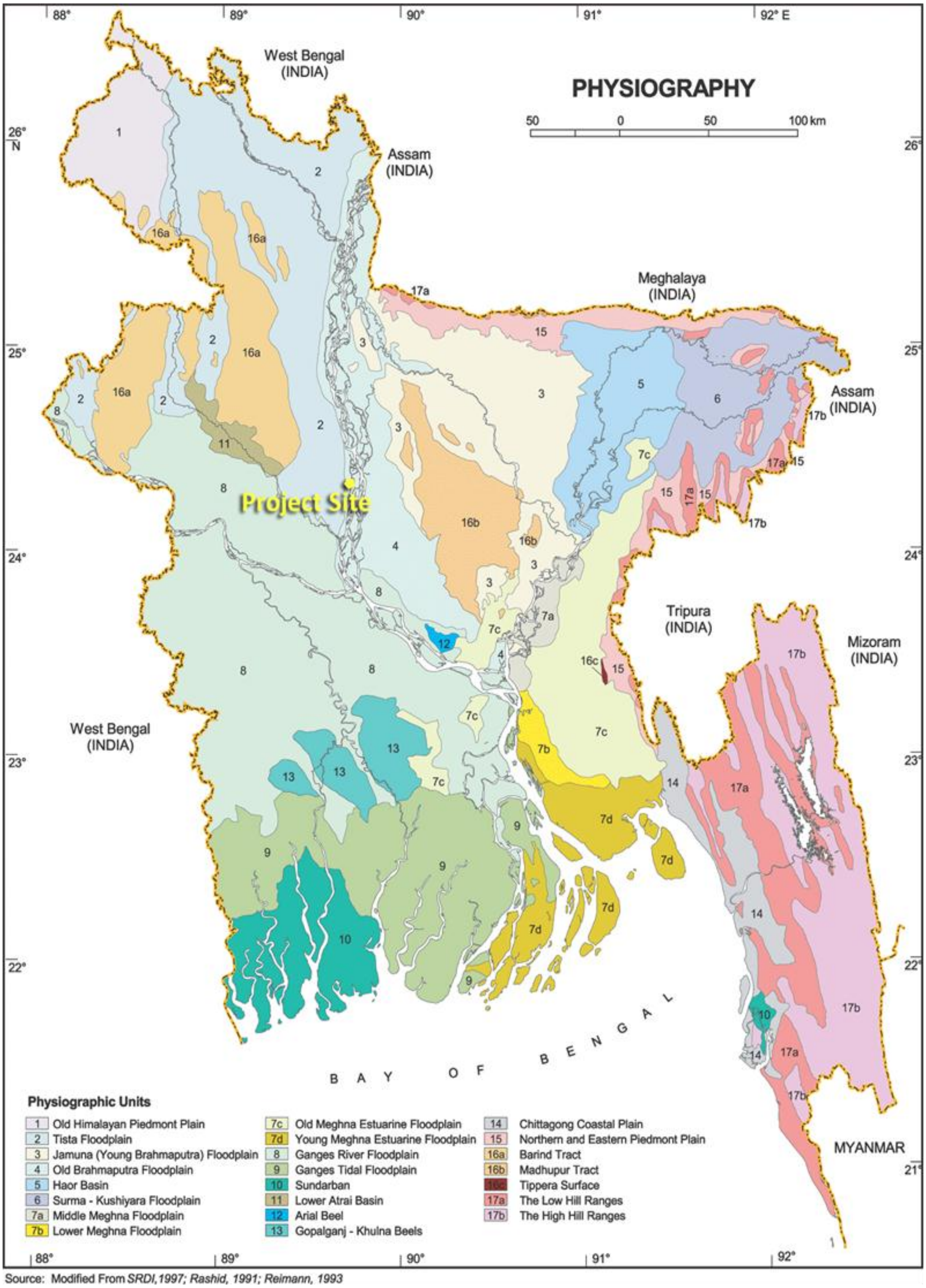
191. Morphogeologically this area is divided into active channel, abandoned channel, crevasse splay, natural levee, floodplain and flood basin deposits characterized by different physiographic, sedimentological and genetic aspects of their own. The present landform is the result of erosion, deposition, migration and abandonment of the river system. Quaternary floodplain sediments underlie the whole area.

192. Present floodplain along the active rivers are monotonously plain, well drained and are subjected to annual flooding. On the other hand, the older floodplains have fairly high irregular relief, depressed old channel scars and abandoned levees . Geomorphology of

Sirajganj area is the result of deposition and erosion of the Jamuna, Ichamati and Hurasagar rivers.

Physiography

193. Physiographically the Sirajganj area occupies the Jamuna and Karatoya floodplain (Rashid, 1991) **(Map-6-1)**. The elevation of the area varies from 10 m to 14 m AMSL with a gentle slope towards southeast direction.



Map 6-1: Physiographic map of Bangladesh

Stratigraphy and Lithology

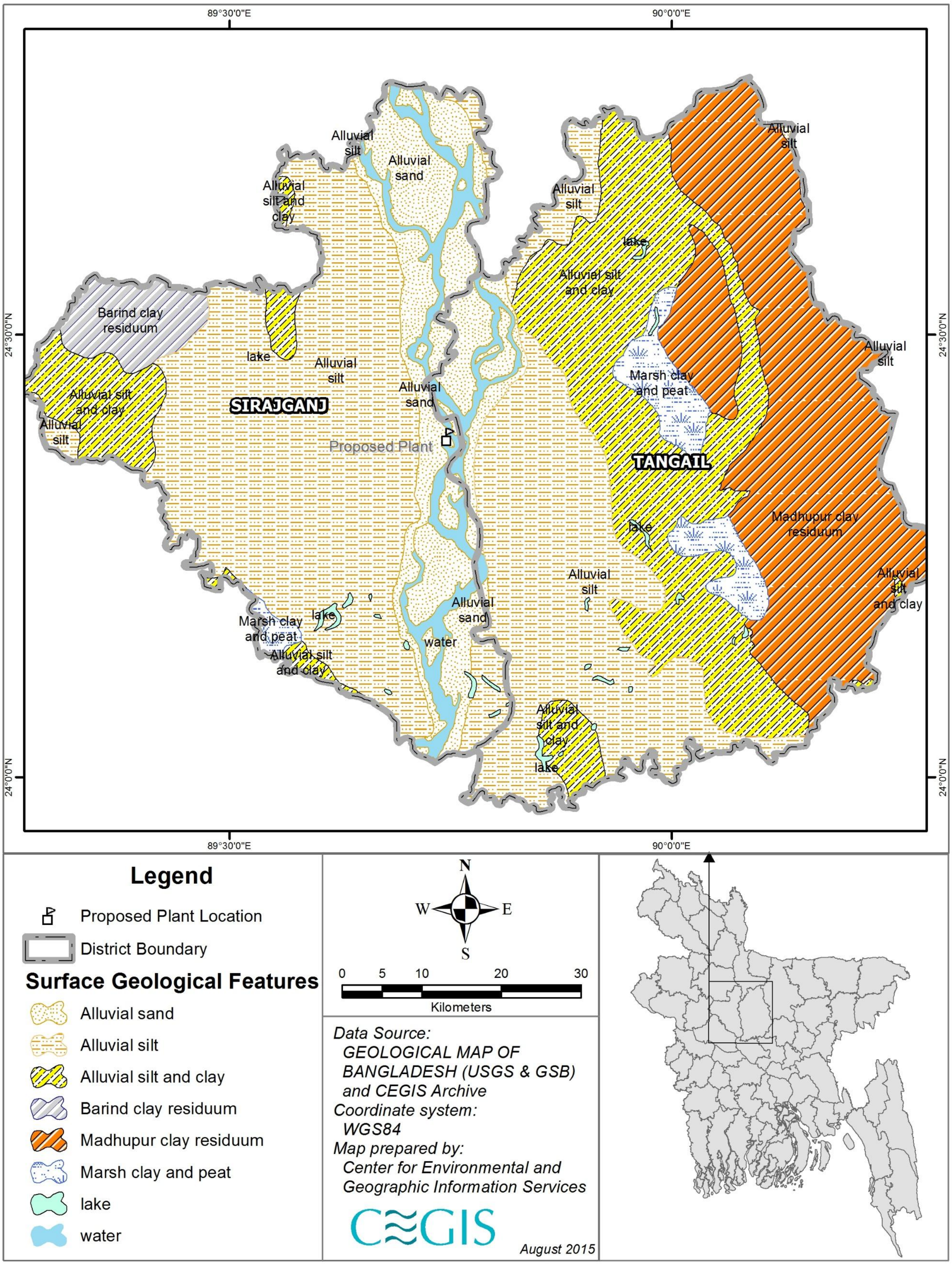
194. Geology of Bangladesh is generally dominated by poorly consolidated sediment deposit over the past 10,000 to 15,000 years (Holocene age).

195. The proposed site is on a floodplain or alluvial soils **(Map 6-2)**. This type of soil mainly comprises sandy barns and sandy clay barns and tends to be gray to dark gray in poorly drained basins and brown on higher and better drained land. The texture of soils of the project area is silty loam to sandy loam.

196. On the basis of lithological variations, sub-surface (up to depth of 85 m) lithology is divided into upper clay, silty clay and sandy clay units; lower fine to medium-grained sands and coarse-grained sands with intercalations of gravels.[6]

[6] Md. Shamsuzzaman, Md. Sultan-Ul-Islam, Md Badrul Islam and Md. Nazim Zaman. Rajshahi University Studies. Part B. Journal of Science; Vol. 32, 2004. ISSN 1689 -0708; "Geo-hazard Assessment for Urban Development: A Case Study from Sirajganj Town and Adjoining Areas, Bangladesh"

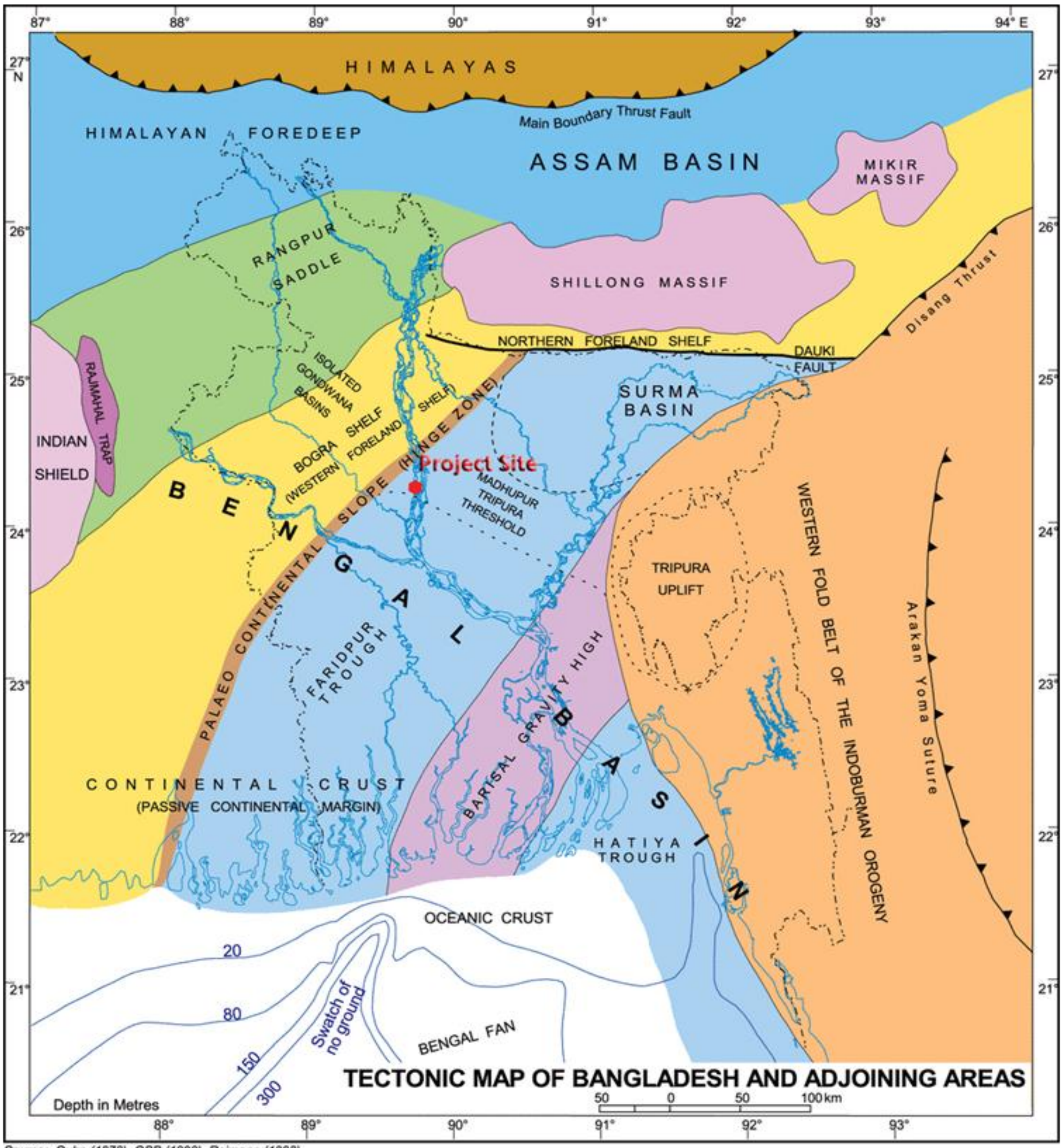
Surface Geology of the Proposed Plant Site of Sirajganj 225 MW CCPP Project (Dual Fuel - 3rd Unit)



Map 6-2: Surface geological map of Sirajganj

Tectonic Setup

197. Tectonically the study area is located at the southeastern part of the Bogra Shelf Zone and northwestern part of the Bengal Foredeep of Bengal Basin (Khan and Rahman, 1992 and Reimann, 1993). This area is characterized by a low and flat topography and covers the Jamuna and Karatoya floodplains. Jamuna fault is the only prominent fault lying in the eastern boundary of the area (HGGL 1981)



Source: Guha (1978), GSB (1990), Reimann (1993)

Map 6-3: Generalized tectonic map of Bangladesh

198. The Geology of Bangladesh is associated with the evolution of Bengal Basin, most of which has been slowly subsiding due to tectonic forces responsible for building the Himalayas. The Himalayas, though the loftiest mountains of the world, have still been rising. The slow subsidence is estimated to be about one inch per year in the coastal regions, as is evident from the present position of tree stumps cleared about a century back in the Sundarbans region, situated in the districts of Khulna and Barisal. This has practically

nullified the sedimentation effect substantially which is, estimated to be about 2000 million tons per year of silt carried by the Ganges, the Jamuna and the Meghna rivers. On the whole the coast line has not extended more than what had been mapped by James Rennel about 250 years ago in 1770. Rather a net loss of land area is observed.

199. The Gangetic Plain was originally a deep depression or trough lying between the peninsula and the mountain region. The depression was, perhaps due to a sagging or subsidence of the northern part of the peninsula. As it arrested the orogenic movement or southward advance of the Himalayan mountains' waves, the depression was rapidly filled up by alluvial deposits, which have completely shrouded the old land surface to a depth of several thousand feet. The deposition of the debris and the sinking of the trough must have taken place for about 30 million years throughout the Miocene, Pliocene and Pleistocene periods of Cenozoic Era. The Bengal Basin from Rajmahal Hills to Assam Hills is, however, of latest origin

6.3.2 Seismicity and Earthquake

200. The seismicity of the country is deeply related with tectonic behavior in and around the Bengal Basin. Historical records show that the country has been shaken by ten large to great earthquakes during the last 250 years. At least ten medium and 163 small earthquakes were recorded from 1906-2001 (Oldham, 1899; Richter, 1958; DGP, 1978; Kaila and Sarker, 1978; Rahman, 2001), of which, 49 events have magnitude of 4.0 to 7.5 in Richter Scale. Among these great earthquakes, Bengal Earthquake of 1885 and Srimangal Earthquakes of 1918 had magnitudes greater than 7 with their epicenters located in Bangladesh. The epicenter of 1885 Bengal Earthquake was located near Manikganj (Khan, 2001) and is reported to be associated with deep-seated Jamuna fault which did considerable damage to masonry buildings at Sirajganj town. The earthquake of 12th June 1897 was also more serious (DGP, 1978). So, earthquake risk factor should also be duly considered in future development.

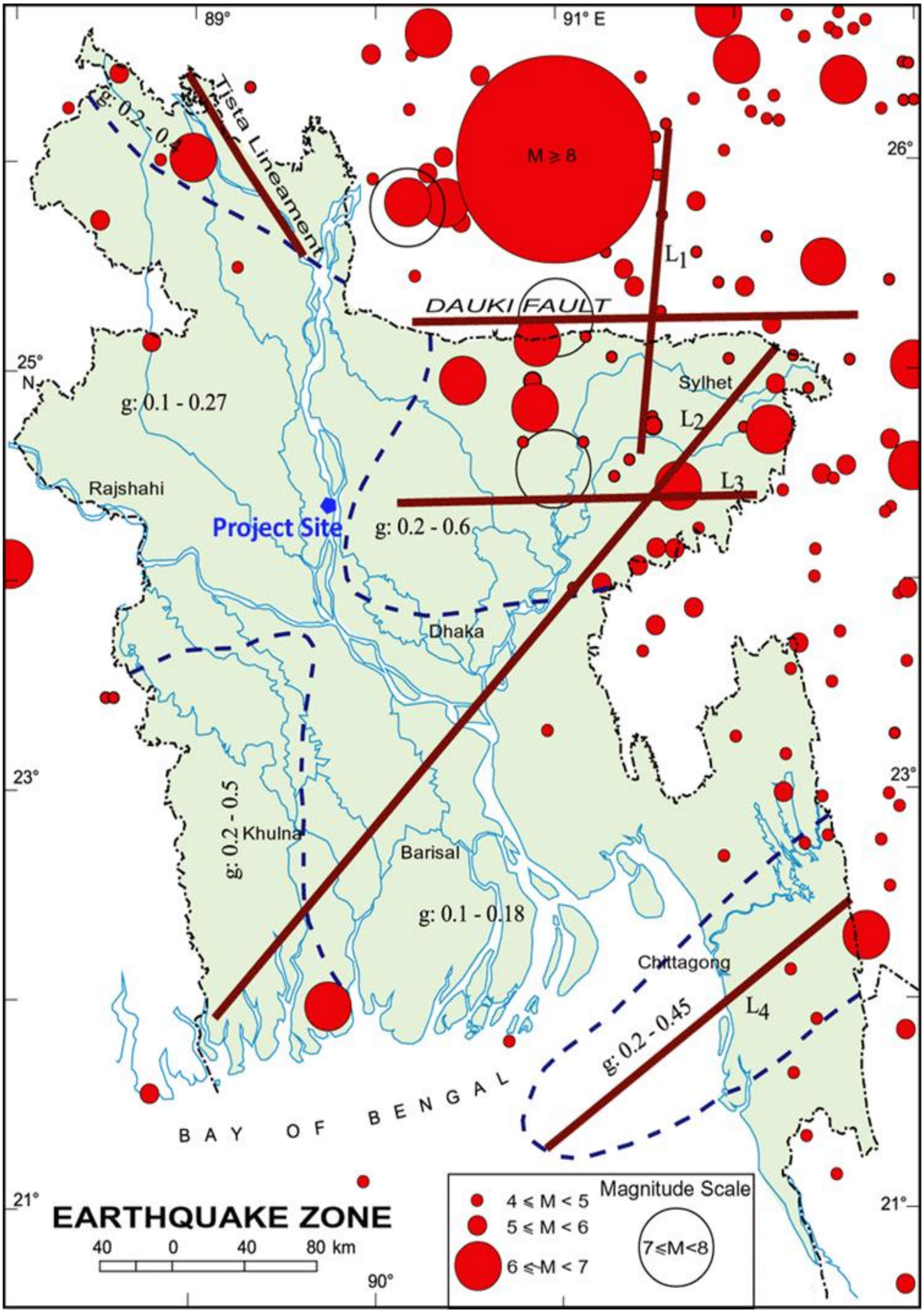
201. The Geologic past shows that the strata under the Himalayas and the adjoining area lying at their feet are in a state of tension and have not yet settled down to their equilibrium planee. By far the largest number of disastrous Indian earthquakes has occurred along these tracts.

202. Based on the severity of the probable intensity of seismic ground motion and damages, Bangladesh has been divided into three seismic Zones; Zone I, Zone II and Zone III as shown in **Map 6-4**, with Zone III being the most severe.

203. The proposed Sirajganj 225 MW project falls under Zone-II (Moderate Damage). This is major affecting zone. The seismic zone co-efficient for this area is Z=0.15.

204. This zone has moderate vulnerability for earthquake with a risk of possible earthquake reaching magnitude up to six on Richter Scale. Details of seismic intensity and the historical records of earth quake in and around the area are presented in the **Map 6-5** and in the **Table 6-3**.

Map 6-4: Earthquake zoning map with seismic co-efficient



Map 6-5: Seismic intensity and the historical records of earthquake in and around Bangladesh

205. The major earthquakes in and around Bangladesh that occurred during last 250 years are listed in **Table 6-3**below:

Table 6-3: Occurrence of major earthquakes in last 250 years

SL	Year	Source Area	Magnitude (Rechter Scale)	Depth (Km)
1	1548	Sylhet	-	-
2	1664	Shillong-Plateau	-	-
3	1762	Chittagong-Arakan	-	-
4	1858	Sandway, Myanmar	6.5	-
5	1869	Cachar, India	7.5	48
6	1885	Sirajganj, Bangladesh	7	72
7	1897	Assam, India	8.1	60
8	1906	Calcutta, India	5.5	-
9	1912	Mandalay, Myanmar	7.9	25
10	1918	Srimangal, Bangladesh	7.6	14
11	1930	Dhubri, India	7.1	60
12	1934	Bihar, India-Nepal	8.3	33
13	1938	Mawlaik, Myanmar	7.2	60
14	1950	Assam, Himalaya	8.6	25
15	1954	Manipur, India	7.4	180
16	1975	Assam, India	6.7	112
17	1984	Cachar, India	5.7	4
18	1988	Bihar, India-Nepal	6.6	65
19	1997	Sylhet, Bangladesh	5.6	35
20	1997	Bangladesh-Myanmar	5.3	56
21	1999	Maheskhali, Bangladesh	4.2	10

Source: Department of Disaster Management, 2012

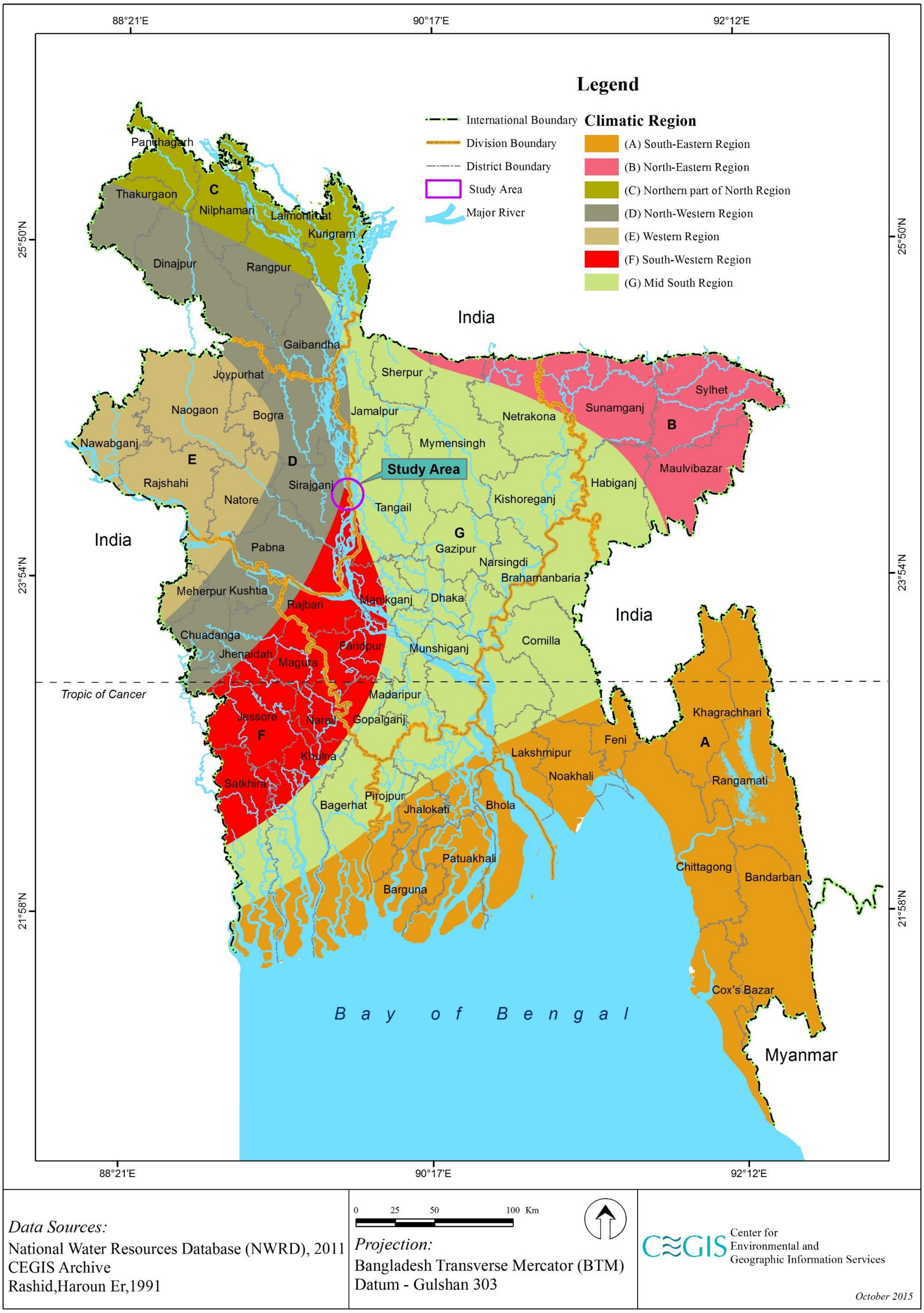
6.4 Climate and Meteorology

6.4.1 Climate

206. According to Köppen climate classification, Sirajganj falls under *Aw* category which is characterized by tropical wet and dry climate with hot and humid summer and dry winter. Among the seven different climatic sub-regions of Bangladesh, the study area falls in three regions such as category *"D", "F"* and *"G"* which are North-Western, South-Western and Mid-South sub-climatic regions of Bangladesh respectively. However, the area lies in a pocket between category *D* and *G* and mainly falls in the south-western sub-climatic region, category F **(Map-6-6)**.

207. To conceptualize the physical environmental condition of the study area, climatic and meteorological data of that area was collected; mainly from National Water Resources Database (NWRD) which were synchronized from the nearest stations of Bangladesh Meteorological Department (BMD) *viz.* Bogra (BMD Station ID: 10408) and Tangail (BMD Station ID: 41909). The summary of the analysis of the climatic and meteorological parameters are discussed in the sections below:

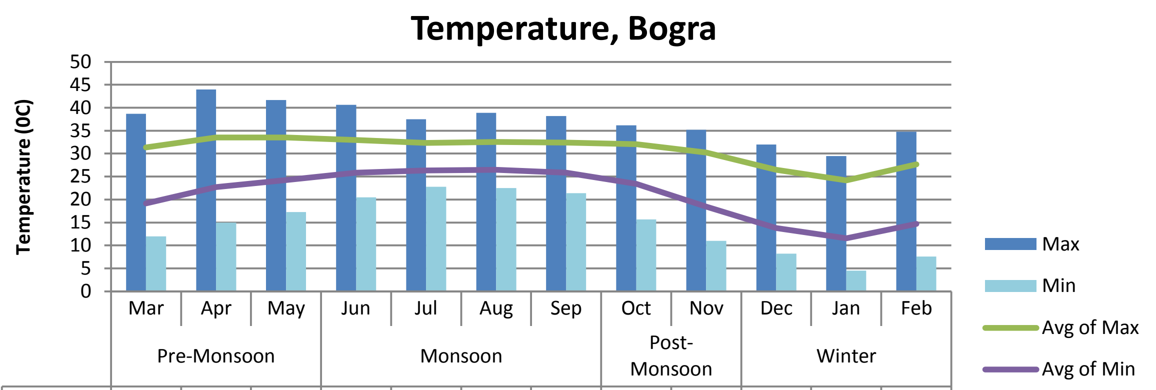
Climatic Region Map: Sirajganj 225 MW CCPP Project (Dual Fuel- 3rd Unit)



Map 6-6: Climatic region of the study area

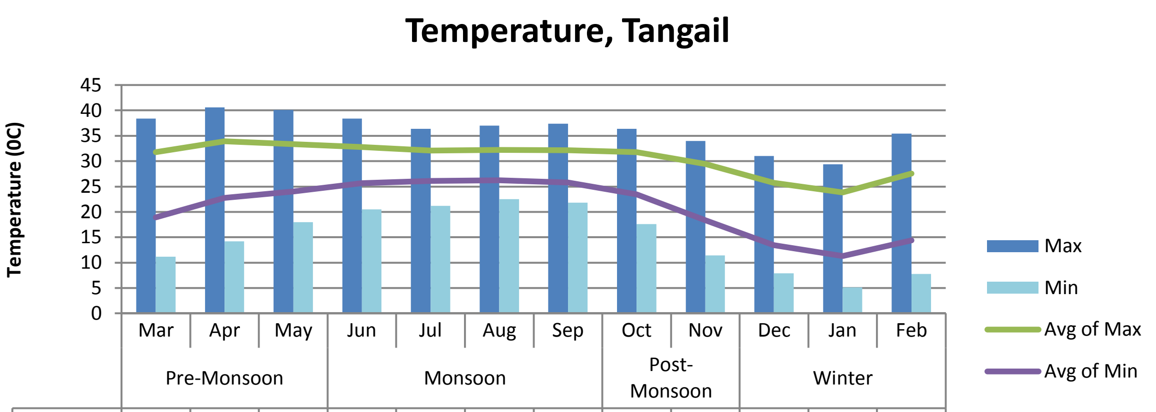
6.4.2 Temperature

208. Bogra and Tangail are two nearest BMD stations from the project site. The analysis of the temperature data of last 27 years (1987-2013), collected from these BMD stations show that the monthly variation of average maximum temperature is between 33.54°C to 24.15°C in Bogra station and 33.89°C to 23.82°C in Tangail station, whereas, the monthly variation of average minimum temperature is 26.45°C to 11.53°C and 26.24°C to 11.29°C in Bogra and Tangail stations respectively. The monthly maximum and minimum temperature data of the last 27 years (January 1987- December, 2013) of Bogra and Tangail stations are represented in **Figure 6-1 and 6-2** respectively.



	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Max	38.7	44	41.7	40.6	37.5	38.9	38.2	36.2	35.2	32	29.5	34.8
Min	12	15	17.3	20.5	22.8	22.5	21.4	15.7	11	8.2	4.5	7.6
Avg of Max	31.393	33.546	33.524	32.956	32.323	32.549	32.438	32.086	30.239	26.462	24.154	27.674
Avg of Min	19.157	22.719	24.23	25.878	26.329	26.453	25.83	23.416	18.445	13.766	11.53	14.671

Figure 6-1: Monthly maximum, minimum and average temperature of Bogra station (1987-2013)



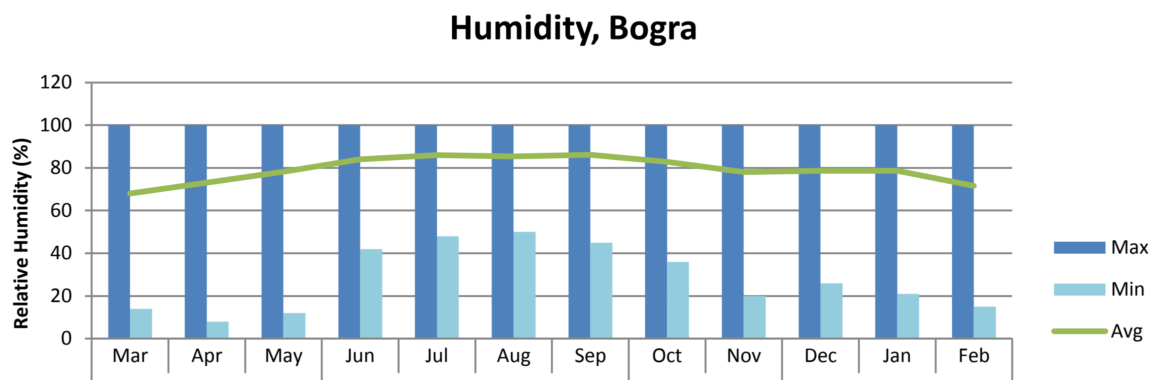
	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
Max	38.4	40.6	40.1	38.4	36.4	37	37.4	36.4	34	31	29.4	35.4
Min	11.2	14.2	18	20.5	21.2	22.5	21.8	17.6	11.4	7.9	5.1	7.8
Avg of Max	31.799	33.89	33.376	32.787	32.058	32.214	32.181	31.747	29.439	25.743	23.823	27.571
Avg of Min	18.928	22.754	23.996	25.688	26.1	26.249	25.77	23.487	18.355	13.46	11.29	14.373

Figure 6-2: Monthly maximum, minimum and average temperature of Tangail station (1987-2013)

209. The highest recorded temperature in Bogra station was 44°C in April of 1989 whereas it was 40.6°C in April of 1988. On the other hand, the minimum temperature (4.5°C) in both the Bogra and Tangail stations were recorded during January, 2013.

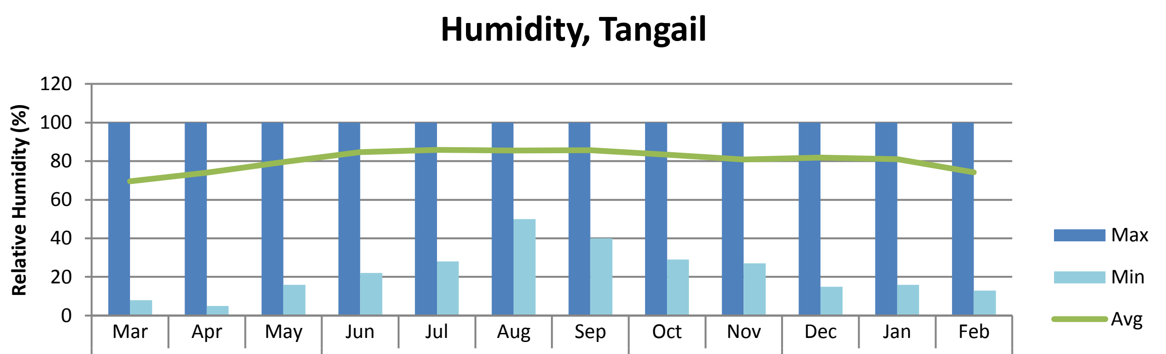
6.4.3 Humidity

210. The average humidity of both Bogra and Tangail stations remain highest during monsoon season (June to September) while the monthly variation of the average relative humidity is between 86.06% to 67.98% in Bogra and 85.896% to 69.568% in Tangail. **Figure 6-3 and 6-4** show the relative maximum, minimum, and average humidity of 26 years (January, 1987 – January, 2013) in those stations.



	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
	Pre-Monsoon			Monsoon				Post-Monsoon		Winter		
Max	100	100	100	100	100	100	100	100	100	100	100	100
Min	14	8	12	42	48	50	45	36	20	26	21	15
Avg	67.98	73.10	78.15	84.09	85.94	85.37	86.06	82.90	78.03	78.62	78.60	71.55

Figure 6-3: Monthly maximum, minimum and average relative humidity in Bogra station (Jan, 1987-Jan, 2013)



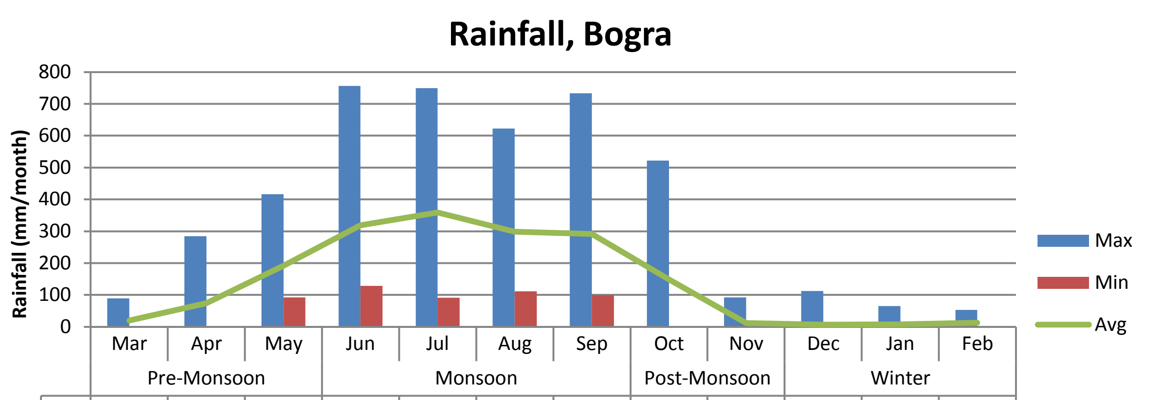
	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
	Pre-Monsoon			Monsoon				Post-Monsoon		Winter		
Max	100	100	100	100	100	100	100	100	100	100	100	100
Min	8	5	16	22	28	50	40	29	27	15	16	13
Avg	69.5688	74.1212	79.5338	84.5976	85.8965	85.4485	85.7277	83.3277	80.8135	81.8769	80.9759	74.2423

Figure 6-4: Monthly maximum, minimum and average relative humidity in Tangail station (Jan, 1987-Jan, 2013)

6.4.4 Rainfall

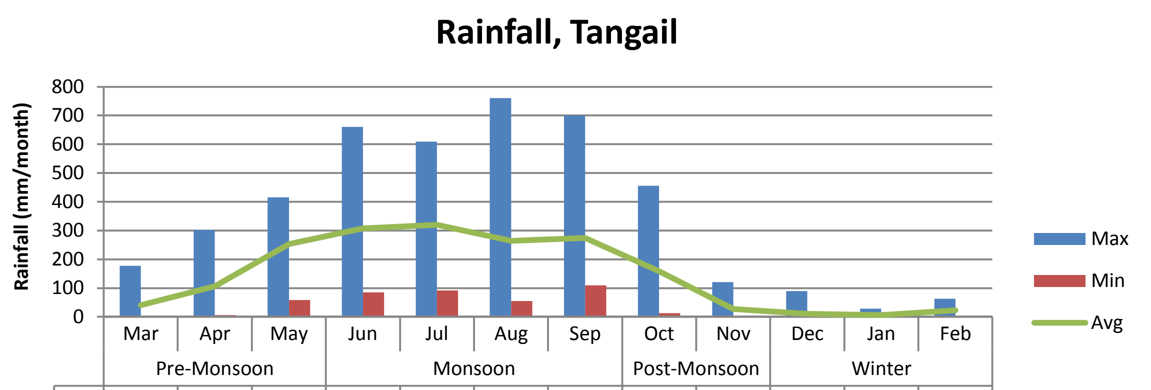
211. Monsoon is a prominent season here. The average monthly rainfall during monsoon season in Bogra and Tangail are 317.02 mm and 291.65 mm respectively. The variance in maximum rainfall during monsoon season (June-September) in Bogra and Tangail stations are 756 mm/month to 623 mm/month and 760 mm/month to 609 mm/month respectively, whereas, the variance in minimum rainfall during monsoon is 128 mm/month to 91 mm/month and 110 mm/month to 55 mm/month in Bogra and Tangail stations respectively. The annual average rainfall (from 1987-2013) recorded in Bogra and Tangail stations are

1740.741 mm/year and 1791.926 mm/year respectively. The average monthly maximum, minimum rainfall from 1992-2013 are shown in **Figure-6-5 and Figure-6-6.**



	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
	Pre-Monsoon			Monsoon				Post-Monsoon		Winter		
Max	89	284	416	756	749	623	733	522	92	112	65	53
Min	0	0	92	128	91	111	99	0	0	0	0	0
Avg	19.8889	73.7037	191.889	319.111	359.074	298.704	291.185	148.111	11.7778	6.62963	7.77778	12.8889

Figure 6-5: Monthly maximum, minimum and average rainfall in Bogra station (Jan, 1987-Dec, 2013)



	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Jan	Feb
	Pre-Monsoon			Monsoon				Post-Monsoon		Winter		
Max	177	302	416	660	609	760	700	456	121	90	28	63
Min	0	6	58	85	92	55	110	13	0	0	0	0
Avg	40.148	106.41	253.3	308.11	319.7	264.3	274.48	158.67	26.741	10.963	6.0741	23.037

Figure 6-6: Monthly maximum, minimum and average rainfall in Tangail station (Jan, 1987-Dec, 2013)

6.4.5 Sunshine Hour

212. The average sunshine hour of Bogra varies from 4.21 hours/day to 7.96 hours/day in a year in Bogra station, whereas, it varies between 4.09 hours/day to 7.72 hours/day in a year in Tangail station. On average, pre-monsoon season gets the highest amount of sunshine in both the station. **Figure 6-7 and Figure 6-8** shows the maximum, minimum and average sunshine hours from January, 1987 to June, 2013 in Bogra station and from October, 1987 to June, 2013 in Tangail station.

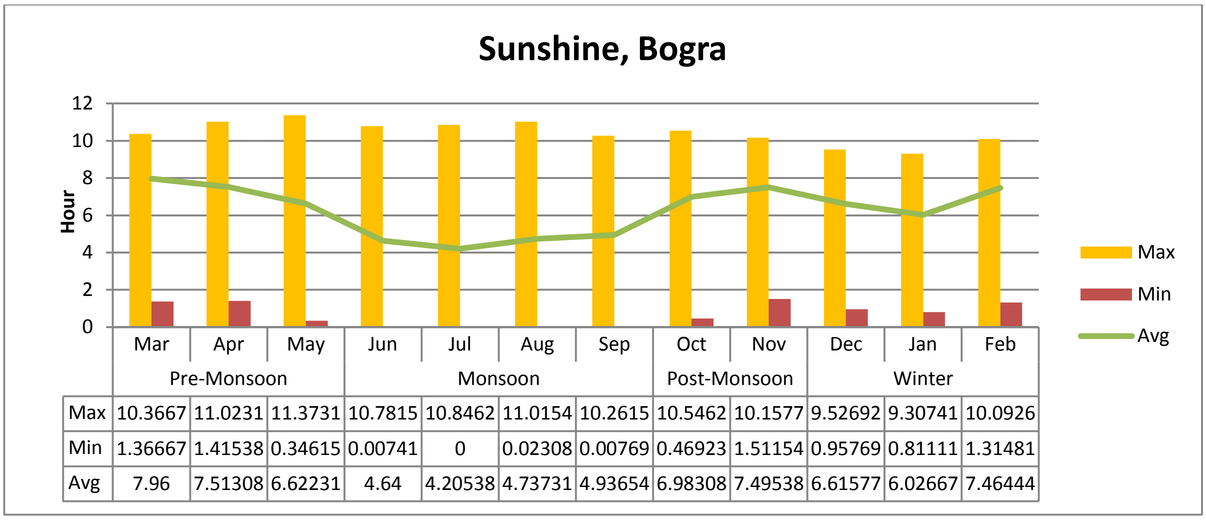


Figure 6-7: Monthly maximum, minimum and average sunshine hours in Bogra station (Jan, 1987-Jun, 2013)

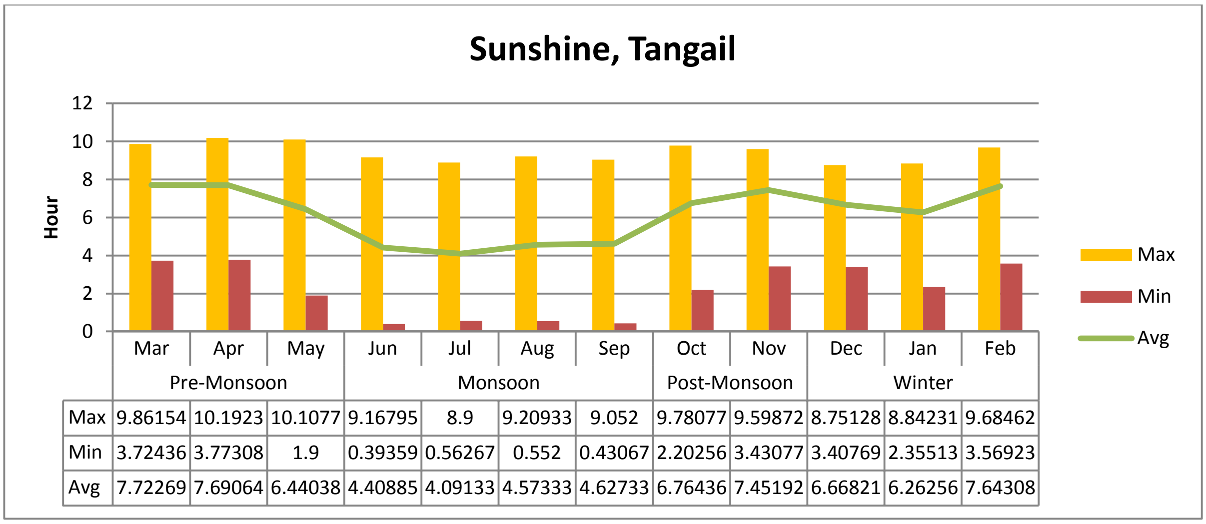


Figure 6-8: Monthly maximum, minimum and average sunshine hours in Tangail station (Oct, 1987-Jun, 2013)

6.4.6 Wind Speed and Direction

213. The maximum yearly wind speed recorded in Bogra and Tangail stations from 1987 to 2012 are depicted in **Table 6-4**. In these 26 years, Bogra station recorded highest 62.96 km/hr (1511 km/day) wind speed during 1996, while, 151.83 km/hr (3644 km/day) in 1991 was the highest recorded speed in Tangail station.

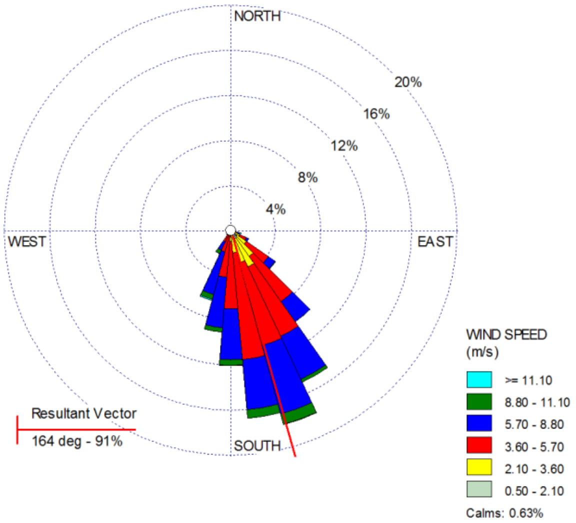
Table 6-4: Maximum Yearly Wind Speed in Bogra and Tangail Stations (1987-2012)

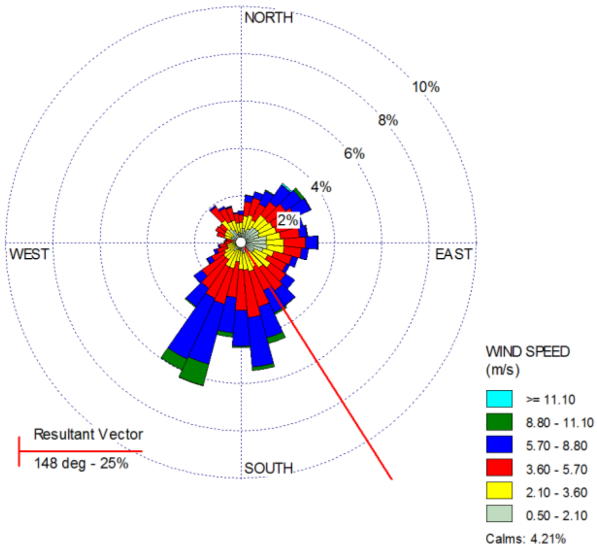
Year	Max Wind Speed in Bogra (km/day)	Max Wind Speed in Tangail (km/day)
1987	800	1111
1988	1066	888
1989	977	888
1990	1111	1155
1991	1111	3644
1992	888	666

Year	Max Wind Speed in Bogra (km/day)	Max Wind Speed in Tangail (km/day)
1993	977	711
1994	888	755
1995	1111	622
1996	1511	666
1997	755	666
1998	1244	711
1999	533	711
2000	800	622
2001	622	666
2002	1111	444
2003	1111	622
2004	755	622
2005	844	533
2006	533	666
2007	800	711
2008	622	711
2009	755	533
2010	444	533
2011	888	400
2012	666	533

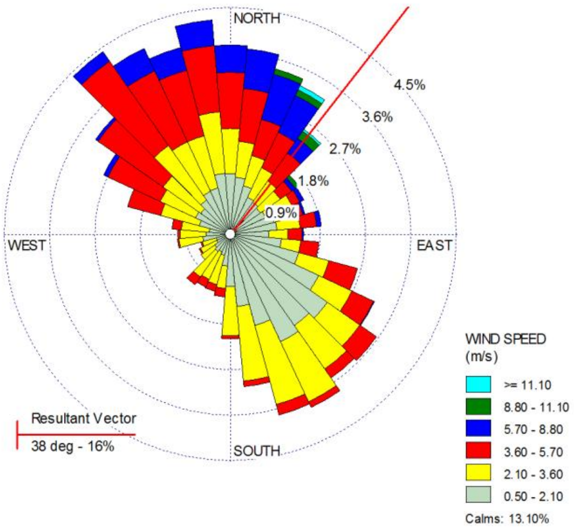
Source: BMD

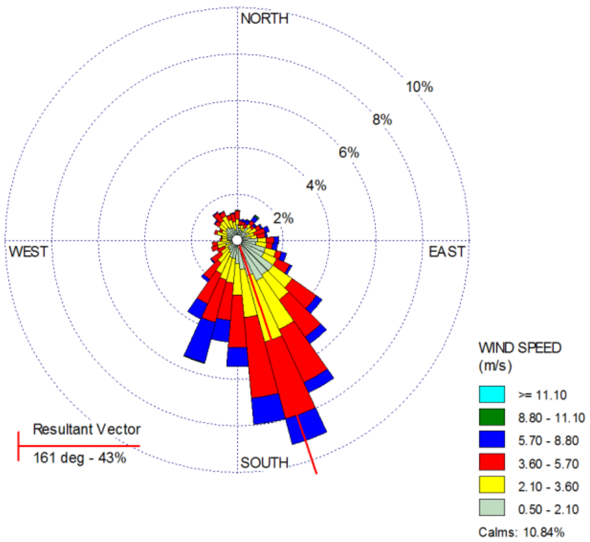
214. The direction of wind is represented through wind-rose diagram in **Figure 6-9**. It can be seen from the figure that during March to May (a), June to August (b), and September to November (c) the prevailing wind direction is South-East. However, during December to February (d) the prevailing wind speed is North-East. It can be seen from the yearly diagram (e) that the prevailing direction of wind throughout the year is South-East.



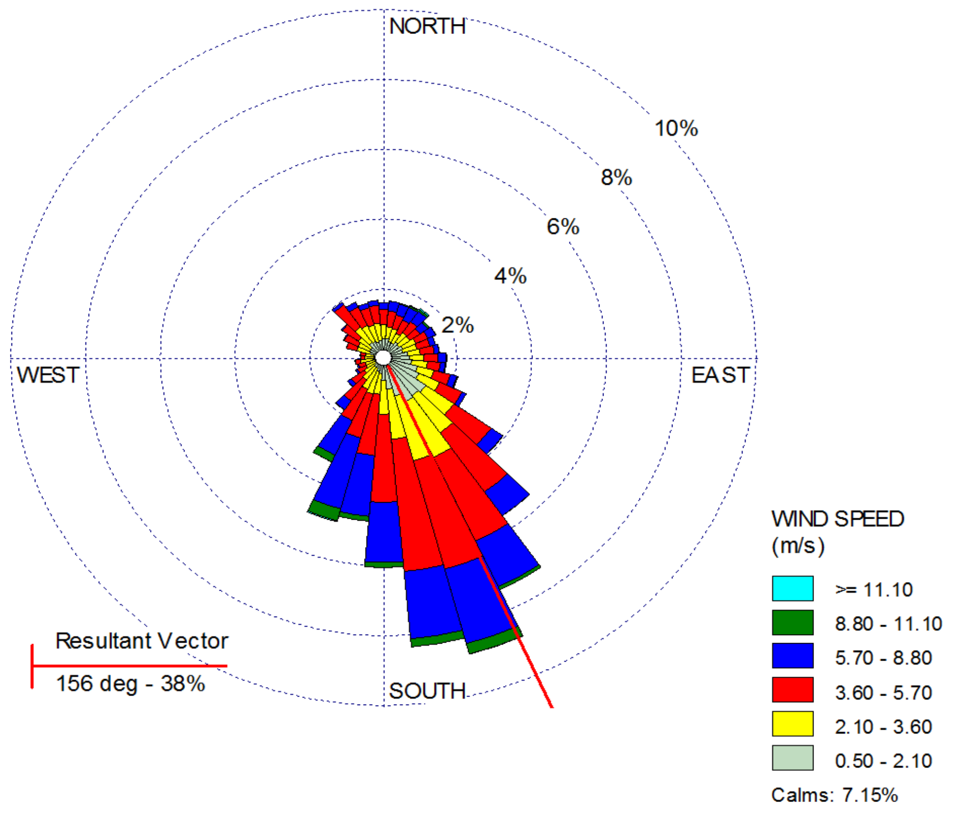


(a) March-May **(b) June- Aug**





(c) Sep- Nov **(d) Dec- Feb**



(e) Yearly windrose diagram

Figure 6-9: Wind Rose diagram for project area at different times of a year (a, b, c, d, e)

6.5 Ambient Air Quality and Noise

6.5.1 Ambient Air Quality

215. The air quality was monitored at four locations (**Map 6-18**) in and around the Project site considering the air directions and sensitivity. Sampling of ambient air and other atmospheric parameters were taken continuously for eight (8) hours at the locations outside the plant site and for 24 hours at the location inside the plant. During sampling period, the wind direction was from the south to the north. **Table 6-5**shows the result of the ambient air quality measurements and the method of analysis for the same. The ambient air quality parameters (e.g. CO, NO_2, SO_2, O_3, PM_{10} and $PM_{2.5}$) of the sampling locations (Project area) were found within the standard limit of Bangladesh. The concentration of Volatile Organic Compound (VOC) in the ambient air was found very low *i.e* 0.001ppm in two locations and was found nil in other two locations. The detailed concentration of the measured parameters are given in the following table:

Table 6-5: Ambient air quality in the project site

Sl. No.	Parameters	Unit	GoB Air Quality Standard*	Concentration of Ambient Air Quality Parameters in Sample Locations			
				24°23’28.43” N 89°44’22.94” E (Rehabilitation Village)	24°23’10.9” N 89°44’45.3” E (Power Plant Site)	24°23’46.68” N 89°44’41.97” E (Eco-Park)	24°22’25.26” N 89°44’53.09” E (Barashimul Village)
1	Carbon Monoxide (CO)	µg/m3	10000 (8 Hour)	516.76	942.69	611.82	454.53
2	Nitrogen Dioxide (NO_2)	µg/m3	100 (Annual)	38.36	57.78	42.06	29.89
3	Sulphur Dioxide (SO_2)	µg/m3	365 (24 Hour)	83.01	54.44	31.66	70.89
4	Ozone (O_3)	µg/m3	157 (8 Hour)	12.41	33.51	25.31	11.74
5	Particulate Matter (PM_{10})	µg/m3	150 (24 Hour)	94.41	113.88	80.56	91.63
6	Particulate Matter ($PM_{2.5}$)	µg/m3	65 (24 Hour)	26.67	32.33	21.16	23.55
7	Volatile Organic Compound (VOC)	ppm	NSE**	0.00	0.001	0.001	0.00
8	Air Temperature	°C	NSE**	30.19	32.36	31.37	33.45
9	Relative Humidity	%	NSE**	70.40	77.17	72.90	61.73
10	Wind Speed	kph	NSE**	6.74	4.64	6.18	7.15
11	Wind Direction	Degree	NSE**	186.33	175.23	189.54	181.08

Note: The amended Schedule-2, 2005, of (Air Quality Standard) Environmental Conservation Rules, 1997; **No Standard Established yet*

216. One sampling point was located inside the project site to account the pollutant concentration inside the plant boundary. Two of the sampling locations (Rehabilitation and Barashimul village) are rural in nature and consist of a variety of tree species, predominantly

the Eucalyptus. One sampling location was set inside the Bangabandhu Eco-park. An inventory and an assessment has been done for the identification of the existing and potential sources of air pollutants of the area. The sources of air pollutants in and around the Project site are mainly the emission of first unit of Sirajganj Power Station, traffic on the paved and non-paved roads, DWL locomotives, households cooking, tailpipe emissions, agricultural lands, construction dust or external sources, exposed earth, etc.

6.5.2 Ambient Noise Level

217. The baseline scenario of acoustic environment is prepared depending on the noise level data collected at different sensitive locations. During the collection of noise data, the existing power plant (first unit) was under operation. Field findings revealed that the first unit and a RMS were the major sources of noise in the area. Noise levels were measured at 23 different locations inside and outside the power plant. The locations are shown in **Map 6-19** and the measured baseline noise levels are depicted in the following table. The permissible level of noise in Bangladesh as per Noise Pollution Control Act, 2006 is 75 dBA, 60 dBA, 55 dBA and 50 dBA during day time (7:00-22:00) and 70 dBA, 50 dBA, 45 dBA and 40 dBA during night time (22:00-6:00) for industrial area, mixed area, residential area and silent zone respectively.The location specific measured noise levels of the area are compared with the Bangladesh Standard of Noise Level and are presented in **Table 6-6**(marked red ones are exceedance and non-compliant with the standard noise level of Bangladesh).

218. The table shows that only at four locations the noise level has the exceedance of the day time standard whereas at 10 locations it has the exceedance of night time standard noise level. In some locations, the noise level during night increases from the level found during day. It was probably due to high sound of some insects like cricket and others.

219. As NS5 and NS16 are work places, the noise level is expected to be high in those places. In case of visiting these places, the workers, employees or any other person have to wear Personal Protective Equipment (PPE).

220. The noise level of Eco Park has exceeded the standard limit of silent zone. However, as the location of the Eco-park (where the noise level was measured) is approximately 1.34 km away from the north-east corner of the power plant site, it can be assumed that the noise level of that location is not/minimally impacted by the activities of the power plant.

Table 6-6: Baseline Noise Level at Different Location around Sirajganj Power Plant Area

SL	Location	Notation	Type	Noise Level (dBA)			
				Day Time		Night Time	
				Measured Noise	Bangladesh Standard	Measured Noise	Bangladesh Standard
1	Main Gate of NWPGCL	NS1	Industrial	70.4	75	65	70
2	Inside office (2nd floor)	NS2	Industrial	53.6		53	
3	PGCL RMS (3 m distance)	NS5	Industrial	76.3		77	
4	Control Room		Industrial	55.6		52.3	
5	Last point of the gate	NS7	Industrial	54.5		54	
6	Mosque	NS8	Industrial	51.3		55.4	
7	In front of PGCB	NS9	Industrial	46		61.1	
8	CT Effluent point	NS11	Industrial	51.3		50.2	
9	In front of Residence Building	NS12	Industrial	63.5		62.7	
10	Road project site	NS14	Industrial	55.9		54.2	
11	Gas booster	NS15	Industrial	69.9		67.6	
12	GT Machine	NS16	Industrial	87.3		88.3	
13	SW Road	NS17	Industrial	53.3		54.1	
14	Administrative Building (Inside)	NS6	Mixed	53.6	60	53	50
15	New Labor colony near PGCL	NS10	Mixed	49.9		45.2	
16	In front of Health Care Unit Building	NS13	Mixed	69.4		69.4	
17	NW corner (Outside)	NS18	Mixed	44		62	
18	SW corner (Outside)	NS19	Mixed	52.5		62.4	
19	SE corner (Outside)	NS20	Mixed	49.1		61.1	
20	NE corner (Outside)	NS21	Mixed	48.8		60	
21	Chinese Labor colony	NS22	Mixed	59.3		55.2	
22	Inside the village near Manab Mukti Sangstha	NS4	Residential	48.2	55	63	45
23	Eco Park	NS3	Silent	52.5	50		40

Source: CEGIS Field Study, 2015

6.6 Water Resources

6.6.1 Surface Water Hydrology

General Hydrological Description

221. The proposed site of the Unit-3 is at Saydabad Mouza, situated on the right bank of the river Jamuna. The nearest channel of the Jamuna is about 2 km far away from the outer boundary of the Plant area during dry season and become closer during wet season.

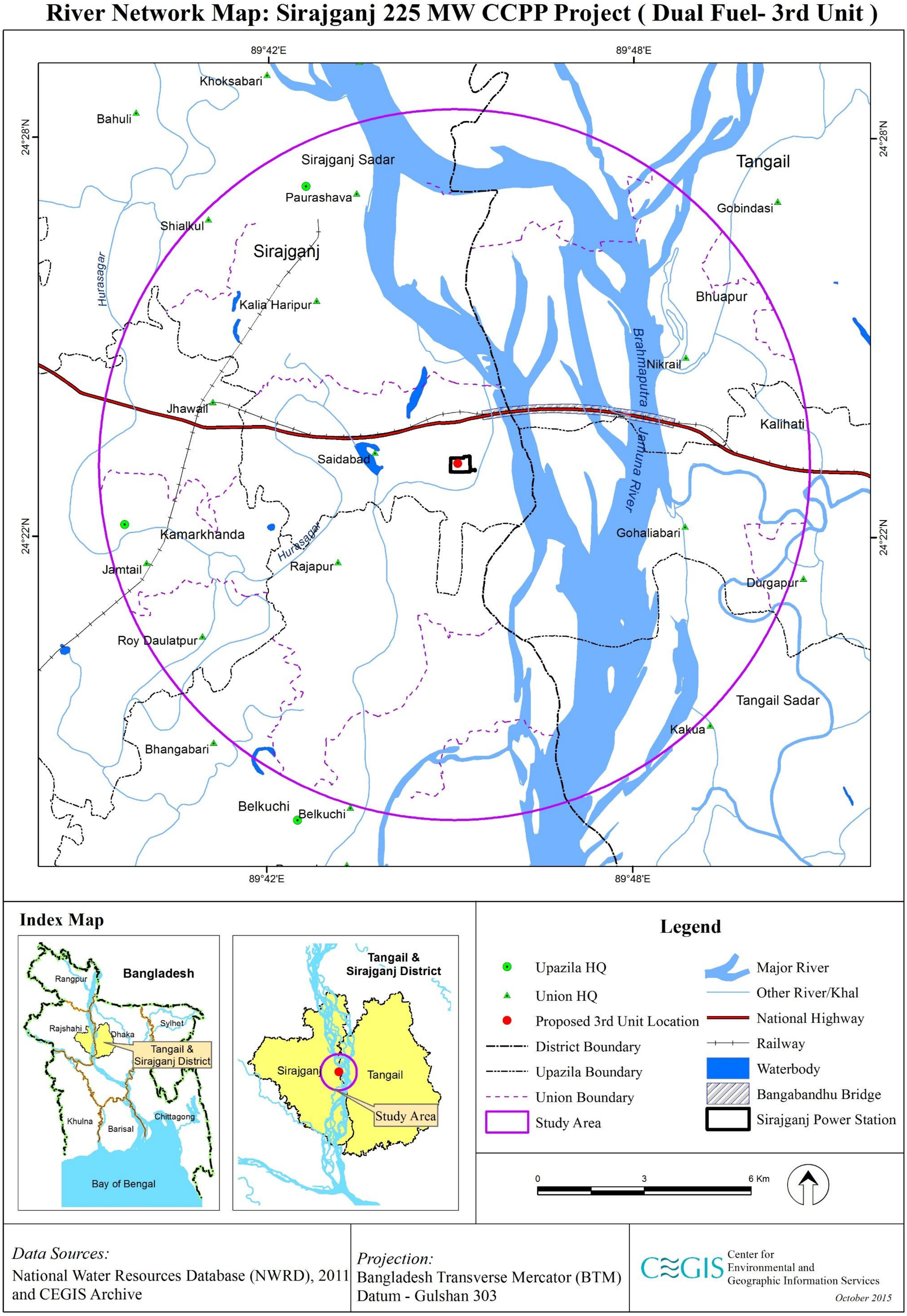
222. A chute channel originated from the Jamuna passes by the proposed site in South direction from the site. This channel after crossing Randhunibari area meets with the Jamuna again. It is seasonal in nature and become very much active in the wet season. It has devastating eroding characteristics mostly at around the Randhunibari village. During the wet season it is a deceased channel.

River Network

223. The Jamuna River is the only surface water source of the area. It originates in the Chemayung-Dung glacier, India and enters Bangladesh through Kurigram district (at the border of Kurigram Sadar and Ulipur upazilas). In its southward course from the entry it meets with the Padma River near Goalundo Ghat, then meets with the Maghna River at Chandpur and finally flows into the Bay of Bengal. This river is highly susceptible to channel migration and avulsion.

224. The Jamuna River is a braided stream which can be portrayed as a network of intertwining channels. It has numerous sandbars which forms and gets destroyed through the process of erosion and deposition of the river at its own nature. Along with the emergence of “chars” or sandbars there develops residence of some squatter depending on the fishing, agricultural and other means of livelihood.

225. It is a very wide river having width of 8 -12.9 km from one bank to another. The width of the river becomes narrowed down to 3.2-4.8 km in the dry season. **The Map 6-7** is showing the river network of the study area and surroundings.



Map 6-7: General river network

Water Level and Discharge

Water Level

226. The fluctuations of water level of the Jamuna are very conspicuous from season to season (pre monsoon, monsoon and post monsoon). Analysis of water level data for the past ten years from 2003-2012 of Station 49 at Sirajganj were collected from the BWDB. It is observed that there is a decreasing trend of water level of this river. The following **Figure 6-10** shows the monthly average maximum and minimum water level variation for the mentioned years.

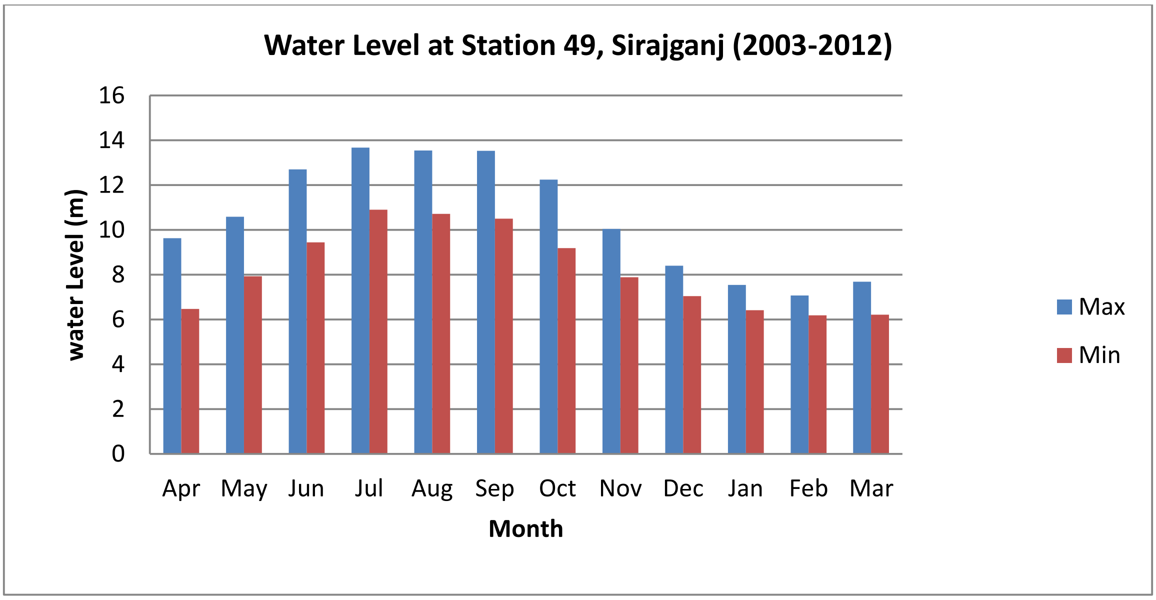


Figure 6-10: Maximum and minimum water level at Station 49, Sirajganj

227. Water level data has also been collected from the station at Bahadurabad 46.9L which is adjacent to the outer boundary of the study area. Historical water level data for the years from 1990 to 2014 has been analyzed both to look at the monthly average variations and yearly fluctuations. The maximum average water level is observed during monsoon, in the month of July as shown in the following **Figure 6-11**.

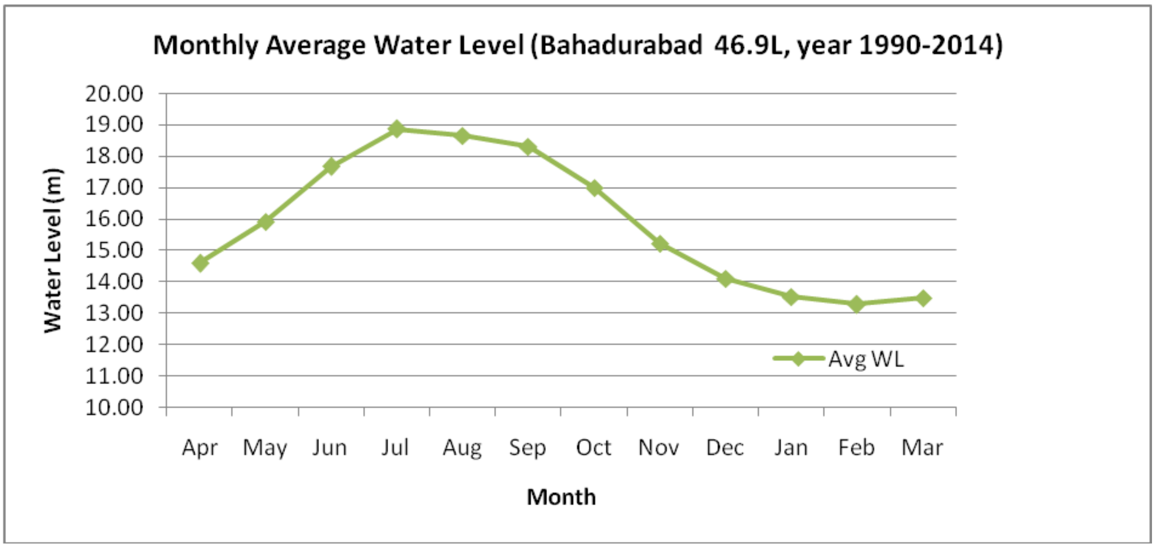


Figure 6-11: Monthly average water level at Bahadurabad 46.9L

228. The following **Figure 6-12** shows the yearly average water level of the Bahadurabad Station. The recorded maximum water level was was 16.87m in 2014 whereas the minimum water level in the last 25 years was recorded during 2013 which was 15.17 m.

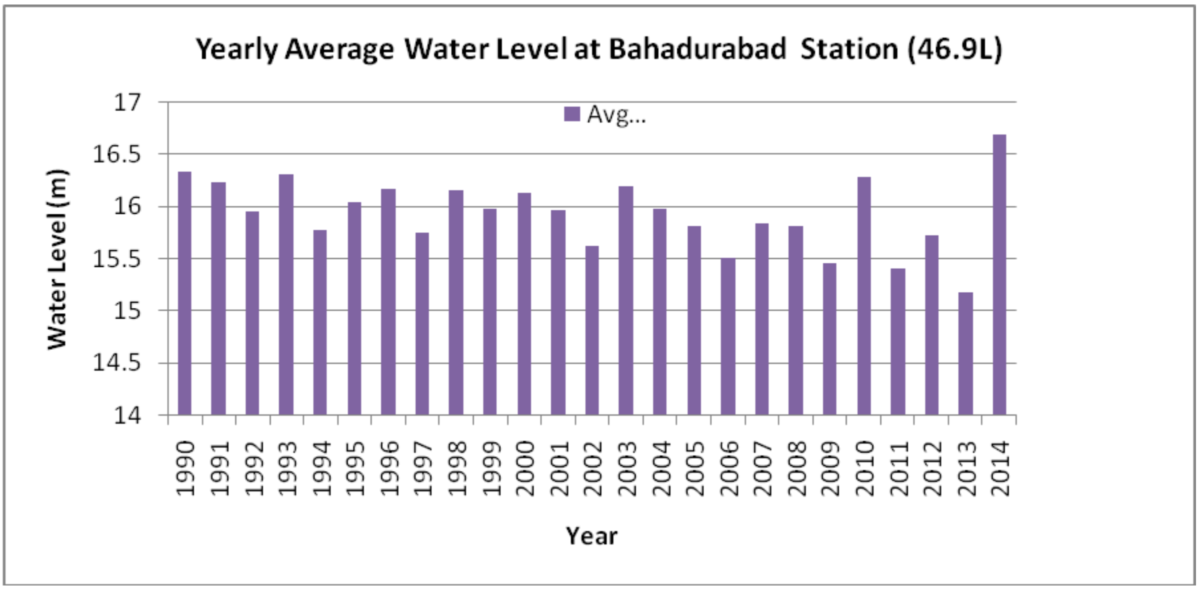


Figure 6-12: Yearly average water level at Bahadurabad Station

Return Period Analysis

229. The water level of Station 49 Sirajganj has been analyzed for 20 years, starting from 1989 to 2009 and thus return period analysis has been conducted. The highest water levels of the station for 10 years, 25 years, 50 years and 100 years return period have been calculated. The following **Table 6-7** shows the results of the return period analysis

Table 6-7: Return Period Analysis

Sl no	Return Period (year)	Mean	Std	HFL
1	10	14.39	0.34	15
2	25	14.39	0.34	15.32
3	50	14.39	0.34	15.57
4	100	14.39	0.34	15.81

Source: CEGIS, 2015 (Based on BWDB database)

230. From the table above, it is seen that the highest water level could be 15 m as per 10-year return period analysis. Similarly, the water level could be 15.32 m and 15.57 m in 25 and 50 years return period analysis respectively. And the water level could be 15.81 m in 100-year return period.

Discharge

231. The monthly discharge is calculated at different points of the Jamuna by the BWDB. The nearest discharge station from the study area is the Bahadurabad 46.9L. Historical data from 1990 to 2014 shows that the maximum rate of discharge observed was 103128.8 cumec recorded in September, 1998, whereas, the minimum rate of discharge is 2036.819 cumec which was observed in March, 2013 (**Figure 6-13)**.

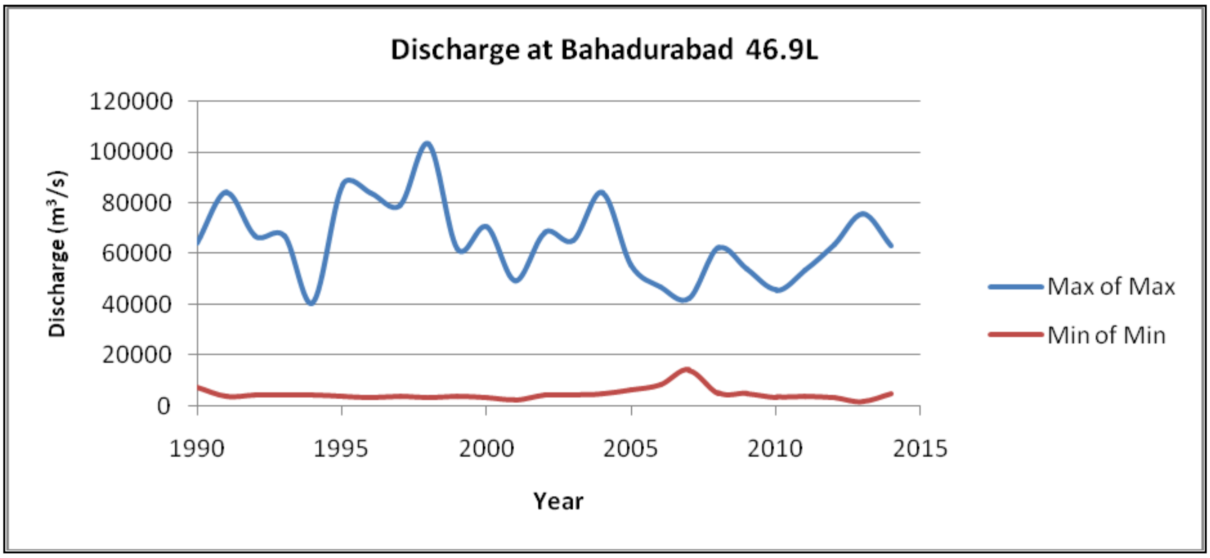


Figure 6-13: Discharge rate at Bahadurabad 46.9L

232. The following **Figure 6-14** shows the average of maximum and average of minimum discharge rates of the same station. It is clearly evident that the Jamuna has a vast fluctuation in its rate over the years and again there remains a decreasing trend in the rate of discharge.

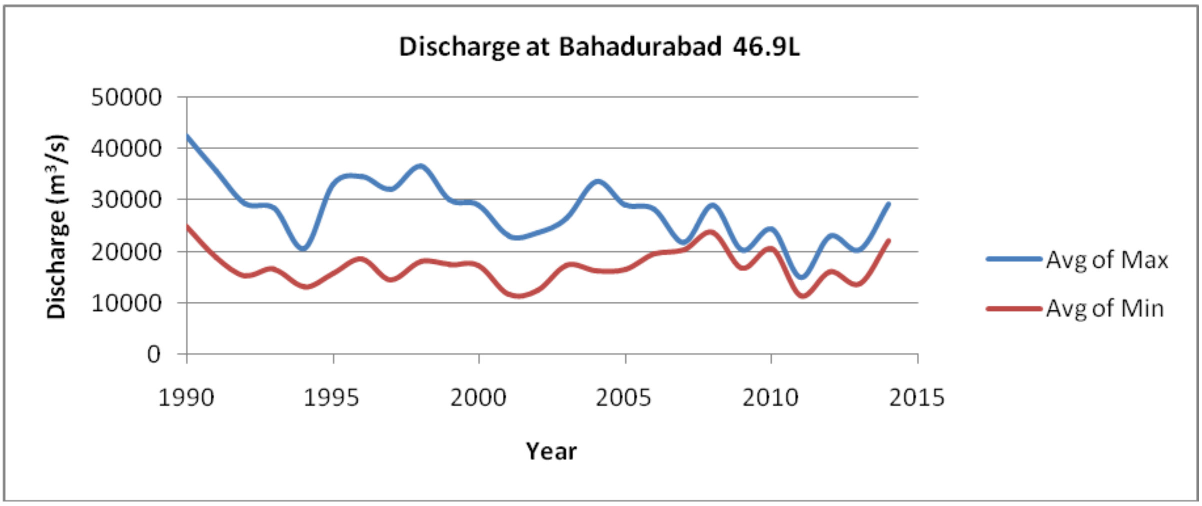


Figure 6-14: Discharge rate at Bahadurabad 46.9L

Water Related Disaster

Flooding

233. Due to the Ganges Delta and many other distributaries that flow to the Bay of Bengal, Bangladesh has a flooding propensity. About 75% of Bangladesh is less than 10 m above the sea level and around 80% is floodplain. Flooding generally occurs in the monsoon (starting from June to September). Each year 26,000 km^2 (around 18% of the country) is flooded.

234. The major floods occurred over the years and the number of death occurred is depictedin the **Table 6-8** below:

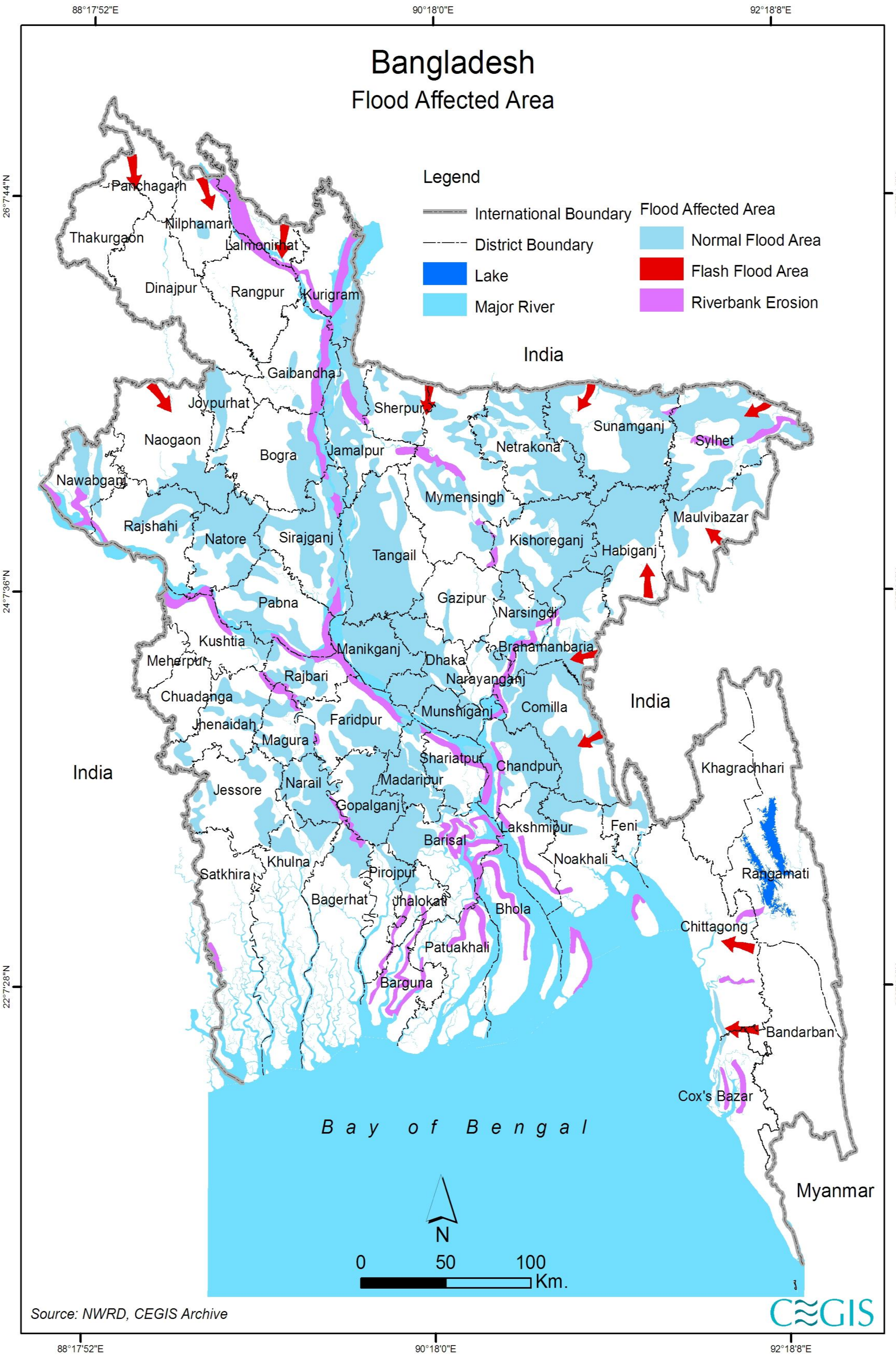
Table 6-8: Major floods in Bangladesh

Year	Death
1988	1708
1998	918
2004	747
2007	800

Source: BWDB

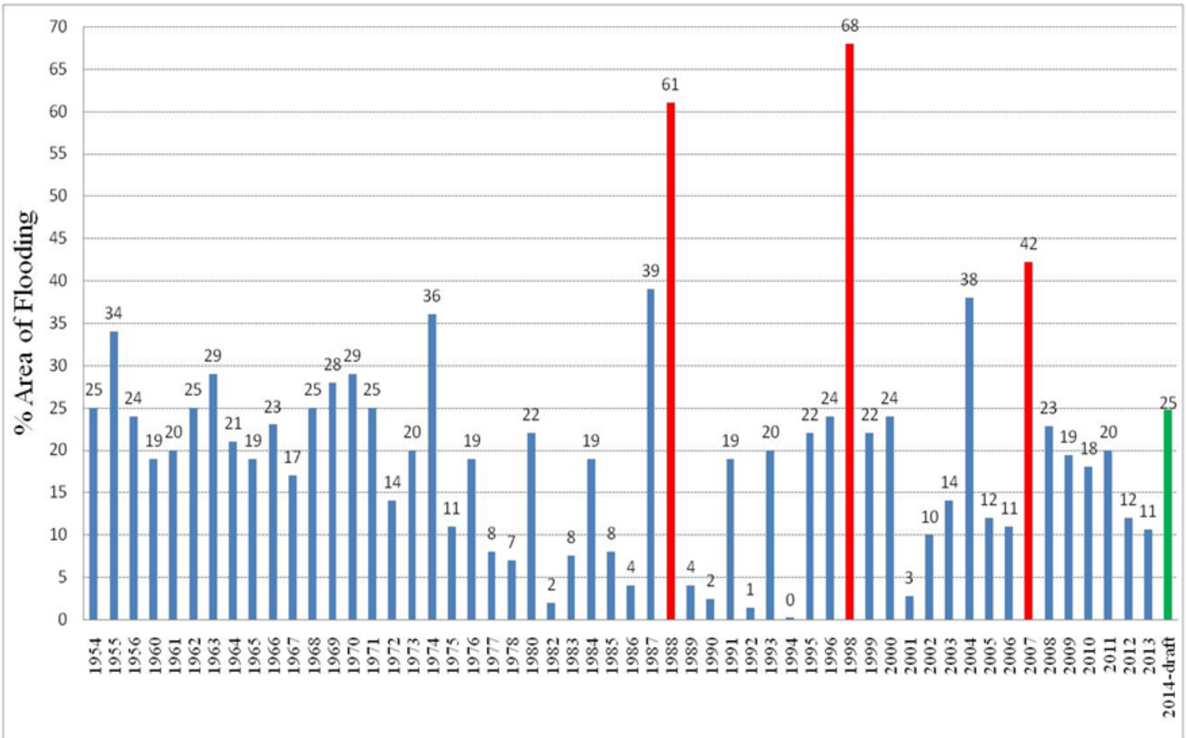
235. The proposed project area along with the study area is a flood prone region during the moonson. Every year during the rainy season, the char areas at the left river bank get inundated towards downstream with the increase of water level. For instance, charBorokhash Shimul remains totally inundated for 20 to 30 days with water of average 2.5 to 3 m depth in a year which was revealed from interview during the field investigation process.

236. The following **Map 6-8** shows the flood prone areas along with normal flood area, flash flood area and river bank erosion.



Map 6-8: Flood prone areas of Bangladesh

237. The following **Figure 6-15** describes the average flooding situation in Bangladesh from the year 1954 to 2013, with clear indication of the flooding area (%). From the figure below it is evident that maximum flooding area coverage is observed in the 68 % in year 1998, 61 % then1987 and 42% in 2007.



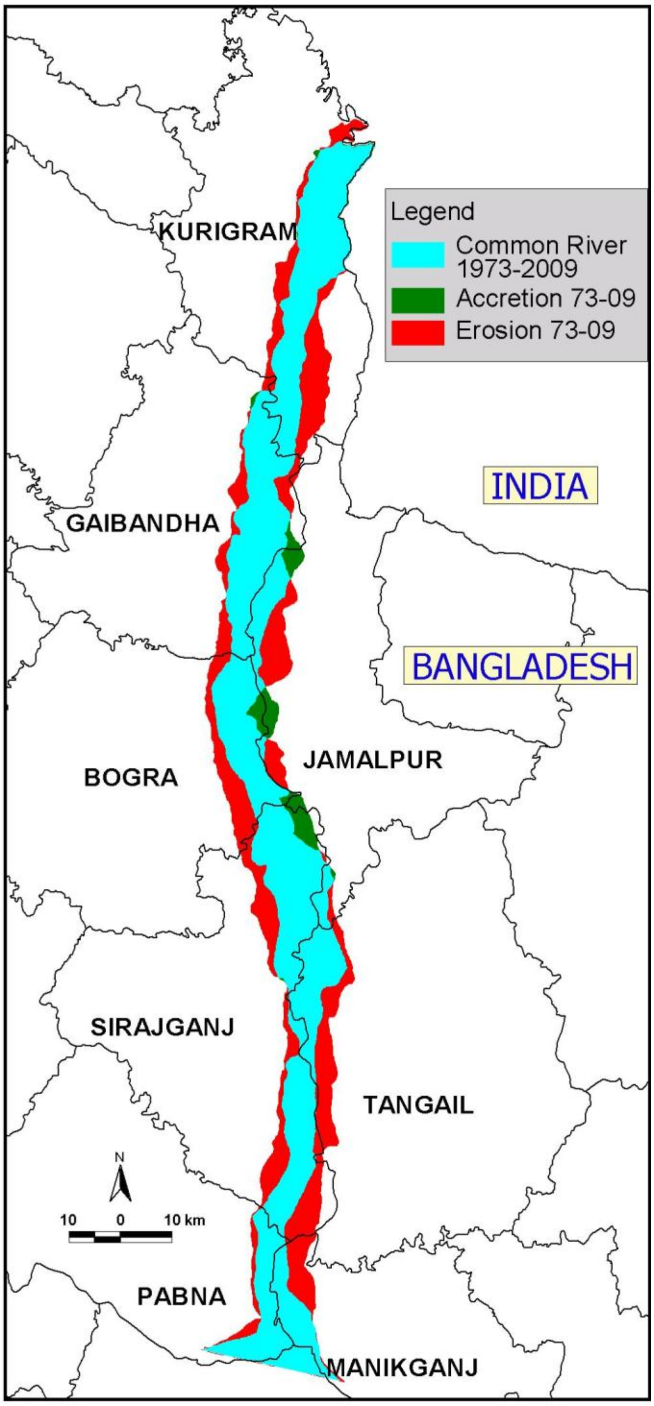
(Source:https://www.google.com.bd/search?q=Historical+flood+of+Bangladesh&biw)

Figure 6-15: Percentage of flooded area in Bangladesh from 1954 to 2014

Riverbank Erosion

238. The Jamuna riverbanks are formed by non-cohesive sediment with sandy soiland high rate of recharge potential. Jamuna is one of the most dynamic rivers and causes tremendous erosion at different bank sides every year. During field investigation it was observed that the right bank was eroding at downstream of the Bangabandhu Bridge.

239. Riverbank erosion is a dominating activity in the River Jamuna for the last few decades. In 1973 about 90830 ha of floodplain has been engulfed by the river whereas only 10,140 ha of land has been accreted during this time. The following **Map 6-9**shows the erosion and accretion of River Jamuna for the year 1973-2009. (Source: CEGIS; Technical Note 1: Channelization of Jamuna River).



Source: CEGIS, (Technical Note 1: Channelization of Jamuna River).

Map 6-9: Erosion-accretion along the Jamuna during 1973-2009

240. The rate of erosion changes over the time and most of the time increase each year. For instances, the rate of erosion was less than 4,000 ha/y in the 70's and it became 4,900 ha/y in the 80's.

241. Different bank protection structures have already been constructed with the aim of reducing the erosion rate and saving the living beings and belongings from the upsetting consequence of this. Some of them are the guide bunds of Bangabandhu Bridge, the hard points of Sirajganj, Sariakandi, Bhuapur, Bahadurabad and several other structures. However, other than the contribution of these protection structures the rate of erosion has

remarkably decreased in the last decades starting from the early 90's.The erosion rate has reduced along with the reduction of the bank widening rate for the mentioned time scale.

6.6.2 Ground Water Hydrology

Ground Water Occurrence

242. Exploratory studies show that the whole study area is underlain by a continuous aquifer of over 100m thick. Groundwater Circle of Bangladesh Water Development Board (BWDB) drilled 18 exploratory boreholes in the study area, the depth of which varies between 92 to 312m. Information of deep aquifer revealsthe exploratory bore logs of about 312m depth in or around the study area. The aquifer system includes a surface aquitard, overlying the aquifers of main interest. Below the surface clay and siltand a series of sand beds which range from fine-grained to coarse-grained in nature. In general, the entire sequence down to some 120 meters below ground level becomes coarser with depth. The hydraulic conductivity of this Holocene sand layer is about 62.8 m/day.

243. Recharge to groundwater depends on different physical settings, climatic conditions and hydraulic properties related to soil and aquifer. In the study area, during June to September, recharge occurs primarily through vertical percolation from relatively large amounts of rainfall and stored water within bunds around the paddy field and floodwater in places. Records of groundwater levels have shown that the water table is very close to the land surface throughout the year and there is a strong correlation between fluctuations in level and the highly seasonal rainfall pattern. In addition, the aquifer piezometry indicates that natural groundwater gradients across the study area are always very small which suggests that lateral movement of groundwater within the study area is consequently small and much less than the groundwater recharge rates inferred for the area. These factors strongly imply that a major proportion of recharge is derived from the vertical percolation of rainfall, while losses from the aquifer are most likely to result from direct evaporation or evapotranspiration from the water Table.

244. The study of UNICEF (1993) estimated mean monthly recharge of Sirajganj Upazila by analysing groundwater level data and rainfall data. This recharge rate is assumed to be valid for the whole study area. **Table 6-9** gives the mean monthly recharge data of the study area.

Table 6-9: Mean Monthly Recharge Rate of Sirajganj Upazila

Month	Recharge (mm) of Sirajganj	Recharge (mm) of Tangail
January	20	8
February	22	9
March	48	22
April	128	119
May	180	173
June	183	179
July	182	152
August	155	101
September	103	51
October	40	12
November	23	9
December	21	8
Yearly Recharge	1,105	843

Source: UNICEF, 1993

A large number of more or less empirical methods have been developed over the last 50 years by numerous scientists and specialists worldwide to estimate evapotranspiration from different climatic variables using meteorological data. These data include mean monthly temperature, mean monthly net radiation, relative humidity and wind velocity. Karim and Akaond (1982) estimated mean monthly potential evapotranspiration of the study area. **Table 6-10** gives the mean monthly potential evapotranspiration of the study area.

Table 6-10: Mean Monthly Evapotranspiration Rate of the Study Area

Month	Potential Evapotranspiration (mm)
January	86.8
February	106.7
March	163.4
April	188.7
May	181.4
June	133.8
July	132.7
August	122.7
September	123.0
October	94.9
November	95.4
December	81.5
Yearly Evapotranspiration	1511

Source: BMD

6.7 Availability of Water

245. The Project site is a reclaimed land and located more or less within the Jamuna flood plain. The area was developed through raising the river bed by 6 to 7m. During wet season, the Jamuna River is flooded and inundates the adjoining flood plains and low lands with water which contribute significantly in recharging the underlying aquifer.

6.7.1 Surface Water

246. The hydrological regime of the Project area is governed by the flow of the Jamuna. Historically, spills from this river carry silt and deposited on the site. The Jamuna, flowing along the eastern side of the proposed Project site, is one of the three major river systems in Bangladesh. The river has no tidal effect. It meets the Padma River at Goalanda about 40km south of the site, which in turn ultimately falls into the Bay of Bengal as Lower Meghna. The mean monthly water level of the Jamuna at Sirajganj gauge shows that there was no major flood in the Project area which may cause any damage to homesteads, agriculture, industries or infrastructures.

247. Jamuna river Water level data of nearby BWDB Station 49 for the period 2003-2012 is given in **Table 6-11**. The highest water level of 14.95m was found in August 2007, whereas the lowest level of 6.19m was found in February 2006. The data showed that the water levels of the river are not much influenced by tidal effect and also indicate wide variation between water levels in monsoon and dry seasons. There is rise in water level with commencement of monsoon rainfall from May/ June till September/ October.

Table 6-11: Jamuna River water level in meter at Sirajganj (BWDB Station No. 49)

Year	Scale	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
2003	Max	7.94	7.44	7.92	9.15	9.71	12.88	14.34	13.1	13.25	13.03	10.83	9.13
	Min	7.45	7.35	7.33	7.86	8.94	9.75	12.68	12.57	12.63	10.9	9.15	8.3
2004	Max	8.29	7.78	8.39	10.56	12.02	13.76	14.81	13.44	13.58	13.19	10.49	8.85
	Min	7.79	7.4	7.37	8.75	9.08	10.98	12.7	12.6	11.82	10.5	8.88	8.05
2005	Max	8.04	8.05	9.33	10.22	10.45	12.43	13.14	13.3	13.31	12.05	10.16	7.9
	Min	7.58	7.37	7.92	9.13	9.55	10.34	11.85	11.81	10.5	9.86	7.92	7.05
2006	Max	7.02	6.41	7.13	9.1	9.44	12.7	12.73	12.54	12.94	11.34	9.24	7.98
	Min	6.42	6.19	6.41	6.47	7.93	9.45	11.91	10.72	11.2	9.28	7.93	7.2
2007	Max	7.19	6.77	6.88	9.76	11.4	13.5	14.9	14.95	14.71	11.97	10.4	8.73
	Min	6.65	6.59	6.67	6.87	8.84	11.04	12.34	13.09	12.05	10.47	8.78	7.71
2008	Max	7.69	7.17	7.62	9.1	10.02	12.52		14.12	14.33	11.55	10.52	8.34
	Min	7	6.85	6.71	7.67	9.06	9.98		13.1	11.59	9.67	8.36	7.41
2009	Max	7.39	6.76	7	8.48	10.27	10.73	12.87	13.68	12.9		9.41	8.3
	Min	6.78	6.4	6.4	6.8	8.51	9.61	10.9	12.55	11.21		8.24	7.33
2010	Max	7.3	6.57	7.03	11.59	12.02	13.23	13.2	13.5	13.83	12.6	10.18	8.59
	Min	6.6	6.22	6.22	7.37	9.95	11.19	12.6	12.17	12.66	10.25	8.64	7.59
2011	Max	7.56	7.07	8.37	8.9	9.88	11.59	13.42	13.33	12.48	12.28	9.14	7.85
	Min	7.05	6.79	6.69	7.75	8.59	9.77	11.64	12.63	11.23	9.19	7.89	7.13
2012	Max	7.11	6.8	7.23	9.43	10.67	13.75			13.98			
	Min	6.74	6.68	6.75	7.26	9.3	10.11			11.79			

Source: BWDB

248. Water level, discharge and velocity are also measured at another BWDB station No. SW46.9L at Bahadurabad Transit on the Jamuna River. Annual average water level/ discharge/ velocity data of BWDB Station SW46.9L for the period 2003-2012 are given in **Table 6-12**.

Table 6-12: Jamuna River Water level/discharge/velocity at BWDB Station SW46.9L

Year	Water level (m)		Max. Discharge (m^3/sec)	Max. Velocity (m/sec)
	Max	Min		
2003	19.86	13.28	65683.93	2.78
2004	20.10	13.04	96105.52	3.19
2005	19.45	13.23	58766.89	2.84
2006	18.63	12.95	47666.45	2.57
2007	18.85	13.31	42240.84	1.93
2008	19.60	13.41	62378.87	2.71
2009	19.22	13.16	86939.11	2.06
2010	19.52	13.03	45775.37	2.37
2011	19.57	13.27	53317.36	2.28
2012	13.40	12.62	4271.76	1.13

Source: BWDB

6.7.2 Groundwater

249. Utilization of groundwater is proposed for domestic and office consumption, firefighting, service water and cooling purposes of the Plant. So, a study on ground water in

the study area has been conducted. It is concluded from this study that the natural aquifer condition in the study area would be suitable for supplying 3200 m^3/hr of water continuously without any permanent lowering of groundwater table and environmental degradations. The Jamuna River invariably fully recharges the aquifer in the wet season of each year.

250. The Department of Public Health Engineering (DPHE) has investigated ground water at Enayetpur near the proposed site under Sadia Chandpur Union of Chauhali Upazila of Sirajganj district. From investigations conducted by DPHE, the following lithologic and hydrostratigraphic conditions in the investigation area were observed:

Lithology

Table 6-13: Lithologic description of the study area

Depth to Top (m)	Depth to Base (m)	Lithologic Description
0	6.1	Silty Clay
6.1	19.2	Very Fine Sand
19.2	28.65	Fine Sand
28.65	37.79	Fine to Medium Sand
37.79	62.79	Medium to Coarse Sand
62.79	68.88	Medium Sand
68.88	79.55	Medium to Coarse Sand

Source: DPHE

Hydrostratigraphy

Table 6-14: Hydrostratigraphic Discretization

Depth to Top (m)	Depth to Base (m)	Hydrostratigraphy
0	6.1	Aquitard 1
6.1	79.55	Aquifer 1

Source: DPHE

251. From hydrostratigraphy table, it is found that there is a huge aquifer with depth of about 73m just 6m below ground level. The average ground water level was measured by the adjacent villagers is about 6m from the ground level. Moreover, the Jamuna River is located beside the proposed site. So, there would be minimum adverse impact in withdrawing groundwater for the proposed power plant.

Groundwater Availability

252. According to the Feasibility Study report of the 3rd unit of SGPP water requirement of the proposed 3rd unit is 400 m^3/h and that of the existing 1st unit is 600 m^3/h and the ongoing 2nd unit is 400 m^3/h. There is a provision of constructing one more unit (4th unit) in the same premise of 55 acres of land which may require another 1,150 m^3/h. This gives a total water requirement of 1,400 m^3/h for units 1-3 and that for all the units 1-4 is 2550 m^3/h.

253. This required water for Plant operation and construction can be fetched either from nearby “The Yamuna (Jamuna)” river as surface water or from underground aquifer as ground water. During monsoon (2-3 months) the Jamuna River flows by the side of the Project. Rest of the year the river flows at about 1.5 Km away from the Project. There is a small branch channel of Jamuna close to the proposed site. This channel becomes dry during dry period. To use surface water in the Plant, water is to be transported by installing pumps of required capacity at the Yamuna River and with the help of necessary pipe lines.

Additional protective measures would be required to save the pump from river erosion involving extra cost. On the other hand ground water availability in the project area as per the comments cited in the feasibility report is good enough to meet the water demand of all the four units. The feasibility report mentioning the reference of two previous studies under the title "Water availability study" states that "Both EAL (2014) and SDCPL (2015) studies clearly mentioned that the maximum allowable withdrawal of groundwater for NWPGCL Power Generation Complex is 3,200 m^3/h without causing conspicuous problem in the groundwater Table of the Plant complex area (EAL, 2014 and SDCPL, 2015). If the findings of those two prior studies are completely relied upon, it can be said that total water requirement of 2,550 m^3/h for all the four units of Sirajganj Power Generation Complex could be met by groundwater abstraction." Considering the non- availability and difficulty of meeting surface water need over the whole year; use of ground water for the project has been considered as a more viable option. To minimize the associated environmental consequence and ground water withdrawal for the Plant use, a closed cooling water system using cooling tower technology has been planned for the proposed 3rd unit of Sirajganj Power Plant.

254. Three major sectors were classified as potential groundwater users in the **Table 6-15** (SDCPL 2015):

Table 6-15: Three major sectors of potential groundwater use

Irrigation	Rural Water Supply	Municipal & Industrial
• Deep Tube wells (DTWs): generally 100m depth, designed and equipped with turbine pumps to deliver approximately 55 l/s (2 cusec). • Shallow Tube wells (STWs): generally 40-50m depth, designed and equipped with surface mounted centrifugal pumps (operate by suction lift) to deliver approximately 15 l/s (0.5 cusec).	• Hand dug wells: Traditional form of groundwater abstraction but are rapidly being replaced by Hand pump tube-wells. • Hand pumps Tube-wells (HTWs).	• A small number of wells constructed by municipal authorities to provide water in urban or suburban areas.

255. Present state of ground water abstraction according to BADC survey is described in **Table 6-16**:

Table 6-16: Number of DTWs and STWs in the study area (BADC 2014)

District	Upazila	DTWs		STWs		Total Area (ha) Irrigated by DTWs and STWs
		No.	Area Irrigated (ha)	No.	Area Irrigated (ha)	
Sirajganj	Sirajganj Sadar	167	3431	17558	113771	117202
	Kamarkanda	14	140	4112	7559	7699
	Belkuchi	5	86	8222	18310	18396
Tangail	Bhuapur	16	275	2580	3986	4261
	Kalihati	58	1082	3958	10728	11810
	Tangail Sadar	61	1750	11831	24332	26082
Total		321	6764	48261	178686	185450

256. A conservative approach was taken in view of the wide range of unknown and scarcity of data regarding past and present irrigation practices and hence a seasonal pumping period of 1050 hours/year has been used by SDCPL (2015). In this study,

therefore, five months of pumping season and a daily pumping duration of 7 hours has been adopted for irrigation usage estimation.

257. Daily withdrawal for domestic and municipal purposes has been estimated in this study using data regarding the present inhabitant status in the study area. Population data were collected from the population census of 2011 (BBS 2011). The present national growth rate of population in Bangladesh is 1.07% per year (BBS 2011) was used to estimate the present population. **Table 6-17** provides the estimation for present abstraction of groundwater for irrigation, domestic and municipal purposes in the study area.

Table 6-17: Present abstraction of groundwater for irrigation, domestic and municipal purposes

District	Upazila	No of DTWs	Groundwater Abstraction by DTWs (m^3/yr)	No of STWs	Groundwater Abstraction by STWs (m^3/yr)	Population of 2011	Estimated Population 2015	Groundwater Abstraction Domestic & Municipal Uses (m^3/yr)	Total Groundwater Abstraction (m^3/yr)
Siraj-ganj	Sirajganj Sadar	167	34700000	17558	996000000	555155	579300	8460000	1040000000
	Kamarkanda	14	2910000	4112	233000000	138645	144675	2110000	238000000
	Belkuchi	5	1040000	8222	466000000	352835	368180	5380000	473000000
Tangail	Bhuapur	16	3330000	2580	146000000	189913	198173	2890000	153000000
	Kalihati	58	12100000	3958	224000000	410293	428137	6250000	243000000
	Tangail Sadar	61	12700000	11831	671000000	521104	543768	7940000	691000000

258. For future projections of groundwater extraction in the study done by SDCPL (2015),it is assumed that the increase of groundwater abstraction for irrigation takes place at a rate of 1% per year until it reaches a saturation point at which all the cultivable land is irrigated groundwater. The abstraction of water for domestic and municipal purposes also increases with the increase in population. The national growth rate of population has been considered for calculating the annual increase in groundwater abstraction. For each year, the rate of abstraction of groundwater for domestic purposes increased by 1.07% in the model. **Table 6-18** and **Table 6-19**provide the projected future abstraction of groundwater in different Upazilas of Sirajganj and Tangail districts respectively.

Table 6-18: Projected abstraction of groundwater for irrigation, domestic and municipal purposes for Sirajganj District (SDCPL 2015)

Year	Sirajganj Sadar			Kamarkanda			Belkuchi		
	Groundwater Abstraction for irrigation (m^3/yr)	Groundwater Abstraction Domestic and Municipal Uses (m^3/yr)	Total Groundwater Abstraction (m^3/yr)	Groundwater Abstraction for irrigation (m^3/yr)	Groundwater Abstraction Domestic and Municipal Uses (m^3/yr)	Total Groundwater Abstraction (m^3/yr)	Groundwater Abstraction for irrigation (m^3/yr)	Groundwater Abstraction Domestic and Municipal Uses (m^3/yr)	Total Groundwater Abstraction (m^3/yr)
1st	310000000	8280000	319000000	212000000	2070000	214000000	252000000	5260000	257000000
2nd	313000000	8370000	322000000	214000000	2090000	216000000	254000000	5320000	260000000
3rd	317000000	8460000	325000000	217000000	2110000	219000000	257000000	5380000	262000000
4th	320000000	8550000	328000000	219000000	2130000	221000000	260000000	5430000	265000000
5th	323000000	8640000	332000000	221000000	2160000	223000000	262000000	5490000	268000000
6th	326000000	8730000	335000000	223000000	2180000	225000000	265000000	5550000	270000000
7th	329000000	8830000	338000000	225000000	2200000	228000000	267000000	5610000	273000000
8th	333000000	8920000	342000000	228000000	2230000	230000000	270000000	5670000	276000000
9th	336000000	9020000	345000000	230000000	2250000	232000000	273000000	5730000	279000000
10th	339000000	9110000	349000000	232000000	2280000	234000000	276000000	5790000	281000000
11th	343000000	9210000	352000000	234000000	2300000	237000000	278000000	5850000	284000000
12th	346000000	9310000	356000000	237000000	2320000	239000000	281000000	5920000	287000000
13th	350000000	9410000	359000000	239000000	2350000	242000000	284000000	5980000	290000000
14th	353000000	9510000	363000000	242000000	2370000	244000000	287000000	6040000	293000000
15th	357000000	9610000	366000000	244000000	2400000	246000000	290000000	6110000	296000000
16th	360000000	9710000	370000000	246000000	2430000	249000000	292000000	6170000	299000000
17th	364000000	9820000	374000000	249000000	2450000	251000000	295000000	6240000	302000000
18th	368000000	9920000	378000000	251000000	2480000	254000000	298000000	6310000	305000000
19th	371000000	10000000	381000000	254000000	2500000	256000000	301000000	6370000	308000000
20th	375000000	10100000	385000000	256000000	2530000	259000000	304000000	6440000	311000000
21st	379000000	10200000	389000000	259000000	2560000	262000000	307000000	6510000	314000000
22nd	383000000	10400000	393000000	262000000	2590000	264000000	310000000	6580000	317000000
23rd	386000000	10500000	397000000	264000000	2610000	267000000	314000000	6650000	320000000
24th	390000000	10600000	401000000	267000000	2640000	269000000	317000000	6720000	323000000

Table 6-19: Projected abstraction of groundwater for irrigation, domestic and municipal purposes for Tangail District (SDCPL 2015)

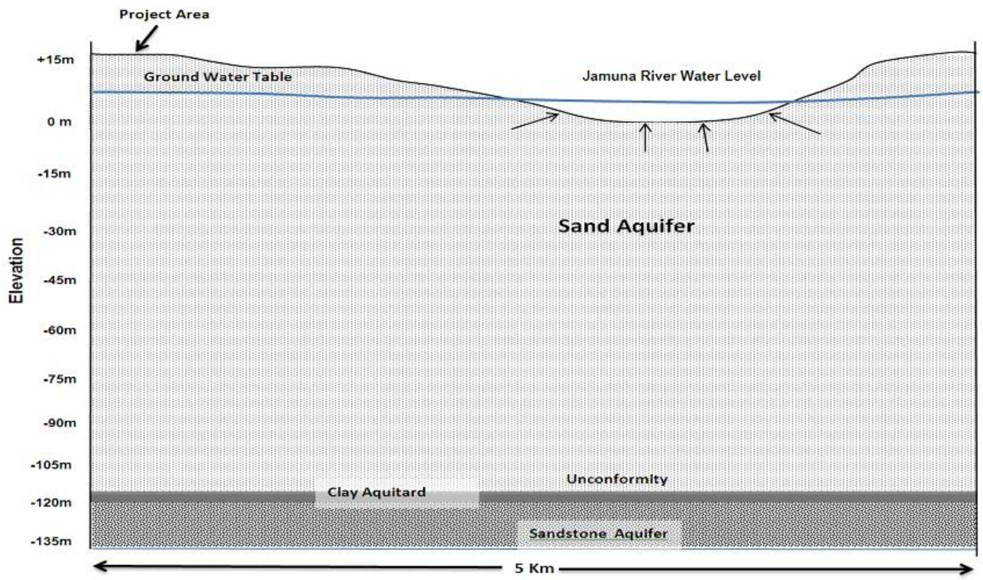
Year	Bhuapur			Kalihati			Tangail Sadar		
	Groundwater Abstraction for irrigation (m3/yr)	Groundwater Abstraction Domestic and Municipal Uses (m3/yr)	Total Groundwater Abstraction (m3/yr)	Groundwater Abstraction for irrigation (m3/yr)	Groundwater Abstraction Domestic and Municipal Uses (m3/yr)	Total Groundwater Abstraction (m3/yr)	Groundwater Abstraction for irrigation (m3/yr)	Groundwater Abstraction Domestic and Municipal Uses (m3/yr)	Total Groundwater Abstraction (m3/yr)
1st	150000000	2830000	152000000	314000000	6120000	320000000	375000000	7770000	383000000
2nd	151000000	2860000	154000000	317000000	6180000	324000000	379000000	7850000	387000000
3rd	153000000	2890000	156000000	321000000	6250000	327000000	383000000	7940000	390000000
4th	154000000	2920000	157000000	324000000	6320000	330000000	386000000	8020000	394000000
5th	156000000	2960000	159000000	327000000	6390000	333000000	390000000	8110000	398000000
6th	157000000	2990000	160000000	330000000	6450000	337000000	394000000	8200000	402000000
7th	159000000	3020000	162000000	334000000	6520000	340000000	398000000	8280000	406000000
8th	160000000	3050000	163000000	337000000	6590000	344000000	402000000	8370000	410000000
9th	162000000	3080000	165000000	340000000	6660000	347000000	406000000	8460000	415000000
10th	164000000	3120000	167000000	344000000	6730000	350000000	410000000	8550000	419000000
11th	165000000	3150000	168000000	347000000	6810000	354000000	414000000	8640000	423000000
12th	167000000	3180000	170000000	351000000	6880000	358000000	418000000	8740000	427000000
13th	169000000	3220000	172000000	354000000	6950000	361000000	423000000	8830000	431000000
14th	170000000	3250000	174000000	358000000	7030000	365000000	427000000	8930000	436000000
15th	172000000	3290000	175000000	361000000	7100000	368000000	431000000	9020000	440000000
16th	174000000	3320000	177000000	365000000	7180000	372000000	435000000	9120000	444000000
17th	175000000	3360000	179000000	369000000	7260000	376000000	440000000	9210000	449000000
18th	180000000	3390000	183000000	378000000	7330000	385000000	444000000	9310000	453000000
19th	184000000	3430000	188000000	387000000	7410000	395000000	449000000	9410000	458000000
20th	189000000	3470000	192000000	397000000	7490000	404000000	453000000	9510000	463000000
21st	194000000	3500000	197000000	407000000	7570000	414000000	458000000	9620000	467000000
22nd	198000000	3540000	202000000	417000000	7650000	425000000	462000000	9720000	472000000
23rd	203000000	3580000	207000000	427000000	7730000	435000000	467000000	9820000	477000000
24th	209000000	3620000	212000000	438000000	7820000	446000000	471000000	9930000	481000000

Safe Yield

259. Both the studies done by EAL (2014) and SDCPL (2015) estimated that the maximum allowable extraction of groundwater for the vicinity of the SPS is 3,200 m^3/h without causing conspicuous problem in the groundwater table of the plant complex area (EAL, 2014 and SDCPL, 2015). If the findings of those studies are relied upon, it can be said that total water requirement of about 2,550 m^3/h for all four units of Sirajganj Power Station could be met by groundwater abstraction.

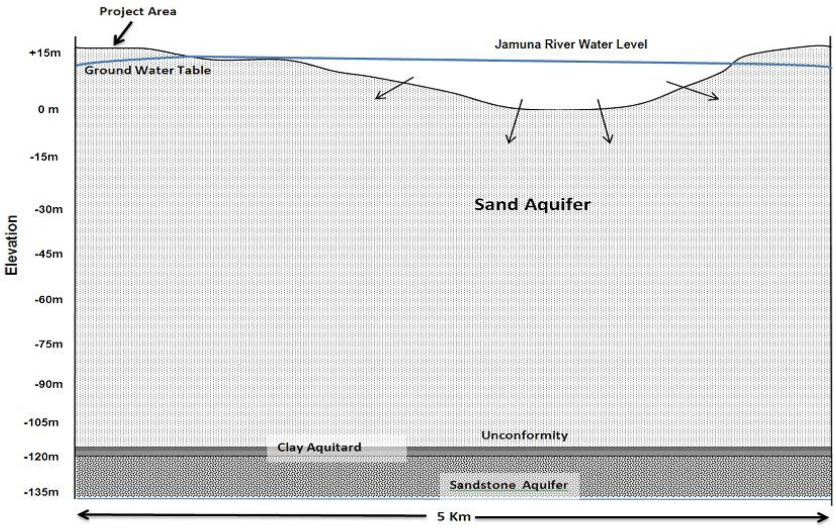
Aquifer Status

260. The Project area is located more or less within the River Jamuna. The area was built by raising the river bed by 6 to 7m. During wet season (July to September) the Project area is surrounded by the Jamuna river water. It has been observed from the bore logs that the thickness of Upper unconfined aquifer is about 120m in the Project area. The aquifer is well connected to the Jamuna River bed. In the dry season, water from the river banks flows towards the aquifer and in the wet season water from the river flows towards the banks of the river. CMC (2012) found that the upper unconfined aquifer is mainly consisted by silty sand, fine sand, and medium to coarse sand with gravel. Beneath it is the confined aquifer of hard sandstone. A clay aquitard of 3 m thickness separates the Upper unconfined and Lower confined aquifer (**Figure 6-16** and **Figure 6-17**).



(Source: SDCPL 2015)

Figure 6-16: Schematic E-W hydro-stratigraphic section through the Project area during dryseason



(Source: SDCPL 2015)

Figure 6-17: Schematic E-W hydro-stratigraphic section through the Project area wet season

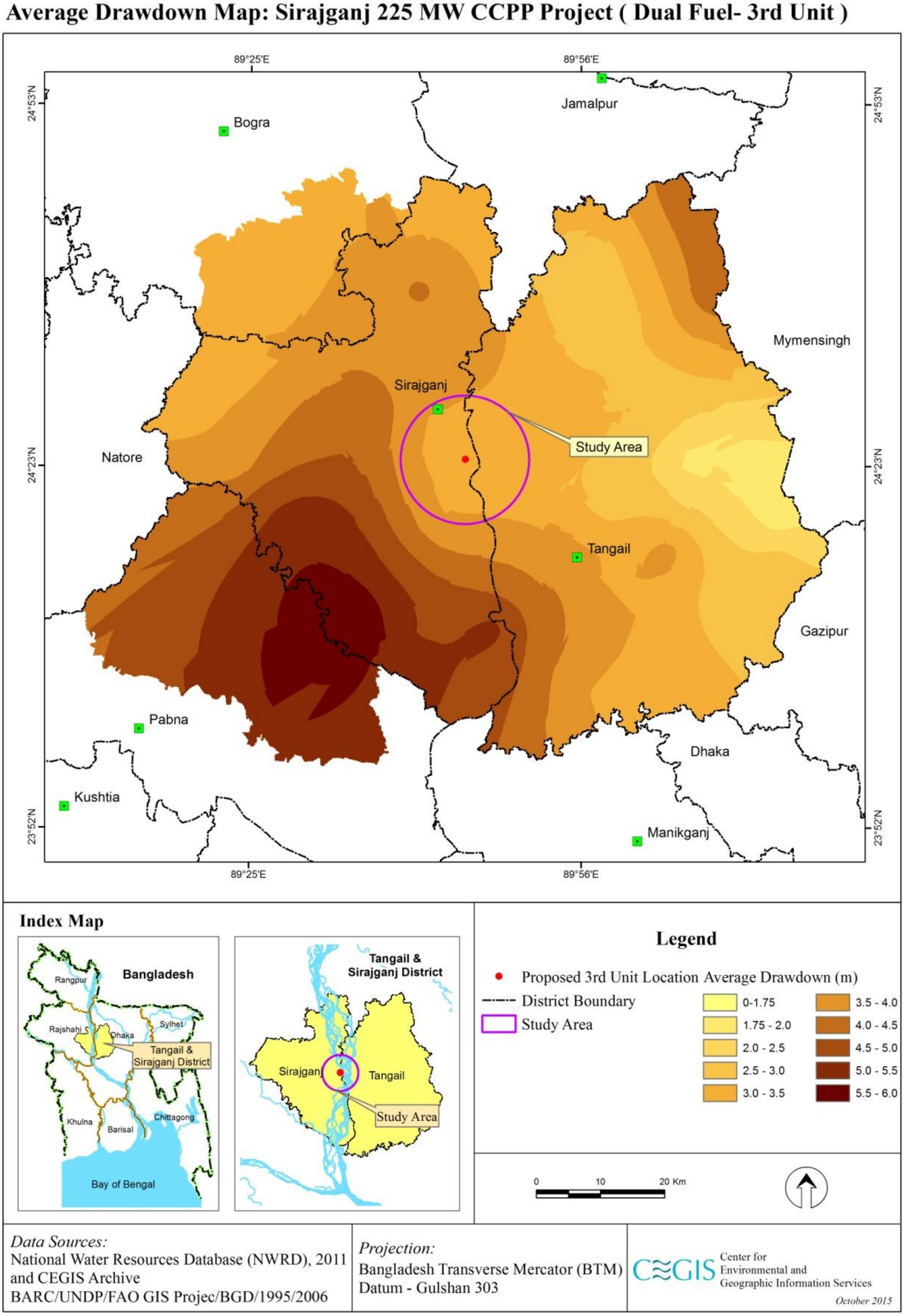
261. During field visit conducted by SDCPL (2015), it has been observed that no large-scale abstraction of groundwater takes place in areas surrounding the power plant. Population living in the Jamuna River Chars use suction mode pumps in tube wells to abstract water. This indicated that the groundwater level is very close to the surface (within 26 feet) near the Project area.

262. Recharge of the aquifer in the study area is maintained primarily by rainfall. During June to September, recharge of the shallow aquifer occurs principally through vertical percolation from relatively large amounts of rainfall and stored water within bunds around the paddy field and floodwater in places. Low topographic relief, slow drainage with large areas of relatively pervious soil and permeable underlying sediments are conducive to high recharge. The region is drained by many large and small rivers which are either major or minor tributaries of the River Jamuna. During wet seasons the rivers are flooded with water which contributes significantly in recharging the regional aquifer. The study conducted by SDCPL (2015) used the recharge estimated by UNICEF (1993) assumed to be valid for the whole study area. **Table 6-20** provides this mean monthly recharge data of the study area.

Table 6-20: Mean Monthly Recharge Rate of the study area

Month	Recharge (mm) of Sirajganj	Recharge (mm) of Tangail
January	20	8
February	22	9
March	48	22
April	128	119
May	180	173
June	183	179
July	182	152
August	155	101
September	103	51
October	40	12
November	23	9
December	21	8
Yearly Recharge	1105	843

263. The average dry season drawdown effect of the study area is shown in the following Map X for the period of five years from 2009-13.



Map 6-10: Average dry season drawdown for five years (2009-2013)

Surface Water Availability and Its Use as an Alternate Source

264. The Jamuna River flow measured at Bahadurabad has been considered to investigate the surface water availability. The Feasibility Study reported that based on historical data, the 50 and 80 percent dependable flow of the Jamuna River during dry period (January-May). They identified February first decade to March second decade (February II – March II) is the driest period for the Jamuna. The 80 and 50 percent dependable flow during this driest period is about 3,500 m^3/s and 4,000 m^3/s, respectively. The report though made a cautionary note by saying that the calculated dependable flow of the Jamuna River is based on the rated discharge; as such there is some uncertainty in the accuracy of Jamuna dry period's rated discharge data.

265. The total requirement for the SPS to operate all four units is 2,550 m^3/h that is equivalent to 42.5 m^3/min. Therefore, the amount required for the power plant could be easily met by the surface water source (i.e. Jamuna River) considering the 80 and 50 percent dependable flow of the Jamuna mentioned above, even considering the uncertainty in the reported corresponding Jamuna River flow data.

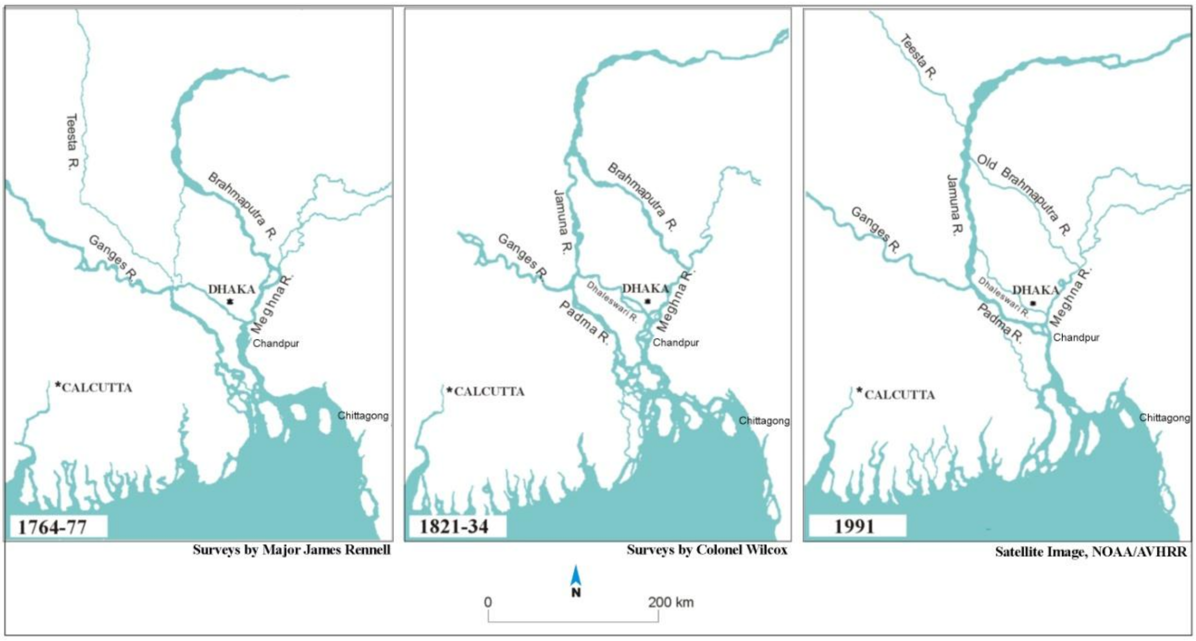
266. Although there is a small river channel close to the proposed site, the water availability in this channel is very low during dry period; hence the required water should be transport from the Jamuna main course. However, the access to the Jamuna flow will not be easy since the main river course is about 1.5 km away from the proposed plant site. In such case, pumping facility and pipe transfer of water should be installed to carry out water from the main river course to the power plant.

267. Taking all the above facts into consideration, it can be concluded that the aquifer underlying the study area will be able to fulfill the demands exerted by extraction of water for the cooling purposes of the power plant without any permanent lowering of the existing groundwater table.

6.7.3 Morphology

Historical Development of River Planform

268. The Brahmaputra, a transboundary river, enters into Bangladesh through Kurigram flows downstream towards the sea. Sometime between 1776 and 1830, the course of the Brahmaputra River shifted from the east of Madhupur block to the west, and the river took the name *Jamuna* in its new course. The term 'avulsion' may be used to describe this shift as the change in channel alignment was achieved by abandonment of one course rather than progressive shifting and adoption of a new one some distance away (Bristow, 1999). There is no agreement among scientists concerning exactly when, how or why the avulsion occurred (Morgan and McIntire, 1959; Coleman, 1969, Monsur, 1995; and Bristow 1999). In this context, use of this term should not be taken to indicate that the shift occurred during a single event or even within a few years. For example, in 1916, Hirst suggested that the avulsion took place gradually over a sixty year period (Morgan and McIntire, 1959). What is known is that shifting did not begin in earnest earlier than 1776, as Major Rennell's map of that date clearly shows the Brahmaputra flowing east of the Madhupur along the present course of the Old Brahmaputra River. It is also clear that shifting of the main course was accomplished by 1830, as Colonel Wilcox's Map of that date indicates that the main flow was diverted to the west of the Madhupur block from the Jamuna (**Map 6-11**).

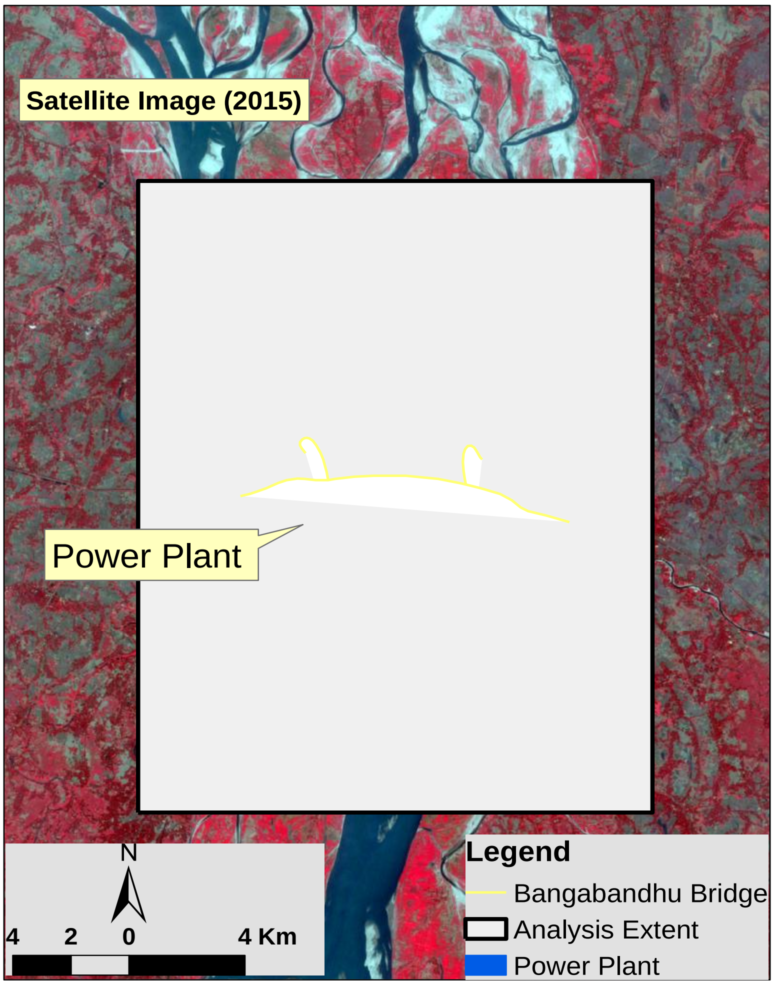


Map 6-11: Development of the main rivers in Bangladesh over time

269. Regarding how the shifting occurred, Buchanan Hamilton noted in 1810 that the Brahmaputra was at that time 'threatening to shift westwards along the course of the Konni (or Jennai) River' (Fergusson, 1863) and for many years the common opinion was that this threat was realized in the late 18th century when 'the Brahmaputra started to divert the flow through the Jhennai River' (Morgan and McIntire, 1959; Coleman, 1969; and Monsur, 1995). However, this opinion has recently been challenged (Bristow, 1999) on the basis that both on Rennell's map of 1776 and on modern maps, the Jhennai River is located to the east of the town of Dewanganj while, following its avulsion, the Brahmaputra occupied a channel west of Dewanganj.

Erosion/Accretion

270. Erosion and accretion reflects how a river is morphologically active or inactive. In this context, as the Jamuna River is eroding and accreting left and right bank every year, this is morphologically most active river among all rivers in Bangladesh. Erosion accretion of this river has been calculated considering a study area of 13km upstream and 10km downstream of the Project site (**Map 6-12**).



Map 6-12: Analysis extent of erosion/ accretion

271. The power plant location is at the immediate downstream of the Right Guide Bank of the Bangabandhu Bridge. As a result, the location of power plant is not so much susceptible to erosion. Though some erosion takes place at the upstream of the bridge, the erosion level at the downstream of the bridge is not significant. Although there is no erosion at the power plant location, the average erosion rate at the analysis extent is 120 ha/yr at the right bank and 77 ha/yr at left bank (**Table 6-21**).

Table 6-21: Rate of yearly erosion-accretion

Year	Left Bank			Right Bank		
	Erosion	Accretion	Net Gain/Loss	Erosion	Accretion	Net Gain/Loss
2001-2002	6.2	39.0	32.8	51.2	73.0	21.8
2002-2003	36.5	65.0	28.5	267.0	2.1	-264.9
2003-2004	119.8	19.4	-100.4	105.6	7.9	-97.7
2004-2005	375.9	0.1	-375.8	141.8	57.6	-84.2
2005-2006	63.4	4.9	-58.5	144.5	11.0	-133.5
2006-2007	4.0	137.0	133.0	187.8	9.4	-178.4
2007-2008	139.5	2.5	-137.0	54.6	35.0	-19.5
2008-2009	46.8	0.3	-46.5	120.0	108.7	-11.3
2009-2010	8.1	1.9	-6.1	132.0	554.8	422.8
2010-2011	31.3	65.5	34.2	184.8	3.2	-181.5

Year	Left Bank			Right Bank		
	Erosion	**Accretion**	**Net Gain/Loss**	**Erosion**	**Accretion**	**Net Gain/Loss**
2011-2012	46.6	5.5	-41.1	128.6	5.3	-123.3
2012-2013	87.2	0.5	-86.7	35.1	17.3	-17.8
2013-2014	37.7	3.1	-34.6	14.8	7.5	-7.3
Average	**77.1**	**26.5**		**120.6**	**68.7**	

Source: CEGIS, 2014

River Bathymetry

272. Bathymetry data are taken from 2010 survey section of BWDB. A long profile has been plotted. At the location of the section of the Jamuna River there are two channels. In the long profile both channel has been considered. The long profile along the chute channel of the Jamuna River has higher elevation at the upstream of the power plant, which indicates that the right bank channel bed is accreting and the left bank channel is becoming prominent (**Figure 6-18)**. That means more sediment will deposit at the right bank channel.

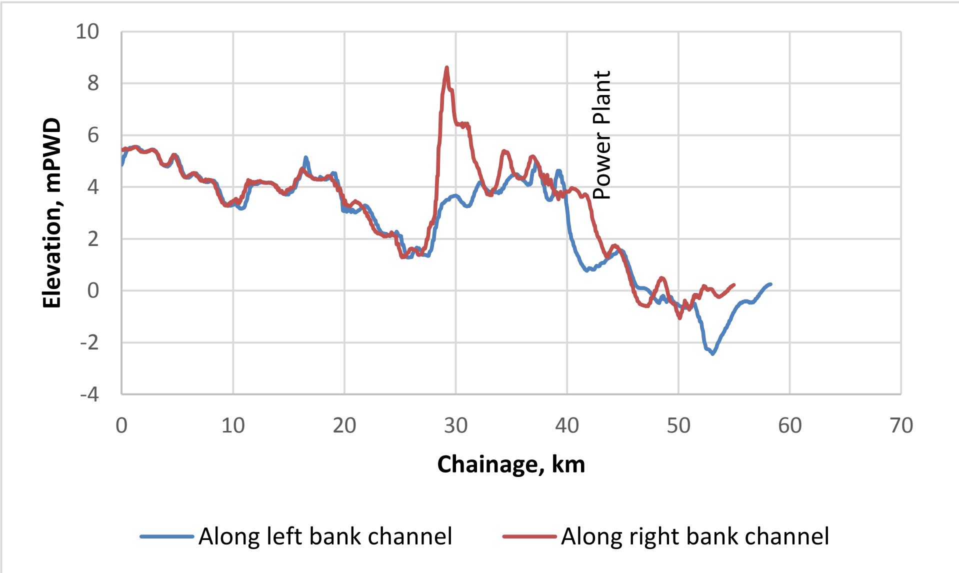


Figure 6-18: Elevation of the banks of Jamuna River

6.7.4 Water Quality

Surface water Quality

273. The main source of surface water is the Jamuna River flows beside the proposed site. The river reach along the site has some channels which are perennial or seasonal in nature. The surface water level and associated quality varies subjected to seasonal changes and monsoonal upshot. Rainfall intensity, sediments, land use practices highly influence the quality of surface water. To determine surface water quality, a number of samples have been collected from different points of the concerned river reach considering u/d stream of effluent disposal site. **Table 6-22** shows the in-situ quality of water data those are taken at different points of the Jamuna. From the table below and with due comparison with the Table 7.6, this can be said that the temperature and pH value is within the limit according to the ECR 1997 only the DO value is exception. Sampling locations are shown in **Map 6-17**.

Table 6-22: Surface Water Quality at different sampling points

Sl. No.	Location		Location name	Date	Time	Temp (°C)	pH	DO
	Latitude (N)	Longitude (E)						
1	24°23'54.2"	89°45'13.6"	Right bank of the Jamuna	07/07/15	10:15 am	28.6	7.45	7.9
2	24°23'36"	89°45'12.6"	200m downstream from bridge	07/07/15	10:30 am	29.4	7.4	5.3
3	24°23'54.2"	89°45'13.6"		07/07/15	1:40 pm	28.1	7.45	5.8
4	24°23'3.48"	89°44'52.69"	Around 50 m at downstream of the discharge point	08/07/15	9:10 am	32.6	8.6	5.4

Source: CEGIS Field Study, 2015

274. The following **Table 6-23** shows the surface water quality tested at DPHE, Dhaka

Table 6-23: Surface Water Quality

Sl. No.	Location		N 24°23'54.2" E 89°45'13.6"	N 24°23'36" E 89°45'12.6"	N 24°22'48.2" E 89°44'42.74"	N 24°23'3.48" E 89°44'52.69"
	Parameter	Unit				
1	Alkalinity	mg/L	75	58	58	410
2	Arsenic (As)	mg/L	<0.001	0.001	0.002	0.009
3	Cadmium (Cd)	mg/L	0.001	0.002	<0.00015	0.0003
4	COD	mg/L	3	2	4	3
5	Chloride	mg/L	24	10	9	28
6	Copper (Cu)	mg/L	0.026	0.019	0.018	0.004
7	Cr (Total)	mg/L	0.0039	0.0057	0.0013	0.0006
8	EC	µS/cm	115	121	109	673
9	Iron (Fe)	mg/L	7.46	9.79	10.54	0.98
10	Lead (Pb)	mg/L	0.014	0.085	0.01	<0.002
11	Nitrogen (Ammonia)	mg/L	0.52	0.49	0.51	0.67
12	TDS	mg/L	54	56	51	325
13	TSS	mg/L	120	122	109	15
14	Turbidity	NTU	246	220	298	6.8
15	Zinc (Zn)	mg/L	<0.08	0.03	0.05	0.07
16	Oil & Grease*	mg/L	-	<5.0**	-	-

Source: Laboratory analysis result from DPHE and BCAS (Sample collected during July, 2015, Wet Season)*

275. The **Table 6-24** shows the standard values of some water quality parameters as per the ECR, 1997.

Table 6-24: Standard values for inland surface water

Sl. No	Best Practice based classification	p^H	DO (mg/l)
1	Source of drinking water for supply only after disinfecting	6.5-8.5	6 or above
2	Water usable for recreational activity	6.5-8.5	5 of more
3	Source of drinking water for supply after conventional treatment	6.5-8.5	6 or more
4	Water usable by fisheries	6.5-8.5	5 or more
5	Water usable by various process and cooling industries	6.5 - 8.5	5 or more
6	Water usable for irrigation	6.5 - 8.5	5 or more

Source: ECR, 1997

Groundwater Quality

276. The availability and sustainability of ground water with quality is essentially a major issue for the proposed Unit-3. Most of the domestic activities, irrigation and Unit-1 are dependent on the ground water. The location specific measured water quality data for few parameters for wet season is presented in **Table 6-25** for wet season. Results of most of the parameters are shown within or less than the Bangladesh Standards except DO. Sampling locations are shown in **Map 6-17**.

Table 6-25: Groundwater quality at different points of Soydabad, Sirajganj

Sl. No.	Location		Location name	Date	Time	Temp (°C)	pH	DO
	Latitude (N)	Longitude (E)						
1	24°23'43.2"	89°44'17.7"	Rehabilitation Centre of Panchasona Village	06/07/15	10:00 am	28.4	6.7	5.2
2	24°23'30.1"	89°42'53.3"	Banshhata of Soydabad Village	06/07/15	12:45 pm	27.6	6.63	4.8
3	24°23'32"	89°43'53.2"	Panchasona Village	06/07/15	04:04 pm	29.1	7.18	6.8
Bangladesh Standard						20-30	6.5-8.5	6

Source: CEGIS Field Survey, July 2015 (Wet Season)

277. The above samples have also been sent to the Department of Public Health Engineering (DPHE) for further examination for more parameters of ground water. The following **Table 6-26**shows the groundwater quality situation of the study area more elaborately.

Table 6-26: Ground water Quality

Sl. No.	Location			N 24°23'54.2" E 89°45'13.6"	N 24°23'36" E 89°45'12.6"	N 24°22'48.2" E 89°44'42.74"
	Parameter	Unit	Bangladesh Standard			
1	Alkalinity	mg/L	-	460	338	113
2	Arsenic (As)	mg/L	0.05	0.006	0.019	0.009
3	Cadmium (Cd)	mg/L	0.005	<0.00015	<0.00015	<0.00015
4	COD	mg/L	4.0	2	2	2
5	Chloride	mg/L	150-600	28	25	10
6	Copper (Cu)	mg/L	1.0	0.002	0.018	0.01
7	Cr (Total)	mg/L	0.05	0.0003	<LOQ	0.0003
8	Fluoride	mg/L	1.0	<0.018	2.10	0.18
9	Hardness	mg/L	200-500	485	300	160
10	Iron (Fe)	mg/L	0.3-1.0	1.01	0.03	2.8
11	Lead (Pb)	mg/L	0.05	0.008	0.009	0.011
12	Phosphate	mg/L	6.0	<LOQ	1.29	0.15
13	Sulphate	mg/L	400	27	3	3
14	TDS	mg/L	1000	436	436	148
15	TSS	mg/L	10	22	22	16
16	Zn	mg/L	5.0	0.03	0.03	0.04

Source: Laboratory analysis result from DPHE and BCAS (Sample collected during July, 2015, Wet Season)*

278. From the above table it is evident that the all the parameters are within the standard value of the potable water except for Floride and TSS in some specific location (marked red in the table). Therefore, it can be concluded that the ground water quality of the proposed

project area is at usual state except for the case of fluoride contamination at Banshhata of Soydabad Village.

Effluent Water Quality

279. The samples of effluent at various discharge points have been collected and conducted in-situ tests for some parameters. The effluent samples were collected from the back flush from De-Mineralized (DM) water treatment plant sump, Cooling tower and HRSG Blow Down Sump and back flush from Iron Removal Plant/Iron Filter plant (for cooling water pre-treatment). The effluent water quality is very important as currently these waters are directly discharged to the nearby canal which becomes connected to the Jamuna during peak monsoon. Presence of any hazardous or toxic element in the effluent may cause serious hazard to the aquatic environmental locally. Samples obtained during field investigation have been sent to the DPHE laboratory for further testing. **Table 6-27** shows the results of in-situ measured quality of the effluent. Sampling locations of effluent are shown in **Map 6-19**.

Table 6-27: Effluent Water Quality

Sl. No.	Location	Location Name	Date	Time	Temp	pH	DO
1	N 24°23'12.31" E 89°44'47.17"	Sump 1 (Backflash of Demineralization)	06/07/15	03:45 pm	30.02	10.69	4.6
2	N 24°23'6.18" E 89°44'47.23"	Sump 2 (Cooling tower blow down)	06/07/15	03:50 pm	30.45	8.7	7.2
3	N 24°23'5.43" E89°44'49.86"	Sump 3 (backflash of iron removing plant)	06/07/15	03:55 pm	29.10	7.25	4.7

Source: CEGIS Field Survey, July 2015 (Wet Season)

280. From the **Table 6-28** it can be observed that all the measured parameters are found according to the standard value of inland surface water at discharge point. So effluent water quality doesn't possess any daviation is value from the regular quality standard.

Table 6-28: Effluent Quality Analysis

Sl	Location			N 24°23'12.31" E 89°44'47.17"	N 24°23'6.18" E89°44'47.23"	N24°23'5.43" E89°44'49.86"
	Parameter	Unit	Bangladesh Standard			
1	Arsenic (As)	mg/L	0.2	<0.001	0.003	0.001
2	Cadmium (Cd)	mg/L	0.05	0.003	0.003	0.003
3	Chemical Oxygen Demand (COD)	mg/L	200	2	3	3
4	Copper (Cu)	mg/L	0.5	0.013	0.02	0.014
5	Cr (Total)	mg/L	0.1	0.0005	<LOQ	0.0003
6	Iron (Fe)	mg/L	2	0.41	0.83	0.34
7	Lead (Pb)	mg/L	0.1	0.007	0.017	0.003
8	Total Dissolved Solid (TDS)	mg/L	2100	835	420	170
9	Total Suspended Solid (TSS)	mg/L	150	36	4	7
10	Zinc (Zn)	mg/L	5	0.02	0.16	0.02
11	Oil & Grease	mg/L	10	6.67	<5	<5

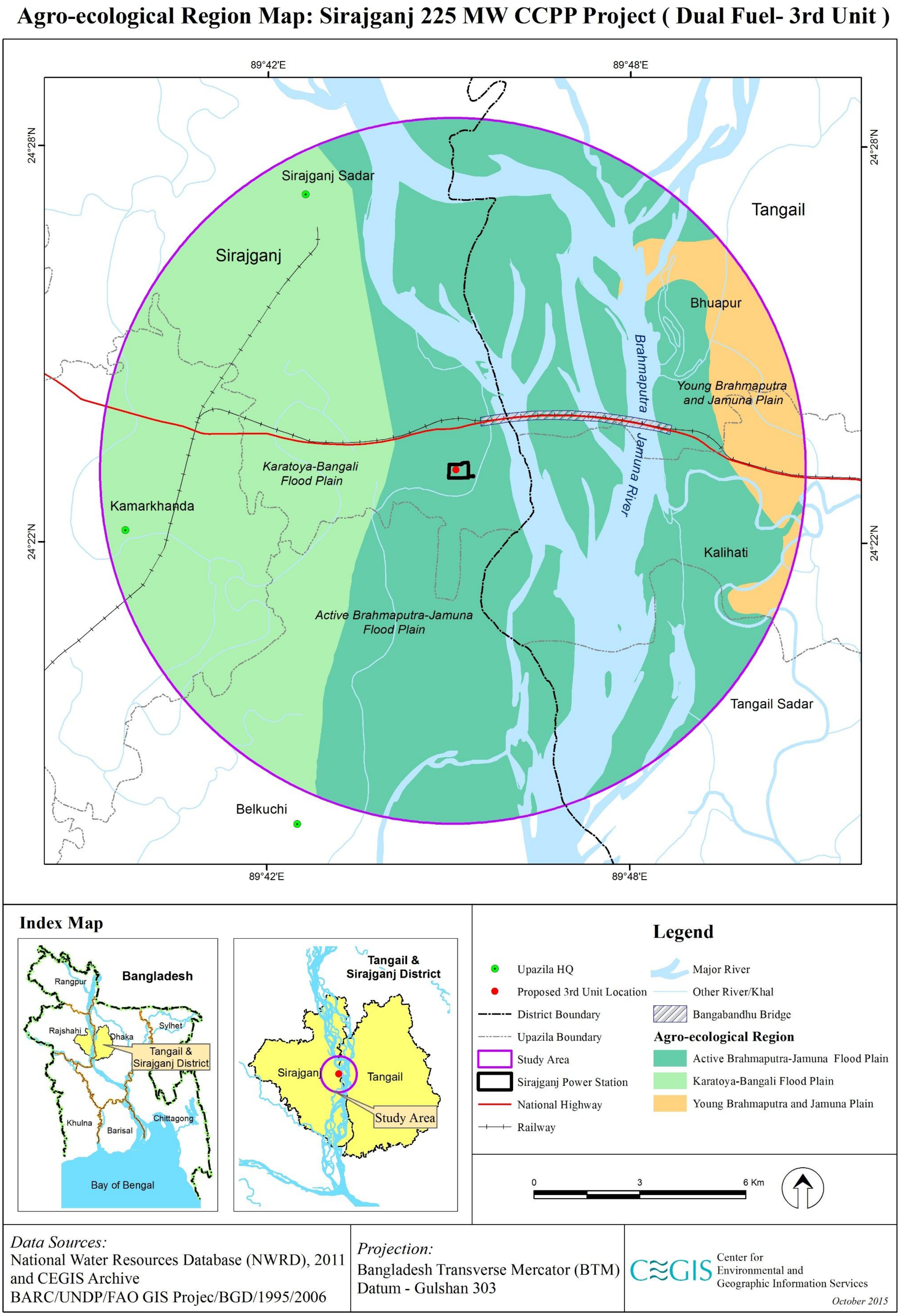
Source: Laboratory analysis result from DPHE and BCAS (Sample collected during July, 2015, Wet Season)*

6.8 Land Resources

281. Land comprises natural resources such as soils, minerals, water and biota. These components are organized in ecosystems which provide a variety of services essential to maintain the integrity of life–support systems and the productive capacity.

6.8.1 Agro-ecological Zone

282. Thirty agro-ecological zones and 88 sub-zones have been identified by adding successive layers of information on the physical environment which are relevant for land use and assessing agricultural potential. The study area comprises two agro-ecological zones. These are (i) Karatoya-Bangali Floodplain (AEZ-4) and (ii) Active Brahmaputra-Jamuna Flood plain (AEZ-7). The locations of agro-ecological zone are shown in **Map 6-13**.



Map 6-13: Agro-ecological zones of the study area

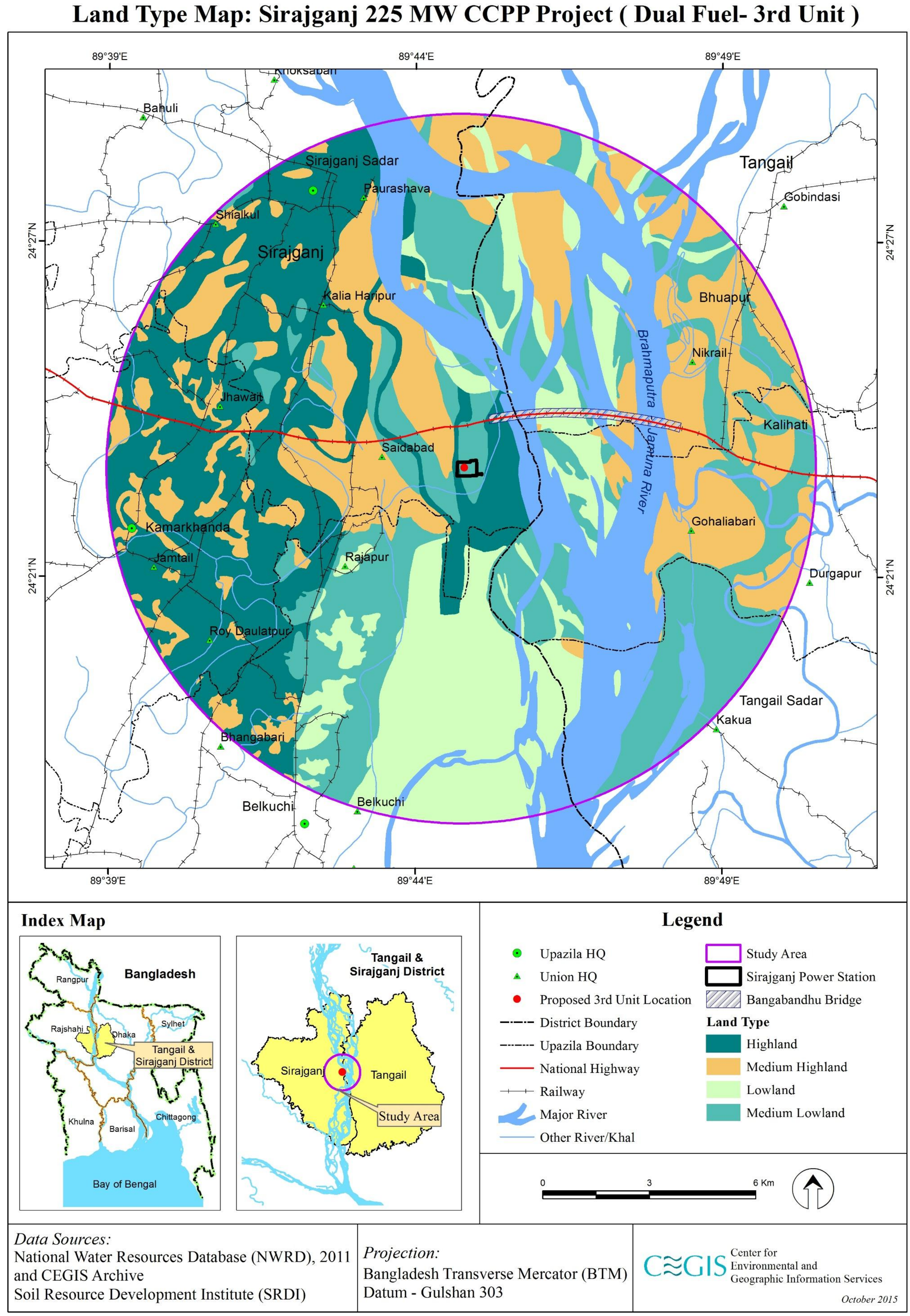
6.8.2 Land Type

283. Land type classifications are based on depth of inundation on agriculture land during monsoon season due to normal flooding. Based on Soil Resource Development Institute (SRDI, 1988), five land types (High land, Medium Highland, Medium Lowland, Lowland and Very Lowland) have been classified in terms of depth of flooding on agriculture land. In the study area, four among the five categories of land types have been identified whereas only one type of land prevails in the project area i.e. high land (land filled up to above flood level). Here, 10km and 2 km radius have been considered as study area and closed vicinity area respectively. Detailed distributions of land type of the study and project area are presented in **Table 6-29**and **Map 6-14.**

Table 6-29: Detailed land type of study, project and closed vicinity area

Land Type	Description	Flooding depth	Flooding characteristics	Project area		Study area		Closed vicinity area	
				Area (ha)	% of NCA	Area (ha)	% of NCA	Area (ha)	% of NCA
F_0	High land	Above flood level	Non-flooded to intermittent	3	100	4,326	30.0	14	2
F_1	Medium High Land	0-90cm	Seasonal	0	0	4,546	31.6	247	36
F_2	Medium Low Land	90-180cm	Seasonal	0	0	4,142	28.8	425	62
F_3	Low Land	180-275cm	Seasonal, but remains wet in early dry season	0	0	1,391	9.7	0	0
			Total	**3**	**100**	**14,405**	**100**	**685**	**14,405**

Sources: SOLARIS-SRDI, 2006



Map 6-14: Land Type Map of Study Area

6.8.3 Soil Texture

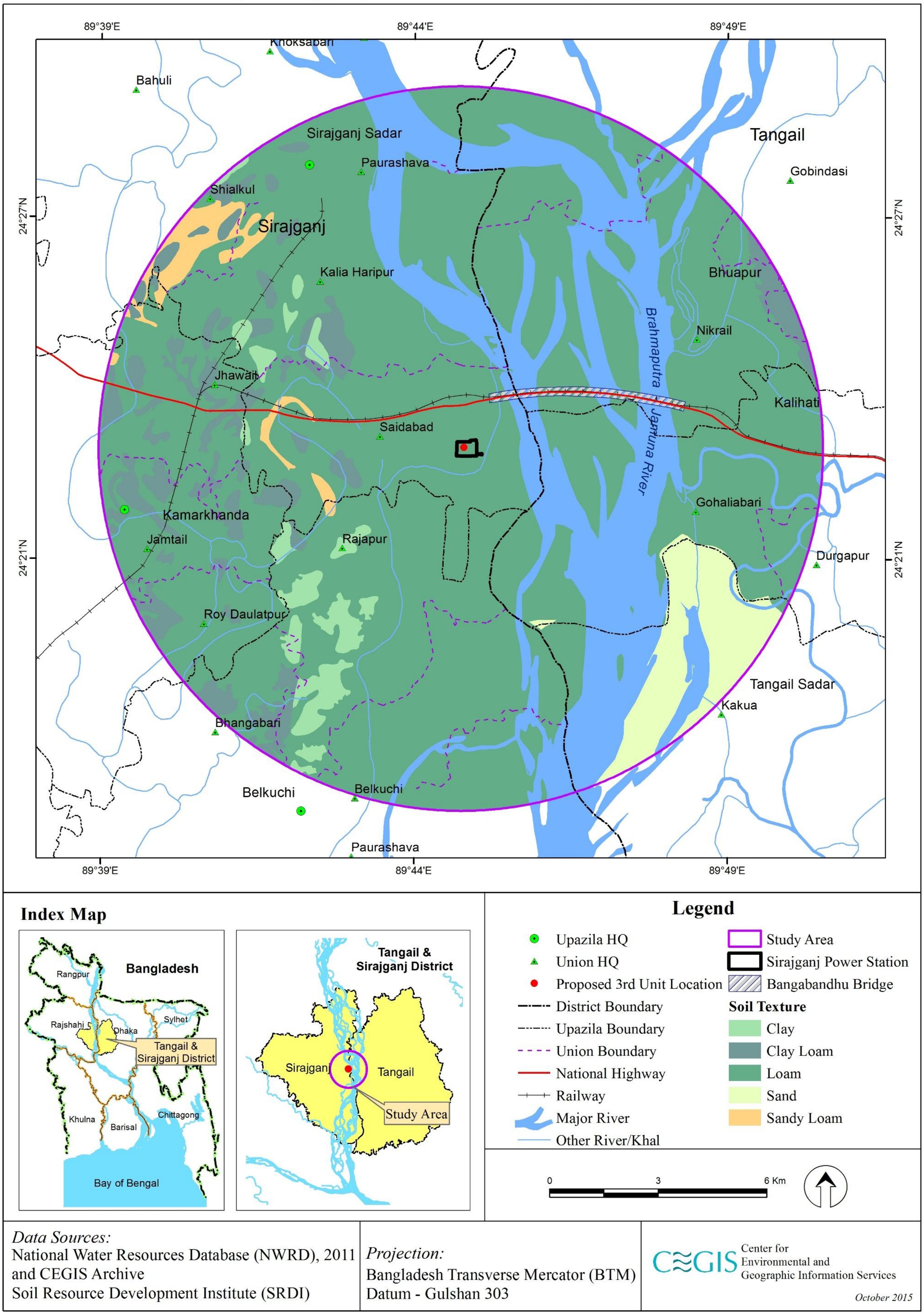
284. Soil texture is the relative proportions of sand, silt and clay. There are five types of soil texture in the study area i.e. clay, clay loam, loam, sand and sandy loam. Detailed distribution of soil texture are presented in **Table 6-30**and **Map 6-15**.

Table 6-30: Detailed soil texture of the study and vicinity area

Texture	Study area		Closed to vicinity	
	Area(ha)	% of NCA	Area(ha)	% of NCA
Clay	431	3	0	0
Clay loam	1,063	7	0	0
Loam	11,666	81	685	100
Sand	982	7	0	0
Sandy loam	264	2	0	0
Total	**14,405**	**100**	**685**	**100**

Sources:SOLARIS-SRDI, 2006

Soil Texture Map: Sirajganj 225 MW CCPP Project (Dual Fuel- 3rd Unit)



Map 6-15: Soil texture of the study area

6.8.4 Soil Quality

285. Soil sample were collected from three locations in three depths (0-15 cm,15-30 cm and 30-45 cm) inside the study area on 6th and 7th July, 2015.Collected soil samples were submitted to SRDI, Dhaka to analyze the samples. The methods were using for determining the Soil reaction(pH), Organic Matter(OM), Nitrogen(N), Potassium(K), Calcium(Ca), Magnessium(Mg), Sulphur(S), Phosphorus(P), Zinc(Zn), Ferum(Fe), Manganese(Mn), Lead(Pb) and Cadmium(Cd) by Glass Electrode method, Wet oxidation method, Kjeldahl distillation method, NH_4OAc method, CaH_2PO4 Extracting method, modified Olsen/Bray and Kurtz method, DTPA Extraction method, Atomic Absorption Spectrophotometry method at SRDI laboratory. Detailed soil quality report of the study area is presented in **Table 6-31** and sample locations are shown in **Map 6-19**.

286. The pH levels are observed 7.3 to 7.9 in all locations of all depth. It indicates that, pH level was neutral to moderately alkaline and within the limit in all locations. The Jetty point pH level was neutral to moderately alkaline. The Organic Matter (OM%) is 0.12 to 1.60% in all locations. The OM status was found very low to low (≤1.0-1.7%) in all the locations. Waste water is released from existing power plant by a canal. However, in the Jetty locations it exhibits very low status.In case of Nitrogen (N%) level, it was found 0.007 to 0.09% in all locations of the soils. The N level observed very low to low in nature in all depth. However, the status of N in the Jetty point was very low level.Potassium (K) level was found, 0.09 to 0.20(meq/100g) in all locations. The K level observed very low to medium level in all depths. In the Jetty location, K level was very low to medium in nature.Calcium (Ca) level was found, 2.33 to 5.81(meq/100g) in all the depths. The Ca level revealed that, it was low to medium status in all locations. The Jetty point Ca status observed low to medium. The Magnesium (Mg) level was found, 0.67 to 2.92(meq/100g) in all the locations of all depths. The Mg level showed higher in all locations. The Jetty point Mg showed low to medium in nature.

Table 6-31: Detailed information on soil characteristics of the study area

Location (Mouza)	GPS reading	Depth (cm)	pH	OM	N	K	Ca	Mg	P	S	Fe	Mn	Zn	Pb	Cd
				%		Meq/100g			µg/g						
Khas Baro Shimul (Near Jetty)	24°23'3.7"N 89°44'51.8"E	0-15	7.3	0.12	0.007	0.10	2.88	0.67	4.23	1.20	7.37	7.30	0.29	12.05	1.66
		15-30	7.6	0.24	0.014	0.12	3.25	1.02	4.56	0.83	12.34	7.61	0.16	14.56	1.83
		30-45	7.9	0.12	0.007	0.10	3.54	0.85	4.15	2.78	11.66	11.88	0.59	14.38	1.60
Khas Baro Shimul	24°23'16.2"N 89°44'32.6"E	0-15	7.8	0.36	0.02	0.09	2.33	0.96	4.09	2.11	26.05	18.86	0.46	13.13	1.56
		15-30	7.5	0.86	0.05	0.12	3.60	1.67	4.75	0.63	29.92	31.30	0.99	20.11	1.89
		30-45	7.7	0.48	0.03	0.15	4.76	2.08	5.85	2.11	18.70	18.75	0.56	17.60	1.92
Pancho Shona	24°23'11.8"N 89°44'25.0"E	0-15	7.9	0.74	0.04	0.17	5.68	2.82	4.95	2.41	26.84	26.20	0.89	23.50	2.17
		15-30	7.7	0.84	0.03	0.20	5.81	2.92	8.43	4.73	29.83	22.79	0.98	25.47	2.20
		30-45	7.7	1.60	0.09	0.15	3.75	1.30	43.00	1.83	34.55	30.49	0.80	22.36	1.78

Source: SRDI Laboratory analysis report, August; 2015

Note: Salinity data was not collected but it is known to us that there is no salinity in the study area.

287. Concentration of Phosphorus (P) was found, 4.09 to 8.43 (µg/g) which is low. In one sample depth 30-45cm is 43.00 (µg/g) which seems to be abnormal. But in Jetty location it was observed very low status.The concentration of Sulfer (S) was found, 0.63 to 4.73 (µg/g) in all locations. The S level was very low in all locations including Jetty point.The Iron (Fe) levels are 7.37 to 34.55(µg/g) in all depth and locations. It was observed medium to very high in all locations. However, it observed in Jetty location was medium to high in nature.The concentrations of Manganese (Mn) levels are 7.30 to 31.30 (µg/g) in all depths. It revealed that the Mn level was very high in all locations including Jetty area.The Zinc (Zn) levels are 0.16 to 0.99(µg/g) in all locations. The level of Zn was very low to medium in nature. But, in Jetty area it observed very low to low status.Pb concentration observed 12.05 to 25.47(µg/gm) in all locations. Pb concentration observed in Jetty points from 12.05 to 14.56(µg/gm).The concentration of Cadmium (Cd) observed 1.60 to 2.20(µg/gm) in all locations. However, Cd concentration observed in jetty area from 1.60 to 1.83(µg/gm).

6.8.5 Drainage Characteristics

288. Drainage plays a vital role in the management of soil in the study area. As per the SRDI, the drainage characteristics have been divided into six classes from the agriculture point of view. These are excessively drained, well drained, moderately well drained, imperfectly drained, poorly drained and very poorly drained. There are two types of drainage classes in the study area. Details are presented in **Table 6-32**.

Table 6-32: Detailed drainage characteristics of the study area

Drainage	Characteristics	Study area(ha)	% of NCA
Imperfectly Drained	Water drained from soil badly or slowly. This soil often remains wet in rainy season due to rainfall. In normal situation, water does not stand on land more than 15 days at a stretch. In rainy season, groundwater stands within 1 meter at least for some time	8,385	58
Poorly Drained	The soil remains under water from 15 days to 7/8 months. Water is drained from the soil slowly. In most cases, the land remains wet/water logged for a considerable period after the rainy season.	6,020	42
Total		**14,405**	**100**

Source: SRDI

6.9 Agricultural Resources

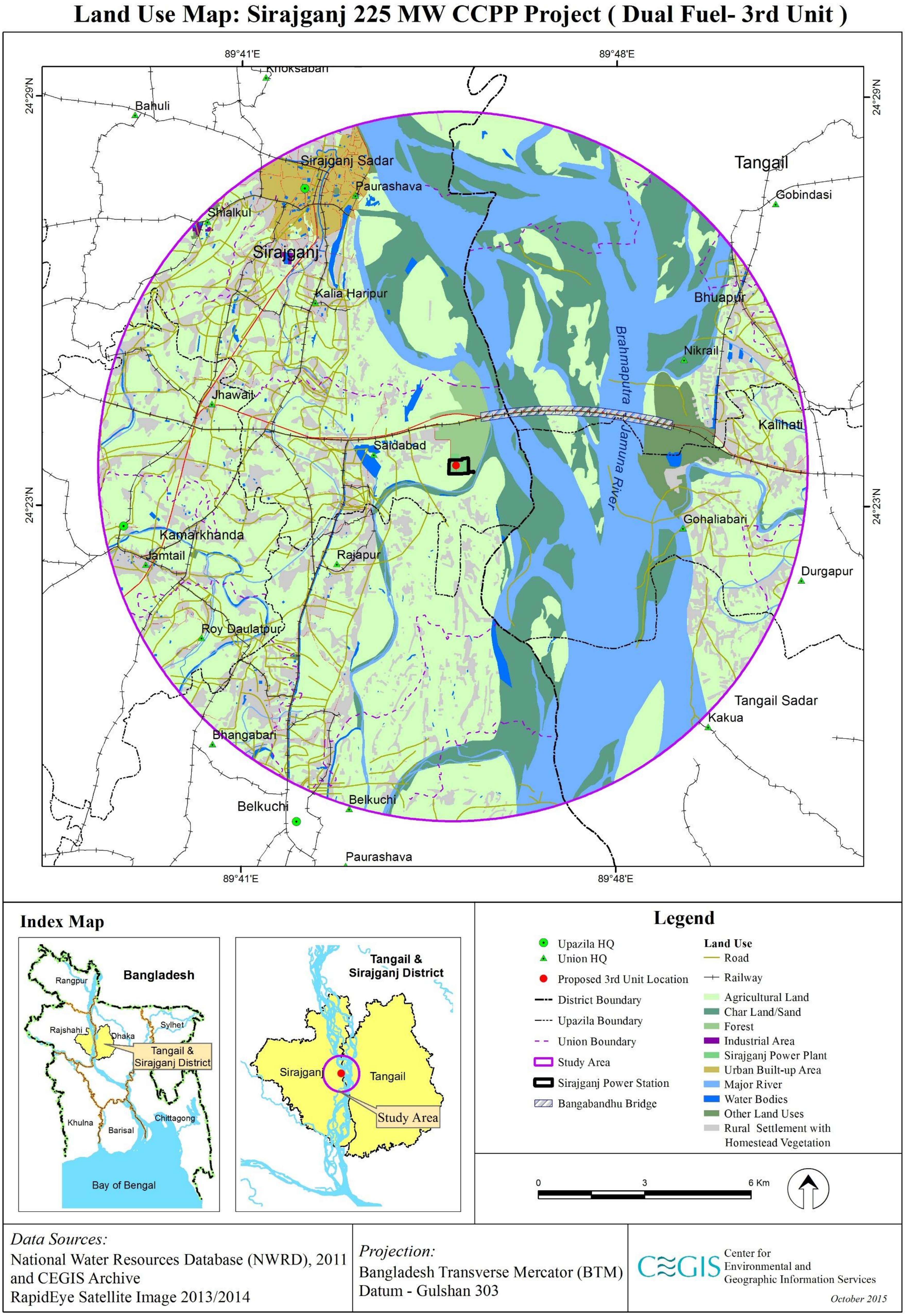
6.9.1 Land use and cropping pattern

289. The gross study area is about 31,415 ha, of which 14,405 ha (45% of gross area) is net cultivable area (NCA). Total area in the power plant is 24ha of which total proposed project area (Unit-3) is about 3 ha which remains fallow due to sand filling above flood level. In the closed vicinity area net cultivable area is about 54% of the NCA. Detailed land use data is presented in **Table 6-33**and **Map 6-16**.

Table 6-33: Detailed land use of the study, project and closed vicinity area

Land use	Project area		Study area		Vicinity area	
	Area (ha)	**% NCA**	**Area (ha)**	**% NCA**	**Area (ha)**	**% of NCA**
Net Cultivable Area(NCA)	0	0	14,405	45.9	685	54.0
Char land/sand	0	0	4,161	13.2	138	10.9
Forest(Eco-Park/Forest)	0	0	258	0.8	187	14.7
Industrial Area	0	0	14	0.0	0	0
Other land uses(Brick field, Chatal, Important Places, Jamuna Resort and Sand quarry)	0	0	492	1.6	0	0
Road (Access Road, National Road, Railway, Regional Road, Rural road and Zilla road)	0	0	231	0.7	15	1.2
Rural Settlement with Homestead Vegetation	0	0	4,414	14.1	107	8.5
Sirajganj Power Plant	3	100	24	0.1	24	1.9
Urban Built-up Area	0	0	538	1.7	0	0
Water Bodies(Baor, Beel, Canal, Ditch, Pond, River, Seasonal water body)	0	0	6,878	21.9	112	8.8
Total	**3**	**100**	**31,415**	**100**	**1,268**	**100**

Source: Satellite Image analysis, June, 2015



Map 6-16: Land use of the study area

6.9.2 *Cropping patterns in the main land of the study area*

290. In the study area, the most dominant cropping patterns are Fallow-Lt. Aman-HYV Boro practiced in 23.1% of the NCA. In the Kharif-I season; HYV Aus, B. Aus, Jute, Sugarcane, Sesame and summer vegetables are grown in about 59.2% of the NCA. The rest 40.8% of the NCA remains fallow. In the Kharif-II season; HYV Aman, Lt. Aman and summer vegetables crops are grown in about 84.7% of the NCA. The rest 15.3% of the NCA remains fallow. In the Rabi/Boro season; HYV Boro, winter vegetables, Wheat, Pulses, Potato and Mustard are grown in 96% of the NCA. Sugarcane is annual crops in the study area. The cropping intensity of the study area is about 244 %. In the close vicinity area, major cropping pattern is Fallow-Fallow-HYV Boro which is practiced in 62% of the NCA. The cropping intensity of the close vicinity area is about 174%.However, the project area remains fallow due to sand filling. Detailed cropping patterns along with land type of the study, close vicinity and project area are presented in **Table 6-34**. (**Photo 6-1** and **Photo 6-2**)

Table 6-34: Detailed cropping pattern of the study, closed vicinity and project area

Study location	Land Type	Cropping patterns			Project area		Study area		Closed vicinity area	
		Kharif-I (March-June)	Kharif-II (July-October)	Rabi (Nov.-Feb.)	Area (ha)	% of NCA	Area (ha)	% of NCA	Area (ha)	% of NCA
Project area	-	Fallow	Fallow	Fallow	3	100	0	0	0	0
		Total			3	100	0	0	0	0
Study area	F_0	Vegetables	Vegetables	HYV Boro	0	0	434	3	0	0
		Vegetables	Vegetables	Vegetables	0	0	736	5	0	0
		Fallow	HYV T. Aman	Mustard-HYV Boro	0	0	1,139	8	0	0
		Jute	HYV T. Aman	Wheat	0	0	2,017	14	0	0
		Sub-total			0	0	4,326	30	0	0
		Sugarcane	Sugarcane	Sugarcane	0	0	576	4	0	0
	F_1	Sesame	Lt Aman	Wheat	0	0	864	6	0	0
		Jute	HYV T. Aman	HYV Boro	0	0	1,223	8.5	0	0
		HYV T. Aus	HYV T. Aman	HYV Boro	0	0	1,101	7.6	0	0
		Jute	HYV T. Aman	Pulses	0	0	782	5.4	0	0
		Sub-total			0	0	4,546	31.6	0	0
	F_2	Fallow	Lt. Aman	HYV Boro	0	0	3,331	23.2	0	0
		B. Aus	Fallow	Potato	0	0	811	5.6	0	0
	Sub-total				0	0	4,142	28.8	0	0
	F_3	Fallow	Fallow	HYV Boro	0	0	1,391	9.7	0	0
	Sub-total				0	0	1391	9.7	0	0
	Total				0	0	14,405	100	0	0
Closed vicinity	F_0	Jute	Fallow	Mustard	0	0	10	1.5	0	0
		Sesame	HYV Aman	Wheat	0	0	3	0.5	0	0
	Sub-total				0	0	13	2.0	0	0
	F_1	Mixed B. Aus+B. Aman	B. Aman	HYV Boro	0	0	51	7.5	0	0
		Fallow	HYV Aman	Mustard-HYV Boro	0	0	137	20	0	0
		Jute	Lt. Aman	Boro	0	0	58	8.5	0	0
	Sub-total				0	0	247	36	0	0
	F_2	Fallow	Fallow	HYV Boro	0	0	425	62	0	0

Study location	Land Type	Cropping patterns			Project area		Study area		Closed vicinity area	
		Kharif-I (March-June)	Kharif-II (July-October)	Rabi (Nov.-Feb.)	Area (ha)	% of NCA	Area (ha)	% of NCA	Area (ha)	% of NCA
	Sub-total				0	0	425	62		0
	Total				0	0	685	100	0	0

Sources: CEGIS Assessment based on farmers interviewed and DAE; July, 2015

Photo 6-1: View of jute field in the main land

Photo 6-2: View of rice field in the main land

6.9.3 Cropping patterns in the char land of the study area

291. Dominant cropping pattern in Char land in the study area is Mixed B. Aus+ B. Aman-B. Aman-HYV Boro practiced in 30% of the NCA. The cropping intensity is 200%.

292. Dominant cropping pattern in Char land in close vicinity area is Fallow-Fallow-HYV Boro which is practiced in 40% of the NCA. The cropping intensity is 166% (**Table 6-35**)

Table 6-35: Detailed cropping pattern in the char land

Cropping patterns			Char in study area		Char in closed vicinity area	
Kharif-I (March-June)	Kharif-II (July-October)	Rabi (Nov.-Feb.)	Area (ha)	% of NCA	Area (ha)	% of NCA
Jute	Fallow	Wheat	416	10	28	20
Fallow	HYV Aman	Mustard	832	20	21	15
Mixed B. Aus+ B. Aman	B. Aman	HYV Boro	1,248	30	7	5
Fallow	Fallow	Mustard-HYV Boro	416	10	28	20
Fallow	Fallow	Ground nut	832	20	0	0
Fallow	Fallow	HYV Boro	416	10	55	40
		Total	**4,161**	**100**	**416**	**10**

Sources: CEGIS Assessment based on farmers interviewed and DAE; July, 2015

Photo 6-3: View of groundnut field in the char area

Photo 6-4: View of field in the char area

6.9.4 Agricultural production and damage

Crop production in the main land of the study area.

293. In the study area, the annual total crop production stands at 179,859 tons of which 60,268 tons is rice and 119,592 tons is non-rice crops. Crop area, yield and annual crop production, crop damage in the study and close vicinity area presented in **Table 6-36.**

Crop damage in the main land of the study area

294. Crops are damaged in the study area mainly by drainage congestion, heavy rainfall. as reported by local farmers and the SAAOs of DAE. Total damage of rice production is 10,535 tons in 3,177 ha

Crop production in the vicinity area of the main land of the study area.

295. The annual total crop production stands at about 3,848 tons of which 3,356 tons is rice and 492 tons is non-rice crop.

Crop production loss in the vicinity area of the main land of the study area

296. In the closed vicinity area total rice production loss is 116 tons in 81ha. Detailed crop production and crop production loss is presented in **Table 6-36.**

Crop production of vicinity area of char land in the study area

297. The annual total crop production stands at about tons 720 of which 452 tons is rice and 268 tons is non-rice crops. Crop area, yield and annual crop production, crop damage in the study and closed vicinity area presented in **Table 6-37.**

Crop production in the char land of the study area

298. The annual total crop production stands at 22,516 tons of which 16,067 tons is rice and 6,450 tons is non-rice crop. The contribution of rice crops about 71% and non-rice is about 29% of total crop production (**Table 6-37**). There is no crop damage in the char land..

Table 6-36: Crop area, yield and annual crop production and damage in the study and closed vicinity area

	Crop Name	Crop Area (ha)	Damage Free		Damaged		Total Production (ton)	Production loss(ton)
			Area (ha)	Yield (ton/ha)	Area (ha)	Yield (ton/ha)		
Study area	HYV T. Aus	1,101	936	3.1	165	2.1	2,901	512
	B. Aus	811	646	2.2	165	1.2	1,421	363
	HYV T. Aman	6,262	4,697	3.3	1,566	2.4	15,499	5,166
	Lt. Aman	4,195	3,776	2.7	420	1.9	10,194	1,133
	HYV Boro	8,619	7,757	3.9	862	2.6	30,253	3,361
	Total rice	**20,988**	**17,811**	**0**	**3,177**	**0**	**60,268**	**10,535**
	Mustard	1,139	1,139	1.5	0	0	1,709	0
	Potato	811	811	25	0	0	20,275	0
	Sesame	864	864	1.1	0	0	950	0
	Wheat	2,881	2,881	3.2	0	0	9,219	0
	Pulses	782	782	1	0	0	782	0
	Jute	4,022	4,022	3.8	0	0	15,284	0
	Sugarcane	576	576	40	0	0	23,040	0
	Winter vegetables	736	736	18	0	0	13,248	0
	Summer vegetables	2,339	2,339	15	0	0	35,085	0
	Total non-rice	**14,150**	**14,150**	**0**	**0**	**0**	**119,592**	**0**
	Total	**35,138**	**31,961**	**0**	**3,177**	**0**	**179,859**	**10,535**
Vicinity area	B. Aus	51	51	2.3	0	0	117	-
	HYV T. Aman	140	126	3.3	14	2.2	448	15
	Lt. Aman	58	58	2.7	0	0	157	0
	B. Aman	51	51	2.3	0	0	117	0
	HYV Boro	671	604	3.9	67	2.4	2,517	101
	Total rice	**971**	**890**	0	**81**	**0**	**3,356**	**116**
	Mustard	147	147	1.5	0	0	221	0
	Sesame	3	3	1.1	0	0	3	0
	Wheat	3	3	3.2	0	0	10	0
	Jute	68	68	3.8	0	0	258	0

	Crop Name	Crop Area (ha)	Damage Free		Damaged		Total Production (ton)	Production loss(ton)
			Area (ha)	Yield (ton/ha)	Area (ha)	Yield (ton/ha)		
Study area	HYV T. Aus	1,101	936	3.1	165	2.1	2,901	512
	B. Aus	811	646	2.2	165	1.2	1,421	363
	HYV T. Aman	6,262	4,697	3.3	1,566	2.4	15,499	5,166
	Lt. Aman	4,195	3,776	2.7	420	1.9	10,194	1,133
	HYV Boro	8,619	7,757	3.9	862	2.6	30,253	3,361
	Total rice	**20,988**	**17,811**	**0**	**3,177**	**0**	**60,268**	**10,535**
	Mustard	1,139	1,139	1.5	0	0	1,709	0
	Potato	811	811	25	0	0	20,275	0
	Sesame	864	864	1.1	0	0	950	0
	Wheat	2,881	2,881	3.2	0	0	9,219	0
	Pulses	782	782	1	0	0	782	0
	Jute	4,022	4,022	3.8	0	0	15,284	0
	Sugarcane	576	576	40	0	0	23,040	0
	Winter vegetables	736	736	18	0	0	13,248	0
	Summer vegetables	2,339	2,339	15	0	0	35,085	0
	Total non-rice	**14,150**	**14,150**	**0**	**0**	**0**	**119,592**	**0**
	Total	**35,138**	**31,961**	**0**	**3,177**	**0**	**179,859**	**10,535**
	Total non-rice	**221**	**221**	**0**	**0**	**0**	**492**	**0**
	Total	**1192**	**1,111**	**0**	**81**	**0**	**3,848**	**116**

*Sources: CEGIS Assessment based on farmers interviewed and DAE; July, 2015 *Indicates cleaned rice*

Table 6-37: Annual crop production and damage in the char land

Study location	Crop Name	Crop Area (ha)	Damage Free		Damaged		Total Production (ton)	Production loss(ton)
			Area (ha)	Yield (ton/ha)	Area (ha)	Yield (ton/ha)		
	B. Aus	1,248	1,061	2.2*	187	1.2*	2,559	2,745
	B.Aman	1,248	999	2.3*	250	1.4*	2,646	2,870
	HYV T. Aman	832	832	3.3*	-	0	2,746	-

Study location	Crop Name	Crop Area (ha)	Damage Free		Damaged		Total Production (ton)	Production loss(ton)
			Area (ha)	Yield (ton/ha)	Area (ha)	Yield (ton/ha)		
Char land in the study area	HYV Boro	2,081	2,081	3.9*	-	0	8,116	-
	Total rice	**5,409**	**4,973**	0	**437**	0	**16,067**	**5,615**
	Mustard	1,248	1,248	1.5	0	0	1,872	0
	Ground nut	832	832	2	0	0	1,664	0
	Wheat	416	416	3.2	0	0	1,332	0
	Jute	416	416	3.8	0	0	1,581	0
	Total non-rice	**2,913**	**2,913**	**0**	**0**	**0**	**6,450**	0
	Total	**8,322**	**7,885**	**0**	**437**	**0**	**22,516**	**5,615**
	HYV T. Aman	21	21	3.3	0	0	69	-
Char land in the vicinity area	B. Aus	7	7	2.2	0	0	15	-
	B.Aman	7	7	2.3	0	0	16	-
	HYV Boro	90	90	3.9	0		351	-
	Total rice	**125**	**125**	0		**0**	**452**	-
	Mustard	48	48	1.5	0	0	72	-
	Wheat	28	28	3.2	0	0	90	-
	Jute	28	28	3.8	0	0	106	-
	Total non-rice	**104**	**104**	**0**	**0**	**0**	**268**	-
	Total	**229**	229	0	0	**0**	**720**	-

Sources: CEGIS Assessment based on farmers interviewed and DAE; July, 2015

**Indicates cleaned rice*

6.9.5 Agricultural inputs

299. Seed, labor, fertilizer, pesticide and irrigation are the major inputs used for crop production. The inputs used in the study/closed to vicinity area are described briefly as follows:

6.9.6 Seeds and labor

300. Selection of seeds should be considered on the basis of more than 85% germination rate, free from disease infestation, good shape and size and high yield potential. About 50% of the cultural practices for crop production are being done manually. So, agricultural labor is considered as one of the essential inputs for crop production. The number of labor requirement varies from crop to crop. The rate of labor wages varies from male and female. Average number of labor used per hectare and farmers area using seeds/ha is presented in **Table 6-38**.

Table 6-38: Seed and labor used in the study and close vicinity area

Crop Name	Seed Used (Kg/ha)	Labor(No/ha)
HYV T. Aus	40-45	150
B. Aus	50-60	100
HYV T. Aman	40-45	160
Lt. Aman	50-55	150
B. Aman	50-60	100
HYV Boro	50-60	180
Wheat	120-150	140
Mustard	8-10	120
Potato	1,500-2,000	160
Sesame	18-20	100
Jute	6-8	120
Pulses	50-60	120
Sugarcane	20,000-25,000 cuttings	180
Winter vegetables	2-3	150
Summer vegetables	2-3	160
Ground nut	80-90	100

Source: CEGIS Assessment from EIA field survey; July, 2015

6.9.7 Fertilizer and pesticides

301. Farmers are applying fertilizers for all the crops grown in the study/close vicinity area. The rate of fertilizer used per hectare varies considerably from farmer to farmer depending on soil fertility, cropping pattern and financial ability. The major fertilizers used in this area are Urea, TSP and MP. Most of the farmer applied fertilizer unbalanced way. The use of pesticides depends on the degree of pest infestation. Application of pesticides has been noticed for 1-3 times to control pest and diseases for the rice crops grown in the areas. The major insects as reported by the farmers are Stem borer, Green leaf hopper, Grass hopper, Rice bug, Brinjal shoot and Fruit borer, Red Pumpkin beetle and Mosaic. Local farmer reported that they are using different types of pesticides such as D-ten 10G, Krishan5G, Krishan10G, Hi power, Heron, Morter, Foker, Raison-60 EC, Brifer-5G, Siperin-10EC, Regent-3G, Sifanon-57EC and Cumulus etc. to prevent pest infestation in rice, vegetables and others crop cultivation. Liquid, granular and powder pesticides are being used for pest control. Farmers in general, apply liquid pesticides with the help of sprayer but sometime they mix granular/powder pesticides with the fertilizers and then apply to the fields. Detailed information on fertilizer and pesticides application is presented in **Table 6-39**.

Table 6-39: Detailed information on fertilizer and pesticides used in the study/closed vicinity area

Crop Name	Fertilizer (Kg/ha)				Pesticides		
	Urea	TSP	MP	Other (Gyp)	No of Appli.	Liq. (ml/ha)	Gran. / Pow. (Kg/ha)
HV T. Aus	100-150	80	50	0	1-2	600	5
B. Aus	40-60	40	20	0	0	0	0
HYV T. Aman	100-150	80	50	0	1-2	800	5
Lt. Aman	20-80	60	30	0	2-3	0	0
B. Aman	0	40	20	0	0	0	0
HYV Boro	160-200	80	60	5	1-2	1,000	8
Potato	80-150	90	80	0	2-3	900	0
Wheat	125-200	40	20	0	1-2	600-1000	0
Sesame	30-60	0	0	0	0	0	0
Mustard	40-100	50	40	0	0	0	0
Pulses	40-80	30	10	0	0	0	0
Sugarcane	300	175-220	200	100	0-1	700-2000	7-8
Winter vegetables	100-150	80	60	0	2-3	600	0
Summer vegetables	130-120	60	30	0	2-3	800	0
Ground nut	80-150	0	0	0	0	0	0

Source: CEGIS Assessment from EIA field study; July, 2015

Photo 6-5: Different types of pesticides used in the study area

6.9.8 Irrigation

302. Ground water is being used for irrigation. Irrigation is provided mainly to HYV Boro crops. The ground water is being lifting with the help of Deep Tube Wells (DTWs) and Shallow Tube Wells (STWs) in the study area. But, in the vicinity area ground water is being extracted with the help of Shallow Tube Wells (STWs). According to the Sub-Assistant Agriculture Officer (SAAO) named Mr. Abu Hashem there are 3(three) agricultural blocks in the vicinity area where 310 nos. of STWs were installed for irrigation. Installation depths of each STDs are about 40-60ft depth. Most of the khals are silted up and dried up in the month of February to March. So, irrigation can not be provided from these khals. B. Aus, HYV T. Aus, B. Aman, HYV T. Aman and Lt. Aman are grown in rain-fed condition.

Supplementary irrigation is also provided to rabi crops such as potato, winter vegetables and wheat. Details are shown in **Table 6-40.**

Table 6-40: Detailed information on irrigated area

Crops name	Study area			Vicinity area		
	Irrigation(Ground water)					
	Irrigated area (ha)	% of NCA	Charge (tk/ha)	Irrigated area (ha)	% of NCA	Charge (tk/ha)
HYV Boro	8,619	59	10,500	671	98	10,500
Potato	811	6	4,500	0	0	0
W. vegetables	736	5	2,500	0	0	0
Wheat	2,881	20	3,000	3	0.5	3,000

Source: CEGIS estimation from field information; July, 2015

6.10 Livestock Resources

6.10.1 Population of livestock and poultry

303. Livestock and poultry, being an essential element of integrated farming system and, plays an important role in the economy of the study area. Most of the households raise poultry and livestock, which plays role in income generation and significantly reduces. Farmers are using cattle's for laddering the land but cattle health is very poor. About 50%, 2%, 25% 5%, 45% and 75% of the households of the study area are rearing cows/bullock, buffalo, goats, sheep, ducks and chickens respectively. Detailed information on livestock and poultry is presented in **Table 6-41**.

Table 6-41: Status of livestock and poultry in the study area

Name of livestock/poultry	% of H/H having livestock/poultry	Number of livestock and poultry of the study area
Cow/Bullock	50	97,583
Buffalo	2	3,903
Goat	25	73,187
Sheep	5	19,517
Duck	45	1,75,649
Chicken	75	3,65,936

Sources: CEGIS Assessment based on field information and DLS; July, 2015

Photo 6-6: Cattles grazing in the study area

Photo 6-7: Sheep in the study area

Photo 6-8: Ducks in the study area

Photo 6-9: Cattles grazing from rice heap in the study area

6.10.2 Feed and fodder

304. The owners of the livestock population in the study area are facing problems in respect of non-availability of fodder and feeds during the months of July to November due to unavailability of grazing land. Rice straw is used as the main source of fodder. Besides oil cake, rice husk is also used as fodder. The poultry population at family level survives by scavenging and generally no feed supplements are provided. However, at times kitchen waste becomes poultry feed.

6.10.3 Livestock and poultry diseases

305. Production of livestock and poultry of the study area are mainly constrained due to diseases and death of the population. Outbreak of diseases causes considerable economic loss in livestock farming. Every year, livestock population is affected by different diseases like Foot and Mouth Disease (FMD), Black leg(Badla), Gola fula (Hemorrhagic Septicemia), Worm, Pet fula (Enterotoxaemia), Diarrhea, Mastitis(Olan fula), Peste Des Petits Ruminants (PPR) etc. The goat cyst in head is a common disease of goat. Major poultry diseases are New Castle (Ranikhet), Fowl Pox and Duck Plague etc. The most vulnerable period is June to October (rainy season) months for spreading diseases to livestock and poultry populations. The Duck Plague generally occurs in summer. However, some diseases are found round the year. During monsoon season, the soggy condition of the animal shelter promotes various kinds of diseases to the bullocks and cows.

6.11 Fisheries

306. The contributionof fisheries sector to national GDP is 4.37 percent, which is almost one-fourth (23.37 %) of agricultural GDP (Bangladesh Economic Review, 2013) and 2.01 percent of foreign exchange earnings through export in 2012-13 (FRSS, 2012-13).

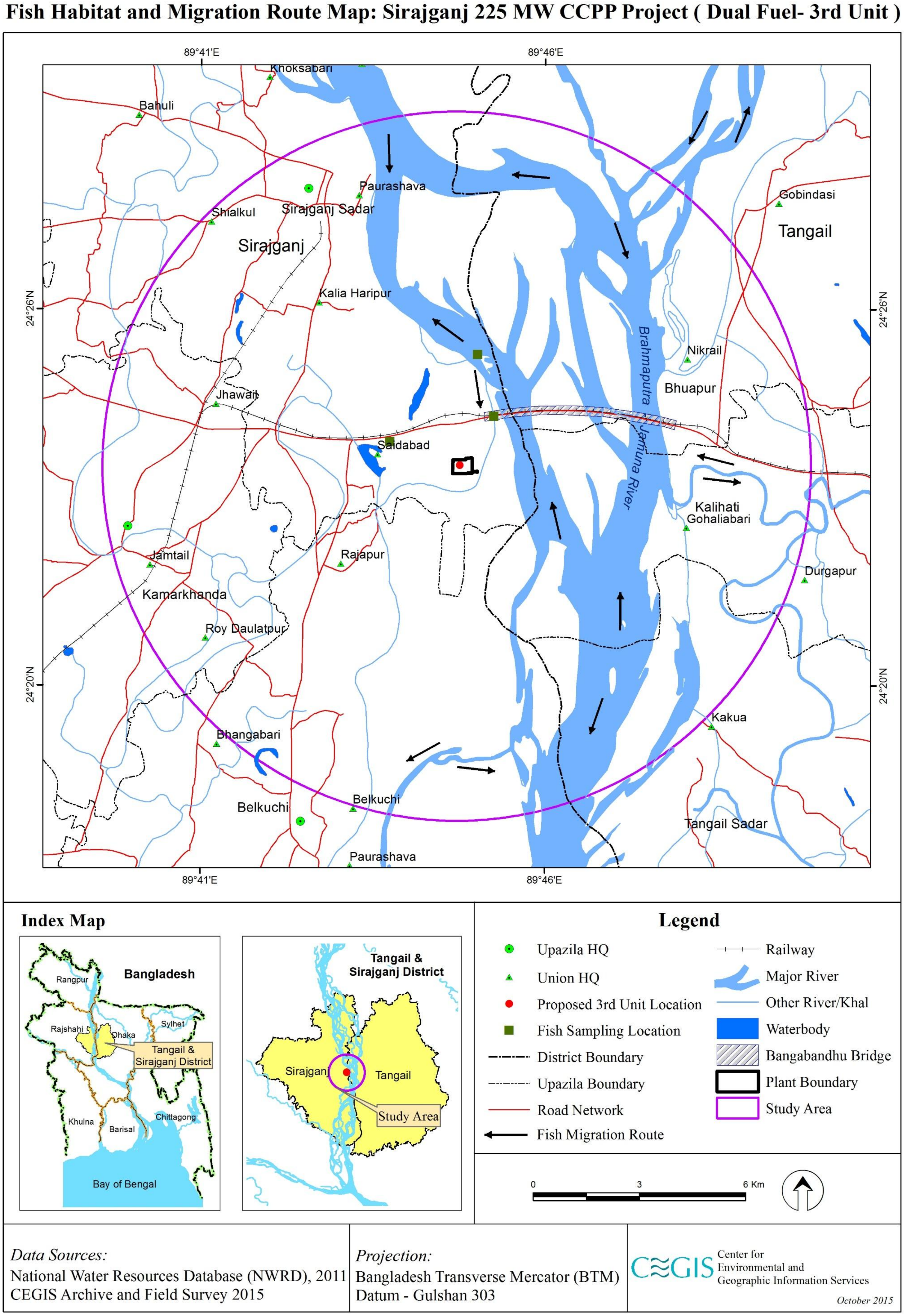
307. Flow patterns, water quality, riverine morphology and fish abundances along with species diversity is highly inter-related. Anthropogenic interventions that change the natural flow patterns of rivers and water quality can alter the ecological integrity or affect the riverine ecosystems, resulting in the loss of native fish species and valuable ecosystem products.

6.11.1 Fish Habitat

308. The study area possesses both capture and culture fresh water fisheries. The identified capture habitats are: river & canal, Beel (depression) and floodplain, and culture habitats are: fish pond, ditch and Baor (oxbow lake), **Map 6-17**.

309. The Jamuna River, crosses across the study area, is the major capture fish habitat, which has been and or will be interfered by different types of erosion protection and communication interventions. These interventions modify the hydro-morphological characteristics of the river with potential far reaching consequences on its ecosystem particularly on fisheries. The mighty Jamuna, a highly dynamic and multi-channel river, has continuously been producing point and longitudinal sandbars on its bed. These sandbars evolve lagoons locally known as 'kol' are fringed by catkin grass and bushes. Such bushy and specialized fish habitats are preferred by different fish species particularly larger catfishes, prawns and notopterids (e.g. Chital) for nesting and breeding. Hatchlings of major carp species along with other small fishes coming from upstream spawning grounds become trapped in such lagoons during the recession period and happen to be susceptible to fishing and natural (desiccation of habitat and bird predation) mortality. Beel becomes connected to the river through canal and floodplain by overspilling spilling of river and canal during wet season (June-September) and restore lateral fish migration.

310. Fish ponds generally retain water round the year as ground water table is relatively high (see details in water resources section) and for fish culture suitability the duration becomes short (40-45 weeks in a year). The Baor retains low water in the dry season and restored in the wet season and fishes are abundant.



Map 6-17: Fish habitat of the study area

6.11.2 Fish Production

The estimated fish habitat in total is about 12,330 ha, where capture fishery contribution is about 98% and culture fishery shares the rest. Sharing of habitats is presented in **Figure 6-19** where highest share (about 52%) comes from riverine habitat and the lowest (about 0.3%) comes from ditch. The annual estimated total fish production of the study area is about 1,650 metric tons which comes from both capture (about 69%) and culture fisheries. Fish production distributions are shown in **Figure 6-20** where riverine habitat contributes the most (about 35%) and canal contributes the lowest (about 0.5%). **Table 6-42** presents the fish habitat areas and corresponding fish productions of the study area. The Project area is a raised land and devoid of any kind of fisheries activities.

Table 6-42: Fish habitats and productions of the study area

Fishery Category	Habitat Types	Habitat Area (Ha)	Production (Ton)
Capture	River	6,396	576
	Canal	152	8
	Beel	38	26
	Floodplain	5,533	526
	Sub-Total=	***12,119***	***1,135***
Culture	Pond	134	466
	Ditch	31	16
	Baor	43	32
	Sub-Total=	***208***	***514***
	Grand Total=	**12,327**	**1,648**

Source: CEGIS estimation based on field visit, Image data and FRSS, 2012-13

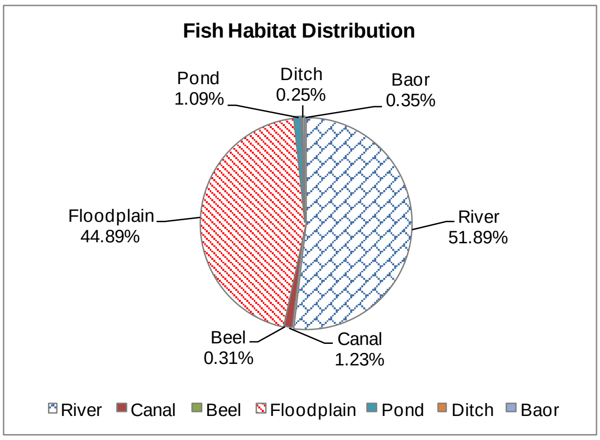


Figure 6-19: Fish habitat distribution

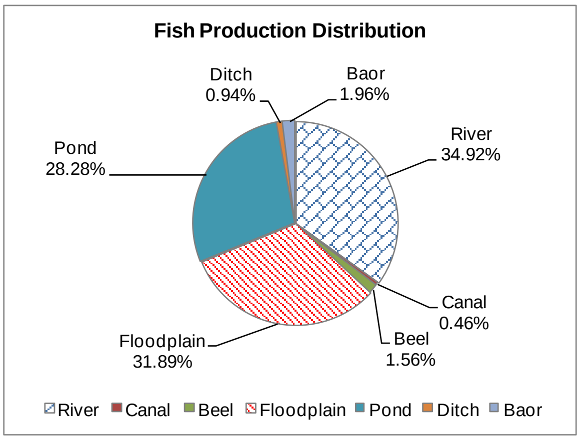


Figure 6-20: Fish production distribution

6.11.3 Fishing Effort

311. During wet season most parts of the study area become a fishing ground especially in the months of July to September. At that time, a good number of households from both mainland and charland (around 25%), as reported by the local fishermen and the concerned UFOs, become engaged in fishing activities in the river, submersible char and floodplain. Overall assessment of the fishermen communities of the study area reveals that about 30% households of the fishing communities are engaged in commercial fishing in and around the study area and they are termed as professional fisherman whereas occasional fisherman (35%) and subsistence fisherman (35%).During dry season, the professional fishermen

mostly and subsistence fishermen partly catch fish from the rivers, perennial Beels and Baor. Professional fishermen also remain engaged as and when necessary especially during dry season in culture fishery for harvesting in exchange of wages or equivalent amount of fish.

6.11.4 Fishing Gears and Frames

312. Different types of fishing gears and traps are used for catching fish depending on seasonality, abundance of species, habitat morphology, etc. A list of widely used gears in the study reaches of the river with seasonality of operation and target species is presented in the following **Table 6-43.** The fishermen have been operating such fishing gears and traps using dinghy, kosha and mechanized boats.

Table 6-43: List of gears and target fish species

Sl. No.	Name of Gears/ Traps	Seasons	Target Fish
1	Chhip jal (Lift net)	Boishakh to Ashar	Boal, Chital, Katol, Rui, Mrigel, Etc.
2	Khara/bhesal (Lift net)	Boishakh to Ashar	Pialee, Rayek, Boal, Kalibaush (Prefer clear water), etc.
3	Nagini jal	Pre-monsoon season	Banshpata
4	Baro khop Ber jal (Large meshed seine net)	Boishakh to Ashyin	Rui, Katol, Boal, Ayer, Baghayer, Beush/ Guizza Ayer, Pangas, Dhaing, Etc.
5	Chhoto khop Ber jal (Dense meshed Seine net)	Chaitra to Jaishthya and Agrahayan to Poush	Chela, Pialee, Rui, Katol, Mrigel, Banshpata, Koikanta, Ghero, Bacha, Chital, Beush, etc.
6	Fish Aggregating Device (FAD), specialized fish trap	Dry season	All types of fish
7	Kerrant jal (Ilish jal)	Wet season	Ilish
8	Doail/doghair (Bamboo trap)	All the year round	Golda, Chhatka Chingri, Bele, etc.
9	Daoin (Long line)	Dry to pre-monsoon season	Rita
10	Borshi (Angler)	Dry to pre-monsoon season	Rita, Kalibaush, Baro Baim, Golda, etc.
11	Savar jal	Ashar to Sravon	Hatchling of Rui, Katol and Mrigel

Source: Field study, 2015

6.11.5 Savar Fishing

313. According to the information of the Senior Upazila Fisheries Officer of Sirajganj Sadar, there were about 44 Savars in 2014 for catching hatchlings/fries along the Sirajganj Sadar Upazila reach of the Jamuna River. Dominant species of the catches include: hatchlings of Rui, Katol, Mrigel, Doira, Rayek, etc. The fishermen set their Savars in the early Jaishthya and remove in the early to mid Sravon. Major Savars are observed in the following villages like Bhat Pieri, Panchasona (nearby the Project site, just about 200 m d/s of the Bangabandhu Bridge), Simla, Hatboira, Soyaselkha, etc. The total harvested hatchlings in 2014 were about 160 kg.


Photo 6-10: Savar FIshing

6.11.6 Pond Aquaculture

314. Major aquaculture practices are observed in and around the rehabilitation center on the west side of the Project site. Habitations in the Char lands have negligible aquaculture practice. Fish species cultured in those fish ponds are dominated by Rui, Kato, Mrigel, Silver Carp, Tilapia, Pangus, etc.

6.11.7 Fish Migration

315. Major carp species like Rui, Katol and Mrigel, catfishes like Baghayer, Ayer and clupeid like Ilish use the Jamuna River for their longitudinal migration. These fishes migrate mostly for feeding and spawning. They migrate toward upstream during July to August for breeding when thunder storm occurs. Fries of the major carp species perform their drifting migration from the upstream to the down and spread over the sandbars and lagoons in their courses.

6.11.8 Fish Species Diversityand Composition

316. Highly nutrient laden water of the Jamuna River supports a wide variety of fish species. Multitude of anthropogenic interventions and natural events has been altering the hydrological regime and corresponding erosion induced induction of silt into water has been causing disruption to fish in many ways. Moreover, addition of untreated effluent though with low quantity from the existing power plant is found to be serious threat to local aquatic organisms including fisheries. The available and indicator fish species of the study area are listed in **Table 6-44**below:

Table 6-44: List of fish species regularly caught

Common Name	Local Name	Habitat Types			
		River	Floodplain	Beel	Pond
Labeo rohita	Rui	P	P	P	P
Jebelion catla	Katol	P	P	P	P
Cirrhinus mrigala	Mrigel	P	P	-	P
L. calbasu	Kalibaush	P	-	-	
Cirrhinus reba	Rayek	P	-	-	
Tenualosa ilisha	Ilish	P	-	-	
Pangasius pangasius	Pangas	P	-	-	
Wallago attu	Boal	P	P	P	
Bagarius yarrelii	Baghayer	P	-	-	
Sperata seenghala	Beush/Guizza ayer	P	-	-	

Common Name	Local Name	Habitat Types			
		River	Floodplain	Beel	Pond
Sperata aor	Ayer	P	-	-	
Rita rita	Rita	P	-	-	
Ailia coila	Banshpata/Kajuli	P	-	-	
Clupisoma garua	Ghaura	P	-	-	
Eutropiichthys vacha	Bacha	P	-	-	
Notopterus chitala	Chital	P	-	-	P
Aspidoparia morar	Chigasi/Pialee	P	-	-	
Channa marulius	Gozar	-	-	P	
C. striata	Shol	-	P	P	
Heteropneustes fossilis	Shingh	-	P	P	-
Clarius batrachus	Magur	-	-	P	-
Salmostomo sp.	Patari chela	P	-	-	-
Corica soborna	Kachki	P	-		
Gagata cenia	Ang tengra	P	-		
Glossogobius giuris	Bele	P	P	P	
Tilapia nilotica	Tilapia	-	-	-	P
Pungasius sutchi	Pungus	-	-	-	P
Hypophthalmichthyes molitrix	Silver carp	-	-	-	P

Source: Field data, 2015

Bagarius yarrelii (Baghayer)

Labeo calbasu (Kalibaush)

Cirrhina reba (Rayek)

Labeo rohita (Rui)

Photo 6-11: Indicative riverine fish species of the study area

6.11.9 Fish breeding grounds and seasonality

317. The scours and charland fringed vegetations spread over the study area river function as fish breeding grounds of diversified fish species. Most of the riverine fishes generally breed within the period of May to August (**Table 6-45**).

Table 6-45: Fish species and hatchling period

Name of Fish Species	Egg Release/Hatching Period	Place of Hatching
Rui, Katol, Mrigel	May-June (egg release during rain & thunder storm)	River (Hatchling trapped in pockets/lagoons of charlands with clear

Name of Fish Species	Egg Release/Hatching Period	Place of Hatching
		water)
Boal	June-July (egg release by rubbing with bushes of charland fringes)	Trapped in lagoons; some manage to escape in the river and some are caught (net) or dried up.
Baghaayer	June-July (egg release in deep water)	Mostly found in the scour area
Chingri	All the year round (egg release in bushes)	Lagoons or small channels
Khorsula	May-June-July (egg release in shallow water)	Nearby bank and charlands
Chital	May-June (building nest at scours and release egg on blocks, geo bags and submerged boat or other objects)	Scours of river and after attaining the size of fingerling they move individually.
Gozar	June-July (hatch as offspring)	Remain in school and become splitted after attaining the size of 4 inches
Ayer	May-June (*Poin*- nest building by making hole in deep water and hatching a mucous like things and hatchlings feed on themucous.	Deep water
Kalibaush	May-July (egg release in block sides under deep water)	Block dumped area
Ilish	December-January and May-August	It goes upstream in deep water (17-25 m) for laying eggs where current is high.
Bashpata	May-July (egg release while move to deeper water)	Pool water
Bacha, Ghero, Kocha	July-August (egg release in moderately deep water)	Becomes trapped in lagoons of charlands
Chingri	August-November (egg release in turbid water)	Both moderately deep and shallow water
Shailo baim	September-October (egg release on bushes)	Fringing bushes of banks and char lands

Source: Field study, 2015

6.12 Ecosystem and Biodiversity

318. The proposed site is a raised land having a terrestrial bushy ecosystem. The Jamuna passes beside the site on the east which is a large riverine ecosystem which supports aquatic biodiversity and terrestrial as well at land-water transitional zones. There is an extension of eco-park on the north attached to the site boundary possess a glimpse of wildlife fauna. Other types of ecosystem are also present around the site in the range of homestead vegetation to crop-field ecosystem. Different landforms create different ecosystems with the variation of floral and faunal diversity.

6.12.1 Bio-ecological Region

319. The site falls in the Bio-ecological Zone- 11 (signifies major river) and the study area (10 km radius from the site) falls under two of Bio-ecological zones namely The Teesta Floodplain (4a) and the Brahmaputra-Jamuna Floodplain (4c) (IUCN 2002).

6.12.2 Ecosystem and Biodiversity

The Proposed Site

320. The site is a terrestrial and fallow land, which is densely covered by tall grasses, herbs and moderate number of shrubs. The site is a newly reclaimed land having sandy top

soil and possessing no succession of economically valued plant species. This ecosystem supports a wide variety of wildlife and avifauna. Mammalian fauna available with moderate abundance in the site are mongoose and mouse. Among the avian roam in this area, sparrow, mynahs, robin, drungoes are important. Two types of lizards i.e.Garden lizard and house lizard were noticed in the proposed site during field visits. No bird nest was observed inside the site. The site seems a haven for the wild dwellers except little disturbances created by the noise generated from the operation of the Unit-1 though they are habituated with the situation. Following **Photo 6-12** shows a glimpse of the site and created ecosystem.

Status of Biodiversity

321. A total of 52 species of plants from 18 families have been recorded from the proposed site. Among the sp Fabaceae, Poaceae and Asteracea are the most Abundance of *Imperata cylindrica, Cynodon dactylon, Fimbristylis schoenoides, Euphorbia hirta, Cyperus sp* is higher than other species. **Table 6-46** provides the detail floral composition of the proposed site.

Table 6-46: Floral species composition of the proposed site

Sl	Species Name	Family	Biodiversity Index	Density	Frequency	Abundance
1	*Imperata cylindrica*	Poaceae	**2.16**	105.75	66.67	7,050
2	*Fimbristylis schoenoides*	Cyperaceae		8.00	50.00	400
3	*Tephrosia purpurea*	Fabaceae		7.50	66.67	500
4	*Richardia scabra*	Rubiaceae		6.00	83.33	400
5	*Oxalis tricodrifolia*	Oxalidaceae		11.33	50.00	567
6	*Euphorbia hirta*	Euphorbiaceae		14.50	33.33	483
7	*Cyperus sp*	Cyperaceae		13.33	66.67	667
8	*Abutilon indicum*	Malvaceae		2.00	33.33	67
9	*Ageratum conyzoides*	Asteraceae		11.00	33.33	183
10	*Amaranthus viridis*	Amaranthaceae		1.00	16.67	17
11	*Blumea lacera*	Asteraceae		2.00	16.67	33
12	*Bothriochola pertusa*	Poaceae		8.00	50.00	267
13	*Brachiaria kurzii*	Poaceae		8.00	33.33	267
14	*Calotropis gigantea*	Apocynaceae		1.00	16.67	17
15	*Calotropis procera*	Apocynaceae		1.50	33.33	50
16	*Cayratia trifolia*	Vitaceae		1.00	16.67	17
17	*Cephalandra indica*	Cucurbitaceae		1.00	16.67	17
18	*Chloris gayana*	Poaceae		3.00	16.67	50
19	*Chromolaena odorata*	Asteraceae		1.00	16.67	17
20	*Clerodendrum viscossum*	Lamiaceae		1.00	16.67	17
21	*Corchorus aestuans*	Malvaceae		1.00	16.67	17
22	*Crotolaria juncea*	Fabaceae		1.00	16.67	17
23	*Crotolaria pallida*	Fabaceae		1.00	33.33	33
24	*Croton banplandianum*	Euphorbiaceae		3.00	50.00	50
25	*Cullen corylifolium*	Fabaceae		2.00	33.33	33
26	*Cynodon dactylon*	Poaceae		60.00	50.00	2,000
27	*Dactyloctenium aegyptium*	Poaceae		5.50	50.00	183
28	*Desmodium dichotomum*	Fabaceae		0.50	16.67	17
29	*Desmodium heterophyllum*	Fabaceae		3.50	33.33	117
30	*Eclipta alba*	Asteraceae		2.00	50.00	100
31	*Eragrostis ciliaris*	Poaceae		1.00	66.67	17
33	*Hemistepta lyrata*	Asteraceae		1.00	66.67	17
34	*Leucus aspera*	Euphorbiaceae		8.00	33.33	133

Sl	Species Name	Family	Biodiversity Index	Density	Frequency	Abundance
35	*Malvastrum coromandelianum*	Malvaceae		1.50	33.33	50
36	*Melilotus indica*	Fabaceae		1.00	16.67	17
37	*Merremia gemella*	Solanaceae		2.00	16.67	33
38	*Mollugo pentaphylla*	Molluginaceae		3.00	33.33	50
39	*Paspallum scrobiculatum*	Poaceae		6.00	66.67	100
40	*Phyla nodiflora*	Verbinaceae		1.00	16.67	17
41	*Physalis angulata*	Solanaceae		1.00	66.67	17
42	*Pogostemon plectranthoides*	Lamiaceae		3.00	33.33	50
43	*Richardia scabra*	Rubiaceae		3.00	50.00	100
44	*Sesbania bispinosa*	Fabaceae		1.00	16.67	17
45	*Smithia sensitiva*	Fabaceae		1.00	16.67	17
46	*Solanum cisymbrifolium*	Solanaceae		1.00	16.67	17
47	*Solanum nigrum*	Solanaceae		1.67	33.33	83
48	*Swietenia mahagoni*	Meliaceae		1.00	16.67	17
49	*Trema orientalis*	Cannabaceae		3.00	33.33	50
50	*Tridax procumbense*	Asteraceae		4.00	16.67	67
51	*Urena lobata*	Malvaceae		1.50	50.00	50
52	*Zizyphus sp*	Rhamnaceae		1.00	16.67	17

Source: CEGIS Field Survey, July 2015

322. The site does not possess big trees. A total of 14 saplings of 3 hard wood tree species were observed in the site during filed visit. The count of trees and their sizes are represented in the following **Table 6-47**.

Table 6-47: Existing trees on the proposed plant location

Sl.	Species Name	DBH (Inch)	Avg Height (m)	No. of Trees
1	Mahagoni *(Swietenia mahagoni)*	4	3	2
		2	2	1
3	*Neem (Azadirachta indica)*	5	4	1
4	Sissoo *(Dalbergia sissoo)*	3	3	10
Total				**14**

Source: CEGIS Field Survey, July 2015

Photo 6-12: Vegetation pattern of the proposed plant site

The Study Area

323. The study area possesses different landforms with different ecosystems. The major ecosystems of the area are as follows:

- Settlement and homestead: Interaction of terrestrial ecological communities between houses and homesteads and their vegetation.
- Crop field: Eco-elements of the agriculture fields interact with soil and water or moisture having seasonal variation.
- River and levee: Predominantly aquatic ecosystem having land-water transitional area characterized by aquatic, amphibian and terrestrial flora and fauna.
- Charland with sand dune: This ecosystem ischaracterized by submersible vegetation, hard wood trees in the permanent sandbars, and appearances of diversified dependent fauna in the range of insects to fish.
- Major road and highway: Characterized by roadside vegetation and dependent fauna.
- Seasonal floodplain: Characterized by submersible macrophytes, other vegetation and dependent fauna.

6.12.3 Status of Biodiversity

324. The aforementioned ecosystems possess versatile habitats, which support a wide variety of floral and faunal species.

Floral Abundance

325. The settlement and homestead pattern of the area is almost identical to each other. The study mostly considers the settlement and homestead ecosystem of the villages closer to the site for biodiversity analysis. The villages are: Panchasona and Borshimul. This ecosystem possesses about 30 tree species which are dominated by *Eucalyptus (Eucalyptus sp)*, *Kola (Musa sp)* and *Jiga (Lennea coromandelica).* A listof tree species of the homestead vegetation is presented in **Table 6-48**.

Table 6-48: Indicative tree species in the settlement and homestead ecosystem

Species Name	Density/Acre	Using Parts	Utilization
Aam (Mangifera indica)	35	Fruit and trunk	Food, Timber
Ata (Anona squamosa)	7	Fruit	Food
Bansh (Bamboosa sp)	35	Trunk	Thatch
Charcoal (Trema orientalis)	3	Whole plant	Fuel
Eucalyptus (Eucalyptus sp)	138	Whole plant	Timber, Fuel
Jiga (Lennea coromandelica)	43	Whole plant	Fencing
Kanthal (Artocarpus heterophylla)	8	Fruit and trunk	Food, Timber
Kola (Musa sp)	68	Fruit	Food
Mahagoni (Swietenia mahagoni)	13	Trunk and fruit	Timber,Medicine
Mandar (Erythrina ovalifolia)	1	Whole plant	Fuel
Neem (Azadirachta indica)	4	Trunk and fruit	Timber,Medicine
Peyara (Psidium guajava)	15	Fruit	Food
Pitali (Trewia nudiflora)	11	Trunk and branches	Timber, Fuel
Shimul (Salmalia malabarica)	3	Fruit and branch	Fiber, Fuel
Supari (Areca catechu)	4	Fruit and trunk	Food, Thatch
Bel (Aegle marmelos)	1	Fruit	Food, Medicine
Kamranga (Averrhoa carambola)	1	Fruit	Food
Kochu (Colocasia esculenta)	14	Whole plant	Vegetables

Species Name	Density/Acre	Using Parts	Utilization
Kul Boroi (Zizyphus sp)	8	Fruit	Food
Litchu (Litchi cinensis)	1	Fruit	Food
Mehendi (Lawsonia inermis)	1	Leaf	Aesthetic
Narikel (Cocos nucifera)	1	Fruit,leafand trunk	Food, Thatch
Pepey (Carica papaya)	14	Fruit	Food
Sazna (Moringa oleifera)	1	Fruit	Vegetables
Gora Neem (Melia azadirachta)	10	Trunk	Timber
Lebu (Citrus medica)	1	Fruit	Food

Source: CEGIS Field Survey, July 2015


Tephrosia candida


Crotolaria pallida


Euphorbia hirta


Solanum cisymbrifolium


Calotropis procera


Dactyloctenium aegyptium


Richardia scabra


Cephalandra indica


Urena lobata


Desmodium trifolium


Chromolaena odorata


Physalis angulata

Photo 6-13: Common floral composition of the proposed plant site

326. River slopes and in some cases levees are dominated by Dhol Kolmi *(Ipomoea fistulosa)* which grows naturally with some grasses like *Brachiara* sp, *Dactyloctinum* sp, *Cyperus* sp. Large portions of the river levees along the site are used as paddy field in the dry season and leguminous plant, Dhaincha *(Sesbania bipinosa)* field in the wet season.

327. Charlands are mainly vegetated with catkin (Chhan) and other tall grasses. Some timber trees are also observed in the permanent sandbars. The catkins *(Imperata cylindrica)* grasses are generally grown around the lagoons created by the sandbars.

328. Seasonal floodplains are actually crop fields that are inundated during monsoon. This type of land grows grassy vegetation; most of those species come from Cyperaceae or Poaceae family.

Fauna

329. The area is is rich in faunal diversity due to the presence of large flowing river, the Jamuna and its distributaries. The area is also inundated seasonally and created different ecosystem which supports aquatic biodiversity and refreshes the terrestrial ecosystems as well.

330. A number of local avifaunal species (i.e.: Black Drungo, Spotted Dove, Long-tailed Shrike, Red Vented Bulbul etc.) roam in the site as their grazing and feeding habitat. The presence of tall grasses, small shrubs and various herbs support different kinds of insects like grasshoppers, millipedes, ants, etc and arthropods like earth worms, etc which attract local avifauna as their food. In addition, mongoose, rats, mouse, etc also inhabited the site and graze as well as breed there. A list of wildlife communities is represented in **Appendix-6**.

6.12.4 Existence of Important Habitat near the proposed site

331. There is an important ecological habitat, the Bangabandhu Eco Park, protected in nature, situated on the right bank of the Jamuna and close to the Bangabandhu Bridge. It is about 1.5 km far away from the sit on the north. Moreover, there is an extension of the Eco Park towards the south up to the Project site is semi-protected. This is also a significant habitat for the wildlife and birds. The Jamuna is the roaming way for the Ganges River Dolphin which is endangered in IUCN global status. They use the main channel of the river for their migration particularly during wet season. There is a chute channel which flows towards Randhunibari and meets again to the main channel becomes dry in the lean season. No evidence of dolphin were noted through this channel for the last 10 years. Except the Eco Park there is no protected area or important habitat within 10 km radius from the site.

6.12.5 Sensitivity of Wildlife to the existing noise from the Unit 1

332. A number of formal and informal public consultations were conducted within the study area for detecting disturbance to wildlife by the noise generated from the existing Unit-1. The wildlife which are residing inside the power plant boundary becomes habituated with the regular noise generated from the Plant. In some cases, birds and other wildlife become scared by sudden noise due to gas pressure release through flare after a long interval. According to local people, they have not noticed any attitudinal change of wildlife due to usual noise or the sudden high noise. Officials of the Bangabandhu Eco-park informed that the noise generated from the vehicular movement along the road and bridge is higher than the noise from existing power plant. The wildlife dwellers of the Eco-park are adapted to the existing noise level generated from the vehicles. So, there is no sensitivity of wildlife to noise from the existing Power Plant. The sensistivity of wildlife due to noise generated from first unit of the power plant is depicted in **Figure 6-21**.

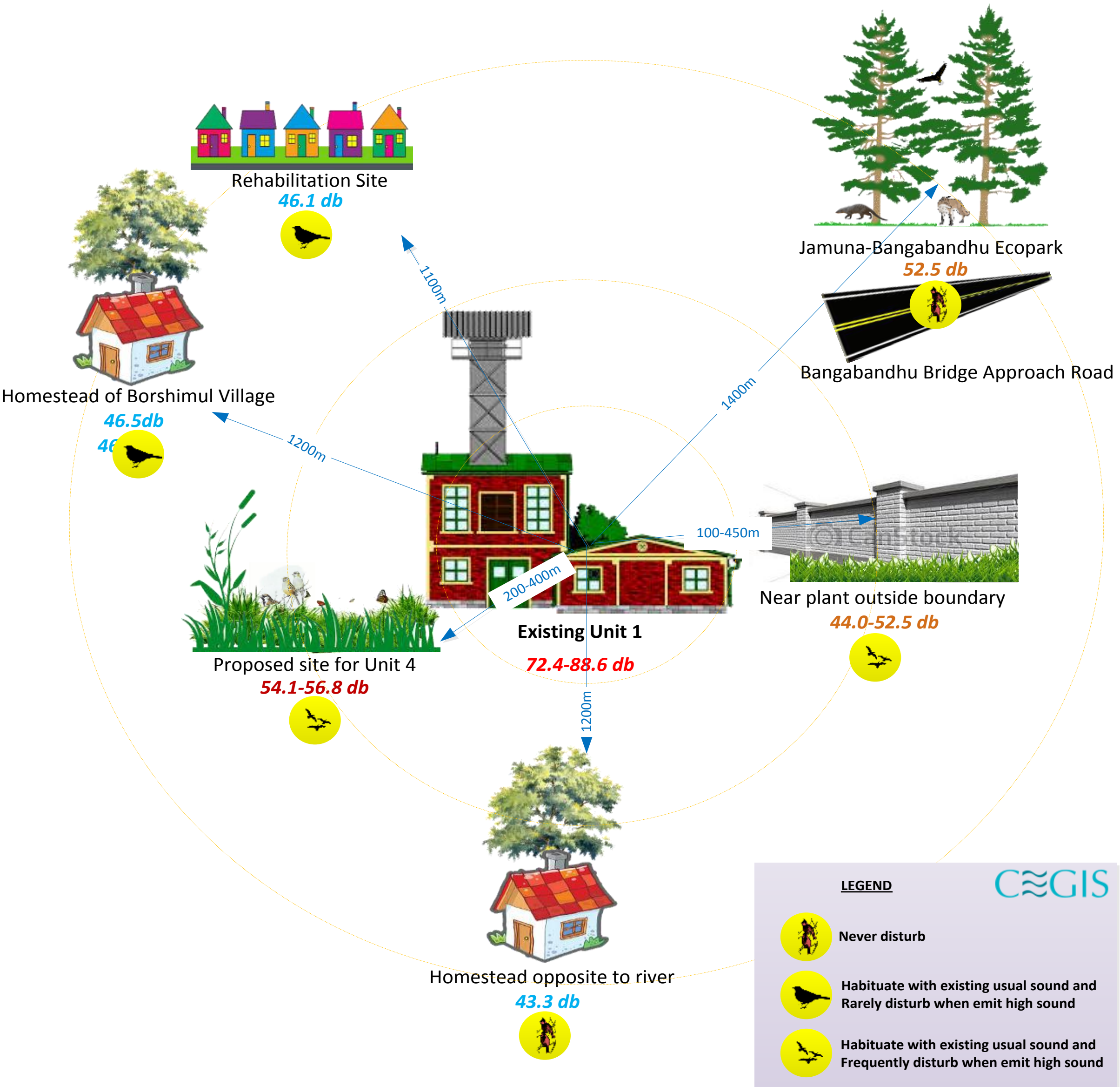


Figure 6-21: Sensitivity to wildlife due to existing noise level form the 1st unit

6.13 Socio-economic Condition

333. The data on the socio-economic condition of the inhabitants of the study area were collected from both primary and secondary sources. The primary data were collected using a range of Rapid Rural Appraisal (RRA) tools and techniques including Key Informant's Interviews (KIIs), Focus Group Discussions (FGDs), observation and informal public consultations. On the contrary, relevant secondary information was compiled from the community series of the Population Census, 2011 published by Bangladesh Bureau of Statistics (BBS).

6.13.1 Area and Location

334. Administratively, the study area consists of 17 unions and 1 municipality either partially or fully. The municipality falls in the Sirajganj Sadar Upazila while unions are dispersed as follows: three unions in Bhuapur, two unions in Kalihati, one union in Tangail Sadar Upazila of Tangail district; four unions in Belkuchi, three unions in Kamarkhanda and five unions in Sirajganj Sadar Upazila of Sirajganj district. Percentages of unions in the study area are shown in the following **Table 6-49**.

Table 6-49: Unions and upazilas in the study area

Name of district	Name of upazila	Name of unions	Percentage of union within study area
Tangail	Bhuapur	Gabsara	19.61
		Gobindasi	12.98
		Nikrail	97.18
	Kalihati	Durgapur	19.24
		Gohaliabari	94.68
	Tangail Sadar	Kakua	54.53
Sirajganj	Belkuchi	Bara Dhul	28.03
		Belkuchi	88.79
		Bhangabari	23.78
		Rajapur	99.10
	Kamarkhanda	Jamtail	57.27
		Jhawail	73.85
		Roy Daulatpur	31.91
	Sirajganj Sadar	Kalia Haripur	100.00
		Kaoakola	13.40
		Saidabad	100.00
		Shialkul	24.46
		Sirajganj Paurashava	74.49

Source: Spatial GIS Analysis, CEGIS, 2015

6.13.2 Demographic Profile

335. The area has 97,583 households, having a total population of 440,768, of which 222,256 are male marginally dominant over female (218,513). The average male-female sex ratio[7] is 101.7 i.e. there are 101.7 males per 100 females which is higher than the national

[7]Number of males per 100 females in a population, using the formula: Sex Ratio SR = M x 100 / F

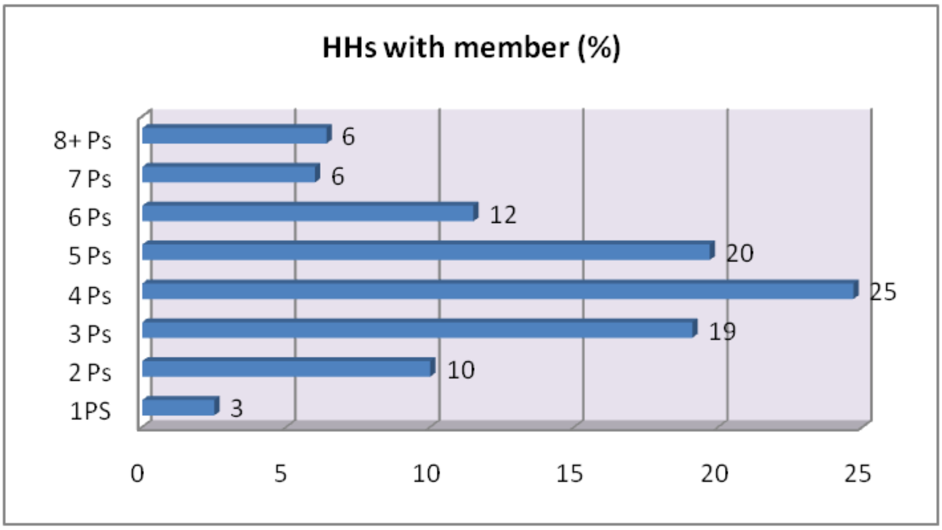
figure of 100.3 (HIES) 2010]. The average population density is 1,273 in compared to the national density of 1,015 persons per sq. km. The inhabitants belong to two main religious groups; i.e. the Muslim and the Hindu. The demographic data of this area is presented in **Table 6-50**.

Table 6-50: Demographic data of the study area

Households	Population			Sex ratio	Population density
	Total	Male	Female		
97,583	440,768	222,256	218,513	100	1,273
	100 (%)	50.42 (%)	49.58 (%)		

Source: Population Census 2011, BBS

336. The average household (HH) size of the area is 4.5 while it is XX nationally. The size of highest percentage (about 25%) of HHs is 4 and the lowest percentage (about 3%) of HHs is 1 as shown in the following **Figure 6-22**.

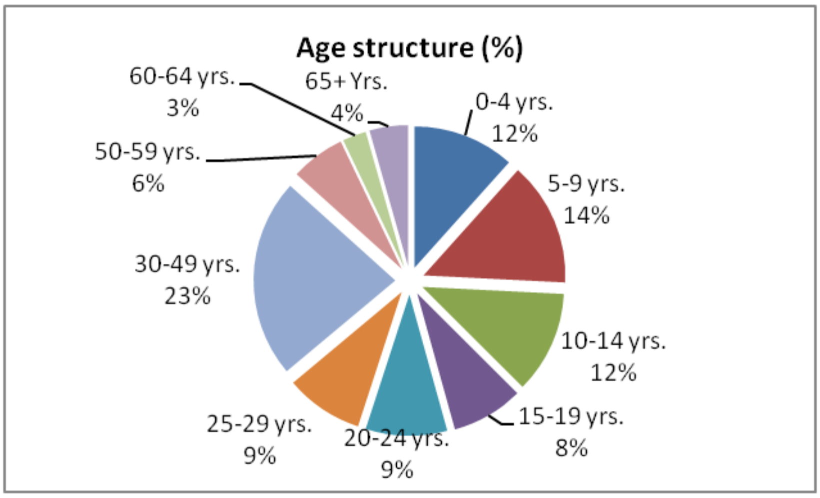


Source: Housing and Population Census, BBS, 2011

Figure 6-22: The household sizes of the study area

Age structure

337. In the study area, the highest number of population (about 23%) belongs to age group of 30 to 49 years while the lowest number (about 3%) belongs to 60 to 64 years age group as shown in **Figure 6-23**. Age groups of 0-14 years is defined as children, 15-24 years as early working age, 25-59 years as prime working age, above 60 and over as elderly people. This classification is important as the size of young population (under age 15) would need more investment in education, while size of older populations (ages 65 and over) would need for more invest in health sector.



Source: Housing and Population Census, BBS, 2011

Figure 6-23: Age structure of the studied population

Education

338. Literacy rate of the area is 41.7% (nationally 53%), where for male it accounts to 44.3% (nationally 54%) and female 39.1% (nationally 49%). Field survey showed that there are 6 (six) primary schools just around the Project site. These are: (i) Baroshimul Panchosona Primary School, (ii) Jamunabali Primary School, (iii) Bangabandhu Bridge Paschim Primary School (Situated within 1 km from the project site) (iv) Saidabad Primary School, (v) Saidabad Gachabari Primary School, and (vi) Sarutia Primary School (within 2 km from the project site). There are also 1 (one) High School, 1 (one) Degree College namely the Jamuna Degree College and 4 Madrashas in the same area (**Photo 6-14**). There is an NGO (Manob Mukti Academy) school is located in the Rehabilitation Center (approximately 500 meter away from the power plant), very closed to the Project site.

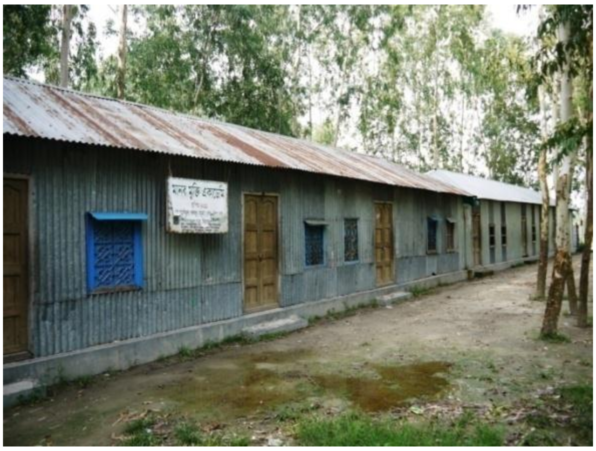


Photo 6-14: Educational institutions in the study area

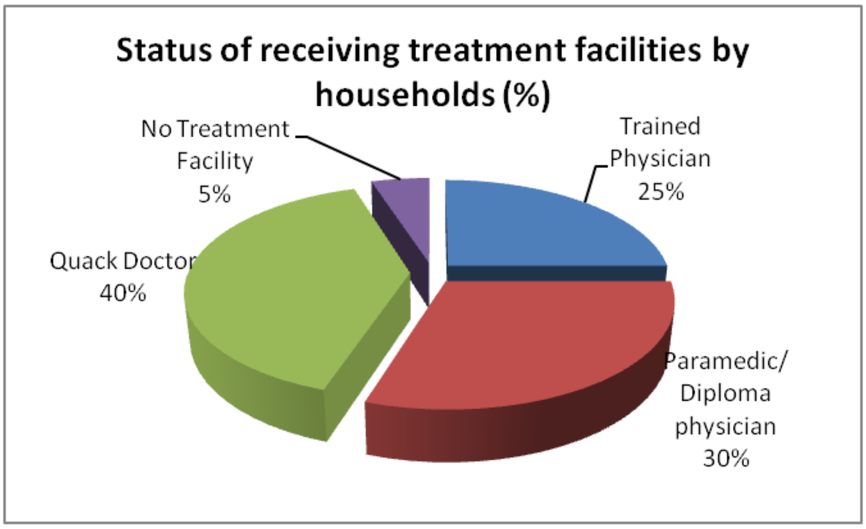
6.13.3 Public Health

Access to Health

339. There are 10 Community Clinics in the area out of which 6 (six) are in Kalia Haripur union and 4 (four) are in Saidabad union and 1 (one) Family Welfare Center around the Project site for providing health services. There is a Health Complex in the Rehabilitation Center but it remains closed round the year.According to local inhabitants, the existing services are almost inaccessible to rural poor people. Therefore, local people have been

receiving services from local chemist, paramedic or village trained physicians**Figure6-24**shows the status of receiving treatment facilities by households.

Photo 6-15: Existing health facilities in the study area



Source: Field Survey, 2015

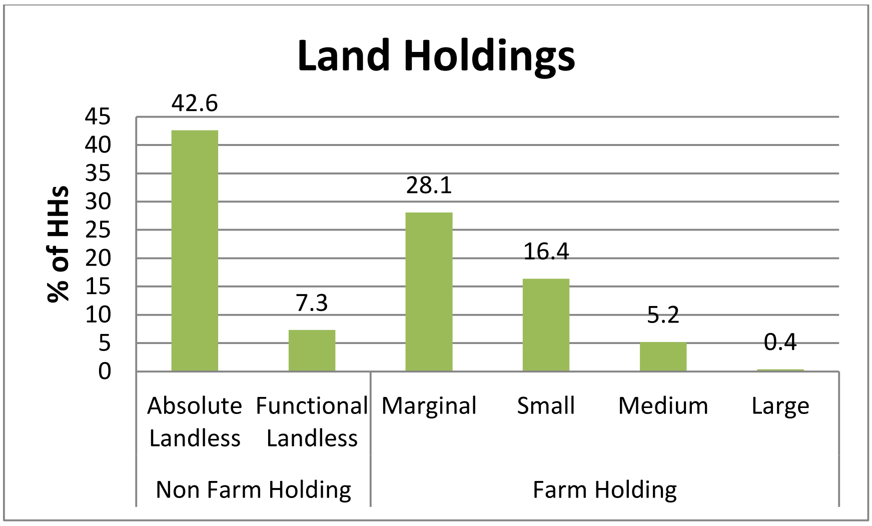
Figure 6-24: Status of receiving treatment facilities by household

6.13.4 Community health condition and common diseases

340. The Population Census, 2011 identified almost six types of disabilities and their proportionate distribution in the respective area. It is found that the study area comprises 1.6% of all types of disabilities and 0.6% people reported that they are physically challenged. 0.1% mentioned speech and 0.2% mental disorder. Local people claimed that diseases like dysentery, skin diseases, diabetes and common fevers are commonly found in the area

6.13.5 Ownership and Utilization of Land

341. Out of total land holdings, about 50.01% are farm-holdings and the remainders are non-farm holdings. Land holding patterns of the area are as follows: about 42.6% households are absolute landless, about 7.3% households belong to functional landless category and other land holdings are shown in the **Figure 6-25** and land tenure arrangement of the area are presented in **Table 6-51**.



Source: *The Census of Agriculture, 2008, BBS*

Figure 6-25: Households by land holdings

Table 6-51: Land tenure arrangement in the study area

Tenancy type	Farmers by holding category (%)				Total
	Marginal	Small	Medium	Large	
Owner	54.33	45.21	49.72	55.44	51.17
Owner-cum-tenant	39.9	51.99	49.04	44.19	46.28
Tenant	5.75	2.83	1.24	0.36	2.54

Source: The Census of Agriculture, 2008, BBS

6.13.6 Occupation and Livelihood

342. According to the *BBS 2011*, about 41% (male- 38% & female- 3%) of local people are employed, about 43% (only female) are occupied in the household activities and about 16% (male- 7% & female- 9%) people do not work in the study area (**Figure 6-26**). Here, household work particularly for women participation is accounted in terms of household activities as well as alternative income generation such as livestock rearing, poultry farming, etc. Local people opined that both male and female are works together in the industry. Moreover, the proposed EZ and BSCIC Industrial Park will expand the livelihood options furthermore.

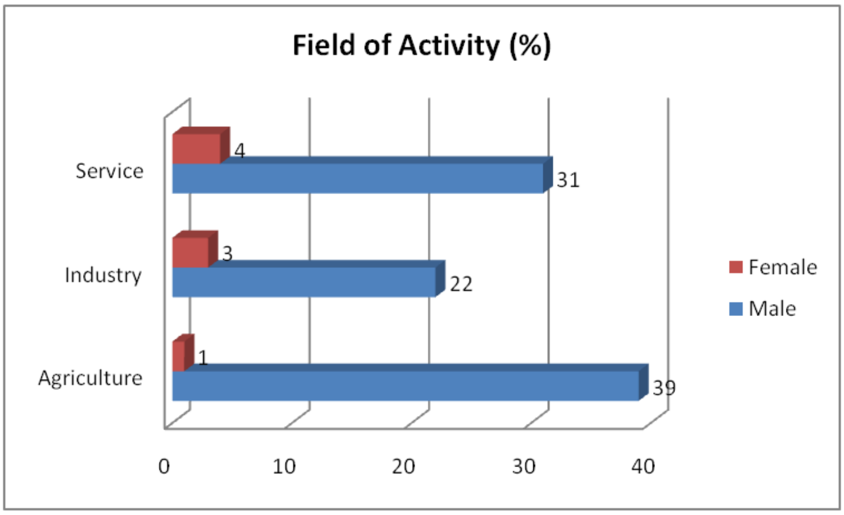


Figure 6-26: Field of Activity (%)

343. The distributions of employment of the area at reference period of census are as follows: about 40% are engaged in agricultural activities, about 25% in industrial and about 35% in service sectors. Agricultural activities includes broadly crop farming, fishery and livestock and poultry farming. Scope of employment in agricultural sectors is gradually decreasing due to expansion of industry. At present, most of them haveengaged themselves in non-agricultural activities like loom industry, handicrafts making, tailoring, etc. There is a huge potential of industrial development in this area with the establishment of EZ and BSCIC.

6.13.7 Labor Market

344. The labor market of the area is prospective as hand and power loom sector is rapidly expanding. Establishment of EZ and BSCIC will boost up the labor market with the potential of in-migration of labor may come up.

345. The present wage rate varies between BDT 300 to BDT 350 per day for male agriculture laborer. The loom weavers get Tk.100 for making each Saree and Tk. 60 for making each Lungi.

6.13.8 Migration

346. During field visit, people stated that out-migration of laborers is commonly found around 25% while in-migration is 12%. The out-migrants usually go to Chittagong, Dhaka, Barisal and Khulna for diversified jobs predominantly in the garments and rickshaw pulling sectors. The in-migrants come here to be engaged in loom weave industry. Besides, a remarkable number of out migrants are engaged in the existing Sirajganj Power Plant. Moreover, there are trivial international out-migrants (about 2%) who tend to go to Middle East for searching of better livelihood options.

6.13.9 Standard of Living

347. Standard of living indicates the level of wealth, comfort; material goods and necessities available to the study are population.

348. Electricity facility is very poor (about 44%) in the area. BBS data shows that Sirajganj Paurashava comprises the highest (90.6%) electricity coverage whereas Bara Dhul union has the lowest (3.9%) coverage. The people of the char areas are yet not receiving electricity connection.

349. The overall housing condition[8] is not satisfactory. The housing pattern of the area is as follows: Kutcha houses (about 87%) followed by Semi-pucca houses about 9%, Pucca houses about 2% and Jhupri houses about 2%.

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[8]BBS distinguishes housing structures into four classes such as- i) **Jhupri**: House which consist mud walls of 1.5 to 3.0 ft thickness, which carry the roof load. Earthen floor, thatch or CI sheets are used as roofing materials. . There is no monolithic joint between the wall and the roof. ii) **Kutcha**: Walls: Organic materials like jute stick, catkin grass, straw, and bamboo mats. Split are bamboo framing. In some areas wall are made by earth. Foundation: Earthen plinth with bamboo or timber posts. Roof: Thatch-rice or wheat or maize straw, and catkin grass, with split bamboo framing; iii) **Semi-pucka**: Walls: Bamboo mats, CI sheet, Timber or bamboo framing. In some areas wall are made by earth, sometimes part or full brick. Foundation: Earthen plinth; Brick perimeter wall with earth infill; Brick and concrete also use. Roof: CI sheet with timber or bamboo framing; and iv) **Pucka**: House which is made by fully concrete, cement, and iron

Photo 6-16: Houses pattern of the study area

350. Sanitation[9] facilities of the area are dominated by non-sanitary latrine households about 41% followed by non-water sealed sanitary latrine households about 39%, water sealed sanitary latrine households about 14% and the rests have no latrine households.

351. Drinking water source of the area is ground water and is generally abstracted using tube-well. About 96% of the households use ground water as drinking water through tube-well. During acute lean period (Chaitra-Boishakh) the inhabitants have been facing problems in abstracting water for the last several years. Only 1% of households collect drinking water from tap. Sirajganj Paurashava comprises the highest percentage (15.1%) of collecting tap water. And 3% of households collect drinking water from other (pond, river, etc) sources.

352. Household income and expenditure is an important indicator to assess the socio-economic condition of the people. The following **Table 6-52** describes the income and expenditure level of the people of the area.

Table 6-52: Distribution of income and expenditure

Range (Tk./month)	Percentage of Households	
	Income	Expenditure
< 1,000	-	-
1,000 - 2,000	-	-
2,000 – 5,000	10	13
5,000 - 9,000	40	65
9,000 - 20,000	42	20
> 20,000	8	2

Source: RRA, 2015

6.13.10 Roads/ Railway/Waterway

353. Various types of roads provide means of communication mostly within the adjacent area. In the Saidabad union 1.78 km roads are paved, 1.83 km roads are brick soled and earthen. The data of Saidabad union has presented as the project is located in the union and

[9]BBS defined four types sanitation in Bangladesh such as (i) Sanitary (water-sealed): A water sealed latrine is simply a pit latrine that has a water barrier to prevent odors. These latrines are simply pits dug in the ground in which human waste is deposited. (ii) Sanitary (not water-sealed/ring slab), latrine with a slab or other secure cover over the drop hole, or a polyethylene flap preventing in-sects from flying into or coming out of the pit; and (iii) Non-sanitary (Kucha): latrine is a frame or platform extending over earth or water; an "open pit latrine" does not have a squat platform or slab on the pit and (iv) No facilities: Defecation in bushes or fields or other outdoor locations.

very adjacent areas are also situated in this union. The total roadway communication system of the study area with Dhaka city is good. Soydabad union is the entry point to North Bengal from Dhaka. The conjunction of railway network of East Bengal, North Bengal and South western zone is also situated in this union. That is why this union is very important in the context of both roadway and railway communication. Mostly the Jamuna River is used for the transportation of goods. The commercial transportation of the surrounding areas also uses the river. **Table 6-53** presents data on road network of the adjacent area;

Table 6-53: Road Network in the adjacent area

Name of Union	Type of Road	Description	Length (Km)
Saidabad	Paved/Brick soling	Porabari hat to Saidabad UP	1.11
		Saidabad U.P-Randhunibari hat	0.62
		Saydabad U.P-R&H via H/O Mahiruddin	0.50
	Earthen road	Porabari hat to Saidabad UP Saidabad U.P-Randhunibari hat	1.39 0.44

Source: CEGIS fieldwork and LGED website, 2015

6.13.11 Poverty Situation

354. Poverty profile has been prepared by the participants of the RRA themselves through a self-assessment exercise. The assessment is based on the year-round income along with the food consumption of the inhabitants within three different categories. It is observed that about 45% percent of the households in average are in the 'balance' category followed by deficit category (about 40%) and surplus category (about 15%).

6.13.12 Safety nets

355. The major social safety nets and poverty reduction programs initiated in the area include the Vulnerable Group Development (VGD), Food/Taka for Work (F/TFW), Food for Education/Cash for Education, Rural Maintenance Program (RMP), Old Age Allowance, Freedom Fighter Allowance and Integrated Poverty Reduction Program. According to local people, these programs have created food security as well as social safety nets among the targeted poor households and vulnerable communities to some extent. **Table 6-54** shows the current social services and facilities for alleviating poverty in the study area.

Table 6-54: Households served by different social safety nets programs

Social Safety Net Programs	Households/Communities Served (%)
Vulnerable Group Development (VGD)	6
Food/Taka For Work (F/TFW) of PIO	4
Food for Education/Cash for Education	10
Rural Maintenance Program (RMP)	6
Old Age Allowance	5
Freedom Fighter Allowance	3
Integrated Poverty Reduction Program of BRDB	6

Source: CEGIS Fieldwork, 2015

356. A number of local, national and international NGOs are working in the study area. The main activities of these NGOs are operating micro credit programs among the rural poor and landless women/men. The major NGOs working in the area include BRAC (Bangladesh Rural Advancement Centre), ASA (Association for Social Advancement), Manob Mukti Sanghstha, DORP, NDP etc.

6.13.13 Market/growth centre

357. There are 5 (five) markets/bazaars are situated around the Project area. These are: Saidabad Hat, Punorbason hat, Zarila Bazar, Porabari Bazar, and Koddarmor Bazar.

6.13.14 Vulnerability to natural disaster

358. Local people opined that, flood is the main natural disaster of the study area. It occurs every year in the area. But historically the flood of 1998 was destructive and long lasting. Moreover, riverbank erosion, storm, hailstorm, drought are the other notable natural disasters occuring in the area.

6.13.15 Key Point Installation

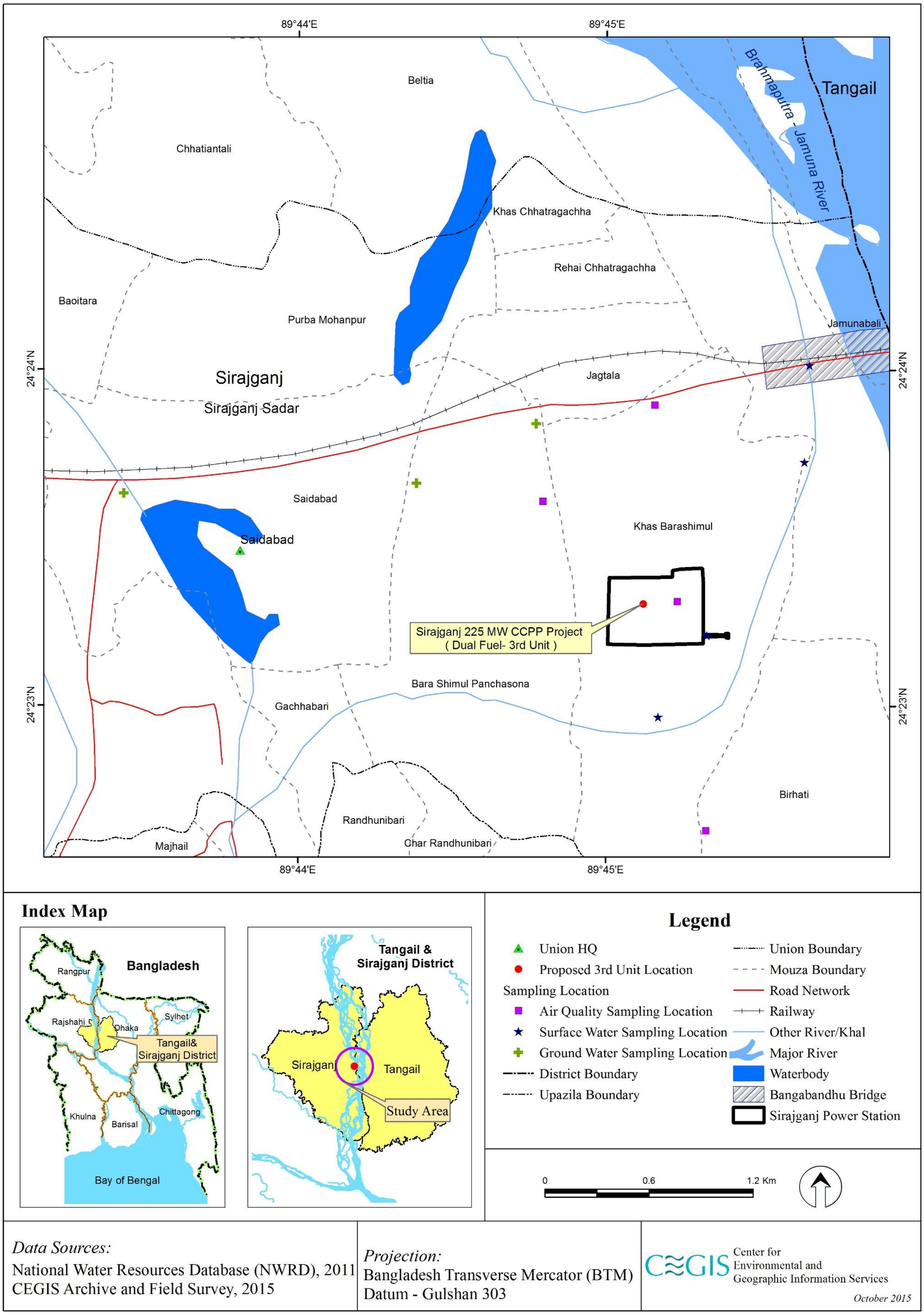
359. Key Point Installation (KPI) is a sensitive establishment of Government guarded on the spot by one security guard and one security supervisor/security head guard in each eight-hour shift, for three shifts a day. The KPIs in the adjacent areas of the NWPGCL are the Bangabandhu Bridge, PGCB substation and PGCL.

6.13.16 Common Property Resources

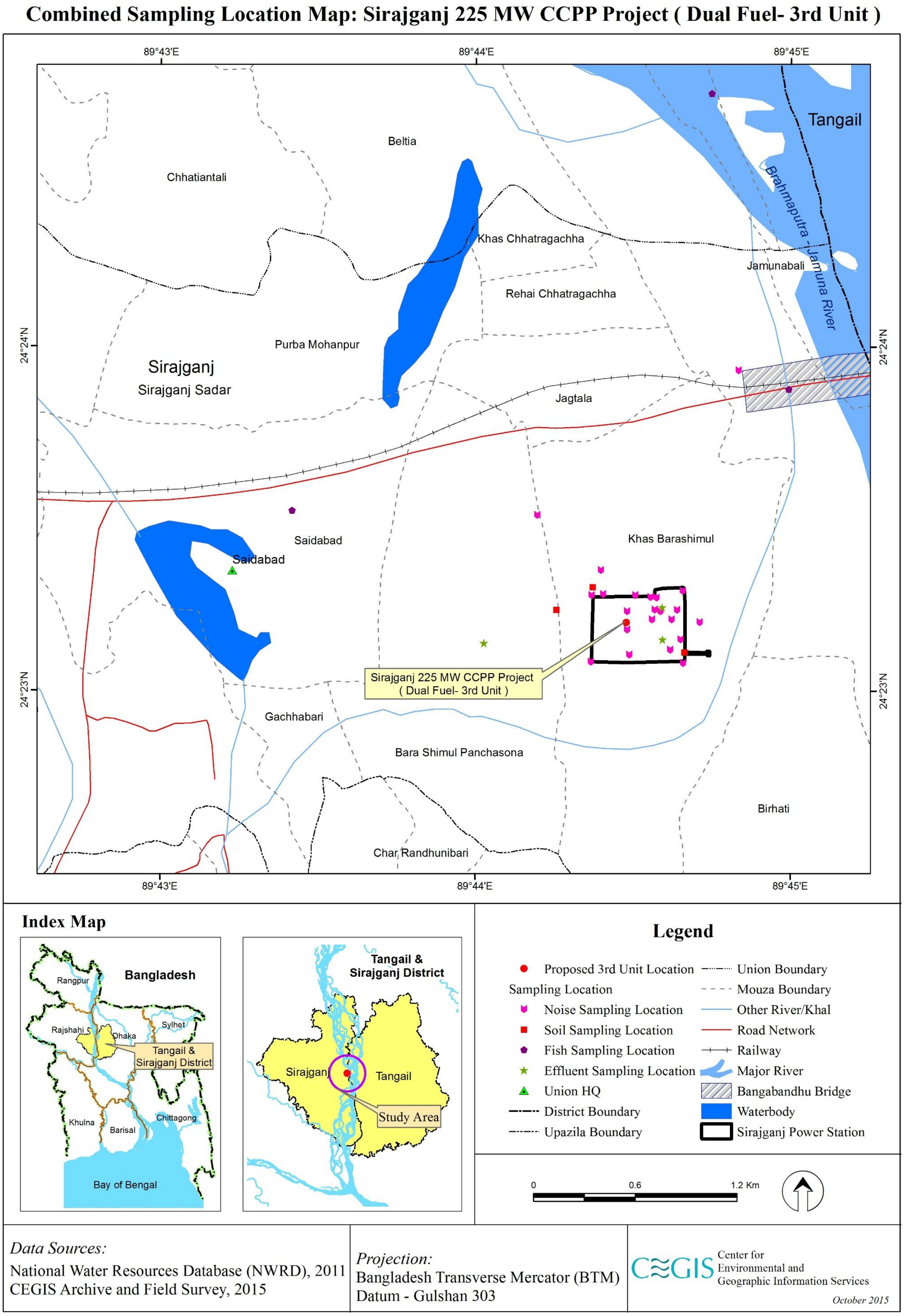
360. The common property resources and/or community facilities in the area are different social amenities e.g. mosques, graveyards, temples, cremation grounds, playgrounds, open water bodies and Eidgahs (place for offering Eid prayers). These are used by the local people for the purposes of religious, social and cultural gathering. Besides these, the Jamuna Bridge, Bangabandhu Eco Park is also used nationally. It is situated very close to the proposed site. There are 4 mosques, 2 Eidgah, 1 graveyard (the only graveyard for the people of jogtola, Monpur, Char Saidabad, Panchosona vilage), 4 playgrounds and 3 markets within the 2 km radius area of power plant. However, there are no known historical and archeological sites declared by government in the Project area.

Photo 6-17: Mosque and graveyard adjacent to the power plant

Combined Sampling Location Map: Sirajganj 225 MW CCPP Project (Dual Fuel- 3rd Unit)



Map 6-18: Sampling location of air, surface water and groundwater



Map 6-19: Sampling location map of noise, soil, fish and effluent

7 Environmental Impacts

7.1 General

361. The existing Sirajganj Unit-1 CCPP is under operation and the construction of Unit-2 is underway. The proposed Unit-3 Dual Fuel 225MW CCPP in the same premise and within a common boundary will enhance the current electricity generation capacity in the same environment using same sources for water, air, fuel, etc and hence will create additional impacts. The proposed major activities will involve construction of labor camp, site preparation, transportation of machinery and ancillaries, storage of equipment and materials for construction, erection of all equipments and machineries, their auxiliaries and ancillaries of Unit-3, construction of gas pipelines. Land acquisition is not required for the construction of the Plant, as well as for the improvement of access road along the right bank of the Jamuna River. These activities will have diversified impacts on the environment and the socio-economic conditions of the local people with various natures and magnitudes. Among the impacts from the proposed activities, some are temporary in nature and limited to pre-construction and construction period, and others are permanent in nature during the operation period. Based on the experience of other similar power generation projects, many of the environmental issues are mainstreamed in the project design (e.g., minimize NOx emission by using de low NOx burner, lower the specific-relative water requirement for condenser cooling, decrease specific-relative fuel requirement, etc.). Clearing of bushes and felling of trees during site preparation and labor camp induced sanitation and social stress are the most significant impacts of the construction works. A small number of tree felling will be done which may have little ecological fragment effect and lead to loss of critical bird habitats. Technological improvement is expected to reduce the generation of solid and liquid waste which will facilitate management of such wastes within the environmental limits. The overall positive impacts of the project are as follow:- the enhancement of the generation capacity of the electricity and improving the socio-economic conditions and lifestyle of the local as well as of country people.

7.2 Impact Assessment Methodology

362. Potential environmental and social impacts were identified on the basis of the review of Feasibility Report, field visits, and stakeholder consultations. The significance of potential impacts was assessed using the criteria and methodology given below.

7.2.1 Impact Magnitude

363. The potential impacts of the project have been categorized as major, moderate, minor or nominal based on consideration of the parameters such as: i) duration of the impact; ii) spatial extent of the impact; iii) reversibility; iv) likelihood; and v) legal standards and established professional criteria.

364. The magnitude of potential impacts of the Project has generally been identified according to the categories outlined in **Table 7-1**.

Table 7-1: Parameters for Determining Magnitude

Parameter	Major	Moderate	Minor	Minimal
Duration of potential impacts	Long term (more than 15 years)	Medium Term Lifespan of the project (5 to 15 years)	Limited to construction period	Temporary with no detectable potential impact
Spatial extent of the potential impacts	Widespread far beyond project boundaries	Beyond immediate project components, site boundaries or local area	Within project boundary	Specific location within project component or site boundaries with no detectable potential impact
Reversibility of potential impacts	Potential impact is effectively permanent, requiring considerable intervention to return to baseline	Potential impact requires a year or so for recovering with some interventions to return to baseline	Baseline returns naturally or with limited intervention within a few months	Baseline remains almost constant
Legal standards and established professional criteria	Breaches national standards and/or international guidelines/ obligations	Complies with limits given in national standards but breaches international lender guidelines in one or more parameters	Meets minimum national standard limits or international guidelines	Not applicable
Likelihood of potential impacts occurring	Occurs under typical operating or construction conditions (Certain)	Occurs under worst case (negative impact) or best case (positive impact) operating conditions (Likely)	Occurs under abnormal, exceptional or emergency conditions (Occasional)	Unlikely to occur

7.2.2 Sensitivity of Receptor

365. The sensitivity of a receptor has been determined based on review of the population (including proximity / numbers / vulnerability) and presence of the features on the site or the surrounding area. Each detailed assessment has defined sensitivity in relation to the topic. Criteria for determining receptor sensitivity of the Project's potential impacts are outlined in**Table 7-2**.

Table 7-2: Criteria for Determining Sensitivity

Sensitivity Determination	Definition
Very High	Vulnerable receptor with little or no capacity to absorb proposed changes or minimal opportunities for mitigation.
High	Vulnerable receptor with little or no capacity to absorb proposed changes or limited opportunities for mitigation.
Medium	Vulnerable receptor with some capacity to absorb proposed changes or

Sensitivity Determination	Definition
	moderate opportunities for mitigation
Low	Vulnerable receptor with good capacity to absorb proposed changes and/or good opportunities for mitigation

7.2.3 Assigning Significance

366. Following the assessment of magnitude, the quality and sensitivity of the receiving environment or potential receptor has been determined and the significance of each potential impact established using the impact significance matrix shown in**Table 7-3**.

Table 7-3: Significance of Impact Criteria

Magnitude of Impact	Sensitivity of Receptors			
	Very High	High	Medium	Low
Major	Critical	Major	Moderate	Minimal
Moderate	Major	Major	Moderate	Minimal
Minor	Moderate	Moderate	Minor	Minimal
Minimal	Minimal	Minimal	Minimal	Minimal

7.3 Summary of Assessed Impacts

367. The project's potential impacts and their significance have been assessed using the methodology described above. A summary of these impacts and their significance is presented in **Table 7-4**.

Table 7-4: Potential impacts and their significance

IECs/Issues	Potential Impacts from various Activities	Sensitivity	Magnitude	Significance Prior to Mitigation	Compliance to laws, regulation or accepted national or international standards, protected status of site or species
Environmental impacts during pre construction stage:					
A. Ambient Air					
		No impact	No impact	No impact	
B. Ambient Noise					
B1. Noise pollution	Little increase in the ambient noise level during construction of labor shed, felling timber trees and leveling up the land.	Low	Minor	Minimal adverse	Noise Pollution Control Act, 2006 of Bangladesh
C. Water Resources					
C1. Surface Water Quality	Direct disposal of debris or waste materials from the vegetation clearance site, kitchen waste or sanitation waste from labor shed may cause water Quality deterioration.	Low	Moderate	Minimal adverse	ECR 1997, Performance Standards on Environmental and Social Sustainability
C2. Internal Drainage System	Drainage congestion would be caused if waste generated from vegetation clearance, site preparation and domestic activities from labor colony are dumped irregularly near the drainage system.	Low	Minor	Minimal adverse	ECR 1997, Performance Standards on Environmental and Social Sustainability
D. Land Resources					
D1. Top Soil	During site preparation, earthworks would destroy quality of fertile top soils that are enriched with nutrients required for afforested and naturally grown plant growth.	High	Minimal	Minimal adverse	
E. Agricultural Resource					
		No impact	No impact	No impact	
F. Livestock Resources					
		No impact	No impact	No impact	
G. Fisheries Resources					

IECs/Issues	Potential Impacts from various Activities	Sensitivity	Magnitude	Significance Prior to Mitigation	Compliance to laws, regulation or accepted national or international standards, protected status of site or species
		No impact	No impact	No impact	
H. Ecosystem					
H1. Terrestrial vegetation	Vegetation clearance due to temporary storage of construction materials/construction machineries and facilitate labour shed	Medium	Moderate	Moderate	ECP 1
H2. Wildlife habitat	Clearance of vegetation will damage dependent wildlife habitat and relocate impacted wildlife to the nearer ground	Medium	Moderate	Moderate	ECP 2
I. Socio-economic Condition					
I1. Extra burden on accommodation	Mobilization of laborers to the site would create extra pressure on the existing accommodation facilities along with the social amenities including sanitation.	Medium	Minor	Minor adverse	Labor Law, 2006
I2. Cultural conflicts	Migrant workers may come from different parts of the country thus a cultural conflict may be created between the migrant workers and the communities.	Medium	Minor	Minor adverse	
I3. Employment of local people	Employment generation of the local people based on their skill will bring positive notion of the local inhabitants towards the Project.	Medium	Minor	Minor beneficial	
I4. Labor Migration	Susceptibility of unconventional relations between the migrant laborers and local vulnerable women may lead to the risk of gender oriented/sexually transmitted diseases like HIV/ AIDS and STI.	High	Moderate	Major adverse	WHO Guidelines
J. Non-Hazardous Waste Generation					
J1. Solid Waste	Aesthetic tiring due to negligence in management of waste generated from vegetation clearance, land development and domestic activities	Low	Minor	Minor adverse	ECR 1997, IFC's Performance Standards on Environmental and Social Sustainability
J2. Kitchen Waste	Aesthetic tiring due to negligence in management of kitchen waste	High	Moderate	Major adverse	ECR 1997, IFC's Performance Standards

IECs/Issues	Potential Impacts from various Activities	Sensitivity	Magnitude	Significance Prior to Mitigation	Compliance to laws, regulation or accepted national or international standards, protected status of site or species
					on Environmental and Social Sustainability
J3. Liquid Waste and Sewerage	Aesthetic tiring due to negligence in management of waste	Low	Minor	Minimal adverse	ECR 1997, IFC's Performance Standards on Environmental and Social Sustainability
Environmental Impact during Construction Stage					
K. Ambient Air					
K1. Dust and gases from construction equipment and vehicles	Emissions of dust and gases will be generated from excavation of trenches, operation of construction equipment and vehicles, and material transport, which is injurious to human health.	Medium	Moderate	Moderate adverse	ECR 2005 WBG General EHS Guidelines, 2007
L. Ambient Noise					
L1. Noise pollution	Noise would be generated from the moving and idling vehicles and heavy machineries, which may cause disturbance, increased stress level, increased blood pressure etc. on the people who are susceptible to the generated noise.	Moderate	Medium	Moderate adverse	Noise Pollution Control Act, 2006 of Bangladesh
M. Water Resources					
M1. Surface Water Quality	Disposal of untreated rainfall wash water coming from unplanned storage of construction raw materials and equipments, and irregular release of construction waste water may contaminate water. Discharge of oil and grease containing bilge water from the water transport in the river may also contaminate water leads to deterioration of water quality.	Medium	Moderate	Moderate adverse	ECR 1997, Performance Standards on Environmental and Social Sustainability
M2. Internal Drainage System	Discharging of liquid waste generated from the construction work of the proposed Project through existing internal drainage system may create drainage congestion.	Medium	Minor	Minor adverse	ECR 1997, Performance Standards on Environmental and Social Sustainability

IECs/Issues	Potential Impacts from various Activities	Sensitivity	Magnitude	Significance Prior to Mitigation	Compliance to laws, regulation or accepted national or international standards, protected status of site or species
M3. Groundwater Availability	Little local impact; no regional impact. Aquifer seasonally fully recharged by Jamuna River.	Moderate	Medium	Moderate adverse	Bangladesh Water Act, 2013
N. Land Resources					
N1. Land Use Change	During construction phase, the land use might be affected due to construction of Power plant.	High	Minor	Moderate adverse	
O. Agricultural Resources					
		No impact	No impact	No impact	
P. Livestock Resources					
		No impact	No impact	No impact	
Q. Fisheries Resources					
Q1. Habitat condition	During transportation of machinery and ancillaries, disposal of waste water like ballast and bilge water from the ship/cargo into the river containing oil and grease contaminants might affect the local aquatic habitat quality temporarily. Dredging for accessing ship to the jetty from main river channel might disturb the benthic community (demersal fish species like Bele, Baro Baim, Chital, Bagair, etc.; snail; submersible macrophytes, etc.) in their habitation.	High	Minor	Moderate adverse	Dredging is a 'Red' category activity as per the ECR, 1997. So it may need to be considered separately.
R. Ecology					
R1. Aquatic habitat quality	Deteriorate local aquatic habitat quality due to disposal of waste water like ballast and bilge water from the ship/cargo into the river having oil and grease contaminants during transportation of machinery and ancillaries	High	Minor	Moderate	ECP3
	Impact on aquatic habitats including benthic habitat due to dredging operation for creating sufficient navigation channel for ship carrying heavy plant equipment.	High	Minor	Moderate	ECP3

IECs/Issues	Potential Impacts from various Activities	Sensitivity	Magnitude	Significance Prior to Mitigation	Compliance to laws, regulation or accepted national or international standards, protected status of site or species
R2. Terrestrial vegetation	Felling of 14 hard wood trees and clearance of all naturally grown herbs and shrubs for construction of civil structures, lying gas pipeline, construction of machinery unloading area and storing of imported machinery	Medium	Moderate	Minor	ECP 1
R3. Wildlife habitat	In consequence of vegetation clearance, dependent wildlife will lose their abodes and relocate to nearby bushes and create pressure on the wildlife of the new area and its quality.	Medium	Minor	Minor	ECP 2
	Interrupt free movement of wildlife for placement of machineries/construction materials and generate noise Disturbance to nocturnal animals for excess lightening at the site	Low	Minor	Minimal	ECP 2
S. Socio-Economic Condition					
S1. Extra burden on accommodation	Approximately 100 to 125 laborers and technicians will be engaged in different activities during construction phase by the EPC contractor. Out of which around 50-60% of laborers is expected to be hired and engaged on day basis form the local community. This would alleviate the problems related to accommodation and other social amenities including sanitation. Accommodating the remaining laborers and technicians in the labor camp established on the leased land of BBA would create extra pressure on the local community on different issues, such as social amenities including sanitation, potable water, market price, prevailing socio-cultural situation, etc.	Medium	Moderate	Moderate adverse	
S2. Noise pollution	Noise will be generated from moving and idling	Medium	Moderate	Moderate	

IECs/Issues	Potential Impacts from various Activities	Sensitivity	Magnitude	Significance Prior to Mitigation	Compliance to laws, regulation or accepted national or international standards, protected status of site or species
	vehicles, welding operations and movement of heavy machineries and it may be cause hearing problem and create panic to the adjacent people.			adverse	
S3. Cultural conflicts	Migrant workers may come from different parts of the country thus a cultural conflict may be created between the migrant workers and the communities.	Medium	Minor	Minor adverse	
S4. Employment of local people	Employment generation of the local people based on their skill will bring positive notion of the local inhabitants towards the Project.	Medium	Moderate	Moderate beneficial	
T. Non-Hazardous Waste Generation					
T1. Solid Waste	Aesthetic tiring due to negligence in management of waste generated from construction activities and labor sheds	Medium	Moderate	Moderate adverse	ECR 1997, IFC's Performance Standards on Environmental and Social Sustainability
T2. Kitchen Waste	Aesthetic tiring due to negligence in management of kitchen waste	High	Moderate	Major adverse	ECR 1997, IFC's Performance Standards on Environmental and Social Sustainability
Environmental impacts during operation stage:					
U. Ambient Air					
U1. Maximum ground level concentration of pollutants	Emission of exhaust gas from the stack may contribute elevated ground concentration of CO, NOx, PM_{10}, $PM_{2.5}$ etc. at the downwind direction.	Medium	Moderate	Moderate adverse	ECR 2005 WBG General EHS Guidelines, 2007
V. Ambient Noise					
V1. Noise Pollution	Noise producing from the first, second and third units cumulatively would have a tendency of exceeding the noise level standard in some palces. This might result in hearing complexity and loss along with increased blood pressure, disturbances and discomfort to the site engineers, technicians and workers and	Major	Medium	Moderate adverse	Noise Pollution Control Act, 2006 of Bangladesh

IECs/Issues	Potential Impacts from various Activities	Sensitivity	Magnitude	Significance Prior to Mitigation	Compliance to laws, regulation or accepted national or international standards, protected status of site or species
	surrounding communities.				
W. Water Resources					
W1. Surface Water Quality	Increasing and cumulative load of effluent from all four units when in operation may exacerbate the water quality condition leading to degradation.	High	Major	Major adverse	ECR 1997, Performance Standards on Environmental and Social Sustainability
W2. Ground Water Quality	Ground water may be contaminated subjected to seepage and infiltration of the water which is polluted due to the direct disposal of effluent.	Medium	Moderate	Moderate adverse	ECR 1997, Performance Standards on Environmental and Social Sustainability
W3. Ground Water Availability	Little local impact; no regional impact. Aquifer seasonally fully recharged by Jamuna River.	Moderate	Medium	Moderate adverse	Bangladesh Water Act, 2013
W4. Internal Drainage System	Drainage congestion may be occurred if the internal drainage system is linked with any kitchen waste, waste from officers/ workers colony disposal.	Medium	Moderate	Moderate adverse	ECR 1997, Performance Standards on Environmental and Social Sustainability
X. Land Resources					
X1. Soil quality	Accidental spillage of untreated effluent on the nearby land from the Plant, and during filling the oil tank leakage of oil pipe may cause spillage of HSD oil to the land either side of the pipe leading to degradation of the soil quality.	High	Moderate	Major adverse	
X2. Land Use Change	Operation of the power plant, might cause the changes in local infrastructures.	High	Major	Major adverse	
Y. Agricutltural Resources					
Y1. Disrupt Irrigation Facility	Use of ground water for cooling purposes of the third unit would limit the availability. The cumulative effect of other units and development of EZ and BSCIC might exacerbate the ground water availability. Thus irrigation activity would be more costly and production	Very High	Major	Critical adverse	

IECs/Issues	Potential Impacts from various Activities	Sensitivity	Magnitude	Significance Prior to Mitigation	Compliance to laws, regulation or accepted national or international standards, protected status of site or species
	of crops will be declined.				
Z. Livestock Resources					
Z1. Loss of Fodder and harmful for Livestock	Construction of the proposed power plant would restrict grazing land. Release of untreated liquid waste/effluent from the existing Plant in the adjacent water body s might cause retardation of the growth of along with the toxicity to the fodder vegetation. Increase of pollution load when first three units are in operation might lead more devastation to the fodder vegetation of the cattle.	Medium	Moderate	Moderate adverse	
AA. Fisheries Resources					
AA1. Habitat condition	For meeting up the requirement of makeup water, withdrawal of ground water will be needed at a rate of 400 m^3/hr for third Unit during the Plant life time. The first unit has been withdrawing 600 m^3/hr. So, the cumulative effect of withdrawing ground water (2550 m^3/hr) for all four units when in operation might affect the pond water availability period of the area under the influence of the cone of depression. As a result, pond aquaculture may be affected with low productivity of fish.	High	Major	Major adverse	
BB. Ecosystem					
BB1. Disturbance to local aquatic habitat	Accidental discharge of hazardous effluents and hot water may demolished aquatic micro organisms/fishes and deteriorate habitat quality	High	Major	Major	ECP3
BB2. Disturbance to terrestrial wildlife	Fear/scared wildlife like birds and rodents for emit excess noise from the power plant at excess level	Medium	Moderate	Moderate	ECP 2
CC. Socio-Economic Condition					
CC1. Noise pollution	It may create excessive noise during the trial period of	High	Moderate	Major adverse	ECR, 1997 WBG General

IECs/Issues	Potential Impacts from various Activities	Sensitivity	Magnitude	Significance Prior to Mitigation	Compliance to laws, regulation or accepted national or international standards, protected status of site or species
	commissioning of new unit and it may cause a matter of hearing complexity, and loss along with increase blood pressure, disturbances and discomfort to the technicians and workers and surrounding communities.				EHS Guidelines
CC2. Contribution of the project to the local livelihood and economy of the nation	Implementation of the project may reduce the energy shortfall and revive associated economy. It may attract the new entrepreneurs to build new industry for development of the nearby areas to power plant.	Very high	Moderate	Major beneficial	
CC3. Employment Generation	Supplementary employment opportunities, in the way to increased prosperity and security due to higher and stable incomes of employed people.	High	Moderate	Major beneficial	
CC4. Expansion of new industry	The construction of the new unit may expand the possibility of developing new small scale industry in the local area.	Medium	Moderate	Moderate beneficial	
DD. Non-Hazardous Waste Generation					
DD1. Liquid Waste and Sewerage	Aesthetic tiring due to negligence in management of waste	Medium	Moderate	Moderate adverse	ECR 1997, IFC's Performance Standards on Environmental and Social Sustainability
DD2. Wastewater Treatment (The proposed unit considers construction of a Central Water Treatment Plant.)	Improvement of Environmental Performance of the Sirajganj power Station by providing a means of effluent treatment of existing unit and proposed 2nd and 3rd units. (Positive Impacts)	High	Major	Major beneficial	ECR 1997, IFC's Performance Standards on Environmental and Social Sustainability
DD3. Kitchen Waste	Large amount of kitchen waste to be generated. This may cause a Aesthetic tiring due to negligence in management of waste.	High	Moderate	Major adverse	ECR 1997, IFC's Performance Standards on Environmental and Social Sustainability

IECs/Issues	Potential Impacts from various Activities	Sensitivity	Magnitude	Significance Prior to Mitigation	Compliance to laws, regulation or accepted national or international standards, protected status of site or species
EE. Hazardous Waste Generation					
EE1. Use of Hydrazine in feed water for oxygen scavenging	Hydrazine is genotoxic carcinogen. Exposure to hydrazine is hazardous to health. The HRSG boiler blow down may contain residual hydrazine which may reach to river or canal ultimately.	Very High	Moderate	Major adverse	Hazardous Waste and Ship Breaking Waste Management Rules 2011, CER 1997, The International Conference on Chemicals Management in 2006 IFC's Performance Standards on Environmental and Social Sustainability
EE2. Hazardous sludge from water pre-treatment and treatment plant	Contamination of surface water, ground water and soil if not properly managed	High	Major	Major adverse	Hazardous Waste and Ship Breaking Waste Management Rules 2011, CER 1997, IFC's Performance Standards on Environmental and Social Sustainability

7.4 Environmental Impacts during Pre-Construction Stage

7.4.1 Impact on Ambient Noise

368. As the land of the project site is already developed, the level of noise is not expected to increase much from the activities during pre-construction period. Nevertheless, little increase in the ambient noise level would be felt during construction of labor shed (outside the Project site), felling timber trees and leveling up the land. However, prolonged exposure to the increased noise can cause disturbances, increased stress level, increased blood pressure etc. to the staffs and workers during different activities. The impact is characterized as minimal adverse in **Table 7-4**.

7.4.2 Impact on Water Resources

Surface Water Quality

369. During the preconstruction phase, there is a susceptibility of deterioration of surface water quality due to the disposal of debris or waste materials from the vegetation clearance site, kitchen waste or sanitation waste from labor shed which are disposed off directly in the nearby water bodies. The only surface water resource available in the study area is the Jamuna River which has its nearest channel about 1-1.5 km far from the project periphery. Thus any unplanned dumping of waste near the river bank or the channel may result in water quality degradation and may be unsafe for the aquatic organisms and people residing near the channel who are dependent on the river water for bathing, households or other domestic usages.

370. Again, there remains some unplanned dumping of used broken or damaged materials or equipments of the first unit. Deposited liquid waste products from such materials/equipments might also be present. Hence, during monsoon season if the rainfall runoff flows through the haphazardly dumped liquid waste, chemicals waste materials, then these may be a source of surface water pollution.

Groundwater Quality

371. The pre-construction and land development phase will have no impact upon the groundwater reservoir.

Internal Drainage System:

372. The internal drainage system of the proposed power plant and the existing power plant at the plant area is a very important and valued environmental component. During this phase, on site activities will be limited to site preparation through vegetation clearance and site development with minor dressing and leveling. Since the internal drainage system supports the smooth passing of storm water during the monsoon it may create some drainage congestion if the waste dumping is not done properly and dumped beside the drainage lines. For the off-site, the activities will be limited to construction of labor shed on the leased land of Bangladesh Bridge Authority (BBA). Unplanned disposal of waste material or unnecessary/unused materials/waste from the worker colony may cause unhealthy environment with-in the drainage system, especially during the monsoon season creating nuisence to the local inhabitants.

7.5 Impacts on Land Resources

Impact on Soil

373. During site preparation, earthworks such as leveling and compaction of soil would be done for construction of power plant. This would destroy the quality of fertile top soils that are enriched with nutrients required for afforested and naturally grown plant growth. This might occurr in the project construction site where construction will be done. This impact is characterized as **Minimal Adverse,** as given in **Table 7-4**.

7.5.1 Impacts on Ecosystem

Impact on terrestrial vegetation

374. Terrestrial vegetaion will be cleared from the site area for creating temporary storage forconstruction materials and machineries will be caused vegetation clearance from the site. During this phase, vegetation will be damaged in those places where the materials/machineries will be kept and labour shed will be constructed. These areas are the habitat of wildlife like mouse, mongoose, lizards, snakes and different types of birds. They are dependent on these vegetation for grazing and feeding. By clearing the vegetation coverage, their habitat would be destroyed and they will have to relocae themselves to other similar type of vegetated areas. Comparing to the proposed damaged area, there would be vast area at nearby site to relocate the impacted wildlife. As such clearance of or damage to vegetation has moderate environmental impacts.

7.5.2 Impact on Socio-Economic Condition

375. The project site is a raised land, covered with dense bushes and some shrubs. Vegetation clearance for making the site suitable for civil construction and other site preparation activities will require a substantial number of laborers (approx. 100 to 125 laborers). Labor sheds will be established on the leased land (about 3 acres) of BBA. This will create pressure on the natural environment, sanitation facilities, potable water facilities, market price, prevailing socio-cultural situation, etc of the locality. The beneficial impact will be the creation of employment opportunity to the labor-class people of the area. Moreover, a cultural conflict may occurr due to assemblage of migrant workers with diverse cultural background.

7.5.3 Non-Hazardous Waste Generation

Solid Waste

376. Land development would require clearing of existing vegetation bushes and 14 hard wood trees from the area which would eventually generate a small amount of vegetation and wooden debris. Some office and domestic wastes along with scraps of Unit-1 were observed disposed off haphazardly at the area to be developed for 3rd unit (**Photo 7-1**) which is degradting of soil quality and damaging aesthetic view. Disposal of such wastes and scraps demands good house keeping, good management and safeguarding to environment.


Photo 7-1: Haphazardly disposed debris, domestic wastes and scraps

377. There would not be any major pollution from this waste. However, the impact would be for a temporary period, limited within the plant premises, reversible and may happen only in worst-case scenario (i.e. no management of solid waste). On the other hand, the impact on the residents of the power plant is low as it can be easily mitigated by adopting proper waste management plant. Significance of the impact would be **minimal adverse** and needs to be controlled by adopting Environmental Code of Practices (ECPs).

Kitchen waste

378. A total of about 100-150 laborers will be engaged during pre-construction and land development period, out of which around 50 people will be living at the labor shed constructed on the BBA's leased land outside the Project site. Among them, only 10-15 people will come from EPC contractor and NWPGCL and rest will be as day labour. **Table 7-5** below shows the estimation of kitchen waste during pre-construction and land development period.

Table 7-5: Estimation of Kitchen Waste during Pre-construction and Land Development Period

Sl No	Economic Classes of Employee	Project employee/ Worker	Rate of kitchen waste generation (kg/day/capita)*	Total generated waste (kg/day)
1	High Income Group (>20000 tk/month)	10	0.513	5.1
2	Middle Income Group (tk 10000-20000tk / month)	15	0.4	2.0
3	Low Income Group (< 10000 tk/month)	35	0.26	9.1
	Total	**50**		**16.2**

source: (JICA, Pacific Consultant Internationals, & Co, 2005)

379. It is estimated that around 16kg of kitchen waste will be generated each day from the labor-shed and employee's residents. Careless disposal of these wastes would create pollution, odor problem, nuisance and aesthetic tiring. However, the impact would be for a temporary period, limited within the labor shed premises, reversible and may happen only in worst-case scenario (i.e. no management of kitchen waste). On the other hand, sensitivity of this impact to the residents of the SPS (Sirajganj Power Station) is High as presently there is no Kitchen Waste Management System. Thus the significance of the impact would be **Major adverse** and needs to be minimized by EMP.

Sewerage

380. During land development several numbers of employee and laborers (roughly to be 50) would be living at site for land development activities. It is estimated that maximum 13 m3/day (considering 260 L/day per capita sewerage generation) sewerage would be generated from temporary labor sheds and officers' residence. A small portion of this sewerage may escape sewerage collection and disposal system. The fecal sludge would go to the existing septic tank and septic tanks of the temporary toilets constructed for laborers.

381. This added sewerage from the officers' residence would not have any significant impact on the existing sewerage system and the sewerage coming from the labor shed is expected to be managed properly by following the Schedule 9 of the ECR, 1997. The magnitude of the impact would be minor and sensitivity would also be low. Thus significant of the impact would also be minimum adverese and can be easily controlled by adopting ECP.

7.6 Environmental Impacts during Construction Stage

7.6.1 Impact on Ambient Air

382. Fugitive dust particles may be generated due to site preparation, material transport, piling up of construction materials, excavation of trenches, batch mixing plant, etc. In addition to these, operation of construction equipment and vehicles may generate CO, CO_2, NO_x, SO_x, etc. Prolonged inhalation of dusts by the site engineers and workers might suffer from lung diseases with symptoms of shortness of breath, coughing, wheezing; chest pain; loss of appetite; tiredness etc.

7.6.2 Impact on Ambient Noise

383. The noise and vibration generated from different stationary (concrete mixture machine, grinding machine, piling, etc.) and mobile sources during construction period may have adverse impacts on the existing acoustic environment. Prolonged exposure to such high noise might create disturbances, hearing difficulties, discomfort, loss of concentration, high blood pressure etc. among the workers, site engineers and nearby residents. This impact is characterized as moderate adverse as given in **Table 7-4**.

7.6.3 Impact on Water Resources

Surface Water Quality

384. The major activities during construction period will include construction of civil infrastructure and erection of plant of machineries. Surface water may be contaminated and degraded in two ways from the construction work. These are: disposal of untreated rainfall wash water flowing from unplanned storage of raw construction raw materials and equipments, and irregular release of construction waste water. Some construction materials may be brought at the site using waterways transport through river way. Discharge of oil and grease containing bilge water from the water transport in the river may contaminate water. This may lead to the degradation of water quality and discomfort to the local aquatic organisms. Besides, disposal of domestic waste (e.g. kitchen waste, etc.) from the labor sheds and release of hydrocarbon from the machineries and metallic equipments along with unused or damaged construction materials if dumped adjacent to the surrounding canal/ditch may increase the risk of surface water pollution thus affect the water quality of the Jamuna.

Groundwater Quality

385. Water requirements during construction phase maybe fulfilled through pumping but its impact is negligible.

Internal Drainage System:

386. Discharging of liquid waste generated from the construction work of the proposed Project through existing internal drainage system may create drainage congestion. Because, the internal drainage system was basically designed to serve for drainage of storm water, cleaning water, etc. Again, unplanned dumping of construction materials and droppings of solid substances in the drains may also create drainage congestion.

7.6.4 Impacts on Land Resources

Impact on Land Use

387. During construction phase, the present land use as fallow land having covered with bushes and grasses would be changed into a different land use as industrial set up with power plant.. This change of land use in the project site is permanent in nature. This impact is characterized as **Moderate Adverse,** as given in **Table 7-4**.

7.6.5 Impacts on Fisheries and Their Habitat

388. The ship/cargo carrying machineries and ancillaries may discharge ballast and bilge waste water into the river. This ballast and bilge water may have oil, grease, food waste and other contaminants which might affect the fisheries resources and their habitat quality. Having disposed of such harmful substances into the river water, a localized and temporary disturbance to fish breathing may lead some species to death. Dredging for accessing ship to the jetty will also disturb the benthic habitat which may require a substantial time to recover. Discharge of wash water from the construction site may increase the turbidity of the local fish habitat. This would affect the food supply for fishes temporarily. The impact is characterized as **moderate adverese** in **Table 7-4**.

7.6.6 Impact on Ecosystems

Impact on aquatic habitat quality

389. Water vessels which would carry machinery and ancillaries might incautiously discharge of waste water. This may result deterioration of water quality of the river channels. Dredging for the access of vessels will increase water turbidity that negatively impact on fishes as well as aquatic microbes due to obstacle light penetration. This will reduce primary productivity of aquatic ecosystem of that river channel. Intensity of this negative impact will be lower in wet season for available flow of water from main river channel.

Impact on terrestrial vegetation and dweller wildlife

390. All the existing vegetation will be need to shave out from the proposed site for construction of civil structures, lying gas pipeline, construction of machinery unloading area and storing of imported machinery. The ecological survey of the plant site recorded only 14 hardwood timber trees from three species with maximum height of 4 meter. Except this, all the existing small plants are seasonally grown and not found any species which have national and international conservation significance.

391. As the dweller wildlife are depend on vegetation, so they will disturbed and relocate from the site where vegetation will be shaved out. The nearer site of the proposed plant contains same type of vegetation and impacted wildlife will settle there. This will create

population pressure of the wildlife. Due to high population pressure some wildlife will bound to relocate at nearer homesteads and suspect to collision with human.

392. The rodents like mongoose and mouse those are moving from one place to another place are used the proposed plant site as corridor. Their movement will be hindered for construction of civil structures and increase labour movement (**Figure 7-1**). For this reason, they have to use alternate way. In addition, nocturnal animals like bats will be slightly disturbed while fly over the construction site due to excess lightening.

7.6.7 Impact on Socio-Economic Condition

393. The increase in temporary and permanent jobs in laborers, staffs, engineers and officers would result in more transaction of money locally for purchasing of different goods and services. Accommodation of construction labor might create extra burden on human habitation, common property resources, purchasing capacity etc. Migrant workers coming from the different parts of the country would create cultural conflicts between workers and local communities. Increased vehicle on access road due to movement of construction materials might also affect easy access of the inhabitants to the local market and houses close to the road and nearby areas temporarily. The increase in traffic could result in increased congestion and number of traffic accidents. The flow of concerned skilled technicians from abroad means that they might bring sexually transmitted diseases, e.g., HIV/AIDS, which might become epidemic if preventive measures from the beginning are not taken. During construction of the power plant, disturbance may be created due to generation of noise from moving and idling vehicles, welding operations and moving heavy machineries.

7.6.8 Non-Hazardous Waste Generation

Solid Waste

394. During construction, large amount of construction waste that includes unused construction materials, construction debris, excavated spoils, abandoned or broken machine parts, debris, kitchen wastes from labor sheds, packaging materials, used home appliances, etc will be produced. Moreover, food waste, plastic, papers, cock sheet, cartons, metal or plastic binders, etc. may be produced as solid waste during this stage.**Photo 7-2** shows typical waste materials from construction works. If these wastes are not disposed and maintained properly, these would have impact on surrounding environment. Space for storage and disposal of stuffs and materials generated along with old and used equipments and materials is limited.

Used home appliances

Wooden debris


Wastes from demolished labor sheds

Photo 7-2: Typical Construction Waste from a Power Plant Construction

395. Unarranged piling up and disposal of construction waste will cause unhealthy situation in the area and become visual tiring. If not properly managed, this impact would remain during the life span of the Project but would be extended within the plant premises only. The impact is reversible. It is very likely to take place if proper management is not adopted which is the requirement of national and international environmental regulations. Considering all of these, it can be assumed that the magnitude of the impact would be moderate. Sensitivity of this impact would be medium as the SPS has the capacity to mitigate this impact by improving existing waste management plan. From the analysis of sensitivity and magnitude, it is apprehended that the significance of the impact would be **moderate adverse**.

Kitchen Waste

396. During construction, it is assumed that around 100 people will be living at site. Among them, 30 personnel from EPC contractor, 10 person from Owner's Engineers, supervision consultants, environmental consultants, NWPGCL and rest will be day labour. The **Table 7-6** below shows the estimation of kitchen waste during pre-construction and land development period.

Table 7-6: Estimation of Kitchen Waste during Pre-construction and Land Development Period

Sl no	Economic Classes of Employee	Project employee	Rate of kitchen waste generation (kg/day/capita)*	Total generated waste (kg/day)
1	High Income Group (>20000 tk/month)	30	0.513	15.4
2	Middle Income Group (tk 10000-20000tk / month)	10	0.4	4.0
3	Low Income Group (< 10000 tk/month)	60	0.26	15.6
	Total	**100**		35.0

**source: (JICA, Pacific Consultant Internationals, & Co, 2005)*

397. It is estimated that around 35 kg kitchen waste will be generated each day from the labor-shed and employee's residences. Careless disposal of this waste would create pollution, odor problem, nuisance and aesthetic tiring. However, the impact would be for a temporary period, limited within the plant premises, reversible and may happen only in

worst-case scenario (i.e. no management of kitchen waste). On the other hand, sensitivity of this impact to the residents of the SPS (Sirajganj Power Station) is High as presently there is no Kitchen Waste Management System at SPS. Thus the significance of the impact would be **Major adverse** and needs to be minimized by EMP.

Liquid Waste and Sewerage

398. It is assumed that during construction phase around 100 employees including laborers will be living at site for construction related activities. Therefore, it is estimated that maximum 26 m^3/day (considering 260 L/day per capita sewerage generation) sewerage would be generated from temporary labor sheds and officers' residence. A small portion of this sewerage may escape sewerage collection and disposal system. The fecal sludge would go to the existing septic tank and septic tanks of the temporary toilets.

399. This added sewerage would not have any significant impact on the existing sewerage system. The magnitude of the impact would be moderate and sensitivity would also be moderate. Thus significant of the impact would be **medium adverse** and needs to be controlled by adopting EMP.

7.7 Environmental Impacts during Operation Stage

7.7.1 Impact on Air Quality

400. Impact assessment of the ambient air quality is one of the key issues for any power plant Project. This study provides detailed emission estimates and air quality dispersion modeling output/result to support the air quality impact assessment done for the Sirajganj Power Station Complex. Construction activities will cause temporary increase in pollutant emission while operation of power plant will be causing emission of pollutants during the Project life leading to increase the ground level concentration of air pollutants. s The air pollutants considered in the air quality analysis include nitrogen dioxide (NO_2), carbon monoxide (CO), sulfur dioxide (SO_2), and particulate matters less than 10 microns and 2.5 microns in diameter (PM10 and PM2.5).

Pollutants of Concern

401. The chemical composition of the fuel (natural gas) of the proposed power plant is very important for the emission estimation. Pollutants of concern, released from natural gas fired power stations are Oxides of Nitrogen (NO_x), Oxides of Sulfur (SO_x), Carbon Monoxide (CO) and Volatile Organic Compounds (VOCs). Particulate Matter is generally not of a major concern from the combustion of natural gas and has been estimated to be less than 1 micrometer (□m) in diameter and has filterable and condensable fractions (EPA, 1998). However, currently no regulations and standards exist for such particulate matters, therefore, emissions from the power plant will be evaluated and compared to applicable standards for $PM_{2.5}$and PM_{10} (Particles $\leq$2.5µm and PM$\leq$10 µm in size). Natural gas contains trace amount of Sulfur and hence formation of SO_2 is negligible for certain time. The pollutant of most concern from natural gas fired power plants is NO_x. The formation of thermal NOx is dependent on three (3) factors during combustion; (i) oxygen concentration, (ii) peak temperature, and (iii) time of exposure at peak temperature (EPA, 1998). NO_x is composed of NO and $NO_{2.}$ NO_2 is of particular concern and is considered as criteria pollutant. NO_2 is used as the indicator for the larger group of nitrogen oxides (NO_x). In addition to the contribution of NO_2 in the formation of ground-level ozone, and fine particle pollution, this pollutant is linked with a number of adverse effects on the respiratory system. Significant health risks are associated with high levels of ambient NO_2, CO, SO_2 and $PM_{2.5,}$ PM_{10} concentrations. Carbon Dioxide (CO_2), Methane (CH_4) and Nitrous Oxide (N_2O) are the major greenhouse gases that are also emitted from the power stations.

402. Emissions from the power plant are estimated for two scenarios (i) Baseline scenario and (ii) third Unit scenario (considering operation of three units 1, 2 and 3 together).

Air Quality ModelingData and Methodology

403. Regulatory agencies rely on dispersion models as part of their approval processes. The Department of Environment (DoE) in Bangladesh does not recommend any specific models for the impact assessment study. Therefore, this study has considered the USEPA recommended air dispersion model to assess the emission to the adjacent areas of the Project site. However, USEPA does not recommend any individual models, therefore allows the modeler to judge and select a suitable model for assessment.

404. The latest version of the USEPA regulatory model CALPUFF 7.5.3 has been used to predict and simulate the effects of criteria pollutants from major emission sources in the Project area and analyze the effect on ambient air quality for NOx, NO_2, CO, SO_2, PM2.5 and PM10. CALPUFF contains algorithms for near-source effects such as building downwash, transitional plume rise, partial plume penetration, as well as longer-range effects such as chemical transformation, and pollutant removal (wet scavenging and dry deposition). It can accommodate arbitrarily varying point source and area source emissions.

405. Since there was very little information available on the power plant emissions, criteria pollutant emissions were calculated based on the plant's fuel consumption and USEPA AP 42 emission factors. This is considered as a conservative approach to modeling. Greenhouse gas emissions were calculated using fuel consumption and IPCC greenhouse gas emission factors.

Project Area

406. An area, 50 km by 50 km centering the proposed stack of third Unit of Sirajganj Power Station was selected for the air quality analysis. The plant boundary and air quality-modeling domain have been presented in **Table 7-7**. At present first Unit is running with natural gas. **Figure 7-1** shows the baseline situation inside the plant boundary related to the air dispersion modeling.

Table 7-7: CALPUFF Study Area Coordinates (UTM Zone: N 45)

Model Domain		Easting (m)	Northing (m)
Study Area	Southwest Corner	753467	2674935
	Southeast Corner	803411	2674685
	Northeast Corner	803411	2724745
	Northwest Corner	753476	2724745
Computational Grid	Southwest Corner	758462	2679858
	Southeast Corner	798554	2679667
	Northeast Corner	79843	271964
	Northwest Corner	758457	2719889

Source: CEGIS, 2015

Figure 7-1: Existing plant Area (First Unit with blue color code)

Project Area Pollution Sources

407. Emission inventories were prepared for all major point, area, and line sources within the study area. The major point sources within the model area were identified as follows:

- Stack 1 (1^{st} Unit) 225 MW
- Stack 2 (2^{nd} Unit) 225 MW
- Stack 3 (3^{rd} Unit) 225 MW

408. The stack emissions and stack parameters of the thermal power plants are given in **Table 7-8**. The rate of pollutant emission has been calculated based on the emission inventories of USEPA AP-42 Volume-1 (1995); Stationary sources for Gas Turbine Power Plant.

Table 7-8: Major Point Source Emissions in the Project Area

Sirajganj Power Plant	No. of Stack	Capacity (MW)	Stack Height (m)	Inner Dia. (m)	Flue Gas Temp. (K)	Emission Rate (g/s)				
						NO_x	CO	SO_2	PM_{10}	$PM_{2.5}$
Unit 1	1	255	45	7	373	17.32	2.64	0.59	0.83	0.33
Unit 2	1	255	60	7	373	17.32	2.64	0.59	0.83	0.33
Unit 3	1	255	60	6	372	17.32	2.64	0.59	0.83	0.33

Source: CEGIS, 2015

409. Major line sources of pollution considered in the model are traffic along the major roads and highways, which include: N405, R541, Z5402 and Z5406 and Train line.

410. The traffic data of the adjacent roads N405, R541, Z5402 and Z5406 was used as line source for air pollution dispersion modeling. The length of the line is given in **Error! eference source not found.7-9** below.

Table 7-9: Traffic Data (AADT) and Locomotives Used For Air Quality Modeling

Road	Heavy Truck	Medium Truck	Large Truck	Large Bus	Medium Bus	Micro Bus	Utility	Car	Auto Ricks-haw	Motor Cycle	Train (Per Day)
N405	16	2,434	519	2,211	287	629	169	544	794	464	22
R541	5	322	268	25	149	155	74	92	1,096	579	
Z5402	3	80	50	61	90	28	37	25	1,305	605	
Z5406	1	2	23	0	0	5	1	5	270	205	

Source: Roads and Highways Department, Bangladesh, 2015

Meteorological Data

411. Pre-processed hourly 3D meteorological data of the year 2012, 2013 and 2014 was procured from the Lakes Environmental Software (CALMET-Ready MM5, location at 24.386211 N, 89.745619E). This is known as upper atmospheric or air surrounding data which is used in the air dispersion model. The regional meteorological conditions are assessed after analysis of meteorological data of last 3 years (2012, 2013 and 2014) from the BMD station, Bogra. **Figure- 7-2** and **Table 7-10** show the meteorological states of the study area related to the dispersion modeling.

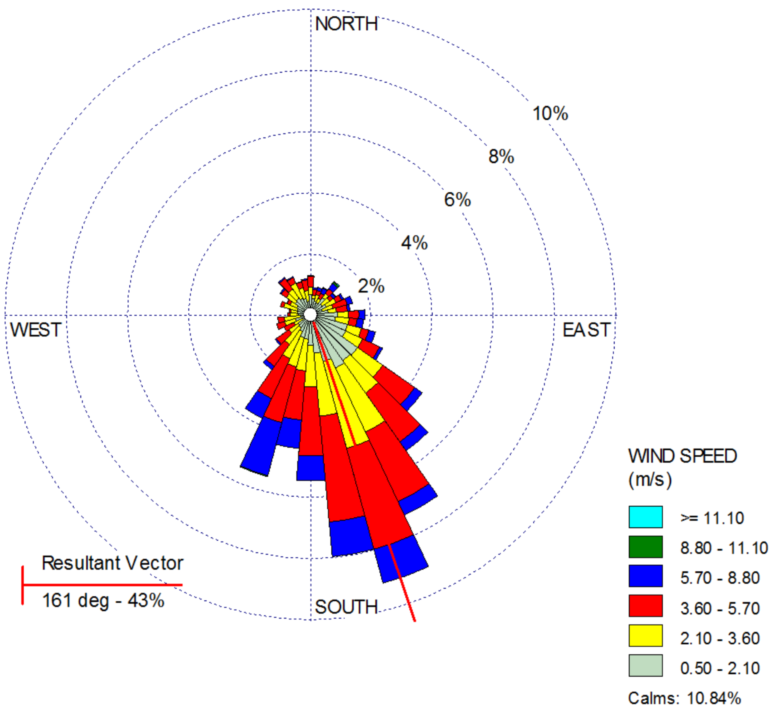


Figure 7-2: Wind-rose diagram of last 3 years (2012, 2013 and 2014), Bogra

Table 7-10: Summary of 2012, 2013 and 2014 Meteorological Data

Month	Wind		Temperature (ºC)		Relative Humidity (%)
	Max. Speed (m/s)	Predominant Direction	Max	Min	Average
Jan	3.3	NE	28.5	4.5	77.60
Feb	3.8	NE	32.5	9.3	67.62
Mar	3.6	SE	37	14.8	61.96

Month	Wind		Temperature (°C)		Relative Humidity (%)
	Max. Speed (m/s)	Predominant Direction	Max	Min	Average
Apr	3.7	SE	39.5	18.8	66.50
May	3.6	SE	39.5	19.5	74.94
Jun	3.4	SE	37.8	22.5	80.96
Jul	3.7	SE	36.5	24.9	82.68
Aug	4.2	SE	35.8	25	84.22
Sept	3.6	SE	38.2	23.4	83.22
Oct	2.7	SE	35.5	19.2	80.14
Nov	2.5	SE	34.2	12.7	73.64
Dec	3.1	NE	30.5	8.9	82.14

Source: BMD, 2015

Receptors

412. Two types of receptors are defined within the Model Domain. These are: A) Nested Cartesian Grid Points and B) Discrete Receptors.

A) Nested Cartesian Grid Receptors

413. Cartesian grids are nested into smaller size to capture more precise pollutant concentration after dispersion. The gridded receptors are placing based on the following spacing:

- 20 m spacing along the Sirajganj Power Station Complex boundary
- 50 m spacing within the Sirajganj Power Station Complex boundary e.g. 250 m from the 3rd Unit
- 250 m spacing within 2 km from the stack of 3rd unit of Sirajganj Power Station
- 500 m spacing within 10km by 10 km area
- 10000 m spacing within 15 km by 15 km area

B) Discrete Receptors

414. In addition, discrete locations corresponding to specific sites of interest are included in this assessment. These receptors are broadly located as the places which are populated with human being especially children and patients since their health is much vulnerable to air pollution. Around 100 numbers of primary school, Madrasa, health complex and union head quarters are selected as discrete receptors around the SPS complex. Moreover, Bangabandhu Eco-Park and Jamuna Resort are considered as eco-sensitive discrete receptors during this modeling study. The baseline monitoring points are also included as discrete receptor for future comparison. The effects on air quality at these sensitive sites were also assessed in more details. The list of sensitive receptors, their locations and details are given in **Table 7-11**.

Table 7-11: Details of Sensitive Receptors

Sl No	Name of Sensitive Receptors	Location (m)	
		Latitude	Longitude
1	Primary School	774359.29	2690923.28
2	Primary School	778450.51	2691080.40
3	Madrasa	773554.39	2691069.56
4	Primary School	774816.42	2692264.70
5	Primary School	772606.73	2692346.98
6	Primary School	774301.91	2692539.91
7	Family Welfare Centre	785457.78	2692947.62
8	Primary School	771644.47	2692878.73
9	Primary School	773390.07	2693032.15
10	Family Welfare Centre	771096.49	2693265.05
11	Madrasa	774931.02	2693536.85
12	Hospital	772496.41	2693610.03
13	Primary School	775251.19	2694324.21
14	Community Clinic	772692.95	2694463.11
15	Primary School	772500.30	2694629.00
16	Primary School	779504.19	2694841.25
17	Primary School	773566.68	2694848.98
18	Primary School	772305.57	2694855.93
19	High School	785548.72	2695313.83
20	High School	785546.02	2695357.72
21	Primary School	785396.16	2695466.96
22	Union HQ	769629.70	2695143.83
23	Primary School	772975.28	2695435.31
24	Primary School	772097.96	2695445.15
25	Primary School	770208.84	2695454.70
26	Primary School	774141.96	2695614.41
27	Primary School	771174.73	2695769.98
28	Primary School	775734.56	2696128.03
29	Primary School	784709.54	2696726.99
30	Primary School	774864.83	2696663.25
31	High School	784967.00	2696829.36
32	Primary School	770966.28	2696650.25
33	Union HQ	769665.95	2696734.24
34	High School	770291.44	2696767.64
35	Union HQ	775057.86	2696871.39
36	Primary School	769118.64	2696744.24
37	Primary School	773816.37	2697126.77
38	Upazila HQ	769733.28	2697045.75
39	Primary School	787195.54	2697479.74
40	Family Welfare Centre	774304.10	2697588.65

Sl No	Name of Sensitive Receptors	Location (m)	
		Latitude	Longitude
41	Primary School	770960.03	2697570.22
42	Madrasa	785481.56	2697936.18
43	Primary School	772656.02	2697807.26
44	Primary School	785509.67	2698221.89
45	Community Clinic	775757.64	2698268.16
46	Primary School	770810.58	2698178.42
47	Primary School	775985.47	2698511.50
48	Primary School	776533.06	2698767.09
49	Primary School	773492.86	2698864.47
50	Primary School	787751.16	2699409.37
51	Primary School	772497.98	2699109.17
52	Primary School	774581.03	2699211.85
53	Primary School	769631.43	2699239.49
54	Madrasa	784945.10	2699600.43
55	Primary School	771219.62	2699321.09
56	Primary School	776744.70	2699513.18
57	Primary School	786595.79	2699798.79
58	Madrasa	774158.97	2699563.30
59	Community Clinic	776190.69	2699921.43
60	Union HQ	776029.63	2699981.34
61	Primary School	771623.91	2699911.80
62	Primary School	769814.93	2699896.44
63	Primary School	773085.74	2699967.92
64	Family Welfare Centre	775551.15	2700024.84
65	Primary School	783456.00	2700395.44
66	Primary School	776585.80	2700129.47
67	Madrasa	786239.74	2700373.47
68	Primary School	769732.98	2700485.76
69	Primary School	772466.35	2700630.94
70	Primary School	787026.08	2701098.54
71	Primary School	784650.09	2701203.75
72	Family Welfare Centre	771586.26	2701203.26
73	Union HQ	771433.48	2701308.91
74	Primary School	768462.51	2701404.41
75	Primary School	773090.32	2701516.84
76	Primary School	771084.55	2701521.78
77	Primary School	769514.97	2701711.36
78	Primary School	781669.20	2702008.81
79	Primary School	773982.02	2701894.52
80	Primary School	772604.75	2702541.84
81	Primary School	773649.64	2702760.98

Sl No	Name of Sensitive Receptors	Location (m)	
		Latitude	Longitude
82	Primary School	770513.66	2702773.26
83	Primary School	770005.05	2703029.15
84	Madrasa	769195.69	2703067.78
85	Primary School	771371.84	2703286.50
86	Primary School	775883.67	2703487.12
87	Primary School	773588.21	2703511.53
88	Community Clinic	774465.02	2703929.34
89	Primary School	773212.05	2704042.94
90	Union HQ	774291.95	2704229.99
91	Primary School	786794.33	2704537.86
92	Family Welfare Centre	774479.27	2704275.20
93	Primary School	771000.72	2704608.82
94	Growth Centre	772703.05	2704970.40
95	Bangabandhu Eco Park	778406.80	2700860.15
96	Primary School	775498.81	2705273.82
97	Community Clinic	772698.54	2705303.27
98	Primary School	773291.64	2705468.45
99	Family Welfare Centre	771073.43	2705947.15
100	Primary School	772491.81	2706010.71
101	Primary School	771169.34	2706164.65
102	Jamuna Resort	785623.22	2700279.76
103	Union HQ	771200.22	2706447.77
104	Primary School	772898.59	2707060.32
105	District HQ	774626.47	2707228.16
106	Upazila HQ	774978.25	2707321.92
107	Primary School	774438.18	2707778.33
108	High School	775120.32	2707948.96
109	Primary School	775205.87	2708297.46
110	Primary School	775133.71	2708712.31
111	Barashimul village Monitoring Point	778768.17	2698359.84
112	Eco park Monitoring Point	778405.06	2700859.65
113	Rehabilitation village Monitoring Point	777879.76	2700287.33
114	Power Plant site Monitoring Point	778520.74	2699760.24

Source: CEGIS, 2015

Air Quality Modeling

415. The modeling has been run for predicting the maximum concentration levels of ambient air pollutants like NOx, NO_2, $PM_{2.5}$, PM_{10} and CO for both the baseline and third Unit scenarios. Only, emissions from the Sirajganj Power Station were modeled and a measured ambient background concentration and the value have been added to the modeled results to predict concentration at the sensitive receptors at the time of operation of unit -1, 2 and 3 in future together.

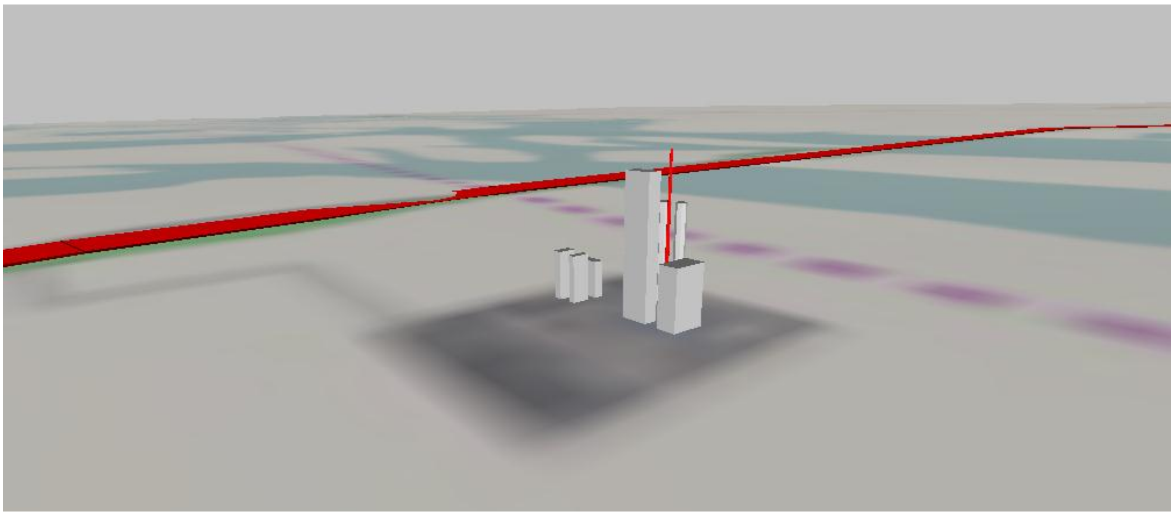


Figure 7-3: Baseline Scenario for Unit -1

Background Concentrations

416. Background ambient air quality of the criteria pollutants are contributed by multiple sources. Continuously vehicle movement, DWL locomotives, power plant emission, household cooking, non-paved line sources and area sources are responsible for increasing the concentration of air pollutants in the study area. To understand the baseline situation, four locations have been monitored for continually 8 hours or 24 hours in the study area. The real-time monitoring data and model simulated data are presented in the **Table-12** to assess the contribution of power plant in ambient environment.

Table 7-12: Background concentration of the ambient environment both for monitored and modeled data

Location	Ambient and Measured Pollutant Components	CO (μg/m³)	NO_2 (μg/m³)	$PM_{2.5}$(μg/m³)	PM_{10} (μg/m³)	SO_2 (μg/m³)
Power Plant Site	Ambient Measured (Avg. 8 Hr)	1282.2	410.02	43.97	154.9	74.05
	Plant Contribution Calpuff. (Avg. 8 Hr)	0.97	0.49	0.01	0.03	0.01
	Ambient Measured (Avg. 24 Hr)	942.69	57.78	32.33	113.88	54.44
	Plant Contribution Calpuff. (Avg. 24 Hr)	0.56	0.36	0.007	0.02	0.01
Rehabilitation	Ambient Measured (Avg. 8 Hr)	516.76	38.36	26.67	94.41	83.01
	Plant Contribution Calpuff. (Avg. 8 Hr)	0.19	1.32	0.01	0.09	0.04
	Ambient Measured (Avg. 24 Hr)	379.92	28.2	15.4	54.5	61.02
	Plant Contribution Calpuff. (Avg. 24 Hr)	0.14	0.97	0.01	0.05	0.03
Eco-Park	Ambient Measured (Avg. 8 Hr)	611.82	42.06	21.16	80.56	31.66
	Plant Contribution Calpuff. (Avg. 8 Hr)	0.11	0.67	0.02	0.03	0.03
	Ambient Measured (Avg. 24 Hr)	449.81	30.92	12.47	46.51	23.28
	Plant Contribution Calpuff. (Avg. 24 Hr)	0.08	0.49	0.009	0.02	0.02
Barashimul Village	Ambient Measured (Avg. 8 Hr)	454.53	29.89	23.55	91.63	70.89
	Plant Contribution Calpuff. (Avg. 8 Hr)	0.08	0.49	0.001	0.03	0.02

Location	Ambient and Measured Pollutant Components	CO (µg/m³)	NO_2 (µg/m³)	$PM_{2.5}$(µg/m³)	PM_{10} (µg/m³)	SO_2 (µg/m³)
	Ambient Measured (Avg. 24 Hr)	334.1	21.98	13.6	52.9	52.12
	Plant Contribution Calpuff. (Avg. 24 Hr)	0.06	0.36	0.007	0.02	0.01
Average Measured value	Ambient Environment In the Study Area (8-Hr)	716.33	130.08	28.84	105.38	64.90
	Ambient Environment in the Study Area (24-Hr)	526.63	34.72	18.45	66.95	47.72

Source: CEGIS, 2015

417. All the measured ambient background concentration values are for an 8-hour averaging period and have to be converted to 1-hour, 24-hour, and annual averaging periods using the power law relationship (OMOE, 2014) given below:

$$C_{long} = C_{short}(t_{short}/t_{long})^{P}$$

where:

C_{long}= the concentration for the longer averaging time

C_{short}= the concentration for the shorter averaging time

T_{short}= the shorter averaging time (in minutes)

T_{long} = the longer averaging time (in minutes)

p = the power law exponent

418. For ambient air assessments a p value of 0.28 is used (OMOE, 2014) for the gaseous pollutants. In case of dust particle, the p value is considered as 0.5 to convert annual or 24 hr concentration of TSP in ambient air (Beychok, 2005). This methodology is deemed to give conservative estimates and thus is deemed appropriate for this case. The background study has been done maintaining the condition of scenario-I.

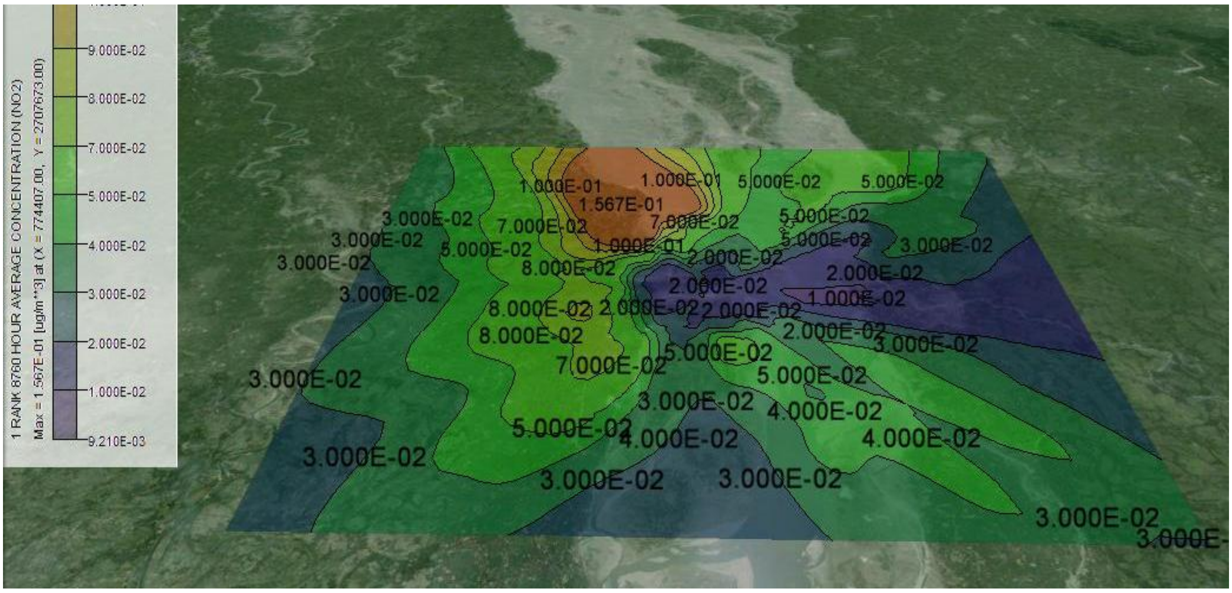


Figure 7-4: Annual NO2 dispersion in the study area (25 Km x 25 km grid)

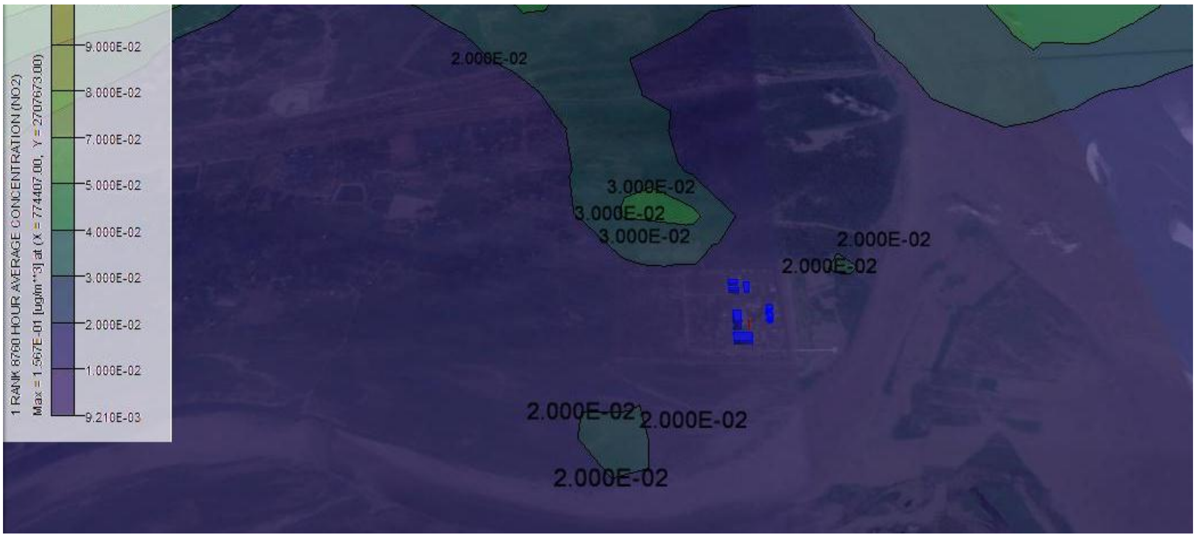


Figure 7-5: Annual NO2 dispersion in closure view

Future concentration of the pollutants

419. The third Unit will run simultaneously with the first and second units. Therefore, the dispersion of the pollutants will need to be assessed collectively in the study area. Around 114 discrete receptors have been fixed around the SPS and high Cartesian grids are also to be nested to account the concentration level in each cell. The Model has been run for three years (2012-2014) to account the worst case period and cumulative pollution level. Concentration of pollutants at different sensitive points is presented in **Appendix-7**. **Figure 7-6** and **Figure 7-7** shows 1 hr NO_2 concentration and 24 hr PM_{10} concentration for impact scenario after dispersion modeling respectively.

CO

420. The maximum 1-hr and 8-hr averaging values of CO are accounted through the modeling process of three years meteorological data in the study area. The highest concentration of CO would reach to the ground level depending on the worst-case meteorological situation. The peak ground level concentration of CO has been predicted for both Scenario-1 (Baseline) and Scenario-2 (Impact) within the study area (**Table 7-13**).

Table 7-13: Air Quality Modeling Data - CO

Pollutant CO	Concentration (μg/m³)			Coordinates of Max Point (UTM:45)	
	Averaging Time	Receptor Type	Max Value	East (m)	North (m)
Baseline Scenario-1	1-hr	Gridded	6.4	779907	2697173
	8-hr	Gridded	3.4	779907	2697173
Impact Scenario-2	1-hr	Discrete	17.2	779907	2701673
	8-hr	Discrete	9.6	779907	2701673

Source: CEGIS, 2015

421. The highest contribution of CO in ground level has been predicted only 6.4 μg/m³ for 1-hr and 3.4 μg/m³ for 8-hr during baseline situation. After commissioning the second and third unit, the peak concentration of CO would increase by 168.8 % for 1-hr and 182.4 % for

8-hr (**Table7-14**). However, the resultant concentration during operation of three units will add less than 1% of CO with the present baseline concentration. Moreover, the resultant concentration of peak CO concentration will be within the standard limit of ECR, 2005 of DoE.

Table 7-14: Resultant Concentration – CO

CO Concentration	Increasing in terms of Baseline Scenario	Resultant Concentration (μg/m³)	Percentage of Total	Bangladesh National Standards (μg/m³) ECR, 2005	World Bank Guidelines (μg/m³) IFC, 2007
1-Hr Average	168.8 %	1293.035	0.84%	40,000	N/A
8- Hr Average	182.4 %	722.5275	0.87%	10,000	N/A

Source: CEGIS, 2015

NO_2

422. The concentration of NO_2 for averaging time of maximum 1-hr and annual is accounted (**Table 7-15**) through the CALPUFF modeling process using the three years meteorological data of the study area. The maximum concentration values of NO_2 for both Scenario-1 (Baseline) and Scenario-2 (Impact) within the study area have been predicted. This peak concentration value would reach to the ground level depending on the worst case meteorological situation.

Table 7-15: Air Quality Modeling – NO_2

Pollutant NO_2	Concentration (μg/m³)			Coordinates of Max Point (UTM:45)	
	Averaging Time	Receptor Type	MaxValue	East(m)	North (m)
Baseline Scenario -1	1-hr	Gridded	41.9	779907	2697173
	Annual	Discrete	0.16	774407	2707673
Impact Scenario -2	1-hr	Discrete	112.82	779907	2701673
	Annual	Discrete	0.46	774407	2708173

Source: CEGIS, 2015

423. The maximum concentration of NO_2 that would contribute to the ground level is 41.9 μg/m³ for 1-hr and 0.16 μg/m³ for annual averaging time during the baseline situation. After commissioning of the second and third unit, the peak concentration of NO_2 would enhance by 169.3% for 1-hr average and 187.5% for annual average time (**Table 7-16**). The resultant concentration during the operation of the three units will add 83.9% of the NO_2 with the present baseline concentration for the 1-hr average and 4.5% of the NO_2 for the annual average. However, this resultant value of peak NO_2 concentration for annual averaging time will still be within the standard limit of World Bank standard as well as ECR 2005 standards.

Table 7-16: Resultant Concentration – NO_2

NO_2 Concentration	Increasing in terms of Baseline Scenario	Resultant Concentration (μg/m³)	Percentage of Total	Bangladesh National Standards (μg/m³) ECR, 2005	World Bank Guidelines (μg/m³) IFC, 2007
1-Hr Average	169.30%	155.5	83.90%	N/A	200
Annual Average	187.50%	6.95	4.50%	100	40

Source: CEGIS, 2015

$PM_{2.5}$

There is very little amount of filterable particulate matter ($PM_{2.5}$) emits through the stacks of the power plant. The maximum concentration of $PM_{2.5}$ for 24-hr and annual averaging time is accounted through the modeling process using the three years meteorological data of the study area. The peak concentration will be found in the ground level depending on the worst-case meteorological situation. This maximum concentration values have been predicted for both Scenario-1 (Baseline) and Scenario-2 (Impact) within the study area (**Table 7-17**).

Table 7-17: Air Quality Modeling – $PM_{2.5}$

$PM_{2.5}$Pollutant	Concentration (µg/m³)			Coordinates of Max Point (UTM:45)	
	Averaging Time	Receptor Type	Max Value	East (m)	North (m)
Baseline Scenario -1	24-Hr	Gridded	0.09	779907	2697173
	Annual	Discrete	0.003	774407	2707673
Impact Scenario -2	24- Hr	Discrete	0.24	779907	2696673
	Annual	Discrete	0.009	774407	2708173

During the baseline situation, the highest concentration of $PM_{2.5}$ in the ground level is only 0.09 µg/m³ for 24-hr and only 0.003 µg/m³ for annual averaging time. After commissioning of the second and third unit of the power plant would increase the maximum concentration of $PM_{2.5}$ for 24-hr average by 166.7% and annual average by200% of the baseline scenario (**Table 7-18**). The resultant concentration during the operation of three units together will add less than 1% of the $PM_{2.5}$ with the present baseline concentration. This resultant peak values for both averaging time will still be within standard limit of WB and ECR, 2005

Table 7-18: Resultant Concentration – $PM_{2.5}$

$PM_{2.5}$ Concentration	Increasing in terms of Baseline Scenario	Resultant Concentration (µg/m³)	Percentage of Total	Bangladesh National Standards (µg/m³) ECR, 2005	World Bank Guidelines (µg/m³) IFC, 2007
24 Hr average	166.7%	18.6	0.8%	65	25
Annual average	200%	4.9	0.12%	15	10

Source: CEGIS, 2015

PM_{10}

424. The condensable particulate maters are generally included into PM_{10}. The highest concentration of PM_{10} for 24-hr and annual averaging time is estimated through the modeling process with the help of three years meteorological data of the study area. The maximum concentration of PM_{10} would only found in the ground level for the worst-case meteorological situation. The peak concentration of this pollutant has been predicted for both Scenario-1 (Baseline) and Scenario-2 (Impact) within the study area.

Table 7-19: Air Quality Modeling – PM_{10}

PM_{10} Pollutant	Concentration (μg/m³)			Coordinates of Max Point (UTM:45)	
	Averaging Time	Receptor Type	Max Value	East (m)	North (m)
Baseline Scenario - 1	24 Hr Average	Gridded	0.2	779907	2697173
	Annual Average	Discrete	0.008	774407	2707673
Impact Scenario -2	24 Hr Average	Discrete	0.6	779907	2696673
	Annual Average	Discrete	0.02	774407	2708173

Source: CEGIS, 2015

425. The highest contribution of PM_{10} to the ground level is only 0.2 μg/m³ for 24-hr and only 0.008 μg/m³ for annual averaging time during the baseline situation. The peak concentration of PM_{10} would increase by 200% for 24-hr and by 150% for annual average time after the commissioning of the second and the third unit of the power plant (**Table 7-20**). The resultant concentration of PM_{10} will add around 0.6% PM_{10} for 24 hr and 0.06% PM_{10} for annual with the baseline situation. This resultant concentration will still be within the standard limit of ECR, 2005 of DoE but crossing the limit of IFC, 2007 standard of WB. Operation of power plants is not responsible for breaching of the standard. The recorded baseline values were quite higher than the standard limit of WB, especially inside the plant area. The baseline data were collected at the time of construction of 2nd unit.

Table 7-20: Resultant Concentration- PM_{10}

PM_{10} Concentration	Increasing in terms of Baseline Scenario	Resultant Concentration (μg/m³)	Percentag e of Total	Bangladesh National Standards (μg/m³) ECR, 2005	World Bank Guidelines (μg/m³) IFC, 2007
24-Hr Average	200 %	67.3	0.6%	150	50
Annual Average	150 %	18.2	0.06%	50	20

Source: CEGIS, 2015

SO_2

Since natural gas contains a trace amount of Sulfur and emission of SO_2 after combustion of natural gas in the power plant is considered negligible. Therefore, this study does not find merits of modeling SO_2. The monitoring stations are influenced by the multiple sources of SO_2 other than the power plants.

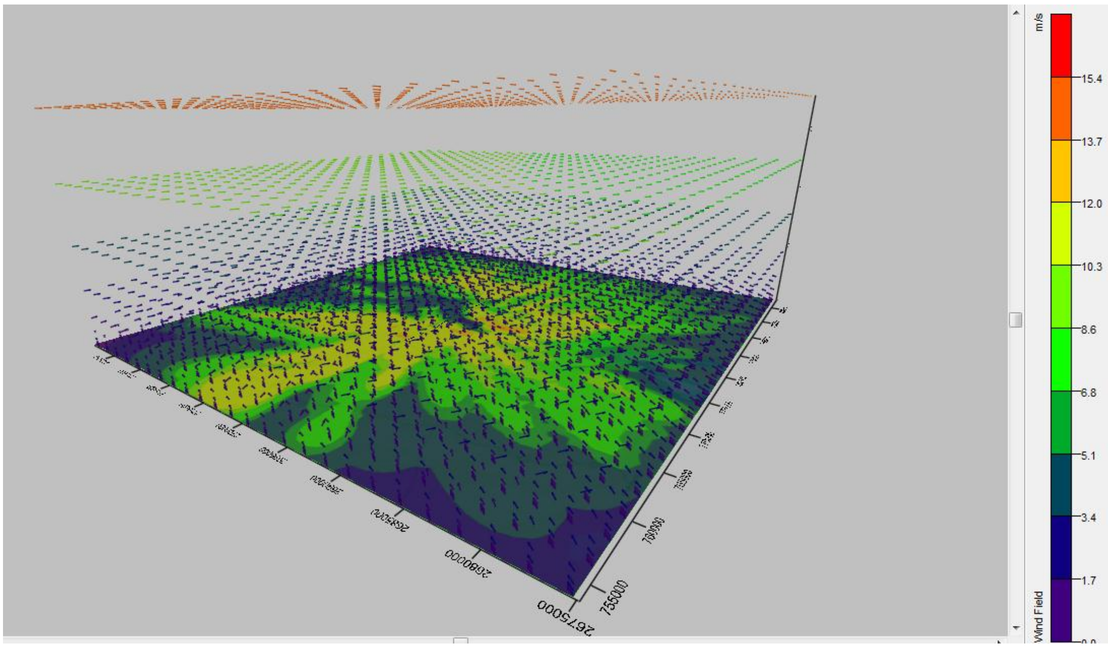


Figure 7-6: 1-hr NO_2 concentration during the Impact Scenario

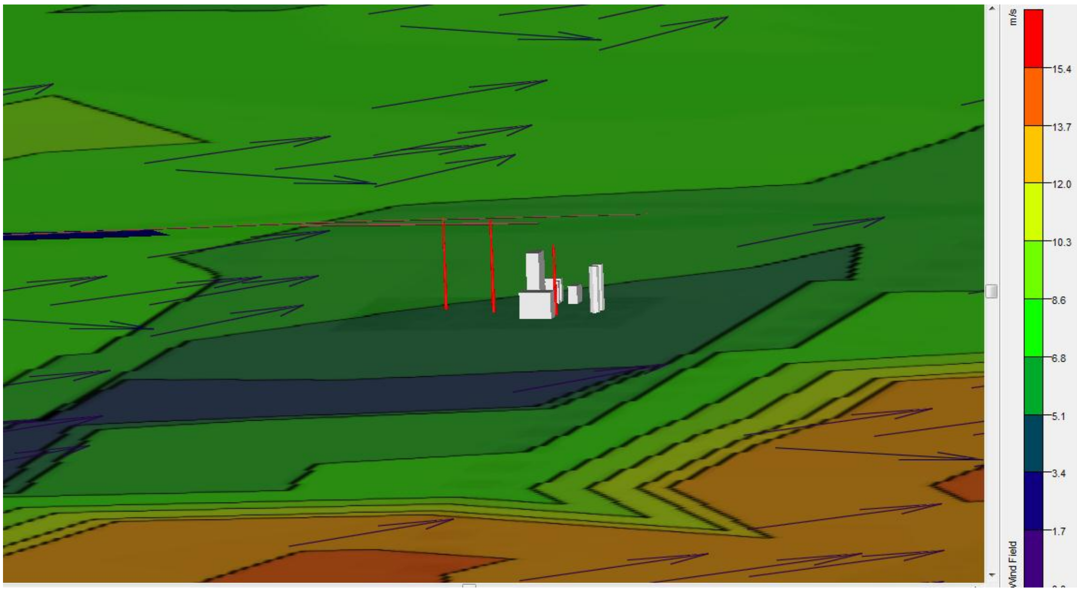


Figure 7-7: 24-hr PM_{10} concentration during the Impact Scenario

Stack Height

426. At present, the stack height of first Unit is 45 m. As per EIA report of 2[nd] Unit of Sirajganj Power Station, the stack height has been designed to 60 m height from the ground level. The third unit also recommends constructing 60 m stack heights after the dispersion modeling. The whole modeling study has been done considering the 60 m stack height. Use of HSD during the absence of Natural Gas will emit higher amount of SO_2 from the stack. Therefore, 60m stack will definitely reduce the ground level concentration (GLC) of SO_2 at that stage. The building height near the stack must be maintained the GEP guideline of IFC, 2007.

GHG Emission

427. The implementation of combined cycle would further reduce the emission of greenhouse gases as the flue gas emitted from the gas turbine is used again in the Heat

Recovery Steam Generator. Such power generation process combined with the implementation of energy efficiency programs in power sectors and in other infrastructures would not only make the production cost-effective but also reduces greenhouse gas emissions. Natural gas-fired, primarily combined-cycle fleet consumes significantly less fuel to generate power than conventional boiler/steam turbine power plants and emits fewer GHG emissions per MWh of power produced as compared to coal-fired or oil fired power plants. The proposed project thus demonstrates a case of voluntary GHG emission reduction. These reductions may qualify Clean Development Mechanism (CDM).

428. The clean development mechanism was designed to meet a dual objective: (a) to help developed countries fulfill their commitments to reduce emissions, and (b) to assist developing countries in achieving sustainable development. CDM projects earn tradable, saleable certified emission reduction (CER) credits that can be used by industrialized countries to meet a part of their emission reduction targets under the Kyoto Protocol. Benefits of CDM projects include investment in climate change mitigation projects in developing countries, transfer or diffusion of technology in the host countries, as well as improvement in the livelihood of communities through the creation of employment or increased economic activity.

429. Summarizes approximate annual GHG emissions from the natural gas-fired, combined-cycle power plant is estimated that 723385.35 ton/y of CO_2 equivalent emission generates from the proposed third Unit (Unit 3) of the plant and 2166861.83 ton/y of CO_2 equivalent emission produced from the combined Unit -1, 2, 3 case. For the entire project life (25 years), the net CO_2 emission from Unit 3 and Combined Unit-1,2, 3 are estimated as 18084633.75 ton and 54171545.75 ton respectively.

Table 7-21: GHG emissions in baseline and repowering conditions

Parameter	Unit -3	Unit – 1, 2 , 3
CO_2 (tons/y)	718328.15	2154984.45
CH_4 (tons/y)	268.8929	806.6787
N_2O (tons/y)	4788.3023	11070.6989
CO_2 - equivalent (tons/y)	723385.35	2166861.83

Notes:
1) CO_2 and CH_4 emission factors from 2006 IPCC Guidelines for National Greenhouse Gas Inventories
2) N_2O emission factor from EPA AP 42, Fifth Edition, Volume I.
3) GWP of 1, 21, and 310 used for CO_2, CH_4 and N_2O, respectively.

7.7.2 Impact on Ambient Noise

430. It is envisaged that the noise level would increase due to the operation of existing unit and the future units. For understanding the level of noise dispersed from the project activities in different selected locations, noise propagation modeling was conducted for two different scenarios, which are noise propagation during the operation of only 3rd unit and noise propagation during the operation of 2nd and 3rd unit.

431. In general, persistence exposure to the high level of noise can have adverse health impacts and can increase the level of stress to the susceptible individuals. It can also cause permanent damage to the hearing ability of the exposed persons. Next section presents noise modeling output for the mentioned two scenarios. The cumulative impacts of noise are also presented in the next section.

Noise Modeling

432. A simulation of the noise propagation during the operation of the plant was done by using CUSTIC 3.2 software. CUSTIC noise model was developed by Canarina

Environmental Software Solutions, which is widely used for noise propagation modeling and is approved by European Environment Agency.

433. For running the model, the average daytime temperature and relative humidity was considered as 300C and 70%, whereas average night time temperature and relative humidity was considered as 200C and 90%, respectively. The existing boundary wall of 2.1336 meter (7 feet) height with approximate density of 150-220 kg/m3 and with sound attenuation level of 34 dBA was considered around the project site. Moreover, the obstacles of other wall (existing and proposed) inside the power plant area were also kept in consideration.

Scenario 1: Noise propagation during the operation of 3rd unit

434. The first scenario is the scenario where the operation of the proposed 3rd unit was considered. In this scenario the considered major noise sources were Gas Turbine (GT), Steam Turbine (ST) and one RMS. The considered noise level of GT, ST and RMS were 90 dBA, 90 dBA and 80 dBA respectively (the noise levels were estimated from the measurement during field visit). The result of the modeling in this scenario is presented in **Figure 7-8** and the predicted level of noise in different sensitive locations around the plant side for scenario 1 is presented in **Table 7-22**.

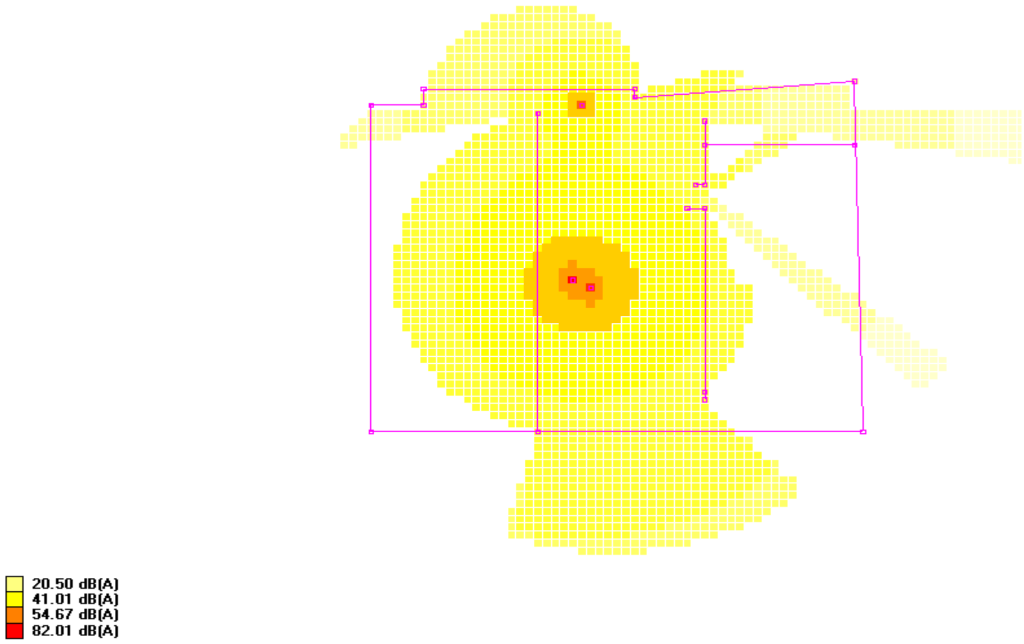


Figure 7-8: Noise Propagation Modeling for Scenario 1

Table 7-22: Predicted Noise Level in Different Sensitive Locations in Scenario 1

SL	Location	Notation	Type	Noise Level (dBA)					
				Day Time			Night Time		
				Simulated only unit 3	Baseline	Cumulative unit (1+3)	Simulated only unit 3	Baseline	Cumulative unit (1+3)
1	Main Gate of NWPGCL	NS1	Industrial	41.01	70.4	70.4	41.01	65	65
2	Inside office (2nd floor)	NS2	Industrial	34.17	53.6	53.6	34.17	53	53
3	PGCL RMS (3 m distance)	NS5	Industrial	34.17	76.3	76.3	34.17	77	77
4	Last point of the gate	NS7	Industrial	41.01	54.5	54.5	41.01	54	54
5	Mosque	NS8	Industrial	25	51.3	51.3	25	55.4	55.4
6	In front of PGCB	NS9	Industrial	In*	46	46	In*	61.1	61.1
7	CT Effluent point	NS11	Industrial	25	51.3	51.3	25	50.2	50.2
8	In front of Residence Building	NS12	Industrial	34.17	63.5	63.5	34.17	62.7	62.7
9	Road project site	NS14	Industrial	75.18	55.9	75.18	75.18	54.2	75.18
10	Gas booster	NS15	Industrial	In	69.9	69.9	In	67.6	67.6
11	GT Machine	NS16	Industrial	In	87.3	87.3	In	88.3	88.3
12	SW Road	NS17	Industrial	41.01	53.3	53.3	41.01	54.1	54.1
13	Administrative Building (Inside)	NS6	Mixed	41.01	53.6	53.6	41.01	53	53
14	New Labor colony near PGCL	NS10	Mixed	68.67	49.9	68.67	68.67	45.2	68.67
15	In front of Health Care Unit Building	NS13	Mixed	34.17	69.4	69.4	34.17	69.4	69.4
16	NW corner (Outside)	NS18	Mixed	25	44	44	25	62	62
17	SW corner (Outside)	NS19	Mixed	In	52.5	52.5	In	62.4	62.4
18	SE corner (Outside)	NS20	Mixed	In	49.1	49.1	In	61.1	61.1
19	NE corner (Outside)	NS21	Mixed	In	48.8	48.8	In	60	60
20	Chinese Labor colony	NS22	Mixed	In	59.3	59.3	In	55.2	55.2
21	Inside the village near Manab Mukti Sangstha	NS4	Residential	In	48.2	48.2	In	63	63
22	Eco Park	NS3	Silent	In	52.5	52.5	In		

*Here, In= Insignificant

435. In the table the marked red ones are exceedance and non-compliant with the standard noise level of Bangladesh. It can be seen from the table that, during the operation of only 3rd unit the level of noise exceeds only on two different locations *i.e.* NS10 and NS14 both during day and night. However, if the cumulative impact of noise from unit 1 (baseline noise) and unit 3 is considered than noise level exceeds in 6 different locations during day time and 12 different locations during night time. This impact is characterized as **moderate adverse** as given in **Table 7-4**.

Scenario 2: Noise propagation during the operation of 2nd and 3rd unit

436. In the second scenario the operation of both 2nd and 3rd unit were considered. In this case, the considered major noise sources were 2 gas turbine (90 dBA each), 2 steam turbine (90 dBA each), and 2 RMS (80 dBA each). The noise levels of the sources were estimated from the measurement during field visit. The result of the modeling in this scenario is presented in **Figure 7-9** and the predicted level of noise in different sensitive locations around the plant side for scenario 2 is presented in **Table 7-23**.

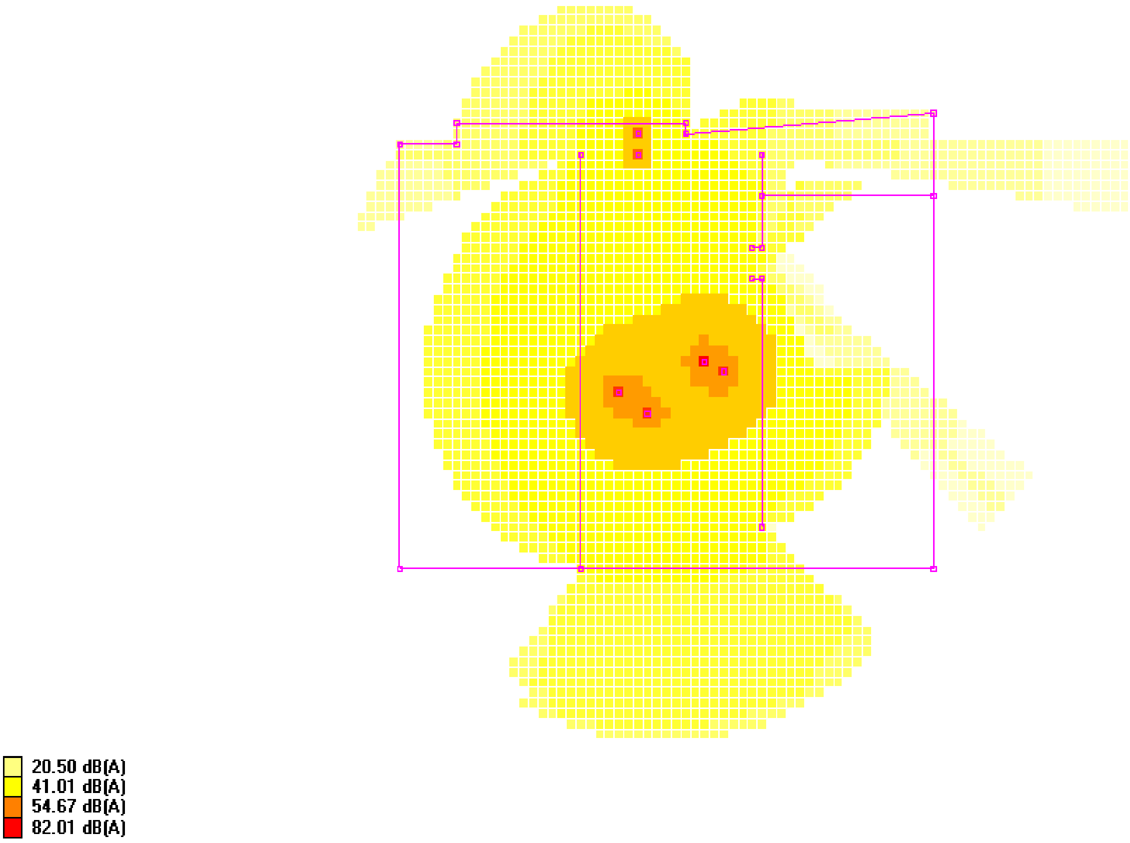


Figure 7-9: Noise Propagation Modelling for Scenario 2

Table 7-23: Predicted Noise Level in Different Sensitive Locations in Scenario 2

SL	Location	Notation	Type	Noise Level (dBA)					
				Day Time			Night Time		
				Simulated Unit (2+3)	Baseline	Cumulative Unit (1+2+3)	Simulated Unit (2+3)	Baseline	Cumulative Unit (1+2+3)
1	Main Gate of NWPGCL	NS1	Industrial	75.18	70.4	76.18	75.18	65	75.18
2	Inside office (2nd floor)	NS2	Industrial	41.01	53.6	53.6	41.01	53	53
3	PGCL RMS (3 m distance)	NS5	Industrial	47.84	76.3	76.3	47.84	77	77
4	Last point of the gate	NS7	Industrial	44.43	54.5	54.5	44.43	54	54.5
5	Mosque	NS8	Industrial	34	51.3	51.3	34	55.4	55.4
6	In front of PGCB	NS9	Industrial	In	46	46	In	61.1	61.1
7	CT Effluent point	NS11	Industrial	34.17	51.3	51.3	34.17	50.2	50.2
8	In front of Residence Building	NS12	Industrial	41.01	63.5	63.5	41.01	62.7	62.7
9	Road project site	NS14	Industrial	75.18	55.9	75.18	75.18	54.2	75.18
10	Gas booster	NS15	Industrial	In	69.9	69.9	In	67.6	67.6
11	GT Machine	NS16	Industrial	In	87.3	87.3	In	88.3	88.3
12	SW Road	NS17	Industrial	44.43	53.3	53.3	44.43	54.1	54.6
13	Administrative Building (Inside)	NS6	Mixed	47.84	53.6	53.6	47.84	53	54
14	New Labor colony near PGCL	NS10	Mixed	68.87	49.9	68.87	68.87	45.2	68.87
15	In front of Health Care Unit Building	NS13	Mixed	41.01	69.4	69.4	41.01	69.4	69.4
16	NW corner (Outside)	NS18	Mixed	25	44	44	25	62	62
17	SW corner (Outside)	NS19	Mixed	In	52.5	52.5	In	62.4	62.4
18	SE corner (Outside)	NS20	Mixed	In	49.1	49.1	In	61.1	61.1
19	NE corner (Outside)	NS21	Mixed	25	48.8	48.8	25	60	60
20	Chinese Labor colony	NS22	Mixed	In	59.3	59.3	In	55.2	55.2
21	Inside the village near Manab Mukti Sangstha	NS4	Residential	In	48.2	48.2	In	63	63
22	Eco Park	NS3	Silent	In	52.5	52.5	In		

*Here, In= Insignificant

437. It can be seen from **Table-23** that when only the impact of unit 2 and 3 is considered then the level of noise exceeds the standard level in three different locations inside the plant such as NS1, NS10, NS14. However, when the cumulative impact of noise from all the three units is considered than the noise level exceeds the standard level of noise in different other places. This impact is characterized as **moderate adverse** as given in **Table 7-4**.

7.7.3 Impact on Water Resources

Surface Water Quality

438. The major reason of the surface water quality deterioration is the existing direct disposal of effluent in the water bodies. Effluents from the demineralization process, cooling tower and HRSG blow down etc are disposed of in the nearby channel of river through drainage outlets. This can be a crucial source of water pollution for the proposed Plant also if it is continued for long time without any treatment or action. The increasing and cumulative load of effluent from all four units when in operation may exacerbate the water quality condition leading to degradation.

Internal Drainage:

439. If the internal drainage system is linked with any kitchen waste, waste from officers/ workers colony disposal then it may cause drainage problem, especially during the monsoon when the drainage canals will be highly engaged for storm water passing.

Ground Water Quality:

440. Direct disposal of effluent in the surface water body for longer period may cause some degradation in the ground water quality through infiltration and percolation as the proposed site has a soil formation with sandy soil having susceptibility to greater recharge potential.

Ground Water Availability

441. The safe operation of the plant requires 400 m^3/h of water for cooling purposes which will be fulfilled through pumping of multiple wells at the site. This added stress to the underlying aquifer will result in a lowering of water table through continuous abstraction during its operational cycle and will consequently affect well yield.

442. The proponent has carried out separate studies on ground water modeling for examining the feasibility of ground water abstraction for unit 2 and unit 4 (SDCPL & Bashar, 2015 and EAL; NWPGCL, 2014). Both of the studies (SDCPL-NWPGCL 2015 and EAL-NWPGCL 2014) confirm that the aquifer is replenished fully by the Jamuna River during the monsoon and this yearly cycle ensures a continuous supply of cooling water throughout the operational stage. However, the base flow of the area is envisaged to reduce a little. Whatever minimal permanent lowering of water table (1.5 m to 2.5 m after 25 years) does occur, will ultimately be contained within the vicinity of the plant area thus having little to no impact on the regional subsurface flow system.

7.7.4 Impacts on Land Resources

Impact on Land Use

443. Operation of the Plant would need around 200 staffs and officers for whom market facilities and other amenities would be generated. For creating such facilities it would need some lands which are under different land uses including agriculture. Generation of more power would lead to development of more industries around the Project site on the agriculture land. Therefore, operation of the plant would create serious pressure on the

existing land use of the area. This impact is characterized as **Major Adverse**, as given in **Table 7-4.**

Impact on Soil

444. Accidental spillage of untreated effluent on the nearby land from the Plant, and during filling the oil tank leakage of oil pipe may cause spillage of HSD oil to the land either side of the pipe leading to degradation of the soil quality. This is characterized as **Major Adverse**, as given in **Table 7-4.**

7.7.5 Impacts on Agricultural Resources

Impact on Irrigation Facility

445. Ground water (600 MT/hr) is being used for cooling, potable and other purposes in the existing power plant (first unit) and irrigation purposes in both study and vicinity area (within 2 km radius from the stack). The coverage of Deep Tube Wells (DTWs) and Shallow Tube Wells (STWs) based irrigation facilities in cereal crops are about 11,500 ha in the study area, yielding about 39,472 tons of crops annually. On the other hand, with such irrigation facilities in cereal crops area of about 674 ha in the vicinity area, is yielding about 2,527 tons of crops annually. In the present ground water table condition, the farmers are to pay about Tk. 10,500/ha/season for rice and for wheat 3,000/ha/season which are costly.

446. Extraction of ground water (400 MT/hr) for cooling system of the proposed third unit CCPP would limit the availability of irrigation water. When all four units in operation would require about 2,500 MT/hr against the ground water yielding capacity of 3,000 MT/hr would cause further drawdown of the aquifer. Moreover, proposed Economic Zone and BSCIC industrial park would be established in future in the vicinity area and they would also extract ground water for their own purpose as well. Hence, availability of ground water in this area may appear as a serious crisis which would lead to escalate the irrigation cost resulting in decline of crop production. However, this impact would be for a long term, might be spread out to the extended area, reversible. This is a critical impact. However, sensitivity of this impact is characterized as **critical adverse,** as given in **Table 7-4**.

7.7.6 Impacts on Livestock Resources

Fodder and Diseases

447. Construction of the proposed power plant would restrict grazing land. Release of untreated liquid waste/effluent from the existing Plant in the adjacent water body s might cause retardation of the growth of along with the toxicity to the fodder vegetation. Increase of pollution load when first three units are in operation might lead more devastation to the fodder vegetation of the cattle. It might also harmful for livestock health. By drinking this waste water cattle might be suffered from different diseases in the vicinity area. This impact is characterized as **Moderate Adverse** in **Table 7-4.**

7.7.7 Impacts on Fisheries and Their Habitat

448. Discharge of untreated effluent from the existing first Unit has been contaminating the canal water around the SPS which has wet season connectivity with the Jamuna River. Continuous loading of such contaminated effluent may become harmful for the local capture fisheries. A CETP is considered under this Project with the capacity of treating effluents of first three units (1, 2 & 3). Regular and proper operation of the CETP will remove the contaminants from the effluent and fresh water will be discharged to the canal or reused in the gardens of SPS or diverted to the near crop fields for irrigation. As such the

environmental performance of the Project will be better and fisheries and other aquatic organisms will be safe from its hazardous effect.

449. Abstraction of ground water at the rate of 1400 m^3/hr for three units (1, 2 & 3) including 400 m^3/hr for third Unit may cause crisis for pond water availability period (PWAP) around the Project site. This incident may cause the reduction of fish productivity of the aquaculture ponds. Withdrawal of another 1150 m^3/hr for the fourth Unit may further aggravate the situation. Though the ground water model result shows the maximum allowable withdrawal of groundwater is 3,200 m^3/h without causing conspicuous problem in the groundwater table of the SPS area (EAL, 2014 and SDCPL, 2015). This impact is characterized as **Major Adverse**, as given in **Table 7-4**.

7.7.8 Impact on Ecosystems

Impact on aquatic habitat quality

450. Accidental discharge of waste and warm water will adversely impact on river ecosystems. However, this negative impact will occur only in adverse situation if the plant ETP will be failed. The river channel that passed nearby the plant occurred no aquatic mammals but support various fish species, snakes and frogs. These aquatic fauna will be main victims. Jamuna itself a large and wide river that flows huge amount of water and fluctuation of water varies in seasonal variation. Adversity of this impact will be highly intense in dry season and minimize in wet season due to presence of huge flow from the main channel of Jamuna River. Considering environmental consequences and seasonal water fluctuation, this impact is addressed in major.

Impact on terrestrial wildlife

451. Emission of noise from turbines and other machineries will be caused fear to the faunal communities specially for avifauna which are roaming inside the plant boundaries and nearer locations. The field observation for the impact on avifauna and other wildlife due to existing noise from Unit 1 revealed that the most of them are habituate in continuous usual noise. However, the avifauna inside the plant boundaries get fear when emit sudden high noise due to release gas pressure of the plant and they are normal again after stop of the sound. It is predicted that the additional usual noise from the new plant will also have minor impact to the terrestrial wildlife especially to the avifauna.

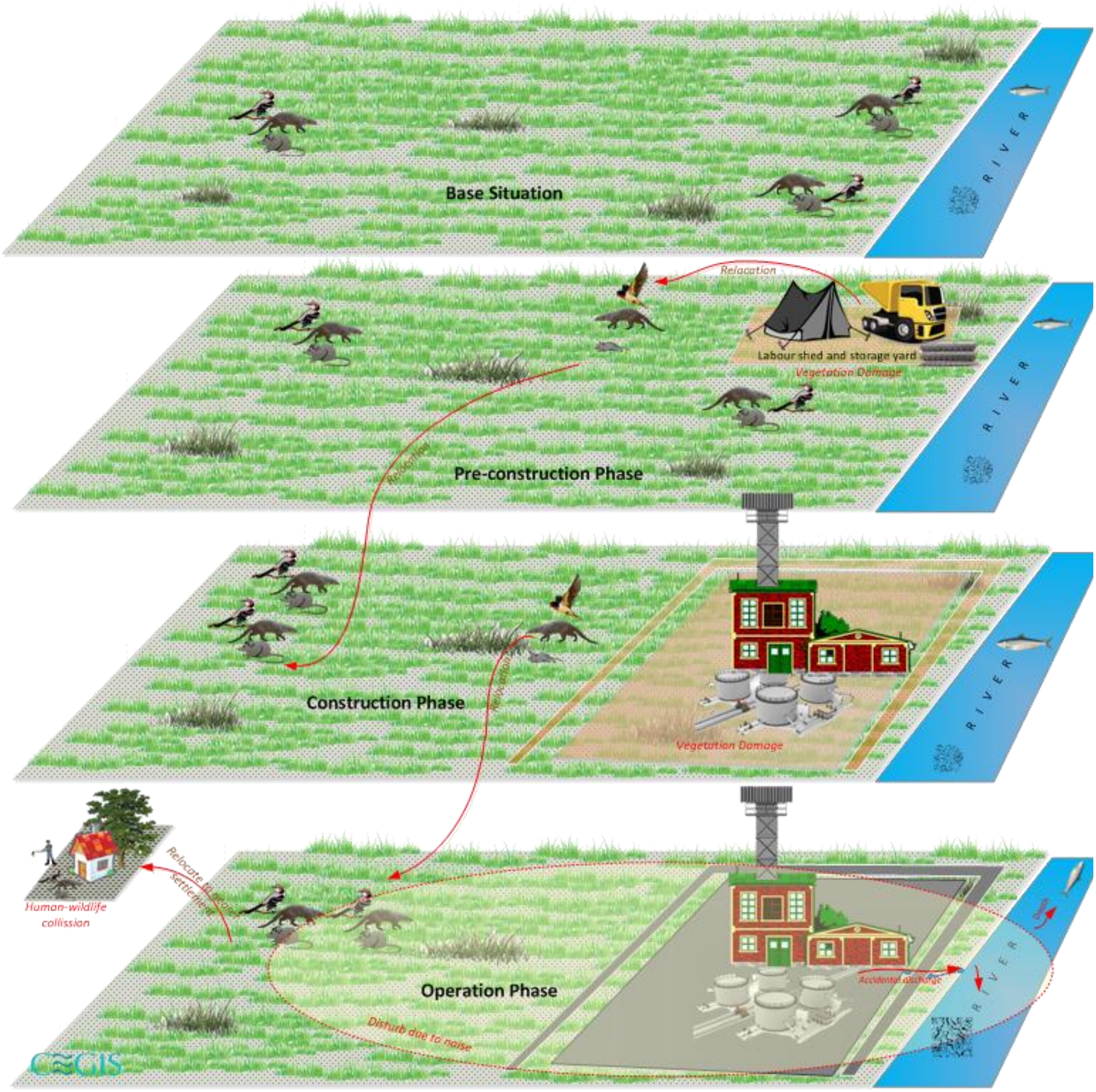


Figure 7-10: Overall impacts on ecological resources in different spheres of project life

7.7.9 Impact on Socio-Economic Condition

452. Construction of the proposed Plant may create excessive noise during the commissioning period. Trial time generation of excessive noise will be scaring to nearby residents, medical facilities, school children or users of nearby park and recreational places. On the other hand, it would increase the power generation and reduce energy shortfall and revive associated economy. The development of existing and new units would attract various new entrepreneurs. The activities for establishing BSCIC industrial park (to the north of the power plant) and proposed Economic Zone (to the south of the power plant) are going on. The surrounding areas are very apposite for launching various small scale industries. The construction of power plant may promote further the industrial activities.

7.7.10 Non-Hazardous Waste Generation

Waste Water

453. Generally, effluents from the proposed power plant would be HRSG blow down, cooling tower blow down, back flash from ion exchanger and iron filter of water treatment plant, floor and yard drains (cleaning), oily water from turbine hall and sub-station yard, etc. Generally this waste water is contaminated with Chlorine, Chromium, Copper, Iron, Zinc, and heavy metals. The effluent characteristic of the existing plant which is more or less similar to the proposed Unit 3 Power Plant is presented in the **Table 7-24**:

Table 7-24: Characteristics of Wastewater from Unit-1 Power Plant, Siirajganj

Parameter	Unit	Effluent Sump-1*	Effluent Sump 2**	Effluent Sump 2***	MoEF's Standard	IFC Standard
pH[10]	-	8.53	8.53	8.53	6-9	6-9
TSS	mg/L	36	04	07	150	50
TDS		835	420	170		
COD	mg/L	02	03	03	200	ND
Oil and Grease	mg/L	6.67	<5	<5	10	10
Cr	mg/L	0.0005	<LOQ	0.003	0.5	0.5
Cu	mg/L	0.013	0.02	0.014	0.5	0.5
Fe	mg/L	0.41	0.83	0.34	2	1.0
Zn	mg/L	0.02	0.16	0.02	5	1.0
Pb	mg/L	0.007	0.017	0.003	0.1	0.5
Cd	mg/L	0.003	0.003	0.003	0.5	0.1
As	mg/L	<0.001	0.003	0.001	0.2	0.5

Note: *Cooling tower and HRSG Blow Down Sump, ** Backflush from DM water treatment plant sump, *** Backflash of iron removing plant

454. The detail sources and quantity of the waste water is clearly described in Water Balance Diagram provided in section **4.3.7** of **Chapter 4**. From the water balance diagram it is estimated that the total quantity of the effluent from the power plant (excluding effluent from domestic water use) would be around 69 m^3/ hr (**Table 7-25**).

Table 7-25: Effluent Sources and Quantity in the Proposed Unit – 3 Power Plant

Sl no	Sources	Quantity (m^3/hr)	Discharge Pathway
1	Water Pre-treatment Plant: Clarifier Tank, Sand Filter and Sludge thickening Plant	1.40	Waste Water Sump > CETP > Discharge Channel > River
2	Cooling Tower blow Down and HRSG Blow Down	61.60	
3	Water Demineralization Plant Blow Down	6.00	
	Total	**69.0**	

Source: CEGIS, 2015

455. The proposed project considers a Central Water Treatment Plant (CWTP) to be constructed. This CWTP will be common for all three units of the SPS. Therefore, no waste water will be discharged to the river or canal without treatment and satisfying the MoEF's standard of effluent quality. As there is no effluent treatment plant for the existing unit,

[10] Effluent water quality test report of BUET (collected from Corporate office of NWGPCL), sample were taken and submitted by the NWPGCL in April 2014.

therefore, this CWTP would improve the environmental performance of the SPS by providing the means of effluent treatment plant for existing unit and proposed 2nd and 3rd units.

Kitchen Waste

456. During operation, it is assumed that around 160 people will be living at site. The **Table 7-26** below shows the estimation of kitchen waste during operation.

Table 7-26: Estimation of Kitchen Waste during Pre-construction and Land Development Period

Sl No	Economic Classes of Employee	Project employee	Rate of kitchen waste generation (kg/day/capita)*	Total generated waste (kg/day)
1	High Income Group (>20000 tk/month)	67	0.513	34
2	Middle Income Group (tk 10000-20000tk / month)	25	0.4	10
3	Low Income Group (< 10000 tk/month)	68	0.26	18
Total		**160**		**62**

**source: (JICA, Pacific Consultant Internationals, & Co, 2005)*

457. It is estimated that around 62 kg of kitchen waste will be generated each day from the residential area of the proposed unit. Careless disposal of this waste would create pollution, odor problem, nuisance and aesthetic tiring.

458. However, the impact would be for long term but would be limited within the plant premises, reversible and may happen only in worst-case scenario (i.e. no management of kitchen waste). On the other hand, sensitivity of this impact to the residents of the SPS is High as presently there is no Kitchen Waste Management System at SPS. Thus the significance of the impact would be **major adverse** and needs to be minimized by EMP.

Sewerage

459. It is assumed that during operation phase around 160 employees including staffs will be living at site for operation related activities. Therefore, it is estimated that maximum 42 m^3/day (considering 260 L/day per capita sewerage generation) sewerage would be generated from the staff and officers' residence. A small portion of this sewerage may escape sewerage collection and disposal system. The fecal sludge would go to the existing septic tank.

460. This added sewerage would not have any significant impact on the existing sewerage system. The magnitude of the impact would be moderate and sensitivity would also be moderate. Thus significant of the impact would be **medium adverse** and needs to be controlled by adopting EMP.

7.7.11 Hazardous Waste Generation

Condensate from RMS Unit

461. Condensate is a flammable hydrocarbon liquid generated from pressure drop of natural gas in Gas Regulating and Metering Station (RMS). The RMS (s) to be installed at PGCL end and power plant end will produce condensate. This produced condensate will be stored in the condensate tank and finally to be sold to oil refinery factory. Therefore, there will be **no impacts** on surrounding environment due to this condensate. However, this condensate tank posses risk of explosion.

Hydrazine residue from De-oxygenation of Feed Water

462. The proposed unit considers using of Hydrazine (either N_2H_4 or $N_2H_4 \cdot H_2O$) as oxygen scavenger in feed water. Hydrazine is a genotoxic carcinogen and enlisted as hazardous chemical in Hazardous Waste and Ship Breaking Waste Management Rules 2011 of Bangladesh. The use of Hydrazine is also internationally restricted. Use of hydrazine is prohibited in Europe, USA, Australia, Thailand, South Africa, Saudi Arabia, and many other countries. The magnitude of the impact is moderate but sensitivity of the impact is very high. Thence, the significance of the impact is **major adverse**.

463. Therefore, it is strongly recommended to seek alternative chemical (e.g. Helamin, Diethylhydroxylamine, etc.) to use Hydrazine or alternative design of Water Treatment to avoid use of any oxygen scavenger.

Oil and Oily Water

464. Lube oil is generally used in the power plant in different equipments like bearing, turbine hydraulic system, etc. Wash water or drained water from turbine hall, substation yard, etc may contain oil and oily water. However, the proposed plant considers to install an Oil Water Separation Unit integrated with a central water treatment plant. Therefore, the impact would **not be significant**. On the other hand, this proposed third unit would bring a means of treating oily water from existing unit.

Sludge from Water Treatment Plant

465. Concentrated sludge would be generated from water pre-treatment plant, demineralization plants, waste water treatment plants and oily water separation unit. These sludge would go to the sludge sump for dewatering and thickening. Disposal of the dry sludge might contaminate ground water of surface water if it is not properly managed. The magnitude of the impact major and sensitivity is also high. Therefore, significance of the impact is **major adverse** that calls for adoption of proper EMP.

8 Mitigation of Impacts

8.1 Preamble

466. The proposed third unit is a gas based CCPP and is environmentally friendly in nature as described in Chapter 4. There is an existing operating power plant (first unit), which does not contain effluent treatment plant for removing contamination of water and sludge treatment. Scraps and other solid wastes generated from the first unit are dumped haphazardly. Therefore, it requires particular attention to harmonize the management of liquid and solid wastes with the existing and other proposed operations in the SPS facility. Specific design changes proposed in this project are presented in the following sections.

8.2 Change in the project layout

467. It is proposed to include the following items in the project layout developed by the engineering consultant:

- A storm water drainage system around the proposed Plant and link it with the existing drainage network of the SPS.
- A temporary but arranged storage yard for scrap materials individually for all units in the southern side of the Sirajganj Power Station.
- A central water/effluent treatment plant.
- A green belt around the whole of the SPS boundary.

8.3 Engineering design

468. During site visit, it is learnt from the operation staffs of the first unit that there is no effluent treatment plant (ETP) and sludge treatment system for checking waste water generated from different sections of the Plant before releasing in the open environment. As a result, waste waters are being discharged in the canal around the Plant and contaminating the river water when regain connectivity. The existing water treatment plant at SPS is a recent Plant with adequate capacity for first unit. It uses Hydrazine as oxygen scavenger in the HRSG feed water system, resin based demineralization and aluminum sulfate for raw water treatment.

469. It is proposed that the third unit will include a central water treatment plant for first three units containing effluent treatment plant, sludge treatment plant, and a reverse osmosis plant for de-mineralization of water. The plant will use more environment friendly chemicals, such as, Sodium Erythorbate or Helamin as alternatives to hydrazine to treat feed water and reverse osmosis technology to replace resin based demineralization.

8.3.1 Alternative to use of Hydrazine as oxygen scavenger in Feed Water

470. Hydrazine is generally used as an oxygen scavenger for corrosion control in thermalpower plants. Although hydrazine is very effective in this application, it is a genotoxiccarcinogen. Instead of using Hygrazine, it is recommended to use alternative oxygen scavenging chemical e.g. Helamin, Diethylhydroxylamine, etc in feed water for corrosion protection in HRSG boiler. However, the design of the HRSG and water treatment can also be changed to avoid use of any oxygen scavenger. There are two alternatives for that:

- Combined Water Treatment (CWT) or oxygen treatment for through-flow boilers

- All Volatile Treatment (AVT) Oxidizing +High-AVT (treatment by a volatile substance with a high pH value without using Hydrazine)

471. However, freedom can be given to EPC contractor to find an appropriate alternative of using Hydrazine.

8.4 Mitigation measures for major impacts

472. The following sections present the mitigation measures for the major impacts identified in Chapter 7 of the EIA report. Minor and some moderate impacts will be managed and mitigated using environmental code of practices (**Appendix-8**) and Contractors' good practice.

8.4.1 Pre-Construction Stage

A. Socio-Economic Condition

473. The flow of migrant workers may aggravate the risk of HIV/AIDS and STI. Awareness programs on HIV/AIDS infection through well-designed campaign needs to be implemented; targeting all risk prone groups. Acclimatization with the mores, rituals and customs of local people can also reduce the chances of spreading such infectious diseases. Adopting and carrying out Behavior Change Communication (BCC) among target groups may also reduce the spread of the diseases. The contractor will put in place a referral healthcare facility to deal with medical aspects of HIV/AIDS treatment with specialized services. The in-house medical facility will diagnose for STD/STI and TB infection among the workers and provide treatment as necessary. Serious cases of infection may be referred to specialized treatment facilities of the region.

B. Kitchen Waste

474. A good practice of kitchen waste collection and disposal system should be adopted. Some temporary bins with color marking indicating degradable and non degradable waste might be installed at labor shed and work places to prevent scattered throwing of wastes. There should be a designated site or scientific landfill area for kitchen waste disposal for controlling bad odor and leachate having susceptibility to contaminate water.

8.4.2 Construction Stage

C. Ambient Air quality

475. Regualr watering of the unpaved roads and open areas inside the project boundary which may be increased during high wind and excavation/granding. Dust suppressants should be applied or cover to soil stockpiles and disturbed areas when inactive for more than two weeks. The vehicle speeds will be limited 10 mph during the dry seasons inside the project area. The truck must be covered when hauling material that could be entrained during transit. The diesel fueled equipment should be ultra-low sulfur (15 ppm sulfur) containing. Moreover, limiting diesel heavy equipment idling to less than 5 minutes to the extent practical.

D. Noise Level

476. During construction activity, noise might be generated from the moving and idling vehicles, heavy machineries and different other construction related activities. The machines/vehicles/equipments thus should be turned off when not in use, to minimize noise generation. The equipments used during the construction phase should be with proper silencer where applicable and properly maintained as proper maintenance can decrease the level of sound level significantly. For protecting the workers from the adverse impacts of high

noise level, Personal Protective Equipments (PPEs) such as air plug/earmuffs should be provided. The use of the PPE should be made mandatory to the site engineers, workers and other staffs who are susceptible to high noise.

E. Surface Water Quality

477. The construction raw materials should be properly stockpiled, used, handled and managed so that the dust or any chemical or contaminant cannot reach to the surface water through rainfall runoff. Direct disposal of liquid waste from the construction activities to the surface water should be prohibited. The construction materials that would be brought to the site through the river/road way, are to be properly covered and the unloading process should be carried out with due care.

478. The members of the worker colonies should obey the guideline of best practices in order to avoid or minimize the domestic waste from the workers colony. Chemical substances and scrap should be kept on a specified covered areas so that contaminants from such substances cannot come into the natural environment. The workers must be trained or made aware of about their duties during abnormal or emgency sitution like oil spill, chemical spill, etc. The above mentioned steps could positively mitigate the possibility of the surface water quality deteoration during the construction stage.

F. Socio-Economic Condition

479. Local Union Councils should have ordinances that regulate loud and intolerable noise; the Project authority can make the people aware about noise to the adjacent people before the construction activities, night construction work should be limited to relatively quiet activities, such as interior work. The proponent should facilitate the involvement of local people in supplying construction materials and food for the workers for suppressing the chances of grievances and disappointment for not being a part of the construction activities.

G. Kitchen Waste

480. A good practice of kitchen waste collection and disposal system should be adopted. Some temporary bins with color marking indicating degradable and non degradable waste might be installed at labor shed and work places to prevent scattered throwing of wastes. There should be a designated site or scientific landfill area for kitchen waste disposal for controlling bad odor and leachate having susceptibility to contaminate water.

8.4.3 Operation Stage

H. Ambient Air

481. During operation, the appropriate mitigation measures is to reduce potential air emissions before they are emitted. This is accomplished by the careful design of the project, including the installation of the Best Available Control Technology (BACT) to minimize air emission. Built-in Low-NO_x burner in GT will reduce the NO_x emission below 25 ppmv. All modern GT manufacturers give the guaranty of having NO_x less than 25 ppmv with their dry low-NO_x burner.CEMS technology must be installed at the stack to record pollutant emission rate and avoid any uneven situation. Use low sulfur containing HSD during operation in absence of natural gas.

I. Noise Level

482. Loud noises generated from the plant operation activities can lead to hearing complexity and loss along with increased blood pressure; disturbances and discomfort to the site engineers, technicians, workers, staffs and surrounding communities. The machines/equipments/vehicles, which are not in use, should be turned off to limit noise

generation. The machineries should be maintained properly according to the provided instructions as proper maintenance can decrease the level of noise significantly. The rotating machinery, such as turbines, pumps, fans etc. should be covered with noise proof hood to limit the spread of noise. Silencer should be used wherever possible. A green belt consisting of trees of different heights and canopy coverage should be developed along the boundary wall of the power plant area. The green belt should be of at least 3.5 m width consisting two rows of plantation with the gradual increase of height of plant from inside row to outside row.

J. Surface Water Quality

483. The effluent from the demineralization unit, the cooling tower and the other effluent outlets should not be disposed to the nearby surface water sources without proper treatment. A Central Effluent Treatment Plant (CETP) will be constructed under this Project should be operated and managed properly. It means the existing 1st units, 2nd unit and also the proposed 3rd unit should be brought under a central effluent treatment plant in order to ensure contaminant free discharge of the power plant to the open environment.

484. The used, damaged or broken materials from the construction work should be managed properly. Thus the onsite and offsite waste dumping should be well maintained to avoid the susceptibility of river water pollution or contamination.

K. Internal Drainage

485. The internal drainage system should only be used to serve the purpose to what it is built specially for the storm water release during the monsoon or rainy day. Any sort of waste or effluent disposal from the plant should not be allowed to pass through the internal drainage system.

L. Ground Water Resources

486. To ensure minimal well interference and to maximize potential yield, the layout of the required amount of wells have to be designed accordingly. The groundwater modeling studies (EAL & NWPGCL, 2014 and SDCPL & Bashar, 2015) suggested that the typical spacing between consecutive wells be approximately 500m. Also, the best form of placement would be along a line parallel to the river Jamuna so that the catchment of the pumping wells spread mostly on the river. The study also mentioned that even if there is interference, the placement of the wells within the Plant area will not hinder yield. The wells are to be dug up to the bottom of the aquifer.

487. Besides, measures for recharging groundwater by using rainwater can be adopted. As such the following measures can be adopted:

- Installation of rooftop rainwater harvesting system for groundwater recharge (see **Figure 8-1**)
- Installation of trench/groundwater recharge bed (constructed with open space, sand layer and gravel layer) along the road side within the plant area (see **Figure 8-2**)
- Keep green plantation and open area for at least 10% of the entire power plant premises

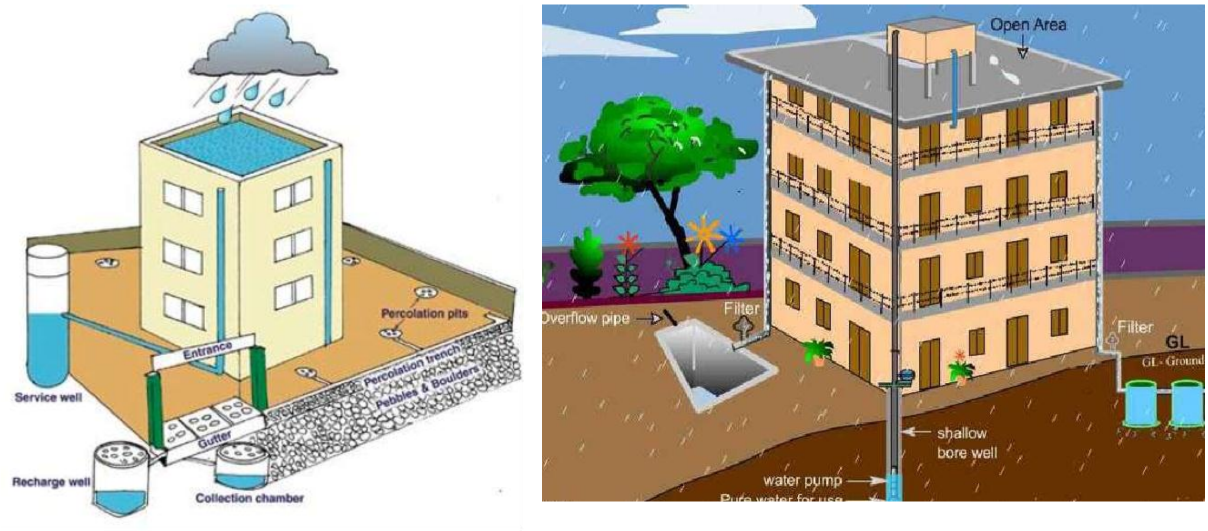


Figure 8-1: Roof Top Rainwater Harvesting System for Groundwater Recharge

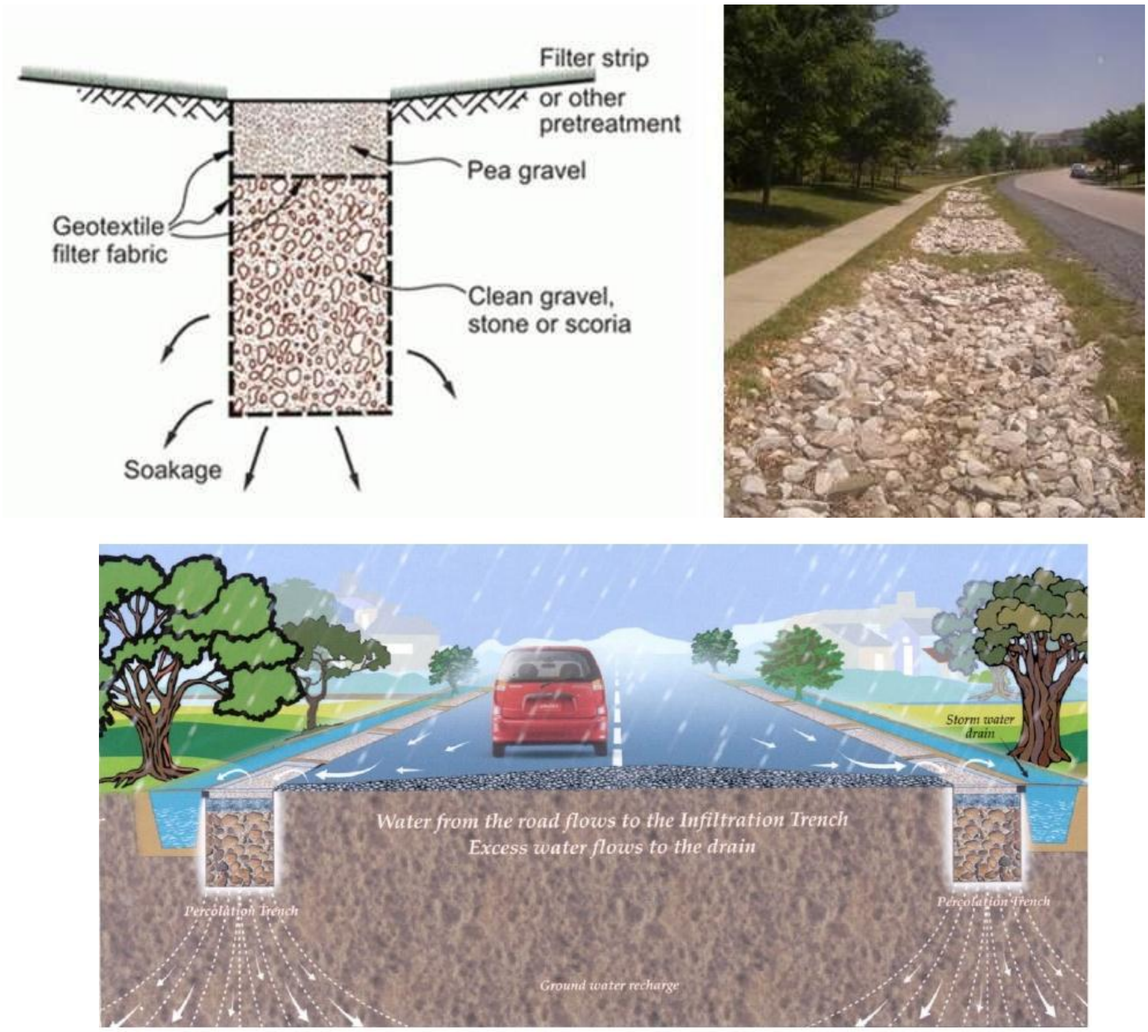


Figure 8-2: Roadside trench for groundwater recharge

M. Unavailability of irrigation water

488. Continuous extraction of ground water at the rate of 400 m^3/hr over the Project life (25 years) for the proposed CCPP might cause the unavailability and crisis of irrigation water in future in the close vicinity of the Project site. But the ground water study reveals that there

would be no or little impact on the ground water availability for irrigation facilities of the adjoining area crop fields. On the other hand, establishment of the proposed Economic Zone (EZ) and BSCIC Industrial Park would be established in future around the Project site. These industries would also have ground water extraction potentials for their own consumptions. Cumulative ground water extractions of such industries may pose problem to the availability of irrigation water. Considering, the severity of the issue and the significant benefits to the communities, it is suggested to divert treated waste water to the crop fields around the Project site through irrigation canal for reducing pressure on ground water extraction.

N. Reduction of agricultural land

489. Considering the severity of the issue, a regional/local 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 different land use other than agriculture.

O. Aquatic habitat quality

490. Effluent Treatment Plant (ETP) should be properly functional. A secondary effluent pit may be created just close to the project boundary to arrest the accidental effluents during the condition of ETP failure. The effluent pit should be well dyke above maximum flood level of that land so that the accidental effluent s are limiting disperse at the confined small area and not to contaminated surrounding waterbodies. The barrow pit existed close to eastern and southern boundaries are suggested to use as secondary effluent pit during emergency situation (see **Figure 8-3**).

Figure 8-3: Proposed layout for creating secondary effluent pit

P. Socio-Economic Condition

491. It may create excessive noise during the commissioning period of third unit. The authority should aware and warn the local people about it. And it may cause a matter of

hearing complexity, and loss along with increase blood pressure, disturbances and discomfort to the technicians and workers and surrounding communities. If it make health problem to the local people then the authority should take the responsibility of medical treatment of the local people. In this case, the local Union Councils should have ordinances that regulate loud and objectionable noise.

Q. Kitchen Waste

492. Standard practice of kitchen waste collection and disposal should be implemented. Some temporary bins with color marking indicating degradable and non degradable waste might be installed in the staff colony and work places to prevent scattered throwing of wastes. There should be a designated site or scientific landfill area for kitchen waste disposal for controlling bad odor and leachate having susceptibility to contaminate water. Moreover, it should be protected from the scavenging by birds and animals, washing out by rain fall runoff, etc. Furthermore, a site should be designated for biodegradable kitchen waste disposal. Above all, for managing such wastes in a hygienic way a set of cleaners should be involved permanently.

R. Sewerage

493. It is recommended to construct and commission a central sewerage treatment plant (STP) for treating sanitary waste as a large numbers of employee will be residing in the Sirajganj Power Station complex when 2nd and 3rd units are in operation along with 1st unit. The sewerage treatment plant might be of biological type or in combination with physical, chemical and biological type. Generally, a STP consists of screening devices, aeration, active sludge treatment, sedimentation, clarification and separation/recirculation of sewage sludge. Membrane bio reaction is a good alternative. The EPC contractor should construct a STP including the sewerage collection network. The STP should have capacity corresponding to the numbers of employee in the first three units of the SPS. The Plant should be designed in a way that would comply the effluent standard (sewerage) of IFC and MoEF. The provision of reusing the treated waste should be considered in the design. The treated water can also be supplied to the nearest agricultural lands for irrigation.

The sludge from STP should be disposed in compliance with the IFC standard and ECR 1997.

S. Hazardous Sludge from Water Treatment Plant

494. The feasibility study proposes thickening and dewatering of sludge, in the form of dry cake, generated from water treatment plant. The dry cake of sludge should be managed properly so as to avoid leaching of heavy metals in the rainfall run off. Dry cake that would be mostly iron sludge has market potential in steel rolling mill. However, the EPC contractor should consider this issue and propose a sustainable management plan for sludge handling.

9 Environmental Management Plan

495. The Environmental Management Plan (EMP) includes several plans for implementing mitigation and enhancement measures including Emergency Response Plan (ERP), Occupational Health and Safety Plan (OHSP), and Environmental Code of Practices (ECPs). ***Generally, the impacts, which are minor or moderate, are to be mitigated by adopting Environmental Code of Practices (ECP) (Appendix-8) and Contractor's good practices during project implementation***. On the other hand, impacts and risks which are critical or major will be mitigated or prevented by adopting mitigation measures are discussed in Chapter 8 and specific plans are discussed in this Chapter.

9.1 Objectives of EMP

496. The basic objective of the EMP is to manage adverse impacts of the Project interventions in a way, which minimizes the impacts on the environment and people of the Project area. The specific objectives of the EMP are to:

- Facilitate the implementation of the mitigation measures identified during the present EIA to comply with regulatory requirements and discussed earlier in the document.
- Maximize potential project benefits and control negative impacts.
- Draw responsibilities for project proponent, contractors, consultants, and other members of the Project team for the environmental management of the Project; and
- Maintain essential ecological process, preserving biodiversity, and where possible restoring degraded natural resources.

497. The EMP will be managed through a number of tasks and activities. One purpose of the EMP is to record the procedure and methodology for management of mitigation and enhancement measures identified for each negative and positive impacts of the Project respectively. The management will clearly delineate the responsibility of various participants and stakeholders involved in planning, implementation, and operation of the Project.

9.2 Various Categories of Mitigation Measures

498. The EMP includes various categories of mitigation measures and plans: (i) general and non-site-specific measures in the form of Environmental Codes of Practices (ECPs) presented in **Appendix-8** to address general construction and operation matters identified as moderate and minor in significance prior to mitigation in **Table 7-4**; (ii) project specific and to the extent possible, site-specific mitigation measures discussed in **Chapter 8** and summarized in **Table 9-2**; and (iv) Construction Environmental Action Plan (CEAP) with site-specific and construction-specific management plans to be prepared by the contractor, which include pollution prevention, occupational health, safety and environment, and emergency response.

9.3 Inclusion of EMP in Contract Documents

In order to make the Contractor fully aware of the implications of the EMP and responsible for ensuring compliance, technical specifications in the tender documents will include compliance with mitigation measures proposed in the EIA as well as financer's General Environmental Health and Safety Guidelines. The Contractor must be made accountable through contract documents for the obligations regarding the environmental and social components of the Project.

9.4 Environmental Code of Practices

499. A set of Environmental Code of Practices (ECPs) has been prepared for various environmental and social management aspects: ECP 1: Waste Management; ECP 2: Fuels and Hazardous Goods Management; ECP 3: Water Resources Management; ECP 4: Drainage Management; ECP 5: Soil Quality Management; ECP 6: Erosion and Sediment Control; ECP 7: Top Soil Management; ECP 8: Topography and Landscaping; ECP 9: Quarry Areas Development and Operation; ECP 10: Air Quality Management; ECP 11: Noise Management; ECP 12: Protection of Flora; ECP 13: Protection of Fauna; ECP 14: Protection of Fisheries; ECP 15: Road Transport and Road Traffic Management; ECP 16: Construction Camp Management; ECP 17: Cultural and Religious Issues; ECP 18: Workers Health and Safety, and ECP 19: Construction and Operation Phase Security. The Contractors will be contractually obligated to comply with these ECPs, presented in **Appendix-8**.

500. The Contractor will prepare one Construction Environmental Action Plan to address pollution prevention, occupational health, safety and environment, and emergency response including the requirements of ECPs and EMP. These will be reviewed and approved by Owner's Engineer (OE), EHSU Circle, and PIU before implementation of construction works.

9.5 Environmental Management Plans during Pre-Construction

9.5.1 Site Preparation

501. The site preparation would require base stripping, felling of 14 small timber trees and clearance of vegetation. The contractor will prepare a site preparation plan on the basis of ECP 4, ECP 5, ECP 7, ECP 8, ECP 12, and ECP 13 to ensure safeguarding of environment. This plan must be submitted to OE for review and approval.

9.5.2 Kitchen Waste

502. A good practice of kitchen waste collection and disposal system should be adopted. The aim should be reduction of the waste generation. Degradable waste, glasses, recyclable and reusable waste, papers, plastic, etc should be collected by nature of the materials and managed separately. Some temporary bins with different colors indicating disposal of degradable and non degradable wastes might be installed at labor shed and work places to prevent scattered throwing of solid wastes. There should be a designated site for kitchen waste disposal. Scattered throwing and burning of waste should be prohibited.

9.6 Environmental Management Plans during Construction

503. The followings are some of the plans proposed in this EMP to guide the Contractor to prepare a Construction Environmental Action Plan (CEAP). The Contractor will expand the plan to address site specific measures.

9.6.1 Kitchen Waste

504. A good practice of kitchen waste collection and disposal system should be adopted. The aim should be reduction of the waste generation. Degradable waste, glasses, recyclable and reusable waste, papers, plastic, etc should be collected by nature of the materials and managed separately. Some temporary bins with different colors indicating disposal of degradable and non degradable wastes might be installed at labor shed and work places to

prevent scattered throwing of solid wastes. There should be a designated site for kitchen waste disposal. Scattered throwing and burning of waste should be prohibited.

9.6.2 Construction waste management plan

505. The waste to be generated from construction work should be managed properly. Rate of waste generation should be minimized through prior take up efficient technique and limiting waste generating activities. The essential possible measures for controlling construction waste may include limiting site clearance activities, planned stocking and gathering of construction materials and equipment with covering, 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 pre allocated and provided with efficient waste collection and disposal techniques. No waste should be dumped to the nearby river or to the surface water body around the site. 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 and they should not be dumped anywhere of the plant site. Hazardous material from construction site including fuel and other combustible materials shall have to be stored with highest care and caution. Spillage, accidental release must be controlled adopting hazardous material handling guideline. Liquid waste management is again in important issue. No liquid waste during the construction activities should be discharged or released straight to the open environment or internal drainage system. There must remain separate and isolated drainage procedure to release and manage the liquid waste outside the project premises.

9.6.3 Aquatic Habitat Condition

506. A minor dredging may require for bringing the ship/vessel carrying heavy machinery to the jetty point for unloading them. The dredging operation would affect the aquatic habitats, particularly the benthic organisms of the river channel to be dredged nearby the plant. Dredging operation is suggested to carry out in the alignment having minimum aquatic habitat. Appropriate benthic survey will be carried out prior to the dredging activities. The crews of the ships/cargos which will carry the machineries should maintain International Maritime Laws so as to avoid or little disturbance to aquatic habitats.

9.6.4 Erosion, sediment and drainage control plan

507. An erosion, sediment and drainage control plan will be necessary to manage rainfall run off in the construction site. This plan will be prepared by each contractor on the basis of ECP 4 and 6, and the mitigation measures given in EIA. The Plan will be submitted to the OE for review and approval before contractor mobilization.

9.6.5 Pollution Prevention Plan

508. Pollution Prevention Plan will be prepared and implemented by the Contractor on the basis of ECP 1, ECP 2, ECP 11, and Financer’s EHS Guidelines, as well as the mitigation plans given in EIA. The Plan will be submitted to the OE for review and approval before contractor mobilization.

9.6.6 Waste Disposal and Effluent Management Plan

509. Waste Disposal and Effluent Management Plan is mandatory to manage the construction waste and effluent including waste and effluent from labor sheds. A detail plan will be prepared and implemented by the Contractor on the basis of ECP 1, ECP 4, and

Financer's EHS Guidelines, as well as the mitigation plans given in this EIA. The Plan will be submitted to the OE for review and approval before contractor mobilization.

9.6.7 Traffic Management Plan

510. During construction, a number of vehicles will be running from/to the construction site. To avoid the impacts of this additional traffic there must be a management plan for traffic operation. A detail plan will be prepared by the Contractor on the basis of ECP 15 and also the mitigation plans given in this EIA, after discussion with PMU and authorities responsible for roads and traffic. The Plan will be submitted to the OE for their review and approval before contractor mobilization.

9.6.8 Burrow Area Management and Restoration Plan

511. An environmental plan for management and restoration of burrow areas will be prepared by the Contractor on the basis of ECPs 8 and 9 and other requirements described in the mitigation plans. This Plan will aim at minimizing the environmental and social impacts during burrowing activities and restoring as much as possible the original natural situation of these sites by various measures (refill, leveling or smoothening). Restoration methodologies will be included in the Plan. The Plan will be approved by the OE and PMU.

9.6.9 Drinking Water Supply and Sanitation Plan

512. A separate water supply and sanitation provisions might be needed for the temporary facilities, labor camp and workshops, in order not to cause shortages and/or contamination of water. A Plan will be prepared by the Contractor on basis of ECP 3. The Plan will be submitted to the OE for review and approval before contractor mobilization.

9.6.10 Management Plan for alternative use of ground water

513. The SPS will require about 2550 m^3/hr water for the operation of four units of which one is running, one is under construction and two others under EIA study stage. According to ground water modeling of SDPCL in 2015, abstraction of ground water at the rate of 3200 m^3/hr would not cause any permanent loss of ground water with drawdown effect of 1-1.5m in 20 years. Because, the site is situated on the raised land within the conveyance of the Jamuna River having the high recharge potential laterally and vertically. If the ground water is used for all the units still there may remain a susceptibility to depletion of the ground water table. An alternative source can be anticipated as utilization of the surface water in a different way.

514. There is a chute channel besides the proposed site which flows toward the Randhunibari village with a severe devastating effect during the monsoon. This channel becomes almost dry in the winter. According to Sirajganj BWDB officials, this channel could be closed with an enclosure at a certain point near the site and a water basin/storage could be developed where the water can be stored during the monsoon. The water basin should be designed in a way so that it possesses the accessibility and capability to hold the water and should also contain a pumping facility to supply water to the power plants. The pumping facilities should be well designed and managed for providing continuous supply of water in the proposed power plants even in the dry season. This could be proven as a good alternative of ground water for all the units of the proposed power plants subjected to proper planning and implementation. Implementation of this surface water facilities will need separate detailed study.

515. But implementation of this surface water facilities will need separate detailed study to see its feasibility and possibilities.

9.6.11 Good Handling and Operation of Construction Equipment

516. The equipments and machinery for construction activities should be handled and operated in a way that would ensure low noise, low emission of SOx, NOx, smoke, no oil leaks, no accidental event, etc. A detail plan of handling and operation of construction equipment will be prepared by each Contractor on the basis of ECP 2, 10 and 11. The Plan will be submitted to the OE for review and approval before contractor mobilization.

9.6.12 Fuel and Hazardous Substances Management Plan

517. The plan will be prepared by each Contractor on the basis of ECP 2 as well as the mitigation plans given in this EIA and in accordance with the standard operating procedures, relevant guidelines, and where applicable, material safety data sheets. The Plan will include the procedures for handling oils and chemical spills. The Plan will be submitted to the OE for review and approval before contractor mobilization.

9.6.13 Communication Plan

518. A communication plan has been prepared and presented in **Table 9-1** while carrying out the communication plan modifications of process and planning may be done as per the Project's requirement.

Table 9-1: Communication Plan Adopted for the Project

Stakeholder	Information/Message	Communication Means	Timing/Frequency	Responsibility
PAPs	Project awareness (general project information, etc.)	Consultations	Scoping session in the preparation of Draft EIA	EIA Consultant, supervised by Project Implementation Unit (PIU)-NWPGCL
	Project findings (environmental and social concerns)	Disclosures: Financer through Info seek website; DoE through presentation; public through NWPGCL website and formal & informal consultations	Immediately after preparation of Draft EIA	EIA Consultant, Financer, NWPGCL, supervised by PIU
	Employment opportunities	Government procedure: for new recruitment at AE position informed public by TV, radio, newspaper (English / Bangla); for others, NWPGCL internal system.	4 weeks before recruitment / job opening	PIU, NWPGCL
	Implementation of construction of third unit Project	Consultations	At the start of third unit construction plant implementation	EPC, OE, independent monitor, supervised by PIU- NWPGCL

Stakeholder	Information/Message	Communication Means	Timing/Frequency	Responsibility
	Operation of the proposed Plant (grievance redress)	Consultations	At the commissioning of the Plant	Independent monitor, supervised by PIU- NWPGCL
General population (Local)	Skilled and unskilled labour employment opportunities	Poster, local daily newspaper	3 to 4 weeks before recruitment	PIU- NWPGCL
Fire Service	Incidents of disasters	Telephone, cell phone	Immediately when any incident is detected	Shift Engineer (PIU)
Police Station	Incidents of disasters and security issues	Telephone, cell phone	Immediately when any incident is detected	Shift Engineer (PIU)

Source: CEGIS, 2015

9.7 EMP during operation phase

519. With reference to the possible significant environmental impacts during operation stage identified in **Chapter 7**, impact specific EMP have been prepared to address those impacts. The plans are prepared on the basis of mitigation measures proposed in **Chapter 8**. In the following sections these plans are discussed.

9.7.1 Kitchen Waste

520. A good practice of kitchen waste collection and disposal system should be adopted. The aim should be reduction of the waste generation. Degradable waste, glasses, recyclable and reusable waste, papers, plastic, etc should be collected by nature of the materials and managed separately. Proper number of waste bins with different colors indicating disposal of degradable and non degradable wastes might be installed at the staff colonies/residential areas, work places and walkways to prevent scattered throwing of solid wastes. There should be a designated site for kitchen waste disposal. Scattered throwing and burning of waste should be prohibited.

9.7.2 Sewerage

521. The EPC contractor should develop a detail management plan for sewerage management and treatment.

522. The STP might be consisting of screening devices, aeration, active sludge treatment, sedimentation, clarification and separation/recirculation of sewage sludge. Membrane bio reaction is a good alternative. There should be an efficient network of sewerage collection and draining system. The treatment plant should be designed in a way that would satisfy the effluent standard of ECR 1997 and IFC.

523. The treated water might be reused in gardening, or supplied to nearest community for irrigation. The sludge from STP should be disposed in compliance with the ECR 1997 and IFC standard.

9.7.3 Waste Water Management

524. Presently rejected water, sludge and slurry from different water treatment plants (e.g. coagulation, clarification, demineralization, etc.) of the first unit are directly drained to respective drainage system for disposal. A Central Water/Effluent Treatment Plant (CETP) is proposed for third unit to treat raw and effluent water generated from the Unit. The CETP will include a central Effluent Treatment Plant, Sludge and Slurry Treatment Plant, Sludge and

Slurry disposal system, Treatment facilities for feed water using environment friendly oxygen scavenger (e.g., Helamin, Diethylhydroxylamine) and demineralization water using reverse osmosis process, domestic waste water treatment facilities, etc. The Contractor will design the Plant according to the type, characteristics, quantity, and regulatory guideline of DoE and financer EHS Guidelines on Water and Sanitation. All waste water generated from various processes of third unit and liquid wastes will be treated in the CETP before discharging or disposing to the natural environment.

525. NWPGCL may consider increasing the capacity of the CETP to treat raw and effluent water of other units of NWPGCL by charging a fee to others. NWPGCL may take this matter to the policy level with the support of DoE.s

9.7.4 Hazardous Sludge from Water Treatment Plant

526. The sludge from water treatment plant should be disposed properly considering its hazardousness and usability. Iron rich sludge from water pre-treatment and demineralization plant might be utilized in the industries which use iron as raw materials. The EPC contractor should explore the market of the iron sludge. Generally, there is a good demand of iron sludge in steel re-rolling mills. The sludge from oily water separation unit should be managed properly with due treatment and disposing in scientific pit. It should be disposed in accordance with the Hazardous Waste and Ship Waste Rules 2011.

9.7.5 Solid Waste Management

527. SPS shall develop a waste prevention strategy, which will significantly reduce the total amount of waste. The strategy will focus on recycling and the facility wise implementation of recycling plans, considering the following items (as per Financer/IFC Guidelines):

- Evaluation of waste production processes and identification of potentially recyclable materials
- Identification and recycling of products that can be reintroduced into the operation of the plant
- Investigation of external markets for recycling by other power plant operations located in the neighborhood or region of the facility (e.g., waste exchange)
- Establishing recycling objectives and formal tracking of waste generation and recycling rates
- Providing training and incentives to employees in order to meet these objectives.

9.7.6 House Keeping

528. SPS should implement a good house-keeping practice, such as the sorting and placing loose materials generated from different repairing activities in the established areas away from common workspace, cleaning up excessive waste debris and liquid spills regularly, locating electrical cords and ropes in common areas and marked corridors.

9.7.7 Occupational Health Safety and Environment

529. A detail Occupational Health, Safety and Environment (OHSE) Plan has been prepared and presented in **Section 10.6.** The Plan includes the following:

- Occupational Hazard Identification and Control Plan
- Inspection and Auditing Plan
- Leadership and Administration Plan
- OHSE Communication Plan

- Required PPEs
- Site Security Plan
- HSE Program for the Contractors/Sub-Contractors
- Preventative Maintenance Plan
- Incident Investigation Mechanism
- Safe Work Practices and Procedures.

530. The plan has been prepared in a way, which will be applicable for entire life cycle of the Project. Application of the OHSE plan is responsibility of all including management, employee, contractors, sub-contractors, vendors in their daily activities. The plan also proposes a management and administration system (Organogram) for OHSE Plan application. It is suggested that NWPGCL develops an OHSE Management System program activities and commitment and ensure the programs are implemented during each phases of the third unit construction Project. **Table 9-2** presents OHSE management systems and key responsibilities, for detailed information specific Section number in the detailed report are referenced.

9.7.8 Agricultural Land Management

531. Agricultural crop land might reduce for the infrastructural and industrial development in the study area. So food security should be assured by increasing crop production and cropping intensity. It should be done through the use of modern technology in the crop production and the fallow lands would be under cultivation. There should be concerned to avoid agricultural land for infrastructural development. Infertile lands would be under infrastructural development. Moreover, insect infestation might increase in the surrounding agricultural land due to lighting of the plant site. So, farmers should be properly trained about the system and management of i.e Integrated Crop Management (ICM).

Table 9-2: OHSE Management Systems and key responsibilities register

OHSE program activities **EHSU Manager-NWPGCL** **(to implement)**	**OHSE program activities** **Superintendent Engineer –NWPGCL** **(to ensure)**	**Employees** ***(Includes EPC and other contractors)*** ***(to follow)***
1. Policy and commitment		
Make a draft OHSE Policy for Project director for approval	□ Communicate policy. □ Provide leadership in line with policy commitments. □ Assess any changes to organization structures, activities, processes, etc. for OHSE implications.	□ Feedback ideas for changes to policy. □ Understand policy and follow intent. □ Follow OHSE processes.
Collate changes and publish.	□ Assist with important changes.	
2. Legal & other requirements		
Monitor legal requirements and produce a monthly report to communicate relevant changes to the business.	□ Implement actions required to ensure legal compliance. □ Communicate requirements, including any changes to work programs or practices, to staff.	□ Follow procedures, work instructions etc as these should be in compliance with legal and other requirements. □ Report issues where procedures / work instructions may not be in compliance with legal requirements to Manager or OHSE representatives.
Develop corrective and preventative actions to ensure that relevant changes to legal requirements are incorporated into OHSE documentation.		
Update OHSE processes.	□ Assist with important changes.	
3. Hazard identification & risk management		
Coordinate strategic risk assessment process within lines of business.	□ Ensure risk assessments are carried out and registers are updated. □ Understand key risks and mitigation measures.	□ Understand key risks and mitigation measures relevant to their own areas. □ Report new risks and hazards. □ Participate in risk reviews. □ Report potential gaps in controls.
Facilitate Site Hazard Register development and maintenance.	□ Coordinate Site Hazard Register development and maintenance, including providing adequate resources.	
Provide OHSE technical advice on the development of project risk assessments and plans.	□ Ensure controls are in place to control identified risks.	
Provide technical advice on the development of operational risk assessments and plans.	□ Coordinate development and implementation of operational risk assessment and plans, including providing adequate resources.	
4. Planning & objectives		

OHSE program activities **EHSU Manager-NWPGCL** **(to implement)**	**OHSE program activities** **Superintendent Engineer –NWPGCL** **(to ensure)**	**Employees** ***(Includes EPC and other contractors)*** ***(to follow)***
Coordinate the development of strategic OHSE plans. Advise and propose OHSE objectives, targets and improvement activities. Facilitate the development of OHSE programs and advise on OHSE strategy.	□ Engage and provide resources to enable strategic assessment and subsequent plans to be developed.	□ Be involved in the development and implementation of OHSE objectives, targets and programs.
5. Accountability & Leadership		
Ensure that OHSE accountabilities, roles and responsibilities are clearly documented in OHSE documentation and communicated in OHSE training.	□ Ensure OHSE accountabilities and requirements are identified and documented in Work Plans and Position Descriptions. □ Lead and support OHSE system requirements. □ Provide adequate supervision and leadership to staff (especially new starters).	□ Ensure OHSE requirements are understood and met □ Participate in the continual improvement of the OHSE system.
6. Awareness, training & competency		
Coordinate OHSE training needs analysis for the development of a comprehensive training requirements register.	□ Conduct OHSE training needs assessment for the team. □ Ensure teams' training requirements are communicated to OHSE representatives for inclusion in the OHSE training program.	
Incorporate core OHSE training requirements in the training requirements register.		
Facilitate OHSE training program.	□ Understand training and competency requirements for personnel they are responsible for (including contractors).	□ Sign up to and attend training. □ Understand competency requirements and make sure they are met.
Coordinate and deliver some in house training (e.g. OHSE system training, OHSE inductions, OHSE risk management, etc.).	□ Ensure staffs (including contractors) are trained and competent to do the work assigned to them.	
Maintain records of training required, training attendance and competencies awarded (via HR).	□ Incorporate OHSE training requirements into data management system. □ Make people available to attend training.	□ Provide evidence of prior learning, licenses or other relevant competencies required to do the

OHSE program activities EHSU Manager-NWPGCL (to implement)	**OHSE program activities Superintendent Engineer –NWPGCL (to ensure)**	**Employees *(Includes EPC and other contractors)* *(to follow)***
	□ Ensure records of training and competency requirements, training attendance and competencies awarded are documented within their jurisdiction.	assigned work. □ Provide feedback on training suitability and quality.
7. Communication, consultation & involvement		
Ensure that management and staff are consulted when changes are made to the OHSE system.	□ Ensure staffs are consulted when changes are made to assets and operations that might affect OHSE policies and procedures.	□ Participate in team meetings and communicate/raise OHSE concerns, issues, key learning and wins. □ Participate in OHSE policies / procedures review.
Provide monthly OHSE report with key learning.	□ Communicate OHSE issues at team meetings (e.g. monthly status and key learning).	□ Engage with and discuss monthly reports and key learning.
Compose and circulate OHSE alerts.	□ Respond to OHSE issues / concerns.	□
Compose and circulate program newsletters and updates.		□ Read OHSE communication items and attends communication sessions.
Communicate changes to OHSE policies and procedures to management.	□ Communicate relevant information on OHSE system changes to staff.	□
Develop and maintain OHSE Essentials web portal.		
8. Document & record management		
Maintain OHSE documentation, including: □ Filing OHSE records such as assessments, plans and reports. □ Developing and distributing monthly report for project director. □ Developing and maintaining internet sites to enable ease of access to OHSE documents and information □ Reviewing and updating OHSE	□ Ensure resources are available to manage documents and records. □ Ensure documents and records are adequately managed.	□ Manage documents and records as required.

OHSE program activities EHSU Manager-NWPGCL (to implement)	**OHSE program activities Superintendent Engineer –NWPGCL (to ensure)**	**Employees *(Includes EPC and other contractors)* *(to follow)***
documentation. □ Maintaining OHSE documents and records in accordance with OHSE system requirements.		
Manage OHSE document change requests.	□ Ensure area-specific OHSE process requirements are appropriately documented.	□ Provide input into development of OHSE documents. □ Raise OHSE document change requests where gaps or issues are identified.
9. Assets & operations		
Administer OHSE operational control processes.	□ Identify OHSE risks associated with assets and operations, ensuring they are recorded in OHSE risk registers. □ Ensure controls and processes are implemented to adequately manage OHSE risks.	□ Be involved in the development of OHSE risk management programs, plans and processes.
Facilitate strategic and operational risk management processes to enable the development and implementation of appropriate control measures.	□ Document all monitoring and measuring processes implemented in order to demonstrate that controls are effective.	□ Implement / follow OHSE risk control measures.
Provide professional advice to business units on OHSE management and improvement initiatives.		
10. Project management		
Provide advice and support to project managers in the development and implementation of project OHSE Management Plans.	Project Team Managers: □ Ensure that OHSE Risk Assessments are conducted for all projects. □ Understand their OHSE accountabilities.	Project Managers: □ Ensure that project OHSE management plans are developed and implemented.
Lead and participate in project-related OHSE	□ Participate in, and inform staff of, project-related	

OHSE program activities EHSU Manager-NWPGCL (to implement)	**OHSE program activities Superintendent Engineer –NWPGCL (to ensure)**	**Employees *(Includes EPC and other contractors) (to follow)***
initiatives.	OHSE initiatives.	
Ensure other OHSE procedures support project management (e.g. Hazard ID and Risk Management, Audit, Management of Contractors & Suppliers)		
11. Management of contractors & suppliers		
Document process to ensure OHSE risks associated with contractors and suppliers comply with legal requirements (OHSE and Contracts & Procurement processes)	Ensure process for managing contractors and suppliers are in place and followed. Ensure relevant personnel are trained in contractor and supplier management, as required (e.g. project managers).	Follow OHSE processes around contractors and suppliers. Monitor contractor / supplier compliance with OHSE system requirements.
12. Emergency preparedness		
Facilitate strategic emergency assessment and planning processes. Guideline- Refer to Emergency Response Plan that attached in the EIA report	Identify potential OHSE emergency situations.	Understand roles and responsibilities in Emergency Response Plan situations
Provide advice on assessing emergency risk and planning adequate responses.	Ensure adequate response plans are resourced, developed and maintained Ensure adequate drills, training and response equipment are resourced, maintained and in place.	Attend OHSE emergency training and participate in drills. Be involved in debriefs and response plan improvements.
Facilitate the development of emergency response plans, when required.		
13. Monitoring & measuring		
Provide data to measure OHSE performance	Review performance data and agree on improvement programs	
Recommend programs based on review of OHSE performance	Ensure equipment used to monitor OHSE performance is maintained , calibrated etc people are trained e.g., gas detectors.	Ensure relevant procedures are followed.
14. Incident management		

OHSE program activities **EHSU Manager-NWPGCL** **(to implement)**	**OHSE program activities** **Superintendent Engineer –NWPGCL** **(to ensure)**	**Employees** ***(Includes EPC and other contractors)*** ***(to follow)***
Provide technical advice on incident investigations and the development of corrective actions.	Ensure OHSE incidents are reported and investigated as per the procedure. Ensure root causes are identified and actions implemented to prevent recurrence.	Complete and submit incident reports for all health, safety or environmental incidents, hazards and near-misses. Participate in incident investigations as required.
Audit the Incident Management procedure. Analyze incident data to identify trends and communicate them to management.		
15. Audit		
Develop and facilitate annual internal OHSE audit programs	Consider audit requirements and nominate projects or processes to be audited.	
Conduct OHSE audits	Participate in audits. Make staff and resources available to auditors. Develop and implement actions from audits.	Participate in audits. Develop and implement actions from audits
Facilitate OHSE certification process (ISO 14001 and OHSAS 18001)		
16. Management review		
Facilitate OHSE management review processes.	Conduct OHSE management reviews. Develop actions and programs aimed at continual improvement of OHSE performance. Communicate and implement OHSE improvement programs.	Participate in OHSE management review process through employee representatives attending Executive Safety Team meetings. Participate in relevant improvement programs.
Provide data analysis and information for OHSE management review processes.		

532. EPC contractor will prepare site specific OHSE plan based on the general guidelines for OHSE plan and present to OE and PIU for approval. The plan should address all pertinent issues to create a work place that protects worker health and safety with due respect to the environment, and promote an atmosphere to grow employee learning and opportunity in a way that is fulfilling, recognized and fairly rewarded during construction phase of the project. **Table 9-3** presents general expectations from the EPC contractor while implementing the OHSE plan.

Table 9-3: Expectation from the EPC Contactor

Commitment and Leadership	Management shall provide strong visible commitment, leadership and personal involvement in health, safety and the environment. Management shall make available the resources necessary to achieve NWPGCL's OHSE objectives.
Policies and Objectives	Develop and communicate policies demonstrating a commitment to OHSE that is consistent with, and at least equal to, other business aims. Supporting objectives shall be defined, deployed and maintained at all organizational levels.
Organization, Resources and Documentation	Define, document and communicate the roles, responsibilities and accountabilities to enable every individual to fulfill their role in improving OHSE performance.
Risk Evaluation and Management	Continually evaluate the OHSE risks to the workforce, customers and the environment. Continually evaluate processes and activities for specific hazards- assess potentials, record and control the subsequent risk to a tolerable level.
Planning	OHSE considerations shall be integral to all aspects of business planning or changes in the design, development, purchasing and delivery of our products and services.
Implementation, Recording and Monitoring	Determine and record whether those actions are effective. Activities shall be conducted in accordance with defined standards, and continuous improvement shall be promoted and monitored through active employee participation.
Audit and Review	Audits and reviews shall be conducted to verify the implementation and effectiveness of the OHSE Management System and its conformation to this specification.

9.8 EMP to Address Cumulative Impacts

9.8.1 Air Quality Management

533. Emission of NO_x, PM and CO from the proposed third unit would add to the ambient air quality which is already contributed by the first unit. This would increase the ground level concentration of the mentioned parameters of the air quality. Further increase in the emission level of the same parameters when all three units (1, 2 & 3) are in operation. Other pollutant emitting industries in the airshed of the area are limited except brick field and line sources (road). Based on cumulative impact assessments of ambient air quality, CALPUFFdispersion modelling predicted that concentration of $PM_{2.5}$ will be within the limit while PM_{10} concentration will be exceeded WHO Guidelines and NO_2 concentration meets

the ambient air quality standards. Major contributor of NO_2 is the fuel gas of the first unit. Scientific study[11] available, which indicates that $PM_{2.5}$ concentration in Bangladesh is mostly trans-boundary (secondary pollutants formed from NOx and SOx after chemical transformation in the ambient air).The combustion of gaseous fuels such as natural gas does not produce significant particulate matter. Also, natural gas from Bangladesh is naturally very low in contaminants such as sulfur and is considered as sweet gas. NWPGCL should take initiative at the policy level to reduce emissions from selected facility. DoE can take action to bring specific facility in compliance. In addition, a trade-off between heavy and low polluting industries should be established with the initiative of DoE. For ensuring a sustainable development and pollution free airshed, some policy intervention and strategic initiatives are very much required.

9.8.2 Noise Management

534. A comprehensive plan for noise reduction and attenuation is required to control ambient noise limit within the permissible level. Therefore, the contractor should develop an integrated plan on the basis of ECP 11. The following mitigation measures have been proposed in **Chapter 8** that also need to be considered in the Noise Management Plan:

- Development of a Greenbelt around the SPS boundary that will separate the Plant area from the surrounding crop fields and residential areas.
- Rise of noise dampening wall for protecting the staffs from loud noise who resides in the buildings adjacent to the RMS with keeping open north-south sides for free air flow and for taking immediate measure during emergency.
- Repair the doors and windows sealing of which are damaged and leaking the sound into the control room and office building to attenuate noise to the ECR 1997 recommended level.

535. In addition, NWPGCL needs to take initiatives to construct a 3 m high brick wall having capacity of noise attenuation at outer boundary of the RMS and other units to buffer noise propagating to nearest community.

9.8.3 Central Water Treatment Plant

536. The baseline water quality of the Jamuna River indicates that the water is not yet degraded (high BOD, low DO and presence of other pollutants) at the level which is detrimental to fish and other aquatic organisms.

537. It is not out-of-subject to mention that SPS has an obligation to treat wastewater complying ECR 1997 before disposing to the river, as the Jamuna River has huge potentials in supporting aquatic organisms including fisheries. A large number of 'Savars' (catching hatchlings of the major carps and other commercially valued fish species) are set at different parts of this river for harvesting pure bred hatchlings of major carps which has fisheries as well as economic potential. Untreated discharge of effluent from the SPS may create havoc to the availability of hatchlings. The river has also immense ground water recharge potential. Existing first unit has the water treatment plant (WTP), which can support only this unit but there is no effluent treatment plant (ETP). Therefore, it is proposed to develop a Central

[11] Billah, M., Chatani, S., and Sudo, K. (2009); Application of WRF-CMAQ Modeling System to Study of Urban and Regional Air Pollution in Bangladesh, 8th Annual CMAS Conference, Chapel Hill, NC, October 19-21, 2009

Water/Effluent Treatment Plant (CETP) for third Unit. The CETP will be an integral part of the Environmental Infrastructure of the third Unit. This CETP will meet ECR 1997 and IFC's EHS Guidelines. The CETP will be environmentally sustainable and cost viable system for the collection, treatment and ultimate discharge of effluents from the SPS, third Unit in particular. The CETP will consist of, (a) Raw water supply and treatment system, (b) Waste water treatment system, (c) Demineralization plant, (d) Effluent treatment system, and (e) Sludge treatment and disposal system.

538. As a law enforcement Agency, Department of Environment may take an initiative at policy makers' level to find a way to build a Central Effluent Treatment Plant. NWPGCL may also take initiative of constructing a large scale CETP and commercially offer effluent treatment services to all four units in place. As the area has the huge potential for growing industries so the Government may also invite private partnership to construct possible CETP where the industries would contribute as polluter-pay basis (based on the nature and quantity of its effluent) to the CETP authority for treating their water and effluents.

9.9 Mitigation Plan

539. The mitigation plan presented in **Table 9-4** is organized around various project activities and includes various actions identified under the mitigation measures discussed in Chapter 8, define responsibilities for implementation as well as supervision of each action, and also indicate the timing of these actions. After this assessment stage, if there is any changes to the Project design or methods of constructionand operation,the impacts and mitigation measures discussed may need to be revised. To address the changes, the environmental and social implications will require re-addressing.

Table 9-4: Mitigation Plan

VECs/Issues	Environmental Impacts	Mitigation Measures	Institutional Responsibilities	
			Implementation	Supervision
CONSTRUCTION PHASE				
A. Ambient air A1. Dust and gases generated from excavation, construction equipments, and vehicles	Emissions of dust and gases will be generated from excavation of trenches for laying gas pipes; RMS, turbine and HRSG foundation, operation of construction equipment and vehicles, and material transport, which is injurious to human health.	• Casing will be used when buried pipes cross a road. The minimum depth of cover shall be measured from the top of the pipe to the surface of the working grade. Crown materials along the surface of the ground level will not be considered as a part of the depth of cover. The specified depth of trench can be varied as suggested by the Engineer or his representatives considering the site condition. • Trench shall be carefully cut so that the pipe is evenly bedded throughout its length with sufficient joint holes and trial holes made where necessary. • Pipeline will be evenly bedded upon the bottom of the trench throughout its length and will be correctly positioned, before any back filing is performed. • Compaction of back filling material shall be performed by an approved method to prevent any subsequent settlement. • Pipes should be strung only on the right-of-way which has been cleared and where grading has been completed. • The Contractor shall ensure that the pipe is strung for proper placement of the pipe size. Pipes shall be raised on sandbags.	Contractor	OE/ESHSU
B. Ambient noise B1. Noise level	Noise will be generated from the moving and idling vehicles, welding operation, and heavy machineries.	• The machines/equipments/vehicles should be turned off when not in use. • Using PPEs during construction work.	Contractor	OE/EHSU
C. Water bodies C1. Water pollution	Improper storage and handling of fuels, lubricants, chemicals, hazardous	• Oils, lubricants and other hazardous materials should be bunded and stored separately so as to limit the spillage. • Workers should be trained on safety precautions on	Contractor	OE/EHSU

VECs/Issues	Environmental Impacts	Mitigation Measures	Institutional Responsibilities	
			Implementation	Supervision
	goods/materials on-site, wash down of plant and equipment, and potential spills may contaminate the water bodies and harm the environment and health of construction workers.	using/handling such hazardous materials. • The workers should be encouraged to use PPEs everytime when handling oils, lubricants, chemicals and other hazardous materials.		
C2. Internal Drainage System	Some drainage congestion caused by irregular dumping of construction waste, waste water near/inside the drainage channel and domestic activities from labor colony	• The liquid waste disposal system should not be linked with the existing internal drainage system. • Separate drainage channel should be there to disposed the construction liquid waste. • No waste materials should be dumped in a unplanned manner and blocking the drainage facilities.	NWPGCL and EHS officers	EHSU
D. Ecology D1. Aquatic habitat condition	Impact on aquatic habitats, including benthic habitat, due to dredging operation for creating sufficient navigation channel for ship carrying heavy plant equipment.	• Dredging operation should be carried out in the route having minimum aquatic habitats. Appropriate benthic survey must be carried out prior to any dredging activities. • The shipping company must ensure that the ship carrying construction materials and other raw materials, obey the appropriate International Maritime Laws.	Contractor	OE/EHSU
E. Occupational Health and Safety E1. Health and safety hazard	Injuries leading to casualty, or death may be caused during transportation of machinery and equipment, from the ship to site, and their installation/erection, lifting heavy materials, working at heights, etc.	• Proper health and safety training on hazard identification and how to handle hazardous equipments must be provided to the workers before starting any construction activities. • The health and safety staff of contractor must ensure that the equipments and safety harness are working properly before the workers start their work. In identification of a faulty equipment, they must be promptly replaced. • An on-site medical team should be set up and emergency first-aid kit should be at hand in case of any accidental injuries (burns, cuts, broken bones etc.). • The workers should use the appropriate PPEs. • Ensure workers hygiene and health status. Conduct	Contractor	EHSU

VECs/Issues	Environmental Impacts	Mitigation Measures	Institutional Responsibilities	
			Implementation	Supervision
		monthly health check up to monitor their health condition and provide appropriate treatment for any ailments.		
E2. Fire hazards from welding	Welding operations during laying of pipeline may cause fire accidents if proper care is not taken	• All arc welding and cutting operations shall be shielded by non-combustible or flameproof screens which will protect welders and other persons working in the vicinity from the direct rays of the arc. • In addition, the welders should use (i) hand shields to protect against flashes and radiant energy, (ii) see his skin is covered completely to prevent burns and other damage by ultraviolet rays, (iii) Welding helmets shall be free of leaks and openings, and free of highly reflective surface, and (iv) welding trucks shall be equipped with approved fire extinguishers and first aid.	Contractor	OE/EHSU
F. Solid Waste Disposal F1. Storage space and visual effect	Poor aesthetic view due to the storage and disposal of old and used equipment and materials. Moreover, spillage and leakage from improper storage can result in contamination in soil.	• Rubbles generated from the construciton site should be stored in approriate bins/skips, well-covered and later buried in an approved landfill site. • All solid wastes, hazardous and non-hazardous, should be stored in designated sites prior to final disposal	Contractor	Health and Safety Officer
OPERATION PHASE				
G. Ambient Air G1. Maximum ground level concentration of air pollutants	Emission of exhaust gas from the stack may contribute elevated ground level concentration of NO_x, PM_{10}, $PM_{2.5}$ etc. at the downwind direction.	• Individually the proposed plant does not need additional de low NOx burner (DLN) as it is built-in with GT which will reduce NO_x emission below 25 ppmv. The resultant cumulative concentration of NOx from first three units obtained from the model is also within the standard limit of both Bangladesh and World Bank guidelines. So no additional mitigation measure is required for reducing NOx level (Model result in impact **Chapter 7**). • Similarly, emission level of $PM_{2.5}$ will also be within the standard but PM_{10} has the exceedance in respect of World Bank guideline but compliant with the Bangladesh standard.	NWPGCL	EHSU

VECs/Issues	Environmental Impacts	Mitigation Measures	Institutional Responsibilities	
			Implementation	Supervision
H. Noise level H1. Noise level inside the control room, turbine hall	Hearing complexity and loss along with increase blood pressure, disturbances and discomfort to the technicians and workers and surrounding communities due to noise generated from rotator machineries at exceedance level.	• Install 3 m high brick boundary walls and thick plantation to attenuate noise in the sensitive receptors. • Replace the sealing of doors and windows of the control room and office building for making noise proof the workspace. • The machines/equipments/vehicles should be turned off when not in use. • The turbines, pumps, fans etc. should be covered with soundproof dampeners to limit the spread of noise. • Greenbelts should be developed around the power plant area to limit the spread of noise to the nearby community. • Workers should use appropriate PPEs (soundproof earpiece, earmuffs etc.) while working close to noise equipment.	Contractor	EHSU
I. Water bodies I1. Pollution of receiving water bodies	Sludge generated from the chemical assisted raw water at pretreatment and water treatment plants may impact groundwater quality and receiving water bodies if come in contact to sludge.	• Construction of a leak-proof sump should be made to store sludge temporarily and limit their spillage. They should then be transferred to sludge treatment plant for treatment proposed under this Project. • The sump should be monitored and maintained by on board chemist and technicians and make sure everything (e.g. pollutant content, spill control etc.) goes smoothly.	NWPGCL and EHSU officers	NWPGCL and EHSU officers
I2. Internal Drainage System	There remains a scope of drainage congestion if the internal drainage system is linked with any kitchen waste, waste from officers/ workers colony disposal.	• Any sort of waste , liquid waste or effluent should not pass through the internal drainage system	NWPGCL and EHS officers	EHSU
J. Risks and emergency J1. Corrosion of gas pipes	Corrosion on the internal wall of a natural gas pipeline can occur when the pipe wall is exposed to water and contaminants in the gas, such as O_2, H_2S, CO_2, or	• Pipe will be coated using 3 layer polyethylene (3 LPE). • Buried pipes and fittings shall be protected against corrosion by means of external coating and wrapping. • Holiday detector shall be used to detect any holiday and shall be repaired. • Cathodic protection test points shall be installed and	Contractor	OE/EHSU

VECs/Issues	Environmental Impacts	Mitigation Measures	Institutional Responsibilities	
			Implementation	Supervision
	chlorides.	connected to temporary cathodic protection facilities in accordance with the specification as the final operation of lowering or tieing-in is in progress. • Conduct inspection after all installation before back-filling.		
J2. Gas compressor fouling	Polymer deposits on compressor internals which increases frictional losses and alters flow pattern and lead to loss of compressor efficiency, pressure drop increase in after coolers, potential for unbalancing, rotor, and seal damage.	• A cleaning regime in Bangladesh would be a combination of on-line cleaning and semi-annual off-line washing.	Contractor	OE/ESHSU
J3. Gas pipeline leak	Poor tieing-in may cause leak of significant amount of gas from the pipe	• Separate welded joint sections of the pipeline shall be tied into a continuous system in such a manner that no stress will be induced into the pipe as a consequence of the tieing-in operation.	Contractor	OE/ESHSU

Source: CEGIS, 2015

9.10 Emergency Response Plan

540. An Emergency Response Plan (ERP) is prepared and presented in Chapter 10. Each Contractor after assessing potential emergencies that could be encountered during construction phase should prepare site specific ERPs (guidance can be taken from the ERP proposed in this EIA) and include in their Construction Environmental Action Plan (CEAP). The CEAP will be submitted to the OE for review and approval before contractor mobilization.

541. The ERP proposed for NWPGCL identified possible emergency events during construction and operational phase. The emergencies could be immediate medical evacuation due to personnel injury, traffic accidents (road), leakage of hazardous chemicals, terrorist events/threats and gas leakage/explosion, kidnap and/or extortion, bomb threat, pandemic, significant business loss, pollution incident, fire and explosion, gas leak and structure collapse.

542. The ERP outlines the framework of Emergency Response Strategy which will be followed by the contractor's, operation and maintenance staffs of NWPGCL during decommissioning, construction, and erection and operation and maintenance phases.

9.11 Budget for EMP

543. The cost of implementing the EMP including monitoring is about USD 2.1 million. Details of EMP and associated costs are given in **Table 9-5**.

Table 9-5: Estimated cost of EMP

Items	Unit	Quan tity	Unit Rate	Amount (USD)
EPC Contractor (Investment Cost)				
Continuous Stack Emission Monitoring System	No	1	30,000	30,000.00
Central Water Effluent Treatment Plant	Included in Project Cost			-
Continuous Ambient Air Quality Monitoring Station	No	1	20,000	20,000.00
Noise Attenuation Measures	LS	1	5,000	5,000.00
Environmental Laboratory	No	1	200,000	200,000.00
EHS Staffs of Contractor (2)	LS			50,000.00
Environmental Management Plan				
Plantation Program				5,600.00
Emergency Response Plan				200,000.00
Environmental Monitoring Plan				
Pre-construction, Construction (3 yrs) & Commissioning (3 yrs)				217,500.00
Independent Monitoring (Construction and Commissioning)				150,000.00
Institutional Arrangements				
EHS Consultant of Owner's Engineer				800,000.00
EHS Staffs of EHSU Circle (3 Years)				200,000.00

Items	Unit	Quan tity	Unit Rate	Amount (USD)
Capacity Building and Training				100,000.00
Independent Monitor (Fees), Operation				100,000.00
			Grand Total=	**2,078,100.00**

9.12 Administrative Setup and Organogram

9.12.1 North-West Power Generation Company. Ltd. (NWPGCL)

544. NWPGCL is a wholly owned subsidiary of the Bangladesh Power Development Board (BPDB) a state-operated entity executing power supply to Bangladesh's northwestern districts.

545. Being founded in August 2007, NWPGCL started generating electricity from November, 2012, with a present generation capacity of 375 MW, current development activities are intended to generate 717 MW and the future development plan has the projection as high as 4,220 MW.

546. 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. The organogram of the NWPGCL is presented in **Figure 9-1**.

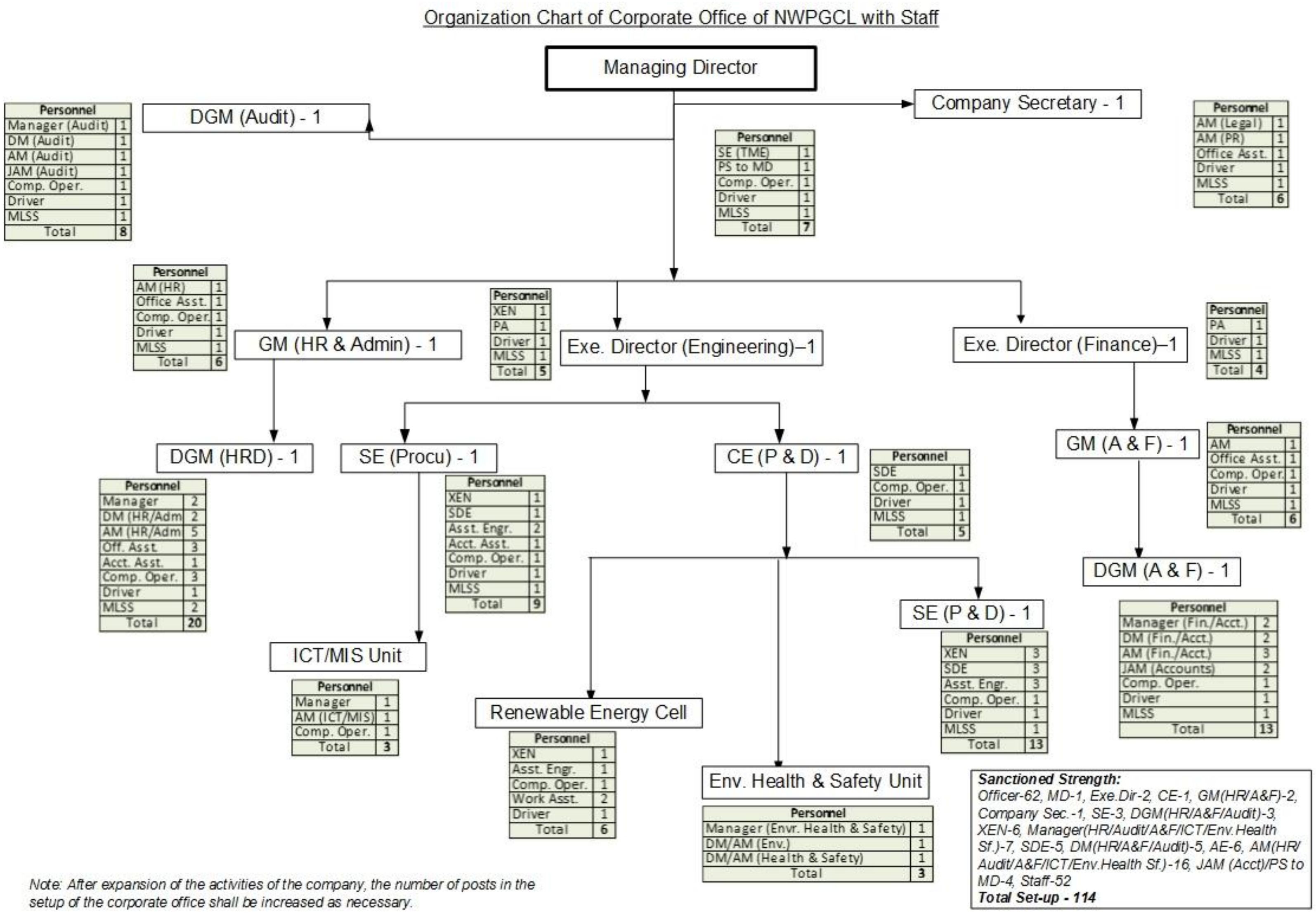


Figure 9-1: Organogram of NWPGCL

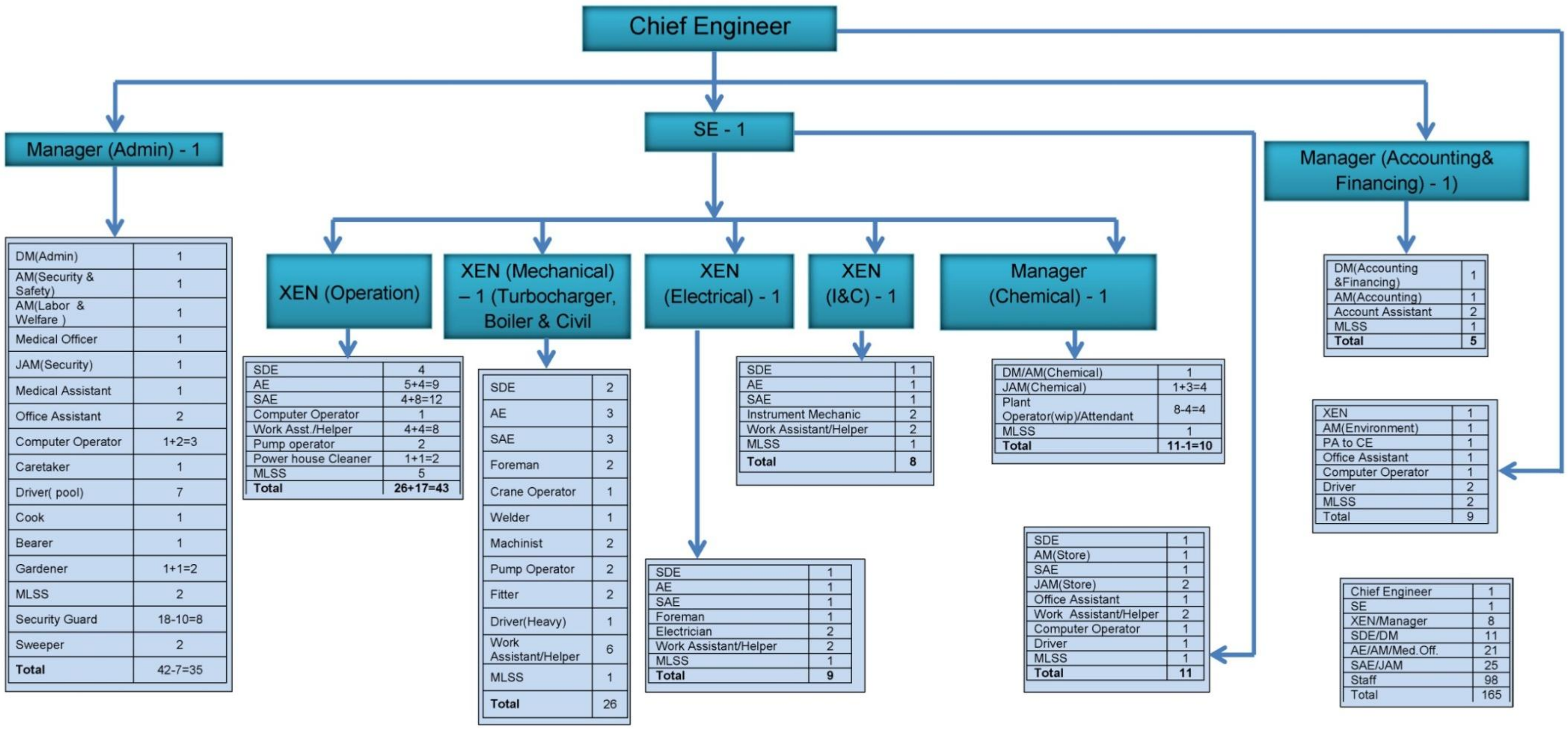
9.12.2 Sirajganj Power Station (SPS) 3rd Unit

547. Sirajganj Power Station started its operation in 2012. The 1st unit is currently in operation, generating 225 MW electricity while the 2nd will be coming into operation soon; a new venture has been taken to initiate the development of another unit, 225 MW Dual Fuel 3rd Unit Combined Cycle Power Plant. The unit will be headed by a Chief Engineer. **Table 9-6**gives a summary of posts proposed by the proponent. The organogram is presented in**Figure 9-2**.

Table 9-6: Proposed Levels and number of positions in Sirajganj 225 MW Dual Fuel 3rd Unit CCPP

Designation	Allocation
Chief Engineer	1
Superintending Engineer	1
Executive Engineer/ Manager	8
Sub-Divisional Engineer/ Deputy Manager	11
Assistant Engineer/ Asst. Manager/ Medical Officer	21
Sub-Assistant Engineer/ Jr. Asst. Manager	25
Staffs (Technical & Non-Technical)	98
Total	**165**

Proposed Organogram for O&M of 225 MW Combined Cycle Power Plant at Sirajganj



Note: 10 (ten) Security Guards shall be contract out. Ansars for security purpose shall also be outsourced. Remaining manpower will be recruited on contract basis as per service rules.

*Mali, Sweeper & Cleaner additional if required will be hired.

Figure 9-2: Proposed Organogram of SPS

9.12.3 Project Implementation Unit (PIU)

548. For the operation of Sirajganj 225 MW Dual Fuel 3rd Unit Combined Cycle Power Plant, the NWPGCL has created a project implementation unit (PIU) as in **Figure 9-3**, under the office of the Chief Engineer, P&D. The PIU is lead by a Project Director (PD) followed by one Executive Engineer, acting as a Deputy Project Director.

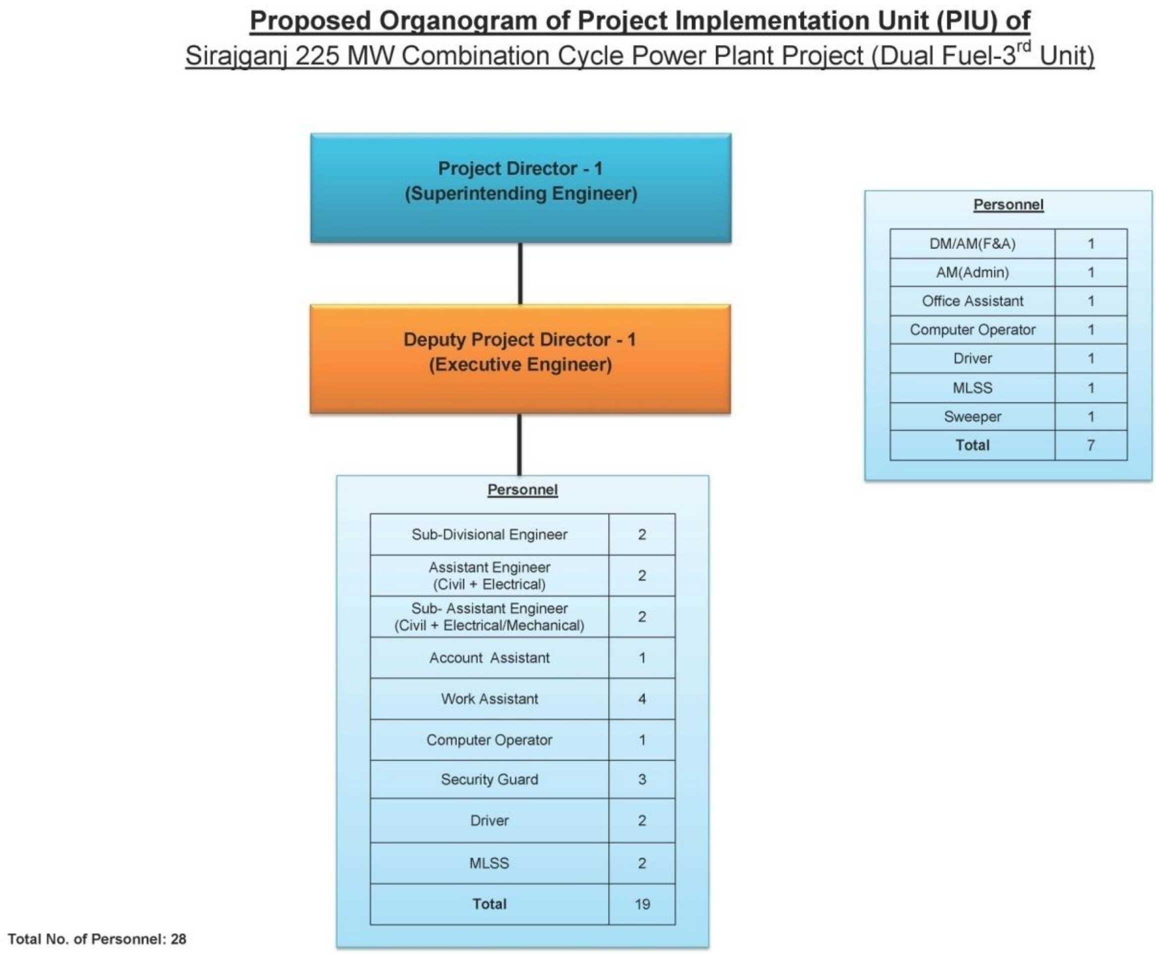


Figure 9-3: Proposed NWPGCL Organogram for PIU

549. To strengthen the PIU, additional resources are needed as illustrated in **Figure 9-4**. Detailed qualification, required number of people in each post and responsibility of each position is depicted in **Table 9-10**in section 9.12.6.

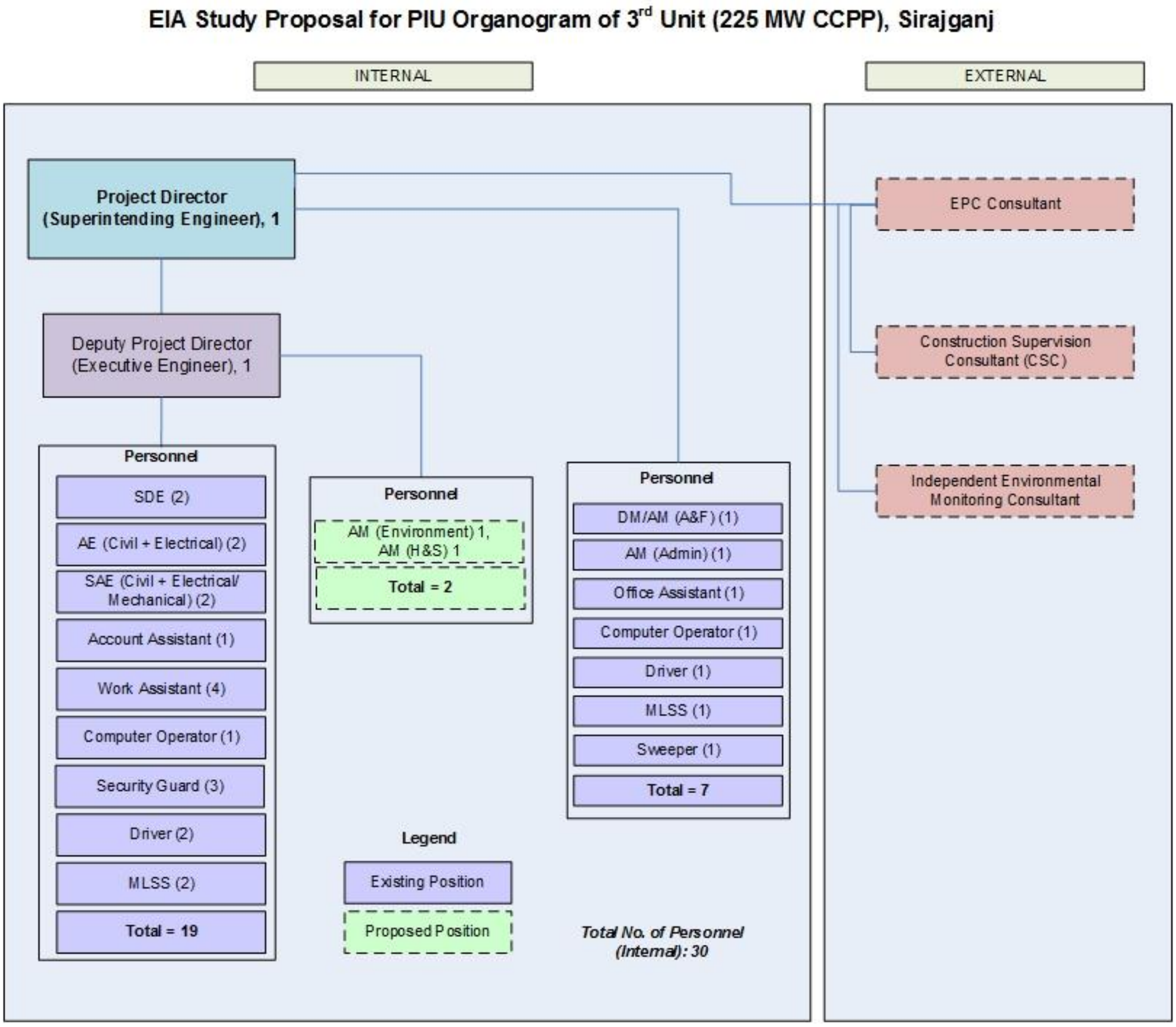


Figure 9-4: EIA Study proposal for PIU

External Monitor

550. Besides internal monitoring and evaluation by the PIU for environmental management and monitoring, independent external monitors will be retained by NWPGCL, to undertake monitoring of all compliance. These external monitors will carry out monitoring implementation of the different components and submit an independent monitoring and appraisal report to the PIU, and to NWPGCL.

Contractor

551. Each Contractor procured under this Project (especially EPC Contractor) will be recommended to be a compliant of ISO 14001, Environmental Management System (EMS) certification. Further conditions of compliancy for OHSAH 18000 (2007) related Occupational Health and Safety (OHS) and SA 8000 (Social Accountability) could also be imposed on the Contractors. Each contractor will be recommended to have one Environmental Specialist and one Occupational, Health and Safety Specialist, who will be working in close coordination with the environmental staff of Owner's Engineer and PIU.

Other Relevant Organizations

552. Other relevant organizations involved in the implementation of EMP are: (a) Department of Environment (DOE) oversee implementation of all development projects in the country verifying that the environmental requirements are fulfilled, government guidelines

and procedures are followed and environmental quality standards are maintained properly. DOE will be consulted in case of complicated issues and if it requires any further environmental clearance certificates (ECC), (b) Department of Fisheries (DoF) is responsible for fisheries resources, (c) Department of Public Health Engineering (DPHE) is responsible for maintaining the quality of drinking water and addressing sanitation issues, and (d) District administration and municipality are responsible for traffic management, law and order and resolving the social disputes that may arise during construction activities.

9.12.4 Human Resources Plan for EHS division of SPS 3rd Unit

Institutional Strengthening of EHS Circle

553. Presently, the proposed SPS 3rd unit has five (5) circles which are Operation, Mechanical, Electrical, I&C and Chemical. However, currently there is no dedicated Environment, Health, and Safety (EHS) Circle to address environmental management and occupational health and safety issues. A proposal has been made by the EIA consultant to create an EHS Circle headed by a manager, a deputy managers supporting the manger and two assistant managers; one for environment and another one for health and safety. A separate medical unit is also proposed, which will be headed by a manager, a medical officer and a medical assistant. The medical officer and medical assistant will be deputed from Admin circle. Currently SPS has no staff with previous experience in implementing environmental management and monitoring plan. In order to implement the environmental management plan (EMP) as proposed in this EIA, an effective PIU with dedicated staff will be of crucial significance. Without qualified full time staff it would be nearly impossible to minimize and/or eliminate the effects of environmental hazards and risks and ensuring a safe working environment for the workers, staffs and staff family members, who are residing in the project compound. The detail of the revised organogram from the EIA consultant is shown in **Figure 9-5**.

PIU Dedicated EHS Staff Requirements

554. Under the proposed DPP there is a request for additional 2 staffs to strengthen the PIU. However, in the DPP no provisions have been made for dedicated staff to ensure compliance to EHS issues. For effective and meaningful implementation of the EMP, it is recommended that one superintending engineer and one Executive Engineer, with requisite training and practical experiences in implementing and/or monitoring environmental, health and safety issues pertaining to power sector are recruited. This team of two would be supported by two Assistant Managers (one experienced in environmental management, and other in Occupational Health and Safety).

EIA Study Proposal for O&M Organogram of 3rd Unit (225 MW CCPP), Sirajganj

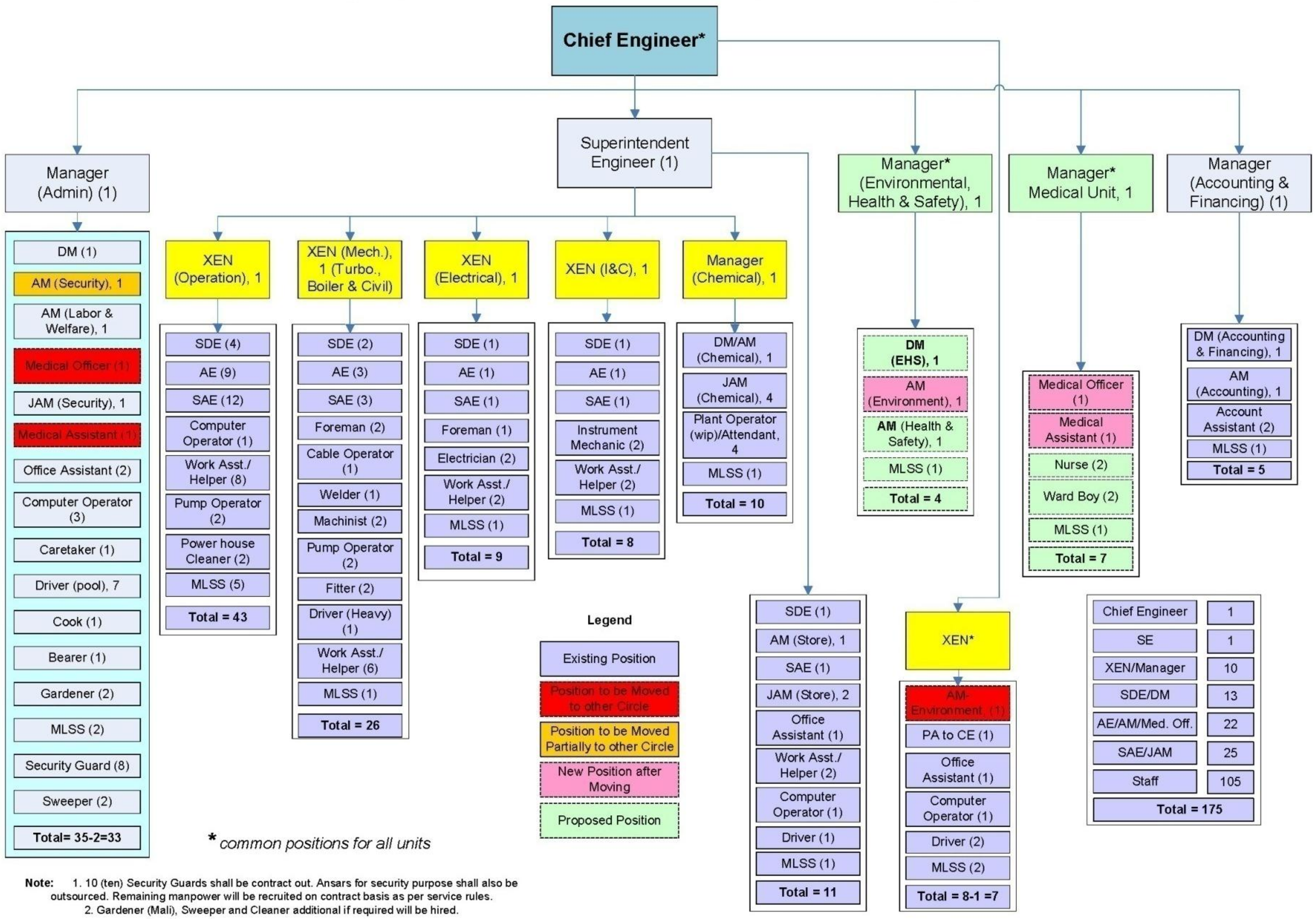


Figure 9-5: Organogram of SPS 3rd Unit Proposed by the Consultant

Table 9-7: Revised Levels and number of positions in Sirajganj Power Station by EIA Consultant

Designation	Allocation
Chief Engineer	1
Superintending Engineer	1
Executive Engineer/ Manager	10
Sub-Divisional Engineer/ Deputy Manager	13
Assistant Engineer/ Asst. Manager/ Medical Officer	22
Sub-Assistant Engineer/ Jr. Asst. Manager	25
Staffs (Technical & Non-Technical)	105
Total	**175**

Capacity Building Programs

555. The environmental and social trainings will help to ensure that the requirements of the EMP are clearly understood and followed by all project personnel. The primary responsibility of providing these trainings to all project personnel will be that of the contractor, Owner's Engineer, and a designated training consultant. The trainings will be provided to different professional groups separately such as managers, skilled personnel, unskilled labors, and camp staff. Capacity building will be aimed at strengthening the PIU and EHSU Circle of SPS staffs in the field of environmental management and occupational health and safety. Members of the EHSU Circle responsible for supervision of environmental mitigation measures would be trained in environmental management, environmental quality control, ecology, environmental awareness, participatory approach and occupational health and safety. The contractor will also be required to provide environmental and health and safety trainings to its staff, to ensure effective implementation of the EMP. The contractors' training plan shall include a program for the delivery of intermittent training, to cover the subjects included in**Table 9-8**. Training should be carried out initially at induction of staff and repeated throughout the project.

Table 9-8: Training Subjects for Inclusion in Contractors Training Plan

Training Subject	Target Audience
Handling, use & disposal of hazardous material	Construction workers with authorized access to hazardous material storage areas and required to use hazardous material during their works
Waste Management	All staff (construction and camp staff)
Efficient & safe driving practices, including road & vehicle restrictions	Drivers & mobile plant operators
Actions to be taken in the event of major or minor pollution event on land	All construction staff
Use of flexible booms and surface skimmers in event of pollution event in water	All construction staff working on the jetty renovation (if required)
Pollution prevention: Best practice	All staff
Refuelling of water borne plant – pollution prevention	Operators of water borne plant & vehicles
Health & Safety: Safe way to work & hazard awareness	All construction staff
Health & Safety: Safe use of plant & equipment	Operators of plant & equipment
Health & Safety: Working at height	Turbine hall, HRSG and cooling tower refurbishment construction staff

Training Subject	Target Audience
Health & Safety: Working near/on water	All staff working on jetty strengthening and unloading heavy equipment from ship
Health & Safety: Use of PPE	All construction staff
Emergency procedures and evacuation	All staff
Fire fighting	All staff
Site inductions, including requirements under the Environmental Management Plan & details of environmentally sensitive areas of the site	All staff
Awareness raising on risks, prevention and available treatment of vector-borne diseases	All staff
Cultural sensitivities of the local population	On induction of all non-local staff

9.12.5 Formation of a Grievance Redress Committee

Grievance Redress

556. A grievance redress committee needs to be formed in order to address all questions and queries of the public related to the proposed project as well as monitoring the EMP proposed in the EIA. One of their roles would be to compile and understand issues that are in public discourse. To improve public perceptions of the project, the Committee must work out appropriate measures to implement people's suggestion through readjustment of the EMP measures. Among others, the Committee can invite people for submission suggestions in written forms (by dropping them in a designated box that could be placed in an accessible place) within a defined time frame. Alternatively, the Committee could also organize public hearing meetings with the residents of Sirajganj Power Plant and surrounding communities and discuss the EMPs and any potential grievance that could arise due to the implementation of the project.

557. A project level grievance redress committee (GRC) will be established for the project with the Manager of EHSU Circle as the convener and Ward Councilor as the member secretary. The other members of the Committee could be the representatives of the community, Owner's Engineer, contractors plus any other major stakeholder group. The claims and complaints will need to be brought to the attention of the Ward Councilor. They will then forward grievances to the higher levels of authorities as desired. The recommended members of the Grievance Redress Committee are presented in**Table 9-9**.

Table 9-9: Grievance Redress Committee

Representative	Position
Manager EHSU Circle	Convenor
Ward Councillor	Member Secretary
Community Representative(s)[12]	Member(s)
Construction Supervision Consultant's Representative	Member
Contractors Representative	Member
Representative of any other major stakeholders group	Member

9.12.6 Responsibility Matrix

558. The job descriptions of the PIU staff with preferred responsibilities and qualifications are presented in **Table 9-10**.

[12] This may be, for example, any community member representing project affected persons and one woman.

Table 9-10: Qualification and Responsibilities of the PIU Staffs

Sl no.	Name of the post	Quantity	Qualification	Responsibility
1	Project Director (Superintending Engineer)	1	B.Sc. Engineering or as per NWPGCL's Service Rule	Responsible to implement the project on time and furnishing both financial and physical progress report of the project for deliberation on the progress in the monthly Pre-steering and Steering meetings.
	Deputy Project Director (Executive Engineer)	1	B.Sc. Engineering or as per NWPGCL's Service Rule	To assist the Project Director in all respect. In the absence of the PD, responsible for implementing the project. Co-ordinate Environmental Health and Safety (EHS) issues to Superintending Engineer. Supervision of contractor's work during the construction of the proposed power plant as per the design and scope of works outlined in the contract document. Report on work progress from time to time to the PD.
2	Sub-Divisional Engineer	2	B.Sc. Engineering or as per NWPGCL's Service Rule	Providing all support to the Deputy Project Director (DPD) and PD in the supervision of file works of proposed power plant project. Monitor all issues related to (EHS). One of the two SDEs should be fully assigned to cover EHS issues. Work with AM (Environment and EHS) in finding solutions to issues related to environment and worker's health and safety.
3	Assistant Engineers (Civil)	1	B.Sc. Civil Engineering or as per NWPGCL's Service Rule	Providing all support to the DPD in the supervision of file works of proposed power plant project. In-charge of preserving and maintaining the blueprints and design maps of boilers and machineries. Construct maps and blue prints regarding setting up structures (boilers, HRSG etc.) for the proposed development. Look for any mechanical/design flaws of any structures and mobilizing workers in rectifying them. Working with other AEs, AMs

Sl no.	Name of the post	Quantity	Qualification	Responsibility
				and SAEs in smooth operation of the plant. Reporting to DPD/PD of any issues related to power plant structure.
4	Assistant Engineers (Electrical)	1	B.Sc. Electrical Engineering or as per NWPGCL's Service Rule	Providing all support to the DPD in the supervision of file works of proposed power plant project. In-charge of electrical works inside the power plant vicinity. Ensuring smooth operation of boilers and other machineries. Working with other AEs, AMs and SAEs in smooth operation of the plant.
5	Sub-Assistant Engineers (Civil + Mechanical/Electrical)	2	Diploma Engineering	Assisting AEs/PD/DPD in plant operation related activities
6	Assistant Manager (Environment)	1	Minimum B.Sc. and M.Sc. in Environmental Sciences or any related background	Co-ordinate and monitor environmental issues. Assisting EPC contractor, Construction Supervision Consultant (CSC) and Independent Environmental Monitoring Consultant in monitoring and reporting any environmental issues related to the project and in conducting regular audits. Maintaining close relationship with DoE and Ministry of Finance related to Health. Reporting to DPD/PD of any electrical issues related to power plant operation.
7	Assistant Manager (Health and Safety)	1	Minimum B.Sc. and M.Sc. in Environmental Sciences/ Engineering or any related background with trainings on Occupational Health and Safety and Hazard and Risk Assessment is also preferred	Co-ordinate and monitor worker's health and safety related issues. Assist EPC contractors and other independent monitoring agencies in conducting regular audits on worker's physical and mental health, work environment and instruments, PPEs and machineries. Reporting to Deputy Project Director on issues related to worker's health and safety. Maintaining close relationship with DoE and Ministry of Finance related to Health.
8	Assistant Manager	1	Bachelors and	Maintaining general ledger book,

Sl no.	Name of the post	Quantity	Qualification	Responsibility
	(Accounting & Finance)		Masters in Accounting/Finance Engineering or as per NWPGCL's Service Rule	processing of contractor's bill for payment, preparation of monthly accounts statement for the project related financial transaction. Also responsible for all personnel and administrative matters as per delegation of authority.
9	Assistant Manager (Admin)	1	Bachelors and Masters in Human Resource and Development or as per NWPGCL's Service Rule	The Assistant Manager is responsible for the general administration of office operations of the power plant. Responsibilities include, but are not limited to, reception, administrative and clerical support; dealing with plant's workers and attendants (e.g Drivers, Gardeners, Security Guards, MLSS etc.); supporting PD and DPD, Managing transport, important documents and blueprints, worker's salaries, purchase receipt. etc.
10	Accounts Assistant	1	Masters/Graduate or as per NWPGCL's Service Rule	Assisting AM (A&F) in maintaining accounting related activities.

Source: CEGIS, 2015

559. The job descriptions of the key EHS staffs of EHSU Circle with preferred responsibilities and qualifications are presented in **Table 9-11**.

Table 9-11: Job descriptions and responsibility with qualifications of key EHS staffs

Positions	No. of positions	Job Responsibilities	Qualifications
Manager EHS	1	• Supervise environmental management plan during construction and operation stages including compliance and effects monitoring • Ensure the occupational health and safety and security of all employees and supervise contractors' compliance of EMP obligations. • Maintain the EHS management system and ensure all electricity generation related work in compliance with all the requirements of health and safety programs. Maintenance of all documentation. • Initiate actions for improvement of all environmental and health & safety programs based on periodical audits	• At least a Master's Degree in Environmental Engineering or Environmental Science with experience in Occupational Health and Safety or related field. • At least 15 years of experience in power sector and a minimum of 5 years working experience in development Bank financed Projects preferably in power

Positions	No. of positions	Job Responsibilities	Qualifications
		of the EHS management system. • Working closely with deputy managers of EHS and Chief Chemist to ensure all works are done in compliance with ISO 14000 and ISO 31000 standards. • Monitor the progress of boiler decommissioning and safe disposal of Hazardous Wastes. • Ensure compliance with all NWPGCL policies and administrative rules, including the Health and Safety policy and other environmental requirements. • Practice safe work habits in accordance with Occupational Safety & Health Administration (OSHA) guidelines, Factories Act, 1965 and Environmental Conservation Rules, 1997.	sector. • Must have adept knowledge of national policies, such as the Labour Act, 2006, The Factories Act, 1965, Environmental Conservation Rules, 1997 as well as International OHSA standards such as ISO 14001, ISO 31000 and other related OHSA guidelines.
Deputy Manager (EHS)	1	• Manage and supervise environmental management and monitoring activities of the plant. • Monitor environmental mitigation and compensation measures carried out by the contractors along with the consultants as outlined in the project's EMP. • Conduct periodic consultations with various stakeholders, focus group discussions, and community consultation to monitor the progress of the EMP implementation. • Participate in grievance redress committee and resolve issues related to environmental concerns raised by the communities. • Assists in the preparation, implementation, monitoring and controlling of annual budget for the Circle. • Review quarterly and annual environmental monitoring reports and submit them to SPS, NWPGCL and development partners. • Play a lead role in acquiring environmental permits, licenses, and approvals from regulatory agencies (e.g., DoE) in support of boiler decommissioning and new boiler erection projects. • Perform any other relevant and lawful duties as assigned by the Manager of	• Master's degree from a reputed institution on Environmental Engineering or Science or any related field • Must have good knowledge on various environmental and occupational health and safety policies and standards, both national and international. • Minimum 10 years of working experience on power sector projects or any environmental related projects that are funded by development Banks and a diploma in OHS from a reputed institution (e.g. NEBOSH or anything similar)

Positions	No. of positions	Job Responsibilities	Qualifications
		EHSU from time to time. • The Environmental Specialist should adhere to the rules and regulations of Bangladesh and of development partners such as World Bank, ADB, etc. • Ensure a safe and healthy working environment and systems of work through sensitizing employees on occupation health and safety. • Advise SPS management of areas not in compliance with Environmental Conservation Rules, 1997; Factory Act, 1965; Bangladesh Labour Act, 2006 and OSHA guidelines. • Train workers on how to recognize hazards; environmental and OSHA regulations; how to properly use personal protective equipments (PPEs); fire safety drills etc. • Evaluate the probability and severity of accidents. Supervise the preparation of accident reports and continually update these reports and inform them to the EHSU Manager.	
Assistant Manger (Environment)	1	• Conduct environmental screening and scoping and assist in environmental impact assessments of all SPS and donor funded projects. • Monitor environmental mitigation and compensation measures carried out by the contractors along with the consultants as outlined in the project's EMP. • Conduct periodic consultations with various stakeholders, focus group discussions, and community consultation to monitor the progress of the EMP implementation. • Participate in grievance redress committee and resolve issues related to environmental concerns raised by the communities. • Prepare the implementation of a range of environmental compliance documents required for project approval and implementation, such as IEE, EIA, EMPs, etc.. • Perform any other relevant and lawful duties as assigned by the Manager of EHSU from time to time.	• Bachelor of Science degree in Environmental Science from a reputed institution • Must have good knowledge on various environmental policies and standards, both national and international. • Working experience in power sector projects or any environmental related projects are preferred.
Assistant	1	• Monitor all health and safety activities	• Bachelor of Science

Positions	No. of positions	Job Responsibilities	Qualifications
Manger (Occupational health and safety)		carried out by the contractors along with the consultants as outlined in the project's EMP. • Conduct, arrange and report periodic inspections of all installations/ laboratories/ workshops to identify risks and safeguard of all persons from death or injury. • Provide personal protective equipment (PPE) to operation sections where necessary and monitor the adequacy of contractor's PPE at construction site. • Conduct fire safety audits on all SPS buildings to ensure that facilities are compliant with safety rules and ensure that appropriate procedures to minimize risks are in place. • Prepare monthly and quarterly reports on occupational health and safety and providing updates on health and safety issues. • Perform any other relevant and lawful duties as may be reasonably assigned.	degree in occupational Health and safety or public health or related field from an international accredited institution and a minimum 2 years of working experience or a diploma in OHS from a reputed institution. • Must have adept knowledge of national policies, such the Labour Act, 2006, The Factories Act, 1965, Environmental Conservation Rules, 1997 as well as International OSHA standards such as ISO 14001, ISO 31000 and other related OSHA guidelines.

Source: CEGIS, 2015

Institutional Framework for Implementing EMP

560. Proposed Institutional Framework for Implementation of EMP is shown in**Figure 9-6**.

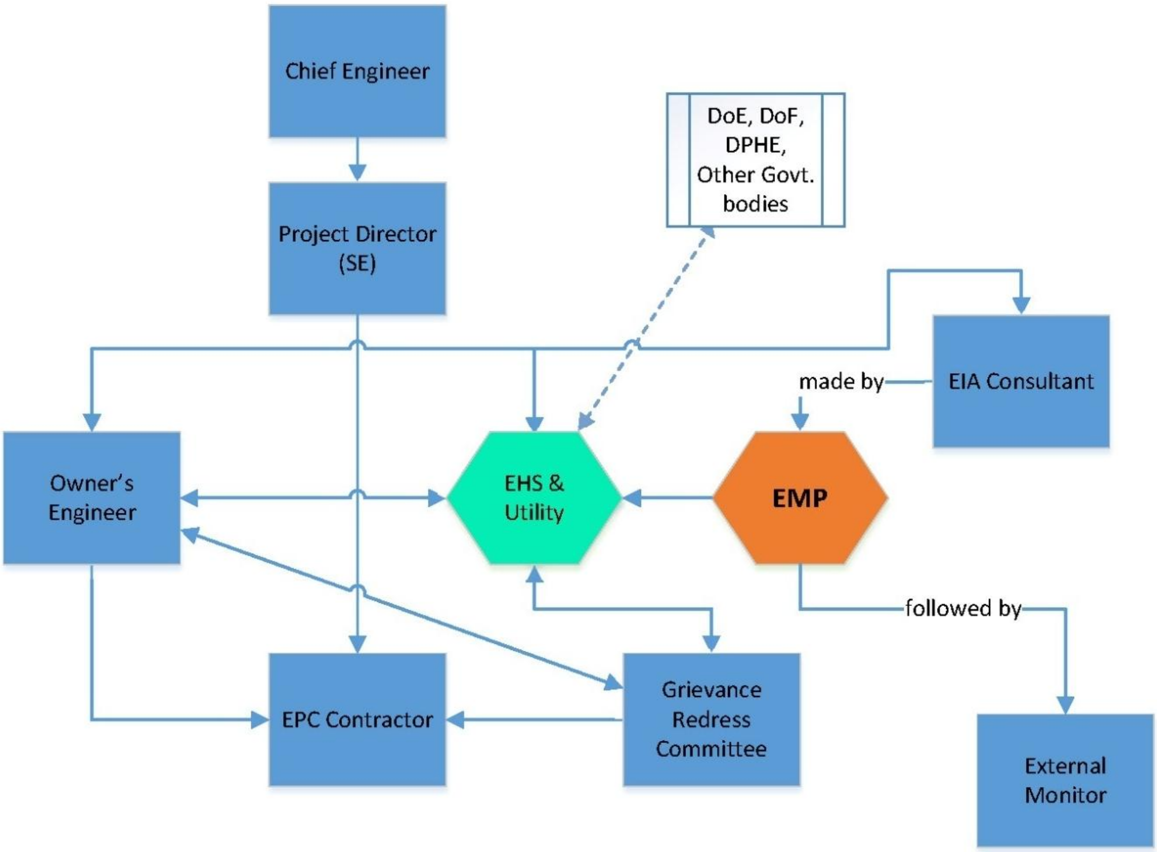


Figure 9-6: Proposed Institutional Framework for EMP Implementation

10 Hazard and Risk Assessment

10.1 Introduction

561. Risk assessment is a part of the EIA process which aims at identifying all the potential hazards, exposure to hazardous condition or hazards, and their mitigation or safety measures. The approach of risk assessment is in combination of qualitative and quantitative assessment of hazard sources, exposures, consequences and possible mitigation measures. A comprehensive risk mitigation plan, occupational health and safety plan, and emergency response plan are the outcome of the risk assessment process. In addition, a brief guideline on implementing Hazard and Operability Assessment during operation is also prepared through risk assessment practice.

10.2 Potential Hazard and Risk during Construction and Erection

562. The possible hazards in construction stages are mostly related to construction of civil structures and erection of heavy machinery. The **Table 10-1** identifies the potential hazards during general construction activities, their root causes, consequences along with the safety measures.

Table 10-1: Table Possible Hazards in Construction Stage

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 and loss of life	• Fall protection, use of Personal Protection Equipments (PPEs)
Falls	Fall from elevated areas, high heights, etc.	Health injury and loss of life	• Fall protection, awareness, use of PPEs
Electrocution	Cutting and welding, switchyard, cable gallery, etc.	Health injury and loss of life	• Use of PPEs, proper training, awareness, keeping safe distance from hazardous points, maintaining safety of high switchyard, cable gallery, control room, etc.
Fire and Explosion	Cable gallery, power transformer, generator, turbine and its ancillary components, furnace, switchyard, switchyard control room fuel stockpile,flammable chemical, power transformer, HRSG boiler and pressure parts, live steam line, fuel stockpile, etc.	Health injury and loss of life	• Arrangement of fire fighting equipments with training to the staffs from workers to officers • Staffs should be trained on emergency handling procedures • Control hot work via Permit to Work from the responsible persons. • Adoption of fire safety for each of the equipments and machinery subject to fire hazard • Safe handling and storage of flammable chemicals and fuels • Regular inspection and monitoring of pressure parts and units • Use of PPEs • Consciousness during working period.
Noise and Vibration	Noise and vibration from rotating machinery, traffic and testing of main plant, etc.	Hearing complexity; vomiting to the pregnant women; scaring to wildlife, livestock, human being, etc.	• Compliance with the national Noise Control Rules and Regulations and IFC occupational health and safety standards • Equipment to be used by competent operatives • Provision of equipment with low noise and vibration outputs where possible • Personal protective equipments (PPEs) provided and used where necessary

Hazard	Source	Consequences	Safety measures
			• Consider suitable timing of the work to reduce disturbance • Appropriate choice of modern equipment and machinery to reduce noise
Traffic Accident	Onsite and off site	Health injury, life loss, property damage, etc.	• Driver should strictly follow the traffic rules and regulations of the country • Proper traffic marking on the road and effective signaling system should be implemented in and around the Project site • Traffic safety should be ensured for long vehicle • Provision and use of high visibility clothing. • Provision of walkways
Confined space	Storage tank, HRSG Boiler, Ventilation or Exhaust Ducts, Sewers & Manholes, Underground Utility Vaults, Tunnels, Pipelines, Open top spaces more than 4 feet in Depth, Temporary Enclosures (heating enclosures for break), Dumpsters, Stair-wells, Elevator Shafts, Basements, Attics, Trenches & Excavations	Oxygen deficiency, flammable and/or toxic lead to health injury, loss of life	Contractors must coordinate work in confined or enclosed Spaces: • Identify hazards and classify the space accordingly • Eliminate and/or control the hazards: engineering control (ventilation) • Personal protective equipments (PPEs) • Coordinate entry operations; entrant & attendant- test oxygen content, flammable environment, toxicity responsibilities, ensure proper communication • Ensure prompt rescue; team readily available, properly equipped & trained
Intoxication/ Toxic exposure	Chemical storage, Gas pipeline Leaks, Hazardous atmosphere in confined space	Health injury and loss of life	• Safe storage of chemicals should be ensured • Safe working condition • Use of PPEs, Emergency Health Services, etc. • Ensuring the compliance of gas safety rules and regulations
Unsafe Working Place	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 • Monthly health inspection, provision of medical leave for labor, awareness, etc.

10.3 Potential Hazard and Risk during Operation

10.3.1 On Site Hazards

563. In general, the proposed Plant will have four major components those involve different hazards:

- Natural gas lateral supply pipeline (20 inch) from National Grid Valve Station to the Regulating Metering Station (RMS) of PGCL
- Gas receiving station and RMS of PGCL at power Plant Boundary
- Gas Pipeline (14 inch) from PGCL's RMS to Plant site Gas Booster and RMS
- Gas Booster and RMS at Plant site
- Gas turbine hall and generator
- Heat Recovery Steam Generator (HRSG)
- Steam Turbine (ST) hall and generator
- Carbon dioxide (or other asphyxiant fire quenching gas) storage
- Chemical Storage Tank
- HSD Fuel Storage Tanks
- Power evacuation Bay
- Cooling Tower

564. **Table 10-2** provides an site specific hazards mitigation measures:

Table 10-2: Location-wise hazard identification and management

Event	Cause/Comments	Possible Consequences	Prevention/ Protection
Natural gas lateral supply pipeline (16 inch) from National Grid Valve Station to the RMS of PGCL			
• Mechanical impact causes release of flammable gas.	3^{rd} party involvement digging or trenching, or other earth work.	Massive release of natural gas (NG). If ignition occurs, then possibility of flash or jet fire.	o Pipe should be buried (minimum 750mm in soil or 450mm in rock). o Sign along pipe route, including Dial Before You Dig information, Drawings available to Dial Before You Dig. o Resistance of pipelines to penetration through use of pipe thickness and low design factor. o Rapid shut down from low pressure trips if massive leak at pipelines prevents backflow from Plant and uncontrolled flow from Gas pipeline. o Manual shut down (by isolating manually at the Gas pipeline off-take point and/or at gas receiving station). o NG disperses readily upwards, minimizing chances of ignition. Explosion not credible in unconfined situation. **The risk associated with this scenario is evaluated quantitatively in the sub-section entitled consequence analysis.**
• Corrosion causes release of flammable gas.	Damage of pipeline coating due to excavation inspection damage leads to corrosion	If ignition, a jet fire is possible.	o Cathodic protection for external corrosion with regular inspections and testing as per AS2885. o Internal corrosion virtually absent with clean hydrocarbon. o Coating on external surfaces of pipelines. o Regular patrolling of pipelines. Vegetation browning off around ground leak (lack of oxygen) aid detection. Further, a small hole will be sonic – possible detection through high pitched sound.

Event	Cause/Comments	Possible Consequences	Prevention/ Protection
			○ NG disperses readily upwards, minimizing chances of ignition. **The risk associated with this scenario is evaluated quantitatively in the sub-section entitled consequence analysis.**
• Valve gland nut of flange leak causes release of flammable gas.	Maintenance failure at valves. Wear and tear impact.	Release of natural gas. If ignition, then possibility of fire.	○ Periodic surveillance of pipe and valve points. ○ Valves will be exercised periodically. ○ Gas detectors at valve stations. ○ Icing up at leak point improves detection. ○ Valve stations contained on site. ○ Minimum number of flanges. Welded connections wherever possible. **The risk associated with this scenario is evaluated quantitatively in the sub-section entitled consequence analysis.**
• Terrorism / vandalism damages pipe or valve causing release of flammable gas or HSD oil (if used).	Terrorism / vandalism	Massive release of natural gas. If ignited, then possibility of flash or jet fire. Leakage of oil from the pipeline may spread over the land on the either sides of the pipeline resulting deterioration of soil quality. Ignition of oil may cause wild fire.	○ Terrorism and severe vandalism is highly discouraged and the country men should be patriotic and aware about the loss of property. ○ Enforcement of law in protecting the national property. ○ Pipelineswould be buried and no valve points at public areas. ○ Valve station would be fenced. ○ Regular and periodic surveillance of the pipelines. ○ Intruder detection mechanism should be adopted. **This scenario does not require further action for this site.**
• Explosion at neighboring natural gas (Gas) Trunk line	Failure of maintenance of Trunk line. Hot tapping by error.	Massive release of natural gas (NG). If ignited, then possibility of flash or jet fire.	○ Internal risk management procedures / systems would be disseminated to the staffs and workers by pipeline operators.

Event	Cause/Comments	Possible Consequences	Prevention/ Protection
causes damage to gas supply pipeline.			○ Pipeline integrity plan (incl. protection, pigging etc. to monitor integrity of pipeline and coating inspection). ○ 24 hour monitoring of natural gas pipelines. ○ Mechanism should be there for NG dispersion directed upwards for minimizing chances of ignition. Explosion not credible in unconfined situation. ○ Buried natural gas Trunk line. ○ Thickness and grade of pipelines. ○ Hot tapping is a specialist field with highly trained personnel. **This scenario does not require further action for this site.**
• Pressure excursion leading to failure of the pipeline.	Operational error up or downstream of gas supply pipeline.	Release of natural gas. If ignited, then possibility of fire.	○ The pipelines are to be hydro tested at a minimum of 1.4 times the MAOP (maximum allowable operating pressure). ○ The pipelines can operate against closed head (i.e. the main valve at the entrance to the site may be closed). ○ 24 hour monitoring of Trunk line and lateral supply gas pipeline. ○ Continuous monitoring of pressure of the pipelines supplying natural gas to the power plant. ○ High and low pressures of the natural gas supply will be monitored and if required (as defined in detailed HAZOP), associated with an automatic trip / shut down, see Recommendation. **The risk associated with this scenario is evaluated quantitatively in the sub-section entitled consequence analysis.**

Event	Cause/Comments	Possible Consequences	Prevention/ Protection
• Spontaneous loss of integrity of pipe.	Construction defect or operational error (repeated)	Massive release of natural gas. If ignited, then possibility of flash or jet fire.	○ All welds are x-rayed (100%). ○ Thickness of pipe material and temperature cycling make this scenario highly unlikely to be occurred. ○ Cathodic protection. ○ Design for pipelines to prevent crack propagation. **This scenario does not require further action for this site.**
• Land subsidence induced damage to pipe and release of flammable gas.	Mining activities in and around the alignment of pipeline or earthquake	Distortion to the pipeline, release of natural gas. If ignition, then possibility of flash or jet fire.	- See Event number 9 and 11 below (for the whole site)
Gas receiving station and Regulating Metering Station (RMS) of PGCL at power Plant Boundary			
• Leak of natural gas to atmosphere from gas pipes on-site (outside the turbine housing).	Mechanical impact, weld failure, operational error corrosion, sabotage etc.	Release of odorized natural gas. If ignition source available (or if ignited at source), then flash fire or jet fire possible.	○ Use of fully welded pipework wherever possible. Minimize pipe-runs (pipe lengths). Pipes of robust design. ○ Detectors positioned strategically at high risk leak areas. ○ The use of fusible tubing around high risk leak piping to be investigated, see Recommendation. ○ Over pressure protection. ○ Communication systems. ○ Actuated isolation valve at receiving station inlet. ○ Fire protection system to be installed, incl. fixed sprinkler or water/hose system. **The risk associated with this scenario is evaluated quantitatively in the sub-section entitled consequence analysis.**
• Venting of gas from process.	Maintenance work, shutdown, flaring.	Release of flammable gas or heat to process area. Fire hazard.	○ Releases of gas to be piped to safe area (flare). ○ Venting of gas at elevated point.

Event	Cause/Comments	Possible Consequences	Prevention/ Protection
			Standard design practices to be applied.
• An explosion within piping or inside a pressure vessel.	Failure of maintenance activities creates ingress of air into natural gas piping and vessels and subsequent start-up without adequate purging.	Possible explosion. Due to the limited quantities of gas involved the effects of the explosion would however not be expected to pose a threat to nearby land uses.	○ This scenario is only theoretically possible during start-up, shut-down and maintenance operations; ○ Piping normally operated at a positive pressure, preventing ingress of air; ○ Prevention of ingress of air will be considered throughout the design and operation of the facility (for example in the preparation of start-up, shut-down and maintenance procedures). **This scenario does not require further action for this site.**
Turbine Enclosure			
• Leak of natural gas to inside the turbine housing due to failure of pipe.	Mechanical impact, weld failure, operational error corrosion, sabotage etc.	Release of odorized natural gas (NG). If ignition source available (or if ignited at source), then the possibility of flash fire or jet fire. If confinement sufficient then an explosion is possible with overpressure effects and projectiles. Due to the limited quantities of gas involved and the size of the site, the effects of the explosion would however not be expected to pose a threat to nearby land uses.	○ The detailed design of the turbine housing and associated equipments need to demonstrate that explosive situations do not arise and need to clearly outline the basis of safety measures used to this end ; ○ Training of operators and maintenance workers. ○ System put in place to ensure removal of safety critical functions is subject to careful scrutiny (see Recommendation). ○ Permit to Work procedures, including for entry into Confined Space. ○ Emergency procedures and drills. **The risk associated with this scenario is evaluated quantitatively in the sub-section entitled consequence analysis.**

Event	Cause/Comments	Possible Consequences	Prevention/ Protection
• Leak of natural gas to inside of turbine housing due to projectile.	Violent mechanical failure of rotating machine (compressor, turbine) creates projectile.	Projectile would be ejected with high energy. Personnel hazard if in the vicinity. If a gas pipe is hit by the projectile or associated equipment / instrumentation then it may fail, causing gas release and fire / explosion if there is an ignition source.	○ Preventative maintenance of rotating machines. ○ Vibration monitoring. ○ Shut down of machine and repair if out of alignment. ○ Rotating machines to be designed as such that risk associated with projectile is minimized (gas pipelines protected or not in probable line of projectile, people protected substation and electricity facility not in direct line of projectile or protected etc.). ○ Buried pipeline is not at risk from such projectiles. **The risk associated with this scenario is evaluated quantitatively in the sub-section entitled consequence analysis.**
Generator Hall			
• Fire in Generator Hall	Electrical short circuit or electrical failure Violent mechanical failure of rotating parts, shafts, etc. Failure in Gas pipeline of steam line Fire from power evacuation bay	Damage of the generator, fire may lead fire in other area of the plant e.g. electric bay, fuel tank, fuel supply line, etc.	○ Preventive maintenance with regular inspection and monitoring as per the operational protocol of the manufacturer/ EPC contractor; ○ The EPC contractor should develop a safety guideline for preventing fire damage; ○ Vibration monitoring; ○ Automatic fire detection, alarming and fighting system.
• Failure in Generator cooling	Mechanical failure	Loss of efficiency, fire in generator and Power Plant tripping	○ Preventive maintenance with regular inspection and monitoring as per the operational protocol of the manufacturer/EPC contractor. ○ The EPC contractor should develop a safety guideline for preventing any failure ○ Automated monitoring through DCS

Event	Cause/Comments	Possible Consequences	Prevention/ Protection
• Damage in Generator due to lack of lubrication and coupling shaft	Design fault, engineering fault, mechanical failure	Loss of efficiency, fire in generator and Power Plant tripping	○ Installation as per the instruction of the manufacturer; ○ Operation and Maintenance as per the protocol of the manufacturer/EPC contractor
Power Evacuation bay			
• Fire	Short Circuit, thunderstorm, fire in transformer	Fire in power plant, Power Plant tripping and injury of personnel	○ Preventive Inspection and maintenance ○ The EPC contractor should develop specific safety plan for ensuring safeguarding ○ The transmission line and GIS should be properly designed ensuring safeguarding ○ Installation of Active Fires Suppression system ○ Gravel around switchyard provides separation distance from neighbouring combustible material (grass, bush, etc.) ○ Ensures any oil spill seeps into the gravel and does no pool.
Cooling Tower			
• Non-Functional	Malfunction of pumps, fans, etc	Less efficient cooling Less efficient turbine Rapture of steam line Power Plant tripping	○ Monitoring of flow, pressure, in water line, steam line; ○ Regular preventive inspection and maintenance; ○ DCS monitoring of pumps, FD/ID fans, etc.
Carbon dioxide (or other asphyxiant fire quenching gas) Storage			
• Release of carbon dioxide (or of other fire quenching material to be used for fire protection) into turbine housing.	Leaking cylinders, flanges, pipes into enclosed area.	Potential asphyxiation (lack of oxygen) of person inside the enclosed area if concentrations reach hazardous levels.	○ Small quantities, impact localized to enclosed area; ○ Permit to Work requirements; ○ Alarm (visual and audible) inside enclosed area allowing personnel escape prior to offloading carbon dioxide / other fire quenching material. **The consequences of this scenario are local only to the immediate vicinity of the release. No off-site consequences expected.**

Event	Cause/Comments	Possible Consequences	Prevention/ Protection
Whole Site (including supply pipeline)			
• Earthquake results in process upsets, potential damage to process / storage facilities resulting in hazardous releases.	Earthquake	Potential damage to process / storage facilities resulting in hazardous releases, fire / explosion.	○ Structures and plant are designed to withstand earthquake effects using well-established procedures in accordance with relevant national or international standards.

10.4 Consequence Analysis

10.4.1 Leakage from Gas Pipe Line

565. Natural gas is a flammable chemical which is enlisted as explosive under the Explosive Act of 1884 of Bangladesh. The natural gas is to be used for the proposed plant consists of mostly Methane (96% by volume) and ethane, propane, butane and other alkanes. Though methane is highly flammable gas, its explosion limit is low (5% - 15%). Leakage of gas from pipeline and other associated events may cause series of hazards. It describes and assesses the unplanned events that could potentially cause risks to public safety and harm to the environment. In the following sections, potential hazards and consequences are discussed.

566. Natural gas as fuel will be supplied through a 20 inch dia. Pipe by Pashchimanchal Gas Company Limited (PGCL) from its valve station on 30 inch line up to the proposed RMS inside the power plant boundary. From the RMS gas will be supplied through a 75 m long, 14 inch dia. Pipe to the gas booster and then to the combuster through 18 inch dia pipe. The gas pipeline may experience leakage due to any fracture or failure of the pipeline which may lead to a number of potential and sequential hazards. **Table 10-3** lists all identified major potential hazards and hazard sourcing points related to natural gas during plant operation. Sequential Hazard Event from a Gas Leakage is shown in **Figure 10-1**.

Table 10-3: Potential Hazard Points and Possible Hazards

<table>
<tr><th>Hazard Points</th><th>Possible Hazards</th><th>Consequences</th></tr>
<tr><td colspan="3">On Site</td></tr>
<tr><td>20″ Gas Pipeline (RMS of PGCL to RMS of NWPGCL)</td><td rowspan="3">Gas Leak leads to:
• Toxic Vapor Cloud Formation
• Vapor Cloud Explosion
• Jet Fire
• Limited Space Explosion
• Over Pressure Explosion</td><td rowspan="3">• Fire
• Poisoning
• Suffocation
• Damage to structure
• Health loss</td></tr>
<tr><td>14″ Gas Pipeline (RMS and Gas Booster of NWPGCL near Plant)</td></tr>
<tr><td>Underground Gas Pipeline from Gas Booster to Gas Turbine</td></tr>
<tr><td colspan="3">Off Site</td></tr>
<tr><td>30″ National Grid Pipeline of PGCL</td><td rowspan="3">• Toxic Vapor Cloud Formation
• Vapor Cloud Explosion
• Jet Fire
• Limited Space Explosion
• Over Pressure Explosion</td><td rowspan="3">• Fire
• Poisoning
• Suffocation
• Damage to Structure
• Health Loss</td></tr>
<tr><td>20″ inch Gas Pipeline (National Grid to RMS of PGCL)</td></tr>
<tr><td>RMS of PGCL near Plant Site</td></tr>
</table>

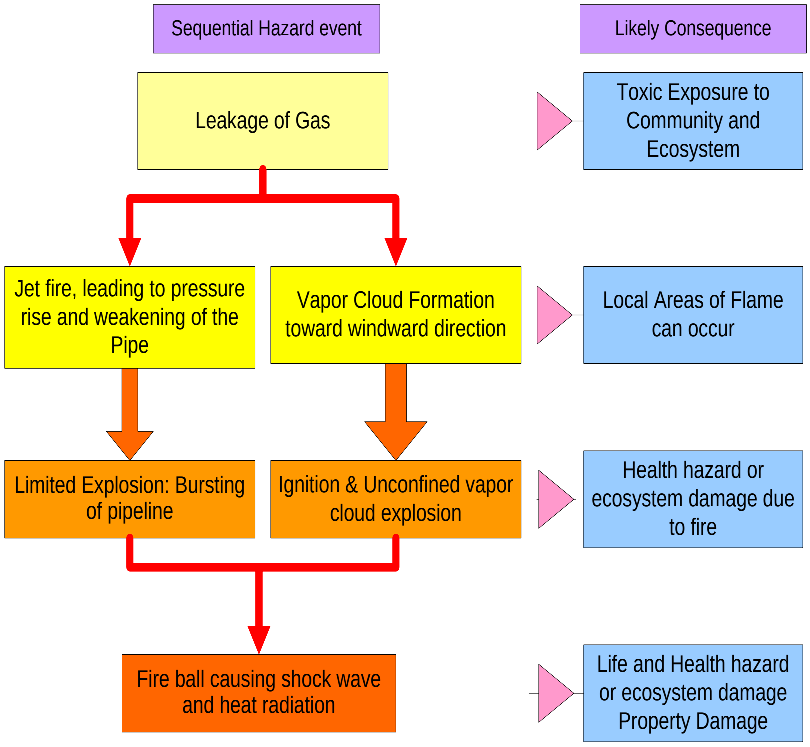


Figure 10-1: Sequential Hazard Event from a Gas Leakage

567. ALOHA (Areal Locations of Hazardous Atmospheres) software has been used to simulate the consequence of gas leakage. It is a modeling program to estimate threat zones associated with hazardous chemical releases, including toxic gas clouds, fires, and explosions (**Appendix-9**). The simulation considers that it is possible to close off the gas supply connection through valve installed at RMS. ALOHA has been applied to simulate the following sequential hazards

- Toxic Area of Vapor Cloud Formation
- Flammable Area of Vapor Cloud Formation
- Blast Area of Vapor Cloud Formation

568. One of the key assumptions is wind direction, which has been considered as ‘North-East’ considering worst case scenario, plant locations and on the basis of the analysis of the wind rose diagrams and provided in **Figure 6-9** in **Chapter 6**. Average Wind speed has been considered as 3.72 m/s at 10 m height.

569. Both ends of the gas pipe between plant and RMS is regulated by valves. Both of the valves are operated by DCS. In ALOHA, it is assumed that the release of gas duration would be 4 minutes considering DCS operated valves, pipe length, and possible amount of gas in the pipe. As the valves are operated by DCS, therefore, 1 minute is enough to shut down the valve.

Simulation of Toxic Area of Vapor Cloud Formation

570. ALOHA estimates that toxicity may spread up to 110 m though the death threatening toxicity may spread up to 45 m towards windward.**Figure 10-2** presents the threat zone area of toxic vapor cloud formation. In addition, **Table 10-4** presents a brief summary of the toxicity.

Table 10-4: Threat Zone of Vapor Cloud Formation

Items	Red Threat Zone (meter)	Orange Threat Zone (meter)	Yellow Threat Zone (meter)
Definition	PAC 3: Concentration <17000 PPM More than one hour exposure to this concentration threats adverse health effect or death	PAC 2: concentration < 2900 PPM, More than one hour exposure to this concentration threats irreversible or other serious, long-lasting, adverse health effects or an impaired ability to escape	< 2900 PPM Exposure to this concentration threats discomfort, irritation, or certain asymptomatic, non-sensory effects
Toxic Area	45 m	110 m	110 m

Note: PAC: Protective Action Criteria

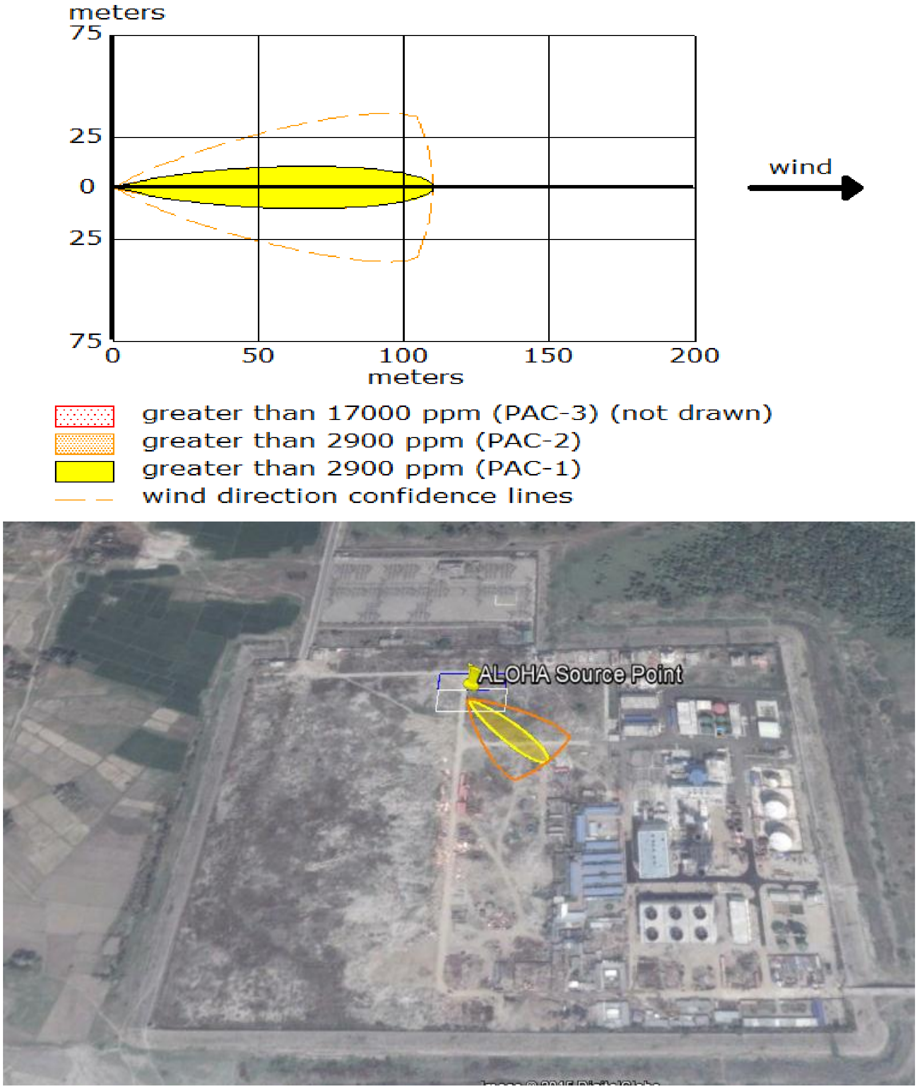


Figure 10-2: Toxic Area of Vapor Cloud Formation

Simulation of Flammable Area of Vapor Cloud Formation

571. The vapor cloud formed from a leakage of a gas pipeline has flammability. ALOHA has been applied to estimate the possible flammable area of the vapor cloud. The local area of flame can occur even though the concentration is below the lowest explosion limit (LEL), only 5% (LEL) - 15% (UEL). ALOHA considers 60% of the LEL to cause a flame.

572. 60% of the LEL level i.e., 30,000 ppm concentration has been considered as high threat zone (red) of occurring flame which might spread up to 48 m. As ALOHA could not estimate the moderate threat zone (orange) but a 10% of LEL i.e., 5,000 ppm is considered as low threat zone (yellow) of occurring flame. The model estimated that, the threat zone i.e. flame might spread up to 118 m. The details of the simulation results are shown in **Figure 10-3** and **Table 10-5**.

Table 10-5: Threat Zone of Flammable Vapor Cloud Formation

Items	Red Threat Zone (meter)	Yellow Threat Zone (meter)
Definition	LOC: > 30,000 PPM which is 60% of the Lowest Explosion Limit (LEL) of Methane. LEL of Methane if 50,000ppm	LOC: > 5000 PPM which is 10% of the Lowest Explosion Limit (LEL) of Methane. LEL of Methane if 50,000ppm
Toxic Area	48 m	118 m

Note: LOC: Level of Concern

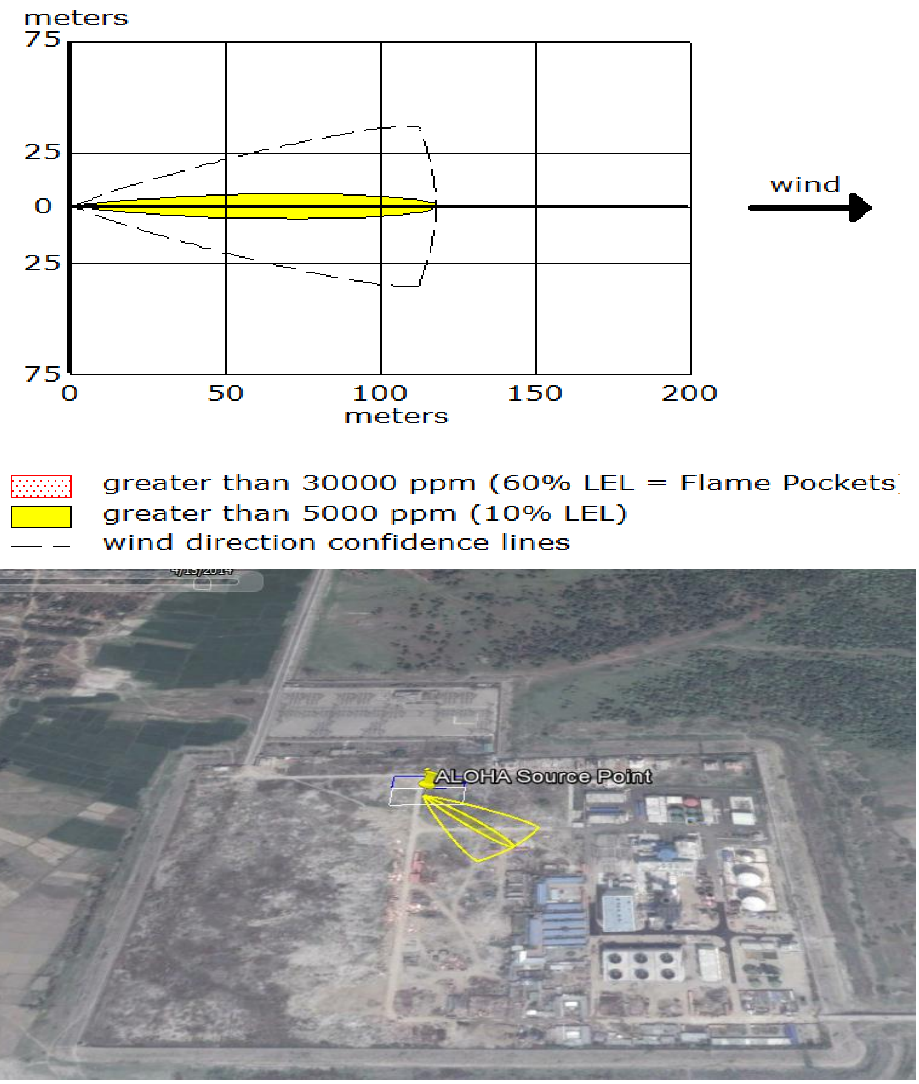


Figure 10-3: Flammable area of vapor cloud formation

Simulation of Blast Area of Vapor Cloud Formation:

ALOHA defines three Level of concern for classifying threat zones on the basis of overpressure formed by the shock wave created from blast:

- High Threat Zone, 8 psi pressure which is destructive for buildings
- Moderate Threat Zone, 3.5 psi pressure serious injury
- Low Threat Zone, 1.0 psi pressure that is enough to shatter window glass

The model predicts that, the possible blast of the flammable vapor would not be strong enough to create any pressure above 1 psi to shatter even a window glass.

Simulation of Jet Fire

Methane gas leakage from a pipeline may cause a jet fire if it ignites with fire; come close proximity to thermal radiation, heat and toxic byproducts. ALOHA software has been applied for estimating the threat zone of thermal radiation of the possible jet fire. The **Figure 10-4** shows the predicted areas of different threat zone and **Table 10-6** gives a narrative summary of the prediction.

Table 10-6: Threat zone of thermal heat radiation of a jet fire from gas leak

Items	Red Threat Zone (meter)	Orange Threat Zone (meter)	Yellow Threat Zone (meter)
Definition	LOC: 10 kw/m^2 Potentially lethal within 60 sec exposure	LOC: 5 /m^2 2nd degree burn within 60 sec exposure	LOC: 2 kw/m^2 Pain within 60 sec exposure
Toxic Area	19 m	32 m	50 m

Note: LOC: Level of Concern

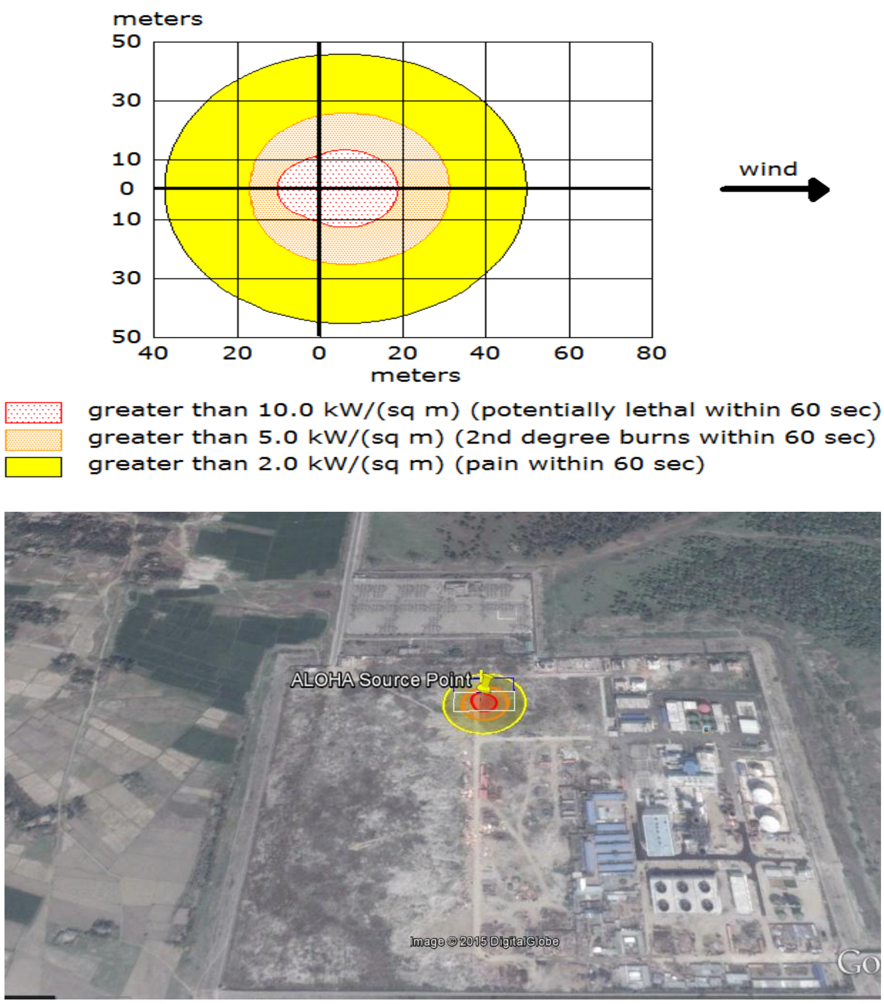


Figure 10-4: Thermal radiation from jet fire

10.5 Risk Management Plan

10.5.1 Change of Layout

573. The main entrance road goes in between RMS of PGCL and RMS of NWPGCL unit 3. Hence, additional safety measures should be ensured in the road section beside these RMS. The control room and residential area of the PGCL is just next to the RMS of PGCL which is completely against the safety rules. The residential place for the PGCL staff should be at safe distance from the RMS.

10.5.2 Change in Engineering Design

574. The valves of the gas pipeline in the PGCL's RMS are manually operated. These valves should be of automatically operated system. The control room of the RMS should be sound proof.

10.5.3 Risk Mitigation Measures

Table 10-7: Site Specific Mitigation Measures

Sl No	Site/Project Component	Risk Mitigation Measures
1	Water Treatment Plant	o Hazardous Sludge should be disposed carefully after appropriate treatment (thickening, dewatering, etc); o The Effluent Sump should be constructed in a way that would not allow any leakage to nearby soil and ground water; o Chemical use safety, Limited entry, use of PPEs, available spill kits in case of accident, safety shower, eye wash and first aid facilities.
2	HRSG and High Pressure steam line	o Regularly scheduled maintenance on all piping infrastructure and structural testing; o Continuous monitoring of feed flow rates; o Proper control alarms in place will warn of any deviation in temperature, steam pressure or water flow, alert operators, and allow them to shut down the process before the deviation causes damage.
3	Chemical Storage Area	o The hazardous chemicals should be stored in protective building/storage; o Entry into the storage area should be limited to trained personnel, wearing the appropriate personal protective equipments (PPEs); o Appropriate chemical spill kits should be readily available in case of accidents. Safety shower, eye-wash, and first aid facilities should be available in case of emergency; o Material and Safety Data Sheets (MSDS) should be available for emergency personnel in an accident situation.
4	Air Circulation System	o Temperature, oxygen, NOx, and CO alarms will alert the operators of the deviation; o Compliance to a regular maintenance schedule will prevent this from occurring; o Regular maintenance and monitoring control system, functioning of FD, ID Fans and vacuum systems.
5	Compressed Air system	o Safety bulb, limited entry, use of PPEs, control system to

Sl No	Site/Project Component	Risk Mitigation Measures
	and Pipeline	monitor required pressure at different points.
6	RMS	o The control room should be noise proof with proper sealing of the doors and windows. o Valves should be of automatic system controlled by DCS
7	Turbine and its ancillary	o Safe design, regular inspection, continuous monitoring, computerized controlling system and monitoring. Installation of fire defense and fighting systems.
8	Generator and Cable Gallery	o Safe design, regular inspection, continuous monitoring, computerized controlling system and monitoring. Installation of fire defense and fighting systems. o Proper ventilation system, insulation of cables with non-inflammable fire resistance sealing materials.
9	Power Transformers and Switchyard	o Maintaining the specific standard for all electric fittings and cables, insulation of covering of electric cable with non-inflammable fire resistance sealing materials. o Installation of fire fighting system including water deluge system. Installation of cooling system. o Installation of light arrestor, keeping safe distance from right of way, fencing, warning signal, fire fighting system and portable fire extinguisher.

Source: CEGIS, 2015

10.6 Occupational Health and Safety Plan

Table 10-8: General Occupational Health and Safety Plan

SL No.	Occupational Hazards	Safety Measures
1	GeneralSafety	o All the work should be carried out in line with the safety requirements of ECR 1997 and international standards (e.g. IFC) o GeneralHealth and Safety Policy of NWPGCL o Appropriatestandards, instruction manual of the manufacturer of the equipments o A general Health and Safety Guideline and specific Safety Procedure of plant operation, maintenance and decommissioning should Developed by the EPC contractor
2	Hazardous Materials	o Hazardous materials should be handled in accordance with the safety data procedure as mentioned in the safety data sheet of the particular materials o Only the trained personnel should be involved in hazardous material handling o What are the hazardous and risk associated with the material should be mentioned clearly on the material's label o Other appropriate regulations and codes complied with (e.g. chemical Regulations). o Provide suitable personal protection equipment.
3	Electricity	o Compliance with Electricity at Work Regulations and Health and Safety Manager's guidance notes. o Planned inspection and maintenance of electrical tools and equipment.

SL No.	Occupational Hazards	Safety Measures
		o Use of electrical safety devices (e.g. Residual Circuit Device). o Supply High Voltage and Low Voltage cable plans. o Cable locations and permits.
4	ManualHandling	o Appropriate lifting equipment should be used for handling heavy equipments. o The personnel and labor involved in equipment handling should have proper training o Specific training should be provided to those employees regularly required to lift. o For ensuring health and safety, Reduce handled loads too less than 20kg.
5	Noise andVibration	o Compliance with Noise Control Rules 2006, ECR 1997 (hereafter amendments), and IFC standards. o Vibration should be limited to IFC standard. o Equipments generating significant noise should be equipped with noise hood. o PPEs should be provided to all employees working in area exposed to noise above the allowable limit. o Provision of equipment with low noise outputs where possible. o Timing of the work to reduce disturbance. o Appropriate choice of equipment to reduce noise. o Noise Mitigation Measures suggested in the EMP chapter should be followed strictly
6	FireandExplosion	o Ensure Building Code has been followed strictly in designing and constructing the buildings, and other civil structures. o Procedures established to minimise risk of gas ignition if relevant. o Gas safety rules and Explosive Act should be followed strictly. o Firefighting equipment provided. o Staff trained in emergency procedures. o Control hot work via Permit to Work. Remove combustibles.
7	Use ofMachinery	o Machinery operated in compliance with Work Equipment Regulations. o Machinery used by competent operators. o Planned maintenance of machinery. o Compliance with legislation under the Management of Health and Safety at Work Regulations.1999.
8	Tripsandfalls	o Compliance with Workplace Regulations. o Suitable access equipment provided and inspected.

10.7 Hazard and Operability Assessment (HAZOP)

575. HAZOP is a structured and systematic technique for system examination and risk assessment. It is a process that helps the operator to identify all the risks, operability problems, safety measures and emergency procedure. There are other techniques available

for hazard and safety assessment. Generally, HAZOP is recommended by different international standards to adopt HAZOP in operation of large scale industrial unit like power plant for ensuring safeguarding of the plant, personnel and the nearby community as well. Following the risk mitigation plan and safety plan presented in **Table 10-1, 10-2, 10-7, and 10-8** the responsible HAZOP team and personnel of the proposed unit as well as the SPS will prepare the HAZOP template (an example template is provided in **Appendix-10**). This template will help the HAZOP team to examine the risks associated with a set of particular activities and monitor the safety measures.

10.8 Emergency Response Plan

576. An Emergency Response Plan (ERP) is to provide a systematic approach to the protection of employees, assets and the environment from impact of serious incidents. A well-constructed ERP will prevent a minor incident from becoming a disaster, save lives, prevent injuries and minimize damage to property and the environment. The goals of the ERP are to:

- Provide for clear lines of authority and communication during incident and crisis events;
- Provide a means by which trained people and resources are available to those managing the incident or crisis event;
- Possible emergency events that have been identified for this Project are; Immediate medical evacuation due to personnel injury, traffic accidents (road), leakage of hazardous chemicals, civil disturbance/riot, terrorist events/threats and gas leak/explosion.

577. This ERP is intended to provide information, strategies and procedures relating to all aspects of emergency management which comprise:

- Prevention of emergencies;
- Preparation for emergencies;
- Response to an emergency and;
- Recovery following an emergency.

10.8.1 Emergency Prevention

578. Project risks are prevented through implementation of risk mitigation measures to address events such as; gas main leak/explosion, traffic accidents, structural failure and other minor structural issues (e.g., pavement). The potential risks and measures to reduce each type of risk are given in the **Table 10-9** below.

Table 10-9: Risk and Mitigation Measures

Risk	Preventative Mitigation Measure
Flooding	• Regular checking and maintenance of River Training Works.
Traffic Accidents (Road & Rail)	• Traffic Control devices (road signs and markings, speed signs, stop signs, speed bumps and safety barriers) • Infrastructure maintenance and improvements (including upgrades of road surfaces, rail lines, rail crossings, bridges and drainage) • Closing of bridge during extreme wind.
Spill/leak of Hazardous Materials in Land and Water	• Fire Department personnel in the ERC will possess sufficient Hazmat training and have access to an appropriate number of Hazmat suits.
Terrorist Events/Threats	• Regular contact and updates from National intelligence

Risk	Preventative Mitigation Measure
	agencies regarding threats. • Random security checks at the bridge ends during threats. • Bangladesh Army and Police personnel will be appropriately resourced and trained to quickly respond to terrorist emergency events.
Gas Leak/ Explosion	• Regular inspection and preventative maintenance of Gas main according to the *Operation and Maintenance Manual.* • Regular checking of Gas main pressure and pressure valves.

10.8.2 Emergency Preparedness

579. Preparedness includes emergencies from fire related disasters and the necessary steps required to prepare for such emergencies. For this, it is required to design, manufacture, deliver to the site, install, test and commission the fire-fighting and fire detection equipment to protect the steam & gas turbine, generating units and all associated equipment. The following **Table 10-10** includes the list of preparedness measures to be included:

Table 10-10: List of preparedness measures

SI	Area of Requirement	Preparedness Actions
1	Design Requirement	• Design should take into account basic operating policy • All automatic systems must have a manual initiation facility • All fire protection installations should comply with the requirements of the codes of practice of the National Fire Protection Association, Boston, Massachusetts, U.S.A., as appropriate for the respective systems, to the approval of the Engineer.
2	CO_2 Gas Fire Protection System	• An automatic Carbon Dioxide (CO_2) gas fire protection system should be provided in all machinery enclosures of gas turbine generating units except in the unit local control package. • The Protection System should consists of a fire detectors and an automated fire extinguishing mechanism once fire/smoke is detected. • Facilities for alternative manual actuation of the fire protection system should also be provided such that, when the manual mode has been selected the protection sequence will not proceed beyond the alarm stage without manual action by an operator. • High risk areas should be marked as “fire protection zones” and should have a separate fire protection system independent of others. • The protection system should be checked on a monthly basis to test their functionality. Any defect should be reported to the manger and should be replaced immediately.
3	Hydrant System	• Water hydrants should be provided in the plant in such places that are suscetible to fire, such as, gas & steam turbine generating units, HRSG, Gas station, Gas Booster, Chemical Plant electrical building, Outdoor transformers etc.

SI	Area of Requirement	Preparedness Actions
		• Fire fighting water pool/ storage tank should have a capacity of minimum 4 hours of supply in case of worst case scenario. • Regular inspection of the hydrant system should be made to see if they are functioning properly or not. Any defect should be reported to the manger and should be replaced immediately.
4	Piping	• The fire-fighting water mains should consist of buried piping of at least 150 mm diameter. • The underground pipe-work should be provided with an approved protective coating unless the pipe is manufactured from an approved non-corrosive material.
5	Portable Equipment	• Portable equipments such as, CO_2 extinguishers and dry chemical extinguishers of various weights and sizes should be provided at various locations of the plant • Regular inspection of portable extinguishers should be made and noted. Expired extinguishers should be replaced immediately.

Source: CEGIS, 2015

10.8.3 Training

580. A professional training needs to be given to the designated fire team. The training would include the following:

Table 10-11: Type of training and training actions

SI	Type of Training	Training Actions
1	Actions to be taken in the event of a fire	Use fire exit and educating workers and staffs of the nearest emergency evacuation zone. Proper evacuation procedure in the event of a fire. Training on locating emergency equipments and use of portable fire extinguishers to extinguish fires. Training on whim to contact in case of an emergency.
2	Handling of flammable liquids	Training on the safe handling and storage of volatile/flammable chemicals/oils. Training on waste classification system and use of various colour-coded bins for various waste disposals. Training on the use of PPEs.
3	Emergency Drills	Regular monthly training on mock fire drills. Regular monthly workshop on emergency response and preparedness plan.
4	First-aid and medical assistance	Training on first-aid treatment for broken bones/fractures, burns, cuts/wounds, unconsciousness, breathlessness.

Source: CEGIS, 2015

581. In case of an emergency fire breakout, the Manager/AM of the EHS should be notified immediately who will delineate the information and responsibilities to other staff

member. An emergency contact list should be prepared by the EPC contractor consisting of Manager's/ AM's contact details, Hospitals, Police, Ambulance services and other relevant contact details.

10.8.4 Emergency Response

582. An emergency response group (ERG) should be formed, lead by the Chief Engineer. The ERG would initiate and mobilize the incidence response team (IRT) in the event of an emergency. The following table shows the responsibility of each of the members of the emergency response group:

Table 10-12: Roles and responsibility of ERG

Role	Responsibility
Emergency Response Group Leader	• Responsible for managing and co-ordinating the overall response of the ERG to the emergency situation. Reports to the IMT Leader. • Responsible for mobilising the ERG and support personnel. • Responsible for informing and updating the IMT Leader. • Responsible for compliance with the actions and procedures laid down in this document for dealing with emergency situations. • Responsible for obtaining authority from the IMT Leader for the release of information to Government, key Stakeholders and Media.
Operations & Technical Co-ordinator	• Reports to the ERG Leader and responsible to him/her for providing operational and technical information. • Responsible for providing operational and technical advice, including production, drilling and subsurface, to the emergency site • Responsible for all communications with the IRT Leader at the emergency site. • Responsible for maintaining the information on the status boards.
Logistics and procurement Co-ordinator	• Reports to the ERG Leader and responsible for providing and managing logistics support. • Responsible for providing and co-ordinating air, marine and road transport requirements. • Responsible for establishing contracts for logistic support. • Provides access to contractor information on business or technology (non HR) issues. • Responsible for procuring and transporting equipment, supplies and service as required by the emergency site.
Environmental Health and Safety (EHS) co-ordinator	• Reports to the ERG Leader and responsible for providing risk, health, safety and environmental information. • Responsible for compliance with legislation and obtaining authority from ERG Leader to inform and liaise with National Government and Regulatory authorities. • Responsible for providing OHSE advice & support and information to the ERG and the IRT at the emergency site. • Responsible for co-ordinating office security. • Responsible for advising and maintaining the emergency responses in

Role	Responsibility
	line with the Company emergency response procedures.
Human Resources & Travel Services (HR) Co-ordinator	• Reports to the ERG Leader and responsible for providing information and managing all human resources matters pertaining to the emergency situation. • Responsible for arranging medical and hospital requirements including arranging meeting and transportation of casualties and medical cases to hospital. • Responsible for liaising with emergency site through the Operations & Technical Coordinator and arranging and co-ordinating evacuation. • Responsible for providing welfare support and advice to employees and their families. • Responsible for arranging temporary accommodation, transportation and assistance for personnel being evacuated from emergency site. • Responsible for co-ordinating with the Logistics Co-ordinator onward travel for personnel being evacuated. • Responsible for communication with and notifying the next of kin. • Responsible for providing information about all personnel at the emergency site to the IMT HR Co-ordinator. • Responsible for providing information to Contractor Companies about their personnel at the emergency site. • Responsible for co-ordinating the arrangements for the disposal of fatalities.
Public Affairs (PA) Co-ordinator	• Reports to the ERG Leader and responsible to him/her for gathering and preparing information and managing all communications with the Public and Media in line with Company policy. • Responsible for preparing the Media Holding Statement and obtaining authority from ERG Leader / IMT Leader for release. • Co-ordinates public affairs response. • Responsible for gathering information and preparing media statements to the National Media for the approval of the ERG Leader. Prepares Corporate and agrees the content of Country statements to the media. • Responsible for providing information to the Corporate PA Co-ordinator to prepare International Media releases. • Responsible for arranging and co-ordinating media conferences. May be instructed by ERG Leader to issue statements.
Reception	• Reports to the OHSE Co-ordinator and responsible for managing the reception of all personnel arriving and leaving the office.

Source: CEGIS, 2015

583. The various threats are classified into three tiers – tier 1, 2 and 3. Tier 1 having the minimum threat level and tier 3 having the maximum threat level. The following **Table 10-13** shows the emergency response towards various levels of threats and whom to escalate these threats:

Table 10-13: Emergency Response Escalation Protocol

Impact/ Consequence	Health & Safety	Natural Environment	Reputation Government Community Media	Financial $	Civil Unrest Hartals	Definition	Country Threat Level	Escalation →				Site specific IRT Members
Tier 1	Minor injury – First Aid treatment.	Negligible impact on fauna/flora, habitat, aquatic ecosystem or water resources. Incident reporting according to routine protocols.	Minimal impact to reputation.	Financial loss <$50,000	Situation generally stable with some protests / Hartals against government	Incidents that are containable by the Operations' Site Incident Response Team (IRT)	**Insignificant Low**	Operation Sites	Plant Manager	**IRT**	ERG Leader	Plant Manager other **IRT** members **ERG - as required**
Tier 2	Moderate injury- Medical Treatment , Lost Time injury	Impact on fauna, flora and/or habitat but no negative effects on ecosystem, may require immediate regulator notification.	Moderate to small impact on business reputation.	Financial loss >$50,000	Security unrest appears to escalate to regular outburst - but **authorities appear to be capable of maintaining control**	Incidents that require Dhaka based ERG, governmental and regulatory support	**Medium High**	**ERG**	ERG Leader	Chief Engineer NWPGCL **activates Dhaka ERG**	**Inform Member-Generation**	ERG Leader – Chief Engineer other ERG members **ERG - activated for EHS / Security issues**
Tier 3	Injury requiring ISOS activation. Permanent disabling injury and or long term off work and fatality.	Long term impact of regional significance on sensitive environmental features, likely to result in regulatory intervention/action	Significant impact on business reputation/ or international media exposure.	Financial loss greater than $100,000.	Confirmed direct threat to foreign business interest or against expatriates **Situation certain to escalate further beyond Government control**	Incidents when there are multiple injuries or fatalities requiring IMT support and also international support, regulatory and public relations assistance.	**High Extreme**	**IMT**	IMT Leader **activates IMT**	Director Technical	**Managing Director-NWPGCL** **IMT**	**IMT** other **IMT** members **IMT - activated**

10.8.5 Emergency Recovery

584. After the emergency situation had passed, the ERG would assess and categorize the damage and would provide for compensations for the injured; provide provisions for temporary services; reinstate normal environmental and working standards; initiating investigation process for the cause of disaster; evaluating response procedure and providing a recommendation to mitigate future emergencies.

10.8.6 Emergency Evacuation Plan

585. The EPC contractor will formulate a plan for evacuation in the event of an emergency. He/she will make a layout plan, showing all the possible emergency fire exits and the location of the evacuation zone. An emergency contact list should also be prepared by the EPC contractor consisting of Manager's/ AM's contact details, Hospitals, Police, Ambulance services and other relevant contact details

11 Environmental Monitoring Plan

11.1 Monitoring Plan

586. A three-tier monitoring program has been proposed comprising of compliance monitoring, impact monitoring, and external or independent monitoring, as one of the key elements of the EIA study. The main purpose of this monitoring program is to ensure that the various tasks those detailed out in the environmental management plan, particularly the mitigation measures which are to be implemented efficiently and effectively, and also to evaluate project's impacts on the key environment and social parameters. Various types of monitoring are presented in the following sections and the locations of monitoring are presented in Map 12.1.

11.1.1 Compliance Monitoring

Compliance monitoring is a very important tool/aspect of environmental management to safeguard the environment. The compliance monitoring plan is presented in **Table 11-1**. The monitoring will comprise surveillance to check whether the contractor is meeting the compliance provisions of the contract during construction and operation of the Project including the responsible agencies for implementation and supervision.

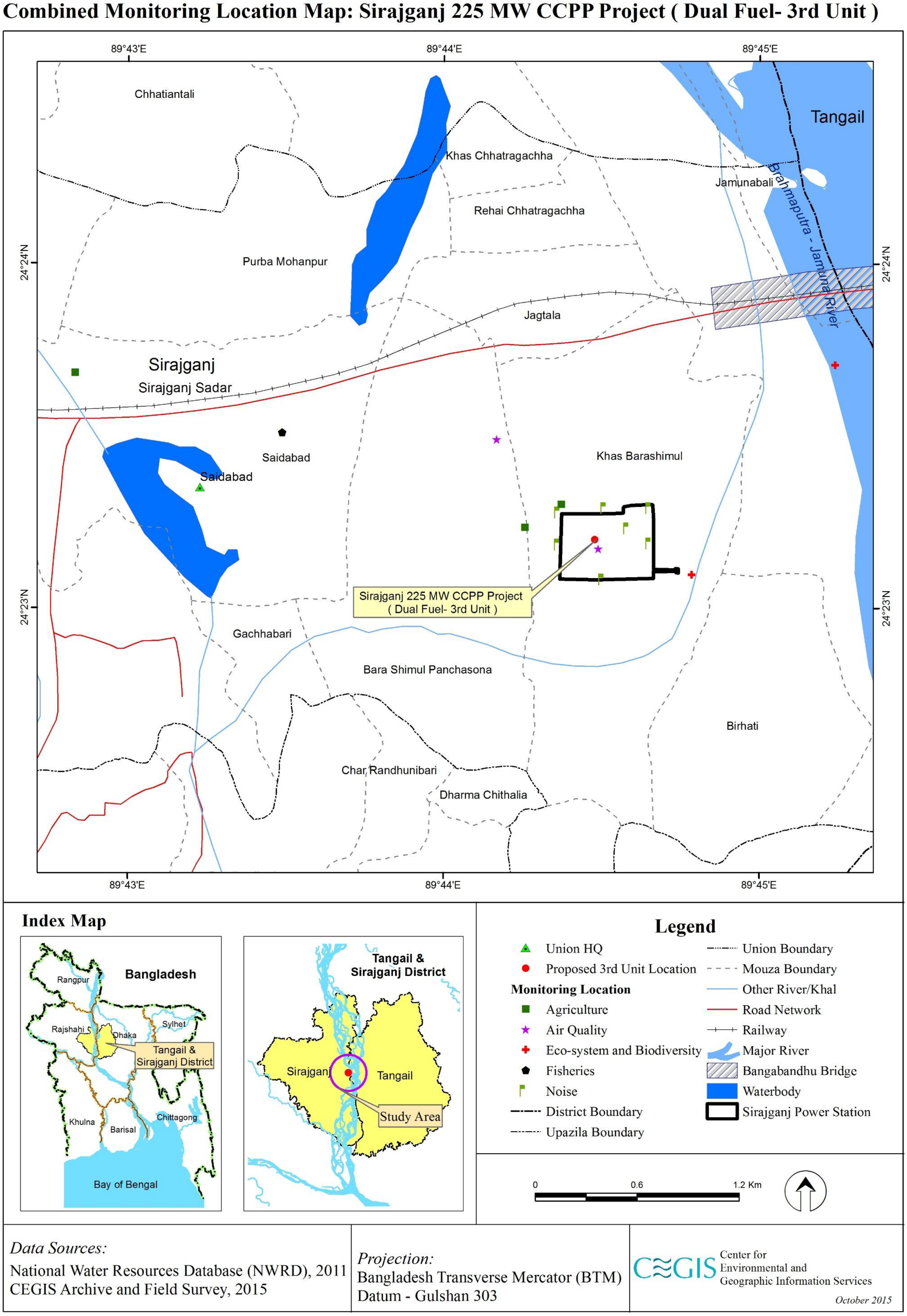
For monitoring of physico-chemical parameters, locations near the baseline sampling points are suggested. Actual monitoring time and location will be decided by the Owner's Engineer (OE) and NWPGCL. The Contractor will be responsible for carrying out, or contracting an approved third party for monitoring all the parameters as required with frequency is shown in the following table. This monitoring will be carried out by its own cost during the construction phase. The measurement values are to be compared with the IFC's General EHS Guidelines, where relevant standards are specified, or the national standards (Environmental Conservation Rules, 1997 and amended in 2005)..

11.1.2 Impacts Monitoring during Construction

587. The purpose of the impact monitoring is to ensure that the contractor implements the mitigation measures given in the EMP efficiently, effectively and timely. This monitoring will generally be carried out by the Owner's Engineer (OE) with the help of checklists prepared on the basis of the impact monitoring Plan (**Table 11-2**).

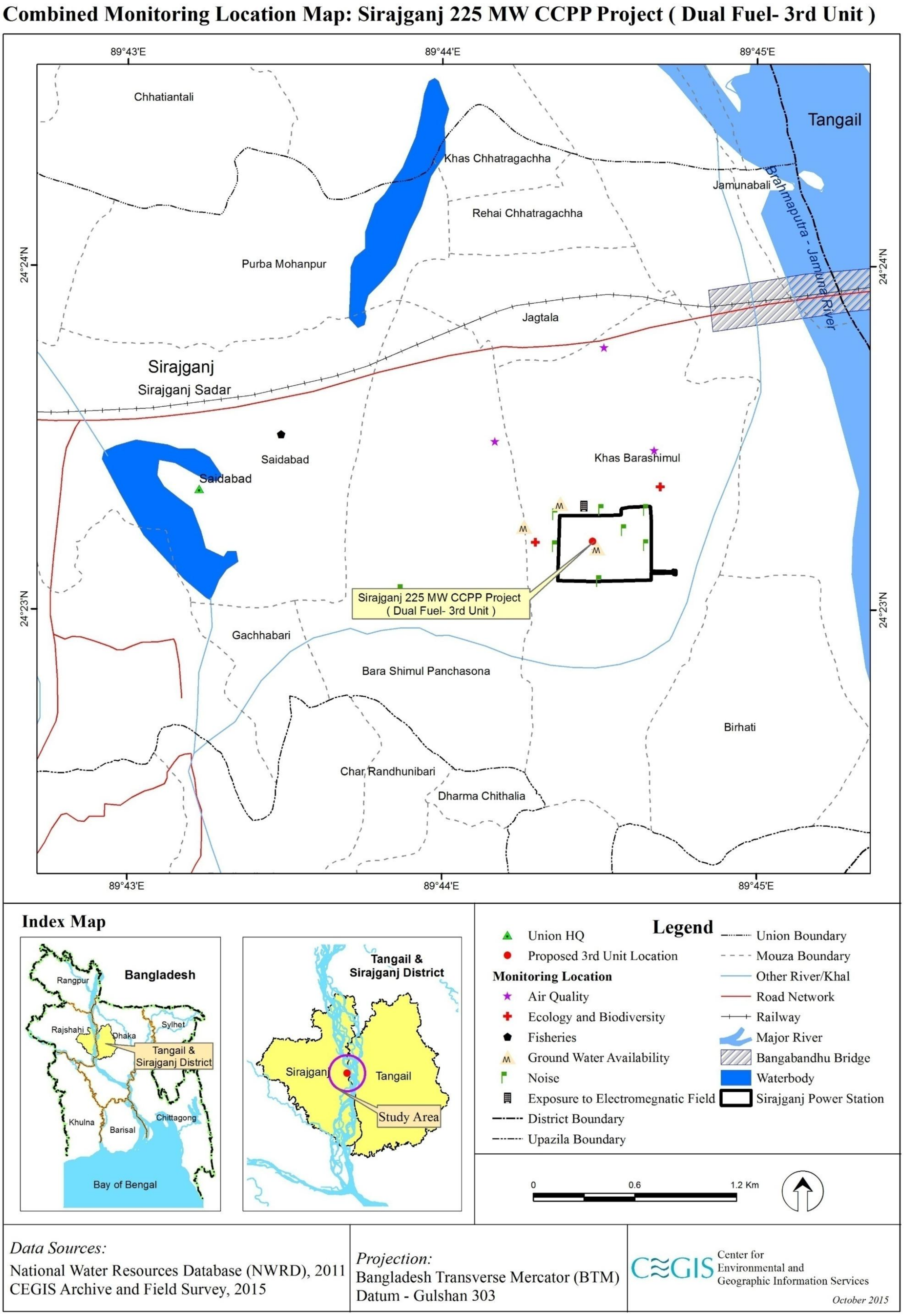
11.1.3 Independent/External Monitoring

588. The NWPGCL will engage an independent organization for monitoring the implementation of EMP. The main purpose of the Independent monitoring is to ensure that all key entities including EHSU, Owner's Engineer (OE), and contractors are effectively and adequately fulfilling their designated role for EMP implementation. All the EMP requirements are being implemented efficiently, effectively and timely. The ToR of the Independent monitor is presented in **Appendix-11**.



Map 11-1: Monitoring locations during pre-construction and construction phase

Some monitoring locations could not be shown in the map. Please check **Table 11-1 for detailed locations.*



*Some monitoring locations could not be shown in the map. Please check **Table 11-2** for detailed locations.*

Map 11-2: Monitoring location during operation phase

Table 11-1: Environmental Compliance Monitoring Plan

SL	Components of EHS Monitoring	Monitoring Indicators	Locations	Frequency	Type/Duration of Sampling	Implemented By	
						Monitoring	Supervision
1.	**Environmental Monitoring during Pre-construction and Construction Phase**						
1.1.	Ambient Air Quality	SPM, PM_{10}, $PM_{2.5}$	• Near Rehabilitation Village • Plant site	Continuous during civil construction		EPC Contractor	OE, NWPGCL
1.2.	Ambient Noise	Day time (6:00 – 21:00) and Night time (21:00 – 6:00) L10, L90	• outdoor Noise: ➢ In front of existing administrative building ➢ Main gate ➢ 6 points along the boundary wall as mentioned in the monitoring location **Map 12-1** (NW and NE corner of the boundary wall and one point between two corners of each side of the boundary wall) ➢ Baro-Shimul Primary School • Indoor Noise: ➢ Administrative building ➢ Control Tower ➢ Health care unit ➢ Residential buildings	Daily during construction work in progress	Three Samples during day time and one sample during night, for noise, 15 min sampling each time. by using: ANSI Type II Noise Meter	EPC Contractor	OE, NWPGCL
1.3.	Ecosystem and Biodiversity	Plant Growth, Canopy Coverage, Disease, etc.	Green belt area within the project site	Six-monthly	Plot Survey	EPC Contractor	OE, NWPGCL
		Species composition and population of planktons and Benthos	Two sites (one nearby the jetty) and one within 1km reach of Jamuna River	Six-monthly	Plankton and Benthos Survey		
1.4.	Fish Diversity	Culture Fisheries	Fish pond in the rehabilitation	Six monthly	Pond water	EPC	OE, NWPGCL

SL	Components of EHS Monitoring	Monitoring Indicators	Locations	Frequency	Type/Duration of Sampling	Implemented By	
						Monitoring	Supervision
	and Composition	*Pond water availability period,* Productivity	Center, beside the Bridge-Hatikumrul Road. About 1.5 km away from the Project site		availability period (PWAP) and productivity	Contractor	
1.5.	Agricultural Production	Crop Production Loss	Three locations: these are Khas Baroshimul, Panchosona and Saydabad	Six monthly following cropping patterns	Agricultural Survey	EPC Contractor	OE, NWPGCL
1.6.	Occupational Noise	LAeq	Two locations: Construction site, Labor shed	Daily during construction work in progress	Same as sl. no. 1.2	EPC Contractor	OE, NWPGCL
1.7.	Health and Sanitation	Availability of Potable Water, Drinking water quality, Availability of Hygienic Toilet	Power Plant Complex	Six-Monthly	Inspection and interview of labor, project personnel	EPC Contractor	OE, NWPGCL
1.8.	Workers Health, Safety and Security	Implementation of ECP 18	As specified in the ECP	Quarterly	Inspection and interview of labor, Project personnel followed by a checklist	EPC Contractor	OE, NWPGCL

Table 11-2: Environmental Monitoring Plan during Operation

<table>
<tr><th rowspan="2">SL No</th><th rowspan="2">Components of EHS Monitoring</th><th rowspan="2">Monitoring Indicators</th><th rowspan="2">Locations</th><th rowspan="2">Frequency</th><th rowspan="2">Type/Duration of Sampling</th><th colspan="2">Implemented by</th></tr>
<tr><th>Monitoring</th><th>Supervision</th></tr>
<tr><td></td><td colspan="7">Environmental Monitoring During Operation</td></tr>
<tr><td></td><td colspan="7">Physical Environment</td></tr>
<tr><td></td><td>Stack Emission</td><td>NOx, PM_{10}, $PM_{2.5}$ (Sox in case of HSD firing)</td><td>Stack</td><td>Continuous</td><td>Continuous</td><td>EHSU /SPS</td><td>Independent Monitor/ NWPGCL</td></tr>
<tr><td rowspan="2"></td><td rowspan="2">Ambient Air Quality</td><td rowspan="2">NOx, SOx, SPM, PM_{10}, $PM_{2.5}$, CO, O_3</td><td>• Within the boundary of SPS</td><td rowspan="2">Quarterly</td><td>24 hour</td><td>EHSU/ SPS</td><td>Independent Monitor/ NWPGCL</td></tr>
<tr><td>• Near Rehabilitation Village
• Plant site
• Near Eco-park
• Bara-Shimul village</td><td>24 hour</td><td>EHSU/ SPS</td><td>Independent Monitor/ NWPGCL</td></tr>
<tr><td></td><td>Ambient Noise</td><td>Day time (6:00 – 21:00) and Night time (21:00 – 6:00) LAeq, L10, L90</td><td>• outdoor Noise:
➢ In front of Administrative Building
➢ Main gate
➢ Eight points surrounding the boundary wall (four corner points, one point between two corners at each side)
➢ Baro-shimul Primary School
• Indoor Noise:
➢ Administrative building
➢ Health care unit
➢ Residential buildings</td><td>Monthly</td><td>Three Sample during day time and one sample during night, 15 min sampling each time.</td><td>EHSU/ SPS</td><td>Independent Monitor/ NWPGCL</td></tr>
</table>

SL No	Components of EHS Monitoring	Monitoring Indicators	Locations	Frequency	Type/Duration of Sampling	Implemented by	
						Monitoring	Supervision
	Leak detection	Along corridors to locate secondary indicators and walking the corridor with a “sniffer”	RMS and pipeline corridor	Every shift of every day	Visual Observation for stressed vegetation and with a “sniffer”	EHSU	Independent Monitor/ NWPGCL, PGCL
	Meteorology	Temperature, Rainfall, Humidity, wind speed, wind direction	Plant Area	Continuous	Continuous	EHSU	Independent Monitor/ NWPGCL
	Effluent (Waste Water)	pH, EC	Effluent Discharge Channel	Continuous	Continuous	EHSU	Independent Monitor/ NWPGCL
		Oil and grease, Total Residual Cl, TSS, TDS, COD, BOD	Effluent Discharge Channel	Monthly	Grab Sampling	EHSU	Independent Monitor/ NWPGCL
	Storm Water	As above	Combined Discharge Channel	Thrice during monsoon season	Grab Sampling	EHSU	Independent Monitor/ NWPGCL
	Water Quality: Surface Water	pH, TSS, TDS, Oil and Grease, Total Residual Cl, Total Cr, Fe, Ca, Zn, Pb, Cd, Hg, As, total alkalinity, Ammonium Nitrogen, Free Ammonia, BOD_5, COD, EC , Temperature outside the mixing zone, etc.	Around 50 m at downstream of the discharge point (near plant site jetty)	Once during dry season and once during monsoon	Grab Sampling	EHSU	Independent Monitor/ NWPGCL
	Water Quality: Ground Water	pH, Total Hardness, Cl, F, Fe, Mn, As, PO_4,	• Groundwater tank/pump at plant site	Once during dry season, once during	Grab Sampling	EHSU	Independent Monitor/ NWPGCL

SL No	Components of EHS Monitoring	Monitoring Indicators	Locations	Frequency	Type/Duration of Sampling	Implemented by	
						Monitoring	Supervision
		SO_4, etc.		monsoon season			
	Ground Water Availability	Ground Water Level	Checking of observation well of BADC and DPHE	Once during winter and once during summer		EHSU	Independent Monitor/ NWPGCL
		Ground water scarcity	• Plant site • Panchasona Village • Bara-shimul Village	Yearly	Interview of local people, irrigation pump operators, women involved in collecting water from hand pump tube well (this section might also be covered during yearly stakeholder consultation; however, the participation of the mentioned stakeholders have to be ensured)	EHSU	Independent Monitor/ NWPGCL
	Waste Generation and Management						
	Generation of Non Hazardous Solid Waste (Domestic waste, Office Waste,)	Collection system, Proper disposal, waste sprawling	Designated Site	15 days	Visual Inspection, waste classification	IM	SPS/ NWPGCL
	Generation of Hazardous Solid Waste	Types and Quantity, Materials screening, Associated hazards, disposing method	Waste Disposal Point, Waste Generation Sources	Quarterly	Visual Inspection, waste classification	IM	SPS/NWPGCL
	Generation of Hazardous Liquid Waste, Sludge (return from Water Treatment Plant, Sludge	Types, quantity, materials screening	Output of ETP	Quarterly	Visual Inspection, waste classification	IM	SPS/NWPGCL

SL No	Components of EHS Monitoring	Monitoring Indicators	Locations	Frequency	Type/Duration of Sampling	Implemented by	
						Monitoring	Supervision
	from clarifier, neutralization pond)						
	Ecosystem and Biodiversity						
	Plant Health	Plant Growth, Canopy Coverage, Disease, etc.	1. Greenbelt area in plant Complex 2. Homestead at Boro Shimul village (West side from the plant) 3. Extended part of Eco-park within influence zone	Yearly	4 plots (25m x 25m) at four corners inside plant complex Selected 2 homesteads platform in Borshimul Village Two plots (25m X 25m) near Forest Office and one plot at northern boundary of the Eco-park	IM	SPS/ NWPGCL
	Disturbance to Wildlife	Wildlife behavior to noise		Yearly Stakeholder Consultation	4 plots at four corners inside plant complex Selected 2 homesteads platform in Borshimul and Khash Borshimul Villages Two plots near Forest Office and one plot at northern boundary of the Ecopark	IM	SPS/ NWPGCL
	Fish Diversity and Composition	Capture Fisheries: Diversity Index, Richness, Composition, Habitat Suitability Index, hatchling availability, etc.		Yearly Stakeholder Consultation	Fish Catch Assessment, 'Savar' Fishing Survey and Fishers' interview	IM	SPS/ NWPGCL
		Culture Fisheries *Pond water availability period,* Productivity	Fish pond in the rehabilitation Center, beside the Bridge-Hatikumrul Road. About	Six Monthly	PWAP and Productivity	IM	SPS/ NWPGCL

SL No	Components of EHS Monitoring	Monitoring Indicators	Locations	Frequency	Type/Duration of Sampling	Implemented by	
						Monitoring	Supervision
			1.5 km away from the Project site				
	Land and Agricultural Resources						
	Land use and Land Cover change	Land cover and Land use	5km radius area of the Plant	Once in three years	Stakeholder Consultation	IM	SPS/ NWPGCL
	Agricultural Production	Crop Production Loss	Agricultural land around the SPS complex	Yearly	Farmers' Interview, Secondary Data from DAE	IM	SPS/ NWPGCL
	Occupational Health and Safety						
	Occupational Noise	LAeq, noise exposure	• Inside Plant Area (Turbine hall, RMS, etc.) • Control room • Administrative building, residential buildings, health unit	Quarterly	Three Samples during daytime and one sample during night, for noise 15 min sampling each time. by using: ANSI Type II Noise Meter Inspection of record of shifting hour, workers' roster	IM/SPS	SPS/ NWPGCL
	Exposure to Electro-magnetic Field	Electrical Field, Magnetic Field	Outside the safety fence of Substation, Power evacuation bay, other EHV area	Quarterly	Measurement by EMF Meter Inspection of workers' roster shifting hours etc.	IM/SPS	SPS/ NWPGCL
	Worker Health	General Health Condition, Hearing health, skin disease, etc.	Workers involved in the Plant operation and maintenance	Quarterly	Health Check up	SPS	SPS/ NWPGCL
	Labor and Working Condition						
	Health and Sanitation	Availability of Potable Water	Power Plant Complex	Six Monthly	Visual Inspection and Record Checking	IM	SPS/ NWPGCL
		Drinking water quality (pH, TS, EC, F, Cl, As, Mn, Fe, Total Hardness, Total Coliform, PO4,	Water Supply System	Monthly	Three samples from Drinking water supply system	IM	SPS/NWPGCL

SL No	Components of EHS Monitoring	Monitoring Indicators	Locations	Frequency	Type/Duration of Sampling	Implemented by	
						Monitoring	Supervision
		SO4)					
		Availability of Hygienic Toilet	Office Building, Township Area, Common Places, etc.	Monthly	Visual Inspection	IM	SPS/ NWPGCL
	Community Health, Safety and Security						
	Community Health	Status of Communicable Diseases	Plant area, Residential area	Yearly	Inspection of Disease Profile/Records in Health unit, nearby Hospital	IM	SPS/ NWPGCL
		Status of Vector Borne Diseases					
	Safety and Security	Emergency Preparedness and Response of SPS	N/A		Visual Inspection and Record Checking	IM	SPS/ NWPGCL
		Community Relation Program/ Community Awareness Program, Training	N/A		Visual Inspection and Record Checking	IM	SPS/ NWPGCL
	Measures beyond compliance						
	Social Development Program	Number of benefited person/family	N/A	Yearly	Stakeholder Consultation	IM	SPS/ NWPGCL
	Treated waste water based irrigation network	Number of additional hectare of farmland	N/A	Yearly	Stakeholder Consultation	IM	SPS/ NWPGCL/ BADC
	HealthCare/Development Program	Number of benefited person/family	N/A	Yearly	Stakeholder Consultation	IM	SPS/ NWPGCL
	Other Aid to Community	Number of benefited person/family	N/A	Yearly	Stakeholder Consultation	IM	SPS/ NWPGCL

Note:

These monitoring parameters will be revised after monitoring the effluent water quality from the discharge channel. Some parameters might become redundant if the effluent water does not contain in the effluents.

Table 11-3: Impact Monitoring Plan

Parameter / Activity	Location	Means of Monitoring	Frequency	Responsible Agency	
				Implemented By	Supervised By
During Construction					
Hydrocarbon and chemical storage	Construction area	Visual Inspection of storage facilities	Monthly	EPC Contractor	OE/ Independent Monitor
Damage to local roads	Approach Roads to the construction sites	Visual inspection to ensure local roads are not damaged	Monthly	EPC Contractor	OE/ Independent Monitor
Traffic Safety	SPS approach Roads	Visual inspection to see whether proper traffic signs are placed and flag-men for traffic management are engaged	Monthly	EPC Contractor	OE/ Independent Monitor
Air Quality (dust, - smoke)	Construction sites	Visual inspection to ensure good standard equipment is in use and dust suppression measures (e.g., spraying of waters) are in place.	Daily	EPC Contractor	OE/ Independent Monitor
	Batch mixing Plant	Visual inspection to ensure batch plant is located >500 m from residential areas	Monthly	EPC Contractor	OE/ Independent Monitor
	Material storage sites	Visual inspection to ensure proper maintenance *i.e.* covering, dust suppression etc. as per ECP	Monthly	EPC Contractor	OE/ Independent Monitor
Noise	Construction sites	Physical inspection to ensure good standard equipment are in use	Weekly	EPC Contractor	OE/ Independent Monitor
	Construction sites	Visual inspection to ensure ear plugs/earmuffs are in use by the construction workers	Daily	EPC Contractor	OE/ Independent Monitor

Parameter / Activity	Location	Means of Monitoring	Frequency	Responsible Agency	
				Implemented By	Supervised By
		Ensure work restriction between 20:00-06:00	Daily	EPC Contractor	OE/ Independent Monitor
Plantation	Designated sites	Visual inspection to observe growth of saplings as per provided green belt design(subjected to the initiation of plantation)	Monthly	EPC Contractor	OE/ Independent Monitor
Waste Management	Construction area	Visual inspection that solid waste is disposed at designated site and are managed in efficient way	Weekly	EPC Contractor	OE/ Independent Monitor
Hazardous Waste Handling	Hazardous Material Storage Area Hazardous Waste Disposal Area	Visual Inspection of safe handling and storage of hazardous waste and hazardous materials	Fort-nightly	EPC Contractor	OE/ Independent Monitor
Drinking water and sanitation	Labor shed, offices	Ensure the construction workers are provided with potable water and sanitation facilities in the site	Fort-nightly	EPC Contractor	OE/ Independent Monitor
Restoration of Work Sites	All Work Sites	Visual Inspection	After completion of all works	EPC Contractor	OE/ Independent Monitor
Safety of workers Monitoring and reporting accidents	At work sites	Visual inspection of usage of Personal Protective equipment, Safety Sign, Safety Documentation, safety training, etc.	Daily	EPC Contractor	OE/ Independent Monitor
Emergency Response Facilities	At project sites	Inspection of Emergency Preparedness and Response mechanism and facilities	Monthly	EPC Contractor	OE/ Independent Monitor
Grievance Mechanism	At project site	Inspection of the complain register	Monthly	EPC Contractor	OE/ Independent Monitor

Parameter / Activity	Location	Means of Monitoring	Frequency	Responsible Agency	
				Implemented By	Supervised By
During Operation and Maintenance					
Monitoring of Environmental Quality (Ambient Air, Noise, Water, effluent, Soil, etc.)	As specified in **Table11-1** and **11-2**	Inspection and Record checking of Monitoring activities carried out by EHSU circle of SPS	Quarterly	Independent Monitor	NWPGCL
Environmental Laboratory	SPS Complex	Inspection of laboratory Condition, accreditation and certification (from GoB) status	Six-monthly	PIU	Independent Monitor, NWPGCL
Meteorological Condition	SPS	Checking and compiling climatic data collected and recorded by micro weather station installed in SPS	Quarterly	Independent Monitor	NWPGCL
Ambient Noise Level	Residential area, Administrative area and nearby community	Noise nuisance/ disturbance perceived by power plant personnel and nearby community to be surveyed by interview and FGD	Yearly during stakeholder consultation	Independent Monitor	NWPGCL
Fisheries	Effluent discharge points on the canal around the SPS	Interviewing local fishermen	Yearly during stakeholder consultation	Independent Monitor	NWPGCL
Plant Health	Green belt area and influence zone	Visual inspection	Yearly	Independent Monitor	NWPGCL
Land use and land cover	5km radius area of the plant	Stakeholder consultation	Yearly	Independent Monitor	NWPGCL
Hazardous Waste and Hazardous Material Handling	Hazardous Material Storage Area and Use Area Hazardous Waste Disposal Area	Visual Inspection of safe handling and storage hazardous waste and hazardous materials	Quarterly	EHSU Circle	Independent Monitor, NWPGCL
Grievance Mechanism	At project site	Inspection of the complaint register/grievance form and	Six-monthly	EHSU Circle	Independent Monitor, NWPGCL

Parameter / Activity	Location	Means of Monitoring	Frequency	Responsible Agency	
				Implemented By	Supervised By
		interviewing local people			
Emergency Response Plan	Project site	Inspection of Emergency Preparedness and Response mechanism	Quarterly	EHSU Circle	Independent Monitor, NWPGCL
Health and Safety Preparedness	SPS Complex	Inspection of training list, safety meetings records, means of awareness growing	Quarterly	EHSU Circle	Independent Monitor, NWPGCL
Community Relation	SPS Complex, Nearby Community	Inspection of community relation maintaining procedures, relation building activities, FGD with community	Quarterly	EHSU Circle	Independent Monitor, NWPGCL
CSR Program (if any)		Inspection of record completed and planned CSR programs and activities	Six-monthly	Independent Monitor	NWPGCL

11.2 Implementation of Environmental Monitoring Plan

11.2.1 Responsible Agency

589. The Chief Engineer, Sirajganj Power Station (SPS) is the responsible authority for administering and implementing the Project and the Project Director of third Unit will implement environmental monitoring program during construction and the Plant Manager (Superintending Engineer) of third Unit will implement monitoring plan during operation stage. During construction stage, the Environmental Compliance Monitoring will be conducted by the Contractor(s) supervised by the Owner's Engineer (OE) and Environmental Impact Monitoring will be carried out by the Owner's Engineer (OE) with the support of the Contractor(s). In addition, an independent Monitor will also be retained by PIU during three years of construction and by SPS during three years of post-construction (operation stage). The EHSU Circle of SPS will implement the monitoring program during operation stage. The Terms of References of Independent Monitoring is attached in **Appendix-11**.

11.3 Action during Emergent Operation

590. The Plant can have an Emergent operation if there is a major failure of control system, plant component, grid failure, etc. Normally the modern distributed control system (DCS) is good enough to handle all such emergencies. Otherwise, the plant operator/shift in-charge can change the plant control to manual mode and adjust the process variables and

finally change the plant back to auto mode. The proposed project will have DCS control system with modern sensors and a proper interface with the existing old sensors/system.

591. The plant will be operated ensuring all pollution control devices are in order. In case of any event of malfunction of a pollution control device, immediate action of resolving the problem will be taken. If any emergent situation arises during operation, the shift in-charge will be immediately notified to take corrective measures and action.

11.4 Performance Indicators

592. For evaluating the performance of the environmental management and monitoring plan, performance indicators are identified to, for efficient and timely implementation of measures/actions proposed in EMP. The indicators are defined both for construction and operation phases. OE will be responsible for compiling the information on these indicators and report to NWPGCL.

593. Separate performance indicators for each environmental issue have been specified in **Table 11-1, 11-2** and **Table 11-3**. To measure the overall environmental performance of the project, an additional list of performance indicators is provided below:

- Number of inspections carried out by OE per month
- Number of non-compliances observed by OE or EHSU.
- Continuous period of non-compliance
- Number of grievances received.
- Number of grievances resolved.
- Number of construction and occupational related accidents.
- Timely reporting of documents (as defined in EMP and monitoring plan)
- Availability of environmental and H&S specialists in EHSU.
- Availability of environmental and H&S specialists in OE.
- Availability of environmental specialists and H&S with contractors.
- Number of trainings imparted to stakeholders/other capacity building initiatives

11.5 Reporting and Feedback Mechanism

594. The monitoring activities will require proper documentation. In case of Independent monitor, the monitoring results and relevant document should be properly reported to the project implementation authority. The project authority would submit the report to the Department of Environment and to the Financer.

595. During construction stage, the environmental specialist of OE will be engaged in monthly discussion meeting with the project implementation unit and the Contractor(s) for giving necessary feedback. The project implementation unit may arrange a discussion meeting quarterly with the financer regarding environmental compliance.

596. During the operation phase, the EHSU Circle will carry out the monitoring activities and keep all the records and results of monitoring with proper documentation and will produce quarterly reports on Environmental Monitoring. Besides, the third party Independent

Monitor would prepare and submit environmental compliance monitoring report annually to the power plant authority. All the reports should be submitted to DoE which is a condition of renewing the Environmental Clearance Certificate from DoE and to the financer for post-completion monitoring and evaluation of the Project.

597. During operation, the EHSU Circle will give necessary feedback instantly to the person in concern. The EHSU Circle will arrange a monthly meeting to disclose the results of environmental monitoring to the personnel.

11.6 Budgets for Monitoring

598. Summary costs of monitoring including investments costs are presented in **Table 11-4, Table 11-5**, and **Table 11-6**.

Table 11-4: Environmental Compliance Monitoring Cost

Sl. No.	Activities	Estimated Cost (USD)/Year
During pre-construction and Construction (borne by EPC Contractor)		
1	Environmental quality (air, water, noise, soil) monitoring	25,000.00
2	Occupational health, safety, and sanitation	2,500.00
3	Ecosystem, Biodiversity, Fisheries Resources and Agricultural Resources Monitoring	2,000.00
	Subtotal=	***29,500.00***
During 3 years of operation (to be included in O/M cost)		
1	Environmental quality (air, water, effluent, noise, soil) monitoring	30,000.00
2	Waste Generation and Management	4,500.00
3	Ecosystem, Biodiversity, Agriculture and Fisheries	2,500.00
4	Occupational Health, Safety and Security	3,000.00
5	Community Health Safety and Security	1,000.00
6	Monitoring beyond compliance	2,000.00
	Subtotal=	***43,000.00***
	Total Monitoring=	**72,500.00**

Table 11-5: Investment Cost of Environmental Monitoring

Sl. No.	Activities	Estimated Cost (USD)
1	Continuous Stack Emission Monitoring System	30,000.00
2	Continuous Ambient Air Quality Monitoring Stations	20,000.00
5	Environmental Laboratory	200,000.00
7	ANSI Type II Occupation Noise Monitoring Instrument (capable of recording 8 hour noise data and measuring Leq, L90, etc), 2 sets	5,000.00
	Estimated Total Cost	**255,000.00**

Note: Cost would vary as per the quotation of the EPC contractor

Table 11-6: Cost of Independent Monitor

Sl no	Activities	Estimated Cost (USD)
1	Independent Monitor for a six (6) years period including 3 years of operation (only fees and cost)	**150,000.00**

12 Indirect Project Benefits and Measures Proposed Beyond Compliance

12.1 Preamble

599. The third Unit CCPP Project is designed as environmentally sound in comparison to the existing first Unit which is under operation as described in Chapter 4. Even then, the Project might have sensitivity to environment and thus measures to go beyond regulatory requirements are introduced in the EIA and EMP. Aspects such as corporate social responsibility, extending support to use of treated effluent or waste water from different components for irrigation, and measures such as, green belting around the SPS and neutralization pond are therefore proposed.

12.2 Measures under corporate social responsibility

600. Corporate Social Responsibility (CSR) has become an important part of corporate obligations reflecting non-financial aspects of an organization’s performance like NWPGCL. These non-financial aspects have significant implications for a company’s internal and external stakeholders, including nearby communities, civil society organizations, regulators, international financial organizations, and news media. Local people have the concern about corporate accountability and the impact of corporate strategies and operations on the physical, economic, and socio-political environments. Financial analysts often view adverse public opinion on corporate social performance as a measure of long-term reputational risk to a company’s market value. Thus, CSR have become a competitive tool in promoting an organization’s practices and values when compared with those of its peers and competitors. CSR activities for the proponent to construct new gas based third Unit CCPP of Sirajganj Power Station are therefore proposed as follows:

- The health facility presently available in the SPS is not adequately supportive to the present human resources for the operation of the first Unit. It needs to expand its extent considering the human resources for second and third Units. This facility can also be available for the poor people around the SPS.Appropriate security measures may be taken;
- Providing sanitation facilities, such as setting up of public toilets at different hot spots around the Project site particularly along the Bangabandhu Bridge-Hatikumrul road and in the Eco Park at Saidabad Union area following the guidelines for public toilet [13] and with the coordination of Saidabad Union Administration. Management of those toilets may be based on lease system, so that it remains usable over a long period to a large number ofpeople;
- Training of local youth so that they can, in turn, be employed during project construction and SPS operation. Bangladesh is one of the major manpower supplying countries of the world. But it supplies non-skilled to semi-skilled manpower particularly in the Middle East and South East Asian countries and earns low foreign currency compared to the countries which provide skilled manpower. There is a huge demand of power related technicians. So, there is a

[13] WaterAid Bangladesh, 2006. Step by Step Implementation Guidelines for Public Toilet

scope of developing manpower in power sector in technician category and as such they can earn more foreign currency. In this connection, this Project can facilitate capacity development of the local youths through relevant training programs using knowledge hub of the Sirajganj Power Station.

- Develop socio-cultural facilities such as mosques, playgrounds and community centers for the community.

Table 12-1: Estimated budget for CSR

Sl	Items	Quantity	Amount (US$)
1	Public toilets	3	10,500
2	Training of local youths	200	15,000
3	Socio-cultural facilities	3	30,000

12.3 Use of treated waste water discharge for irrigation – extending support for Project life

601. The cooling technology of the existing first unit and the upcoming three units including the third unit of the Sirajganj Power Station is the close-circuit cooling. The individual daily requirement of water is not much but altogether is good quantity (about 2,550 m^3/hr) and is to be met as make up water from the ground water. A portion of makeup water is being generated as waste water which is contaminated and needs treatment. After treating in the central effluent treatment plant (CETP), this water can be reused in the gardening of the Plant as well as in the nearby crop fields for irrigation through canal. As a result, at least a small number of farmers around the Project site will be benefitted out of this with low cost water. It will also reduce pressure on the ground water. During the public consultation local farmers expressed their deep concern about the future unavailability ground water for irrigation and requested to supply of water for irrigation with some sorts of management. Taking the opportunity of the availability and considering the usefulness of cooling water discharge, the Bangladesh Agricultural Development Corporation (BADC) facilitated development of canalized surface water irrigation to the farmlands around the Project site. To make the irrigation system more effective, the BADC and NWPGCL jointly can develop facilities for irrigation and drinking water.

602. The irrigation cost per hectare of land is about Taka 10,500.00 if the water is directly withdrawn from the ground water aquifer. But the use of treated waste and cooling water discharge in irrigation, cost will be reduced significantly.

12.4 Greenbelt Development

603. There will be about 14 small timber trees of different species, shrubs, and grasses require clearing for the project footprint, which requires compensation by 3-5 times per tree felt to comply with DoE requirements. In addition, wildlife habitat especially bird species will be affected. To compensate the trees and wildlife habitat loss, a plantation program under the project is considered in terms of green belt development beyond compliance within the project boundary. The greenbelt will minimize the ambient noise generated from the power plant. As well as help attenuate the dust. Indigenous tree species that are pollution resistant and with thick foliage will be selected for green belt development. **Table 12-2** presents the distribution and number of each species for the plantation program. It is proposed that saplings should be planted in rows around the SPS boundary (**Figure 12-1**). The saplings will be planted and maintained by SPS authority. **Table 12-3** presents the budget for greenbelt development program.

Table 12-2: Species distribution and numbers for greenbelt program

Scientific Name	Local Name	No. of sapling to be required
Albizia richardiana	Chambol	104
Artocarpus heterophyllus	Kanthal	42
Mangifera indica	Aam	75
Psidium guajava	Peyara	84
Mesua ferrea	Nageswar	54
Delonix regia	Krishnachura	19
Azadirachta indica	Neem	60
Terminalia arjuna	Arjun	59
Zizyphus sp	Kul Boroi	122
Swietenia mahagoni	Mahagoni	103
Grasses and flower plants		LS
Total (Except grasses and flower plants)		**722**

Source: CEGIS, 2015

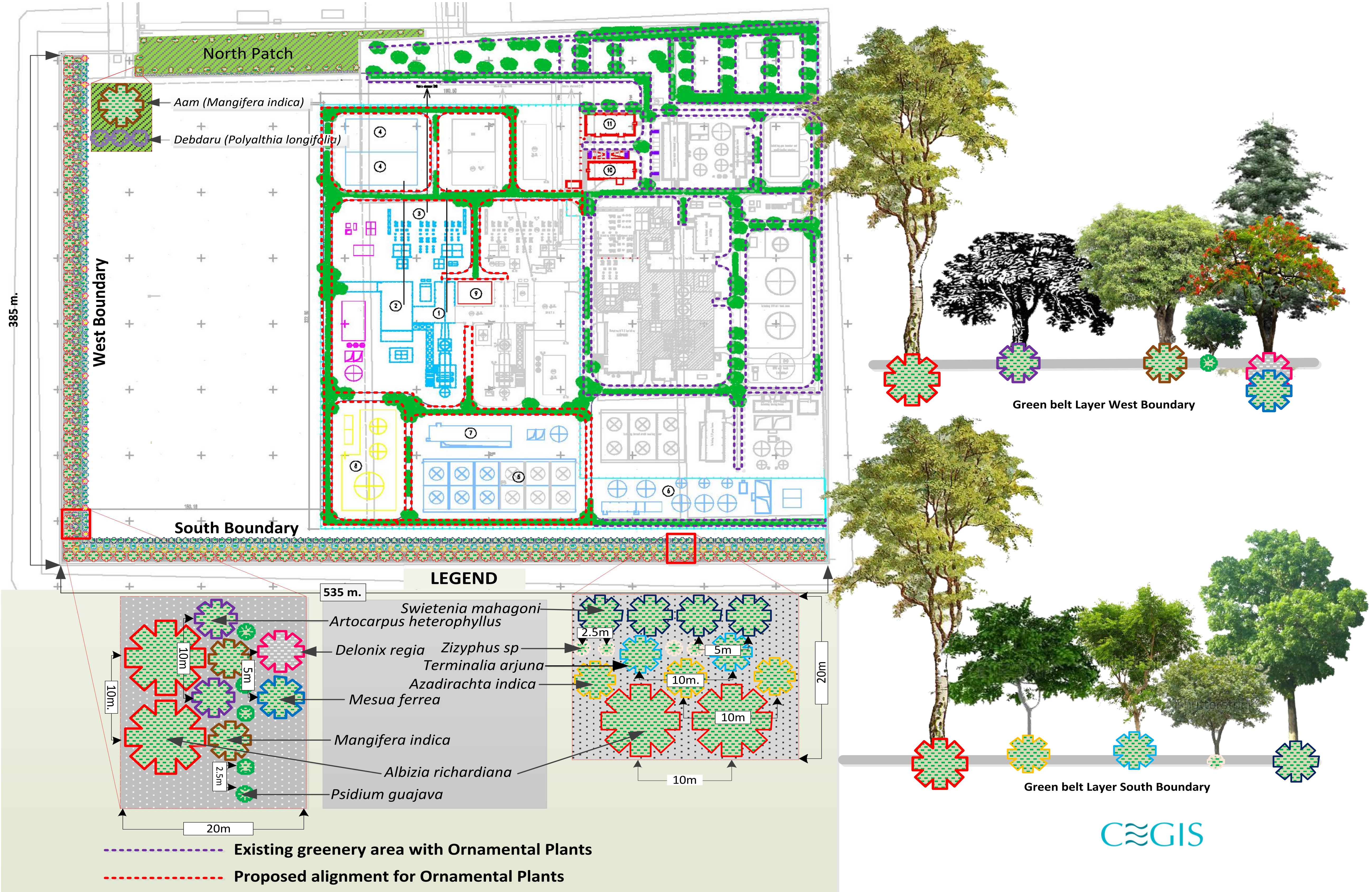


Figure 12-1: Schematic diagram showing plantation around the SPS boundary

Table 12-3: Budget for plantation program

Items	Amount (USD)
Saplings	3,900.00
Labor cost for planting	1,460.00
Others	1,000.00
Total	**6,360.00**

12.5 Closing

604. The third Unit CCPP Project is designed as environmentally sound Project and an environmental management plan has been devised to take care of the environmental issues. With the apprehension that the Project might still have sensitivity to the environment, measures discussed above are considered to enhance environmental and social conditions of the Project area. These measures are essentially beyond compliance requirements and can provide inspiration to other companies and corporations in Bangladesh to follow.

13 Stakeholder Consultation

13.1 Public Consultation

13.1.1 Introduction

605. The Government of Bangladesh (GoB) has given impetus on involving primary and secondary stakeholders for determining the environmental and social impacts associated with implementation of the project. In order to gather local knowledge for baseline conditions, understand perceptions of the community regarding impact significance, and propose meaningful mitigation measures, participation of stakeholders is an integral part of the EIA process. During EIA study, an attempt has been made to consult with a full range of stakeholders to obtain their views on project interventions.

606. Dissemination of the prospect of the project and objectives to the local level stakeholders including land owners, sharecroppers, leaseholders, landless people, local government representatives etc. was made during the EIA study of the project through public consultations.

607. The present EIA has been conducted after consulting local communities, non-governmental organizations (NGOs) and concerned government departments/organizations dealing particularly with related fields, thus ensuring that their views and concerns are taken into account in the study.

608. This chapter provides detail of the consultations held with the stakeholders at the project site and framework for consultations to be carried out during construction phase and included disclosure requirements for the EIA.

13.2 Regulatory Requirements

13.2.1 Bangladesh Guidelines

609. The EIA guidelines formulated by DoE in 1997 (Chapter 4, Section 4.11) stated that since the general public is the ultimate recipient of the economic benefit and environmental damages, an EIA study should involve the public as part of decision making process development. To achieve effective public participation, it is necessary to communicate with as many people as possible and as through as many different ways as possible. This requires pre-planning, resources, identification of target groups and several techniques for effective communication.

13.2.2 World Bank Group Requirements

Consultation

610. Each of the financers has own policy, guidelines and due diligence for disbursing loan to the borrower for the construction of industries or implementation of any other projects. The World Bank guidelines are stringent over the guidelines of other financers. For this reason, the EIA study follows the guidelines of the World Bank. The Bank recognizes and endorses the fundamental importance of transparency and accountability to the development process. Banks policy is to be open about its activities and to welcome and seek out opportunities to explain its work to the widest possible audience. According to 'Operation Policy, OP 4.01: Environmental Assessment' needs to be done for 'A' category Project. In a Project, the borrower should consult the project-affected groups and local Non

Governmental Organizations (NGOs) about the Project's environmental aspects and takes their views into account. Consultations should be conducted twice: (a) shortly after environmental screening and before the terms of reference for the EIA are finalized; and (b) once a draft report is prepared. In addition, the borrower should consult with such groups throughout Project implementation as necessary to address EIA related issues that affect them.

Disclosure

611. For a category 'A' project, the borrower should provide relevant information on Project information in a timely manner prior to consultation and in a form and language that are understandable and accessible to the groups being consulted. The borrower should provide a summary of the proposed Project objectives, description and potential impacts for the initial consultation. For consultation, after the draft EIA report is prepared, the borrower makes the draft EIA report available at a public place accessible to project-affected groups and local NGOs. The borrower also ensures that EIA reports for category 'A' Project are made available in a public place accessible to affected groups and local NGOs. Public availability of the EIA report for a category 'A' project in the borrowing country and official receipt by the Bank are prerequisites to Bank appraisal of these Projects.

Grievance Redress

612. The borrower will respond to the concerns of the Project affected communities in a timely manner. For this purpose, the borrower will adopt a grievance mechanism, process or procedure to receive and facilitate resolutions of stakeholders concerns and grievance regarding the borrowers' environmental and social performance. The grievance mechanism will be scaled to the risks and potential adverse impacts of the Project. Where possible, such grievance mechanism will utilize existing formal and informal grievance mechanisms suitable for project purpose, supplemented as needed with project specific arrangements.

613. The grievance mechanism, process or procedure is expected to address concerns promptly and effectively, in a transparent manner that is culturally appropriate and readily accessible to all segments of the Project affected communities, at no cost and without retribution. The borrower will inform the Project affected communities about the grievance process in the course of its community engagement activities, and will make publicly available a record documenting the responses to all grievances received; and

614. Handling of grievances will be done in a culturally appropriate manner and be discreet, objective, sensitive and responsive to the needs and concerns of the Project affected communities. Where there is threat of reprisal, the mechanism will also allow for anonymous complaints to be raised and addressed

13.3 Consultation Methodology

615. *Consultation Approach:* Participatory approach was followed for identifying the stakeholders for conducting consultations. The study team consulted the Project Proponent (NWPGCL) for understanding the Project brief and identifying the potential stakeholders. Therefore, the key stakeholders include occupational groups, such as farmers, loom owners/workers, fishermen, traders, elite persons, teachers, NGOs etc. whose activities are likely to be impacted due to the implementation of the proposed Project. Furthermore, local inhabitants, interested groups, and NWPGCL officials were considered as the potential stakeholders and were also consulted at this stage.

616. An expert of multidisciplinary team made a number of visits to the study area for conducting informal consultations with the predefined/on spot stakeholders. Furthermore, a

formal public consultation meeting was held at Manab Mukti Sangstha (MMS), an NGO which is situated nearby the proposed site in Soydabad union. It was done by informing the stakeholders through communicating formally by invitation letters with the help of the Local Government Institute (LGI). A common sheet, comprising of a set of questions, was prepared, covering all potential environmental and social issues of the Project and distributed to the participants. This common sheet was used in the meeting to unveil people's perception and opinion on the proposed Project along with their suggestions.

617. The team also informed the stakeholders about the activities and potential impacts that may surface during construction and eventual operation of the Plant. The team sought stakeholders' views on various aspects of the Project, and recorded all findings for analysis and finally incorporated in the report.The overall consultation approach is depicted in **Figure 13-1**.

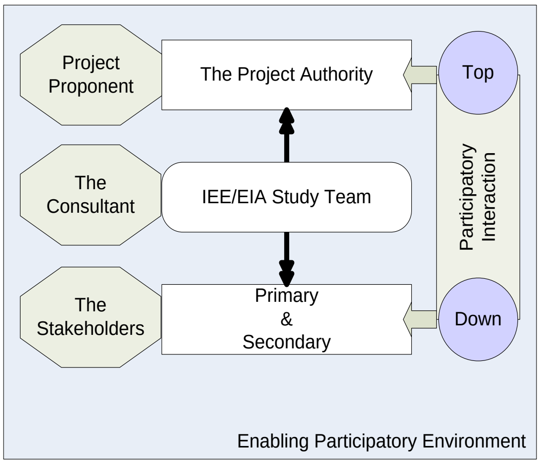


Figure 13-1: Overall consultation approach

618. *Stakeholder identification:* Stakeholders include all those who affect and are being affected by policies, decisions or actions within a particular system. Stakeholders can be groups of people, organizations, institutions and sometimes even individuals. Stakeholders can be divided into primary and secondary stakeholder categories.

619. Primary stakeholders are people who would be directly benefited or impacted by the proposed Project. In this context, people who have/had land within the project boundary were considered as the primary stakeholders.

620. Secondary stakeholders pertain to those who may not be directly affected but have interests that could contribute to the study, play a role in implementation at some stage, or affect decision making on Project aspects. In this project NGOs, concerned government departments, and line agencies fall under this category.

621. Secondary stakeholders for the Project include local government institutions (LGIs), North West Power Generation Company Limited, Department of Forest, other government agencies, academicians, NGOs, and general public. Information and views on the construction of the proposed Project from the relevant line agencies of the concerned Upazila were taken through official visits and this has been treated as Expert/Institutional Consultation.

13.4 Details of Consultation Meetings

622. The details of consultation meetings are presented below:

Informal consultation

623. A number of occupational groups and other relevant stakeholders were consulted informally. These consultations were made on spot when the team was visited in the project area. This was done to create awareness and clear any misunderstanding about the Project and eventually obtain support from the local communities to conduct baseline environmental, ecological, fisheries, and socio-economic surveys. No informal questionnaire was used rather peoples were consulted by the individual team member in terms of sectors (i.e. agriculture, fishery, socio-economic, etc.) to which he/she was assigned.

Expert/Institution Consultation

624. Experts were consulted through individual and group meetings, during early stage of the study, selected individuals and organizations with professional knowledge of EIA processes. The meeting was conducted at a very early stage (scoping stage) of the EIA with the objective to identify people to be consulted, to brief stakeholders about the Project components, and to discuss potential environmental and social impacts of the Project. The outcomes of those consultations will surely help in strengthening of NWPGCL institutionally to implement the EMP devised under this study.

Focus Group Discussion

625. FGDs were held on 7th and 8th July 2015 with agri farmers, fishermen, fish farmers and loom weaver groups to obtain their feedback on the construction of the proposed 3rd Unit. The FGDs were conducted at Rehabilitation Center, Baroshimul and Panchosona villages. The purposes of the FGDs were to harness knowledge on different issues, such as, how noise and air pollution are affecting the nearby communities (e.g., hearing difficulties, respiratory ailments and problems related with pregnancies), whether the discharge of contaminated water/effluent affecting the fishermen and farmers and whether the proposed project will aid in any socio-economic development or not; availability of construction materials close to the Project site; availability of local labors; site safety and security; community involvement, and sustainable environmental management. The outcomes of these discussions were used to prioritize impacts and risks, and to construct the EMP.

Public Consultation

626. A formal public consultation meeting was held at 10:00 am on 11th August 2015 (Tuesday) at the Conference Hall of the Manab Mukti Sangstha. Probable affected people were invited in that meeting. People of different occupational levels and local resident officers were invited in the meeting. A total of 34 participants had attended which comprised of local government representatives, occupation groups, NGO representative etc (**Appendix-12)**.

Photo 13-1: Participants in the Public Consultation Meeting

13.5 Consultation outcome

13.5.1 Stakeholder consultations

627. The following **Table 13-1** presents the comments, suggestions, concerns obtained and action points taken to address them during FGDs, informal consultations and formal public consultation Greetings: At the outset, the team spelled greetings to all participants. Welcomed them for attending and stated the entire design of the meeting.

Table 13-1: Comments, suggestions, concerns and action points from different stakeholders

Groups/Sectors	Comments/ Suggestions/Concerns	Action Points
Socio-economic	○ The participants stated that they have no objection on the construction of 3rd Unit in the Sirajganj Power Plant. Rather they thought that it would expedite local, regional and national development as power is the main driving force of development. ○ They also believe that the successful construction and operation of the proposed project will yield considerable employment opportunities for local people. ○ The proposed plant would have a positive	○ Possible mitigation measures suggested includes soundproof turbines or structures for limiting noise, plantation around the plant area as noise barriers, noise dampening wall etc. ○ Alarming system can be arranged for noticing the people prior emitting loud noise from the Plant.

Groups/Sectors	Comments/ Suggestions/Concerns	Action Points
	impact in curbing load-shedding, socio-economic development and continuous supply of electricity to residential and other commercial and industrial sectors. ○ They stated that sometimes not very often noise is generated from the Plant in such an intensity which is intolerable for the local people, detrimental to the children and pregnant women, resident wildlife, etc. If this Project produces noise as such it will exacerbate this problem. ○ They demanded employment opportunity for the local manpower in each phase of the Plant from construction to operation based on their skill (unskilled, semi skilled and skilled). They have also suggested for the promulgation of policy on how to create employment opportunity for the affected people and how to allocate some megawatt power for bringing the area under electricity coverage.	○ Local people should be given priority in terms of involvement in the project activities. ○ They suggested to use surface water from the Jamuna River for meeting up the water demand of the power plant instead of using ground water.
Water Resource	**Bangladesh Water Development Board** ○ The Sub divisional Engineer of BWDB raised the issue of the availability of chute channel which is not perennial in nature and has a devastating erosion propensity during the wet season. ○ During the monsoon this particular chute channel serves with water for domestic usage, movement through the water ways, some fishing etc. But during the dry season this channel remains dead and possesses no use at all.	○ The chute channel should be stopped with a closer in order to stop it permanently. Then there a water basin should be developed where water can be stored during the wet season and used for the power plant ○ This will again resolve the erosion problem at the Randhurnibari area.
	Department of Public Health Engineering ○ The existing technology which is used so far for the installation of the deep tube well at the Power Plant Area are not fully similar to the regular aquifer design of Bangladesh. ○ The cone of depression of two deep tube wells should never be co inside; otherwise both of them would be chocked up.	○ The installation of deep tube wells should be according to the prescribed and approved design of the DPHE. ○ To avoid the coinciding of the cone of depression, about 1 km distance should be kept between any two deep tube wells
	Department of Environment ○ There should remain alternative source of water for the proposed power plant, other than the ground water. Since when the four units of power plants will run altogether, there remains a susceptibility of ground water table depletion or drawdown.	○ The power plants should not only depend on the Ground water, some other steps can be taken to prevent the single dependency of ground water in order to stop the water table draw down. ○ Rain water harvesting, external water injection

Groups/Sectors	Comments/ Suggestions/Concerns	Action Points
		to the water table during dry season and other could be taken based on the project situations and other dependent issues.
Agriculture	o Extraction of ground water for making up the losses of the cooling tower of the proposed CCPP will be continued during its life time. Moreover, construction of other two units of power plant is underway. Furthermore, Govt. has planned to establish Economic Zone and BSCIC industrial Park. Multi-types of industries may be constructed there and they will need water. So, cumulative impact of ground water abstraction from the above sources may affect the crop field irrigation and household water use in future. o Irrigation cost is very high in the vicinity area due to diesel operated STWs are being used for irrigation. Charges of diesel operated STWs are Tk. 12,350/ha for HYV Boro cultivation. o Ground water withdrawal for the power plant if done may decline the ground water availability.	o Due to the use of common resource by the Power Plant Authority and the local farmers, the ground water availability may become scarce for the later users with the present depth of deep tubewell. Considering the issue, the Proponent can dedicate a pump for irrigation and drinking water for the users around the site during operation. o To minimize the severity of water scarcity, discourage farmers to cultivate high water requirement crops and encourage to cultivating low water requirement crops such as wheat, mustard in future. o Rainwater harvesting program may be initiated for meeting up the cooling water requirement. o Ensuring electricity facility in the vicinity area to minimize irrigation cost. The charges of electricity operated STWs are Tk. 8,645/ha for HYV Boro cultivation. o Irrigation should be applied as per appropriate manner.
Fisheries Resources	o According to the opinion of the participants, the river Jamuna has significant role in capture fisheries and the aquaculture as well. At upstream, there are major carp breeding grounds and occurrences of spawns. These spawns are harvested at different points along the river by setting up a number of 'Savars' and sell out to the	o Effluent should be released in the open environment through proper drainage system with due treatment complying with national and international standards, so that habitat quality remain

Groups/Sectors	Comments/ Suggestions/Concerns	Action Points
	aquaculture farmers and hatcheries. These spawn are mainly used for brood fish development. . o Decades ago there were lots of fishermen fishing in the river and linked water bodies. However, their numbers are greatly reduced. o Release of untreated effluent may hamper the local aquatic habitat quality and the fish spawn availability as well. Overfishing, by fine mesh nets (unconventional), also lead to the death of many fingerlings and fish species. o In the coming years when more power plants, proposed Economic Zone (EZ) and proposed BSCIC shall come under operation, the amount of effluent will be increased manifold. As such there would be a huge possibility of deterioration of water quality and thus the habitat quality as well. o Extraction of ground water may decrease the Pond Water Availability Period and thus aquaculture production may be declined.	congenial for the inhabitants. o Ground water pumps should be set up along the Jamuna River considering the cone of depression and drawdown effect.
Ecology	o Disturbance to wildlife during emission of high sound from the power plant	o The plant authority should take necessary steps to minimize noise level by installation of low noise machineries. o Plantation of long trees along the power plant boundaries should be done.

13.5.2 Expert/Institution consultation

Table 13-2: List of experts/Institutions consulted and their opinion

Name	Organization and position	Expert opinion	Action points
Omar Ali Sheikh (Deputy Director, Agriculture)	Department of Agriculture Extension(DAE), Sirajganj	Extraction of ground water for combined cycle cooling in the proposed Power plant and proposed Economic Zone as well as BSCIC industrial Park might cause the unavailability of irrigation water in future. One pump would be dedicated for the irrigation and drinking water for project operation. To minimize the severance of water scarcity, discourage to cultivating high water requirement crops and encouraging to cultivating low water requirement crops such as wheat, mustard in future.	Water allocation for irrigation and drinking purposes by arranging one of the pumps dedicated for irrigation and drinking facilities. BADC can go for an agreement with the DFPS in this regard. EMP has considered rainwater-harvesting program in the project area, which may minimize irrigation scarcity in the future. DAE will be motivated farmers to cultivate low

Name	**Organization and position**	**Expert opinion**	**Action points**
		Rain water harvesting program may initiate for cooling water. Irrigation should be applied as per appropriate manner.	water requirement crops by demonstration.
Abu Hashem (Sub-Assistant Agriculture Officer)	Department of Agriculture Extension(DAE), Syadabad Union Parishad, Sirajganj	Irrigation cost is very high in the vicinity area due to diesel operated STWs are being used for irrigation. Charges of diesel operated STWs are Taka 10,500/ha for HYV Boro cultivation. Ground water withdrawal for the power plant if done may decline the ground water availability. Ensuring electricity facility in the vicinity area to minimize irrigation cost. The charges of electricity operated STWs are 8,000/ha for HYV Boro cultivation. Adoption of new technology with low water requirement may affect the present irrigation water demand. AWD method may be applied during irrigation.	
Md. Shariful Islam (Sub-Divisional Engineer)	Bangladesh Water Development Board(BWDB), Sirajganj	Water re-charges naturally in the vicinity area. If blow down in dry season then always create problem otherwise it is ok. Have long water channel so no problem will be arise in future. Protective works may be done in the Choto channel and Well drainage system may be established in the power plant area. Water may be use by silt trapping. It may be used by establishing floating pump in the Jamuna Rivera and finally water comes in to the primary pump in the Power plant.	EMP has considered using alternative water source for cooling.
Ala Uddin	SAAO, Syadabad UP,Sirajganj	Irrigation cost is very high in the vicinity due to diesel operated STWs are being used for irrigation. Irrigation might be disrupted in future.	Ensuring electricity facility in the vicinity area to minimize irrigation cost. AWD method may be applied during irrigation.
Mr. Hajrat Ali (Assistant Director General)	Bangladesh Small and Cottage Industries Corporation (BSCIC) Sirajganj	Proposed BSCIC industrial park would established in 400acre of land Employment would be generated around 1 Lakh people in the Proposed BCSIC industrial park. Local people would prioritized during construction and operation	

Name	Organization and position	Expert opinion	Action points
		of the proposed industrial park according to their qualification and skillness. 6.2 Km embankment would be constructed for protect proposed BCSIC industrial Park. 40%foreing investor may be investing in this park. BCSIC Park would be established in the reclaimed land. Prime Minister declared that infrastructure would be established in infertile land in future. Industries would not establish any agricultural land. Industries would not be established in residential area. If anyone could not allocated in the BSCIC industrial park he must be allocated in the proposed Economic Zone.	

Source: CEGIS, 2015

13.6 Grievance Redress Mechanism

628. Grievances are actual or perceived problems that might give grounds for complaints. As a general policy, project Implementation Unit (PIU will work proactively towards preventing grievances through implementation of impact mitigation and community liaison activities that anticipate and address potential issues before they become grievances. Minor issues will be solved by the contractor in consultation with the Owners Engineer.

629. The project will establish a grievance redress mechanism (GRM) for addressing grievances and complaints received from the Project affected person. The claims and complaints will need to be brought to the attention of the ward member. They will then forward grievances to the higher levels of authorities as desired. The fundamental objective of the GRM will be to resolve any Project related grievances locally in consultation with the aggrieved party to facilitate smooth implementation of the EMP. And another important objective is to democratize the development process at the local level and to establish accountability to the affected people.

630. Under the GRM, two grievance redress committees (GRCs) will be formed: local grievance redress committee (LGRC); and Project grievance redress committee (PGRC). Most of the grievances would be resolved at LGRC within 7 days of receipts of compliant, while a few might be forwarded to PGRC, which will take two weeks to resolve the compliant. These GRCs are described below:

13.6.1 Local Grievance Redress Committee

631. The following LGRC composition has been proposed for the proposed Project:

- Deputy Manager/Executive Engineer (Environment)
- Ward Member: Member Secretary
- Environmental Specialist, Owners Engineer: Member
- Community Representative: Members

- Representative of women affected persons (APs): Member
- Contractors Representative: Member

632. LGRC meetings will be held in the Convener's office in the Project area or location as agreed by the committee members. If needed, LGRC members may undertake field visit to verify and review the issues, including mistakes related to temporary disturbance due to construction works, unauthorized disposal of solid and hazardous wastes, noise and vibration due to the use of heavy equipment, access restrictions.

13.6.2 Project Grievance Redress committee

633. The grievances that are not resolved at the LGRC will be forwarded to the PGRC. The PGRC will be empowered to take a decision, which would be binding on NWPGCL but it will require approval of the Project Director for implementation of the decision. The project Director will be head of the PGRC. The composition of the PGRC will be as follows:

- Project Director: Chair Person
- Member Secretary (Environmental Specialist of Owners Engineer will assist the Member Secretary in grievance redress mechanism)
- Representative of Civil Society: Member (nominated by Project Director with the help of Owners Engineer)

634. The secretary of PGRC with the help of Environmental Specialist of Owners Engineer will provide necessary knowledge and information regarding relevant Project policies and agreements with the development partner. The provision of PGRC will further establish fairness and transparency in the resolution of grievances of the project affected persons. In case of technical nature of environmental issue, or any legal matters, Environmental Specialist of Owners Engineer will advice the PGRC. In specific cases, extreme legal and or technical advice may also be sought, if required.

14 Conclusion & Recommendation

635. Implementation of the proposed project, 3rd Unit of Sirajganj Power Station, will play essentially an important role in meeting the objective of the nation's power plan. The expected gross capacity of this Unit is 225 MW while the net capacity is 220 MW. It is a duel fuel based combined cycle power plant i.e. Natural Gas (NG) or High Speed Diesel (HSD) but the predominant fuel will be the NG. Because, the fuel is NG the investment and operation cost would be relatively lower and environment friendly.

636. Construction of such a power plant falls under "Red" category Project and thus EIA study has been carried out for identifying the major environmental and social concerns, and corresponding measures for avoiding, mitigating or compensating the impacts. The Plant will use ground water at the rate of 400 m^3/hr for its closed cycle cooling system and natural gas as fuel at the rate of 35 MMCFD. The major impacts those are identified under this study include: (i) emission of air pollutant through exhaust gas with potential of causing health and environmental hazard; (ii) generation of high level of noise having potential of health hazard and scaring the local wildlife; (iii) contamination to water quality leading to decline in aquatic organisms; (iv) generation of solid waste and its disposal may create unhygienic environment and contaminate aquatic habitat; etc.

637. Corresponding measures proposed under this study are: (i) installation of dry low NOx burner and electrostatic Precipitator (ESP), and greenbelt development for the mitigation of air pollution; (ii) construction of boundary walls, green belt development, sealing of doors and windows, shutting off unused machines, soundproof hood, appropriate PPEs, etc. for mitigating noise induced impacts; (iii) installation of central effluent treatment plant (CETP), oily water separator, leak-proof sump, soak pit, etc.; and (iv) segregation of wastes by category in covered bins and dumping in designated place, etc.

638. An emergency response plan (ERP) has been prepared for effective response to deal any emergency situation, major accident and/or natural disaster effectively and efficiently.

639. An occupational health, safety and environmental plan (OHSE) has also been suggested to ensure least/no lost time incident during construction and operation of the Project.

640. The Organogram of the proponent has been revised and proposed to strengthen the monitoring of environmental and occupational health and safety issues by adding required posts. This will help the proponent in the compliance of environmental and occupational health and safety issues. Different types of capacity building programs and trainings have been recommended for the employees and workers so that the project could be established and operated with causing less disturbance to the environment and workers and public health. Moreover, as a part of social corporate responsibility (SCR) of the proponent, it is suggested to provide training to local people in technician level for developing skilled and quality manpower so that more remittance could be ensured through exporting such manpower to the developed countries.

641. The specific recommendations of the EIA study are listed below:

- Strictly follow the **Environmental Code of Practice** described in Appendix-8
- Follow the mentioned mitigation measures and EMP in the EIA study

- Regularly monitor the activities of the project as mentioned in the environment compliance and environment monitoring plan during different phases of the project
- If any anomaly/exceedance is noticed during the monitoring result, mitigation measures should be taken to control the anomaly/exceedance
- Should not release waste water without due treatment and ensuring that the concerned/relevant standards are within permissible limit
- Before using the treated water for agricultural purposes, it has to be made sure that the quality of the treated water is within the permissible limit of water for agricultural use
- Ensure regular monitoring of ground water drawdown effect
- Ensure use of PPEs
- Encourage environmental friendly activities and practices
- If the mentioned measures of the EIA, do not seem to be enough for mitigating a problem faced during the project activities in its different phases appropriate mitigation measures have to be taken to control the problem
- Public consultation/stakeholder consultation should be conducted regularly to know the problems of local people and stakeholders related to the project activities

References

CMC 2012. Sirajganj 150mw Peaking Power Plant Project, Construction Report of Deep Tube Well #1

CMC 2013a. Up-gradation of Sirajganj 150mw Peaking Power Plant To 225mw Combined Cycle Power Plant, Performance Test Report of Deep Tube Well #1

CMC 2013b. Up-gradation of Sirajganj 150mw Peaking Power Plant To 225mw Combined Cycle Power Plant, Performance Test Report of Deep Tube Well #2

CMC 2013c. Up-gradation of Sirajganj 150mw Peaking Power Plant To 225mw Combined Cycle Power Plant, Construction Report of Deep Tube Well #1

CMC 2013d. Up-gradation of Sirajganj 150mw Peaking Power Plant To 225mw Combined Cycle Power Plant, Construction Report of Deep Tube Well #2

EAL & NWPGCL. (2014). *Groundwater modelling of the proposed site of Sirajganj 225 MW combined cycle power plant project (2nd unit- dual fuel),Saydabad, Sirajganj and surrounding areas.* Dhaka: ENGINEERS ASSOCIATES LIMITED and NORTH WEST POWER GENERATION COMPANY LTD.

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SDCPL, & Bashar, K. (2015). *Hydrogeology and Groundwater Modeling of SirajganjPower Plant Area, Soydabad, Sirajganj, Bangladesh.* Dhaka: Sembcorp Design and Construction Pte Ltd.

Appendix-1: Industry specific standards on emission and effluent standards (Schedule 2 to 11 of ECR, 1997 and Amendment 2005)

SCHEDULE – 2

Standards for Air
[See Rule 12]

Density in microgram per cusec meter

Sl. No.	Categories of Area	Suspended Particulate Maters (SPM)	Sulphur-dioxide	Carbon Monoxide	Oxides Nitrogen
a.	Industrial and mixed	500	120	5000	100
b.	Commercial and mixed	400	100	5000	100
c.	Residential and rural	200	80	2000	80
d.	Sensitive	100	30	1000	30

Notes:

(1) At national level, sensitive area includes monuments, health center, hospital, archeological site, educational institution, and government designated areas (if any).

(2) Industrial units located in areas not designated as industrial areas shall not discharge pollutants which may contribute to exceeding the standard for air surrounding the areas specified at Sl. nos. c and d above.

(3) Suspended Particulate Matter means airborne particles of a diameter of 10 micron or less.

SCHEDULE – 3

Standards for Water

[See Rule 12]

(A) Standards for inland surface water

Best Practice based classification	Parameter			
	pH	**BOD mg/l**	**DO mg/l**	**Total Coliform number/100**
a. Source of drinking water for supply only after disinfecting:	6.5-8.5	2 or less	6 or above	50 or less
b. Water usable for recreational activity :	6.5 – 8.5	3 or less	5 of more	200 or less
c. Source of drinking water for supply after conventional treatment :	6.5 – 8.5	6 of less	6 or more	5000 or less
d. Water usable by fisheries:	6.5 – 8.5	6 of less	5 or more	---
e. Water usable by various process and cooling industries :	6.5 – 8.5	10 or less	5 or more	5000 or less
f. Water usable for irrigation:	6.5 – 8.5	10 or less	5 or more	1000 or less

Notes:

1. In water used for pisiculture, maximum limit of presence of ammonia as Nitrogen is 1.2 mg/l.

2. Electrical conductivity for irrigation water – 2250 μmhoms/cm (at a temperature of 25°C); Sodium less than 26%; boron less than 0.2%.

(B) Standards for drinking water

Sl. No.	Parameter	Unit	Standards
1	**2**	**3**	**4**
1.	Aluminum	mg/l	0.2
2.	Ammonia (NH_3)	,,	0.5
3.	Arsenic	,,	0.05
4.	Balium	,,	0.01
5.	Benzene	,,	0.01

1	2	3	4
6.	BOD_5 20°C	,,	0.2
7.	Boron	,,	1.0
8.	Cadmium	,,	0.005
9.	Calcium	,,	75
10.	Chloride	,,	150 – 600*
11.	Chlorinated alkanes		
	carbontetrachloride	,,	0.01
	1.1 dichloroethylene	,,	0.001
	1.2 dichloroethylene	,,	0.03
	tetrachloroethylene	,,	0.03
	trichloroethylene	,,	0.09
12.	Chlorinated phenols		
	- pentachlorophenol	mg/l	0.03
	- 2.4.6 trichlorophenol	,,	0.03
13.	Chlorine (residual)	,,	0.2
14.	Chloroform	,,	0.09
15.	Chromium (hexavalent)	,,	0.05
16.	Chromium (total)	,,	0.05
17.	COD	,,	4
18.	Coliform (fecal)	n/100 ml	0
19.	Coliform (total)	n/100 ml	0
20.	Color	Hazen unit	15
21.	Copper	mg/l	1
22.	Cyanide	,,	0.1
23.	Detergents	,,	0.2
24.	DO	,,	6
25.	Fluoride	,,	1
26.	Hardness (as $CaCO_3$)	,,	200 – 500
27.	Iron	,,	0.3 – 1.0
28.	Kjeldhl Nitrogen (total)	,,	1
29.	Lead	,,	0.05

1	2	3	4
30.	Magnesium	,,	30 – 35
31.	Manganese	,,	0.1
32.	Mercury	,,	0.001
33.	Nickel	,,	0.1
34.	Nitrate	,,	10
35.	Nitrite	,,	<1
36.	Odor	,,	Odorless
37.	Oil and grease	,,	0.01
38.	pH	,,	6.5 – 8.5
39.	Phenolic compounds	,,	0.002
40.	Phosphate	,,	6
41.	Phosphorus	,,	0
42.	Potassium	,,	12
43.	Radioactive materials (gross alpha activity)	Bq/l	0.01
44.	Radioactive materials (gross beta activity)	Bq/l	0.1
45.	Selenium	mg/l	0.01
46.	Silver	,,	0.02
47.	Sodium	,,	200
48.	Suspended particulate matters	,,	10
49.	Sufide	,,	0
50.	Sulfate	,,	400
51.	Total dissolved solids	,,	1000
52.	Temperature	°C	20-30
53.	Tin	mg/l	2
54.	Turbidity	JTU	10
55.	Zinc	mg/l	5

SCHEDULE – 4

Standards for Sound

[See Rule 12]

Sl. No.	Category of areas	Standards determined at dBa unit Day	Night
a.	Silent zone	45	35
b.	Residential area	50	40
c.	Mixed area (mainly residential area, and also simultaneously used for commercial and industrial purposes)	60	50
d.	Commercial area	70	60
e.	Industrial area	75	70

Notes:

1. The time from 6 a.m. to 9 p.m. is counted as daytime.
2. The time from 9 p.m. to 6 a.m. is counted as night time.
3. Area up to a radius of 100 meters around hospitals or educational institutions or special institutions/ establishments identified/to be identified by the Government is designated as Silent Zones where use of horns of vehicles or other audio signals, and loudspeakers are prohibited.

SCHEDULE – 5

Standards for Sound originating from Motor Vehicles or Mechanized Vessels
[See Rule 12]

Category of Vehicles	Unit	Standards	Remarks
*Motor Vehicles (all types)	dBa	85	As measured at a distance of 7.5 meters from exhaust pipe.
		100	As measured at a distance of 0.5 meter from exhaust pipe.
Mechanized Vessels	dBa	85	As measured at a distance of 7.5 meters from the vessel which is not in motion, not loaded and is at two thirds of its maximum rotating speed.
		100	As measured at a distance of 0.5 meter from the vessel which is in the same condition as above.

* At the time of taking measurement, the motor vehicle shall not be in motion and its engine conditions shall be as follows:-

(a) Diesel engine – maximum rotating speed.

(b) Gasoline engine –at two thirds of its maximum rotating speed and without any load.

(c) Motorcycle – If maximum rotating speed is above 5000 rpm; two-thirds of the speed, and if maximum rotating speed is less than 5000 rpm, three-fourth of the speed.

SCHEDULE – 6

Standards for Emission from Motor Vehicles
[See Rule 12]

Parameter	Unit	Standard Limit
Black Smoke	Hartridge Smoke Unit (HSU)	65
Carbon Monoxide	gm/k.m. percent area	24 04
Hydrocarbon	gm/k.m. ppm	02 180
Oxides of Nitrogen	gm/k.m. ppm	02 600

* As measured at two thirds of maximum rotating speed.

SCHEDULE – 7

Standards for Emission from Mechanized Vessels
[See Rule 12]

Parameter	Unit	Standard Limit
Black Smoke*	Hartridge Smoke Unit (HSU)	65

* As measured at two thirds of maximum rotating speed.

SCHEDULE – 8

Standards for Odor
[See Rule 12]

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

Notes :

(1) Following regulatory limit shall be generally applicable to emission/exhaust outlet pipe of above 5 meter height:

Q = 0.108 x He^2Cm (Where Q = Gas Emission rate Nm^3/hour)
He = Height of exhaust outlet pipe (m)
Cm = Above mentioned limit (ppm)

(2) In cases where a special parameter has been mentioned, the lower limit shall be applicable for warning purposes, and the higher limit shall be applicable for prosecution purpose or punitive measure.

SCHEDULE – 9

Standards for Sewage Discharge

[See Rule 12]

Parameter	Unit	Standard Limit
BOD	miligram/l	40
Nitrate	,,	250
Phosphate	,,	35
Suspended Solids (SS)	,,	100
Temperature	Degree Centigrade	30
Coliform	number per 100 ml	1000

Notes :

(1) This limit shall be applicable to discharges into surface and inland waters bodies.

(2) Sewage shall be chlorinated before final discharge.

SCHEDULE – 10

Standards for Waste From Industrial Units or Projects Waste

[See Rule 13]

Sl. No.	Parameter	Unit	Places for determination of standards		
			Inland Surface Water	Public Sewerage system connected to treatment at second stage	Irrigated Land
1	2	3	4	5	6
1	Ammonical Nitrogen (as elementary N)	mg/l	50	75	75
2	Ammonia (as free ammonia)	,,	5	5	15
3	Arsenic (as)	,,	0.2	0.05	0.2
4	BOD_5 at 20^oC	,,	50	250	100
5	Boron	,,	2	2	2

1	2	3	4	5	6
6	Cadmium (as CD)	,,	0.50	0.05	0.05
7	Chloride	,,	600	600	600
8	Chromium (as total Cr)	,,	0.5	1.0	1.0
9	COD	,,	200	400	400
10	Chromium (as hexavalent Cr)	,,	0.1	1.0	1.0
11	Copper (as Cu)	,,	0.5	3.0	3.0
12	Dissolved Oxygen (DO)	,,	4.5 – 8	4.5 – 8	4.5 – 8
13	Electro-conductivity (EC)	micro mho/ cm	1200	1200	1200
14	Total Dissolved Solids	,,	2,100	2,100	2,100
15	Fluoride (as F)	,,	2	15	10
16	Sulfide (as S)	,,	1	2	2
17	Iran (as Fe)	,,	2	2	2
18	Total Kjeldahl Nitrogen (as N)	,,	100	100	100
19	Lead (as Pb)	,,	0.1	1.0	0.1
20	Manganese (as Mn)	,,	5	5	5
21	Mercury (as Hg)	,,	0.01	0.01	0.01
22	Nickel (as Ni)	,,	1.0	2.0	1.0
23	Nitrate (as elementary N)	mg/l	10.0	Not yet Fixed	10
24	Oil and Grease	,,	10	20	10
25	Phenolic Compounds (as C_6H_5OH)	,,	1.0	5	1
26	Dissolved Phosphorus (as P)	,,	8	8	15
27	Radioactive substance	To be specified by Bangladesh Atomic Energy Commission			
28	pH		6 – 9	6 – 9	6 – 9
29	Selenium (as Se)	mg/l	0.05	0.05	0.05
30	Zinc (as Zn)	Degree	5	10	10

1	2	3	4	5	6
31	Total Dissolved Solids	,,	2,100	2,100	2,100
32	Temperature	Centig rade	40	40	40-Summer
			45	45	45-Winter
33	Suspended Solids (SS)	mg/l	150	500	200
34	Cyanide (as Cn)	,,	0.1	2.0	0.2

Notes:

(1) These standards shall be applicable to all industries or projects other than those specified under the heading "Standards for sector-wise industrial effluent or emission."

(2) Compliance with these standards shall be ensured from the moment an industrial unit starts trial production, and in other cases, from the moment a project starts operation.

(3) These standards shall be inviolable even in case of any sample collected instantly at any point of time. These standards may be enforced in a more stringent manner if considered necessary in view of the environmental conditions of a particular situation.

(4) Inland Surface Water means drains/ponds/tanks/water bodies/ ditches, canals, rivers, springs and estuaries.

(5) Public sewerage system means treatment facilities of the first and second stage and also the combined and complete treatment facilities.

(6) Irrigable land means such land area which is sufficiently irrigated by waste water taking into consideration the quantity and quality of such water for cultivation of selected crops on that land.

(7) Inland Surface Water Standards shall apply to any discharge to a public sewerage system or to land if the discharge does not meet the requirements of the definitions in notes 5 and 6 above.

SCHEDULE – 11

Standards for Gaseous Emission from Industries or Projects

[See Rule 13]

Sl.No.		Parameters	Standard present in a unit of mg/Nm^3
1		2	3
1.		Particulate	
	(a)	Power plant with capacity of 200 Megawatt or above.	150
	(b)	Power plant with capacity less than 200 Megawatt.	350
2.		Chlorine	150
3.		Hydrochloric acid vapor and mist	350
4.		Total Fluoride F	25
5.		Sulfuric acid mist	50
6.		Lead particulate	10
7.		Mercury particulate	0.2
8.		Sulfur dioxide	kg/ton acid
	(a)	Sulfuric acid production (DCDA* process)	4
	(b)	Sulfuric acid production (SCSA* process)	10

(* DCDA: Double Conversion, Double Absorption;

SCSA: Single Conversion, Single Absorption.)

Lowest height of stack for dispersion of sulfuric acid (in meter).

(a)	Coal based power plant		
	(1)	500 Megawatt or above	275
	(2)	200 to 500 Megawatt	220
	(3)	Less than 200 Megawatt	$14(Q)^{0.3}$
(b)	Boiler		
	(1)	Steam per hour up to 15 tons	11
	(2)	Steam per hour more that 15 tons	$14(Q)^{0.3}$

[Q = Emission of Sulfur dioxide (kg/hour)].

1	2	3
9.	Oxides of Nitrogen	
(a)	Nitric acid production	3 kg/ton acid
(b)	Gas Fuel based Power Plant	50 ppm
	(1) 500 Megawatt or above	50 ppm
	(2) 200 to 500 Megawatt	40 ppm
	(3) Below 200 Megawatt	30 ppm
(c)	Metallurgical oven	200 ppm
10.	Kiln soot and dust	mg/Nm^3
(a)	Blast Furnace	500
(b)	Brick Kiln	1000
(c)	Coke oven	500
(d)	Lime Kiln	250

রেজিস্টার্ড নং ডি এ-১

বাংলাদেশ গেজেট

অতিরিক্ত সংখ্যা
কর্তৃপক্ষ কর্তৃক প্রকাশিত

মঙ্গলবার, জুলাই ১৯, ২০০৫

গণপ্রজাতন্ত্রী বাংলাদেশ সরকার

পরিবেশ ও বন মন্ত্রণালয়

পরিকল্পনা শাখা-৫

প্রজ্ঞাপন

তারিখ, ১ শ্রাবণ ১৪১২/১৬ জুলাই ২০০৫

এস, আর, ও নং ২২০-আইন/২০০৫—বাংলাদেশ পরিবেশ সংরক্ষণ আইন, ১৯৯৫ (১৯৯৫ সনের ১ নং আইন) এর ধারা ২০ এ প্রদত্ত ক্ষমতাবলে সরকার পরিবেশ সংরক্ষণ বিধিমালা, ১৯৯৭ এর নিম্নরূপ সংশোধন করিল, যথা ঃ—

উপরি-উক্ত বিধিমালার—

(ক) তফসিল ২ এর পরিবর্তে নিম্নরূপ তফসিল ২ প্রতিস্থাপিত হইবে, যথা ঃ—

"তফসিল-২

বায়ুর মানমাত্রা (Air Quality Standards)*

[বিধি ১২ দ্রষ্টব্য]

বায়ু দূষণ	মানমাত্রা	গড় সময়
১	২	৩
কার্বন মনোঅক্সাইড	১০ মিলিগ্রাম/ঘনমিটার (৯ পিপিএম) [ক]	৮ ঘন্টা
	৪০ মিলিগ্রাম/ঘনমিটার (৩৫ পিপিএম) [ক]	১ ঘন্টা
লেড	০.৫ মাইক্রোগ্রাম/ঘনমিটার	বার্ষিক

(৭৫৬৭)

মূল্য ঃ টাকা ৪.০০

১		৩
নাইট্রোজেনের অক্সাইড	১০০ মাইক্রোগ্রাম/ঘনমিটার (০.০৫৩ পিপিএম)	বার্ষিক
প্রলম্বিত বস্তুকণা (এস পি এম)	২০০ মাইক্রোগ্রাম/ঘনমিটার	৮ ঘন্টা
বস্তুকণা ১০	৫০ মাইক্রোগ্রাম/ ঘনমিটার (খ)	বার্ষিক
	১৫০ মাইক্রোগ্রাম/ ঘনমিটার (গ)	২৪ ঘন্টা
বস্তুকণা ২.৫	১৫ মাইক্রোগ্রাম/ ঘনমিটার	বার্ষিক
	৬৫ মাইক্রোগ্রাম/ ঘনমিটার	২৪ ঘন্টা
ওজোন	২৩৫ মাইক্রোগ্রাম/ঘনমিটার (০.১২ পিপিএম) (ঘ)	১ ঘন্টা
	১৫৭ মাইক্রোগ্রাম/ঘনমিটার (০.০৮ পিপিএম)	৮ ঘন্টা
সালফার ডাইঅক্সাইড	৮০ মাইক্রোগ্রাম/ঘনমিটার (০.০৩ পিপিএম)	বার্ষিক
	৩৬৫ মাইক্রোগ্রাম/ঘনমিটার (০.১৪ পিপিএম) (ক)	২৪ ঘন্টা

শব্দ সংক্ষেপ ঃ

পিপিএম ঃ পার্টস পার মিলিয়ন।

নোট ঃ * এই তফসিলে বায়ুর মানমাত্রা বলিতে পরিবেষ্টক বায়ুর মানমাত্রা (Ambient Air Quality Standards) কে বুঝাইবে।

(ক) প্রতি বৎসরে একবারের বেশী অতিক্রম করিবে না।

(খ) বার্ষিক গড় মান ৫০ মাইক্রোগ্রাম/মি^{৩} হইতে কম বা উহার সমান হইতে পারিবে।

(গ) ২৪ ঘন্টার গড় মান বৎসরে ১ (এক) দিন ১৫০ মাইক্রোগ্রাম/ মি^{৩} হইতে কম বা উহার সমান হইতে পারিবে।

(ঘ) প্রতি ঘন্টার সর্বোচ্চ গড় মান বৎসরে ১ (এক) দিন ০.১২ পিপিএম হইতে কম বা উহার সমান হইতে পারিবে।

Appendix-2: The "Equator Principles" – the World Bank and IFC's global environment and social guidelines for project finance

In is now widely acknowledged that large-scale infrastructure and industrial projects have adverse impacts on people and on the environment. The "Equator Principles" are developed to identify, assess and manage environmental and social risks and impacts in a structured way, on an ongoing basis to promote sustainable environmental and social performance and thereby to ensure improved financial, environmental and social outcomes of projects.

Currently 80 financial institutions in 35 countries grouped under the banner "Equator Principles Financial Institutions (EPFIs),14 have adopted the Equator Principles to ensure that the projects which these institutes finance and advise on are developed in a manner that is socially responsible and reflects sound environmental management practices and provide a minimum standard for due diligence to support responsible risk decision-making.

The Equator Principles are applied globally by its EPFI members and also ask their cooperating partners to embrace them. EPFIs commit to implementing the Equator Principles in their internal environmental and social policies, procedures and standards for financing projects and also do not get involved where the partner (or client) is unable to comply with the Equator Principles.

While the Equator Principles are not intended to be applied retroactively, EPFIs apply them to the expansion or upgrade of an existing project where changes in scale or scope may create significant environmental and social risks and impacts, or significantly change the nature or degree of an existing impact.

The Equator Principles have greatly increased the attention and focus on social/community standards and responsibility, including robust standards for indigenous peoples, labour standards, and consultation with locally affected communities within the project. They have also promoted convergence around common environmental and social standards. The Equator Principles have also helped to spur the development of other responsible environmental and social management practices in the financial sector and banking industry for example, Carbon principles in the US and Climate principles worldwide, and have provided a platform for engagement with a broad range of interested stakeholders, including non-government organizations and industrial bodies. The key ten (10) principles are outlined below.

> <u>Principle 1: Review and Categorization.</u> The risk of the project is categorized in accordance with internal guidelines based upon the environmental and social screening criteria of the IFC. Projects are classified, relating to social or environmental impacts, in Category A (significant impacts), Category B (limited impacts), and Category C (minimal or no impacts).
>
> <u>Principle 2: Social and Environmental Assessment.</u> For all medium- or high-risk projects (Category A and B projects), sponsors complete an Environmental Assessment, the preparation of which must meet certain requirements and satisfactorily address key environmental and social issues.

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[14]http://www.equator-principles.com/index.php/about-ep (downloaded on 20 July 2015)

Principle 3: Applicable Social and Environmental Standards.The environmental assessment report addresses baseline environmental and social conditions, requirements under host country laws and regulations, applicable international treaties and agreements, sustainable development and use of renewable natural resources, protection of human health, cultural properties, and biodiversity, including endangered species and sensitive ecosystems, use of dangerous substances, major hazards, occupational health and safety, fire prevention and life safety, socioeconomic impacts, land acquisition and land use, involuntary resettlement, impacts on indigenous peoples and communities, cumulative impacts of existing projects, the proposed project, and anticipated future projects, participation of affected parties in the design, review and implementation of the project, consideration of feasible environmentally and socially preferable alternatives, efficient production, delivery and use of energy, pollution prevention and waste minimization, pollution controls (liquid effluents and air emissions), and solid and chemical waste management.

Principle 4: Action Plan and Management System.Based on the Environmental Assessment, the lending agency then make agreements with their clients on how they mitigate, monitor and manage those risks through a "Social Environmental Management Plan".

Principle 5: Consultation and Disclosure.For risky projects, the borrower consults with stakeholders such as NGOs and affected groups and provides them with information on the risks of the project. The borrower has to consult the project affected communities in a structured and culturally appropriate manner. The process will ensure free, prior, and informed consultation for affected communities.

Principle 6: Grievance Mechanism.The borrower will establish a grievance mechanism as part of the management system.

Principle 7: Independent Review.For all projects, an independent social or environmental expert not directly associated with the borrower will review the Assessment, Action Plan and consultation process documentation in order to assist EPFI's due diligence, and assess Equator Principles compliance.

Principle 8: Covenants.Incorporation of covenants linked to compliance. Compliance with the plan is required in the covenant. If the borrower does not comply with the agreed terms, the bank will take corrective action, which if successful, could ultimately result in the bank cancelling the loan and demanding immediate repayment.

Principle 9: Independent Monitoring and Reporting.Over the life of the loan, in Category A and, if necessary in Category B, an independent expert is consulted.

Principle 10: EPFI Reporting.Each EPFI adopting the Equator Principles commits to report publicly at least annually about its Equator Principles implementation processes and experience, taking into account appropriate confidentiality considerations.

Appendix-3: Gas analysis report

PASHCHIMANCHAL GAS COMPANY LIMITED
NALKA, SIRAJAGNJ, BANGLADESH

'USTOMER: North-West Power Generator Company Limited, Sirajganj, Bangladesh
'TATION : Sirajganj, 150MW Peaking Power Plant

'URRENT REPORT SHEET 08/07/2015 11:37:17

;tream-02 (Metering Line 2404)

;TD Volume TOTAL	:	25661628.33 MCF
4ass TOTAL	:	1159274.23 M.lbs
:nergy TOTAL	:	27184223.33 MMBtu
;tatic Pressure	:	146.56 psig
)ifferential Pressure	:	211.03 mbar
.ine Temperature	:	66.77 Deg.F
;pecific Gravity	:	0.58938
)rifice Plate Bore Diameter	:	6.60600 in
4ass Flow Rate	:	67.73 K.lbs/h
Nitrogen	:	0.24271 %
CO2	:	0.15267 %
Methane	:	96.07566 %
Etane	:	2.18200 %
Propane	:	0.59219 %
N_Butane	:	0.13064 %
I_Butane	:	0.19297 %
N_Pentane	:	0.04188 %
I_Pentane	:	0.08297 %
Neo Pentane	:	0.00000 %
Hexane	:	0.14539 %
Heptane	:	0.10825 %
Octane	:	0.05267 %
TOTAL	:	100.00000 %
Heating Value (Superior)	:	1057.99 BTU/SCF (*)

(*) : Inferior Heating Value (NHV) = Superior Heating Value / 1.1088

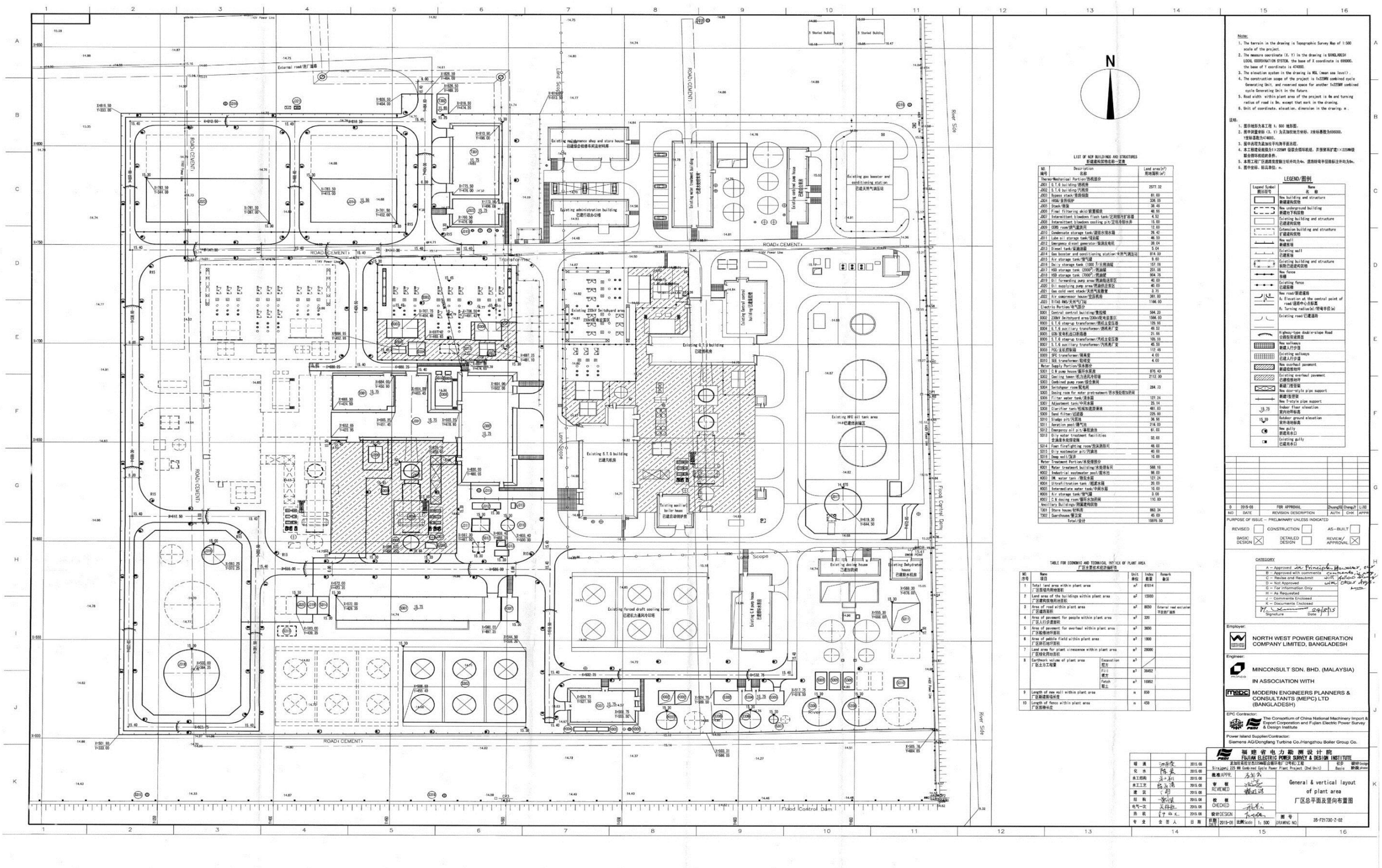
Appendix-4: High Diesel Specification Report

SPECIFICATIONS OF HIGH SPEED DIESEL(HSD)

Delivery Specifications.

PROPERTY	METHOD	LIMIT
SPECIFIC GRAVITY 60 DEG F/60 DEG F	ASTM D1298	MIN 0.820 MAX 0.870
COLOUR, ASTM	ASTM D1500	MAX 3.0
FLASH POINT (DEG F)	ASTM D93	MIN 95
POUR POINT (DEG C)	ASTM D97	MAX 6
VISCOSITY KINEMATIC AT 100 DEG F (cst)	ASTM D445	LESS THAN 9.0
SEDIMENT (% WT)	ASTM D473	MAX 0.01
WATER (% VOL)	ASTM D95	MAX 0.10
CARBON RESIDUE, CONRADSON (% WT)	ASTM D189	LESS THAN 0.1
ASH (% WT)	ASTM D482	MAX 0.01
NEUTRALIZATION VALUE STRONG ACID NUMBER (mgKOH/G) TOTAL ACID NUMBER (mgKOH/G)	ASTM D974	 NIL MAX 0.5
CETANE INDEX (CALCULATED)	ASTM D976	MIN 45
SULFUR CONTENT (%WT)	ASTM D1551	MAX 0.25
COPPER STRIP CORROSION 3 HRS AT 212 DEG F	ASTM D130	 MAX NO.1
DISTILLATION 90% RECOVERY. VOL (DEG C)	ASTM D86	 MAX 370

Appendix-5: Project Layout



Appendix-6: Status of the resident wildlife of the study area

Name			Conservation Status										Existence in proposed Plant Site
			IUCN					CITES			Wildlife Act		
Scientific	English	Bangla	Ex	CR	EN	VU	LR	I	II	III	P	G	
CLASS MAMMALIA													
Order Rodentia													
Family Sciuridae													
Cllosciurus pygerythrus	Irrawaddy Squirrel	Badami Katbirali											No
Family Muridae													
Bandicota bengalensis	Mole Rat	Indur											Yes
Bandicota indica	Bandicot Rat	Dhari Indur											
Mus booduga	Field Mouse	Metho Indur											No
Mus musculus	House Mouse	Nengti Indur											Yes
Rattus rattus	Common House Rat	Indur											Yes
Family Soricidae													
Suncus murinus	Grey Musk Shrew	Chika									x		Yes
Family Pteropodidae													
Cynopterus sphinx	Short-nosed Bat	Bocha Kola Badur											No
Pteropus giganteus	Flying fox	Badur											No
Family Megadermatidae													
Megaderma lyra	False Vampire	Dhani Badur											Yes
Family Vespertilionidae													
Hespereptenus tickllii	Tickell's Bat	Chamchika											Yes
Pipistrellus coromandra	Indian Pipistrelle	Khudi Chamchika											No
Order Carnivora													
Family Canidae													
Canis aureus	Jackal	Pati Shail				x							No
Vulpes bengalensis	Bengal Fox	Khek Shial				x					x		No
Family Herpestidae													
Herpestes autopunctatus	Small Indian Mongoose	Beji, Nakul									x		Yes
Herpestes edwardsi	Common	Bara Beji				x				x	x		No

Name			Conservation Status										Existence in proposed Plant Site
			IUCN					CITES			Wildlife Act		
Scientific	English	Bangla	Ex	CR	EN	VU	LR	I	II	III	P	G	
	Mongoose												
Family Mustelidae													
Lutra lutra monticola	Eurasian Otter	Ud Biral		x				x			x		No
Family Viverridae													
Viverra zibetha	Large Indian Civet	Bagdash			x					x			No
Viverricula indica	Small Indian Civet	Khatash								x	x		No
Family Felidae													
Felis chaus	Jangle Cat	Bon Biral			x				x		x		No
Felis viverrina	Fishing Cat	Mecho Biral							x		x		No
CLASS REPTILIA													
Order Testudines													
Family Emydidae													
Geoclemys hamiltoni	Spotted Pond Turtle	Kalo Kasim			x			x					No
Hardella thurjii	Brahminy Turtle	Kali Kaitta			x				x				No
Kachuga dhongoka	Three Striped Roof Turtle	Tinsira Kachap			x				x				No
Kachuga tecta tecta	Common Roof Turtle	Kori Kaitta			x				x				No
Family Trionychidae													
Aspideretes gangeticus	Ganges Soft Shell	Khalua Kasim			x			x					No
Aspideretes hurum	Peacock Soft Shell	Dhum Kasim			x			x					No
Lissemys punctata punctata	Flap-shelled Spotted Turtle	Sundi Kachap				x			x				No
Order Sauria													
Family Gekkonidae													
Gekko gecko	Wall Lizard	Tokkhak				x							No
Hemidactylus brooki	House Lizard	Tiktiki											Yes
Hemidactylus frenatus	Common Lizard	Tiktiki											Yes
Family Agamidae													
Calotes versicolor	Garden Lizard	Raktochusa											Yes
Mabuya carinata	Common Skink	Anjan											Yes
Family Varanidar													

Name			Conservation Status										Existence in proposed Plant Site
			IUCN					CITES			Wildlife Act		
Scientific	English	Bangla	Ex	CR	EN	VU	LR	I	II	III	P	G	
Varanus bengalensis	Bengal Grey Monitor	Gui Shap				x		x			x		No
Varanus flavescens	Yellow Common Monitor	Shona Gui			x			x			x		No
Order Serpentes													
Family Dipradidae													
Lycodon jara	Yellow Wolf Snake	Ghorginni											Yes
Pareas monticola	Assam Snail-eater	Samukkhor											No
Family Natricidae													
Amphiesma stolata	Stripes Keelback	Dora Sap											Yes
Atretium schistosum	Olive Keelback	Mete Sap								x			Yes
Xenochrophis cerasogaster	Dark-bellied Marsh Snake	Kalo Mete Dora				x							No
Xenochrophis piscator	Checkered Keelback	Dhora Sap								x			Yes
Family Colubridae													
Ahaetulla nasutus	Common Vine Snake	Laodoga				x							Yes
Ptyas mucosus	Rat Snake	Daraj/Darash							x				Yes
Family Homalopsidae													
Cerberus rhynchops	Dog-faced Water Snake	Jalbora				x							No
Enhydris enhydris	Smooth Water Snake	Pyna Sap											No
Family Elaphidae													
Bungarus caeruleus	Common Krait	Kal Keotey											No
Bungarus fasiciatus	Banded Krait	Sankini											No
Naja naja kaouthia	Monocellate Cobra	Gokhra				x							Yes
Naja naja naja	Binocellate Cobra	Khoia Gokhra			x				x				No
CLASS AMPHIBIA													
Order Anura													
Family Bufonidae													

Name			Conservation Status										Existence in proposed Plant Site
			IUCN					CITES			Wildlife Act		
Scientific	**English**	**Bangla**	**Ex**	**CR**	**EN**	**VU**	**LR**	**I**	**II**	**III**	**P**	**G**	
Bufo melanostictus	Common Toad	Kuno Bang											Yes
Family Mirohylidae													
Microhyla ornata	Ornata Frog	China Bang				x							Yes
Family Ranidae													
Hoplobactrachus tigerinus	Bull Frog	Sona Bang							x			x	Yes
Rana cyanophlyctis	Skipper Frog	Kotkoti Bang											No
Rana limnocharis	Cricket Frog	Jhi Jhi Bang										x	Yes
Rana temporalis	Tree Frog	Gecho Bang											No

Note: IUCN Status: EX=Extinct, CR=Critically Endangered, EN=Endangered, VU=Vulnerable, LR=Lower Risk; Source: CEGIS Field Survey, July 2015; IUCN 2000 and CITES Database

Appendix-7: Air Quality Modeling Result

Table: Air quality modeling result at discrete sensitive receptors – CO

Sl	Name of Sensitive Receptors	1 hr Concentration(μg/m³)		24 hr Concentration(μg/m³)	
		Baseline	Impact	Baseline	Impact
1	Primary School	1.72	3.94	0.18	0.45
2	Primary School	1.07	3.18	0.10	0.29
3	Madrasa	0.94	3.65	0.14	0.33
4	Primary School	1.25	4.18	0.19	0.48
5	Primary School	1.22	2.59	0.19	0.39
6	Primary School	1.52	4.74	0.15	0.33
7	Family Welfare Centre	1.80	3.58	0.22	0.50
8	Primary School	1.07	3.38	0.13	0.37
9	Primary School	1.28	3.32	0.19	0.49
10	Family Welfare Centre	0.96	2.61	0.08	0.24
11	Madrasa	1.16	3.25	0.16	0.36
12	Hospital	1.40	4.66	0.16	0.45
13	Primary School	1.38	4.53	0.18	0.42
14	Community Clinic	1.29	3.87	0.13	0.40
15	Primary School	1.27	3.62	0.13	0.41
16	Primary School	4.87	12.43	0.30	0.81
17	Primary School	1.52	4.21	0.20	0.53
18	Primary School	1.18	3.60	0.14	0.43
19	High School	1.65	4.80	0.17	0.44
20	High School	1.60	4.60	0.17	0.44
21	Primary School	1.56	4.34	0.17	0.43
22	Union HQ	0.93	2.55	0.11	0.26
23	Primary School	1.71	5.77	0.16	0.50
24	Primary School	1.63	4.03	0.17	0.50
25	Primary School	1.07	2.92	0.12	0.34
26	Primary School	2.33	6.78	0.18	0.48
27	Primary School	1.35	3.62	0.15	0.46
28	Primary School	2.13	5.18	0.17	0.59
29	Primary School	1.29	3.86	0.13	0.25
30	Primary School	1.83	5.41	0.14	0.51
31	High School	1.19	3.73	0.14	0.26
32	Primary School	1.19	2.90	0.14	0.44
33	Union HQ	1.15	2.41	0.12	0.31
34	High School	1.25	2.45	0.13	0.35
35	Union HQ	1.73	5.09	0.16	0.57
36	Primary School	0.94	2.15	0.10	0.27

SI	Name of Sensitive Receptors	1 hr Concentration(μg/m³)		24 hr Concentration(μg/m³)	
		Baseline	Impact	Baseline	Impact
37	Primary School	1.99	4.96	0.30	0.70
38	Upazila HQ	1.09	2.41	0.12	0.32
39	Primary School	0.70	1.90	0.05	0.10
40	Family Welfare Centre	2.42	4.79	0.29	0.65
41	Primary School	1.42	4.01	0.16	0.43
42	Madrasa	0.77	1.57	0.05	0.10
43	Primary School	1.59	4.26	0.19	0.53
44	Primary School	0.74	1.46	0.05	0.10
45	Community Clinic	2.10	7.94	0.17	0.64
46	Primary School	1.83	4.34	0.22	0.57
47	Primary School	1.92	6.78	0.11	0.49
48	Primary School	1.34	3.61	0.06	0.19
49	Primary School	2.61	7.89	0.30	0.99
50	Primary School	0.83	3.32	0.09	0.18
51	Primary School	2.53	6.72	0.24	0.75
52	Primary School	2.54	8.16	0.21	0.72
53	Primary School	2.15	8.18	0.12	0.44
54	Madrasa	0.77	1.08	0.08	0.13
55	Primary School	3.02	9.25	0.18	0.58
56	Primary School	1.17	3.05	0.05	0.14
57	Primary School	0.67	1.73	0.06	0.13
58	Madrasa	2.38	7.24	0.28	0.85
59	Community Clinic	1.54	3.17	0.12	0.15
60	Union HQ	2.21	3.23	0.15	0.16
61	Primary School	4.61	14.89	0.25	0.86
62	Primary School	2.41	7.22	0.15	0.46
63	Primary School	3.21	11.01	0.22	0.78
64	Family Welfare Centre	2.81	3.93	0.19	0.26
65	Primary School	0.84	1.59	0.08	0.10
66	Primary School	1.10	3.32	0.05	0.16
67	Madrasa	1.21	2.19	0.09	0.23
68	Primary School	1.82	5.65	0.14	0.42
69	Primary School	1.99	7.09	0.30	0.94
70	Primary School	1.27	3.47	0.10	0.25
71	Primary School	2.28	5.44	0.13	0.25
72	Family Welfare Centre	1.92	5.72	0.22	0.64
73	Union HQ	2.06	6.18	0.23	0.67
74	Primary School	1.00	3.05	0.11	0.32
75	Primary School	2.05	6.07	0.22	0.70
76	Primary School	2.15	6.48	0.24	0.70

SI	Name of Sensitive Receptors	1 hr Concentration(μg/m³)		24 hr Concentration(μg/m³)	
		Baseline	Impact	Baseline	Impact
77	Primary School	1.43	4.29	0.16	0.49
78	Primary School	1.32	3.71	0.09	0.30
79	Primary School	1.81	5.64	0.26	0.78
80	Primary School	2.35	7.36	0.25	0.73
81	Primary School	2.04	5.91	0.21	0.68
82	Primary School	1.50	4.49	0.23	0.70
83	Primary School	1.37	4.12	0.23	0.71
84	Madrasa	1.11	3.39	0.20	0.60
85	Primary School	1.62	4.82	0.19	0.57
86	Primary School	1.74	5.82	0.16	0.58
87	Primary School	2.46	7.56	0.23	0.78
88	Community Clinic	2.07	5.99	0.23	0.62
89	Primary School	2.05	8.08	0.31	0.94
90	Union HQ	2.08	5.91	0.22	0.59
91	Primary School	1.99	6.02	0.12	0.29
92	Family Welfare Centre	1.72	5.79	0.19	0.54
93	Primary School	1.46	4.79	0.15	0.49
94	Growth Centre	2.07	7.84	0.31	0.86
95	Bangabandhu Eco Park	1.53	2.16	0.08	0.12
96	Primary School	2.65	6.76	0.16	0.48
97	Community Clinic	2.17	7.37	0.26	0.71
98	Primary School	1.62	4.86	0.19	0.54
99	Family Welfare Centre	1.35	3.60	0.23	0.65
100	Primary School	2.37	6.20	0.17	0.52
101	Primary School	1.53	4.05	0.24	0.66
102	Jamuna Resort	0.85	2.28	0.04	0.12
103	Union HQ	1.65	4.32	0.23	0.63
104	Primary School	1.49	4.26	0.20	0.51
105	District HQ	1.54	3.38	0.25	0.59
106	Upazila HQ	1.32	3.02	0.25	0.67
107	Primary School	1.23	3.29	0.25	0.61
108	High School	1.16	3.54	0.22	0.60
109	Primary School	1.21	3.55	0.17	0.49
110	Primary School	1.07	3.36	0.17	0.49
111	Barashimul village Monitoring Point	0.91	2.06	0.06	0.16
112	Eco park Monitoring Point	1.53	2.16	0.08	0.12
113	Rehabilitation village Monitoring Point	1.45	1.54	0.15	0.16
114	Power Plant site Monitoring Point	1.16	1.43	0.06	0.09

Table: Air quality modeling result at discrete sensitive receptors – NO_2

SI	Name of Sensitive Receptors	1 hr Concentration(µg/m³)		Annual Concentration(µg/m³)	
		Baseline	Impact	Baseline	Impact
1	Primary School	11.26	25.85	0.04	0.12
2	Primary School	7.02	20.84	0.02	0.08
3	Madrasa	6.18	23.92	0.05	0.13
4	Primary School	8.22	27.42	0.05	0.14
5	Primary School	7.99	16.98	0.06	0.16
6	Primary School	9.95	31.09	0.06	0.16
7	Family Welfare Centre	11.84	23.49	0.04	0.10
8	Primary School	7.01	22.20	0.05	0.14
9	Primary School	8.42	21.80	0.06	0.18
10	Family Welfare Centre	6.32	17.14	0.04	0.13
11	Madrasa	7.60	21.31	0.06	0.16
12	Hospital	9.16	30.57	0.06	0.17
13	Primary School	9.03	29.74	0.06	0.16
14	Community Clinic	8.48	25.39	0.06	0.17
15	Primary School	8.30	23.72	0.06	0.17
16	Primary School	31.95	81.55	0.05	0.16
17	Primary School	9.97	27.62	0.07	0.20
18	Primary School	7.76	23.62	0.06	0.17
19	High School	10.85	31.49	0.03	0.08
20	High School	10.51	30.21	0.03	0.08
21	Primary School	10.22	28.47	0.03	0.08
22	Union HQ	6.13	16.76	0.04	0.13
23	Primary School	11.25	37.84	0.06	0.19
24	Primary School	10.72	26.45	0.06	0.18
25	Primary School	7.04	19.17	0.05	0.14
26	Primary School	15.27	44.50	0.07	0.21
27	Primary School	8.86	23.72	0.06	0.17
28	Primary School	13.95	33.98	0.05	0.16
29	Primary School	8.45	25.32	0.03	0.06
30	Primary School	12.02	35.49	0.06	0.20
31	High School	7.79	24.45	0.02	0.06
32	Primary School	7.80	19.04	0.06	0.17
33	Union HQ	7.57	15.80	0.05	0.13
34	High School	8.22	16.10	0.05	0.15
35	Union HQ	11.36	33.37	0.05	0.19

SI	Name of Sensitive Receptors	1 hr Concentration(μg/m³)		Annual Concentration(μg/m³)	
		Baseline	Impact	Baseline	Impact
36	Primary School	6.18	14.10	0.04	0.12
37	Primary School	13.03	32.55	0.07	0.23
38	Upazila HQ	7.17	15.83	0.05	0.14
39	Primary School	4.60	12.44	0.01	0.03
40	Family Welfare Centre	15.86	31.40	0.07	0.23
41	Primary School	9.32	26.31	0.06	0.17
42	Madrasa	5.05	10.32	0.01	0.02
43	Primary School	10.40	27.93	0.08	0.22
44	Primary School	4.88	9.60	0.01	0.02
45	Community Clinic	13.80	52.12	0.03	0.13
46	Primary School	11.98	28.50	0.06	0.17
47	Primary School	12.60	44.45	0.02	0.10
48	Primary School	8.80	23.68	0.01	0.04
49	Primary School	17.10	51.77	0.07	0.23
50	Primary School	5.46	21.80	0.01	0.03
51	Primary School	16.61	44.09	0.07	0.21
52	Primary School	16.65	53.52	0.06	0.22
53	Primary School	14.09	53.68	0.04	0.13
54	Madrasa	5.02	7.06	0.01	0.02
55	Primary School	19.78	60.68	0.06	0.17
56	Primary School	7.68	19.98	0.01	0.03
57	Primary School	4.41	11.34	0.01	0.03
58	Madrasa	15.63	47.51	0.07	0.24
59	Community Clinic	10.12	20.80	0.01	0.04
60	Union HQ	14.52	21.21	0.01	0.04
61	Primary School	30.23	97.69	0.06	0.18
62	Primary School	15.80	47.38	0.04	0.13
63	Primary School	21.08	72.20	0.07	0.22
64	Family Welfare Centre	18.41	25.76	0.02	0.06
65	Primary School	5.49	10.42	0.01	0.02
66	Primary School	7.19	21.80	0.01	0.03
67	Madrasa	7.93	14.38	0.01	0.04
68	Primary School	11.92	37.08	0.05	0.14
69	Primary School	13.05	46.53	0.07	0.22
70	Primary School	8.33	22.77	0.02	0.05
71	Primary School	14.97	35.72	0.01	0.03

Sl	Name of Sensitive Receptors	1 hr Concentration(µg/m³)		Annual Concentration(µg/m³)	
		Baseline	Impact	Baseline	Impact
72	Family Welfare Centre	12.61	37.56	0.06	0.20
73	Union HQ	13.54	40.56	0.06	0.20
74	Primary School	6.53	20.02	0.03	0.10
75	Primary School	13.48	39.84	0.07	0.22
76	Primary School	14.09	42.48	0.06	0.19
77	Primary School	9.36	28.16	0.05	0.15
78	Primary School	8.64	24.33	0.01	0.05
79	Primary School	11.85	36.97	0.06	0.22
80	Primary School	15.44	48.29	0.08	0.25
81	Primary School	13.37	38.75	0.08	0.27
82	Primary School	9.86	29.47	0.06	0.18
83	Primary School	8.99	27.05	0.05	0.16
84	Madrasa	7.25	22.22	0.04	0.13
85	Primary School	10.66	31.64	0.07	0.22
86	Primary School	11.39	38.18	0.08	0.25
87	Primary School	16.12	49.59	0.09	0.30
88	Community Clinic	13.56	39.28	0.11	0.35
89	Primary School	13.47	52.99	0.09	0.30
90	Union HQ	13.66	38.78	0.11	0.36
91	Primary School	13.09	39.51	0.02	0.06
92	Family Welfare Centre	11.31	38.02	0.11	0.36
93	Primary School	9.60	31.44	0.07	0.21
94	Growth Centre	13.61	51.46	0.09	0.28
95	Bangabandhu Eco Park	10.06	14.19	0.01	0.03
96	Primary School	17.36	44.36	0.12	0.36
97	Community Clinic	14.24	48.34	0.09	0.29
98	Primary School	10.64	31.92	0.10	0.32
99	Family Welfare Centre	8.84	23.59	0.07	0.21
100	Primary School	15.53	40.68	0.09	0.29
101	Primary School	10.06	26.54	0.07	0.21
102	Jamuna Resort	5.55	14.97	0.01	0.03
103	Union HQ	10.85	28.31	0.07	0.22
104	Primary School	9.78	27.93	0.12	0.34
105	District HQ	10.12	22.15	0.14	0.41
106	Upazila HQ	8.65	19.82	0.14	0.40
107	Primary School	8.07	21.56	0.15	0.42

SI	Name of Sensitive Receptors	1 hr Concentration(μg/m³)		Annual Concentration(μg/m³)	
		Baseline	Impact	Baseline	Impact
108	High School	7.61	23.25	0.13	0.40
109	Primary School	7.93	23.29	0.13	0.39
110	Primary School	7.05	22.03	0.12	0.38
111	Barashimul village Monitoring Point	5.96	13.49	0.01	0.03
112	Eco park Monitoring Point	10.04	14.17	0.01	0.03
113	Rehabilitation village Monitoring Point	9.49	10.09	0.01	0.02
114	Power Plant site Monitoring Point	7.58	9.40	0.01	0.02

Table: Air quality modeling result at discrete sensitive receptors – $PM_{2.5}$

SI	Name of Sensitive Receptors	24 hr Concentration(μg/m³)		Annual Concentration(μg/m³)	
		Baseline	Impact	Baseline	Impact
1	Primary School	0.02	0.06	0.00	0.00
2	Primary School	0.01	0.04	0.00	0.00
3	Madrasa	0.02	0.04	0.00	0.00
4	Primary School	0.02	0.06	0.00	0.00
5	Primary School	0.02	0.05	0.00	0.00
6	Primary School	0.02	0.04	0.00	0.00
7	Family Welfare Centre	0.03	0.06	0.00	0.00
8	Primary School	0.02	0.05	0.00	0.00
9	Primary School	0.02	0.06	0.00	0.00
10	Family Welfare Centre	0.01	0.03	0.00	0.00
11	Madrasa	0.02	0.05	0.00	0.00
12	Hospital	0.02	0.06	0.00	0.00
13	Primary School	0.02	0.05	0.00	0.00
14	Community Clinic	0.02	0.05	0.00	0.00
15	Primary School	0.02	0.05	0.00	0.00
16	Primary School	0.04	0.10	0.00	0.00
17	Primary School	0.03	0.07	0.00	0.00
18	Primary School	0.02	0.05	0.00	0.00
19	High School	0.02	0.05	0.00	0.00
20	High School	0.02	0.05	0.00	0.00
21	Primary School	0.02	0.05	0.00	0.00
22	Union HQ	0.01	0.03	0.00	0.00
23	Primary School	0.02	0.06	0.00	0.00

Sl	Name of Sensitive Receptors	24 hr Concentration(μg/m³)		Annual Concentration(μg/m³)	
		Baseline	Impact	Baseline	Impact
24	Primary School	0.02	0.06	0.00	0.00
25	Primary School	0.02	0.04	0.00	0.00
26	Primary School	0.02	0.06	0.00	0.00
27	Primary School	0.02	0.06	0.00	0.00
28	Primary School	0.02	0.07	0.00	0.00
29	Primary School	0.02	0.03	0.00	0.00
30	Primary School	0.02	0.06	0.00	0.00
31	High School	0.02	0.03	0.00	0.00
32	Primary School	0.02	0.06	0.00	0.00
33	Union HQ	0.01	0.04	0.00	0.00
34	High School	0.02	0.04	0.00	0.00
35	Union HQ	0.02	0.07	0.00	0.00
36	Primary School	0.01	0.03	0.00	0.00
37	Primary School	0.04	0.09	0.00	0.00
38	Upazila HQ	0.01	0.04	0.00	0.00
39	Primary School	0.01	0.01	0.00	0.00
40	Family Welfare Centre	0.04	0.08	0.00	0.00
41	Primary School	0.02	0.05	0.00	0.00
42	Madrasa	0.01	0.01	0.00	0.00
43	Primary School	0.02	0.07	0.00	0.00
44	Primary School	0.01	0.01	0.00	0.00
45	Community Clinic	0.02	0.08	0.00	0.00
46	Primary School	0.03	0.07	0.00	0.00
47	Primary School	0.01	0.06	0.00	0.00
48	Primary School	0.01	0.02	0.00	0.00
49	Primary School	0.04	0.12	0.00	0.00
50	Primary School	0.01	0.02	0.00	0.00
51	Primary School	0.03	0.09	0.00	0.00
52	Primary School	0.03	0.09	0.00	0.00
53	Primary School	0.02	0.05	0.00	0.00
54	Madrasa	0.01	0.02	0.00	0.00
55	Primary School	0.02	0.07	0.00	0.00
56	Primary School	0.01	0.02	0.00	0.00
57	Primary School	0.01	0.02	0.00	0.00
58	Madrasa	0.04	0.11	0.00	0.00
59	Community Clinic	0.02	0.02	0.00	0.00

Sl	Name of Sensitive Receptors	24 hr Concentration(µg/m³)		Annual Concentration(µg/m³)	
		Baseline	Impact	Baseline	Impact
60	Union HQ	0.02	0.02	0.00	0.00
61	Primary School	0.03	0.11	0.00	0.00
62	Primary School	0.02	0.06	0.00	0.00
63	Primary School	0.03	0.10	0.00	0.00
64	Family Welfare Centre	0.02	0.03	0.00	0.00
65	Primary School	0.01	0.01	0.00	0.00
66	Primary School	0.01	0.02	0.00	0.00
67	Madrasa	0.01	0.03	0.00	0.00
68	Primary School	0.02	0.05	0.00	0.00
69	Primary School	0.04	0.12	0.00	0.00
70	Primary School	0.01	0.03	0.00	0.00
71	Primary School	0.02	0.03	0.00	0.00
72	Family Welfare Centre	0.03	0.08	0.00	0.00
73	Union HQ	0.03	0.08	0.00	0.00
74	Primary School	0.01	0.04	0.00	0.00
75	Primary School	0.03	0.09	0.00	0.00
76	Primary School	0.03	0.09	0.00	0.00
77	Primary School	0.02	0.06	0.00	0.00
78	Primary School	0.01	0.04	0.00	0.00
79	Primary School	0.03	0.10	0.00	0.00
80	Primary School	0.03	0.09	0.00	0.00
81	Primary School	0.03	0.08	0.00	0.01
82	Primary School	0.03	0.09	0.00	0.00
83	Primary School	0.03	0.09	0.00	0.00
84	Madrasa	0.02	0.08	0.00	0.00
85	Primary School	0.02	0.07	0.00	0.00
86	Primary School	0.02	0.07	0.00	0.00
87	Primary School	0.03	0.10	0.00	0.01
88	Community Clinic	0.03	0.08	0.00	0.01
89	Primary School	0.04	0.12	0.00	0.01
90	Union HQ	0.03	0.07	0.00	0.01
91	Primary School	0.02	0.04	0.00	0.00
92	Family Welfare Centre	0.02	0.07	0.00	0.01
93	Primary School	0.02	0.06	0.00	0.00
94	Growth Centre	0.04	0.11	0.00	0.01
95	Bangabandhu Eco Park	0.01	0.02	0.00	0.00

Sl	Name of Sensitive Receptors	24 hr Concentration(µg/m³)		Annual Concentration(µg/m³)	
		Baseline	Impact	Baseline	Impact
96	Primary School	0.02	0.06	0.00	0.01
97	Community Clinic	0.03	0.09	0.00	0.01
98	Primary School	0.02	0.07	0.00	0.01
99	Family Welfare Centre	0.03	0.08	0.00	0.00
100	Primary School	0.02	0.06	0.00	0.01
101	Primary School	0.03	0.08	0.00	0.00
102	Jamuna Resort	0.01	0.01	0.00	0.00
103	Union HQ	0.03	0.08	0.00	0.00
104	Primary School	0.02	0.06	0.00	0.01
105	District HQ	0.03	0.07	0.00	0.01
106	Upazila HQ	0.03	0.08	0.00	0.01
107	Primary School	0.03	0.08	0.00	0.01
108	High School	0.03	0.07	0.00	0.01
109	Primary School	0.02	0.06	0.00	0.01
110	Primary School	0.02	0.06	0.00	0.01
111	Barashimul village Monitoring Point	0.01	0.02	0.00	0.00
112	Eco park Monitoring Point	0.01	0.02	0.00	0.00
113	Rehabilitation village Monitoring Point	0.02	0.02	0.00	0.00
114	Power Plant site Monitoring Point	0.01	0.01	0.00	0.00

Table: Air quality modeling result at discrete sensitive receptors – PM_{10}

Sl	Name of Sensitive Receptors	24 hr Concentration(µg/m³)		Annual Concentration(µg/m³)	
		Baseline	Impact	Baseline	Impact
1	Primary School	0.06	0.14	0.00	0.01
2	Primary School	0.03	0.09	0.00	0.00
3	Madrasa	0.04	0.10	0.00	0.01
4	Primary School	0.06	0.15	0.00	0.01
5	Primary School	0.06	0.12	0.00	0.01
6	Primary School	0.05	0.10	0.00	0.01
7	Family Welfare Centre	0.07	0.16	0.00	0.00
8	Primary School	0.04	0.12	0.00	0.01
9	Primary School	0.06	0.15	0.00	0.01
10	Family Welfare Centre	0.03	0.07	0.00	0.01
11	Madrasa	0.05	0.11	0.00	0.01
12	Hospital	0.05	0.14	0.00	0.01
13	Primary School	0.06	0.13	0.00	0.01
14	Community Clinic	0.04	0.12	0.00	0.01
15	Primary School	0.04	0.13	0.00	0.01
16	Primary School	0.09	0.25	0.00	0.01
17	Primary School	0.06	0.17	0.00	0.01
18	Primary School	0.04	0.13	0.00	0.01
19	High School	0.05	0.14	0.00	0.00
20	High School	0.05	0.14	0.00	0.00
21	Primary School	0.05	0.13	0.00	0.00
22	Union HQ	0.04	0.08	0.00	0.01
23	Primary School	0.05	0.16	0.00	0.01
24	Primary School	0.05	0.16	0.00	0.01
25	Primary School	0.04	0.11	0.00	0.01
26	Primary School	0.06	0.15	0.00	0.01
27	Primary School	0.05	0.15	0.00	0.01
28	Primary School	0.05	0.19	0.00	0.01
29	Primary School	0.04	0.08	0.00	0.00
30	Primary School	0.04	0.16	0.00	0.01
31	High School	0.04	0.08	0.00	0.00
32	Primary School	0.05	0.14	0.00	0.01
33	Union HQ	0.04	0.10	0.00	0.01
34	High School	0.04	0.11	0.00	0.01
35	Union HQ	0.05	0.18	0.00	0.01

Sl	Name of Sensitive Receptors	24 hr Concentration(µg/m³)		Annual Concentration(µg/m³)	
		Baseline	Impact	Baseline	Impact
36	Primary School	0.03	0.08	0.00	0.01
37	Primary School	0.09	0.22	0.00	0.01
38	Upazila HQ	0.04	0.10	0.00	0.01
39	Primary School	0.02	0.03	0.00	0.00
40	Family Welfare Centre	0.09	0.21	0.00	0.01
41	Primary School	0.05	0.13	0.00	0.01
42	Madrasa	0.02	0.03	0.00	0.00
43	Primary School	0.06	0.17	0.00	0.01
44	Primary School	0.02	0.03	0.00	0.00
45	Community Clinic	0.05	0.20	0.00	0.01
46	Primary School	0.07	0.18	0.00	0.01
47	Primary School	0.04	0.15	0.00	0.00
48	Primary School	0.02	0.06	0.00	0.00
49	Primary School	0.10	0.31	0.00	0.01
50	Primary School	0.03	0.06	0.00	0.00
51	Primary School	0.08	0.24	0.00	0.01
52	Primary School	0.07	0.23	0.00	0.01
53	Primary School	0.04	0.14	0.00	0.01
54	Madrasa	0.02	0.04	0.00	0.00
55	Primary School	0.06	0.18	0.00	0.01
56	Primary School	0.02	0.05	0.00	0.00
57	Primary School	0.02	0.04	0.00	0.00
58	Madrasa	0.09	0.27	0.00	0.01
59	Community Clinic	0.04	0.05	0.00	0.00
60	Union HQ	0.05	0.05	0.00	0.00
61	Primary School	0.08	0.27	0.00	0.01
62	Primary School	0.05	0.14	0.00	0.01
63	Primary School	0.07	0.25	0.00	0.01
64	Family Welfare Centre	0.06	0.08	0.00	0.00
65	Primary School	0.03	0.03	0.00	0.00
66	Primary School	0.02	0.05	0.00	0.00
67	Madrasa	0.03	0.07	0.00	0.00
68	Primary School	0.05	0.13	0.00	0.01
69	Primary School	0.09	0.30	0.00	0.01
70	Primary School	0.03	0.08	0.00	0.00
71	Primary School	0.04	0.08	0.00	0.00

Sl	Name of Sensitive Receptors	24 hr Concentration(µg/m³)		Annual Concentration(µg/m³)	
		Baseline	Impact	Baseline	Impact
72	Family Welfare Centre	0.07	0.20	0.00	0.01
73	Union HQ	0.07	0.21	0.00	0.01
74	Primary School	0.03	0.10	0.00	0.00
75	Primary School	0.07	0.22	0.00	0.01
76	Primary School	0.07	0.22	0.00	0.01
77	Primary School	0.05	0.15	0.00	0.01
78	Primary School	0.03	0.10	0.00	0.00
79	Primary School	0.08	0.25	0.00	0.01
80	Primary School	0.08	0.23	0.00	0.01
81	Primary School	0.07	0.21	0.00	0.01
82	Primary School	0.07	0.22	0.00	0.01
83	Primary School	0.07	0.22	0.00	0.01
84	Madrasa	0.06	0.19	0.00	0.01
85	Primary School	0.06	0.18	0.00	0.01
86	Primary School	0.05	0.18	0.00	0.01
87	Primary School	0.07	0.25	0.00	0.01
88	Community Clinic	0.07	0.20	0.01	0.02
89	Primary School	0.10	0.29	0.00	0.01
90	Union HQ	0.07	0.19	0.01	0.02
91	Primary School	0.04	0.09	0.00	0.00
92	Family Welfare Centre	0.06	0.17	0.01	0.02
93	Primary School	0.05	0.15	0.00	0.01
94	Growth Centre	0.10	0.27	0.00	0.01
95	Bangabandhu Eco Park	0.02	0.04	0.00	0.00
96	Primary School	0.05	0.15	0.01	0.02
97	Community Clinic	0.08	0.22	0.00	0.01
98	Primary School	0.06	0.17	0.01	0.02
99	Family Welfare Centre	0.07	0.20	0.00	0.01
100	Primary School	0.05	0.16	0.00	0.01
101	Primary School	0.07	0.21	0.00	0.01
102	Jamuna Resort	0.01	0.04	0.00	0.00
103	Union HQ	0.07	0.20	0.00	0.01
104	Primary School	0.06	0.16	0.01	0.02
105	District HQ	0.08	0.18	0.01	0.02
106	Upazila HQ	0.08	0.21	0.01	0.02
107	Primary School	0.08	0.19	0.01	0.02

SI	Name of Sensitive Receptors	24 hr Concentration(μg/m³)		Annual Concentration(μg/m³)	
		Baseline	Impact	Baseline	Impact
108	High School	0.07	0.19	0.01	0.02
109	Primary School	0.05	0.16	0.01	0.02
110	Primary School	0.05	0.15	0.01	0.02
111	Barashimul village Monitoring Point	0.02	0.05	0.00	0.00
112	Eco park Monitoring Point	0.02	0.04	0.00	0.00
113	Rehabilitation village Monitoring Point	0.05	0.05	0.00	0.00
114	Power Plant site Monitoring Point	0.02	0.03	0.00	0.00

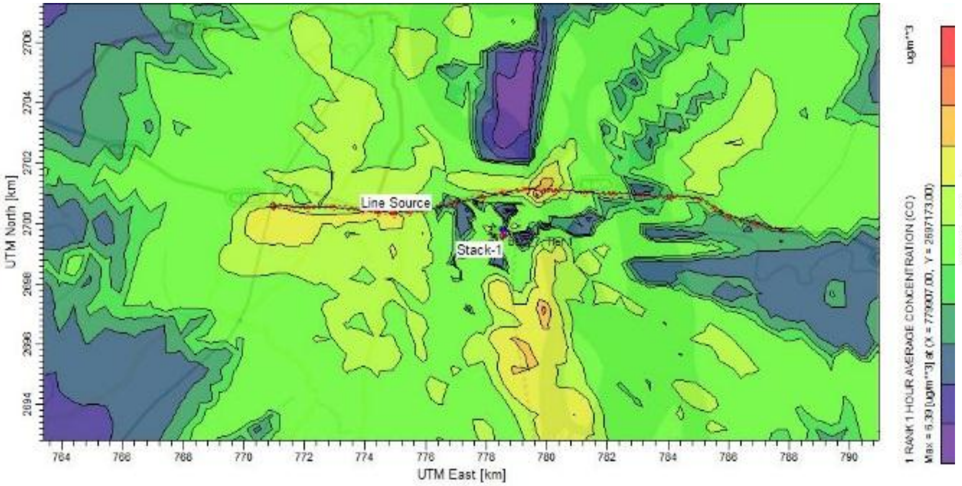


Figure: Baseline 1-Hr CO

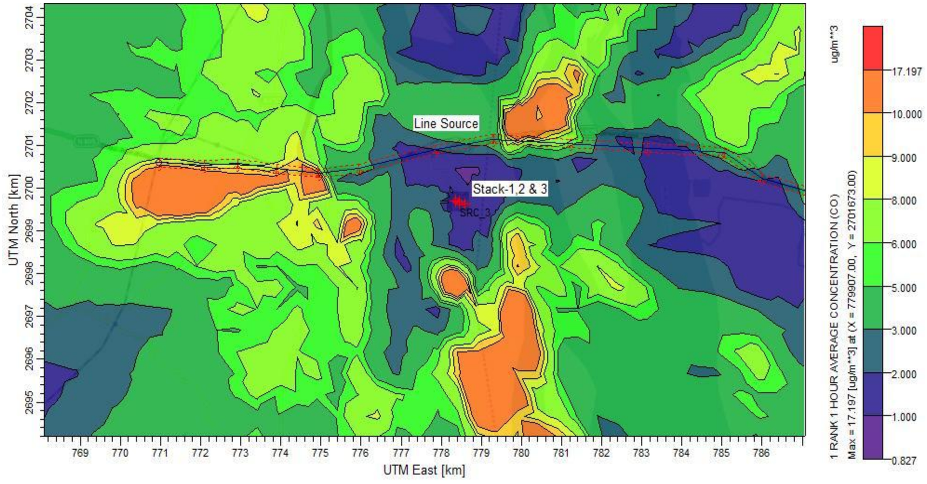


Figure: Impact 1-Hr CO

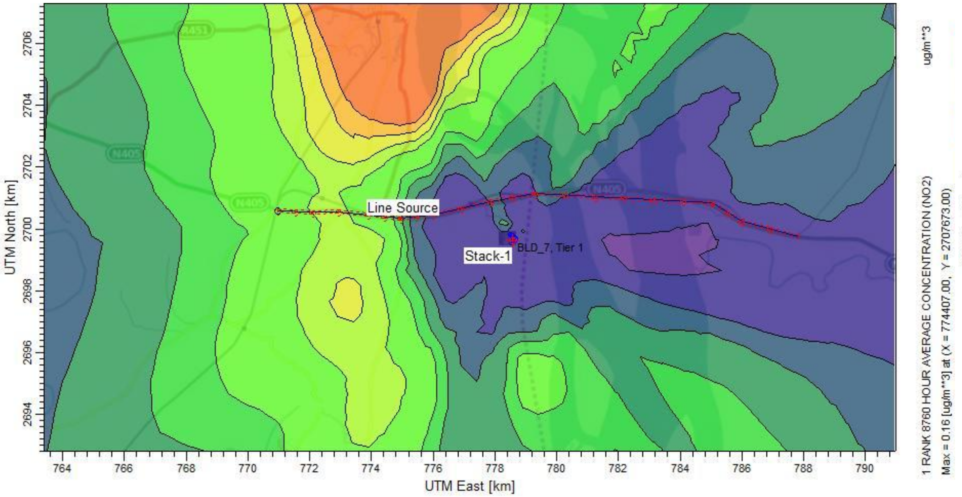


Figure: Baseline Annual NO_2

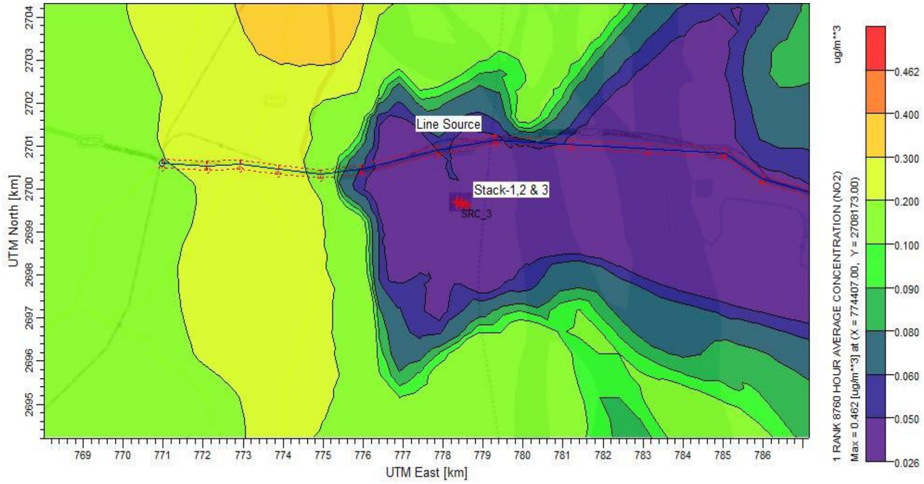


Figure: Impact Annual NO_2

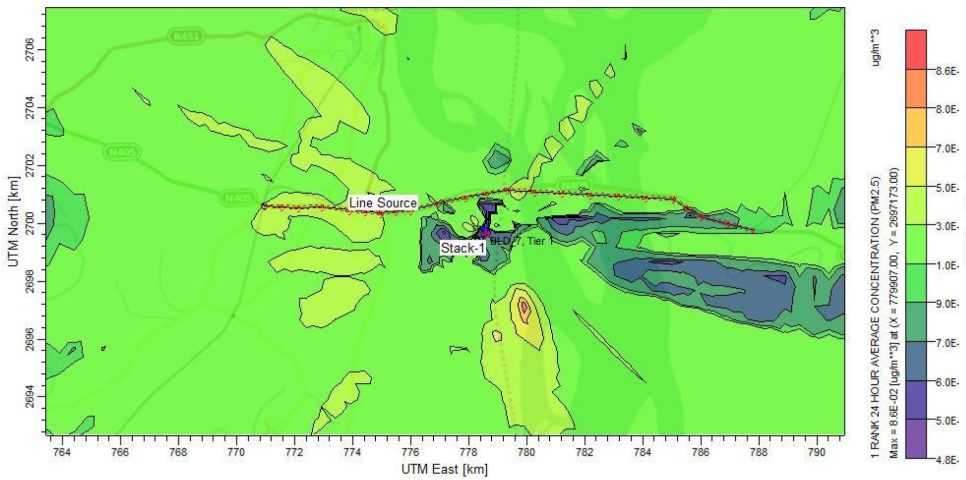


Figure: Baseline 24-Hr PM2.5

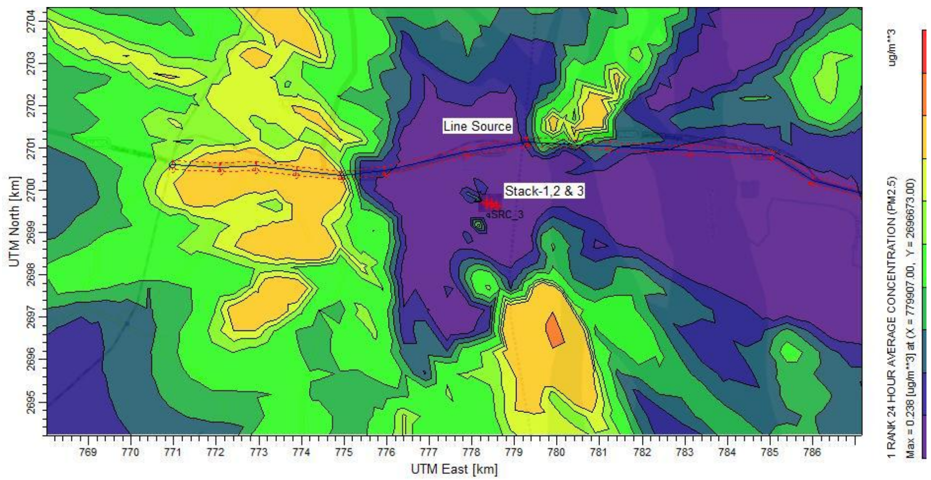


Figure: Impact 24 Hr PM2.5

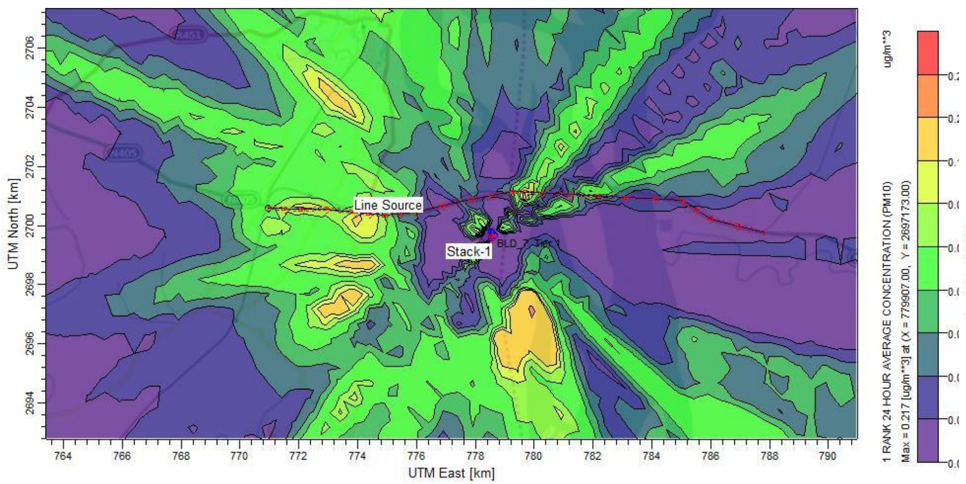


Figure: Baseline 24 Hr PM10

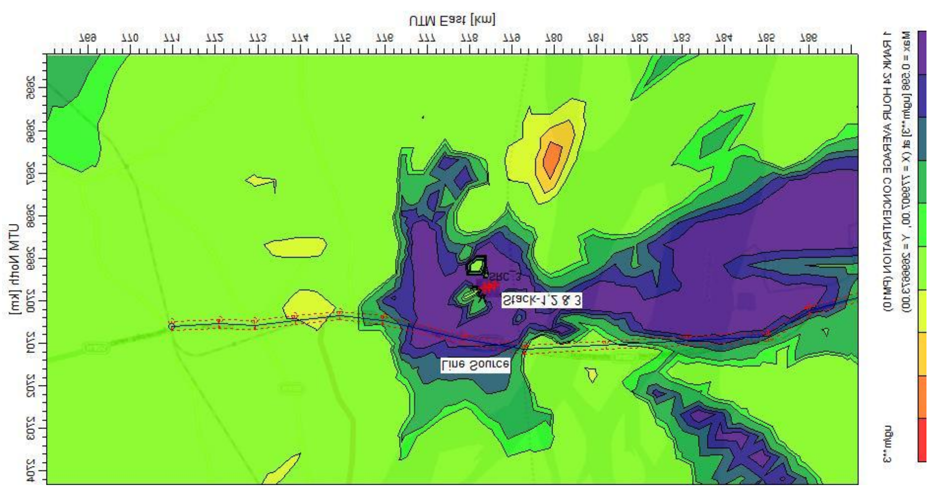


Figure: Impact 24 Hr PM10

Appendix-8: Environmental Code of Practice

Introduction

The objective of the Environmental Code of Practices (ECPs) is to address all potential and general construction related impacts of Sirajganj Power Plant-3rd unit. The ECPs will provide guidelines for best operating practices and environmental management guidelines to be followed by the contractors for sustainable management of all environmental issues. These ECPs shall be annexed to the general conditions of all the contracts, including subcontracts, carried out under the Project.

The list of ECPs prepared for the Project is given below.

ECP 1: Waste Management
ECP 2: Fuels and Hazardous Goods Management
ECP 3: Water Resources Management
ECP 4: Drainage Management
ECP 5: Soil Quality Management
ECP 6: Erosion and Sediment Control
ECP 7: Top Soil Management
ECP 8: Topography and Landscaping
ECP 9: Quarry Areas Development and Operation
ECP 10: Air Quality Management
ECP 11: Noise and Vibration Management
ECP 12: Protection of Flora
ECP 13: Protection of Fauna
ECP 14: Protection of Fish
ECP 15: Road Transport and Road Traffic Management
ECP 16: Construction Camp Management
ECP 17: Cultural and Religious Issues
ECP 18: Worker Health and Safety
ECP 19: Construction and Operation Phase Security

Contractors will prepare site specific management plans, namely Construction Environmental Management Plan (CEMP), in compliance with financers guidelines and Environmental Conservation Rules o 1997 of Bangladesh and based on the guidance given in the ECPs. The CEMP will form the part of the contract documents and will be used as monitoring tool for compliance. It is mandatory for the main contractors procured directly by the project to include these ECPs in their subcontracts. Violation of these requirements will be treated as non-compliance leading to the corrections or otherwise imposing penalty on the contractors.

ECP 1: Waste Management

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
General Waste	Soil and water pollution from the improper management of wastes and excess materials from the construction sites.	The Contractor shall • Develop site specific waste management plan for various waste streams (e.g., reusable waste, flammable waste, construction debris, food waste etc.) prior to commencing of construction and submit to supervision consultant for approval. • Organize disposal of all wastes generated during construction in the designated disposal sites approved by the Project authority.

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
		• Minimize the production of waste materials by 3R (Reduce, Recycle and Reuse) approach. • Segregate all wastes, wherever practical. • Vehicles transporting solid waste shall be totally confined within an enclosed vehicle or is fully covered with a tarp to prevent spilling waste along the route. • Tarp must be undamaged (not torn or frayed) properly secured to the body of the vehicle or trailer with ropes, chains, straps, or cords so that no waste is exposed. The edges of the tarps shall extend 12 inches over the permanent sides and back of the open top vehicle or trailer and must be secured to the permanent vehicle. All loads must be tarped from the point of origin of the waste to the tipping area of the final disposal/landfill. • Train and instruct all personnel in waste management practices and procedures as a component of the environmental induction process. • Provide refuse containers at each worksite. • Request suppliers to minimize packaging where practicable. • Place a high emphasis on good housekeeping practices. • Maintain all construction sites clean, tidy and safe and provide and maintain appropriate facilities as temporary storage of all wastes before transporting to final disposal. • Potable water should be supplied in bulk containers to reduce the quantity of plastic waste (plastic bins). Plastic bag use should be avoided.
Hazardous Waste	Health hazards and environmental impacts due to improper waste management practices	The Contractor shall • Collect chemical wastes in 200 liter drums (or similar sealed container), appropriately labeled for safe transport to an approved chemical waste depot. • Store, transport and handle all chemicals avoiding potential environmental pollution. • Store all hazardous wastes appropriately in bunded areas away from water courses. • Make available all Material Safety Data Sheets (MSDS) for hazardous materials on-site during construction. • Collect hydrocarbon wastes, including lube oils, for safer transport off-site to reuse, recycle, treatment or disposal at approved locations. • Construct concrete or other impermeable hard-stand to prevent seepage in case of spills. • Keep sufficient stock of absorbents for generally used chemicals or for petrochemicals (e.g., dirt, sawdust, etc.) within the storage area to contain accidental spills.

ECP 2: Fuels and Hazardous Goods Management

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Fuels and hazardous goods.	Materials used in construction have a potential to be a source of contamination. Improper storage and handling of fuels, lubricants, chemicals, hazardous goods/materials on-site, wash down of plant and equipment, and potential spills may harm the environment or health of construction workers.	The Contractor shall • Prepare spill control procedures and submit them for supervision consultant for approval. • Train the relevant construction personnel in handling of fuels and spill control procedures. • Refueling shall occur only within bunded areas. • Store dangerous goods in bunded areas on top of a sealed plastic sheet away from watercourses. Store all liquid fuels in fully bunded storage containers, with appropriate volumes, a roof, a collection point and appropriate filling/decanting point. • Store and use fuels in accordance with material safety data sheets (MSDS). Make available MSDS for chemicals and dangerous goods on-site. • Store hazardous materials at above flood level,determined for construction. • Make sure all containers, drums, and tanks that are used for storage are in good condition and are labeled with expiry date. Any container, drum, or tank that is dented, cracked, or rusted might eventually leak. Check for leakage regularly to identify potential problems before they occur. • Sit containers and drums in temporary storages in clearly marked areas, where they will not be run-over by vehicles or heavy machinery. The area shall preferably drain to a safe collection area in the event of a spill. • Take all precautionary measures when handling and storing fuels and lubricants, avoiding environmental pollution. • All machinery is to be stored and away from any water body, drainage inlets or natural drainage area, where practical. Environmental control measures such as appropriate barriers (i.e. bunding, sediment fence, etc.) will be considered and/or implemented to control runoff away from the machinery and prevent any washout in to adjacent water body, drainage inlets or natural drainage area. • Transport waste of dangerous goods, which cannot be recycled, to an approved

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
		waste disposal facility. Safe transport of fuel or other hazardous liquids to and from the storage container will be facilitated through the provision detailed within the Material Safety Data Sheets (MSDS). • Wash down of plant and equipment and vehicle servicing will be performed only in isolated impervious areas away from drainage inlets, connecting the drainage with an oil interceptor. Pits/bunds located away from waterways will be provided for concrete wash near construction areas. The contractor's environmental officer with assistance from supervisors is to ensure that pits/bunds are available, maintained at capacity and drivers instructed regarding the location and required procedures. • Keep stock of absorbent and containment material (e.g., absorbent matting, dirt, sawdust, etc.) where hazardous material are used and stored; and ensure staffs are trained in their correct use. • Oil and chemical spills and washouts shall be cleaned up and collected immediately, where safety permits. Disposal of remediated / cleanup/ washout materials shall be to an approved waste disposal facility. Materials shall be transported by an approved / licensed transporter. Contaminated Material to be removed from site as soon as reasonably practical after the incident. • Provide appropriate personal protective equipment (protective clothing, safety boots, helmets, masks, gloves, goggles, etc.) to the construction personnel, depending on the materials handled. • Avoid the use of material with greater potential for contamination by substituting them with more environmentally friendly materials.

ECP 3: Water Resources Management

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Hazardous material and Waste	Water pollution from the storage, handling and disposal of hazardous materials and general construction waste, and accidental spillage	The Contractor shall • Follow the management guidelines proposed inECP 1: Waste Management and ECP 2: Fuels and Hazardous Goods Management. • Minimize the generation of spoils, oil and grease, excess nutrients, organic matter, litter, debris and any form of waste (particularly petroleum and chemical wastes). These substances must not enter waterways or storm water systems.
Discharge from construction sites	Construction activities, sewerages from construction sites and work camps may effect the surface water quality. The construction works will modify groundcover and topography, changing the surface water drainage patterns of the area. These changes in hydrological regime lead to increased rate of runoff, increase in sediment and contaminant loading, increased flooding, and effect habitat of fish and other aquatic biology.	The Contractor shall • Install temporary drainage works (channels and check dams) in areas required for sediment and erosion control and around storage areas for construction materials. • Install temporary sediment lagoons, where appropriate, to capture sediment-laden run-off from work site. • Divert runoff from undisturbed areas around the construction site. • Stockpile materials away from drainage lines. • Prevent all solid and liquid wastes entering waterways by collecting spoils, oils, chemicals, bitumen spray waste and wastewaters from brick, concrete and asphalt cutting where possible and transport to an approved waste disposal site or recycling depot. • Wash out ready-mix concrete agitators and concrete handling equipment at washing facilities off site or into approved bunded areas on site. Ensure that tires of construction vehicles are cleaned in the washing bay (constructed at the entrance of the construction site) to remove the mud from the wheels. This should be done in every exit of each construction vehicle to ensure the local roads are kept clean.
Soil erosion and siltation	Soil erosion and dust from the material stockpiles will increase the sediment and contaminant loading of surface water bodies.	The Contractor shall • Stabilize the cleared areas not used for construction activities with vegetation or appropriate surface water treatments as soon as practicable following earthwork to minimize erosion. • Ensure that roads used by construction vehicles are swept regularly to remove dust and sediment. • Water the loose material stockpiles, access roads and bare soils on an as needed basis to

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
		minimize dust. Increase the watering frequency during periods of high risk (e.g. high winds).
Drinking water	Untreated surface water is not suitable for drinking purposes due to presence of suspended solids and ecoli.	The Contractor Shall • Provide drinking water that meets National and WHO Drinking Water standards. Drinking water to be chlorinated at source, and ensure presence of residual chlorine 0.1 ~ 0.25 ppm as minimum after 30 minutes of chlorine contact time.

ECP 4: Drainage Management

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Excavation and earth works, and construction yards	Lack of proper drainage for rainwater/liquid waste or wastewater owing to the construction activities harms environment in terms of water and soil contamination, and mosquito growth.	The Contractor shall • Prepare drainage management procedures and submit them for supervision consultant for approval. • Prepare a program to prevent/avoid standing waters, which supervision consultant will verify in advance and confirm during implementation. • Provide alternative drainage for rainwater if the construction works/earth-fillings cut the established drainage line. • Establish local drainage line with appropriate silt collector and silt screen for rainwater or wastewater connecting to the existing established drainage lines already there. • Rehabilitate road drainage structures immediately if damaged by contractors' road transports. • Build new drainage lines as appropriate and required for wastewater from construction yards connecting to the available nearby recipient water bodies. Ensure wastewater quality conforms to National Standards, before it is being discharged into the recipient water bodies. • Ensure that there will be no water stagnation at the construction sites and camps. • Provide appropriate silt collector and silt screen at the inlet and manholes and periodically clean the drainage system to avoid drainage congestion. • Protect natural slopes of drainage channels to ensure adequate storm water drains. • Regularly inspect and maintain all drainage channels to assess and alleviate any drainage congestion problem.

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Ponding of water	Health hazards due to mosquito breeding	• Do not allow ponding of water especially near the waste storage areas and construction camps. • Discard all the storage containers that are capable of storing of water, after use or store them in inverted position.

ECP 5: Soil Quality Management

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Storage of hazardous and toxic chemicals	Spillage of hazardous and toxic chemicals will contaminate the soils	The Contractor shall • Strictly manage the wastes management plans proposed in ECP 1: **Waste Management** and storage of materials and ECP 2**: Fuels and Hazardous Goods Management**. • Construct appropriate spill containment facilities for all fuel storage areas. • Establish and maintain a hazardous material register detailing the location and quantities of hazardous substances including the storage, and their disposals. • Train personnel and implement safe work practices for minimizing the risk of spillage. • Identify the cause of contamination, if it is reported, and contain the area of contamination. The impact may be contained by isolating the source or implementing controls around the affected site. • Remediate the contaminated land using the most appropriate available method.
Construction material stock piles	Erosion from construction material stockpiles may contaminate the soils	The Contractor shall • Protect the toe of all stockpiles, where erosion is likely to occur, with silt fences, straw bales or bunds.

ECP 6: Erosion and Sediment Control

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Clearing of construction sites	Cleared areas and slopes are susceptible for erosion of top soils, which affects the growth of vegetation and causes ecological imbalance.	The Contractor shall • Prepare site specific erosion and sediment control measures and submit them for supervision consultant for approval. • Reinstate and protect cleared areas as soon as possible. • Cover unused area of disturbed or exposed surfaces immediately with mulch/grass

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
		turf/tree plantations.
Construction activities and material stockpiles	The impact of soil erosion are (i) Increased run off and sedimentation causing a greater flood hazard to the downstream and silt accumulation and (ii) destruction of aquatic environment by erosion and/or deposition of sediment damaging the spawning grounds of fish	The Contractor shall • Locate stockpiles away from drainage lines. • Protect the toe of all stockpiles, where erosion is likely to occur, with silt fences, straw bales or bunds. • Remove debris from drainage paths and sediment control structures. • Cover the loose sediments of construction material and water them if required. • Divert natural runoff around construction areas prior to any site disturbance. • Install protective measures on site prior to construction, for example, sediment traps. • Install ‘cut off drains’ on large cut/fill batter slopes to control water runoff speed and hence erosion. • Observe the performance of drainage structures and erosion controls during rain and modify as required.
Soil erosion and siltation	Soil erosion and dust from the material stockpiles will increase the sediment and contaminant loading of surface water bodies.	The Contractor shall • Stabilize the cleared areas not used for construction activities with vegetation or appropriate surface water treatments as soon as practicable following earthwork to minimize erosion. • Ensure that roads used by construction vehicles are swept regularly to remove sediment. • Water the material stockpiles, access roads and bare soils on an as required basis to minimize dust. Increase the watering frequency during periods of high risk (e.g. high winds).

ECP 7: Top Soil Management

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Land clearing and earth works	Earthworks will impact the fertile top soils that are enriched with nutrients required for plant growth or agricultural development.	The Contractor shall • Strip the top soil to a depth of 35 cm and store in stock piles of height not exceeding 2m. • Remove unwanted materials from top soil like grass, roots of trees and others. • The stockpiles will be done in slopes of 2:1 to reduce surface runoff and enhance percolation through the mass of stored soil. • Locate topsoil stockpiles in areas outside drainage lines and protect from erosion. • Construct diversion channels and silt fences around the topsoil stockpiles to prevent erosion and loss of topsoil. • Spread the topsoil to maintain the physico-chemical and biological activity of the soil. The stored top soil will be utilized for covering all disturbed area and along the proposed plantation sites. • Prior to the re-spreading of topsoil, the ground surface will be ripped to assist the bunding of the soil layers, water penetration and re-vegetation
Transport	Vehicular movement outside ROW or temporary access roads will affect the soil fertility of the agricultural lands	• Limit equipment and vehicular movements to within the approved construction zone. • Plan construction access to make use, if possible, of the final road alignment.

ECP 8: Topography and Landscaping

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Land clearing and earth works	Construction activities especially earthworks will change topography and disturb the natural rainwater/flood water drainage as well as change the local landscape.	The Contractor shall • Prepare landscaping and plantation plan and submit the plan to supervision consultant for approval. • Ensure the topography of the final surface of all raised lands (construction yards, approach roads and rails, access roads, etc.) are conducive to enhance natural draining of rainwater/flood water. • Keep the final or finished surface of all the raised lands free from any kind of depression that causes water logging. • Undertake mitigation measures for erosion control/prevention by grass-turfing and tree plantation, where there is a possibility of rain-cut that will change

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
		the shape of topography. • Cover immediately the uncovered open surface that has no use of construction activities with grass-cover and tree plantation to prevent soil erosion and better landscaping. • Reinstate the natural landscape of the ancillary construction sites after completion of works.

ECP 9: Quarry Areas Development and Operation

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Development and operation of borrow areas	Borrow areas might have impacts on local topography, landscaping and natural drainage.	The Contractor shall • Prepare borrow/quarry area management plan and submit the plan for supervision consultant approval. • Use only approved quarry and borrow sites. • Identify new borrow and quarry areas in consultation with the client, if required. • Reuse excavated or disposed material available in the project to the maximum extent possible. • Store top soil for reinstatement and landscaping. • Develop surface water collection and drainage systems, anti-erosion measures (berms, revegetation etc.) and retaining walls and gabions where required. Implement mitigation measures in, **ECP 3 : Water Resource Management** and**ECP 6: Erosion and Sediment Control** • The use of explosive should be used as low as possible to reduce noise, vibration, and dust. • Control dust and air pollution by application of watering and implementing mitigation measures proposed in **ECP 10: Air Quality Management** • Noise and vibration control by **ECP 11:** Noise and Vibration Management.

ECP 10: Air Quality Management

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Construction vehicular traffic	Air quality can be adversely affected by vehicle exhaust emissions and combustion of fuels.	The Contractor shall • Prepare air quality management plan (under the Pollution Prevention Plan) and submit the plan for supervision consultant approval. • Fit vehicles with appropriate exhaust systems and emission control devices. Maintain these devices in good working condition. • Operate the vehicles in a fuel efficient manner. • Cover hauling vehicles carrying dusty materials moving outside the construction site. • Impose speed limits on all vehicle movement at the worksite to reduce dust emissions. • Control the movement of construction traffic. • Water construction materials prior to loading and transport. • Service all vehicles regularly to minimize emissions. • Limit the idling time of vehicles not more than 2 minutes.
Construction machinery	Air quality can be adversely affected by emissions from machinery and combustion of fuels.	The Contractor shall • Fit machinery with appropriate exhaust systems and emission control devices. Maintain these devices in good working condition in accordance with the specifications defined by their manufacturers to maximize combustion efficiency and minimize the contaminant emissions. Proof of maintenance register shall be required by the equipment suppliers and contractors/subcontractors. • Pay special attention to control emissions from fuel generators. • Machinery causing excessive pollution (e.g., visible smoke) will be banned from construction sites. • Service all equipment regularly to minimize emissions. • Provide filtering systems, dust collectors or humidification or other techniques (as applicable) to the concrete batching and mixing plant to control the particle emissions in all stages, including unloading, collection, aggregate handling, cement application, circulation of trucks and machinery inside the installations.
Construction activities	Dust generation from construction sites, material stockpiles and access roads is a nuisance in the	The Contractor shall • Water the material stockpiles, access roads and bare soils on an as needed basis to minimize the potential for environmental nuisance due to dust. Increase the watering frequency during periods of

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
	environment and can be a health hazard, and also can affect the adjacent water bodies	high risk (e.g. high winds). Stored materials such as gravel and sand shall be covered and confined to avoid their being wind-drifted. • Minimize the extent and period of exposure of the bare surfaces. • Restore disturbed areas as soon as practicable by grasses or trees • Store the cement in silos and minimize the emissions from silos by equipping them with filters. • Establish adequate locations for storage, mixing and loading of construction materials, in a way that dust generation is minimized during such operations. • Use water as dust suppression in such way that will never produce any liquid waste stream. • Crushing of rock and aggregate materials shall be wet-crushed, or performed with particle emission control systems. • Not permit the burning of solid waste.

ECP 11: Noise and Vibration Management

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Construction vehicular traffic	Noise quality will be deteriorated due to vehicular traffic	The Contractor shall • Prepare a noise and vibration management plan (under the Pollution Prevention Plan) and submit the plan for supervision consultant/Owners Engineer (OE) for approval. • Maintain all vehicles in order to keep it in good working condition in accordance with manufactures maintenance procedures. • Make sure all drivers will comply with the traffic codes concerning maximum speed limit, driving hours, etc. • Perform the loading and unloading of trucks, and handling operations minimizing construction noise on the work site.
Construction machinery	Noise and vibration may have an impact on people, property, fauna, livestock and the natural environment.	The Contractor shall • Appropriately organize all noise generating activities to avoid noise pollution to local residents. • Use the quietest available machinery and equipment in construction work. • Maintain all equipment in order to keep them in good working order in accordance with manufactures maintenance procedures.

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
		Equipment suppliers and contractors shall present proof of maintenance register of their equipments. • Install acoustic enclosures around generators to reduce noise levels. • Fit high efficiency mufflers to appropriate construction equipment. • Avoid unnecessary use of alarms, horns and sirens.
Construction activity	Noise and vibration may have an impact on people, property, fauna, livestock and the natural environment.	The Contractor shall • Notify adjacent landholders prior to typical noise events outside of daylight hours. • Educate the operators of construction equipment on potential noise problems and the techniques to minimize noise emissions. • Employ best available work practices on-site to minimize occupational noise levels. • Install temporary noise control barriers where appropriate. • Notify affected people if major noisy activities will be undertaken, e.g. blasting. • Plan activities on site and deliveries to and from site to minimize impact. • Monitor and analyze noise and vibration results and adjust construction practices as required. • Avoid undertaking the noisiest activities, where possible, when working at night near the residential areas.

ECP 12: Protection of Flora

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Vegetation clearance for site preparation	Clearance of vegetation for materials storing, labour shed construction and all kind of civil structures construction	The Contractor shall- • Prepare a plan to clearance of vegetation supervised by experienced consultant • Use comparatively barren places for storing/ labour shed to minimize vegetation damage • Clear only the vegetation that needs to be cleared in accordance with the engineering plans and designs. These measures are applicable to both the construction areas as well as to any associated activities such as sites for storing, labour movement and construction vehicle running • Aware and trained the workers regarding nature protection and the need of avoid vegetation damage during construction

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
		• Implement proper plantation after completion of construction works prior to engaging experienced plantation planner

ECP 13: Protection of Fauna

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Construction activities	Damage of wildlife habitat and relocation wildlife from the construction site due to vegetation damage	The Contractor shall • Survey faunal communities at first before site clearing and prepare a plan for protection of fauna supervised by experienced consultant • Use comparatively barren places for storing/ labour shed to minimize vegetation damage • Limit the construction works within the designated sites allocated to the contractors. • Check the site (both sites for Unit-3 and Unit 4) for trapped animals, rescue them by the help of a qualified person and release them in nearer protected area (i.e.: Bangabandhu-Jamuna Eco-park).
	Interrupt free movement of wildlife for placement of machineries/construction materials and generate noise	The Contractor shall- • Reserve a corridor through the construction sites to provide temporary access to the animals from the site for Unit 2 to Unit 4. • Aware workers about wildlife conservation
Night time lighting	Disturbance to nocturnal animals for excess lightening at the site	The Contractor shall • Use lower wattage flat lens fixtures that direct light down and reduce glare, thus reducing light pollution, • Avoid floodlights unless they are required. • Use motion sensitive lighting to minimize unneeded lighting. • Use, if possible, green lights that are considered as bird's friendly lighting instead of white or red colored lights. • Install light shades or plan the direction of lights to reduce light spilling outside the construction area. • Avoid working in night time
Excess level noise	Fear/scared wildlife like birds and rodents due excess noise	The Contractor shall • Use sound limiter with gas stacks • Implement green belt with dense canopy plants surround the proposed power unit

ECP 14: Protection of fish and aquatic ecosystems

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Spillage from water vessels which carry power machinery and ancillaries	Deteriorate aquatic habitat quality of nearby river channel due to disposal of waste like ballast and bilge water	The contractor shall • Warn to the vessel sailors to ensure taking all cautionary steps for protecting spillage in river water • Ensure the construction equipment used in the river are well maintained and do not have oil leakage to contaminate river water • Make an emergency oil spill containment plan (under the Fuels and Hazardous Substances Management Plan) to be supported with enough equipment, materials and human resources if discharged any incautious event.
Accidental discharge of hazardous effluents and hot water	Demolished aquatic micro organisms/fishes and deteriorate habitat quality	The Contractor shall • Follow mitigation measures proposed ECP 3: Water Resources Management and ECP 4: Drainage Management.

ECP 15: Road Transport and Road Traffic Management

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Construction vehicular traffic	Increased traffic use of road by construction vehicles will affect the movement of normal road traffics and the safety of the road-users.	The Contractor shall • Prepare a traffic management plan and submit the plan for supervision consultant approval. • Strictly follow the Project's 'Traffic Management Plan' and work with close coordination with the Traffic Management Unit. • Prepare and submit additional traffic plan, if any of his traffic routes are not covered in the Project's Traffic Management Plan, and requires traffic diversion and management. • Include in the traffic plan to ensure uninterrupted traffic movement during construction: detailed drawings of traffic arrangements showing all detours, temporary road, temporary bridges, temporary diversions, necessary barricades, warning signs / lights, road signs, construction schedule etc. • Provide signs at strategic locations of the roads complying with the schedules of signs contained in the National Traffic

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
		Regulations.
	Accidents and spillage of fuels and chemicals	The Contractor shall • Restrict truck deliveries, where practicable, to day time working hours. • Restrict the transport of oversize loads. • Operate vehicles, if possible, to non-peak periods to minimize traffic disruptions. • Enforce on-site speed limit, especiallyclose to the sensitive receptors, schools, health centers, etc.

ECP 16: Construction Camp Management

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Siting and location of construction camps	Campsites for construction workers are the important locations that have significant impacts such as health and safety hazards on local resources and infrastructure of nearby communities	The Contractor shall • Prepare a construction camp management plan and submit the plan to supervision consultant/OE for approval. • Locate the construction camps within the designated sites or at areas which are acceptable from environmental, cultural or social point of view and approved by the supervision consultant/OE or the Client. • Conduct consultation with communities including local government institutes bodies prior to set-up the camp. • 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 supervision consultant 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 access 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 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 matters.

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Construction Camp Facilities	Lack of proper infrastructure facilities, such as housing, water supply, and sanitation facilities will increase pressure on the local services and generate substandard living standards and health hazards.	Contractor shall provide the following facilities in the campsites • Adequate housing for all workers. • Safe and reliable water supply, which should meet national/WHO standards. Drinking water to be chlorinated at source, and ensure presence of residual chlorine 0.1 ~ 0.25 ppm as minimum after 30 minutes of chlorine contact time (WHO guideline). • Hygienic sanitary facilities and sewerage system. The toilets and domestic waste water will be collected through a common sewerage. Provide separate latrines and bathing places for males and females with total isolation 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. • Paved internal roads. • Provide child crèches/day care center facilities for women working at 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.

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Disposal of waste	Management of wastes is crucial to minimize impacts on the environment	The Contractor shall • Ensure proper collection and disposal of solid wastes within the construction camps. • Insist waste separation by source; organic wastes in one container and inorganic wastes in another container at household level. Color marked bins can be used for the separation of wastes at source. • 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 equipment/vehicles needed. • Do not establish site specific landfill sites. All solid waste will be collected and removed from the work camps and disposed in approved waste disposal sites.
Fuel supplies for cooking purposes	Illegal sourcing of fuel wood by construction workers will impact the natural flora and fauna	The Contractor shall • Provide fuel to the construction camps for their domestic purpose, in order to discourage them to use fuel wood or other biomass. • Made available alternative fuels like natural gas or kerosene on ration to the workforce in order to prevent them from using biomass for cooking. • Conduct awareness campaigns to educate workers on preserving the protection of biodiversity and wildlife of the project area, and relevant government regulations and punishments on wildlife protection.
Health and Hygiene	There will be a potential for diseases to be transmitted including malaria, exacerbated by inadequate health and safety practices. There will be an increased risk of work crews spreading sexually transmitted diseases (STD), infections (STI) such as HIV/AIDS.	The Contractor shall • 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 about basic sanitation and health care issues and safety matters, and on the specific hazards of their work. • Provide HIV awareness programming,

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
		including STI, STD and especially HIV information, education and communication for all workers on regular basis. • Provide adequate drainage facilities throughout the camps to ensure that the source of vector borne diseases such as stagnant water bodies and puddles do not form. Regular mosquito repellant sprays during rainy season in offices, construction camps and yards. • Not disposing food waste openly as that will attract rats and stray dogs. • 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 hygiene practices.
Security and Safety	Inadequate security and safety provision in construction camps may create security and safety problems of workforces and assets and fire hazards	The Contractor shall • Provide appropriate security personnel (police or private security guards) and enclosures to prevent unauthorized entry in to the camp area. • Maintain register to keep a track on a head count of persons present in the camp at any given time. • Encourage use of flameproof material for the construction of labor housing / site office. Also, ensure that these houses/rooms are of sound construction and capable of withstanding wind storms/cyclones. • Provide appropriate type of firefighting equipment suitable for the construction camps. • All construction material storage should be sitting at a visible location secured with fence or solid walls with locks to avoid theft and vandalism. • Display emergency contact numbers clearly and prominently at strategic places in camps. • Communicate the roles and responsibilities of laborers in case of emergency in the monthly meetings with contractors.
Site Restoration	Restoration of the construction camps to original condition requires demolition of construction camps.	The Contractor shall • Dismantle and remove all the established facilities from the site of the construction camp including the perimeter fence and lockable gates at the completion of the construction work. • Dismantle camps in phases and as the workload decreases instead of waiting for the

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
		entire work to be completed. • Provide prior notice to the laborers before demolishing their camps/units. • Maintain the noise levels within the national standards during demolition activities. • Different contractors should be hired to demolish different structures to promote recycling or reuse of demolished material. • Reuse the demolition debris to a maximum extent. Dispose remaining debris at the designated waste disposal site. • Restore the site to its condition prior to commencement of the works or to an agreed condition with the landowner.

ECP 17: Cultural and Religious Issues

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Construction activities near religious and cultural sites	Disturbance from construction works to the cultural and religious sites, and contractors lack of knowledge on cultural issues cause social disturbances.	The Contractor shall • Communicate to the public through community consultation regarding the scope and schedule of construction, as well as certain construction activities causing disruptions or access restriction. • Not block access to cultural and religious sites, wherever possible. • Restrict all construction activities within the foot prints of the construction sites. • Stop construction works that produce noise (particularly during prayer time) should there be any church/mosque/religious/educational institutions and health center close to the construction sites and users make objections. • Take special care and use appropriate equipment when working next to a cultural/religious center. • Stop work immediately and notify the site manager, if during construction, an archaeological or burial site is discovered. It is an offence to recommence work in the vicinity of the site until ‘approval to continue’ is obtained by the archaeological authority. • Provide independent prayer facilities to the construction workers. • Show appropriate behavior with all construction workers especially women and elderly people. • Allow the workers to participate in praying during construction time, if there is a request.

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
		• Resolve cultural issues in consultation with local leaders and supervision consultants. • Establish a mechanism that allows local people to raise grievances arising from the construction process. • Inform the local authorities responsible for health, religious and security duly informed before commencement of civil works so as to maintain effective surveillance over public health, social, and security matters.

ECP 128: Worker Health and Safety

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
Best practices	Construction works may pose health and safety risks to the construction workers and site visitors leading to severe injuries and deaths. The population in the proximity of the construction site and the construction workers will be exposed to a number of (i) biophysical health risk factors, (e.g., noise, dust, chemicals, construction material, solid waste, waste water, vector transmitted diseases, etc.), (ii) risk factors resulting from human behavior (e.g., STD, HIV/AIDS, etc.) and (iii) road accidents from construction traffic.	The Contractor shall • Prepare an Occupational Health and Safety plan and submit the plan for supervision consultant's approval. • Implement suitable safety standards for all workers and site visitors, with sufficient provisions to comply with international standards (e.g. International Labor Office guideline on 'Safety and Health in Construction; World Bank Group's 'Environmental Health and Safety Guidelines') and contractor's own safety standards, in addition to complying with national standards. • Provide the workers with a safe and healthy work environment, taking into account inherent risks in its particular construction activity and specific classes of hazards in the work areas. • Provide personal protective equipment (PPE) for workers, such as safety boots, helmets, masks, gloves, protective clothing, goggles, full-face eye shields, and ear protection. Maintain the PPE properly by cleaning dirty ones and replacing the damaged ones. • Safety procedures include provision of information, training and protective clothing to workers involved in hazardous operations and proper performance of their job. • Appoint an environment, health and safety manager to look after the health and safety of the workers. • Inform the local authorities responsible for health, religious and security duly informed before commencement of civil works and establishment of construction camps so as to maintain effective surveillance over public health, social and security matters.

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
	Child and pregnant labor	The Contractor shall • not hire children of less than 14 years of age and pregnant women or women who delivered a child within 8 preceding weeks.
Accidents	Lack of first aid facilities and health care facilities in the immediate vicinity will aggravate the health conditions of the victims	The Contractor shall • Ensure health care facilities and first aid facilities are readily available. Appropriately equipped first-aid stations should be easily accessible throughout the place of work. • Document and report occupational accidents, diseases, and incidents. • Prevent accidents, injury, and disease arising from, associated with, or occurring in the course of work by minimizing, so far as reasonably practicable, the causes of hazards, in a manner consistent with good international industry practice. • Identify potential hazards to workers, particularly those that may be life-threatening and provide necessary preventive and protective measures. • Provide awareness to the construction drivers to strictly follow the driving rules. • Provide adequate lighting in the construction area, inside the tunnels, inside the powerhouse cavern and along the roads.
Construction Camps	Lack of proper infrastructure facilities, such as housing, water supply and sanitation facilities will increase pressure on the local services and generate substandard living standards and health hazards.	The Contractor shall provide the following facilities in the campsites to improve health and hygienic conditions as mentioned in ECP 16**: Construction Camp Management**: • Adequate ventilation facilities • Safe and reliable water supply. • Hygienic sanitary facilities and sewerage system. • Treatment facilities for sewerage of toilet and domestic wastes • Storm water drainage facilities. • Recreational and social facilities • Safe storage facilities for petroleum and other chemicals in accordance with ECP 2 • Solid waste collection and disposal system in accordance with ECP1. • Arrangement for trainings • Paved internal roads. • Security fence at least 2 m height and security guards at entrances and every corner of the facility. • Sick bay and first aid facilities
Water and	Lack of Water sanitation	The contractor shall

Project Activity/ Impact Source	Environmental Impacts	Mitigation Measures/ Management Guidelines
sanitation facilities at the construction sites	facilities at construction sites cause inconvenience to the construction workers and affect their personal hygiene.	• Provide portable toilets at the construction sites with workforce size 25 people or more, work the whole day for a month. Location of portable facilities should be at least 6 m away from storm drain system and surface waters. These portable toilets should be cleaned once a day and all the sewerage should be pumped from the collection tank once a day and should be brought to the common septic tank for further treatment. • Provide safe drinking water facilities to the construction workers at all the construction sites.
Other ECPs	Potential risks on health and hygiene of construction workers and general public	The Contractor shall follow the following ECPs to reduce health risks to the construction workers and nearby community • ECP 2: **Fuels and Hazardous Goods Management** • ECP 4: **Drainage Management** • ECP 10: **Air Quality Management** • ECP 11: **Noise and Vibration Management** • ECP 15: **Road Transport and Road Traffic Management**
Trainings	Lack of awareness and basic knowledge in health care among the construction workforce, make them susceptible to potential diseases.	The Contractor shall • Train all construction workers in basic sanitation and health care issues (e.g., how to avoid malaria, transmission of sexually transmitted infections (STI), and HIV/AIDS. • Train all construction workers in general health and safety matters, and on the specific hazards of their work. Training should consist of basic hazard awareness, site specific hazards, safe work practices, and emergency procedures for fire, evacuation, and natural disaster, as appropriate. • Implement malaria, HIV/AIDS and STI education campaign targeting all workers hired, international and national, female and male, skilled, semi- and unskilled workforces, at the time of recruitment and thereafter pursued throughout the construction phase on ongoing and regular basis. This should be complemented by easy access to condoms at the workplace as well as to voluntary counseling and testing.

ECP 139: Construction and Operation Phase Security

Project Activity/ Impact Source	Impacts /Concerns	Mitigation Measures/ Management Guidelines
Construction Phase	Inadequate construction site security poses a significant risk to assets, construction materials and property. Theft/vandalism of assets, materials and property would increase construction costs and cause delays in project completion.	The Contractor shall: • Provide appropriate security personnel (i.e. security guards) to prevent unauthorized entry into the camp area. • Employ night watchman for periods of significant on-site storage or when the area necessitates. • Ensure all assets (i.e., tools, equipment, etc.) and construction materials at construction site are identified, inventoried and tracked as closely as possible. All assets should be clearly labeled and marked. Keep records of tool serial numbers and check inventory on a regular basis. • All tools and equipment should have a check out/in system, if not in use should be secured and stored in a proper place to prevent theft or loss. Provide storage sheds for the secure storage of equipment and tools when not in use. • Ensure there is proper fencing around construction site perimeter. Fencing should be chain-link at least 2.4 m high and secured with a steel chain and lock. If possible the entire site should be fenced; if this is not possible, make sure construction trailer and any equipment storage areas are fenced. • Ensure construction site has controlled access points (one or two entry points at most), allowing for close monitoring of comings and goings from the site. • Workers should be easily identified and have credentials that indicate site access. • No trespassing signs should be posted in conspicuous areas throughout the job site. • List of employees who have after hour access to the property should be available to the PMU and local authorities. • Ensure job site is properly lighted at night. Well-lit areas should include any office trailers and equipment storage trailers. Floodlights operated by sensors should also be installed where appropriate. • Pre-employment screening investigations should be used to verify the applicants relating to their employment, education and criminal history background.
	Improper security measures may pose security risk for construction workers and especially foreign staff on construction sites.	The Contractor shall: • Prepare site specific security plan. • Maintain register to keep track of number of persons present in the camp at any given time. • Provide appropriate security personnel at job sites as mentioned above. • Ensure proper fencing as mentioned above. • Ensure controlled access points to job site as

Project Activity/ Impact Source	**Impacts /Concerns**	**Mitigation Measures/ Management Guidelines**
		mentioned above. • Ensure works have easily identified credentials as mentioned above. • Ensure job sites are properly lighted at night, as mentioned above.
Operation Phase	Vandalism/damage (including use of explosives) of water transmission mains, transfer stationsPlant, Gas Pipelines, RMS, control stations and storage reservoirs. Theft of infrastructure (i.e. metals and etc.) is also of concern.	• Patrol Men and Pipeline Community Policing Forum shall routinely conduct patrols and inspections of transmission mains Plant area and facilities. • They shall monitor suspicious activity and notify local authorities and NWPGCL along with VH/GVH/TA's in event of any such occurrence/incident. • Ensure strategic infrastructure sites such as reservoirs RMS, Gas Pipelines, and main Plant transfer stations are secure and fenced with controlled access points. Fencing should be chain-link at least 2.4 m high and secured with a steel chain and lock.

Appendix-9: ALOHA Model Setup and Assumptions

Model Set up for simulating Toxic Area of Vapor Cloud Formation

SITE DATA:

Location: SIRAJGANJ, BANGLADESH

Building Air Exchanges Per Hour: 0.73 (unsheltered single storied)

Time: October 18, 2015 0934 hours ST (user specified)

CHEMICAL DATA:

Chemical Name: METHANE Molecular Weight: 16.04 g/mol

PAC-1: 2900 ppm PAC-2: 2900 ppm PAC-3: 17000 ppm

LEL: 50000 ppm UEL: 150000 ppm

Ambient Boiling Point: -161.5° C

Vapor Pressure at Ambient Temperature: greater than 1 atm

Ambient Saturation Concentration: 1,000,000 ppm or 100.0%

ATMOSPHERIC DATA: (MANUAL INPUT OF DATA)

Wind: 3.7 meters/second from NW at 10 meters

Ground Roughness: open country Cloud Cover: 5 tenths

Air Temperature: 32° C Stability Class: C

No Inversion Height Relative Humidity: 50%

SOURCE STRENGTH:

Flammable gas escaping from pipe (not burning)

Pipe Diameter: 14 inches Pipe Length: 75 meters

Unbroken end of the pipe is closed off

Pipe Roughness: smooth Hole Area: 132.7 sq in

Pipe Press: 350 psia Pipe Temperature: 20° C

Release Duration: 1 minute

Max Average Sustained Release Rate: 1.89 kilograms/sec

(averaged over a minute or more)

Total Amount Released: 113 kilograms

THREAT ZONE:

Model Run: Gaussian

Red : 45 meters --- (17000 ppm = PAC-3)

Note: Threat zone was not drawn because effects of near-field patchiness make dispersion predictions less reliable for short distances.

Orange: 110 meters --- (2900 ppm = PAC-2)

Yellow: 110 meters --- (2900 ppm = PAC-1).

Mode Setup for simulating Flammable Area of Vapor Cloud Explosion

SITE DATA:

Location: SIRAJGANJ, BANGLADESH

Building Air Exchanges Per Hour: 0.73 (unsheltered single storied)

Time: October 18, 2015 0934 hours ST (user specified)

CHEMICAL DATA:

Chemical Name: METHANE Molecular Weight: 16.04 g/mol

PAC-1: 2900 ppm PAC-2: 2900 ppm PAC-3: 17000 ppm

LEL: 50000 ppm UEL: 150000 ppm

Ambient Boiling Point: -161.5° C

Vapor Pressure at Ambient Temperature: greater than 1 atm

Ambient Saturation Concentration: 1,000,000 ppm or 100.0%

ATMOSPHERIC DATA: (MANUAL INPUT OF DATA)

Wind: 3.7 meters/second from NW at 10 meters

Ground Roughness: open country Cloud Cover: 5 tenths

Air Temperature: 32° C Stability Class: C

No Inversion Height Relative Humidity: 50%

SOURCE STRENGTH:

Flammable gas escaping from pipe (not burning)

Pipe Diameter: 14 inches Pipe Length: 75 meters

Unbroken end of the pipe is closed off

Pipe Roughness: smooth Hole Area: 132.7 sq in

Pipe Press: 350 psia Pipe Temperature: 20° C

Release Duration: 1 minute

Max Average Sustained Release Rate: 1.89 kilograms/sec
(averaged over a minute or more)

Total Amount Released: 113 kilograms

THREAT ZONE:

Threat Modeled: Flammable Area of Vapor Cloud

Model Run: Gaussian

Red : 48 meters --- (30000 ppm = 60% LEL = Flame Pockets)

Note: Threat zone was not drawn because effects of near-field patchiness
make dispersion predictions less reliable for short distances.

Yellow: 118 meters --- (5000 ppm = 10% LEL)

THREAT AT POINT:

Concentration Estimates at the point:

Downwind: 273 meters Off Centerline: 8.02 meters

Max Concentration:

Outdoor: 832 ppm

Indoor: 10 ppm

Mode Setup for simulating Thermal Radiation from Jet Fire

SITE DATA:

Location: SIRAJGANJ, BANGLADESH

Building Air Exchanges Per Hour: 0.73 (unsheltered single storied)

Time: October 18, 2015 0934 hours ST (user specified)

CHEMICAL DATA:

Chemical Name: METHANE Molecular Weight: 16.04 g/mol

PAC-1: 2900 ppm PAC-2: 2900 ppm PAC-3: 17000 ppm

LEL: 50000 ppm UEL: 150000 ppm

Ambient Boiling Point: -161.5° C

Vapor Pressure at Ambient Temperature: greater than 1 atm

Ambient Saturation Concentration: 1,000,000 ppm or 100.0%

ATMOSPHERIC DATA: (MANUAL INPUT OF DATA)

Wind: 3.7 meters/second from NW at 10 meters

Ground Roughness: open country Cloud Cover: 5 tenths

Air Temperature: 32° C Stability Class: C

No Inversion Height Relative Humidity: 50%

SOURCE STRENGTH:

Flammable gas is burning as it escapes from pipe

Pipe Diameter: 14 inches Pipe Length: 75 meters

Unbroken end of the pipe is closed off

Pipe Roughness: smooth Hole Area: 132.7 sq in

Pipe Press: 350 psia Pipe Temperature: 20° C

Flame Length: 26 meters Burn Duration: 20 seconds

Burn Rate: 339 kilograms/sec

Total Amount Burned: 113 kilograms

THREAT ZONE:

Threat Modeled: Thermal radiation from jet fire

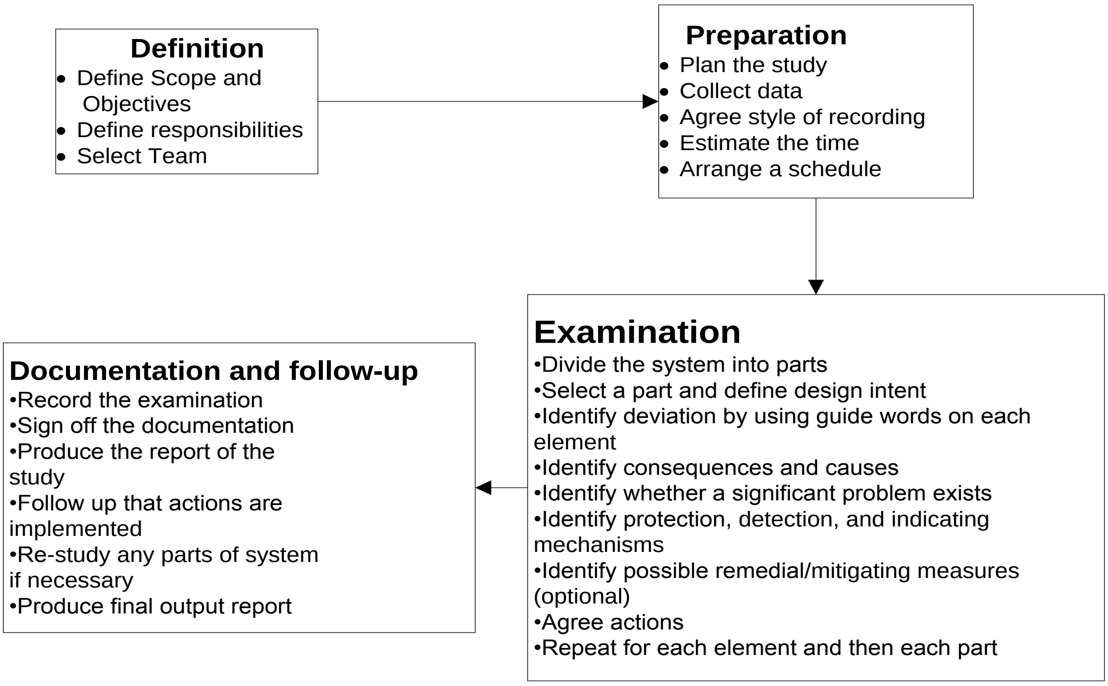
Red : 19 meters --- (10.0 kW/(sq m) = potentially lethal within 60 sec)

Orange: 32 meters --- (5.0 kW/(sq m) = 2nd degree burns within 60 sec)

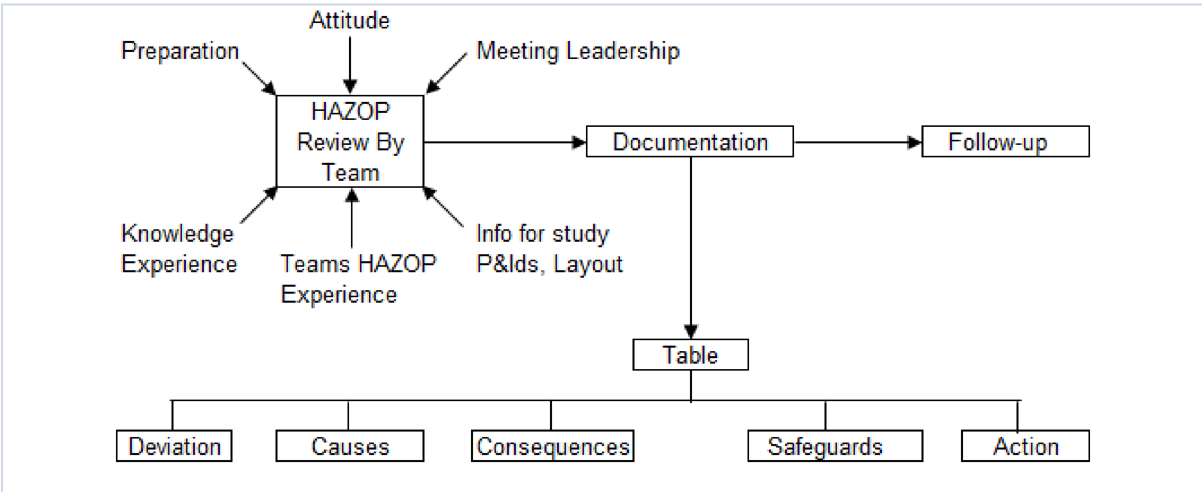
Yellow: 50 meters --- (2.0 kW/(sq m) = pain within 60 sec)

Appendix-10: An example of HAZOP Template

Four Phases of HAZOP



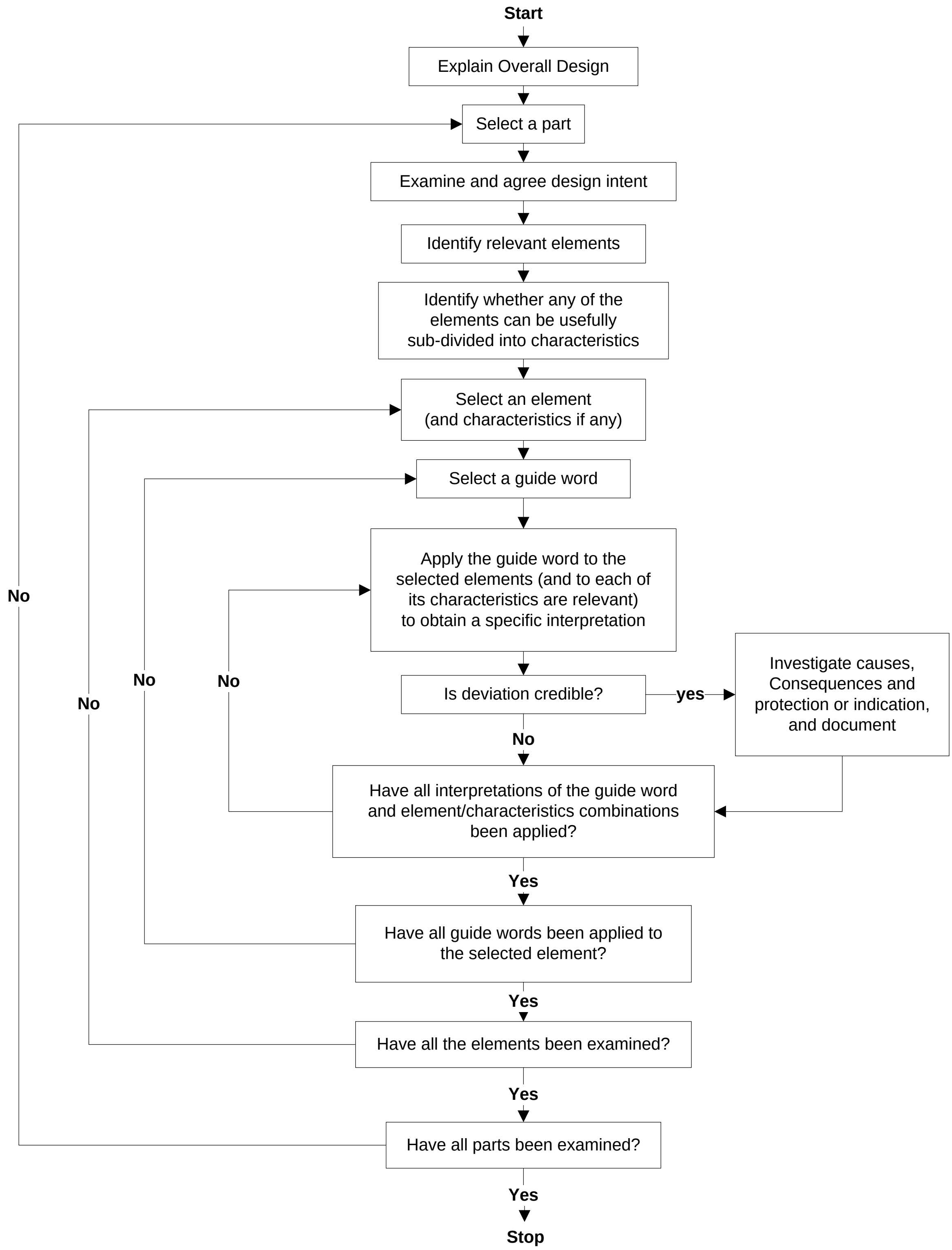
Overall Process in HAZOP Assessment



Common Guiding Word in HAZOP

NO or NOT	Negation of intention	No Flow of A
MORE	Quantitative increase	Flow of A greater than design flow
LESS	Quantitative decrease	Flow of A less than design flow
AS WELL AS	Quantitative increase	Transfer of some component additional to A
PART OF	Quantitative decrease	Failure to transfer all components of A
REVERSE	Logical opposite of intention	Flow of A in direction opposite to design direction
OTHER THAN	Complete substitution	Transfer of some material other than A

Process Flow in Examination Phase of HAZOP



HAZOP Assessment Template

NO	Guide Word	Element	Deviation	Possible Cause	Consequences	Safeguard	Comments	Action Required	Action Assigned to
Assign each entry a unique tracking number	Insert deviation guide word used	Describe what the guide word pertains to (material, process step, etc.)	Describe the deviation	Describe how the deviation may occur	Describe what may happen if the deviation occurs	List controls (preventive or reactive) that reduce deviation likelihood or severity	Capture key relevant rationale, assumptions, data, etc.	Identify any hazard mitigation or control actions required	Record who is responsible for actions
Examples from Plant Operator (Air Mixing) Deviation									
1	More	Plant Operator (Air Mixing)	Excess Air (more than 15%) in Gas combustion	Ignorance of the Operator	Increase of NOx	Operator check air mixing ratio to comply with the standard	Operator should comply the guideline of the air mixing ratio	Consider alarm for higher air mixing	Plant Operator
Example from Personnel Deviation from PPE use during working in high height									
1	No	Technician	No use of fall protector	No supply of fall protector	Technician falls from the height and gets injured	EHS specialist keeps records of all PPE	availability of fall protectors were less than demand	Re-estimate the PPEs requirements and supply In case of not availability of specific PPE restrict permit to work	EHS Manager

Appendix 11: Terms of reference of the Independent Monitor

A. Background

The North West Power Generation Company Limited (NWPGCL), an enterprise of the Ministry of Power Energy and Mineral Resources (MoPEMR) takes an initiative fordeveloping a Power Generation Hub in Saydabad of Sirajganj, on the right bank the Jamuna. Presently, a 225 MW Combined Cycle Power Plant (upgraded from 150 Peaking Power Plant) is under operation there and another 225 MW CCPP (2^{nd} Unit) is under construction. The NWPGCL now sets a plan of installing another 225 MW Dual Fuel Based (HSD & Gas) CCPP (3^{rd} Unit). For this third unit, a land of 7.5 acre area has been allocated within the existing complex besides the second unit (which is under construction).

The proposed plant will be consisting of 150 MW Gas Turbine and 75 MW Steam Turbine and HRSG. The Cooling system might be of close-circuit cooling tower. Water from the ground water aquifer will be used for plant operation, cooling and other purposes. The proposed plant is conceived to be a bidder's finance project. This project is in line with the Government's road map of providing electricity to all by 2020.

The ECR 1997 of MoEF and EHS guideline of IFC require detail environmental monitoring during pre-construction, construction and operation of the plant. The monitoring includes environmental compliance monitoring, impact monitoring and monitoring of environmental quality.

B. Objectives

A detailed EMP has been prepared as part of the present EIA study. As one of the key elements of the EMP, a three-tier monitoring program has been proposed comprising compliance monitoring, impact monitoring, and Independent monitoring. The main purpose of the monitoring program is to ensure that the various tasks detailed in the EMP particularly the mitigation measures are implemented in an effective manner, and also to evaluate project's impacts on the key environment and social parameters.

The main purpose of the Independent monitoring – the third tier of the monitoring program - will be to ensure that all the key entities including EHSU Circle, OE, and contractors are effectively and adequately fulfilling their designated role for EMP implementation, and that all the EMP requirements are being implemented in a timely and effective manner. The primary objective for engaging an independent monitor is to review the efficacy of EMP implementation as well as internal monitoring, and conduct periodic third party monitoring and provide feedback to NWPGCL and Financer on policy improvement and enhancement of implementation process. The Independent Monitoring Consultants (IMC) will review implementation process as per set procedures and tasks given in the EMP and assess the achievement of overall environmental management objectives.

The Independent Monitoring Consultant should have good experience in carrying out Environmental Monitoring including Environmental Compliance Monitoring of Power Plant. The Consulting Institute/Firm should have well equipped and certified laboratory for necessary analysis or should have arrangement with other laboratories which are certified by the relevant statutory body of the country.

C. Scope of Work

The scope of work of the IMC will include the following specific tasks:

- To develop specific monitoring indicators, checklists, and questionnaires to undertake external monitoring (a preliminary list of monitoring indicators has been given in the EMP) in consultation with NWPGCL and Financer.
- To review and verify the implementation progress of various EMP elements, particularly, mitigation plan, compliance and impact monitoring, environmental trainings, documentation, and grievance redress mechanism.
- To review and verify the functioning of the key entities – EHSU circle, OE, and contractors - for environmental management.
- Identify the strengths and weaknesses of the design of EMP and its implementation, and also the entities tasked to undertake various tasks detailed in the EMP.
- Evaluate and assess the institutional arrangements established for the environmental management of the project. Evaluate and assess the effectiveness and appropriateness of the key personnel of EHSU Circle, OE, and contractors tasked to implement various aspects of the EMP.
- Evaluate and assess the adequacy of the mitigation measures proposed in the Mitigation Plan in addressing the potentially negative impacts of the project activities and propose changes as appropriate.
- Review results of internal monitoring (compliance and impact monitoring) and verify its effectiveness through community consultations, spot checks, and field observations.
- Review the process and outcome of environmental trainings conducted by different project entities in line with the training program given in the EMP.
- Review the process and outcome of the documentation and reporting being carried out by various project entities in line with the EMP requirements.
- Identify, quantify, and qualify the types of EMP-related conflicts and grievances reported and resolved and the consultation and participation procedures.
- Provide a summary of whether EMP is being effectively implemented
- Describe any outstanding actions that are required to bring EMP implementation in line with the GoB and IFC requirements as stated in the EIA. Describe further mitigation measures and or corrective actions needed to ensure that the project remains environmentally and socially acceptable. Provide a timetable and define budget requirements for these supplementary mitigation measures / corrective actions.
- Describe any lessons learned that might be useful for environmental assessment and management of future projects.

D. Approach and Methodology

The general approach will include monitoring of EMP implementation activities and to identify any environmental impacts actually caused by the project. The IMC will conduct quarterly field visits for external monitoring. During the field visits, the IMC will carry out meetings with the key project entities including PMU, EHSU Circle, OE, and contractors; review reports and record of IMP implementation; conduct consultation meetings with key stakeholders particularly communities and local government officials; carry out field investigations including spot checks and visual observations, and identify need of any sampling and laboratory analysis.

The IMC will prepare checklists and questionnaires for the field investigations, comprising both qualitative and quantitative parameters. After each field visit, the IMC will prepare external monitoring report comprising field observations and findings, assessment of EMP implementation, key gaps identified, conclusions, and recommendations for addressing the gaps.

E. Responsibility of NWPGCL

The NWPGCL through it's PIU will ensure timely supply of background references, data and project options to the IMC. It will ensure uninterrupted access to work sites, relevant offices of the GOB and NWPGCL in particular. The IMC will participate in quarterly coordination meetings with the NWPGCL in presence of the OE.

Recommendation based on the result of the external monitoring will be provided to NWPGCL to cover up the deficiencies identified by the IMC. NWPGCL will accept the recommendations of the IMC if they are within the scope of work and there is nothing incorrect in the report.

F. Responsibility of Owner's Engineer

The OE will provide appropriate protocol at site or at its Project Office for the field visit of the IMC. It will on behalf of NWPGCL ensure free access to work sites, impact areas and the database on EMP implementation. The OE will ensure timely intimation of its works planning as and when made or updated during the construction period and keep the IMC informed.

G. Team Composition of the IMC

The tasks of the key members of the IMC are given below:

Position/expertise	Qualification and experience
1. Team Leader/ EMP Implementation Specialist	B.Sc. in environment engineering or environmental science, with M. Sc. in relevant field with 15 years (including development bank funded project) experience in planning, implementation and monitoring of environmental management for large infrastructure projects. Experience in institutional capacity analysis, preparation and implementation of EMPs, monitoring reports, and knowledge of latest environmental safeguard policies of the international financial institutions are required.
2. Environment Specialist(s)	B.Sc. in environment engineering or environmental science with 10 years working experience in environmental impact assessment including field surveys, stakeholder consultations, and analyzing environmental impacts to identify mitigation measures in compliance with environmental safeguard policies of the international financing institutions and national legislations. Experience of preparing and implementing EMP for externally financed projects is essential.
3. Ecology and Fisheries	Masters in biological sciences with 10 years working experience in

Position/expertise	Qualification and experience
Specialist	relevant fields. Thorough knowledge of ecological issues (natural vegetation, terrestrial as well as aquatic fauna, fish, and birds) and their implications for development projects; research and work experience relating to ecological issues; and knowledge of techniques for data collection and analysis.
4. Occupational Health and Safety Specialist	Masters in Occupational health and safety or relevant fields with 10 years of experience in IEE, EIA, EMP planning, environment monitoring, and occupational health and safety Issues.
5. Data Base Specialist	Graduate in relevant field with working experience and knowledge of software, those are commonly used in Bangladesh; demonstrated ability to design and implement automated MIS(s) for monitoring progress, comparing targets with achieved progress and the procedural steps.
6. Junior Environmental Monitoring Specialist (s)	B.Sc. in environment engineering or environmental science with minimum three (3) years of experience in Environmental monitoring, data collection and analysis, environmental analysis, or relevant environmental field.

H. Time Frame and Reporting

The IMC will be employed over a period of five years with intermittent inputs from the professional team to continue one year after completion of the Power Plant Commissioning.

Quarterly and annual monitoring reports should be submitted to the NWPGCL with copies to the Financer. An evaluation report at the end of the Project should be submitted to the NWPGCL and Financer with critical analysis of the achievement of the programs and the environmental performance of Sirajganj third Unit.

The IMC will provide monitoring and evaluation report covering the following aspects:

- Field observations, results of any field investigations and or laboratory analysis
- Assessment of whether the EMP is being implemented as planned and budgeted
- Assessment of the extent to which the specific EMP objectives and the expected outcomes/results have been achieved and the factors affecting their achievement or non achievement
- Major areas of improvement and key risk factors
- Major lessons learnt and
- Recommendations.

Formats for collection and presentation of monitoring data will be designed in consultation with NWPGCL.

E. Budget and Logistics

The budget should include all expenses such as staff salary, office accommodation, training, computer/software, transport, field expenses and other logistics necessary for field activities, data collection, processing and analysis for monitoring and evaluation work. Additional expense claims whatsoever outside the proposed and negotiated budget will not be entertained. VAT, Income Tax and other charges admissible will be deducted at source as per GOB laws.

Sl..	**Item**	**Unit**	**Qty**	**Rate, USD**	**Amount, USD**
Remuneration					
1	Team Leader/EMP Implementation Specialist	man-month	24	6,000	144,000
2	Environmental Specialist	man-month	36	4,000	144,000
3	Ecology and Fisheries Specialist	man-month	24	4,000	96,000
4	Occupational Health and Safety Specialist	man-month	24	4,000	96,000
5	Data Base Specialist	man-month	36	3,000	108,000
6	Junior Environmental Monitoring Specialist (s)	man-month	72	1,500	108,000
	Subtotal				*696,000*
Reimbursable Cost					
1	Vehicle Rental	Months	36	800	28,800
2	Vehicle Fuel	LS			5,000
3	Logistics	LS			10,000
4	Monitoring Costs (3 years of operation)				122,330
	Subtotal				*166,130*
	Contingency (10%)				*86,213*
	Total				**948,343**

Appendix 12: List of Participants of Public Consultation

অংশগ্রহণকারীদের তালিকা

সিরাজগঞ্জ ২২৫ মে.ও. কম্বাইন্ড সাইকেল বিদ্যুৎ প্রকল্প (ডুয়েল ফুয়েল-৩য় ইউনিট)

পরিবেশগত ও আর্থসামাজিক প্রভাব নিরুপণের জন্য মতবিনিময় সভা

স্থানঃ সম্মেলন কক্ষ, মানবমুক্তি সংস্থা

তারিখ: ১১ই আগষ্ট, ২০১৫, সময়: ১০:০০ ঘটিকা

ক্রঃ	নাম	স্বাক্ষর	ঠিকানা/প্রতিষ্ঠান	মোবাইল নাম্বার এবং ইমেইল
১.	[illegible]	[illegible]	[illegible]	01718024902
২.	মো: [illegible]	[illegible]	[illegible]	01712-994639
৩	মো: [illegible]	[illegible]	[illegible]	01736703602
৪	[illegible]	[illegible]	[illegible]	০১৭১২৯৩০১৮৫
৫.	[illegible]	[illegible]	[illegible]	০১৮৪৬৯৮৫৮১১
৬.	[illegible]	[illegible]	[illegible]	০১৯৪৭৫৩৫৮৩৫
৭.	[illegible]	[illegible]		
৮.	ইতি রানী ঘোষ	[illegible]	[illegible]	01748-976411
৯.	[illegible]	[illegible]	[illegible]	01742-168866
১০.	মো: [illegible]	[illegible]	[illegible]	01925608103
১১	[illegible]	[illegible]	[illegible]	01740906438
১২	" [illegible]	[illegible]	[illegible]	
১৩	" [illegible]	[illegible]	[illegible]	
১৪	" [illegible]	[illegible]	[illegible]	
১৫	" [illegible]	[illegible]	[illegible]	01719845399
১৬	" [illegible]	[illegible]		01725-5644 30
১৭	" [illegible]	[illegible]		01740561544
১৮	[illegible]	[illegible]	[illegible]	01725477929
১৯	মো: [illegible]		[illegible]	01745048075
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২১	[illegible]	[illegible]	[illegible]	০১৭২৮৩২৮৭০২
২২	[illegible]	[illegible]		
২৩	মো: [illegible]	[illegible]	[illegible]	017126960235
২৪	মো: [illegible]	[illegible]	[illegible]	01715391740
২৫	মো: [illegible]	[illegible]	[illegible]	01790453054

ক্র:	নাম	স্বাক্ষর	ঠিকানা/প্রতিষ্ঠান	মোবাইল নাম্বার এবং ইমেইল
২৬।	মো: আতিয়ার [illegible]	[illegible]	[illegible]	01788421545
২৭।	আ: [illegible]	[illegible]	বড় শিমুল	জানা নাই
২৮।	মো: হাকিম	[illegible]	ফুলবাড়ী	01919-484946
২৯।	মো: কাদের	[illegible]	পূর্বপাড়া	01753.137773
৩০।	মো: হাবিবুল মোল্লা,	[illegible]	পুন: বাসন (৩ নং)	01725-64899[illegible]
৩১।	মো: [illegible]	[illegible]	[illegible]	01722657384
৩২।	মো: মিজানুর রহমান	[illegible]	NWPGCL	01777736432
৩৩।	[illegible] কুমার [illegible]	[illegible]	NWPGCL	01755630003
৩৪।	[illegible]	[illegible]	MMS	01714-874142

Appendix 13: Compliant of the Comments of DoE

Comments-Responses Matrix

EIA Study of Sirajganj 225MW (3rd Unit) Dual Fuel based CCTP

Sl. No.	Comments	Responses	Remarks
1.	Need to include conclusion and recommendation	Included	Chapter 14; Page# 339-340
2.	Mention about the reduction in base flow and the extent of damage in ground water table	Mentioned	Chapter 7, Section 7.6.3-Groundwater Availability, paragraph # 446, Page # 209
3.	Mention that the treated water need to be monitored for ensuring the quality before releasing it for agricultural purpose	Mentioned	Chapter 14, Paragraph # 653, Page # 340